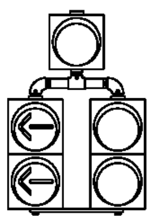
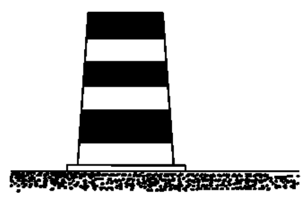
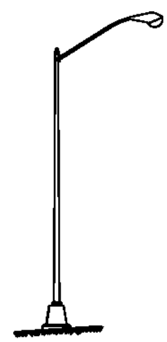
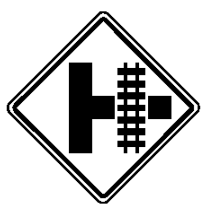
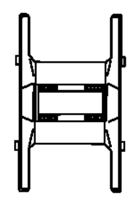
Traffic Engineering Manual











Office of Roadway Engineering
Ohio Department of Transportation

John Kasich
Governor
State of Ohio

Jerry Wray
Director, Ohio Department of Transportation

Office of Roadway Engineering

Traffic Engineering Manual (TEM)

January 19, 2018 Revision

As of January 19, 2018 this publication has been revised.

The revision involves updates of the Title Sheet, preface materials, and Parts 2, 3, 4, 6, 9, 11, 12 and 13.

The updated manual and the separate revision package, which includes a Revision Log, are available from the **ODOT Design Reference Resource Center**, or from the **Office of Roadway Engineering's website**.

Per ODOT policy, revisions will only be available via the web pages noted above.

For questions, comments, or concerns please contact:

Duane Soisson, P.E., Traffic Control Design Engineer
614-466-3649, or Duane.Soisson@dot.ohio.gov

or,

Scott Roeder, P.E., Traffic Standards Engineer
614-752-6109, or Scott.Roeder@dot.ohio.gov

Intentionally blank

Office of Roadway Engineering

Traffic Engineering Manual (TEM)
Revision Log

January 19, 2018 Revision (of the October 2002 Edition)

The following is a detailed list of the changes made in the Preface Materials and Parts 2, 3, 4, 6, 9, 11, 12, and 13 of the TEM as of January 19, 2018:

Revision Involves:			**Type ***	**Section Title & Revision Description**
Chapter / Section	**Page**	**New Page**		
* **Key for Revision Type: Change** - change in a standard, new information, revising text to provide clarification, updating references, or correcting a mistake in the text, more than simple editorial change; **Deletion** - deleting a section, form, table or figure; **Editorial** - correcting a simple typing or drawing mistake, simple editorial changes such as rephrasing a statement or making a format change.				
Preface Materials				
Title Sheet	i - ii	i - ii	Editorial	Updated to reflect the January 19, 2018 date for this revision.
Preface & Mission Statement	iii - iv	iii - iv		No change.
Pub. Record	v – xvii	v – xviii	Editorial	Updated per this revision.
Table of Contents	xvii – xlvi	xix – xlvi	Editorial	Updated per this revision.
Part 1, General				
Part 2, Signs				
	2-1 – 2-8	2-1 – 2-8		**Table of Contents.** Updated per this revision
201-14	2-17 – 2-18	2-17 – 2-18	Change	**Regulatory Signs, Traffic Law Photo Monitoring Signs (R10-18), Automated Traffic Enforcement and Surveillance Devices. (New title).** Expanded section to address conditions imposed on local authorities in ORC Section 4511.094. Revised last paragraph to also address automated enforcement and surveillance devices. Added sentence to last paragraph; provides examples of such devices.
202-2	2-19	2-19	Change	**Warning Signs, Warning Signs for Children (New title).** Included BLIND CHILD, as signing ODOT does not provide.
	2-20	2-20		Included as part of the Revision Set.
	2-95	2-95		Included as part of the Revision Set.
240-9	2-96	2-96	Change	**Design Information, Rectangular Rapid Flashing Beacon (RRFB) Sign Assembly.** Revised to reflect recent FHWA action rescinding Interim Approval IA-11.
240-10	2-97	2-97	Change	**Design, Solar-Powered Devices.** Removed “Rectangular Rapid Flashing Sign assemblies,” in first line.

Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	**Page**	**New Page**		
	2-98	2-98		Included as part of the Revision Set.
	2-101	2-101		Included as part of the Revision Set.
242-8	2-102 – 2-105	2-102	**Change**	**Plan Notes, Reserved – Existing Note Deleted (new Title).** Deleted the RRFB plan note.
	2-106	2-103 - 2-106		Text shifted.
Part 3, Markings				
301-4	3-7	3-7	**Change**	**Pavement & Curb Markings, Longitudinal Markings.** In table, added row for “Multilane Undivided Highways”. Deleted “ – Rural” from third row (is now “Multilane Divided Highway”).
	3-8	3-8		Included as part of the Revision Set.
Part 4, Highway Signals				
	4-1 – 4-8	4-1 – 4-8		Table of Contents. Updated per this Revision.
403-5	4-27	4-27	**Change**	**Traffic Control Signal Features and Operation, Traffic Law Photo Monitoring, Automated Traffic Enforcement and Surveillance Devices (New Title).** Revised first sentence of first paragraph to reflect updated bill information. Revised last paragraph to also address automated enforcement and surveillance devices. Added sentence to last paragraph; provides examples of such devices.
	4-28 – 4-32	4-28 – 4-32		Text shifted.
405-3	4-43	4-43	**Change**	**Flashing Beacons, Rectangular Rapid Flashing Beacon (RFFB).** Revised to reflect recent FHWA action rescinding Interim Approval IA-11.
	4-44	4-44		Included as part of the Revision Set.
	4-53	4-53		Included as part of the Revision Set.
420-5	4-54	4-54	**Change**	**Materials and Signal Hardware, Detector Loop Placement.** In **Subsection 420-5.2, Detection of Motorcycles and Bicycles**, added new item 2. re. Stop Bar Radar Detection and renumbered subsequent items. In item 1, changed “All loop configurataions…” to “Most loop configurations.” Added reference to TC-82.10 in last paragraph.
	4-61	4-61		Included as part of the Revision Set.
440-6	4-62	4-62	**Change**	**Design Information, Traffic Signal Timing Analysis.** In **Subsection 440-6.1, Traffic Signal Timing Software**, changed version number of Synchro program.
	4-67	4-67		Included as part of the Revision Set.
440-11	4-68	4-68	**Change**	**Design Information, Solar-Powered Electrical Devices.** Deleted first paragraph re. RRFBs.
442-4	4-73 – 4-74	4-73 – 4-74	**Change**	**Plan Notes, 632 Removal of Traffic Signal Installation.** Added text re. delivery of removed items to nearest ODOT facility.
	4-75	4-75		Text shifted.
442-13	4-76 – 4-77	4-76 – 4-77	**Change**	**Plan Notes, 632 Vehicular Signal Head, (LED), (By Type), As Per Plan (New title).** Removed “Black” and “With Backplate” from title. In last full paragraph, before Designer Note, removed “Black” and “With Backplate”.

Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	Page	New Page		
442-15	4-77	4-77	Change	**Plan Notes, Guaranteee.** Revised third paragraph re. what guarantee covers.
442-16	4-78	4-78	Change	**Plan Notes, 633 Alternate Bid Item.** Added "Example of a standard bid item:" before first line. Revised "(Example of a standard bid item)" to "Example of an alternate bid item:".
	4-79	4-79		Included as part of the Revision Set.
442-25	4-80 – 4-81	4-80 – 4-81	Change	**Plan Notes, 633 Preemption.** Minor editorial changes.
	4-82	4-82		Included as part of the Revision Set.
442-50	4-91	4-91	Change	**Plan Notes, General Electrical Requirements for Solar-Powered Devices.** In last paragraph (Designer Note), deleted "Rectangular Rapid Flashing Sign assemblies" in first line.
	4-92	4-92		Included as part of the Revision Set.
Part 5, Low-Volume Roads				
Part 6, Temporary Traffic Control				
	6-1 – 6-12	6-1 – 6-12		Table of Contents. Updated per this Revision.
600-1	6-13	6-13	Change	**General, Introlduction.** Split second paragraph into two paragraphs. The second of these paragraph's first sentence changed from "It does not address every conceivable condition." To "This Part does not address every conceivable temporary traffic control condition."
	6-14	6-14		Included as part of the Revision Set.
605-11	6-41	6-41	Change	**Temporary Traffic Control Zone Devices, Channelizing Devices.** In **Subsection 605-11.2, Placement**, added text to address barrier.
	6-42 – 6-45	6-42 – 6-45		Text shifted.
605-12	6-46	6-46	Change	**Temporary Traffic Control Zone Devices, Lighting Devices.** In **Subsection 605-12.3, Flashing Warning Beacons**, changed 6F.77 reference to 4L.03. In **Subsection 605-12.5, Warning Lights**, changed 6F.78 reference to 6F.83.
	6-47	6-47		Text shifted.
	6-48	6-48		Included as part of the Revision Set.
	6-85	6-85		Included as part of the Revision Set.
640-2	6-86	6-86	Change	**Design Information, Geometrics.** In next-to-last paragraph, deleted "(excluding Interstates and other freeways)" and "and a detour is not feasible" from the first sentence. In next-to-last sentence added distance info. for multi-lane highways ≥ 45 mph.
640-9	6-89 – 6-90	6-89 – 6-90	Change	**Design Information, Construction Access Points.** In first paragraph, second sentence, removed "divided" and changed "55" to "45". In item 5, deleted "undivided highways, on multi-lane divided" and change "55" to 45". In last paragraph deleted "divided" and changed "55" to "45".

Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	Page	New Page		
640-19	6-99	6-99	Change	**Design Information, Law Enforcement Officers (LEOs).** In **Subsection 640-19.1, LEOs for Assistance During Construction Operations**, deleted last sentence in last paragraph re. LEOs used to circulate through work area. In **Subsection 640-19.2, Reserved for Future Information** (New title), deleted text. Subsection was “LEO’s for Enforcement in Work Zones”.
	6-100	6-100		Included as part of the Revision Set.
	6-101 – 6-106	6-101 – 6-106		Text shifted.
	6-131	6-131		Included as part of the Revision Set.
641-30	6-132	6-132	Change	**Plan Preparation / Production, Work Zone Delineation (MT-99.30).** In first paragraph, first sentence, changed “freeway and expressway” to “”multi-lane highways ≥ 45 mph”.
	6-133	6-133		Included as part of the Revision Set.
641-33	6-134	6-134	Change	**Plan Preparation / Production, Construction Access Points (MT-103.10).** In first paragraph, second sentence, deleted “divided” and changed “55” to “45”.
642-18	6-141	6-141	Change	**Plan Notes, Reserved for Future Information.** Removed reference to Plan Note 642-56 since it is being deleted this revision.
	6-142	6-142		Included as part of the Revision Set.
	6-151	6-151		Included as part of the Revision Set.
642-36	6-152	6-152	Change	**Plan Notes, Multi-Plan, Time-of-Day Operation of Work Zone Signal.** Deleted asterisks in both tables. Added sentence to Designer Note re. “example purposes only”.
642-37	6-152	6-152	Change	**Plan Notes, Fully-Actuated Operation of Work Zone Traffic Signal.** Deleted asterisks in table and under table. Modified note under the table including elimination of reference to clearance times. Added sentence to Designer Note re. “example purposes only”.
	6-165	6-165		Included as part of the Revision Set.
642-55	6-166	6-166	Change	**Plan Notes, Item 614 – Law Enforcement Officer (With Patrol Car) for Assistance During Construction Operations.** In seventh paragraph (“The LEO shall….”), deleted fourth sentence (“Once the LEO has completed…”).
642-56	6-167	6-167	Change	**Plan Notes, Reserved – Existing Note Deleted (New title).** Deleted previous Plan Note (Item 614 – Law Enforcement Officer (With Patrol Car) for Enforcement in Work Zone.)
642-59	6-168	6-168	Change	**Plan Notes, Work Zone Egress Warning System.** Added sentence to Designer Note re. Approved List Supplement 1129.
	6-169	6-169		Text shifted.
	6-170	6-170		Included as part of the Revision Set.
697-3	6-209	6-209	Change	**Table 697-3, Initial Timing Chart.** Deleted asterisks in both tables.
	6-210	6-210		Included as part of the Revision Set.
Part 7, Zones and Studies				
Part 8, Rail Grade Crossings				
Part 9, Bicycles				

Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	Page	New Page		
	9-1 – 9-2	9-1 – 9-2		Table of Contents. Updated per this Revision.
	9-3	9-3		Included as part of the Revision Set.
901-1	9-4	9-4	Change	**Signing, General.** This is a new Section. (Contains the text previously found under 901.)
901-2	9-4	9-4	Change	**Signing, Bicycle 3-Foot Clearance Sign (R3-H16).** This is a new Section.
995-3	9-9	9-9	Deletion	**Reference Resources, Policy on Accomodating Bicycle and Pedestrian Travel on ODOT Owned or Maintained Facilities.** Deleted this section.
	9-10	9-10		Included as part of the Revision Set.
Part 10, Reserved for Future Use				
Part 11, Highway Lighting				
	11-1 – 11-8	11-1 – 11-8	Change	**Table of Contents.** Updated per this Revision.
	11-15	11-15		Included as part of the Revision Set.
1103-6	11-16	11-16 – 11-18	Change	**Warrants and Guidelines, Special Locations.** Remamed **Subsection 1103-6.9, Underpasses & Tunnels.** Added new **Subsections 1103-6.9.1, Underpasses**; **1103-6.9.2, Tunnels**; **1103-6.9.3, Warrant for Daytime Tunnel Lighting**; **1103-6.9.4, Need for Tunnel Fire Protection**, and **1103-6.9.5, Need for Tunnel Traffic Control and ITS Devices**.
1107-4	11-25	11-25 – 11-26	Change	**Guidelines for Reduction/Removal of Existing Lighting, User Objections.** Added new **Subsection, 1107-4.4, Agricultural Areas**.
1120-5	11-27	11-27	Change	**Materials and Hardware, Local Preferences.** Replaced first two paragraphs with a sentence referencing TEM Section 120-4. In first sentence of new second paragraph, added “steel” before “light poles.”
	11-28	11-28		Text shifted.
	11-33	11-33		Included as part of the Revision Set.
1140-3	11-34	11-34	Change	**Design Information, Lighting Theory.** In **Subsection 1140-3.1, General,** in fifth paragraph (“Roadway luminaires…”) added “lateral” to last sentence.
1140-4	11-47 – 11-48	11-47 – 11-50	Change	**Design Information, Luminaires and Sources.** In **Subsection 1140-4.6.8, Specific Cases, Tunnels,** added new first sentence to first paragraph. Added new **Subsection 1140-4.6.8.1, Tunnel Lighting Design Guidance** and **Subsection 1140-4.6.8.2, Tunnel Fire Protection Design Guidance**.
	11-49 – 11-56	11-51- 11-59		Text shifted.
1140-8	11-57	11-60	Change	**Design Information, Suggested Procedure for Light Tower Foundations.** Added new, next-to-last paragraph re. Broms method of design
	11-58 – 11-59	11-61 – 11-62		Included as part of the Revision Set.
1141-3	11-60	11-63	Change	**Plan Preparation / Production, Plan Composition**. In **Subsection 1141-3.6, Plan Sheets**, modified item 18 by deleting “Signal,” and “Sign & Luminaire” inside parentheses.

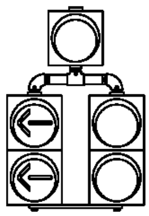
Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	Page	New Page		
	11-61 – 11-72	11-64 – 11-75		Text shifted.
1142-22	11-73	11-76	Change	**Plan Notes, 625 Lighting, Misc.: FAA Type L-864 Obstruction Lighting, LED.** In last paragraph (Designer Note) revised "632" to "625" in second line.
1142-23	11-74	11-77	Change	**Plan Notes, 625 Lighting, Misc.: Bridge Mounted Marine Navigation Lighting, LED.** In last paragraph (Designer Note) revised "632" to "625" in second line.
	11-75 – 11-90	11-78 - 11-93		Text shifted.
1160-3	11-91	11-94	Change	**Maintenance / Operations, Determination of Responsibility.** In **Subsection 1160-3.1, ODOT and Local Jurisdictions,** added new first sentence re. lighting responsibility to first paragraph.
	11-92 – 11-102	11-95 – 11-105		Text shifted. (The insertion of new Subsections added four more pages to this Part.)
1197-3	11-103	11-106	Change	**Table 1197-3, ODOT Warrants for Freeway and Interchange Lighting.** Added note beneath table re. volume criteria.
	11-104	11-107		Text shifted. (The insertion of new Subsections added four more pages to this Part.)
1197-5	11-105	11-108	Change	**Table 1197-5, Nominal Mounting Height and HPS Wattage (new title).** Added "HPS" to table title and header in second column. Added * to header in second column, with * text added below the table.
1197-6	11-105	11-108	Change	**Table 1197-6, Typical Bracker Arm Lengths (HPS) (new title).** Added HPS to table title.
	11-106 – 11-124	11-109- 11-128		Text shifted. (The insertion of new Subsections added four more pages to this Part.)
Part 12, Zones and Traffic Engineering Studies				
1203-2	12-7	12-7	Change	**Speed Zones, Procedures for Requesting and Authorizing Speed Zones.** In **Subsection 1203-2.2, ODOT-Maintained Highways – General Procedure**, second paragraph, first sentence, changed "…District shall" to "…District should".
	12-8	12-8		Included as part of the Revision Set.
Part 13, ITS				
	13-1 – 13-2	13-1 – 13-2	Change	**Table of Contents.** Updated per this Revision.
	13-15	13-15		Included as part of the Revision Set.
1303-4	13-16	13-16	Change	**Freeway Management Systems on ODOT-:Maintained Hwys., Communication.** Added item 10. re. conduit installed within 6 feet of guardrail.
1303-5	13-17	13-17	Change	**Freeway Management Systems on ODOT-:Maintained Hwys., Dynamic Message Signs (DMSs).** In the first item 2., changed OTO to SCD's. In first paragraph after item 5., changed Table 1397-5 to 1397-5a or 1397-5b.
	13-18	13-18		Text shifted.
1342-3	13-25	13-25	Change	**Plan Notes, Dynamic Message Sign Installations.** Revised Designer Note sentence; changed 1397-5 to 1397-5a or 1397-5b.

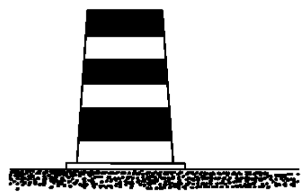
Revision Involves:			Type *	Section Title & Revision Description
Chapter / Section	Page	New Page		
1342-7	13-26	13-26	Change	**Plan Notes, Items 625E25740 and 625E25750: Conduit…**Under "Materials", added sentence re. multi-cell duct to end of second paragraph. After "Installed under Roadway" section, added "Installed within 6 feet of guardrail" section.
	13-27	13-27		Text shifted.
1342-12	13-28	13-28	Change	**Plan Notes, Utilities.** This is a new section.
	13-41	13-41		Included as part of the Revision Set.
1397-5a	13-42	13-42	Change	**Table 1397-5a, Full-Size Walk-In Dynamic Message Sign (DMS) Installations.** Previous Table 1397-5 has been split into two tables, 1397-5a and 1397-5b.
1397-5b	--	13-43	Change	**Table 1397-5b, Front Access Dynamic Message Sign (DMS) Installations.** Previous Table 1397-5 has been split into two tables, 1397-5a and 1397-5b.
	13-43 – 13-45	13-44 – 13-46		Text shifted.
1397-9	13-46	13-47	Change	**Table 1397-9, Ramp Metering Installations.** In first row, last column, changed PIS 207610 to ITS-76.10.
	13-47	13-48		Text shifted.
Part 14, Miscellaneous				
Part 15, Appendix				

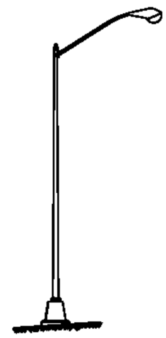
Intentionally blank

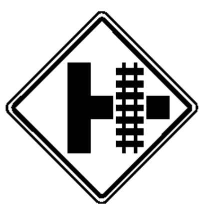
Intentionally blank

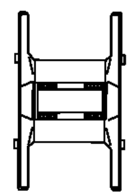
Traffic Engineering Manual











October 23, 2002 Edition

(Includes revisions through January 19, 2018.)

Ohio Department of Transportation
Office of Roadway Engineering

Revisions of this Manual are published on a quarterly basis, as needed. They are published only on-line, at the Office of Roadway Engineering (ORE) and DRRC websites noted below.

Ohio Department of Transportation
Office of Roadway Engineering
1980 W. Broad St., P.O. Box 899
Columbus, OH 43216-0899

Web addresses:
ODOT: http://www.dot.state.oh.us

Office of Roadway Engineering (ORE):
http://www.dot.state.oh.us/divisions/Engineering/Roadway

Office of Traffic Operations (OTO):
http://www.dot.state.oh.us/divisions/Operations/traffic/

ODOT Publications (Design Reference Resource Center (DRRC)):
http://www.dot.state.oh.us/drrc

Traffic Engineering Manual (TEM) website:
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/TEM/Pages/default.aspx

PREFACE

The **Traffic Engineering Manual (TEM)** has been developed to assure uniformity in application of **ODOT** traffic engineering policies, guidelines, standards and practices. The **OMUTCD** establishes the basic, minimum traffic control standards for any street, highway, bikeway or private road open to public travel in **Ohio**, and all supplemental **ODOT** traffic engineering design, construction and operations related information is either contained in the **TEM** or referenced from it.

This Manual contains standards, policies, etc. established for use in **ODOT** work; however, various situations will present themselves where engineering knowledge, experience and judgment will have to be used to determine how to apply the information included herein to specific situations. Comments, questions and proposed revisions should be submitted to the **ODOT Office of Roadway Engineering, Design Standards Section,** at the address noted on page ii. Email and telephone contact information is also available on the **Contacts for Traffic Standards Publication web page.**

Ohio Department of Transportation
MISSION STATEMENT

To provide easy conveyance of people and goods from place to place, we will:

- **Take care of what we have**
- **Make our system work better**
- **Improve safety**
- **Enhance capacity**

.

PUBLICATION RECORD

2002 October 23, 2002 Edition, effective December 2, 2002

New edition, updating and consolidating information previously published in the ODOT Traffic Control Application Standards Manual, the Traffic Control Design Information Manual, the Construction Guidelines for Traffic Control Devices and various separate policies, guidelines and procedures.

2003 January 17, 2003 – Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet**, **Publication Record**, and **Table of Contents**;
- **in Part 1**, a revised Table 197-1;
- **in Part 2**, a revised Section 208-3, and editorial changes in Section 205-2.3.1;
- **in Part 3**, a revised Table of Content, revised Sections 304-2, 342-2, 342-3, 342-4, 342-5 and 343, and editorial changes in Sections 301-1, 301-3, 302-1, 304-1, 304-3, 304-6, 306, 307, 320-4, 320-5, 340-1, 340-2, 340-3 and 350-2;
- **in Part 4**, a revised Table of Content, revised Sections 442-3, 442-5, 442-9, 442-10, 442-11, 442-15, 442-16 and 442-19, deleted Sections 442-14, 442-17 and 442-18, and editorial changes in Sections 401-1, 403-1, 404-1, 420-1, 421-1, 441-9, 442-4, 442-6, 442-7, 442-8, 442-12, 442-13, 443, 450-3.2 thru 450-3.6, 450-4.1, 450-4.3, 450-4.4, 450-6.2, 450-6.3, 450-8.2, 450-8.5, 450-8.7, 450-8.8, 450-9, 450-10.2 thru 450-10.7 and 450-11.1 thru 450-11.8;
- **in Part 6**, a revised Table of Content, a new Section 605-8.4, revised Sections 605-6.5, 607-40, 607-41, 640-14, 640-24.1, 641-8.4, 641-10.5, 642-3, 642-9, 642-16, 642-17, 642-19, 642-20, 642-21, 642-24, 642-25, 642-26, 642-27, 642-28, 642-30, 642-31, 642-32, 642-35, 642-39, 642-41, 670-7 and Figure 698-3a, and editorial changes in Sections 605-2.1, 605-7.3, 605-11.3, 605-11.4.1, 605-11.5, 605-11.10.2, 606-2, 606-12, 606-14, 606-15, 607-1, 620-3, 620-6.1, 620-6.2, 620-6.3, 640-1, 640-8, 640-11.3, 640-11.6, 640-11.7, 640-18.2, 640-21, 640-22, 641-2.6, 641-5.1 thru 641-5.4, 641-5.6, 641-6.1 thru 641-6.5, 641-7.2, 641-8.5, 641-9.6, 641-9.7, 641-10.4, 641-10.8, 641-11, 641-12, 641-13, 641-14, 641-15, 641-16, 641-17, 641-19, 642-2, 642-4, 642-5, 642-6, 642-9, 642-10, 642-12, 642-18, 642-22, 642-29, 642-33, 642-34, 642-36, 642-37, 642-38 and 642-40;
- **in Part 11**, a revised Table of Content, revised Sections 1141-3.1, 1142-2 thru 1142-19, 1142-21 thru 1142-23, 1142-26, 1142-31, 1142-32 and 1142-34, and editorial changes in Sections 1142-20, 1142-24, 1142-25, 1142-27 thru 1142-30, 1142-33, 1142-35 and 1143;
- **in Part 12**, a revised Table of Content and revised Section 1215; and
- **in Part 14**, the Index was revised.

2003 April 18, 2003 – Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- new **Cover Sheet**, **Publication Record** and **Table of Contents**;
- **in Part 2**, revised Section 201-8 and Table 297-9;
- **in Part 3**, revised Sections 302-3 and 343; and editorial corrections in Section 302-2 and Table 397-1;
- **in Part 4**, new Sections 442-17, 442-18 and 442-19; a revised Table of Contents and revised Sections 442-1 thru 442-16 and Figures 498-3 and 498-5;
- **in Part 6**, a revised Table of Contents, and revised Sections 602-5.3, 605-10.2, 642-1 thru 642-32 and Table 697-9; and editorial changes in Sections 605-11.4.1, 640-12.2, 640-20, 640-23.3.4, 640-23.5, 641-7.4, 641-15, 642-9, 642-36;
- **in Part 11**, new Sections 1150-1 thru 1150-21 and 1160-11 thru 1160-14; a revised Table of Contents; and editorial changes in Section 1100-1, 1140-4.3.5, 1140-5.6.2, 1140-5.7.2, 1140-7.3, 1141-4.2.3, 1142-16, 1142-17 and 1142-18; and
- **in Part 12**, revised Section 1202-1.

2003 October 17, 2003 – Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents,** and an updated **Publication Record**;
- **in Part 1**, a revised Table of Contents, and revised Sections 100-2, 100-5, 101-1, 101-2, 101-3.2, 101-3.3, 101-3.4, 101-4, 101-5, 102-2, 102-3.2, 102-3.4, 102-3.5, 102-5, 103-3.1, 103-3.3, 103-3.8, 103-4, 103-5, 104-1, 104.2, 105-1, 106-2, 106-3, 130-2.1, 130-2.3, 140-2.6, 194-9, 197 and 198, and Form 196-3, Tables 197-1, 197-2, 197-3, 197-9 and 197-10, and Figures 198-1a, 198-1b, 198-1c and 198-2; deleted Section 106-4 and Figure 198-1d; editorial changes in Sections 100-1.4 and 103-3.4; and general editorial/formatting changes;
- **in Part 3**, a new Section 301-14; revised and renumbered Sections 301-12.4 and 301-12.5 (now Sections 301-12 and 301-13, respectively); a revised Table of Contents, and revised Sections 301-1, 301-4 through 301-11, 302-1, 303-1, 303-2, 304-1, 304-3, 304-5, 304-6, 305, 306 and 310, and Figures 398-1, and 398-3 through 398-5; deleted Sections 301-12.1 through 301-12.3; editorial changes in Sections 301-2 and 320-1; and general editorial/ formatting changes;
- **in Part 4**, new Sections 401-6 through 401-8, 402-3.5, 403-7, 408-2, 440-5 and 440-6, and Forms 496-8 through 496-18; a revised Table of Contents, and revised Sections 400-1, 401-1, 401-3, 401-4, 402-1, 402-3.1 through 402-3.4, 403-1 through 403-3, 403-5, 403-6.1, 404-1 through 404-3, 405-1, 406-1 through 406-3, 407-2, 408-1, 420-4.1 through 420-4.4, 420-4.7, 420-4.8, 421-1, 441-3, 450-10.4, 450-10.6, 496 and 497, and Table 497-3; and general editorial/reformatting changes;
- **in Part 5**, revised Sections 500 and 595;
- **in Part 7**, a revised Table of Contents, and revised Sections 700, 701, 702-1 through 702-5, 702-7 and 704; and general editorial/reformatting changes;
- **in Part 8**, a revised Table of Contents, and revised Sections 800, 801-1, 801-2.2, 802-1, 802-2, 803, and 804; and general editorial/reformatting changes;
- **in Part 9**, a revised Table of Contents and revised Section 900; and general editorial/ reformatting changes;
- **in Part 10**, revised Sections 1000 and 1095; and
- **in Part 11**, a revised Table of Contents, and Sections 1100-1, 1103-6.8, 1140-4.6.2, 1142-14, 1142-15, 1142-25, 1160-6 and 1160-8; and an editorial change in Section 1160-13.

2004 **January 16, 2004 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents,** and an updated **Publication Record**;
- **in Part 2**, a revised Table of Contents, and revised Sections 200-1, 201-1 through 201-3, 201-5, 201-7, 201-8, 201-10 through 201-13, 202-1, 202-4 through 202-7, 203-1, 203-2, 204-1 through 204-4, 205-1, 205-2.1, 205-2.3.3, 205-3, 206-1, 206-3 through 206-15, 207, 207-1, 207-2.1, 207-3.1, 207-4, 207-5, 207-6.1, 207-6.3, 207-6.4, 207-7, 208-1, 208-2, 208-3, 208-4, 208-6, 209-1, 209-2.2, 209-2.3, 209-3, 209-4, 209-5, 210-2, 211-1, 212-1, 220-7, 240-2.3, 240-3, 250-3.1, 295-2, 297 and 298, and Tables 297-1 and 297-4, and Figures 298-1, 298-2, 298-4a, 298-4b, 298-5a through 298-5d, 298-6a, 298-6b, 298-7, 298-22 and 298-24; deleted Sections 201-6, 206-2 and 295-3, and Figure 298-6c; and general editorial/formatting changes;
- **in Part 3**, editorial corrections in Section 398;
- **in Part 6**, new Sections 605-5.12 through 605-5.15, 606-19, 606-20, 640-26, 642-42 through 642-45, 670-6.1 through 670-6.3; a revised Table of Contents, and revised Sections 601-1, 602-4.1, 602-4.4.4, 602-5.1 through 602-5.6, 602-5.8, 602-6, 602-7, 603, 604, 605-1 through 605-3, 605-4.2, 605-4.3, 605-5.1 through 605-5.11, 605-6, 605-7, 605-8, 605-9605-10.1, 605-10.2, 605-11.1 through 605-11.9, 605-11.10.1, 605-11.11 through 605-11.13, 605-12, 605-13, 605-14.1, 605-14.2, 605-14.5, 605-15.1, 605-15.2.2, 605-15.2.3, 605-16 through 605-20, 606-1 through 606-18, 607-1 through 607-15, 620-3, 620-6.1, 640-4, 640-5.3, 640-12.1, 640-12.4, 640-18.2, 640-20, 640-22, 641-5.2, 641-5.3, 641-6.3, 641-6.5, 641-7.3, 641-8.3, 641-9.3, 641-9.6, 641-10.3, 641-10.4, 641-11 through 641-13, 641-15, 641-17, 641-19, 642-24, 642-27, 642-31 through 642-34, 660-2, 670-6 through 670-8, 695-2, 697, 698, and Tables 697-5 through 697-9, and Figures 698-1 through 698-4; deleted Sections 605-6.1 through 605-6.5, 605-9.1 through 605-9.3, 605-10.3, 605-11.14, 607-16 through 607-44, 670-9, 670-10, and Tables 697-10 through 697-14, and Figures 698-5 through 698-49; editorial corrections in Sections 620-2.2, 642-5, 642-30; and general editorial/formatting changes.
- **in Part 11**, revised Section 1141-3.1;
- **in Part 12**, a revised Table of Contents, and revised Sections 1210, 1211, 1212-1, 1212-2.2, 1212-2.3, 1213-1, 1213-2, 1213-3, 1214, 1215, 1220-3, 1220-5.1, 1230-2.1 and 1230-6.13; and editorial corrections in Sections 1220-5.7 and 1230-6.9.
- **in Part 13**, a revised Table of Contents, and revised Sections 1301-2, 1301-3, 1305, 1312 and 1399, and general editorial/formatting changes.

2004 **April 16, 2004 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents,** and an updated **Publication Record**;
- **in Part 1**, a new Section 140-7; and revised Tables 197-1 and 197-10;
- **in Part 2**, a new Section 240-8; a revised Table of Contents and Sections 240-1 and 295-2;
- **in Part 3**, a new Section 350-3; a revised Table of Contents, revised Sections 301-1, 301-2, 301-14, 302-2 thru 302-4, 304-4, 320-1, 320-5, 340-2 thru 340-4, 342-2, 343 and 397, and revised Table 397-1; deleted Sections 342-3 thru 342-5; and a minor editorial correction in Section 301-10;
- **in Part 4**, a new Section 440-7; a revised Table of Contents and Section 440-1;
- **in Part 6**, new Sections 630-5, 641-23 and 642-46, and Figures 698-5 through 698-9; a revised Table of Contents, revised Sections 606-16, 606-17, 607-10, 607-12, 607-13, 607-15, 630-1, 640-12.1, 640-12.4, 640-23.3.1 and 698; and editorial corrections/changes in Sections 640-2, 642-44 and 642-45

2004 **July 16, 2004 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents,** and an updated **Publication Record**;
- **in Part 1**, a revised Table of Contents and Sections 10-1.3, 100-5, 101-3.3, 101-4, 101-5, 102-3.1, 102-3.2, 102-3.3, 102-5, 103-4, 103-5, 104-3, 140-2.3, 140-2.4, 140-7, 150-1, 160, 193-10.2, 194-14 and 198, and Figures 198-1a and 198-2; deleted Figures 198-1b and 198-1c; and editorial corrections/changes in Sections 100-1.1, 100-1.4, 100-6, 101-2, 101-3.2, 101-3.4, 102-1, 102-2, 102-3.6, 103-1, 140-2.2, 140-2.5, 140-2.6, 193-10.1, 193-11, 193-12, 194-3, 194-6, 194-9, 194-10, 194-11 and 194-17.
- **in Part 2**, five renamed sections: existing Sections 205-2, 205-3, 205-3.1, 205-3.2 and 209-1.1 are now 205-3, 205-4, 205-4.1, 205-4.2 and 211-3, respectively; new Sections 202-8, 205-2, 205-5, 206-16, 207-8, 209-6, 209-7 and 211-2, and Figures 298-28 thru 298-36; a revised Table of Contents, and Sections 200-1, 201-1, 201-4, 201-5, 201-7, 201-8, 202-4 thru 202-7, 203-1, 203-2, 204-1 thru 204-4, 205-1, 205-2.1, 205-2.2, 205-2.3.2, 205-2.3.3, 206-1, 206-3, 206-4, 206-5.1, 206-5.2, 206-5.5, 206-6, 206-7.2, 206-7.3, 206-8, 206-14, 206-15, 207-1, 207-2.1 thru 207-2.3, 207-3.1, 207-5.2, 207-5.3, 207-6.2, 207-6.3, 207-7, 208-1 thru 208-4, 208-6, 209-1, 209-2.1, 209-2.2, 209-3, 209-4.1, 209-4.2, 209-5, 210-2, 211-1, 211-2, 212-1 thru 212-3, 220-4 thru 220-7, 220-8.2, 220-8.3, 220-8.5, 221-1, 240-2.1, 240-2.2, 240-3, 240-4.3, 240-4.5, 240-4.7 thru 240-4.9, 240-5.3, 240-5.6, 240-5.7, 240-6.3, 240-6.4, 240-7.1 thru 240-7.3, 240-8, 241-1, 241-3, 241-7, 242-1 thru 242-4, 250-2, 250-3.1, 250-4.3, 250-5.3, 250-5.7, 250-8.1, 260-1, 260-4.2, 260-4.3, 260-6.1 and 298, and Tables 297-1 and 297-6, and Figures 298-5a thru 298-5d and 298-22; and editorial corrections/changes in Sections 200-3, 201-2, 201-3, 201-10 thru 201-13, 202-1, 205-2.4, 206-7.1, 206-7.4, 207-2, 207-4.2, 207-4.4, 207-5.1, 207-6.1, 207-6.4, 209-2.3, 209-2.5, 209-2.6, 220-8.4, 221-5, 240-7.5 thru 240-7.7, 241-2, 241-6, 242-5, 250-3.2, 250-3.3, 250-4.1, 250-4.2, 250-4.6, 250-5.2 and 250-6.2, and Tables 297-2, 297-4, 297-9, 297-11.
- **in Part 3**, four renamed sections: existing Sections 340-2, 340-3, 340-4 and 340-5 are now 341-2, 341-3, 341-4 and 341-5, respectively; new Sections 340-2, 341, 341-1, 350-4, 360-1, 360-2 and 360-3; a revised Table of Contents and revised Sections 301-14.1, 302-1, 340-1, 350-3 and 360; and a minor editorial corrections/changes in Sections 300-1 and 301-14.4;
- **in Part 4**, new Sections 442-20, 442-21, 442-22 and 442-23; a revised Table of Contents and Sections 401-6 and 440-7, and Form 496-13; and editorial corrections/changes in Sections 442-1, 442-3, 442-4, 442-5, 442-6, 442-7, 442-8, 442-9, 442-10, 442-11, 442-12, 442-13, 442-14, 442-15, 442-16 and 442-19;
- **in Part 6**, new Sections 630-6 and 640-27, and Form 696-1; a revised Table of Contents, revised Sections 605-4.3, 605-5.3, 605-5.12 thru 605-5.15, 605-11.3, 630-4, 630-5, 640-12.2, 642-24, 642-27, 642-33, 696 and 698, and Figures 698-3a, 698-3b and 698-4; and editorial corrections/changes in Sections 607-10, 607-13, 607-15, 640-18.2, 642-14, 642-15, 642-42 and 642-46.

- **in Part 11**, new Sections 1141-3.7 thru 1141-3.9; a revised Table of Contents and Sections 1140-6.1.1.4, 1140-6.1.2.2, 1141-2, 1141-3.1 thru 1141-3.6 and 1141-4; and an editorial corrections in Section 1142-35.
- **in Part 14**, a revised listing.

2004 **October 22, 2004 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents,** and an updated **Publication Record**;
- **in Part 1**, a revised Table of Contents and Section 103-3.2; and editorial corrections/changes in Sections 100-3.3 and 140-7;
- **in Part 4**, editorial corrections/changes in Sections 442-20, 442-21 and 442-23; and
- **in Part 6**, new Section 642-47; a revised Table of Contents, revised Sections 605-11.3, 640-18.2, 641-5.1, 641-6.1, 642-9, 642-19 and 642-24.

2005 **January 21, 2005 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised **Preface** and an updated **Cover Sheet, Revision Record** and **Table of Contents,**;
- **in Part 1**, new Sections 194-21 and 194-22; a revised Table of Contents and Sections 100-3, 100-4, 101-3.3, 102-1, 102-3.4, 103-3.1, 103-3.2, 103-3.4, 103-3.7, 103-5, 105-1, 105-3, 120-1 thru 120-3, 140-7, 193-3, 193-10.1, 193-14, 193-15, 194-1, 194-2, 194-13, 194-15, 194-16 and 194-19, Tables 197-2, 197-8 and 197-9, and Figure 198-1; editorial corrections or changes in Sections 101-2, 101-4, 101-5, 102-2, 102-3.2, 102-3.5, 102-3.6, 102-4, 103-4, 104-1 thru 104-3, 106-1, 106-3, 130-2.3, 130-3, 130-4, 130-6, 140-1, 140-2.4, 140-2.6, 140-2.7, 140-5, 150-1, 150-2, 160, 193-5, 193-10.2, 193-12, 193-20, 194-5, 194-9 thru 194-11, 195-1, 196, 197and 198, Forms 196-1 thru 196-4, Tables 197-3 thru 197-6, 197-7 and 197-10; and minor format changes.
- **in Part 2,** new Sections 205-6 and 210-3; revised Table of Contents and Sections 205-4, 209-4 and 240-8, and Table 297-7;
- **in Part 4**, new Forms 496-19 and 496-20, and Table 497-6; a revised Table of Contents, revised Sections 403-5, 403-6, 403-6.1, 403-6.4, 403-7, 440-3, 440-5 thru 440-7, 441-2, 441-3, 441-8, 441-11, 496 and 497, and revised Forms 496-3 and 496-4; editorial corrections in Form 496-6; and deleted Section 403-6.5; and
- **in Part 6**, a revised Table of Contents, revised Sections 605-4.3, 605-10.1, 642-21, 642-28, 642-30 thru 642-32 and 642-44; and editorial corrections or changes in Sections 642-33, 642-34, 642-36, 642-37, 642-40 thru 642-43, 642-45 and 642-47, and Tables 697-3 thru 697-5 .

2005 **April 15, 2005 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and **Table of Contents**, and an updated **Publication Record**;
- **in Part 1**, revised Tables 197-2 and 197-3;
- **in Part 3**, a revised Table of Contents, revised Sections 301-1, 301-7, 301-14.4, 302-2, 302-6, 307-2, 310, 320-1, 320-4, 341-1, 342-2 and 343, and Table 397-2; and minor editorial/format changes;
- **in Part 4,** a revised Table of Contents, Sections 401-6, 401-7, 404-2, 442-20, 442-21, 442-22 and 442-23, Form 496-2, and Table 497-5; deleted Forms 496-12 through 496-18; editorial revisions in Forms 496-8 through 496-11, and 496-19, Table 497-6, and Figure 498-37; and minor editorial/format changes;
- **in Part 6**, a revised Table of Contents, revised Sections 630-4, 630-5, 640-23.4, 640-23.5, 641-9.6, 641-23, 642-46 and Form 696-1; and minor editorial/format changes;
- **in Part 11**, a revised Section 1142-30;
- **in Part 12**, a revised Section 1220-5.6; and
- **in Part 13,** added copies of ODOT Policies 16-004(P), 22-007(P), 25-005(P), 122-002(P), 322-002(P), 512-002(P), and Standard Procedures 122-004(SP) and 510-005(SP); revised Sections 1301-2, 1310, 1312, 1314 and 1399; and minor editorial/format changes.

2006 **January 20, 2006 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Preface, Publication Record** and **Table of Contents**;
- **in Part 1**, a new Section 193-11; deleted Section 193-14; three renumbered Sections (Sections 193-11 thru 193-13 are now Sections 193-12 thru 193-14); a revised Table of Contents, Sections 101-2, 101-3.2 thru 101-3.4, 101-4, 101-5, 102-2, 102-3.4 thru 102-3.6, 102-4, 103-3, 103-3.4 thru 103-3.6, 103-4, 103-5, 104-4, 106-1 thru 106-3, 120-1, 120-2, 130-2.2, 130-2.3, 140-2.3, 140-2.4, 193-4 thru 193-7, 193-9, 193-15 thru 193-18, 194-1 thru 194-3, 194-6 thru 194-8, 194-19, Chapter 197, Forms 196-1 thru 196-4, Tables 197-1 thru 197-3 and197-5 thru 197-10, and Figures 198-1 and 198-2; and editorial revisions in Sections 100-1.2, 100-1.4, 100-4 thru 100-6, 101-3.1, 102,3.1 thru 102-3.3, 102-5, 103-3.2, 104-2, 105-1, 120-3, 130-1, 130-2.1, 130-5, 140-1, 140-2.6, 140-2.7, 140-3, 140-4, 140-5, 140-7, 193-1, 193-2, 193-10, 194-4, 194-21 and 195-1, and Chapters 160 and 180;
- **in Part 5**, revised Chapters 500 and 595;
- **in Part 7**, revised Chapter 704, Sections 702-5, 702-6, 705-1, 705-2 and 705-4; and editorial revisions to the Table of Contents, Chapters 795 and 796, and Forms 796-4 and 796-5;
- **in Part 8**, revised Chapters 803, 805 and 840, Sections 801-2.2, 801-2.3, 802-1, 802-2, 880-2, 895-1, 895-2, 895-3, and 895-4; and editorial revisions to Chapters 850 and 860, Sections 830-1 880-1;
- **in Part 9**, a new Section 995-4; revised Table of Contents, Chapters 900, 930, 940 and 950, and Sections 995-1 and 995-2; and
- **in Part 10**, revised Chapters 1000 and 1095

2006 **April 21, 2006 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 2**, a new Figure 298-37; deleted Figure 298-5d; a revised Table of Contents, Chapter 243, Sections 200-1, 201-1 thru 201-4, 201-8, 201-10 thru 201-13, 202-5, 202-7, 202-8, 203-2, 204-1, 204-2, 205-2, 205-4 thru 205-6, 206-1, 206-3, 206-4, 206-5.2, 206-6, 206-7.2, 206-8, 206-10 thru 206-12, 206-14, 206-15, 207-1, 207-4.4, 207-5.1, 207-6.1, 207-6.3, 207-6.4, 207-7, 208-1, 208-2, 208-4 thru 208-6, 209-1, 209-4.1, 209-5 thru 209-7, 211-1 thru 211-4, 212-1, 212-3, 220-4, 220-5, 221-2, 221-4, 240-2.2, 240-3, 240-4.1, 240-4.2, 240-4.6, 240-4.8, 240-4.9, 240-5.3 thru 240-5.5, 240-6.2, 240-7.2, 240-7.3, 240-7.6, 240-7.7, 241-5, 242-4, 250-2, 250-2, 250-3.1 thru 250-3.4, 250-4.2 thru 250-4.6, 250-5.2 thru 250-5.8, 250-6.2, 250-6.4, 250-6.5, 250-7.1, 250-7.2, 250-7.4 thru 250-7.6, 250-8.1, 250-8.2, 260-4.2, 260-4.3, 260-5, 260-6.1, 260-6.2, 295-1 thru 295-4, Figure Index, Figures 298-4a and 298-5a thru 298-5c; and editorial revisions in Chapter 230, Sections 200-2, 201-5, 201-9, 202-1, 202-4, 202-6, 203-1, 204-4, 205-1, 206-2, 206-5.1, 206-7.1, 207-2.2, 207-2.3, 207-3.1, 207-3.2, 207-3.3, 207-5.2, 207-5.3, 209-2.5, 209-4.2, 210-1, 210-3, 220-1, 220-7, 220-9, 221-1, 221-3, 221-5, 240-1, 240-2.1, 240-4.3, 240-4.5, 240-4.7, 240-5.7, 240-6.3, 240-7.4, 240-7.5, 240-8, 241-1, 241-6, 241-7, 242-1, 250-4.1, 250-5.1, 250-6.1, 250-6.3, 260-1, 260-4.1 and Figure 298-22; and minor editorial/format changes;
- **in Part 3**, new Sections 304-7, 341-6, 342-3 thru 342-5, and 350-5 thru 350-8; deleted Section 360-3; a revised Table of Contents, a revised title for Chapter 303, revised Chapters 310 and 343, Sections 300-1, 300-3, 301-1 thru 301-4, 301-6 thru 301-12, 301-14.1, 301-14.2, 301-14.4, 301-14.5, 302-1, 302-5, 303-1, 303-3, 304-2, 304-6, 307-2, 320-1, 320-4, 341-2, 341-5, 342-2, 360-1 and 360-2, Form 396-1, Figures Index, and Figures 398-2 thru 398-5; and editorial revisions to the Tables Index, Sections 300-2, 301-13, 303-4, 304-3, 340-1, 340-2, 341-1, 341-4, 342-1, 350-3 and 350-4, Chapters 330, 370 and 380, and Table 397-1; and minor editorial/format changes; and
- **in Part 4**, new Sections 442-24 thru 442-29, revised Table of Contents, Chapter 443, Sections 400-1, 401-2, 401-3, 401-6, 403-2, 403-7, 404-2, 404-3, 406-2, 407-2.2 thru 407-2.4, 420-4.2, 420-4.8, 440-6, 441-7, 441-8, 442-3, 442-13, 442-17 thru 442-19, 450-1, 450-3.2 thru 450-3.5, 450-6.2, 450-6.3, 450-8.4, 450-8.5, 450-10.2 thru 450-10.7, 450-11.2, 450-11.5 thru 45011.8, 460-3.4, 495-1, Forms Index, Table 497-5, Figures Index, and Figures 498-7, 498-23 and 498-27; and editorial revisions to Chapters 430, 470 and 480, Sections 400-2, 400-3, 401-4, 402-1, 402-2, 402-3.1 thru 402-3.3, 402-4, 403-1, 403-3, 403-5, 403-6.1, 403-6.2, 404-1, 406-1, 407-1, 408-1, 408-2, 420-2, 420-4.1, 420-4.4, 420-4.5, 420-5, 440-1 thru 440-3, 440-5, 440-7, 441-1, 441-2, 441-5, 441-10, 441-11, 442-1, 450-5, 450-6.1, 450-8.1, 450-10.1, 460-5, 460-7, 460-8, 460-9.2, 460-9.3, and Forms 496-2, 496-6 and 496-7; and minor editorial/format changes.

2006 **July 21, 2006 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 4**, new Section 450-12; a revised Table of Contents and Section 420-4.6;
- **in Part 6**, new Sections 600-6, 606-21, 606-22, 642-48 thru 642-52, and Table 697-10; deleted Section 605-14.5; a revised Table of Contents, Sections 601-2, 602-3, 602-5.1, 602-5.3, 602-5.6, 602-5.7, 603-2, 603-3, 604-2, 604-3, 604-6, 605-1, 605-2.1 thru 605-2.3, 605-4.3, 605-5.1, 605-5.2, 605-5.5 thru 605-5.7, 605-5.9 thru 605-5.15, 605-6, 605-7.2, 605-7.3, 605-8.4, 605-9, 605-10.1, 605-10.2, 605-11.1 thru 605-11.13, 605-12.1 thru 605-12.5, 605-13.1, 605-14.1, 605-14.2, 605-14.4, 605-15.1, 605-16 thru 605-18, 605-20, 606-1, 606-3, 606-6 thru 606-9, 606-11 thru 606-20, 607-1, 607-6, 607-10, 607-13, 607-15, 620-3, 620-5, 630-5, 640-2, 640-5.2, 640-9, 640-12.1, 640-13.2, 640-18.1, 640-18.2, 640-22, 640-24.1, 640-24.2, 640-25, 640-26, 641-5.4, 641-5.6, 641-6.4, 641-8.4, 641-9.6, 641-10.6, 641-11 thru 641-14, 641-18, 641-23, 642-4, 642-6, 642-17, 642-21, 642-24, 642-25, 642-27, 642-39, 642-44, 642-46, 670-5 and Tables Index; and editorial revisions in Chapter 643, Sections 600-1 thru 600-5, 602-1, 602-5.8, 602-6, 602-7.1, 602-7.3, 602-8, 603-1, 604-1, 604-4, 605-3.1, 605-4.1, 605-4.2, 605-5.8, 605-7.1, 605-8.1, 605-8.3, 605-13.2, 605-15.2, 605-19, 606-2, 606-5, 606-10, 607-4, 607-7, 607-11, 607-12, 620-1, 630-1, 630-3, 630-4, 640-1, 640-3, 640-4, 640-5.1, 640-6, 640-7.1, 640-8, 640-11.3, 640-11.5, 640-13.1, 640-14, 640-16, 640-17, 640-19 thru 640-21, 640-23.1, 640-23.3, 640-23.4, 641-1, 641-2.1, 641-2.3, 641-2.5, 641-2.7, 641-2.8, 641-3, 641-4, 641-5.1 thru 641-5.3, 641-6.1 thru 641-6.3, 641-6.5, 641-7.1, 641-7.3, 641-8.1, 641-8.3, 641-9.3, 641-10.1, 641-10.3, 641-10.7, 641-15 thru 641-17, 641-19, 642-1, 642-10, 642-30, 642-43, 642-47, 650-1, 660-1, 660-2, 670-1, 670-2, 670-6.2, 695-1, 695-2, 695-5, 695-6 and Table 697-1d; and minor editorial/format changes;
- **in Part 11**, deleted Section 1142-32; a revised Table of Contents, Chapter 1150, Sections 1104-3, 1130-5, 1140-4.2, 1140-4.4, 1140-4.6, 1140-5.7, 1140-5.9, 1140-7.3, 1141-3.6, 1142-14, 1142-15, 1142-24, 1160-2, 1160-3.1 and Figures Index; editorial revisions in Chapter 1195, Sections 1100-1, 1100-2, 1100-3, 1103-6.6, 1103-6.8, 1104-1, 1104-2, 1105-1 thru 1105-3, 1106-2.2, 1107-3, 1120-3, 1130-2, 1130-3.1, 1130-4, 1140-1, 1140-3.2, 1140-3.3, 1140-3.5, 1140-4.3, 1140-4.7, 1140-5.3 thru 1140-5.6, 1140-5.8, 1140-6.1, 1140-6.2, 1140-8, 1141-1, 1141-2, 1141-3.1 thru 1141-3.3, 1141-4.1 thru 1141-4.5, 1142-8, 1142-13, 1142-25, 1142-28, 1142-31, 1142-35, 1160-1, 1160-4, 1160-13.5, the Tables Index, Tables 1197-4 thru Table 1197-7 and Figure 1198-4; and minor editorial/format changes.

2006 **September 5, 2006 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**; and
- **in Part 6**, deleted Table 697-6; a revised Table of Contents, Sections 605-8.4, 605-12.2, 605-15.2, 606-10, 606-16, 607-10, 630-5, 640-5.1, 640-9, 641-5, 641-6.2, 641-6.4, 641-11, 641-18, 641-19, 642-10, 642-42, Tables Index, and Figures 698-6 and 698-8; and editorial revisions in Sections 601-2, 630-4, 630-6, and Table 697-10; and minor editorial/format changes.

2006 **October 20, 2006 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 3**, revised Form 396-1;
- **in Part 4**, revised Section 420-4.2;
- **in Part 6**, a revised Table of Contents and Sections 642-26, 642-50 and 642-51;
- **in Part 8**, revised Chapter 805; and
- **in Part 12**, new Sections 1215-1 thru 1215-5 and 1230-7, Form 1296-13, Table 1297-5 and Figures 1298-17 thru 1298-40; a revised Table of Contents, Chapters 1210 and 1211, Sections 1201-1 thru 1201-5, 1202-1, 1212-2, 1212-3, 1213-1, 1213-2, 1220-2, 1220-6, 1230-1 thru 1230-3, 1230-6, 1250-2, Forms Index, 1296-1, 1296-2, 1296-11, 1296-12, Tables Index,

Figures Index and Figures 1298-2, 1298-6, 1298-7, 1298-10, 1298-11, 1298-12, 1298-15, 1298-16; and editorial revisions in Chapters 1200, 1214, 1280 and 1295, Sections 1212-1, 1212-4, 1213-3, 1220-1, 1220-3 thru 1220-5, 1250-1; and minor editorial/format changes.

2007 **January 19, 2007 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, revised Figure 198-1;
- **in Part 2**, new Sections 202-9, 202-10, 204-5, 204-6, 220-10 and 221-6, Tables 297-12 and 297-13, and Figures 298-38 through 298-44; a revised Table of Contents, Sections 201-1, 201-3, 202-7, 203-1, 205-3, 208-1 and 221-5, Tables Index, Figures Index, Figure 298-6, 298-14, 298-15 and 298-27; editorial corrections in Sections 200-1, 201-5, 201-7, 204-4, 207-5, 207-6, 240-4, 250-4, 250-7 and 260-5, Table 297-4, and Figures 298-26 and 298-28 through 298-32; and minor editorial/format changes;
- **in Part 4**, new Sections 442-30, 442-31 and 442-32, and Figures 498-39, 498-40, 498-41 and 498-42; a revised Table of Contents and Figures Index; editorial corrections in Sections 407-2 and 450-10, and Figure 498-1; and minor editorial/format changes;
- **in Part 6**, a new section 620-7; a revised Table of Contents and Sections 605-1, 605-2, 605-11, 620-2, 620-4, 640-18, 642-24, 642-27, 642-33 and 642-34; editorial corrections in Sections 605-4, 605-5, 620-1, 641-17 and 641-19; and minor editorial/format changes; and
- **in Part 7**, revised Chapter 704.

2007 **April 20, 2007 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 1**, revised Sections 103-3, 103-4, 104-2 and 104-3, Table Index, and Tables 197-1 through 197-3, and 197-5 through 197-10;
- **in Part 2**, a revised Table of Contents, Section 207-4, Figures 298-15 and 298-22; and editorial corrections in Figures 298-12, and 298-13 ;
- **in Part 4**, new Sections 402-5 and 402-6, and Tables 497-7 and 497-8; a revised Table of Contents, Forms Index, Forms 496-12 and 496-13, and Tables Index; editorial corrections in Sections 402-3, 404-2, 404-3 and 450-8, and Figures 498-6 through 498-8, 498-21, 498-26, and 498-28 through 498-35; and minor editorial/format changes;
- **in Part 6**, new Sections 641-24 and 642-53, a revised Table of Contents and Sections 602-2, 605-14, 607-12, 607-13, 640-1, 640-12, 641-23, 642-9, 642-21, 642-22, 642-30, 642-31, 642-44 and 642-48; editorial corrections in Sections 640-2, 641-6, 641-7, 641-19, 642-10, 642-11, 642-16 and 642-42; and minor editorial/format changes;
- **in Part 11**, revised Section 1140-5; and
- **in Part 12**, a revised Table of Contents and Section 1220-3.

2007 **July 20, 2007 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 1**, new Sections 120-7, 150-3, 195-3 through 195-7 and Figures 198-3 through 198-6; revised Table of Contents, Chapters 106, 160, 180 and 195, Sections 100-1, 100-4, 101-2, 101-5, 102-1 through 102-3, 120-1 through 120-6, 130-2, 140-7, 193-9 and 195-1, Forms 196-1 and 196-3, Tables 197-2, 197-3, 197-9 and 197-10, and Figures Index; editorial corrections in Sections 193-7, 193-10, 193-15 and 193-16; and minor editorial/format changes;
- **in Part 2**, a revised Table of Contents and Sections 220-2, 220-3, 240-4, 260-4 and 295-2;
- **in Part 3,** revised Sections 320-2 and 320-3;
- **in Part 4**, new Sections 401-9 and 440-8; a revised Table of Contents and Sections 401-2, 404-3, 420-2, 420-3 and 420-4;
- **in Part 6**, new Chapter 608, Section 695-7, Forms 696-2 through 696-9, and Figure 698-10; a revised Table of Contents, Sections 600-4, 600-6, 601-2, 602-3, 602-5, 605-3, 605-14, 605-17, 605-19, 606-14, 606-20, 630-4, 630-5, 640-12 through 640-14, 640-18, 641-2, 641-24, 642-35, 642-51, 642-52, 695-6, Forms Index, Form 696-1 and Figures Index; editorial corrections in Sections 607-13, 620-7, 630-1, 630-6, 640-23, 640-26, 641-6 and Figure 698-1; and minor editorial/format changes;
- **in Part 8,** revised Chapter 805;
- **in Part 11**, a revised Table of Contents and Sections 1120-3 through 1120-5;
- **in Part 12**, new Chapters 1203, 1204 and 1205, a revised Table of Contents, Chapters 1200, 1201, 1202, 1210, 1211, 1212, 1213, 1220, 1250, 1280, Forms Index, Form 1296-1, Tables Index, Figures Index, and Figures 1298-1, 1298-3 through 1298-5, 1298-21 and 1298-24; deleted Chapters 1213 through 1215, and1230; editorial corrections in Form 1296-2 and Figures 1298-21 and 1298-24; and minor editorial/format changes;
- **in Part 13,** new title, Table of Contents and Chapters replaced existing text, which was relocated Part 15;
- **in Part 14**, new title, Table of Contents, Chapters 1400, 1401, 1402, 1415, 1420, 1430, 1450, 1480, 1495, Forms Index, and Form 1496-1; and deleted the index; and
- added **Part 15.**

2007 **October 19, 2007 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 1**, revised Table of Contents, Section 120-4, and Tables 197-1 and 197-2; an editorial correction in Sections 101-2; and minor editorial/format changes;
- **in Part 2**, revised Figures 298-10 and 298-29 through 298-32; editorial corrections in Section 240-4 and Figures 298-8, 298-9, 298-11 and 298-26; and minor editorial/format changes;
- **in Part 3**, an editorial correction in Table 397-1;

- **In Part 4,** a revised Table of Contents and Section 406-3; deletion of Section 402-6; and an editorial correction in Section 401-9;
- **in Part 6,** revised Table of Contents and Sections 641-12, 641-13, 641-14, 641-15, 642-30, 642-39 and 642-41;
- **in Part 11,** a revised Table of Contents; and editorial corrections to Chapters 1103 and 1120, and Section 1150-3;
- **in Part 13**, a revised Section 1301-3, Forms Index, and Form 1396-1.

2008 **January 18, 2008 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 4**, new Section 460-10 and Table 497-9; a revised Table of Contents, Sections 440-4, 442-13, 442-17, 442-24,and Tables Index; and minor editorial/format changes;
- **in Part 6**, new Form 696-6; renumbered Forms 696-1 through 696-9 (now Forms 696-1a, 696-1b, 696-2a, 696-2b, 696-3a, 696-3b, 696-4a, 696-4b and 696-5); a revised Table of Contents, Sections 605-2, 605-9, 605-13, 605-14, 605-18, 606-6, 606-16, 630-5, 640-2, 640-12, 640-19, 641-9, 641-10, 642-18, 642-39, 642-44 and 695-7, and Forms Index; editorial corrections in Sections 606-1, 640-11, 641-1, 641-12 through 641-15, and Figure 698-3a; and minor editorial/format changes; and
- **in Part 13**, revised Sections 1301-1 and 1301-2, Forms 1396-1 and 1396-2, and Table 1397-1.

2008 **April 18, 2008 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 1**, revised Tables 197-2 and 197-9; ;
- **in Part 2**, revised Table of Contents and Sections 240-4 through 240-6; and minor editorial/format changes;
- **in Part 3**, revised Table of Contents, Sections 342-3, 350-7 and 350-8; and minor editorial/format changes;
- **in Part 4**, new Section 401-10; a revised Table of Contents, Chapter 443, Sections 403-6, 403-7, 440-2, 440-6, 441-6, 441-9, 442-1, 442-3, 442-6, 442-11, 442-17 through 442-19, 442-24, 450-3, 450-8, 450-10, 450-11, 460-4, 460-7, 460-8, Forms Index, Forms 496-14, 496-15, 496-19, Tables 497-1, 497-4, and Figures 498-10, 498-22, 498-25, 498-34 and 498-37; editorial corrections in Section 442-32, the Figures Index and Figure 498-37;and minor editorial/format changes;
- **in Part 6**, new Section/Plan Note 642-54; a revised Table of Contents, Sections 605-9, 605-11, 605-13, 620-6, 640-2, 641-10, 642-39; and minor editorial/format changes; and;
- **in Part 7**, new Chapter 742 with new Sections 742-1 and 742-2; a revised Table of Contents, and Section 702-4; and minor editorial/format changes
- **in Part 11,** editorial correction in Section 1142-25; and minor editorial/format changes;
- **in Part 13**, deleted Form 1396-2; revised Table of Contents, Section 1301-1, Forms Index and Figures Index; and minor editorial/format changes.

2008 **July 18, 2008 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new **Cover Sheet** and an updated **Publication Record** and **Table of Contents**;
- **in Part 2**, new Section 206-17 and Table 297-14; a revised Table of Contents and Sections 201-6, 240-4, 260-5, the Table Index and Figure 298-18; and minor editorial/format changes;
- **in Part 3**, revised Table of Contents; deleted Sections 341-6, 342-4 and 342-5;
- **in Part 4**, new Section 440-9; a revised Table of Contents and Section 440-3;
- **in Part 6**, new Section 604-21, a revised Table of Contents, Sections 605-11, 605-18, 605-20, 607-15, 640-2, 642-24, 642-39, 642-41 and 642-50; and minor editorial/format changes;
- **in Part 7**, revised Table of Contents and Section 702-4; and minor editorial/format changes; and
- **in Part 12**, new Forms 1296-14 through 1296-16, and Table 1297-6; revised Table of Contents, Chapters 1201 and 1202, Sections 1203-1 through 1203-5, the Forms Index, Forms 1296-1, 1296-3, 1296-4, 1296-11, the Tables Index, the Figures Index, Figures 1298-3 through 1298-5; and minor editorial/format changes.

2008 **October 17, 2008 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2**, new Section 201-14; a revised Table of Contents and Section 210-3;
- **in Part 3**, new Table 397-5; revised Table of Contents, Section 350-2 and Tables 397-1, 397-3 and 397-4; deleted Figure 398-6; editorial changes in Sections 301-13, 302-2, 303-3, 307-2, 320-4, 350-6, 350-7, 350-8, the Tables Index and the Figures Index; and minor editorial changes;
- **in Part 4**, a revised Table of Contents, Chapter 430, and Sections 401-3, 442-26, 442-28, 460-2 and 460-2; editorial changes in Sections 401-10 and 403-3; and minor editorial changes;
- **in Part 6**, a revised Table of Contents, Sections 605-13, 605-20, 620-6, 640-18, 640-23, 641-23, 642-24, 642-25, 642-48 and 642-50; editorial changes in Sections 602-6, 605-2, 605-9, 605-10, 605-11, 605-19, 608-2, 620-3, 620-7, 641-9, 641-10, 641-24, 642-21, 642-27, 642-41, 642-54 and 670-6; and minor editorial/format changes;
- **in Part 7**, revised Table of Contents; and an editorial change in Section 702-2;
- **In Part 11**, revised Figure 1198-12;
- **In Part 12**, new Section 1213-6; revised Table of Contents, Chapter 1210, Section 1213-1 and Forms 1296-1 and 1296-14; editorial changes in Section 1212-10; and minor editorial/format changes; and
- **in Part 13**, new Figures 1398-2 and 1398-3; revised Table of Contents, Sections 1301-1, 1301-2, 1301-3, Form 1396-1 and Table 1397-3; and editorial changes in the Forms Index and the Figures.

2009 **January 16, 2009 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;

- **in Part 2**, a revised Table of Contents and Sections 201-3 and 240-5; and minor editorial/format changes;
- **in Part 3**, new Section 342-4; and a revised Table of Contents;
- **in Part 4**, new Sections 442-33 through 442-39; a revised Table of Contents, Sections 403-5, 440-3, 440-4 and 450-8, Tables Index, Tables 497-4 and 497-5, Figures Index and Figures 498-3 through 498-5, 498-12, 498-35 and 498-37; editorial change for Section 401-10; and minor editorial changes;
- **in Part 6**, new Section 641-19 and renumbered existing Sections 641-19 through 641-24, a revised Table of Contents, Sections 603-2, 605-5, 605-11, 605-13, 640-6, 640-22, 640-24, 640-25, 641-9, 641-10, new 641-21 (formerly 641-20), new 641-22 (formerly 641-21), 642-4, 642-6, 642-14, 642-15, 642-35, 642-38 and 642-39; editorial change in Section 642-41; and minor editorial/format changes; and
- **in Part 13**, new Section 1301-4 and Form 1396-2; deleted Figure 1398-1 and renumbered Figures 1398-2 and 1398-3; revised Table of Contents, Sections 1301-1 through 1301-3, Forms Index, Form 1396-1, Tables Index, Table 1397-1, and the Figures Index; editorial corrections in Table 1397-3; and minor editorial/format changes.

2009 **March 6, 2009 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents; and
- **in Part 2**, a revised Section 240-4.

2009 **April 17, 2009 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents; and
- **in Part 2**, new Tables 297-15, 297-16, 297-17 and 297-18; a revised Table of Contents, Sections 206-8, 206-13, 207-2, 207-3, 240-4, the Tables Index, and Figures 298-5a and 298-5b; editorial change in Section 207-4; and minor editorial/format changes;
- **in Part 3**, new Sections 301-15 and 341-6; and a revised Table of Contents and Sections 301-10, 302-1 and 341-4; and editorial changes in Chapters 350, 360, 370, 380, 395 and Table 397-2;
- **in Part 4**, a revised Table of Contents, Chapter 443, Sections 401-7, 403-2, 440-3, 440-6, 442-7, 442-8, 442-13, 442-17, 442-18, 442-25 and 442-32, and Figure 498-5; editorial changes for Sections 442-20 and 442-22; and minor editorial changes;
- **in Part 6**, new Section 604-5 and renumbered existing Sections 604-5 and 605-6, new Section 640-28, and new Section 641-19 and renumbered existing Sections 641-19 through 641-25, and new Figures 698-11 and 698-12; a revised Table of Contents, Sections 601-2, 605-2, 605-5, 605-11, 605-14, 605-19, 606-10, 620-4, 640-9, 640-11, 640-12, 640-19, 640-22, 640-23, 641-5, 641-6, 641-9, 641-10, 641-17, 641-18, new 641-20 through 641-22 (formerly 641-19 through 641-21), new 641-24 through 641-26 (formerly 641-23 through 641-25), 642-6, 642-14, 642-15, 642-18, 642-30, 642-31 642-36, 642-37, 642-44, 642-46, 642-50, 642-53, and 642-54, the Tables Index, and the Figures Index; editorial changes in Sections 641-8 and 642-24, and Form 696-1a; and minor editorial/format changes;
- **in Part 9**, new Sections 940-1 and 940-2, and a new Chapter 942, with new Sections 942-1 and 942-2; a revised Table of Contents and Chapter 940;
- **In Part 12**, a new Section 1213-7; a revised Table of Contents, Chapter 1210, Sections 1203-2, 1203-3, 1213-1, the Forms Index, Form 1296-2 and Form 1296-14; editorial changes in Sections 1203-1 and Form 1296-1; and minor editorial/format changes;
- **in Part 13**, a revised Table of Contents, Sections 1301-1, 1301-2, 1301-3 and 1301-4, and Form 1396-1; and minor editorial/format changes; and
- **in Part 15**, a revised Table of Contents, Chapter 1505, and Section 1501-3; and minor editorial/format changes.

2009 **July 17, 2009 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, new Section 195-8, a revised Table of Contents, Chapter 106, Sections 100-1, 100-4, 100-5, 101-4, 101-5, 102-1, 102-3 through 102-5, 103-1, 103-3 through 103-5, 104-1 through 104-4, 105-1, 120-3, 120-6, 130-2, 130-4 through 130-6, 140-7, 193-7, 193-11, 194-1, 194-17, 194-18, 195-3 through 195-6, Forms Index, Forms 196-1 and 196-3, Tables Index, Tables 197-1 through 197-3, Tables 197-9 and 197-10, and Figure 198-2; editorial changes in Section 140-2 and Figure 198-6; and minor editorial/format changes;
- **in Part 2**, new Sections 202-11 and 242-6; a revised Table of Contents, Sections 201-3, 201-6, 201-8, 201-11, and Section 295-2; editorial changes in Sections 202-6 and 206-11; and minor editorial/format changes;
- **in Part 3**, revised Chapter 343, Sections 302-5, 304-3, 320.1, 320-5, and Form 396-1; editorial changes in Sections 301-3, 301-7, 301-10, 301-14, 350-7 and Table 397-1; and minor editorial changes;
- **in Part 4**, new Section 403-8; a revised Table of Contents, Chapter 443; Sections 402-2, 402-3, 408-2, 420-1, 421-1, 421-2, 440-3, 440-8, 441-7, 442-27, 442-29, 450-1, 460-7, 460-9, and the Forms Index; editorial changes in Sections 440-4, 442-5, 442-22, 442-32 and 442-33; and minor editorial changes;
- **in Part 6**, a revised Table of Contents, Sections 600-4, 605-4, 605-11, 605-13, 605-14, 608-4, 608-11, 608-12, 620-3, 620-7, 640-9, 641-3, 641-4, 641-10, 642-50, 650-2, 650-3, 660-3, 670-3, 695-2, 695-4, 695-6, and 695-7; editorial changes in Sections 601-2, 604-5, 605-9, 605-10, 608-2, 608-4, 630-4, 630-5, 640-23, 640-26, 642-43, 642-44, and the Forms Index; and minor editorial/format changes;
- **in Part 13**, revised Sections 1301-3 and 1301-4, the Forms Index, and the Tables Index; editorial change in Section 1301-1; and minor editorial/format changes.

2009 **October 16, 2009 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, new Section 140-8, a revised Table of Contents; revised Sections 120-4 and 193-19, and Table 197-2; and minor editorial/format changes;

- **in Part 3**, a revised Section 342-2;
- **in Part 4**, a revised Table of Contents, Sections 420-5, 440-7, 450-10, 450-11, Forms 496-4 and 496-6, the Figures Index, and Figures 498-3 through 498-5, 498-23, 498-27, 498-29, 498-30 and 498-33; an editorial correction in Sections 420-4; and minor editorial changes;
- **in Part 11**, a revised Table of Contents; revised Sections 1140-4, 1142-24 and 1142-26, and Figure 1198-12; editorial corrections in Sections 1140-6, 1140-8, 1142-25; and minor editorial/format changes.

2010 **January 15, 2010 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, revised Section 101-5, Forms 196-3 and 196-4, and Table 197-2;
- **in Part 2,** new Sections 202-12, 202-13 and 260-7, a revised Table of Contents and Sections 201-8 and 240-2;
- **in Part 3**, new Section 301-16, and a revised Table of Contents, Section 301-14 and Table 397-2;
- **in Part 4,** a revised Table of Contents and Section 440-3; and minor editorial changes.

2010 **April 16, 2010 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, new Sections 130-7 and 140-9; a revised Table of Contents and Sections 140-8, 195-2, and Tables 197-2 and 197-9; and an editorial correction in Section 130-6;
- **in Part 4,** new Sections 403-9, 403-10, 442-40, 442-41 and 442-42; a revised Table of Contents and Sections 402-3, 403-3, 403-6 and 420-5; and minor editorial/format changes;
- **in Part 8**, new Sections 804-1 through 804-4, 830-3, 830-4, 840-1 through 840-4, 895-5, a new Forms Index and Form 896-1, and a new Figures Index and Figure 898-1; a revised Table of Contents, Chapters 804 and 840, Section 830-1; and minor editorial/format changes; and
- **in Part 10, a** revised Chapter 1000.

2010 **May 14, 2010 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 6**, new Section 660-4 and new Figures 698-13 and 698-14; a revised Table of Contents and Section 660-1, and a revised Figures Index; editorial corrections in Sections 601-2, 608-4, 608-6, 608-8, 630-4, 630-5, 640-1, 640-13, 640-14, and Figure 698-1; and minor editorial/format changes.

2010 **July 16, 2010 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents and Sections 202-4, 202-12, 202-13 and 205-3, Tables 297-1, 297-4, 297-12, 297-13 and 297-17, and Figures 298-20, 298-22 and 298-28; editorial corrections in the Figures Index and Figure 298-10; and minor editorial/format changes;
- **in Part 3,** a revised Table of Contents and Sections 301-1, 301-8 and 301-15; and an editorial correction in Section 301-16;
- **in Part 4**, a revised Table of Contents and Sections 440-3, 442-25, 442-26, 442-27, 442-28, 442-29, 442-31, 442-40, 442-41 and 450-8;
- **in Part 6**, a revised Table of Contents and Sections 605-6, 605-8, 642-41, 642-44 and 670-4, Table 697-1b, and Figure 698-3b;
- **in Part 7,** a revised Section 742-2; and
- **in Part 9,** new Chapters 901 and 902; a revised Table of Contents and Chapter 900, and Sections 940-1 and 940-2.

2010 **October 15, 2010 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents; ;
- **in Part 1,** a revised Table of Contents and Sections 140-7 and 195-8, and Table 197-9;
- **in Part 2,** a revised Table of Contents and Sections 209-2, 211-1 through 211-4 and 240-8; editorial corrections in Tables 297-16 and 297-17; and minor editorial/format changes;
- **in Part 3,** revised Chapter 343, Sections 302-1, 304-1, 304-3, 307-1, 320-5, 341-2, 350-3, 350-6 and 350-8; and minor editorial changes;
- **in Part 4**, a revised Figure 498-21;
- **in Part 6**, a revised Table of Contents and Sections 602-8, 605-11, 606-16, 607-10, 640-12, 641-9, 641-21, 641-25 and 695-4; an editorial correction in Section 640-18; and minor editorial changes; and
- **in Part 9,** a revised Table of Contents and Chapter 930 (replacing the existing text with new Sections 930-1 and 930-2).

2011 **January 21, 2011 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents and Sections 212-1 through 212-3, 240-4 , 240-7, 250-4, 250-5, 250-7 and 250-8; and minor editorial/format changes;
- **in Part 3,** revised Table of Contents and Section 301-9, the Figures Index, and Figure 398-1;
- **in Part 4**, a revised Table of Contents and Sections 403-6, 420-4, 440-2, 440-5, 440-7, 442-27, 442-29, Tables 497-1 and 497-6; and an editorial change in Figure 498-38;

- **in Part 6**, a revised Table of Contents and Sections 605-19, 605-20, 607-10, 642-50 and 642-51 and Figures 698-3a and 698-3b,
- **in Part 8**, a revised Section 804-4; and
- **in Part 11,** a revised Table of Contents and Chapter 1142, deleting fourteen Plan Notes, while renumbering and revising the others.

2011 **April 15, 2011 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1,** revised Forms 196-3, 196-4 and 197-9, and Figure 198-1;
- **in Part 2,** revised Sections 241-6;
- **in Part 4,** a revised Sections 440-5, 441-7, 441-10, 442-10, 460-2 and 460-3; editorial changes in Sections 440-3, 440-8, 441-3, 441-5, 441-6, 442-12 and 442-14; and other minor editorial/format changes;
- **in Part 6**, new Section 650-4; a revised Table of Contents and Sections 600-2, 602-6, 602-8, 603-3, 605-2, 605-14, 605-15, 608-5, 608-8, 620-7, 640-4, 640-11, 640-12, 640-13, 640-17, 640-18, 641-2, 641-5, 641-6, 641-7, 641-8, 641-9,641-25, 642-6, 642-24, 642-26, 642-30, 642-31, 642-33, 642-48, and 650-3, the Tables Index, and Table 697-7; editorial changes to Sections 600-5, 602-4, 602-5, 602-7, 604-5, 605-4, 605-5, 605-6, 605-7, 605-11, 605-13, 605-17, 605-18, 605-19, 605-20, 606-6, 606-7, 606-9, 607-10, 630-5, 640-2, 640-5, 640-25, 640-28, 641-10, 641-12 through 641-17, 641-19, 641-20, 641-21, 641-26, 642-9, 642-10, 642-15, 642-16, 642-19, 642-21, 642-25, 642-27, 642-28, 642-34, 642-35, 642-39, 642-40, 642-41, 642-50 through 642-54, 670-6 and 695-4, Tables 697-1c, 697-2, 697-4, 697-8 and 697-9, and the Figures Index; and other minor editorial/format changes;
- **in Part 8**, a revised Section 804-4.
- **in Part 12**, new Forms 1296-6b, 1297-7b, 1296-17, 1296-18 and 1296-19; a revised Table of Contents, Chapter 1250, Sections 1203-1, 1203-2, 1203-3, 1203-4, 1203-5, 1204-2, 1204-5, the Forms Index, Forms 1296-6a, 1296-7a and 1296-16, the Tables Index, Table1297-7, the Figures Index and Figure 1298-1; and editorial changes in Forms 1296-2, 1296-4, 1296-11 and 1296-12; and other minor editorial/format changes; and
- **in Part 14,** a revised Table of Contents, the Chapter 1415 title and Sections 1401-1, 1401-2, 1401-3, 1401-6, 1402-1, 1415-1, 1415-2, 1415-3; editorial changes in Sections 1401-4 and 1401-5, the Form Index, and Form 1496-1; and other minor editorial/format changes.

2011 **July 15, 2011 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents and Section 206-5;
- **in Part 4,** an editorial change in Section 460-8; and
- **in Part 11,** a revised Table of Contents, Section 1140-4, the Figure Index, and Figure 1198-6; and other minor editorial/format changes.

2011 **October 21, 2011 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2**, a revised Table of Contents;
- **in Part 3,** revised Sections 301-5 and 350-4; and other minor editorial changes;
- **in Part 4,** revised Sections 420-4 and 450-8; and other minor editorial changes;
- **in Part 6,** revised Sections 642-37 and 642-41; and a minor editorial correction; and
- **in Part 11** a revised Table of Contents; revised Section 1120-5; deleted Section 1142-15; and other minor editorial changes.

2012 **January 20, 2012 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, revised Forms 196-3 and 193-4, and Table 197-3; and made editorial corrections in Sections 100-1 100-4, 101-4, 101-5, 102-4, 102-5, 103-1, 103-4, 103-5, 104-1 104-3, 104-4, 105-1, 106, 195-3, 195-5, 195-6, 195-8, 196-1, 196-2, 196-3, and 196-4;
- **in Part 3,** revised Chapters 305, 306, and 310, Sections 300-1, 301-1, 301-4, 301-5, 301-6, 301-7, 301-8, 301-9, 301-10, 301-11, 301-12, 301-14, 303-1, 303-2, 304-1, 304-3, 304-5, 304-6, 341-2, 342-2, 342-4, 350-3, 350-5, 350-6, 350-7, 350-8, Table 397-2, and Figures 398-2, and 398-3;
- **in Part 4,** a revised Table of Contents; Sections 400-1, 401-7, 403-2, 403-6, 403-10, 404-3, 405-1, 406-1, 406-3, 407-2, 408-1, 408-2, 420-4, 420-5, 421-1, 441-3, 450-10, Table 497-3; and deleted Section 403-7;
- **in Part 5,** revised Chapter 500;
- **in Part 6,** revised Sections 602-5, 602-6, 604-5, 604-6, 604-7, 605-3, 605-5, 605-6, 605-7, 605-9, 605-10. 605-11, 605-12, 605-13, 605-14, 606-15, 605-17, 605-18, 605-21, 606-14, 606-18, 606-19, 606-21, 606-22, 607-1, 607-2, 620-6, 640-18, 640-26, 641-5, 641-7, 641-8, 641-9, 641-10, 641-12, 641-13, 641-14, and 641-15;
- **in Part 8,** a new Part Title; a revised Table of Contents, Chapters 800, 803 and Sections 802-1, 804-1, 804-2, 804-3, 830-3, 840-2, 840-3, and 840-4;
- **in Part 9,** revised Chapter 900;
- **in Part 10,** contents have been incorporated into Part 8; Part 10 now reserved for future use; and
- **in Part 11,** a revised Table of Contents, and Section 1141-4.

2012 **April 20, 2012 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;

- **in Part 1**, a revised Table of Contents; revised Sections 101-2, 101-3, 101-4, 102-2, 102-3, 102-5, 103-2, 103-3, 103-5, 120-4, 120-6, 120-7, 130-6, 140-7, 193-7, 193-15, 193-19, 194-6, 194-10, 194-14, 195-3, and 195-4; revised Tables 197-1, 197-2, 197-9, 197-10; and revised Figures 198-1, 198-5 and 198-6.
- **in Part 2,** a revised Table of Contents; new Sections 202-14 and 242-7; revised Sections 200-1, 201-1, 201-2, 201-3, 201-5, 201-6, 201-7, 201-8, 201-10, 201-11, 201-12, 201-13, 202-1, 202-4, 202-5, 202-6, 202-7, 202-9, 202-10, 202-11, 202-12, 203-1, 203-2, 204-2, 204-3, 204-4, 205-1, 205-2, 205-3, 205-4, 205-5, 205-6, 206-1, 206-3, 206-4, 206-5, 206-6, 206-7, 206-8, 206-10, 206-11, 206-12, 206-14, 206-15, 206-16, 206-17, 207-1, 207-2, 207-3, 207-4, 207-5, 207-6, 207-7, 207-8, 208-1, 208-2, 208-3, 208-4, 208-5, 209-1, 209-2, 209-3, 209-4, 209-5, 209-6, 209-7, 210-3, 211-1, 211-2, 211-3, 211-4, 212-1, 212-2, 220-5, 220-6, 220-7, 220-10, 221-1, 221-2, 221-3, 221-4, 221-5, 221-6, 240-2, 240-3, 240-4, 240-5, 240-6, 240-7, 240-8, 241-5, 242-3, 242-4, 242-5, 242-6, 250-3, 250-4, 250-5, 250-6. 250-7, 260-2, 260-4, 260-5, 295-2; deleted Section 210-2; revised Tables 297-1, 297-2, 297-8f, 297-9, 297-10, 297-12; and deleted Table 297-13; revised Figures Index, revised Figures, 298-4a, 298-4b, 298-5a, 298-5b, 298-7, 298-9, 298-11, 298-12, 298-13, 298-15, 298-18, 298-29, 298-30, 298-31, 298-32, 298-42; and deleted Figure 298-10
- **in Part 3,** a revised Table of Contents, new Section 342-5; revised Sections 301-4, 301-9, 301-10, 301-13, 301-14, 302-6. 304-4, 304-5, 304-6, 340-2, 341-2, 342-2, and 350-8; revised Chapter 305, deleted Chapter 303; and other minor editorial/format changes.
- **in Part 4,** a revised Table of Contents, new Sections 442-43 and 442-44; revised Sections 401-7, 402-2, 402-3, 403-2, 404-2, 404-3, 407-2, 420-1, 420-4, 421-1, 440-3, 440-7, 441-6, 441-8, 442-5, 442-9, 442-19, 442-21, 442-25, 442-29, 442-36, 442-39, 442-40, 442-41, 450-3, 450-6., 450-8, 450-10, 460-3; revised Forms 496-2 and 496-5; revised Table 497-3, revised Figures Index, and revised Figures 498-1, 498-3, 498-4, and 498-5; and other minor editorial/format changes.
- **in Part, 6,** a revised Table of Contents, revised Chapter 643; revised Sections 602-4, 602-8, 605-10, 606-7, 607-1, 607-15, 620-7, 640-21, 640-26, 640-28, 641-5, 641-6, 641-9, 641-17, 642-41, 650-2, 660-2, and 660-3; and revised Figures 698-13 and 698-14.
- **in Part 11,** a revised Table of Contents; and deleted Section 1142-4.

2012 **July 20, 2012 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 1**, a revised Table of Contents; revised Chapter 106; revised Sections 100-1, 100-4, 100-5, 100-6, 101-4, 102-4, 102-5, 103-1, 103-3, 103-4, 105-1, 105-2, 120-5, 193-1, 193-3, 194-1, 194-22, 195-1, and 195-2; revised Form 196-3; revised Tables Index; deleted Tables 197-1 and 197-2 (with subsequent Tables renumbered).
- **in Part 2,** a revised Table of Contents; new Section 241-8; revised Sections 202-14, 240-4; and Revised Figures 298-5b, 298-6a, 298-6b, 298-6c, 298-6d, 298-7, 298-8, 298-9, 298-22, 298-28, 298-29, 298-30, 298-31, 298-32, 298-33, 298-34, 298-35, 298-36, 298-39, 298-40, 298-41, 298-42, and 298-43.
- **in Part 3,** a revised Table of Contents; new Section 341-6; revised Sections 301-8, 301-12, 301-14, 302-6, 304-4, 304-5, 304-6, and 307-2, revised Figures Index; deleted Section 341-5; and deleted Figure 398-1 (with subsequent Figures renumbered).
- **in Part 4,** a revised Table of Contents; new Sections 403-7, 442-45, 442-46, and 442-47; revised Sections 440-3, 442-4, 442-21, and 442-44; and deleted Section 442-42.
- **in Part, 6,** a revised Table of Contents; new Section 642-46; revised Chapters 643, and 695: revised Sections 604-5, 605-14, 605-18, 605-19, 605-20, 608-10, 620-1, 620-7, 630-5, 640-2, 640-6, 640-19, 640-28, 641-5, 641-6, 641-9, 641-10, 641-13, 641-17, 641-19, 641-20, 641-21, 642-26, 642-35, 642-41, 642-45, 642-50, 660-2, and 660-4; revised Table 697-5; revised Forms Index; revised Figures Index; deleted Form 696-5: and deleted Figures 698-11 and 698-12 (with subsequent Figures renumbered).
- **in Part 7,** a revised Table of Contents; new Section 702-8; revised Chapters 701 and 704; revised Sections 702-2, 702-3, 702-4, 702-5, 702-6, 702-7, 705-1, 705-2 and 705-4; revised Forms Index 796; revised Forms 796-2 and 796-3; and an editorial correction in Table 797-1.
- **In Part 11,** a revised Table of Contents; and revised Sections 1140-5, 1140-6, 1142-10, 1142-12, 1142-16 and 1142-18.
- **in Part 12,** a revised Table of Contents; revised Chapter 1202; revised Sections 1211-1, 1211-4, 1211-10, 1212-1, 1212-8, 1212-10, 1213-6, and 1213-7; revised Forms Index; deleted Form 1296-13; revised Tables Index; deleted Table 1297-5; and an editorial correction in Table 1297-4.

2012 **October 19, 2012 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover Sheet and an updated Publication Record and Table of Contents;
- **in Part 2,** revised Sections 207-7, 208-6, 220-8 and 242-6; an editorial correction in Section 208-4;
- **in Part 3,** revised Section 302-5; and editorial corrections in Sections 301-16 and 341-6;
- **in Part 4,** a revised Table of Contents; a new Figure 498-43; revised Chapter 443, Sections 401-8, 403-3. 403-6, 403-8, 403-9, 404-2, 407-2, 420-1, 420-4, 421-1, 421-2 and 450-10, the Forms Index, and the Figures Index; and an editorial correction in Section 440-3;
- **in Part, 6,** a revised Table of Contents; revised Sections 605-5, 606-6, 641-3, 641-4 and 642-37; and
- **in Part 12,** revised Sections 1213-6 and 1213-7.

2013 **January 18, 2013 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a new Cover, Title Sheet and an updated Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents; new Sections 240-9 and 242-8; revised Sections 240-4, 241-7, 242-5 and Table 297-4; and an editorial correction in Section 240-8;
- **in Part 4,** a revised Table of Contents; new Sections 405-3, 442-48, 442-49 and 442-50; revised Chapter 443; revised Sections 403-9, 420-1, 420-5, 421-1, 440-3, 440-5, 440-7, 442-44, 450-3, 450-6, 450-8 and 450-10; and miscellaneous minor editorial/format corrections;
- **in Part, 6,** revised Sections 642-41 and 670-6;
- **in Part, 9,** a revised Table of Contents; and revised Section 902-2; and

- **in Part 11,** a revised Table of Contents; revised Sections 1103-6 and 1140-4; and an editorial correction in Section 1120-5.

2013 **April 19, 2013 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents; and
- **in Part 6,** revised Table of Contents; revised Sections 642-41 and 642-46, and deleted Section 642-45.

2013 **July 19, 2013 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 4,** revised Section 403-10: and an editorial correction in Section 442-32;
- **in Part 6,** revised Table of Contents; added new Figure 698-11; revised Sections 601-2, 602-5, 603-2, 605-2 – 605-5, 605-7, 605-11 – 605-14, 605-17 – 605-19, 606-10, 606-11, 606-13, 606-16, 606-17, 607-1, 607-7, 607-10, 607-12, 607-13, 607-15, 608-6 thru 608-11 (now 608-5 thru 608-10), 608-13 (now 608-11), 620-3, 620-4, 620-7, 630-4, 630-5, 640-2, 640-5, 640-6, 640-9, 640-11 thru 640-13, 640-15, 640-18, 640-19, 640-22, 640-25, 640-26, 640-28, 641-2 – 641-19, 641-21 – 641-26, 642-6, 642-14, 642-15, 642-21, 642-24, 642-30, 642-31, 642-34, 642-44, 642-53, 650-3, 660-2, 660-4, 670-3, 670-6, 670-7, 695-2 and 695-4; 695-7 (now 605-6); revised Forms Index; revised Tables Index, Table 697-5 and renumbered Tables 697-8 – 697-10 (now 697-6 – 697-8); revised Figures Index, revised and renumbered Figures 698-3a and 698-3b (now 698-2), and renumbered Figures 698-4 and 698-6 thru 698-12 (now 698-3 thru 698-11); deleted Sections 608-5, 608-12, 650-4, 695-6, Form 696-5 (now Figure 698-11), Tables 697-6 and 697-7, and Figures 698-2 and 698-5; editorial corrections in Sections 600-1, 600-2, 600-5, 605-6, 606-14, 607-3, 640-8 and 640-24; and miscellaneous minor editorial/format corrections;
- **in Part 7,** revised Table of Contents; revised Chapters 701 and 704, Sections 702-6, 705-2, 705-4, 742-1 and 742-2; deleted Chapter 795; editorial corrections in Sections 702-3, 702-4, 702-5 and 705-1, and Form 796-2; and miscellaneous minor editorial/format corrections;
- **in Part 9,** revised Table of Contents; revised Chapters 900, 901 and 950, Sections 902-1, 930-1, 930-2, 940-1, 942-2, 995-1, 995-2 and 995-4 (now 995-3); deleted Chapter 980 and existing Section 995-3; and miscellaneous minor editorial/format corrections; and
- **in Part 12,** revised Form 1296-17.

2013 **October 18, 2013 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 3,** revised Sections 302-1 and 302-3;
- **in Part 4,** revised Table of Contents; revised Chapter 443, Sections 401-4, 442-13, 442-17, 442-30, 442-31, 442-45, 460-2, 460-3 and 460-7; deleted existing Sections/Plan Notes 442-18, 442-33 – 442-38; editorial corrections in Sections/Plan Notes 442-4 – 442-6, 442-9 – 442-11, 442-14, 442-16, 442-41, 442-43, 442-44 and 442-46 – 442-49; and miscellaneous minor editorial/format corrections;
- **in Part 6,** revised Table of Contents; revised Sections 605-5, 605-20, 641-11, 641-19; editorial corrections in Sections 641-18; and miscellaneous minor editorial/format corrections;
- **in Part 12,** revised Table of Contents; revised Sections 1213-1, 1213-2, 1213-4 (now 1213-3), 1213-6 (now 1213-4), 1213-7 (now 1213-5), the Forms Index, Forms 1296-11, the Figures Index, and Figure 1298-2; deleted Chapters 1220, 1250, 1280 and 1295, Sections 1213-3 and 1213-5, and Form 1296-12; editorial corrections in Form 1296-13; and miscellaneous minor editorial/format corrections; and
- **in Part 14,** revised Table of Contents; new Chapter 1416 and Section 1416-1; revised Chapter 1400, Sections 1401-1 through 1401-6, 1415-1 – 1415-3, 1415-5 (now 1415-4); deleted Chapters 1402, 1420, 1430, 1450, 1480, 1495, Section 1415-4, the Forms Index and Form 1496-1; and miscellaneous minor editorial/format corrections.

2014 **January 17, 2014 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 2,** revised Table of Contents; new Figures 298-45 through 298-47; revised Sections 201-9, 207-2, 207-3, 209-7, 240-7, 242-6, 242-7, 250-2 and 250-8, Tables 297-17 and 297-18, the Figure Index and Figure 298-18; deleted existing Plan Note 242-7; editorial corrections in Chapter 243, Sections 240-5 and 250-7, and Figures 298-6b, 298-31 and 298-32; and miscellaneous minor editorial/format corrections;
- **in Part 3,** revised Table of Contents; revised Sections 301-1, 301-4, 301-12, 301-13, 301-15, 304-7, 341-2, 350-3, 350-4 and 350-8; editorial corrections in Sections 301-3, 301-8, 301-9, 301-10, 301-11, 301-14, 304-1, 304-2, 304-3, 304-5, 304-6, 341-1, 341-3 and 350-2; and miscellaneous minor editorial/format corrections;
- **in Part 4,** revised Sections 402-3, 420-4, 450-3, 450-8 and 450-10; editorial changes in Sections 420-1, 450-4 and 450-9; and miscellaneous minor editorial/format corrections;
- **in Part 6,** revised Table of Contents; revised Sections 604-5, 605-14, 605-19, 605-21 (now 605-20), 608-3, 608-6 through 608-8, 640-21, 640-27, 641-19, 641-21, 641-26, 641-46, 642-51 through 642-53, 650-1, 650-3 (now 650-2), 660-1, 660-4 (now 660-3), 670-4, Table 697-8, Figures 698-4 and 698-6, and the Figures Index; deleted existing Sections 605-20, Plan Notes 642-26 and 642-50, and Sections 650-2 and 660-3; editorial corrections in Chapter 643, Sections 605-18, 608-1, 608-10, 640-5, 640-20, 640-26, 641-17, 641-20, 641-25, 642-27 through 642-29, 642-33 through 642-38, 642-41, 642-43, 642-44, 642-48, 642-49, 642-55, 670-2 and 695-4; and miscellaneous minor editorial/format corrections;
- **in Part 8,** revised Table of Contents; new Chapter 843; revised Chapters 800, 803 and 805, Sections 801-2, 804-3, 804-4, 830-1, 895-3 (now 895-1), 895-4 (now 895-2), 895-5 (now 895-3), the Forms Index, the Figures Index and Figure 898-1; deleted Chapters 850, 860 and 880 and Sections 895-1 and 895-2; editorial corrections in Sections 802-1, 802-2, 804-2, 830-4 and 840-2; and miscellaneous minor editorial/format corrections; and

- **in Part 13,** revised Table of Contents; new Figures 1398-3 through 1398-5; revised Chapter 1300, Sections 1301-1, 1301-3, 1303-1 through 1303-4, 1303-6 through 1303-10, the Forms Index, Forms 1396-1 and 1396-2, the Tables Index, Tables 1397-2 and 1397-3, the Figures Index and Figures 1398-1 and 1398-2; editorial corrections in Sections 1301-2, 1301-4 and 1303-5; and miscellaneous minor editorial/format corrections.

2014 **April 18, 2014 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- **in Part 13,** a new Form 1396-3, a revised Table of Contents, revised Sections 1301-1, 1301-2, 1301-3 and 1301-4, and a revised Forms Index, Tables Index and Table 1397-1.

2014 **July 18, 2014 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 2,** revised Table of Contents; revised Sections 201-1, 201-3, 201-7, 201-8, 202-13, 203-1, 204-2, 205-6, 206-7, 206-8, 206-11, 207-2, 207-3, 211-2, 211-4, 220-7, 220-8, 221-3, 240-7, 242-1 through 242-5, 260-2 and 295-2, the Forms Index, Form 296-3, the Tables Index, Tables 297-1 and 297-3, the Figures Index, and Figures 298-3, 298-4a-b, 298-5a-c and 298-6a-c; deleted Form 296-5; editorial corrections in Sections 200-3, 202-9, 220-1, 221-1, 221-6, 240-1, 240-2, 240-4 through 240-6, 241-1, 241-7, 250-2 through 250-8, Table 297-10, and Figures 298-38a, 298-38b and 298-46; and miscellaneous minor editorial/format corrections;
- **in Part 3,** revised Table of Contents; revised Sections 301-1, 301-2, 301-7, 301-14, 340-2, 341-2, 342-2, 350-3, 350-4 and 350-8; deleted Chapter 303; editorial corrections in Chapter 305, 310 and 343, Sections 300-3, 302-1 through 302-3, 302-6, 307-1, 307-2, 320-1, 320-4, 320-5, 341-4, 341-6, 342-1, 350-5, 350-6, the Tables Index and Tables 397-1, 397-3, and Figures 398-1 through 398-4; and miscellaneous minor editorial/format corrections;
- **in Part 4,** revised Table of Contents; new Section 403-11; revised Sections 401-4, 401-7, 401-9, 402-2, 403-7, 407-2, 408-2, 440-3, 440-7, 442-14, 442-20, 442-43, 442-48, 460-8, 495-2, the Form Index, Forms 496-3, 496-5 and 496-7, and Figures 498-3 through 498-5, 498-12, 498-13, 498-16 through 498-20, 498-23, and 498-36 through 498-38; deleted Section/Plan Note 442-50 and Forms 496-16, 496-17 and 496-18; revised/renumbered Form 496-19 to 496-16, and Form 496-20 to 496-17; editorial changes in Chapter 443, Sections 400-3, 401-1, 403-1, 403-9, 404-1, 420-4, 420-5, 421-1, 421-2, 440-1, 440-2, 440-4 through 440-6, 441-1, 441-3, 441-8 through 441-11, 442-1, 442-4, 442-5, 442-6, 442-9 through 442-13, 442-17 through 442-19, 442-21, 442-32, 442-41, 442-44, 442-46, 450-1, 450-3, 450-6, 450-8, 450-10 and 450-11, Forms 496-4, 496-6, and 496-8 through 496-11, the Table Index, Tables 497-4 and 497-8, and Figure 498-31; and miscellaneous minor editorial/format corrections;
- **in Part 6,** revised Table of Contents; new Section 641-27; revised Sections 607-10, 620-7, 641-5, 641-6, 641-9, 641-10, 641-17, 641-21, 641-25, 642-6, 642-21, 642-37 and 642-44; editorial corrections in Sections 600-3, 605-2, 605-9, 605-11, 605-14, 605-15, 607-1, 607-13, 607-15, 620-3, 620-6, 630-1, 640-1, 640-2, 640-11, 640-18, 641-1, 641-2, 641-8, 641-16, 642-1, 642-2, 642-5, 642-9, 642-12 642-20 and 642-24; and miscellaneous minor editorial/format corrections;
- **in Part 8,** editorial corrections in Section 802-2;
- **in Part 9,** revised Table of Contents; revised Sections 940-2 and 942-2; editorial corrections in Section 942-1; and miscellaneous minor editorial/format corrections:
- **in Part 11,** revised Table of Contents; revised Sections 1106-2, 1120-5, 1140-4, 1141-1, 1141-3, 1141-4, 1142-14, 1160-6 and 1160-8, and Figure 1198-11; editorial corrections in Chapter 1143, Sections 1100-1, 1100-3, 1103-6, 1130-4, 1130-5, 1140-3, 1140-5 through 1140-8, 1142-2, 1142-3, 1142-5 through 1142-8, 1142-13, 1142-17, 1142-18, 1142-20, 1150-2, 1150-5, 1150-6, 1150-10, 1150-13, 1160-4, 1160-11, 1160-13, Tables 1197-3 through 1197-7, and Figure 1198-4; deleted Chapters 1170, 1180 and 1190; and miscellaneous minor editorial/format corrections: and
- **in Part 14,** editorial corrections in Sections 1415-1 and 1415-2; and miscellaneous minor editorial/format updates.

2015 **January 16, 2015 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 2,** revised Table of Contents; new Sections 206-18 and 240-10; revised Section 240-9; and miscellaneous minor editorial/format corrections;
- **in Part 3,** revised Sections 301-6 and 302-2, and Table 397-1; and miscellaneous minor editorial/format corrections;
- **in Part 4,** revised Table of Contents; new Sections 440-10, 440-11, 440-12 and 442-50, new Form 496-18, and new Figures 498-44, 498-45 and 498-46; revised Chapter 443, Sections 402-2, 403-8, 420-5, 440-1, 440-3, 440-7, 442-3, 442-7, 442-8, 442-12, 442-13, 442-17, 442-18, 442-21, 442-22, 442-23, 442-24, 442-39, 442-41, 442-43, 442-44, 442-48, 442-49, 450-10, the Forms Index, Forms 496-3, 496-4, 496-5 and 496-16, Table 497-6, the Figures Index, and Figures 498-13, 498-21, 498-36 and 498-37; editorial changes in Figures 498-4, 498-12 and 498-38; and miscellaneous minor editorial/format corrections;
- **in Part 6,** revised Table of Contents; new Section 641-28; revised Chapter 643, Sections 605-4, 605-14, 605-17, 640-2, 640-9, 640-12, 640-18, 640-19, 641-11, 642-24, 642-26, 642-41, 642-55 and 660-2, and Table 697-5; and miscellaneous minor editorial/format corrections;
- **in Part 7,** revised Sections 705-4 and 742-2;
- **in Part 8,** editorial corrections in Chapter 843;
- **in Part 11,** revised Table of Contents; new Sections 1142-22 and 1142-23; revised Section 1140-6; and miscellaneous minor editorial/format corrections;
- **in Part 12,** revised Table of Contents; revised Chapter 1211 and Sections 1203-2, 1203-3, 1203-5 and 1204-5, the Forms Index (1296), Forms 1296-1, 1296-2, 1296-6b, 1296-7b, 1296-14, 1296-16, 1296-17 and 1296-18, the Tables Index (1297), Table 1297-7, the Figures Index (1298), and Figures 1298-1a through 1298-1c, and 1298-6 through 1298-22; an editorial correction in Chapter 1202; deleted Chapter 1212 and Figures 1298-23 through 1298-40; and miscellaneous minor editorial/format corrections;
- **in Part 13,** revised Table of Contents; new Chapter 1343; and miscellaneous minor editorial/format corrections; and
- **in Part 14**, revised Table of Contents; revised Sections 1415-1 and 1415-3; and miscellaneous minor editorial/format updates.

2015 **July 17, 2015 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 1,** revised Table of Contents; revised Chapters 104, 106, 160, 180, 193, 194 and 195; revised Sections 100-1 through 100-5, 101-1, 101-3, 101-4 and 101-5, 102-2 through 102-5, 103-1 through 103-5, 105-3, 120-1, 120-2, 120-4, 120-6, 120-7, 130-2, 130-4, 130-5, 140-2, 140-7, 150-1 through 150-3; deleted existing Forms 196-1, 196-2 and 196-4, and renumbered 196-3 to 196-1; revised Table 197-1, deleted Tables 197-3 through 197-6, and renumbered and revised Tables 197-7 and 197-8 to 197-3 and 197-4, respectively; revised Figures 198-4 through 198-6; made editorial changes to Chapter 170, Sections 101-2, 102-1, 105-1, 105-2, 120-3, 130-3, 130-6, 130-7, 140-6, the Forms Index, the Tables Index, the Figures Index, and Figures 198-1 through 198-3. ; and miscellaneous minor editorial/format corrections;
- **in Part 2,** revised Table of Contents; new Sections 201-15 and 202-15; revised Sections 201-3, 201-6, 202-8, 202-11, 206-16, 207-2, 209-2, 240-6, 242-5, 242-6 and 242-7; made editorial changes to Chapters 202, 205 through 209, 241, 242 and 243, and Sections 201-5, 201-10 through 201-14, 240-5, 240-9 and 298-20; and miscellaneous minor editorial/format corrections;
- **in Part 3,** revised Table of Contents; revised Section 301-12 and Table 397-1; made editorial changes in Sections 301-13 through 301-15 and 304-3; deleted Section 304-7; and miscellaneous minor editorial/format corrections;
- **in Part 4,** revised Table of Contents; revised Sections 401-1 through 401-3, 403-1, 407-2, 420-4, 420-5, 440-1, 440-3, 440-7, 440-8, 440-10, 441-1, 442-14, 442-33, 442-44, 442-45, 442-46, 442-48, 442-49, 450-6, 450-8, 450-10, 450-11, 495-2, the Forms Index, Forms 496-3 through 496-5, 496-10, 496-16 and 496-17, Table 497-1, the Figures Index, and Figures 498-2, 498-3, 498-5, 498-9 and 498-15; editorial changes in Chapter 408, 421, 441, 443, Sections 403-2, 403-3, 420-1, 440-4, 440-5, 440-12, 442-39, 442-43, Forms 496-8, 496-9, 496-11, and 496-18, the Tables Index, Table 497-4, Figures 498-12, 498-13, 498-37 and 498-45; and miscellaneous minor editorial/format corrections;
- **in Part 6,** revised Table of Contents; Sections 601-2, 602-3, 605-1, 605-3, 605-4, 605-6, 605-14, 605-15, 606-14, 607-1, 608-7, 608-8, 620-2, 630-4 through 630-6, 640-5, 640-13, 640-14, 640-18, 641-2, 642-5, 642-21, 642-27, 642-30, 642-31, 642-35, 642-41, 695-2 and 695-6, and Figure 698-2; editorial changes in Chapters 602, 605, 606, 607, 608, 620, 630, 640, 641, 642, 643 and 695 and miscellaneous minor editorial/format corrections;
- **in Part 7,** revised Section 705-4 and editorial changes to Chapter 705;
- **in Part 11,** revised Table of Contents; new Section 1120-8; revised Sections 1120-2, 1140-4, 1140-6; editorial changes in Chapter 1141, and Sections 1120-5, 1140-5, 1140-7, 1140-8; and miscellaneous minor editorial/format corrections;
- **in Part 12,** revised Table of Contents; revised Sections 1203-1, 1203-3, 1203-5, 1204-5, 1213-4, and Forms 1296-6a, 1296-6b, 1296-7a, 1296-7b, 1296-14; and an editorial change in Section 1203-2;
- **in Part 13,** revised Table of Contents; new Chapters 1340, 1342 and 1395, and Tables 1397-4 through 1397-9; revised Chapter 1343; revised Sections 1303-1, 1303-3 through 1303-7, 1303-10; editorial changes in Chapters 1300 and 1301, and Sections 1303-2, 1303-8, 1303-9, the Forms Index, the Tables Index, Tables 1397-1 and 1397-3, and Figures 1398-1 through 1398-5; and miscellaneous minor editorial/format corrections; and
  in Part 15, revised Table of Contents; revised Chapter 1599, and Sections 1501-1 through 1501-3 and 1505-1; editorial changes in Sections 1505-2 and 1505-3; deleted Chapters 1510 through 1514 and 1596; and miscellaneous minor editorial/format updates.

2015 **October 16, 2015 –** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- an updated Title Sheet, Preface, Publication Record and Table of Contents;
- **in Part 6,** revised Table of Contents; new Section 641-29; revised Sections 605-3, 605-6, 640-17, 640-18, 640-26, 641-5 through 641-9, 642-24 and 642-26; editorial changes in Sections 605-4, 605-7, 640-19, 640-22, 640-24, 640-25, 640-28, 641-2, 641-10 though 641-28; and miscellaneous minor editorial/format corrections; and
- **in Part 12,** revised Table of Contents; revised Sections 1203-4, 1203-5; revised Forms Index and Forms 1296-6a, 1296-6b, 1296-7b, 1296-16, 1296-17, 1296-18; revised Tables Index and Table 1297-7; revised Figures Index and Figures 1298-1a, 1b and 1c; editorial changes in Sections 1203-1 and 1203-2; and miscellaneous minor editorial/format corrections.

2016 **January 15, 2016 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents; new Section 221-7; new Figure 298-48; revised Sections 201-9 and 209-2; revised Table 297-4; revised Figures Index and Figure 298-48; and editorial changes in Section 221-6 and Figure 298-47;
- **in Part 3,** a revised Forms Index;
- **in Part 4,** a revised Table of Contents; revised Sections 402-3, 404-2, 420-4, 420-5, 440-7, 441-5, 441-8, 442-13, 442-18, 442-19, 442-21, 442-41, 450-3, 450-6, 450-10, 460-3, 460-7; revised Table 497-6; and revised Figures 498-12. 498-13 and 498-36;
- **in Part 6,** a revised Table of Contents and revised Section 641-17;
- **in Part 11,** a revised Table of Contents; revised Sections 1140-4, 1142-6, 1142-7, 1150-9, and revised Figure 1198-12; and
- **in Part 13,** revised Sections 1303-3, 1303-6, and 1340-2; and revised Tables 1397-5 and 1397-6.

2016 **July 15, 2016 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 1**, a revised Form 196-1 and revised Table 197-4;
- **in Part 2,** a revised Table of Contents; revised Sections 202-5, 202-14, 205-2, 211-1, 211-2, 211-3, 211-4, 240-8, 242-6 and 260-5;
- **in Part 3,** a revised Table of Contents, revised Sections 301-4, 301-15, 302-6, 304-4, and 304-5; a revised Table 397-1, revised Figures Index and Figure 398-1; and deleted Figures 398-3 and 398-4;

- **in Part 4,** a revised Table of Contents; new Section 403-12; revised Sections 402-2, 442-20, 442-45, and 460-3; and deleted Section 442-23;
- **in Part 6,** a revised Table of Contents; new Sections 601-3, 641-7, 641-10, 641-20, 641-23, 641-24 and 642-57; revised Sections 601-2, 602-5, 605-11, 605-13, 605-14, 605-19, 606-14, 606-16, 607-12, 607-13, 607-15, 608-4, 608-7, 630-4, 630-5, 640-2, 640-5, 640-9, 640-13, 640-14, 640-18, 640-24, 640-28, 640-29, 641-2, 641-12, 642-24, 642-30, 642-31, 642-35, and 642-38; revised Forms 696-1a, 696-1b, 696-3a and 696-3b; revised Tables Index; and revised Table 697-1c.
- **in Part 11,** a revised Section 1142-21 and revised Table 1197-3;
- **in Part 12,** revised Sections 1203-2, 1203-3, and 1204-1; revised Forms 1296-2, 1296-5, 1296-8 and 1296-9; and revised Table 1297-6;
- **in Part 13,** revised Section 1303-4 and revised Table 1397-7; and
- **in Part 15,** revised Chapter 1599 and new Standard Procedure 123-001(SP).

2017 **January 20, 2017 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 1,** revised Section 120-4;
- **in Part 2,** a revised Table of Contents; new Section 242-9; revised Sections 202-2 and 242-8;
- **in Part 3,** a revised Table of Contents; new Sections 301-17, 301-18, 301-19 and 307-3; revised Section 342-4;
- **in Part 4,** a revised Table of Contents; revised Sections 403-2, 403-3, 420-4, 442-24, 442-33, and 442-45; and revised Table 497-1;
- **in Part 6,** a revised Table of Contents; new Sections 642-58 and 642-59; new Figure 698-12; revised Sections 605-6, 605-7, 605-12, 605-14, 605-15, 605-16, 606-16, 607-15, 620-7, 630-5, 640-8, 640-12, 640-18, 640-26, 640-29, 641-5, 641-6, 641-11, 641-34, 642-8, 642-24, 642-43, and 642-57;
- **in Part 7,** revised Form 796-4;
- **in Part 9,** revised Section 902-2;
- **in Part 11,** a revised Table of Contents; new Section 1142-4; revised Sections 1140-5 and 1141-4;
- **in Part 14**, revised Sections 1415-1, 1415-2, and 1415-3.

2017 **July 21, 2017 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 1,** a revised Table of Contents; revised Sections 120-4 and 140-7; revised Form 196-1; revised Tables Index; deleted Table 197-4; and revised Figure 198-1;
- **in Part 2,** revised Section 242-9 revised Table 297-17; and revised Figure 298-29;
- **in Part 3,** a revised Table of Contents; new Sections 301-20, 301-21, 302-7, 307-4 and 342-6; revised Sections 301-2, 301-13 and 350-7; revised Tables Index; new Table 397-6; and revised Table 397-1; revised Figures Index; an editorial change in Figure 398-1; and deleted Figure 398-4.
- **in Part 4,** a revised Table of Contents; revised Sections 402-1, 403-2, 403-12, 440-6, 442-20 and 460-6;
- **in Part 6,** a revised Table of Contents; revised Sections 605-11, 605-19, 606-13, 630-5, 640-2, 640-12, 640-18, 640-29, 641-5, 641-6, 641-9, 641-11, 641-12, 641-14, 641-15, 641-16, 641-17, 641-19, 641-26, 641-30, 642-20, 642-32, 642-44, 642-48, 642-49, 642-51, 642-57, and 642-58; an editorial change in Section 642-8; deleted Section 642-46; revised Form 696-1a; revised Table 697-4; revised Figures 698-5 and 698-7;
- **in Part 7,** revised Form 796-4;
- **in Part 8,** revised Form 896-1;
- **in Part 11,** a revised Table of Contents; new Section 1142-24; revised Sections 1120-6, 1140-5, and 1160-8; revised Table 1197-3; and revised Figure 1198-11.
- **in Part 12,** revised Section 1203-1; and
- **in Part 13,** a revised Table of Contents; revised Sections 1303-6, and 1342-7; deleted Section 1342-12 ; and revised Form 1396-3;

2018 **January 19, 2018 -** Revision consists of the following (as well as related pages needed for double-sided printing of the revised pages):

- a revised Title Sheet, Publication Record and Table of Contents;
- **in Part 2,** a revised Table of Contents, and revised Sections 201-14, 202-2, 240-9, 240-10 and 242-8;
- **in Part 3,** revised Section 301-4;
- **in Part 4,** a revised Table of Contents; revised Sections 403-5, 405-3, 420-5, 440-6, 440-11. 442-4, 442-13, 442-15, 442-16, 442-25 and 442-50;
- **in Part 6,** a revised Table of Contents; revised Sections 600-1, 605-11, 605-12, 640-2, 640-9, 640-19, 641-30, 641-33, 642-18, 642-36, 642-37, 642-55, 642-56 and 642-59; and revised Table 697-3;
- **in Part 9,** a revised Table of Contents; new Sections 901-1 and 901-2, and deleted Section 995-3.
- **in Part 11,** a revised Table of Contents; revised Sections 1103-6, 1107-4, 1120-5, 1140-3, 1140-4, 1140-8, 1141-3, 1142-22, 1142-23 and 1160-3; and revised Tables 1197-3, 1197-5 and 1197-6;
- **in Part 12,** revised Section 1203-2; and
- **in Part 13,** a revised Table of Contents; revised Sections 1303-4, 1303-5, 1342-3, 1342-7 and 1342-12; and revised Table 1397-5, and 1397-9.

TABLE OF CONTENTS

TABLE OF CONTENTS
Part 1 – GENERAL

Part 1 – GENERAL

100 INTRODUCTION

100-1 Uniformity in Traffic Control Standards

100-1.1 General

Uniform traffic control standards throughout the country have long been recognized as necessary to meet the ever increasing demands of modern transportation. Once established, it is very important that standards are kept current. Developments in traffic control devices often lead to changes in the design or application of them. As improvements (or problems/concerns with existing devices) are identified, needed changes should be incorporated into the standards and the revisions disseminated in a way to assure that they are implemented.

100-1.2 National Standards

To meet the need for nationwide uniformity of standards for signs, signals, markings and other devices on or adjacent to streets and highways, the **Federal Highway Administration (FHWA)** publishes the **Manual on Uniform Traffic Control Devices (MUTCD)** ***(see Section 193-10)*** and periodic revisions. Federal regulations **(23 CFR Part 655)**, as well as **Section 4511.09 of the Ohio Revised Code (ORC)**, require that the **Ohio Department of Transportation (ODOT)** adopt a **State** manual of uniform traffic control devices that correlates with, and so far as possible conforms to, “the system approved by the federal highway administration.”

The national **MUTCD** is available on-line ***(also see Table 197-1)***. Proposed changes to the national standards in the **MUTCD** are published by **FHWA** using the **Federal Register Docket** system.

100-1.3 State Standards

The **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)** ***(see Chapter 101)*** is the **State** manual adopted by the **ODOT Director of Transportation** to establish standards for traffic control devices in **Ohio** in general conformance to the national manual. To promote statewide uniformity in the design and application of traffic control devices, the **OMUTCD** standards apply to all public streets and highways, regardless of type or the level of governmental agency having jurisdiction, and private roads open to public travel. The **OMUTCD** is available on-line.

100-1.4 Additional Specific Standards

As noted in the **OMUTCD** Introduction, **ORC Sections 4511.10 and 4511.11** “address the responsibilities that **ODOT**, local highway authorities, and owners of private roads open to public travel have to place and maintain traffic control devices on all highways within their respective jurisdictions in conformance with the **OMUTCD.”**

For **ODOT**, the **Traffic Engineering Manual (TEM)**, **Traffic Standard Construction Drawings (Traffic SCDs)**, **Traffic Plan Insert Sheets (Traffic PISs)** and the **Construction and Materials Specifications (C&MS)** establish traffic control policies, standards, guidelines and specifications which supplement the basic standards established in the **OMUTCD**. These publications are discussed in detail in ***Chapters 102, 103, 104 and 105***, respectively. See ***Table 197-3*** for a list of available traffic engineering publications from the **ODOT** **Office of Roadway Engineering (ORE)** and the **Office of Traffic Operations (OTO).** Contact information for both **ORE** and **OTO** is provided on page ii.

100-2 ODOT's Role/Responsibility

As required by law **(ORC Section 4511.09),** the **Ohio Department of Transportation (ODOT)** is responsible for adopting a manual which establishes traffic control standards that apply to all public streets and highways in **Ohio**, regardless of facility type or the level of governmental agency having jurisdiction.

The **Traffic Control Design Section** of the **Office of Roadway Engineering (ORE)** is responsible for developing and maintaining the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**, and any additional **ODOT** traffic engineering design policies, guidelines, standards, etc.

The **ORE Traffic Control Design Section** is also responsible for coordinating **ODOT's** review of proposed changes to the national **MUTCD** ***(see Section 193-10)*** and preparing **ODOT's** response. Comments are solicited from related offices in **Central Office** and, time permitting, the **Districts** and others.

The procedures for revising the **OMUTCD, TEM, SCDs, PISs** and the **C&MS** are addressed in ***Sections 101-5, 102-5, 103-5, 104-4 and 105-3***, respectively.

The **Office of Traffic Operations (OTO)** is generally responsible for **ODOT's** traffic engineering operations and maintenance concerns.

100-3 Jurisdiction

As noted earlier, the **OMUTCD** establishes standards for all public streets and highways in **Ohio**, and private roads open to public travel**.** Unless noted otherwise, all other **ODOT** policies, guidelines, standards, manuals and handbooks apply only to highways under **ODOT's** jurisdiction, but are also recommended for use by local jurisdictions.

When referring to highways under **ODOT's** jurisdiction, generally this involves Interstate Routes, State Routes and U.S. Routes outside municipal limits..

Some **TEM** standards and guidelines are referenced in the **OMUTCD** as recommended practice or examples. Also, due to publishing constraints, guidelines that **ODOT** is sometimes required by legislation to develop for use by **ODOT** and other highway agencies may be contained in this publication, rather than the **OMUTCD**.

100-4 Contacts

General traffic engineering inquiries should be directed to the **Ohio Department of Transportation**, **Administrator, Office of Roadway Engineering**, see the contact information on page ii of this Manual and in ***Table 197-1***.

Comments, questions and proposed revisions of the **TEM** should be submitted to the **Office of Roadway Engineering Traffic Control Design Section** at that same address. Submissions by email are also welcome.

Comments or questions involving a specific area of concern handled by one of the **ORE** or **OTO** section supervisors or their staff may be referred directly to the appropriate area. For your convenience in addressing questions or concerns related to specific traffic engineering topics, a roster of **ORE** and **OTO** personnel is available on the respective Office websites, noted on page ii.

100-5 ODOT Organization

Figure 198-1 presents an overall organization chart for **ODOT**. The most current update of this information is available by typing "organization" in the Search **ODOT** box on the **Ohio Department of Transportation (ODOT)** Home Page. Information is also provided in ***Table 197-2 and Figure 198-2*** about the **ODOT Districts**, including addresses and phone numbers for contacting each **District**. Current information on the **Districts** and contact information for them is also available on-line.

100-6 Other Resource Reference and Contact Information

Table 197-1 provides information to help in locating various resource references and contacting agencies and organizations at the local, **State** (including **ODOT**) and national levels. In addition to mailing addresses, when available, telephone and fax numbers and web and e-mail addresses have been provided. Suggestions for additions to this list are welcome.

Intentionally blank.

101 OHIO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES

101-1 Legal Authority

As noted in ***TEM Section 100-1.3***, the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)** is the **State** manual adopted by the **ODOT Director of Transportation** to establish standards for traffic control devices in **Ohio** in general conformance to the national manual ***(see Section 193-10)***. This is also addressed in the **OMUTCD Introduction and in OMUTCD Section 1A.07**.

As noted in ***TEM Section 100-1.4***, **ORC Sections 4511.10 and 4511.11** make **ODOT** and local authorities within their respective jurisdictions, as well as owners of private roads open to public travel responsible for placing and maintaining traffic control devices that conform to this manual. The **OMUTCD** and subsequent revisions apply to all traffic control devices erected in **Ohio** after the date of their adoption.

101-2 Organization

The organization of the **OMUTCD** is very similar to that of the national manual and most of the text is the same. Currently, the **OMUTCD** is organized as follows:

- **Part 1** provides general information about the purpose of, and requirements for, traffic control devices, the legal authority of the manual, definitions and procedural information.
- **Part 2** provides information about signs, and includes barricades, gates and object markers.
- **Part 3** provides information about Markings, i.e., Pavement and Curb Markings, Delineators, Colored Pavements, and Channelizing Devices. Information about traffic control islands is also located in Part 3.
- **Part 4** provides information about highway traffic signals.
- **Part 5** provides information about low-volume roads.
- **Part 6** provides information about temporary traffic control, including traffic incident management.
- **Part 7** provides information about traffic controls for school areas.
- **Part 8** provides information about traffic controls for highway-rail grade crossings and light rail transit grade crossings.
- **Part 9** provides information about traffic controls for bicycle facilities.
- **Appendix A** provides information about federal legislation related to the national **MUTCD**.
- **Appendix B** provides a cross-reference to various related **ORC** sections, and provides reprints of some of the most often referenced **ORC** sections.
- **Appendix C** provides a visual, graphical quick reference for signs addressed in the manual, with cross-referencing to related sections in the manual.

101-3 Format

101-3.1 General

For the convenience of those who may not be familiar with the **OMUTCD** (and as a record and reminder for those developing text for it), various format conventions used in that manual have been consolidated in this Section.

101-3.2 Numbering/Labeling Conventions

Given the size of the publication, and for convenience in handling future revisions, the following numbering conventions have been used for the text, figures and tables in the **OMUTCD**:

1. Page numbers are sequential beginning with Page 1 in Chapter 1 and ending with the last page in Chapter 9. The Table of Contents is numbered separately, and consists of a "TC" designation and the page number within the Table of Contents. Page numbers in Appendices A, B and C use the first letter of the particular appendix and the page number within it (e.g., Page C-3).

2. Section, figure and table numbers consist of the Chapter number and a sequential number for the Section, figure or table within the Chapter. For example, "2C" identifies Sections, figures and tables from the Warning Signs and Object Markers Chapter.

3. Text in the header has been used as a reminder that the page is part of the 2012 Edition.

101-3.3 Text

The following formatting conventions have been used in the **OMUTCD**:

1. Numbers related to time and quantities are usually written out, but dimensions are generally shown as numbers.
2. Dimensions are shown in English units. (Metric equivalents can be determined by using the appropriate tables in **OMUTCD Appendix A2**.)
3. For consistency, the terms "Standard," "Guidance," "Option" and "Support" are defined in the **OMUTCD Introduction**, and a general listing of definitions of other terms used in the manual is provided in **Part 1**.
4. To provide emphasis and to differentiate between Standard, Guidance, Option and Support text, the text has been separated using these titles.
5. The format of the text copied from the **MUTCD** has also been used to help differentiate between the types of information.
   a. Text addressing Standards information is in **bold**, 11 point Times New Roman font.
   b. Text addressing Guidance information is *italicized* in 11 point Times New Roman font.
   c. Text addressing Support and Option information is in 11 point Times New Roman font.
6. The format of the **OMUTCD** text has also been used to help identify **Ohio** text, as opposed to that copied from the **MUTCD**. The **Ohio** text is shown in 10 point Arial font (the same font used in the **TEM**).
7. In referring to a sign by name, if the name used is also the sign legend it will be shown in all capital letters, if not, just the initial letters will be capitalized, e.g., STOP sign and Winding Road sign.

101-3.4 Artwork

The following formatting conventions have been used in the **OMUTCD**:

1. The numbering format for the figures is described in ***Section 101-3.2***.
2. Dimensions are as described in ***Section 101-3.3***.
3. A gray background is typically used to depict the pavement.

4. Colors, conforming to the specifications published on-line by **FHWA** at http://mutcd.fhwa.dot.gov/kno-colorspec.htm, are used for traffic control devices. For printing purposes, the **Pantone** color specifications noted on that same **MUTCD** web page may be used.
5. Sign cuts are shown in figures as groupings of similar signs (rather than individually with the related Sections).
6. Sign size tables have been included in signing related chapters showing groups of signs, instead of individual notations about sign sizes with the sign cuts.
7. A sign index **(OMUTCD Appendix C)** has been included to provide a quick visual cross reference guide to text about signs discussed in the manual.

101-4 Distribution

The **OMUTCD** is available electronically on-line. It can be accessed directly from the **OMUTCD** website. It can also be accessed from the **ODOT Office of Roadway Engineering (ORE)** and **ODOT Design Reference Resource Center (DRRC)** websites (the web addresses are provided on page ii of this Manual).

The **OMUTCD** is also available in paper format and is distributed through the **Office of Contracts**. Copies are distributed free to local jurisdictions, other government agencies and public libraries.

101-5 Revisions

For convenience in reviewing and updating the **OMUTCD**, the basic **ODOT** policy (since publication of **Revision 13 of the OMUTCD 1972 Edition**) has been to adopt the related text from the national manual **(MUTCD)** when preparing an **OMUTCD** revision, unless it is determined that there is a good reason to be different.

Maintaining/updating the **OMUTCD** is an ongoing function of the **Office of Roadway Engineering**. **OMUTCD Table I-1** depicts the evolution of the **OMUTCD**, listing the various editions and revisions.

Comments and suggestions from users of the **OMUTCD** about the manual or proposed revisions of it are anticipated and welcome. **OMUTCD Section 1A.10** addresses the procedures for requesting interpretations, experimentations, changes and interim approvals. Design, application and placement of traffic control devices other than those adopted in the **OMUTCD** are prohibited unless the procedures outlined in **Section 1A.10** are followed. Requests for interpretations or changes in the **OMUTCD** shall be submitted to the **ODOT Office of Roadway Engineering**. As noted in ***Chapter 180***, **OMUTCD Section 1A.10** requires that requests for permission to experiment or for interim approval of a device be submitted to the **Federal Highway Administration (FHWA)**.

All proposed revisions to the **OMUTCD** will be reviewed according to the following process:

1. All proposed revisions should be submitted to the **ORE Administrator**. Preferably, a proposal for a revision of the text should include a marked-up copy of the related manual text.
2. The **ORE Traffic Control Design Section** will review the proposal and circulate it within **ODOT** for review and comment. For major revisions, a special task team or advisory committee, including representatives from the **ODOT Districts** as well as agencies and organizations outside **ODOT**, including **FHWA**, may be established to review the matter and provide comments. If a change is recommended, a draft revision will be prepared.
3. If approved by the **ORE Administrator**, the draft revision will be circulated among the **Districts**, related offices in **Central Office**, and other agencies and organizations as

appropriate for review and comment.

4. The **Traffic Control Design Section** will coordinate review of comments received and preparation of revised text as needed. A final draft plus a list of any major technical difficulties, and proposed solutions, will be submitted to the **ORE Administrator** for approval.
5. If a revision of the **OMUTCD** is to be made, it will be prepared by the **Traffic Control Design Section** and a copy will be submitted to the local **FHWA** office for review and concurrence.
6. If the scope of the revision results in a complete new edition of the **OMUTCD,** it will be published to the website; otherwise, a copy of the Revision Set will be posted on the **OMUTCD** website with an updated copy of the Manual. In either case, an e-mail announcement will also be sent to all those who have subscribed to the list service for the **OMUTCD** on the **ODOT Design Reference Resource Center (DRCC)** web page.

102 TRAFFIC ENGINEERING MANUAL

102-1 General

Over the years, as a supplement to the information in the **OMUTCD**, a variety of policies, standards, procedures, guidelines, standard drawings, typical drawings and publications regarding **ODOT's** traffic engineering practices were developed and disseminated in various ways. Many of these were originally published in the **ODOT Traffic Control Application Standards Manual (ASM)**; however, others were issued separately.

As noted in the Preface, the purpose of the **Traffic Engineering Manual (TEM)** is to assure, as much as possible, uniformity within **ODOT** regarding traffic engineering concerns by consolidating all this supplemental information into one manual. Some of this information can be critical in addressing the needs of our customers, and some may just be useful in simplifying or clarifying information published elsewhere. The **TEM** should be a useful tool in training personnel new to the subject, as well as providing a resource in addressing the wide range of inquiries from our customers, **ODOT** personnel, consultants, contractors, other government agencies and private citizens.

Except as noted in specific Sections, the policies, guidelines, procedures and standards established in this Manual are applicable only to **ODOT**-maintained highways and not local roads and streets. However, local jurisdictions are encouraged to use this publication and, as noted in ***Section 100-3***, may need to reference it at times, e.g., the **OMUTCD** references the **TEM** for some information.

102-2 Organization

The **TEM** has been arranged generally in the sequence of topics addressed in the **OMUTCD**. The Manual includes fifteen parts, arranged in the following sequence:

- ***Part 1, General,*** provides information about the organization and use of this and other publications, as well as general traffic-related materials, planning/programming, design, construction and maintenance/operations information.
- ***Part 2, Signs,*** provides information about traffic control signs that supplements information in **OMUTCD Part 2.**
- ***Part 3, Markings,*** provides information about markings and islands that supplements **OMUTCD Part 3**.
- ***Part 4, Signals,*** provides information about traffic signals that supplements the basic standards in **OMUTCD Part 4**.
- ***Part 5, Low-Volume Roads,*** has been reserved to address additional information, as needed, supplementing **OMUTCD Part 5**.
- ***Part 6, Temporary Traffic Control,*** provides information about temporary traffic control devices and applications, including traffic incident management, supplementing information in **OMUTCD Part 6**.
- ***Part 7, School Areas,*** provides information about standards for traffic control in school areas, including school zone extensions, supplementing **OMUTCD Part 7**.
- ***Part 8, Railroad and Light Rail Transit Grade Crossings***, provides information about traffic controls at railroad-highway and light rail grade crossings, supplementing information in **OMUTCD Part 8.**
- ***Part 9, Bicycle Facilities,*** provides information about traffic control devices related to Bicycle Facilities and supplements information found in **OMUTCD Part 9**.
- ***Part 10,*** has been reserved for future use.

- ***Part 11, Highway Lighting,*** provides information about highway lighting.
- ***Part 12, Zones and Traffic Engineering Studies***, provides information about traffic control zones and traffic engineering studies.
- ***Part 13, Intelligent Transportation Systems (ITS)*** provides information about various aspects of this subject, such as Systems Engineering Analysis (SEA) and Freeway Management Systems.
- ***Part 14, Miscellaneous,*** provides information about miscellaneous related devices, procedures, etc., such as rumble strips and driveway mirrors, that are not directly related to any single topic discussed in one of the other Parts of the **TEM**.
- ***Part 15, Appendix*** provides information about definitions for terms used in this Manual, which are not already defined in the **OMUTCD,** and an explanation of various acronyms ***(see Chapter 1501)***. Information about other **ODOT** policies and guidelines is also provided, as well as copies of traffic-related policies and procedures referenced in the Manual.

102-3 Format

102-3.1 General

Various format conventions have been adopted for this Manual. For convenience (and as a record and reminder for those developing text for the Manual), they have been consolidated in this Section.

A Table of Contents has been provided for each Part, listing each Section, form, table or figure. An overall Table of Contents has also been provided in the front of the Manual; however, to conserve space, only the Part and Chapter headings and the underlined Section headings are shown (including the forms, tables and figures). However, to avoid clutter, the Subsection titles in the overall Table of Contents do not include the underlining used in the text.

102-3.2 Numbering/Labeling Conventions

The following numbering conventions have been used in this Manual to provide a consistent organization for each Part. This is intended to help locate information and to simplify cross-references within the **TEM**:

1. Chapters and Sections within each Part are numbered based on the Part or Chapter number. For example, in Part 1 the Chapter and Section numbers start with 100. The Chapter headings in each Part are identified with a slightly larger font shown in bold and all capital letters. Typically, the Chapter headings begin on a new odd-numbered page.
2. Material within each Part in the **TEM** is generally arranged in a set pattern, for example (with “x” representing the Part number):

    a. Chapters x10 thru x29 – general standards and guidelines information presented.
    b. Chapter x30 – Planning/Programming information.
    c. Chapter x40 – Design Information.
    d. Chapter x41 – Plan Preparation/Production information.
    e. Chapter x42 – **Plan Notes** and related designer information.
    f. Chapter x43 – a listing of related **specification** items.
    g. Chapter x50 – Construction-related material. This is generally intended to include information used in inspecting installation of traffic control devices on construction projects; however, this information may also be useful for **ODOT** force account installation of various devices.

h. Chapter x60 – Maintenance/Operations information. This generally addresses preventive maintenance and other operational issues.

i. Chapter x95 – has been reserved in each Part to incorporate discussion, as appropriate, about related, but separately published publications. For example, although the **Sign Designs and Markings Manual (SDMM)** is formally "incorporated" into the **TEM** as ***Section 295-2***, due to its size, and the fact that some people will not need both the **TEM** and the **SDMM**, the **SDMM** is published separately. To help avoid unnecessary reference to these other volumes, a brief description of each of these publications is included in the **TEM** text, with an indication of how it relates to the other information in this Manual ***(see Sections 295-2)***.

j. Chapter x96 – Forms referenced in the text, including a Forms Index with cross-references to related text Sections.

k. Chapter x997 – Tables referenced in the text, including a Tables Index with cross-references to related text Sections.

l. Chapter x98 – Figures referenced in the text, including a Figures Index with cross-references to related text Sections. Some figures may include charts.

3. Subdivisions of Chapters, Sections, have been labeled with a hyphenated number based on the Chapter number, e.g., ***Section 102-3***. The titles of these Sections are bold and underlined.

4. If further subdividing of information in a Section is needed, decimals are used with the number, e.g., ***Section 102-3.2*** and ***Section 205-2.3.1***. The titles of these subdivisions are bold, but not underlined.

102-3.3 Text

Text format in the **TEM** generally follows that used in the **OMUTCD**; however, a few additional conventions have also been used.

1. The type font used is Arial. The default font size is 10; however, size 12 has been used for the Chapter headings and the titles for the forms, tables and figures.
2. References to Sections, forms, tables and figures within the **TEM** are highlighted using bold/italic text, e.g., ***Chapter 102***.
3. References to organizations, titles, documents, etc. are highlighted using bold text, e.g., **OMUTCD**.

102-3.4 Units of Measure

ODOT's policy is to use English units as the standard.

If metric equivalents are required on a particular project and they are not available herein, or in **OMUTCD Appendix A2** or a related **SCD**, the English units shall be converted to metric units using the English to SI (Metric) Conversion Factors provided in **Table 109.02-1 of the Construction and Materials Specifications**. The appendix of **ASTM E 380** shall be utilized for any additional conversion factors required. Conversions shall be appropriately precise and shall reflect standard industry English values where suitable. The contractor and the project engineer are responsible for the accuracy of the conversions used for a construction project.

102-3.5 Definitions

As noted earlier ***(Section 102-2)***, in addition to **OMUTCD Part 1**, ***Chapter 1501*** of this Manual provides definitions of terms (including acronyms) used in this and related documents.

102-3.6 Artwork

Sign cuts for signs addressed in the **TEM** and not shown in the **OMUTCD** are included in the **TEM**. They are accurate, proportional representations of the signs.

Each form, table and figure is individually numbered and appears in the Table of Contents. Editable copies of the forms and tables are available, as well as most of the figures. Generally, editable full-size copies and pdfs of most of the forms are available on the Forms web page on the **Office of Traffic Operations** website.

102-4 Distribution

The **TEM** is available electronically from the **ODOT Office of Roadway Engineering (ORE)** and the **ODOT Design Reference Resource Center (DRRC)** websites (the addresses are provided on page ii of this Manual).

As needed, revisions of the **TEM** are currently posted to the web on a semi-annual basis (starting January 2014). It is the responsibility of the individual receiving or downloading the Manual to update it as needed. A subscription service is available on the **DRRC** website to allow interested individuals to receive e-mail notifications when updates and notices are posted. Separate Revision Sets are also available for updating paper copies.

102-5 Revisions

Maintaining/updating the **TEM** is an ongoing **ORE** function. The Publication Record (located in the front of the Manual, after the Title Page, Preface and Mission Statement) documents revisions of this Manual. Comments and suggestions from users of the Manual are anticipated and welcome.

All revisions to this Manual will be reviewed according to the following process:

1. All proposed revisions from outside **ORE** should be submitted to the **ORE Administrator or the ORE Traffic Control Design Engineer**. Preferably, a revision proposal should include a marked-up copy of the related Manual text.
2. The proposal is circulated within **ORE** for review and comment. Depending on the subject and the scope of the proposed revision, the proposal should also be circulated to the **Districts** and related Offices in **Central Office** for review and comment. For major revisions, a special task team, including representatives from outside **ORE**, may be established to review the matter and provide comments. If a change is recommended, a draft revision will be prepared by the **Traffic Control Design Section**.
3. Per **Standard Procedure 122-004(SP)**, an approved **TEM** revision proposal is submitted to the **ODOT Standards and Specifications Committee** for review and approval; and then to the **Executive Committee** for final approval.
4. If approved, a **TEM** revision is finalized and posted to both the **TEM** website and the **ODOT Design Reference Resource Center (DRRC)**. An e-mail announcement is sent to all those who have subscribed to the list service for the **TEM/SDMM** (on the **DRRC** web page).

103 STANDARD CONSTRUCTION DRAWINGS

103-1 General

Numbered **Standard Construction Drawings (SCDs)** published by **ORE** have been established to standardize inclusion of certain traffic control information in **ODOT** contract plans. The drawings are developed and published by **ORE**. In addition to contract plans, they should also be used by **ODOT** operational forces as directed in this Manual and at other times when considered appropriate. **Designer Notes** have been developed to help define the intended use of **SCDs** ***(see Section 140-3)***.

Copies of the drawings are available on-line from the **ORE Traffic SCD** website and may be purchased from the **Office of Contracts** ***(see Table 197-4)***.

103-2 Organization

The **Traffic Standard Construction Drawings (SCDs)** set is composed of individual standard drawings, grouped in four general categories, Highway Lighting (HL), Maintenance of Traffic (MT), Intelligent Transportation Systems (ITS) and other Traffic Control items (TC). The drawings in the Traffic Control group are subdivided into the following groups:

- Overhead Sign Supports, beginning with **TC-7.65**;
- Overhead Sign Supports - Associated Details, beginning with **TC-21.10**;
- Signing Electrical Details (currently there are no **SCDs** in this category);
- Ground-Mounted Sign Supports and Signs, beginning with **TC-41.10**;
- Delineation and Pavement Marking, beginning with **TC-61.10**; and
- Traffic Signals, beginning with **TC-81.10**.

103-3 Format

To promote uniformity within **ODOT**, CADD standards have been established for published documents. Generally, these standards should be used in all **MicroStation** drawings that are intended to be incorporated within the various publications. The **CADD Engineering Standards Manual** establishes specific CADD standards for use in developing plan sheets, including plan detail sheets developed for individual plans.

Although there is not one set of CADD standards for all **SCDs**, each Office developing **SCDs** has established general guidelines for its standard drawings. The **Traffic SCDs** follow the standards established in the **CADD Engineering Standards Manual** for the regular plan sheets.

Each person developing or creating **SCDs** should use good graphical judgment in the arrangement and placement of both graphic objects and blocks of text. A drawing that is loaded with text or too many highly detailed drawings may be overwhelming to the end user.

103-4 Distribution

Traffic SCDs, and the index for them, are available for downloading, as **MicroStation** or .pdf files, from both the **Office of Roadway Engineering (ORE) SCD** and the **ODOT Design Reference Resource Center (DRRC)** websites. The web addresses are also provided on page ii of this Manual. Paper copies can be purchased through the **Office of Contracts**.

Revisions are currently posted on a semi-annual basis (started January 2014). It is the responsibility of the individual receiving or downloading the drawings to update them as needed. A subscription service is available on the **DRRC** website to allow interested individuals to receive e-mail notifications when updates and notices are posted.

103-5 Revisions

Comments or questions about the drawings should be directed to the **ORE Traffic Control Design Section**.

The **Section** maintains a log of work needed on the **Traffic SCDs**, assigns drawing numbers as needed, and generally coordinates development and approval of the drawings. The **ORE Traffic Control Design Section** reviews and develops new or revised, and when considered complete, submits the proposed new or revised drawing for review and approval by the Standards and Specifications, and Executive Committees. When approved, the official "revision date" is added to the drawing and it is scheduled for distribution in the next revision. (The semi-annual revision date is used as the official "revision date" for each drawing.)

104 PLAN INSERT SHEETS

Plan Insert Sheets (PISs) are standardized drawings that may be included in plans, to modify standard details to more closely depict conditions for an individual location, to show methods of work that are not currently shown in an **SCD**, or to show a modification or variation of an existing **SCD**. They are drawings that are expected to be used in more than one plan, but for various reasons have not yet been developed into a **Traffic SCD**. Since the **SCDs** and **PISs** now follow the same review process, generally, as **PISs** are being revised they are being updated to **SCDs**.

The **Office of Roadway Engineering (ORE)** currently has a set of **Traffic PISs** that supplements the **Traffic SCDs.** These **Traffic PISs** are, available on-line from the **ORE** website, or from the **DRRC** website. For other situations, a **Plan Detail Sheet** (prepared for the individual plan) should be used.

The **Traffic Plan Insert Sheets (PISs)** use the same format as described in **Chapter 103 for the Traffic SCDs**. They also follow the same distribution and revision process as established for the **Traffic SCDs**.

105 CONSTRUCTION & MATERIAL SPECIFICATIONS

105-1 General

For purposes of the **TEM**, the general term "construction and material specifications" includes: the **Construction & Materials Specifications Book (C&MS)**, **Supplemental Specifications (SS), Supplements, Special Provision Specifications, Proposal Notes** and **Plan Notes**. As needed, these are addressed individually by number reference within the **TEM** Parts.

The **Construction and Material Specifications Book (C&MS)** contains detailed provisions, which, together with the plans and the Proposal, constitute the Contract for performance of required work. It is the official legal and technical document by which **ODOT** bids and constructs highway projects. Provisions within the **C&MS** are numbered as individual items, and generally, the reference format used herein is **C&MS Item xx** when a specific bid item is involved and **C&MS xxx** when the referenced section does not involve a bid item. For convenience, as appropriate, ***Chapter x43*** (where x is the Part number) has been reserved in each Part to provide a consolidation of information about specifications related to the topic addressed in that **TEM** Part. For example, ***Chapter 443*** provides a summary of **C&MS** sections, **Supplemental Specifications** and **Supplements** related to traffic signal equipment.

Supplemental Specifications (SS) are individual numbered documents describing the construction and material specifications for new items.

Special Provision Specifications are individual numbered specifications prepared in loose-leaf form describing the construction and material specifications for items whose requirements are not covered in the **C&MS** or in **Supplemental Specifications**.

Supplements provide necessary information such as laboratory methods of test, and certification or pre-qualification procedures for materials.

Proposal Notes contain a wide variety of legal and technical requirements necessary for the proper bidding and sale of an individual project. These notes override all other requirements in the Plan, **C&MS**, **Supplemental Specifications** and **Standard Construction Drawings**.

Plan Notes describe non-standard pay items that deviate from the **C&MS**, **Supplemental Specifications** or **Standard Construction Drawings**. As appropriate, these notes are addressed in **TEM** Parts in **Chapter x42**, where x is the Part number.

The current **C&MS** is available on-line via the **Division of Construction Management** website and from the **DRRC** website.
The **Supplemental Specifications (SS)**, **Supplements**, and **Proposal Notes** are also available on-line via the **Division of Construction Management** website.

105-2 Distribution

In addition to these publications being available on-line (see above), the **C&MS** may also be purchased from the **Office of Contracts**.

105-3 Revisions

As noted in **Standard Procedure 122-004(SP)** ***(see Section 1599)***, six standards and specifications committees process revision proposals in the major work items: Contract Administration, Geotechnical, Pavement, Structures, Hydraulics and Environmental and Traffic and Roadway. An Executive Committee gives final review and approval of all **ODOT** specifications.

All specification issues are to be addressed to the specific Committee Chairs. The Chair for Traffic and Roadway items is the **Administrator of the Office of Roadway Engineering**.

For information on requests for new product evaluations see ***Section 120-3***.

106 OTHER PUBLICATIONS

It is intended that, as much as possible, all **ODOT** traffic engineering information, especially any information pertinent to designers, will be incorporated into the **TEM**, eliminating separate publications, guidelines, standard operating procedures, etc. However, for various reasons some related traffic engineering publications may not have been physically incorporated into the text of this Manual. In some cases, they are expected to remain physically separate publications. In others, this is expected to be a temporary situation. For example, some new publications may initially be developed separately and incorporated (physically or by reference) later.

Table 197-3 provides a consolidated list of **ODOT** traffic engineering publications. These publications are available electronically from both the **ODOT Office of Roadway Engineering** website and the **ODOT Design Reference Resource Center (DRRC)** website. The respective addresses for these websites are also provided on page ii of this Manual.

Chapter 195 provides information about **ORE** publications not addressed in ***Chapters 101 through 105***.

Chapter 193 provides a listing of related national publications and ***Chapter 194*** addresses other **ODOT** publications which may contain information needed, or useful, for traffic engineering projects or studies.

Intentionally blank.

120 TRAFFIC CONTROL DEVICES AND MATERIALS

120-1 General

In general, only traffic control devices addressed in the **OMUTCD** are approved for use on public highways, and private roads open to public travel. However, new devices are being developed regularly and the fact that they are not addressed specifically in the **OMUTCD** is not intended to exclude them from use. **OMUTCD Section 1A.10** states that "Design, application, and placement of traffic control devices other than those adopted in this Manual shall be prohibited unless the provisions of this Section are followed." **OMUTCD Section 1A.10** then describes the review and approval processes for experimentation, interim approval, interpretation and changes related to traffic control devices. ***TEM Section 120-3*** provides additional details regarding **ODOT's** procedures for reviewing and evaluating new products.

In general, information about traffic control materials is located within each **TEM** Part according to the type of material involved. Information that addresses more than one type of material, such as the guidelines for handling patented or proprietary materials, or the process whereby local agencies can purchase traffic control materials and equipment using Federal funds, is addressed in ***TEM Part 1.***

120-2 Specifications

Per **ODOT Policy 16-004(P), Standard Procedure 122-004(SP)**, **Development of Standards and Specifications,** describes the procedures for development, approval, distribution and implementation of all new and revised **ODOT** specifications. For further information on **ODOT** specifications in general, see ***Chapter 105*** of this Manual. Information on specific types of traffic control devices are addressed in the individual **TEM** Parts related to the particular types of traffic control.

120-3 New Products

Per **ODOT Policy 27-014(P), Standard Procedure 515-001(SP)** establishes the process by which new products are evaluated and approved/disapproved for use. Information about the **ODOT** new products program is available on-line from the **Office of Materials Management's** New Products web page. Also see **OMUTCD Section 1A.10**.

120-4 Patented or Proprietary Materials, Specifications or Processes

Patented or proprietary materials, specifications, or processes shall not be included in a contract unless one of the following conditions applies:

1. The item is to be purchased or obtained through competitive bidding with equally suitable items. In which case, the plans shall specify a minimum of two acceptable items and include the phrase "or approved equal."
2. No equally suitable alternate exists.
3. The item is essential for compatibility with existing highway facilities.
4. The item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.
5. There is a determination by the **District Deputy Director (DDD)** that it is in the best public interest to specify one such item to the exclusion of any other acceptable alternate.

A request and justification shall be submitted by the maintaining agency to the **Office of Roadway Engineering (ORE)** with a copy to the appropriate **District**. Forms to assist maintaining agencies make a proprietary bid item request are available for download from the **ODOT Office of Local Programs** website. It is very important that each item requested include:

1. model and/or manufacturer
2. an engineering justification that details why the proprietary item is necessary.

ORE shall evaluate the request; coordinate with **FHWA** if appropriate; and subsequently notify the requesting agency of the disposition of the request. Proprietary Product Approval Request forms are available at the Local Projects office website:
http://www.dot.state.oh.us/Divisions/Planning/LocalPrograms/Forms/Forms/AllItems.aspx
All requests for traffic signal equipment shall include a table listing all signalized intersections under the agency's jurisdiction, the brand of equipment installed at each and the date of installation. A separate form is generally needed for each item and must clearly state one or more *engineering reasons* for each proprietary bid item request.

Requests shall be submitted in accordance with the Project Development Process (PDP) or the Local-let procedures, whichever is applicable.

Where research or experimentation is proposed, it will also be necessary to set up an evaluation program per the **New Product Development Policy 27-014(P)**.

In the case of traffic signals, the vast majority of alternate bid requests are made for controller items or emergency vehicle preemption. Proprietary bids shall be considered instead of alternate bids when:

1. The signal controllers are an extension of an existing arterial coordinated signal system. Typically the number of controllers being added is less than the number of existing controllers in the system. The coordinated arterial may be controlled by on-street masters, directly by a central control center or simple hardwire with time based control.
2. Greater than fifty percent of the agency's controllers are of a single brand.
3. Greater than fifty percent of the agency's signalized intersections operate with a single brand of emergency vehicle preemption equipment. The extension of preemption equipment on an existing preempted arterial will not be a basis for approval of proprietary bids for preemption equipment. Specifying the type of preemption (light, sound, radio, etc.) is a proprietary bid that requires **ODOT's** approval.
4. Greater than fifty percent of the agency's signalized intersections operate with a single brand of video detection equipment.
5. Greater than fifty percent of the agency's signalized intersections operate with a single brand of spread spectrum radio equipment. Proprietary bids will be considered if the spread spectrum radios are an extension of an existing coordinated signal system and the number of radios being added is less than the number of existing radios in the system.
6. Greater than 50% of the agency's signalized intersections operate with a single brand of UPS equipment.

There should be no upgrading of the existing equipment (controllers, preemption, video detection, spread spectrum radio, etc.), or the upgraded existing equipment will be evaluated as new/added equipment.

In accordance with **FHWA** guidance, items provided to an agency at any price below normal fair market value shall not be included as part of the proprietary calculation. Documentation may be requested verifying purchase at fair market value.

If greater than fifty percent of the agency's equipment is comprised of two brands, consideration may be given to limiting the bids to the two brands without the use of the phrase "or approved equal."

If at least fifty percent of the agency's controllers are of a single brand, central control software upgrades may be considered. The single brand controllers do not have to be currently connected to the central control. Upgraded existing controllers will be evaluated as new/added controllers.

The addition of an interconnection card to an existing controller is not considered an upgrade to the controller.

Proprietary bids for aesthetically designed luminaries, highway lighting or signal supports shall not be considered because of the numerous manufacturers of similar support designs.

In lieu of proprietary bids for aesthetically designed signal or lighting supports, alternate bids may be taken using three brands of similar aesthetically designed supports for the generic bid and an alternate bid for the preferred choice. If three brands of similarly designed signal supports are not utilized, the generic bid will be for a standard painted **TC-81.21** mast arm support.

When the **Office of Roadway Engineering (ORE)** determines that a proprietary bid is justified, written documentation must be kept on file supporting the use of proprietary items. Should the request not be approved, **ORE** will inform the requesting agency they may consider alternate bidding procedures and that Federal-aid participation will be based on the lowest price so established. **ORE** will copy the **District** on all correspondence related to the proprietary bid request.

120-5 Cooperative Purchasing Program

Under the Cooperative Purchasing Program, political subdivisions may purchase machinery, materials, supplies and other articles from the **ODOT** Annual Term Contracts and the **ODOT** Single Purchase Contracts with their own funds. A copy of the program may be obtained from the **ODOT Office of Contracts, Purchasing Services *(see Table 197-1)***.

120-6 Alternative Purchasing Program for Local Agencies

120-6.1 General

ODOT also sponsors another program with respect to the purchase of traffic control materials for installation and use by local government agencies. In this program, funding for the purchase of traffic control materials for installation and use by a requesting local governmental agency is allocated by **ODOT** to the local governmental agency and does not involve the use of **ODOT** term purchase contracts. This method was developed primarily for traffic control materials, but can encompass the purchase of other roadway appurtenances such as roadway lighting, signing and street beautification items

This purchase order procedure was originally created to provide local agencies with a means of purchasing traffic signal materials with Federal project funds. The procedure has also been used to purchase signing materials and can be expanded to include other roadway appurtenances. All materials acquired using this procedure are to be installed by the local agency without cost to **ODOT**.

If traffic signal material is involved, data must be submitted for evaluation of traffic signal warrants as contained in **OMUTCD Part 4**. The signal warrant data shall be evaluated and approved by the **District**. Assistance is available from **ORE** upon request. Only the intersections with **District** approved signal warrants are eligible for Federal funding of traffic signal materials.

The following procedure has been the process to be followed in procuring materials and equipment for purchase order contracts. These functions are also shown as a flow chart in ***Figure 198-3***. The steps shown in ***Sections 120-6.7 through 120-6.10*** are initiated concurrently.

120-6.2 Programming and Funding

The **District** shall prepare and submit the programming package to the **Office of Systems Planning and Program Management.** Any State or Federal funds allocated to the agency that are eligible may be utilized, except for nontraditional transportation funds. Funds shall be sufficient to encompass the material costs, plus preliminary and construction engineering if requested. Any additional cost in the procurement of materials due to increased costs, or to insure a completed installation, shall be the agency's responsibility unless changes are approved in advance and funds are available.

The agency's cost participation, the local share, whether due to normal project funding splits or 100 percent local cost items, shall be based on the estimate as provided by the agency in ***Section 120-6.6(2a)***.

120-6.3 Alternate Bids

Alternate bids cannot be used in the automated purchase order system. There must be only one bid item for each item.

120-6.4 Proprietary Bids *(also see Section 120-4)*

The purchasing regulations allow a vendor to supply a comparable item for any proprietary brand listed in the bid package. There are two ways to purchase approved proprietary items:

1. Appear before the **State Controlling Board** and request an exemption from the **Department of Administrative Services** purchasing regulations.
2. Have the agency use their own purchasing system to purchase the approved proprietary items. **ODOT** utilizes a "Pass Through of Federal Funds" account in the **Office of Accounting** so that the agency does not have to use their own funds in the purchase. The agency submits the invoices from the vendors to the **District** for payment. This process requires that all preliminary engineering documents and approvals be processed as if **ODOT** were the sole purchasing agent.

120-6.5 Prequalification of Materials

The agency can prequalify a number of manufacturers of a purchase order item. A minimum of three brands should be listed and the supplied item must be one of these specified brands. The agency must document the procedure or reasons for limiting bidding.

120-6.6 Bid Documents Package

The agency shall prepare the bid documents package and submit it to the **District**. The **District** shall coordinate and consolidate review comments and respond to the agency. The bid documents package shall include the following information as required:

1. Preliminary Plans or Sketches.
   a. For traffic signal projects, plans or sketches should depict existing and proposed signal operation and equipment locations. The complexity of the detail drawings will be determined by the **District** based on the extent of the signal work involved.
   b. If the work is not signal related, the drawings shall show the locations of all proposed items and any existing conditions that will be affected. Roadway lighting work may require an illumination review to determine the effect the proposed lighting will have on the roadway. Based on the scope of the roadway lighting, the **District** will determine if this review is necessary.
   c. Plans and sketches shall show right-of-way.
2. Summary of Estimated Quantities and Cost Estimate.
   a. Detailed sub-summaries with item descriptions and quantities shall be prepared. They shall be subdivided by each intersection and separately subtotaled for any funding splits.

b. Two general summaries shall also be submitted; one with the cost estimate included for **ODOT's** use and the other without the cost estimate. The general summary without the cost estimate is used in the bid package that will be sent to the vendors and will provide places for the bid prices to be stated by the vendors.

c. Usually, the project must be separated into multiple bid packages in order to group similar items so that the various vendors can bid on only the item group that they can supply.

3. Material Specifications.

   a. **ODOT's Construction and Material Specifications (C&MS)** and **Supplemental Specifications** shall be used where feasible, but may be supplemented by the agency's requirements, as necessary.

   b. **ODOT** does not review and approve shop drawings or catalog sheets. If the agency wants to review and approve these items, this requirement must be included in the material specifications.

4. Miscellaneous Documentation.

   a. Assurance that all pavement markings, signing and signal installations within the project area are, or will be, in compliance with the **OMUTCD**. This should be accomplished by a field inspection by **District** and agency personnel, with any deficiencies documented.

      The deficiencies shall be corrected by the agency prior to completion of their installation of the purchased materials. By performing this inspection early in the project development, materials can be included in the bid package to correct the deficiencies.

   b. Assurance that all work is within the right-of-way.

   c. A proposal for disposition of removed equipment.

   d. Justification of any proprietary items or specialized equipment.

   e. A schedule of the agency's installation work, based on equipment delivery dates. This should also be referenced in the agreement.

   f. Maintenance of Traffic standards which will govern the agency's work.

All plans and documents in the bid document package shall be on 8 ½ x 11 inch sheets, and the agency shall submit all computerized plans and document files to the **District** by disk or by electronic file transfer.

After the agency provides the **District** with the final, **District** approved, version of the bid documents package, the **District** will provide **ORE** with the originals of the bid documents package.

120-6.7 Requisitions

The **District** or the **Office of Accounting** will enter the project into the automated purchasing system. The **ORE Administrator** shall be added as a required authorization on the requisition.

120-6.8 Agreement

ORE will send to the **District** an agreement to be forwarded to the agency for signature.

The agreement will be reviewed by the agency, signed by the agency's contractual officer, and returned to the **District** for the **Deputy Director** to sign.

The **District** will keep the original of the executed agreement and provide copies to the agency and **ORE**.

If the agency is responsible for a share of the project costs:

1. A check shall accompany the agreement when returned to the **District**.

2. The **District** shall forward the check to the **Office of Payroll and Project Accounting** and that office will ensure that the agency's check is properly credited to the project and processed. The **District** will furnish **ORE** with a copy of the check transmittal letter.

120-6.9 Federal Approval

If Federal funding is involved, **ORE** will submit a bid document package, excluding the agreement, to the **Office of Payroll and Project Accounting** to obtain PS&E approval from **FHWA**.

120-6.10 Pass Through of Federal Funds

If a "Pass Through of Federal Funds" process is used, as described in ***Section 120-6.4***:

ORE will request that the **Office of Accounting** establish the account and create the requisition for the agency's items. The **Office of Accounting** shall add the **ORE Administrator** as a required authorization on the requisition.

120-6.11 Approval and Invitation to Bid

When all of the concurrently initiated actions in ***Sections 120-6.7 through 6.10*** are finalized, **ORE** will:

1. Approve the electronic requisitions so they proceed to **Purchasing Services** in the **ODOT Office of Contracts**;
2. Forward the bid documents package to **Purchasing Services** to process an Invitation to Bid; and
3. Advise the agency to proceed with their purchase process if a "Pass Through of Federal Funds" process is used ***(see Section 120-6.4)***.

120-6.12 Recommendation for Award of Bids

After the bids have been received and reviewed by **Purchasing Services**, they will be tabulated and sent to **ORE**. **ORE** shall process the bids as follows:

1. Discuss the bids with the **District** and the agency and make award recommendations.
2. In the case of Federal projects with active Federal oversight, obtain **FHWA's** concurrence with the award recommendations.
3. Forward award recommendations to **Purchasing Services** for further processing.

120-6.13 Purchase Order

Purchasing Services will create the purchase orders to be issued to the supplier. The purchase order shall include:

1. A "Shop Drawing" note indicating that material catalog sheets or data sheets shall be submitted to the agency before any material is shipped; and
2. A note that all invoices are to be mailed directly to the **District** and materials shipped to the agency.

For those items requiring certified test data as determined by the **District**, the Purchase Order shall also indicate that submissions are required to be submitted to the **District** by the supplier. This would include any submissions which contain a material composition analysis which must be in accordance with a recognized standard.

120-6.14 Catalog Sheets, Certified Test Data and Testing

If specified in the project specifications, catalog sheets shall be received and reviewed by the agency. The agency will indicate comments on the catalog sheets as to the acceptability of the submitted items and their compliance with the material specifications. The submittal shall be marked "Approved," "Approved as Noted," or "Not Approved," and will be transmitted to the various affected parties.

The agency shall notify the material supplier as to the acceptability of the submitted product, thus enabling them to commence fabrication and/or shipping in the case of an approval, or to make other arrangements in the case of disapproval. The supplier will be advised to send invoices to the **District**.

Certified test data shall be received by the agency with material shipment. It shall be sent to the **District** for review and retention.

Submittals requiring testing shall be conveyed to the **District Highway Management Administrator** and the **Office of Materials Management** for review and approval.

120-6.15 Inspection of Material Received

Upon receipt of materials, the agency shall contact the **District** to arrange for the inspection of the materials and completion of the necessary **Receiving Forms (MR-541)** and **Field Inspection Report (TE-30)** if required. If only **Receiving Forms (MR-541)** are necessary, the **District** may direct the agency to fulfill this function.

120-6.16 Invoice Payment

The following shall be submitted to the **District** for payment: invoice, **Invoice Coding Strip (AU-60), Receiving Form (MR-541)**, **Field Inspection Report (TE-30)** if required, and certified test data if required.

120-6.17 Project Completion

Upon project completion, the agency shall contact the **District** to arrange a final field inspection. If Federal funding was used and the project has direct Federal oversight, **FHWA** shall be included in the process and its representative should be given copies of all approved certified test data submittals.

After completion of the inspection and correction of any deficiencies, the **District** will document that **ODOT** accepts the physical work as performed by the agency. The **District** will also document that any deficiencies identified in the engineering phase of project development have been corrected.

The **District** shall formally advise the **Office of Payroll and Project Accounting** when the project is completed and acceptable to **ODOT** and **FHWA**. With this information the **Office of Payroll and Project Accounting** will seek final Federal reimbursement of project funds. This process will finalize the project.

120-7 <u>Alternate Bids for Traffic Control and Lighting Items</u>

120-7.1 General

The alternate bid procedure has been established to permit a local agency to obtain a specific brand, feature or design of traffic control or lighting device for use on a project.

Some of the generalized uses of the procedure are as follows:

1. To obtain a specific brand and model of equipment, which is expected to simplify maintenance and operation or reduce operating costs.
2. To obtain supports which include architectural features or designs used exclusively within the jurisdiction of the local agency, and which are more expensive than the support designs normally used in **ODOT** plans. This may include items in local areas with historic or theme backgrounds.
3. To obtain a specialized design feature which is patented or manufactured by only one supplier, and which the agency expects will improve maintenance or operation.
4. To obtain devices which are not presently justified for efficient use on the project or are not acceptably justified by agreed future conditions, but which the local agency believes will be necessary at some future time.
5. To obtain items whose extra costs are not justified when lower cost items can provide acceptable results.

120-7.2 Eligibility

The local agency should inquire from the **District Planning and Engineering Administrator** as to whether or not an item is eligible for normal project participation. In many cases where a precedent has not been established, the request is reviewed with **FHWA** (when Federal funds are involved) and a decision is rendered. This request may be made informally or in writing depending on the nature of items involved and precedents already established. If it is determined that alternate bids are necessary, the local agency shall submit a request in writing through the appropriate **District** that alternate bids be taken. ***Figure 198-5*** shows a sample letter which may be used by local authorities to request alternate bids.

Each request must include the following information:

1. Specific brand (and model) or design features desired.
2. Reasons why the local agency desires the product or feature in question.
3. Locations for use on the project under consideration.
4. Past history or experience with the product where applicable.
5. Confirmation that the local agency understands the procedures of the alternate bid process ***(Section 120-7.3)***.
6. Name and telephone number or email address of the responsible authority within the local agency to be contacted after the bid opening to determine the disposition of the alternate bids.

120-7.3 Procedure

The alternate bid procedure consists of adding a second bid item (alternate bid) for each general (generic) bid item which is affected by the local agency's special requirements. The generic bid item reflects the customary item that is sufficient to meet the needs of the project and is eligible for normal project participation. The alternate bid item describes a similar item that will satisfy the same needs of the project but also contains the local agency's special requirements. After bid opening, **ODOT** compares the costs of generic versus alternate bids for the affected bid items. In the event the generic items are bid at a higher price than the alternate items by the successful bidder, the award will normally be made on the basis of the alternate items with no additional cost incurred by the local agency. In the event the alternate items are bid at a higher price than the generic items, the maintaining agency will have the opportunity to either reject the alternate bids or to agree to accept the alternate bids with the understanding that local agency funds will pay the entire cost differential between the alternate bid and the generic bid.

A representative of the **District** will contact the responsible authority of the maintaining agency ***(see Section 120-7.2, item 6)*** by telephone or email and furnish unit prices and total bids for the generic and alternate bid items involved, including cost differentials for the apparent low bidder. Where the alternate bid process involves more than one item description, alternate bids can be selectively accepted or rejected; however, similar equipment types should be grouped together, such as all controller bid items or all preemption bid items. Only a limited period of time (one or two days) will be available for the maintaining agency to make known their preference by return telephone call or email (if time is needed to deliberate the preference) and to forward a letter with written confirmation to the **District**.

The apparent low bidder for the project will be determined solely on the lowest bid prices submitted. The cost differential presented to the local agency will be based only upon generic and alternate bid prices submitted by the apparent low bidder. Alternate bid prices submitted by other bidders will not be considered when determining the local agency's added costs.

The project must be awarded or rejected within ten days of the bid opening; therefore, **ODOT** must receive the local agency's written acceptance of the alternate bids within the time period or **ODOT** may award the project on the basis of the lowest bids. If the local agency refuses the alternate bids, written confirmation is still required for **ODOT** documentation. The letter of confirmation must be sent directly to the **District Planning and Engineering Administrator**. The letter shall also include a statement of willingness of the maintaining agency to pay the entire difference in cost, if the local choice is alternate bids involving a higher cost than that for generic bid items. The letter shall be signed by the contractual officer for the local agency. ***Figure 198-6*** shows a sample letter that may be used by local authorities to acknowledge acceptance or rejection of the alternate bids.

Intentionally blank.

130 PLANNING / PROGRAMMING

130-1 General

This Chapter is intended to provide general background information in the planning and programming areas. Specific planning and programming concerns will be addressed as needed in the individual Parts.

130-2 Engineering Studies

130-2.1 General

OMUTCD Section 1A.09 states that "the decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment." Therefore, while the **OMUTCD** and this Manual provide standards and policy information, neither manual can be a substitute for engineering judgment.

130-2.2 Scope of Studies

The scope of the study needed to determine what traffic control device to use, and how to use it, in a particular situation will depend on the specifics of the situation. As noted in ***Section 193-14***, the **ITE Manual of Transportation Engineering Studies** is useful in providing guidance on preparing, conducting and analyzing different types of traffic studies. Additional information about specific types of traffic engineering studies (e.g., Safety Studies, Speed Studies, Ball Banking Studies and Systematic Signal Timing and Phasing Program and Road Safety Audits) is provided in ***Part 12***.

130-2.3 Assistance to Other Jurisdictions

For those jurisdictions with responsibility for traffic control that do not have engineers on their staff, **OMUTCD Section 1A.09** indicates that they should seek such advice from others, including **ODOT**. Aside from the community service aspect, this sharing of experience and ideas will help encourage uniformity in the design and use of traffic control devices. Hopefully, this Manual will provide some help in supporting these jurisdictions. However, it is inevitable that questions will arise, and **ODOT** will continue to help other jurisdictions as much as possible within the constraints of **ODOT's** personnel and workload limitations.

The Circuit Rider Program sponsored by the **Ohio LTAP (Local Technical Assistance Program) Center** is designed to provide free on-site training classes on subjects such as work zone traffic control and safety to local governments. The **Ohio LTAP Center** also has other resources available to help local agencies, including a quarterly newsletter.

130-3 Design and Roadside Safety Issues

Generally, the **OMUTCD** addresses design and roadside safety issues only as they apply to the application of specific traffic control devices. Additional detail information on such issues as clear zone, barriers, supports, impact attenuators and rumble strips are available in the **L&D Manual Volume One**, the **C&MS**, and in the **Roadway and Traffic SCDs**.

130-4 Functional Classification

The Functional Classification System is a method of classifying streets and highways based on their general characteristics. This classification system has been used over the years to establish a systematic method of categorizing the range of facilities that make up the overall highway network. Historically, one of the most important and common uses of this tool has been to identify streets and highways eligible for certain types of funding.

The Functional Classification System groups streets and highways in a hierarchy based on the type of highway service they provide. The **Highway Functional Classification - Concepts, Criteria and Procedures** manual, published by **FHWA**, basically established the current system in 1974. The different functional systems are defined in that manual, and general concepts and characteristics used to identify each are presented, as well as the procedure to follow in designating a system. The **Office of Program Management (Division of Planning)** is responsible for administering this system.

In general, highways can be categorized as arterials, collectors or locals. However, depending on whether the route is considered urban or rural, the classifications are also broken down into smaller categories, e.g., rural principal arterial, rural minor arterial, rural major collectors and urban collectors. Additional information, as well as an inventory of the functional classifications of streets and highways in **Ohio**, including maps, is available from the **Program Management** website. This information is also now available through TIMS (Transportation Information Mapping System).

130-5 National Highway System (NHS)

The National Highway System (NHS) consists of interconnected urban and rural principal arterials and highways (including toll facilities) which serve major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities and other major travel destinations. NHS routes meet national defense requirements and serve interstate and interregional travel. All routes on the Interstate System are a part of the NHS.

The NHS includes all high-priority corridors identified in **Section 1105(c)** of the **ISTEA**. It was originally not permitted to exceed 178,250 miles; however, legislation known as **MAP-21** expanded the system. Most of the state highway system is on this national network. Maps of the system are available on-line. This information is also now available through TIMS (Transportation Information Mapping System).

130-6 Access Management

Access is critical to the usefulness of any transportation system. However, the combination of increasing travel demands and an increasing demand for access points (intersections and driveways) along the highways can result in increased congestion and delay, and can contribute to an increase in accidents. By controlling access to our highway system, a better balance can be achieved between these competing demands.

ODOT has developed an Access Management Program based on the functional classification of roadways ***(Section 130-4)***. The program is administered by **Central Office** with input from the **Districts**. The **State Highway Access Management Manual** ***(see Section 194-17)*** was developed to support this program. It is available from the **Office of Roadway Engineering (ORE)** website. The purpose of this program and the manual is to establish uniform permit procedures for use in considering requests for new or revised highway access.

Access management involves many areas of concern, including planning, design, construction, maintenance and traffic operations. Anyone expected to address traffic operations concerns should become familiar with the permit procedures and best practice information contained in the **Access Management Manual**.

130-7 Railroads and Highway-Rail Grade Crossings

The presence of a railroad within a project creates an area where specific planning is necessary in order to successfully complete a project. Generally, railroads have very specific requirements in regards to working within their property, commonly referred to as the right-of-way. Access is granted through an agreement intended for such purpose and may impact many stakeholders including **ODOT**, local agencies, engineering firms and contractors. Many of the requirements are imposed upon the railroad by the **Federal Railroad Administration** and for which the railroad has no authority to grant a waiver or exception. These include items such as working distance from an active track, flagging, protection of train moves, railroad protective insurance, etc. Each of the parties involved in the project will usually be required to execute an agreement prior to having access to the right-of-way. Time must be allocated for execution of agreements as well as funding for railroad work.

When a project involves a highway-rail grade crossing, it requires attention from the beginning of the project to properly plan for railroad related costs. Any work regarding surface or signal improvements will require coordination with the railroad which will result in the production of an estimate of cost for the proposed improvements. The process adds time and complexity whenever a traffic signal is located within the distance from the crossing that preemption and interconnection with the railroad warning system is required. In some cases, the cost of the railroad signal work may well exceed the cost of the entire signal project. The **Ohio Rail Development Commission (ORDC)** and the **Public Utilities Commission of Ohio (PUCO)** are both valuable assets to assist with railroad coordination. Refer to ***TEM Part 800*** for additional information required to properly plan for projects which require railroad signal work.

Intentionally blank.

140 DESIGN INFORMATION

140-1 General

This Chapter addresses information related to traffic control design in general. Design information related to specific areas of traffic control is located in the individual **TEM** Parts.

140-2 Traffic Control Plan Requirements

140-2.1 General

Submissions of traffic control plans shall conform to the requirements noted herein.

140-2.2 Base Plan Scale

The Base Plan shall consist of two parts:

1. Part A, to a scale of 1"= 200' (1:2000) or 1"= 100' (1:1000) continuous for the entire project, shall show all proposed roadways and connections to existing construction.
2. Part B of the Base Plan shall show supplemental coverage to a minimum scale of 1"= 50' (1:500) for all interchanged crossroads and mainline at-grade intersections, and for other critical at-grade intersections in urban areas.

On some projects, particularly in urban areas, it may be more efficient to show the entire project on one plan at 1"= 50' (1:500) or 1"= 20' (1:200) scale.

Information on traffic signal Base Plans is contained in ***Section 441-2***.

140-2.3 Plan Information

Plans and details involving permanent traffic control items, such as pavement markings, signing and signalization, shall be prepared in accordance with the **OMUTCD** and the **Signal Design Reference Packet** ***(Section 495-2)***.

Base Plans shall contain the following design information:

1. Clearly defined pavement edges, speed change lanes, ramps, transitions, raised medians, islands and bridge structures on mainline, ramps and crossroads.
2. Number of lanes on each roadway, shown by directional arrows (one for each lane); and lane widths (plans should show all lane widths).
3. Pavement width at each overhead sign support spanning the roadway at a location not conforming to the typical roadway section.
4. Location of proposed traffic control devices, using the **OMUTCD** as a guide. Plan symbols, levels, weights and colors for CADD drawings shall conform to standards contained in the **CADD Engineering Standards Manual**.
    a. Proposed sign legends at each sign location. All the Regulatory and Warning Signs proposed for the crossroads or at-grade intersections may be shown on Part B.
    b. For Part A show pavement marking at merging, diverging or intersecting roadways. Show painted gore stations for merging and diverging roadways. For Part B, complete pavement marking should be shown.
    c. Indicate "Signalized Intersection," if existing or proposed.
    d. Other special devices that may be required.

140-2.4 Miscellaneous Data

Each submission should include:

1. Existing overhead electrical and communication lines.
2. Underground utility facilities as required by **ORC Section 153.64**. “Underground utility facilities" includes any item buried or placed below ground or submerged under water for use in connection with the storage or conveyance of water or sewage; or electronic, telephonic, or telegraphic communications; electricity; electric energy; petroleum products; manufactured, mixed, or natural gas; synthetic or liquefied natural gas; propane gas; or other substances. "Underground utility facilities" includes, but is not limited to, all operational underground pipes, sewers, tubing, conduits, cables, valves, lines, wires, manholes, and attachments…””
3. Available power source service points and poles available.
4. Location of existing traffic control items and <u>ownership</u> in the project area (this can be a separate plan and/or listing).
5. Corporation lines.
6. Right-of-way lines.

140-2.5 Supplemental Plan Information

Each submission shall be accompanied by one print of each of the following:

1. Roadway profiles for all roadways within the project showing vertical clearance at grade separations (i.e., copy of line and grade submission, as approved).
2. Typical sections for all roadways within project.

140-2.6 Supplemental Design Information

Each submission shall include a summary or checklist addressing the following items:

1. Signs.
   a. Level of signing proposed, ground mounted or overhead.
   b. Comment or indication on the Base Plan whether signs or other traffic control devices on adjoining projects under construction, or open to traffic, should be revised to fit the traffic pattern change resulting from the proposed project.
2. Highway lighting.

   Extent of lighting proposed to be installed for the project, or status of determination; and type of voltages available.
3. Signals.
   a. A review of traffic volumes at each intersection shall be made to determine the possible need for traffic signals.
   b. If the geometric design is predicated on signalization (submit statement to this effect) or a review of volumes reveals the need, an analysis of traffic signal warrants **(OMUTCD Chapter 4C)** shall be made for the intersection, based on the traffic projected to the estimated construction completion year.
   c. If signals are warranted, a warrant analysis for each intersection shall be submitted along with capacity analysis.
   d. Indication of location and reason for any temporary signalization that may be required for traffic control during construction.

e. If any existing traffic signals are affected by the proposed project, furnish complete information on the existing signal to the extent possible, including type of controller, location of poles, type of poles, ownership of poles, signal heads, detectors, etc.

4. Miscellaneous Data

   a. Design Year, Design Speed, Legal Speed Limit and Directional Design Hourly Volume for all roadways. At intersections show all through and turning volumes.
   b. A list of all design exceptions.

140-2.7 Reuse of Equipment

Any signs or overhead sign supports to be reused should be indicated on the plans. Ground-mounted supports may be reused in place, but shall not be removed and re-erected. Any decision to reuse existing equipment must be based on a field check of the structural integrity and condition of the devices.

140-3 Designer Notes

As deemed necessary, **Designer Notes** are prepared to help define the intended use of **SCDs** and **Plan Notes**. The information is also addressed in ***Chapter x41*** (Plan Preparation / Production), where x is the related **TEM** Part number. **Designer Notes** related specifically to the use of the **Plan Notes** are located in this Manual with the individual **Plan Notes** ***(Section 140-4)***.

140-4 Plan Notes

Plan Notes for Maintenance of Traffic concerns and other traffic control items are currently in ***Chapter x42*** (where x is the Part number) in each **TEM Part**.

140-5 Plan Detail Sheets

Plan Detail Sheets are similar to **Traffic Plan Insert Sheets**, but are prepared for use in an individual, specific plan ***(see Chapter 104)***.

140-6 Estimating

Compilations of previous Contract Bid Item information are available on-line from the **Office of Estimating**. That **Office** should be contacted for any additional information needed on estimating.

140-7 Review Submissions

As part of **ODOT's Project Development Process** ***(see Section 194-10)***, the following traffic control design submissions may be required:

1. Alternate Evaluation Report (AER) Design – Task 2.3
   a. Maintenance of Traffic Alternative Analysis (MOTAA) including Queue Analysis (for interstate or interstate look-alikes) ***(see Section 630-5)***.
   b. Documentation of highway lighting considerations and warrants ***(see Chapter 1103)***.
   c. Maintenance of Traffic investigations (for non-interstate or non-interstate look-alikes).
   d. MOT Policy Exception Request (MOTEC/PIAC), if necessary ***(see Section 601-2).***
   e. Signal warrants ***(see Chapter 402)***. This submission, based upon an analysis of traffic counts, traffic projections, pedestrian information, intersection geometrics and physical conditions, speeds, gaps, delay data and accident history is prepared according to the requirements of the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**. It is intended to determine locations where traffic signals are justified. New traffic signals, or

significant modifications to existing signals, will not be included in contract plans unless acceptably justified.

f. Documentation of Proprietary Bid Justification ***(see Section 120-4)***.

g. Documentation of alternate bid considerations for signal and lighting equipment ***(see Section 120-7)***.

2. Stage 1 Design – Task 2.7 – ITS Systems Engineering Analysis ***(see Section 1301-3).***

3. Stage 2 Design – Task 3.3.

   This submission is intended to present a complete concept of how traffic control devices (signing, signals, markings, highway lighting and maintenance of traffic) will control traffic in relation to the roadway geometric design, physical conditions, traffic characteristics, and the surrounding environment. These submissions portray the type, approximate locations, size, color, shape, legend and operational characteristics of the proposed traffic control devices. These concepts, applications and preliminary designs shall be in accord with the **OMUTCD**. They should also conform to the criteria and recommendations of the **ODOT Construction and Material Specifications (C&MS)**, **SCDs**, and **TEM**, as well as other current publications dealing with the proper use of traffic control devices.

   a. Maintenance of Traffic sequence of operations and local alternated detour notes.
   b. Maintenance of Traffic Phasing Plans including:
      i. Location of proposed work, by phase.
      ii. Existing and maintenance of traffic signing and pavement marking.
      iii. Median crossovers.
      iv. Channelizing devices (e.g., barriers, drums).
      v. Work zone lane widths.
      vi. Pavement for maintaining traffic.
      vii. Sections showing existing and proposed pavement and lane widths.
      viii. Crash cushions.
   c. Detour map.
   d. Pavement Marking and Signing Plan Sheets ***(see Chapter 211 and Sections 240-8, 340-2 and 341-2)*** with SignCad files on a CD ***(see Section 211-4)***.
   e. Signal Plan sheets ***(see Section 440-7)***.
      i. SWISS files on a CD ***(see Section 440-5)***.
      ii. Synchro files on a CD ***(see Section 440-6)***.
   f. Lighting Plan sheets ***(see Chapter 1141)***.

4. Stage 3 Detailed Design – Task 4.2

   These are a complete set of construction plans, submitted as ready for **Contract Sales** ***(see Sections 240-8, 340-2 and 440-7 and Chapter 1141)***. It contains, or properly refers to, all information and details necessary to furnish, erect and complete the required traffic control devices. It includes notes, details, calculations, specifications, quantities and information on payment and other contractual obligations.

140-8 Salvage of Project Materials

The costs associated with delivery of salvaged project materials are eligible for Federal funds. The contractor may be directed to deliver the salvaged items to a maintaining agency's facility. The facility shall be located a limited distance from the project; within the same County for an **ODOT** project.

If the maintaining agency elects not to have the salvaged materials delivered, the contractor shall be directed to temporarily store salvaged project materials on site for pick-up by the maintaining agency. If the maintaining agency does not pick up the materials within the designated time period with their own forces, then the materials shall become the property of the contractor.

140-9 Spare Parts

Spare parts purchased as part of a project are not eligible for Federal participation.

Intentionally blank.

150 CONSTRUCTION

150-1 General

The **C&MS**, together with the plans and Proposal, constitute the contract for the performance of required work. It is the legal and technical document by which **ODOT** bids and constructs highway projects. Traffic control provisions in these documents are required to be in conformance with the **OMUTCD**.

Temporary traffic control issues are addressed in **Part 6** of this Manual. Other construction issues that are related to specific areas of traffic engineering are addressed in the applicable **TEM** Parts.

Although the related information provided in individual **TEM** Parts is intended primarily to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices, it may also be useful for maintenance personnel performing the same functions. It can also be useful in helping designers understand/visualize the work involved. Typically, inspection procedures for the various types of traffic control devices are outlined to assist project personnel in performing their duties. The information points out the various important features of each device and references the applicable specification or standard drawing. Illustrations are often used for easy recognition of the device or feature being discussed.

150-2 Pre-Construction Conference

During the Pre-Construction Conference held for the project the following items relative to traffic control devices may be reviewed:

1. Inspection of signs, supports and other traffic control devices.
2. Traffic control devices for maintaining traffic.
3. Any work zone speed zones related to the project.
4. Certifications of sign and signal supports.
5. Approval requirements for catalog cuts of traffic control devices.
6. Delivery schedule of traffic control devices.
7. Storage and special care for traffic control devices.
8. Plans for maintenance of traffic.
9. Staking of foundations for sign and signal supports and pull boxes.
10. Location of overhead utilities and underground facilities.
11. Coordination required with utilities for necessary relocations and attachments to their facilities.
12. Sequence of construction for traffic control devices.
13. Coordination required with local agencies for erection of new devices and removal or relocation of existing devices.
14. Work by other contractors and agencies.
15. Layout procedure for pavement markings.
16. Visibility inspection of traffic control devices.
17. Partial and final acceptance and opening to the road users.

150-3 Local Government Agency / Utility Force Account Work

150-3.1 General

Procedures for administering force account work ***(see Section 1501-3)*** associated with an active construction project are described herein, and they are also shown as a flow chart in ***Figure 198-4***.

Federal requirements for the use of force account work on **Federal-Aid** projects can be found in **23 CFR 635 Subpart B** and **FHWA Order 5060.1**.

150-3.2 Procedure

Force account proposals shall be submitted and evaluated prior to PS&E so that funds can be encumbered in a timely manner.

The agency proposing to perform the work shall submit the following information to the appropriate **District** for review and approval:

1. A Force Account Proposal documenting the work to be performed and why. It should include a detailed work description, an estimate, and explanation of the need for the work and why it is best performed by the force account method.

2. Plan Drawings that are clear enough to be followed by an engineer not familiar with the project. They shall define the extent and details of the necessary work, and they should include or refer to standards of quality which the work must meet (i.e., **ODOT Specifications, Ohio Manual of Uniform Traffic Control Devices, National Electric Code, National Electric Safety Code**, etc.)

3. A cost comparison which includes a comparison between the agency's proposed cost and the cost of having the work performed by the contractor.

In order to be approved, the above submittal must show that the force account method is cost effective assuring the lowest overall cost.

The **District** shall: review the submittal; and if it finds the proposal and other documentation to be acceptable, draft a tentative agreement between **ODOT** and the requesting agency. The agreement shall be sent to the requesting agency for signature.

Upon its return, the agreement shall be sent to the **Office of Project Coordination** which will arrange to obtain the **Director's** signature. As part of the transmittal IOC to the **Office of Estimating**, an encumbrance number shall be requested for the force account work. The IOC shall also contain the estimated cost associated with the force account work.

After the agreement is signed and an encumbrance number assigned, the **District** shall return a copy of the executed agreement along with formal approval of the proposal to the agency.

At such time as the work is being performed, the responsible agency will submit its billings to the **District** for review and approval. If the charges are reasonable and are in conformance with the proposal, they shall be forwarded to the **District Business and Human Services Administrator** for payment.

160 MAINTENANCE / OPERATIONS

As needed, specific operational issues will be addressed in the related **TEM** Parts. In general, it is intended that, when included, these issues will be addressed in Chapters numbered in the x60's, where x is the **TEM** Part number.

Although the construction information provided in the individual Parts (in Chapters numbered in the x50s, where x is the **TEM** Part number) is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices, it may also be useful for maintenance personnel performing the same functions. Typically, inspection procedures for the various types of traffic control devices are outlined to assist project personnel in performing their duties. The information points out the various important features of each device and references the applicable specification or standard drawing. Illustrations are often used for easy recognition of the device or feature being discussed.

ODOT personnel performing work involving signing, traffic signals, lighting, markings or maintenance of traffic are required to comply with the requirements of the **OMUTCD**. Other requirements, such as other **ODOT** policies, standards, procedures, etc. that are related to specific areas of traffic engineering will be addressed in the applicable **TEM** Parts.

The **C&MS** and the **SCDs** should be used by **ODOT** operational forces as directed by this Manual and at other times when considered appropriate. They provide a wealth of information on construction requirements, materials and details that should prove helpful in the performance of maintenance, upgrading, removal and inspection of traffic control devices. However, it should be recognized that the information in the **C&MS** and the **SCDs** is designed for contract work and does not necessarily provide the only acceptable method or materials to achieve a given objective.

170 OTHER CONSIDERATIONS

Depending on the specifics of a particular location, various special considerations, such as pedestrians, bicycles, motorcycles, public transit vehicles, commercial vehicles, airports and waterways, may have to be addressed in developing traffic control standards. As needed, information on these concerns will be incorporated within the individual Parts of this Manual.

180 RESEARCH

This Chapter in each **TEM** Part has been reserved to document pertinent research information.

OMUTCD Section 1A.10 prohibits the design, application and placement of traffic control devices other than those adopted in the **OMUTCD** unless the provisions of **Section 1A.10** are followed. All such requests are sent to **FHWA**. For **ODOT**, the **Office of Roadway Engineering (ORE)** coordinates this process. Local authorities submit such requests to **FHWA** with a copy to the **ORE Administrator**.

Intentionally blank.

193 NATIONAL REFERENCE RESOURCES

193-1 General

This Chapter provides a brief description of related national publications (based on on-line descriptions), and how they apply to **ODOT** projects and work. Copies of these publications can be ordered by contacting the agency or organization publishing the document. For documents published by **FHWA**, contact the **Government Printing Office (GPO).** See ***Table 197-1*** for contact information for the **GPO** and other resource agencies and organizations.

The following publications have been listed generally in alphabetical order; however, for convenience later additions to the list may be added to the end of the group, rather than renumbering all other entries.

193-2 AASHTO Design Guide (A Policy on Geometric Design of Highways and Streets)

A Policy on Geometric Design of Highways and Streets, published by the **American Association of State Highway and Transportation Officials (AASHTO)** and commonly known as the **AASHTO Design Guide** or the "Green Book," discusses nationwide policies, practices and criteria for the geometric design of highways and streets. It is intended to present a consensus view on the most widely accepted approach to the design of a variety of geometric design elements including design speed, horizontal and vertical alignment, cross section widths, intersections and interchanges.

The geometric design treatments addressed in the **ODOT L&D Manuals** are based, at least in part, on the **AASHTO Design Guide**.

193-3 AASHTO Guide for the Development of Bicycle Facilities

The **AASHTO** **Guide for the Development of Bicycle Facilities** provides information on the development of new facilities to enhance and encourage safe bicycle travel. Planning considerations, design and construction guidelines, and operation and maintenance recommendations are included.

193-4 AASHTO Roadside Design Guide (RSDG)

The **Roadside Design Guide (RSDG)**, published by **AASHTO,** is a synthesis of current information and operating practices related to roadside safety. It focuses on safety treatments that can minimize the likelihood of serious injuries when a motorist leaves the roadway.

The **OMUTCD**, the **TEM** and the **L&D Manuals** address roadside safety issues. The roadside safety criteria are generally based on the criteria presented in the **Roadside Design Guide**.

193-5 AASHTO Roadway Lighting Design Guide

The **Roadway Lighting Design Guide**, published by **AASHTO**, replaces the 1984 publication entitled **An Informational Guide for Roadway Lighting** and provides a general overview of lighting systems from the point of view of the transportation departments and recommends minimum levels of quality.

The **TEM** addresses highway lighting in ***Part 11.*** The highway lighting criteria in that Part are based on this **AASHTO** publication and other documents, and tailored to the prevailing practices and conditions in **Ohio**. Also, the **TEM** is intended to clarify, where needed, the issues presented in this **AASHTO** publication and to discuss lighting information not included in it.

193-6 ADA Accessibility Guidelines

The **ADA Accessibility Guidelines**, published by the **U.S. Access Board**, presents nationwide accessibility criteria for individuals with disabilities. Initially these guidelines were intended to establish the criteria mandated by the **Americans with Disabilities Act (ADA) of 1990**, providing accessibility criteria for interior and exterior facilities, including parking spaces, sidewalks, hallways, doorways, curb ramps, ramps, stairs, telephones, drinking fountains, rest rooms, elevators, etc. They have since been updated to include communications and IT systems, recreation facilities, streets and sidewalks, etc.

193-7 (ANSI/IES Approved) Roadway Lighting (RP-8)

This Recommended Practice (RP) for **Roadway Lighting (RP-8)** provides the design basis for lighting roadways, adjacent bikeways and pedestrian ways. It deals entirely with lighting and does not give advice on construction. It is not intended to be applied to existing lighting systems until such systems are redesigned. Roadway lighting is intended to produce quick, accurate and comfortable vision at night that will safeguard, facilitate, and encourage vehicular and pedestrian traffic. The proper use of roadway lighting is also associated here with certain economic and social benefits including a reduction in nighttime accidents, aid to the police, facilitation of traffic flow, and the promotion of business during nighttime hours.

193-8 (ANSI Approved) Tunnel Lighting (RP-22-11)

The information in the **Illuminating Engineering Society's** Recommended Practice **Tunnel Lighting (RP-22-11)** assists engineers and designers in determining lighting needs, recommending solutions, and evaluating resulting visibility at tunnel approaches and interiors. The design criteria and procedures included in this Recommended Practice (RP) are based on theory and on information drawn from practical experience and engineering judgment.

193-9 FHWA Lighting Handbook

This **Lighting Handbook** presents guidance in the planning, design, operation and maintenance of roadway lighting systems. It is intended to present a consensus view on the most widely accepted approach to providing a reasonable roadway lighting system.

The **TEM** addresses highway lighting in ***Part 11***. The lighting criteria in it are based on the criteria presented in this handbook and other documents. They are tailored to meet the prevailing practices and conditions in **Ohio**.

193-10 FHWA Railroad-Highway Grade Crossing Handbook

The **Railroad-Highway Grade Crossing Handbook**, published by **FHWA**, presents guidelines for prioritizing improvements to highway-rail grade crossings and information on the various types of improvements that can be made to the crossing. Procedures, models and computer programs which will assist making these selections are described.

193-11 Highway Capacity Manual (HCM)

The **Highway Capacity Manual (HCM)**, published by the **Transportation Research Board (TRB)**, presents nationwide criteria for capacity analyses for highway projects. The **HCM** includes methodologies for freeways, weaving areas, freeway/ramp junctions, two-way two-lane facilities, signalized intersections, non-signalized intersections, etc. The latest **HCM** is also available on a CD-ROM, which adds tutorials, narrated example problems, explanatory videos, navigation tools, and hyperlinks between sections.

ODOT uses the **HCM** for capacity analyses with some adjustments for local factors.

193-12 Highway Safety Manual (HSM)

The **Highway Safety Manual (HSM)** was developed to help measurably reduce the frequency and severity of crashes by providing a variety of tools/methods for considering safety in the project development process. The HSM assists practitioners in selecting countermeasures and prioritizing projects, comparing alternatives, and quantifying and predicting the safety performance of roadway elements considered in planning, design, construction, maintenance and operation.

193-13 ITE Manual of Traffic Signal Design

The **Manual of Traffic Signal Design**, published by the **Institute of Transportation Engineers (ITE)**, presents fundamental concepts and standard practices related to traffic signal design commensurate with the state of the art. It contains information on operational requirements, signal display and design configuration, traffic signal controllers, detectors, wiring, cabling, signal timing, etc.

This manual may be used by designers for additional guidance on design elements not addressed in the **TEM**.

193-14 ITE Manual of Transportation Engineering Studies

The **Manual of Transportation Engineering Studies**, published by **ITE**, shows in detail how to conduct several transportation engineering studies in the field; discusses experimental design, survey design, statistical analyses, data presentation techniques, and report writing concepts; and provides guidelines for both oral and written presentation of study results. Useful forms for various transportation studies are included.

TEM Sections 130-2, 1203-3 and 1204-3 address engineering studies. For additional guidance on the actual procedures for conducting these studies, the designer may reference the **ITE** manual.

193-15 ITE Traffic Engineering Handbook

The **Traffic Engineering Handbook**, published by **ITE**, provides a current, updated source of information for people entering the practice and for those already practicing. It provides a convenient desk reference of the principles and proven techniques in traffic engineering.

This handbook may be used by designers for additional guidance on design elements not addressed in the **TEM**.

193-16 ITE Trip Generation Manual

The **Trip Generation Manual**, published by **ITE**, provides guidance for various types of traffic generators. This is a three-volume report, with basically two volumes of data and one volume explaining how to use it. It contains data from more than 5,500 individual trip generation studies and provides information on multi-use projects and pass-by trips. It includes trip generation data for commercial development, office development, residential, etc.

Unless local data is available or where a developer can substantiate its basis, **ODOT** requires that all traffic impact analyses use the **ITE Trip Generation** data.

193-17 Manual on Uniform Traffic Control Devices (MUTCD)

193-17.1 General

As noted in ***TEM Section 100-1.2***, the **Manual on Uniform Traffic Control Devices**

(MUTCD), published by **FHWA** in coordination with the **National Committee on Uniform Traffic Control Devices (NCUTCD)**, presents nationwide criteria for the selection, design and placement of signs, pavement markings, traffic signals, temporary traffic control, and traffic controls for school areas, highway-rail grade crossings, bicycle facilities, and highway-light rail transit grade crossings. The basic objective of the **MUTCD** is to establish effective means to convey traffic control information to the driver for uniform nationwide application.

Ohio Revised Code Section 4511.09 requires **ODOT** to adopt a manual which conforms as much as possible to this national **MUTCD**. The **OMUTCD** is that manual **(*see Chapter 101*)**. In **Ohio**, the **MUTCD** is basically a resource manual which supports the **OMUTCD**.

193-17.2 MUTCD Review Process

Proposed changes to the national standards in the **MUTCD** are published by **FHWA** using the **Federal Register Docket** system. The **ORE Traffic Control Design Section** is responsible for coordinating **ODOT's** review of these proposals and preparing **ODOT's** response. Comments are solicited from the **Districts** and related offices in **Central Office**, as well as others outside **ODOT**, as appropriate.

Proposed changes to the national standards are also reviewed by the **National Committee on Uniform Traffic Control Devices (NCUTCD)**. As a member of this committee, **AASHTO** periodically circulates **Ballots** to its member agencies, including **ODOT**, soliciting comments on proposed changes that have been posted in the **Docket**, as well as other proposed changes its technical subcommittees may be reviewing. As with the **Docket** proposals, the **ORE Traffic Control Design Section** is responsible for coordinating **ODOT's** review and preparing the response to the **AASHTO Ballots**.

193-18 Standard Highway Signs and Markings Book

The **Standard Highway Signs and Markings** book, published by **FHWA**, presents sign designs for standard highway signs and criteria for laying out information on highway signs, as well as standard alphabets and symbols for highway signs and pavement markings. The book is to be used in conjunction with the **MUTCD**. Symbols which are used on signs are provided on grids to allow the designer to change the symbol size and yet present it in proper proportion.

ODOT has adopted the standard alphabets found in Chapters 9 and 10 of the **Standard Highway Signs and Markings** book for all of its signs and pavement markings. ***TEM Parts 2 and 3*** and the **SCDs** provide additional guidance on the application of letters and numerals on the highway signs and pavement markings.

In **Ohio**, the **Standard Highway Signs and Markings** book published by **FHWA** is used as a reference resource for the design and layout of all signs. Designs shown in the **(ODOT) Sign Designs and Markings Manual (SDMM)** ***(see Section 295-2)*** include some which are basically duplicates of those in the **Standard Highway Signs and Markings** book and others developed by **ODOT**.

193-19 Traffic Control Devices Handbook (TCDH)

The **Traffic Control Devices Handbook (TCDH)**, published by **ITE**, provides guidance and information to implement the provisions of the **MUTCD**. The objective of the handbook is to bridge the gap between the **MUTCD** requirements and field applications. It is meant as guidance material to assist in determining the appropriate device(s) for a specific condition based on judgment and/or study.

194 ODOT REFERENCE RESOURCES

194-1 General

ODOT traffic engineering information and publications have been addressed in ***Chapters 101 through 106 and Chapter 195***. **ODOT** also has various other publications which may provide needed or useful information for traffic engineering projects or studies. This Chapter briefly discusses these other **ODOT** publications.

ODOT's design-related publications are also listed on the **Design Reference Resource Center (DRRC)** website (also see page ii). When posted electronically, the references are also available by hyperlink from the **DRRC** website. Some of these publications can be ordered through the responsible Office or the **Office of Contracts** **(*see Table 197-4)***; however, some may be available only from the **ODOT** website.

The following publications have been listed generally in alphabetical order; however, for convenience later additions to the list may be added to the end of the group, rather than renumbering all other entries.

194-2 Bridge Design Manual (BDM)

The **Office of Structural Engineering** publishes the **Bridge Design Manual (BDM)**. The purpose of this manual, and its addendum, is to provide general guidelines, procedures and instructions, for the design and preparation of bridge plans and specifications for **ODOT**. The manual includes information on preliminary and detail design, structure rehabilitation and repair, general and detail **Plan Notes**, temporary structures, noise barriers and bridge structure ratings. This manual is available only on-line.

194-3 Construction Administration Manual of Procedures

The **Construction Administration Manual of Procedures** addresses procedures in various areas of construction, e.g., concrete, earthwork, flexible pavement, rigid pavement, structures and pipe. It is intended to serve as a guide to the engineer and inspector during construction. Personnel need to have a thorough knowledge of the plans, specifications, proposal notes, and standard drawings. The manual does not in any manner alter or replace these governing regulations, but is a supplement to them. The normal sequence of inspection procedures are outlined to assist project personnel in performing their duties.

194-4 Construction and Materials Specifications (C&MS)

The specifications used in **ODOT** contract plans are contained in the **C&MS** and **Supplemental Specifications** published on the website and discussed earlier in ***Chapter 105***.

194-5 Consultant Contract Administration Manual

The **Consultant Contract Administration Manual** from the **Office of Consultant Services** is intended to provide uniform guidelines for **ODOT** employees to follow in administering contractual agreements between **ODOT** and consultants who are hired to provide technical services. These services include, but are not limited to environmental studies, design and plan preparation, construction inspection, bridge inspection and right-of-way acquisition. Also see the **Specifications for Consulting Engineers** described in ***Section 194-11***.

194-6 L&D Manual Volume 1- Roadway Design

The purpose of **L&D Manual Volume 1- Roadway Design**, published by the **Office of Roadway Engineering**, is to consolidate and document **ODOT** design policies, standards, guidelines and practices. Criteria included in the manual closely conform to the **AASHTO** publications **A Policy**

on Geometric Design of Highway and Streets, **A Policy on Design Standards** and **Roadside Design Guide**.

This manual is intended to establish uniform procedures for implementing design decisions, assure quality and continuity in design of state highways, and assure compliance with Federal criteria. The manual is considered a primary source of reference by **ODOT** roadway design personnel; however, as noted in the Preface of the manual "it must be recognized that the practices suggested in it may be inappropriate for some projects because of fiscal limitations or other reasons." Also, design standards adopted by city, county or other local agencies must be taken into consideration on projects under their jurisdiction. This manual is available only on-line.

194-7 L&D Manual Volume 2 - Drainage Design

The purpose of **L&D Manual Volume 2 - Drainage Design**, published by the **Office of Hydraulic Engineering**, is to provide guidance for the hydraulic design of highway drainage features. As noted in the Preface of the manual, adhering to the recommended design procedures and controls outlined in the manual should result in drainage facilities that will not cause: "a) damaging flooding of private property; b) undue inconvenience to the motorist during moderate to heavy rainfall; [or] c) undue disturbance to the environment."

This manual is intended to establish uniform procedures for implementing drainage design decisions, assure quality and continuity in design of state highways, and assure compliance with Federal criteria. The manual is considered a primary source of reference by **ODOT** roadway design personnel; however, as noted in the Preface of the manual "it must be recognized that the practices suggested in it may be inappropriate for some projects because of fiscal limitations or other reasons." Also, design standards adopted by city, county or other local agencies must be taken into consideration on projects under their jurisdiction. This manual is available only on-line.

194-8 L&D Manual Volume 3 - Highway Plans

The purpose of **L&D Manual Volume 3 - Highway Plans**, published by the **Office of CADD and Mapping Services**, is to standardize the form and process for **ODOT** highway plan preparation. However, it is also recognized that many projects will involve unusual circumstances requiring deviations from the manual guidelines. This manual is available only on-line.

194-9 Pavement Design Manual (PDM)

The **Pavement Design Manual** is published by the **Office of Pavement Engineering** and is intended to bring all pavement design and rehabilitation procedures together in one document, reduce the selection of design variables to those most appropriate for **Ohio**, to document **Ohio's** interpretation of various policies and to include design criteria which may be unique to **Ohio**.

Information in this manual is based on the results of the **AASHTO** Road Test, the **AASHTO Guide for Design of Pavement Structures**, **FHWA** guidelines and technical advisories, various training course manuals, as well as the experience of the authors. In addition, the application of other studies, experiences and engineering judgment have been included to fit **Ohio's** conditions. The pavement engineering concepts described are intended for use with all new or reconstruction projects, major and minor maintenance projects, and with all **ODOT** preventative maintenance projects.

194-10 Project Development Process (PDP) Manual

This manual is an integral part of **ODOT's Project Development Process** **(PDP)** which provides a detailed process designed to improve not only the quality of highway construction plans, but also the reliability of project delivery.

194-11 Specifications for Consulting Engineers

The **ORC** authorizes the **Director of Transportation** to "employ consulting engineers and with the consent of the controlling board may enter into contracts for consulting engineering services..." **Specifications for Consulting Engineers**, from the **Office of Consultant Services**, is written from the standpoint of a contractual relationship between **ODOT** and a consultant. It includes definitions, general conditions, auditing and bidding aspects of all agreements, the consultant selection process, the agreement modification process, requirements for price proposals and explains preparation of consultant cost data for supporting documentation. The specifications are included by reference in each agreement, thereby substantially reducing the agreement text. Also see the **Consultant Contract Administration Manual** described in ***Section 194-5***.

194-12 Specifications for Subsurface Investigations

The **Office of Geotechnical Engineering** publishes standards and guidelines related to subsurface investigations, such as **Specifications for Geological Explorations** and the **Rock Slope Design Guide**.

194-13 Standard Bridge Drawings

Bridge standard drawings are published by the **Office of Structural Engineering**. They consist of **SCDs**, **Plan Insert Sheets** and **Design Data Sheets**. They include details for bridge railings abutments, vandal protection, fence and approach slabs, etc.

194-14 Standard Roadway Drawings

Roadway standard drawings are published by the **Office of Roadway Engineering**. They consist of **Roadway Standard Construction Drawings (Roadway SCDs)** and **Roadway Plan Insert Sheets (PISs)**. On the **DRRC website** and the **Office of Contract's** list, these drawings are currently listed under "Standard Drawings: Construction" or "Standard Construction Drawings."

194-15 Standard Pavement Construction Drawings

Pavement Standard Construction Drawings (Pavement SCDs) are maintained by the **Office of Pavement Engineering**. These drawings cover Pavement Design Features (BP Series). On the **DRRC website** and the **Office of Contract's** list, these drawings are currently listed under "Standard Drawings: Construction" or "Standard Construction Drawings."

194-16 Standard Hydraulic Construction Drawings

Hydraulic Standard Construction Drawings (Hydraulic SCDs) are maintained by the **Office of Hydraulic Engineering**. These drawings cover Drainage Design Features. On the **DRRC website** and the **Office of Contract's** list, these drawings are currently listed under "Standard Drawings: Construction" or "Standard Construction Drawings."

194-17 State Highway Access Management Manual

The purpose of the **State Highway Access Management Manual,** published by the **Office of Roadway Engineering,** is to establish statewide uniform, equitable standards and procedures, prolong the service life of the state highway system, reduce public maintenance costs, promote orderly development, and maintain accessibility to adjacent land uses, and to accomplish all of this while preserving traffic mobility. The manual establishes access classes, uniform permit application procedures, variance and appeal procedures, and change of use conditions. It provides for monitoring access construction. The manual also encourages local jurisdictions to develop access control plans consistent with **ODOT** and/or local access policies. See ***Section 130-6*** for additional information.

194-18 Straight Line Diagrams (SLDs)

A **Straight Line Diagram (SLD)** is a two dimensional graphic representation of the physical roadway characteristics of a highway as if it had no turns or curves. Mileage is based on the centerline of the roadway as measured from the western or southern county line or other true beginning. All routes on the **Interstate, U. S. and State Route Systems** are shown on these diagrams. The **Office of Technical Services** provides these diagrams on-line.

194-19 Supplemental Specifications

As noted in ***Section 105-1***, **Supplemental Specifications** are part of **ODOT's** construction and materials specifications. They are individual numbered documents describing the construction and material specifications for new items. These are available only on-line.

194-20 Supplements

As noted in ***Section 105-1***, **Supplements** are part of **ODOT's** construction and materials specifications. They provide necessary information such as laboratory methods of test, and certification or pre-qualification procedures for materials.

195 TRAFFIC ENGINEERING REFERENCE RESOURCES

195-1 General

Table 197-3 provides a consolidated list of **ODOT** traffic engineering publications. This Chapter provides brief descriptions of traffic engineering publications/reference resources from the **Offices of Roadway Engineering** and **Traffic Operations** that were not discussed in detail in the earlier Sections of ***TEM Part 1***.

195-2 Guidelines for Traffic Control in Work Zones

This is a pocket-sized consolidation of information regarding temporary traffic control. The information is based on that in the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**, but some additional guidelines/handbook information is included. See ***Section 695-7*** for additional information. This "pocket guide" may be viewed on-line. It may also be purchased from **LTAP** or the **Office of Contracts**. **Districts** should also contact the **Office of Contracts** for copies of this publication.

195-3 Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles

This document sets standards for acceptability of conditions of temporary traffic control devices and addresses delineation methods for vehicles. This guide may be viewed on-line or downloaded from the website. See ***Section 695-4*** for further information.

195-4 Sign Designs and Markings Manual (SDMM)

Although published separately because of its size, the **Sign Designs and Markings Manual (SDMM)** has been incorporated into the **TEM** by reference, as ***Section 295-2***. The **SDMM** contains standard **Sign Designs**, design guidelines and letter spacing information, for standard traffic control signs and major Guide Signs addressed in the **OMUTCD** and the **TEM**, as well as some additional signs that are not presently addressed in either of these manuals. The pavement marking alphabet and symbols are also provided. The **SDMM** is referenced in the **OMUTCD** and is used to assure uniformity in the design of standard traffic signs in **Ohio**. See ***Section 295-2*** in **Part 2** for further information about the **SDMM**. This manual is only available on-line.

195-5 Signal Design Reference Packet

The **Signal Design Reference Packet** ***(Section 495-2)*** is published by the **Office of Traffic Operations**. The purpose of this packet is to provide guidance on designing and reviewing traffic signal plans. The packet and design files are available on the **Office of Traffic Operations** website.

195-6 Temporary Traffic Control Manual (TTCM)

Parts 1 (General), 5 (Low-Volume Roads) and 6 (Temporary Traffic Control) of the OMUTCD have been reprinted in a separate **Temporary Traffic Control Manual (TTCM)** to provide a convenient size copy of this information. See ***Section 695-2*** for further information. This manual can be viewed or downloaded on-line; however, it is also currently available in paper format and can be purchased by contacting the **Office of Contracts**.

Intentionally blank.

196 FORMS INDEX

196-1 ORE Publications Order Form

Form 196-1 may be used by a local jurisdiction or public agency to order **Traffic** publications. An electronic copy of this form is available on-line.

Intentionally blank.

Form 196-1. Traffic Publications Order Form

Date ___________________

TRAFFIC PUBLICATIONS ORDER FORM
FOR
LOCAL JURISDICTIONS AND PUBLIC AGENCIES

Publication	Unit Cost	Quantity
Ohio Manual of Uniform Traffic Control Devices (OMUTCD) (2012 Edition)	free	_______
2012 Temporary Traffic Control Manual (TTCM) (Reprint of OMUTCD Parts 1, 5 and 6)	$12.00 *	_______
2014 Guidelines for Traffic Control in Work Zones (Pocket Guide)	$2.50 *	_______

(The publications may also be ordered directly from the Office of Contracts at 800-459-3778 or 614-466-3778.)

* Price per copy, plus shipping and handling based on quantities ordered.

Name: ____

Title: ____

Organization: ____

****Street Address**____

City: ______________________________ **State:** ___________ **Zip Code:** ________________

Telephone: ____

**** If available, please provide street address, not a P.O. Box. Whenever possible we use UPS to ship our publications.**

Please return the completed form by mail to:

Ohio Department of Transportation
Office of Contracts / Mail Stop 4110
1980 W. Broad St., 1st floor
Columbus, Ohio 43223

Intentionally blank.

197 TABLES INDEX

197-1 Resource Reference/Contact Information

As noted in ***Section 100-6***, ***Table 197-1*** provides contact information for various agencies and organizations (including **ODOT**), and other resource references that may be useful.

197-2 Ohio Counties and ODOT Districts

As noted in ***Section 100-5***, ***Table 197-2*** provides a list of the eighty-eight counties in **Ohio** with the three-letter designation used in **ODOT** records and cross-references to the related **Districts**.

197-3 Traffic Engineering Publications

As noted in ***Section 195-1***, ***Table 197-3*** presents a consolidated list of all **ODOT** traffic engineering publications. All the publications listed are available for viewing and downloading from the **ORE** and **DRRC** websites. Those that are also available in paper format are noted in the comments column of this table.

197-4 Reserved for Future Information

Intentionally blank.

Table 197-1. Resource Reference/Contact Information

Resource Name / Mailing Address	Telephone / Fax / Web Address
ADA Accessibility Guidelines US Access Board 1331 F Street NW, Suite 1000 Washington, DC 20004-1111	Telephone: 202-272-0080 Toll Free: 800-872-2253 Fax: 202-272-0081 Website: www.access-board.gov
Aggressive Driving (NHTSA)	Web site: www.nhtsa.dot.gov/people/injury/enforce/adsped.htm
American Association of State Highway and Transportation Officials (AASHTO) 444 North Capitol Street, NW, Suite 249 Washington, DC 20001	Telephone: 202-624-5800 Fax: 202-624-5806 Website: www.transportation.org
American Traffic Safety Services Association (ATSSA) 15 Riverside Parkway, Suite 100 Fredericksburg, VA 22406-1022	Telephone: 540-368-1701 Toll Free 1-800-272-8772 Fax: 540-368-1717 Website: www.atssa.com
American National Standards Institute (ANSI) 1819 L Street, NW, Suite 600 Washington, DC 20036	Telephone: 202-293-8020 General Inquiries: 212-642-4900 Fax: 202-293-9287 Website: www.ansi.org
Bureau of Transportation Statistics Research and Innovative Technology Admin. U.S. Department of Transportation 400 7th Street, SW, Room 3430 Washington, DC 20590	Telephone: 800-853-1351 Main Fax: 202-366-3759 Website: www.bts.gov/
U.S. Army Corps of Engineers, Great Lakes and Ohio River Division 550 Main Street, Room 10122 P.O. Box 1159 Cincinnati, Ohio 45201-1159 (Includes Buffalo, Huntington, Louisville, and Pittsburg Districts)	Telephone: (513) 684-3010 Executive Fax: 513-684-2085 Website: www.lrd.usace.army.mil/
County Engineers Association of Ohio 37 West Broad Street, Suite 660 Columbus, OH 43215	Telephone: 614-221-0707 Fax: 614-221-5761 Website: www.ceao.org/
Design Reference Resource Center (ODOT)	Website: www.dot.state.oh.us/drrc/
Docket Management System (DMS)	Website: www.regulation.gov
Federal Emergency Management Administration (FEMA) Region V 536 South Clark Street, 6th Floor Chicago, IL 60605	Telephone: 312-408-5500 Website: http://www.fema.gov/region-v-il-mi-mn-oh-wi
Federal Highway Administration (FHWA) 400 7th Street, SW Washington, DC 20590	Telephone: 202-366-0537 (Personnel locator) Website: www.fhwa.dot.gov
Federal Highway Administration (FHWA) Ohio Division Office 200 North High Street, Room 328 Columbus, OH 43215-2408	Telephone: 614-280-6896 Fax: 614-280-6876 Website: http://www.fhwa.dot.gov/ohdiv/

Resource Name / Mailing Address	Telephone / Fax / Web Address
FHWA - other websites:	
➢ **Resources – Legislation, Regulations and Guidance**	http://www.fhwa.dot.gov/resources/legsregs/
➢ **Federal Reg. 23 CFR940 (ITS)**	https://www.federalregister.gov/select-citation/2009/10/08/23-CFR-940
➢ **ITS Standards**	http://www.standards.its.dot.gov
➢ **MUTCD (includes links to Interim Approvals, Interpretations, etc.)**	http://mutcd.fhwa.dot.gov/
➢ **Roadside Hardware (includes NCHRP 350 information)**	http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/
➢ **Safety**	http://safety.fhwa.dot.gov/
Federal Register information	Website: http://www.gpoaccess.gov/fr/index.html
U.S. Government Printing Office 732 North Capital St. NW Washington , DC 20401	Telephone: 202-512-0000 Website: http://www.gpo.gov/
U.S. Government Online Bookstore	Website: http://bookstore.gpo.gov/
Illuminating Engineering Society of North America (IESNA) 120 Wall Street, Floor 17 New York, NY 10005	Telephone: 212-248-5000 Fax: 212-248-5017/8 Website: http://www.iesna.org/
Institute of Transportation Engineers (ITE) 1099 14th St, SW, Suite 300 West Washington, DC 20005-3438	Telephone: 222-289-0222 Fax: 202-289-7722 Website: http://www.ite.org/
ITS Architecture, National Version 7.1	Website: http://itsarch.iteris.com/itsarch/
ITS Architecture, Turbo Version 7.1 Overview	Website: www.iteris.com www.iteris.com/itsarch/html/turbo/turbomain.htm
McTrans Center for Microcomputers in Transportation University of Florida P.O. Box 116585 Gainesville, FL 32611-6585	Telephone: 352-392-0378 Toll Free: 1-800-226-1013 Fax: 352-392-6629 Website: www-mctrans.ce.ufl.edu
Metropolitan Planning Organizations (MPOs)	See ***TEM Table 1397-3***.
National Highway Institute Arlington Center Building 4600 North Fairfax Drive, Suite 800 Arlington, VA 22203	Telephone: 1-877-558-6873 Fax: 703-235-0593 Website: http://www.nhi.fhwa.dot.gov/Home.aspx
National Highway Traffic Safety Administration (NHTSA) 400 7th Street, SW Washington, DC, 20590	Toll Free 1-888-327-4236 Website: http://www.nhtsa.gov/
National Incident Management System (NIMS)	Website: http://www.fema.gov/national-incident-management-system
National Transportation Safety Board 490 L'Enfant Plaza, SW Washington, DC, 20594	Telephone: 202-314-6000 Website: http://www.ntsb.gov/Pages/default.aspx

Resource Name / Mailing Address	Telephone / Fax / Web Address
Ohio Contractors Association 1313 Dublin Road P.O. Box 909 Columbus, OH 43216	Telephone: 614-488-0724 or 800-229-1388 Fax: 614-488-0728 Website: http://www.ohiocontractors.org/
Ohio Development Services Agency 77 S. High Street, 29th Floor Columbus, OH 43215	Telephone: 800-848-1300 Website: http://development.ohio.gov/contact/contact_phoneaddress.htm
Ohio Department of Natural Resources (ODNR) 2045 Morse Road,, Building D Columbus OH 43229	Telephone: 614-265-6565 Website: http://ohiodnr.com/
Ohio Department of Natural Resources Division of Natural Areas & Preserves 2045 Morse Rd., Bldg. B-floors 1 and 2 Columbus, OH 43229-6693	Telephone: 614-265-6717 FAX: 614-447-9503 Website: http://ohiodnr.com/water/tabid/3252/Default.aspx
Ohio Department of Natural Resources Division of Wildlife 2045 Morse Rd, Building G Columbus OH 43229-6693	Telephone: 614-265-6300 Website: http://ohiodnr.com/tabid/4414/Default.aspx
Ohio Department of Public Safety (ODPS) Charles D. Shipley Building 1970 W. Broad Street P.O. Box 182081 Columbus, OH 43218-2081	Telephone: 614-466-2550 Fax: 614-752-8410 Website: www.publicsafety.ohio.gov/
Ohio Department of Public Safety Bureau of Motor Vehicles (BMV) 1970 W. Broad Street P.O. Box 16520 Columbus, OH 43216-6520	Telephone: 614-752-7500 Website: http://bmv.ohio.gov/
Ohio Department of Public Safety Ohio State Highway Patrol (OSHP) 1970 W. Broad Street P.O. Box 182074 Columbus, OH 43218-2074	Website: www.statepatrol.ohio.gov/
Ohio Department of Transportation (ODOT) 1980 W. Broad Street P.O. Box 899 Columbus, OH 43216-0899	Telephone: 614-466-7170 Fax: 614-644-8662 Website: www.dot.state.oh.us/pages/home.aspx
Ohio Environmental Protection Agency (OEPS) 50 West Town Street, Suite 700 P.O. Box 1049 Columbus, OH 43215	Telephone: 614-644-3020 Website: www.epa.ohio.gov/
ODOT Office of Traffic Operations (OTO) 1980 W. Broad Street – Mailstop 5160 P.O. Box 899 Columbus, OH 43216-0899	Telephone: 614-466-3601 Fax: 614-466-8199 Website: www.dot.state.oh.us/Divisions/Operations/Traffic/

Resource Name / Mailing Address	Telephone / Fax / Web Address
Ohio Historical Society 1982 Velma Avenue Columbus, OH 43211	Telephone: 614-297-2300 Web site: http://www.ohiohistory.org/
Ohio General Assembly	Web site: https://www.legislature.ohio.gov/
Ohio Local Technical Assistance Program (LTAP) Center 1980 W. Broad Street, 2nd Floor P.O. Box 899 Columbus, OH 43216-0899	Telephone: 614-387-7359 Toll Free 877-800-0031 Fax: 614-466-2120 Web site: http://www.dot.state.oh.us/ltap/
Ohio Revised Code	Web site: http://codes.ohio.gov/
The Ohio Turnpike Commission 682 Prospect Street Berea, OH 44017	Telephone: 440-234-2081 Website: http://www.ohioturnpike.org/
PC Trans KU Transportation Center Room 2011 Learned Hall 1530 W 15th Street Lawrence, KS 66045	Telephone: 785-864-5658 Fax: 785-864-3199 Website: http://www.kutc.ku.edu/cgiwrap/kutc/pctrans/index.php
Public Utilities Commission of Ohio (PUCO) 180 E. Broad Street Columbus, OH 43215-3793	Telephone: 614-466-3292 Toll Free (Ohio) 1-800-686-7826 Fax: 614-752-8351 Web site: http://www.puco.ohio.gov/puco.cfm
Rumble strips website	Website: http://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/
State Agencies	Website: http://ohio.gov/agencies/
State Cities, Townships & Counties	Website: http://ohio.gov/government/localities/
State Library of Ohio	Website: http://www.library.ohio.gov/
State of Ohio website	Website: http://ohio.gov/
State websites (links to other states)	Website: http://www.fhwa.dot.gov/webstate.cfm
Keck Center of the National Academies Transportation Research Board 500 Fifth Street, NW Washington DC 20001	Telephone: 202-334-2934 Fax: 202-334-2003 Website: http://www.trb.org/Main/Home.aspx
U.S. Department of Transportation 400 7th Street, SW Washington, DC 20590	Telephone: 202-366-4000 Website: http://www.dot.gov/
US DOT agencies	Website: http://www.dot.gov/DOTagencies.htm

Table 197-2. Ohio Counties and ODOT Districts

County	Code	Dist.	County	Code	Dist.	County	Code	Dist.
Adams	ADA	9	Hamilton	HAM	8	Noble	NOB	10
Allen	ALL	1	Hancock	HAN	1			
Ashland	ASD	3	Hardin	HAR	1	Ottawa	OTT	2
Ashtabula	ATB	4	Harrison	HAS	11			
Athens	ATH	10	Henry	HEN	2	Paulding	PAU	1
Auglaize	AUG	7	Highland	HIG	9	Perry	PER	5
			Hocking	HOC	10	Pickaway	PIC	6
Belmont	BEL	11	Holmes	HOL	11	Pike	PIK	9
Brown	BRO	9	Huron	HUR	3	Portage	POR	4
Butler	BUT	8				Preble	PRE	8
			Jackson	JAC	9	Putnam	PUT	1
Carroll	CAR	11	Jefferson	JEF	11			
Champaign	CHP	7				Richland	RIC	3
Clark	CLA	7	Knox	KNO	5	Ross	ROS	9
Clermont	CLE	8						
Clinton	CLI	8	Lake	LAK	12	Sandusky	SAN	2
Columbiana	COL	11	Lawrence	LAW	9	Scioto	SCI	9
Coshocton	COS	5	Licking	LIC	5	Seneca	SEN	2
Crawford	CRA	3	Logan	LOG	7	Shelby	SHE	7
Cuyahoga	CUY	12	Lorain	LOR	3	Stark	STA	4
			Lucas	LUC	2	Summit	SUM	4
Darke	DAR	7						
Defiance	DEF	1	Madison	MAD	6	Trumbull	TRU	4
Delaware	DEL	6	Mahoning	MAH	4	Tuscarawas	TUS	11
			Marion	MAR	6			
Erie	ERI	3	Medina	MED	3	Union	UNI	6
			Meigs	MEG	10			
Fairfield	FAI	5	Mercer	MER	7	Van Wert	VAN	1
Fayette	FAY	6	Miami	MIA	7	Vinton	VIN	10
Franklin	FRA	6	Monroe	MOE	10			
Fulton	FUL	2	Montgomery	MOT	7	Warren	WAR	8
			Morgan	MRG	10	Washington	WAS	10
Gallia	GAL	10	Morrow	MRW	6	Wayne	WAY	3
Geauga	GEA	12	Muskingum	MUS	5	Williams	WIL	2
Greene	GRE	8				Wood	WOO	2
Guernsey	GUE	5				Wyandot	WYA	1

Table 197-3. Traffic Engineering Publications

Publication Name	Audience	Comments
Ohio Manual of Uniform Traffic Control Devices (OMUTCD), 2012 Edition	State, county officials and other local jurisdictions, contractors, consultants, utilities, public	Available on-line from the **DRRC** and **ORE** websites; paper copies are available from the **Office of Contracts**.*
Guidelines for Traffic Control in Work Zones (pocket guide)	State, county officials and other local jurisdictions, contractors, utilities	Available on-line from the **ORE** and **LTAP** websites, and in paper format by contacting LTAP or the **Office of Contracts**.*
Plan Insert Sheets (PISs) - Traffic	State, county officials and other local jurisdictions, contractors, consultants	Available on-line from the **DRRC** and **ORE** websites.
Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles	State, county officials, and other local jurisdictions, contractors	Available on-line from the **DRRC** and **ORE** websites.
Sign Designs and Markings Manual (SDMM) – TEM Section 295-2	State, county officials and other local jurisdictions, contractors, consultants	Available on-line from the **DRRC** and **ORE** websites. (Maintained by the **Office of Traffic Operations**; published on-line by the **Office of Roadway**.)
Standard Construction Drawings (SCDs) - Traffic	State, county officials and other local jurisdictions, contractors, consultants	Available on-line from the **DRRC** and **ORE** websites; paper copies are available from the **Office of Contracts**.*
Temporary Traffic Control Manual (TTCM), 2012 Edition (Reprint of Parts 1, 5 and 6 of the **OMUTCD**.)	State, county officials and other local jurisdictions, contractors, consultants, utilities, public	Available on-line from the **DRRC** and **ORE** websites; paper copies are available from the **Office of Contracts**.*
Traffic Engineering Manual (TEM)	State, county officials and other local jurisdictions, contractors, consultants	Available on-line from the **DRRC** and **ORE** websites.

* See ***Table 197-4*** for pricing information.

Table 197-4. Reserved for Future Information

Intentionally blank.

198 FIGURES INDEX

198-1 ODOT Table of Organization

Figure 198-1 is a reproduction of the overall Table of Organization for **ODOT** that is posted on the **ODOT** website.

198-2 ODOT Districts - Locations and Addresses

Figure 198-2 presents a map of **Ohio** showing the **ODOT Districts** and contact information (addresses and phone numbers) for each of them.

198-3 Alternative Purchasing Program for Local Agencies

Figure 198-3 presents a chart which visually depicts the process described in detail in ***Section 120-6***.

198-4 Administering Local Government Agency / Utility Force Account Work

Figure 198-4 presents a chart which visually depicts the process described in detail in ***Section 150-3***.

198-5 Sample Letter Requesting Alternate Bids

Figure 198-5 shows a sample letter from local authorities requesting alternate bids as referenced in ***Section 120-7.2***.

198-6 Sample Letter Stating Local Decision on Alternate Bids

Figure 198-6 shows a sample letter of acceptance or rejection by local authorities of the alternate bids as referenced in ***Section 120-7.3***.

Intentionally blank.

Figure 198-1. ODOT Table of Organization

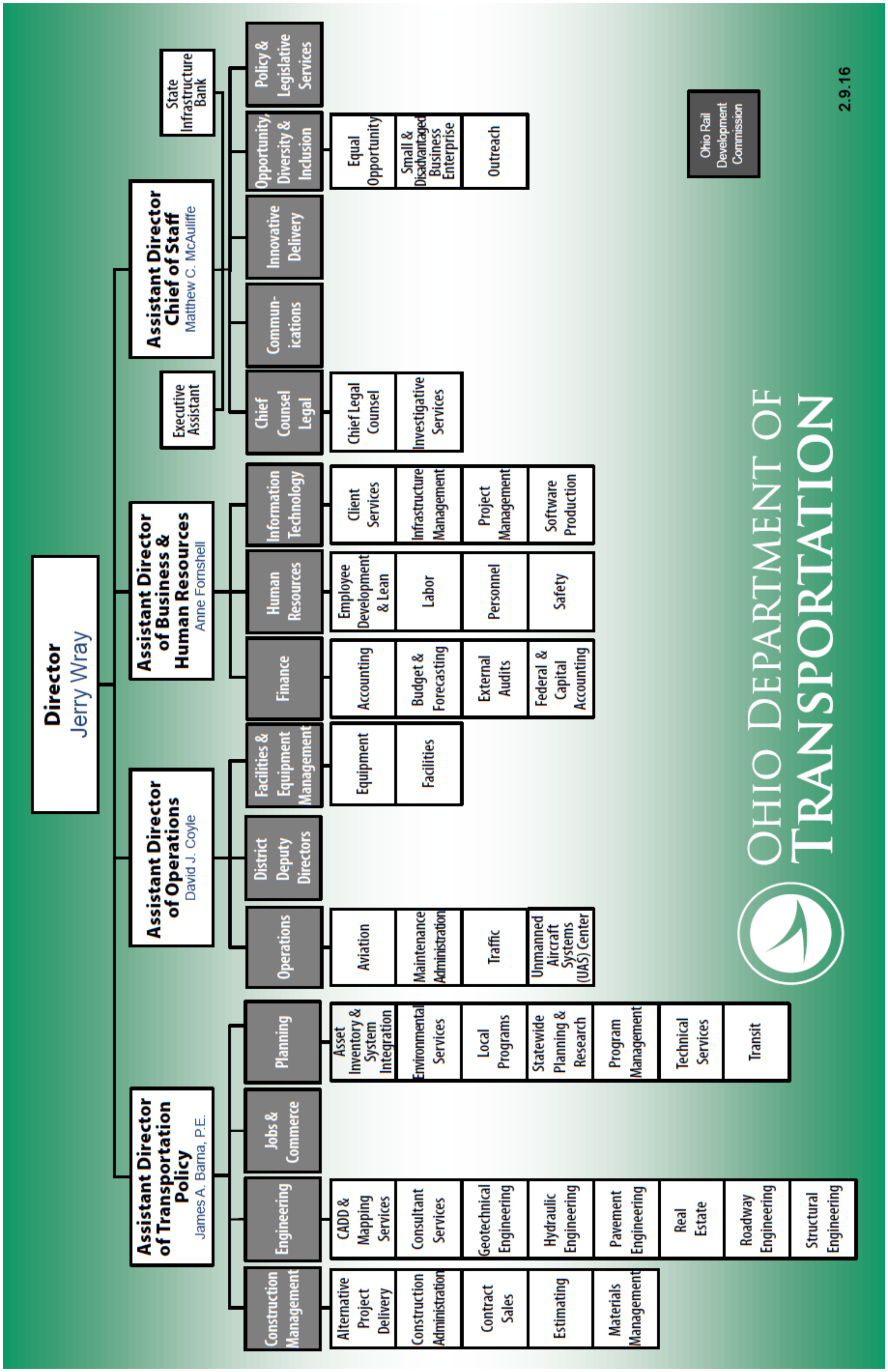


Figure 198-2. ODOT District Locations and Addresses

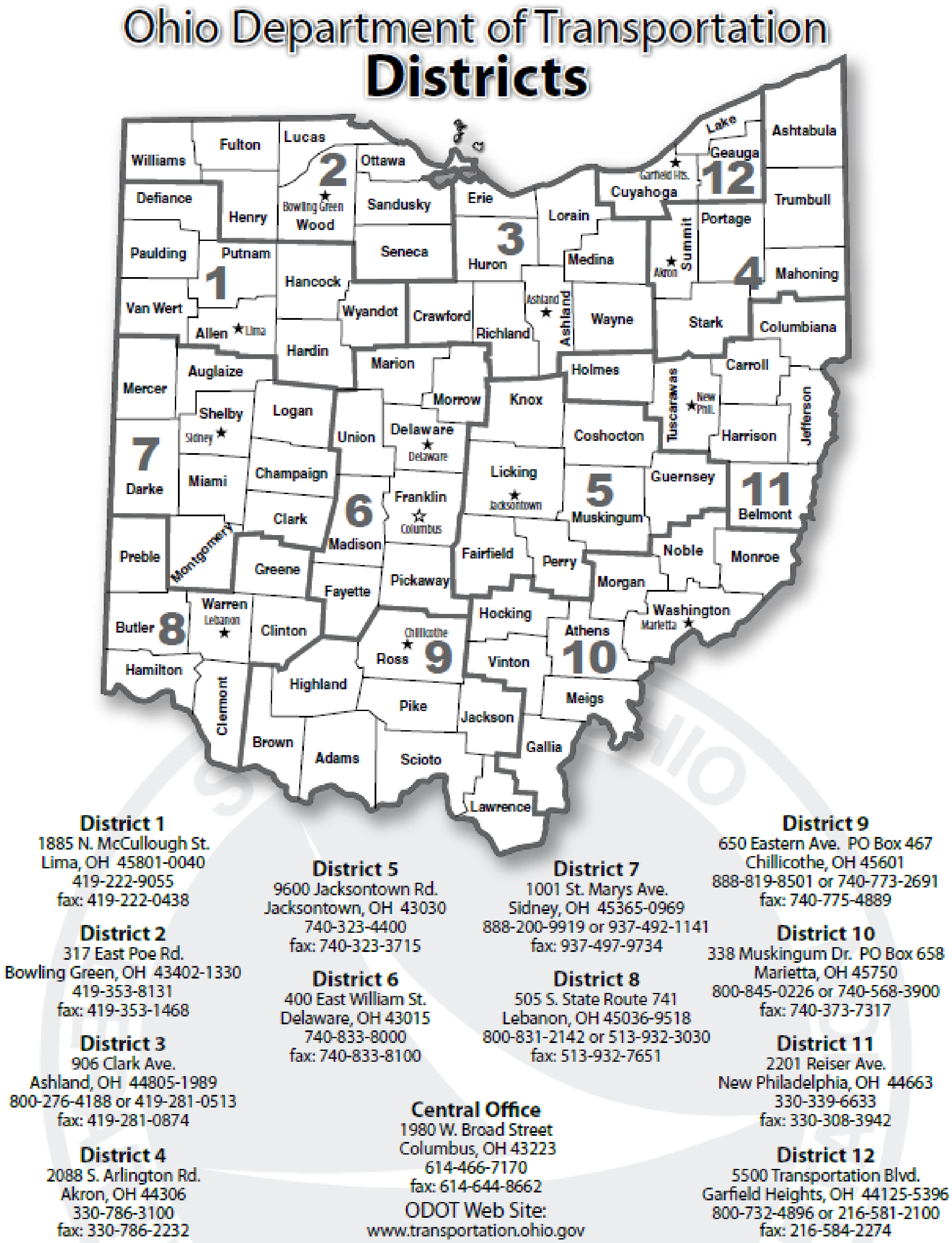


Figure 198-3. Alternative Purchasing Program for Local Agencies (Page 1 of 3)

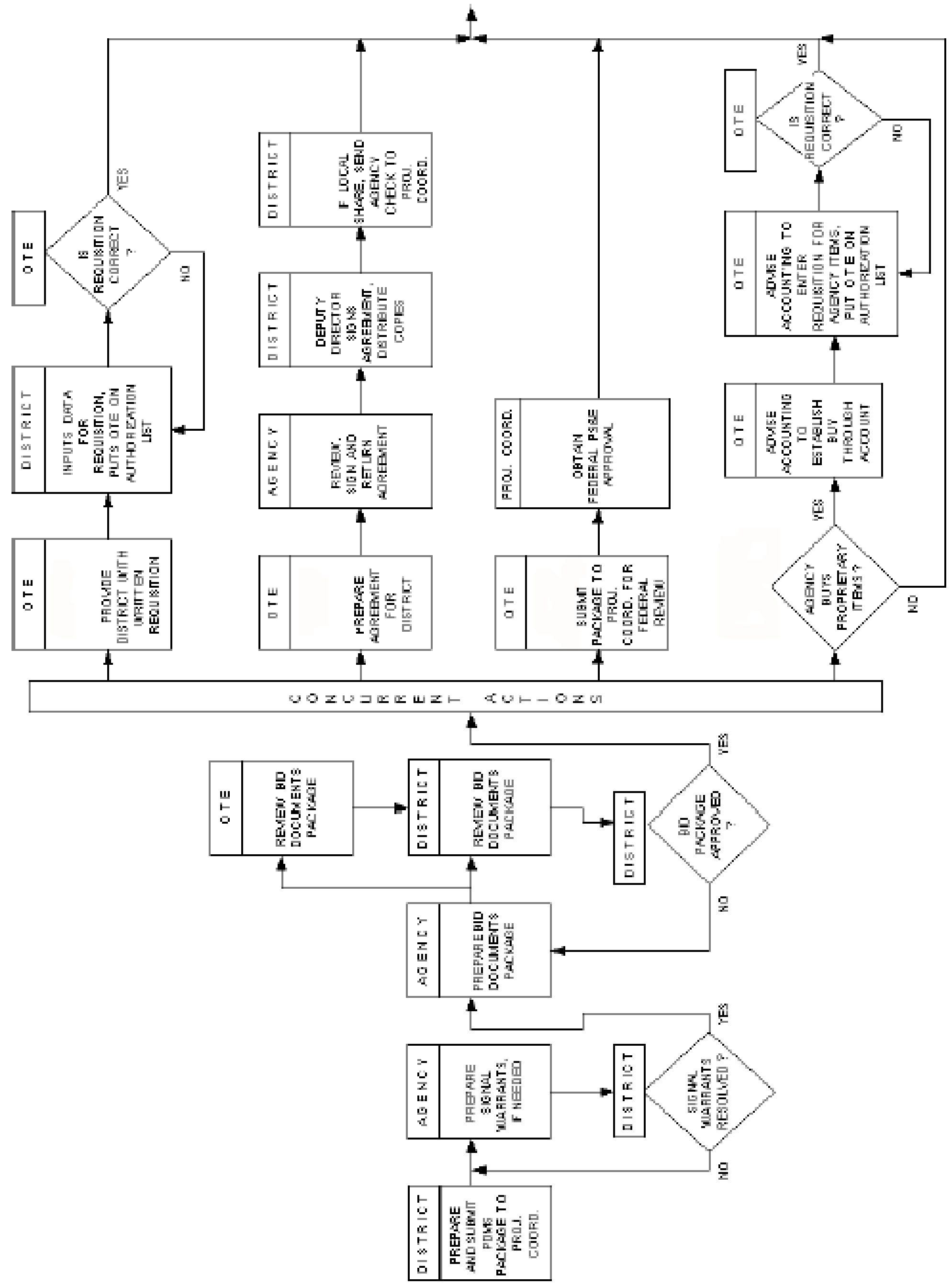


Figure 198-3 Alternative Purchasing Program for Local Agencies (Page 2 of 3)

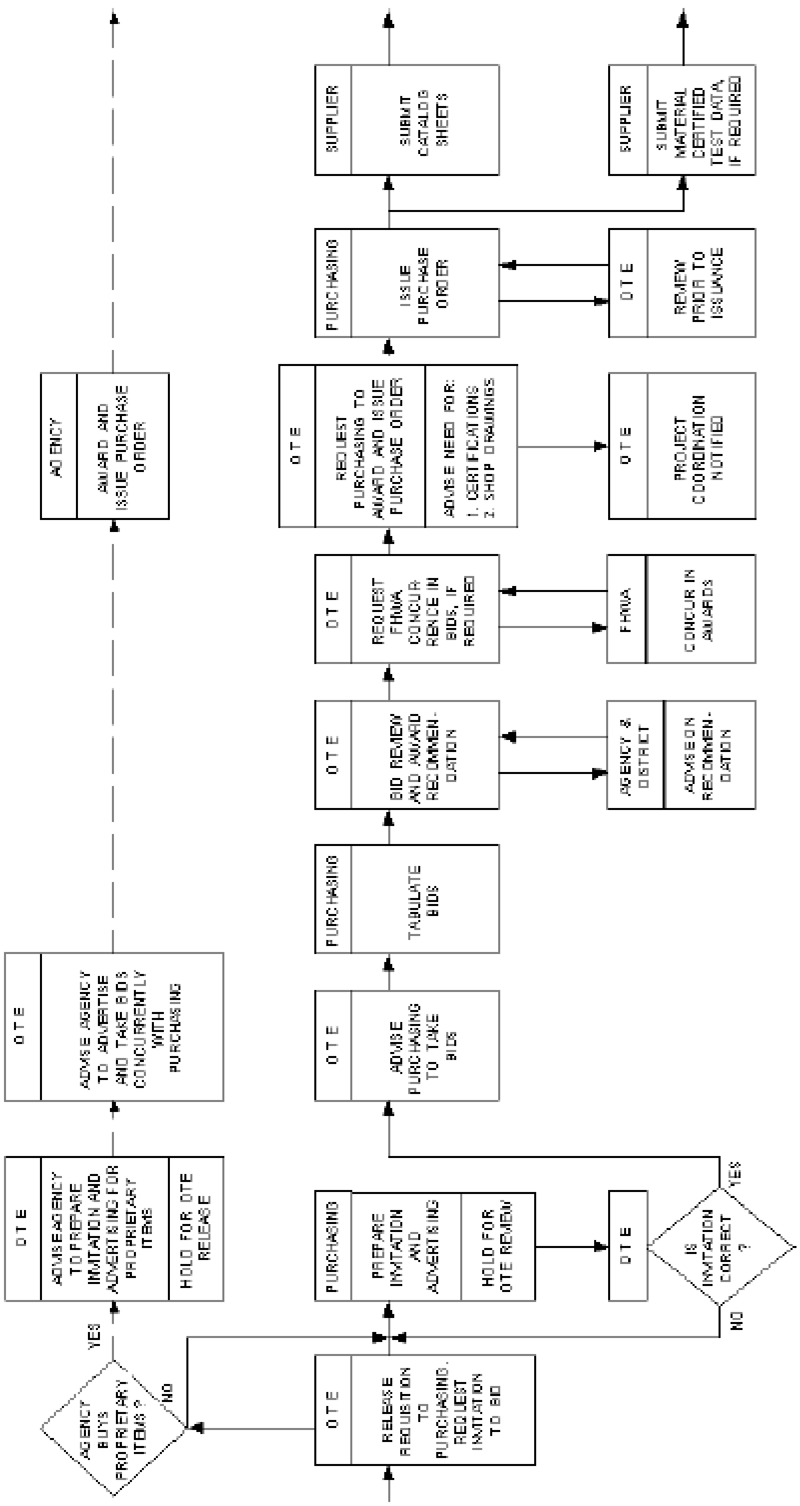


Figure 198-3 Alternative Purchasing Program for Local Agencies (Page 3 of 3)

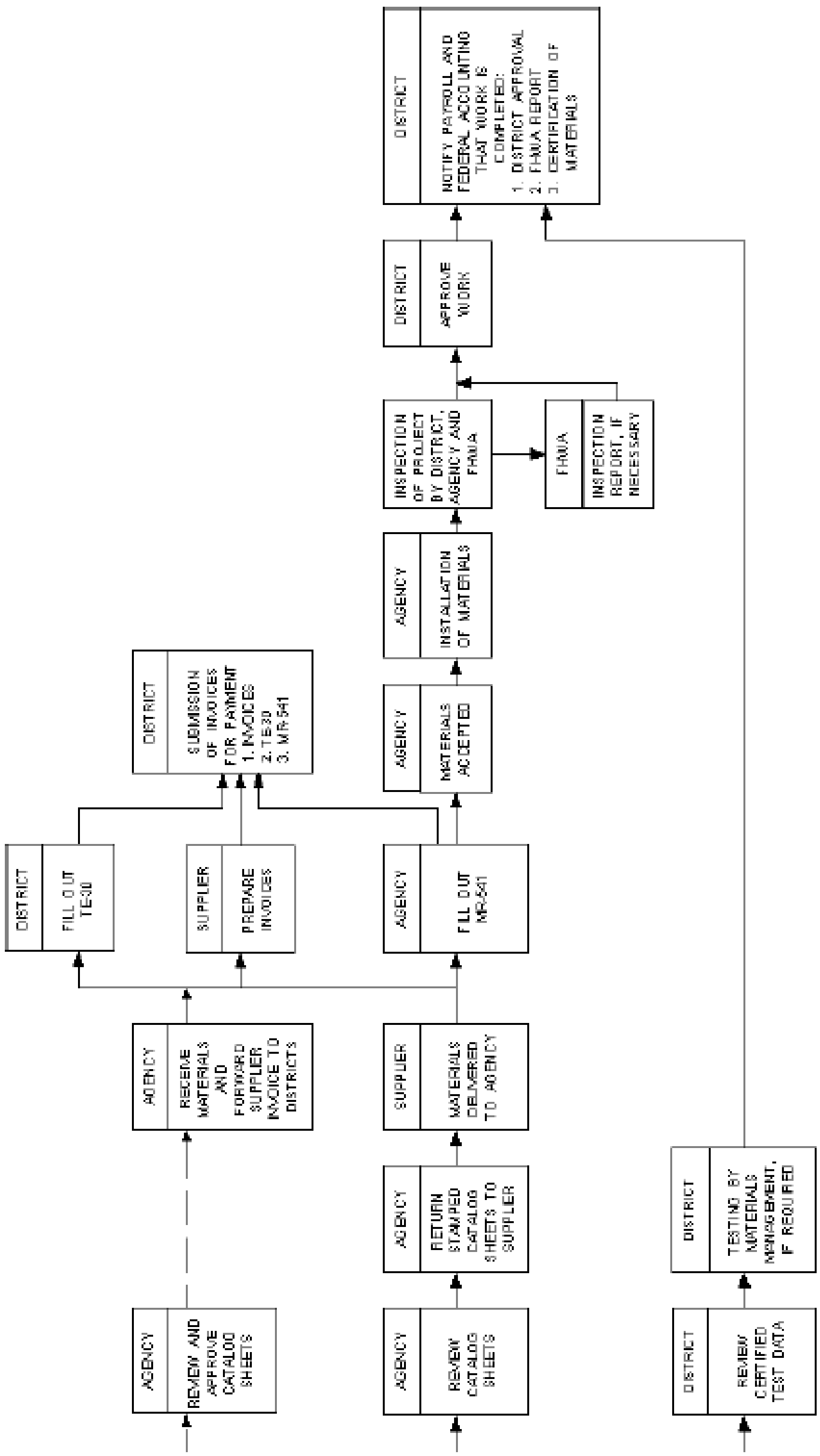


Figure 198-4. Local Government Agency / Utility Force Account Work

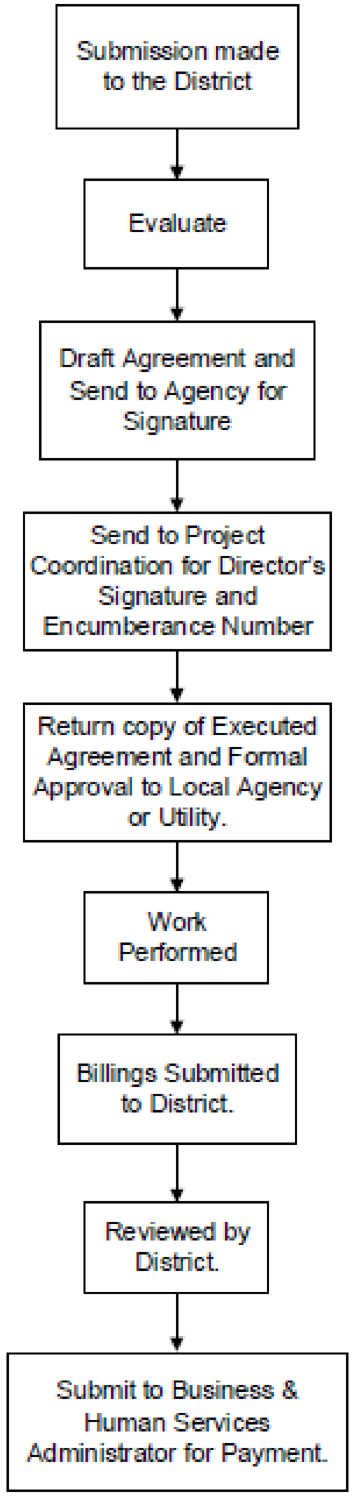


Figure 198-5. Sample Letter/Email Requesting Alternate Bids

Date: ____________

District Planning and Engineering Administrator
Ohio Department of Transportation
Street
City

Re: County – Route – Section

Dear ________________:

We request that alternate bids be incorporated into the subject plan for the following item(s):

1.
2.

This item(s) will be used at the following locations:

1.
2.

We further request that the alternate bids describe the following brand and model of equipment:

1.
2.

We make this request because…

At such time as bids have been taken, please contact (phone _____________; email _____________) to advise us of the comparative prices. We understand that our decision concerning acceptance or rejection of the alternates must be made quickly and reported by telephone/email. We also understand that our letter confirming this decision and agreeing to pay any extra costs must be in your hands within 10 calendar days following opening of bids.

Signed

Figure 198-6. Sample Letter/Email Stating Local Decision on Alternate Bids

Date: ____________

District Planning and Engineering Administrator
Ohio Department of Transportation
Street
City

Re: County – Route – Section
Project ________
Alternate Bids

Dear ________________:

We have been advised, by a telephone call/email from ___________________ of your office, of the bid price received for the alternate items on this project.

This letter/email confirms our recent (telephone) conversation concerning disposition of those alternate bids.

We request that the award be based upon the alternate (Brand Name) bids for reference items ____-A, ____-A….____-A. We understand that this will increase our financial obligation to the project by $_______ and agree to pay this when invoiced.

OR

We request that the award be based upon the generic bids for reference items ____, ____ …. and ____. This decision will not increase our project financial obligation.

Signed

TABLE OF CONTENTS
Part 2 - SIGNS

296 FORMS INDEX 2-139

297 TABLES INDEX 2-151

298 FIGURES INDEX 2-201

Part 2 – SIGNS

200 GENERAL

200-1 Introduction

The information provided in this Part is intended to supplement the **OMUTCD Part 2** by presenting **ODOT** policies, standards, guidelines, practices and procedures concerning the design, construction, operations and maintenance of various types of traffic control signing.

After some general discussion of the overall subject of signing in ***Chapter 200***, this Part of the **TEM** is organized to generally address the various types of signs (i.e., Regulatory, Warning and Guide Signs) separately. Given the range of signs covered under the general heading of Guide Signs, that category has also been subdivided further, with separate Chapters on Route Signs, Conventional Road Destination and Distance Signs, General Information Signs, Motorist Services Signs, Rest Area Signs, and Freeway and Expressway Destination and Distance Signs. A Section for Miscellaneous Signs has also been provided.

Separate Chapters have been provided for information specifically related to Sign Designing ***(Chapter 211)***, Sign Lighting ***(Chapter 212)***, Materials and Hardware ***(Chapter 220)***, Sign Supports ***(Chapter 221)***, Design Information, Plan Preparation/Production, Plan Notes and Specifications ***(Chapters 240 through 243)***, Construction ***(Chapter 250)*** and Maintenance/Operations ***(Chapter 260)***.

The **OMUTCD** provides general information on the design of traffic control signs, including the basic concepts of shape and color. It also provides specific information on the application of standard signs. Information on the location of signs, including height, lateral offset and longitudinal placement, is included as well.

Since the **OMUTCD** applies to jurisdictions statewide, some of the requirements contained therein are general rather than specific in nature. This allows the respective jurisdictions, where appropriate, to develop their own standards and policies within the framework of the **OMUTCD**. For example, **OMUTCD Section 2A.07** requires that traffic control signs be reflectorized to show the same shape and color both by day and night. As noted in ***Section 220-6***, Type G, H or J reflective sheeting shall be used for all permanent new traffic control signs on **ODOT**-maintained highways. Other jurisdictions may elect to use different reflective materials for their traffic control signs.

200-2 Construction Projects

Chapter 140 addresses the general application of **ODOT** standards, specifications and standard construction drawings to construction projects and ***Chapter 250*** provides additional construction-related information specific to traffic control signs.

200-3 Force Account (ODOT Operations) Work

Districts performing force account signing work must comply with the requirements in the **OMUTCD** and this Manual. It is recommended that the **Districts** follow the provisions in the applicable signing related **SCDs** and **C&MS** sections as well.

It should be recognized, however, that the information in the **C&MS** and **SCDs** does not necessarily provide the only method to achieve a given objective. For instance, **Traffic SCD TC-41.20** provides details on the use of yielding posts that are typically used for flatsheet signs. If a **District** instead wanted to use a breakaway support, this departure from common practice would be acceptable provided the support system met breakaway requirements, was installed accordingly, and had sufficient capacity to support the sign load.

Intentionally blank.

201 REGULATORY SIGNS

201-1 General

Regulatory Signs are addressed in **OMUTCD Chapter 2B**. Although many Regulatory Sign designs are shown in the **OMUTCD**, additional Regulatory Sign designs are contained in the **Sign Designs and Markings Manual (SDMM)**. **OMUTCD Section 2B.01** states that Regulatory Signs contained in the **SDMM** are incorporated by reference into the **OMUTCD**, and have the same legal applicability as if they had been included in the **OMUTCD**. Therefore, a regulatory sign appearing in either the **OMUTCD** or **SDMM** is legally enforceable.

As noted in **OMUTCD Section 2A.06**, there may be circumstances where a jurisdiction determines that signing is needed, but related signing is not addressed in the current **OMUTCD** or **SDMM**. In this situation, the responsible jurisdiction may develop the needed signing, as long as the design conforms to the **OMUTCD** standards. For local jurisdictions, such as a municipality, **County**, or **Township**, legislation (ordinance, resolution) is necessary for the sign to be legally enforceable. For **ODOT**-maintained facilities, a different process is followed.

ODOT does not have the ability to enact legislation. Therefore, for regulatory situations on **ODOT**-maintained facilities where no sign design is contained in the **OMUTCD** or **SDMM**, it will be necessary to create a new Regulatory Sign. **Districts** wanting to create a new Regulatory Sign design should contact the **Office of Traffic Operations (OTO)**. **OTO** will work with the **District** to develop appropriate wording, assign a code number, create a sign design, and incorporate the design into the **SDMM**. A new Regulatory Sign may be installed in the field as soon as it is developed; however, it will only become legally enforceable by **ORC Chapter 4511** once included in the **SDMM**, since by reference it then becomes part of the **OMUTCD**.

OMUTCD Table 2B-1 addresses Regulatory Sign sizes and contains “minimum” sign sizes for certain of these signs. These sizes, which are smaller than the conventional road sizes, should not be used on **ODOT**-maintained facilities.

The following Sections address Regulatory Signs not in the **OMUTCD,** or provide additional information about the intended use of signs that do appear in the **OMUTCD**. ***Figure 298-4a*** illustrates Regulatory Signs discussed in this Chapter which are not shown in the **OMUTCD**.

201-2 Prohibition of U-Turns at Median Crossovers

ORC Section 4511.35 permits indiscriminate use of median openings for the purpose of making U-turns. Experience has shown this to be an unsafe practice on high-speed, limited-access divided highways. It has been determined that U-turns may be prohibited at median openings on divided highways by authority granted under **ORC Section 4511.10**.

When a median opening is restricted to emergency or authorized vehicles only, the standard treatment consists of erecting the U-Turn Prohibition sign (R3-4) and the AUTHORIZED VEHICLES ONLY sign (R5-11) as shown in ***Figure 298-1*** **(also see OMUTCD Section 2B.39)**. This standard treatment should be used at all median crossovers on the Interstate system and at median crossovers on other divided highways where the **District Deputy Director** has determined that a median opening should be restricted to emergency and authorized use only.

201-3 STOP Signs

The STOP sign (R1-1) is one of the most important devices used to control traffic at intersections. Its purpose is to assign the right-of-way to drivers of vehicles so that they may proceed through an intersection in an orderly and safe manner. The use of STOP signs at highway-rail grade crossings is addressed in ***Section 801-2.*** The maintenance responsibilities of STOP and YIELD signs at **County** and **Township** road intersections with state highways is addressed in ***Section 260-6***.

STOP signs are commonly used upon the approaches to through roadways so that a driver may proceed along the highway for a considerable distance and be given the right-of-way at succeeding intersections. The principles contained herein should be used in determining which highway approach or approaches to an intersection should have STOP sign control. **OMUTCD Sections 2B.04, 2B.05, 2B.06** and **2B.10** provide additional information on the use of STOP signs.

ORC Section 4511.41 defines the "Right Hand Rule" regarding the right-of-way at an intersection, **Section 4511.43** defines the obedience required to a STOP sign, and **Section 4511.65** defines the right-of-way at through highways. **Section 4511.65** also indicates that YIELDS signs ***(see Section 201-11)*** and traffic control signals can be used to control intersecting traffic on a through highway; however, this is less common on the rural state highway system.

Normally, the selection of the highway approach to be stopped should be made in accordance with the functional class of the highway. The classification of the various types of highways in order of priority for assignment of right-of-way is as follows: (1) Interstate, (2) Freeway, (3) Expressway, (4) Principal Arterial, (5) Minor Arterial, (6) Major Collector, (7) Minor Collector, and (8) Local Street or Road.

The highway with the lower functional class should normally be stopped. Generally, a lower-volume highway should be stopped for a higher-volume highway where the intersecting highways have the same functional classification.

The preceding principles may be modified when any of the following conditions exist at an intersection:

1. A higher class route approach may be stopped for a lower class route when the traffic volume on the lower class route is at least 25 percent greater than the traffic on the higher class route, or when unusual intersection geometrics exist.

2. The selection of the highway approaches to be stopped should include consideration of conflicting uncontrolled travel paths. For example, drivers who are making a left turn usually recognize that they are required by law to yield to oncoming traffic on the same roadway. But there are instances, such as where a State Route turns, where the drivers on the State Route may not expect to yield to a vehicle on an adjacent approach ***(see Figure 298-2(A), (B) and (C))***.

   In the case illustrated in ***Figure 298-2(A)***, STOP signs should normally be placed on the State Route approach with the lower volume and the opposing County Road. In all cases, STOP signs (and YIELD signs where applicable) shall be placed so there are no conflicting movements which have the right-of-way.

   A driver approaching a Y-type intersection may not recognize that he will be executing a left-turn movement across the path of oncoming traffic ***(see Figure 298-2(C))***. Whenever this condition exists, the selection of the highway approaches to be stopped shall be made so as to eliminate this conflict.

3. The location and type of traffic control at intersections upstream or downstream may influence the selection of STOP sign controlled approaches. For example, if drivers on a highway have the right-of-way at successive major intersections for a considerable distance it may be desirable to give them the right-of-way at the subject intersection rather than create an unexpected stop.

STOP signs shall not be used at intersections with traffic control signals.

STOP signs shall be used in conjunction with the flashing red indication of Intersection Control Beacons.

At an intersection, the higher classification street or highway should be used to determine the size of the STOP sign to be erected at that intersection.

A STOP sign shall be erected at the point where the vehicle is to stop or as near thereto as possible, and may be supplemented with a Stop Line and the word STOP on the pavement, as shown in the **OMUTCD Figure 2A-3.** Except where unusual intersection geometrics exist, STOP signs should not be placed farther than 50 feet from the intersected roadway. Where there is a marked or unmarked crosswalk, the sign should be erected approximately 4 feet in advance of the crosswalk edge nearest to approaching traffic.

Dual Stop signs shall be installed on all rural and high-speed (>45 mph) Stop sign controlled U.S. and State Route intersection approaches in accordance with the **ODOT** Comprehensive Highway Safety Plan. (See ***Section 202-10*** regarding the use of dual Stop Ahead signs on these approaches.)

Dual Stop signs shall be installed on all **County** and **Township** Stop sign controlled intersection approaches with U.S. and State Routes with eleven or more intersection angle crashes in a three-year period, in accordance with the **ODOT** Comprehensive Highway Safety Plan.

Stop signs shall be augmented with flashing beacons or flashing LEDs at Stop sign controlled intersection approaches with fourteen or more intersection angle crashes in a three-year period, in accordance with the **ODOT** Comprehensive Highway Safety Plan. If a **District's** review of the crashes shows this countermeasure would not reasonably have a positive effect on the noted crash pattern, the **District** shall document the reasons why they are not installing the flashing beacon or flashing LED signs.

201-4 No Turn on Red Signing

ORC Section 4511.13 indicates that unless a sign prohibiting such action is in place: vehicular traffic, after stopping, may cautiously make a right turn on a steady red signal; and that vehicular traffic, after stopping, may cautiously make a left turn on a steady red signal from a one-way street to a one-way street on which traffic moves to the left. It also authorizes local authorities by ordinance, or the **Director of Transportation** on state highways, to "prohibit a right or a left turn against a steady red signal at any intersection, which shall be effective when signs giving notice thereof are posted at the intersection."

The **District** or any maintaining agency may prohibit or restrict turns against a steady red signal. The following factors should be considered in making the determination:

1. Sight distance from the stop position to approaching traffic is less than adequate for the right or left-turning driver to observe safe gaps.

2. Geometrics of the intersection are such that the path of the right or left-turning vehicle crosses rather than merges with the path of the vehicle which has a green indication.

3. Right or left-turning vehicles conflict with other traffic which has been given a green arrow indication.

4. Right or left-turning vehicles create a storage or capacity problem on the street onto which they are turning.

5. Right or left-turns are permitted from two or more lanes on an approach. (Consideration can be given to permitting turns against a steady red signal from the curb lane only.)

6. An intersection has five or more approaches.

7. An intersection is used by a substantial number of school children, elderly persons or other pedestrians where right or left-turning vehicles would be a hazard to the pedestrians.

8. An intersection is near a highway-rail grade crossing.

9. Other hazards or conflicts.

The **District** or maintaining agency should document reasons where turns against a steady red signal are prohibited.

201-5 Safety Belt Signing (R16-H1)

Safety belt signing is intended to remind motorists of the mandatory safety belt law, and to encourage safety belt use. The R16-H1 sign is used for this purpose (see **OMUTCD** **Section 2B.66** and **Figure 2B-32**).

A sign should be used in rest areas at a point where traffic leaves the rest area to re-enter the highway. For freeway rest areas, the suggested location is at the first part of the freeway entrance ramp in a conspicuous location that does not interfere with other signs. For rest areas on other routes, the sign should be located in a conspicuous location that does not obstruct sight distance.

A sign should be erected near the State Line for traffic entering **Ohio**. It should be erected on all **ODOT**-maintained highways, unless a suitable location cannot be found, or the route is minor in nature with insignificant traffic volumes. Where the State Line location falls within a municipality, arrangements should be made with the municipality for erection of a sign.

A sign should also be erected on selected highways outside municipalities for traffic leaving the municipality. To limit the number of signs to a reasonable amount, consideration should be given to traffic volumes, the distance between municipalities, and the number of signs on a particular route.

The red, white and blue N-84 information sign, and black on white R16-H2 word message regulatory sign, are no longer used. Existing installations of these signs may remain in place until they have reached the end of their service life, at which time they should be replaced with an R16-H1 sign.

201-6 Speed Limit Signs

Standards for the design and use of Speed Limit signs are addressed in **OMUTCD** **Chapter 2B.** As noted in **OMUTCD Section 2B.13**, **ORC Section 4511.21** establishes the statutory speed limits in Ohio, and "prescribes how those speed limits may be altered."

TEM Chapter 1203 describes the processes by which altered speed limits, including those in temporary traffic control zones, are established and the forms that are used.

School Speed Limit signs, School Speed Limit Signs with Beacons, and school zones are discussed in **OMUTCD** **Section 7B.10** and ***TEM Chapters 702 and 705.***

ODOT guidelines for reducing the speed limit in certain types of temporary traffic control zones are described in ***Subsection 640-18.***2, and Work Zone Speed Limit signs are further addressed in ***Subsection 605-3.4.***

Refer to ***Section 202-11*** for information regarding the use of the Reduced Speed Limit Ahead (W3-5, W3-5a) signs.

201-7 Signing for Engine Brake Restrictions (R20-H1, R20-H2, R10-H20bP, R10-H20cP)

An engine brake is a device used on vehicles, principally large trucks, that changes the timing of the exhaust valves to slow the vehicle. The engine brake is used instead of, or in addition to, the friction brakes and produces an audible “popping” noise that is sometimes perceived as objectionable.

The slang term “Jake Brake” is sometimes used to refer to engine brakes in general. However, this term is a registered trademark of **Jacobs Vehicle Systems**, a major manufacturer of engine brakes. Since this term actually refers to all of **Jacobs Vehicle Systems** retarding products and is brand specific, it should not be construed as being equivalent to “engine brake,” and should not be used on highway signing.

The **Ohio Office of the Attorney General** has determined that, pursuant to **ORC Sections 505.17(A) and 4513.221(E)(4)**, a **Board of County Commissioners** or **Township Trustees** may enact a regulation prohibiting the use of engine brakes on vehicles within the unincorporated area of the **County** or **Township**. This includes **ODOT**-maintained highways within the boundary of the **County** or **Township**, as well as **County** and **Township** Roads.

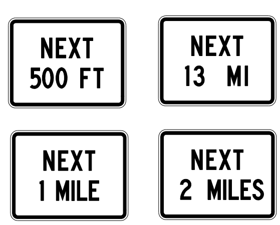
Section 4917 of the United States Code is part of the **Noise Control Act of 1972**, and sets maximum noise emissions for motor carriers engaged in interstate commerce. According to an opinion issued by the **Ohio Office of the Attorney General**, local regulations restricting the use of engine brakes to control noise for motor carriers engaged in interstate commerce “may be inconsistent with federal law, and thus preempted and unenforceable.” For this reason **ODOT** will not install NO ENGINE BRAKE signs on the mainline and ramps of Interstate Routes.

The NO ENGINE BRAKE sign (R20-H1) shall be used where the use of engine brakes has been restricted by the proper resolution per the **ORC**. The R10-H20bP and R10-H20cP auxiliary plaques may be used to indicate specifics regarding when or where the restriction applies, and may be combined with the R20-H1 sign on a single panel. Sample legends for these plates are “6 PM - 6 AM” for the R10-H20bP and “NEXT ½ MILE” or “NEXT 500 FT” for the R20-H20cP. The END ENGINE BRAKE RESTRICTION sign (R20-H2) may be used to indicate the terminus of the restriction.

For a **Township** restriction, typically only one NO ENGINE BRAKE sign (R20-H1) in each direction of travel within the **Township** should be installed on a state highway. More than one sign in each direction of travel may be needed for a countywide restriction, based on the length of the route within the **County**. The signs should be placed at strategic locations where the use of engine brakes has been a problem, such as at the beginning of a downgrade or an approach to an intersection. Alternatively, signs may be placed near where the state highway enters the**County** or **Township** or where a state highway begins within a **County** or **Township**. Overuse of signing should be avoided.

When a **County** or **Township** has passed a resolution restricting the use of engine brakes pursuant to **ORC Sections 505.17(A) and 4513.221(E)(4)**, **ODOT** will install signs on the rural state highway system indicating such a restriction. The **County** or **Township** is responsible for furnishing all signs to **ODOT**. The signs shall be fabricated in accordance with **ODOT** design standards and material specifications. **ODOT** will supply the sign supports and necessary hardware.

R10-H20bP



R10-H20cP

R20-H1

R20-H2

Code No.	Route Type	Size in inches (width x height)
R20-H1, R20-H2	Conventional	24 x 30
R10-H20bP		24 x 8
R10-H20cP		24 x 18
R20-H1, R20-H2	Expressway	36 x 48
R10-H20bP		36 x 12
R10-H20cP		36 x 24
R20-H1, R20-H2	Freeway	48 x 60
R10-H20bP		48 x 16)
R10-H20cP		48 x 30

201-8 <u>Move Over Signs (R25-H1)</u>

R25-H1 signs were installed at 75 locations on **ODOT**-maintained highways in 2000 at the request of the **Ohio State Highway Patrol (OSHP)** to publicize the provisions in **ORC Section 4511.213.** The sign legend was revised to reflect changes to **ORC Section 4511.213** which became effective on April 1, 2009. In December 2013, this provision was revised to also address construction, maintenance and public utilities commission vehicles, and the sign legend was subsequently revised.

The **OSHP** provided funding for initial sign fabrication, and the **Districts** provided the materials and labor for installation. However, no funding has been provided by **OSHP** to cover fabrication costs of signs needed for maintenance replacements. The **Districts** should order and install replacement signs as needed using established procedures.

R25-H1
120” x 60”

201-9 <u>Truck Restrictions</u>

A municipal corporation may restrict truck traffic on State or U.S. Routes through the municipal corporation only by regulating weight limits on the route, and only with the approval of the **Director of Transportation**.

A municipal corporation can regulate the use of its streets and can restrict the type of vehicles that travel over those streets pursuant to **ORC Section 4511.07**. However, **ORC Sections 4511.06 and 4513.33** restrict the use of that power for trucks traversing designated State or U.S. Routes. Thus, a municipal corporation may establish its own truck weight limits for streets and highways within its jurisdiction that differ from those established in **ORC Chapter 5577** and must post signs notifying the traveling public. However, when such weight limits involve State or U.S. Routes, **ORC 4513.33** requires the approval of the **Director** to alter them. Otherwise, the ordinance may conflict with **ORC Sections 4511.06 and 4513.33** and be found ineffective.

Weight Limit signs are discussed in **OMUTCD Section 2B.59**, and the **ODOT Bridge Design Manual (BDM)** also addresses this signing in **BDM Section 919.3.2 and Figure 905**.

201-10 Lane-Use Control Signs

OMUTCD Sections 2B.19 through 2B.22 address Lane-Use Control signs and show some of them. However, there are many more of these signs that have been designed and assigned code numbers than could practically be shown in the **OMUTCD**. For reference purposes, ***Table 297-1*** provides a listing of them with their standard sizes and ***Figure 298-22*** provides illustrations of them.

201-11 YIELD Signs (R1-2)

OMUTCD Sections 2B.04, 2B.08, 2B.09 and 2B.10 discuss YIELD signs. **OMUTCD Section 3B.16** addresses Yield Lines. The maintenance responsibilities of STOP and YIELD signs at **County** and **Township** road intersections with state highways is addressed in ***Section 260-6***.

A YIELD sign shall be erected at the point where the vehicle is to stop if necessary to yield the right-of-way. Except where unusual intersection geometrics exist, YIELD signs should not be placed further than 50 feet from the intersected roadway. Where there is a marked or unmarked crosswalk, the sign should be erected approximately 4 feet in advance of the crosswalk edge nearest to approaching traffic **(see OMUTCD Figure 2A-3).**

201-12 DO NOT ENTER Signs (R5-1)

OMUTCD Section 2B.37 discusses the DO NOT ENTER sign.

In accordance with **OMUTCD Section 2B.10**, when a DO NOT ENTER sign is mounted back-to-back with a STOP sign, the DO NOT ENTER sign should stay within the edges of the STOP sign. If necessary, the size of the STOP sign should be increased so that the DO NOT ENTER sign installed back-to-back with the STOP sign remains within the edges of the STOP sign.

201-13 KEEP RIGHT (LEFT) Signs (R4-7, R4-8)

OMUTCD Section 2B.32 discusses KEEP RIGHT (LEFT) signs.

On a median, the KEEP RIGHT (LEFT) sign should be mounted not more than 50 feet beyond the approach end of the island. To facilitate guidance of left-turning traffic entering from a cross street, the KEEP RIGHT (LEFT) sign may be erected at an angle of up to 45 degrees with the cross street.

201-14 Traffic Law Photo-Monitoring Signs (R10-18), Automated Traffic Enforcement and Surveillance Devices

Among other conditions on the use of traffic law photo-monitoring devices to detect or enforce traffic law violations set out in **Senate Bill 342, 130th General Assembly, Ohio Revised Code Section 4511.094** imposes certain conditions on any local authority for placement or use of traffic law photo-monitoring devices:

1. Erect R10-18 signs on every highway that is not a freeway that is part of the state highway system and that enters the local authority to inform inbound traffic that the local authority utilizes traffic law photo-monitoring devices to enforce traffic laws.

2. Beginning on March 23, 2015, erect signs at each fixed system location informing motorists that a traffic law photo-monitoring device is present at the location.

3. The sign shall be erected within the first three hundred feet of the boundary of the jurisdiction or within three hundred feet of the fixed system location, as applicable. If the signs cannot be located within the first three hundred feet of the boundary of the local authority or within three hundred feet of the fixed system location, the local authority shall erect the signs as close to that distance as possible. If a particular highway enters and exits the jurisdiction multiple times, the local authority shall erect the signs at the locations in each direction of travel where inbound traffic on the highway first enters the jurisdiction.

4 All signs erected must conform in size, color, location, and content standards contained in the **OMUTCD** and shall remain in place for as long as the local authority uses traffic law photo-monitoring devices to enforce any traffic law.

5 All required R10-18 signs shall be maintained and replaced as needed so that at all times at least ninety percent of the required signs are in place and functional.

6 The local authority shall annually document and, upon request, certify compliance with provision 5 of this Section.

7 At all intersections where traffic law photo-monitoring devices are placed, which are controlled by traffic signals, the operation of the yellow change lights and arrows must be timed so that the steady yellow interval exceed by one second the minimum yellow change interval determined in accordance with ***Section 403-2***.

No traffic law photo-monitoring, automated enforcement or surveillance device (including, but not limited to red light cameras, speed cameras, license plate readers (LPRs) and electronic surveillance devices) shall be installed at any intersection or on any highway maintained by **ODOT.**

201-15 KEEP RIGHT EXCEPT TO PASS (R4-16) Sign

ORC Section 4511.351 requires **ODOT** to erect the KEEP RIGHT EXCEPT TO PASS (R4-16) sign on Interstate highways with three or more lanes in the same direction. The purpose of the sign is to direct drivers to stay in the right-hand lane except when passing another vehicle.

The KEEP RIGHT EXCEPT TO PASS sign would be expected to have the greatest benefit in rural areas with a higher percentage of long distance traffic and greater spacing between interchanges. The message will be less relevant in urban areas with complex freeway designs and a higher percentage of relatively local traffic. For this reason, the sign is not recommended for installation within the outerbelt of major metropolitan areas, but should be installed on the outerbelt itself where, based on geometrics and other roadway characteristics, the message would be appropriate.

The recommended placement is on the left-hand (median) side of the roadway. Alternatively, the sign may be placed on the right-hand side of the roadway, or erected as a dual installation.

A sign should be placed where a rural Interstate highway transitions from two lanes to three lanes in the same direction. For long stretches of rural Interstate highways with three or more lanes, signs should be installed at a maximum interval of 10 miles.

The sign should not be installed in areas where, based on engineering judgment, it could have the potential to cause vehicle operators to make unnecessary or ill-advised lane changes. Factors to be considered for omitting the sign include closely spaced interchanges, dropped right lane at an interchange, dual right-hand exit lanes with or without option lane, left-hand exits, major freeway bifurcations, areas with lack of lane continuity, reduction in the number of through lanes at an interchange, horizontal curves, where the right lane ends requiring a merge into the adjacent lane, and in congested areas where THROUGH TRAFFIC KEEP LEFT or similar signs have been installed.

The KEEP RIGHT EXCEPT TO PASS sign may be used on Interstate highways with two lanes in the same direction, and on non-Interstate freeways, based on engineering judgment.

202 WARNING SIGNS

202-1 General

Warning Signs are addressed in **OMUTCD Chapter 2C**. As noted in **OMUTCD Section 2A.06**, there may be circumstances where a jurisdiction determines that signing is needed, but related signing is not addressed in the current **OMUTCD** text. In this situation, the jurisdiction may develop the needed signing, as long as the design conforms to the **OMUTCD** standards.

The following Sections address Warning Signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**. ***Figures 298-4a and 4b*** illustrate Warning Signs discussed in this Chapter which are not shown in the **OMUTCD**.

202-2 Warning Signs for Children

Signs intended to alert drivers that children may be present in an area, such as CHILDREN AT PLAY, WATCH FOR CHILDREN, BLIND CHILD, DEAF CHILD or AUTISTIC CHILD have not been shown to have a discernable benefit to traffic safety but still remain popular with the public. No factual evidence has been presented to document the success of this type of signing in reducing pedestrian accidents, operating speeds or legal liability. Studies have shown that many types of signs attempting to warn of normal conditions in residential areas, or conditions that are not always present, have failed to achieve the desired safety benefits.

Children should not be encouraged to play in the roadway. If signs encourage parents and children to believe they have an added degree of protection, which the signs do not and cannot provide, this can result in a disservice. This type of signing has long been rejected since it is a direct and open suggestion that this behavior is acceptable.

For these reasons, **ODOT** does not provide CHILDREN AT PLAY, WATCH FOR CHILDREN, BLIND CHILD, DEAF CHILD, AUTISTIC CHILD or similar signing. This type of signing is not recommended for use on any roadway at any time.

202-3 HIDDEN DRIVE Signs

The use of this sign was discontinued on **ODOT**-maintained highways in 1970 when traffic observations and experience disclosed that drivers on the through roadway were ignoring the sign message. The signs had little or no effect in alerting drivers or in reducing their speed.

The erection of HIDDEN DRIVE signs could create a false sense of security for the driveway user. The driveway traffic should be fully aware of the hazard of entering the through roadway, and should not be misled into thinking that the through traffic will be prepared to yield or stop.

For these reasons, **ODOT** does not provide HIDDEN DRIVE or similar signing.

202-4 No Reentry Signing (W13-H10P, W13-H11P)

Some freeway and expressway interchanges have been built as “half-diamonds,” with the exit and same direction entrance ramps several miles apart. Since this is not the usual situation, it is not expected by drivers. Although trailblazing to the entrance ramp may be provided, the lack of direct reentry can be confusing and irritating and some through drivers would choose not to exit at such an interchange if they were given advance warning.

The black on yellow NO REENTRY ______BOUND sign (W13-H10P) has been developed for this situation. When this interchange configuration creates a problem on **ODOT**-maintained freeways and expressways, this sign should be mounted as a supplemental panel with one or more of the Guide Signs for the exit. For signs less than 12 feet in width, the two-line sign (W13-H11P) is available. The sign width of the W13-H10P or W13-H11P may be increased to match the width of the Guide Sign.

W13-H10P

W13-H11P

Use of a black on orange version of this sign for construction situations is discussed in ***Section 605-6.3***.

202-5 Narrow and One-Lane Bridges

On **ODOT**-maintained highways, narrow bridges shall be identified using the NARROW BRIDGE sign (W5-2) in accordance with **OMUTCD Section 2C.20**, and the ONE LANE BRIDGE sign (W5-3) shall be used at one-lane bridges in accordance with **OMUTCD Section 2C.21**.

A NO PASSING ZONE sign (W14-3) shall be erected in accordance with **OMUTCD Section 2C.45**; however, the W14-3 sign shall only be used where the No-Passing Zone and the narrow or one-lane bridge treatment begin at the same location.

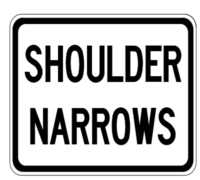
Figure 398-2 illustrates the signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in ***Sections 302-6 and 304-4***.

202-6 Amish Buggy Signing Where Paved Shoulder Becomes Narrower (W11-H14a, W11-H14P)

In order to accommodate buggy traffic, paved shoulders are being provided along some **ODOT**-maintained highways in the vicinity of Amish communities. This allows the slow moving buggies to use the shoulder instead of the roadway.

A potential conflict exists where a paved shoulder ends and buggies enter the roadway. Motorists who are accustomed to seeing buggies on the shoulder may not be expecting to encounter them on the roadway. As shown in ***Figure 298-7***, Warning Signs may be used to inform drivers that the shoulder is narrowing and to be prepared for buggies on the roadway ahead.

W11-H14a



W11-H14P

Code No.	Route Type	Size in inches (width x height)
W11-H14a	Conventional	36 x 36
W11-H14P		24 x 18

202-7 Low Clearance Signs

OMUTCD Section 2C.27 discusses Low Clearance signs and **Ohio Revised Code Section 5577.05** establishes a maximum vehicle height of 13 feet-6 inches.

The Low Clearance sign (W12-2) shall be used to warn road users of clearances less than 14 feet-6 inches. The structure-mounted Low Clearance sign (W12-2a) shall be used for clearances of 13 feet-6 inches or less, and may be used for clearances greater than 13 feet-6 inches. The W12-2a sign should be centered over the approach lane(s) with the low vertical clearance. The W12-2 and the W12-2a should display the same clearance height. The vertical clearance shown should be the minimum clearance measured to the bottom of a chord not less than 10 feet in width over the approach lane(s).

The Side Low Clearance sign (W12-H3) is intended to show the vertical clearance directly above the face of the side rail or curb. This sign shall be used on the structure where the vertical clearance at the face of the side rail or curb is 13 feet-6 inches or less. This sign should be used as necessary on variable clearance structures where the side clearance is more than 13 feet-6 inches, but less than 14 feet-6 inches. When W12-H3 signs are used on a structure, the W12-2a sign should also be used even if the center clearance is more than 13 feet-6 inches.

Example applications of Low Clearance signs on low structures are shown in ***Figure 298-42***.

202-8 Entrance Sign (W11-H13)

The Entrance sign (W11-H13) may be used to provide advance warning of driveways where there is poor sight distance or a fairly large volume of entering or exiting traffic. Where the driveway traffic is seasonal, the sign should be covered or removed during the period the entrance is not in common use.

Commonly used Entrance signs include TRUCK, PARK, SCHOOL, CHURCH, PLANT and HOSPITAL. Refer to ***Section 702-5*** for additional information on the use of the SCHOOL ENTRANCE sign.

Although not addressed specifically in the **OMUTCD**, designs for a generic ENTRANCE (W11-H13) sign and the SCHOOL ENTRANCE (S3-H3) sign are provided in the **Sign Designs and Markings Manual (SDMM)**.

202-9 Transition Signing

The **OMUTCD** describes various warning signs that can be used in highway transitions for a reduction in the number of lanes. Larger warning signs (W9-H4a, W9-H4b) can be used for added emphasis. For ground mounting of these signs, a size of 144" x 48" is recommended. For overhead mounting, a size of 192" x 60" is recommended.

Example transition signing is shown in ***Figures 298-43*** and ***298-44***.

W9-H4a

W9-H4b

202-10 Stop Ahead Signs (W3-1)

OMUTCD Section 2C.36 discusses the Stop Ahead signs.

Dual Stop Ahead signs shall be installed on all rural and high-speed (>45 mph) Stop sign controlled US and State Route intersection approaches in accordance with the **ODOT** Comprehensive Highway Safety Plan. (See ***Section 201-3*** regarding the use of dual Stop signs on these approaches.)

202-11 Reduced Speed Limit Ahead Signs (W3-5, W3-5a)

OMUTCD Section 2C.38 indicates that **"**a Reduced Speed Limit Ahead (W3-5, W3-5a) sign **(see OMUTCD Figure 2C-7)** should be used to inform road users of a reduced speed zone where the speed limit is being reduced by more than 10 mph, or where engineering judgment indicates the need for advance notice to comply with the posted speed limit ahead." On **ODOT**-maintained highways, a Speed Reduction (W3-5 or W3-5a) sign should be installed whenever the speed limit is reduced by more than 10 miles per hour, whether it is the statutory speed limit or an authorized Speed Zone.

However, before installing the W3-5 or W3-5a in advance of a Speed Limit sign erected by others (at Corporation Limits) the speed limit should be confirmed. The Speed Reduction signs shall not be erected in advance of inappropriate Speed Limit signs (e.g., an unapproved Speed Zone or signs that do not reflect the correct statutory speed limit).

Reduced Speed Limit Ahead signs are also used when the speed limit is reduced through a temporary traffic control zone ***(see Section 640-18)***; and if such a speed zone uses variable speed lmits, as noted in ***Section 605-6.4*** the VARIABLE SPEED LIMIT AHEAD (W3-H5b) sign should be used.

202-12 GROOVED PAVEMENT Sign (W8-15)

Longitudinal grooves in pavement surfaces, excluding diamond grinding, may cause lateral control problems for bicycles, motorcycles and other small vehicles. Without adequate warning, an operator may not have sufficient time to adjust the vehicle's speed to safely negotiate the grooved pavement section. See **OMUTCD Section 2C.33 and Figure 2C-6**.

A GROOVED PAVEMENT Sign (W8-15) shall be erected in advance of longitudinally grooved pavement sections.

A distance plaque may be used to supplement the sign.

202-13 METAL BRIDGE DECK Sign (W8-16)

Grated/metal bridge decks may cause vehicle control problems for bicycles, motorcycles and small cars due to low traction on this type of bridge deck. See **OMUTCD Section 2C.33 and Figure 2C-6**.

These bridge decks shall be marked with the METAL BRIDGE DECK sign (W8-16).

A distance plaque may be used to supplement the sign.

202-14 Object Markers and End-of-Roadway Markers

202-14.1 General

OMUTCD Chapter 2C establishes standards and guidelines for the design and use of object markers and end-of-roadway markers. Additional design and application information is provided herein. As noted in ***Section 341-5***, for plan purposes object markers and end-of-roadway markers shall be treated as flatsheet signs.

202-14.2 Narrow and One-Lane Bridges

Type 3 object markers shall be used in accordance with OMUTCD **Sections 2C.65** to mark narrow and one-lane bridges. ***Figure 398-2*** illustrates the signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in ***Sections 202-5, 302-6 and 304-5*****.**

202-14.3 Barrier Object Marker

A Barrier Object Marker is a special type of marker mounted on top of 32-inch Portable Barrier (PB). Barrier Object Markers may also be used on other temporary traffic barriers. See ***Section 605-19*** for details**.**

202-15 Signing for High Water

202-15.1 General

At times, high water may cover portions of highways. Advance warning of this condition allows road users to take appropriate action based on the conditions encountered. Appropriate Warning Signs should be erected in advance of affected highway sections as soon as practical after becoming aware of high water covering the highway.

In many cases, conditions change rapidly. Adjustments to High Water signing should be made as appropriate when warranted by changing conditions.

In March 2015, **ORC 4511.714,** which addresses ROAD CLOSED signing for high water situations became effective. When the road becomes impassable due to high water conditions, the ROAD CLOSED HIGH WATER MAX FINE $2000 (R11-H4a) sign should be installed. ***See Section 605-3.2*** for further details.

202-15.2 HIGH WATER Sign (W8-H18a)

The HIGH WATER sign (W8-H18a) may be used where high water temporarily covers the road. It should be erected as soon as practical after becoming aware that such a condition exists.

While traffic can still pass over the affected section of highway, the sign should be located in advance of the section in accordance with OMUTCD **Table 2C-4.** When the section becomes impassible, an additional HIGH WATER sign may be placed at the point where traffic can select an alternate route.

HIGH WATER signs may be placed on temporary supports. On sections of highway where high water events occur often, hinged signs may be permanently mounted and displayed when needed. When the road is expected to be impassible for an extended length of time, other devices may be used to supplement the HIGH WATER signs. These include R11-H4a Road Closed signs, detour signs, barricades, cones and drums. See OMUTCD **Part 6** and ***TEM Part 6*** for further information on these device.

202-15.3 ROAD MAY FLOOD Sign (W8-18)

For locations where high water coverage occurs often, the ROAD MAY FLOOD sign (W8-18) may be permanently mounted to alert road users to the flooding potential. This sign should be located in advance of the affected section in accordance with OMUTCD **Table 2C-4**.

When high water is present, the HIGH WATER sign (W8-H18a) may be used to supplement the ROAD MAY FLOOD sign. When the road becomes impassable, as noted in ***Section 202-15.1***, the R11-H4a sign should be installed.

202-15.4 Depth Gauge Sign (W8-19)

The Depth Gauge Sign (W8-19) may be used as a permanent marker along a section where flooding is a frequent occurrence, in accordance with **OMUTCD** **Section 2C.35**.

When used, the signs should be erected on both sides of the road at intervals of 200 feet or less along the section subject to high water coverage. Two signs may be mounted back-to-back on one post. The signs should, where possible, be placed 2 feet-6 inches from the edge of the paved shoulder or from the edge of the pavement when no paved shoulder exists. All markers should be erected the same distance from the edge of the road in order that the driver may be able to estimate his position with respect to the edge of the traveled highway at times when the road is covered with water. Each marker shall be mounted so that its zero foot line is at the same elevation as the pavement or traveled roadway edge.

When high water is present, the HIGH WATER sign (W8-H18a) may be used to supplement the Depth Gauge Signs. When the road becomes impassable, as noted in ***Section 202-15.1***, the R11-H4a sign should be installed.

203 GUIDE SIGNS

203-1 General

Guide Signs on conventional roads are addressed generally in **OMUTCD Chapter 2D**, and Guide Signs on freeways and expressways are addressed generally in **OMUTCD Chapter 2E**. Additional specific information on General Information Signs, General Service Signs, Specific Service Signing (Logos), Tourist-Oriented Directional Signs (TODS), Changeable Message Signs, Recreational and Cultural Interest Signs, and Emergency Management Signing is provided in **OMUTCD Chapters 2H, 2I, 2J, 2K, 2L, 2M and 2N**, respectively.

Sizes for commonly used Guide Signs are shown in ***Tables 297-12***. Additional guidance related to these signs is provided in ***Chapters 204 through 209*** of this Manual. Various Guide Signs discussed in this Manual which are not shown in the **OMUTCD** are illustrated in ***Figures 298-5a through 5c, and 298-6a through 6c***.

203-2 Minor Interchanges

OMUTCD Section 2E.51 allows for fewer Guide Signs at Minor Interchanges, and this is illustrated in **OMUTCD Figures 2D-12 and 2E-40**. However, as noted in the **OMUTCD** text there are no Minor Interchanges in **Ohio**. Generally, this type of Minor Interchange is seen only in the wide open areas of the western states.

Intentionally blank.

204 ROUTE SIGNS

204-1 General

OMUTCD Chapter 2D addresses route signs and route sign auxiliaries. The following Sections address route signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**. ***Figures 298-5a and 5c*** illustrates route signs discussed in this Section which are not shown in the **OMUTCD**.

204-2 Ohio Byway Signing (M8-H3, M8-H3P)

As noted in **OMUTCD Section 2D.56**, certain roads have been designated by **ODOT** as Ohio Byways based on their archeological, cultural, historic, natural, recreational, or scenic qualities. The Ohio Byway program (see www.ohiobyways.com) is administered by the **Office of Local Programs**. A route must be approved by **ODOT** as an Ohio Byway before signs can be installed, and a route designated by **ODOT** as an Ohio Byway shall be signed.

Ohio Byways are not limited to **ODOT**-maintained highways, and may follow **County**, **Township** and municipal roads as well. **ODOT** is responsible for installing and maintaining Ohio Byway signs and auxiliary signs on **ODOT**-maintained highways, including state route extensions within municipalities. To assure uniformity of appearance, **ODOT** will provide signs to the local authority for use on local roads. The local authority is responsible for installing and maintaining the signs on local roads.

The Ohio Byway sign (M8-H3) is considered a route sign. Auxiliary signs used with the Ohio Byway sign shall have a white legend on a green background (e.g., M5-1, M6-1).

The Ohio Byway sign should be installed in accordance with **OMUTCD Section 2D.56** and other **OMUTCD** standards for route signs.

The Ohio Byway supplemental sign (M8-H3P) may be used at the discretion of the sponsoring agency. If used, the signs shall be fabricated by the sponsoring agency and supplied to the appropriate jurisdictions for erection. The decision by the sponsoring agency to have M8-H3P signs installed does not necessitate their use with all M8-H3 signs along the route. The M8-H3P signs can be selectively utilized at key locations as determined by the sponsoring agency, with the concurrence of the responsible jurisdiction. Their use may be particularly beneficial where overlapping Ohio Byways diverge.

204-3 Business Routes (M1-2, M1-3, M4-3, D20-H1, D20-H2)

Ordinarily, when an **ODOT**-maintained highway bypasses the central business district (CBD) of a municipal corporation, standard Guide Signs and route marking for the routes which remain in the urban area will be adequate to guide drivers from the bypass route to the CBD and back. In cases where existing signing does not adequately perform this function, additional guidance may be provided by establishing an official Business Route.

A Business Route may be either a business loop or a business spur. A business loop is a route which begins at an **ODOT**-maintained interchange or intersection, traverses over adequate streets and highways to and through the CBD of the bypassed municipal corporation, and returns to the **ODOT**-maintained highway at another location. A business spur is a route which begins at an **ODOT**-maintained interchange or intersection, leads traffic into the CBD of the bypassed municipal corporation, and returns to the **ODOT**-maintained highway along the same route to the point where it began.

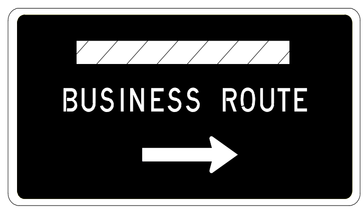
A Business Route may be established by the **District** where an **ODOT**-maintained highway has been constructed on a new alignment which bypasses the CBD of a municipality and no other **ODOT**-maintained highway provides a direct two-way connection between the bypass route and the CBD, or where the existing guide signing does not adequately direct the driver from the bypass route to the CBD and back to the bypass route. A business loop or spur from an **ODOT**-maintained highway may be routed over the existing State and U.S. Routes, County Roads, and municipal streets as applicable. The business loop or spur route should be clearly marked by appropriate signing.

Where portions of a proposed Business Route will follow County Roads or municipal streets (including state route extensions within the corporation limits), appropriate resolutions should be submitted from the County and/or municipality (see ***Forms 296-1 and 296-2)***.

Business Route signing should be installed in accordance with **OMUTCD** standards. The Interstate Business Route Markers (M1-2, M1-3) should be used where appropriate. The BUSINESS auxiliary sign (M4-3) should be used with standard State or U.S. Route Markers and auxiliary signs. Supplemental Guide Signs or supplemental plaques may be used on freeway and expressway routes. On conventional roads, the D20-H1 and D20-H2 signs may be used.

Normally, **ODOT** will furnish and install the signing for the business route, and the local jurisdictions will be responsible for the future replacement and maintenance of the signing on their respective portions of the route.

D20-H1



D20-H2

204-4 <u>Lake Erie Circle Tour Signing (M8-H1, M8-H2)</u>

Due to their proximity to the Lake Erie shoreline or connecting waterways, the **ODOT**-maintained highways in ***Table 297-2*** have been designated as the Lake Erie Circle Tour (LECT). **ODOT** is responsible for installing and maintaining LECT signs (M8-H1) and auxiliary markers on these routes, including state route extensions within municipalities.

The M8-H1 sign has a white legend on a green background, and is considered a route sign. Auxiliary signs used with the M8-H1 sign shall also have a white legend on a green background (e.g., M5-1, M6-1).

The M8-H1 sign should be installed in accordance with **OMUTCD** standards for route signs. Signs should be installed in both directions along the established route. A sign should be installed at the beginning of the route near the State Lines. A sign and directional arrow should be placed before each turn in the route, and at each intersection where the route turns or changes direction. A sign should also be installed after each turn to confirm the routing. Additional signs should be installed at 5 to 10 mile intervals and at other key locations along the route. Signs may also be placed on major intersecting highways informing of the junction with the LECT route as appropriate. An LECT route sign may be installed in an assembly with other route signs.

To help establish a link between the Lake Erie Circle Tour and the overall Great Lakes Circle Tour (GLCT) system, GLCT route signs (M8-H2) should be erected near the State Lines. One sign should be placed on southbound I-75 near the **Michigan State Line** and another on westbound U.S. Route 20 near the **Pennsylvania State Line**.

Local communities may identify, promote and sign spur and loop routes from the LECT system. Proposals for such routes and the related signing must be reviewed jointly by representatives of the **Ohio Departments of Development, Transportation and Natural Resources**.

Sign placement criteria for approved spur and loop routes is the same as described for the LECT route signs; and the sign used is identical to the M8-H1 sign, except that the sign has a white legend on a brown background. Auxiliary signs shall also have a white legend on a brown background.

Markers for approved spur and loop routes should be furnished, installed and maintained by the agency having jurisdiction over the roadway, at the cost of the agency or group sponsoring the spur or loop route. When the approved spur or loop is on an **ODOT**-maintained highway, **ODOT** shall furnish, install and maintain the signs; however, all expenses shall be reimbursed per an agreement between **ODOT** and the route sponsor executed prior to sign placement.

M8-H1

M8-H2

204-5 Appalachian Highway Signing (M1-H11)

State Route 32 has been designated as the Appalachian Highway for its entire length across the **State of Ohio**. The Appalachian Highway supplemental plaque (M1-H11) should be installed above all State Route 32 confirming assemblies (above the cardinal direction plaque). The width of the M1-H11 plaque should match the width of the route sign. This plaque shall not be used with junction assemblies and directional assemblies on intersecting routes.

M1-H11

204-6 Municipal Street System Signing

Figure 298-38 is an example of route marking for municipal street systems. ***Section 260-4*** provides information on the responsibilities regarding signing within municipalities.

Intentionally blank.

205 CONVENTIONAL ROAD DESTINATION AND DISTANCE SIGNS

205-1 General

Conventional Road Destination and Distance Signs are addressed in **OMUTCD** **Sections 2D.36 through 2D.42**. The following Sections address signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**.

205-2 Conventional Road Destination Signs

OMUTCD **Section 2D.05** indicates that "the lettering for names of places, streets, and highways on conventional road guide signs shall be a combination of lower-case letter with initial upper-case letter letters." The optional use of all capital letters for conventional road destination signs was eliminated with the issuance of the 2012 **OMUTCD**. **ODOT's** practice had been to use all capital letters on these Destination signs. However, in late 2005 it was decided that **ODOT** would start changing over to a practice of using upper and lower-case letters for these legends..

For many years, **ODOT** has used the 72 x 12 inch destination signs at intersections on conventional roads. Where more than one destination is shown, separate signs have been used for each destination with the signs mounted in an assembly on the same supports. This system has provided versatility and convenience for **ODOT**, while providing pertinent information to the motoring public. Keeping sign lengths at 72 inches by using various series letters has simplified installation, especially where right-of-way is limited or physical constraints make the installation of longer signs difficult.

Unless there is a preference to do otherwise, on **ODOT**-maintained conventional highways, the **Districts** should install destination signs as follows:

1. On two-lane conventional rural roads use the 72 x 12 inch D1-H1 and D1-H1a signs. For two or three destinations, use multiple assemblies of the 72 x 12 inch D1-H1 and D1-H1a signs.
2. On four or more lane conventional rural roads, use the 96 x 24 inch D1-H1 and D1-H1a signs. For two or three destinations, use multiple assemblies of the 96 x 24 inch D1-H1 and D1-H1a signs.
3. For urban applications, use the 48 x 8 inch D1-H1 and D1-H1a signs. For two or three destinations, use multiple assemblies of the 48 x 8 inch D1-H1 and D1-H1a signs.
4. For recreational destinations, use the D7-H1 and D7-H1a signs in the same manner as described for the D1-H1 and D1-H1a signs in items 1 through 3 above. When used in mixed multiple assemblies, position the white-on-green destination signs above the white-on-brown destination signs.

205-3 Signing for Traffic Generators at Intersections

205-3.1 General

OMUTCD **Chapters 2D and 2M** discuss the use of Guide Signs on conventional roads to provide guidance to traffic generators. In order to control the proliferation of such signing, each responsible jurisdiction is encouraged to establish a traffic generator policy in general agreement with the "official **ODOT** policy." This Section establishes the **ODOT** criteria for determining when a destination qualifies as a traffic generator for which Guide Signs, typically containing the name of the generator, may be erected at intersections on **ODOT**-maintained conventional roads.

As used in this Section, "non-profit" also refers to facilities or organizations described as "not for profit."

205-3.2 Procedure for Reviewing Requests

For signing requests for traffic generators at intersections, the following procedures apply:

1. Signs may be erected at intersections on **ODOT**-maintained highways after a written request has been received from the operator of the generator (with all data necessary to determine eligibility) and an investigation by the **District** has confirmed the eligibility of the generator as defined by this standard.
2. Requests for generator signing which would be erected completely inside a municipality should be forwarded to the local authority for their consideration. Where part of the warranted signing for a generator will be within a municipality and part outside, the **District** shall request the municipality to furnish and erect the necessary signing within its corporation limits.
3. The erection of signs for eligible generators shall be in accordance with standards for sign type, height, lateral placement and location as specified in the **OMUTCD**. The number of destinations used in any one destination sign assembly should be in accordance with **OMUTCD Section 2D.37**. The legend size of generator signing should be consistent with the legend size of other existing destination signs in the vicinity.
4. Signs for eligible generators shall not be erected when the proposed signs would conflict with existing primary Guide Signs or other traffic control signs. Therefore, no commitment should be made to erect signs until an on-site inspection has been conducted at the proposed sign location in order to determine that sufficient space exists.
5. Signs erected for eligible generators should be placed on the nearest **ODOT**-maintained highway at its intersection with the road which leads to the generator. If the nearest **ODOT**-maintained highway is not used by the majority of the drivers traveling to the generator, the signs may be erected at the intersection of the **ODOT**-maintained highway which is used by the majority of the drivers traveling to the generator instead of the lesser used highway.
6. When the generator is located on an **ODOT**-maintained highway, a sign indicating the entrance to the generator should only be erected when the entrance to the generator is not conspicuously marked or readily visible.
7. **ODOT** shall not erect signs until necessary trailblazing signs off the state system have been erected by others.
8. Under exceptional circumstances, additional signs may be necessary to adequately sign for a traffic generator. Additional signs should be approved by the **District Deputy Director** based on an engineering study that documents the need.
9. Not all demands for generator signing can be accommodated. Therefore, the **District** should develop a priority system to determine which of the generators should get the limited space available. If signs for the generator requesting signing would result in too many signs or too many destinations on a sign, the **District** shall review the information and determine which generators would receive signing. To minimize future conflicts and removals of existing generator signs, consideration should be given to future expectations and priorities of signing at intersections before erecting signs.

205-3.3 Criteria and Eligible Generators

Signing for traffic generators may vary in color depending on the category of the generator. **ODOT** has established the following criteria in determining which generators will qualify for signing and what color will be used for the sign.

205-3.3.1 Signs with a Green Background

Signs for the following generators shall have a white legend on a green background:

1. **Airport, Heliport, Ferry, Train Station and Bus Station.**

   Signs may be erected for any public airport or ferry shown on the official **Ohio Transportation map**, or any public heliport, train station, or bus station which has regularly scheduled departures and/or arrivals.

   To warrant signing at a particular intersection, an airport should also be within 15 miles of the intersection. Optional guide (trailblazer) signing may also be provided along routes other than the primary route within a 10 mile radius of the airport for commercial airports, and within a 7.5 mile radius of other airports. Guide signing shall not be permitted for privately owned airports that are not open to the public.

2. **College, University and Other Post High School Educational Institution.**

   Signs may be erected when the institution is duly accredited, provides multiple associate, bachelors, masters, and/or doctorate degree programs of the traditional academic variety, and is within 5 miles of the intersection.

3. **Joint Vocational School.**

   A joint vocational school is a public school primarily intended for vocational training for high school juniors and seniors. Signs may be erected when the school is within 5 miles of the intersection.

4. **Boarding School.**

   Signs may be erected when the school provides a traditional academic curriculum and has a substantial portion of the student enrollment comprised of individuals whose permanent residence is not considered to be local to the community in which the school is located. This includes college preparatory schools and military academies.

5. **Major Military Installation.**

   Signs may be erected when the military installation has at least 500 permanently assigned personnel or employees and the installation is within 5 miles of the intersection.

6. **Privately Owned Non-Profit Campground.**

   Signs may be erected when the privately owned non-profit campground is within 5 miles of the intersection. This includes scout, church, **4-H**, youth, and **YMCA/YWCA** camps.

7. **Hospice Facility.**

   Signs may be erected when the hospice is licensed by the **Ohio Department of Health**, is within 5 miles of the intersection, and is a freestanding facility.

205-3.3.2 Signs with a Blue Background

Signs for the following generators shall have a white legend on a blue background:

1. **Law Enforcement Agency.**

   Signs may be erected when the law enforcement agency facility is within 5 miles of the intersection, and the agency headquarters approves of or requests the installation.

2. **General Service.**

   Signing for hospitals is addressed in ***Section 207-4***, signing for generic general services (fuel, food, lodging and camping) is addressed in ***Section 207-5***, and signing for tourist information centers is addressed in ***Section 207-6***.

3. **Tourist Oriented Directional Signing (TODS).**

   The TODS program is described in ***Section 207-3***.

205-3.3.3 Signs with a Brown Background

Permanent signs may be erected for the following generators provided: (1) the generator is a publicly owned or a privately owned non-profit facility; and (2) the generator has an annual attendance of 100,000 plus 10,000 per mile in urban areas, or 50,000 plus 5,000 per mile in rural areas, where the distance is measured from the generator to the intersection. In rural areas, where generators are less common and more space for generator signing is available, attendance requirements may be reduced by up to 60 percent by the **District Deputy Director**. Signs for these generators shall have a white legend on a brown background:

1. **Miscellaneous Generator** - Arenas, coliseums, stadiums, auditoriums, convention halls, fairgrounds, parks (national, state, county, municipal, etc.), racetracks, casinos and zoos.
2. **Recreation Area** - Recreation areas (e.g., beaches and lakes). Where recreational areas are established at a large lake, reservoir or forest and many recreational facilities are available, boundaries may be established for the purpose of informing oncoming traffic. On roadways entering the region, the D7-H3 sign may be erected at the boundary.
3. **Tourist Attraction** - Aquariums, arboretums, botanical gardens, geological sites, historical sites, State memorials, restorations, monuments, museums, planetariums and other attractions of historic or cultural interest.

Also, permanent signs may be erected for privately-owned major tourist attractions (e.g., large amusement parks) where the traffic volumes are such as to warrant additional signing to facilitate an orderly flow of traffic to the facility. Signs for these generators shall have a white legend on a brown background.

205-3.4 Generators That Do Not Normally Warrant Signing

Except as covered in the previous paragraph, activities signed for under the Tourist Oriented Directional Signing (TODS) program do not qualify for generator signing under this Section.

Also, it has been determined that the following facilities do not normally qualify for signing under these provisions for traffic generators:

1. **Business** - Industrial parks, shopping centers, shopping malls, television stations, radio stations and theaters.
2. **Cemetery -** National, local, State, military, public and private.
3. **Community Facility** - Churches, civic centers, libraries and subdivisions.
4. **Educational** - Grade schools and high schools (except as provided in ***Section 205-3.3.1***).
5. **Governmental** - Courthouses, disaster assistance facilities, civil defense facilities, driver's license centers, jails, prisons, local government highway buildings, post offices, research facilities, experimental facilities.
6. **Medical** - County homes, fraternal homes, nursing homes, humane facilities (i.e., animal shelters), infirmaries, treatment centers, mental facilities, research facilities, retirement facilities, sanitariums, veteran facilities.
7. **Military** - Armories, arsenals, sites and detachments.

8. **Recreational** - Amusement parks, country clubs and golf courses.

205-3.5 Temporary Event Signing

Directional signing may be installed for temporary events. Temporary events include shows (e.g., boat, car, air, horse, RV), street fairs and festivals, reenactments, sports tournaments, concerts and other similar short-term activities that generate a significant amount of traffic from outside the immediate area of the event, but for which permanently installed signs would not be appropriate. The duration of these events would typically be several days or several successive weekends; however, some could be as short as a few hours. Temporary directional signs will assist the unfamiliar road user, and facilitate the orderly flow of traffic to the event.

Generally, for events expected to attract fewer than 1,000 visitors per day, or attracting visitors principally from the local area, directional signage would not be needed. For events attracting 1,000 or more visitors per day, with many from outside the local area, appropriately designed and installed directional signs would be beneficial.

Requests for directional signage to be placed on the rural state highway system under **ODOT's** jurisdiction should be submitted by the sponsoring agency to the appropriate **ODOT District Office** at least 45 days prior to the event. The **District Office** should review the request, and on a case-by-case basis, determine what, if any, directional signage would be appropriate on the rural state highway system.

The sponsoring agency shall be responsible for the fabrication and installation of the signs on the rural state highway system, once the sign designs, locations and support arrangements have been approved by **ODOT**. The sponsoring agency shall obtain an **ODOT** right-of-way use permit prior to the installation of the signs. Alternatively, **ODOT** may install the approved signs furnished by the sponsoring agency on the rural state highway system, and bill the sponsoring agency for the costs incurred.

The sponsoring agency shall be responsible for the removal of the signs within 24 hours after the conclusion of the event. **ODOT** may remove signs not removed by the sponsoring agency within a timely manner, and bill the sponsoring agency for the costs incurred.

The directional signs are intended to provide guidance to road users looking for the event, and are not meant to entice others to attend. The signs shall conform to the requirements in the **OMUTCD**, and shall not contain any advertising. On conventional roads, a minimum upper case letter height of 4 inches is recommended. For major conventional roads, a minimum upper case letter height of 6 inches is recommended. The sign background should be brown or green, with a white legend. The legend should be as concise as possible while still conveying the necessary pertinent information to associate the sign with the event.

The signs may be installed on their own ground-embedded supports, may be attached to existing supports or utility poles, or may be mounted on portable supports. Signs installed in exposed locations (i.e., not protected by guardrail or concrete barrier), must be on crashworthy, ground-embedded or portable supports (except for signs attached to utility poles). Signs on portable supports shall have a minimum mounting height of 1 foot above the edge of pavement. The mounting height of other signs shall be in accordance with the **OMUTCD**.

If determined by **ODOT** to be appropriate, **ODOT** may allow the sponsoring agency to install portable changeable message signs on the rural state highway system, in accordance with the provisions of the **OMUTCD**.

205-4 Weigh Station Signing for Conventional Roads

Weigh Station signing for conventional roads is addressed in **OMUTCD** **Section 2D.49** and **Figure 2D-17**. There are currently no weigh stations on **ODOT**-maintained two-lane conventional roads.

Signing for weigh stations on **ODOT**-maintained major conventional roads should be the same as that used for freeways and expressways ***(see Section 209-4)***.

205-5 Street Name Signing for At-Grade Intersections on Conventional Roads

Street Name signs on conventional roads are normally installed by the agency having jurisdiction over the intersected street, although these may be installed by **ODOT**. The D3-H1 and D3-H1b signs are used for this purpose. Where it is desired to include the name of the maintaining agency on the sign, the D3-H6b and D3-H6c signs may be used.

Figures 298-31 and 298-32 illustrate examples of signing arrangements that may be used where it is desired to provide advance notice of intersections with important public roads.

For at-grade intersections on expressways and major conventional roads ***(see Section 209-6.2)***, refer to ***Section 209-6 and Figures 298-28 through 298-30***.

205-6 Signing for Historical Markers on Conventional Roads

Guide signing may be used to alert road users to the presence of an historical marker along the roadway or on an intersected road. The D7-H8, D7-H8a and D7-H9 signs are used for this purpose.

To be eligible for guide signing, historical markers located along the roadway must be in an area with adequate sight distance for safe ingress and egress and a minimum of two parking spaces. Historical markers located on an intersected road should be within 1 mile of the intersection with the main highway, and have all necessary trailblazer signs installed by the responsible jurisdiction prior to the installation of signs along the main highway.

The D7-H8, D7-H8a and D7-H9 signs have a white legend on a brown background, with a standard size of 24 x 24 inches. Larger sizes may be used on multi-lane roads or where additional emphasis is desired. The D7-H8 and D7-H8a signs may be installed in an assembly with a white on brown M5 or M6 series auxiliary sign. Where an historical marker is associated with an Ohio Byway **(see OMUTCD Section 2D.56 and *TEM Section 204-2*)**, the historical marker sign may be installed in an assembly below the Byway sign.

When signing is provided for an historical marker located along the roadway, a D7-H8 sign with appropriate distance should be used in advance of the site. This sign would typically be placed 500 feet in advance of the site on a two-lane road, and one-half mile in advance of the site on a multi-lane road. Other distances may be used as appropriate. On a two-lane road, an M5 or M6 series auxiliary sign may be used with the D7-H8 sign. On a multi-lane road, the D7-H8 sign should normally be augmented with an M5 or M6 series auxiliary sign. A D7-H9 sign may be used at the site where additional guidance is desired.

When signing is provided for an historical marker located on an intersecting road, a D7-H8a sign should be used in advance of the intersection. This sign would typically be placed 500 feet in advance of the intersection on a two-lane road, and one-half mile in advance of the intersection on a multi-lane road. Other distances may be used as appropriate. On a two-lane road, an M5 or M6 series auxiliary sign may be used with the D7-H8a sign. On a multi-lane road, the D7-H8a sign should normally be augmented with an M5 or M6 series auxiliary sign. At the intersection, a D7-H8 sign showing the appropriate distance to the site of the historical marker, with an M6 series auxiliary arrow sign mounted below, should be used.

Figure 298-37 provides examples of the use of these signs.

D7-H8
24 x 24

D7-H8a
24 x 24

D7-H9
24 x 24

Intentionally blank.

Intentionally blank.

206 GENERAL INFORMATION SIGNS

206-1 General

General Information Signs are addressed in **OMUTCD Chapter 2H**. The following Sections address signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**. ***Figures 298-5a through 5c*** illustrate Guide Signs that fall into the General Information Signs category discussed in this Chapter which are not shown in the **OMUTCD**.

206-2 Reserved for Future Information

This Section is reserved for future information.

206-3 Township Limit Signing (I-H2e)

ORC Section 503.061 requires **ODOT** to erect Township Limit signs on **ODOT**-maintained highways, other than freeways and expressways, located within the **Township** and outside the limits of an incorporated municipality, indicating the boundaries of the **Township**, when a resolution requesting signs has been adopted by the **Township**. The I-H2e sign is used for this purpose **(see OMUTCD Section 2H.02 and Appendix C)**.

Although there is no legal requirement to erect signs on freeways and expressways, **Districts** may, at their discretion, erect I-H2e signs on these facilities for townships which have populations in excess of 5,000 outside of municipal corporation limits.

206-4 Signing for Unincorporated Communities (I-H2d)

The Unincorporated Community Name sign (I-H2d) shown in **OMUTCD Appendix C** may be erected on **ODOT**-maintained conventional roads in accordance with **OMUTCD Section 2H.02**. Requests should be referred to the local **Board of County Commissioners** to confirm the spelling and the boundaries of the community. Unincorporated communities which claim to be historically significant should furnish confirmation from the **Ohio Historical Society** or a local historical society.

A driver should be able to recognize a change from rural conditions. A community usually has a cluster of homes, schools, churches, businesses furnishing motorist services, stores, parking, pedestrians, or other land development. Signs should not be erected where the unincorporated community name is synonymous with that of a developer, contractor or real estate broker where the sign could be considered an advertisement.

206-5 Highway Advisory Radio (HAR) Signing (D12-H6, D12-H7, D12-H8P, D12-H9)

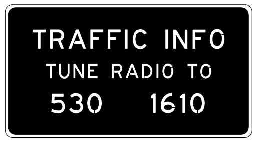
206-5.1 General

Basic guidelines for Radio Information Signs are provided in **OMUTCD Section 2I.09**. The following additional guidelines and criteria have been developed for use of this signing on **ODOT**-maintained highways.

HAR signing may be authorized for systems installed by local jurisdictions or governmental agencies when the criteria set forth in the **OMUTCD** and this Section are met, and after receiving approval by the **District**, as outlined below.

The owner/operator of the HAR system will be responsible for the fabrication, erection and maintenance of the signs under an Agreement (and Occupancy Permit) with the **Director of Transportation**. With a written notice, the **Director** may require the owner/operator to remove signs that have not been properly installed or maintained.

D12-H6



D12-H7

D12-H8P

D12-H9

206-5.2 Guidelines

For situations which cannot be addressed by other signing, the following guidelines have been established to support a determination for the use of signs to supplement HAR systems (also known as Traffic Advisory Systems and Radio-Traffic Information Systems) installed by local jurisdictions or governmental agencies on high-volume or high-speed roadways. However, these should not be considered the only justification for the erection of this signing.

1. Extraordinary circumstances in one or both of the following categories:
   a. Unusual road conditions, including extended construction or maintenance operations, detours, and management of traffic incidents.
   b. Traffic and parking advisories - information for traffic destined for specific events (e.g., World's Fair) or major traffic generators (e.g., transportation terminals or stadiums).
2. As a component of a traffic management system.

206-5.3 Procedures for Approval, Installation and Removal

The following procedure shall be used for approval, installation and removal of an HAR system:

1. The owner/operator shall submit a written request to the **District** including, but not limited to, the following information:
   a. Map of the region showing transmitter location, broadcast frequency, area of coverage and route(s) on which signs are requested.
   b. A general description of message content, anticipated frequency of message repetition and message changes, and hours of transmission.
   c. Names of persons operating the HAR station and where it is located.
   d. Number of signs requested, including approximate location and legend for each sign.
2. The **District** reviews the information provided and makes a field check to determine if the system is eligible and if the signs and locations are appropriate.
3. If approved by the **District**, an Agreement is prepared (see ***Form 296-3*** for a **Sample Agreement**) and returned to the owner for review and execution.
4. When the executed Agreement and a copy of the station's **Federal Communications Commission (FCC)** license are returned to the **District** by the owner, the following package of information is then provided by the **District** to the owner:
   a. **Occupancy Permit Application** for work in the right-of-way.
   b. Sample plan sheets including design information, applicable **ODOT** specifications and **Standard Construction Drawings**.
   c. Specific sign locations determined by **District** review of requested sign locations.
5. Owner/operator submits **Occupancy Permit Application** and construction plans for installation of the signs to the **District**.
6. After approval of the construction plans by the **District** and issuance of the **Occupancy Permit**, the owner/operator has the signs installed. The completed installation shall be

inspected and approved by the **District**.

7. The owner/operator shall immediately notify the **District** of any event or condition which may significantly affect its ability to perform in accordance with the provisions of its Agreement with **ODOT**.
8. Any modifications or alterations of the signing will require written approval of the **Director**.
9. As provided in the Agreement, the owner/operator will be responsible for removal of the signs and restoration of the area when the HAR system ceases to operate.

206-5.4 Operational Criteria

The following operational criteria shall apply:

1. Only traffic advisory or directional messages shall be broadcast over the radio station.
2. No message of a commercial or promotional nature may be broadcast at any time.
3. Messages concerning disruptions of normal traffic flow or road conditions due to highway construction or maintenance activities shall be broadcast when requested by **ODOT.**
4. The radio station shall be operated at all times in accordance with **FCC** rules and regulations.
5. The HAR system shall be operated on a permanent year-round basis, twenty-four hours a day unless otherwise approved by the **District**.
6. The location(s) of the broadcast receptions zone(s) shall not be altered subsequent to placement of the related signs.

206-5.5 Signing for HAR Systems

The following criteria shall apply when signing has been approved for an HAR system:

1. The design and placement of HAR signs shall be in accordance with standards in the **OMUTCD**. These signs usually have a white legend on a blue background; however, if used as work zone signs the standard colors shall be used (i.e., black legend with an orange background). The signs and their sizes are shown in the **Sign Designs and Markings Manual (SDMM)**.
2. Signing for an HAR zone normally consists of three signs in each direction of travel: the D12-H6 sign 1 mile in advance of the broadcast zone, the D12-H7 at the beginning of the broadcast zone and the D12-H9 at the end of the zone. Depending on the circumstances (e.g., length of zone and sign crowding in the area) it may be desirable to erect more than one of the D12-H7 signs in the broadcast zone and/or not use the D12-H9 sign.
3. Other legend elements such as AIRPORT or VISITORS instead of TRAFFIC may be warranted.
4. As noted in **OMUTCD Section 2I.09**, when circumstances warranting the signing are seasonal, the owner/operator shall remove or cover the signs when the HAR system is not in use.
5. When the HAR system is able to remotely provide incident information, the black on yellow TRAFFIC ALERT WHEN FLASHING (D12-H8P) supplemental panel shall be mounted below the D12-H7 sign at the beginning of the broadcast zone, with yellow flashing beacons mounted above. The beacons shall be activated when incident information is being broadcast.

206-6 Carpool Signing (D12-2)

As noted in **OMUTCD** **Section 2I.11**, the availability of rideshare opportunities is publicized using

Carpool Information Signs. On **ODOT**-maintained highways the D12-2 sign is used. The local rideshare agency (LRA) is responsible for furnishing all signs to **ODOT**. The signs shall be fabricated in accordance with **ODOT** design standards and material specifications. **ODOT** will supply the sign supports and necessary hardware, and install the signs. The locations for the signs may be suggested by the local rideshare agency, but must be approved by **ODOT** prior to installation.

The **Districts** should maintain the signs. Replacement signs should be obtained from the LRA as needed.

D12-2

206-7 Signing for Countywide 9-1-1 Systems (D12-H14)

206-7.1 General

ORC Section 4931.46 indicates that upon installation of a countywide 9-1-1 system, the **Board of County Commissioners** may direct the **County Engineer** to erect and maintain at the **County** boundaries on **County** Roads and **State** and Interstate Routes, signs indicating the availability of a countywide 9-1-1 system. Any sign erected by a **County** under this Section shall be erected in accordance with and meet the specifications established in ***Section 206-7.2.*** All expenses incurred in erecting and maintaining the signs shall be paid by the **County**.

For other signing dealing with 9-1-1 systems, see **OMUTCD** **Section 2I.09 and *TEM Section 207-7***.

206-7.2 Sign Details

ORC Section 4931.46(B)(2) requires the **Director of Transportation** to develop design specifications for signs giving notice of the availability of a countywide 9-1-1 system and establish standards for erection of the signs. Consequently, the D12-H14 sign was developed. The standard size for use on conventional roads is 36 x 24 inches, and on freeways and expressways the standard size is 60 x 36 inches. Type G, H or J reflective sheeting shall be used for the signs.

The signs shall be flatsheet material. **Traffic SCD TC-52.20** provides information about bolt hole spacing for flatsheet signs. The sign blank material, sign supports and mounting hardware shall conform to **C&MS Item 730**. **Traffic SCD TC-41.20** provides post information.

D12-H14

206-7.3 Procedure

If a countywide 9-1-1 system exists and the **Board of County Commissioners** directs the **County Engineer** to erect signs on an **ODOT**-maintained highway, the **County Engineer** shall contact the local **ODOT District Office** in writing to obtain: (1) approval of the proposed sign locations, and (2) a permit to work within the State right-of-way. The request should include specific information about the proposed sign locations and a proposed traffic control plan.

Unless the **District** agrees to another arrangement, the **County Engineer** shall have the proposed sign locations marked by stake or paint to assist in **District** review; no paint marks shall be permitted on the pavement surface. The D12-H14 sign shall be placed for traffic entering the **County** at or near the location where the route crosses the County Line. It should be placed on the right side of the highway, except that when the existing County Line sign is in the median, the 9-1-1 sign(s) may also be placed in the median. Further, the D12-H14 sign is a separate installation and shall not be mounted with the County Line sign or any other signs. Existing signs shall not be moved to accommodate placement of the D12-H14 on **ODOT**-maintained highways.

The **District** shall field check each proposed site to assure the placement of the signs will be in accordance with **OMUTCD Sections 2A.18, 2A.19 and 2E.26**, which establish horizontal and vertical placement criteria, and **Traffic SCDs TC-42.10 and TC-42.20**. If the **District** concurs with the proposed location and the traffic control plan, the **County Engineer** may schedule erection of the sign once the permit is approved.

When the signs have been erected, the **District** should have the locations checked for compliance to **ODOT** standards. All discrepancies will be corrected by the **County Engineer**.

206-7.4 Maintenance

The **County Engineer** shall maintain these signs in good condition and shall advise the **District** of who should be contacted for repair or replacement of signs erected on **ODOT**-maintained highways. Damage reports received by **ODOT** concerning the signs shall be forwarded to the **County Engineer's** office or a designated contact.

If the **County** should choose to discontinue the countywide 9-1-1 signing program, the **County Engineer** will notify the **District** in writing. The **County Engineer** will be responsible for removing all D12-H14 signs and supports on the State right-of-way.

If D12-H14 signs erected on **ODOT**-maintained highways become a hazard or nuisance and the problem is not corrected by the **County** within a reasonable time, the **District** shall remove the signs and supports. The **County** shall be billed for the work and advised where the sign(s) and supports can be picked up.

206-8 Memorial Highway/Bridge Signing (D6-H5)

Any street/highway or bridge that is part of the **State** highway system may be officially assigned a distinctive name, commemorative of an historical event or personage or a commonly accepted and appropriate name, by which the highway or bridge is known. A list of named highways and bridges established by **ORC Chapter 5533** is shown in ***Table 297-17***. A list of named highways and bridges on the rural state highway system established by the **Director of Transportation** in accordance with **ORC Section 5511.01** and local governments in accordance with **ORC Section 5511.09** is shown in ***Table 297-18***.

There are three processes by which **ODOT**-maintained highways and bridges can be memorialized or named. They are as follows:

1. The most frequently used process is by legislation. **ORC Chapter 5533** contains numerous examples of action by the legislature to name or memorialize a highway or bridge.
2. Where the section of **State** highway is completely rural, **ORC Section 5511.01** allows the **Director**, by administrative action, to assign a distinctive name to the highway. (We have, however, been advised that this does not include naming individual bridges.)
3. Local governments may request the naming of a highway or bridge that is part of the rural state

highway system that lies within their boundaries. This requires unanimous agreement of the local governments in accordance with **ORC Section 5511.09**, and approval by the **Director**. Requests from local governments should be submitted to the **District** for approval. The decision on approval should be made by the **District Deputy Director** on behalf of the **Director**. The **District** shall notify **OTO** of such approvals.

For rural roads that are totally under the maintenance and operational authority of local governments, the **Director** has no involvement in the naming/memorializing process. **ORC Sections 5541.04 and 5543.04** assign responsibility for naming/memorializing County and Township Roads to **County** officials.

Municipal corporations also do not require action by the **Director** to name/memorialize streets located totally within their boundary. **ORC Section 723.01** grants broad authority for the control of streets within the municipal corporation to the municipality officials, and **ORC Section 5511.09** addresses the authority of municipal officials to name highways and bridges on the state highway system within the municipal corporation without action of the **Director**.

Signing of memorial highways and bridges should be in accordance with **OMUTCD Section 2M.10**. Signs for memorial highways or bridges on the rural state highway system and **Interstate** highways within municipal corporation limits established by the legislature in accordance with **ORC Chapter 5533** or by the **Director** in accordance with **ORC Section 5511.01** should be furnished and installed by the **District**. Signs for memorial highways and bridges on the U.S. and State Routes inside municipal corporation limits established by the legislature in accordance with **ORC Chapter 5533** shall not be installed by **ODOT**. **ODOT** may furnish the signs to the municipal corporation for a fee commensurate with the sign size and construction.

Signs for memorial highways and bridges on the rural state highway system established by local governments in accordance with **ORC Section 5511.09** shall be furnished and installed by the requesting agency at locations approved by the **District**.

The D6-H5 sign is used in rest areas, scenic overlooks and other off-highway locations, and on the mainline of conventional roads, freeways and expressways. For sign design details refer to the **Sign Designs and Markings Manual** ***(see Section 295-2).***

D6-H5

206-9 TARGET ENFORCEMENT AREA Sign (D12-H15)

Every six months the **Ohio State Highway Patrol (OSHP)** produces a list of their high accident locations for each patrol post. These locations may be targeted for increased enforcement efforts.

ODOT has agreed to cooperate with the **OSHP** in posting signs indicating the target enforcement areas. The TARGET ENFORCEMENT AREA sign (D12-H15) is used for this purpose.

Each post will have one location to be marked with these signs. The size of the target enforcement area is determined by **OSHP**, and may consist of an intersection or section of highway. The location may change every six months.

A sign should be installed on each **ODOT**-maintained approach to the target enforcement area, including locations on **ODOT**-maintained highways inside **Villages**.

D12-H15

206-10 Signing for Over/Underpasses on Freeways and Expressways

Districts may, at their discretion, elect to provide signing on freeways and expressways to identify roads that pass over or under the mainline. For those **Districts** that decide to provide such signing, a D3-H1 sign may be ground mounted in advance of the structure. Other signing methods, such as the use of direct applied sheeting on the bridge beams, can be considered, if acceptable to the **District**.

Use of this signing is optional and can be selectively applied at over/underpasses in the **District**.

206-11 Drinking Water Protection Area Signs (I-H15)

In 1999, the **Ohio Environmental Protection Agency (Ohio EPA)** requested that signs be erected to designate those areas that have been scientifically determined to be contributing ground water to public drinking water systems serving populations of 500 or more persons. The I-H15 sign is used for this purpose.

The signs are intended to increase public awareness, and alert emergency response teams that they are entering a **Drinking Water Protection Area**. The clean-up of spills is handled differently in these areas.

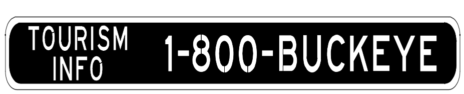
The I-H15 sign includes a phone number. The statewide **Ohio EPA** emergency response phone number is 1-800-282-9378. The public drinking water provider will decide what phone number to include on the sign. This can be the statewide emergency response number or a local emergency response number (including 9-1-1).

ODOT fabricates and erects I-H15 signs at locations where an **ODOT**-maintained highway crosses the five-year time of travel zone for aquifers serving populations of 500 or more persons. Specific locations for the signs are determined by the **Ohio EPA**. Signs for locations within municipal corporation limits should be provided and erected by the municipal corporation.

I-H15

206-12 TOURISM INFO 1-800-BUCKEYE Sign (D7-H10P)

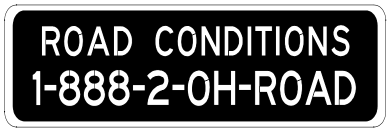
The TOURISM INFO 1-800-BUCKEYE sign (D7-H10P) is intended for installation as a supplemental panel below Recreational and Cultural Interest Area signs to acquaint drivers with the toll-free tourist information telephone number. This sign should be installed on all Recreational and Cultural Interest Area signs on the Interstate system that do not have another supplemental panel.



D7-H10P

206-13 ROAD CONDITIONS 1-888-2-OH-ROAD Sign (D12-H10)- (Discontinued)

The ROAD CONDITIONS 1-888-2-OH-ROAD sign (D12-H10) was first used in 1998 to acquaint drivers with the toll-free weather and highway construction telephone number. Effective March 1, 2009, the telephone number was deactivated. All the signs shall be removed.



(Discontinued)

D12-H10

206-14 Community Recognition Signing

Periodically, communities desire signing for the purpose of recognizing a local achievement, such as a State high school championship athletic team or an award from a professional organization. This signing does not provide pertinent information to drivers to enable them to perform their driving task, nor does it meet the basic principles for traffic control devices outlined in the **OMUTCD**. To control proliferation of this type of signing along the rights-of-way of **ODOT**-maintained highways, the following guidelines should be used when determining whether a community that has requested such signing should receive it.

Under **Ohio** law, state route extensions within municipal corporations are the responsibility of the local authority. **ODOT** does not endorse installation of Community Recognition Signing on such extensions, nor does it accept any responsibility for such signs. However, **ODOT** generally does not question decisions made by local authorities regarding signs erected on such routes. Anyone requesting Community Recognition signing should be referred to the local authority. If the authority agrees to erect this signing inside the municipality, the requesting community is responsible for obtaining the signing. In addition, any such signing should not be erected on Corporation Limit (I-H2a) or Unincorporated Community (I-H2d) signs. Furthermore, it is recommended that only one such sign be erected on a particular state route extension into a municipality.

Similarly, **ODOT** does not generally endorse installation of signing on **ODOT**-maintained highways recognizing a **County's** achievement except when approved by the **County Commissioners** and the **District** office. When this occurs, such signing may be installed on County Line signs (I-H2f, I-H2g) by the **District** office after the sign's design has received the approval of the **District Deputy Director**. Only one Community Recognition sign should be erected on any I-H2f or I-H2g sign.

The **ODOT Sign Shop** will normally not fabricate Community Recognition signs; the community should provide the sign.

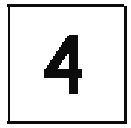
These signs shall not be installed on Interstates or other freeways.

206-15 Maintenance Marker Sign (D10-H8, D10-H8a)

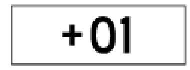
The Maintenance Marker sign (D10-H8) should be used on all non-Interstate **ODOT**-maintained highways. These signs give the distance in miles along the route, and should be installed in accordance with the mileages contained in the **ODOT Straight Line Diagrams (SLDs).**

The signs may be single faced for mounting on both sides of the road. For mounting on one side of the road, the signs may be double faced or mounted back-to-back. Where physical restrictions prevent the installation of the D10-H8 sign at the even mile, the D10-H8a sign may be used with the D10-H8 sign indicating the distance in hundredths of a mile that the sign is located from the proper location. The use of a zero (0) marker indicating the beginning of a route at the County line or within a County is optional.

The D10-H8 signs should be mounted at a minimum height of 4 feet above the pavement edge.



D10-H8



D10-H8a

206-16 Reserved for Future Information

The information on High Water signing has been moved to the Warning Signs Chapter, ***Section 202-15***.

206-17 WATERSHED Signs (I-H3d)

The boundary between the **Lake Erie** watershed to the north and the **Ohio River** watershed to the south runs through six **ODOT Districts**, specifically **Districts 1, 3, 4, 6, 7 and 12**, and seventeen **Ohio** Counties, namely **Mercer, Shelby, Auglaize, Allen, Hardin, Marion, Wyandot, Crawford, Richland, Ashland, Medina, Summit, Portage, Stark, Geauga, Trumbull and Ashtabula**. To identify this significant watershed boundary, **ODOT** will install signs at (or as close as practical to) the locations shown in ***Table 297-14***.

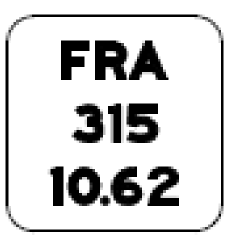
The **Lake Erie** and **Ohio River** watershed signs should be installed directly opposite each other at the locations specified in ***Table 297-14***.

The **Lake Erie** and **Ohio River** watersheds can be subsequently subdivided into progressively smaller watersheds and sub-watersheds. However, **ODOT** will not install signs identifying any of these smaller watershed and sub-watershed boundaries. Signs will only be installed at the major boundary between the **Lake Erie** and **Ohio River** watersheds at the locations in ***Table 297-14.***

206-18 ODOT Bridge and Culvert Signs (I-H25a, I-H25b, I-H25c)

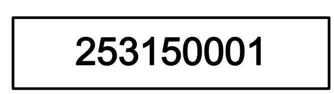
The ODOT Bridge and Culvert signs (I-H25a, I-H25b, I-H25c) may be used to identify bridges and culverts on **ODOT**-maintained highways. These signs give a unique identifier for each bridge and culvert. The I-H25a and I-H25b also provide a Straight Line Mileage identifier for the structure.

The signs are placed on each approach, off the right shoulder, facing traffic and behind guardrail if applicable. The signs may have non-reflective sheeting background.



I-H25a

I-H25b



I-H25c

Intentionally blank.

207 GENERAL SERVICE SIGNS

207-1 General

General Service signs are addressed in **OMUTCD** **Chapter 2I**. As noted in ***Section 203-1***, information on Specific Service Signs (Logos), Tourist-Oriented Directional Signs (TODS), and Recreational and Cultural Interest Signs is provided in **OMUTCD Chapters 2J, 2K and 2M**, respectively. They are also addressed further herein. ***Figures 298-5b and 298-5c*** include illustrations of General Service type Guide Signs discussed in this Chapter which are not shown in the **OMUTCD**.

The following Sections address signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**.

207-2 Logo (Specific Service) Sign Program

207-2.1 General

Logo (Specific Service) Signs are addressed in **OMUTCD** **Chapter 2J**. The Ohio Business Logo Sign Program established by **ODOT**, also known as the Specific Service Sign Program, permits eligible businesses which provide fuel, food, lodging, camping or attraction services to road users to have their Logo Sign Panels placed on Specific Service Signs. Mainline Logo Sign Panels are placed in advance of eligible interchanges, and directional Logo Sign Panels are placed along the exit ramps. The Logo Sign Program is operated by a private company **(Program Manager)** under contract with **ODOT**. ***Table 297-15*** provides a summary of the eligibility criteria for this program.

Documents that define the program adopted by **ODOT** are available upon request from the **Office of Traffic Operations**. Generally, the document package contains the following: (1) Contract with **Program Manager**; (2) **Program Administrative Rules and Regulations**; (3) **Signing Standards and Guidelines**; (4) **Ohio Revised Code Section 4511.101 and 5516.02**; (5) **Right-of-Way Permits Process**; and (6) Remittance information**.**

Information regarding removal, and temporary or permanent re-erection, of Logo Signs due to construction and maintenance activities is addressed in ***TEM Section 640-21*** **and** **C&MS 614.07 and 630.09*.*** Logo Signs issues that arise due to maintenance activities should be directed to the District's Logo Program Coordinator.

207-2.2 District Procedures and Responsibilities

District procedures to be followed are contained in the documents referred to in ***Section 207-2.1***. **District** responsibilities include, but are not necessarily limited to, the following:

1. Approve work plans for each interchange.
2. Approve relocation of existing signs to accommodate Specific Service Signs.
3. Provide written notice to the **Program Manager** to remove or relocate Specific Service Signs due to other necessary non-specific service signs.
4. Remove the danger when any Specific Service Sign, Logo Sign Panel or support becomes, or is in danger of becoming, a clear and present danger to the public, and the **Program Manager** is unavailable.
5. Notify the **Program Manager** of needed relocations or removal of Specific Service Signs.

207-2.3 Central Office Procedures and Responsibilities

Central Office procedures to be followed are also contained in the documents referenced in ***Section 207-2.1***. **Central Office** responsibilities include, but are not necessarily limited to, the following:

1. Approve the **Program Manager's** advertising agreement.
2. Approve the general plans for work zone traffic control.
3. Review and approve Logo Sign Panel designs, including alternative fuel legends or symbols.
4. Approve the form and content of consent legislation drafted and processed by the **Program Manager**.

207-3 TODS Program

207-3.1 General

Tourist-Oriented Directional Signs (TODS) are addressed in **OMUTCD Chapter 2K**. This Section describes the Ohio Tourist-Oriented Directional Signs (TODS) Program as established by **ODOT**. This program permits eligible tourist-oriented activities to be identified on directional signs established for the program. These signs are placed in advance of intersections on **ODOT**-maintained highways, but not at interchanges on freeways and expressways. The TODS Program is operated by a private company **(Program Manager)** under contract with **ODOT**. Table 297-16 provides a summary of the eligibility criteria for this program

The following documents, available upon request from the **Office of Traffic Operations**, define the TODS Program, including the procedures, standards and guidelines: (1) Contract with **Program Manager**; (2) **Program Administrative Rules and Regulations**; (3) **Signing Standards and Guidelines**; (4) **ORC Sections 4511.102 to 4511.107**; and (5) **Right-of-Way Permits Process**.

Information regarding removal, and temporary or permanent re-erection, of TODS due to construction and maintenance activities is addressed in ***TEM Section 640-21*** **and C&MS 614.07 and 630.09*.*** TODS issues that arise due to maintenance activities should be directed to the District's TODS Program Coordinator.

207-3.2 District Responsibilities

The documents referenced in ***Section 207-3.1*** outline the responsibilities assigned to the **Districts**. They include, but are not necessarily limited to, the following:

1. Approve advanced signing at an intersection.
2. Provide construction project information to the **Program Manager**.
3. Approve the work plan for each intersection.
4. Remove the danger when any TODS installation becomes, or is in danger of becoming, a clear and present danger to the public and the **Program Manager** is unavailable.
5. Notify the **Program Manager** of needed relocations or removal of TODS signing.
6. Determine which existing **ODOT**-maintained signs will continue to be maintained at each intersection prior to the **Program Manager** marketing the program at that intersection.
7. Determine where safety or operational features preclude sign installation.

207-3.3 Central Office Responsibilities

The documents referenced in ***Section 207-3.1*** also outline **Central Office** responsibilities for this program. They include, but are not necessarily limited to, the following:

1. Extend, modify or terminate the contract as needed.
2. Approve the **Program Manager's** advertising agreement.
3. Approve the general plans for the work zone traffic control.
4. Approve all forms, applications, agreements and other documents necessary to carry out the program.
5. Coordinate the review of proposed non-standard symbols and submit them to **FHWA**.
6. Cancel individual advertising agreements with reasonable cause.

207-4 Hospital and Emergency Medical Care Facility Signing (D9-2, D9-H2a, D9-H2b, D9-H13g, D9-H13h, D12-H17, D12-H17aP, D12-H17b)

207-4.1 General

Signing for hospitals and emergency medical care facilities is in the general service sign category. It is intended to provide directional information to a treatment facility for the unfamiliar motorist with a medical emergency. For this reason, the name of the facility is not normally used on the signs.

Signing for hospitals and emergency medical care facilities should be erected for treatment facilities that meet the requirements of ***Section 207-4.3***. Signs may be erected by **ODOT** for the following types of routes:

1. Interstate Routes inside and outside of corporation limits.
2. Freeways and expressways outside of corporation limits.
3. Other National Highway System (NHS) routes ***(Section 130-5)*** outside of corporation limits.

207-4.2 Procedures for Reviewing Requests

In order to avoid a proliferation of signs for hospitals and emergency medical care facilities, not more than one treatment facility should be signed for at an interchange or intersection.

When two or more treatment facilities fulfill the requirements for signing, preference should be based on the hierarchy established in ***Section 207-4.3*** and accessibility and distance from the interchange or intersection.

When U.S. and State routes enter municipalities, signing will normally not be erected by **ODOT** since the most appropriate interchange or intersection for signing will usually be within the corporation limits.

Signing will normally not be erected on NHS routes when the treatment facility is located adjacent to the highway.

ODOT will erect necessary trailblazing signs on **ODOT**-maintained routes outside the corporation limits. Local officials are responsible for furnishing, erecting, and maintaining necessary trailblazing signs on roads within their jurisdiction. The **District** shall not erect signs until necessary trailblazing signs have been erected by local authorities having jurisdiction over the roadway.

207-4.3 Criteria for Hospital and Emergency Medical Care Facility Signing

To qualify for signing, the treatment facility must provide emergency medical care twenty-four hours per day, 365 days per year. To qualify as a hospital, the facility must also provide hospital beds intended primarily for the care of inpatients (patients staying for twenty-four hours or longer). Emergency medical care facilities differ from hospitals in that they do not provide inpatient hospital beds.

The following hierarchy shall be used in determining the medical treatment facilities for which to provide signing.

1. Hospital with level 1 trauma center.
2. Hospital with level 2 trauma center.
3. Hospital with level 3 trauma center.
4. Hospital without trauma center designation, with physician on duty within the emergency department.
5. Hospital without trauma center designation, with registered nurse on duty within the emergency department with a physician in the hospital on call.
6. Hospital without trauma center designation, with registered nurse on duty within the emergency department with a physician on-call from his/her office or home.
7. Emergency medical care facility with physician on duty.
8. Emergency medical care facility with registered nurse on duty with a physician on call from his/her office or home.

The **American College of Surgeons** maintains a list of hospitals with trauma centers.

The hospital or emergency medical care facility shall be located within 5 roadway miles of the interchange or intersection where signing is initiated.

207-4.4 Signing

Signing for hospitals and emergency medical care facilities should be in accordance with **OMUTCD Chapter 2I**.

For hospitals with trauma centers, the D9-H2a and D9-H2b signs should be used. The D9-H2a sign is intended for use as a panel on freeway and expressway D9-18 and D9-18b General Service Signs. It can also be appended to other Major Guide Signs. The D9-H2b sign, with supplemental arrow plate, is intended for use on conventional roads, freeway and expressway ramps, and for trailblazing.

For hospitals without trauma centers, the D9-2 sign should be used. This sign is intended for use as a panel on freeway and expressway D9-18 and D9-18b General Service Signs. It can also be appended to other Major Guide Signs. Alternatively, word message signs (D12-H17, D12-H17b) may be installed, or the word message supplemental panel (D12-H17aP) may be appended to other Major Guide Signs, on freeways and expressways. The D9-2 sign, with supplemental arrow plate, is used on conventional roads, freeway and expressway ramps, and for trailblazing.

For emergency medical care facilities, the D9-H13g and D9-H13h signs should be used. (As per the requirements of **OMUTCD Section 2I.02**, the D9-13 Emergency Medical Services symbol cannot be used without a supplemental message indicating the type of service provided.) The D9-H13g sign is intended for use as a panel on freeway and expressway D9-18 and D9-H18b General Service Signs. It can also be appended to other Major Guide Signs.

The D9-H13h sign, with supplemental arrow plate, is intended for use on conventional roads, freeway and expressway ramps, and for trailblazing.

207-5 Generic General Service Signing

207-5.1 General

The TODS and Logo Programs discussed in ***Sections 207-2 and 207-3***, respectively, address signing for various fuel, food, lodging and camping facilities. See those Sections for details of those programs.

This Section establishes guidelines and criteria for the use of generic General Service signing for fuel, food, lodging and camping. However, this standard does not apply to privately-owned, non-profit campgrounds which are addressed in ***Section 205-2.***

For purposes of this discussion, the term "non-profit" also refers to facilities or organizations described as "not for profit."

207-5.2 Guidelines

The following guidelines shall be used in determining when to use generic General Service signing:

1. Generic General Service signing should only be provided for facilities meeting the criteria established in ***Section 207-5.3***.
2. Under the terms of **Ohio's** TODS Program contract ***(Section 207-3)***, certain food, lodging and camping establishments may be eligible for TODS signing in advance of intersections on U.S. and State Routes. Fuel establishments are not eligible for this program.

   New generic General Service signs for fuel, food, lodging and camping establishments that are not eligible for the TODS Program, are not normally warranted at intersections on U.S. and State Routes.

   However, existing generic General Service signs for fuel, food, lodging and camping may remain in place until they have reached the end of their effective performance life, or until the facilities have been signed for under the TODS Program, if eligible.
3. Signing for fuel, food, lodging and camping at interchanges on freeways and expressways should be in accordance with the Specific Service Signing (Logo) Program described in ***Section 207-2***. Generic General Service signing for fuel, food, lodging or camping at interchanges eligible for Logo signing is only warranted for a specific type of service when none of that type of service is signed for with Logo signing at that interchange and the criteria in ***Section 207-5.3*** are met. Interchanges on the Interstate system not eligible for Logo signing would normally not be eligible for generic General Service signing for fuel, food, lodging and camping.
4. Generic General Service signs for fuel, food, lodging and camping are not normally warranted in urban areas.
5. Generic General Service signs for fuel, food, lodging and camping should only be erected where the road user can directly return to the highway and continue in the same direction of travel.
6. The erection of signs for general services shall be in accordance with standards for sign type, height, lateral placement and location specified in the OMUTCD **Chapter 2A**.
7. General Service signing shall not be erected when the proposed signs would conflict with existing primary Guide Signs or other traffic control devices. Therefore, no commitment should be made to erect signs until an on-site inspection has been conducted at the proposed sign location in order to determine that sufficient space exists.

8. **ODOT** shall not erect signs until necessary trailblazing signs off the State system have been erected by others.

207-5.3 Criteria

Specific criteria have been established for generic General Service signing, depending on the type of service:

1. Fuel - The facility shall:
   a. Be located within 5 miles of the highway for which signing is sought.
   b. Provide vehicle services to include fuel, oil and water.
   c. Be in continuous operation for at least sixteen hours a day, seven days a week, all weeks of the year.
2. Food - The facility shall:
   a. Be located within 5 miles of the highway for which signing is sought.
   b. Have all required licensing or approval.
   c. Be operated continuously to serve at least two meals per day, at least 6 days per week.
3. Lodging - The facility shall:
   a. Be located within 5 miles of the highway for which signing is sought.
   b. Have all required licensing or approval.
   c. Provide adequate sleeping accommodations.
   d. Provide modern sanitary facilities.
4. Camping - The facility shall:
   a. Be located within 15 miles of the highway for which signing is sought.
   b. Have all required licensing or approval.
   c. Provide adequate parking accommodations.
   d. Provide sanitary facilities and drinking water.
5. Other Facilities

   Signing for emergency medical treatment facilities is addressed in ***Section 207-4***. Signing for law enforcement agencies is addressed in ***Sections 205-2 and 209-2.*** Signing for privately owned, non-profit campgrounds is addressed in ***Section 205-2.3***. Signing for Tourist Information Centers is addressed in ***Section 207-6***.

207-6 Tourist Information Center Signing

207-6.1 General

OMUTCD Section 2I.08 establishes standard freeway and expressway signing for Tourist Information Centers. The following procedure and criteria shall be used in addressing requests for public and privately-owned Tourist Information Centers signing for freeways and expressways.

Signs should not be erected unless requested by the Tourist Information Center operator. Upon receipt of a request, the **District's** designee should visit the center to check for compliance with the following criteria. Signs shall not be erected unless the criteria noted in ***Section 207-6.2*** are met and the **District** recommends signing for the Tourist Information Center.

If a local Tourist Information Center meets the criteria, except that the information available pertains only to the local area, signing may be provided at the discretion of the **District**. These centers shall be signed for as described herein, except that the sign legend should be revised to read “LOCAL TOURIST INFO CENTER.”

207-6.2 Criteria for Signing

When evaluating a request for Tourist Information Center signing on a freeway or expressway, the following criteria shall apply:

1. The Tourist Information Center shall be located either:
   a. Within a rest area on a freeway or expressway, or
   b. Within 1 mile of a freeway or expressway interchange.
2. The Tourist Information Center shall be open at least eight hours a day, seven days a week. If operated on a seasonal basis, TOURIST INFO signs shall be removed or covered during the off-season.
3. Unless approved by the **District Deputy Director**, the Tourist Information Center shall not be located within a building, or on the same property, as a building used for the primary purpose of selling services to the motoring public.
4. The center shall have an adequate number of free parking spaces for automobiles with and without trailers, campers and motor homes. If located within an urban area, a turnaround shall be available to accommodate trailers, campers and motor homes.
5. The center shall provide, or be located adjacent to, well-maintained public restroom facilities.
6. The center shall provide, or be located adjacent to, at least one public telephone.
7. A privately-owned center should be endorsed by local authorities and/or civic organizations.
8. Information available to tourists should include, but is not limited to, the following:
   a. Local Tourist Services - Hotels, motels, restaurants, churches, hospitals with twenty-four hour emergency services and camping facilities.
   b. Local and Regional Points of Interest - Cultural locations, historical sites and geographical landmarks.
   c. Local and Regional Attractions - Recreation areas, amusement parks, festivals and fairs, concerts, outdoor dramas, State parks and national parks.
9. It is desirable, but not mandatory, that facilities for Tourist Information Centers located off of freeways and expressway include the following:
   a. Benches and picnic tables on the lawn,
   b. A feminine napkin vendor in the women's restroom, and
   c. Sanitary drinking water.
10. The Tourist Information Center may be either a manned or self-service facility.

207-6.3 Signing for Centers on Freeways and Expressways

In general, if the Tourist Information Center meets the criteria in ***Section 207-6.2*** and is recommended for signing by the **District**, the center shall be signed in accordance with OMUTCD **Section 2I.08**.

If the Tourist Information Center is located within a rest area the following shall apply:

1. If Rest Area signs are in place, a supplemental TOURIST INFO CENTER (D5-H7aP) or TOURIST INFO (D5-H7bP) panel should be attached above the Rest Area Advance sign (D5-H1) and above the Rest Area Exit Direction sign (D5-H2 or D5-H1a). The width of the supplemental panel (D5-H7aP or D5-H7bP) should not be wider than the existing signs. Alternatively, the Tourist Information symbol (D9-10) may be appended beneath the Rest Area Advance sign.

2. If the signing for the Tourist Information Center is to be erected as part of the initial Rest Area signing, one of the following signing methods may be used:
   a. Erect D5-H1 and D5-H2 (or D5-H1a) signs with the TOURIST INFO CENTER (D5-H7aP) or TOURIST INFO (D5-H7bP) supplemental panel; or
   b. Erect the REST AREA TOURIST INFO CENTER X MILES sign (D5-H7) and the REST AREA TOURIST INFO CENTER NEXT RIGHT (D5-H8a) sign; or
   c. Erect the REST AREA TOURIST INFO CENTER X MILES sign (D5-H7) and the REST AREA TOURIST INFO CENTER (with arrow) (D5-H8) sign.
3. The D5-H7 and D5-H8a (or D5-H8) signs may also be erected if the existing Rest Area signs are being replaced because of safety upgrading, sign damage or deterioration. Serviceable Rest Area signs should not be replaced with D5-H7 and D5-H8a (or D5-H8) signs solely for the purpose of adding the TOURIST INFO CENTER or TOURIST INFO legend.
4. The D5-H7 and D5-H8a (or D5-H8) signs shall not be erected for Tourist Information Centers which operate on a seasonal basis.

207-6.4 Signing for Centers Off of the Freeway or Expressway

For a Tourist Information Center located off the freeway or expressway, the following additional provisions shall apply:

1. If a General Services sign (D9-18, D9-18b) is in place for the interchange, a Tourist Information symbol (D9-10) should be added to the sign. If space is not available to add the symbol, a larger General Services sign may be installed.
2. If no General Services sign is in place at the interchange, the Tourist Information symbol (D9-10) may be appended to ground-mounted interchange Guide Signs. Alternatively, a Tourist Information Center word message sign (D5-H7c) may be erected.
4. Tourist Information symbol signs (D9-10) with appropriate Directional Arrow Auxiliary Signs should be erected:
   a. On multi-lane ramps, and
   b. At the end of a ramp when the Tourist Information Center is not within sight of the interchange.
5. Signs shall not be erected by **ODOT** for Tourist Information Centers located off the **State** right-of-way until the operator or appropriate local authorities have provided, at other than **State** expense, any additional signing necessary to direct tourists to the center.
6. **ODOT** shall not erect trailblazing signs on **City** streets, or **County** or **Township** roads.

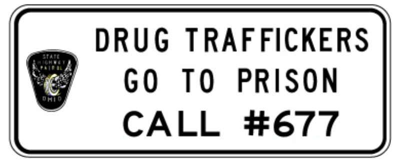
207-7 <u>Drug Enforcement Signs (D12-H22, D12-H23)</u>

DRUG ACTIVITY IMPAIRED DRIVERS CALL #677 signs (D12-H22) and DRUG TRAFFICKERS GO TO PRISON CALL #677 signs (D12-H23) were installed by **ODOT** on **ODOT**-maintained highways in early 2012. These signs were installed at the request of the **Ohio State Highway Patrol (OSHP)**, to publicize their #677 phone number. These signs replaced the NEED HELP 1-877-7-PATROL and EMERGENCY CALL 9-1-1 signs (D12-H11, D12-H12), which were initially installed in 1999. The 1-877-7-PATROL phone number is no longer in service..

OSHP provided funding for initial sign fabrication. The **Districts** provided the materials and labor for installation.

No funding has been provided by **OSHP** to cover fabrication costs of signs needed for maintenance replacements. The **Districts** should order and install replacement signs as needed using established procedures.

D12-H22



D12-H23

Signing for the EMERGENCY CALL XX (D12-4) sign is addressed in **OMUTCD Section 2I.09**, and signing for the Countywide 9-1-1 Systems (D12-H14) is addressed in ***Section 206-7.***

207-8 Recreational and Cultural Interest Area Guide Signs

OMUTCD Chapter 2M provides information on Guide Signs used for recreational and cultural interest areas. On **ODOT**-maintained highways, the use of rectangular signs with a white legend and border on a brown background is preferred. The trapezoidal shape should not be used.

Intentionally blank.

208 REST AREA SIGNS

208-1 General

The **OMUTCD** addresses signing for rest areas in **Section 2I.05**. Additional signing has been developed over the years for use in **ODOT** rest areas. For the most part, these signs have been developed to address specific requests from the **Department of Public Safety (ODPS)** or the offices responsible for maintaining the facilities. The following Sections address additional signing approved for use in advance of, and within, rest areas. ***Figures 298-6a through 298-6c*** illustrate est Area signs discussed herein that are not shown in the **OMUTCD**.

Mainline rest area signs for use on **ODOT**-maintained highways are shown in ***Figure 298-6a***. Example applications of these signs are shown in ***Figures 298-39 through 298-41***.

208-2 REST ROOMS CLOSED Sign (D5-H33)

The REST ROOMS CLOSED sign (D5-H33) shall be erected on conventional roads and on the mainline of freeways and expressways when rest rooms are closed for other than routine maintenance of short duration. This sign should be erected under the Advance Rest Area sign (D5-H1). On freeways and expressways, an additional sign may be erected under the Exit Direction Rest Area sign (D5-H1a or D5-H2).

If the Rest Area signs are supplemented with panels, the D5-H33 sign should be erected under the bottom panel. If the sign support has a breakaway connection, care shall be taken to assure that the D5-H33 sign does not interfere with the breakaway action.

Code No.	Route Type	Size Inches
D5-H33	Freeway & Expressway	48 x 48
D5-H33	Conventional	24 x 24

208-3 SAFETY BREAK FREE COFFEE Sign (D5-H51P, D5-H52P)

The SAFETY BREAK FREE COFFEE signs (D5-H51P, D5-H52P) may be erected when authorized by the **District Deputy Director**. These signs shall not be easel-mounted, and should not be erected on separate supports. If the D5-H52P sign is used, extreme care shall be taken to assure that it does not interfere with the breakaway (or yielding) aspect of the supports and that the supports are of sufficient size to accommodate the extra signing area and wind loading.

D5-H51P

D5-H52P

Code No.	Route Type	Size Inches
D5-H51P	All	48 x 48
D5-H52P	Freeway & Expressway	120 x 48

208-4 NO FACILITIES Sign Panel (D5-H17)

The NO FACILITIES panel (D5-H17) may be used on freeways and expressways when a rest area is constructed with the rest room facilities to be added at a later date. This panel is erected below the Advance Rest Area sign (D5-H1). An additional panel may be erected below the Exit Direction Rest Area sign (D5-H1a or D5-H2).

Code No.	Route Type	Size Inches
D5-H17	Freeway & Expressway	72 x 36

208-5 Other Rest Area Signs

Additional approved signs for use within the rest area are shown in ***Figure 298-6a***. Color and size information is provided in the Sign Designs and Markings Manual (SDMM) ***(see Section 295-2)***.

208-6 Report Drunk Drivers Sign (D12-H13)

The D12-H13 sign is intended to assist the **Ohio Department of Public Safety's** campaign to encourage reporting of drunk drivers.

This sign should be erected in all **ODOT** rest areas. It should be erected on separate supports along the ramp exiting the rest area when possible, but may be erected elsewhere in the rest area if space is unavailable along the ramp.

D12-H13
48" x 30"

Intentionally blank.

Intentionally blank.

209 FREEWAY & EXPRESSWAY DISTANCE & DESTINATION SIGNS

209-1 General

Freeway and expressway Distance and Destination signs are addressed in **OMUTCD Chapter 2E**. Information regarding the design of freeway and expressway Guide Signs is provided in **OMUTCD Sections 2E.01 through 2E.19** and **Appendix C of the SDMM *(see Section 295-2)***. This is discussed further in ***Section 211-3***.

The following Sections address signs not in the **OMUTCD**, or provide additional information about the intended use of signs that do appear in the **OMUTCD**.

209-2 Signing for Generators at Interchanges on Freeways & Expressways

209-2.1 General

As noted in **OMUTCD Section 2E.35**, the following guidelines have been developed for determining when a destination qualifies as a traffic generator for which Guide Signs, typically containing the name of the generator, may be erected at interchanges on freeways and expressways.

209-2.2 Participation Within a Municipality

Within the corporation limits of a municipality, **ODOT's** involvement with generator signing shall only occur in the following ways:

1. On Interstate Routes, in conformance with the provisions of **SOP OPS-111**, **ODOT** will furnish signing for eligible traffic generators. The municipality is responsible for acquiring necessary data and determining eligibility before requesting signs from **ODOT**.
2. At interchanges on other freeways and expressways, federal or State funding may participate in the costs of furnishing or installing generator signing as part of a highway improvement. The signing must meet the generator signing criteria established by local authorities which, in turn, must be in substantial agreement with the criteria contained herein **(see OMUTCD Section 2E.35, and Chapter 2M)**.

209-2.3 Procedures for Reviewing Signing Requests

Signs may be erected at interchanges on freeways and expressways: (1) after a written request has been received from the operator of the generator (with all data necessary to determine eligibility) and an investigation by the **District** has confirmed the eligibility of the generator as defined by this standard; or (2) after receipt of a written request from local authorities for generator signs on an Interstate Route within a municipality where the requirements of ***Section 209-2.2.*** are satisfied.

The design and erection of signs for eligible generators shall be in accordance with standards for sign type, height, lateral placement and location as specified in the **OMUTCD**. The signs typically contain the name of the generator, and are typically classified as Supplemental Guide Signs. As noted in **OMUTCD Section 2E.35**, Supplemental Guide Signs may show one or two destinations not shown on the major Guide Signs. However, only one Supplemental Guide Sign should be used on each interchange approach.

Signs for eligible generators shall not be erected when the proposed signs would conflict with existing primary Guide Signs or other warranted signs. Therefore, no commitment should be made to erect signs until an on-site inspection has been conducted at the proposed sign location in order to determine that sufficient space exists.

Generator signs should not be erected at freeway-to-freeway interchanges.

Normally, the Supplemental Guide Sign for each direction of travel on the mainline should be at the same interchange. Where it would be more appropriate to erect the generator signs for each direction of travel at separate interchanges, this may be done. The operator of the generator may recommend an interchange for signing in each direction on the mainline. However, the final decision as to sign placement rests with **ODOT**. Within the corporate limits of a municipality, this determination of sign location shall be coordinated with local authorities.

Under exceptional circumstances, additional signs may be necessary at interchanges on other freeways and expressways to adequately sign for an eligible generator. Additional signs should be approved by the **District Deputy Director** based on an engineering study that documents the need.

Erection and maintenance of signs which trailblaze from the freeway or expressway interchange to the generator are the responsibility of **ODOT** on **ODOT**-maintained highways, and local officials for municipal, **County** and **Township** Roads. Generator signs on freeways and expressways shall not be erected until trailblazer signs are in place.

Not all demands for generator signing can be accommodated. Therefore, the **District** should develop a priority system to determine which of the generators should get the limited space available. If signs for the generator requesting signing would result in too many signs or too many destinations on a sign, the **District** shall review the information and determine which generators will receive signing. To minimize future conflicts and removals of existing generator signs, consideration should be given to future expectations and priorities of signing at interchanges before erecting signs.

209-2.4 Criteria and Eligible Generators

Signs for a traffic generator may be erected on a freeway or expressway when the generator meets the criteria specified in ***Table 297-4***. The intent of such signing is to provide “wayfinding” for unfamiliar motorists that are not local to the area.

209-2.5 Traffic Generators that Do Not Warrant Signing

Activities signed for under the Specific Service Signing (Logo) Program ***(Section 207-2)*** do not qualify for generator signing under this Section.

It has also been determined that the following traffic generators do not warrant signing:

1. Businesses - Factories, manufacturing facilities, industrial parks, shopping centers, shopping malls, television stations, radio stations and theaters.
2. Cemeteries - National, local, State, military, public and private.
3. Community Facilities - Churches, civic centers, recreational center, recreational complex, YMCA facilities, libraries, subdivisions, historic districts and privately-owned historical facilities.
4. Educational - Grade schools, boarding schools and high schools.
5. Governmental - Courthouses, disaster assistance facilities, civil defense facilities, driver’s license centers, jails, prisons, local government highway buildings, post offices, research facilities and experimental facilities.
6. Medical - County homes, fraternal homes, nursing homes, hospices, humane facilities (animal shelters), infirmaries, treatment centers, mental facilities, research facilities, retirement facilities, sanitariums and veteran facilities.
7. Military - Armories, arsenals, sites and detachments.

8. Recreational - Country clubs, golf courses, health clubs, sports complexes/centers (e.g., soccer fields, amateur baseball/softball fields, basketball courts), ice skating rinks, bowling alleys, planetariums, fish hatcheries, game farms, game preserves, game refuges, arboretums and privately-owned campgrounds.

209-2.6 Temporary Event Signing

Directional signing may be installed on freeways and expressways for temporary events. Temporary events include shows (e.g., boat, car, air, horse, RV), street fairs and festivals, reenactments, sports tournaments, concerts and other similar short-term activities that generate a significant amount of traffic from outside the immediate area of the event, but for which permanently installed signs would not be appropriate. The duration of these events would typically be several days or several successive weekends; however, some could be as short as a few hours. Temporary directional signs will assist the unfamiliar road user with the selection of the appropriate exit from the freeway or expressway. These directional signs are intended to provide guidance to road users looking for the event, and are not meant to entice others to attend.

Generally, for events expected to attract fewer than 25,000 visitors per day, or attracting visitors principally from the local area, directional signage on the freeway or expressway would not be needed. For events attracting 25,000 or more visitors per day, with many from outside the local area, appropriately designed and installed directional signs would be beneficial.

Directional signing should only be considered for events located within 5 miles of the freeway or expressway interchange. This distance can be waived by the **District Deputy Director**. Signs should not be used at freeway to freeway (system) interchanges.

Requests for directional signage to be placed on the mainline and ramps of Interstate highways and other freeways and expressways under **ODOT's** jurisdiction, should be submitted by the sponsoring agency to the appropriate **ODOT District** at least 45 days prior to the event. As a minimum, this request should include the proposed sign designs and locations. The **District** should review the request, and on a case-by-case basis, determine what, if any, directional signage would be appropriate on the mainline and ramps of Interstate highways and other freeways and expressways.

Once the sign designs, locations and support arrangements have been approved by **ODOT,** the sponsoring agency shall be responsible for the fabrication and installation of the signs on the mainline and ramps. The sponsoring agency shall obtain an **ODOT** right-of-way permit prior to the installation of the signs. Alternately, **ODOT** may install the approved signs furnished by the sponsoring agency and bill the sponsoring agency for the costs incurred.

The sponsoring agency shall be responsible for the removal of the signs within 24 hours after the conclusion of the event. **ODOT** may remove signs not removed by the sponsoring agency within a timely manner, and bill the sponsoring agency for the costs incurred.

The signs shall conform to the requirements in the **OMUTCD**, and shall not contain any advertising. On the freeway and expressway mainline, the minimum capital or upper case letter height should be 8 inches. On the freeway and expressway ramps, the minimum capital or upper case letter height should be 4 inches. The sign background color should be brown or green, with a white legend. The legend should be as concise as possible while still conveying the necessary pertinent information to associate the sign with the event.

The signs shall be installed on their own ground-embedded supports unless the **District** agrees that they may be attached to existing signs, sign supports, utility poles, or mounted on portable supports. Signs installed in exposed locations (i.e., not protected by guardrail or concrete barrier), must be on crashworthy **(see OMUTCD Section 1A.13)** ground-embedded or portable supports (except for signs attached to utility poles). Signs on portable supports shall have a minimum mounting height of 1 foot above the edge of pavement. The mounting height of other signs shall be in accordance with the **OMUTCD**.

If determined by **ODOT** to be appropriate, **ODOT** may allow the sponsoring agency to install portable changeable message signs (PCMSs) on the freeway or expressway, in accordance with the provisions of the **OMUTCD**. The PCMSs shall be placed at locations approved by **ODOT**, and should be installed behind guardrail whenever possible.

Signs directing road users from the freeway or expressway to the event shall be in place prior to displaying sign messages on the freeway or expressway. Installed signs and PCMSs on the freeway and expressway shall remain covered or inactivated until such time as the necessary directional signing on the conventional and local street systems is in place.

209-2.7 Signing on Freeways and Expressways for Other Generators

Emergency Hospital signing is addressed in ***Section 207-4***, signing for generic Motorist Services is addressed in ***Section 207-5***, and signing for Tourist Information Centers is addressed in ***Section 207-6***. Also, signing for the Logo Program is described in ***Section 207-2***.

209-3 Control City Destinations for Ohio's Interstate Highway System

Control cities are major destinations and population centers of national significance, located on or near the Interstate Highway System, that have been identified through a process established by **AASHTO** for use in guide signing. Each State is involved in the process, and the list is subject to change. The list of all control cities in the **United States** is in the **AASHTO** publication **"List of Control Cities for Use in Guide Signs on Interstate Highways."**

Guide Sign directional and distance information shall be uniformly based on these control cities, instead of presenting a variety of short-range destinations at small mileage intervals that are of little value to the non-local, unfamiliar traveler. Consequently, the number of control cities should be kept to the minimum necessary to provide broad directional information, and they should be used as legends in the following situations:

1. Interchanges between freeways.
2. Separation points of overlapping freeways.
3. On directional signs on intersecting routes, to guide traffic entering the freeway.

In addition, **OMUTCD** **Section 2E.12** addresses the use of control cities on Pull-Thru signs and **Section 2E.39** addresses their use on the bottom line of Post-Interchange Distance (E7-H1) signs.

Control cities for loop, spur, outerbelt or innerbelt type facilities should be determined from the linear Interstate Routes to which they connect. Control cities identified for **Ohio's** Interstate Highway System are listed in ***Table 297-5***.

209-4 Weigh Station Signing for Freeways and Expressways

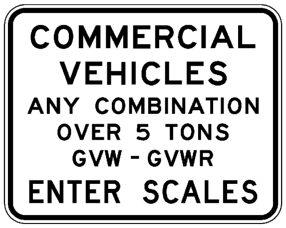
209-4.1 General

Weigh Station Signing for freeways and expressways is addressed in **OMUTCD** **Sections 2D.49 and 2E.54, and Figure 2D-17**. On **ODOT**-maintained highways, the D8-H2, R13-H1 and R13-H2 signs shall be used (in addition to the D8-1 and D8-3).

The R13-H1 sign shall be located approximately 4,000 feet in advance of the gore. The R13-H2 sign shall be located approximately 3,200 feet in advance of the gore.

209-4.2 Exit Direction Sign (D8-H2)

As noted in OMUTCD **Section 2E.54**, on freeways and expressways this sign shall be erected at a minimum of 1500 feet in advance of the gore. The bottom line consists of a changeable message panel capable of displaying the words “OPEN” and “CLOSED.” The legend “CLOSED” shall be displayed when the station is closed and the legend “OPEN” shall be displayed when the station is open and shall be controlled from the scale house.



R13-H1
120 x 96

R13-H2
120 x 72

D8-H2
156 x 72

209-5 Interchange Exit Numbering (E1-H5P) and Reference Location Signs (D10-1 through D10-5, D10-H5a)

The OMUTCD discusses interchange exit numbering in **Section 2E.31**. Reference Locations signs (including Enhanced Reference Location signs) are addressed in **OMUTCD Sections 2H.05 and 2H.06**.

The Enhanced Reference Location signs addressed in **OMUTCD Section 2H.06 and Figure 2H-4** may be used on **ODOT**-maintained freeways, expressways and major conventional roads.

209-6 Street Name Signing for At-Grade Intersections on Expressways and Multi-Lane Conventional Roads

209-6.1 General

The OMUTCD discusses street name signing for at-grade intersections on expressways in **Sections 2E.29.1 and 2E.29.2**. This type of signing will also be appropriate at some intersections on multi-lane conventional roads. The type of signing to use on the mainline of expressways and multi-lane conventional roads at and in advance of intersecting public highways depends upon the characteristics of both roadways. Different signing arrangements may even be appropriate for adjacent intersections on a particular section of highway. ***Section 209-6*** discusses the signing arrangements that are used for at-grade intersections on expressways and multi-lane conventional roads.

209-6.2 At-Grade Intersections on Expressways

For expressways where the primary access is by grade-separated interchange and at-grade intersections with public roads with few or no commercial and/or private driveways, the signing arrangements shown in ***Figures 298-28 and 298-29*** would typically be used for at-grade intersections. ***Figure 298-28*** applies to a numbered intersecting route and ***Figure 298-29*** applies to an unnumbered intersecting route.

The major Guide Signs are designed as level 2. Supplemental Guide Signs, if used, would be designed as level 3. Signing levels are discussed in the SDMM Appendix C ***(see Section 295-2)***.

209-6.3 At-Grade Intersections on Multi-Lane Conventional Roads

A multi-lane conventional road is a divided or undivided highway with two or more through lanes in one or both directions where the primary access is by grade-separated interchanges and at-grade intersections with public roads, with numerous secondary access points with commercial and/or private driveways. Multi-lane conventional roads may or may not have partial control of access. Although they may sometimes meet the definition of an expressway, they function more as arterial streets due to the amount of development that can be directly accessed via commercial and/or private driveways.
On multi-lane conventional roads, for at-grade intersections with important public roads, the signing arrangement shown in ***Figure 298-30*** would typically be used. The arrangements shown in ***Figures 298-28 and 298-29*** may be considered where additional advance notice of intersections having significant amounts of cross traffic is desired.

209-6.4 Minor At-Grade Intersections on Expressways and Multi-Lane Conventional Roads

The use of advance signing may not be necessary at some at-grade intersections with relatively minor public roads located in the vicinity of numerous commercial and/or private driveways. Examples include dead end streets, or streets that serve only a few residential properties, where the amount of turning traffic may be less than at adjacent driveways. In these cases, the use of advance signing may provide minimal benefit and could interfere with the effectiveness of advance signing for more important at-grade intersections or grade-separated interchanges.

209-7 Signs for Option Lanes

An option lane exit is any multi-lane exit where the total number of through and exiting lanes exceeds the number of approach lanes. An option lane is that lane from which traffic has a choice of either continuing on the through roadway or exiting without changing lanes. Option lanes are always accompanied by a lane drop **(see OMUTCD Sections 2E.20 and 2E.23 and Figures 2E-4 through 2E-12)**.

Roadway geometrics of option lane exits are often further complicated by a bifurcation beyond the mainline gore immediately beyond the mainline exit (2000 feet or less) which may also contain option and/or drop lanes.

The directional signing for an option lane exit must convey to the approaching driver: (1) a warning of the lane drop; (2) the existence of the option lane; and (3) adequate advance notice of a bifurcation beyond the mainline gore and lane drops.

Chapter 2E of the 2012 OMUTCD, includes expanded information regarding guide signing used for option lanes, and introduces the Arrow-per-Lane Guide Signs. It also prohibits or discourages many guide signing practices that are commonly used in Ohio. The following are of particular concern:

Section 2E.20, paragraph 02, requires the use of Arrow-per-Lane or Diagrammatic signs for multi-lane exits or splits that have an option lane.

Section 2E.19, paragraph 05, and **Section 2E.23**, paragraph 06 prohibit the use of a single down arrow over an option lane if that lane also serves another destination.

Section 2E.19, paragraph 06 prohibits the use of two down arrows on adjacent signs pointing to the same lane.

Section 2E.21, paragraph 07 (H) prohibits any indication of ramp splits beyond the mainline exit on the Arrow-per-Lane sign.

These requirements may not present any particular problems when used at isolated locations. However, problems may arise in cases where a mainline exit from an option lane is followed shortly thereafter by a ramp split, especially where the ramp split also contains an option lane, or where interchanges are closely spaced. Both of these situations are prevalent on Ohio freeways.

OMUTCD Figures 2E-4, 2E-5 and 2E-6 provide examples regarding the use of Arrow-per-Lane signs for multi-lane exits and splits that have an option lane, but do not have a subsequent ramp split. **Figure 2E-34** provides examples of guide signing for ramp splits beyond the mainline exit, but where there is no mainline option lane or ramp option lane. There are no examples in the **OMUTCD** showing guide signing arrangements for multi-lane exits with an option lane followed by a ramp split. There are also no examples for multi-lane exits with an option lane for closely spaced interchanges.

For major highway reconstruction, efforts should be made to follow the **OMUTCD** to the greatest extent practical. This includes working with the highway design team to develop highway entrance and exit ramp configurations and interchange spacings that will be conducive to the application of the signing design principals in the **OMUTCD**.

The use of two down arrows on adjacent signs pointing to the same lane should be avoided on major highway reconstruction. This signing method can work effectively when done properly. However, past experience has shown that oftentimes the down arrows are placed on the signs at inappropriate angles, or the signs are improperly positioned on the overhead support, such that the intended information is poorly conveyed to the motorist. The continued use of slanting down arrows on adjacent signs pointing to the same lane can be continued at existing interchanges. When performing sign upgradings, consideration should be given to using other appropriate signing arrangements.

Besides the figures included in the **OMUTCD**, ***TEM Figures 298-33 through 298-36, and 298-45 through 298-47*** should be referred to when designing interchange guide signing.

Intentionally blank.

210 MISCELLANEOUS SIGNS

210-1 General

This Chapter addresses miscellaneous signs not in the **OMUTCD**.

210-2 Reserved for Future Information

210-3 Decorative Signs in State Right-of-Way

Districts may, at their discretion, elect to allow local communities to erect decorative signs within the rights-of-way under **ODOT** jurisdiction. For those **Districts** that decide to allow such signing, the following criteria shall apply:

1. Four sets of detailed plans showing the sign face, post(s), lettering, colors, location, etc. shall be submitted to the **District** with a permit application in the community's name for review and comment.
2. The sign is to be erected on a maximum 4 x 4 inch wooden post(s).
3. The sign face is to be no greater than 32 square feet
4. Neutral colors shall be used on the sign.
5. The sign shall be located a minimum of 40 feet from the edge of the paved shoulder unless located behind guardrail. Additionally, the sign should be located outside interchange roadways, including ramps.
6. The sign is to be installed and maintained by the Permit Holder. A minimum radius of 20 feet around the sign is to be maintained (grass mowed) by the Permit Holder.
7. Posts shall be direct buried. They cannot be encased in concrete.
8. No electricity shall be installed for the sign.
9. No advertising is permitted on the sign or supports, including acknowledgment or sponsorship.
10. The sign must be officially authorized by local ordinance or resolution.

Intentionally blank.

211 SIGN DESIGNING

211-1 General

OMUTCD Section 2A.06 briefly addresses sign designs, and additional general design information is provided in each **OMUTCD** signing chapter. General information is also provided in the **Sign Designs and Markings Manual (SDMM) Introduction and Appendix B** ***(see Section 295-2)***. Additional information is provided in the following Sections, and detailed information used for the design and fabrication of traffic control signs is contained in the **SDMM**.

The **FHWA** counterpart to the **SDMM** is the **Standard Highway Signs and Markings (SHS)** book ***(see Section 193-15)***.

211-2 Standard Signs

Generally, the designs for standard Regulatory and Warning Signs, as well as various Guide Signs where the design is basically set, are prepared by **OTO** and published in the **SDMM**. ***Section 205-2*** provides some additional information on Conventional Road Destination Signs. The standard symbols used in these signs are provided in **SDMM Appendix A**, and design information is provided in **SDMM Appendices B and D**. The symbols, arrows, alphabet information and design standards used are based on those established by **FHWA**.

211-3 Designable Guide Signs

As noted in ***Section 209-1***, **OMUTCD Sections 2E.01 through 2E.19** and **SDMM Appendix C** provide information regarding the design of freeway and expressway Guide Signs.

211-4 Sign Design Computer Program

A computerized sign design package (design and fabrication/production software) is currently in use in the **Office of Traffic Operations (OTO), Office of Roadway Engineering (ORE)** and the **Districts**. Purchase and maintenance of the program, called **SignCAD**, is coordinated by **OTO**.

The program includes a library of **ODOT** standard signs, maintained through a maintenance agreement **OTO** has with the supplier.

OTO can assist the **Districts** in designing directional Guide Signs for construction project or force account installation purposes, as well as special Regulatory and Warning Signs that may become necessary. **OTO** can also can provide **SignCAD** training.

Intentionally blank.

212 SIGN LIGHTING

212-1 General

OMUTCD Section 2E.06 indicates that overhead sign installations should be illuminated unless an engineering study shows that retroreflectorization alone will perform effectively, providing effective and reasonably uniform illumination of the sign face and message. The following Sections, as well as ***Sections 240-7, 241-4, 242-2, 250-8, 260-7 and 1103-6.8***, provide additional information about sign lighting.

212-2 Sign Lighting for Overhead Guide Signs

Research has shown that sign lighting is not necessary for overhead Guide Signs when Type H or J reflective sheeting is used for the reflective legends. ***Section 220-6*** requires that Type H or J sheeting be used for the reflective legends (including shields, arrows and symbols) on overhead extrusheet signs on **ODOT**-maintained highways. Therefore, for new installations on **ODOT**-maintained highways, sign lighting should not be used, and as noted in ***Section 260-7***, mercury vapor sign lighting shall not be used.

For existing installations, sign lighting may remain; however, as noted in ***Section 260-7***, mercury vapor sign lighting shall not be maintained. As existing signs are upgraded with legends of Type H or J reflective sheeting, the existing sign lighting should be removed. Removal shall include, as a minimum, the physical removal of the luminaires and luminaire support assemblies.

212-3 Sign Lighting for Other Traffic Signs

Sign lighting is not necessary for other overhead and ground-mounted traffic signs. This includes overhead lane-use control signs and ground-mounted PREPARE TO STOP WHEN FLASHING signs.

Intentionally blank.

220 MATERIALS AND HARDWARE

220-1 General

Refer to the **ODOT Construction and Material Specifications (C&MS) and Supplemental Specifications** for details regarding signing materials. ***Chapter 241*** lists the related **C&MS** references and ***Chapters 240 and 250*** address additional design and construction information related to signing materials and hardware.

220-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is addressed in ***Section 120-4***.

220-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using federal funds, ***Sections 120-5 and 120-6*** describe processes that have been established whereby local agencies can purchase such items through **ODOT**.

220-4 Sign Reflectivity

Traffic control signs utilize reflective sheeting materials containing optical elements designed to return a large portion of the incident light back towards the source. At night, this property, known as retroreflectivity, redirects incident light from a vehicle's headlights back toward the vehicle's occupants. This allows traffic control signs to remain visible after dark.

The retroreflective properties of traffic control signs degrade over time, due principally to exposure to ultraviolet radiation from the sun and environmental contaminants. Signs that may appear satisfactory during the day may have insufficient retroreflectivity to be visible at night.

The **ODOT** systematic sign replacement program ***(see Section 260-5)*** provides for traffic control signs to be replaced on a regularly scheduled basis to assure that they have adequate levels of retroreflectivity. Therefore, periodic night inspections of signs should not be necessary. Districts wanting to conduct night sign inspections may do so at their own discretion. A recommended procedure is described in ***Section 220-5***.

220-5 Sign Reflectivity Inspections

Sign reflectivity can be checked at night using one of the Visual Nighttime Inspection procedures described in **OMUTCD Section 2A.08**. Additional information about these methods is contained in the 2007 Edition of **FHWA**'s "Maintaining Traffic Sign Retroreflectivity" and the **FHWA** web site. However, the **ODOT** systematic sign replacement program ***(see Section 260-5)*** should preclude the need to conduct periodic reflectivity checks, provided the replacement intervals are followed.

The formation of dew or frost on the face of a sign will negatively impact the sign's retroreflective properties. When performing night inspections, evaluators should be aware of this potential condition. Night inspections should only be conducted when atmospheric conditions do not allow the formation of dew or frost on the sign face.

Retroreflectivity can also be measured with a retroreflectometer. However, this is a time consuming and labor intensive method, as it requires that multiple measurements be physically taken with the meter at each sign.

220-6 Use of Reflective Sheeting for Permanent Traffic Control Signs

For flatsheet and ground-mounted extrusheet signs, Type G, H or J reflective sheeting shall be used for the background and reflective legends. For overhead extrusheet signs, Type G, H or J reflective sheeting shall be used for the background, and Type H or J reflective sheeting shall be used for the reflective legends, shields, arrows and symbols (including the hazardous cargo plate, airport symbol, and borders). Type G reflective sheeting shall not be used for legends, shields, arrows and symbols on overhead extrusheet signs.

Existing signs made with Type F reflective sheeting may remain in the field until they have reached the end of their sign service life. New Type F signs shall not be installed. Any remaining stocks of Type F signs should be disposed of by the **District.**

Existing signs with legends of demountable embossed copy may remain in the field until they have reached the end of their sign service life. New signs with demountable embossed copy shall not be installed. Any remaining stocks of signs with legends of demountable embossed copy should be disposed of by the **District.**

220-7 Use of Fluorescent Yellow-Green Sheeting

The **OMUTCD** requires the use of fluorescent yellow-green sheeting for school warning signs, including the “SCHOOL” portion of the School Speed Limit sign and including any supplemental plaques used in association with these warning signs, and allows for the optional use of fluorescent yellow-green sheeting for pedestrian, bicycle, and playground Warning Signs. It also states that the mixing of standard yellow and fluorescent yellow-green signs within a zone or area should be avoided.

For **ODOT**-maintained highways, the following signs will normally be fabricated with fluorescent yellow-green reflective sheeting: School Advance Warning (S1-1), School Bus Stop Ahead (S3-1), SCHOOL BUS TURN AHEAD (S3-2), SCHOOL ENTRANCE (S3-H3), SCHOOL (S4-3P), yellow portions of School Speed Limit (S5-H1), In-Street Pedestrian Crossing (R1-6, R1-6b), and Overhead Pedestrian Crossing (R1-9), Bicycle (W11-1), Pedestrian (W11-2), Handicapped (W11-9), Bicycle/Pedestrian (W11-15), TRAIL CROSSING (W11-15a), Playground (W15-1), and SAFETY ZONE (W15-H2). The process **ODOT** will follow to transition to fluorescent yellow-green sheeting is described in this Section.

Existing yellow signs of the above code numbers may remain in the field until the signs have reached the end of their effective performance life, except that when upgrading a sign within a zone or area to fluorescent yellow-green, all yellow signs of the above code numbers within the zone or area should be replaced with fluorescent yellow-green signs. Yellow signs that have been removed prior to the end of their effective performance life may be returned to **District** stocks for use in maintenance activities.

Signs of the above code numbers will be provided from the **ODOT Sign Shop** in fluorescent yellow-green, unless specified otherwise by the **District**. The intent is to convert the above signs to fluorescent yellow-green as existing signs are upgraded.

Supplemental sign plaques, such as Advisory Speed (W13-1P), SHARE THE ROAD (W16-1P), Distance (W16-2P, W16-2aP, W16-3P, W16-3aP), Supplemental Arrows (W16-5P, W16-6P, W16-7P) and AHEAD (W16-9P) should match the color of the primary sign.

220-8 Production and Purchasing of Signs and Related Materials

220-8.1 General

In accordance with **ORC Section 5147.07**, the **Office of Traffic Operations (OTO)** operates a sign production facility and is responsible for the manufacture and coordination for procurement of all signs and related items required for use by **ODOT**. Actual sign production is accomplished by the **Central Office Sign Shop** located in Columbus.

Except for normal field maintenance of Guide Signs or in extreme emergencies, **Districts** should not fabricate, repaint or re-stencil any sign for use on **ODOT**-maintained highways.

Temporary non-standard signing, if used, should be replaced by standard signs as soon as possible.

220-8.2 Sign Shop Orders

All orders for signs, markers and any other materials or equipment to be supplied or manufactured by the **Sign Shop** shall be submitted to the **Sign Shop** through the automated Smart Sign Ordering System (SSOS). All necessary information shall be provided.

Orders for designable extrusheet signs should be accompanied by a **SignCAD** file so that the **District** can be assured that the **Sign Shop** will provide what they are expecting. If there are questions associated with this requirement, call the **Sign Shop** for assistance.

Excluding warehouse orders, standard sign orders shall be submitted in advance with as much lead time as possible, to afford the **Sign Shop** sufficient time to integrate fabrication into regular production schedules. “Rush” orders” shall be kept to a minimum.

In extreme situations, when circumstances dictate urgent need, orders may be made by telephone. The **Sign Shop** may be called directly when an emergency situation arises. However, a confirming Sign Shop Order via SSOS must be submitted following any telephone order.

220-8.3 Delivery

The **Sign Shop** will strive to complete, and have ready for pick-up or delivery, all orders for flatsheet signs within 30 days after receipt of order (ARO), and all extrusheet sign orders within 45 days ARO. The only exception to the preceding timeline is warehouse signs, which can be accessed on a daily basis. The primary delivery of flatsheet signs to the **Districts** will be the pony system. Each **District** should provide an adequately sized vehicle for the transporting of signs from the **Sign Shop** – full-sized vans or trucks ideally with bed covers to provide all weather transportation. The **Sign Shop** will deliver flatsheet signs when necessary and will routinely deliver all extrusheet signs.

220-8.4 Special Projects

The **Sign Shop** will accept special requests from various **ODOT** offices and other State agencies; however, all special requests must have prior approval from the **Sign Shop Administrator**. Regular highway sign production work will have priority in the scheduling of work through the **Sign Shop**.

220-8.5 Sign Costs

On July 1, 2000 the **Sign Shop’s** operating budget was decentralized to the **Districts**. This funding measure now requires the **Districts** to designate a portion of their operating budget for the acquisition of traffic signs used in **District** sign maintenance activities. Billable sign costs that are passed on to the **Districts** are for materials only. Labor, benefits and overhead are excluded.

220-9 Salvaging Sign Material

The **Sign Shop** does not reclaim, recycle or reuse salvaged flatsheet aluminum sign blanks or extrusheet sign panels. This has not been found to be cost-effective for **ODOT** operations. Used sign blanks and extrusheet panels should be disposed of by the **Districts**. Preferably, the used material should be sold to local area scrap aluminum dealers. These types of transactions will be in accordance with **ODOT's Purchasing Guidelines, Procedures and General Terms and Conditions** as set forth by the **Office of Contracts**. Profits from the aluminum scrap sales can supplement the **District's** operating budget.

220-10 Use of Fluorescent Yellow Sheeting

OMUTCD Section 2A.10 and Table 2A-5 specifies the use of yellow as the background color of certain sign types. Reflective sheeting materials are currently available in two version of yellow – nonfluorescent yellow and fluorescent yellow. Either of these versions of yellow meets the **OMUTCD** requirement. Due to the improved appearance of signs made with fluorescent yellow sheeting over those made with nonfluorescent yellow sheeting, especially in overcast and twilight conditions, it has been decided that for **ODOT**-maintained highways, yellow signs will be made with fluorescent yellow sheeting.

All yellow signs, yellow portions of multi-colored signs, and yellow sign post reflectors, except for signs and portions of signs required to be fabricated with fluorescent yellow-green reflective sheeting ***(see Section 220-7)***, shall be fabricated with fluorescent yellow sheeting.

Existing nonfluorescent yellow signs may remain in the field until they have reached the end of their sign service life. After December 31, 2009, remaining stocks of nonfluorescent yellow signs should be disposed of; however, until December 31, 2009, existing stocks of new nonfluorescent yellow signs may continue to be installed.

221 SIGN SUPPORTS

221-1 General

In addition to the guidelines provided in this Chapter, ***Chapters 240 and 250*** provide design and construction information on the selection and use of standard sign supports. Overhead sign supports are also addressed in **Traffic SCDs TC-7.65 through TC-22.20**, and ground-mounted sign supports are covered in **Traffic SCDs TC-41.10 through TC-42.20**. Design charts are included herein as ***Figures 298-12 through 298-18*** to facilitate selection of the proper support for the proposed sign area.

All sign supports used in exposed locations must meet the breakaway requirements of the **National Cooperative Highway Research Program (NCHRP) Report 350**. Sign supports detailed in the **Traffic SCDs** meet these requirements when installed as specified.

FHWA maintains a list of approved sign supports and breakaway connections that have passed crash testing requirements and are acceptable for use in exposed locations. Sign supports used in exposed locations on **ODOT**-maintained highways must be approved for use by **FHWA**, and must be installed in accordance with the conditions of their approval.

221-2 Splicing of U-Channel Posts

The splicing of U-channel drive posts can be accomplished with steel or aluminum bolts. When the connection is made with steel bolts, the drive posts are considered as acting as a one piece post. When using aluminum bolts, the connection would be expected to come open upon impact.

With steel bolts, the connection between the stub post and upper post should be made with a minimum of two 5/16 inch bolts with a minimum center-to-center spacing of 4 inches. No restrictions to stub height are imposed when using steel bolts for the connection. To reduce the possibility of vehicle snagging, the upper post should be attached behind the stub post when splicing posts of the same weight per unit length. When splicing a no. 2 U-channel upper post to a no. 3 U-channel stub post, the no. 2 post should be attached in front of the no. 3 post to achieve a sound structural connection.

Stub height should be limited to 4 inches above the ground when using aluminum bolts for the connection.

221-3 Overhead Sign Support Inspection

Inspection of overhead sign supports on construction projects is addressed in ***Sections 250-4 and 250-5***.

Bridge-mounted overhead sign supports and overhead sign supports with bridge-mounted foundations should be inspected annually, preferably at the time of, and included with, the annual bridge inspection. All other overhead sign supports should be inspected at a maximum five-year interval. New overhead sign supports should be inspected at the time of construction.

A statewide uniform practice for the periodic inspection of the structural components of existing **ODOT**-maintained overhead sign supports is also necessary to assure their structural integrity. All overhead sign supports, including but not limited to cantilever, butterfly, box truss, monotube, span wire, semi-overhead and bridge-mounted supports, should be periodically inspected. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked. The use of an inspection form is recommended. A sample form ***(Form 296-4)***, has been provided which may be used as is or modified by the **District** as desired.

Supports should be visually inspected from the ground. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means is not necessary on a routine basis, but may be used to more closely examine a defect that has been detected from the ground. Anchor bolts should be tested for structural integrity by sounding with a hammer. Non-destructive testing procedures, such as dye penetrant, ultrasonics and magnetic particle, are not necessary on a routine basis, but can be used to define the extent of a defect that has been detected by visual means. Written documentation of all inspections should be kept.

Items to be inspected should include, but not be limited to, foundation concrete, soil around the foundation, anchor bolts and nuts, structural members, structural connections, sign attachment assemblies and structural components of the sign lighting.

Deficiencies to be inspected for should include, but not be limited to, cracks in the concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, and corrosion.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Written documentation of corrective actions should be kept.

Overhead sign support inspection training is available from the **Office of Traffic Operations** .

221-4 <u>Erecting Highway Signs On or Near Utility Poles</u>

Highway signs should normally be mounted on supports installed by **ODOT**. These installations should, whenever practical, be placed a minimum of 4 feet from utility poles.

However, **ORC Section 5515.04** authorizes **ODOT** to attach signs to utility poles along the public highway. Permission of the pole owner is not required. Therefore, districts may, at their discretion, use any suitably located utility pole as a support for a highway sign.

221-5 <u>Solid Wood Posts</u>

Solid wood posts have been crash tested and are approved for use as sign supports. Approved post sizes are 4 x 4, 4 x 6, 6 x 6 and 6 x 8 inch (nominal dimensions); however, they must be installed as per the details in ***Figure 298-26*** to meet breakaway requirements.

For the two larger post sizes (6 x 6 and 6 x 8 inch), only one post is permitted in a 7 foot path. This means that a minimum of 7 feet clear distance must be maintained between the two posts. For the two smaller post sizes (4 x 4 and 4 x 6 inch), two posts are permitted in a 7 foot path.

More than two posts can be used for a sign. However, no more than two of the smaller posts (4 x 4 and 4 x 6 inch) or one of the larger posts (6 x 6 and 6 x 8 inch) is permitted within any 7 foot width. For instance, if three 4 x 6 inch posts are used for a sign, a minimum clear distance of 7 feet shall be maintained between the outermost posts. If three 6 x 8 inch posts are used, a minimum clear distance of 7 feet shall be maintained between the left and center post, and between the center and right post. Please note that these are clear distances, not center-to-center distances.

The three larger post sizes must have holes drilled perpendicular to the roadway centerline at 4 inches and 18 inches above the ground line after installation. The hole size is dependent upon the post size, and is shown in ***Figure 298-26***. The 4 x 4 inch post does not require any drilled holes.

Grade 2 Southern Yellow Pine was used in the crash tests. The **FHWA** approval letter notes that:

> Southern Yellow Pine is a relatively strong softwood; therefore, most other softwoods and some hardwoods will be acceptable for use as breakaway signposts. Care should be taken in specifying wood for posts to ensure that the strength does not significantly exceed that of the Grade 2 Southern Yellow Pine.

The wood used should be pressure treated with CCA (chromated-copper-arsenate) preservative. Retention should be a minimum of 0.40 lbs/ft, with 0.60 lbs/ft preferable.

Flatsheet signs can be attached directly to the wood posts with lag screws. For extrusheet signs, sections of U-channel drive post of the same height as the sign can be attached to the wood posts with lag screws. The extrusheet sign can then be installed using standard sign clips.

Additional information regarding wood sign posts is contained in ***Figure 298-26***. This includes the recommended wind pressures, minimum embedment depths and maximum allowable moment per post. The wind pressures are based on a 60 mile per hour sustained wind speed.

A design chart for solid wood posts is provided in ***Figure 298-27***.

221-6 Sign Post Reflectorization

OMUTCD Section 2A.21 discusses the use of sign post reflectorization.

Sign posts shall be reflectorized with Type G, H or J reflective sheeting as shown on **Traffic SCD TC-41.30**, in accordance with the **ODOT** Comprehensive Highway Safety Plan. It has been determined that the most cost effective method to accomplish sign post reflectorization is by applying the reflective sheeting to strips of flatsheet aluminum, and then bolting these strips to the sign post. Other mounting arrangements may be used. The reflective strips should have a nominal width of 3 inches, and a length as described in **SCD TC-41.30**.

Red sign post reflectors shall be installed with all post-mounted STOP (R1-1), YIELD (R1-2), DO NOT ENTER (R5-1) and WRONG WAY (R5-1a) signs.

Yellow sign post reflectors shall be installed with all post-mounted One-Direction Large Arrow (W1-6), Two-Direction Large Arrow (W1-7), Chevron Alignment (W1-8), and Stop Ahead (W3-1) signs. As noted in ***Section 220-10***, **ODOT** is transitioning to the use of fluorescent yellow sheeting for yellow signs on **ODOT**-maintained highways. Although it is preferable that nonfluorescent yellow sign post reflectors be used with nonfluorescent yellow signs, and fluorescent yellow sign post reflectors be used with fluorescent yellow signs, the intermixing of these versions of yellow in the same assembly is acceptable.

The use of sign post reflectors on other Regulatory and Warning Signs is optional. In accordance with **OMUTCD Section 2A-21**, the color of the sign post reflector shall match the background color of the sign. In the case of the yellow color, either version of yellow (nonfluorescent and fluorescent), whether used exclusively or intermixed in an installation, is considered as fulfilling the **OMUTCD** requirement that the sign post reflector match the background color of the sign.

221-7 Laminated Veneer Wooden Box Beam Sign Supports

Laminated veneer wooden box beams have been crash tested and are approved for use as sign supports. Approved beam sizes (in nominal dimensions) are 8 x 8 inch (Type M) and 8 x 15 inch (Type L). Installation details are shown on **Traffic SCD TC-41.25**.

For both beam sizes, only one beam is permitted in a 7-foot path. This means that a minimum of 7 feet clear distance must be maintained between the two beams. More than two beams can be used for a sign; however, only one beam is permitted within any 7-foot width. For instance, when three beams are used for a sign, a minimum clear distance of 7 feet shall be maintained between the left and center beam, and between the center and right beam. Please note that these are clear distances, not center-to-center distances.

Beams installed in exposed locations must be made breakaway by drilling holes and connecting the holes with a saw cut as detailed on **Traffic SCD TC-41.25**. Beams installed in protected locations do not need to have the breakaway feature installed.

Material specifications for these supports are covered in **C&MS** **Section 730.017**; and design charts for the laminated veneer wooden box beam sign supports are provided in ***Figure 298-48***.

230 PLANNING / PROGRAMMING

This Chapter has been reserved to address, as needed, planning and programming information related to traffic control signs.

240 DESIGN INFORMATION

240-1 General

The **L&D Manual Volumes 1 and 3** and ***Chapter 140*** provide general background regarding design information for **ODOT** projects, including the three-stage review process typically used for traffic control plans. Additional design information has been provided in this Chapter, including checklists for Stage 2 and 3 submittals ***(see Section 240-8)***. See ***Chapter 241*** for additional information specifically related to plan preparation. **Plan Notes** are addressed in ***Chapter 242***, and ***Chapter 243*** provides a listing of related **C&MS** Items.

240-2 Signs and Sign Attachments

240-2.1 General

Except as noted in this Section, furnishing and erecting permanent signs on construction projects shall be the responsibility of the contractor.

The freeway and expressway State Line sign (E8-H1) and the Ohio Byway sign (M8-H3) shall normally be furnished by **ODOT** for erection by the contractor. For these signs the bid item "Signs Erected, by Type" shall be used.

240-2.2 Sign Attachments

The standard drawings and specifications provide several methods of attaching signs to supports, depending on the circumstances. The summary below lists the applicable bid items with reference to standards and specifications:

1. Sign Attachment Assembly: Used to attach extrusheet signs to overhead sign supports **(Traffic SCD TC-22.20)**. This consists of a sign bracket, U-bolts and hardware. They are furnished with new overhead sign supports. The bid item is only necessary if the support is an existing installation. The bid item is "Sign Attachment Assembly" **(C&MS Item 630.06(E))**.

2. Sign Backing Assembly: Used to provide the necessary posts and hardware to attach a supplemental sign or exit number plaque to the main Guide Sign or to provide the back bracing for a grouping of flatsheet signs in an assembly **(Traffic SCD TC-42.10)**. They are furnished with the "sign" bid item. The bid item is only necessary for reerected signs. The bid item is "Sign Backing Assembly" **(C&MS 630.14)**.

3. Sign Hanger Assembly: Used to attach signs to span wire and mast arm signal supports **(Traffic SCD TC-41.41)**. The item includes all necessary hardware to attach one individual sign. The bid items are "Sign Hanger Assembly, Span Wire" and "Sign Hanger Assembly, Mast Arm."

   "Sign Hanger Assembly, Span Wire" is furnished with new **Traffic SCD TC-17.10** span wire sign supports.

4. Sign Support Assembly: Used for the attachment of flatsheet type signs to bridge parapets or miscellaneous poles **(Traffic SCD TC-41.40)**. The bid items are "Sign Support Assembly, Pole Mounted" and "Sign Support Assembly, Bridge Mounted" **(C&MS 630.06(E) and 630.14)**.

240-2.3 Overhead Lighted Signs

When overhead lighted signs are part of the traffic control plans the following criteria shall be used concerning their inclusion in the plans:

1. On the base plans, the sign height shown shall be the effective sign height. This is the height from the **Sign Designs and Markings Manual, Appendix C *(Section 295-2)***. It does not include the glare shield.
2. In the subsummary, the actual sign height shall be used. The actual sign height is the effective sign height plus the glare shield height of 6 inches. The quantity of "Signs, Extrusheet" paid for in the plans is the length times the actual sign height.
3. In the elevation views, the overall sign height is to be used. This height is the effective sign height plus 12 inches (luminaire support tube of 6 inches plus glare shield height of 6 inches).

240-3 Overhead Sign Clearance After Pavement Overlay

As noted in **OMUTCD Section 2A.18**, overhead-mounted signs shall provide a vertical clearance of not less than 17 feet to the sign, light fixture or sign bridge over the entire width of the pavement and shoulders except where the structure on which the overhead signs are to be mounted or other structures along the roadway near the sign structure have a lesser vertical clearance. If the vertical clearance of other structures along the roadway near the sign structure is less than 16 feet, the vertical clearance to an overhead sign structure or support may be as low as 1 foot higher than the vertical clearance of the other structures in order to improve the visibility of the overhead signs. Most actual sign installations were in excess of 17 feet when first erected.

As a result of the build-up of pavement due to various types of pavement overlays, this minimum may be violated. When a roadway surface increment of more than 6 inches is to be added, or when the total of all resurfacing courses will become more than 10 inches, the clearances of overhead signs shall be checked and appropriate corrections made.

The Stage 2 submission will identify the clearance each sign would have if it were not raised, the future clearance of adjacent bridges, and recommendations regarding signs to be raised, including the distance to be raised and the method. The following steps should be taken:

1. Determine or obtain clearance requirements for major structures on the section of roadway.

a. New construction or major reconstruction

Interstate, Priority and Rural	16 to 17 feet
Interstate, Urban non-priority	15 to 17 feet
Other Freeway, Expressway or Arterial	15 to 16.5 feet
Collectors	14.5 to 15 feet
Locals	14.5 to 15 feet

b. Resurfacing, minor rehabilitation

Interstate, Priority and Rural	16 feet
Interstate, Urban non-priority	14 feet
Other Freeway, Expressway or Arterial	14 feet
Collectors	14 feet
Locals	14 feet

2. For new supports, provide sign clearance based on new structure clearance plus 1 foot.

3. For existing supports, establish the desired sign clearance criteria as either 1 foot more than the clearance for major structures which will be provided on the section, or as 1 foot more than the clearance prescribed for major rehabilitated structures plus an allowance for any resurfacing anticipated in the next 15 years, whichever is greater.

   Determine the individual sign clearances expected when the project is completed, and compare them to the desired sign clearance above. If the sign clearance will be greater than or within 3 inches of the desired sign clearance, no action is required at that time. If the sign clearance will be greater than 3 inches below desired sign clearance, the sign clearance should be increased.

4. If grading can be accomplished around the existing foundation to avoid standing water around the anchor bolts, it may be possible to simply raise the signs on the supports to obtain 1 foot of extra clearance. If raising the sign results in the sign being an unsupported distance of more than 4 feet above the centerline of the top support chord, intermediate sign brackets will be required. Also, if the existing sign support is at its maximum capacity prior to raising the sign, the support will have to be evaluated in detail to determine if this is feasible.

5. If grading around the existing foundation can be accomplished, another possibility might involve design of a "pole extension" which would engage the anchor bolts of the existing foundation and connect to the support base plates with new bolts. These would have stub shafts to provide a variable amount of rise to the support. This should not be done if the present foundation design is marginal.

6. If the system cannot be properly graded or the sign cannot be raised on the support for other reasons, the foundation top can be raised using a system of barrel nuts and anchor bolt extension studs, repouring the top of the foundation and re-erecting the sign support.

   When a sign is raised on an existing support, a new item of work must be described in a note to cover raising each sign.

   If the support must be raised, items of work and notes may be needed for:

   - Removing the support with sign.
   - Modifying the foundation or inserting the pole extension(s).
   - Re-erecting the sign and support.
   - Replacing any electrical power cable between the disconnect switch and the pullbox.
   - Re-connecting the ground wire.

240-4 Overhead Sign Supports

240-4.1 General

Overhead sign supports and foundations shall be included in the contract plans. All overhead sign support foundations shall be electrically grounded.

If an overhead sign support exceeding **ODOT's** design charts is required in a plan, the consultant shall be responsible for determining the support and foundation size required. Details similar to those shown on **ODOT Traffic Standard Construction Drawings** shall be included in the plans. As part of the Stage 3 submission, the consultant shall submit detailed structural calculations showing the adequacy of the proposed design including foundation.

When determining the sign area for design, use only the sign area exposed to the wind. For back-to-back signs, add the total square footage for both signs and subtract the square footage where the signs overlap.

240-4.2 Location

The exact location (by station to the nearest 1 foot) of the overhead supports should be determined according to the following criteria:

1. Refer to standard placement drawings ***(see Figures 298-8 through 298-11)***.

2. The preferred location for overhead sign supports is in the middle one-third of the design spacing for conventional roadway lighting units.

3. When the desired location criteria for a sign support does not place the support within the preferred area, the following minimum separation between overhead sign installations and lighting units should be maintained:

Mounting Height for Lighting	Minimum Separation
32.5 feet	40 feet
40 feet	60 feet
50 feet	90 feet

   If the lighting unit or the sign support locations cannot be adjusted to maintain the above minimum separation, the lighting unit may be placed immediately in advance of the sign support when a 40 foot or 50 foot mounting height is used for the lighting. However, this position cannot be used effectively when the mounting height is 32.5 feet, and consideration should be given, particularly for complete or intermediate lighting design, to an adjustment of the mounting height for several light pole units in the general vicinity of the sign support.

   At intersections, it is preferable to combine lighting units with overhead sign and/or traffic signal supports, when practical to do so, in consideration of current safety criteria, and in order to minimize the cost or clutter effect of a number of separate support poles.

4. Supports should be shown at 90 degrees to the roadway centerline in the plan view, or with the angle shown on the plan if not 90 degrees.

5. For medians 30 feet or less in width, the sign support should be centered in the median.

6. Every effort should be made to locate overhead sign supports off of bridge structures. The following is the order of preference for location.
   a. Off of the bridge structure
   b. Mounted directly to the pier
   c. Over top of a pier
   d. On the bridge mid-span. This location should be avoided if at all possible.

7. Minimum lateral clearances shall be as per **Section 600** of the **L&D Manual Volume 1**.

240-4.3 Design of Cantilever Sign Supports

Cantilever supports are addressed in **Traffic SCDs TC-12.30 and TC-16.21**. Standard practice for choosing a specific design for cantilever type overhead supports is as follows:

1. For supports in **Traffic SCD TC-12.30**:

   a. Determine the sign area. Include glare shield, luminaire support tube and Exit Number Panel, if applicable. For design purposes, use the total sign area, or a minimum of 120 square feet for mainline signs, or a minimum of 80 square feet for lead-in signs, whichever is larger.

b. Determine the lateral location of the sign over the pavement (use ***Figure 298-9*** and item g below).

c. Determine the lateral location of the support pole ***centerline*** with respect to the pavement.

d. Determine the distance from the centerline of the sign to the center of the pole.

e. Choose an adequate design from the design chart for the **SCD TC-12.30** supports ***(Figure 298-12)***.

f. Compare the standard arm length with the nominal length required for the sign location originally determined.

g. Adjust the lateral sign location (normal tolerance is within ±2 feet of the desired location) to enable use of an arm length in whole foot increments, using the standard length if possible.

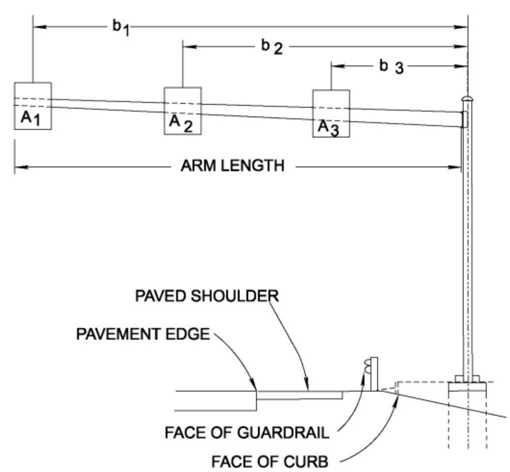
h. Determine the required elevation of the top of the foundation to provide proper clearance to the sign. Clearance shall be determined using the highest elevation of the pavement or shoulder under the sign. For design, use overall sign height, or 10 feet on mainline or 8 feet on lead-in signs, whichever is larger.

2. For supports in **Traffic SCD TC-16.21**:

a. Determine the approximate arm length as the horizontal distance from the pole flange plates to the outer edge of the most remote sign.

b. Calculate the area moment design factor "K" by multiplying each sign area (in square feet) by the distance (in feet) from its centerline to the pole centerline and add the products.

$K=A_1b_1+A_2b_2+A_3b_3$



c. Select the design number from the following Table. Choose a design number that provides both an adequate design factor and maximum arm length that meets or exceeds the actual arm length.

Design Factor "K"	Design No.	Max. Arm Length (feet)
1081	5	24
1033.5	6	27
1091.5	7	30
1300	8	33
1597.5	9	36
1925	10	39
1909	11	42
2136	12	45
3042	13	60
3666	14	72

d. A given design number may have an adequate design factor "K" but have a maximum arm length that is too short for the intended application. If the arm length cannot be adjusted as explained below, the proper design will be controlled by the arm length. Do not exceed the maximum arm length for any design number.

   The arm length may be adjusted by carefully choosing the proper lateral pole location and sign placement. The most remote sign on the arm may be positioned 2 feet short of being centered over its applicable lane. Minimum pole offsets are given in **Section 600** of the **L&D Manual Volume 1**.

e. The design pole length and attachment point may be increased 1 foot if necessary to provide adequate vertical clearance.

Figure 298-20 provides an example of a table used in plans to present design information for this support.

240-4.4 Design of Center-Mount Sign Supports

Center-mount supports are addressed in **Traffic SCDs TC-9.10 and TC 9.30**.

The **SCD TC-9.10** support is intended for use with Guide Sign installations, generally in urban areas, where the sign is not over the roadway and reduced vertical clearance is required for visibility (typically 10 feet minimum).

For either support, the sign is normally centered on the pole laterally, but may be eccentrically located if necessary. The design number selected must accommodate within its maximum allowable area, and maximum arm length L, the actual area and sign length.

Plan details shall show the actual lateral arm position and sign bracket locations. Sign brackets shall be spaced to avoid the arm attachment plate.

240-4.5 Design of Span Sign Supports

Span sign supports are addressed in **Traffic SCDs TC-7.65, TC-15.115 and TC-17.10**. Standard practice for choosing a specific design for the span type overhead support is as follows:

1. For supports in **Traffic SCD TC-17.10**:

   a. Determine the total sign area.

b. Determine the lateral location of the strain poles with respect to the pavement.

c. Determine the length of the span.

d. Choose an adequate design from the **SCD TC-17.10** design chart ***(Figure 298-18)***.

e. Calculate the wire sag as 5 percent of the span length.

f. Calculate the elevation of the attachment point of the top wire by adding to the critical pavement elevation the clearance, height of the sign, and the sag.

g. Determine the elevation of the top of the foundation.

h. Determine pole lengths by subtracting the foundation elevation from the attachment elevation and selecting a value, to the nearest whole foot, that will result in attachment at a point from 12 to 24 inches below the pole top.

i. Special design calculations must be made in the following circumstances:

   i. Sign areas or span lengths exceeding the limits of the design chart.

   ii. Required pole heights that exceed the standard (a higher design number with an adequate pole height may be selected if practical).

   ii. Special conditions, such as a large difference in the two pole lengths or an installation requiring attachment points at unequal elevations.

j. ***Figure 298-21*** provides an example of a table used to present design information for span-wire sign supports in the plans.

2. For supports in **Traffic SCDs TC-7.65 and TC-15.115**:

   a. Determine the total sign area. Include glare shields, luminaire support tubes and Exit Number plaques, if applicable. For design, use the total sign area, or 120 square feet per lane spanned for mainline signs, or 80 square feet per lane spanned for lead-in signs, whichever is larger.

   b. Determine the lateral location of support end frame centerlines with respect to the pavement.

   c. Determine the length of span. The span length shall be in whole foot increments unless structures or other physical restrictions require special lengths.

   d. Choose an adequate design from the design chart for overhead support trusses ***(Figure 298-13)***.

   e. Determine the required elevations of the top of the end frame foundations and end frame lengths to provide proper clearance of the signs. Clearance shall be determined using the highest pavement or shoulder elevation under the span to the bottom of the largest sign (or critical sign) on the span. For design, use overall sign heights, or 10 feet on mainline, or 8 feet on lead-in signs, whichever is larger.

240-4.6 Vertical Clearance and Modification of Designs

Overhead-mounted signs shall provide a vertical clearance of not less than 17 feet, except where lesser clearance are allowed (see ***Section 240-3***).

To obtain required vertical clearance and maintain a minimum of exposed concrete foundation, pole or end frame lengths may be varied from the standard lengths shown on the **Traffic SCDs**. Lengths may be shortened as necessary, but increased a maximum of 2 feet over standard length. For increases over 2 feet a special design will be necessary.

240-4.7 Elevation Views

Elevation views, in the direction of traffic viewing the sign faces, shall be prepared to a scale of 1"= 5' showing the following for each sign support:

1. Total span or arm lengths for horizontal support members, to the nearest 1 foot, unless physical conditions dictate greater precision.

2. Pavement elevations at the highest critical pavement or shoulder point, e.g., outside edges of the pavement and the crown, to the nearest 0.1 foot.

3. Pavement and shoulder widths to the nearest 1 inch.

4. Concrete foundation elevations at the top and bottom, to the nearest 0.1 foot, if foundation dimensions are not as shown on the **Traffic SCDs**, or when steep roadside slopes or roadway superelevation would make foundation elevations difficult to determine.

5. Ground line elevation at the foundations to the nearest 0.1 foot. The amount of exposed concrete should be restricted to a range from 0.1 foot minimum to 0.3 foot maximum.

6. Guardrail placement dimensions, laterally from the centerline of the sign support pole or end frame to the face of guardrail, to the nearest 1 inch.

7. Minimum design vertical sign clearance and actual sign clearance to the nearest 0.01 foot. Signs (including glare shield and luminaires) shall be centered vertically on the span or arms. Exit Number plaques are excluded from this positioning.

8. Horizontal sign placement, with sign dimensions and spacing continuous across the span or arm supports to horizontal limits of the support to the nearest 1 inch.

   All signs carrying lane arrows shall be placed so that lane arrows are centered over the lanes, with a maximum 2 feet offset from lane arrow to lane centerline where required.

9. Overall sign height, including glare shield and luminaire support tubes.

10. Sign bracket spacing for the center-mount supports **(Traffic SCDs TC-9.10 and TC-9.30)**, otherwise only if it varies from that shown on the **SCDs**.

    Intermediate sign brackets shall be provided whenever the sign (excluding Exit Number plaque) extends more than 4 feet above or below the attachment point.

11. Station location, sign reference number, and design number of the support.

12. Sign bracket lengths if different from overall sign height.

240-4.8 Concrete Barrier Median Foundations

Concrete Barrier Median Foundations for overhead sign support foundations are addressed in **SCD TC-21.50**. With this treatment, the median is widened maintaining typical wall slope configuration. A 10-foot length of the special median section is provided at each sign support location, and for a typical median section with a 6 to 12 inch top width, a 40 foot taper transition is provided on either side of the 10-foot foundation section.

The transition section of the median barrier shall be shown on the roadway plans with a reference note to that portion of the traffic control plans showing the details.

Even if roadway lighting circuits are located in the median, electrical sign service, if used, should remain on the right end frame or support (looking at signs), with crossover conduit provided from the median to a pull box located 10 feet beyond the sign support in the direction of travel. Conduit, cable, pull boxes and connector kits shall be included in the roadway lighting quantities.

Payment for the 10-foot foundation section of barrier median shall be included in **Item 630** "Rigid Overhead Sign Support Foundation." Sealing of the 10-foot foundation section of barrier median, if required, shall be paid for under Item 512.

The transition sections shall be included in the regular roadway quantities for the barrier median. Details of the transition section are shown on **Roadway SCD RM-4.4**.

240-4.9 Overpass Structure-Mounted Sign Supports

The following information should be included in the plans for structure-mounted sign supports **(see Traffic SCDs TC-18.24 and TC-18.26)**:

1. Elevation view with the following:

    a. Lateral location of the sign with respect to the edge of the pavement.

    b. Bracket spacing, if different from that shown on the **SCD**.

    c. Minimum design and actual vertical clearance from the critical pavement elevation or, for a roadside location, from the ground line.

2. Adjacent to the elevation view, a cross-section view of the bridge parapet and sign attachment showing the frame height.

3. When the bridge is being designed concurrently with the signing plan, the designer shall consider these support loads and incorporate them into the bridge design. If the bridge is existing, the designer shall contact the **Office of Structural Engineering** to make sure that they have no objections to the use of this type of support.

240-5 Ground-Mounted Sign Supports

240-5.1 General

Ground-mounted sign supports included in the contract plans shall be yielding posts, structural beams or structural pipe supports.

240-5.2 Yielding Sign Supports

Yielding posts are addressed in **Traffic SCD TC-41.20** and the design of these posts shall be in accordance with design charts in ***Figures 298-14 and 298-15***. They are designated:

No. 2 Post
No. 3 Post
No. 4 Post (all except single post Type S installations shall be used only behind guardrail or concrete barrier)
No. 6 Post (shall be used only behind guardrail or concrete barrier)

240-5.3 Structural Beam Sign Supports

Structural beam sign support installations are addressed in **Traffic SCD TC-41.10** and ***Figure 298-19***.

The beam supports are designated S4 x 7.7, W6 x 9, W8 x 18, W10 x 12, W10 x 22, and W12 x 30, and the design charts in ***Figures 298-16 and 298-17*** shall be used to determine which beam to use.

When structural beams are used, breakaway accessories shall be provided if the sign cannot be placed behind an adequate length of guardrail or concrete barrier ***(see Section 240-6)***. Signs requiring beams larger than W8 x 18, with a clear distance between supports of less than 7 feet, shall be protected by guardrail in accordance with ***Section 240-6.3***. Also, beam support installations subject to multidirectional impacts at intersections should use only the S4 x 7.7 beams (or require the use of the alternate breakaway design described in Note 8 of **SCD TC-41.10**).

240-5.4 "One Way" Sign Supports

The "One Way" Sign Support shown in **Traffic SCD TC-41.50** shall be used when it is necessary to mount two or more signs at 90 degrees to each other on the same post.

240-5.5 Breakaway Connections

When the breakaway connections shown in **Traffic SCD TC-41.10** are used, there shall be one each required as pay item for each beam installed (i.e., a sign requiring three beams will have three breakaway connections).

240-5.6 Lateral Offset and Vertical Clearance

Lateral offset and vertical clearance details for signs are addressed in **Traffic SCDs TC-42.10 and TC-42.20**.

A 30-foot offset from the edge of pavement should be provided on all mainline freeway or expressway Guide Signs unless adequately protected by guardrail or concrete barrier installed for other purposes or have breakaway connections. Minimum clearances above the pavement are shown on **SCD TC-42.10**.

Signs supports shall not be placed in drainage ditches. The sign locations should be adjusted laterally or longitudinally to avoid ditches.

240-5.7 Elevation Views

Elevation views, in the direction of traffic viewing the sign faces, shall be prepared to a scaleof 1"= 5' for all Guide Signs mounted on beam supports. Elevation views are ***not*** required for structural pipe supports. The elevation views shall typically contain the following:

1. Edge of pavement, shoulder and break point elevations.

2. Size, placement, support size, length and elevations at the ground line at each leg.

3. Existing and proposed guardrail, fence and related devices.

4. Foundation elevations and depth.

5. Station, placement right (Rt) or left (Lt), and sign support number.

Regulatory, Warning and Route Signs shall be installed in conformance with **Traffic SCD TC-42.20**. If placement is different than shown in the SCD, typical placement details should be shown on the plans.

240-5.8 Street Name Sign Supports

Street Name signs are typically erected and maintained by local authorities, but they may be included in contract plans **(see Traffic SCD TC-41.40)**.

240-5.9 Structural Pipe Supports

Structural pipe support installations are addressed in **Traffic SCD TC-41.15**.

240-6 Guardrail Protection For Signs

240-6.1 General

An effort should be made to locate signs behind proposed lengths of standard guardrail or concrete barrier used for other purposes. Be sure to recheck sign distance to the exit when so doing. Distance should be correct to the nearest one-quarter mile. No independent guardrail shall be provided for beam supports except as described below or in ***Section 240-5.3.***

If the sign cannot be relocated, see ***Section 240-6.3*** for the requirements for advance guardrail protection for it.

240-6.2 New Overhead Installations

Guardrail protection is required for all overhead sign installations not protected by concrete barrier or located outside the clear zone on highways where the operating speed is anticipated to be 50 miles per hour or more. Where independent guardrail is required, a total Length of Need as calculated per **L&D Manual Volume 1, Section 600** should be provided. See **Roadway SCDs MGS-5.2 and MGS-5.3** for further details. The standard offset is 5.5 feet from the face of the guardrail to the face of the support.

In median locations, guardrail protection will be required on the opposite roadway if the sign support is within the clear zone of opposing traffic per **L&D Manual Volume 1, Section 600**. For details refer to **Roadway SCD MGS-6.2** (treat similar to a bridge pier).

240-6.3 Ground-Mounted Installations

Beam supports located behind roadway guardrail require the following minimum advance protection (assumes that the near-edge of the sign is typically offset 4 feet from the face of the guardrail):

Sign Width	Advance Guardrail
< 15 feet	100 feet
16 to 19 feet	125 feet
20 to 24 feet	150 feet
≥ 25 feet	175 feet

These measurements do not include the anchor assembly.

240-6.4 Existing Overhead Installations

At existing overhead sign supports with less than 5.5 feet, but more than 3 feet, of clearance from the face of the guardrail to the face of the support, reduced post spacing per **L&D Manual Volume 1, Section 600** can be utilized to achieve reduced guardrail deflection. At supports with 3 feet or less clearance, Type D concrete barrier shall be used per **Roadway SCD RM-4.5**.

240-7 Sign Lighting

Sign lighting is typically not used. Current guidelines governing lighting of signs are contained in ***Chapter 212***.

240-8 Stage 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage 2 and 3 plan submittals.

1. Stage 2 Plan Requirements
   a. Base plan drawn at a scale of 1 inch equals 200 feet or 1 inch equals 100 feet continuous for the entire project. A second base plan drawn at a minimum scale of 1 inch equals **50** feet for all interchanged crossroads and mainline intersections, and for other critical at-grade intersections in urban areas. Show all proposed roadways and connections to existing construction.

      On some projects, particularly in urban areas, it may be more efficient to show the entire project on one plan drawn at a scale of 1 inch equals 50 feet or 1 inch equals 20 feet.
   b. Location of pavement edges, number of lanes, lane widths if other than 12 feet, speed change lanes, transitions, raised medians and all structures.
   c. Location of existing signing; and existing sign legends at each location.
   d. Directional arrows (one per lane) indicating the number of lanes.
   e. Location of proposed signing.
   f. Proposed sign legends at each location.
   g. Level of signing proposed, ground mounted or overhead.
   h. Size of signs.
   i. Sign code numbers.
   j. Legend for symbols used.
   k. Guardrail locations.
   l. SignCad files on CD showing detailed designs for all designable guide signs.
2. Stage 3 Plan Requirements:
   a. General Notes.
   b. Estimated quantities.
   c. Special details.
   d. Elevation views.

240-9 Rectangular Rapid Flashing Beacon (RRFB) Sign Assembly

On December 21, 2017 FHWA rescinded Interim Approval (IA-11) for Rectangular Rapid Flashing Beacons (RRFB), for all new installations of these devices. Existing RRFB's may remain in place through the end of their useful life.

240-10 Solar-Powered Devices

Solar-powered School Speed Limit Sign assemblies, and Crossing Sign assemblies are addressed separately in this manual ***(see Section 440-11)***. For other devices powered by batteries and recharged by solar power, such as STOP sign beacons, a generic **Plan Note** is available in ***Section 442-50***.

Intentionally blank.

241 PLAN PREPARATION / PRODUCTION

241-1 General

The **L&D Manual Volume 3** and ***Chapter 140*** describe general **ODOT** plan preparation and production guidelines and standards. ***Chapter 240*** provides additional design detail information, including a discussion of Stage 2 and 3 plan submissions ***(Section 240-8)***. **Plan Notes** are addressed in ***Chapter 242***, and ***Chapter 243*** provides a listing of related **ODOT C&MS** sections. The following Sections provide additional information regarding how signing items are shown in plans.

241-2 Signs

Proposed sign legends shall be shown at each sign location. Also, the supplemental design information should include a comment or indication as to whether signs on adjoining projects under construction, or open to traffic, should be revised to fit traffic pattern changes resulting from the proposed project.

241-3 Signal and Sign Supports

Section 440-7 addresses Stage 2 and 3 plan submissions for traffic signal items, and ***Section 441-2*** describes location requirements for both signal and sign supports that apply to Stage 2 plans.

241-4 Power Service

Service for sign lighting is usually through the power service provided for traffic signals or highway lighting. See ***Sections 240-7.7, 441-3 and 441-8*** for information on handling power service details in the plans.

241-5 Quantities

In the General Summary, all quantities should be shown in whole units of measurement.

241-6 Bid Item Descriptions

Bid item descriptions are required to exactly match the descriptions published in the "Item Master."

When the standard bid item description is inappropriate, the words "As Per Plan" shall be added to the description, and a note shall be provided to describe the deviation from the standard specifications and/or details. See ***Chapter 242*** for examples of **Plan Notes**.

241-7 Sign Support, Detail Design Requirements

Instructions for designing sign supports are included in ***Chapter 240*** and the related **Traffic SCDs**. ***Figures 298-19 and 298-20*** provide examples of tables for presenting signal support information in the plans for support types described in **Traffic SCDs TC-16.21 and TC-17.10**.

Use of the sample tables is recommended as a means of uniformly presenting support information to the contractor or support manufacturer. The support designer should note that the orientation angles consist of:

- A field angle that establishes the angular relationship between a line perpendicular to the project centerline and a pole feature (handhold or mast arm) which serves as an index; and
- Angles for all pole appurtenances that are measured from this index pole feature.

241-8 Object Markers and End-of-Roadway Markers

For plan purposes, object markers and end-of-roadway markers shall be considered flatsheet signs.

242 PLAN NOTES

242-1 General

Typical **Plan Notes** related to signing items have been consolidated in this Chapter for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid item will be "As Per Plan." Where there are design instructions pertaining to a specific note, they are listed herein at the end of each note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with the traditional format of **Plan Notes**, the format used in the following Sections varies slightly from that used elsewhere in the **TEM**, e.g., the terms "Contractor" and "Engineer" are capitalized, and references to publications are not shown in bold font.

See ***Sections 442-10 and 442-11*** for **Plan Notes** related to combination signal and sign supports.

242-2 Power Supply for Sign Lighting

Electric power shall be obtained from the _________________ at the location indicated on the plans. Power supplied shall be ___ volts.

Designer Note: This note should be included on projects with lighted signs when separate service is required for one or more signs which cannot be integrated with the highway lighting circuits. The name and address of the power company and voltage to be supplied shall be specified in the appropriate blanks.

242-3 630 Overhead Sign Support Modification, by Type

Overhead sign supports shall be modified as shown in the plans. The modification shall consist of (see examples below):

1. The insertion of a new box truss section of ___ feet.
2. The replacement of an existing arm with a new arm of ___ feet.
3. The replacement of an existing end frame with a new end frame.
4. The replacement of the existing pole with a new pole of ___ feet.
5. The relocation of an existing end frame.

Payment will be at the contract unit price for the modification of the overhead sign support, including all necessary material, parts, equipment and labor, using the designation: 630 Each - Overhead Sign Support Modifications, By Type.

Designer Note: This note should be included on projects which require the modification of overhead sign supports. The note should be edited as required to specify the modification needed and to fill in the blank. When example 1 is used, it is typically used in combination with 3 or 5.

The following is a bid Item example: Overhead Sign Support Modification, Type TC-7.65, Design 6, New Box Truss Section ___ feet.

242-4 Reference Location Signs

The location of Reference Location signs on the plans are approximate and a more precise location will be provided by the Department. The Contractor shall notify the Engineer at least 30 days in advance of the planned date of Reference Location sign installation. The Engineer will contact the Office of Technical Services which will locate the longitudinal position of Reference Location signs by means of a paint mark on the pavement edge. Alternate marks will not be provided on divided highways and the Contractor shall set Reference Location signs for the opposite roadway across from the provided mark. Delineators whose normal position falls within 50 feet of a Reference Location sign shall be omitted.

Designer Note: This note should be included on all projects where Reference Location signs are being installed.

242-5 630 Modification of Barrier Wall Assembly

Existing Barrier Wall Assemblies detailed in the now-rescinded Traffic SCD TC-21.41, provide a 3-inch high clearance below the bottom of the steel wall plates for the drainage of water away from the sign support foundation and for ventilation.

Asphalt concrete shall be placed and compacted around the sign support foundation so that no water will be trapped in this area when all project work is completed.

If the resurfacing of the shoulders reduces the clearance to less than 2 inches the following shall be done:

1. Remove the steel wall plates;

2. Remove, by sawing, cutting or grinding, enough material from the bottom of the steel wall plates and the center bulkhead to provide a 3-inch clearance from the finished asphalt;

3. Paint the cut edges and any damaged galvanized areas with two coats of zinc-rich paint; and

4. Reinstall the steel wall plates in their proper positions, using new bolts, nuts and washers.

Payment will be at the contract unit price for each Item 630 "Modification of Barrier Wall Assembly" including all necessary material, parts, equipment and labor at each foundation.

Designer Note: This note shall be included on resurfacing projects with this type of existing barrier wall assemblies.

242-6 Reserved – Existing Note Deleted

The **Plan Note** for "630 Sign, Extrusheet Guide" has been deleted.

242-7 Reserved – Existing Note Deleted

The **Plan Note** for "630, Specific Service and Tourist-Oriented Directional Signs Removal and Reinstallation" has been deleted. It is not needed with the **current C&MS book**.

242-8 Reserved – Existing Note Deleted

The **Plan Note** for "630 Signing Misc.: Solar Powered Rectangular Rapid Flashing Beacon (RRFB) Sign Assembly" has been deleted.

242-9 Signing, Misc: Solar Powered LED Enhanced (Sign Type, Sign Size)

This specification describes the minimum acceptable design and performance requirements for LED enhanced [Signal ahead (W3-3), stop ahead (W3-1), STOP (R1-1)] Sign. The sign shall be self-powered by solar panels and batteries with no external electrical power installation. The LED enhanced sign shall be MUTCD compliant.

The following criteria shall be met:

1. The new unit shall attach securely to the proposed sign support using a tamper resistant fastening system. Special tools needed for the tamper resistant fastening system shall be supplied with each sign.
2. Each sign unit shall be identified with the manufacturer's name, date of manufacture, and serial number on the back side.
3. The sign unit shall be visible at a minimum of ¼ mi. during all conditions.
4. The sign unit shall incorporate circuitry and a photocell to ensure that is has brightness adjustment during day, dusk, and at night.
5. The lens of the LED unit shall be capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.
6. The lenses shall withstand a 3 foot drop test onto a hard surface and shall be a minimum of ¼ inch thick and free of bubbles and imperfections. The lenses shall be smooth on the outside, with no external facets to prevent dirt and debris build-up.
7. If lenses are tinted, they shall match the wavelength (chromaticity) of the LED.
8. The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of more than one LED light source in the sign unit.
9. LED units and associated on-board circuitry shall conform to the requirements in Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.
10. LED's shall be rated for use in the ambient operating temperature range of -40^{o}F to +166^{o}F. (=-40^{o}C to +74^{o}C)
11. The LED's wiring shall be sealed watertight to eliminate dirt contamination and allow for safe handling in all weather conditions. The LED's shall be sealed against dust and moisture intrusion as per the requirements of NEMA Standard 250-1991 for Type 4 Enclosures and to protect all internal LED and electrical components.
12. The sign LED's shall display a minimum of 500,000 MCD for daytime visibility.

Solar Requirements –

See "General Electrical Requirements for Solar-Powered Devices".

Required Documentation -

Each sign unit shall be provided with the following documentation either in hard copy or as a PDF.

1. One schematic diagram shall be provided for the sign unit along with any necessary installation instructions.
2. The LED manufacturers name, brand, and model number.

Warranty -

1. The LED enhanced signal ahead sign unit shall be repaired or replaced by the manufacturer if it exhibits a failure due to workmanship or material defects within 2 years of field operation.

2. The manufacturer shall provide a written warranty against defects in materials, workmanship, and luminous intensity for the LED enhanced sign unit for a period of 2 years after installation. A replacement LED enhanced sign unit shall be provided within 10 days after receipt of failed unit at no cost, except the cost of shipping the failed unit.

Payment -

Payment for item 630, signing misc., solar powered LED enhanced [Signal Ahead (W3-3), Stop Ahead (W3-1), Stop (R1-1)] sign shall be made at the contract bid price, each, completely installed in place and fully functional including all material, labor, and equipment required to furnish the sign with solar powered LED's and mount the solar unit to the sign support as per the LED enhanced sign detail.

Designer Note: Sign supports paid for separately.
Add TEM 442-50, "General Electrical Requirements for Solar-Powered Devices".

(this space intentionally blank)

(this space intentionally blank)

243 SPECIFICATIONS

ODOT specifications for furnishing and installing signing materials and hardware are contained in the following **C&MS** sections:

630 and 730 Traffic Signs and Sign Supports, and Traffic Sign and Support Material
631 and 731 Sign Lighting and Electrical Signs, and Sign Lighting and Electrical Signs Material

C&MS specifications related to specific signing items have been referenced individually as they have been discussed in this Part. **Supplement 1049** covers the prequalification procedure for reflective sign sheeting. **Supplement 1075** defines the load deflection test procedures for U-channel sign posts. **Supplement 1092** defines the certification procedure for sign fabricators. **Supplement 1093** defines the certification procedure for sign support fabricators.

250 CONSTRUCTION

250-1 General

This information is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices and appurtenances. However, it may also be useful for maintenance personnel performing the same functions. Inspection procedures for various types of traffic control devices are outlined, mainly in the form of checklists to assist project personnel in performing their duties. This information points out the various important features of each device and references the applicable specification or standard drawing. Illustrations are used for easy recognition of the device or feature being discussed.

250-2 Sign Service

Sign service shall comply with **Traffic Plan Insert Sheets (PISs) 203210 and 203211** and the plans. Additional information is provided in ***TEM Section 240-7.2*** and **C&MS Item 631.04**. Basically, sign service consists of cable and equipment to provide a complete electrical service from either an underground source or an overhead direct drop to a separately furnished disconnect switch with enclosure. The equipment could include a weatherhead, a conduit riser with necessary fittings, attachment clamps and cable.

A thorough review of the plans should be made to determine the specific requirements of the maintaining agency for sign service.

When required, an electric meter base will be furnished by the applicable utility and installed by the contractor as part of the sign service work.

The sign service shall terminate at the meter base, if used; otherwise termination shall be at the switch enclosure. Sign service may be by:

1. Direct drop by means of a weatherhead and conduit riser routed to the switch enclosure;

2. Underground conduit and the pole interior to the enclosure; or

3. Underground and structure-attached conduit to the enclosure (for overpass-mounted signs).

The conduit riser shall comply with **C&MS Item 725** and the plans, and the weatherhead shall be threaded aluminum or galvanized ferrous metal **(C&MS Item 732.16)**.

The disconnect switch shall be a single-throw safety switch meeting the voltage and capacity requirements of the plans. The enclosure shall be a **NEMA** Type 4 ICS 1-110.15 with sufficient volume to accommodate an internal transformer when specified. The enclosure shall contain a solid neutral bar.

A ground wire shall be used as shown on **Traffic PISs 203210 and 203211** leading to a ground rod installed in accordance with ***Section 240-7.3***.

250-3 Foundations

250-3.1 Staking

Sign support foundations shall be located so that the sign face is at a right angle to the roadway lanes served, unless the plans specify otherwise. An example of an exception is the W1-6 Large Arrow sign (black arrow on yellow background) which is located as shown in ***Figure 298-24***.

Foundations should be staked by the contractor in accordance with the locations shown on the plans.

The stakeout locations should be checked for:

1. The presence of obstructions which could restrict proper visibility of the sign from the point where road users are expected to read the sign. Curved roadway locations should especially be checked.

2. Obvious conflicts with overhead power lines or other utilities. There should be available a proper safe clearance from overhead lines for construction operations, in compliance with the **National Electric Safety Code** and any local codes.

3. Possible conflict with underground facilities.

With the concurrence of the project engineer, foundation locations may be adjusted when necessary to overcome difficulties such as those shown in ***Figure 298-24*** and discussed herein. However, such adjustments should not violate minimum clearance dimensions shown in the **OMUTCD** and on **Traffic SCDs TC-42.10 and TC-42.20**.

250-3.2 Excavation

Foundations shall be placed only in undisturbed soil or compacted embankment, and excavation shall be by an earth auger of the specified diameter to the specified depth. See ***Figure 298-25*** for a diagram of a foundation excavation.

If a minor cave-in should occur, the contractor may continue excavation using an increased diameter; or by sleeving, casing or other method approved by the project engineer. The contractor shall remove all extraneous material from the excavation before concrete placement.

When subsurface obstructions are encountered, permission may be granted by the project engineer to replace the excavated material and relocate the foundation.

When bedrock is encountered, that portion of the specified foundation depth within the bedrock may be reduced as much as fifty percent.

250-3.3 Placement

Anchor bolts and conduit ells shall be of the correct size and furnished with the support. At least one 2 inch minimum conduit ell shall be furnished and capped if unused. Anchor bolts, conduit ell(s) and EMT (Electric Metallic Tubing) shall be oriented in the foundation according to the plans, conduit runs and ground rod location. All anchor bolts shall be provided with standard steel hex nuts, leveling nuts, and plain washers. The nuts shall be capable of developing the full strength of the anchor bolts.

Reinforcing bars, tie loops and tie bars shall be of the correct size and arranged with the anchor bolts into cages according to the applicable **Traffic SCD TC-21.10** or **TC-21.20**. A special foundation design will be required when soil with a load bearing capacity of less than 2,000 pounds per square foot is encountered.

Anchor bolts shall be vertical with their ends projecting the correct distance above the foundation surface in compliance with the plans. When the distance the anchor bolts project above the foundation surface is not specified, a rule of thumb is four times the bolt diameter. The anchor bolts shall be tied to the cage tie bars according to standard details.

The rebar cage shall to be supported 3 to 4 inches above the bottom of the excavation by a piece of concrete block or similar material. The cage shall be positioned with a clearance of 3 inches from the excavation wall by similar blocking so that after concrete placement a full thickness cover is assured.

A template and/or frame shall be used to rigidly hold the anchor bolts and conduit ell(s) in the specified pattern during concrete placement. A form shall be oriented according to the plans to shape the foundation into a square, from the surface or grade shown to a nominal 6 inches below the ground line. The template and form may be combined. Gaps of 6 inches or less between the foundation and adjacent paved surfaces shall be eliminated by increasing the formed foundation.

Water encountered in the foundation excavation shall be pumped out before concrete placement. If this is not feasible, concrete should be placed by the tremi-tube method.

Concrete conforming to **C&MS Item 499** and **C&MS Item 511** shall be placed and vibrated to eliminate voids. Care should be exercised during vibrating to avoid disturbing the anchor bolts, conduit ell(s) and reinforcing cage.

Forms may be removed as soon as the concrete has hardened sufficiently so as not to be susceptible to damage **(C&MS Item 511.16)**.

Minor earth caving external to the hole which may have occurred during excavation using sleeving or casing should be corrected after concrete placement by backfilling and tamping in accordance with **C&MS Item 203**.

Joint filler complying with **C&MS Item 705.03** shall be placed between the formed foundation and adjacent paved surfaces.

Supports and poles may be erected, signs installed, and span wire load applied, only after the concrete has aged sufficiently to be in compliance with ***Section 250-3.4***.

250-3.4 Curing and Loading

Curing and loading of concrete for traffic control devices shall comply with **C&MS Item 511.17**. Concrete for foundations of sign supports shall be cured, have bracing removed and be loaded only when the concrete has achieved the age shown below:

	Age of Concrete in Days	
	Without Beam Test	With Beam Test **
Curing	7	5
Removing Bracing	7	3
Loading*	14	7

* No load shall be applied or other work done that will damage new concrete or interfere with its curing.

** Beam test specimens shall be poured from the same batch, immediately before, during or after foundation pour. Specimen configuration shall be to **ODOT** requirements. Specimens when tested shall have at least an average modulus of rupture for two tests of not less than 650 pounds per square inch.

250-4 Overhead Supports in General

250-4.1 General

Various general aspects of overhead sign supports are addressed in this Section. ***Table 297-7*** provides an overall summary of the structure types, allowable sign area on each, and the span or arm length.

250-4.2 Pole and Support Inspection

This inspection checklist covers the general features of strain poles, mast arm type signal supports, and overhead sign supports. Features pertaining only to specific pole or support types will be found in the Sections of this Manual covering exclusively those poles or supports.

1. When poles and supports of the combination type are specified, they shall provide extra length as necessary for a highway lighting function and a welded-on bracket arm plate(s) complying with **Traffic SCD HL-10.12 or HL-10.11**, for attachment of a separately furnished luminaire arm.

2. Supports may be of an alternate design utilizing all non-tapered tubing structural members.

3. Poles and supports should be inspected when received if possible, but certainly prior to erection.

4. General dimensions should be checked first, including pole length, base diameter, top diameter, and wall thickness. Similar mast arm dimensions should also be checked. Wall thickness is most easily measured with calipers at the end. Caps on poles may have to be removed.

5. Orientations of the various appurtenances should be checked against the plan's orientation diagram if such is available; otherwise, orientations may be determined from certified shop drawings and the intersection drawing.

6. Base plate dimensions should be checked including thickness, bolt circle diameter and bolt hole size. Base plates may be plate or cast steel according to **C&MS Item 730.04**.

7. A handhole with ground lug is to be furnished, with a cover plate complying with **C&MS Item 730.05** and a stainless steel chain complying with **C&MS Item 730.10**.

8. A pole cap conforming to **C&MS Item 730.06** shall be furnished and in place before final inspection.

9. An arm cap conforming to **C&MS Item 730.07** shall be furnished for chords or mast arms.

10. All strain poles and overhead sign and signal support foundations shall be grounded (even if no power is available).

11. Welding shall be inspected in accordance with ***Section 250-4.3***.

12. Galvanizing shall be inspected in accordance with ***Section 250-4.4.***

13. Supports are to include sign brackets, U-bolts and clamps.

14. The correct number and size of anchor bolts and conduit ells shall be furnished for placement in the foundation.

15. Anchor bolt diameter and length shall be in accordance with the plans and **Traffic SCD TC-21.10 or TC-21.20**. Anchor bolt ends may have an L-bend or be fitted with a tapped steel plate. Threaded ends shall not be damaged and shall be galvanized at least 2 inches beyond the threads. The galvanizing should be in good condition, and absent or damaged galvanizing should be repaired by the application of two coats of zinc-rich paint. Galvanizing thickness should permit the turning of nuts by a wrench without difficulty. Loose rust on anchor bolts should be removed.

16. All anchor bolts shall be provided with standard steel hex nuts, leveling nuts and plain washers. The nuts shall be able to develop the full strength of the anchor bolts.

250-4.3 Inspection of Welds

All welds of supports shall be inspected visually as soon as possible following support delivery. Welds should be inspected for flaws and imperfections under good lighting conditions using a magnifying glass as necessary. Evidence of any of the following faults or other imperfections such as warping and misalignment may be cause for rejection of the support. The following features of welds should be checked:

1. A check should be made for the actual presence of all welds called for by the certified shop drawings and standard drawings.

2. Welds on tapered tubes, pipes or structural shapes shall be continuous around the joint. Welds requiring terminations shall be of the correct length.

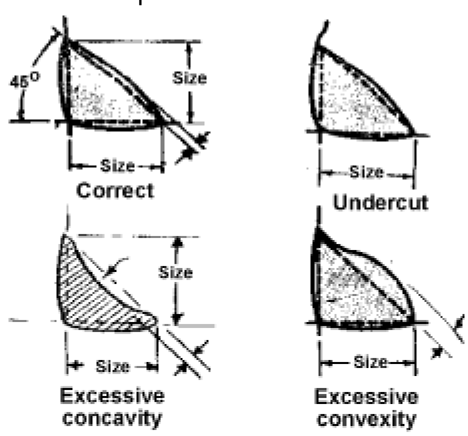
3. Welds shall not exhibit cracks or discontinuities in base metal or weld material and shall not show evidence of porosity, showing up as pitting or pinholes. The galvanizing layer may cover such flaws, but their existence should be checked.

4. Welds shall be full cross section without excessive concavity or convexity. Required weld terminations shall be filled to full section without depressions or craters.

5. There should be no evidence of undercut, a condition where a shallow groove is melted into the base metal adjacent to a weld and left unfilled by weld metal.

6. Base plates shall be welded to two ply poles with **AWS** prequalified welds in conformance with **C&MS Item 730.04**.

7. Arm attachment plates shall be welded inside and outside with fillet or full penetration welds. Each fillet weld shall be equal to the wall thickness of the respective tubing.



250-4.4 Inspection of Galvanizing

The galvanizing cover of supports shall be inspected visually as soon as possible following delivery. The galvanizing should be inspected externally and internally for flaws and imperfections in daylight or strong artificial light. In accordance with **C&MS Item 513.26**, supports shall be loaded, transported, unloaded, stored and erected in a manner avoiding damage to any feature including the galvanizing. Supports stored in the field should be kept off the ground to prevent the galvanizing from contacting water which may result in a premature oxidation condition. The galvanizing should have the appearance of a uniform application. Supports should be checked for assurance that the following flaws or imperfections do not exist:

1. Loose or bare spots in the galvanizing where improper preparation has prevented metal adherence in the molten zinc bath. Poles should be rejected if the point of a penknife can flake off the galvanizing layer.

2. General overall roughness, a symptom of overpickling or of excess zinc bath temperature and/or immersion time.

3. Pimples, due to entrapped bath scum particles.

4. Blisters, due to hydrogen gas absorbed during pickling and coming out at the time of galvanizing.

5. Flux inclusions, picked up from the top of the bath when dipping and burnt-on during immersion.

6. Ash, usually in course lumps picked up from the top of the bath.

7. Patches of dull gray coating, due to the slow cooling of heavier cross sections of supports after immersion.

8. Excess zinc lumps or runs, due to delayed molten metal run-off from surface discontinuities such as joints, seams or holes.

9. Rust stains, due to the weeping of impurities from the pickling process at seams and folds.

Excessive galvanizing faults and imperfections combined with general poor workmanship may be cause for rejection of the support. Gross imperfections may lead to the suspicion of inadequate protective cover which may require inspection with a magnetic instrument. Items 1 through 6 may be cause for rejection. Items 7 through 9, if extreme, may also be cause for rejection, because of poor appearance even if the protection of the support is not affected.

After erection, supports should be given a final inspection for any damage to the galvanizing due to improper handling in the erection process. Damage due to slings, etc., which is more serious than superficial brightening is to be repaired by the contractor with the application of two coats of zinc-rich paint.

250-4.5 Weight of Supports

Tables 297-8a through 297-8f provide information on the weight of various overhead sign supports. For all structures, the weight of the pipe support has been given where pipe has been frequently used in place of tapered tubes. In general, the tapered tube support will be lighter than the pipe support. The support numbers listed may be preceded by I-129, 815, 844 or other designation instead of TC.

For estimating purposes, a 10 x 10 foot extrusheet sign (excluding the sign lighting) weighs approximately 250 pounds.

250-4.6 Assembly and Erection Procedure

Erection procedures pertaining to specific pole or support types will be found in the Sections of this Manual devoted exclusively to those poles or supports. In general the following assembly and erection procedure applies:

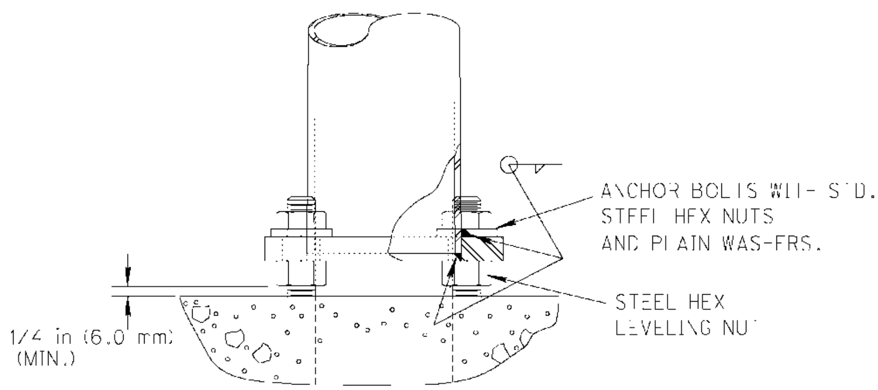
1. To minimize erection time and the hazard to workers and road users where traffic is maintained, supports should be erected with mast arms attached, and horizontal sign

support members (over the roadway) should be prewired for lighted signs or other traffic control devices. See the notes in the plan for traffic maintenance requirements when span-type sign support members are erected.

2. Support components shall be assembled with their threaded fasteners tightened in accordance with **C&MS Item 630.06**. Fasteners 1/2 inch or greater shall have anaerobic adhesive applied to the threads in accordance with the manufacturer's recommendations. Nuts shall be tightened by the "turn of the nut" method.

3. The "turn of the nut" method shall be in accordance with **C&MS Item 513.20**. Nuts shall be made snug tight by the effort of a person using an ordinary spud wrench followed by an additional 1/12 to 1/6 turn.

4. Leveling nuts shall be placed on the anchor bolts, initially clearing the foundation surface by at least 1/4 inch and forming a horizontal plane.



5. Poles or supports shall be raised into position with equipment of adequate lifting capacity and used in a manner to prevent damage to attached appurtenances (signs, brackets, luminaires, etc.) and to the galvanizing. The weight of poles or supports is given in ***Section 250-4.5*** for the use of the contractor in the erection procedure.

6. With the pole or support's base plate resting on the leveling nuts, the plain washers and anchor nuts shall be placed on the anchor bolts, the support plumbed in a vertical position or raked as required, and anchor nuts given a preliminary tightening.

7. After any necessary leveling nut adjustments are made, to assure that the supports are essentially vertical after attachment of signs, sign lighting equipment or signals, the anchor nuts shall have anaerobic adhesive applied and be final tightened in accordance with the instructions for assembling fasteners given in paragraphs 2 and 3 of this Section.

8. Anchor nuts shall not be covered with bolt covers or a cover base regardless of support location **(C&MS Item 630.06 B)**.

9. Poles or supports which are prewired before erection should be checked to determine if the erection procedure has disturbed the wiring. Wire for lighted signs should be supported by looping wire over the J-hook in the vertical support member **(C&MS Item 631.05)**. Cable supported by cable support assemblies should be checked to determine if the sling is over the J-hook and if the adjustment is proper to eliminate strain on the cable jacket.

250-5 Overhead Sign Supports By Type

250-5.1 General

Section 250-4.6 addressed general assembly and erection guidelines for strain poles and supports. The following Sections provide additional information specific to various types of supports. For the most part the information is provided in a checklist format.

250-5.2 Span Wire Support

Span Wire sign supports shall comply with **Traffic SCD TC-17.10** and the plans. These sign supports consist of strain poles, messenger wire with accessories and sign hangers. Strain pole size shall be as specified.

1. Strain poles shall be inspected in accordance with ***Section 450-6.1*** and general features of the poles shall be inspected in accordance with ***Section 250-4.2***. Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4.***

2. Erection shall be in accordance with the general procedure given in ***Section 250-4.6*** except as hereafter noted.

   a. For the initial rake of strain poles see ***Section 450-6.1***.

   b. The upper messenger wire shall be assembled with its accessories according to the standard drawing. Preformed guy grips are not permitted because wind loads on the signs can cause failure of the grips. Alternate methods of attaching messenger wire to strain poles may be used:

      iii. Span wire clamp with clevis, anchor shackle and thimbles on the messenger wire, or

      iv. Messenger wire wrapped twice around the strain pole and secured with a 3-bolt clamp of the proper size.

   c. The upper messenger wire shall be fitted with its signs, furnished under other items of work, and the vertical clearance to sign bottoms adjusted within clearance limits over the roadway. The sag of the upper messenger wire shall be between 4 and 5 percent.

   d. It is essential that the lower messenger wire have more slack than the upper wire. The sag should be approximately 3 inches greater than the upper wire. This sag adjustment shall be made before the sign hangers are attached to the lower wire.

   e. Sign hangers shall be clamped snugly to the lower wire by U or J bolts. In the case of back-to-back signs, the lower messenger wire running in between the sign hangers, is clamped between bolted spacers that are slightly thinner than the messenger wire **(see Traffic SCD TC-17.10)**.

250-5.3 Single Arm Support

1. Single arm supports shall comply with certified shop drawings, **Traffic SCD TC-16.21** and the plans.

2. General features of the support shall be inspected in accordance with ***Section 250-4.2***. Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4.***

3. For arms of two telescoping pieces, a 15-inch overlap is required. The overlapped arms shall be secured with a stainless or galvanized steel hex head through-bolt with nut.

4. Arm caps shall cover at least fifty percent of the end area **(C&MS Item 730.07)**.

5. A minimum of two brackets shall be provided for each sign, each attached to the arm by steel clamps with carriage bolts. The clamps should be able to be tightened in a manner to firmly grasp the arm so as to prevent sign rotation.

6. If signs are lighted, disconnect switch enclosure mounting brackets may be required on the support.

7. Erection shall be in accordance with the general procedure given in ***Section 250-4.5***, except as hereafter noted.

   a. The contractor may choose to attach the signs and any sign lighting items before erection.

   b. Signs are installed at the same elevation. For this purpose, adjustment is provided by two pairs of slotted holes in the sign bracket for attachment of the arm clamp.

   c. Contact between galvanized clamp flanges and aluminum sign brackets shall be prevented by the use of chloroprene gaskets.

   d. Initial rake shall be adjusted so that under the load of signs, the pole will assume an essentially vertical position and the arm rise will be within the limits specified on the standard drawing, i.e., 3 inches minimum, 12 inches maximum.

250-5.4 Cantilever Support

1. Cantilever supports shall comply with certified shop drawings, **Traffic SCD TC-12.30** and the plans.

2. General features of the support shall be inspected in a**ccordance wi**th ***Section 250-4.2.*** Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4.***

3. Supports with arm lengths18 feet and over shall have truss members. Truss members may be angles or pipe.

4. Erection shall be in accordance with the general procedure given in ***Section 250-4.5,*** except as hereafter noted.

   a. The contractor may choose to attach the sign(s) and any sign lighting items before erection.

   b. Signs are centered vertically on the chords.

250-5.5 Center-Mount Support

1. Center-mount supports shall comply with certified shop drawings, **Traffic SCD TC-9.30** and the plans.

2. General features of the support shall be inspected in accordance with ***Section 250-4.2.*** Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4***.

3. Sign clearance above the roadway shall be a minimum of 17 feet.

4. Arms may be either square or round tube. The arm attachment design shall be in accordance with standard details for either square arms or round arms with separate cradle.

5. Erection shall be in accordance with the general procedure given in ***Section 250-4.6***, except as hereafter noted.

   a. Signs are centered vertically on the arms.

   b. Signs may be mounted laterally on the support in an eccentric position. However, a minimum of 2 feet of sign length shall remain to one side of the pole centerline.

   c. The contractor may choose to attach the sign and any sign lighting items before erection.

250-5.6 Semi-Overhead Support

1. Semi-overhead supports shall comply with certified shop drawings, **Traffic SCD TC-9.10** and the plans.

2. General features of the support shall be inspected in accordance with ***Section 250-4.2.*** Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4***.

3. Sign clearance above the ground shall be at least 10 feet unless a lower height is approved by the project engineer to provide sign visibility through preceding overpass structure(s).

4. Arms may be either square or round tube. The arm attachment design shall be in accordance with standard details for either square arms or round arms with separate cradle.

5. Erection shall be in accordance with the general procedure given in ***Section 250-4.6***, except as hereafter noted.

   a. Signs are centered vertically on the arms.

   b. Signs may be mounted laterally on the support in an eccentric position. However, a minimum of 2 feet of sign length shall remain to one side of the pole centerline.

   c. The edge of the sign shall be back at least 2 feet from the edge of the curb.

   d. The contractor may choose to attach the sign and any sign lighting items before erection.

250-5.7 Span Truss Support

1. End frames for span truss supports shall comply with certified shop drawings, the plans, and **Traffic SCD TC-7.65** for aluminum trusses and **Traffic SCD TC-15.115** for steel trusses.

2. General features of end frames shall be inspected in accordance with ***Section 250-4.2.*** Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing shall be inspected according to ***Section 250-4.4.***

3. Handholes shall be oriented on the end frame downstream vertical member on the side away from the direction of traffic.

4. The size of truss members shall be in accordance with standard details. Truss member joints may be of two different designs.

5. An angle shall be furnished and welded onto the end frame, near the top, to support the lower chords of the span box. Stainless steel U-bolts shall be used with aluminum trusses and galvanized steel U-bolts with steel trusses.

6. End frame vertical members shall be furnished with steel clamps and a separate tee or angle (alternate) for supporting the upper chords of the span box. Stainless steel U-bolts shall be used with aluminum trusses and galvanized steel U-bolts with steel trusses.

7. When using an aluminum truss, the following shall apply:

    a. Aluminum trusses shall comply with certified shop drawings, **Traffic SCD TC-7.65** and the plans.

    b. Welds shall be inspected according to ***Section 250-4.3.***

    c. End caps shall be on each end of chords. The top front end caps shall be tapped for wiring.

    d. Span length shall be in accordance with shop drawings and plans.

    e. Span box camber shall be in accordance with standard details.

    f. Flanges between span box sections may be cast or fabricated with forged flanges as an alternate.

    g. Flange attachment hardware shall be stainless steel bolts and nuts.

    h. Supports shall be furnished with necessary sign brackets, U-bolts, luminaire support arms, bracing rods and other necessary structural members.

8. When using a steel truss, the following shall apply:

    a. Steel trusses shall comply with certified shop drawings, **Traffic SCD TC-15.115** and the plans.

    b. Steel truss checking instructions are the same as those for aluminum trusses, except:

       The galvanizing shall be inspected according to ***Section 250-4.4.***

       Flanges between span box sections shall be forged.

       Flange attachment hardware shall be galvanized steel bolts and nuts.

9. See the notes in the plan for traffic maintenance requirements when span type sign support members are erected.

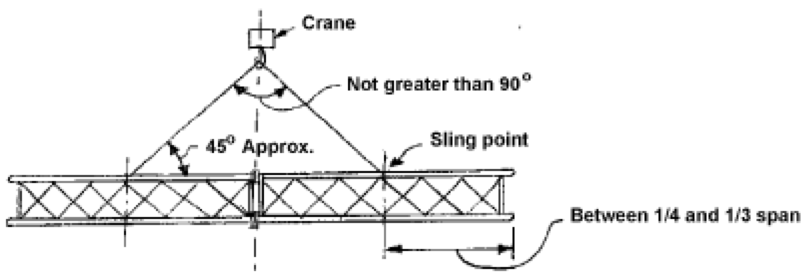
10. The base plates of end frames shall be placed on anchor bolt leveling nuts, plain washers and anchor nuts placed, the frames plumbed into a vertical position in both longitudinal and lateral directions, and nuts made tight in accordance with ***Section 250-4.6.***

11. Truss camber shall be correct. The various truss sections shall be assembled in the arrangement and sequence shown on the shop drawing.

12. Trusses may be assembled into a total span while lying on blocks with wedges. Flanges on truss section ends may be aligned by driving in the wedges as necessary. All flange bolts are then assembled and made tight.

13. Two cranes may be necessary when lifting very long trusses or the heavier steel trusses. For reference, truss weights are given in ***Section 250-4.5.***

14. Care should be taken in the attachment of slings. Trusses should be lifted at positions of a quarter to a third of the total span. Slings should be attached to the top chords and the horizontal diagonals.



15. Trusses may be easily overstressed by poor handling, and care should be taken when moving assembled trusses for temporary storage, during transportation to the erection location, and in the erection procedure.

16. Trusses shall not be erected unless at least one sign will be in place within eight hours, or the trusses are fitted within the same period with damping devices approved by the project engineer **(C&MS Item 630.06 B)**.

17. Attachment of the box truss to the end frames shall be by four U-bolts. Aluminum trusses shall be attached by 5/8 inch stainless steel bolts according to **Traffic SCD TC-7.65** and steel trusses shall be attached by 3/4 inch galvanized steel bolts according to **Traffic SCD TC-15.115**.

18. The contractor may choose to attach the sign(s) and any sign lighting items before erection.

19. Signs are centered vertically on the chords (not considering the height of Exit Number plaques).

250-5.8 Overpass Structure-Mounted Support

1. Overpass structure-mounted supports shall comply with the plans and **Traffic SCD TC-18.24** for flush-type supports and **Traffic SCD TC-18.26** for skewed-type supports.

2. Overpass structure-mounted supports include sign brackets and two different kinds of steel Z-bars which are fastened to bridge concrete. For steel beam bridge mounting, aluminum angles at the bottom are to extend between sign brackets and short steel angles bolted to the bridge steel. For overpass structures essentially perpendicular to the roadway underneath, sign brackets are flush mounted to Z-bars for direct sign viewing. For overpass structures skewed to the roadway underneath, a wedge-shaped box structure is inserted between the sign brackets and Z-bars to provide for direct sign viewing.

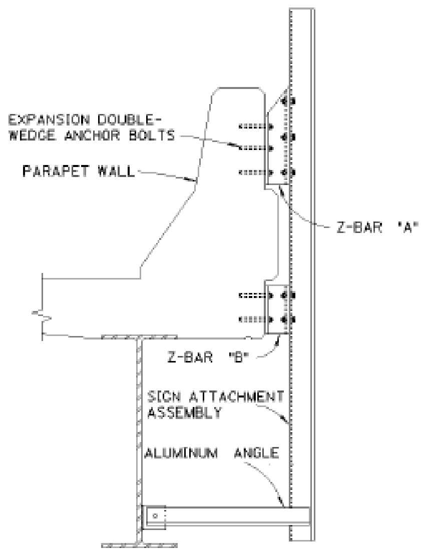
3. The number of sign brackets will vary according to the bracket spacing as required by **Traffic SCD TC-22.20**. Bracket details are also shown on the standard drawing.

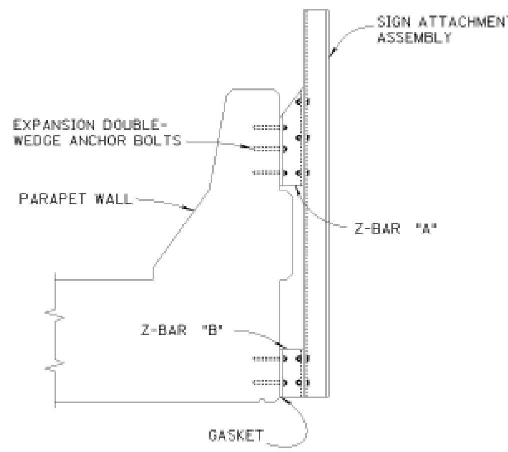
4. The number of aluminum frames in skewed supports shall equal the number of sign brackets. Frame details shall be in accordance with standard details and are to include two angles placed diagonally.

5. Front upper and lower members of skewed supports shall be aluminum angles with a length equal to the sign length.

6. The skewed support structure shall be internally braced by two aluminum angles extending diagonally and horizontally through the interior.

7. For bridge clearance above a roadway of less than 17 feet, the sign clearance above the bottom of the bridge shall be 3 inches minimum without, or 15 inches minimum with, sign lighting fixtures on the lower edge of the sign.





8. Supports shall be mounted on the overpass structure so the sign is horizontal regardless of bridge slope **(C&MS Item 630.06 D)**.

9. Expansion double wedge steel anchor bolts shall be used to fasten the support's Z-bars to the overpass structure concrete parapet. Intended locations of anchor bolts are to be approved by the project engineer before any field drilling. Z-bars "A" are used at the top, and Z-bars "B" at the bottom, of parapet concrete.

10. For a steel beam bridge mounting, aluminum angles at the bottom shall be fastened to short galvanized steel angles bolted to the bridge steel.

11. Chloroprene gaskets shall be used to prevent contact between aluminum sign brackets or support frames and steel Z-bars or bolted-on angles.

12. If the sign extends more than 4 feet above or below the attaching Z-bars, intermediate sign brackets shall be provided.

13. For precast beam bridges, aluminum angles at the bottom shall be fastened to short steel angles and two expansion double wedge steel anchor bolts shall be used.

14. After sign erection, the sturdiness of the support to bridge attachment should be checked.

250-6 Ground-Mounted Sign Supports

250-6.1 General

Section 250-6 provides additional information, generally in the form of checklists, about various ground-mounted supports. ***Chapter 221*** addressed general guidelines about sign supports and ***Section 240-5*** provides additional design information about ground-mounted supports.

250-6.2 Posts

1. Ground-mounted sign supports of the post type shall be U-channels or square posts of the number specified and as shown on **Traffic SCD TC-41.20**.

2. Post lengths appearing on the plans are approximate and the contractor is responsible for determining the exact length of required posts before cutting to length **(C&MS Item 630.06A1)**.

3. No. 4 U-channel posts consist of two No. 2 posts bolted back-to-back. No. 6 U-channel posts consist of two No. 3 posts bolted back-to-back. Back-to-back posts are assembled using 5/16 inch steel bolts, lockwashers and nuts on 4 inch centers below the ground line and 16 inch centers above the ground line. No. 4 and No. 6 U-channel posts shall not be installed in exposed locations.

4. Posts should have a line of paint 48 inches from the end which will be in the earth. The mark when driven to a distance of 6 inches above the ground indicates a post driven to the proper depth.

5. If it is necessary to cut posts to correct length in the field, the cut end should be covered with two coats of zinc-rich paint and the cut end driven in the earth or embedded when required (except for back-to-back posts).

6. Posts shall yield when hit and shall be driven to a depth of 42 inches. Posts are typically <u>not</u> to be embedded in concrete, unless specified in the plans or ordered by the project engineer to overcome problems such as adverse soil conditions or generally prevalent bedrock close to the surface. The driven depth has been established to assure best yielding characteristics. Deeper depths are not beneficial in this regard.

7. Caution shall be used when driving posts in areas of buried cable.

8. Posts shall not be driven in drainage ditches.

9. Posts shall be installed vertically and at right angles to the edge of pavement, except for signs not intended for this orientation, such as Parking, One-Direction Large Arrow, and Chevron Alignment signs. Another exception may be STOP signs located at intersections with curved approaches. In this situation, STOP signs should be placed perpendicular to a line from the viewing point where they are normally recognized and stopping action would begin.

10. Posts shall be driven without bending, distortion or end mutilation. Mutilation may be prevented by the use of a driving cap. Posts should be checked to see if the paint mark is 6 inches out of the ground after driving.

11. Posts located in paved areas shall be driven through a hole provided by sleeving or core drilling. After driving, the hole shall be patched with asphaltic concrete or approved

bituminous material in accordance with **Traffic SCD TC-42.20**.

12. At locations where posts cannot be driven, the post may be moved at no additional cost to **ODOT**, when approved by the project engineer.

13. Typical vertical and horizontal clearances of signs are shown on **Traffic SCDs TC-42.10 and TC-42.20**.

250-6.3 "One Way" Sign Supports

Square posts which are capable of supporting signs at right angles to other signs on the post are used as "one-way" sign supports, based on the most common application. This is shown on **SCD TC-41.50**.

250-6.4 Standard Beams

1. Ground-mounted sign supports of the non-breakaway beam type shall be rolled steel, wide flange sections of the size and weight specified (from the list on **Traffic SCD TC-41.10**). Non-breakaway beams shall be protected by guardrail or concrete barrier installed for another purpose. Inspection of beams of the breakaway type is addressed in ***Section 250-6.5.***

2. Beam lengths appearing on the plans are approximate and the contractor is responsible for determining the exact length of required beams before fabrication **(C&MS Item 630.06 A)**.

3. Galvanizing shall be inspected in accordance with ***Section 250-4.4.***

4. Beams shall be embedded in a concrete foundation in accordance with **Traffic SCD TC-41.10**.

5. Beams shall be raised into position with equipment of adequate lifting capacity and in such a manner as to prevent damage to the galvanizing. The beams shall be braced in a plumb and square position until the concrete has cured. The age of the concrete before it is considered cured and before signs are permitted to be erected is to be in accordance with ***Section 250-3.4***.

250-6.5 Breakaway Beams and Connections

1. Ground-mounted sign supports of the breakaway beam type shall be rolled steel, wide flange sections of the size and weight specified (from the list on **Traffic SCD TC-41.10**).

2. Beam lengths appearing on the plans are approximate and the contractor is responsible for determining the exact length of required beams before fabrication **(C&MS Item 630.06 A)**.

3. Beams shall use a slip base design; however, alternate designs of breakaway connections are permitted.

4. Base plates shall be fabricated to standard details and welded-on with a bead equal to the beam flange and web thickness respectively, but not less than 1/4 inch.

5. Welding shall be inspected in accordance with ***Section 250-4.3.***

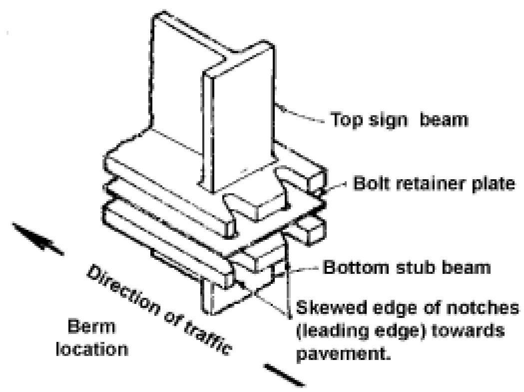
6. Galvanizing of beams shall be inspected in accordance with ***Section 250-4.4.***

7. All portions of beams should be shop assembled, in accordance with **Traffic SCD TC-41.10**.

8. The beam upper portions shall be joined by the bolts attaching the fuse and hinge plates **(see the Section B-B detail on Traffic SCD TC-41.10)**. The plates shall be fabricated to standard details with the fuse plate having notched holes at the bottom and the hinge plate having unnotched holes. The steel hex head bolts, with washers under both head and nut, shall be tensioned in the shop to the final specified value. For S4x7.7 beams only, malleable iron beveled washers are used under bolt head and nuts.

9. The beam lower portions should be joined by steel hex head bolts inserted with their nuts uppermost. A galvanized bolt retainer plate shall be sandwiched between the base plates. Flat washers shall be used under both bolt head and nut as well as under the bolt retainer plate. Bolts shall be snug tightened for delivery to the site with final torquing to be done after erection.

10. Base plate skewed notches should point toward the roadway along the path of a typical vehicle collision. The skewed notches of both base plates should match.

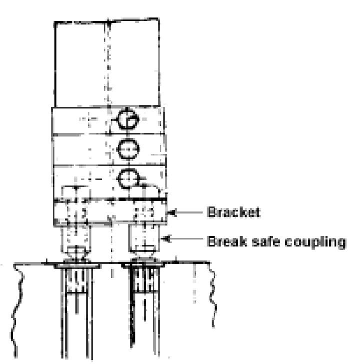


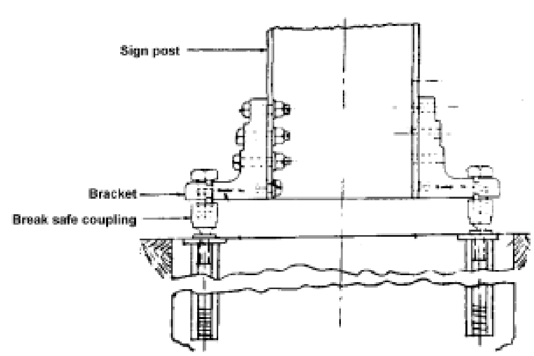
Base Plate Orientation

11. For beams located in medians, the base plates should be welded-on upside down as compared with those of beams located on the right side of the roadway, so the base plate skewed notches will point toward each roadway along the path of vehicle collision from either direction of traffic.

12. For beams located in medians, fuse plates shall be used on both sides of the beam.

13. For beams located on the right side of the roadway, fuse plates shall be on the side of the beam facing traffic.





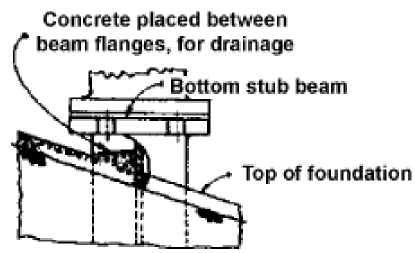
14. For the alternate design, special foot brackets shall be bolted to the upper beam portion, and four couplings incorporating a breakable reduced section are connected between the foot brackets and threaded anchor inserts embedded in the foundation. The couplings permit use of the design in medians where collision can occur in either direction of traffic.

15. The alternate design uses four hinge/fuse plates incorporating a thinned section and bolted where the beam is cut through just under the sign. The pair of plates on the impact side of the beam sever upon impact and a pair on the opposite side bend to allow the beam to swing upward out of the path of the impacting vehicle.

16. Beams should be erected in a single unit because they are easier to plum, square and brace when the entire assembly is raised and set in concrete.

17. Beams shall be erected in accordance with the procedure given for non-breakaway beams in ***Section 250-6.4.***

18. A sloping concrete foundation top surface is required on the high ground side to prevent a water pooling pocket and permit drainage as per **Traffic SCD TC-41.10**. For the alternate design, the foundation top shall be level in the area of the breakable couplings.



19. When a supplemental panel is required below an extrusheet sign, the panel is fastened by sign backing assemblies to the parent sign. The panel shall be separated from the sign by the width of the fuse plate plus 1 inch. This is to permit unhindered hinge plate bending in the event of a vehicle collision.

20. After the foundation concrete is cured, base plate nuts shall be loosened in turn and re-tightened with a torque wrench in a systematic manner to the specified maximum torque shown in the table on **Traffic SCD TC-41.10**, also shown in ***Table 297-9***. Torque wrenches used should be calibrated daily.

21. At least four weeks following the erection of signs on breakaway beams, the breakaway feature shall be inspected by the contractor for evidence of shifting or loose fasteners.

22. All loose fasteners shall be re-torqued to specified values. Base plate fasteners shall be loosened and re-torqued even if no shifting or looseness is detected. Re-torqued nuts at this time shall have anaerobic adhesive applied.

250-7 Signs

250-7.1 General

Signs should be inspected when received on the job site if possible, but certainly prior to erection. The signs should be inspected for conformance with the plans, certified shop drawings, catalog cuts and material specifications.

Flatsheet signs are typically of aluminum sheet cut into geometric shapes of the size specified. Dimensions and thickness are to be as shown on **Traffic SCDs TC-52.10 and TC-**

52.20. Bolt holes are to be drilled or punched **(C&MS Item 630.04)**.

Extrusheet signs are fabricated of aluminum sheet and extrusions, joined by spot welding and assembled by bolts **(Traffic SCD TC-51.11)**. As an alternative, panels extruded in a single operation may be used **(Traffic SCD TC-51.12)**. Extruded panels and spot welded panels shall not be used in the same sign. There shall be no appreciable deviation from flatness on the face of an assembled sign. Regardless of panel construction, the term "extrusheet" is used when referring to these signs.

Overlay signs are of aluminum flatsheet of the thickness specified and used to cover the legend of extrusheet signs. Signs with overlays should be checked for any loose rivets holding the overlay sign.

All signs shall be retroreflectorized by being covered with the appropriate grade of sheeting. The sheeting shall be of the correct color, firmly attached and free of tears, wrinkles, blisters or blemishes.

Sign legend shall be in accordance with the plans, certified shop drawings and the **OMUTCD**.

The type of copy on extrusheet signs shall be as shown on the certified shop drawings. Available types of copy are listed in ***Table 297-6***.

All signs shall be identified on the reverse side by decals as described in ***Section 250-7.4***.

Extrusheet signs shall also be identified by information in a detachable form on the back **(see C&MS Item 630.04)**.

250-7.2 Sign Storage

Signs shall be suitably protected and identified for shipment and storage. Extrusheet signs shall be kept rigid by backbracing or crating and the sign face covered with protective material. The backbracing shall extend sufficiently below the lower edge of the sign to keep the sign off the ground.

Extrusheet and flatsheet signs shall be stored in a vertical position.

Signs must be stored in such a manner that the packaging paper or cardboard material does not get wet. If the packaging material or slip sheeting should become wet, the paper should be removed immediately from contact with sign faces to prevent damage to reflective sheeting on the faces.

In the case of signs furnished by **ODOT** for erection by the contractor, the contractor shall be responsible for the storage and care of the signs after their transfer **(C&MS Item 630.08)**.

250-7.3 Sign Copy

Table 297-6 provides information about the sign copy used, type, material used, design features, etc.

250-7.4 Sign Identification Decals

All signs shall be identified on the reverse side by decals of Type F white reflective sheeting **(C&MS Item 730.18)** with silk screened numerals. Information shall be coded by silk screened or punched-out numerals before decal application and shall include: sheeting manufacturer and year of sign fabrication. At the time of erection, month and year of erection shall be scratched out by the contractor. This procedure is described in **C&MS Item 630.04**, which also contains an illustration of the decal. Decals for overlay signs may be on the front surface.

The following codes shall be used on the decals to identify the manufacturer of the sheeting.

0 - **Avery Dennison**
1 - **Minnesota Mining and Manufacturing Company (3M)**
2 - **Sakai Trading-New York, Inc.**
3 - **Nippon Carbide Industries (USA)**
4 - **Morgan Adhesives Company**
5 - **American Decal and Manufacturing Company**
6 - **Stimsonite Corporation**
7 - **Reflexite North America**
8 - **Oracal USA, Inc.**

250-7.5 Sign Erection

250-7.5.1 General

Section 250-7.5 provides information on erection of the signs. Assembly and erection of various types of overhead sign supports are addressed in ***Sections 250-4 and 250-5*** and ground-mounted supports are addressed in ***Section 250-6***.

250-7.5.2 Ground-Mounted Flatsheet Signs

When erecting ground-mounted flatsheet signs the following provisions apply:

1. Typical vertical and lateral clearances of ground-mounted flatsheet signs are shown on **Traffic SCD TC-42.20**.

2. Flatsheet signs shall be fastened to posts by 5/16 inch hex head steel bolts with a 3/8 inch ID x 1 1/4 inch OD wide washer under the bolt head and using a lockwasher and hex nut. For U-channel posts, at each bolt a bearing plate shall be used behind the sign to reinforce the sign, as indicated on **Traffic SCD TC-41.20**. The hardware and bearing plates are furnished with the signs.

3. Posts supporting groupings of flatsheet signs in multiple arrangements will require the use of sign backing assemblies made up of bolted together short sections of posts. Sign backing assemblies are furnished with the signs unless separately itemized.

4. Flatsheet signs mounted so as to be read by road users using bridges shall be erected on special steel posts in accordance with **Traffic SCD TC-41.40**.

5. Street Name signs shall be erected on square supports in accordance with **Traffic SCD TC-41.40**, unless specified otherwise in the plans.

250-7.5.3 Ground-Mounted Extrusheet Signs

When erecting ground-mounted extrusheet signs the following provisions apply:

1. Typical vertical and lateral clearances of ground-mounted extrusheet signs are shown on **Traffic SCD TC-42.10**.

2. Mounting clips and other attachment hardware shall conform to **Traffic SCD TC-51.11**.

3. Supplemental panels erected below ground-mounted extrusheet signs mounted on non-breakaway beams shall be fastened directly to the beams. The panel shall be separated from the parent sign by 1 inch to conform to **Traffic SCD TC-42.10**. When the panel is too short to reach between the beams, the panel may be fastened to the

parent sign by sign backing assemblies.

4. Supplemental panels erected below ground-mounted extrusheet signs mounted on breakaway beams shall be fastened to the parent sign by sign backing assemblies. The panel shall be separated from the parent sign by the width of the fuse plate plus 1 inch.

5. Exit Number plaques erected above extrusheet signs shall be attached by sign backing assemblies furnished with the Exit Number plaque.

6. The signs should be checked after erection to verify that the beams extend to the top of the signs and that the signs are horizontal and the clearances satisfactory.

250-7.5.4 Overhead Signs

When erecting overhead signs the following provisions apply:

1. The clearance above the roadway for the bottom of overhead signs shall be a minimum of 17 feet, or as shown on the plans.

2. Overhead signs shall be vertical or horizontal regardless of the sag of supporting messenger wire, mast arm rise, chord camber or overpass slope.

3. Signs erected on span wire supports shall be attached in accordance with **Traffic SCD TC-17.10**.

4. Signs erected on single arm supports **(Traffic SCD TC-16.21)** shall be installed so their bottom edge is at the same elevation. Sufficient adjustment for this purpose is provided by the two pair of slotted holes in the sign brackets for the attachment of the arm clamps. The clamps shall be tightened sufficiently to prevent sign rotation about the arm.

5. Signs mounted on semi-overhead supports **(Traffic SCD TC-9.10)** shall be erected so that their edge clearance from the curb line is at least 2 feet.

6. Extrusheet signs over 8 feet in height may be delivered in two pieces for assembly in the field **(C&MS Item 630.08)**.

7. Extrusheet signs erected on supports with two arms shall be centered vertically.

8. Mounting clips and other attachment hardware for extrusheet signs shall conform to **Traffic SCD TC-51.11**.

9. Signs mounted on center-mount supports **(Traffic SCD TC-9.30)** may be mounted laterally on the support in an eccentric position when required by the plans. However, a minimum of 2 feet of sign length shall remain to one side or the other of the vertical member centerline.

10. Overlay signs erected in the field over existing extrusheet signs shall be attached by blind rivets at spacings as required in **C&MS Item 630.04**.

11. Flatsheet signs used in connection with signals supported by span wire shall be fastened to the messenger wire by special attachments in accordance with **Traffic SCD TC-41.41**.

12. Flatsheet signs used in connection with signals supported in a swinging condition on mast arm supports shall be fastened to the arm by a special attachment in accordance with **Traffic SCD TC-41.41**.

13. Exit Number plaques erected above Guide Signs shall be attached by sign backing assemblies furnished with the Exit Number plaque.

14. Extrusheet signs shall be attached to rigid overhead supports using sign brackets in accordance with **Traffic SCD TC-22.20**. Signs extending more than 4 feet above or below an attachment point require the use of intermediate sign brackets.

250-7.6 Sign Inspection

After sign erection, the contractor shall inspect all signs under both day and night conditions. Any necessary adjustments in lateral position or orientation to correct visibility deficiencies shall be made to the satisfaction of the project engineer **(C&MS Item 630.13)**.

Overhead Guide Signs should typically be centered over the lane(s) to which they apply. Down arrows on the signs should normally be centered over the proper lane as viewed by the road user. The maximum displacement of a down arrow from the center of a lane should not be more than 2 feet.

Overhead Guide Signs situated on curved roadways and incorporating down arrows may have the arrow(s) adjusted within the sign and/or the entire sign moved laterally so the arrows when seen from a typical viewing distance on the curve will appear to be over the proper lane(s).

Night conditions inspection is to assure that each sign has visible and uniform retroreflectivity. Any signs not having proper retroreflectivity should be noted and cleaned or replaced by the contractor.

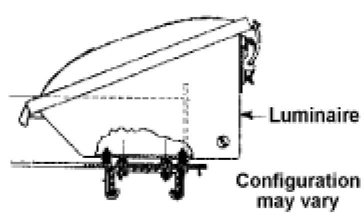
250-8 Sign Lighting

250-8.1 General

Sign lighting is not necessary for overhead Guide Signs when Type H or J reflective sheeting is used for the reflective legends. Therefore, for new installations, sign lighting will normally not be used.

Guidelines and design information on sign lighting are addressed in ***Chapter 212 and Section 240-7***. ***Section 250-8*** provides additional information about what to look for when installing sign lighting.

1. Check certified shop drawings, catalog cuts, etc. for luminaires, ballasts, switches and enclosures.



2. Luminaires shall consist of a housing containing a reflector, lamp socket, wiring and a door containing a glass lens or refractor, meeting the following requirements:

    a. The housing shall be adequately reinforced cast aluminum with a natural finish or painted gray.

    b. The reflector shall be highly reflective aluminum.

   c. The lamp socket shall be a porcelain shrouded mogul screw with lamp grips and a large center spring providing firm contact with a lamp base.

   d. The door shall be an aluminum frame either cast with a natural finish or a formed extrusion with an anodized finish. The door shall be hinged securely to the housing and provided with a spring loaded latch. Hinges shall be stainless steel and designed so that unintentional door separation is impossible. Latches shall be stainless steel and shall not require tools for opening.

   e. A flexible readily removable gasket shall be attached to the housing or door so a waterproof seal is formed when the door is closed and the gasket compressed. The glass lens shall be mounted within the door and sealed with elastic cement or a gasket. The glass lens shall be borosilicate or equivalent, able to withstand hail or the thermal shock of freezing rain.

   f. Drainage weepholes shall be provided in the housing or door depending upon the luminaire's bottom or top position on a sign.

3. Lamp sizes shall be as specified. Ballast type shall match the specified lamp wattage.

4. Sign lighting shall be controlled by a disconnect switch within an enclosure. The switch shall be a two-pole minimum, single throw, fused safety disconnect type rated at 600 volts and 30 amperes **(C&MS Item 631.06)**. The fuse size shall be as specified. A solid neutral bar shall be provided.

5. The enclosure shall be weatherproof and lockable, complying with **NEMA** standard Type 4 ICS 1-110.15. Enclosure size shall be as specified **(see Traffic PIS 203210)**.

6. Each enclosure shall be furnished with at least one padlock, and each padlock shall have a corrosion resistant body and a corrosion proof steel shackle. All padlocks for a project shall be keyed alike from an appropriate master key number obtained by the contractor from the maintaining agency.

7. Sign service to the enclosure shall be in accordance with the plans. Service wiring cable size shall be as specified, single conductor rated at 600 volts and not less than Number 4 **AWG (C&MS Item 631.04)**. Sign service underground from a pull box to a foundation-mounted support, or to a support mounted on a concrete median barrier, is shown on **Traffic PIS 203210**. Sign service from a direct drop is shown on **Traffic PIS 203211**.

8. Sign wiring from the disconnect to the luminaires shall be the size specified, single conductor rated at 600 volts and not less than Number 10 **AWG (C&MS Item 631.05)**. The wiring shall be fully protected within enclosures, support interiors, junction boxes, rigid or flexible conduit and luminaire housings. Wiring shall be continuous from the disconnect switch to a junction box mounted on the sign support or overpass structure. The junction box shall permit disconnection of wiring when a sign and its lighting equipment is removed as a unit. A junction box shall be installed for each sign. Wiring shall be continuous from the junction box to the first luminaire on a sign and continuous between additional luminaires on the sign.

9. Luminaire ballast shall be located within the luminaire (integral) or in a weatherproof housing attached to or beside the luminaire (contiguous). Wiring to the ballast shall be continuous with permitted disconnection at the sign support junction box ***(see paragraph 8)***.

10. The wiring routing for wired signs shall be as shown on **Traffic PIS 203121**.

11. Luminaire supports complying with **Traffic PIS 203121** are specified for new installations. Support arms are of welded tubular design incorporating an attachment flange and a

luminaire support plate. The arms are bolted to a continuous rectangular galvanized steel tube forming the lower portion of the sign's glare shield. The face of the rectangular tube shall be covered with non-reflective sheeting complying with **C&MS Item 730.20** so as to match the color of the glare shield sheeting. Support arms shall not be mounted upside-down or in any other manner than that permitted by the **Traffic SCD**.

12. Luminaires shall be adjusted to a proper aiming angle according to the manufacturer's instructions and inspected at night to determine if they are providing uniform illumination to the sign face.

250-8.2 Sign Lighting Inspection and Testing

1. In accordance with **C&MS Item 631.11**, sign lighting and electrical signs shall meet the requirements of the following tests as required by **C&MS Item 625.19** and performed by the contractor:

    a. Ground rod resistance to ground ***(see Section 450-11.2)***.

    b. Cable insulation (Megger Test) test ***(see Section 450-11.5)***.

    c. Ten-day performance test ***(see Section 450-11.7)***.

    During the ten-day performance test, failure of lamps, ballasts and transformers may be corrected by replacement of the faulty component but will not require restart of the entire test period.

2. The contractor should perform a circuit test on all sign lighting cable and wire conductors to determine if there are any short circuits, cross circuits or other improper connections. Circuit testing may be done in accordance with ***Section 450-11.4***.

3. The test results shall be reported to the project engineer in the test information required by **C&MS Item 625.19**. The test results should be documented.

4. During the ten-day performance test, a night inspection shall be performed by the contractor and final adjustments made to sign lateral positions and the aiming angle of luminaires to the satisfaction of the project engineer **(C&MS Item 631.11)**. The adjustments are to eliminate excessive brightness and glare and to obtain optimum sign face reflected brightness, uniformity of illumination, visibility and legibility.

5. Following successful completion of a ten-day performance test and after there has been a partial or final acceptance of the project, the contractor should turn over to the project engineer all manuals, diagrams, instructions, guarantees and related material. The project engineer should transfer the material to the maintaining agency. For **ODOT**-maintained signs, the material should be given to the appropriate **ODOT District Office**.

6. After the project has been accepted by **ODOT**, the project engineer should immediately notify the maintaining agency that as of a certain exact time and date, the agency is responsible for the maintenance.

Intentionally blank.

260 MAINTENANCE / OPERATIONS

260-1 General

Signing is an essential part of the traffic control system on our highways. The consequences of poor maintenance practices are a reduction in safety to road users and an unnecessarily large exposure to liability claims. **District Roadway Services** personnel and sign maintenance contractors are required to repair, replace and install signs as needed.

The **OMUTCD** and earlier Chapters of ***Part 2*** of this Manual address basic signing standards and guidelines. This Chapter provides additional information regarding **ODOT** maintenance and operations functions related to signing. For example, ***Section 260-5*** describes the Systematic Sign Replacement Program established to help assure adequate visibility of permanent traffic control signs on **ODOT**-maintained highways. It is important that **ODOT** personnel responsible for installation and maintenance of traffic control signs be familiar with these resources.

Although primarily intended as a guide for construction personnel, the information in ***Chapter 250*** should also be helpful for maintenance personnel performing the same functions. That Chapter includes information about various important features of the devices, references applicable specifications and standard drawings, and provides illustrations for easy recognition of the devices or features being discussed.

260-2 Responsibilities

In general, the **Districts** shall do the work necessary to maintain the signing on the state highway system and the **Office of Traffic Operations (OTO)** shall:

1. Staff and maintain a central **Sign Shop**.

2. Assist **Districts** in maintaining reasonable stock levels of materials and hardware required for new installations and maintenance through the management of annual term contracts.

3. Assist the **Districts**, through procedure manuals, training programs, inspections and other methods, in providing quality maintenance of traffic control features used on the state highway system.

260-3 Maintenance on Interstate Routes Within Municipalities

ODOT SOP OPS-111, Maintenance of Interstate Highways through Cities and Villages, addresses maintenance of highway signs and sign supports on Interstate routes within the boundaries of **Cities** and **Villages**.

260-4 Maintenance on Non-Interstate State Highways Within Municipalities

260-4.1 General

ORC Sections 5511.01 and 5511.02 contain provisions pertaining to **ODOT's** responsibility for the maintenance of signs on highways on the state highway system within municipal corporations. **ORC Section 5511.01** contains the following statement: “The director may erect state highway route markers and other signs directing traffic as the director thinks proper upon those portions of the state highway system lying within municipal corporations, and the consent of the municipal corporations to that erection and marking shall not be necessary.” **Section 5511.02** contains the following: “The director of transportation may lay out, establish, acquire, open, construct, improve, maintain, regulate, vacate, or abandon ‘limited access highways’ or ‘freeways’ in the same manner in which the director may lay out, establish, acquire, open, construct, improve, maintain, regulate, vacate, or abandon highways.”

Section 204-3 addresses maintenance of highway signs and sign supports on business routes and ***Section 221-3*** addresses the inspection and maintenance of overhead sign supports. Also, ***Sections 205-2 and 209-2*** address **ODOT's** involvement with traffic generator signs located within a municipality.

260-4.2 Limits and Responsibilities in Cities and Villages

Arrangements other than those described herein are permissible provided they are agreed upon in writing and are acceptable to all involved parties and **ODOT's** responsibility does not exceed the parameters set forth herein.

1. **ODOT** will bear the cost and:

   a. Furnish, install, maintain and repair all signs used in route sign assemblies and signs containing route shields (except for enhanced reference location signs) on conventional roads, and on the mainline and interchange ramps of freeways and expressways;

   b. Furnish, install, maintain and repair all freeway and expressway entrance ramp approach signs located within **ODOT** right-of-way on intersecting highways and streets not on the state highway system, as prescribed in the **OMUTCD**;

   c. Furnish all signs used in trailblazer assemblies considered necessary, as agreed upon by **ODOT** and municipal officials, to provide additional directional guidance to the conventional road, freeway or expressway; and

   d. Furnish, install, maintain and repair all sign supports containing one or more signs that are maintained by **ODOT**, except for supports which have a primary purpose other than for displaying signs, such as, but not limited to, utility, signal and lighting poles.

2. The **City** or **Village** shall:

   a. Furnish, install, maintain and repair all destination signs and other signs not maintained by **ODOT** on conventional roads, and on the mainline and interchange ramps of freeways and expressways;

   b. Furnish, install, maintain and repair all signs not maintained by **ODOT** on intersecting highways and streets not on the state highway system;

   c. Install, maintain and repair all signs used in trailblazer assemblies considered necessary as agreed upon ***(see item 1(c) above)***;

   d.. Furnish, install, maintain and repair all sign supports not containing any signs maintained by **ODOT**;

   e. Furnish and install all necessary modifications required to assure structural integrity of sign supports maintained by **ODOT** when increasing loading on the supports due to the upgrading or addition of **City** or **Village**-maintained signs (written approval shall be obtained from **ODOT** prior to making any modifications to **ODOT**-maintained sign supports);

   f. Furnish, install, maintain and repair all sign lighting on **ODOT** and **City** or **Village**-maintained signs; and

g. Provide electrical energy for the operation of sign lighting on **ODOT** and **City** or **Village**-maintained signs, except where power to **ODOT**-maintained signs is supplied through highway lighting circuits.

260-4.3 Additional Services for Villages

For **Villages** which have requested additional services from **ODOT** under the provisions of **ORC Section 5521.01**, and have on file with **ODOT** an executed **M&R 689**, the following shall also apply:

1. **ODOT** will, in addition to the limits specified in this Section, bear the cost and furnish, install, maintain and repair all:

   a. Regulatory and Warning Signs within the right-of-way of conventional roads and on the mainline and interchange ramps of freeways and expressways;

   b. STOP and YIELD signs on intersecting highways and streets at the intersection with the state highway; and

   c. School Signs with Beacons and related appurtenances located within the State highway right-of-way.

2. Regulatory and Warning Signs previously installed by the **Village** will be maintained and repaired only when justified, designed and installed in conformance with the **OMUTCD** and the **ORC**. For example, non-warranted STOP signs will not be maintained.

260-5 <u>Systematic Sign Replacement Program</u>

Highway signs utilize white or colored reflective sheeting materials containing optical elements designed to return a large portion of incident light back towards the source. At night, this property, known as retroreflectivity, redirects incident light from a vehicle's headlights back toward the vehicle's occupants. Retroreflectivity allows highway signs to remain visible after dark.

The color and retroreflective properties of highway signs degrade over time, due primarily to exposure to ultraviolet light and environmental contaminants. Sign color will fade, and retroreflectivity will be reduced, over time. The purpose of this standard is to assure adequate sign appearance and visibility by establishing a statewide uniform practice for the systematic replacement of permanent traffic control signs on **ODOT**-maintained highways.

All new permanent traffic control signs are required to be reflectorized with Type G, H or J reflective sheeting ***(see Section 220-6)***. It is expected that signs fabricated with Type G, H or J reflective sheeting will have a sign service life of at least fifteen years. Sign service life is the period of time that a sign has an adequate appearance, proper color retention and contrast, and sufficient retroreflectivity to effectively convey its message both day and night and satisfy the retroreflectivity levels in **OMUTCD Table 2A-3**.

Sign service life will depend upon sign color and sign location. At fifteen years, red signs and fluourescent yellow-green signs would be expected to be reaching the end of their service life. However, other color signs, and signs on freeways and expressways, tend to have a longer service life..

OMUTCD Section 2A.08 requires that **ODOT** adopt an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in **OMUTCD Table 2A-3**. **ODOT's** Systematic Sign Replacement Program, begun in 2001 and as described herein, conforms to the Blanket Replacement method in **OMUTCD Section 2A.08**.

Each **District** shall develop and implement a program to provide for the systematic replacement of permanent traffic control signs. This should be done on a route by route basis, with signs on the entire length of a route within a **District** or **County**, or on a segment of a route within a **District** or **County**, scheduled for replacement on an ongoing basis.

The recommended blanket replacement interval is fifteen years for all signs on the conventional road system and twenty years for all signs on freeways and expressways. **Districts** may extend these replacement intervals, or establish variable replacement intervals based on sign color or other criteria, but should verify that the signs are providing the necessary levels of retroreflectivity using an accepted method in **OMUTCD Section 2A.08**. The ODOT Sign Shop can take retroreflectivity measurements on signs removed from service and sent in.

The **District** should make preparations well in advance to provide sufficient time to assure signs are replaced within the recommended time interval. Sign replacements may be by contract or force account, or a combination of the two.

All signs on a route or route segment should be replaced at the same time, unless a variable replacement interval based on sign color or other criteria as described above is used. Signs that have been installed within two years of the scheduled replacement may remain in place. Type G, H or J signs that are removed that have sufficient remaining service life may be returned to **District** stocks to be used in maintenance activities (e.g., knockdown replacements).

The **District** may elect to delay sign replacements on a route segment for up to two years to allow the sign replacement to be combined with other scheduled work for that section of highway, provided the **District** verifies that the signs have sufficient retroreflectivity to effectively convey their messages both day and night, and are at or above minimum reflectivity levels in **OMUTCD Table 2A-3**.

260-6 Maintenance of STOP and YIELD Signs at County and Township Road Intersections

260-6.1 General

ODOT has a general duty to maintain State Routes pursuant to **ORC Sections 5501.01(C), 5501.31 and 5511.01**. Therefore, although they face the cross or side road, since the vast majority of STOP and YIELD signs at intersections of local roads with state highways are on **ODOT** right-of-way, **ODOT** has traditionally accepted the responsibility for them.

The **Districts** should include these signs in their Systematic Sign Replacement Program efforts ***(see Section 260-5)***.

If officials from a **County** or **Township** encounter a STOP or YIELD sign at the intersection of a road under their jurisdiction with a state highway that they believe needs to be replaced, this should be brought to the attention of the appropriate **ODOT District**. If the **District** agrees that a particular sign needs to be replaced, the **District** should proceed to schedule the work. If the **District** does not agree that a particular sign needs to be replaced, then the **County** or **Township** may, at their discretion, replace the sign at the **County** or **Township's** expense.

260-6.2 Limits of Maintenance and Responsibilities

Arrangements other than those described herein are permissible, provided they are agreed upon in writing and are acceptable to all involved parties and **ODOT's** responsibility does not exceed the parameters set forth herein.

ODOT will bear the cost and:

1. Furnish, install, maintain and repair all STOP and YIELD signs at the intersection of **County** and **Township** roads with rural state highways. No distinction will be made as to whether or not the sign is actually located within the limits of **ODOT's** right-of-way

2. Furnish, install, maintain and repair all sign supports used with a STOP or YIELD sign at the intersection of **County** and **Township** roads with rural state highways.

The **County** or **Township** shall furnish and install all STOP and YIELD signs, and related supports, at the intersections of **County** or **Township** roads with rural state highways that they believe are in need of replacement, but which the appropriate **ODOT District** does not agree need to be replaced.

260-7 Maintenance of Sign Lighting

Because of the January 1, 2008 federal government mandate that mercury vapor luminaires and ballasts no longer be manufactured or imported, these parts have become increasingly difficult to obtain.

For this reason, **ODOT** will no longer maintain existing sign lighting. Luminaires and ballasts should be allowed to fail in place.

When the sign lighting is no longer operational, the **District** may, at its discretion, remove the luminaires and/or luminaire support assemblies. Glare shields should not be removed.

Intentionally blank.

295 REFERENCE RESOURCES

295-1 General

Various reference resources that may be useful have been noted in ***Chapters 193 and 194***.

The following document is hereby incorporated into the **TEM** by reference.

295-2 Sign Designs and Markings Manual (SDMM)

295-2.1 General

The **Sign Designs and Markings Manual (SDMM)** is intended to provide Standard Sign Designs for the signs depicted in the **OMUTCD** and the **TEM**, as well as some additional signs that are not currently addressed in either of these manuals. General guidelines for the design of other signs are also provided. As noted in ***Section 195-3***, the **SDMM** is referenced in the **OMUTCD** and is used to assure uniformity in the design of standard traffic signs in **Ohio**.

The information covered includes element sizes, horizontal and vertical arrangements, spacing rules and charts which simplify procedures and minimize time and effort in the design and layout of Guide Signs. Symbols and arrows used for traffic control signs are contained in **Appendix A of the SDMM**; design information is provided in **Appendix B**; the freeway and expressway guide sign design method is in **Appendix C**; letter size and spacing information are in **Appendix D**. The spacing criteria and element sizes contained in **Appendix D** are based on criteria established by **FHWA** in combination with criteria from sign legend manufacturers.

The standard pavement markings alphabet and symbols have also been incorporated into the **SDMM**, as **Appendix F**.

Although the **SDMM** is physically a separate publication, it is also considered part of the **TEM**, i.e., ***Section 295-2***. Cross-referencing is provided as appropriate within the text of this Manual to related additional detail information currently in the **SDMM**.

295-2.2 Format and Design Details (design details in this section are under review and will be updated in a future revision)

Standard Sign Designs intended to be included in the **SDMM** shall be drawn showing the sign layout to scale. The sheet shall be sized to 8.5 x 11. The Sign Design should also include a color graphic version of the sign. This graphic representation shall be shown so as to clearly represent the sign whether the design is printed using a color or a black and white printer. English dimensions in inches should be used in the sign layout. The dimensions shall be indicated either on the sign, when only one size is available, or in a table shown below the sign layout for drawings when more than one size is available. Dimension arrowheads shall use a filled arrowhead design.

Proposed drawings should include in the file a scaled, color layout of the sign which can be used to create graphic images in other formats, for use in other publications. This is in addition to the sheet to be used in the **SDMM**. The file name for a Sign Design shall indicate the sign name/number designation and the date the drawing was created; and shall be submitted to the **Office of Traffic Operations** for review and processing.

The seed file for a **Standard Sign Design** is trafsdm_v8.dgn (I:\tr\trstd\seed\). All **Standard Sign Designs** begin by copying this file and then renaming it for the appropriate drawing. The seed file includes a table which can be removed or modified as needed for the sign design. The phrase “All dimensions shown in inches” shall be shown on the sheet.

Font 30, line weight 0, 0.14 size shall be used overall, with the exceptions of the page header title and the title block sign code designation which shall use Font 30, line weight 0, 0.17 size. If notes are used in the design, they should be typed in an Arial true type font using 0.14 height size.

Levels used for a sign design are SH_Border for the cutline and title block, ST_Details for the sign (both the layout and the smaller graphic design), and ST_Text for dimensions and text.

296 FORMS INDEX

296-1 Business Route Resolution for a County

Form 296-1 is a sample **Resolution** which can be used in establishing a Business Route for a **County** ***(see Section 204-3)***.

296-2 Business Route Resolution for a Municipality

Form 296-2 is a sample **Resolution** for establishing a Business Route within a municipality ***(see Section 204-3)***.

296-3 HAR Installation and Maintenance Agreement

Form 296-3 is a sample **HAR Agreement** as described in ***Section 206-5***.

296-4 Overhead Sign Support Inspection

Form 296-4 is a sample form that can be used for inspection of overhead sign supports ***(Section 221-3)***.

Intentionally blank.

Form 296-1. Request for Business Route Signs on a County Road

Resolution Number ________

Requesting the Ohio Department of Transportation to Erect Business Route Signs on a County Road

WHEREAS, state route _______ has been relocated so as to bypass the Corporation of ___________________, and,

WHEREAS, the ownership of the old and previously marked section of state route _______ from ______________________________ to ________________________________ except that part of the previously marked road which lies inside the Corporation of _____________________ as shown in the attached map, has been transferred from the Ohio Department of Transportation to the County of _______________________, and,

WHEREAS, the ______________________ County Commissioners believe that it is in the best interest of the citizens of ________________________ County and the public in general that motorists be provided with appropriate direction to and from the business district of the Corporation of _______________________,

NOW, THEREFORE, be it resolved by the Commissioners of the County of ____________________, State of Ohio, that

SECTION 1: The Ohio Department of Transportation be requested, and consent is hereby given, to erect appropriate signs at appropriate places and intervals designating route ________ as previously described, as a business route.

SECTION 2: The County of _________________________ shall be responsible for the future replacement and maintenance of the business route signs, and the pavement, berms, traffic signals and all parts of said road, and furthermore, the County agrees to maintain all traffic control devices in accordance with the standards as set forth in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD). It is also understood that all traffic control devices on the above section of road and any of its parts will be subject to inspection by ODOT personnel and failure of the County to maintain the marking system in accordance with the OMUTCD shall be cause for ODOT to rescind approval of the business route and order the removal of the business route signs.

SECTION 3: The County of _______________________ recognizes its responsibility for the section of road described above and it understands and agrees that the posting of this section of road as a business route will not remove the responsibility of any part of it from ___________________ County. Specifically, the County will in no manner be relieved or discharged from any claim or claims of any nature arising from, or growing out of, the maintenance of said section of road and the County shall save the State of Ohio harmless from any and all such claims.

SECTION 4: This resolution shall be in full force and effect from and after its passage, legal publication and earliest period allowed by law.

Passed this _______ day of _________________, _________.

Commissioners	Voting
______________________________	______
______________________________	______
______________________________	______

ATTEST:

____
Clerk of the Board

Form 296-2. Request for Business Route Signs within a Corporation

Resolution Number _________

**Requesting the Ohio Department of Transportation
to Erect Business Route Signs within a Corporation**

WHEREAS, state route _______ has been relocated so as to bypass the Corporation of ___________________, and,

WHEREAS, the streets as described below, which were previously marked as a section of this state route:
____
____
____
have been abandoned by the Ohio Department of Transportation as a part of the state highway system, and

WHEREAS, it is believed that it is in the best interest of the citizens of the Corporation of _______________________ and the public in general that motorists be provided with appropriate direction to and from the business district of the Corporation of _________________________,

NOW, THEREFORE, be it resolved by ____ ____________________________, State of Ohio, that

SECTION 1: The Ohio Department of Transportation be requested, and consent is hereby given, to erect appropriate signs at appropriate places and intervals designating route ________ as previously described, as a business route.

SECTION 2: The Corporation of ________________________ shall be responsible for the future replacement and maintenance of the business route signs, and the pavement, berms, traffic signals and all parts of said road, and furthermore, the Corporation agrees to maintain all traffic control devices in accordance with the standards as set forth in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD). It is also understood that all traffic control devices on the above section of road and any of its parts will be subject to inspection by ODOT personnel and failure of the Corporation to maintain the marking system in accordance with the OMUTCD shall be cause for ODOT to rescind approval of the business route and order the removal of the business route signs.

SECTION 3: The Corporation of _______________________ recognizes its responsibility for the streets described above and it understands and agrees that the posting of this section of road as a business route will not remove the responsibility of any part of it from the Corporation of ___________________. Specifically, the Corporation will in no manner be relieved or discharged from any claim or claims of any nature arising from, or growing out of, the maintenance of said streets and the Corporation shall save the State of Ohio harmless from any and all such claims.

SECTION 4: This resolution shall be in full force and effect from and after its passage, legal publication and earliest period allowed by law.

Passed this _______ day of _________________, _________.

Corporation of __________________	Voting
______________________________	______
______________________________	______
______________________________	______

ATTEST:

____
Clerk of the Board

Form 296-3. HAR Installation and Maintenance Agreement

AGREEMENT NO. ____

This Agreement is made and entered into by and between the Ohio Department of Transportation ("ODOT") and the ______________________________, hereafter referred to as the "owner."

In consideration of the mutual covenants, promises and warranties set forth herein, ODOT and the owner agree as follows:

SECTION 1: DEFINITIONS

The following words and items shall have the following meanings:

1.1 **AGREEMENT**: This Agreement, which is herein identified as Agreement No. ____.

1.2 **APPLICATION**: The written request by the owner.

1.3 **DIRECTOR**: The Director of ODOT.

1.4 **ODOT STANDARD OPERATING PROCEDURE PH-P-403**: Standard Operating Procedure PH-P-403 titled "Permits to Use or Occupy Highway Rights-of-Way" dated April 30, 1991.

1.5 **PERMIT**: An Occupancy Permit issued to owner by ODOT.

1.6 **PROCEDURES**: The procedures in ODOT Traffic Engineering Manual Section 206-5 titled "Highway Advisory Radio (HAR) Signing (D12-H6, D12-H7, D12-H8, D12-H9)."

1.7 **PROJECT**: The project of fabricating, erecting and maintaining Highway Advisory Radio signs in accordance with the procedures.

1.8 **HIGHWAY ADVISORY RADIO SYSTEM**: A specific information radio transmission system.

1.9 **OHIO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES**: A manual titled "Ohio Manual of Uniform Traffic Control Devices for Streets and Highways" published by ODOT's Division of Operations, Office of Traffic Operations.

SECTION 2: PURPOSE OF AGREEMENT

2.1 The purpose of this Agreement is to set forth the covenants, rights, duties, obligations and warranties of the parties with respect to the installation, maintenance, and operation of a Highway Advisory Radio System and the installation and maintenance of associated sign(s) located on Route ____, at or about exit number _____, at mile marker ____, in _________ County.

SECTION 3: SCOPE OF THE PROJECT

3.1 The owner, entirely at its own expense, shall design, construct, and maintain a Highway Advisory Radio System and associated signs as described in this Agreement and in the following documents hereby incorporated by reference:

1. The application.
2. The procedures.
3. ODOT Standard Operating Procedure PH-P-403.
4. Ohio Manual of Uniform Traffic Control Devices.
5. ODOT Standard Construction Drawings.
6. ODOT Construction and Material Specifications.
7. ODOT Traffic Engineering Manual Section 206-5.
8. Approved construction plans for installation of signs.

3.2 The resolution of any conflict among these documents shall be made by the Director upon written request of the owner.

SECTION 4: PROJECT RESTRICTIONS

4.1 The owner agrees to operate a Highway Advisory Radio System transmitter and associated signs in the following manner.

a. Only traffic advisory or directional messages shall be broadcast over the radio station.
b. No message of a commercial or promotional nature may be broadcast at any time.
c. Messages concerning disruptions of normal traffic flow or road conditions due to highway construction or maintenance activities shall be broadcast when requested by the Ohio Department of Transportation.
d. The Highway Advisory Radio System shall be operated at all times in accordance with applicable Federal Communications Commission Rules and Regulations.
e. The Highway Advisory Radio System shall be operated on a permanent year-round basis 24 hours a day unless otherwise approved by the Director.
f. The location(s) of the broadcast reception zone(s), as described in this Agreement, shall not be altered subsequent to placement of the signs referred to herein.
g. The owner shall immediately notify the Ohio Department of Transportation of any event or condition which may significantly affect its ability to perform in accordance with the provisions of this Agreement.

SECTION 5: PERIOD OF PERFORMANCE

5.1 The term of this Agreement shall commence upon the execution thereof by the Director.

5.2 This Agreement shall terminate when one of the following events occurs:

a. The owner no longer operates the Highway Advisory Radio System; or
b. ODOT’s operational needs require removal of all Highway Advisory Radio System signs and/or equipment from the Right of Way;
c. At the discretion of the Director.

5.3 In the event that paragraph 5.2b or 5.2c occurs, ODOT shall provide the owner with reasonable written notice of termination sufficient to allow the owner to find an alternate site, if any.

SECTION 6: PERFORMANCE BOND AND PAYMENT BOND REQUIREMENTS:

6.1 The owner hereby agrees to post a performance bond prior to commencement of the Project and subject to ODOT’s approval in an amount equal to the greater of twenty-five percent of the estimated cost of the initial Project construction cost or Five Thousand Dollars ($5,000), conditioned upon the owner’s promise to perform in accordance with SECTION 8, Removal and Restoration, of this Agreement.

6.2 The owner further agrees to post a payment bond prior to the commencement of the Project and subject to ODOT’s approval in an amount equal to the greater of one hundred percent of the initial project construction cost or Twenty-Five Thousand Dollars ($25,000.00) for the payment of any contractor or subcontractor for labor performed or materials furnished in connection with the Project.

6.3 If the owner or its contractor or subcontractor does not commence work within the time required, or does not carry the same forward with responsible progress, or is improperly performing the work, or has abandoned or fails to prosecute the work in an acceptable manner or fails or refuses to complete this Agreement, ODOT shall so notify the owner in writing and the owner and its contractors shall immediately cease work on the Project. ODOT shall forthwith give written notice, by certified mail, to the sureties on the bonds of the owner’s contractor of such action. If, within ten days after the receipt of such notice, such sureties notify ODOT in writing of their intention to enter upon and complete the work covered by such contract, the sureties shall be permitted to do so. The sureties shall commence work within thirty days after receipt of permission from ODOT.

6.4 In the event said sureties do not undertake their legal and contractual obligations, ODOT may take any action it deems suitable in order to complete the Project or terminate the Project in accordance with Section 13, Default and Termination.

6.5 The owner shall include the terms found in 6.1 through 6.4 above in any and all contracts it enters into with contractors or subcontractors who actually perform work on the Project and shall provide ODOT with a copy of any such contract(s) and/or subcontract(s).

SECTION 7: PERMIT REQUIREMENTS

7.1 Except in emergencies, the owner shall obtain a Permit prior to each occasion that the owner intends to perform any scheduled installation, maintenance, repair and/or removal operations within the State highway right-of-way at or near the location of the Highway Advisory Radio signs described in this Agreement.

7.2 An emergency is defined as: (Add definition)

SECTION 8: MAINTENANCE OF HIGHWAY ADVISORY RADIO SIGNS

8.1 The owner shall provide maintenance of the Highway Advisory Radio signs at no cost to ODOT and in accordance with the specifications and standards defined by ODOT. This will include relocating or removing any Highway Advisory Radio signs which ODOT deems it necessary for any reason to relocate or remove.

8.2 If, in the opinion of ODOT, the Highway Advisory Radio System or associated signs malfunction, cease to function or cause damage or any threat of damage to State property or if the Highway Advisory Radio signs become, in the opinion of ODOT, unsightly, badly faded or in a state of dilapidation, the owner shall, at its own cost, immediately repair any damage or remove any threat of damage, cure any malfunction or make any needed repairs after written notice from ODOT.

8.3 If the owner fails to remedy the defects as noted by ODOT and ODOT repairs, or causes to be repaired, any Highway Advisory Radio sign, the owner shall reimburse ODOT for all expenses incurred as a result of the owner's failure to provide a remedy in accordance with this Section.

8.4 ODOT reserves the right to claim and recover by process of law such sums or otherwise receive satisfaction as may be sufficient to correct any and all errors or make good any and all defects in the performance, workmanship and/or materials involved pursuant to this Agreement.

SECTION 9: REMOVAL AND RESTORATION

9.1 The owner hereby agrees that it shall assume the entire cost of removing signs, sign supports, and foundations for Highway Advisory Radio signs and SHALL restore the area upon termination of this Agreement.

SECTION 10: RELEASE AND INDEMNIFICATION

10.1 The owner covenants and agrees to indemnify and hold ODOT, the State, and its agents harmless against any loss, claim, cause of action, damages, liability (including without limitation, strict absolute liability in tort or by statute imposed), charge, cost or expense (including, without limitation, counsel fees to the extent permitted by law) caused by the owner's negligent, willful, or wanton actions or inactions, including such actions or the failures to act of any contractors or subcontractors or other employee hired by owner in connection with this Agreement.

10.2 No claim, cause of action or request of any kind shall be made by the owner against ODOT or the State for any compensation for damage to the Highway Advisory Radio System and related signs resulting from the performance of ODOT highway maintenance or construction activities.

10.3 In no event shall the owner or any of its employees, agents, contractors or subcontractors, be considered agents or employees of ODOT or the State. The owner agrees that none of its employees, agents, contractors or subcontractors will hold themselves out as, or claim to be, agents, officers or employees of ODOT or the State and will not, by reason of any relationship with ODOT or the State make any claim, demand or application to or for any right or privilege applicable to an agent, officer or employee of ODOT or the State including, but not limited to, rights and privileges concerning workmen's compensation benefits, social security coverage or retirement membership, credit or any other terms, conditions, or privileges of employment.

10.4 The obligation of the owner to indemnify and hold ODOT and the State harmless shall not be limited or reduced in any way by reason of any insurance coverage or lack thereof.

SECTION 11: COMPLIANCE WITH FEDERAL, STATE AND LOCAL REQUIREMENTS

11.1 The owner shall fully comply with all federal, State and local laws, rules, executive orders, and other legal requirements as they apply to the performance of this Agreement.

SECTION 12: NO ADDITIONAL WAIVER IMPLIED

12.1 If any term, provision or condition contained in this Agreement is breached by either the owner or ODOT and thereafter such breach is waived by the other party, such waiver shall be limited to the particular breach so waived and shall not be deemed to waive any other breach hereunder.

12.2 No remedy herein conferred upon or reserved by ODOT is intended to be exclusive of any other available remedy, but each and every such remedy shall be cumulative and shall be in addition to every other remedy given under this Agreement or now or hereafter existing at law or in equity.

12.3 No delay or omission to exercise any right or option accruing to ODOT upon any default by the owner shall impair any such right or option or shall be construed to be a waiver thereof, but any such right or option may be exercised from time to time as often as may be deemed expedient by ODOT.

SECTION 13: DEFAULT AND TERMINATION

13.1 If the owner or its Contractor or Subcontractor does not commence work within the time required, or does not carry the same forward with responsible programs, or is improperly performing the work, or has abandoned or fails to prosecute the work in an acceptable manner, or fails to maintain signing in an acceptable manner, or fails or refuses to complete this Agreement, the Director may terminate this Agreement upon giving the owner 10 days written notice.

13.2 Neglect or failure of the owner to comply with any of the terms, provisions or conditions of this Agreement or failure of any representations made to ODOT in connection with this Agreement by the owner to be true may be an event of default, provided that if by reason of force majeure the owner is unable in whole or in part to carry out its covenants contained herein, the owner shall not be deemed in default during the continuance of such inability.

13.3 The term Aforce majeure@ as used herein shall mean, without limitation: Acts of God, strikes, lockouts or other industrial disturbances; acts of public enemies, order of any kind of government of the United States or of the State or any of their political subdivisions or any of their departments, agencies, or officials, or any civil or military authority; epidemics; landslides; lightning; earthquake; fire; hurricanes; storms; floods; washouts; droughts; restraint of government and people; civil disturbances; explosions; partial or entire failure of utilities; or any other cause not reasonably in the control of the owner. The owner shall, however, remedy with all reasonable effort each cause preventing it from carrying out its covenants contained herein.

13.4 If notified by ODOT in writing that it is in violation of any of the terms, conditions, or provisions of this Agreement, and a default has occurred, the owner shall have thirty (30) days from the date of such notification to remedy the default or, if the remedy will take in excess of thirty (30) days to complete, the owner shall have thirty (30) days to satisfactorily commence a remedy of the causes preventing its compliance and curing the default situation. Expiration of the thirty days and failure by the owner to remedy, or to satisfactorily commence the remedy of, the default whether payment of funds has been fully or partially made, shall result in ODOT, at its discretion, declining to make any further payments to the owner, or termination of this Agreement by ODOT. If this Agreement is terminated, the owner shall repay to ODOT all of the federal funds disbursed to it under this Agreement pursuant to Article XVII of this Agreement.

13.5 The owner, upon receiving a notice of termination from ODOT for default, shall cease work on the terminated activities covered under this Agreement. If so requested by ODOT, the owner shall assign to ODOT all its rights, title, and interest to any contracts it has with any Consultants or Contractors. Otherwise, the owner shall terminate all Contracts and other Agreements it has entered into relating to such covered activities, take all necessary and appropriate steps to limit disbursements and minimize any remaining costs. At the request of ODOT, the owner may be required to furnish a report describing the status of Project activities as of the date of its receipt of notice of termination, including results accomplished and other matters as ODOT may require.

13.6 No remedy herein conferred upon or reserved by ODOT is intended to be exclusive of any other available remedy, but each and every such remedy shall be cumulative and shall be in addition to every other remedy given under this Agreement or now or hereafter existing at law or in equity. No delay or omission to exercise any right or option accruing to ODOT upon any default by the owner shall impair any such right or option or shall be construed to be a waiver thereof, but any such right or option may be exercised from time to time and as often as may be deemed expedient by ODOT.

SECTION 14: SETTLEMENT OF THIRD PARTY AGREEMENT DISPUTES OR BREACHES

14.1 The owner shall avail itself of all legal and equitable remedies under any third party contract which relates to the Project and shall notify ODOT of any current or prospective litigation pertaining to any such third party contract.

SECTION 15: CHANGE IN CONDITIONS OF LAW AFFECTING PERFORMANCE

15.1 The owner shall immediately notify ODOT of any other event, which may significantly affect its ability to perform in accordance with the provisions of this Agreement.

SECTION 16: SEVERABILITY

16.1 If any provision of this Agreement is held to be invalid or unenforceable by a Court of competent jurisdiction, such holding shall not affect the validity or enforceability of the remainder of this Agreement. All provisions of this Agreement shall be deemed severable.

SECTION 17: SUCCESSORS IN INTEREST

17.1 All the obligations incurred by the owner under this Agreement shall pass to and be binding upon any successors, heirs, contractors, subcontractors and assigns of the owner and such successors, heirs, assigns, contractors, subcontractors shall be bound to the terms, conditions, restrictions, specifications and covenants of this Agreement.

17.2 The owner shall not assign, transfer, convey or subcontract, in whole or in part, or otherwise dispose of this Agreement without the express prior written consent of ODOT, and such written consent shall not release the owner from any of the obligations of this Agreement.

SECTION 18: EXCLUSIVE AGREEMENT

18.1 This Agreement, when fully executed by the parties, constitutes the entire Agreement between the parties and shall supersede all other communications, representations or agreements, either oral or written, with respect to the subject matter in this Agreement unless a modification to this Agreement is executed in writing by the parties.

SECTION 19: CAPTION

19.1 The section captions in this Agreement, are used for the convenience of reference only and in no way define, limit or describe the scope or intent of this Agreement or any part hereof and shall not be considered in any construction hereof.

SECTION 20: DRUG-FREE WORK PLACE

20.1 The owner agrees to comply with all applicable State and federal law regarding a drug-free work place. The owner shall make a good faith effort to ensure that its employees will not purchase, transfer, use, or possess illegal drugs, or abuse prescription drugs in any way.

SECTION 21: EQUAL EMPLOYMENT OPPORTUNITY

21.1 In carrying out this Agreement, the owner shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, ancestry, age, or disability as that term is defined in the Americans with Disabilities Act. The owner shall ensure that applicants are hired and that employees are treated during employment without regard to their race, religion, color, sec, national origin, ancestry, age, or disability. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training including apprenticeship.

21.2 The owner agrees to post in conspicuous places available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause, and in all solicitations or advertisements for employees placed by it, state that all qualified applicants shall receive consideration for employment without regard to race, religion, color, sex, national origin, ancestry, age, or disability. The owner shall incorporate this nondiscrimination requirement within all of its Contracts for any of the work on the Project (other than Subcontracts for standard commercial supplies or raw materials) and shall require all of its Contractors to incorporate such requirements in all Subcontracts for any part of such Project work.

21.3 The owner agrees to ensure that minority business enterprises, as such are defined in 49 CFR Part 23, will have the maximum opportunity to participate in the performance of contracts and subcontracts financed in whole or in part with federal funds provided in conjunction with this Agreement.

SECTION 22: GOVERNING LAWS

22.1 This Agreement and any claims arising out of this Agreement shall be governed by the laws of the State of Ohio. Any provision of this Agreement prohibited by the law of Ohio shall be deemed void and of no effect. Any litigation arising out of or relating in any way to this Agreement or the performance thereunder shall be brought only in the courts of Ohio, and the owner hereby irrevocably consents to such jurisdiction. To the extent that ODOT is a party to any litigation arising out of or relating in any way to this Agreement or the performance thereunder, such an action shall be brought only in a court of competent jurisdiction in Franklin County, Ohio.

SECTION 23: NOTICE

23.1 Notice under this Agreement shall be directed as follows:

IF TO THE OWNER	IF TO ODOT:
____________________________	___________________________
____________________________	___________________________
____________________________	___________________________

SECTION 24: ASSIGNMENT

24.1 Neither this Agreement nor any rights, duties, or obligations described herein shall be assigned by either party hereto without the prior express written consent of the other party.

SECTION 25: SIGNATURES

25.1 Any person executing this Contract in a representative capacity hereby warrants that he/she has been duly authorized by his/her principal to execute this Contract on such principal's behalf.

IN WITNESS HEREOF, the parties hereto have executed this Agreement by their duly authorized officers on the day, month and year set forth below.

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

BY: _________________________________
[typed Director's Name] ,
Director

DATE: ________________________________

____
(OWNER)

BY: _________________________________

Print Name: __________________________

Title: ________________________________

DATE: ________________________________

Form 296-4. Overhead Sign Support Inspection

Support Information

Support Identifier: ____________________ Date: ________________________________
Route: _____________________________ Direction: _____________________________
C - R - S: ___________________________ Mile Marker: __________________________

Design No.: ___________________ Bridge Mtd Foundation? ____Yes ____No
Support Type: ____Cantilever ____Box Truss ____Bridge Mtd ____Skewed Bridge Mtd
____Span Wire ____Monotube ____Butterfly ____Semi-Overhead
____Other: ____

Foundation

____Concrete Condition ____Soil Condition ____Anchor Bolts/Nuts
Comments: ____
____

End Frame/Pole

____Structural Members ____Structural Connections
____Damage? ____Yes ____No ____Pitting? ____Yes ____No
____Surface Rust: ____Minimal ____Moderate ____Severe
Comments: ____
____

Cantilever/Span

____Structural Members ____Structural Connections
____Sign Attachments ____Attachments to End Frame/Pole
____Damage? ____Yes ____No ____Pitting? ____Yes ____No
____Surface Rust: ____Minimal ____Moderate ____Severe
Comments: ____
____

Structural Components of Sign Lighting

Type: ____Fluorescent ____Mercury Vapor TC-31.21 (New Design)
____Mercury Vapor TC-31.20 (Old Design) ____Repair Brkt? ____Yes ____No
Comments: ____
____

Inspected by: ____________________________________ **Date:** ________________________

Intentionally blank.

297 TABLES INDEX

297-1 Sizes for Lane-Use Control Signs

As noted in ***Section 201-10***, ***Table 297-1*** provides a listing of the various Lane-Use Control Signs with their sizes. ***Figure 298-22*** also provides a visual representation of these signs.

297-2 Lake Erie Circle Tour Routes

Section 204-4 describes signing provided for the Lake Erie Circle Tour Routes. ***Table 297-2*** lists the routes involved.

297-3 Reserved for Future Information

Existing ***Table 297-3*** was deleted because the ramp identification signs referenced are no longer used.

297-4 Criteria for Signing for Traffic Generators on Freeways and Expressways

As noted in ***Section 209-2***, **Table 297-4** describes the criteria used when reviewing freeway and expressway signing requests for traffic generators.

297-5 Control City Destinations for Ohio's Interstate Highway System

As noted in ***Section 209-3***, ***Table 297-5*** lists the control cities used on **Ohio's** Interstate Routes for major destination references.

297-6 Sign Copy

As noted in ***Section 250-7.3***, ***Table 297-6*** provides information about the various kinds of sign copy.

297-7 Types of Overhead Sign Supports

As noted in ***Section 250-4.1***, ***Table 297-7*** provides a summary of information about the various types of overhead sign supports.

297-8a Weight of Overhead Supports - Truss

Table 297-8a provides information about the weight of truss sign supports ***(see Section 250-4.5)***.

297-8b Weight of Overhead Supports - Semi-Overhead & Center Mount

Table 297-8b provides information about the weight of semi-overhead and center-mount sign supports ***(see Section 250-4.5)***.

297-8c Weight of Overhead Supports - Butterfly

Table 297-8c provides information about the weight of butterfly sign supports ***(see Section 250-4.5)***.

297-8d Weight of Overhead Supports - Single Arm

Table 297-8d provides information about the weight of single arm overhead sign supports ***(see Section 250-4.5)***.

297-8e Weight of Overhead Supports - Cantilever

Table 297-8e provides information about the weight of cantilever sign supports ***(see Section 250-4.5)***.

297-8f Weight of Overhead Supports - Structure-Mounted

Table 297-8f provides information about the weight of overpass structure-mounted sign supports ***(see Section 250-4.5)***.

297-9 Bolt Size and Maximum Torque for Beam Supports

As noted in ***Section 250-6.5***, ***Table 297-9*** provides information about the bolt sizes and maximum torque allowed for beam type supports.

297-10 Bolt Tension

As noted in ***Section 250-4.6***, ***Table 297-10*** provides information from the **Society of Automotive Engineers Handbook** about the tensioning for bolts used with beam supports.

297-11 Sign Lighting Lamps and Ballast

As noted in ***Section 250-8.1***, ***Table 297-11*** provides information about types of lamps and ballasts used for sign lighting.

297-12 Guide Sign Sizes - English

As noted in ***Section 203-1***, ***Table 297-12*** shows sizes in English units for commonly used Guide Signs.

297-13 Guide Sign Sizes - Metric

As noted in ***Section 203-1***, ***Table 297-13*** shows sizes in metric units for commonly used Guide Signs.

297-14 Watershed Sign Locations

As noted in ***Section 206-17***, **ODOT** will install Watershed signs at (or as close as practical to) the locations shown in ***Table 297-14.***

297-15 Specific Service (Logo) Signing Program Eligibility Criteria

Table 297-15 summarizes the eligibility criteria for the Logo Signing Program described in ***Section 207-2.***

297-16 TODS Signing Program Eligibility Criteria

Table 297-16 summarizes the eligibility criteria for the TODS Signing Program described in ***Section 207-3.***

297-17 Memorial Highways and Bridges Established in ORC Chapter 5533

Table 297-17 provides a list of memorial highways and bridges established in **ORC Chapter 5533**, ***see Section 207-3.***

297-18 Memorial Highways and Bridges Established by ORC Sections 5511.01 and 5511.09

Table 297-18 provides a list of memorial highways and bridges established by **ORC Sections 5511.01 and 5511.09**, ***see Section 207-3.***

Intentionally blank.

Table 297-1. Sizes of Lane-Use Control Signs

Code number	Size (Inches)
R3-5	30x36, 36x42
R3-5a	30x36, 36x42
R3-6	30x36, 36x42
R3-H6a	30x36
R3-H6b	42x36
R3-H6e	30x36
R3-H8	30x30
R3-H8ba	30x30
R3-H8bb	30x30
R3-H8bc	30x30
R3-H8bd	30x30
R3-H8be	30x30
R3-H8bf	30x30
R3-H8bg	30x30
R3-H8bh	36x30
R3-H8bj	36x30
R3-H8bk	36x30
R3-H8bm	36x30
R3-H8bn	36x30
R3-H8bp	30x30
R3-H8bq	36x30
R3-H8bs	36x30
R3-H8bt	42x30
R3-H8bu	42x30
R3-H8a	48x30
R3-H8b	48x30
R3-H8ca	48x30
R3-H8cb	48x30

Code number	Size (Inches)
R3-H8cc	48x30
R3-H8cd	48x30
R3-H8ce	48x30
R3-H8cf	48x30
R3-H8cg	48x30
R3-H8ch	48x30
R3-H8cj	48x30
R3-H8ck	48x30
R3-H8cm	48x30
R3-H8cn	48x30
R3-H8cp	48x30
R3-H8cq	48x30
R3-H8cs	48x30
R3-H8ct	48x30
R3-H8cu	48x30
R3-H8cv	48x30
R3-H8cw	48x30
R3-H8cx	48x30
R3-H8cy	48x30
R3-H8cz	48x30
R3-H8caa	48x30
R3-H8cbb	48x30
R3-H8ccc	48x30
R3-H8cdd	48x30
R3-H8cee	54x30
R3-H8cff	54x30
R3-H8cgg	54x30
R3-H8chh	54x30
R3-H8da	54x30
R3-H8db	54x30

Code number	Size (Inches)
R3-H8dc	54x30
R3-H8dd	54x30
R3-H8de	54x30
R3-H8df	60x30
R3-H8dg	60x30
R3-H8dh	54x30
R3-H8dj	54x30
R3-H8dk	54x30
R3-H8dm	54x30
R3-H8dn	54x30
R3-H8dp	54x30
R3-H8dq	54x30
R3-H8dr	54x30
R3-H8ds	66x30
R3-H8dt	72x30
R3-H8du	60x30
R3-H8ea	66x30
R3-H8eb	66x30
R3-H8ec	72x30
R3-H8ed	72x30
R3-H8fa	78x30
R3-H8fb	78x30
R3-H8fc	84x30

Table 297-2. Lake Erie Circle Tour Routes

Dist	County	Route	From	To	Distance miles
2	LUC	I 75	Michigan State Line	I 280	3.49
2	LUC	I280	I 75	SR 2	4.02
2	LUC	SR 2	I 280	Ottawa County Line	12.96
2	OTT	SR 2	Lucas County Line	SR 358	16.40
2	OTT	SR 358	SR 2	SR 163	0.92
2	OTT	SR 163	SR 358	SR 269	10.53
2	OTT	SR 269	SR 163	SR 269 spur	1.71
2	OTT	SR 269 spur	SR 269	SR 2	0.62
2	OTT	SR 2	SR 269 spur	Erie County Line	1.63
3	ERI	SR 2	Ottawa County Line	US 6	4.30
3	ERI	US 6	SR 2	Loraine County Line	25.61
3	LOR	US 6	Erie County Line	Cuyahoga County Line	21.23
12	CUY	US 6	Loraine County Line	SR 2	14.25
12	CUY	SR 2	US 6	I 90	3.25
12	CUY	I 90	SR 2	SR 283	5.11
12	CUY	SR 283	I 90	Lake County Line	7.40
12	LAK	SR 283	Cuyahoga County Line	SR 535	16.32
12	LAK	SR 535	SR 283	US 20	4.85
12	LAK	US 20	SR 535	Ashtabula County Line	12.01
4	ATB	US 20	Lake County Line	SR 534	2.94
4	ATB	SR 534	US 20	SR 531	4.33
4	ATB	SR 531	SR 534	SR 7	22.72
4	ATB	SR 7	SR 531	US 20	1.22
4	ATB	US 20	SR 7	Pennsylvania State Line	2.08
				Total Distance	199.90

Table 297-3. Reserved for Future Information

Table 297-4. Signing for Traffic Generators on Freeways & Expressways

Type of Generator	Sign Type and Background Color	Criteria	Metropolitan Area over 100,000	Urbanized or Metropolitan Area under 100,000	Rural Area	Comments
Airport*, Ferry, Heliport, Bus Station, Train Station	Supplemental Guide Sign – green	Type	An airport* or ferry must be for public use and be shown on the Ohio Transportation Map. A heliport, bus station, or train station must have regularly scheduled departures and/or arrivals.			* Maximum distance from interchange may be extended to 15 miles for each category for commercial airports.
		Maximum distance from interchange	5 miles	7 miles	10 miles	
College, University, Post High School Educational Institute	Supplemental Guide Sign – green	Curriculum	Must be duly accredited. Must offer at least two years instruction and offer at least an Associate Degree.			
		Full time enrollment	4,000	1,000	1,000	Part-time students on a 2 for 1 basis may be used in meeting this criterion.
		Maximum distance from interchange	5 miles	7 miles	10 miles	Distance requirement may be waived by the DDD.
Joint Vocational School	Supplemental Guide Sign – green	Annual adult enrollment	11,000	8,000	5,000	Total adult attendance for all courses in a year
		Maximum distance from interchange	1 mile	3 miles	5 miles	
Major Military Installation	Supplemental Guide Sign – green	Number of employees or permanently assigned personnel	5,000	5,000	5,000	
		Maximum distance from interchange	3 miles	4 miles	5 miles	

Table 297-4. Signing for Traffic Generators on Freeways & Expressways (continued)

Type of Generator	Sign Type and Background Color	Criteria	Metropolitan Area over 100,000	Urbanized or Metropolitan Area under 100,000	Rural Area	Comments
Amusement Park, Arena, Auditorium, Convention Hall, Dam, Historical Site, Museum, Stadium, Zoo	Supplemental Guide Sign – brown	Annual attendance	200,000 plus 20,000 per mile of distance from interchange		100,000 plus 10,000 per mile of distance from interchange	
		Maximum distance from interchange	10 miles	10 miles	10 miles	
Recreation Area	Supplemental Guide Sign – brown	Annual attendance	200,000 plus 20,000 per mile of distance from interchange		100,000 plus 10,000 per mile of distance from interchange	
		Maximum distance from interchange	10 miles	10 miles	15 miles	
Fairground, Racetrack, Casino	Supplemental Guide Sign – brown	Annual attendance for permanent signs	200,000	200,000	200,000	
		Event attendance for temporary signs	20,000 plus 2,000 per mile of distance from interchange			
		Maximum distance from interchange	10 miles	10 miles	15 miles	
Law Enforcement Agency (State, County, Muni. Police)	D12-H16 blue	Maximum distance from interchange	1 mile	1 mile	2 miles	
Toll Highway, Toll Bridge	Supplemental Guide Sign – green	Location	Direct access from exit and a part of the state highway system.			
Central Business District (downtown)	Supplemental Guide Sign – green	Population	City of 300,000 or more population and no direct access to the downtown area.			

Table 297-5. Control City Destinations for Ohio's Interstate System

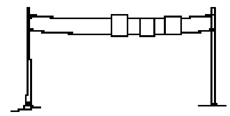
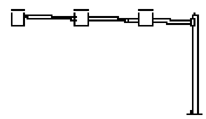
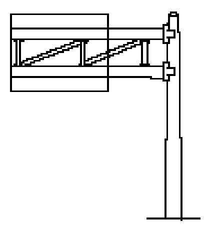
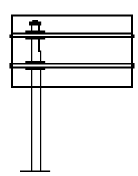
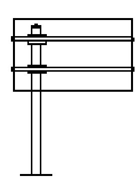
Interstate Route	Control City
I-70	Indianapolis - Dayton - Columbus - Wheeling
I-71	Louisville - Cincinnati - Columbus - Cleveland
I-74	Indianapolis - Cincinnati
I-75	Lexington - Cincinnati - Dayton - Toledo - Detroit
I-76	Akron - Youngstown - Pittsburgh
I-77 NB	Charleston - Marietta - Cleveland
I-77 SB	Cleveland - Akron - Canton - Marietta - Charleston
I-80	Chicago - Toledo -Youngstown - New York City
I-90	Chicago -Toledo - Cleveland - Erie

Table 297-6. Sign Copy

Direct Applied	Material	Attachment
Reflective copy and shields* on overhead Guide Signs	Type H or J reflective sheeting	Adhesive backing
Reflective copy and shields* on ground-mounted Guide Signs	Type G, H or J reflective sheeting	Adhesive backing
Nonreflective copy	Nonreflective black sheeting	Adhesive backing

* Interstate, U.S., State, County, Township, Ohio Turnpike, Hazardous Cargo

Table 297-7. Types of Overhead Sign Supports

Support Type	Allowable Sign Area, Sq. Ft.	Span or Arm Length, Ft.	Configuration	Notes
TC-17.10 Span Wire	10 to 132	20 to 90		-----------
TC-16.20 Single Arm	------------	Arm 23 to 45		-----------
TC-12.30 Cantilever	Up to 300 (Depending on Arm Length)	Arm 16 to 30		Alternate Version - Made of Untapered Tubes.
TC-9.10 Semi-Overhead	Up to 150	-------------		Sign may be eccentric to pole.
TC-9.30 Center Mount	Up to 250	______________		Sign may be eccentric to pole.

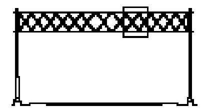
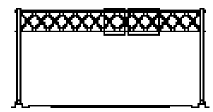
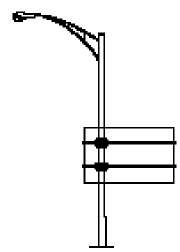
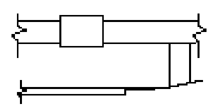
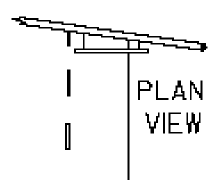
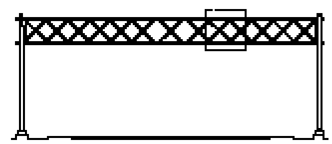
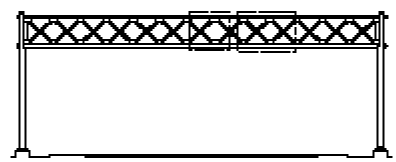
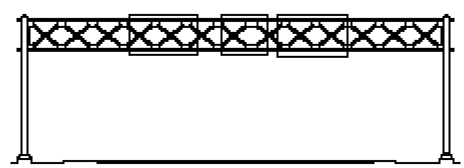
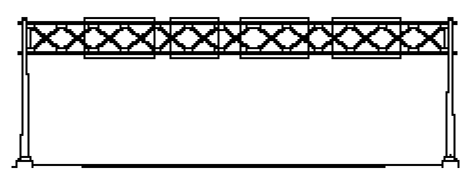
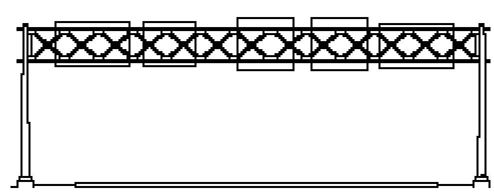
Support Type	Allowable Sign Area, Sq. Ft.	Span or Arm Length, Ft.	Configuration	Notes
TC-7.65 Aluminum Truss (Steel End Frames)	Design 6 Up to 600; Design 8 Up to 650	Design 6 40 to 75; Design 8 40 to 120		Design 6 ~ 3' sq. box Design 8 ~ 5' box
TC-15.115 Steel Truss (Steel End Frames)	Up to 1150	40 to 150		5' square box
Combination Sign Support	According to Sign Support	According to Sign Support		May be used to add a highway lighting function to 16.20, 12.30, 9.10 and 9.30
TC-18.24 Structure Mounted	-----------	-----------		Flush Mounting. Aluminum Brackets
TC-18.26 Skewed Structure	-----------	-----------		Aluminum Structure

Table 297-8a. Weight of Overhead Supports – Truss

Sign Support Type		Span, Ft.	Wt./Ft.	Total Wt. of Truss, lbs.	Configuration
Truss – end frames weigh from 1400 to 1800 pounds each.					
7.2	Des. 1	70	15.4	1150	
	Des. 2	85	16.2	1375	
	Des. 3	105	21.4	2250	
7.3	Des. 1	55	16.8	925	
	Des. 2	80	21.3	1700	
	Des. 3	90	21.1	1900	
	Des. 4	105	21.4	2250	
7.4	Des. 1	75	21.3	1600	
	Des. 2	85	21.2	1800	
	Des. 3	90	32.5	2925	
	Des. 4	110	32.7	3600	
7.5	Des. 1	70	21.4	1500	
	Des. 2	80	21.3	1700	
	Des. 3	86	32.6	2800	
	Des. 4	110	32.7	3600	
7.6	Des. 1	65	21.5	1400	
	Des. 2	75	21.3	1600	
	Des. 3	80	31.1	2650	
	Des. 4	110	32.7	3600	

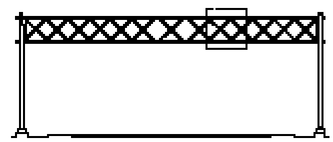
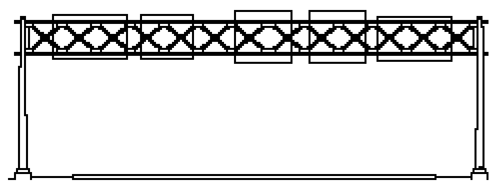
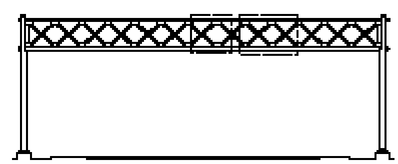
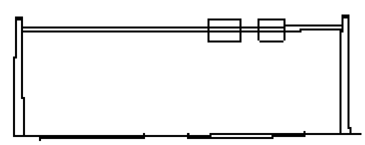
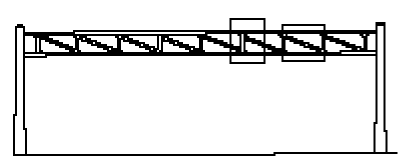
Sign Support Type		Span, Ft.	Wt./Ft.	Total Wt. of Truss, lbs.	Configuration
TC-7.65	Des. 6	55	21.8	1200	
	Des. 6	75	22.7	1700	
	Des. 8	75	29.0	2175	
	Des. 8	120	30.0	3600	
Steel Truss – end frames weigh from 1600 to 2000 pounds each.					
15.8		100	87.0	8700	
		140	87.2	12200	
TC-15.115		100	85	8500	
		140	84.3	11800	
Span Truss – each pole weighs 775 pounds.					
13.2	Des. 1	50		1275	
	Des. 2	60		1500	
	Des. 3	70		1800	
	Des. 4	80		2150	
Flat Truss – each pole weighs 1550 pounds.					
14.5	Des. 1	50		2250	
	Des. 2	60		2700	
	Des. 3	70		3200	
	Des. 4	80		2600	
	Des. 5	90		4050	

Table 297-8b. Weight of Overhead Supports - Semi-Overhead & Center Mount

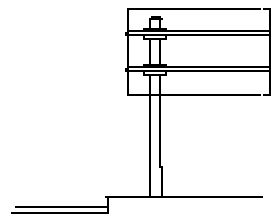
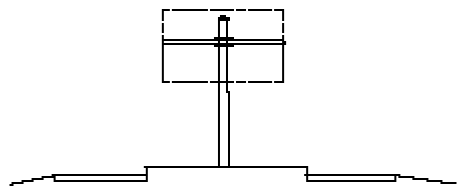
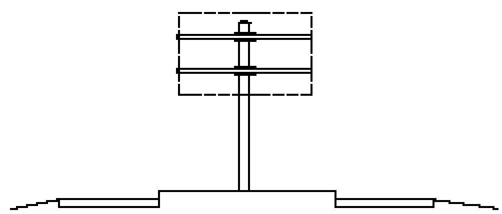
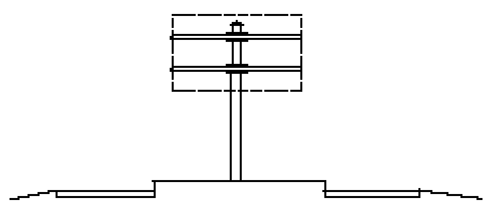
Sign Support Type		Total Wt. of Support, lbs.	Configuration
Semi-Overhead			
TC-9.10	Des. 1	650	
	Des. 2	900	
	Des. 3	1300	
Center Mount			
9.12	Des. 1	800	
	Des. 2	1100	
	Des. 3	1300	
9.24	Des. 1	1350	
	Des. 2	1550	
	Des. 3	1775	
	Des. 4	2300	
TC-9.30	Des. 1	975	
	Des. 2	1525	
	Des. 3	2350	
	Des. 4	4200	
	Des. 5	4500	

Table 297-8c. Weight of Overhead Supports - Butterfly

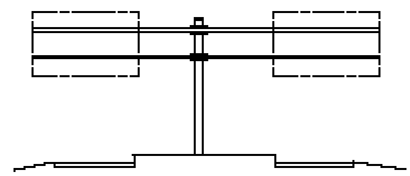
Sign Support Type		Total Wt. of One Set of Arms, lbs.	Total Wt. of Two Sets of Arms, lbs.	Configuration
10.48	Des. 1	1825	2150	
	Des. 2	1975	2500	
	Des. 3	2325	2800	
	Des. 4	2450	3000	
	Des. 5	3925	5000	
	Des. 6	3650	4400	
	Des. 7	4125	5400	
	Des. 8	5050	6700	
	Des. 9	5750	8000	

Table 297-8d. Weight of Overhead Supports - Single Arm

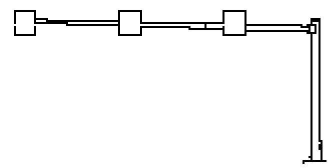
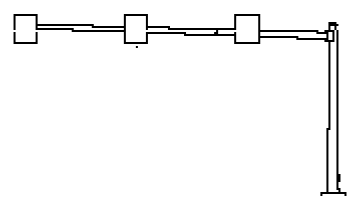
Sign Support Type		Arm Length, Ft.	Total Wt. of Support, lbs.	Configuration
16.10	Des. 1	38	2000	
	Des. 2	28	925	
	Des. 3	36	2350	
	Des. 4	42	2500	
	Des. 5	38	2050	
	Des. 6	28	1250	
	Des. 7	28	1800	
TC-16.20	Des. 1	23	800	
	Des. 2	31	1000	
	Des. 3	35	1200	
	Des. 4	43	1900	
	Des. 5	24	1150	
	Des. 6	27	1200	
	Des. 7	30	1250	
	Des. 8	33	1350	
	Des. 9	36	1800	
	Des. 10	39	2000	
	Des. 11	42	2050	
	Des. 12	45	2300	

Table 297-8e. Weight of Overhead Supports - Cantilever

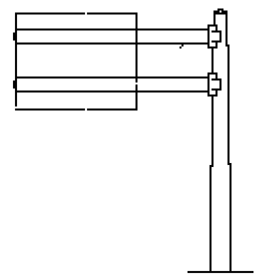
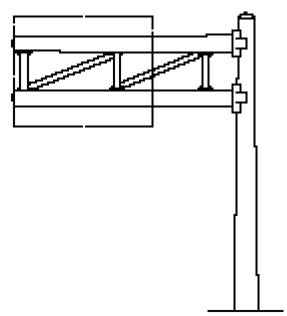
Sign Support Type		Total Wt. of Support, lbs.	Configuration
12.24	Des. 1	1300	
	Des. 2	1650	
	Des. 3	1750	
	Des. 4	2100	
	Des. 5	3300	
	Des. 6	3650	
	Des. 7	4000	
	Des. 8	5500	
12.30	Des. 1	1825	
	Des. 2	2450	
	Des. 3	2125	
	Des. 4	2875	
	Des. 5	3300	
	Des. 6	4000	
	Des. 7	4350	
	Des. 8	4650	
	Des. 9	5275	
	Des. 10	7000	
	Des. 11	6600	
	Des. 12	8400	

Table 297-8f. Weight of Overhead Supports - Structure Mounted

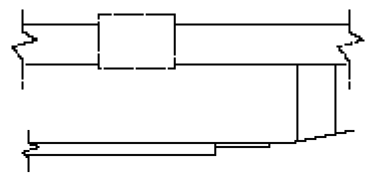
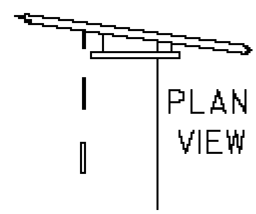
Sign Support Type		Total Wt. of Support, lbs.	Configuration
TC-18.24		Almost all the weight is involved in the sign; approximately 400 lbs. for a support with 10 x 10 foot extrusheet sign, including lights.	
TC-18.26	Des. 1	150	
	Des. 2	200	
	Des. 3	325	
	Des. 4	600	
	Des. 5	175	
	Des. 6	225	
	Des. 7	400	
	Des. 8	175	
	Des. 9	300	
	Des. 10	325	

Table 297-9. Bolt Size and Maximum Torque for Beams

Beam	
Type	**Size (inches)**
S4 x 7.7	4 x 2 5/8
W6 x 9	5 7/8 x 4
W10 x 12	9 7/8 x 4
W8 x 18	8 1/8 x 5 1/4
W10 x 22	10 1/8 x 5 3/4
W12 x 30	12 3/8 x 6 1/2

Bolt Size (inches)	Maximum Torque (in-lb)
1/2	200
1/2	200
3/4	750
3/4	750
1	1325
1	1325

Table 297-10. Bolt Tension

Bolt Tension		
Bolt Size (inches)	**80% Proof Load (lbs.)**	**Proof Load (lbs.)**
1/2	9,700	12,100
5/8	15,400	19,200
3/4	21,900	28,400
7/8	31,400	39,300
1	41,200	51,500
1 1/8	45,200	56,500
1 1/4	57,400	71,700
1 3/8	68,400	85,500
1 1/2	83,100	104,000

Table 297-11. Sign Lighting Lamps and Ballast

Lamp Watts	ANSI Lamp Code	Ballast Type
100	H38HT - 100	CMRI-100-(a)
175	H39KB - 175	CMRI-175-(a)
250	H37KB - 250	CMRI-250-(a)

Where (a) = Operating Voltage

Table 297-12. Guide Sign Sizes - English

Sign	Sign Code	Sign Size in Inches (width x height)								Comments
		Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	
Route Sign (Interstate, Interstate Loop, Interstate Spur, US, State)	M1-1 M1-2 M1-3 M1-4 M1-5	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	36 x 36 (1 or 2 digits) 45 x 36 (3 digit)	36 x 36 (1 or 2 digits) 45 x 36 (3 digit)	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	24 x 24 (1 or 2 digits) 30 x 24 (3 digit)	
Ohio Turnpike	M1-H5a	24 x 24	24 x 24	24 x 24	24 x 24	36 x 36	36 x 36	24 x 24	24 x 24	
Route Sign (County, Township)	M1-6 M1-H6a M1-H6b	24 x 24	24 x 24	24 x 24	24 x 24	36 x 36	36 x 36	24 x 24	24 x 24	
JCT Auxiliary	M2-1	21 x 15	21 x 15	21 x 15	21 x 15	30 x 24	--	—	—	
Combination Route Junction	M2-H2a	—	--	--	—	96 x 96	--	—	—	Refer to Figure 298-28
Combination Route Directional	M2-H3	48 x var	48 x var	48 x var	48 x var	48 x var	--	48 x var	48 x var	Refer to Figure 298-28
Combination Route Multi-Directional	M2-H4	108 x 36	108 x 36	108 x 36	108 x 36	108 x 36	--	108 x 36	108 x 36	Refer to Figure 298-28

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height): Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	Comments
Combination Route Multi-Directional	M2-H5	108 x 48	108 x 48	108 x 48	108 x 48	108 x 48	---	108 x 48	108 x 48	
Word Message Auxiliary (except JCT)	M3-1 M3-2 M3-3 M3-4 M4-1 M4-1a M4-2 M4-3 M4-4 M4-5 M4-6 M4-7 M4-7a	24 x 12	24 x 12	24 x 12	24 x 12	36 x 18	36 x 18	24 x 12	24 x 12	
Advance Turn and Directional Arrow Auxiliary	M5-1 M5-2 M6-1 M6-2 M6-3 M6-4 M6-5 M6-6 M6-7	21 x 15	21 x 15	21 x 15	21 x 15	30 x 24	30 x 24	21 x 15	21 x 15	
Destination (1 dest)	D1-H1 D1-H1a	48 x 8 (1 line) 48 x 16 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	---	---	---	---	

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height)								Comments
		Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	
Destination (1 dest)	D1-H15 D1-H15a	—	---	---	—	var x 36	---	var x 24	var x 24	Refer to Figure 298-28
Destination (2 dest)	D1-H16 D1-H16a	—	---	---	—	var x 72	---	var x 48	var x 48	Refer to Figure 298-28
Destination (3 dest)	D1-H17 D1-H17a	—	---	---	—	var x 108	---	var x 72	var x 72	
Distance (1 line)	D2-H1	—	72 x 12	---	96 x 24	---	---	---	—	
Distance (2 line)	D2-H2	—	72 x 24	---	96 x 36	---	---	---	—	
Distance (3 line)	D2-H3	—	72 x 36	---	96 x 48	---	---	---	—	
Street Name	D3-H1 D3-H1b	48 x 8 (1 line) 48 x 16 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	---	---	—	Refer to Figures 298-29, 298-30, 298-31 and 298-32. These signs are used at the intersection. They are also used in advance of the intersection on multi-lane conventional roads.
Street Name	D3-H3 D3-H3a	—	---	---	—	var x 36	---	var x 24	—	Refer to Figure 298-28
Advance Street Name	D3-H4	—	---	---	—	var x 60	---	---	—	Refer to Figure 298-28
Combination Street Name	D3-H5	—	---	---	—	—	---	var x 36	—	
Street Name (with county or township name)	D3-H6b D3-H6c	48 x 10 (1 line) 48 x 16 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	---	---	—	These signs may be used as alternatives to the D3-H1 and D3-H1b signs at the intersection.

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height)								Comments
		Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	
REST AREA 1 MILE	D5-H1	72 x 36	72 x 36	72 x 36	72 x 36	120 x 60	120 x 60	--	—	Refer to Figures 298-39, 298-40 and 298-41
REST AREA NEXT RIGHT	D5-H1a	—	---	--	—	120 x 60	120 x 60	--	—	Refer to Figure 298-39
REST AREA (with angled arrow)	D5-H2	—	---	--	—	120 x 60	120 x 60	--	—	Refer to Figure 298-39
REST AREA (gore with angled arrow)	D5-H2a	—	---	--	—	72 x 72	72 x 72	--	—	Refer to Figure 298-39
REST AREA (with horizontal arrow)	D5-5	42 x 48	42 x 48	42 x 48	42 x 48	---	---	--	—	Refer to Figures 298-40 and 298-41
NEXT REST AREA XX MILES	D5-6	—	---	--	—	96 x 72	96 x 72	--	—	Refer to Figure 298-39
REST AREA TOURIST INFO CENTER 1 MILE	D5-H7	—	---	--	—	144 x 96	144 x 96	--	—	Alternate legend: OHIO WELCOME CENTER
TOURIST INFO CENTER (plaque)	D5-H7aP	—	---	--	—	108 x 48	108 x 48	--	—	
TOURIST INFO (plaque)	D5-H7bP	—	---	--	—	108 x 24	108 x 24	--	—	
TOURIST INFO CENTER NEXT RIGHT	D5-H7c	—	---	--	—	144 x 72	144 x 72	--	—	

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height): Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	Comments
LOCAL TOURIST INFO CENTER NEXT RIGHT	D5-H7d	--	--	--	--	156 x 72	156 x 72	--	--	
REST AREA TOURIST INFO CENTER (with angled arrow)	D5-H8	--	--	--	--	144 x 96	144 x 96	--	--	Alternate legend: OHIO WELCOME CENTER
OHIO WELCOME CENTER (plaque)	D5-H9aP	--	--	--	--	120 x 48	120 x 48	--	--	
REST AREA TOURIST INFO CENTER NEXT RIGHT	D5-H11	--	--	--	--	144 x 96	144 x 96	--	--	Alternate legend: OHIO WELCOME CENTER
VENDING MACHINES	D5-H50P	--	--	--	--	120 x 24	120 x 24	--	--	
SAFETY BREAK FREE COFFEE	D5-H51P	--	48 x 48	--	48 x 48	48 x 48	48 x 48	--	--	
SAFETY BREAK FREE COFFEE	D5-H52P	--	--	--	--	120 x 48	120 x 48	--	--	The D5-H52P sign may be used in lieu of the D5-H51P sign on freeway and expressway routes
ENTERING (rec area) REGION	D7-H3	var x 18	var x 18	var x 24	var x 24	--	--	--	--	

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height): Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	Comments
ENTERING (rec area) REGION	D7-H3a	--	--	--	--	var x 60	var x 60	--	--	
Recreational Destination (1 dest)	D7-H1 D7-H1a	48 x 8 (1 line) 48 x 16 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	72 x 12 (1 line) 72 x 24 (2 lines)	96 x 24 (1 line) 96 x 36 (2 lines)	--	--	--	--	
Recreational Destination (1 dest)	D7-H15 D7-H15a	--	--	--	--	var x 36	--	var x 24	var x 24	
Recreational Destination (2 dest)	D7-H16 D7-H16a	--	--	--	--	var x 72	--	var x 48	var x 48	
Recreational Destination (3 dest)	D7-H17 D7-H17a	--	--	--	--	var x 108	--	var x 72	var x 72	
HISTORIC MARKER 500 FT	D7-H8	24 x 24	24 x 24	24 x 24	36 x 36	--	--	--	--	
HISTORIC MARKER AHEAD	D7-H8a	24 x 24	24 x 24	24 x 24	36 x 36	--	--	--	--	
HISTORIC MARKER (with arrow)	D7-H9	24 x 24	24 x 24	24 x 24	36 x 36	--	--	--	--	
TOURISM INFO 1-800-BUCKEYE	D7-H10P	--	--	--	--	84 x 12 120 x 12	84 x 12 120 x 12	--	--	For signs 120 inches wide and greater, use the 120 x 12 size. For narrower signs, use the 84 x 12 size.

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height): Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Expressway	Freeway	Expressway and Freeway Exit Ramp	Expressway and Freeway Entrance Ramp Approach	Comments
WELCOME TO OHIO	I-H2	60 x 30	60 x 30	60 x 30	60 x 30	—	—	—	—	
CORPORATION LIMIT	I-H2a	48 x 24	48 x 24	48 x 24	48 x 24	var x 36	var x 36	—	—	
ENTER CORP	I-H2b	24 x 18	24 x 18	24 x 18	24 x 18	36 x 24	36 x 24	—	—	12 x 12 size may be used in lieu of sizes shown
LEAVE CORP	I-H2c	24 x 18	24 x 18	24 x 18	24 x 18	36 x 24	36 x 24	—	—	12 x 12 size may be used in lieu of sizes shown
Unincorporated Community	I-H2d	48 x 24	48 x 24	48 x 24	48 x 24	—	—	—	—	
TOWNSHIP LIMIT	I-H2e	48 x 24	48 x 24	48 x 24	48 x 24	var x 36	var x 36	—	—	
ENTER (county) LEAVE (county)	I-H2f	48 x 24	48 x 24	48 x 24	48 x 24	—	—	—	—	
ENTER (county)	I-H2g	60 x 12	60 x 12	60 x 12	60 x 12	—	—	—	—	For use as a supplemental plaque below the I-H2 state line sign
ENTERING (county)	I-H2h	—	—	—	—	var x 48	var x 48	—	—	
Geographical Feature (e.g. Stream Name)	I-3	var x 18	var x 18	var x 18	var x 18	var x 36	var x 36	—	—	
Airport Name (with arrow)	I-H5a	36 x 36	36 x 36	36 x 36	36 x 36	—	—	—	—	
NEXT EXIT XX MILES (one line)	E2-H1P	—	—	—	—	144 x 24	144 x 24	—	—	For use with guide signs 144 inches wide and greater

Table 297-12. Guide Sign Sizes - English (Continued)

Sign	Sign Code	Sign Size in Inches (width x height): Urban Single Lane Conv Road (25 mph or less)	Single Lane Conv Road	Urban Multi-Lane Conv Road (25 mph or less)	Multi-Lane Conv Road	Express-way	Freeway	Express-way and Freeway Exit Ramp	Express-way and Freeway Entrance Ramp Approach	Comments
NEXT EXIT XX MILES (two lines)	E2-H1aP	—	--	--	—	84 x 36	84 x 36	--	—	For use with guide signs 84 to 132 inches wide
EXIT (with angled arrow, for unnumbered exits)	E5-H1	—	--	--	—	72 x 60	72 x 60	--	—	
EXIT (with exit number and angled arrow)	E5-H1a	—	--	--	—	var x 60	var x 60	--	—	
Narrow Exit Gore	E5-H1c	—	--	--	—	48 x 84	48 x 84	--	—	
(Community Name) NEXT XX EXITS	E7-H4	—	--	--	—	var x 60	var x 60	--	—	

Table 297-13. Reserved for Future Information

Table 297-14. Watershed Sign Locations

Dist	County	Route	Direction	Section	Sign Legend
3	Medina	I-71	North	12.11	Entering Lake Erie Watershed
3	Medina	I-71	South	12.11	Entering Ohio River Watershed
4	Ashtabula	SR 11	North	5.74	Entering Lake Erie Watershed
4	Ashtabula	SR 11	South	5.74	Entering Ohio River Watershed
4	Portage	I-76	West	10.73	Entering Lake Erie Watershed
4	Portage	I-76	East	10.73	Entering Ohio River Watershed
4	Summit	I-76	East	10.02	Entering Lake Erie Watershed
4	Summit	I-76	West	10.02	Entering Ohio River Watershed
4	Summit	I-77	North	22.95	Entering Lake Erie Watershed
4	Summit	I-77	South	22.95	Entering Ohio River Watershed
6	Marion	US 23	North	19.28	Entering Lake Erie Watershed
6	Marion	US 23	South	19.28	Entering Ohio River Watershed
7	Auglaize	I-75	North	0.06	Entering Lake Erie Watershed
7	Auglaize	I-75	South	0.06	Entering Ohio River Watershed

Table 297-15. Specific Service (Logo) Signing Program Eligibility Criteria

	Fuel	Food	Lodging	Camping	Attraction **
Maximum Number of Logos per Direction	12	12	12	12	12
Maximum Distance of Service	3 miles	3 miles	3 miles	3 miles*	3 miles – urban 15 miles - rural
Minimum Period of Operation	Continuous operation 16 hours per day, 7 days per week; 360 days per year.	Continuous operation 12 hours per day, 360 days per year (if space is available on the sign, the business may be closed one day per week).	Continuous operation 24 hours per day, 7 days per week.	Continuous operation 24 hours per day, 7 days per week (seasonal operation is allowed).	Open for a minimum of 40 hours a week, 5 days per week, one of which must be either a Saturday or Sunday, except for an arena, stadium, convention center, or not-for-profit attraction.
Required Service to be Provided & Other Requirements	Possess: Licensing by all appropriate authorities. Provide: Vehicle services including gas, vehicle fuel, diesel and/or alternative fuel; Restroom facilities; Public telephone; Drinking water.	Possess: Licensing by all appropriate authorities; Seating capacity for sit-down, eat-in service with a minimum seating for 24 guests. Provide: Restroom facilities; Public telephone; Drinking water.	Possess: Licensing by all appropriate authorities. Provide: A minimum of 8 rooms available with sleeping and bathroom accommodations; Public telephone.	Possess: Licensing by all appropriate authorities; Valid permits from all appropriate health departments. Provide: A minimum of 50 camping sites; Restroom and shower (hot and cold water). Janitorial service must be provided daily for toilet and shower facilities, refuse disposal and modern sanitary facilities; Public drinking water; Public telephone;	Possess: Have regional significance. Provide: Adequate parking; Public restroom facilities; Drinking water.

* This distance may be extended under certain circumstances as outlined in the ODOT Business Eligibility Rule 5501-2-6-05.

** Attraction means an arena, stadium, amusement park, historical society, historical district, museum, scenic attraction, natural attraction, convention center, zoo, aquarium, shopping center (minimum area 400,000 square feet) winery or a privately owned recreation area.

Table 297-16. TODS Signing Program Eligibility Criteria

	Cultural	Historical	Educational	Recreational	Commercial
Activities	Drama Theaters Galleries	Historic Areas Caves Memorials Reservations Mansions	Museums Tours Colleges Universities Vo-Tech	Arenas Lake/Beach Parks Camping Golf Sports Complexes Speedway Amusement Parks	Antiques Crafts Malls Winery Farm Markets
Maximum # of Activities per Direction / Intersection	12	12	12	12	12
General Eligibility Criteria	▸ Must derive a major portion of its income or motorists during the normal business season from motorists not residing in the immediate area (within 10 miles of the tourist-oriented activity). ▸ Hours of operation: 8 hours per day; and 5 days per week (one of which must be a Saturday or Sunday). ▸ Attendance of at least 2,000 in 12 consecutive months. ▸ Is not eligible to participate in the Logo Signing Program. ▸ Maximum distance of service from the signed intersection is 10 miles.				

Table 297-17. Memorial Highways and Bridges Established by ORC Chapters 5533 & 5534

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.01	None specified	09-28-1973	various	All state and federal highways at points crossed by Morgan's raiders in 1863	May erect suitable markers	5, 8, 9, 10,11	Must be coordinated with the Ohio state archaeological and historical society
5533.02	Atlantic and Pacific Highway	10-01-1953	SR7	Cincinnati to Gallipolis except Rome Township in Lawrence County	No action required	8, 9, 10	
			SR509	Within Rome Township in Lawrence County	No action required	9	
5533.03	Grand Army of the Republic Highway	09-28-1973	US6	Entire length in Ohio	May erect suitable markers	2, 3, 4, 12	
5533.04	General McPherson Highway	09-28-1973	US20	Entire length in Ohio	May erect suitable markers	2, 3, 4, 12	
5533.05	United Spanish War Veterans Memorial Highway	09-28-1973	US23	Entire length in Ohio	May erect suitable markers	1, 2, 6, 9	
	Scioto Trail	09-28-1973	US23	Scioto County thru Wyandot County	May erect suitable markers	1, 6, 9	
5533.051	Branch Rickey Memorial Highway	04-06-2009	US23	Franklin/Delaware County Line to Delaware Corp. Limit	May erect suitable markers	6	
5533.052	Staff Sergeant Christopher L. Brown Memorial Highway	03-22-2013	US23	Franklin County, Seventh Avenue to Northwood Avenue within Columbus	May erect suitable markers	6	
5533.06	Thirty-Seventh Division Memorial Highway	09-28-1973	SR3	Entire length	May erect suitable markers	3, 5, 6, 8, 11, 12	
5533.07	Forty-Second Rainbow Division Memorial Highway	09-28-1973	US42	Entire length in Ohio	May erect suitable markers	3, 6, 7, 8, 12	ORC indicates SR42
5533.071	Warren County Veterans Highway	03-22-2013	US42	Entire length in Warren County	May erect suitable markers	8	
5533.08	Eighty-Third Division Memorial Highway	09-28-1973	US21	Washington County thru Cuyahoga County	May erect suitable markers	3, 4, 5, 10, 11, 12	US21 does not exist
5533.09	Military Order of the Purple Heart Memorial Highway	03-15-2001	I-76	I-71 to I-80	May erect suitable markers	3, 4	
	Purple Heart Trail	03-24-2008	I-70	Entire length in Ohio	May erect suitable markers	5, 6, 7, 8, 11	
	Purple Heart Trail	03-24-2008	I-71	Entire length in Ohio	May erect suitable markers	3, 6, 8, 12	
5533.091	The Luke 'Doc' Emch and Matt 'Doc' Conte Corpsmen Memorial Highway	04-06-2009	I-76	Within Brimfield Township, Portage County	May erect suitable markers	4	
5533.092	Peter J. Delucia Memorial Bridge	04-06-2009	I-76	Lake Milton bridge	May erect suitable markers	4	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.093	Corporal Jason J. Hernandez Memorial Highway	05-31-2010	SR43	Ethan Avenue to Kennedy Road, Portage County	May erect suitable markers	4	
5533.094	Lance Corporal Daniel Nathan Deyarmin Jr. Memorial Highway	03-22-2013	I-76	Summit County, SR91 to SR532	May erect suitable markers	4	
5533.095	Staff Sgt. Howard E. Woodford Medal of Honor Recipient Memorial Highway	03-22-2013	SR619	Summit County, Lockwood Rd. to East State Street within Barberton	May erect suitable markers	4	
5533.10	George Washington Highway	09-28-1973	US50 US50A	Entire length in Ohio	Shall erect black on white 12” x 18” enamel markers	8, 9, 10	
5533.101	LCPL Nicholas B. Erdy Memorial Highway	04-06-2009	US50	MM 13 to SR133 in Clermont County	May erect suitable markers	8	
5533.102	Pfc. Zachary Gullett Memorial Highway	09-23-2011	US50	MM12 to MM24 in Highland County	May erect suitable markers	9	
5533.103	Ryan Seitz Memorial Highway	09-23-2011	US50	Entire length in Vinton County	May erect suitable markers	10	
5533.104	Lance Cpl. Aaron Reed Memorial Highway	03-22-2013	US50	From US35 to SR327 in Ross County	May erect suitable markers	9	
5533.11	General Duncan McArthur Highway	09-28-1973	SR28	Entire length	Shall erect black on white enamel markers	8, 9	
5533.12	Sherman-Sheridan-Stanton-Custer Highway	09-28-1973	US22	Entire length in Ohio	Shall erect suitable markers	5, 6, 8, 11	
5533.121	U.S Army Staff Sergeant Lester O. Kinney II Memorial Highway	07-01-2013	US22	Muskingum County within Zanesville	May erect suitable markers	5	
5533.13	Governor Thomas Kirker Highway	09-28-1973	SR136	Entire length	Shall erect suitable markers	9	
5533.14	Wright Brothers Memorial Highway	09-28-1973	SR4	Entire length	Shall erect black on white enamel markers	2, 3, 6, 7, 8	
5533.15	Governor Robert Lucas Highway	09-28-1973	SR124	Entire length	Shall erect suitable markers	8, 9, 10	
5533.16	Johnny Appleseed Highway	09-28-1973	US68	SR31 to Toledo	May erect suitable markers	1, 2	
			SR31	US68 to US36	May erect suitable markers	1, 6	
5533.17	Gold Star Mothers’ Memorial Highway	11-02-1959	SR82	Entire length	No action required	3, 4, 12	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.171	Sergeant Dennis E. Kancler Memorial Highway	03-22-2013	SR82	I-77 to Brecksville Corp. Limit	May erect suitable markers	12	
5533.18	Thomas A. Edison Memorial Bridge	09-28-1973	SR2	Sandusky Bay bridge	Shall erect suitable markers	2, 3	
5533.19	Tom Jenkins Memorial Highway	09-28-1973	US52	Within Lawrence County	Shall erect suitable markers	9	
5533.20	Old Zane Trace Memorial Highway	09-28-1973	SR41	US52 to US50 (west junction)	Shall erect suitable markers	9	ORC indicates SR50 instead of US50
5533.21	Jeremiah Morrow Bridge	09-28-1973	I-71	Little Miami River bridge	Shall erect suitable markers	8	
5533.22	Camp Sherman Memorial Highway	06-13-1996	SR104	US35 to SR207	May erect suitable markers	9	ORC indicates SR35 instead of US35
5533.23	Simon Kenton Trace Highway	09-28-1973	SR72	Entire length	May erect suitable markers	7, 8, 9	
5533.24	American Legion Memorial Highway	09-28-1973	I-75	Entire length in Ohio	May erect suitable markers	1, 2, 7, 8	
5533.241	Pearl Harbor Memorial Highway	03-05-2004	I-75	Entire length in Ohio	May erect suitable markers	1, 2, 7, 8	
5533.25	Donald H. Rolf Circle Freeway	07-26-1982	I-275	Entire length in Ohio	Shall erect suitable markers	8	
5533.251	S. Sgt. Matt Maupin Veteran’s Memorial Highway	04-06-2009	I-275	Within Clermont County	May erect suitable markers	8	
5533.252	Sgt. Steven Conover – Veterans Memorial Highway	09-23-2011	SR73	Entire length in Clinton County	May erect suitable markers	8	
5533.253	Lance Cpl. Brett Wightman – Veterans Memorial Highway	09-23-2011	SR729	Entire length in Clinton County	May erect suitable markers	8	
5533.254	Sergeant David Kreuter Memorial Highway	03-22-2013	SR264	Hamilton County – Cleves Corp. Limit to South Road	May erect suitable markers	8	
5533.26	James A. Rhodes Appalachian Highway	09-28-1973	SR32	Entire length	Shall erect suitable markers	8, 9, 10	
5533.27	Great Seal Memorial Highway	09-28-1973	US23	SR159 to SR104	Shall erect suitable markers	9	
5533.27	Great Seal Memorial Highway	09-28-1973	US35	Scioto River bridge northwest of Chillicothe to the Scioto River bridge southeast of Chillicothe	Shall erect suitable markers	9	
5533.28	Lake to River Highway	09-28-1973	SR11	Entire length	Shall erect suitable markers	4, 11	
5533.281	Marine Private Henry Kalinowski Memorial Highway	04-06-2009	SR11	Within Ashtabula County	May erect suitable markers	4	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.29	General Thaddeus Kosciusko Memorial Highway	09-28-1973	SR257	Prospect Corp. Limit to US33	May erect suitable markers	6	
5533.30	Veterans of Foreign Wars Memorial Highway	05-07-1976	I-70	Entire length in Ohio	May erect suitable markers	5, 6, 7, 8, 11	
5533.301	Staff Sgt. Jesse Ault Memorial Highway	03-22-2013	I-70	Exit 208 to Exit 213	May erect suitable markers	11	
5533.31	Christopher Columbus Highway	09-16-1977	I-80	Entire length in Ohio	May erect suitable markers	2, 3, 4, 12	
5533.32	Disabled American Veterans' Highway	09-08-1977	I-71	Entire length in Ohio	May erect suitable markers	3, 6, 8, 12	
5533.321	First Lieutenant John Runkle Memorial Highway	03-22-2013	I-71	MM195 to MM 202	May erect suitable markers	3	
5533.322	Master Sergeant Shawn T. Hannon Memorial Highway	03-22-2013	I-71	Stringtown Rd to SR665 in Jackson Township within Grove City	May erect suitable markers	6	
5533.323	Army PFC Robert S. Sombati, Vietnam BSM and OLC PH, Memorial Highway	03-22-2013	I-77	MM133.6 to MM 134.8 Summit County	May erect suitable markers	4	
5533.33	Trooper James R. Gross Memorial Highway	05-14-2002	I-71	MM 189 to MM 191	May erect suitable markers	3	
5533.331	Deputy Brandy Winfield Memorial Highway	09-28-2006	SR423	Bethlehem Road to Marion-Cardington Road in Marion County	May erect suitable markers	6	
5533.332	Corporal Brad D. Squires Memorial Highway	04-06-2009	I-71	Within Middleburg Heights	May erect suitable markers	12	
5533.333	Sgt. Jeremy Murray Memorial Highway	05-31-2010	SR44	County Road 18 in Rootstown to Waterloo Road in Randolph	May erect suitable markers	4	
5533.334	Lance Corporal Thomas O. Keeling Memorial Highway	05-31-2010	I-71	Within Strongsville	May erect suitable markers	12	
5533.335	Lance Corporal David Raymond Baker Memorial Highway	05-31-2010	SR2	SR44 to Painesville exit	May erect suitable markers	12	
5533.34	Melvin E. Newlin Memorial Highway	03-15-2002	SR7	Jefferson/Columbiana County Line to East Liverpool west Corp. Limit	May erect suitable markers	11	
5533.341	Coxswain Robert B. Wood Memorial Highway	09-23-2011	SR9	Hanoverton Corp. Limit to New Garden Corp. Limit in Columbiana County	May erect suitable markers	11	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.35	Amvets Highway	08-04-1978	I-90	Ohio Turnpike to Pennsylvania State line	May erect suitable markers	3, 4, 12	
5533.351	The Ohio Veterans Memorial Bridge	04-06-2009	US20	Conneaut Creek bridge in Conneaut	May erect suitable markers	4	Duplicate of ORC Section 5533.78
5533.352	Cpl. Joshua Harmon Memorial Highway	04-06-2009	I-90	Within Willoughby Hills in Lake County	May erect suitable markers	12	
5533.353	Lance Corporal David Mendez Ruiz Memorial Highway	09-23-2011	US42	Denison Ave. to Memphis Ave. in Cuyahoga County	May erect suitable markers	12	
5533.354	LCPL Danny Scherry Memorial Highway	04-06-2009	I-90	Within Rocky River in Cuyahoga County	May erect suitable markers	12	
5533.355	U.S. Marine Lance Corporal David R. Hall Highway	09-23-2011	SR2	Within Lorain County	May erect suitable markers	3	
5533.356	Sheriff's Lieutenant John P. Gisclon Memorial Highway	03-22-2013	US 250	CR 758 and TR 856 in Ashland County	May erect suitable markers	3	
5533.357	Army Specialist Gavin Colburn Memorial Highway	03-22-2013	SR 138	CR 127 to SR 207 in Ross County	May erect suitable markers	9	
5533.358	Air Force Master Sergeant Brad Clemmons Memorial Highway	03-22-2013	CR 104	US50 to US23 within Chllicothe	May eret suitable markers	9	
5533.36	Lou Groza Highway	12-23-1986	SR7	Within Belmont County and in Martins Ferry	May erect suitable markers	11	
5533.37	Vietnam Veterans' of America Highway	06-13-1996	I-77	Entire length in Ohio	Shall erect at least two suitable markers	4, 5, 10, 11, 12	
5533.371	Pfc. Ralph Dias Memorial Highway	04-06-2009	SR344	Leetonia west Corp. Limit to SR11	May erect suitable markers	11	
5533.372	Staff Sgt. Matthew J. Kuglics Memorial Highway	05-31-2010	I-77	MM 116 to MM 118	May erect suitable markers	4	
5533.373	Senior Airman Alecia Good Memorial Highway	09-23-2011	I-77	Within Broadview Heights	May erect suitable markers	12	
5533.374	U.S.M.C. Pvt. Heath Warner Memorial Highway	10-27-2011	I-77	SR800 to Dressler Rd. in Stark County	May erect suitable markers	4	
5533.375	Army Specialist Four Robert J. Urbassik Memorial Highway	09-23-2011	I-480	Exit 12 to Exit 13	May erect suitable markers	12	
5533.376	Army Private First Class Keith Nepsa Memorial Highway	09-23-2011	I-77	MM79 to MM81 in Tuscarawas County	May erect suitable markers	11	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.377	Lance Corporal Peter James Clore Memorial Highway	03-22-2013	SR39	Ridge Av. NE to Tall Timber Rd. NE in New Philadelphia	May erect suitable markers	11	
5533.378	U.S.M.C. Sgt. Daniel J. Patron Memorial Highway	03-22-2013	SR172	Jackson Ave. to Perry Drive in Stark County	May erect suitable markers	4	
5533.379	Staff Sergeant Joshua Gire Memorial Highway	03-22-2013	SR772	In Ross County from Pike County Line to Chillicothe Corp. Limit	May erect suitable markers	9	
5533.38	Edward J. Parish Highway	09-16-1998	SR125	Within Clermont County	May erect suitable markers	8	
5533.39	Walter ‘Smokey’ Alston Memorial Highway	11-22-1999	SR177	Within Darrtown Corp. Limits	May erect suitable markers	8	
5533.40	William ‘Hopalong Cassidy’ Boyd Memorial Highway	11-02-1999	SR800	Within Hendrysburg Corp. Limits	May erect suitable markers	11	
5533.41	General Walter Churchill Highway	11-02-1999	US23	I-475 to Michigan State line	May erect suitable markers	2	
5533.42	William J. Brown Memorial Highway	08-29-2000	US250	Within Harrison County	May erect suitable markers	11	
5533.43	McClernon-Skyway Memorial Drive	09-22-1989	SR844	I-675 to Wright-Patterson AFB	May erect suitable markers	8	ORC indicates SR444A instead of SR844
5533.44	Rosa Parks Highway	09-13-1989	I-475	Entire length	May erect suitable markers	2	
5533.45	Art Bowers Memorial Highway	05-31-1990	US72	SR7 to Jefferson County Road 22A	May erect suitable markers	11	
5533.46	U.S. Grant Memorial Highway	04-22-1997	US52	Entire length in Ohio	Shall use appropriate discretion with regards to signs	8, 9	
5533.461	U.S.M.C. LCpl Jonathan Etterling Memorial Highway	03-22-2013	US52	Scioto County MM26 to MM31	May erect suitable markers	9	
5533.47	Catholic War Veterans of U.S.A. Highway	12-18-1997	I-280	Between Oregon and Toledo	May erect suitable markers	2	
5533.48	Cliff Skeen Memorial Highway	09-16-1998	US224	SR241 to SR91	May erect suitable markers	4	
5533.49	Simon Kenton Memorial Highway	06-01-1998	US68	North edge of the Simon Kenton Memorial Bridge over the Ohio River to the Kenton north Corp. Limit	May erect suitable markers	1, 7, 8, 9	
5533.491	Ron Burton Memorial Highway	10-13-2004	US68	Within Springfield Township, Clark County to Springfield north Corp. Limit	May erect suitable markers	7	
5533.50	John Kalaman and Robert O’Toole Memorial Highway	09-16-1998	I-675	Entire length	May erect suitable markers	7, 8	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.51	William Green Memorial Highway	11-02-1999	US36	Coshocton Corp. Limit to Coshocton/ Tuscarawas County Line	May erect suitable markers	5	
5533.52	Korean War Veterans' Memorial Highway	10-24-2002	US36	Coshocton/Tuscarawas County Line to I-77	May erect suitable markers	11	
			US36	Champaign/Miami County Line to Indiana State Line	May erect suitable markers	7	
			I-280	I-80 to the Wood/Lucas County Line	May erect suitable markers	2	
			SR8	Within Summit County	May erect suitable markers	4	
		05-31-2010	I-680	Within Mahoning County	May erect suitable markers	4	
5533.53	Annie Oakley Memorial Pike	08-29-2000	US127	Within Darke County	May erect suitable markers	7	
5533.531	Earle Baltes Highway	09-29-2007	SR118	St. Henry south Corp. Limit to SR47	May erect suitable markers	7	
5533.54	A.G. Lancione Memorial Highway	02-13-2001	SR7	MM 14.7 to MM 17.8	May erect suitable markers	11	
5533.541	First Lt. Christopher Rutherford Memorial Highway	09-23-2011	SR7	MM31 in Washington County to Monroe County Line	May erect suitable markers	10	
5533.55	Reverend Dr. Sam Wells, Jr., Memorial Viaduct	06-18-2002	US20	Ashtabula River viaduct in Ashtabula and Ashtabula Township	May erect suitable markers	4	
5533.56	Freedom Memorial Highway	07-05-1982	SR444	SR4 to I-675	May erect suitable markers with names of hostages and servicemen killed in rescue attempt	7,8	
5533.57	Judge Kenneth B. Ater Bridge	06-18-2002	SR7	Paddy Creek bridge near Proctorville	May erect suitable markers	9	
5533.58	Governor James A. Rhodes Memorial Highway	03-19-2003	SR72	I-70 to Clark/Champaign County Line	May erect suitable markers	7	
5533.59	Bill Mazeroski Highway	03-24-2003	SR7	Rush Run Road in Jefferson County to Jefferson/Belmont County Line	May erect suitable markers	11	
5533.591	Captain Nick Hauck Memorial Highway	09-23-2011	SR7	Within Mingo Junction in Jefferson County	May erect suitable markers	11	
5533.60	Joseph Guy LaPointe, Jr. Memorial Parkway	04-07-2003	SR49	Within Trotwood and Clayton Corp. limits	May erect suitable markers	7	
5533.601	Lance Cpl. Kevin S. Smith Memorial Highway	04-06-2009	SR334	Within Clark County	May erect suitable markers	7	
5533.602	Sampson Harrison Memorial Bridge	09-23-2011	SR821	Between MM9 and MM10 in Noble County	May erect suitable markers	10	
5533.603	Freeman C. Thompson Memorial Bridge	09-23-2011	SR821	MM8 to MM9 in Noble County	May erect suitable markers	10	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.604	Sergeant Jeremy D. Barnett Memorial Highway	04-06-2009	SR800	Within Mineral City in Tuscarawas County	May erect suitable markers	11	
5533.605	Cpl. Samuel F. Pearson Memorial Highway	04-06-2009	SR66	Shelby/Miami County line to Washington Avenue in Piqua	May erect suitable markers	7	
5533.606	Major Rocco Barnes Memorial Highway	05-31-2010	SR10	Within North Olmstead Corp. limit	May erect suitable markers	12	
5533.607	Navy Hospitalman Richard “Doc” Powell Memorial Highway	05-31-2010	I-680	SR711 to SR11	May erect suitable markers	4	
5533.608	Master Sergeant Adam F. Benjamin Memorial Highway	03-22-2013	SR10	West most point in Lorain County to SR 83	May erect suitable markers	3	
5533.61	Martin Luther King, Jr. Boulevard	09-24-1986	US42	Xenia Corp. Limit to Cedarville Corp. Limit	May erect suitable markers	8	
5533.62	U.S.A.F. Pararescue Memorial Parkway	05-18-2005	SR48	Entire length	May erect suitable markers	7, 8	
5533.621	Captain Seth Mitchell Memorial Highway	05-31-2010	SR48	Within Loveland Corp. Limit	May erect suitable markers	8	
5533.624	Corporal Lucas Scott Memorial Highway	03-22-2013	SR41	SR32 to Shaker Run Rd. in Peebles	May erect suitable markers	9	
5533.625	Specialist William Seth Blevins Memorial Highway	03-22-2013	US62	CR17D to SR32 in Brown County	May erect suitable markers	9	
5533.626	First Lt. Ashley White-Stumpf Memorial Highway	03-22-2013	SR44	Marlboro Township in Stark County	May erect suitable markers	4	
5533.627	Sgt. Michael Barkey Memorial Highway	03-22-2013	SR21	Arcadia St. to Butterbridge Rd. in Stark County	May erect suitable markers	4	
5533.628	Captain Daniel Stiles Memorial Highway	03-22-2013	SR619	In Stark County, from Summit County Line to Kaufman Ave.	May erect suitable markers	4	
5533.629	Sgt. James L. Smith Memorial Highway	03-22-2013	SR416	New Philadelphia Corp. Limit to Tuscarawas Corp. Limit	May erect suitable markers	11	
5533.63	Marine Corps League Memorial Highway	11-12-1997	US33	Willshire to West Virginia State Line	May erect suitable markers	1, 5, 6, 7, 10	
5533.631	Edward K. Core, Jr. Memorial Highway	08-10-2000	US33	Union/Logan County Line to Logan County Road 57	Shall erect suitable markers	7	Expires 08-10-2009. Remove signs and give to family.

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.632	Brian Montgomery Memorial Highway	09-29-2007	SR2	Within Willoughby Corp. Limit	May erect suitable markers	12	
5533.633	Sergeant Bryan W. Large Memorial Highway	04-06-2009	SR59 north	Kent Road exit to border of Cuyahoga Falls and Silver Lake	May erect suitable markers	4	
5533.634	Sergeant Justin T. Walsh Memorial Highway	04-06-2009	SR59 south	Border of Cuyahoga Falls and Silver Lake to SR8 entrance ramp	May erect suitable markers	4	
5533.635	Corporal Jeffrey A. Boskovitch Memorial Highway	04-06-2009	SR3	West Sprague Road to SR82 in North Royalton	May erect suitable markers	12	
5533.636	Sgt. 1st Class Daniel B. Crabtree Memorial Road	09-23-2011	SR619	Within Corp. of Hartville in Stark County	May erect suitable markers	4	
5533.637	Captain Robert C. Hess Jr. Veterans Bridge	09-23-2011	US33	Spans Hocking River in at the eastern edge of the Corp. of Athens in Athens County	May erect suitable markers	10	
5533.638	Staff Sergeant Jimmy G. Stewart Veterans Bridge	09-23-2011	US33, SR7	Bridge at intersection of US33 and SR7.	May erect suitable markers	10	
5533.639	Lt. Lloyd Thomas Memorial Bridge	09-23-2011	US33	Spans the Hocking River near the community of The Plains in Athens County	May erect suitable markers	10	
5533.64	Thomas A. Van Meter Memorial Highway	11-03-1999	SR60	Within Ashland County	May erect suitable markers	3	
5533.642	Robert E. Netzley Highway	04-07-2003	SR571	Within Miami County	May erect suitable markers with private contributions only	7	
5533.643	Robert E. Hagan Memorial Highway	05-18-2005	SR711	I-680 to US422	May erect suitable markers	4	
5533.644	Senator William Bowen Memorial Highway	05-31-2010	US42	Within Cincinnati Corp. Limit	May erect suitable markers	8	
5533.645	Army Specialist Jesse Adam Snow Memorial Highway	03-22-2013	SR235	Within Fairborn in Greene County	May erect suitable markers	8	
5533.646	Pfc. Douglas E. Dickey Memorial Highway	03-22-2013	SR47	SR49 to US127	May erect suitable markers	7	
5533.648	Deputy Suzanne Hopper Memorial Highway	03-22-2013	I-77	I-675 to Enon Road	May erect suitable markers	7	
5533.65	Wayne Embry Way	09-01-2000	US40	SR235 to Gordon Road, Bethel Township, Clark County	May erect suitable markers	7	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.66	Jackie Mayer Miss America Highway	08-29-2002	SR2	Thomas A. Edison Memorial Bridge approach thru Erie County	May erect suitable markers	3	
5533.67	Troy Lee James Highway	03-19-2003	I-490	I-71 to I-77	May erect suitable markers	12	
5533.68	Trooper Frank G. Vazquez Memorial Highway	04-07-2003	I-270	I-70 to Georgesville Road	May erect suitable markers	6	
5533.681	Trooper Wendy G. Everett Memorial Highway	04-06-2009	I-270	MM 1 to MM 3	May erect suitable markers	6	
5533.682	Patrolman Jerry R. Neff Memorial Highway	04-06-2009	US62	MM 1 to MM 2 in Franklin County	May erect suitable markers	6	
5533.683	Trooper Jody S. Dye Memorial Highway	04-06-2009	I-270	MM 45 to MM 47	May erect suitable markers	6	
5533.684	Deputy Lawrence Barnes Memorial Highway	04-06-2009	US50 west	North Fork Creek bridge in the community of Slate Mills in Ross County	May erect suitable markers	9	
5533.685	Officer Brett Markwood Memorial Highway	05-31-2010	US22	US33 to Memorial Drive in Fairfield County	May erect suitable markers	5	
5533.687	Trooper Andrew C. Baldridge Memorial Highway	09-23-2011	SR103	SR15 to TR95 in Wyandot County	May erect suitable markers	1	
5533.688	Trooper George Conn Memorial Highway	03-22-2013	SR800	Freeport Corp. Limit in Harrison County to SR 799	May erect suitable markers	3	
5533.689	Specialist Damon G. Winkleman Memorial Highway	03-22-2013	SR179	College Street in Hayesville TR 2650 in Ashland County	May erect suitable markers	1	
5533.69	Governor William Bebb Bicentennial Roadway	03-05-2004	SR126	Community of Venice in Butler County to Indiana State Line	May erect suitable markers	8	
5533.70	Governor James M. Cox Bicentennial Roadway	03-05-2004	SR744	Somerville to SR122	May erect suitable markers	8	
5533.71	Governor James E. Campbell Bicentennial Roadway	03-05-2004	SR4	High Street in Hamilton to Central Avenue in Middletown	May erect suitable markers	8	
5533.72	Governor Andrew L. Harris Bicentennial Roadway	03-05-2004	US127	Seven Mile to US35	May erect suitable markers	8	
5533.73	William R. Foster Bridge	03-05-2004	SR129	Maud-Hughes Road bridge over Gregory Creek, Butler County, MM 23.18	May erect suitable markers	8	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.732	Dominic “Dee Dee” Modarelli Memorial Bridge	09-23-2011	Burlington Street	Bridge Spanning SR711 in Youngstown	May erect suitable markers	4	
5533.74	Butler County Veterans Highway	10-13-2004	SR129	I-75 to Indiana State line	May erect suitable markers	8	
5533.75	Deputy Ethan Collins Memorial Highway	03-29-2007	SR188	Within Fairfield County	May erect suitable markers	5	
5533.751	Patrolman George Brentar Memorial Highway	04-06-2009	I-90	Within Euclid in Cuyahoga County	May erect suitable markers	12	
5533.752	Sergeant Brian Dulle Memorial Highway	03-22-2013	US42	Lebanon Corp. Limit to Waynesville Corp. Limit in Warren County	May erect suitable markers	8	
5533.76	Pfc. David C. Armstrong Memorial Highway	04-06-2009	US30	SR598 to SR61	May erect suitable markers	3	
5533.761	Lance Corporal Daniel McVicker Memorial Highway	04-06-2009	US62	Alliance west Corp. Limit to Highland Memorial Park Cemetery in Beloit	May erect suitable markers	4, 11	
5533.762	Sgt. Robert M. Carr Memorial Interchange	04-06-2009	SR45 SR82	Interchange of SR45 and SR82	May erect suitable markers	4	
5533.763	Army Staff Sgt. Shamus O. Goare Memorial Highway	09-23-2011	US62	Millwood in Knox County to Holmes County Line	May erect suitable markers	5	
5533.764	Army Private Jason L. Sparks Memorial Highway	09-23-2011	US20	Boundary of Lime and Ridgefield Twp. in Huron County to Corp. of Norwalk	May erect suitable markers	3	
5533.765	Army Sgt. Keith Kline Memorial Highway	09-23-2011	SR105 SR163	Union Cemetery on W SR 105 to where SR105 ceases and joins with SR163 ending at 8444 W SR 163 within Oak Harbor	May erect suitable markers	2	
5533.766	Army Sgt. Jon Martin Memorial Highway	09-23-2011	US20	CR302 to Prairie Road in Sandusky County	May erect suitable markers	2	
5533.767	Staff Sgt. Kevin J. Kessler Memorial Highway	09-23-2011	US30	Boundary of Canton and Osnaburg Twp. in Stark County to boundary of Osnaburg Twp. and East Canton Corp. Limit	May erect suitable markers	4	
5533.768	U.S. Army Cpl. Zachary Grass Memorial Highway	03-22-2013	US62	SR93 to Mt. Eaton St. SW in Stark County	May erect suitable markers	4	
5533.769	Lt. Jason S. Manse Memorial Highway	03-22-2013	SR172	Woodlawn Ave to Saratoga Ave NW in Stark County	May erect suitable markers	4	
5533.77	Staff Sgt. Kendall H. Ivy II Memorial Highway	04-06-2009	US30	SR602 to SR598	May erect suitable markers	3	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.771	Deputy Chad Edwards Memorial Highway	04-06-2009	SR37	Southernmost point in Lancaster to Fairfield/Licking County Line	May erect suitable markers	5	
5533.772	Sgt. Marco Miller Memorial Interchange	04-06-2009	US422 SR82	Interchange of US422 and SR82	May erect suitable markers	4	
5533.773	SrA Kenneth P. Hauprich, Jr., Memorial Highway	04-06-2009	SR72	New Silvercreek Township Cemetery past the Greeneview schools through Jamestown	May erect suitable markers	8	
5533.774	Tuskegee Airmen Memorial Highway	04-06-2009	SR104	US23 to Lockbourne Road	May erect suitable markers	6	
5533.775	Colonel Wilbur Blount, M.D., Memorial Highway	04-06-2009	I-670	4th Street to International Gateway at Port Columbus	May erect suitable markers	6	
5533.78	The Ohio Veterans Memorial Bridge	04-06-2009	US20	Conneaut Creek bridge in Conneaut	May erect suitable markers	4	Duplicate of ORC Section 5533.351
5533.785	Sgt. Sean Landrus Memorial Highway	05-31-2010	SR528	US322 to Lake County line	May erect suitable markers	12	
5533.79	Heritage Parkway	10-13-2004	SR4	I-70 to Springfield west Corp. Limit	May erect suitable markers	7	
5533.791	Lance Corporal Taylor Prazynski Memorial Highway	09-23-2011	SR4	S. Gilmore Rd. to Symmes Rd. within Fairfield	May erect suitable markers	8	
5533.80	Crile-Lower Memorial Highway	10-13-2004	SR93	Within Coshocton County	May erect suitable markers	5	
5533.81	Veterans' Glass City Skyway	05-18-2005	I-280	Maumee River bridge in Lucas County	May erect suitable markers	2	
5533.811	Henry County Veterans Bridge	09-12-2008	SR108	Maumee River bridge in Napoleon	May erect suitable markers	2	
5533.82	Kenneth Jutte-John Garman Memorial Highway	05-18-2005	SR66	SR119 to SR274	May erect suitable markers	7	
5533.83	Bob Evans Highway	05-18-2005	US35	Within Gallia County	May erect suitable markers	10	
5533.84	Nehemia and Permelia Atwood Memorial Highway	05-18-2005	SR588	Rio Grande to Jackson Pike in Rodney	May erect suitable markers	10	
			Jackson Pike	SR588 to SR160	May erect suitable markers	10	
5533.85	Charles E. Holzer Highway	05-18-2005	SR160	Within Gallia County	May erect suitable markers	10	
5533.86	Ohio Army National Guard 216th Engineering Battalion Memorial Highway	05-18-2005	SR756	Entire length	May erect suitable markers	8, 9	
5533.861	78th Ohio Veteran Volunteer Infantry Highway	03-22-2013	SR78	Counties of Monroe, Noble, Morgan, and Athens	May erect suitable markers	10	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.87	Veterans' Memorial Highway	05-18-2005	SR209	Wheeling Avenue in Cambridge to Exit 178	May erect suitable markers	5	
5533.871	Major James W. Reed Memorial Highway	08-22-2008	SR660	Within Guernsey County	May erect suitable markers	5	
5533.872	Guernsey County Veterans – Flags of Honor Memorial Highway	05-31-2010	SR313	Fritter Road to first intersection with SR83 (West Road)	May erect suitable markers	5	
5533.88	Defiance County Veterans Memorial Highway	05-18-2005	US24	Within Defiance County	May erect suitable markers	1	
5533.881	Ashland County Veterans' Memorial Highway	05-31-2010	US250	Cottage Street to US42 in Ashland County	May erect suitable markers	3	
5533.89	Bill Hinig Memorial Highway	05-18-2005	US250	I-77 thru Ulrichsville	May erect suitable markers	11	
5533.90	Lawrence E. Hughes Memorial Highway	05-18-2005	SR315	King Avenue overpass to Franklin/Delaware County Line	May erect suitable markers	6	
5533.901	Captain Nicholas J. Rozanski Memorial Highway	03-22-2013	I-270	Southernmost point in Dublin to SR161	May erect suitable markers	6	
5533.902	Master Sergeant Jeffrey J. Rieck Memorial Highway	03-22-2013	I-270	SR161 to easternmost point in Dublin	May erect suitable markers	6	
5533.91	LCpl Andy Nowacki Memorial Highway	09-29-2007	SR44	SR2 to Headlands Beach State Park	May erect suitable markers	12	
5533.92	Carl B. Stokes Memorial Highway	04-06-2009	SR2	Within Cuyahoga County	May erect suitable markers	12	
5533.93	Union Workers Memorial Bridge	05-31-2010	I-480	Bridge spanning Cuyahoga River and Ohio Canal	May erect suitable markers	12	
5533.931	Fred Krum Memorial Interchange	05-31-2010	I-77 Shuffel Street	Interchange of I-77 and Shuffel Street, Northwest, Jackson Township, Stark County	May erect suitable markers	4	
5533.932	Corporal Brad Anthony Davis Memorial Highway	09-23-2011	I-480	Within Corp. limits of Garfield Heights in Cuyahoga County	May erect suitable markers	12	
5533.94	Cpl. Joshua Harmon Memorial Highway	09-22-2008	I-90	Within Willoughby Hills Corp. Limit	May erect suitable markers	12	
5533.941	Cpl. Kenneth Tyler Butler Memorial Highway	07-03-2012	SR170	Within Calcutta Corp. in Columbiana County	May erect suitable markers	11	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.95	William Holmes McGuffey Memorial Highway	05-31-2010	I-680	SR711 to SR7	May erect suitable markers	4	
5533.96	Sgt. Michael W. Finke, Jr., Memorial Highway	05-31-2010	SR18	I-71 to Summit County Line	May erect suitable markers	3	
5533.961	Sgt. Mark T. Smykowski Memorial Highway	03-22-2013	SR84	Broadmoor Rd. to Chillicothe Rd. within Mentor	May erect suitable markers	12	
5533.97	Sgt. Kurt D. Schamberg Orwell Memorial Highway	09-23-2011	US322	Within Corp. of Orwell in Ashtabula County	May erect suitable markers	4	
5533.971	Sgt. David J. Luff, Jr. Memorial Highway	03-22-2013	SR177	SR73 to Stahlheber Rd. in Hamilton	May erect suitable markers	8	
5533.972	Sgt. James C. Robinson, Jr. Memorial Highway	03-22-2013	SR63	SR4 to Cincinnati-Dayton Rd. in Middletown	May erect suitable markers	8	
5533.973	LCpl. Billy D. Spencer Memorial Highway	03-22-2013	SR73	SR4 to Warren County boundary in Corp. of Middletown	May erect suitable markers	8	
5533.974	Cpl. Lucas T. Pyeatt Memorial Highway	03-22-2013	SR129	Cincinnati-Dayton Rd. to I-75 in Liberty Twp.	May erect suitable markers	8	
5533.975	PFC Timothy J. Hines, Jr. Memorial Highway	03-22-2013	SR4	West Crescentville Rd. to Muhlhauser Rd. in Fairfield Corp.	May erect suitable markers	8	
5533.976	SFC Gregory S. Rogers Memorial Highway	03-22-2013	SR42	West Chester Rd. to Butler Warren Rd. in West Chester Twp.	May erect suitable markers	8	
5533.977	SFC William B. Woods, Jr. Memorial Highway	03-22-2013	SR42	Butler Warren Rd. to West Main St. in Mason Corp.	May erect suitable markers	8	
5533.978	Sgt. John P. Huling Memorial Highway	03-22-2013	SR42	Creek Rd. in Sharonville to Cox Rd. in West Chester Twp.	May erect suitable markers	8	
5533.979	Staff Sgt. Robert A. Massarelli Memorial Highway	03-22-2013	SR129	SR4 to SR747	May erect suitable markers	8	
5533.98	Cpl. Nickolas H. Olivas Memorial Highway	03-22-2013	SR128	US27 to New London Rd. in Hamilton Corp.	May erect suitable markers	8	
5533.981	PFC Marlin T. Rockhold Memorial Highway	03-22-2013	SR127	High Street to Knightsbridge drive in Hamilton Corp.	May erect suitable markers	8	
5533.982	PFC James Miller, IV Memorial Highway	03-22-2013	SR125	Markley Rd. to Nagel Rd. in Anderson Twp. In Hamilton County	May erect suitable markers	8	

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5533.983	SFC Ricky L. McGinnis Memorial Highway	03-22-2013	SR4	Grand Boulevard to Bobmeyer Rd. in Hamilton Corp.	May erect suitable markers	8	
5533.984	Chief Warrant Officer 2 Jody L. Egnor Memorial Highway	03-22-2013	SR 747	Tylersville Rd. to SR129 in Liberty Twp. In Butler County	May erect suitable markers	8	
5534.37	PFC Burt “Rusty” Miller Memorial Highway		SR 93	Portion of SR 93 in city of New Franklin	May erect suitable markers	4	
5534.38	Lcpl Bret M. Poklar Memorial Highway		SR 2	Lake County, between SR 306 interchange and Lost Nation Road	May erect suitable markers	12	
5534.45	Officer David Fahey		IR 90	Portion within Cuyahoga Falls	May erect suitable markers	4	
5534.47	Ohio Inspector General David D. Sturtz Memorial Highway		SR 541	Coshocton County, between SR 93 and SR 60	May erect suitable markers	5	
5534.49	Officer Thomas W. Cottrell Jr. Memorial Highway		SR 205 and US 62	In Village of Danville beginning on northern border of village on SR 205, proceeding south until the SR intersects US 62, and ending on US 62 at southern border of village	May erect suitbabl markers	5	
5534.74	Army Corporal Carl H. Bemhart Memorial Highway		SR 43	Jefferson County between mile markers 12 and 14	May erect suitable markers	11	
5534.75	Sgt. Bruce R. Jones Memorial Bridge		SR 46	City of Niles. Bridge spanning Meander Creek	May erect suitable markers	4	
5534.80	Specialist Lawrence George Stapleton Memorial Highway		IR 90	Within Cuyahoga County, between mile markers 182 and 185.	May erect suitable markers	12	
5534.94	Virginia E. “Ginny” Kirsch Memorial Highway		SR 7	Trumbull County between SR 82 and SR 62	May erect suitable markers	4	

Table 297-18. Memorial Highways and Bridges Established by ORC Sections 5511.01 and 5511.09

This list needs review and updating. An updated version is under development.

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
5511.01	104th Timberwolf Division Highway	08-03-1959	SR104	Columbus to US52		6, 9	
5511.01	Anthony Wayne Parkway	01-22-1970	US42	Cincinnati to Yellow Springs		7, 8	
			SR47	Greenville to Indiana State line		7	
			SR49	Greenville to Michigan State line		1, 2, 7, 8	
			US68	Cincinnati to Yellow Springs		7,8	
			SR121	Greenville to Indiana State line		7,8	
			US127	Cincinnati to Greenville		7,8	
			US24	Greenville to Michigan State line		7,8	Need to check begin/end points
			US27	Greenville to Michigan State line		7,8	Need to check begin/end points
			SR29	Greenville to Michigan State line		7,8	Need to check begin/end points
			SR111	Greenville to Michigan State line		7,8	Need to check begin/end points
			SR637	Greenville to Michigan State line		7,8	Need to check begin/end points
5511.01	Benjamin Franklin Highway	05-23-1930	US224	Entire length in Ohio		1, 2, 3, 4	
5511.01	Blue Star Highway	11-30-1948	US40	Entire length in Ohio	To be marked	5, 6, 7, 8, 11	
5511.01	Catholic War Veterans of the USA Highway		I-280(?)	Oregon to Toledo		2	
5511.01	Dix Expressway	07-01-1970	SR3	Wooster bypass	To be erected	3	
			SR83	Wooster bypass	To be erected	3	
5511.01	Edison Highway	12-08-1931	SR113	Bellevue to Elyria		3, 12	
5511.01	General Dwight D. Eisenhower Memorial Highway	01-22-1970	I-70	Entire length in Ohio	To be erected in rest areas	5, 6, 7, 8, 11	
5511.01	Jack Nicklaus Freeway	05-01-1981	I-270	Entire length in Ohio		6	
5511.01	Jackie Mayer	01-31-1962	US6	Huron to Venice	To be marked	3	Unknown end point
5511.01	John Glenn, Jr. Highway	03-02-1962	US40	Zanesville to Cambridge	To be marked	5	
5511.01	Lincoln Highway	08-01-1930	US30	Entire length in Ohio		1, 3, 4, 11	
5511.01	Marine Corps League Memorial Highway		US33	Entire length in Ohio		1, 5, 6, 7, 10	
5511.01	Moody-Jackson Highway		SR315	Within Columbus		6	
5511.01	Phil Niekro Highway		US40	Within Belmont County		11	
5511.01	Road of Remembrance	06-17-1930	SR7	Steubenville, Youngstown to North Kingsville			Need to check begin/end points

ORC Section	Name	Effective Date	Route	Beginning and Ending Points*	Action Required	Districts Affected	Comments
			I-90	Steubenville, Youngstown to North Kingsville			Need to check begin/end points
5511.01	Ronald Reagan Highway		SR126			8	
5511.01	White Highway	07-13-1933	I-77	Marietta to US40		5, 10	
5511.01	Zwallen Way	10-25-1966	SR43	Sandy Ave SE in Criton Township to Wellowdale Avenue in Sandy Township			

Intentionally blank.

298 FIGURES INDEX

298-1 Signing for Median Crossovers

Figure 298-1 illustrates the recommended signing layout for a median crossover ***(see Section 201-2)***.

298-2 STOP Signs at Intersections

Figure 298-2 illustrates several variations for placement of STOP signs at intersections. See ***Section 201-3*** for further details.

298-3 Reserved for Future Information

Figure 298-3 was deleted because the related sign identification system is no longer used.

298-4 Regulatory and Warning Signs

Figure 298-4 illustrates Regulatory and Warning Signs discussed in this Manual which are not shown in the **OMUTCD** ***(see Sections 201 and 202)***.

298-5 Route and Information Signs

Figure 298-5a is used to illustrate Route and Information Signs discussed in this Manual which are not shown in the **OMUTCD** ***(see Sections 204, 206 and 207***), including some sample Logo and TODS signs.

298-6 Rest Area and Miscellaneous Signs

Figure 298-6a continues the illustrations of Rest Area Signs and miscellaneous others discussed in this Manual which are not shown in the **OMUTCD**.

298-7 Amish Buggy Signing where Paved Shoulder Becomes Narrower

Figure 298-7 illustrates the situation described in ***Section 202-6*** regarding signing for a narrow shoulder on a route used by Amish buggies.

298-8 Placement of Overhead Exit Direction Sign - Span Type

Figure 298-8 illustrates placement of overhead exit gore signs of the span type.

298-9 Placement of Overhead Exit Direction Sign - Cantilever Type

Figure 298-9 illustrates placement of cantilever signs ***(see Section 240-4.3)***.

298-10 Placement of Overhead Diverging Gore Sign - Span Type

Figure 298-10 illustrates placement of overhead diverging gore signs of the span type.

298-11 Sight Distance Requirements for Overhead Guide Signs

Figure 298-11 illustrates sight distance requirements for overhead signs.

298-12 Design Chart for TC-12.30 Sign Supports

Figure 298-12 is used in designing **TC-12.30** sign supports ***(see Section 240-4.3)***.

298-13 Design Chart for Overhead Sign Support Trusses

Figure 298-13 is used in designing sign supports trusses ***(see Section 240-4.5)***.

298-14 Design Chart for Single Post Installations

Figure 298-14 is used in designing single post installations ***(see Section 240-5.2)***.

298-15 Design Chart for Two Post Installations

Figure 298-15 is used in designing two post installations ***(see Section 240-5.2)***.

298-16 Design Chart for Two Beam Installations

Figure 298-16 is used in designing two beam installations ***(see Section 240-5.3)***.

298-17 Design Chart for Three Beam Installations

Figure 298-17 is used in designing three beam installations ***(see Section 240-5.3).***

298-18 Design Chart for TC-17.10 Sign Supports

Figure 298-18 is used in designing **TC-17.10** sign supports ***(see Section 240-4.5)***.

298-19 Two and Three Beam Installation Details

Figure 298-19 defines dimensions used in designing the supports ***(see Section 240-5.3)***.

298-20 TC-16.21 Overhead Sign Support

Figure 298-20 illustrates design details needed and provides a sample table for use in a plan ***(see Section 240-4.3)***.

298-21 TC-17.10 Span Wire Sign Support

Figure 298-21 illustrates design details needed and provides a sample table for use in a plan ***(see Section 240-4.5)***.

298-22 Lane-Use Control Signs Index

Figure 298-22 illustrates various Lane-Use Control signs not shown in the **OMUTCD**, and provides code number and size information ***(see Section 201-10)***.

298-23 Mounting a Sign Support on Concrete Barrier

Figure 298-23 illustrates a sign support developed to mount signs on concrete barrier.

298-24 Staking Sign Locations

Figure 298-24 is an illustration supporting the discussion in ***Section 250-3.1*** about staking.

298-25 Foundation Excavations

Figure 298-25 illustrates a foundation excavation, as described in ***Section 250-3.2***.

298-26 Solid Wood Posts

Figure 298-26 presents design details for solid wood posts used as sign supports, as described in ***Section 221-5***.

298-27 Design Chart for Solid Wood Posts

Figure 298-27 provides a design chart for solid wood posts used as sign supports ***(Section 221-5)***.

298-28 Example of Signing for an Expressway At-Grade Intersection with a Numbered Route

Figure 298-28 illustrates recommended Guide Sign placement for expressway at-grade intersections with numbered routes, as described in ***Section 209-6***.

298-29 Example of Signing for an Expressway At-Grade Intersection with an Unnumbered Route

Figure 298-29 illustrates recommended Guide Sign placement for expressway at-grade intersections with unnumbered routes, as described in ***Section 209-6***.

298-30 Example of Signing for a Multi-Lane Rural Conventional Road Intersection with an Important Public Road

Figure 298-30 illustrates recommended Guide Sign placement for intersections of major conventional roads with important public roads, as described in ***Section 209-6***.

298-31 Example of Signing for a Single Lane Rural Conventional Road Intersection with an Important Public Road

Figure 298-31 illustrates recommended Guide Sign placement for intersections of conventional roads with important public roads, as described in ***Section 209-6***.

298-32 Example of Signing for a Single Lane Rural Conventional Road Offset Intersection with an Important Public Road

Figure 298-32 illustrates recommended Guide Sign placement for offset conventional road intersections with important public roads, as described in ***Section 209-6***.

298-33 Signing for Optional Lane Exits - Without Secondary Exits

Figure to be updated in future revisions.

298-34 Signing for Optional Lane Exits - Secondary Exits-Low Volume Primary Exit

Figure to be updated in future revisions.

298-35 Signing for Optional Lane Exits - Secondary Exits-High Volume Primary Exit

Figure to be updated in future revisions.

298-36 Signing for Optional Lane Exits - Secondary Exits- Major Split

Figure to be updated in future revisions.

298-37 Examples of Signing for Historical Markers

Figure 298-37 illustrates examples of signing for historical markers, as described in ***Section 205-6***.

298-38 Example of Route Signing for Municipal Street Systems

Figure 298-38 illustrates an example of route signing for municipal street systems, as described in ***Section 204-6***.

298-39 Example of Freeway and Expressway Rest Area Signing

Figure to be updated in future revisions.

298-40 Example of Conventional Road Rest Area Signing

Figure to be updated in future revisions.

298-41 Example of Conventional Road Rest Area Signing

Figure to be updated in future revisions.

298-42 Example of Clearance Signs on a Low Clearance Structure

Figure 298-42 illustrates an example of Clearance signs on a low clearance structure, as described in ***Section 202-7***.

298-43 Example of Freeway Transition Signing

Figure 298-43 illustrates an example of freeway transition signing, as described in ***Section 202-9***.

298-44 Example of Conventional Highway Transition Signing

Figure 298-44 illustrates an example of conventional highway transition signing, as described in ***Section 202-9***.

298-45 Freeway Guide Signing Arrangement (Example A)

Figure 298-45 illustrates an example of freeway guide signing for option lanes, as described in ***Section 209-7***.

298-46 Freeway Guide Signing Arrangement (Example B)

Figure 298-46 illustrates an example of freeway guide signing for option lanes, as described in ***Section 209-7***.

298-47 Freeway Guide Signing Arrangement (Example C)

Figure 298-47 illustrates an example of freeway guide signing for option lanes, as described in ***Section 209-7***.

298-48 Design Charts for Laminated Veneer Wooden Beam Sign Supports

Figure 298-48 provides design charts for the laminated veneer wooden beam sign supports described in ***Section 221-7***.

Figure 298-1. Signing for Median Crossovers

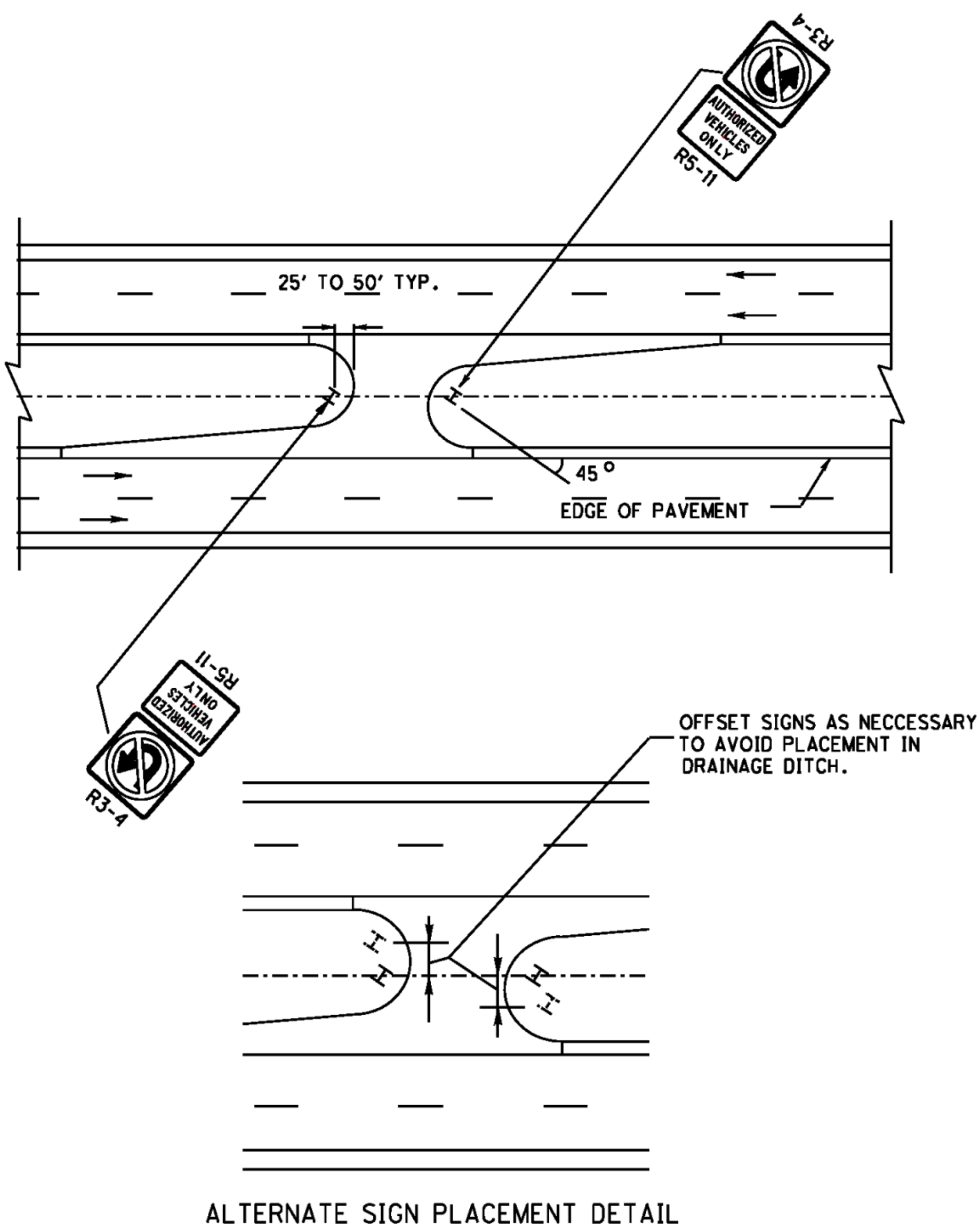


Figure 298-2. STOP Signs at Intersections

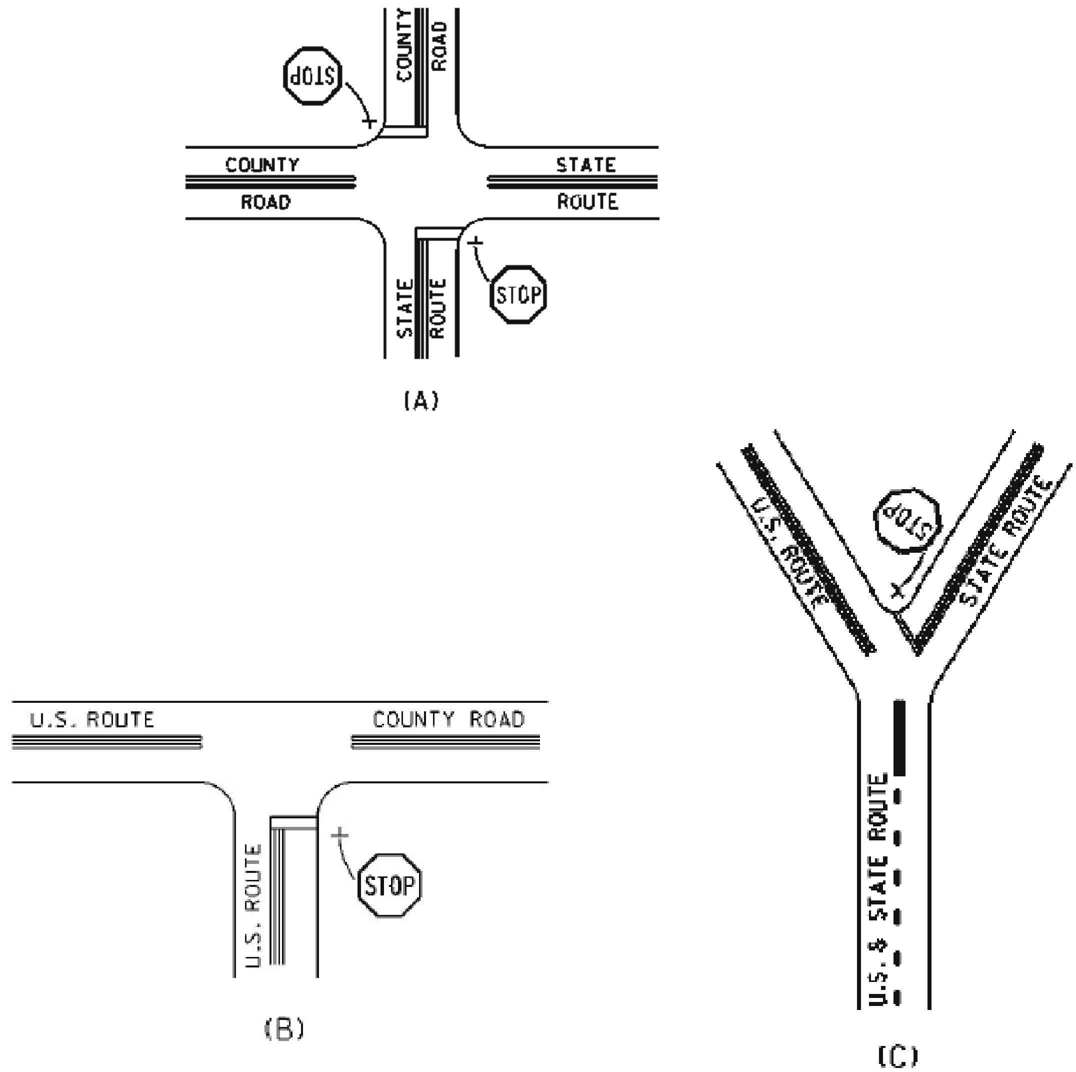
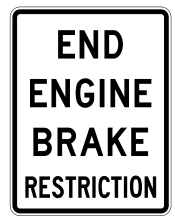


Figure 298-3. Reserved for Future Information

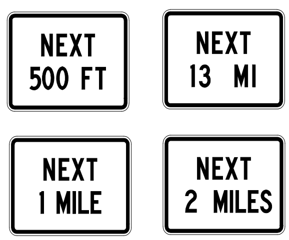
Figure 298-4. Regulatory and Warning Signs (Sheet 1 of 2)

R20-H1
(Sec. 201-7)



R20-H2
(Sec. 201-7)

R10-H20bP
(Sec. 201-7)



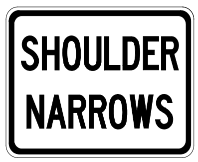
R10-H20cP
(Sec. 201-7)

R25-H1
(Sec. 201-8)

W9-H4a
(Sec. 202-9)

W9-H4b
(Sec. 202-9)

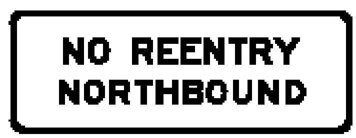
Figure 298-4. Regulatory and Warning Signs (Sheet 2 of 2)



W11-H14P
(Sec. 202-6)

W11-H14a
(Sec. 202-6)

W13-H10P
(Sec. 202-4)



W13-H11P
(Sec. 202-4)

Figure 298-5. Route and Information Signs (Sheet 1 of 3)

D5-H51P

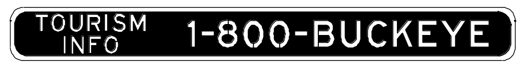
(Sec. 208-3)

D5-H52P

(Sec. 208-3)

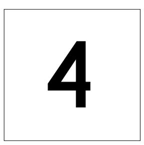
D6-H5

(Sec. 206-8)



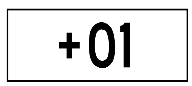
D7-H10P

(Sec. 206-12)



D10-H8

(Sec. 206-15)

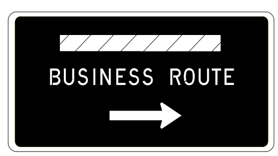


D10-H8a

(Sec. 206-15)

D20-H1

(Sec. 204-3)



D20-H2

(Sec. 204-3)

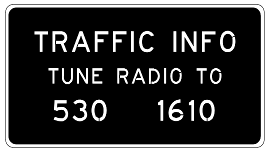
D12-2

(Sec. 206-6)

Figure 298-5. Route and Information Signs (Sheet 2 of 3)

D12-H6

(Sec. 206-5)



D12-H7

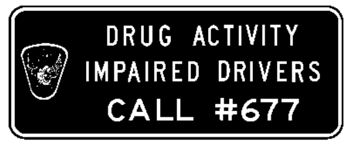
(Sec. 206-5)

D12-H8P

(Sec. 206-5)

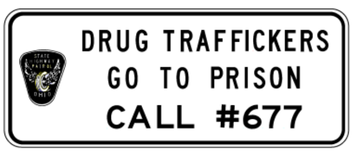
D12-H9

(Sec. 206-5)



D12-H22

(Sec. 207-7)



D12-H23

(Sec. 207-7)

D12-H13

(Sec. 208-6)

D12-H14

(Sec. 206-7)

D12-H15

(Sec. 206-9)

I-H15

(Sec.206-11)

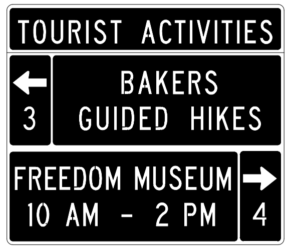
M8-H1

(Sec. 204-4)

M8-H2

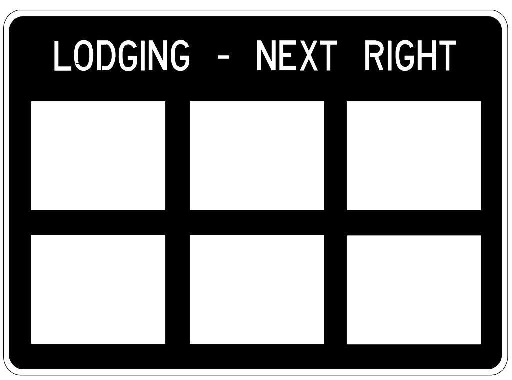
(Sec. 204-4)

Figure 298-5. Route and Information Signs (Sheet 3 of 3)
(TODS and LOGO Signs)

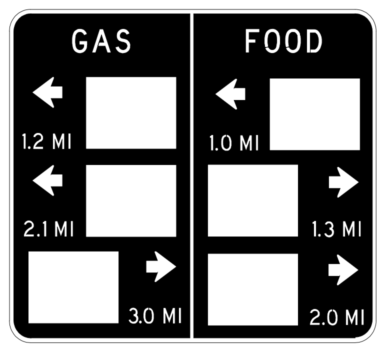


Tourist Oriented Directional Signing (TODS)
(Other variations possible)
(Section 207-3)

Specific Service Signing (LOGO)



E9-H1
(Other variations possible)
(Sec. 207-2)



E9-H17
(Other variations possible)
(Sec. 207-2)

Figure 298-6. Rest Area and Miscellaneous Signs (Sheet 1 of 3)

D5-H7aP
108” x 48”

D5-H7bP
108” x 24”

D5-H7c
144” x 72”

D5-H9aP
120” x 48”

D5-H7d
156 x 72”

Figure 298-6. Rest Area and Miscellaneous Signs (Sheet 2 of 3)

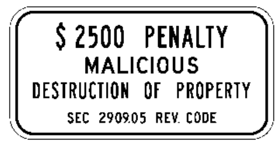
D5-H17
(Sec. 208-4)

D5-H19
(Sec. 208-5)

D5-H18
(Sec. 208-5)

D5-H21
(Sec. 208-5)

D5-H22
(Sec. 208-5)



D5-H23
(Sec. 208-5)

D5-H24
(Sec. 208-5)

D5-H25
(Sec. 208-5)

D5-H26
(Sec. 208-5)

D5-H27
(Sec. 208-5)

D5-H28
(Sec. 208-5)

D5-H29
(Sec. 208-5)

D5-H30
(Sec. 208-5)

Figure 298-6. Rest Area and Miscellaneous Signs (Sheet 3 of 3)

D5-H31
(Sec. 208-5)

D5-H32
(Sec. 208-5)

D5-H33
(Sec. 208-5)

D5-H34
(Sec. 208-5)

D5-H35
(Sec. 208-5)

D5-H37
(Sec. 208-5)

D5-H38
(Sec. 208-5)

D5-H39
(Sec. 208-5)

D5-H40
(Sec. 208-5)

D5-H41
(Sec. 208-5)

D5-H42
(Sec. 208-5)

D5-H43
(Sec. 208-5)

D5-H44
(Sec. 208-5)

D5-H45
(Sec. 208-5)

D5-H46
(Sec. 208-5)

D5-H47
(Sec. 208-5)

Figure 298-7. Amish Buggy Signing where Paved Shoulder Becomes Narrower

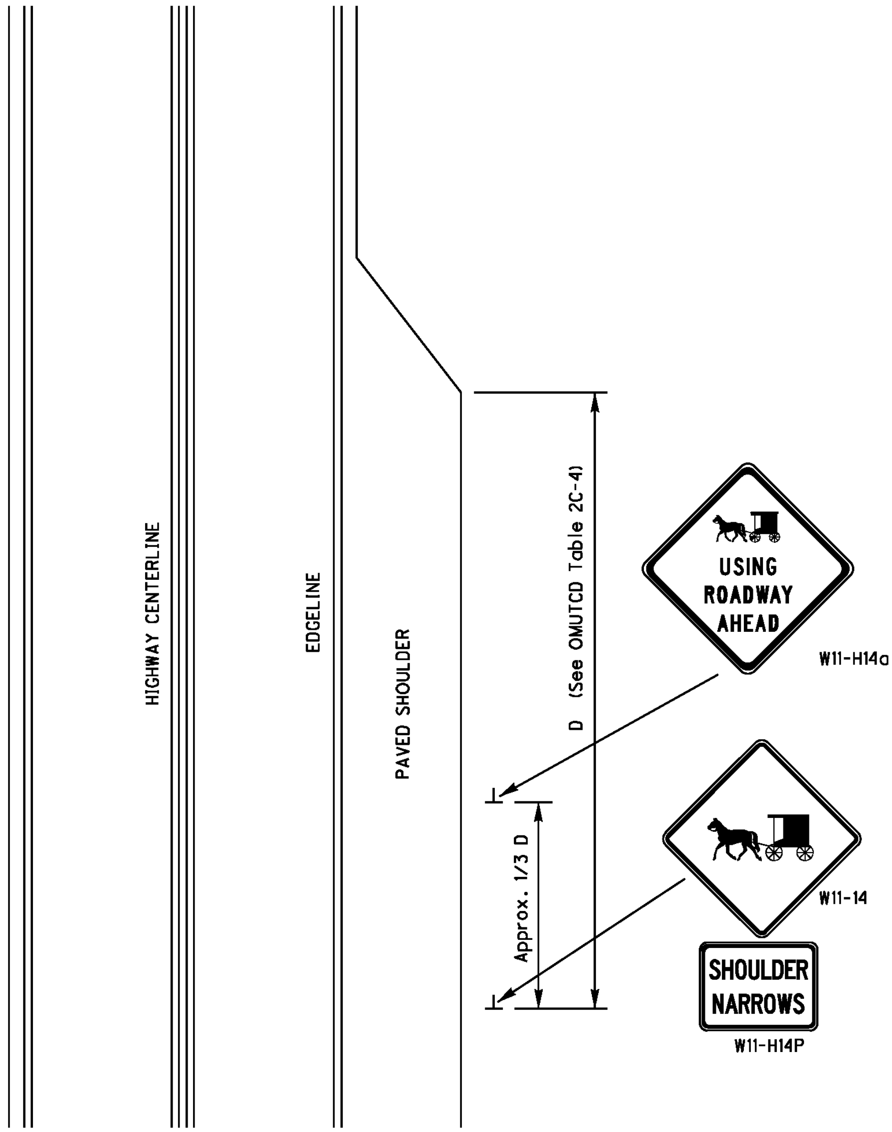
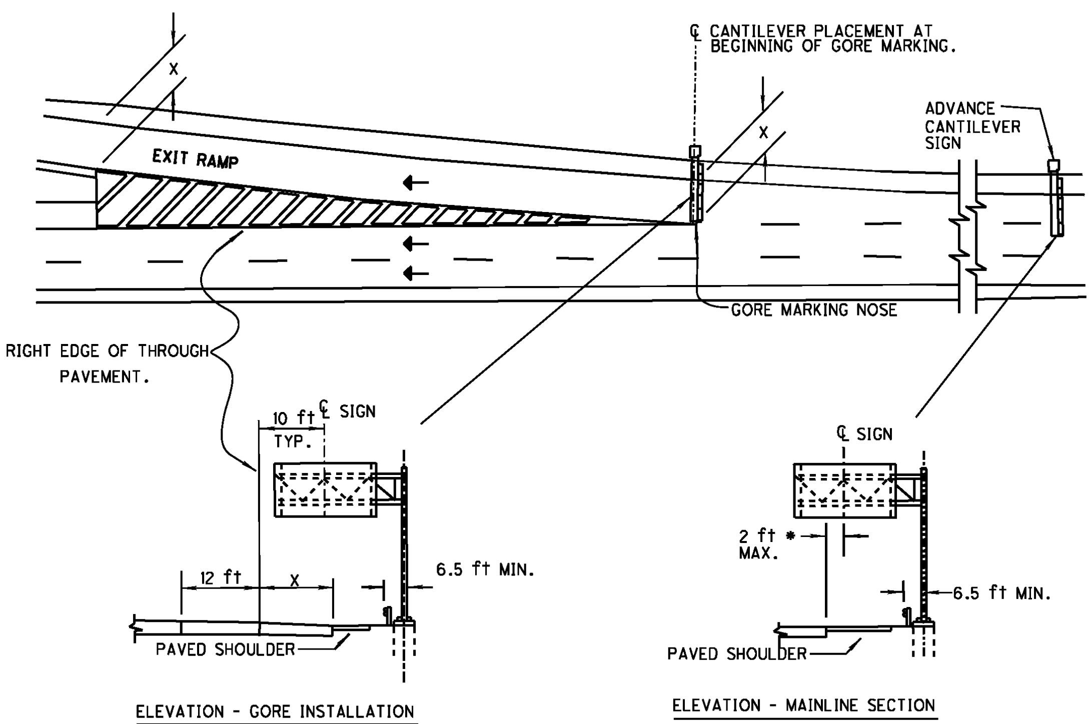


Figure 298-8. Placement of Overhead Exit Direction Sign - Span Type

(Figure to be updated in future revision)

Figure 298-9. Placement of Overhead Exit Direction Sign - Cantilever Type



X = Ramp Lane Width

* Locate the left edge of the sign 12 feet left of the pavement edge when there are three or more directional lanes.

Figure 298-10. Reserved for Future Information

Figure 298-11. Sight Distance Requirements for Overhead Guide Signs (Mainline and Ramps)

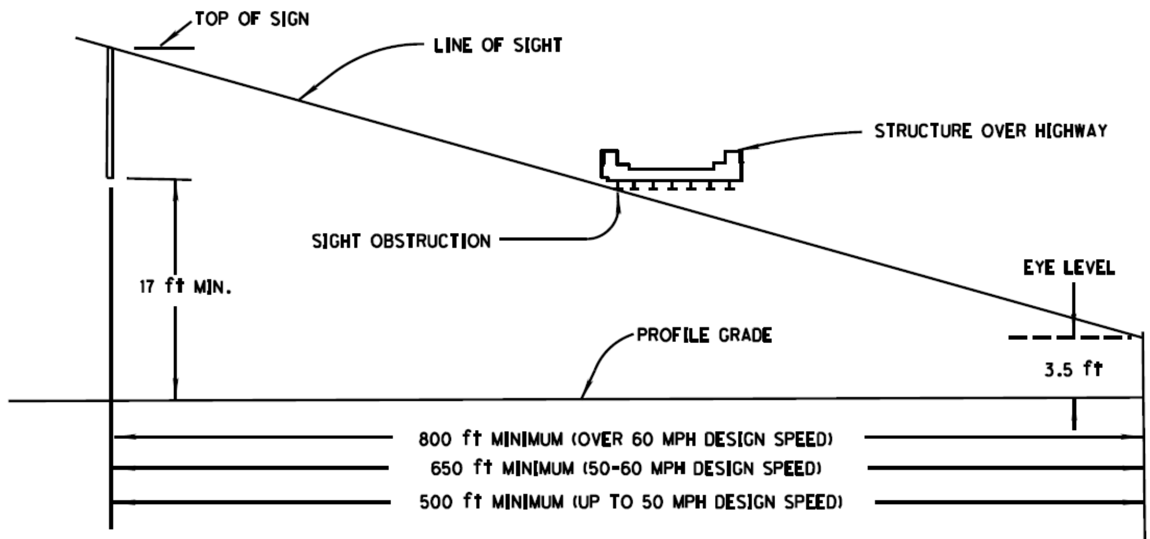


Figure 298-12. Design Chart for TC-12.30 Sign Supports

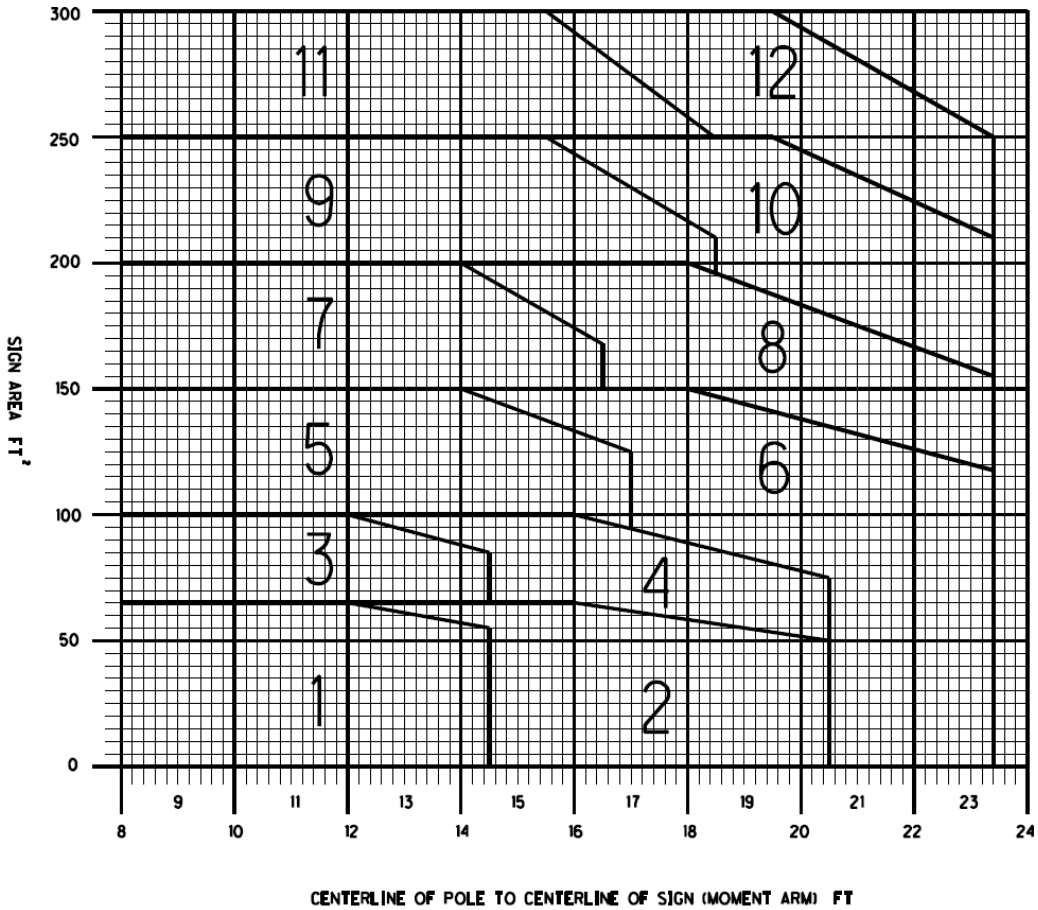


Figure 298-13. Design Chart for Overhead Sign Support Trusses

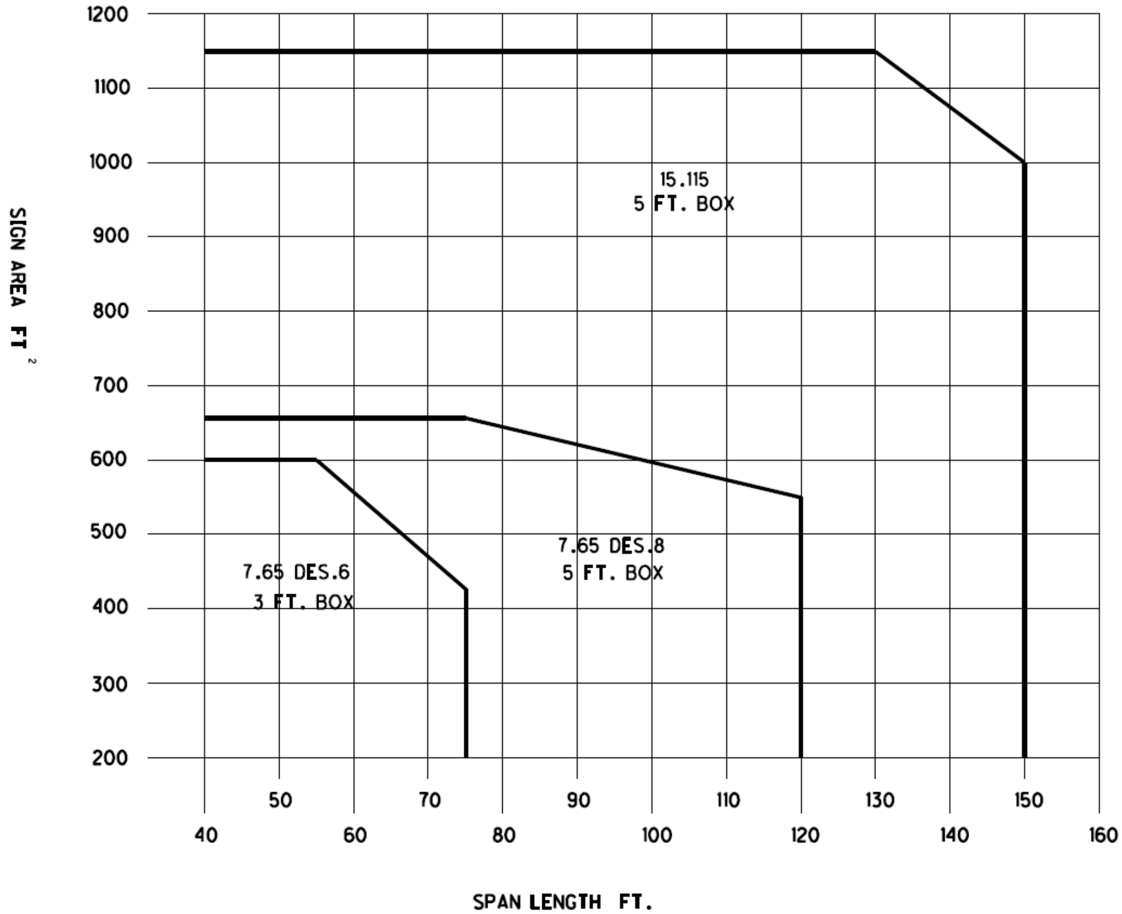


Figure 298-14. Design Chart for Single Post Installations

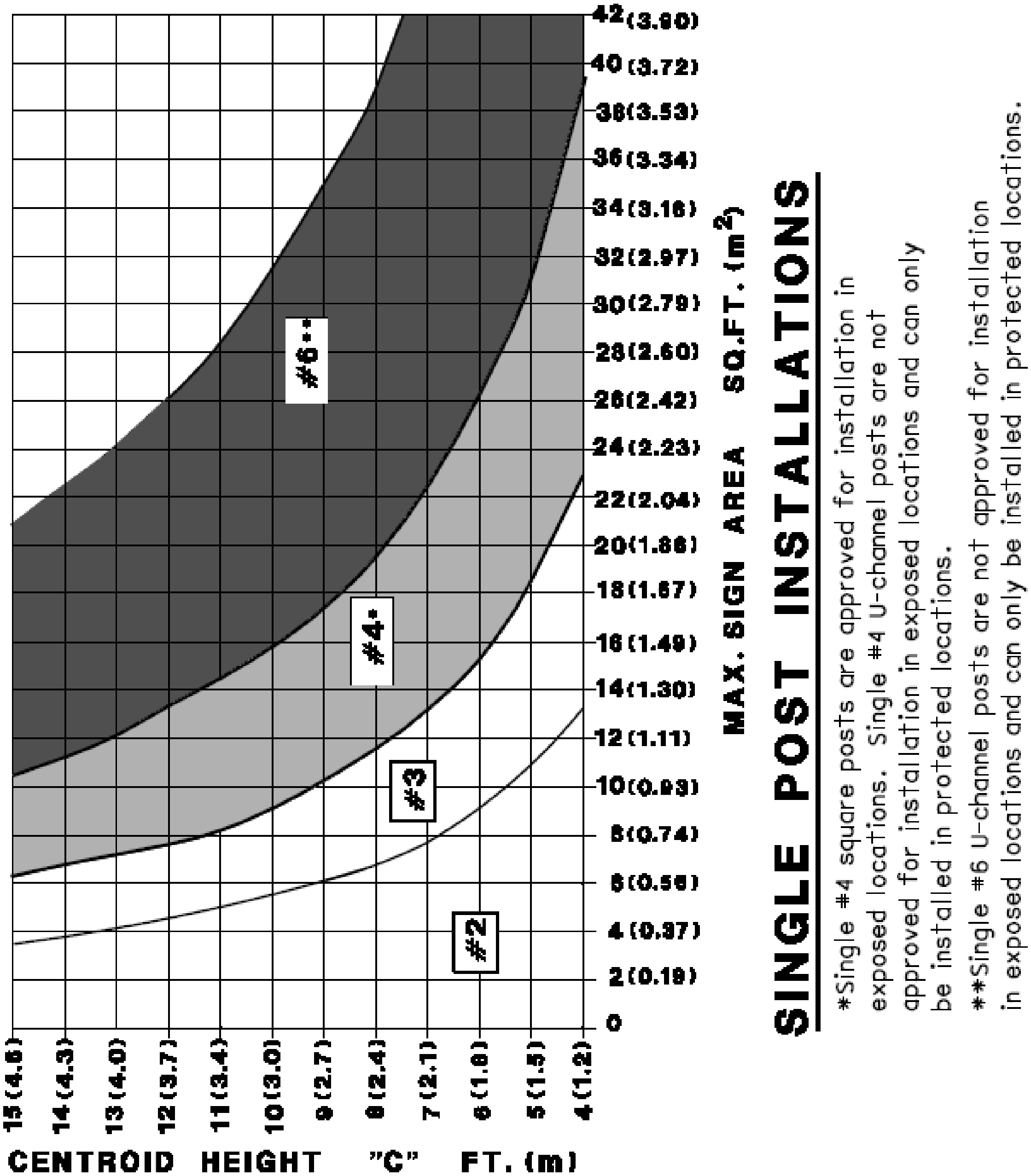


Figure 298-15. Design Chart for Two Post Installations

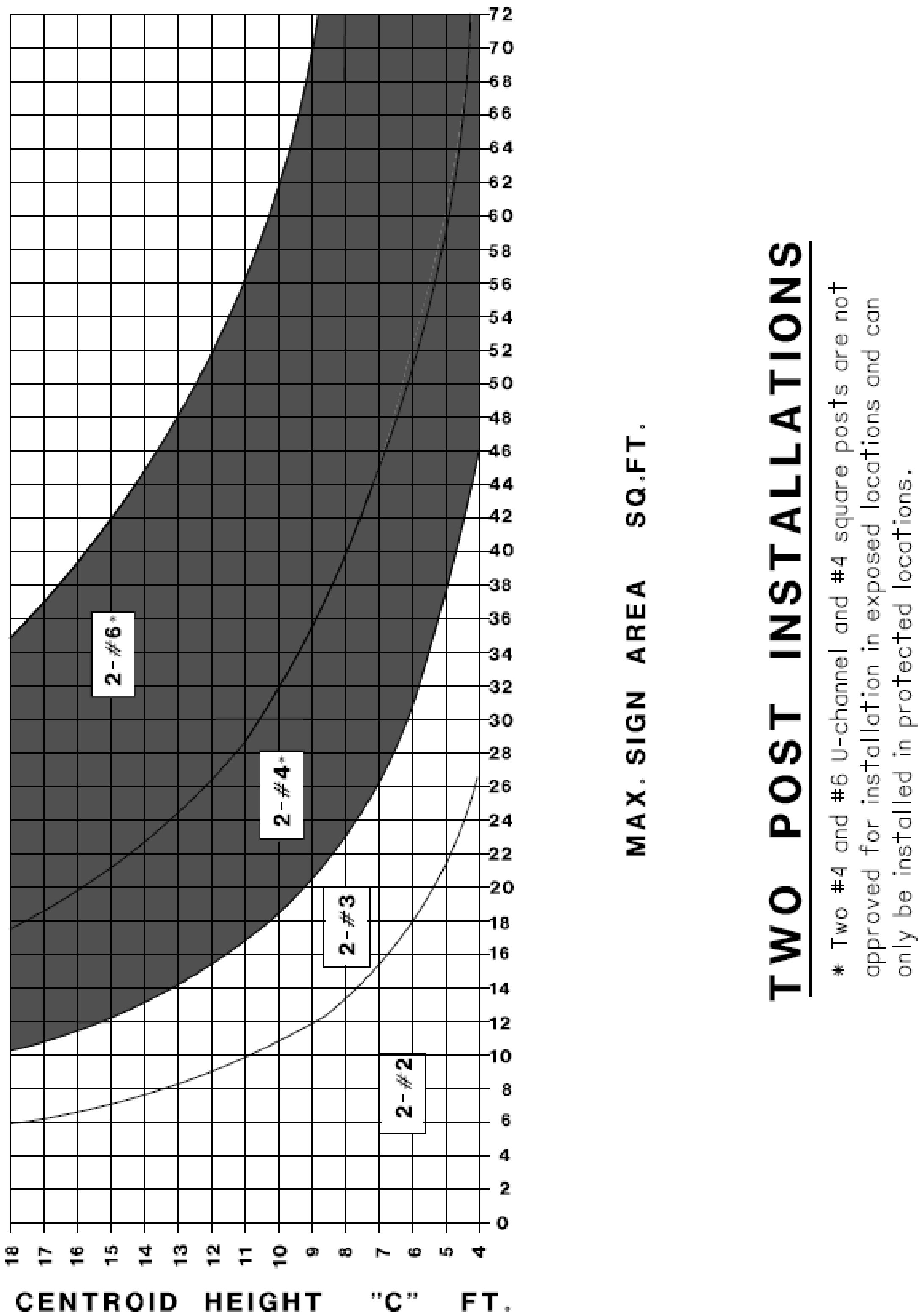
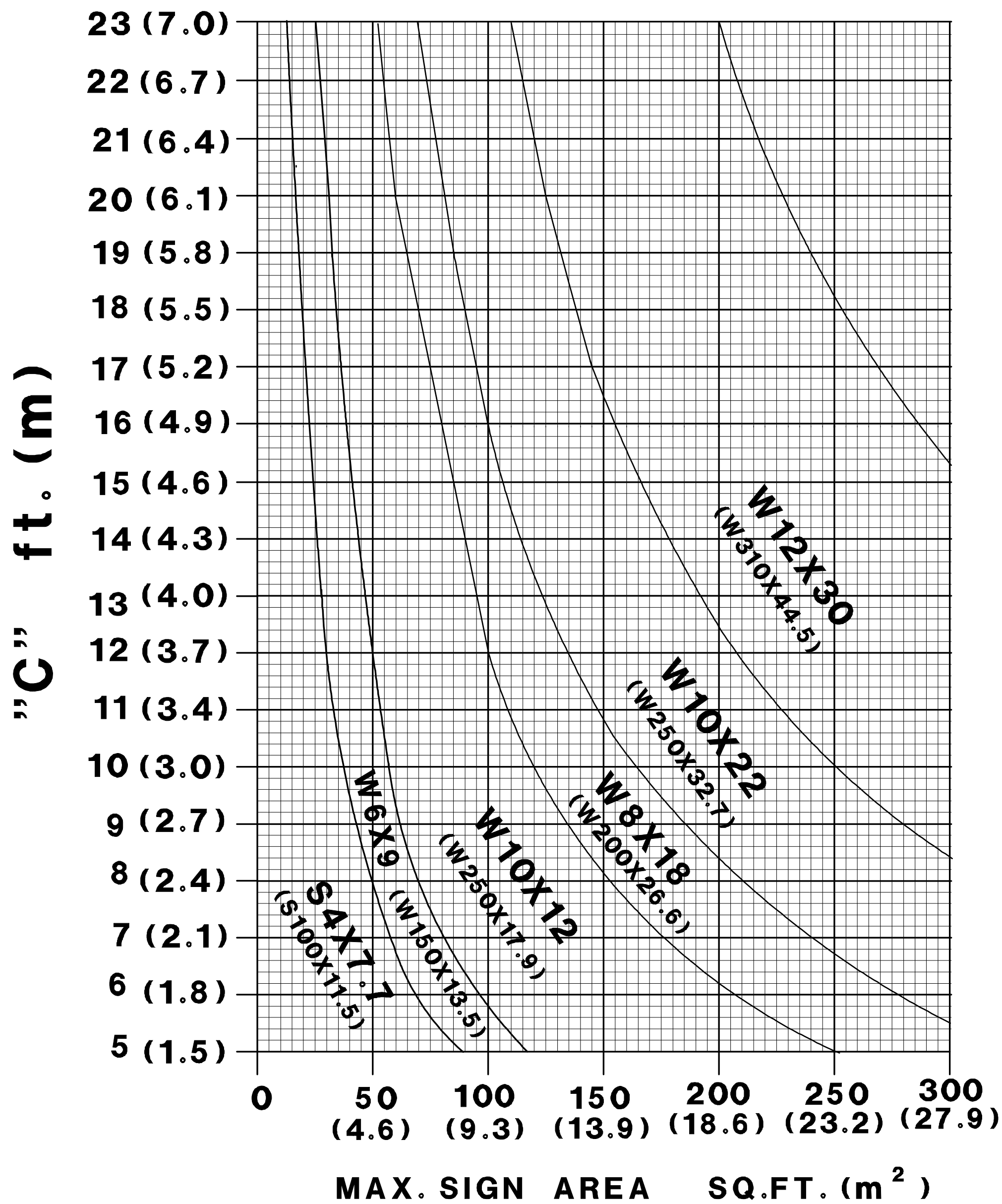


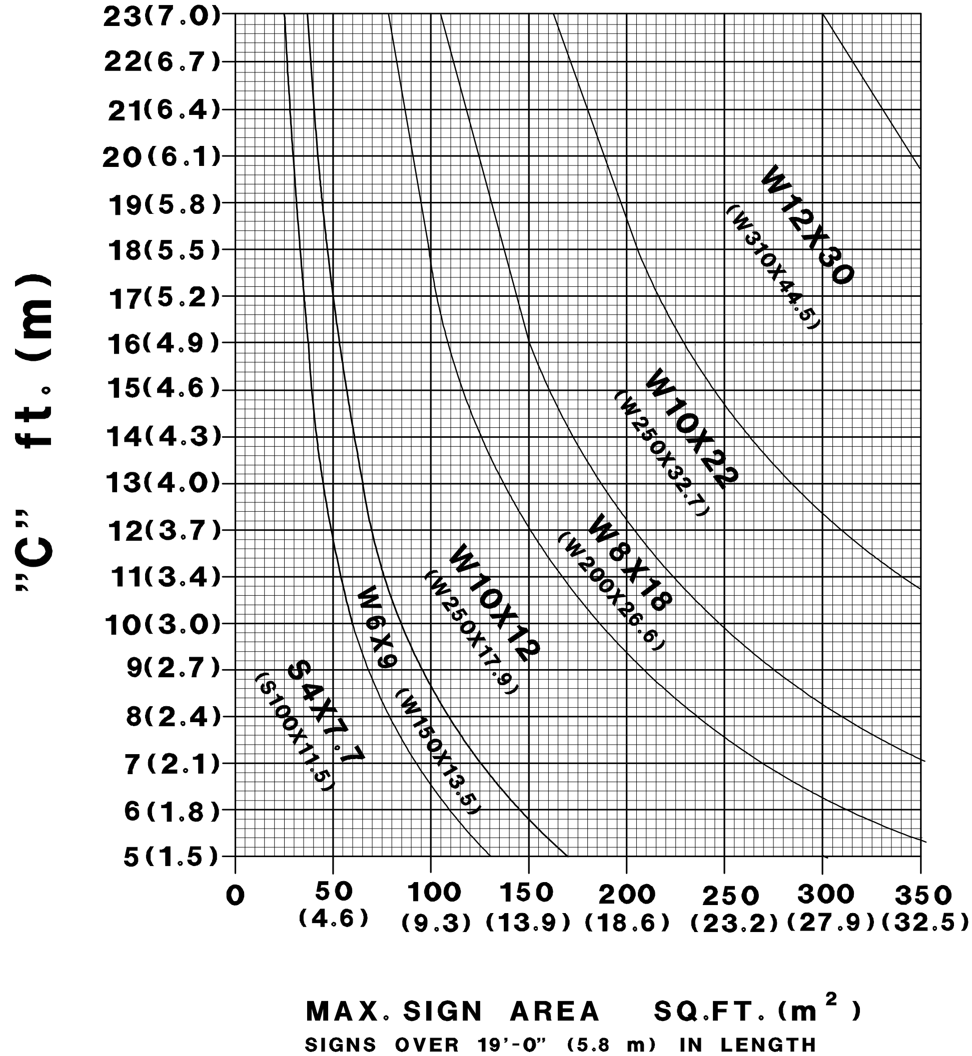
Figure 298-16. Design Chart for Two Beam Installations



TWO BEAM INSTALLATIONS

SIGNS 19'-0" (5.8 m) OR LESS IN LENGTH

Figure 298-17. Design Chart for Three Beam Installations



THREE BEAM INSTALLATIONS

Figure 298-18. Design Chart for TC-17.10 Sign Supports

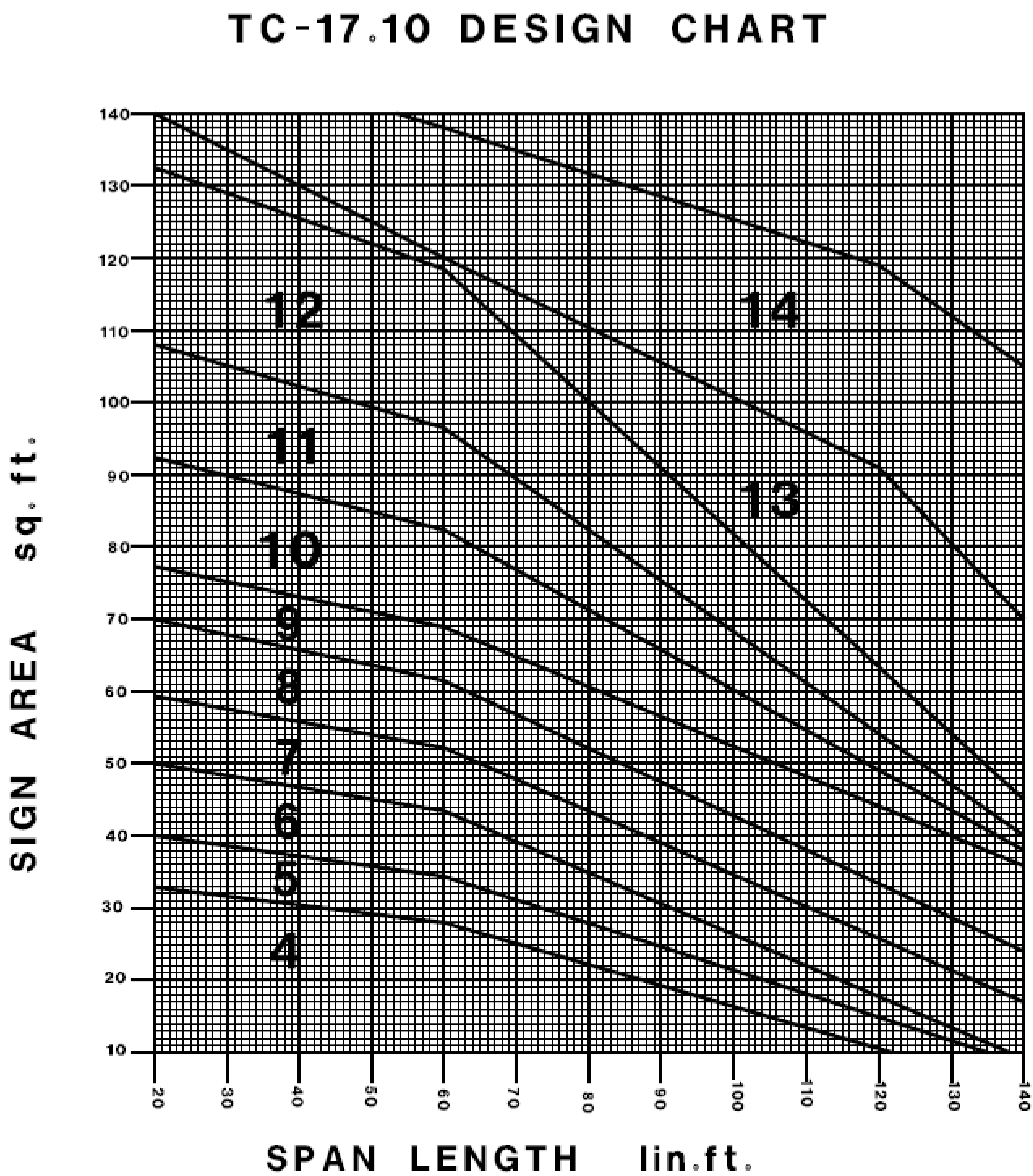
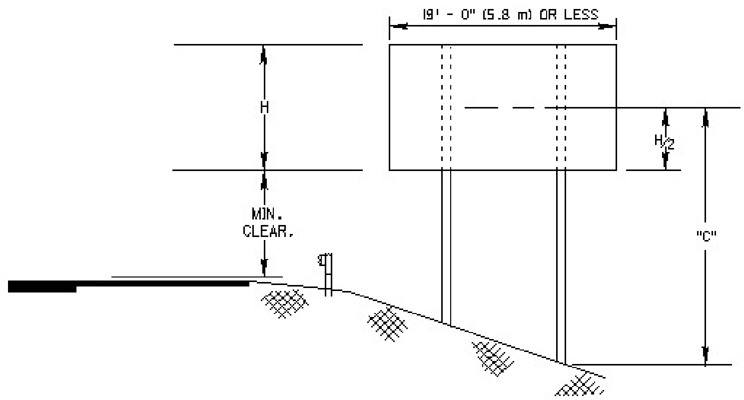
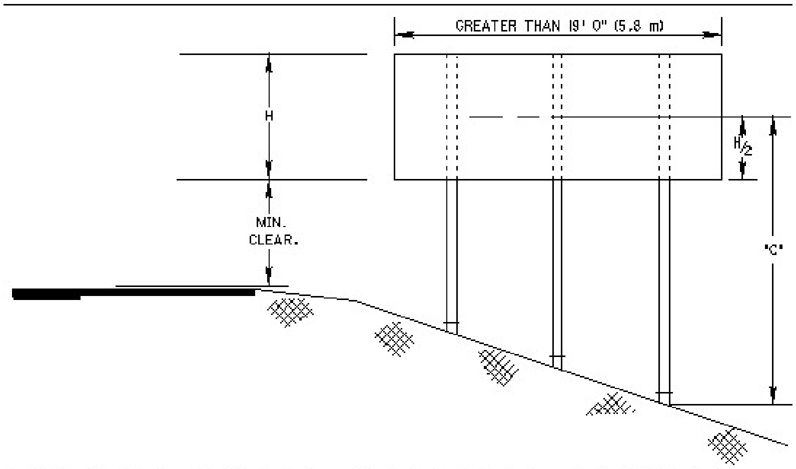


Figure 298-19. Two and Three Beam Installation Details

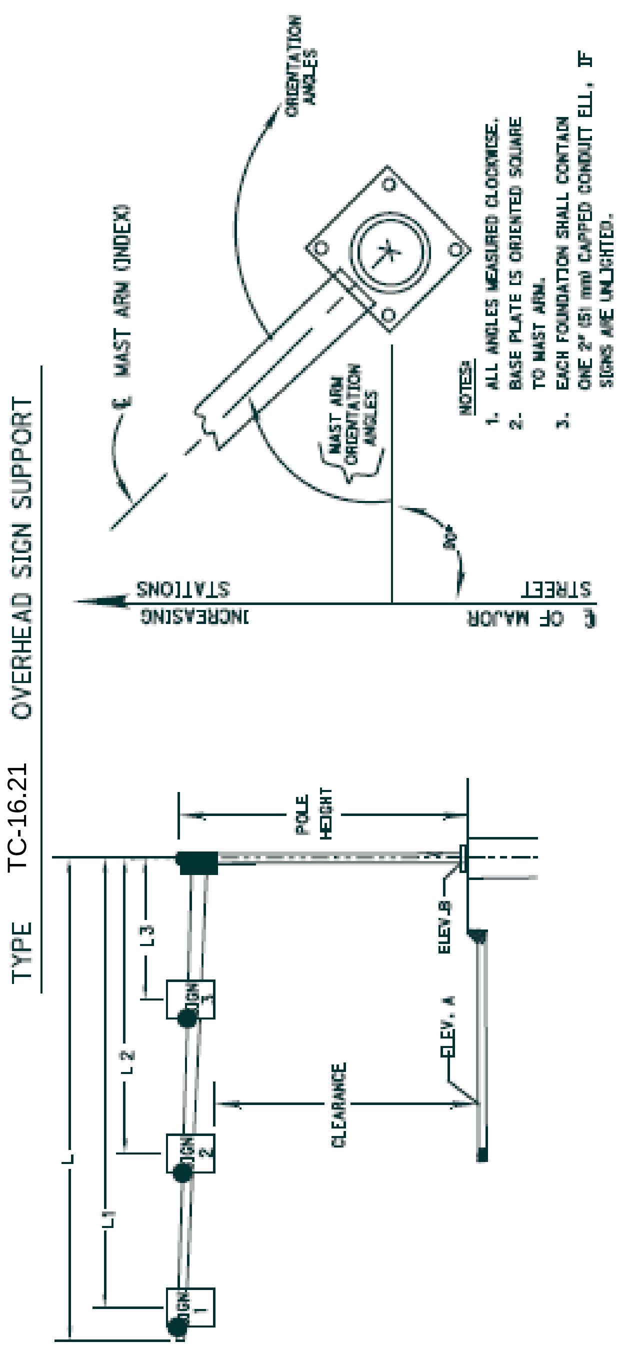


TWO BEAM INSTALLATION



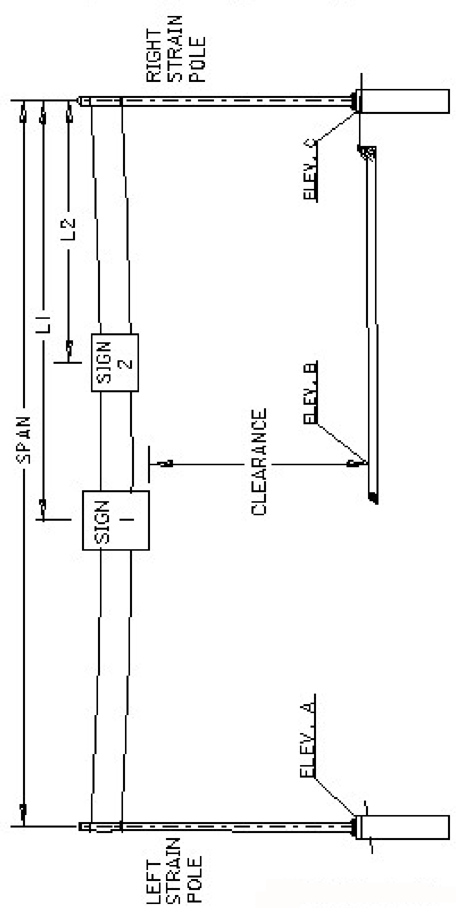
THREE BEAM INSTALLATION

Figure 298-20. TC-16.21 Overhead Sign Support



SUPPORT NO.	STATION	POLE OFFSET	OVERHEAD SIGN SUPPORT TYPE TC - TC-16.21										ELEVATION		MAST ARM ORIENTION ANGLE (DEG.)	ORIENTATION ANGLES FROM MAST ARM				630	625	630
			DESIGN NO.	POLE HEIGHT	L FT (M)	L1 FT (M)	SIGN 1 AREA S.F. (M²)	L2 FT (M)	SIGN 2 AREA S.F. (M²)	L3 FT. (M)	SIGN 3 AREA S.F. (M²)	CLEARANCE	A	B		HANDHOLE	LUMINAIRE BRACKET	2" CONDUIT ELL (CAPPED)		SIGNS FLATSHEET S.F. (M²)	GROUND RODS (EACH)	CONCRETE FOR ANCHOR BASE FOUNDATIONS (C.Y.)

Figure 298-21. TC-17.10 Span Wire Sign Support



NOTES:

1. ALL SIGN SUPPORTS ARE VIEWED IN DIRECTION OF INCREASING STATIONS.
2. SEE TC-81.10 AND TC-21.20 FOR POLE AND FOUNDATION DETAILS.
3. THE HANDHOLE SHALL BE LOCATED ON THE SIDE OF THE POLE FARTHEST FROM THE ROADWAY.
4. A CAPPED 2" (51 mm) BLIND HALF COUPLING SHALL BE LOCATED 12" (0.3 m) FROM THE TOP OF POLE FACING TOWARDS THE ROADWAY.
5. ALL FOUNDATIONS SHALL CONTAIN ONE 2" (51 mm) CAPPED CONDUIT ELL FOR FUTURE USE. IT SHALL BE LOCATED PERPENDICULAR TO THE ROADWAY CENTERLINE ON THE SIDE OF THE FOUNDATION FARTHEST FROM THE ROADWAY.

SUPPORT NO.	SPAN WIRE SIGN SUPPORT TYPE TC - 17.10													ELEVATION			630	625	
	DESIGN NO.	LEFT POLE			RIGHT POLE			SPAN FT (m)	L 1 FT (m)	SIGN 1 AREA S.F (m^2)	L 2 FT (m)	SIGN 2 AREA S.F (m^2)	CLEARANCE	A	B	C	SIGNS FLATSHEET S.F (m^2)	GROUND RODS (EACH)	
		STATION	OFFSET	HEIGHT	STATION	OFFSET	HEIGHT												

Figure 298-22. Lane-Use Control Signs Index

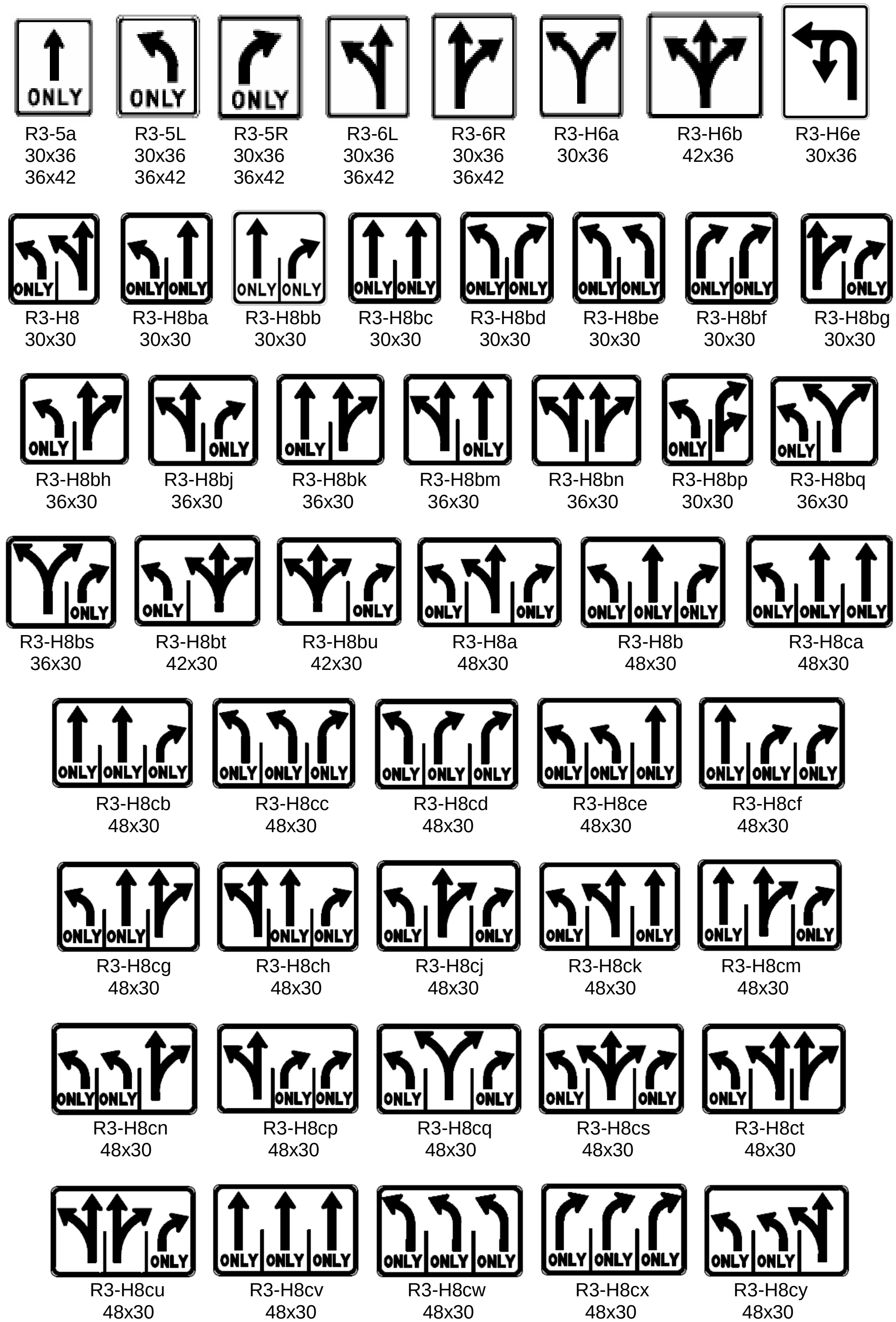
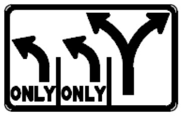


Figure 298-22. Lane Use Control Signs Index (Continued)



R3-H8cz
48x30

R3-H8caa
48x30

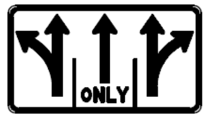
R3-H8cbb
48x30

R3-H8ccc
48x30

R3-H8cdd
48x30

R3-H8cee
54x30

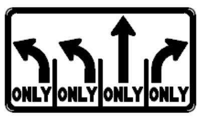
R3-H8cff
54x30



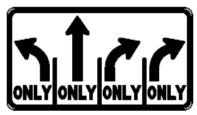
R3-H8cgg
54x30

R3-H8chh
54x30

R3-H8da
54x30



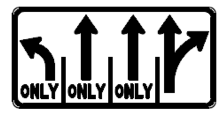
R3-H8db
54x30



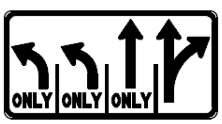
R3-H8dc
54x30

R3-H8dd
54x30

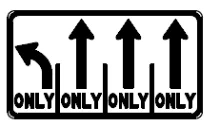
R3-H8de
54x30



R3-H8df
60x30



R3-H8dg
60x30

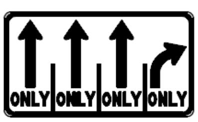


R3-H8dh
54x30

R3-H8dj
54x30

R3-H8dk
54x30

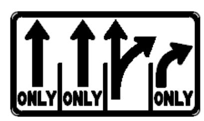
R3-H8dm
54x30



R3-H8dn
54x30

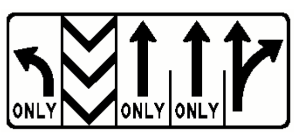
R3-H8dp
54x30

R3-H8dq
54x30

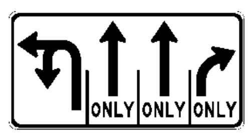


R3-H8dr
54x30

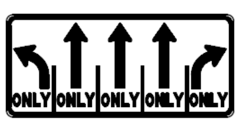
R3-H8ds
66x30



R3-H8dt
72x30



R3-H8du
60x30

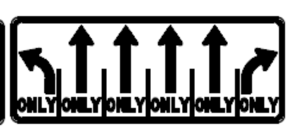


R3-H8ea
66x30

R3-H8eb
72x30

R3-H8ec
72x30

R3-H8ed
72x30



R3-H8fa
78x30

R3-H8fb
78x30

R3-H8fc
84x30

Figure 298-23. Mounting a Sign Support on Concrete Barrier

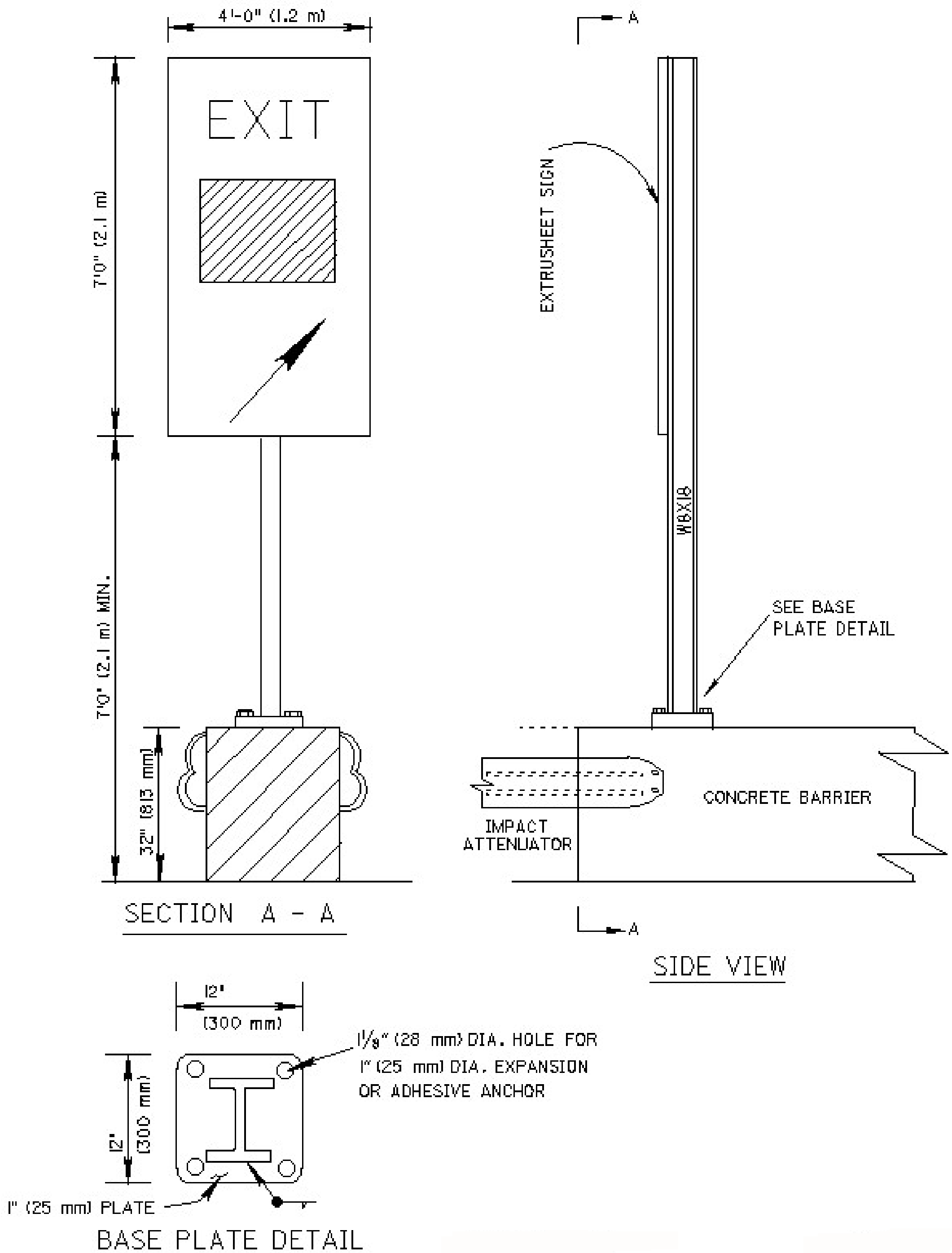
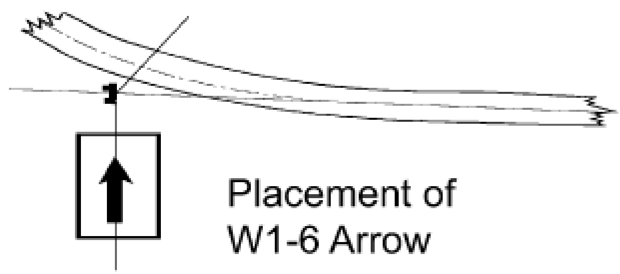


Figure 298-24. Staking Sign Locations



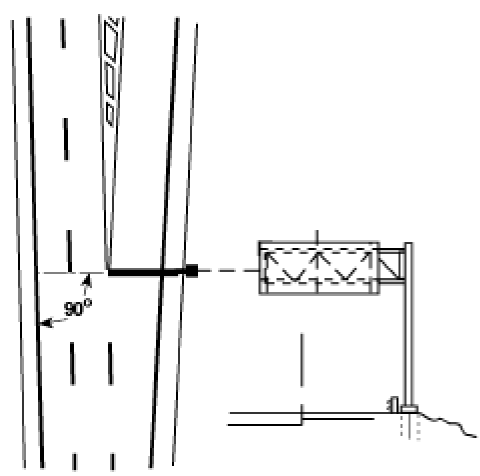
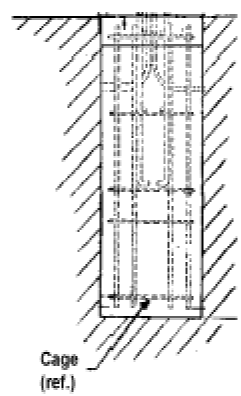


Figure 298-25. Foundation Excavations



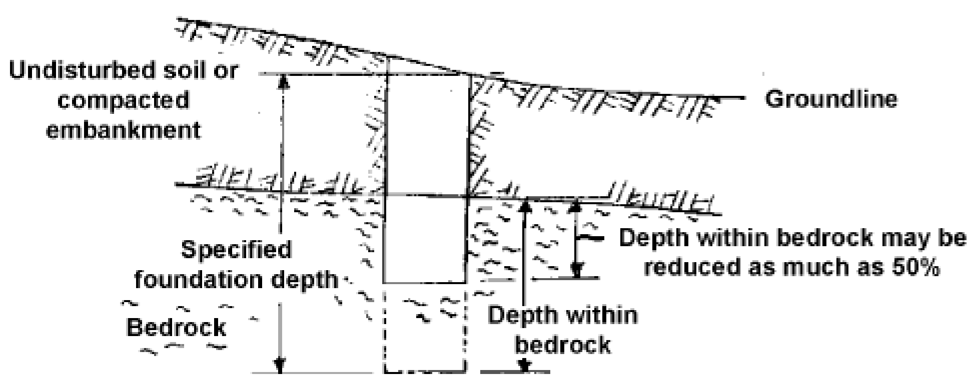
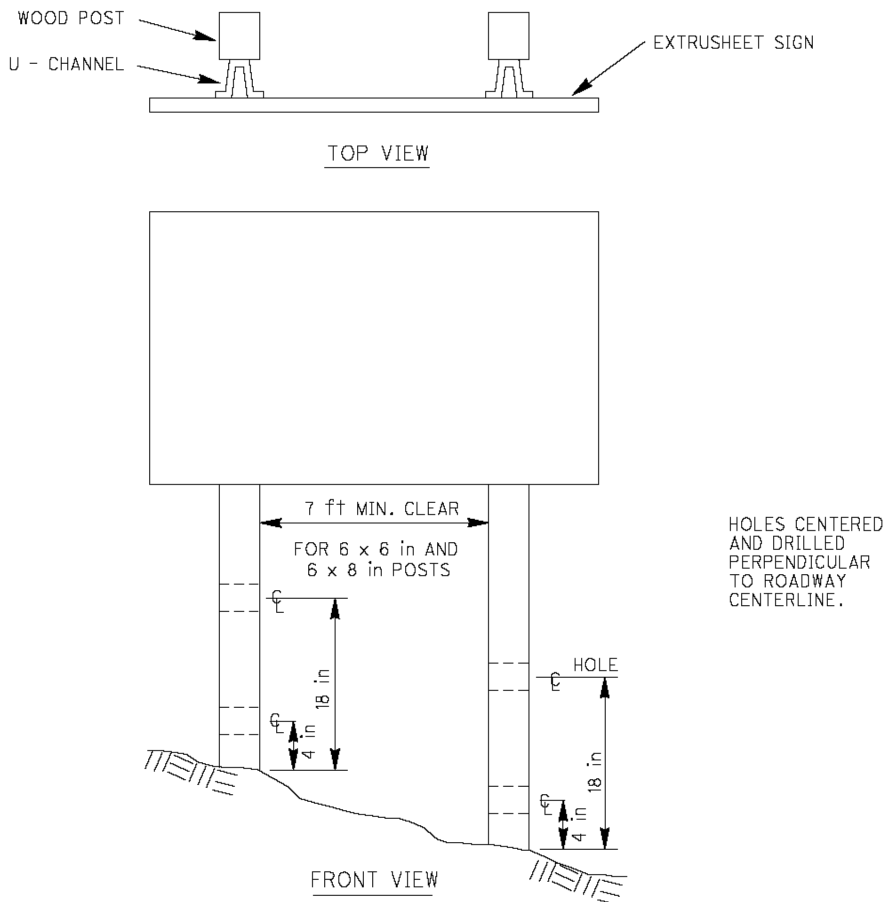


Figure 298-26. Solid Wood Posts



Recommended wind pressure to use in size calculations:

Wind pressure on sign = 15 lb/ft^2
Wind Pressure on exposed post = 18 lb/ft^2

Nominal Post Size (inches)	Hole Diameter (inches)	No. of Posts Permitted in 7' Path in Exposed Locations	Minimum Recommended Embedment Depth (feet)	Maximum Recommended Allowable Moment per Post (ft-lb)
4 x 4	None	2	3.5	1050
4 x 6	1 ½	2	4	2540
6 x 6	2	1	4.5	3880
6 x 8	3	1	5	6580

Figure 298-27. Design Chart for Solid Wood Posts
(See *Section 221-5* and *Figure 298-26* for additional information.)

Two Post Installations
(Nominal Post Size in inches (mm))

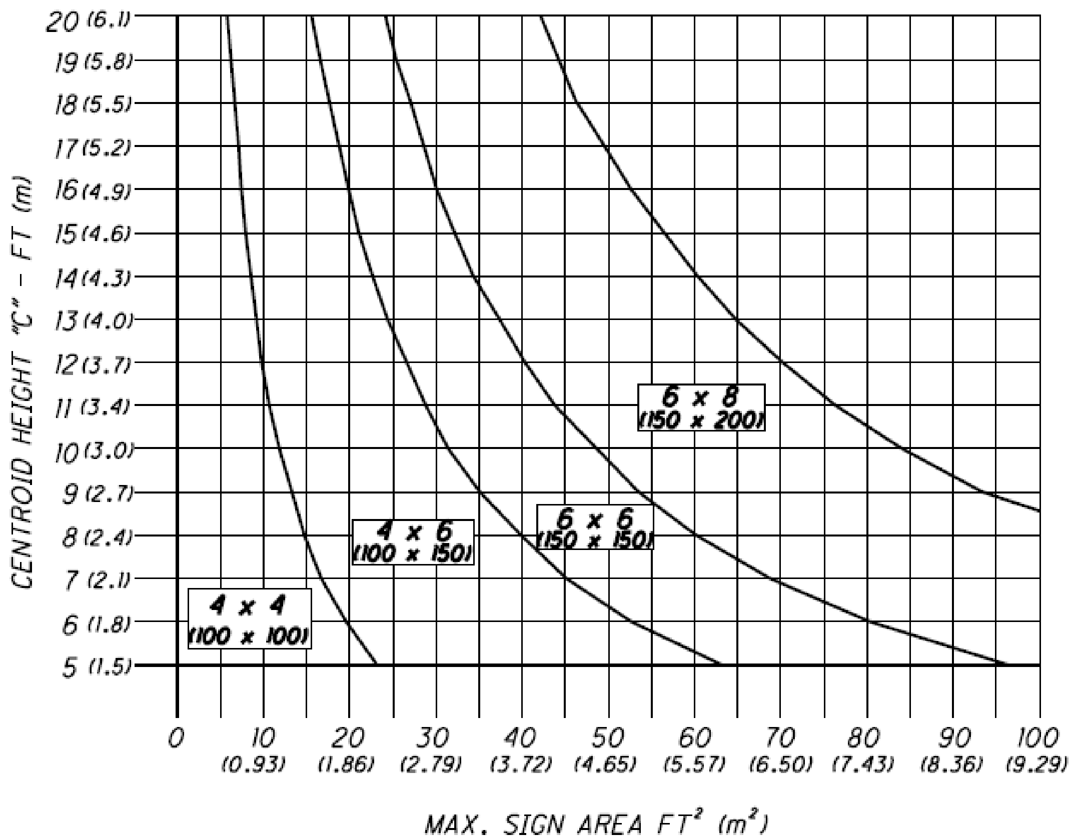
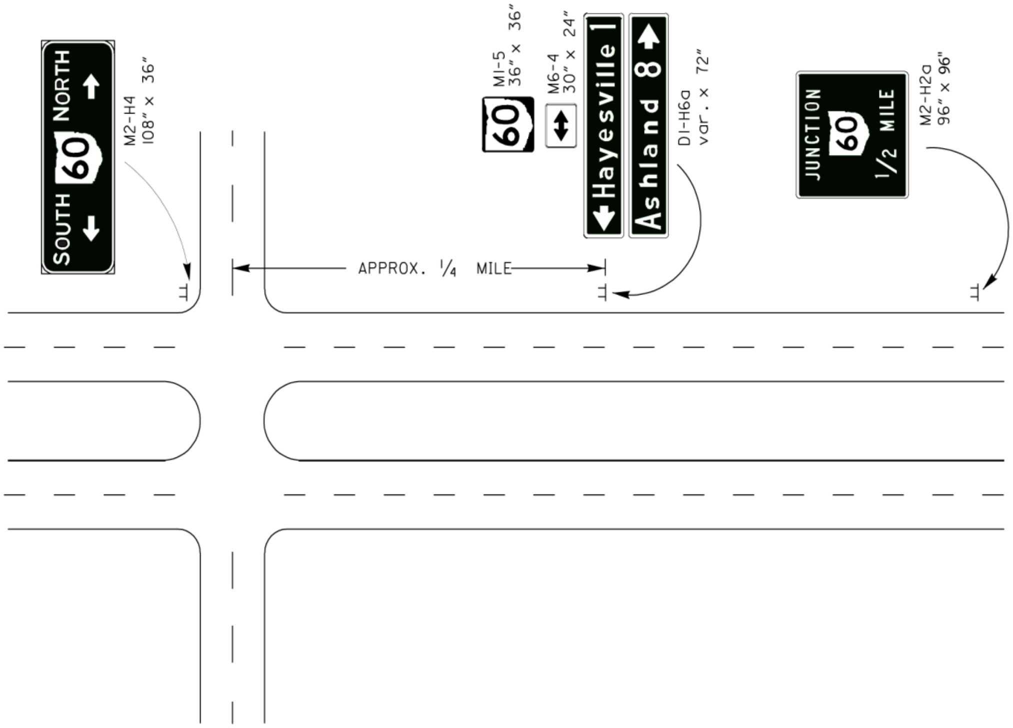


Figure 298-28. Example of Signing for an Expressway At-Grade Intersection with a Numbered Route

(Figure to be updated in future revision)



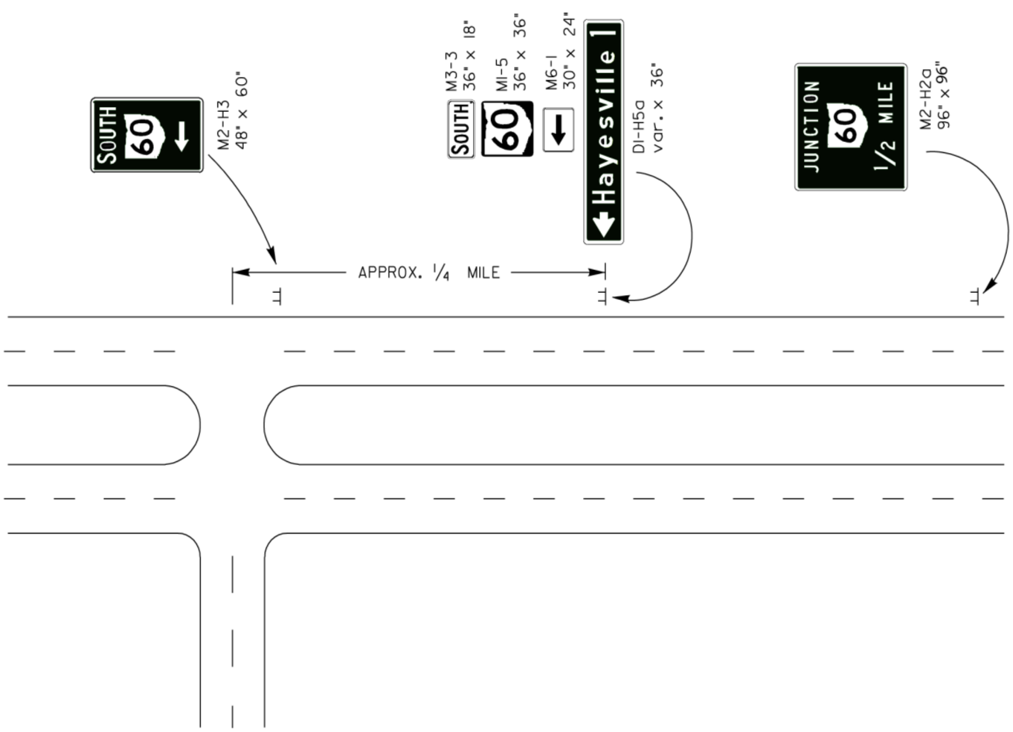


Figure 298-29. Example of Signing for an Expressway At-Grade Intersection with an Unnumbered Route

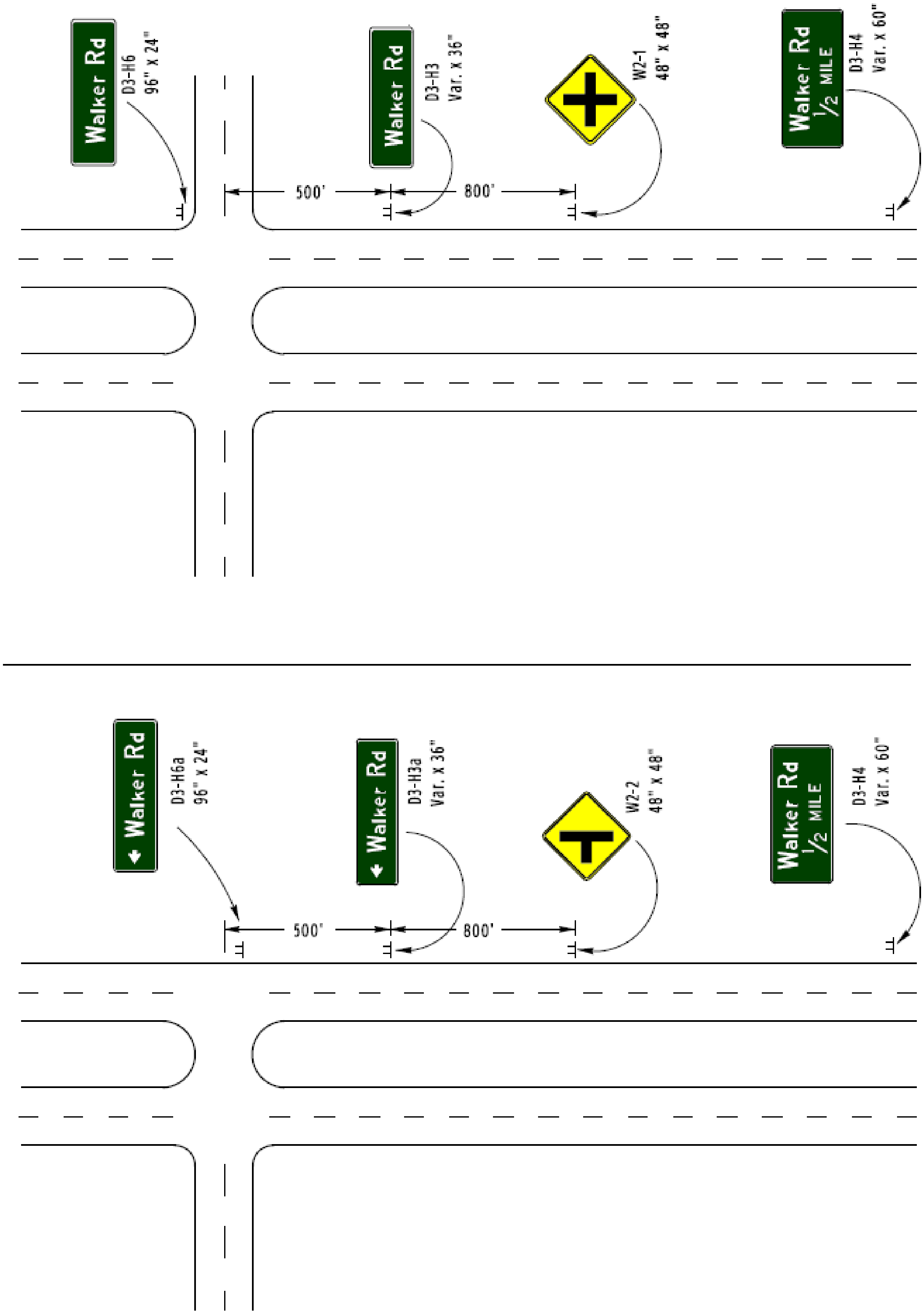
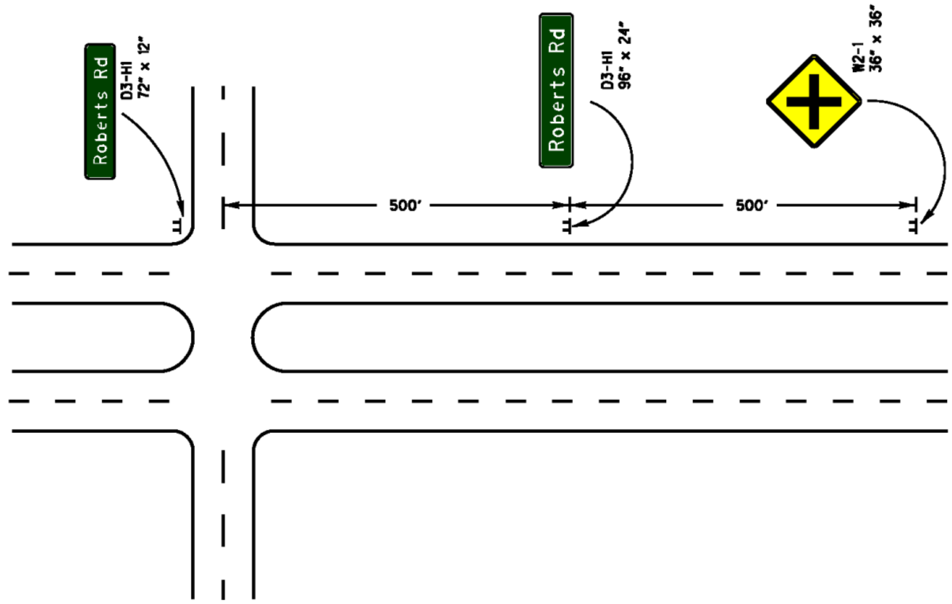
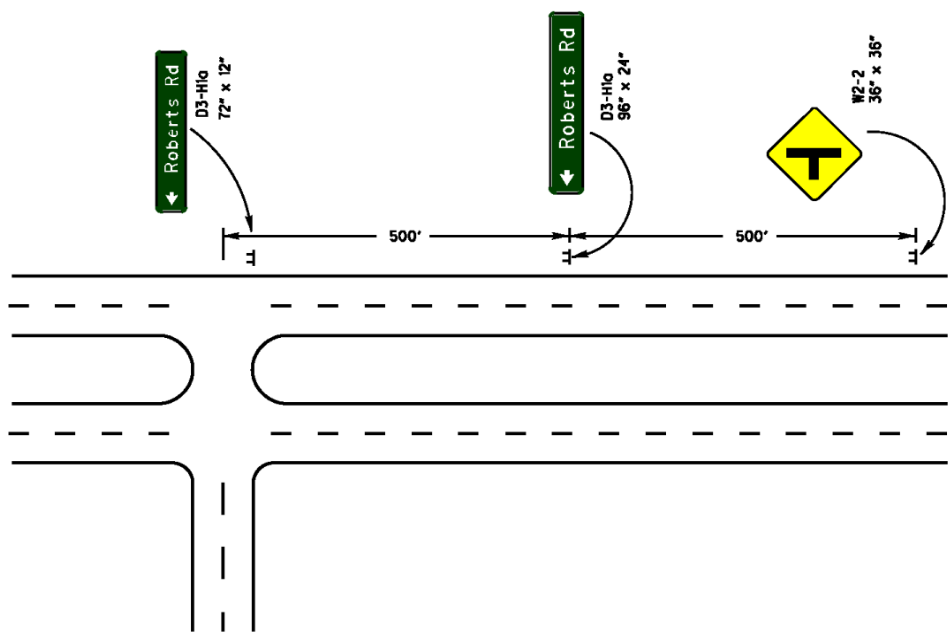


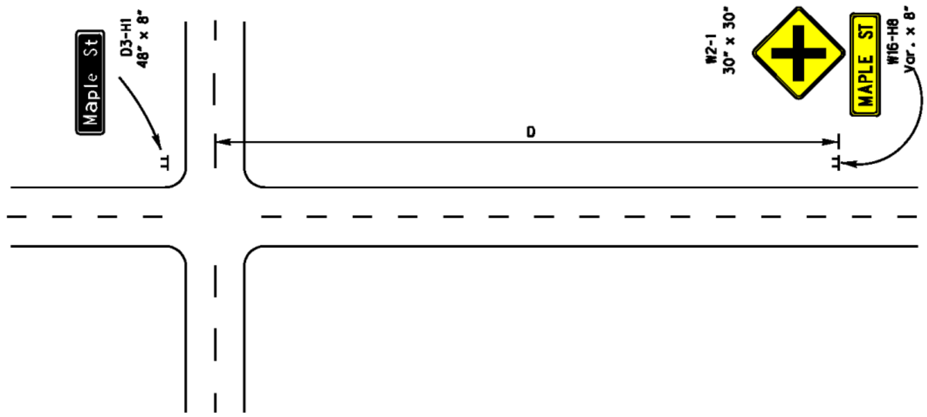
Figure 298-30. Example of Signing for a Multi-Lane Rural Conventional Road Intersection with an Important Public Road

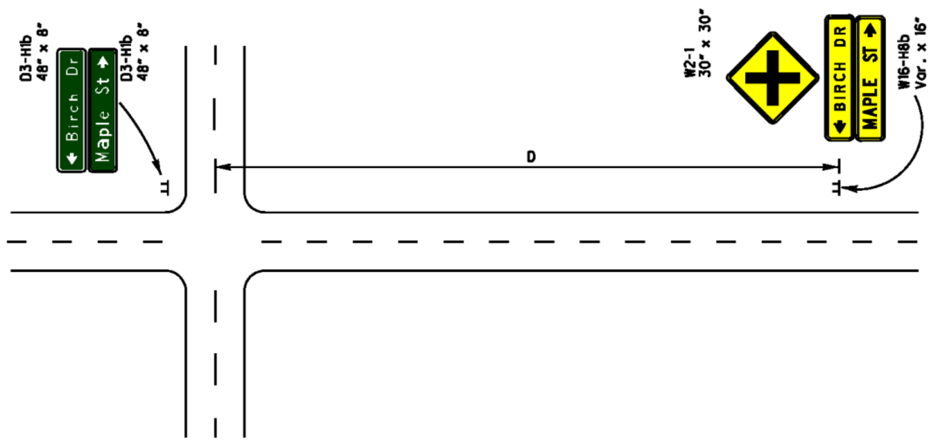


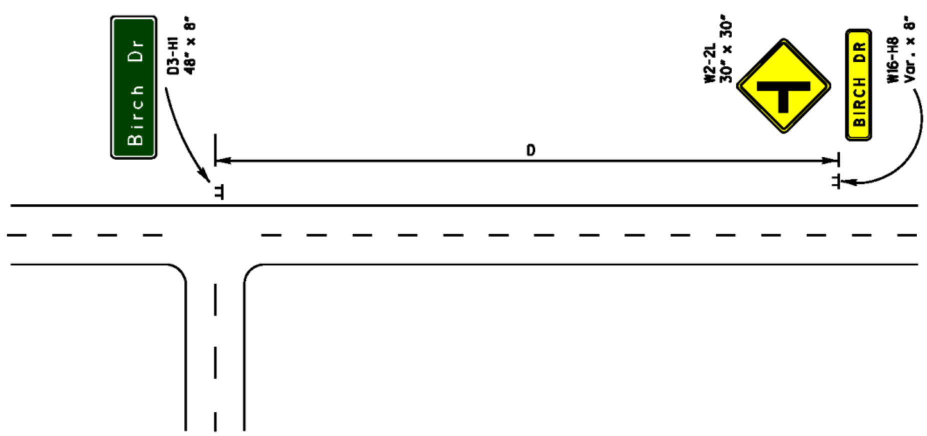


.

Figure 298-31. Example of Signing for a Single Lane Rural Conventional Road Intersection with an Important Public Road





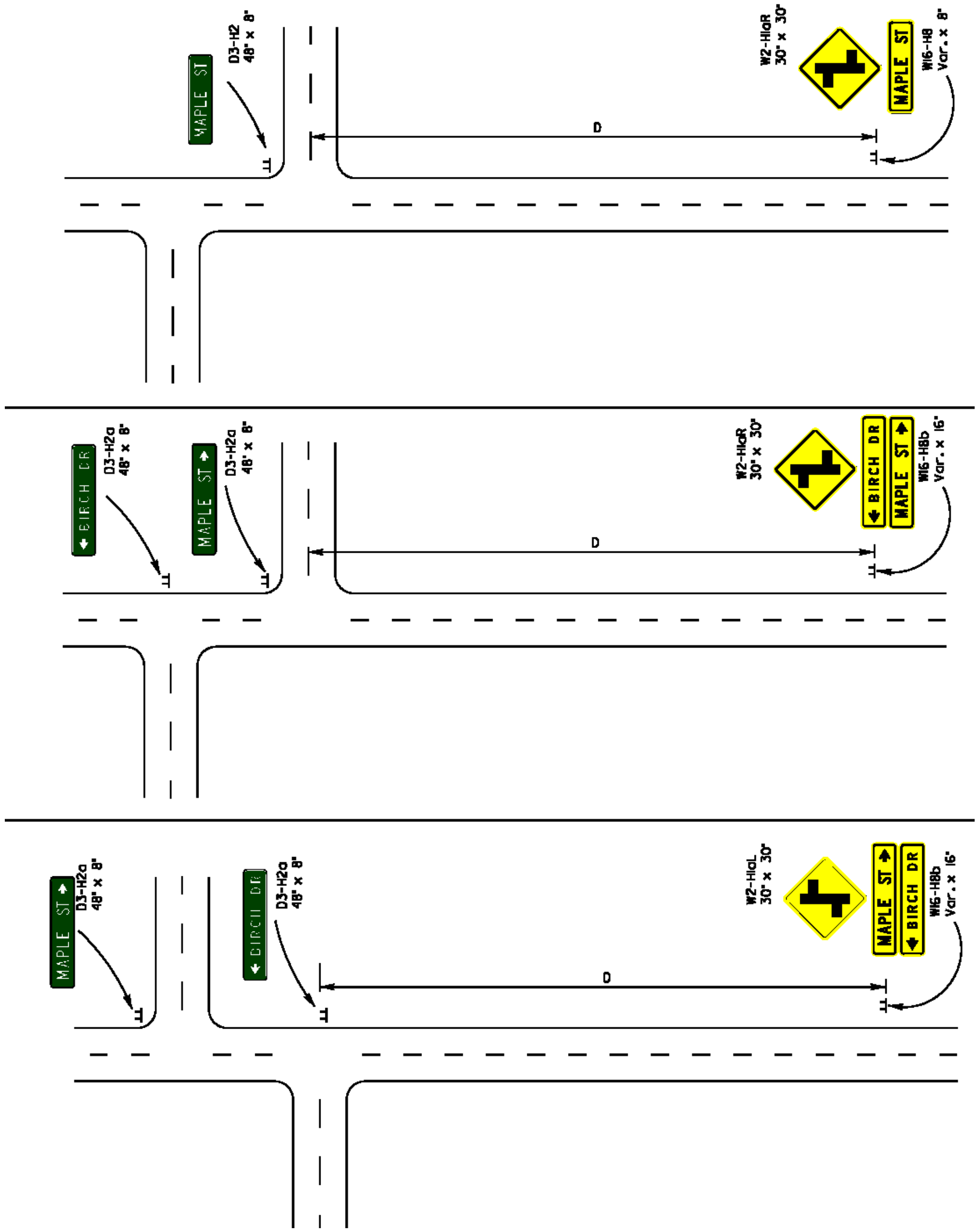


Distance "D" is determined in accordance with **OMUTCD Table 2C-4**, Condition B.

Revision Note: Revise sizes of D3-H1 and D3-H1b to 72" x 12".

Figure 298-32. Example of Signing for a Single Lane Rural Conventional Road Offset Intersection with an Important Public Road

(Figure to be updated in future revision)



Distance "D" is determined in accordance with **OMUTCD Table 2C-4**, Condition B.

Revision Note:

1. Revise the sign code number D3-H2 above to D3-H1.
2. Revise the sign code number D3-H2a above to D3-H1b.
3. Revise the legends on both of these signs from all capitals to upper/lowercase letters.

Figure 298-33. Signing for an Optional Lane Exit without a Secondary Exit

(Figure to be updated in future revision)

Figure 298-34. Example of Signing for an Optional Lane Exit with a Secondary Exit – Low-Volume Primary Exit

(Figure to be updated in future revision)

Figure 298-35. Example of Signing for an Optional Lane Exit with a Secondary Exit – High-Volume Primary Exit

(Figure to be updated in future revision)

Figure 298-36. Example of Signing for an Optional Lane Exit with a Secondary Exit – Major Splits

(Figure to be updated in future revision)

Figure 298-37. Examples of Signing for Historical Markers

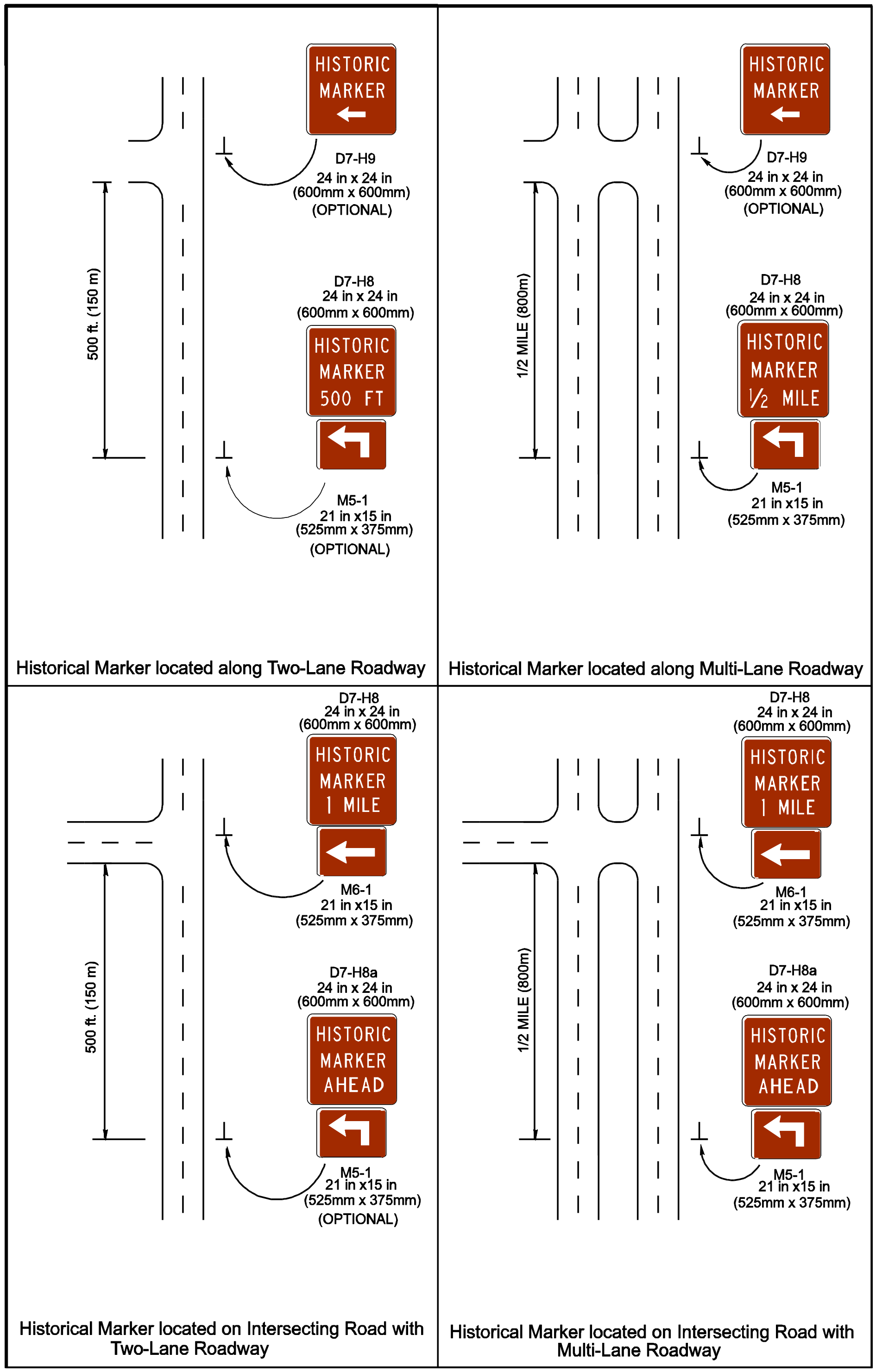


Figure 298-38a. Route Signing for Municipal Street Systems (Example A)

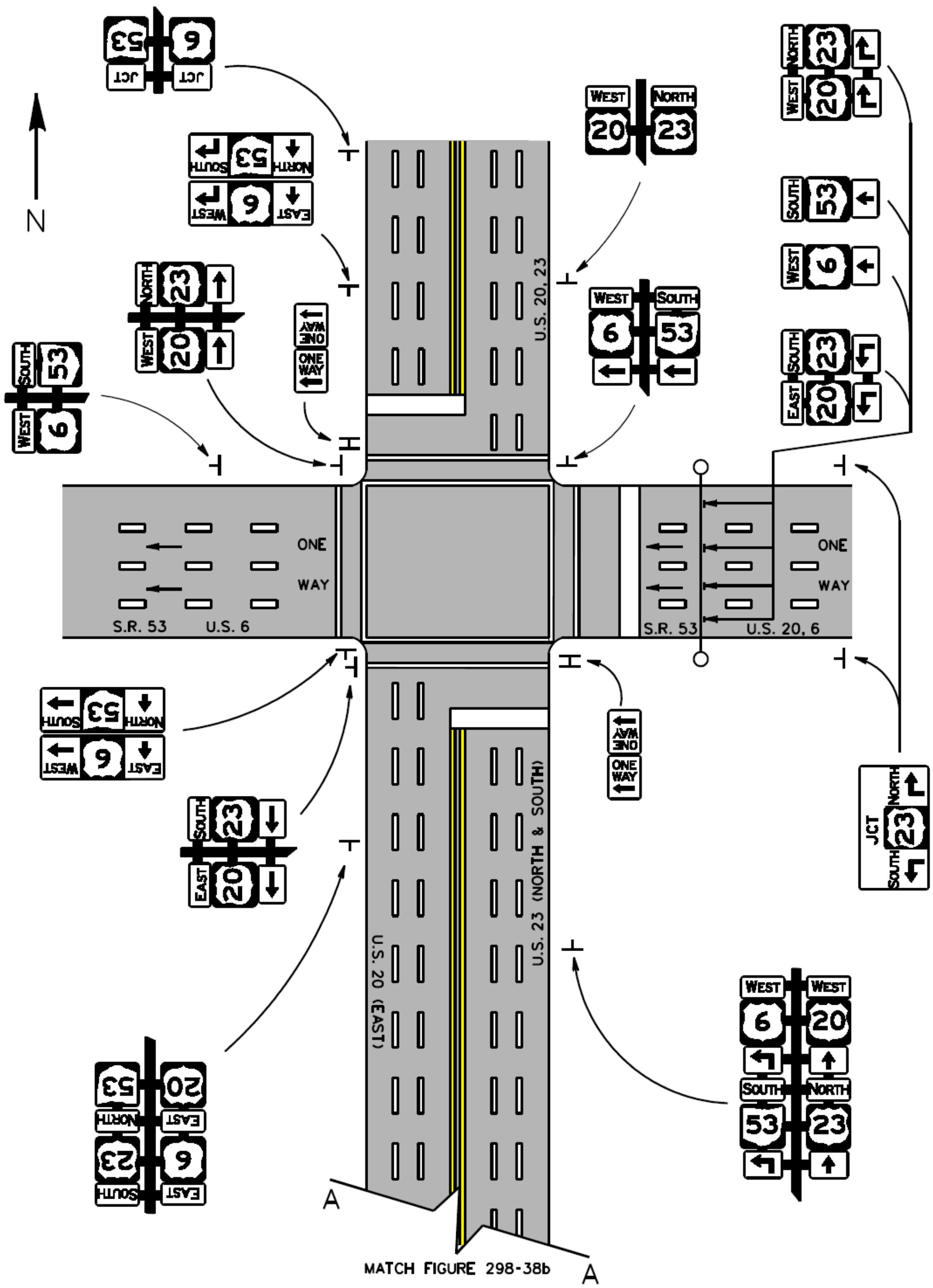


Figure 298-38b. Route Signing for Municipal Street Systems (Example B)

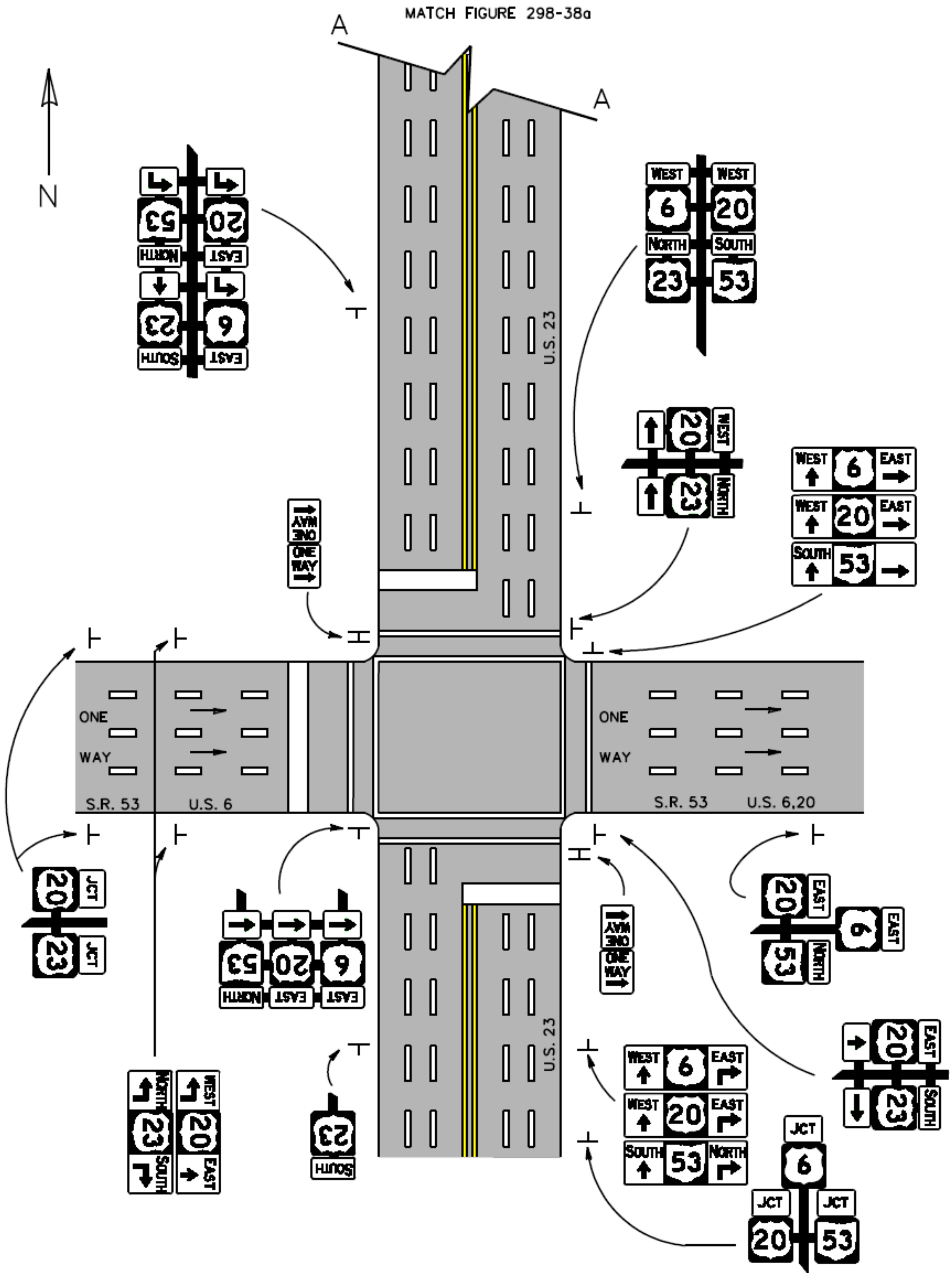


Figure 298-39. Example of Freeway and Expressway Rest Area Signing

(Figure to be updated in future revision)

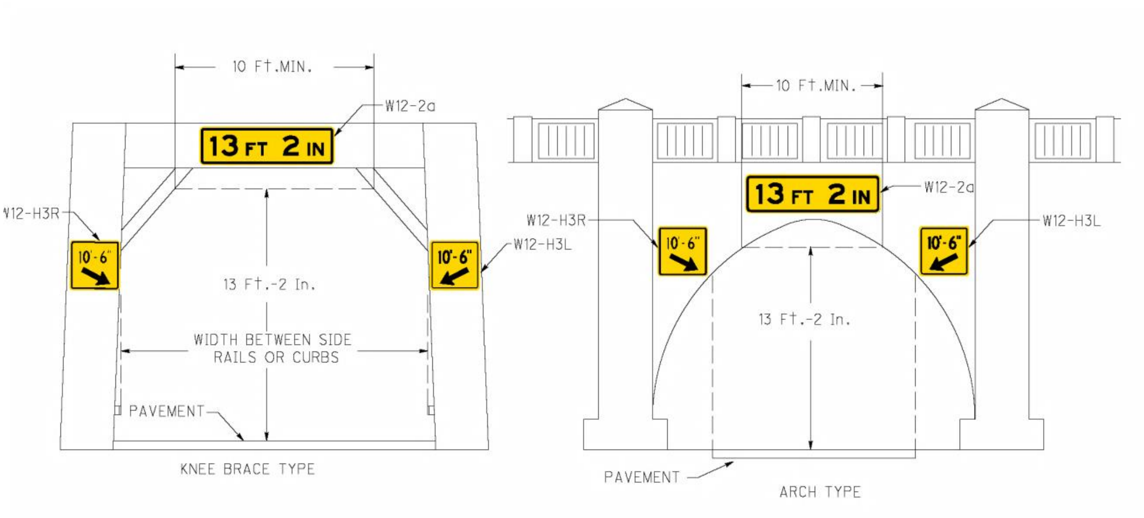
Figure 298-40. Example of Conventional Road Rest Area Signing

(Figure to be updated in future revision)

Figure 298-41. Example of Conventional Road Rest Area Signing

(Figure to be updated in futrure revision)

Figure 298-42. Example of Clearance Signs on a Low Clearance Structure



Note: The W12-2a sign shall be used when the 10 foot chord (center) clearance of the overhead structure is 13.5 feet or less.

Figure 298-43. Example of Freeway Transition Signing

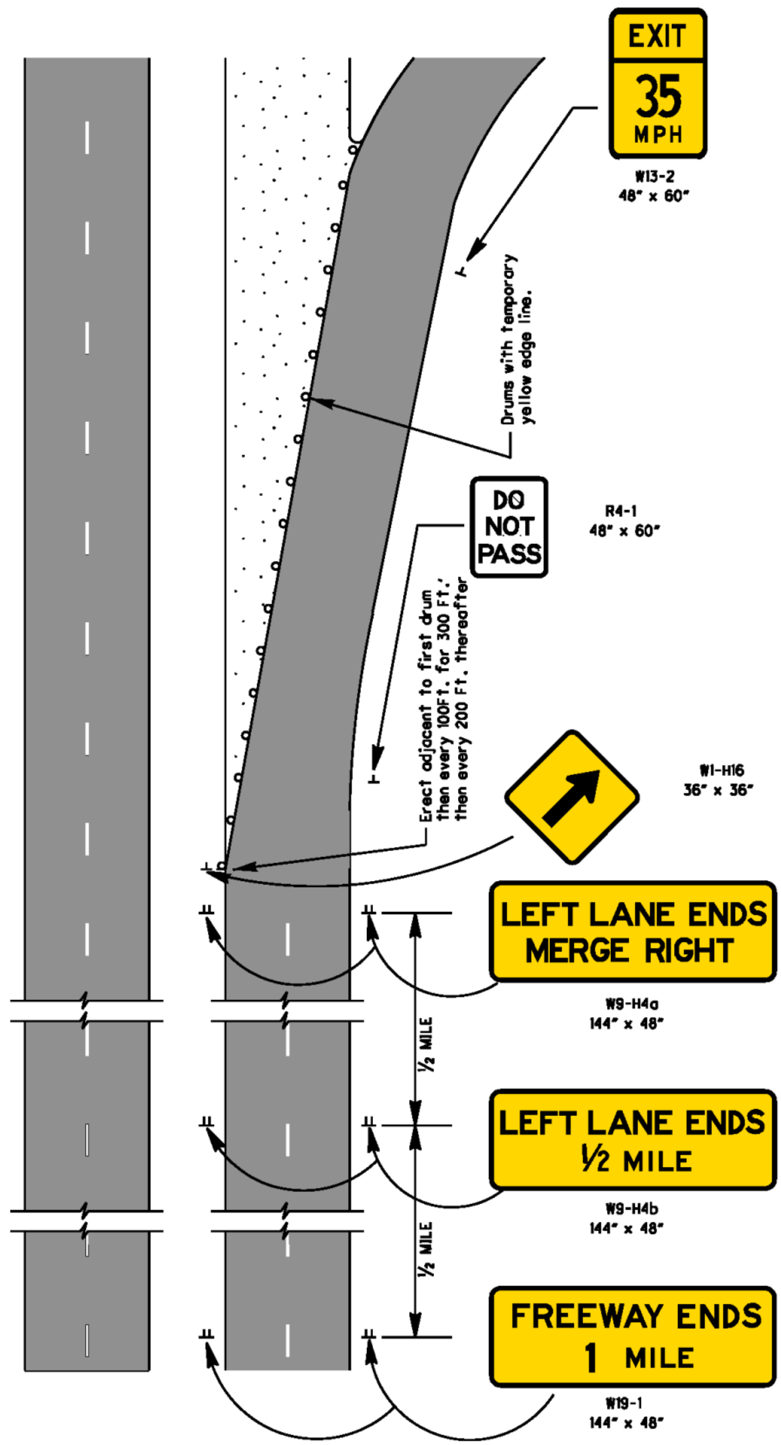
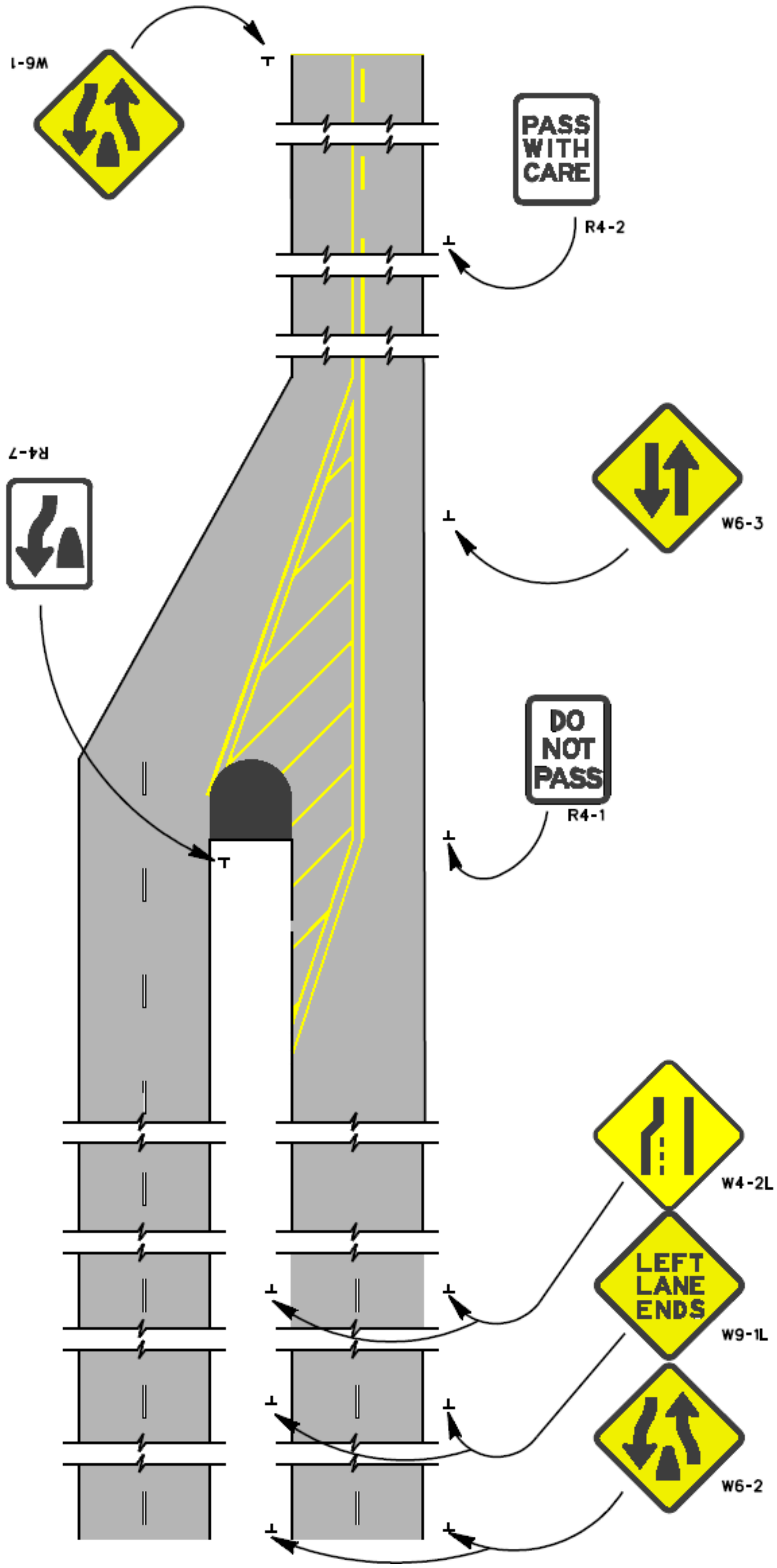


Figure 298-44. Example of Conventional Highway Transition Signing



Note: Refer to the **OMUTCD** for sign placement.

Figure 298-45. Freeway Guide Signing Arrangment (Example A)

Use the guide signing arrangement shown for the following conditions:

1.) Dual lane exit with mainline option lane.
2.) No ramp split beyond mainline exit gore.
3.) On-ramp within major guide signing sequence.
4.) On-ramp becomes auxiliary "exit only" lane.
5.) Mainline lane continuity.

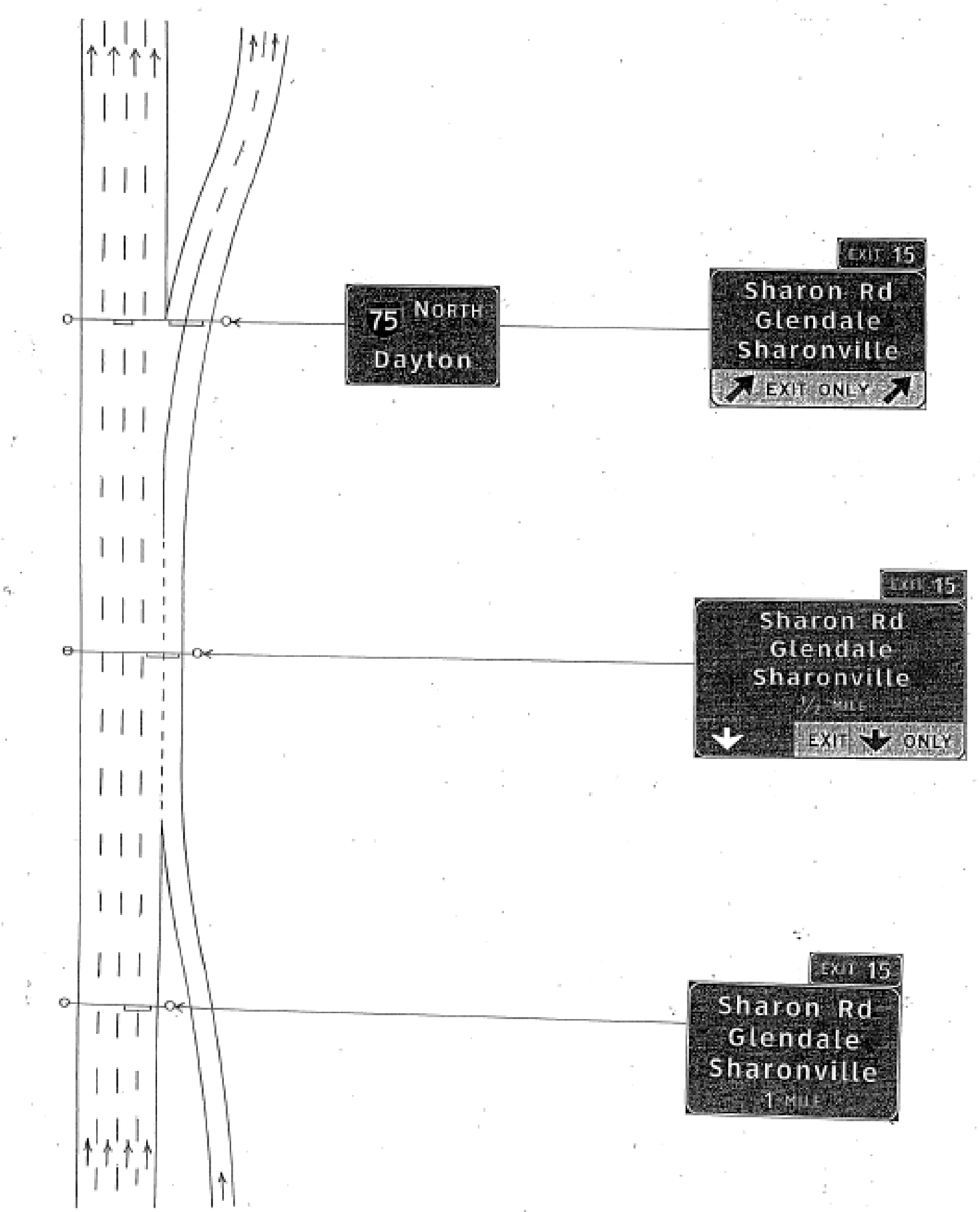


Figure 298-46. Freeway Guide Signing Arrangment (Example B)

Use the guide signing arrangement shown for the following conditions:

1.) Dual lane exit with mainline option lane.
2.) 1/1 ramp split beyond mainline exit gore.
3.) On-ramp within major guide signing sequence.
4.) On-ramp becomes auxiliary "exit only" lane.
5.) Mainline lane continuity.

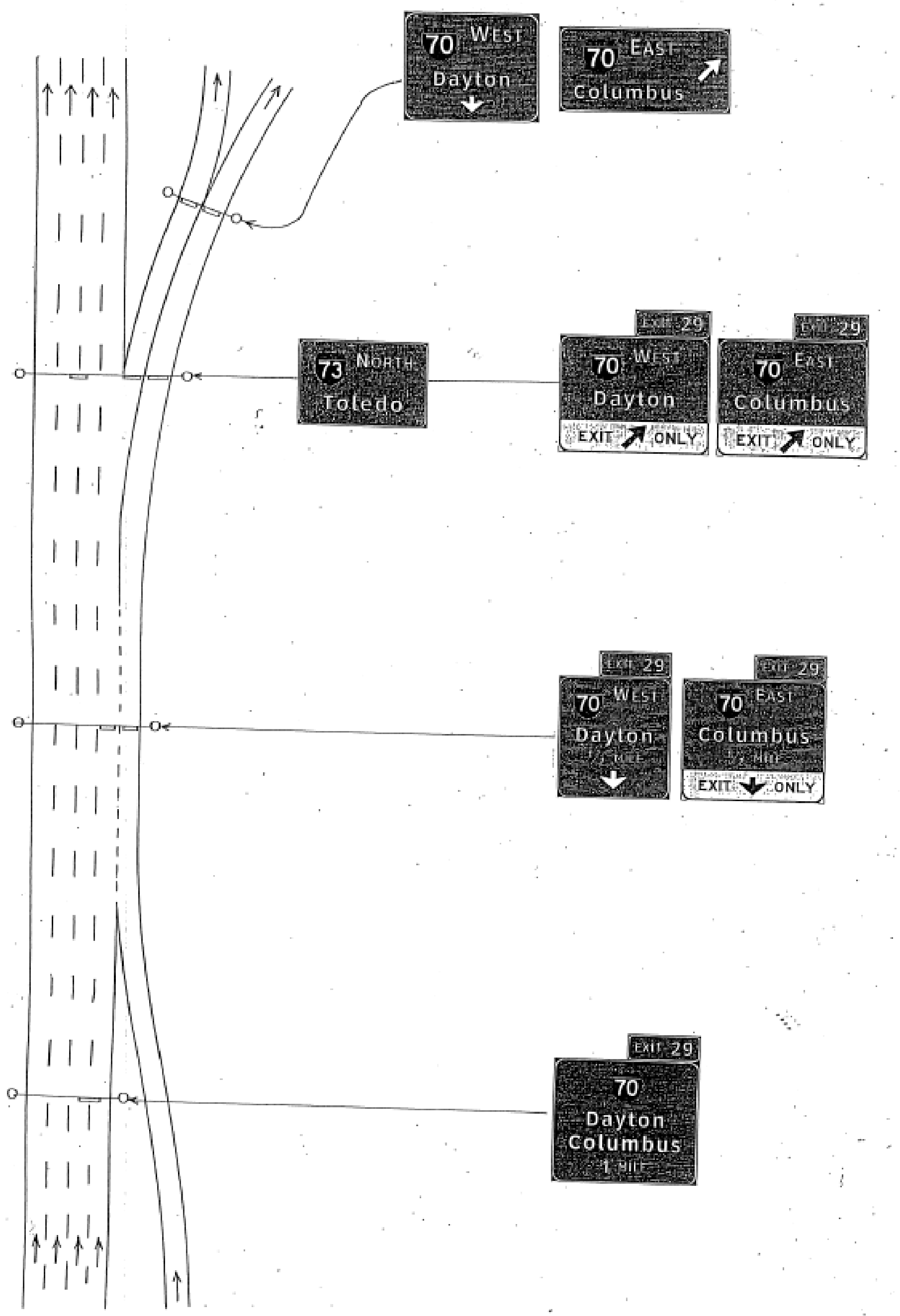


Figure 298-47. Freeway Guide Signing Arrangment (Example C)

Use the guide signing arrangement shown for the following conditions:

1.) Dual lane exit with mainline option lane.
2.) 1/1 ramp split beyond mainline exit gore.
3.) On-ramp within major guide signing sequence.
4.) On-ramp becomes auxiliary "exit only" lane.
5.) Mainline lane continuity.

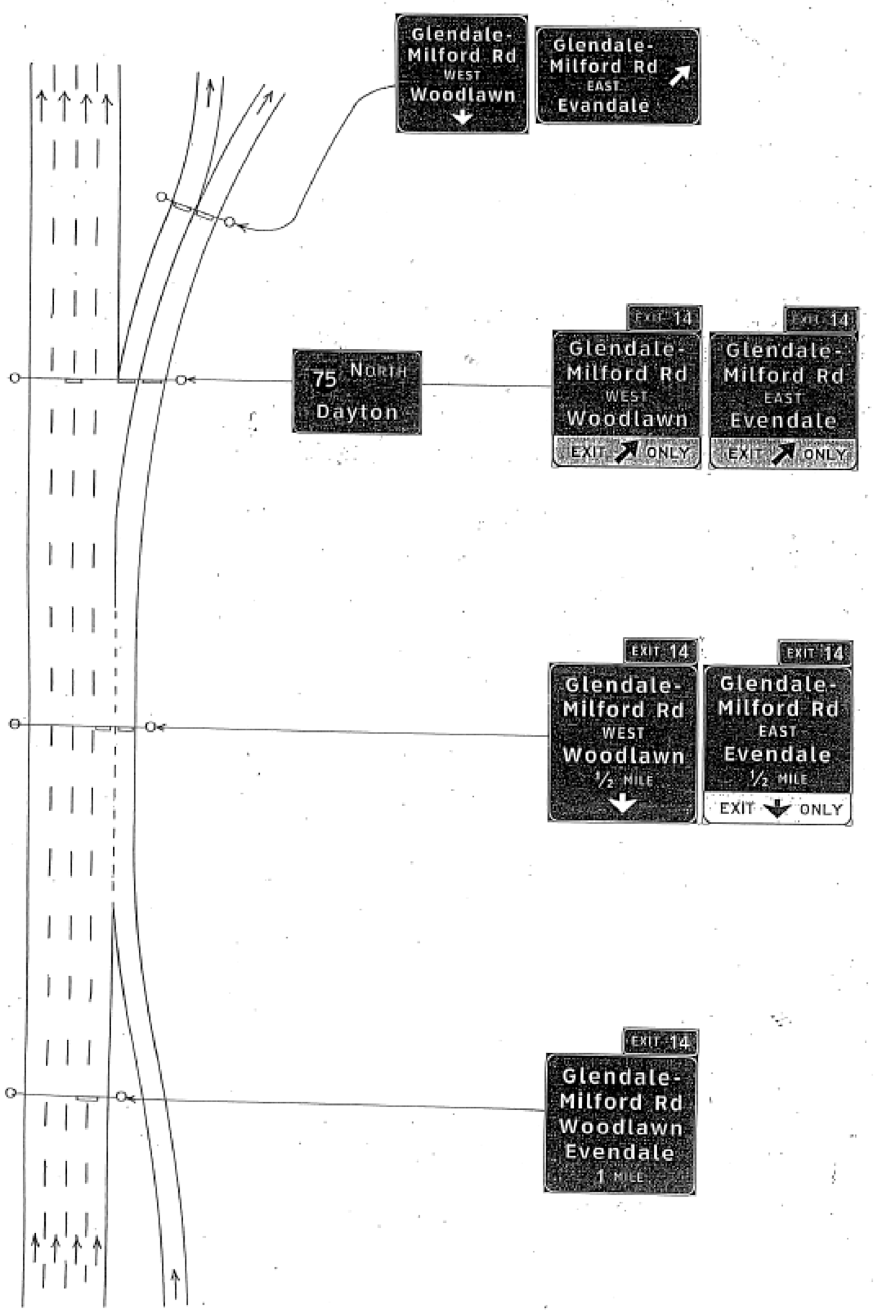
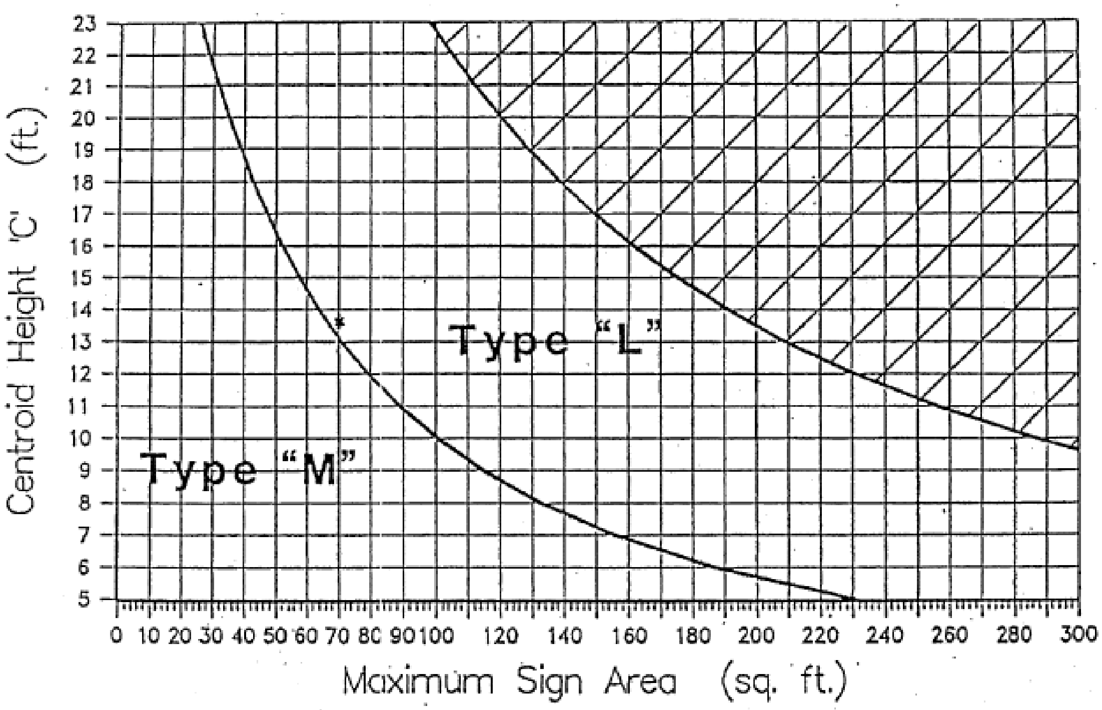
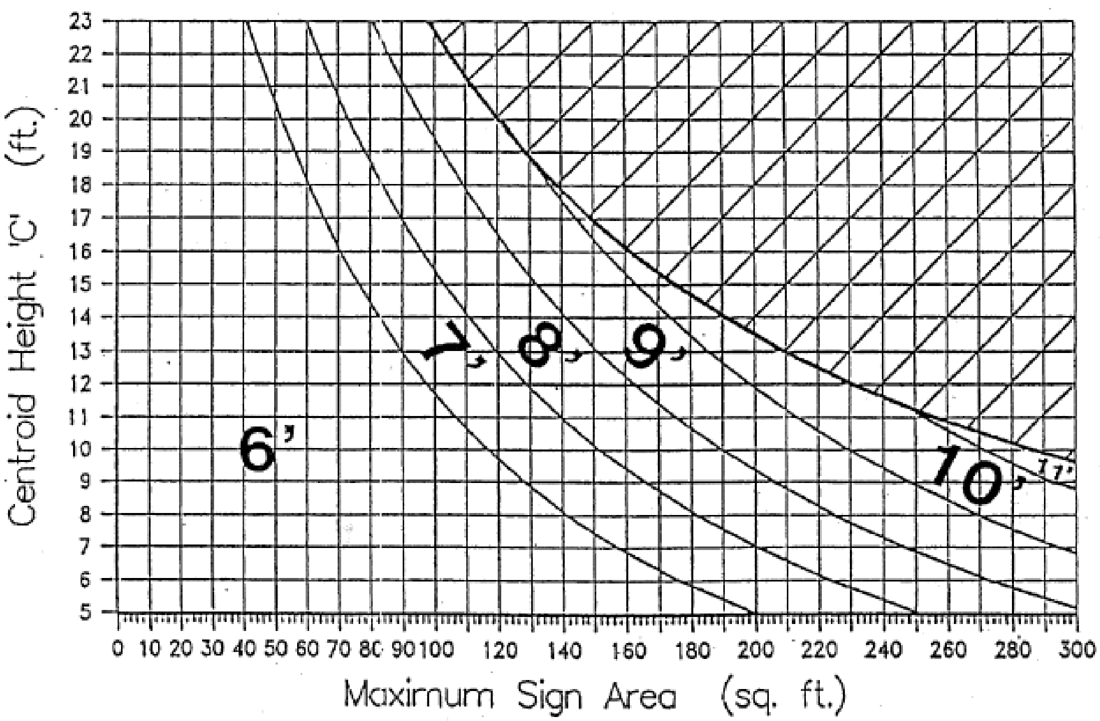


Figure 298-48. Design Charts for Laminated Veneer Wooden Box Beam Sign Supports (sheet 1 of 2)

Two-Beam Installations (for signs 19'-0" or less in length)

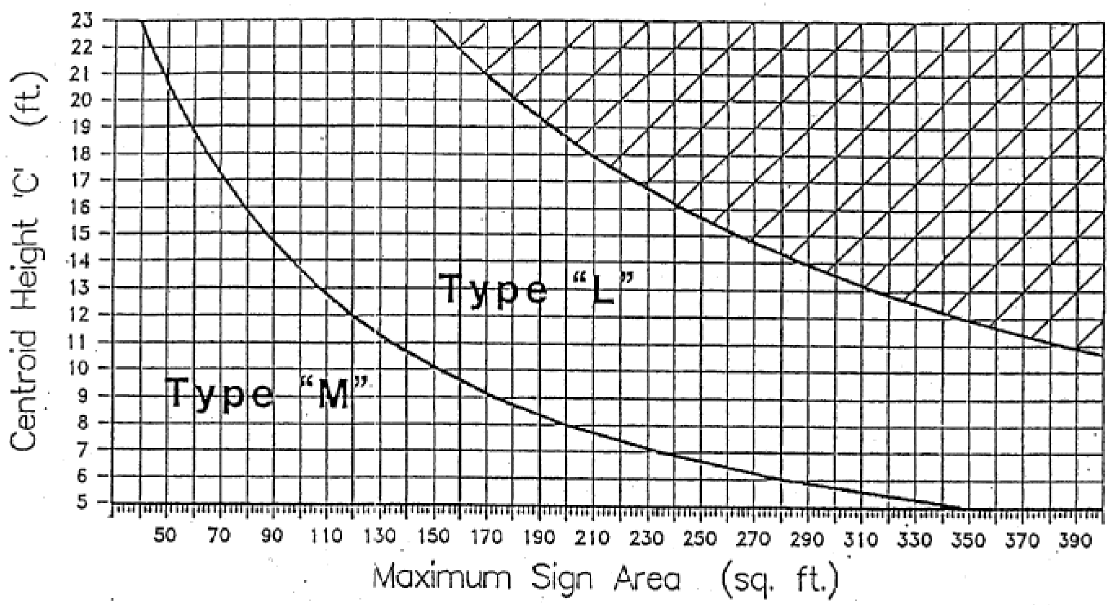


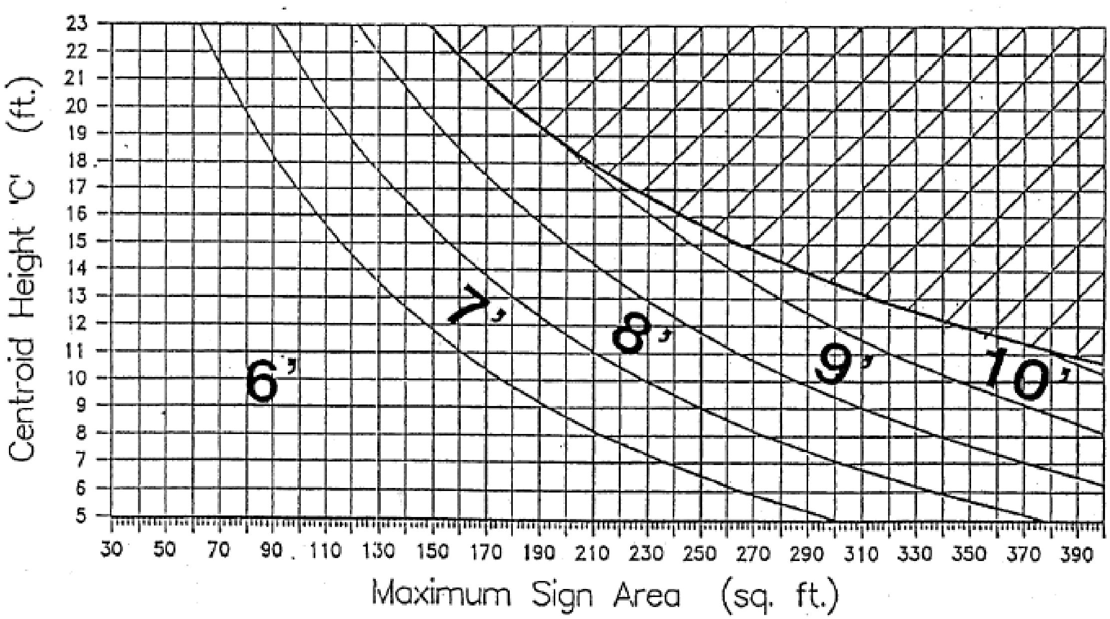


Top Chart = Beam Selection Bottom Chart = Embedment Depth

Figure 298-48. Design Charts for Laminated Veneer Wooden Box Beam Sign Supports (sheet 2 of 2)

Three-Beam Installations (for signs over 19'-0" in length)





Top Chart = Beam Selection Bottom Chart = Embedment Depth

Intentionally blank

TABLE OF CONTENTS
Part 3 - MARKINGS

Intentionally blank.

Part 3 - MARKINGS

300 GENERAL

300-1 Introduction

The information provided in this Part of the **TEM** is intended to supplement the **OMUTCD** by presenting **ODOT** practices and procedures concerning the design, construction, operations and maintenance of various types of traffic marking devices such as pavement markings (including raised pavement markers), barrier reflectors and delineators.

300-2 Construction Projects

Chapter 140 addresses the general application of **ODOT** standards, specifications and standard drawings to construction projects. ***Chapter 350*** provides additional construction related information specific to traffic control markings.

300-3 Force Account (ODOT Operations) Work

Districts performing force account markings work shall comply with the requirements in the **OMUTCD** and this Manual. It is recommended that the **Districts** also follow the provisions in the applicable markings-related **Standard Construction Drawings (SCDs)** and **Construction and Materials Specifications (C&MS)** sections as well. It should be recognized, however, that the information in the **C&MS** and **SCDs** does not necessarily provide the only method to achieve a given objective.

301 PAVEMENT & CURB MARKINGS

301-1 General

OMUTCD Chapters 3A and 3B present information on pavement markings. Additional standards and guidelines are provided herein. ***TEM Chapters 340 through 343, 350 and 360*** present additional design, specification and Supplement information, and **Traffic Standard Construction Drawings (SCDs) TC-71.10 and TC-72.20** also provide additional design and application information.

A raised pavement marker is a special form of pavement marking intended to be used as a positioning guide with longitudinal line markings, or to supplement or substitute for pavement markings. Raised pavement markers (RPMs) are addressed in **OMUTCD Part 3** and in ***Chapter 302*** of this Manual.

The general standards for curb markings are addressed in **OMUTCD Section 3B.23**.

Markings information specifically related to School Areas, Highway-Rail Grade Crossings and Bicycle Facilities is addressed in **OMUTCD Chapters 7C, 8B and 9C**, respectively. Additional information is also presented in ***TEM Chapters 704, 802 and 902***, respectively.

301-2 Selection of Pavement Marking Materials

ODOT currently employs the following material types for pavement markings on **ODOT**-maintained highways: traffic paint, polyester, thermoplastic, preformed, epoxy, heat-fused preformed thermoplastic and spray thermoplastic. Pavement marking materials for application on **ODOT**-maintained highways should be selected from ***Table 397-1***.

The use of pavement marking materials which are capable of longer service lives than that of traffic paint can result in benefits of reduced frequency of renewal, less exposure of the public and workers to the hazards of the pavement marking operation, and a higher percent of time markings are present on the roadway. Therefore, such pavement marking materials shall be used on **ODOT**-maintained highways wherever pavement conditions permit the material to achieve its expected service life while providing comparable economy to alternative materials.

All pavement marking materials will at some point reach the end of their useful life. On many occasions, rather than obliterating the existing stripe, it is more cost-effective and convenient to simply restripe over the old pavement markings without removing them, assuming that the old pavement markings still adhere well to the roadway. However, for restriping to be effective, the pavement marking material that is to be applied must be compatible with the existing pavement marking material.

For highways not maintained by **ODOT**, the method of providing long-life pavement marking materials shall be the same as that described herein for **ODOT**-maintained highways except:

1. Local maintaining agencies shall agree in writing to maintain such markings in-kind in the future.
2. The policy regarding **ODOT**-maintained highways in **Villages** is contained in ***Section 301-3***.

301-3 Pavement Marking in Incorporated Villages

ORC Section 5521.01 provides that the **Director of Transportation**, upon request by, and approval of, the legislative authority of a **Village**, shall maintain, repair and apply standard longitudinal pavement markings on any section of state highway within the limits of the village as considered appropriate.

"Request by, and approval of, the legislative authority of a **Village**" shall be in the form of **ODOT Form No. MR-689** (available from the **Office of Maintenance Administration, Maintenance Section's** website) and shall describe the state highway extensions covered by the Ordinance. All such maintenance ordinances **(MR-689)** shall be filed in the office of the **District Deputy Director**.

The pavement markings shall be maintained by the **District** in conformance with the **OMUTCD** and shall be applied in the course of regularly scheduled pavement marking work. An inventory of these markings shall be maintained in the **District**.
The placing of auxiliary markings shall not be **ODOT's** responsibility, but may be included in a contract administered by **ODOT**. The **Village** shall bear all project costs of such auxiliary markings.

Auxiliary markings shall be defined as all markings described in **C&MS 641.08**, except center lines (note that center lines include two-way left-turn striping and the outline of left-turn islands), lane lines, edge lines and channelizing lines. However, channelizing line segments of 200 feet or less shall be considered auxiliary markings.

301-4 Longitudinal Markings

Longitudinal markings are center lines (which include two-way left-turn striping, excluding the arrows, and the outline of left-turn islands), lane lines, edge lines and channelizing lines.

For ODOT-maintained facilities, the standard width for center lines, lane lines, edge lines and channelizing lines shall be as follows:

ODOT-Maintained Facility	Center Line	Lane Line	Edge Line	Channelizing Line
Interstates	N/A	6”	6”	12”
Freeways and Expressways	N/A	6”	6”	12”
Multilane Divided Highway	N/A	6”	6”	12”
Multilane Undivided Highway	4”	6”	6”	12”
Two Lane Highway – Rural	4”	N/A	6”	8”
All Other Highways	4”	4”	4”	8”

However, wide lines may be used for additional emphasis, and **OMUTCD Section 3A.06** defines a wide line as at least twice the width of a normal line with the width of the line indicating the degree of emphasis.

Center lines, lane lines and edge lines shall be placed as follows:

Edge line – Center of the edge line shall be applied 6 inches from the edge of pavement.
Lane line – Nearest edge of the lane line shall be applied 2 inches to the left of the construction joint. Broken lines shall be in a 40-foot cycle consisting of a 10-foot dash with a 30-foot gap between the lines.
Center line – Nearest edge of the center line shall be applied 2 inches to the left of the construction joint. Broken lines shall be in a 40-foot cycle consisting of a 10-foot dash with a 30-foot gap between the lines.

301-5 Stop Lines

The general standards for Stop Lines are addressed in **OMUTCD Section 3B.16**. For **ODOT**-maintained highways, Stop Lines shall be 24 inches wide. They should be used at all signalized intersections. They should also be used to supplement STOP signs where it is important to indicate the point behind which vehicles are required to stop, typically the point at which motorists have the optimum cross-corner sight distance. They are not typically located adjacent to the STOP sign.

301-6 Crosswalk Markings

The general standards for Crosswalk Lines are addressed in **OMUTCD Section 3B.18**. For **ODOT**-maintained highways, the standard width for Crosswalk Lines shall be 12 inches, except that for a mid-block crosswalk they shall be 24 inches wide.
As noted in **OMUTCD Section 3B.18**, warning signs should be installed for non-intersection pedestrian crossings.

NCHRP Web-Only Document 208 provides design guidance for channelized right-turn lanes. The report recommends a consistent practice for crosswalk location to help enable those with vision impairment to safely traverse the channelized right-turn lane. This document is available on-line at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w208.pdf.

301-7 Parking Space Markings

The general standards for parking space markings are addressed in **OMUTCD Section 3B.19**. For **ODOT** facilities, the standard width for parking space lines shall be 4 inches.

When parking spaces reserved for persons with disabilities are provided, in addition to the required signing (**OMUTCD Section 2B.46**), the International Symbol of Accessibility (wheelchair symbol) shall be used to further identify the reserved stall(s). Unless there is a need for additional emphasis, the standard size pavement marking symbol shall be used (**see OMUTCD Figure 3B.22 and *TEM Table 397-2***).

The **Americans with Disabilities Administrative Guidelines (ADAAG)** issued by the **U.S. Access Board** include requirements regarding the number and design of parking spaces reserved for the handicapped. This information is available from the **Access Board** at www.access-board.gov. A bulletin specifically addressing accessible parking is also available from the **Access Board** website.

301-8 Pavement Marking Words and Symbols

All pavement marking words (letters and numerals) and symbols should be in conformance with **FHWA's Pavement Markings Alphabets and Symbols (see OMUTCD Figures 3B-22 through 3B-26, 3B-28 through 3B-30, and Appendix F of the Sign Designs and Markings Manual)**. **OMUTCD Section 3B.20** establishes general standards for pavement marking words, symbols and arrows, and **Traffic SCD TC-71.10** establishes placement standards, as well as providing additional design detail information. Some standard applications of pavement marking words and symbols are illustrated in **OMUTCD Figures 3B-27**. As noted in ***Section 301-1***, additional markings information specifically related to School Areas, Highway-Rail Grade Crossings and Bicycle Facilities are addressed in **OMUTCD and *TEM Parts 7, 8 and 9***, respectively.

The optional narrow elongated arrow design mentioned in the note in **OMUTCD Figure 3B-24** should not be used on **ODOT**-maintained highways unless needed to match similar arrows used by another jurisdiction in the same area.

Lane-Use Arrow pavement markings should be used in all right-turn and left-turn bays. Signs or arrow markings should be repeated as necessary to prevent entrapment and to help the road users select the appropriate lane early. When used, there should be a minimum of two arrows in each turn bay.

The ONLY word marking may be used only when engineering judgment indicates a need for it.

When used, spacing between the arrows, and arrow and ONLY word markings, should be not more than ten times the height of the characters.

TEM Table 397-2 shows the marking area in square feet for various words and symbols.

301-9 Two-Way Left-Turn Arrows

OMUTCD Sections 3B.03 and 3B.20, and Figures 3B-7 and 3B-24 establish standards for the design and placement of pavement markings for two-way left-turn only (TWLTO) lanes. For uniformity and consistency, the following additional guidelines have been established for spacing two-way left-turn arrows within a TWLTO lane.

As shown in **OMUTCD Figure 3B-7** and **Traffic SCD TC-71.10**, these left-turn arrows, when used, should be spaced 8 to 16 feet apart, tip to tip. The "wing tips" of the arrows should be placed 4 inches from the center of the lane.

The arrow sets should be longitudinally spaced at intervals of 500 to 1000 feet for speeds up to 40 miles per hour, and at intervals of 1000 to 1500 feet for speeds over 40 miles per hour. In addition, an arrow set should be placed 100 to 200 feet from the near edge of an intersecting roadway or inside both ends of TWLTO lanes, to remind road users that they are approaching a TWLTO lane in the middle.

Signing for TWLTO facilities is addressed in **OMUTCD Section 2B.24.**

301-10 Speed Measurement Markings

Speed Measurement Markings **(see OMUTCD Section 3B.21 and Figure 3B-10)** are used to establish Air Speed Check Zones to assist in the enforcement of speed measurements. On **ODOT**-maintained highways, they shall be 24 inches in width (measured in the direction of travel) and a total of 4 feet in length, with 2 feet on each side of the center line or 2 feet on each side of the edge line. However, when the shoulder is 4 feet or more in width, the air speed marking may be placed entirely on the shoulder. They shall be installed in accordance with **OMUTCD Section 3B.21**. Also see ***TEM Section 342-4*** **(Plan Note 342-4)** when Speed Measurement Markings are included in a plan.

1. The following procedure has been established for installing and maintaining (i.e., replacing after resurfacing), or abolishing Air Speed Check Zones:

2. Local **Ohio State Highway Patrol (OSHP) Posts** shall submit requests for establishing, maintaining or abolishing Air Speed Check Zones to the **OSHP Aviation Section Headquarters on the Air Speed Check Zone Request Form (*Form 396-1)***.

3. The **Aviation Section Headquarters** shall determine the necessity of establishing, maintaining or abolishing an Air **Speed Check Zone.**

4. **If the Aviation Section Headquarters** approves the request, it shall be forwarded to the appropriate **ODOT District Highway Management Administrator**.

   The **ODOT District** shall evaluate the practicality of establishing or maintaining the zone. If the request is determined to be practical, the **District** shall complete the requested work. A registered surveyor shall lay out the markings (when originally established and when replaced after resurfacing).

5. Upon completion of the requested work, the **District** shall:

   a. Update its records, including its Air Speed Check Zone inventory,

   b. Complete the **ODOT** portion of the request form, and

   c. Return the completed request form to the **OSHP Aviation Section Commander**, at 2829 W. Dublin-Granville Rd., Don Scott Field, Columbus, Ohio 43235.

6. If for some reason the request is not practical, the **District** shall return the request to the **OSHP**

7. **Aviation Section Headquarters** (at the address noted in item 4c) explaining the reason for not complying with the request.

8. If the request was to abolish an existing Air Speed Check Zone, the **District** shall:

   a. Update its records,

   b. Complete the **ODOT** portion of the request form,

   c. Return the completed request form to the **OSHP Aviation Section Commander**, at 2829 W. Dublin-Granville Rd., Don Scott Field, Columbus, Ohio 43235, and

   d. Allow the markings to wear out.

301-11 Railroad Approach Markings

The general standards for railroad approach markings are addressed in **OMUTCD Sections 8B.27, 8B-28 and 8B.29, and Figures 8B-6, 8B-7 and 8B-8.** Additional railroad approach markings information is provided in ***TEM Section 802*** and **Traffic SCD TC-71.10.**

301-12 Speed Hump Markings

Speed humps are "wave-shaped" paved humps/bumps in the street, spread over about 12 feet with a maximum height in the middle of about 3 inches. They are considered a design feature, rather than a traffic control device. **ODOT** does not have an official policy or standard on the design or use of speed humps.

Drivers may respond to these humps/bumps with alarm or surprise, which could result in loss of control of the vehicle. The humps can also cause problems for ambulances and other emergency vehicles. Therefore, their use should be limited and we do not recommend their use on through public highways. However, since they can be a cost-effective traffic-calming measure for reducing speeds on existing residential streets, local jurisdictions periodically inquire about them. Signing and pavement markings standards for speed humps are addressed in **OMUTCD Sections 2C-29, 3B.25 and 3B.26**. Examples of pavement markings for speed humps are shown in **OMUTCD Figures 3C-29 and 3C-30**. It is recommended that any jurisdiction considering speed humps establish guidelines for their design and use. Sample guidelines are available from the **Institute of Transportation Engineers (ITE)** and various local jurisdictions (e.g., the **City of Columbus**).

301-13 Dotted Lines

The general standards for Dotted Lines at exit and entrance ramps are addressed **in OMUTCD Section 3B.04, OMUTCD Figures 3B-8, 3B-9 and 3B-10**, and **Traffic SCD TC-72.20**.

For ODOT-maintained highways, Dotted Lines at exit and entrance ramps shall consist of white line segments that are 6 inches wide and are 3 feet in length, separated by 9-foot gaps.

The general standards for Dotted Lines through intersections are addressed in **OMUTCD Section 3B.08** and **OMUTCD Figure 3B-13**.

Dotted lines through intersections are optional and may be used when engineering judgment indicates a need for it.

For ODOT-maintained highways, Dotted Lines through intersections shall consist of line segments that are 2 feet in length, separated by 6-foot gaps. The standard width and color shall match the width and color of the existing adjacent lane line or center line.

301-14 Chevron and Diagonal Crosshatch Markings

301-14.1 General

OMUTCD **Section 3B.24** discusses Chevron Crosshatch Markings and Diagonal Crosshatch Markings. These markings are 24 inches wide and placed at approximately 45 degrees to the longitudinal lines that they intersect.

Chevron Crosshatch Markings are used in paved areas that separate traffic flows in the same general direction and shall be white with the point of each chevron facing toward approaching traffic.

Diagonal Crosshatch Markings are used in paved areas that separate opposing directions of traffic and shall be yellow and slant away from traffic in the adjacent travel lanes.

CROSSHATCH MARKINGS SPACING TABLE

FROM*	TO	CROSSHATCH MARKINGS SPACING
0 feet	48 feet	12 feet on center
49 feet	96 feet	24 feet on center
97 feet	Greater than 97 feet	48 feet on center

* measured from the theoretical gore

301-14.2 Entrance and Exit Ramps

Chevron Crosshatch Markings should be used to mark neutral areas of exit ramps at freeway to freeway interchanges and lane drop exits, and when engineering judgment indicates a need for them. As noted in OMUTCD **Section 3B.24**, they may also be used to mark neutral areas of entrance ramps. When used for those situations, the spacing of markings shall be as noted in ***Section 301-14.1***. Also see Traffic SCD TC-72.20, Freeway Entrance and Exit Pavement Markings, for a typical layout.

301-14.3 Obstructions

When there is an obstruction within the paved roadway, Chevron Crosshatch Markings or Diagonal Crosshatch Markings should be used as shown in OMUTCD **Figure 3B-15** in the neutral area formed by the required approach markings, per **OMUTCD Section 3B.10.**

301-14.4 Island Markings

“Painted” islands, including turn lane markings, more than 6 feet in width at their widest part shall include Diagonal Crosshatch Markings in the open area in order to discourage use as a travel lane or parking space. Such markings shall not be used in the open area of islands that are less than 6 feet in width, except when engineering judgment indicates a need for them. The spacing of the markings shall be as shown in the table in ***Section 301-14.1***; however, if the island separates opposing traffic, the 12-foot spacing begins at both ends of the island. Also see Traffic SCD TC-71.10, Word and Symbol Pavement Markings, for a typical island layout.

301-14.5 Shoulders

Highways with paved shoulders may experience operational problems due to vehicles misusing the shoulder (e.g., using the shoulder as a travel lane). Diagonal Crosshatch Markings may be used to discourage shoulder misuse where such problems exist.
When such markings have been placed, appropriate signing (e.g., R4-17, DO NOT DRIVE ON SHOULDER) should be erected.

301-15 Elongated Route Shield Symbol Markings

301-15.1 General

The general standards for Elongated Route Shield Symbol Markings are addressed in OMUTCD Section 3B-20, Figure 3B-25 and Figure 3C-14.

301-15.2 Marking Materials

Installation of elongated route shield symbol and cardinal direction markings shall be in accordance with Supplemental Specification 814 - Heat-Fused Preformed Thermoplastic Shield Pavement Marking.

Installations of elongated route shield symbols using Traffic Paint (Item 642), Polyester (Item 643), Thermoplastic (Item 644), Preformed Thermoplastic (Item 645), Epoxy (item 646) and Spray Thermoplastic (Item 648) pavement marking materials shall not occur.

Approved materials can be found on the ODOT Approved List.

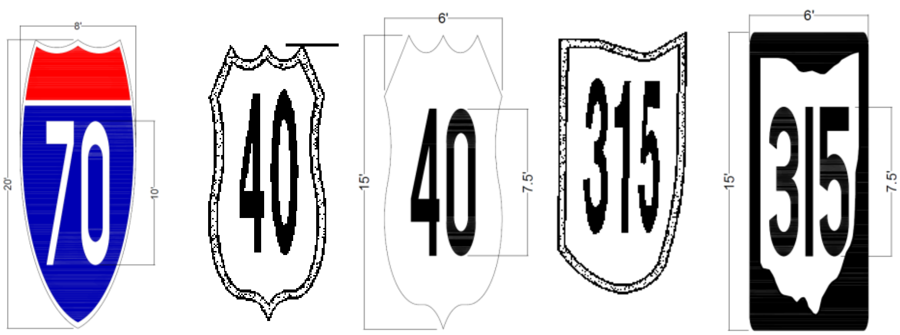
301-15.3 Size of Elongated Route Shield Symbol Markings

The size of the elongated shield symbol and size of the letters shall be according to the Ohio **Sign Designs and Markings Manual (SDMM)** Appendix F as follows:

1. On Interstate Routes the Shield Symbol shall be 8’ x 20’ with 10’ number size.
2. On US Routes the Shield Symbol shall be 6 ’x 15’ with 7.5’ number size.
3. On State Routes the Shield Symbol shall be 6’ x 15’ with 7.5’ number size.

301-15.4 Color of Elongated Route Shield Symbol Markings

The Interstate Elongated Route Shield Symbol Markings are available in red/white/blue. US Route and State Route Shield Symbol Markings are available in black/white.



301-15.5 Cardinal Direction (NORTH, SOUTH, WEST & EAST) Markings

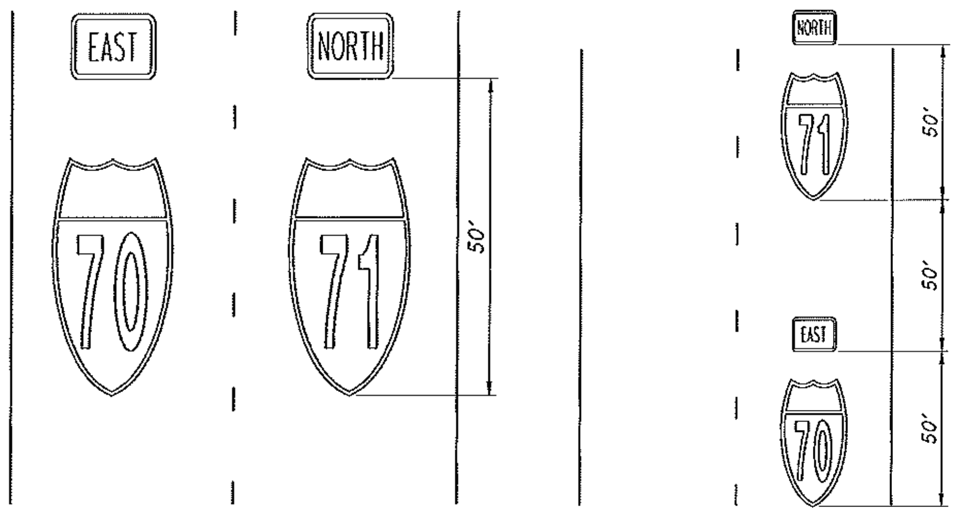
The size and spacing for the cardinal direction (NORTH, SOUTH, WEST & EAST) markings is based on OMUTCD Section 3B-20. ***See Figure 398-1*** for size and spacing information.

301-15.6 Placement of Elongated Route Shield Symbol and Cardinal Direction Markings

The distance from the bottom of the elongated route shield to the bottom of the cardinal direction marking should be 50 feet. The spacing between multiple route shields should be 100 feet from the bottom of the first route shield to the bottom of the next route shield.

The elongated route shield and cardinal direction markings should be centered in the lane.

Single Shield Per Lane **Vertical Stacked Shields**



301-16 Guidelines to Apply Pavement Markings over Chip Seal Surface or Chip Seal Surface Covered with Fog Seal

301-16.1 General

Fog sealing is a process using a diluted emulsion to cover the chip seal surface that fills in the voids in the chip seal.

301-16.2 Surface Prep

The surface shall be swept to remove loose chips prior to pavement marking application.

301-16.3 Work Zone Pavement Markings

Place Work Zone pavement markings per **C&MS 614.11**, except Class I pavement markings should be used instead of Class II.

After the project is completed, **C&MS 642** permanent pavement markings shall be placed per **C&MS 614.11**. This will increase the application thickness for the pavement markings allowing for the extra absorption of pavement marking material into the cover aggregate.

301-16.4 Striping Materials

Apply permanent pavement markings on chip seal or chip seal with fog seal surfaces as follows:

1. Use Item 642 Traffic Paint to install the permanent pavement markings. Monitor line wear as a second application of permanent pavement markings prior to winter may be needed.
2. Maintain permanent pavement markings using either Item 642 Traffic Paint of Item 643 Polyester Pavement Marking.

Thermoplastic and epoxy pavement marking materials are not recommended for striping long line markings on routes with 2500 or less ADT since these materials must be removed before a chip seal coat can be applied to the pavement.

301-17 Wrong-Way Arrows

OMUTCD Section 3B.20 and **Figure 3B-24** establish standards for the design of wrong-way arrow pavement markings.

For uniformity and consistency, additional guidelines have been established for placing the wrong-way arrows on exit ramps. Wrong-way arrow(s), when used, should be placed as follows:

1. On ramps where lane-use arrows are not used, place the first wrong-way arrow 10 to 30 feet in advance of the stop line. Place the second wrong-way arrow according to engineering judgement.
2. On ramps where lane-use arrows are used, place the wrong-way arrow in advance of first traffic control arrow at a spacing equal to or greater than the spacing between the lane-use arrows.
3. On multi-lane ramps, a wrong-way arrow should be placed in each lane, side-by-side.

Basic signing arrangements for wrong-way traffic control at exit ramps is addressed in **OMUTCD Sections 2B.38, 2B.41** and **Figure 2B-18.**

Traffic SCD TC-73.20 (Enhanced Wrong-Way Traffic Control for Ramps) provides details where additional wrong-way traffic control will be used. The decision on where to apply the enhanced treatments should be made based on an engineering study or engineering judgment, taking into consideration the number of documented wrong way movements, crash data, geometric design, interchange complexity, and any other factors that could potentially contribute to wrong way movements.

SCD TC-73.20 is intended to be used at select locations and is not intended to be used at all interchange ramps.

Funding for enhanced treatments and guidance on selecting appropriate location for the enhancements may be requested from the **Division of Planning**'s State Highway Safety Program.

301-18 Lane-Reduction Arrows

OMUTCD Section 3B.20 and **Figures 3B-14** and **3B-24** establish standards for the design and placement of lane-reduction arrow pavement markings. For uniformity and consistency, the following additional guidelines have been established for placing the lane-reduction arrows in the lane-reduction lanes.

As shown in **OMUTCD Figures 3B-14, 3B-24** and **Traffic SCD TC-71.10**, lane-reduction arrows, when used, should be placed as follows:

1. Place the first lane-reduction arrow 100 feet in advance of the "Begin Taper Point".
2. Place the second lane-reduction arrow at ¾ d (d = advance warning sign distance).

Lane-reduction signing is addressed in **OMUTCD Section 2C-42** and **Figure 2C-8.**

301-19 Guidelines to Apply Contrast Markings (Black and White)

301-19.1 General

OMUTCD Section 3A.05 briefly discusses Contrast Markings.

Many concrete and heavily oxidized asphalt pavements are so light in color that during day time, white pavement markings appear to blend in with the pavement surface.

To improve the visibility of white lane line pavement markings on light-colored pavements, contrast pavement markings may be applied as an option.

301-19.2 Marking Materials

The following pavement marking materials may be used for contrast markings (black and white) on the concrete pavements:

1. Item 642 Traffic Paint
2. Item 645 Preformed Thermoplastic
3. Item 646 Epoxy
4. Item 647 Heat-Fused Preformed Thermoplastic

For Item 642 Traffic Paint and Item 646 Epoxy, apply the black marking material that is recommended by the manufacturers.

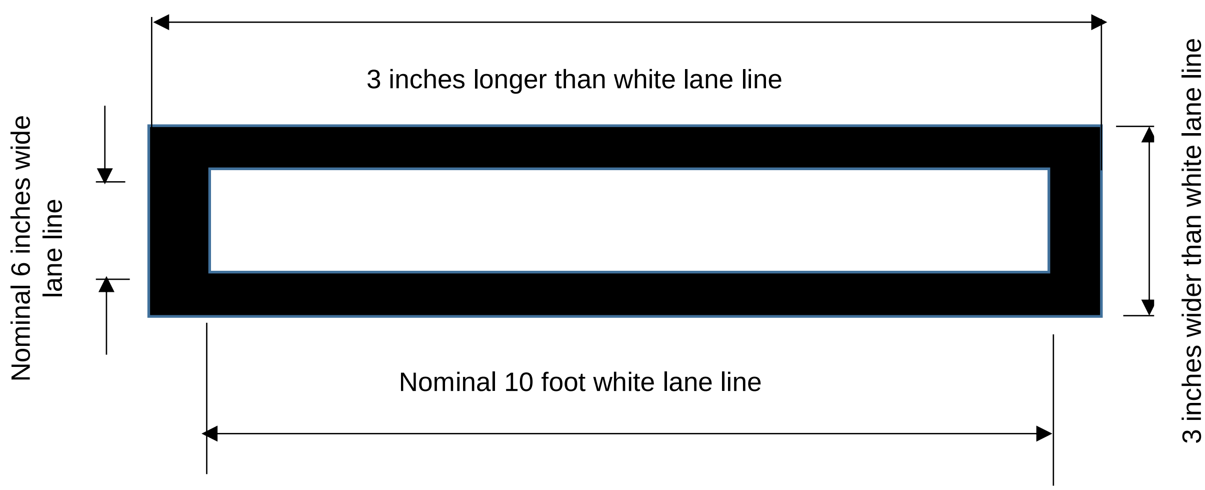
When contrast markings are applied, black is not considered a marking color, but only a contrast-enhancing system for the markings.

301-19.3 Contrast Marking Application

1. Apply white lane line markings over the top of a compatible black marking material or
2. Apply a ten foot white lane line marking and a ten foot black marking end-to-end and then provide a twenty foot gap

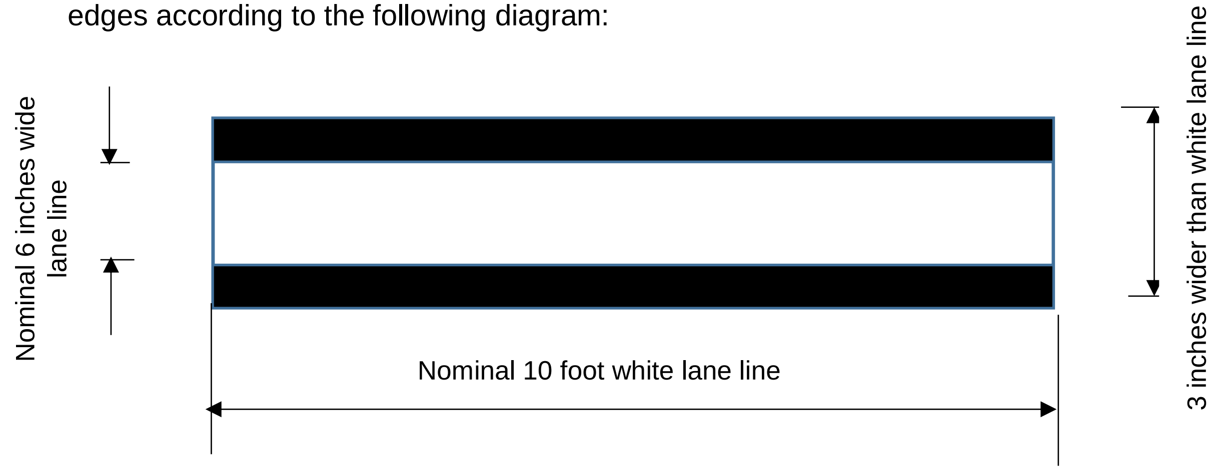
301-19.4 Contrast Marking Application Guidelines for Item 642 and 646

1. First, apply the black pavement marking on the pavement. Second apply the white pavement marking on top of the black marking after the black marking has cured according to manufacturer's recommendations. The black contrast marking and the white lane line marking shall be placed according to the following diagram:

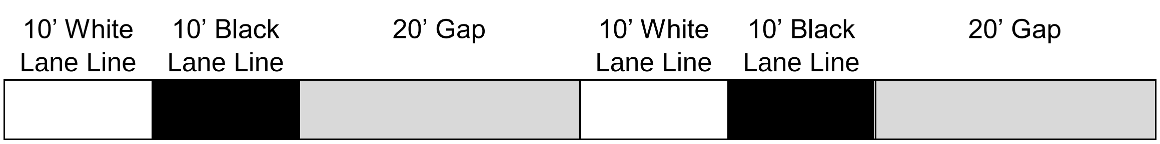


The white lane line shall be centered on the black marking such that there will be a 1.5 inch black border on either side of the white lane line. The white lane line shall be centered within the black paint area with black on both the leading and trailing edges.

2. As an alternate to the above, apply contrast marking without leading or trailing edges according to the following diagram:



1. Apply a ten foot white lane line marking and a ten foot black marking end-to-end and then provide a twenty foot gap according to the following diagram:



301-19.5 Contrast Marking Application Guidelines for Item 645 and 647

Item 645 Preformed Thermoplastic and Item 647 Heat-Fused Preformed Thermoplastic contrast markings (black and white) shall be installed as recommended by the manufacturers.

301-19.6 Basis of Payment

Item 642 and 646
The quantity of black contrast pavement marking will be paid for at the contract unit price for the pay item as included in the contract.

The white intermittent or white solid markings will be paid for separately at the contract unit price for the pay item as included in the contract.

Item 645 and 647

The quantity of black and white contrast pavement marking will be paid for at the contract unit price for the pay item as included in the contract.

301-20 <u>Guidelines to Install Bicycle Facility Markings with Heat-Fused Preformed Thermoplastic Pavement Marking Material (Item 647)</u>

301-20.1 General

OMUTCD Section 9C.03 discusses Shared-Use Path markings.
OMUTCD Section 9C.04 discusses Bicycle Lane markings.
OMUTCD Section 9C.07 discusses Shared Lane markings

301-20.2 Marking Materials

Approved materials for Heat-Fused Preformed Thermoplastic Pavement Marking can be found on the ODOT Approved List.

In CMS Item 647, Heat-Fused Preformed Thermoplastic Pavement Marking, the following type of marking materials are available:

Pre-heated Tape
Type A90 (90 mil thickness)
Type A125 (125 mil thickness)

Post-heated Tape
Type B90 (90 mil thickness)
Type B125 (125 mil thickness)

301-20.3 Marking Material Selection

When the bicycle facility markings are installed with Heat-Fused Preformed Thermoplastic Marking material (Item 647), the tape thickness (90 mil vs 125 mil) should be specified in accordance with the following guidelines:

1. Shared-Use Path Markings

Marking Item	Item 647 Material Thickness
Auxiliary Symbol Markings	90 mil thick
Long Line Markings	90 mil thick

2. Bicycle Lane Markings

Marking Item	Item 647 Material Thickness
Auxiliary Symbol Markings	90 mil thick
Long Line Markings	125 mil thick

3. Shared Lane Markings

Marking Item	Item 647 Material Thickness
Auxiliary Symbol Markings	125 mil thick
Long Line Markings	125 mil thick

301-21 Inlaid Concrete Bridge Deck Long Line Markings

In addition to the requirements of Items 640 and 740, Section 342-6 presents optional procedures for applying the long line pavement markings in grooves on concrete bridge decks. Districts may choose to inlay the long line markings to extend pavement marking life.

Inlaying involves installing the marking in grooves cut into the concrete. This will help protect the markings from snow plowing operations.

When the decision is made to inlay the markings refer to ***Section 342-6*** and Table 397-1d for additional information.

302 RAISED PAVEMENT MARKERS

302-1 General

Raised Pavement Markers (RPMs) are a special form of pavement markings described in **OMUTCD Sections 3B.11 through 3B.14.** Plowable RPMs were developed for use in states that typically have to deal with snow. **C&MS Item 621** and **C&MS 721** establish the specifications for RPMs and **Supplement 1062** addresses testing procedures. Information about the proper installation of RPM castings and reflectors, and inspection guidelines are provided in ***Chapters 350 and 360***, respectively.

As noted in **OMUTCD Sections 3B.12 through 3B.14**, RPMs may be used as positioning guides, or to supplement or substitute for the standard pavement markings. **ODOT's** RPM program basically uses them as positioning guides.

Temporary raised pavement markers are addressed in ***Section 605-11.12*** and **Traffic SCD MT-99.30**. **Supplement 1056** specifies the Prequalification Procedure for Work Zone Raised Pavement Markers.

302-2 Guidelines and Placement Standards

RPMs should be used on **ODOT**-maintained highways. They should be included in new construction and resurfacing projects on **ODOT**-maintained highways. They may also be included in the plans at other locations.

Traffic SCDs TC-65.10 and 65.11 detail the placement standards and guidelines for RPMs used with center lines, lane lines, edge lines and channelizing lines in general. Various specific typical situations, such as one-lane bridges, stop approaches, curves, two-way left-turn lanes and intersections are also addressed in these **SCDs**.

Except for edge lines on one-lane bridges **(see SCD TC-65.11)**, RPMs shall not be installed on bridges less than 400 feet in length on tangent alignments. For bridges longer than 400 feet in length on tangent alignments, RPMs shall be installed at twice the normal spacing. For any length bridge in a curve, RPMs shall be installed at the normal spacing.

Each **District** should periodically inspect their RPMs to determine if nighttime retroreflectivity is still adequate. Reflectors that are cracked, abraded, missing or have marginal optical performance should be scheduled for maintenance. Cracked or loose castings should be removed and replaced as soon as practicable. Systematic replacement of RPM reflectors should be scheduled on a two to four year cycle. A statewide average reflector maintenance rate of 33 percent per year is expected.

302-3 Administrative Responsibilities

Responsibilities for this program are as follows:

1. The **Office of Roadway Engineering (ORE)** shall:

   a. Develop specifications and standards;
   b. Evaluate new RPM materials; determine the method of RPM installation, maintenance and replacement;
   c. Administer the term purchase contract for RPM materials; and
   d. Conduct Quality Assurance Reviews (QARs) at least every two years in each **District**.

2. The **District** shall:

   a. Carry out the RPM program in a manner to install 100 percent of the RPMs on all eligible **ODOT**-maintained highways;

b. Replace RPMs that are removed/disturbed, for whatever reason, as soon as practicable;
c. Maintain a roadway inventory of all RPMs; and
d. Systematically replace RPM prismatic reflectors.

302-4 Maintenance

To be effective, RPMs must be properly maintained to keep prismatic reflectors and castings in good condition. Proper maintenance can be best accomplished by a program which emphasizes replacement of removed/disturbed RPMs as soon as practicable in conjunction with a systematic replacement of RPM reflectors on a two to four year cycle. The length of the replacement cycle would be dependent upon factors such as traffic volumes, traffic composition and environmental conditions. Most highways should have reflectors replaced on a three year cycle. A four year replacement cycle might prove to be adequate for low-volume highways; while heavily traveled freeways and expressways with high volumes of truck traffic might need reflector replacement based on a two-year cycle.

RPMs shall be removed prior to resurfacing and disposed of by the contractor.

302-5 Raised Pavement Markers in Villages

The **District** may install RPMs on state highway extensions in **Villages**, upon request by and approval of the legislative authority of a **Village**. "Request by, and approval of, the legislative authority of a **Village**" shall be in the form of **ODOT Form No. MR-689** (available on-line at http://portal.dot.state.oh.us/Divisions/Operations/MaintAdmin/Pages/MandR.aspx, a web page maintained by the **Office of Maintenance Administration**) and shall describe the state highway extensions covered by the Ordinance. All such maintenance ordinances **(MR-689)** shall be filed in the office of the **District Deputy Director.** The installation of RPMs upon request of a **Village** does not obligate **ODOT** to maintain them.

302-6 Narrow and One-Lane Bridges

RPMs shall be installed in accordance with **Traffic SCD TC-65.11** at narrow and one-lane bridges. The center line pavement marking shall be stopped 150 feet in advance of a one-lane bridge. ***Figure 398-2*** illustrates signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in ***Sections 202-5, 202-14.2 and 304-5*****.**

302-7 Fire Hydrant Markers

OMUTCD Section 3B.11 states that blue raised pavement markers may be used to mark the position of fire hydrants.

In 1983, **FHWA** issued a memorandum on the use of blue retroreflective pavement markers to help identify fire hydrants and water supply locations. They also provided a good set of guidelines that had been developed by the **California Traffic Control Devices Committee** in consultation with fire officials. Over the years this information has been made available to local jurisdictions in response to inquiries on the topic. Copies of the information are available from the **Office of Roadway Engineering**. Generally, this is an urban issue and has been left to local jurisdictions to address as needed.

The blue pavement markers are, of course, subject to the same problems as our standard raised pavement markers (RPMs) in areas subject to snowfall. It has been noted that, if the primary concern is to attract attention quickly to a nearby hydrant, there are other methods that can be used, such as small signs, retroreflective tape or paint. For example, **District 12** has had to address the problem of identifying fire hydrants locations. The hydrants were going to be hidden by a sound barrier. Access holes were provided in the barrier wall and small signs (12 x 6 inches) were mounted on the wall above the access points to identify them, using a local numbering system.

304 DELINEATORS

304-1 General

OMUTCD Chapter 3F establishes standards and guidelines for the design and use of delineators. Additional design and application information is provided herein, and in **Traffic SCD TC-61.10, C&MS Item 620 and C&MS 720.** Delineator reflector and flexible post color shall match that of the nearest edge line.

304-2 Delineator Types

For identification purposes, **C&MS 620.02** designates the following color of each type of delineator: Type C, rectangular white; Type D, rectangular yellow; and Type E, rectangular red.

304-3 Application Guidelines

In accordance with the provisions of **C&MS 620.02**, on **ODOT**-maintained routes, only flexible delineator posts on the Qualified Products List shall be installed for roadside delineation (see Reflector Items).

On **ODOT**-maintained freeways and expressways, delineators shall be used except as noted below.

Delineators should be used on freeway and expressway tangent sections in snowbelt areas (i.e., **District 12** and the northern portions of **Districts 3 and 4**). In other areas of the **State**, roadside delineators shall not be placed on roadway tangent sections of expressways, freeways and other multi-lane divided highways when all the following conditions are met:

1. Raised pavement markers (RPMs) are used continuously on lane lines throughout all curves and on all tangents to supplement pavement markings.

2. Where whole routes or substantial portions of routes have large sections of tangent alignment (where, if roadside delineators were not required on tangents, only short sections of curved alignment would need delineators).

3. Roadside delineators are used to lead into all curves as shown in **OMUTCD Figure 3F-1**.

Once delineators are installed, they shall be maintained. Periodic reviews shall be conducted to assure that good appearance and effectiveness are maintained.

304-4 Narrow and One-Lane Bridges

Type C (white rectangular) delineators should be erected 50 feet apart along both sides of each approach to narrow and one-lane bridges in accordance with **OMUTCD Chapter 3F** and **Traffic SCD TC-61.10.** ***TEM Figure 398-2*** illustrates the signing and markings guidelines for narrow and one-lane bridges. Additional information is also provided in ***Sections 202-5, 202-14.2 and 302-6*****.**

Intentionally blank.

305 COLORED PAVEMENTS

The use of colored pavement as a traffic control device is addressed in **OMUTCD Chapter 3G.**

Information regarding green colored pavement for bike lanes is addressed in **Plan Note 342-5** ***(Section 342-5)*** and **Traffic Plan Insert Sheet (PIS) 207000.**

306 BARRICADES AND CHANNELIZING DEVICES

The use of barricades and channelizing devices in Temporary Traffic Control Zones is addressed in **OMUTCD Part 6** and ***Part 6*** of this manual. Use of channelizing devices in other situations is addressed in **OMUTCD Chapter 3H.** We do not currently have any additional **ODOT**-specific standards related to this use of these devices.

307 BARRIER REFLECTORS

307-1 General

Although not considered traffic control devices, barrier reflectors are used to help mark guardrail and concrete barriers, including bridge parapets. Specifications for these reflectors are covered in **C&MS Item 626** and **C&MS 726.**

Once barrier reflectors are installed, they should be maintained in good condition.

307-2 Application on ODOT-Maintained Highways

Barrier reflectors shall be erected on all new or reconstructed guardrail, new concrete barrier and new or reconditioned bridge parapets. This applies to all State and/or federally-funded projects regardless of the presence of edge lines, retroreflectorized glare screens, RPMs or highway lighting.

These reflectors may be used in highlighting the curb ends of medians.

Barrier Object Markers ***(Section 202-14.4)*** may also be considered for use in highlighting the curb ends of medians.

307-3 Reflector Color

The color of a barrier reflector shall match that of the nearest edge line.

One-way and bi-directional barrier reflectors shall be used in accordance with the following guidelines:

BARRIER REFLECTORS COLOR & DIRECTION	One-Way Reflector		Bi-Directional Reflector	
	Left Edge	Right Edge	Left Edge	Right Edge
Two-Lane, Two-Way			NA	White/White
Interchange Ramp			Yellow/Red**	White/Red
Multilane Undivided			NA	White/White
Multilane Divided with median barrier*		White	Yellow/Yellow	
Multilane Divided without median barrier	NA	White		

* concrete wall, guardrail or cable rail
** if median concrete wall is present

Barrier reflectors shall also be used on temporary traffic barriers in work zones (see ***Section 605-19***). Although they are paid for under **C&MS Item 614**, these reflectors are identical to those described in **C&MS Item 626**.

Systematic replacement of barrier reflectors should be on a five-year cycle.

307-4 Reflector Types

The following five types of Barrier Reflectors are detailed in the **C&MS Item 726.01**:

1. Type 1 barrier reflector is for concrete barriers, retaining walls and bridge rails or bridge parapets.
2. Types 2 to 5 barrier reflectors are for guardrail blockouts.

The selection of a particular guardrail blockout reflector (Types 2-5) as described in C&MS Item 726.01 is a District preference based on engineering judgement and environmental conditions.

Approved Barrier Reflectors can be found on the ODOT Qualified Product List (QPL) at the following link:

http://www.odotonline.org/materialsmanagement/qpl.asp?specref=726.01

310 ISLANDS

OMUTCD Chapter 3I addresses the functions, end protection and approach treatments for traffic control islands. As noted in **OMUTCD Section 1A.13, item 102**:

> Island - a defined area between traffic lanes for control of vehicular movements, for toll collection, or for pedestrian refuge. Within an intersection area, a median or an outer separation is considered to be an island.

L&D Manual Volume 1 Section 300 includes additional information about medians and curbs.

Also see ***Sections 301-14.4*** and ***307-2*** for additional information about marking islands.

320 MATERIALS AND HARDWARE

320-1 General

The **Office of Materials Management** maintains the Qualified Product List (QPL) for raised pavement markers, delineators and barrier reflectors and the Approved List for pavement marking materials. The QPL and the Approved List are available on that office's web page. The list is available on-line at www.dot.state.oh.us/divisions/constructionmgt/materials/pages/default.aspx.

Specifications and testing procedures for markings materials are addressed in ***Chapter 343***. ***Section 350-2*** addresses work zone performance evaluations.

C&MS information may be viewed on-line at www.odotonline.org/cmsportal/.

320-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is discussed in ***Section 120-4***.

320-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using Federal funds. ***Sections 120-5 and 120-6*** describe processes that have been established whereby local agencies can purchase such items through **ODOT**.

320-4 Use of Type G Sheeting

Type G retroreflective sheeting **(see C&MS 730.19)** shall be used on cones and tubular markers used at night, barricades and drums, delineators, object markers, end-of-roadway markers, guardrail anchor assemblies and impact attenuators. Information about guardrail anchor assemblies and impact attenuators is provided in **the L&D Manual Volume 1, Section 603.** Information about the use of Type G sheeting on guardrail anchor assemblies and impact attenuators is found in **Plan Notes R-112, R-113 and R-123 (see L&D Manual Volume 1, Appendix B)**.

320-5 Barrier Reflectors

There is not a testing procedure for barrier reflectors; however, the following approval process has been established:

Barrier reflectors shall be purchased only from companies on the QPL maintained by the **Office of Materials Management**. The manufacturer shall submit to **ODOT** a sample of the reflector along with a catalog description showing recommended installation procedures and certified test data from an independent test laboratory. **ODOT** will evaluate these samples to determine conformance

with **C&MS 726.** Reflectors meeting the specifications will be included on the QPL maintained by the **Office of Materials Management.** Poor field performance or a change in materials will be cause for removal from the prequalified list. Substitutes will not be accepted.
The QPL is available on-line at:
www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/QPL.aspx)**.**

330 PLANNING / PROGRAMMING

This Chapter has been reserved for information regarding planning/programming information related to traffic control markings.

340 DESIGN INFORMATION

340-1 General

Chapter 140 provides general background regarding design information for **ODOT** projects, including the three-stage review process typically used for traffic control plans. This Chapter provides additional design information specific to markings.

Additional plan preparation information specific to markings is provided in ***Chapter 341***. Plan Notes for marking-related items are addressed in ***Chapter 342***, and marking specifications and testing information are addressed in ***Chapter 343***.

340-2 Stage 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage 2 and 3 plan submittals.

1. Stage 2 Plan Requirements:

   a. On most projects, markings should be shown on the same plan sheets as the signing. If a separate marking plan is determined to be necessary, the following shall apply:

      i. Base plan drawn at a scale of 1:200 or 1:100 continuous for the entire project.

      ii. A second base plan drawn at a minimum scale of 1:50 for all interchanged crossroads and mainline intersections, and for other critical at-grade intersections in urban areas.

      iii. All proposed roadways and connections to existing construction shall be shown.

      iv. On some projects, particularly in urban areas, it may be more efficient to show the entire project on one plan drawn at a scale of 1:50 or 1:20.

   b. Location of pavement edges, number of lanes, speed change lanes, transitions, raised medians and all structures. Lane widths if other than 12 feet.

   c. Directional arrows (one per lane) indicating the number of lanes.

   d. Pavement marking at merging, diverging or intersecting roadways. Show painted gores for merging and diverging roadways. Show auxiliary markings.

2. Stage 3 Plan Requirements:

   a. General Notes.

   b. Estimated quantities.

c. Special details.

d. Delineator locations (Table).

e. Raised Pavement Marker locations (Table).

f. Barrier Reflector locations (Table).

Intentionally blank.

341 PLAN PREPARATION / PRODUCTION

341-1 General

The **L&D Manual Volume 3** and ***TEM Chapter 140*** generally describe **ODOT** plan preparation and production guidelines. Additional information is provided in this Chapter and ***Chapters 340*** **(markings plans), 342 (Plan Notes) and 343 (Specifications).**

341-2 Pavement Marking

In a pavement marking plan the following information should be included:

1. All markings on the main roadway, ramps, cross streets and new street intersections, where needed and the type of material to be used (see ***Sections 301-2 and 320*****)**.

2. Special details should be shown in the plans for markings not covered by typical layouts included on **Traffic SCDs TC-71.10 and TC-72.20.** These should be drawn to appropriate scale for the contractor to properly place the markings.

3. Subsummary tabulations shall be made of the various markings, as required in the **Construction and Materials Specifications (C&MS) (i.e., C&MS Items 642, 643, 644, 645, 646, 647 and 648)**. All measurements shall be the length of the completed line, including the gaps, intersections and other sections of pavement not normally marked. Station limits and totals for each item shall be shown as follows:

   a. Edge line (white)
   b. Edge line (yellow)
   c. Lane line
   d. Dotted line, ___ inch
   e. Center line: solid, double
   f. Center line: broken, double
   g. Center line: broken, single
   h. Center line: broken and solid, double
   i. Channelizing line
   j. Stop line
   k. Crosswalk line
   l. Transverse/Diagonal line (white)
   m. Transverse/Diagonal line (yellow)
   n. Curb marking (white)
   o. Curb marking (yellow)
   p. Island marking (white)
   q. Island marking (yellow)
   r. Parking lot stall marking
   s. Lane arrow
   t. Word on pavement, ___ inch
   u. Railroad symbol marking
   v. School symbol marking, ___ inch
   w. Handicap symbol marking
   x. Chevron Markings

4. Payment for all pavement marking items in the General Summary shall be carried as **C&MS Items 642, 643, 644, 645, 646, 647 and 648** on a unit bid basis (no lump sum) as follows:

Description Title	Sum These Items From *Sec. 341-2(3)*	Unit
Edge Line	a, b	Mile
Lane Line	c	Mile
Center Line	e, f, g, h	Mile
Channelizing Line	i	Foot
Stop Line	j	Foot
Crosswalk Line	k	Foot
Transverse/Diagonal Line	l, m	Foot
Curb Marking	n, o	Foot
Island Marking	p, q	Square Foot
Parking Lot Stall Marking	r	Foot
Lane Arrow	s	Each
Word on Pavement, ____ inch (millimeter)	t	Each
Railroad Symbol Marking	u	Each
Dotted Line, ____ inch (millimeter)	d	Foot
School Symbol Marking, ____ inch (millimeter)	v	Each
Handicap Symbol Marking	w	Each
Chevron Markings	x	Each

Typical line widths are described in ***Chapter 301*** of this Manual and in the specifications, and should not be included in the bid item descriptions. Non-typical line widths, when required and approved, shall use “As Per Plan” in the description.

The outline of crosshatched yellow islands shall be constructed with "center line: solid, double." The outline of crosshatched white islands shall be constructed with "channelizing line" or “chevron markings.”

341-3 Work Zone Pavement Marking Materials

Work zone pavement markings are addressed in ***Section 605-11.11*** and **C&MS 614.11.**

341-4 Raised Pavement Markers

As noted in ***Section 302-2***, raised pavement markers (RPMs) should be included in new and resurfacing construction projects on **ODOT**-maintained highways. They may also be included in the plans at other locations as specified in the district**-**wide RPM plans.

The plans shall call for the removal of existing RPM castings which would otherwise be abandoned and paved over, and disposal by the contractor.

Testing procedures for RPMs are covered in **Supplement 1062**.

Plan Note 342-3 ***(Section 342-3)*** may be used on district-wide RPM contracts when the castings should not be replaced due to poor pavement.

341-5 Air Speed Zone Markings

Plan Note 342-4 ***(Section 342-4)*** may be used when air speed zone markings are included in the plans.

341-6 Bikeway Pavement Markings

OMUTCD Chapter 3C and ***TEM Chapter 902*** address markings for bicycle facilities, and **Traffic Plan Insert Sheet 207000** provides additional bikeway pavement marking details.

Plan Note 342-5 (***Section 342-5***) should be used when green bike lanes are included in a plan.

Intentionally blank.

342 PLAN NOTES

342-1 General

Typical **Plan Notes** have been consolidated in this Chapter for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid item will be "as per plan." Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

342-2 Handicap Symbol Marking

1. Work shall consist of the placement of a Handicap Symbol Marking to conform with the following:

2. The symbol of accessibility placed on the parking space shall be as shown in Figure 3B-22 of the current Ohio Manual of Uniform Traffic Control Devices, and in SCD TC-71.10, with the exception that a blue background/white border shall not be used.

3. The height of the symbol shall be 41 inches, the width shall be 36 inches, and the stroke width shall be 4 inches.

4. Materials, equipment, and application shall be according to the type of pavement marking material (642 – Traffic Paint, 643 – Polyester, 644 – Thermoplastic, 645 – Preformed, 646 – Epoxy, 647 – Heat-Fused Preformed Thermoplastic) used.

5. Payment shall be according to the pavement marking material used as follow:

Item 642,	Handicap Symbol Marking, Type ___	Each
Item 643,	Handicap Symbol Marking	Each
Item 644,	Handicap Symbol Marking	Each
Item 645,	Handicap Symbol Marking, Type ___	Each
Item 646,	Handicap Symbol Marking	Each
Item 647,	Handicap Symbol Marking, Type ___	Each

Designer Notes: This note shall be included on projects that include Handicap Symbol Markings. The area for this symbol is 2.7 square feet as shown in ***Table 397-2.***

342-3 621 Raised Pavement Marker Removed

In areas where the raised pavement marker castings cannot be replaced because of pavement conditions, use this item instead of Item 621 RPM, Installation Only to compensate the Contractor for removal of the existing RPM and restoration of the pavement.

All broken, cracked, fragmented or partial remnants of raised pavement markers or missing raised pavement markers shall be totally removed and the pavement restored as described in Construction and Material Specification Item 621.08.

The following is an estimated quantity to be used as directed by the Engineer for the above work:

621 _________ EACH RAISED PAVEMENT MARKER REMOVED

Designer Notes: This note may be used on district-wide RPM contracts for times when the castings should not be replaced due to poor pavement.

342-4 Air Speed Zone Marking

Air speed zone markings shall be white and 24 inches wide measured in the direction of travel and 4 feet in length. On two-lane roadways with paved shoulders less than 4 feet in width, the air speed zone markings shall be placed with 2 feet on each side of the center line or edge line markings. When paved shoulders of sufficient width are available, the air speed zone markings shall be placed on the shoulders.

Place the markings at 0.25 mile intervals over a 1 mile length of roadway.

It is the Contractor's responsibility to have the markings laid out by a Registered Surveyor. A record is to be kept and one original signed and sealed document is to be sent to the District Traffic Engineer and one copy is to be sent to the District Construction Administrator.

Materials, equipment and application shall be according to the type of pavement marking material used.

Payment shall be according to the pavement marking material used and shall include the surveying work. The five markings placed in each 1 mile of roadway shall equal one zone. One zone shall be measured as 1 Each for Air Speed Zone Marking.

Designer Note: This note may be used when air speed zone markings are included in the plan.

342-5 Green Colored Pavement for Bike Lanes

In addition to the requirements of C&MS 641, ___ and 740; the following requirements shall apply:

1. The daytime and nighttime chromaticity coordinates for the color used for green colored pavement shall be as follows:

	Chromaticity Coordinates (Corner Points)							
	1		2		3		4	
	x	y	x	y	x	y	x	y
Daytime	0.230	0.754	0.266	0.500	0.367	0.500	0.444	0.555
Nighttime	0.230	0.754	0.336	0.540	0.450	0.500	0.479	0.520

2. The daytime luminance factor (Y) shall be at least 7, but no more than 35.
3. Green colored pavement shall be [uniformly retroreflective or non-retroreflective].

Payment for "Item ____ Green Colored Pavement for Bike Lanes" will be at the contract unit price per square foot.

Designer Note: This note should be used when green colored pavement for bike lanes is desired. The blanks shall be filled in with the appropriate material specification item. The item that is enclosed in brackets [ ] should be carefully considered and the appropriate option chosen based on the maintaining agency's preferences.

342-6 Item Special – Inlaid Concrete Bridge Deck Long Line Markings

In addition to the requirements of Items 640 and 740, the following requirements shall also apply.

The material used shall be *(select one)*:

1. Traffic Paint Type 1 – as listed on the Approved List
2. PolyCarb Mark 55.4, IPS HPS 4 modified urethane or PolyCarb Mark 75 polyurea.
3. IPS HPS 2 epoxy, Polycarb Mark 55.2 epoxy, Epoplex LS 60 epoxy, 3M 380WR ES preformed tape, Epoplex Glomarc 90 polyurea or IPS HPS 5 polyurea.

All materials shall be installed according to manufacturer's directions.

Inlaid pavement marking on concrete bridge decks shall be installed in a 150 mil (4.0 mm) groove to match the depth of standard bridge deck groove per Item 511.17.

Payment shall be at the contract unit price per foot and shall include the groove.

343 SPECIFICATIONS

ODOT specifications for the furnishing and installation of markings are contained in the following **C&MS** sections:

620 and 720	**Delineators**
621 and 721	**Raised Pavement Markers**
626 and 726	**Barrier Reflectors**
630 and 730	**Traffic Signs and Sign Supports**
640 and 740	**Pavement Markings**

Individually, the different types of pavement marking material are addressed as follows:

C&MS Item	Description
642	Water-based Traffic Paint
643	Polyester Pavement Markings
644	Screed Extruded Thermoplastic Pavement Markings
645	Preformed Pavement Marking Material
646	Epoxy Pavement Markings
647	Heat-fused Preformed Thermoplastic for use as Auxiliary Pavement Markings
648	Spray Thermoplastic Pavement Markings

C&MS specifications related to specific markings items have been referenced individually as they have been discussed in this Part.

The **C&MS** information may be viewed on-line at: www.odotonline.org/cmsportal/

Supplement 1047 addresses the field service testing procedure for pavement marking materials. **Supplement 1020** and **Supplement 1062** cover testing procedures for delineator posts and raised pavement markers, respectively. **Supplement 1089** covers traffic marking certification requirements. These Supplements may be viewed on-line at:
www.dot.state.oh.us/divisions/constructionmgt/pages/proposalnotessupplementalspecificationsandsupplements.aspx

350 CONSTRUCTION

350-1 General

This information is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices. However, it may also be useful for maintenance personnel performing the same functions.

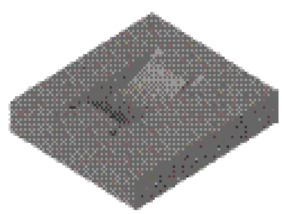
350-2 Work Zone Performance Evaluations

The performance evaluation described in **C&MS 614.11** shall be conducted according to the ratings given in ***TEM Table 397-3*** for color, ***Table 397-4*** for night visibility, and ***Table 397-5*** for test line durability.

350-3 Raised Pavement Marker (RPM) Casting Installation

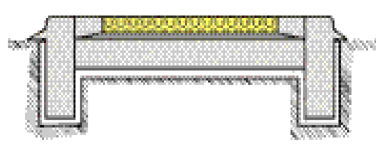
Proper installation is key to getting the epoxy to form a good bond between the pavement and an RPM casting. The following describes the procedure for installing an RPM casting:

1. The pavement shall be cut to the dimensions for the casting being used. The list of approved castings for **ODOT** projects, as well as drawings and sample of them are available for review in the **Office of Material Management**.

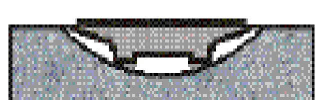


2. Prior to adding the epoxy, pavement cuts shall be inspected for the following:

   a. When a casting is inserted in the cut without epoxy to test proper cut, all four leveling lugs/tabs must contact the pavement surface and all four keel-ends of the casting must be below the surrounding pavement surface.



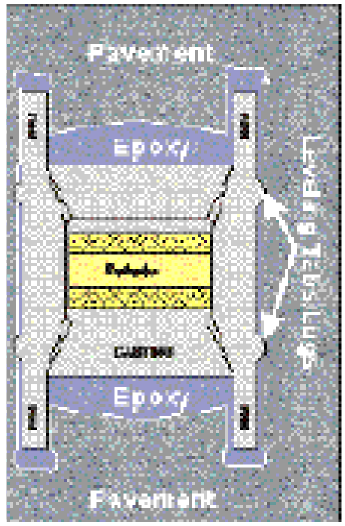
   b. Each casting must be centered lengthwise in the pavement cut, and there should be a 1/8 inch clearance between the pavement cut and the casting. Only the leveling lugs/tabs should be in contact with the pavement surface after insertion of the casting in the pavement.



   c. The pavement cut must be completely dry and free of dust, dirt or any other material that will interfere with the adhesive bond. Epoxy spilled or dropped on the active reflector face shall be removed immediately.

3. Two-component approved epoxy adhesive shall be used to fill the pavement cut to within 3/8 inch of the top of the pavement cut. The four leveling lugs/tabs must be in contact with the pavement. The epoxy should ooze out from under the casting from all sides, filling all voids around the casting, and it should be level with the pavement surface.

4. An acceptable installation should have a minimum of 1/8 inch of epoxy showing around the outside of the casting.



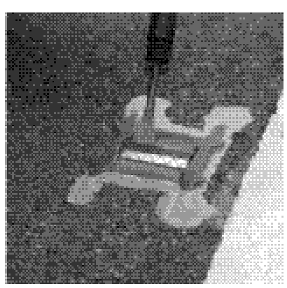
5. Placement of RPM Casting shall be 2 inches from any construction joint (lateral or longitudinal).

350-4 Raised Pavement Marker (RPM) Reflector Replacement

Proper installation of the RPM reflector is also a key factor in the life of an RPM. The following describes the procedure for replacing an RPM reflector:

1. Eye protection should be worn when replacing an RPM reflector.

2. Pry the old reflector out of the casting.



3. Scrape the old pad material and adhesive out of the reflector "pocket." Use an air hammer or wire brush.

4. Remove all residual adhesive, rust and other contaminants from the "pocket." It is important that the casting is clean to ensure long-lasting performance.

5. Peel the release liner from the back of the reflector. Apply a wide bead (approximately 1/2 inch) of an **ODOT**-approved adhesive in the center of the adhesive pad on the back of the reflector.

6. Place the reflector into the "pocket." Apply foot pressure on the reflector for one to three seconds. Adhesive flowing out around all edges of the reflector is an indicator that the adhesive completely covers the entire bottom of the reflector and provides a uniform adhesive layer between the reflector and the casting.

350-5 Remedial Action for Improperly Installed RPM Castings

RPM castings shall be installed properly in accordance with **C&MS Item 621.03 (Layout), C&MS 621.04 (Installation of RPM Casting), and Traffic Standard Construction Drawings (SCDs) TC-65.10 and TC-65.11**.

The following information is a guide for the necessary remedial action to be taken by construction and maintenance personnel when RPM castings are improperly installed.

1. Problem: The RPM is installed with one or more tabs not resting on the pavement surface. Note that a clipboard can fit in the gap between the leveling tabs and the pavement surface.

Illustration 1

Remedial Action:

a. Remove and install the RPM casting at a new location.

b. The distance to the new RPM casting location shall not exceed 25 percent of the specified RPM spacing.

c. If it would be necessary to relocate the RPM casting to a distance greater than 25 percent of the specified spacing, do not reinstall the casting.

d. Fill the original cavity (from where the improperly installed RPM casting was removed) with epoxy or asphalt concrete.

2. Problem: The RPM casting is installed, but either the voids are not filled with epoxy all around the casting (Illustration 2a) or the epoxy is not to the roadway surface all around the casting (Illustration 2b).

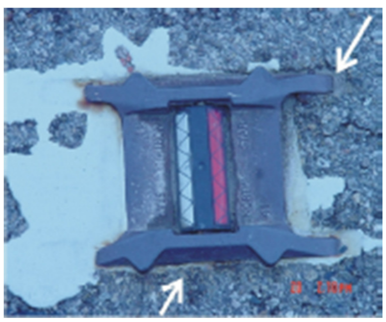


Illustration 2a

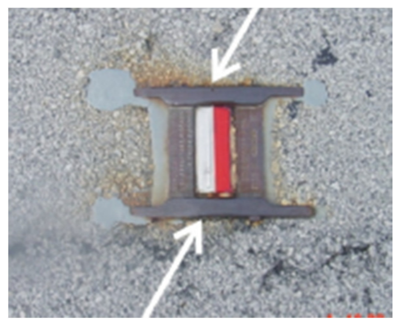


Illustration 2b

Remedial Action:

a. Blow out dirt from around RPM casting with compressed air.

b. Fill the voids and seal the RPM casting all around with epoxy as shown in Illustration below.

Illustration 2c

3. Problem: The RPM casting is installed near or on a longitudinal joint or crack in the roadway surface (Illustration 4).

Illustration 4

Remedial Action: Seal all the cracks up to a minimum of 9 inches from the RPM casting with epoxy (Illustration 5).

Illustration 5

4. Problem: RPM casting is installed on construction joints which have extensive failure (Illustration 6).

Illustration 6

Remedial Action:

a. Remove and install the RPM casting at a new location.

b. The distance to the new RPM casting location shall not exceed 25 percent of the specified RPM spacing.

c. If it would be necessary to relocate the RPM casting to a distance greater than 25 percent of the specified RPM spacing, do not reinstall the casting.

d. Fill the original cavity (from where the improperly installed RPM casting was removed) with epoxy or asphalt concrete.

5. Problem: The RPM casting is installed, but either the epoxy adhesive is not hardened or the epoxy adhesive is not uniform gray in color.

Remedial Action:

a. Remove and install the RPM casting at a new location.

b. The distance to the new RPM casting location shall not exceed 25 percent of the specified RPM spacing.

c. If it would be necessary to relocate the RPM casting to a distance greater than 25 percent of the specified RPM spacing, do not reinstall the casting.

d. Fill the original cavity (from where the improperly installed RPM casting was removed) with epoxy or asphalt concrete.

350-6 Delineators

350-6.1 Qualified Product List (QPL)

Only approved delineator materials listed on the Qualified Product List (on-line at http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/QPL.aspx) shall be used on a project.

350-6.2 Delineator Lateral Placement

The top of the delineator post shall be 48 inches above the edge of pavement.

The delineator post shall be placed 12.5 feet outside the outer edge of the pavement, or 2.5 feet outside the outer edge of the shoulder.

350-6.3 Placement of Delineators on Curves and Tangent Sections

Delineators shall be spaced 400 feet apart on the tangent sections.

Delineators on the horizontal curves shall be spaced according to the table in the **Traffic SCD TC-61.10**.

Delineators should be provided on the outside of horizontal curves on interchange ramps.

The color of the delineator reflector and flexible post shall conform to the color of the pavement markings nearest the delineator.

350-6.4 Delineator Installation

Delineators shall be installed facing traffic, except for red reflectors which face wrong-way traffic, if used.

Protective paper covering the face of flexible post-mounted reflectors shall not be removed until after installation.

Ensure that delineator posts are not more than 1:50 out of plumb. If soil conditions may cause the post to be out of plumb, the contractor may drive a pilot shaft before installation.

Install the flexible posts using methods and equipment that conforms to the post manufacturer's recommendations.

350-6.5 Use of Delineators with Guardrail Anchor Assemblies

Information about guardrail anchor assemblies is provided in **L & D Manual Volume 1, Section 603**. Information about the use of delineators with Type E-98 guardrail anchor assemblies is found in **Plan Note R-113 (see L&D Manual Volume 1, Appendix B)**.

350-7 Barrier Reflectors

350-7.1 Qualified Product List (QPL)

Only approved barrier reflectors listed on the Qualified Product List shall be used. This list is on-line at http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/QPL.aspx.

350-7.2 Barrier Reflector Installation

1. The color of the reflector shall match the color of the nearest edge line.

2. Install Type (2, 3, 4, or 5) (One-Way or Bi-Directional) reflectors on the guardrail blockout.

3. Install Type 1 (One-Way or Bi-Directional) with the top of the barrier reflector so its height is 26 inches above the near edge of pavement, except that the top of the barrier reflector is at least 3 inches below the top of the concrete barrier.

4. Type 1 (One-Way or Bi-Directional) barrier reflectors shall not extend further than 5 inches in a horizontal direction towards the traffic lanes.

5. Loose concrete, rust, dirt and other loose materials shall be removed from the surface of the concrete barrier using a wire brush. Apply adhesive to clean and moisture-free surface according to manufacturer's recommendations.

350- 8 Pavement Markings

350-8.1 General

Per **C&MS Item 641.06**, the contractor shall establish reference points to ensure proper placement of restored markings on projects where resurfacing or other operations will result in obliteration of the existing pavement markings.

350-8.2 Pavement Marking Materials

Pavement marking materials used on construction projects shall be from the Approved Lists, maintained by the **Office of Material Management (OMM).** The pavement marking materials are listed under the following Approved List on that **OMM's** website at: http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Approved-List.

The appropriate type of glass beads shall be applied according to **C&MS Item 740.09** for different types of pavement marking materials.

350-8.3 Application of Pavement Marking Materials

Pavement marking materials shall be applied according to **C&MS Items 640 and 740** as follows:

1. Traffic paint, **C&MS Item 642**.

    a. Material Type, **Item 740.02**.

        i. Traffic paint Type 1, Fast dry, water-based paint.

        ii. Traffic paint Type 1A, Fast dry, water-based paint.

    b. Glass beads, **Item 740.09** Type A.

    c. Application of Traffic Paint, **Item 642**, Type 1 and 1A.

        i. Traffic paint Type 1 shall be applied when the pavement and air temperature are 50ºF and above. Traffic paint Type 1A shall be applied when the pavement and air temperature are between 35ºF and 50ºF.

        ii. Glass beads Type A shall be applied at the rate of 15 pounds per 100 square feet of Type 1 traffic paint applied.

        iii. Glass beads Type A shall be applied at the rate of 8 pounds per 100 square feet of Type 1A traffic paint applied.

        iv. Type 1 traffic paint shall be applied at the rate of 22 gallons per mile of 4-inch solid line and/or at 1.25 gallons per 100 square feet .

        v. Type 1A traffic paint shall be applied at the rate of 16 gallons per mile of 4-inch solid line and/or at 0.94 gallon per 100 square feet.

        vi. Coning of the line is required because the pavement marking is not track free in 2 minutes or less.

2. Polyester Pavement Marking, **Item 643**.

    a. Material Type, **Item 740.03**.

    b. Glass beads, **Item 740.09** Type B.

    c. Application of Polyester, **Item 643**.

        i. Polyester shall be applied when the pavement and air temperature are 50ºF and above.

        ii. Polyester shall be applied in two components (catalyst and resin) in proportions as recommended by the manufacturer.

        iii. Glass beads Type B shall be applied at the rate of 18 pounds per gallon (liter) of paint used.

        iv. Polyester shall be applied at the rate of 16 gallons per mile of 4-inch line and/or at 0.94 gallon per 100 square feet.

v. Since dry time is 45 minutes and less:

(1) Coning is required to protect the line until track free.

(2) If tracking continues after 45 minutes cease marking operation until tracking problem is corrected.

3. Thermoplastic Pavement Marking, **C&MS Item 644**.

a. Material Type, **Item 740.04**.

b. Glass beads, **Item 740.09** Type C.

c. Application of Thermoplastic, **Item 644**.

i. For pavements less than six months old, thermoplastic shall be applied when the pavement surface and the ambient air temperature are 50° F and rising. At the end of the construction season, if the surface temperature is 50° F or less, apply Traffic Paint Type 1A.

ii. For pavements one year or older, thermoplastic shall be applied when the pavement surface and the ambient air temperature are 70°F and rising.

iii. The temperature of thermoplastic at the point of application shall be at least 400° F and not more than 440°F .

iv. Glass beads, Type C shall be applied at the rate of 12 pounds per 100 square feet.

v. Thermoplastic material shall be applied at a thickness of 125 mils using an applicator that has a shoe that rides on the pavement and extrudes the thermoplastic (no ribbon application).

vi. Thermoplastic shall be applied at the rate of 2340 pounds per mile of 4-inch line and/or at 133 pounds per 100 square.

4. Preformed Pavement Marking, **C&MS Item 645**.

a. Material Types, **Items 740.05 and 740.06**.

i. For Type A, permanent markings, Type A1, A2 or A3 material from **Item 740.05** shall be used -

(1) Type A1 material, 0.090 inch thick shall be applied with pre-coated adhesive layer.

(2) Type A2 material, 0.060 inch thick shall be applied with pre-coated adhesive layer.

(3) Type A3 material, 0.020 inch thick shall be applied with pre-coated adhesive layer.

ii. For Type B work zone pavement markings, Type II (non-removable) material from **Item 740.06** shall be used. This material has a minimum thickness of 0.015 inch.

iii. For Type C work zone pavement markings, Type I (removable) material from **Item 740.06** shall be used. This material has a minimum thickness of 0.030 inch.

b. Glass beads - None.

c. Application of Preformed Pavement Marking, **Item 645**: Preformed pavement marking shall be applied according to the manufacturer's recommendations packed with material.

5. Epoxy Pavement Marking, **C&MS Item 646**.

a. Material Type, **Item 740.07**.

b. Glass beads, **Item 740.09** Type D.

c. Application of Epoxy Pavement Marking, **Item 646**.

i. Epoxy shall be applied at a surface temperature of 50°F and above.

ii. Epoxy shall be applied in components, Part A and Part B, in the proportions recommended by the manufacturer.

iii. Cleaning and Surface Preparation shall be done according to Item 646.04 for different pavement types and manufacturer's recommendations.

iv. Glass beads Type D shall be apply at the rate of 31 pounds per 100 square feet. They shall be applied in a double-drop system with Size I, large gradation, first and Size II, regular graduation second in equal amounts by weight in the same pass.

v. Epoxy shall be applied at the rate of 22 gallons per mile of 4-inch line and/or at 1.25 gallon per 100 square feet.

6. Heat-Fused Preformed Thermoplastic Pavement Marking, **Item 647**.

a. Material Type, **Item 740.08**.

i. Type A90 is 90 mil thick.

ii. Type A125 is 125 mil thick.

iii. Type B90 is 90 mil thick.

iv. Type B125 is 125 mil thick.

b. Glass beads - Type A and B shall contain intermix beads throughout. Drop-on glass beads are not required unless using a non-surface beaded markings.

c. Application of Heat-Fused Preformed Thermoplastic Pavement Marking, **Item 647**.

i. Heat-Fused Preformed Thermoplastic Pavement Marking shall be applied only as auxiliary markings according to the manufacturer's recommendations.

ii. Apply primer sealer on Portland cement concrete pavements if recommended by the manufacturer.

7. Spray Thermoplastic Pavement Marking, **Item 648**.

a. Material Type, **Item 740.10.**

b. Glass Beads, **Item 740.09** Type G.

c. Application of Spray Thermoplastic, **Item 648.**

   i. For pavements less than six months old, spray thermoplastic shall be applied when the pavement surface and the ambient air temperature are 50^{o}F and rising
   ii. For pavements one year of older, spray thermoplastic shall be applied when the pavement surface and the ambient air temperature are 70^{o}F.
   iii. The temperature of spray thermoplastic at the point of application shall be at least 400^{o}F and not more than 440^{o}F.
   iv. Glass beads, Type C shall be applied at the rate of 10 pounds per 100 square feet.
   v. Spray thermoplastic material shall be applied at a thickness of 45 mils.
   vi. Spray thermoplastic shall be applied at the rate of 762-886 pounds per mile of 4-inch line.

350-8.4 Data Logging System (DLS)

According to **C&MS Item 641.04**, striping equipment for traffic paint, polyester, epoxy and work zone marking **Item 642** shall be equipped with a computerized Data Logging System (DLS). The following shall be documented, for long line markings only:

1. Measure and record application vehicle speed to the nearest 0.1 miles per hour.

2. Measure and record the weight and/or volume amount of material used by color.

3. Measure and record the weight of glass beads.

4. Measure and record the pavement surface temperature.

5. Measure and record the air temperature.

6. Measure and record the dew point.

7. Measure and record the humidity.

8. Calculate and record average materials application rates and film thickness over the section painted.

ODOT provides standard DLS spreadsheets, which prescribes the correct DLS report format and content prior to beginning at work.

350-8.5 Construction Inspection During Pavement Marking Installation

1. Refer to **C&MS Item 641**, Pavement Marking - General.

2. Before the application of marking material, the pavement surface should be cleaned and dried by using:

   a. Power broom.

   b. Air jets (guns).

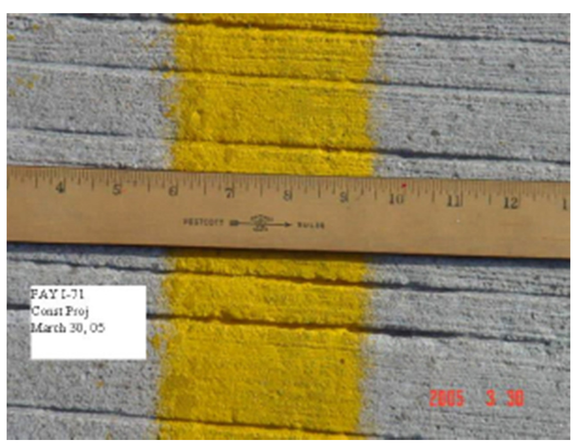
3. Approve the premarking for long lines and auxiliary markings to ensure proper layout placement.

   a. Center lines shall be “T” marked to establish no-passing lines.

b. The District shall provide center line paint logs.

c. Per **Item 641.06**, the contractor shall establish reference points to ensure proper placement of restored markings on projects where resurfacing or other operations will result in obliteration of the existing pavement markings.

4. Marking lines shall be applied to the width specified ± 1/4 inch.



5. Pavement markings shall be free of uneven edges, overspray and other visible defects.

6. As noted in ***Section 301-4***, center lines, lane lines and edge lines shall be placed as follows:

   a. Edge line – Center of the edge line shall be applied 6 inches from the edge of pavement.

   b. Lane line – Nearest edge of the lane line shall be applied 2 inches to the left of the construction joint. Broken lines shall be in a 40-foot cycle consisting of a 10-foot dash with a 30-foot gap between the lines.

   c. Center line – Nearest edge of the center line shall be applied 2 inches to the left of the construction joint. Broken lines shall be in a 40-foot cycle consisting of a 10-foot dash with a 30-foot gap between the lines.

7. Pavement marking lines shall be straight or smoothly curved true to the alignment of the pavement. If deviation is greater than 3 inches in 100 feet, it shall be corrected.

8. Gaps shall be filled that were not marked as a result of template use for spray-applied auxiliary markings with marking material after the template is removed. For extruded thermoplastics gaps may be left.

9. Pavement marking lines shall be sharp, well defined and uniformly retroreflective.

   a. To check for retroreflectivity, put the sun over your shoulder.

   b. If it is not sunny:

      i. A well-beaded line will appear dull in the daylight.

      ii. An unbeaded line will appear shiny.

   c. Review the lines at night.


R
R

360 MAINTENANCE / OPERATIONS

360-1 General

Because markings by their very nature often need replacement, it is imperative that they be well maintained in order to function reliably. The consequences of poor maintenance practices are a reduction in safety to road users and exposure to liability claims.

Although the information in ***Chapter 350*** is primarily intended for construction inspectors or contractors working with markings, it is also of use to **ODOT** maintenance workers performing the same work. For example, ***Section 350-2*** references ***Tables 397-3 and 397-4, and Figure 398-6.*** This information can also be used to help evaluate existing pavement markings.

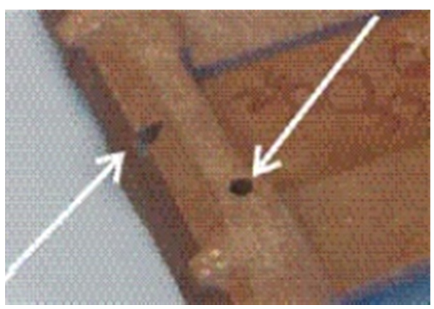
360-2 Maintenance of Raised Pavement Markers (RPMs)

360-2.1 General

Sections 302-2 through 302-6 include information about maintenance of **ODOT** RPM installations. Additional information is provided herein.

360-2.2 Types of RPMs

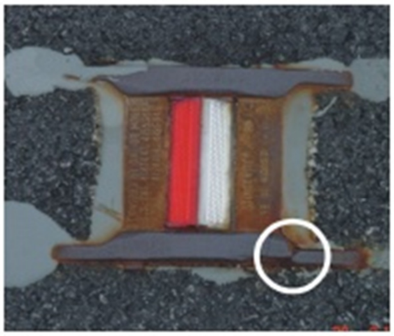
A recycled RPM can be identified in the field by observing either a saw cut or a drilled hole in the surface of the RPM casting.



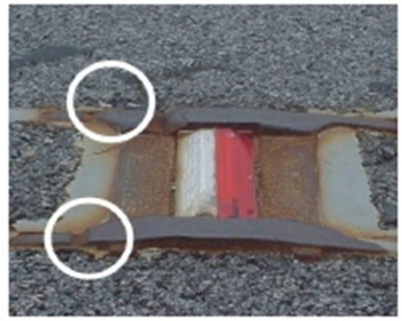
To identify the source of other castings, the manufacturer's name is imprinted on the casting.

360-2.3 Inspection Guidelines for Existing RPM Installations

1. Casting Failure: An RPM casting has "failed" if it is broken, cracked fully or partially, or if the casting is gouged. Broken leveling lugs/tabs or minor shaving or scratches on the casting do not constitute failure of the casting.



Keel is cracked.



Keels are gouged.

2. Poor Quality Installation: The following are considered poor quality installations:

   a. Any of the four lugs/tabs are not resting on the pavement surface ***(see illustration 1, Section 350-5)***.

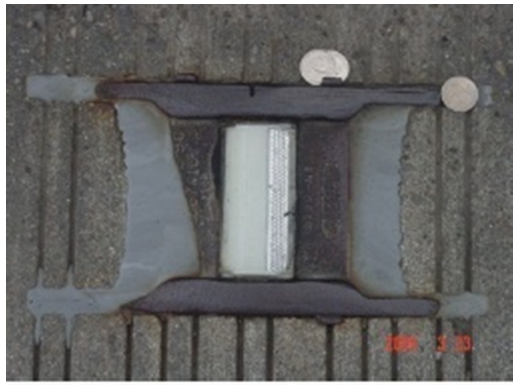
   b. The epoxy adhesive does not fill all the voids around the casting ***(see illustration 2a, Section 350-5)***.

   c. The epoxy adhesive is not all around the casting and level with the roadway surface. For example, ***illustration 2b*** in ***Section 350-5*** shows a casting with space between the casting and the pavement on one side and in contact with the pavement on the other side.

   d. The epoxy is not hardened and/or not a uniform gray color ***(see illustration 7, Section 350-5)***.

   e. The slot or cut for the RPM is intact and the casting is missing. This indicates that there was a poor bond between epoxy and pavement.

   f. The leading casting rails are above the pavement so as to become a blunt edge which can become caught by a snowplow blade.



g. RPM installed on or close to a construction joint ***(see illustration 4, Section 350-5)***.

3. Pavement Failure: A missing casting with the surrounding pavement also missing is an indication of pavement failure. Typically, as shown in the illustration, the slot or cut made for the casting has lost its shape.

4. Adhesive Failure: Adhesive failure occurs when the bond between pavement surface and epoxy under the casting has failed. Usually surface of the under laying old pavement is visible and the casting is missing.

370 OTHER CONSIDERATIONS

This Chapter has been reserved for information regarding other considerations related to traffic control markings.

380 RESEARCH

This Chapter has been reserved for information about pertinent research regarding traffic control markings.

395 REFERENCE RESOURCES

Various reference resources that may be useful have been noted in ***Sections 193, 194 and 195***.

396 FORMS INDEX

396-1 Air Speed Check Zone Request Form

As noted in ***Section 301-10***, the ***Form 396-1*** should be used when requesting a new or revised Air Speed Check Zone. The same form is used to abolish an Air Speed Check Zone. A copy of the form is available on-line at the **OTO** forms web page.

Intentionally blank.

Form 396-1. Air Speed Check Zone Request

Air Speed Check Zone Request

OSP District Office

Request No.: ______________ Date: ____/____/_____

By Lt. _______________, ___________ County: ____________________
Post

Phone: (_____) _____-__________

ZONE(S) DATA

Route Number	Request Type *	Road Type **	Direction of Travel	Begin MP	Ending MP	Description

OSP Aviation Section
Fax: 614-761-9907

Date Reviewed: _____/_____/______

___ Approved

Date Forwarded to ODOT District ___ Office: ____/____/_____

Necessity: ____

___ Disapproved

Date Returned to OSP District Office: _____/_____/______

c: Highway Patrol Post District # ___

ODOT District Office

Reviewed by: ________________________________ Date: ____/____/_____
Name/Title

___ Practical

Date of Layout: ___/___/___ By: ____________________________
Registered Surveyor

Date Work Completed: ___/___/___ By: ____________________________
Traffic Control Supt.

Date Returned to the OSP Aviation Section Commander: ____/____/_____

___ Impractical

Reason for Not Complying with Request: ___________________________

Date Returned to OSP Headquarters: ____/____/_____

*** Request Type**

- A New Zone Installation
- B Restoration of an Existing Zone that may have been obliterated due to roadway resurfacing or other highway construction projects.
- C Remark Existing Zone
- D Measure Existing Zone
- E Abolish Existing Zone

**** Road Type**

- 10 Interstate
- 20 Major Throughfare Divided
- 30 Major Throughfare Other
- 40 Auxiliary
- 50 Local

Note: Air Speed Measurement Marking shall be laid out by a registered surveyor and where approved shall be installed in accordance with the standards contained in the OMUTCD.

Intentionally blank.

397 TABLES INDEX

397-1 Material Selection for Pavement Marking and Expected Marking Life in Years

As noted in ***Section 301-2***, ***Table 397-1*** is used to determine the appropriate type of pavement marking material to use.

397-2 Area Calculations for Words and Symbols

As noted in ***Section 301-8***, to help in calculating materials quantities, ***Table 397-2*** provides information on the area for various auxiliary pavement markings.

397-3 Rating Daytime Color of Long Line Pavement Marking

As noted in ***Section 350-2***, when conducting the performance evaluation described in **C&MS Item 614.11** the ratings given in ***Table 397-3*** shall be used.

397-4 Night Visibility Rating for Long Line Pavement Marking

As noted in ***Section 350-2***, when conducting the performance evaluation described in **C&MS Item 614.11** the ratings given in ***Table 397-4*** shall be used.

397-5 Durability Rating for Long Line Pavement Marking

As noted in ***Section 350-2***, when conducting the performance evaluation described in **C&MS Item 614.11** the ratings given in ***Table 397-54*** shall be used.

397-6 Compatibility of Pavement Marking Materials for Restripe Situations

Table 397-6 is used to determine whether pavement marking materials are compatible when restriping, without removing the old pavement markings.

Intentionally blank.

Table 397-1. Material Selection for Pavement Marking and Expected Marking Life in Years

a. Long Line Pavement Marking – 2 Lane or General System
(See next page for related notes.)

Remaining Pavement Surface Life *	Asphalt				Concrete			
	ADT < 5,000		ADT > 5,000		ADT < 5,000		ADT > 5,000	
	Type	Years	Type	Years	Type	Years	Type	Years
0 - 2 years	Traffic Paint Type 1	1	Polyester Spray Thermo Traffic Paint Type 1	2 2 1	Polyester Traffic Paint Type 1	2 1	Polyester Traffic Paint Type 1	2 1
3 - 4 years	Polyester Spray Thermo Traffic Paint Type 1	3 2 1	Polyester Spray Thermo Traffic Paint Type 1	2 2 1	Traffic Paint Type 1	1	Epoxy Traffic Paint Type 1	4 1
> 4 years	Thermo Polyester Spray Thermo	4 3 2	Epoxy Thermo Polyester Spray Thermo	4 4 2 2	Epoxy Traffic Paint Type 1	4 1	Epoxy	4
New Surface i) 35° to 50° F ii) > 50° F	Traffic Paint Type 1 A Traffic Paint Type 1 Spray Thermo Thermo	1 1 2 4	Traffic Paint Type 1 A Traffic Paint Type 1 Spray Thermo Thermo	1 1 2 4	Traffic Paint Type 1 A Traffic Paint Type 1 Epoxy	1 1 4	Traffic Paint Type 1 A Traffic Paint Type 1 Epoxy	1 1 4

b. Long Line Pavement Marking – Multilane or Priority System
(See next page for related notes.)

Remaining Pavement Surface Life *	Asphalt				Concrete			
	ADT < 5,000		ADT > 5,000		ADT < 5,000		ADT > 5,000	
	Type	Years	Type	Years	Type	Years	Type	Years
0 - 2 years	Polyester Traffic Paint Type 1	2 1	Polyester Spray Thermo Traffic Paint Type 1	2 2 1	Polyester Traffic Paint Type 1	2 1	Polyester Traffic Paint Type 1	2 1
3 - 4 years	Polyester Spray Thermo Traffic Paint Type 1	3 2 1	Polyester Spray Thermo Traffic Paint Type 1	2 2 1	Polyester Traffic Paint Type 1	2 1	Epoxy	4
> 4 years	Thermo Polyester Spray Thermo Traffic Paint Type 1	4 3 2 1	Epoxy Thermo Spray Thermo Polyester	4 4 2 2	Epoxy	4	Epoxy	4
New Surface i) 35° to 50° F ii) > 50° F	Traffic Paint Type 1 A Traffic Paint Type 1 Spray Thermo Thermo	1 1 2 4	Traffic Paint Type 1 A Traffic Paint Type 1 Spray Thermo Thermo	1 1 2 4	Traffic Paint Type 1 A Traffic Paint Type 1 Epoxy	1 1 4	Traffic Paint Type 1 A Traffic Paint Type 1 Epoxy	1 1 4

Table 397-1. Material Selection for Pavement Marking and Expected Marking Life in Years (continued)

c. Auxiliary Pavement Marking – 2-Lane and Multilane or Priority System								
Remaining Pavement Surface Life *	**Asphalt**				**Concrete**			
	ADT < 5,000		ADT > 5,000		ADT < 5,000		ADT > 5,000	
	Type	**Years**	**Type**	**Years**	**Type**	**Years**	**Type**	**Years**
0 - 2 years	Traffic Paint Type 1	1	Traffic Paint Type 1	1	Traffic Paint Type 1 A Traffic Paint Type 1	1 1	Heat-Fused Preformed Thermo Traffic Paint Type 1 A Traffic Paint Type 1	3 1 1
3 - 4 years	Heat-Fused Preformed Thermo Polyester	4 1-2	Heat-Fused Preformed Thermo	3	Heat-Fused Preformed Thermo Epoxy Traffic Paint Type 1	4 3 1	Heat Fused Preformed Thermo Epoxy	3 3
> 4 years	Heat-Fused Preformed Thermo Thermoplastic Polyester Traffic Paint Type 1	4 3 1-2 1	Heat-Fused Preformed Thermo Thermoplastic	3 3	Heat-Fused Preformed Thermo Epoxy	4 3	Heat-Fused Preformed Thermo Epoxy	3 3
New Surface i) 35^o to 50^o F ii) > 50^o F	Same as used for long lines		Same as used for long lines		Same as used for long lines		Same as used for long lines	

* Remaining pavement surface life is the life before resurfacing, reconstruction or before crack sealant will cover the pavement markings.

Notes:

1. **Polyester pavement marking material**
   a. Polyester pavement marking material is addressed in **CMS Item 643**. Since it adheres best to a worn surface, polyester is not to be placed until new asphalt pavement has been open to traffic at least fourteen days.
   b. Polyester pavement marking material shall only be used on **C&MS Item 441, 442, or 424 Type B.**
   c. Polyester pavement marking material shall not be used on the following asphalt concrete surfaces due to poor bonding qualities:
      i. Open graded courses,
      ii. Slurry seal, **C&MS Item 424 Type A or 443**
      iii. Any Asphalt Concrete (Item Special) should be questioned before considering placement of polyester material on it.
2. **Thermoplastic pavement marking material**
   a. Thermoplastic pavement marking material is not recommended for striping long line markings on routes with 2500 or less ADT since these materials must be removed before a chip seal coat can be applied to the pavement.
3. **Preformed Thermoplastic pavement marking material**
   a. Due to the high cost of preformed material, it should only be considered for use where extra-long life is needed or in certain applications, such as bridge decks where thermoplastic has not adhered well.
4. **Epoxy pavement marking material**
   a. Epoxy should only be used on pavements in good condition after surface preparation has been accomplished per manufacturer recommendations.
   b. Epoxy pavement marking material is not recommended for striping long line markings on routes with 2500 or less ADT since these materials must be removed before a chip seal coat can be applied to the pavement.
5. **Rumble Stripes**

a. Since thicker pavement marking materials may reduce the effectiveness of rumble stripes
   i. Preformed pavement marking **(C&MS Item 645)** and Heat-fused preformed thermoplastic **(Item 647)** shall not be used for rumble stripes
   ii. Thermoplastic **(Item 644)** should not be used with rumble stripes.

6. Microsurfacing and Chip Seal Pavements

a. Microsurfacing **(Item 421)** and Chip Seal **(Item 422)** falls under Asphalt Pavement.
b. Thermoplastic **(Item 644)** pavement marking materials shall not be used on Microsurfacing pavements **(Item 421)** for long line pavement markings.

7. Miscellaneous

a. Auxiliary markings not regularly run over by traffic will last 1.5 to 2 times longer.
b. Surface preparation may be required to remove old markings as recommended by supplier.
c. Remove curing compound completely from new concrete surfaces - follow **CMS Item 641.05**.

Table 397-1. Material Selection for Pavement Marking and Expected Marking Life in Years

d. – Concrete Bridge Deck Pavement Marking			
Remaining Surface Life of Concrete Bridge Deck	**Material Group**	**Product Name**	**Years**
< 4 years[4]	740.02 Traffic Paint Type 1	Traffic Paint Type 1 – as listed on the Approved List	1-2
	740.07 Epoxy	PolyCarb Mark 55.4	3-4
	Modified Urethane [1]	IPS HPS 4	3-4
	Polyurea [1,2]	PolyCarb Mark 75	3-4
≥ 4 years	740.07 Epoxy	IPS HPS 2	4-5
		PolyCarb Mark 55.2	4-5
		Epoplex LS 60	4-5
	740.05 Preformed Tape	3M 380WR ES	4-5
	Polyurea [1,2]	Epoplex Glomarc 90	5-6
		IPS HPS 5	5-6

Notes:

1. All inlaid pavement marking on concrete bridge decks shall be installed in a 150 mil (4.0 mm) groove to match the depth of standard bridge deck groove per Item 511.17.

2. Pavement marking materials listed for bridge deck of remaining surface life equal to or greater than (≥) 4 years can also be used on concrete bridge deck for remaining surface life less than (<) 4 years.

3. Modified Urethane and Polyurea are not listed on the Material Approved List but can be used on a limited basis.

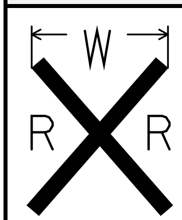
4. Polyurea pavement marking materials need special striping equipment for installation

Table 397-2. Area Calculations for Words and Symbols

WORDS square feet		
TYPE	HEIGHT	
	6 ft.	8 ft.
STOP	17	24
ONLY	17	23
SCHOOL[1]	27	37

LANE-USE ARROWS square feet		
ARROW TYPE	SIZE	AREA
Turn Arrow	8.0	17
Straight Arrow	9.5	13
Combined Arrow	12.75	28
Lane-Reduction Arrow	18.0	46

Handicap Symbol		
Height in.	Width in	Area Square ft.
41	36	2.7

R X R SYMBOL square feet [1]					
	WIDTH (W)[2]				
	8 ft. min.	9 ft.	10 ft.	11 ft.	12 ft.
	67	68	70	71	72

Notes:

1. The area for transverse lines for the Railroad and SCHOOL Pavement Marking Symbols varies with the width of the pavement; therefore, it must be added to the values in the above tables.
2. Width varies according to lane width, except that the "R" is 6 feet long.

Table 397-3. Rating Daytime Color of Long Line Pavement Marking

Scale	Description
10	White and yellow are very vivid and rich in appearance, and are very effective in delineation.
9 8 7	White and yellow are very distinctive and definite in color.
6 5 4	White and yellow appear somewhat grayish; yellow may appear to have a brownish or greenish tint.
3 2 1	White and yellow are dull and grayish; yellow may appear to be green, brown or off-white.
0	White and yellow appear very dull.

Note: The color rating is a subjective field assessment of the vividness of the white markings and the richness of the yellow markings when viewed under dispersed daylight conditions on dry pavement, in accordance with the table below.

Ideally, color should be assessed under uniformly overcast conditions. If it is necessary to conduct evaluations under clear or partly cloudy conditions, the color assessment should be made with the sun as near transit as practical, as the angle of the incident rays of the sun can have a significant effect on the appearance of the color of the pavement markings. Viewing the line with the sun behind and low on the horizon should be avoided, as this can impart a level of retroreflectivity to the pavement marking. Under certain circumstances, especially during the fall and winter, when the sun is low on the horizon even at transit, it may be necessary to view the line in the opposite direction to avoid excessive retroreflectivity imparted from the sun.

<u>The evaluation process is conducted as follows:</u> A trained evaluator observes the line from a distance of 100 feet (±10 feet), and rates the color as per the table below. For lane lines, this distance can be approximated by standing midway between two lane lines, and looking beyond the nearest two lane lines to the third.

In all cases, the color rating is expressed as an integer value.

Table 397-4. Rating Night Visibility of Long Line Pavement Marking

Uniformity		Retroreflectivity		Nighttime Color	
+4	Line is completely consistent in appearance, with no distinguishable variations				
+3	Line is generally consistent in appearance, with minimal variations	+3	Line is very bright	+3	White appears as very clean reflected light; yellow is distinctive and definite in color
+2	Line is generally consistent in appearance, but with distinctly brighter and darker areas	+2	Line is bright	+2	White and yellow appear somewhat grayish; yellow may appear to have a brownish or greenish tint
+1	Line is inconsistent in appearance, with distinctly brighter and darker areas	+1	Line appears adequate, but with unimpressive brightness	+1	White and yellow are dull and grayish; yellow may appear to be green, brown or off-white
0	Line is very inconsistent in appearance and may appear blotchy	0	Line has minimal brightness; line is discernable but only marginally effective	0	White and yellow appear very dull

Note: Night visibility is a subjective rating based on the appearance of the pavement marking line on dry pavement to a trained evaluator in a vehicle when viewed under low beam headlight illumination at night. The night visibility rating consists of an evaluation of three distinct attributes:

Uniformity – The ability of the line to provide a consistent, unvarying appearance along its length and across its width.
Retroreflectivity – The brightness of the line in the return of incident illumination.
Nighttime Color – The vividness of the white markings and the richness of the yellow markings when seen with retroreflected light.

The rating scales for each of these attributes is described in the tables below.

The evaluation process is conducted as follows: With appropriate traffic control in place, slowly drive through the test section at night with low beam headlights, and observe the test line. First, rate the uniformity of the line appearance. Second, rate the line retroreflectivity. Finally, rate the color. Add up the three individual scores to get a composite rating for the line.

In all cases, the night visibility rating is expressed as an integer value.

Table 397-5. Durability of Long Line Pavement Marking

Durability	
Rating	Percentage of Line Remaining
10	100
9	90
8	80
7	70
6	60
5	50

Durability	
Rating	Percentage of Line Remaining
4	40
3	30
2	20
1	10
0	0

Note: Durability is the rating of the adherence of the pavement marking material to the sound pavement surface, based on the percentage of the material remaining adhered. Durability is not an assessment of the thickness of the material or retention of optical elements, but rather an analysis of the amount of bare, sound pavement showing that was once covered with pavement marking material.

Durability is an objective assessment, although there exists no mechanical means to reliably and quickly measure durability in the field. Therefore, the field assessment of pavement marking durability must be made by trained evaluators.

The evaluation process is conducted as follows: Several trained evaluators observe the test line by viewing vertically from above. An assessment of the durability is made by each. The durability rating is agreed upon in the field by a consensus of the evaluators.

If line deterioration is inconsistent throughout the length of the test section, several line segments should be evaluated. Each segment should be a minimum of ten feet in length, and no less than 2% of the total length of the line. The durability rating is the lowest rating for any line segment, as agreed upon by a consensus of the evaluators.

Portions of the line subjected to unusual wear, such as at driveways or from line tracking prior to final curing, should be categorically excluded from the durability assessment. In addition, failures within the pavement must be recognized and discounted when assessing the durability of the pavement marking.

In all cases, the durability rating is expressed as an integer value.

Table 397-6. Compatibility of Pavement Marking Materials for Restripe Situations

Existing (Old) Pavement Marking Material	Restripe (New) Pavement Marking Material						
	Traffic Paint[1]	Polyester[1]	Thermoplastic	Preformed (Item 645)	Epoxy	Heat-Fused Preformed	Spray Thermoplastic
Traffic Paint[3]	Y	Y	Y[2]	N	N	N	Y[2]
Polyester	Y	Y	N	N	N	N	N
Thermoplastic	Y	N	N	N	N	N	Y
Preformed (Item 645)	N	N	N	N	N	N	N
Epoxy	Y	N	N	N	N	N	N
Heat-Fused Preformed	N	N	N	N	N	N	Y
Spray Thermoplastic	Y	N	Y	N	N	N	Y

All pavement marking materials are compatible for striping over Class III Work Zone Markings.

Notes:

1. Do not use wet glass beads
2. Apply only if existing marking is at least 3 month old
3. Includes Class I and II Work Zone Markings

398 FIGURES INDEX

398-1 Cardinal Direction Markings

Figure 398-1 provides sizing and spacing details for Cardinal Direction Markings.

398-2 Marking a Narrow or One-Lane Bridge

As noted in ***Sections 202-5, 202-14.2, 302-6 and 304-5***, ***Figure 398-2*** provides detail guidelines marking of a narrow or one-lane bridge.

398-3 Reserved for Future Information

Figure 398-1. Cardinal Direction Markings

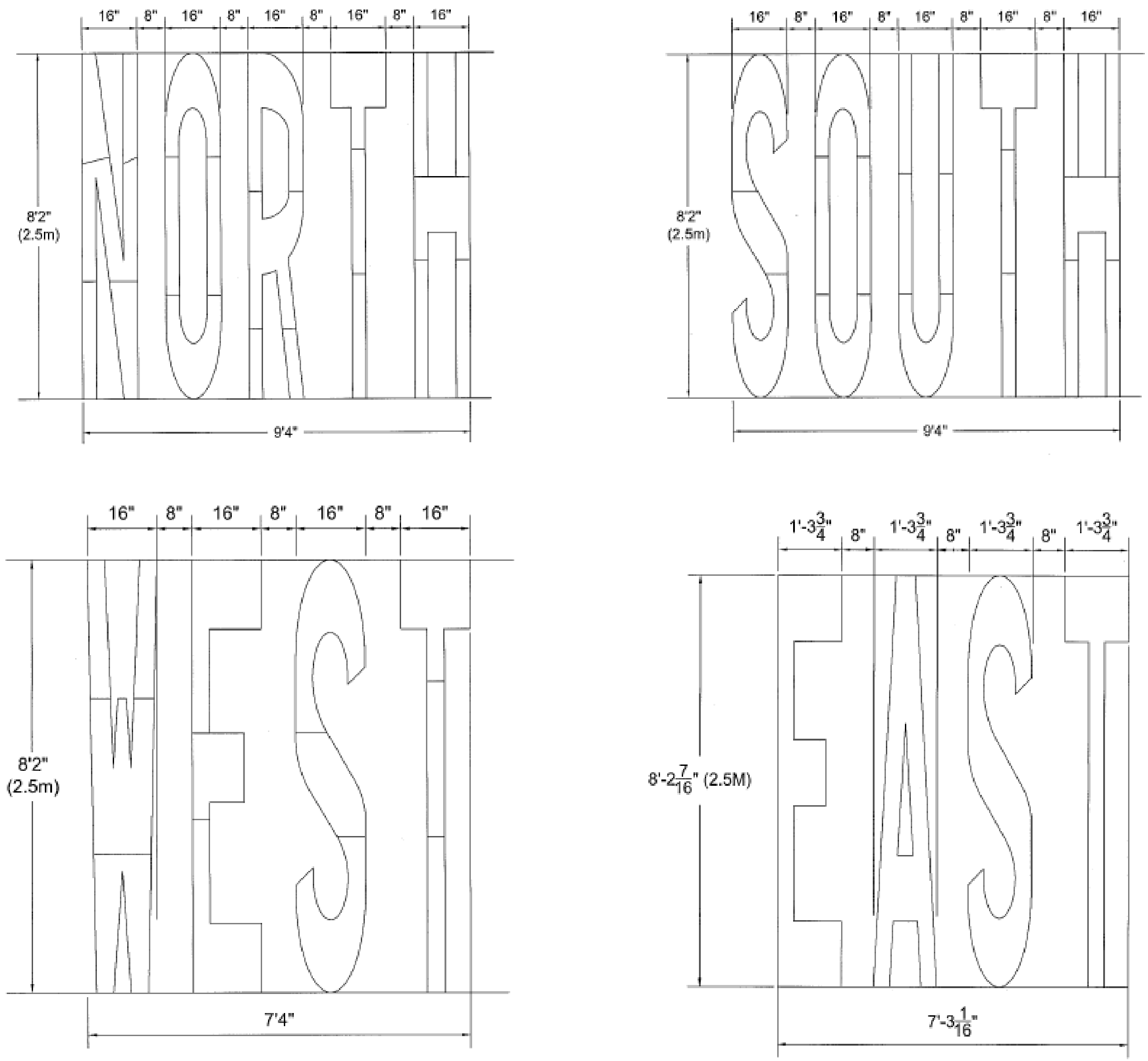
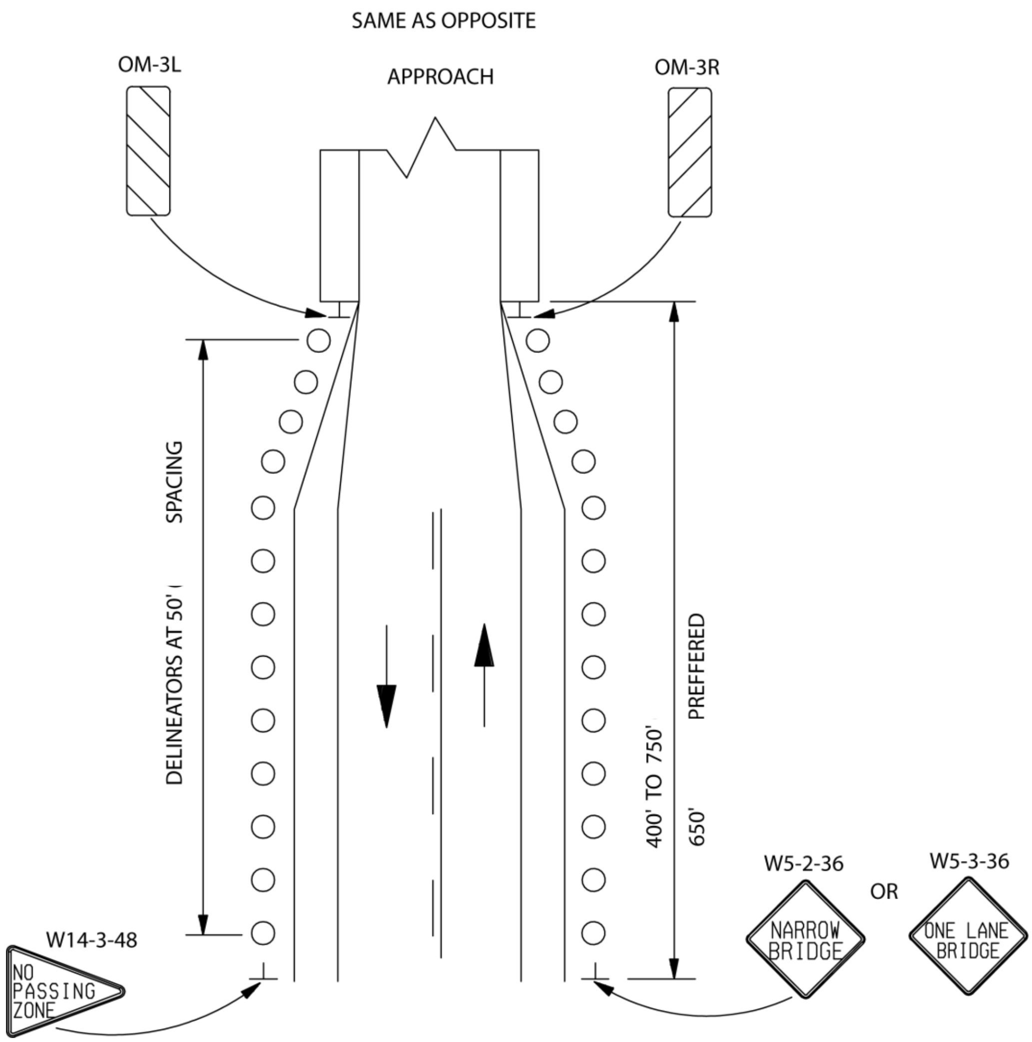


Figure 398-2. Marking a Narrow or One-Lane Bridge



Note: Center line should stop 150 feet before a one-lane bridge, but may be continued across a narrow bridge **(see OMUTCD Section 3B.01)**.

Figure 398-3. Reserved for Future Information

TABLE OF CONTENTS
Part 4 - SIGNALS

Part 4 - SIGNALS

400 GENERAL

400-1 Introduction

OMUTCD Section 1A.13 defines a Highway Traffic Signal as:

> “a power-operated traffic control device by which traffic is warned or directed to take some specific action. “Highway traffic signal” does not include a power-operated sign, steadily-illuminated pavement marker, warning light, or steady burning electric lamp.”

OMUTCD Section 1A.13 defines a Traffic Control Signal (or traffic signal) as:

> “any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed.” [4511.01(RR), ORC].

The various types of traffic signals are discussed in **OMUTCD Part 4**.

The information provided in this Part of the **TEM** is intended to supplement the **OMUTCD** by presenting **ODOT** practices and procedures concerning the design, construction, operation and maintenance of the various traffic signal devices.

400-2 Construction Projects

Chapter 140 addresses the general application of **ODOT** standards, specifications and standard construction drawings in the design of construction projects. ***Chapter 450*** provides additional construction related information specific to traffic control signals.

400-3 Force Account (ODOT Operations) Work

Districts performing force account signal work must comply with the requirements in the **OMUTCD** and this Manual. It is recommended that the **Districts** follow the provisions in the applicable signing related **Standard Construction Drawings (SCDs)** and **Construction and Material Specifications (C&MS)** sections as well. It should be recognized, however, that the information in the **C&MS** and **SCDs** does not necessarily provide the only method to achieve a given objective.

Intentionally blank.

401 TRAFFIC CONTROL SIGNALS - GENERAL

401-1 General

OMUTCD **Chapter 4D** presents information on the design, location and use of traffic control signals. Construction details are shown on the **Traffic SCDs TC-81.10 through TC-85.20**. Traffic signal equipment is specified in **C&MS Items 632 and 633**, and **C&MS 732 and 733**.

401-2 Installation of Traffic Signals on State Highways

Policy 516-002(P) on this subject has been retired. If you have questions on this subject that are not otherwise addressed in this Manual, please contact the **Office of Roadway Engineering Traffic Control Design Section** or the **Office of Traffic Operations**.

401-3 Periodic Review of Signals

As noted in **OMUTCD** **Section 4B.02**, changing traffic patterns may render an existing traffic signal either inefficient or no longer necessary. Therefore, the responsible agency should periodically conduct a traffic engineering study to evaluate the efficiency and necessity of traffic signals under its jurisdiction and determine if revisions may be needed. This traffic engineering study may lead to changing the signal timing, signal phasing, vehicle or pedestrian detection, roadway geometry, or the complete removal of the traffic signal.

Traffic signal installations that are not properly designed and maintained for current traffic conditions, or are no longer warranted, can result in the following conditions:

1. Excessive traffic delay.

2. Increased disobedience of the signal indications.

3. The use of less adequate routes in order to avoid such signals.

4. Increased accident frequency, especially rear-end accidents.

Some signalized intersections and/or signalized corridors may be eligible to apply for, and participate in, the Systematic Signal Timing & Phasing Program (SSTPP). See ***Section 1213-6*** for more information about this program.

401-4 Removal of Traffic Signals Under ODOT Jurisdiction

If a traffic engineering study indicates that the traffic signal is no longer justified, the traffic signal should be removed by a uniform procedure that will consider public input, accidents, site considerations and an appropriate replacement type of traffic control device. Therefore, when **ODOT** determines that an existing traffic signal installation no longer meets signal warrants as contained in the **OMUTCD**, or is no longer the appropriate form of traffic control, the **District** shall proceed through the following removal process to document and determine if the signal installation should be removed:

1. To determine if the traffic signal is still needed, the **District** shall prepare a traffic engineering study for the signal installation documenting the following information, as appropriate:

    a. Warrant analysis summary. If reasons other than the standard warrants were used to justify the signal installation, determine if these reasons are still valid.

    b. Accident history.

    c. Site conditions, especially sight distance problems.

d. Public, business, school board or governmental complaints resulting in the original signal installation.

e. Present and future developmental growth.

f. Known reasons for change in traffic patterns or volumes.

g. Capacity analysis for the alternate traffic control scheme most likely to be installed if the signal is removed.

h. Analysis of the cost of continued signal operation versus a one-time signal removal cost.

i. Discussion of traffic volume growth needed to warrant the signal.

2. Based on the traffic engineering study, the **District** shall decide whether to proceed with the removal process or defer signal removal. If the removal is deferred, the **District** shall document the reasons for deferral. The signalized location shall be reconsidered for removal every year until a signal warrant or other determination of permanent retention is satisfied.

3. If the **District** decides to proceed with the removal process, the following steps shall be taken:

   a. Inform the local media, schools, governmental agencies and local emergency/safety forces of **ODOT's** intent to study the signalized location for removal.

   b. Remove or reduce intersection sight distance restrictions, if needed.

   c. Install the SIGNAL UNDER STUDY FOR REMOVAL (W24-H2b) sign next to the signal heads on each approach.

   d. Check the controller cabinet wiring to ensure that the color of the flashing indications will agree with the alternate traffic control scheme.

   e. Install the alternate traffic control devices, such as STOP signs and advance Warning Signs. Existing Stop Lines on the uncontrolled approaches should not be removed at this time.

   f. Place the signal in flashing operation for ninety days, in conjunction ***with item 3e above***.

4. If the signal is put in flashing operation for ninety days in anticipation of removal, the **District** shall monitor accident experience during the ninety-day flashing period:

   a. If accidents of types susceptible to correction by traffic signal control have increased by more than two, the signalized location shall remain in flashing operation for an additional sixty-day period. If more than two such accidents occur in the second sixty-day period, the **District** should retain the signal in stop-and-go operation until the site conditions can be improved to reduce the accident frequency.

   b. If accidents of types susceptible to correction by traffic signal control have not increased by more than two, continue with the removal process.

   c. The **District** shall also monitor, investigate and respond to the concerns of the public during this period.

5. If the **District** decides to proceed with the removal process after considering the information gathered in ***item 4***:

   a. The signal heads shall be bagged or removed, and the traffic signal turned off for a sixty day period.

   b. The accidents shall be monitored to determine if the absence of flashing traffic signals results in an increase in accidents. If accidents occur, the **District** may consider conversion of the traffic signal to a flashing intersection control beacon.

6. If it is decided to continue with removal of the signal, the **District** shall remove the signal heads, poles, foundations (1 foot below grade), pull boxes, overhead cables and controller. Underground conduit and cables may be abandoned in place. If the **District** wants to monitor the site for an extended period of time, the poles and cables may be left in place for one year.

7. The **District** shall notify all affected parties of the removal of the signal and the termination of any agreements that were in effect. If a signal permit exists for the signal removal location, the **District** will notify the **Office of Traffic Operations** of the signal removal so that a statewide database on **Village** signal permits can be maintained.

401-5 Identifying Maintenance Responsibility for a Traffic Signal

Road users often have a need to know the maintaining agency of a traffic signal in order to report malfunctions or signal timing problems. Many agencies install a sign or a decal on the controller cabinet to inform the public of the responsible agency and give a telephone number to report problems.

In general, the maintaining agency of a traffic signal can be determined as follows:

1. **City/Village**: Inside the corporation limits of a **City** or **Village**, the **City/Village** is responsible for the traffic signal unless the signal is located at the end of an Interstate ramp in which case, **ODOT** may maintain the signals.

2. **ODOT**: Outside the corporation limits of a **City** or **Village**, traffic signals at intersections where at least one of the highways is a State or US Route are maintained by **ODOT**. **ODOT** is responsible for all signals at Interstate ramps.

3. **County**: Outside the corporation limits of a **City** or **Village** and the involved highways are not State or US Routes, the **County** will maintain the signal if at least one of the highways is a County Route.

4. **Township**: Outside the corporation limits of a **City** or **Village** and the involved highways are not State, US or County Routes, the **Township** will maintain the signal.

401-6 Village Signal Permit Procedures

Requests by village authorities for permission to install and operate traffic control signals on state highway extensions within villages ***(Form 496-8)*** should be substantiated by appropriate traffic studies and submitted to the **District Deputy Director**. If it is determined that a traffic control signal is warranted, authorization for the installation of a traffic control signal will be issued to the village authorities.

The authorization is valid for 180 days. During this time, the village shall prepare and submit to **ODOT** an operation plan for the proposed traffic signal installation ***(Form 496-9)***. Upon approval of this plan, the village may purchase and install the traffic control signal. The fact that the **Director of Transportation** is authorized to determine whether a traffic control signal is warranted does not relieve the village authorities in any way from bearing the costs of purchasing, installing and maintaining the traffic signal equipment.

As soon as the traffic control signal has been installed and put in operation, the certification at the bottom of the form shown in ***Form 496-9*** should be filled out and returned to the **District Deputy Director**. The final Traffic Control Signal Permit ***(Form 496-10)*** will then be issued by the **Director of Transportation** and his agent will install an identification tag **(I1-H2)** with the correct permit number. ***Table 497-9*** shows the range of Village Signal Permit numbers to be used by each **District**.

A request for modification of the hours of operation or timing of these village traffic control signals shall be submitted to the **District Deputy Director** for approval using ***Form 496-11***. However, requests for alteration of any other aspect of the operation of a traffic signal covered by permit shall be submitted using the form shown in ***Form 496-8***.

It is the responsibility of the village authorities to periodically review their traffic signals.

401-7 Signal Agreements

401-7.1 General

Stop-and-Go Traffic Signals may be installed at driveways or roadways to private entities. For the purpose of this document "Private Entity" refers to any non-public highway access and may include: local agency, developer, school, church, company, private individual.

Signals should not be installed unless they meet the warrants as outlined in the current version of the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**.

Unless otherwise noted below, all design, construction, maintenance, electrical and related costs for signals, that are installed for the benefit of a private entity shall be paid by the Private Entity or their legally authorized representative.

Prior to issuing a **Right-of-Way Permit (MR509)** for the installation or modification of a signal for a private entity, the District shall have a signed Maintenance Agreement which, amongst other requirements, will stipulate an annual maintenance fee due to **ODOT** from the private entity.

Ongoing electrical energy cost payments will be established in the agreement and in accordance with District policy.

401-7.2 Signalized Intersection Types and Costs

These signalized intersections may take a number of scenarios, of which the following describes the most common:

1. Private Drive only ("T" Intersection)
2. Private Drive across from Private Drive
3. Private Drive across from Public Road (not warranting signalization)
4. Private Drive across from Public Road (warrants signalization, but agency choosing not to signalize)
5. Private Drive across from Public Road (warranted and approved for signalization)

If another scenario arises that is not covered herein, the **District** should consult with the **Office of Traffic Operations**.

Responsibility of costs associated with each scenario above:
1. All costs assumed by Private Entity(s). Maintenance Agreement(s) required.
2. All costs assumed by Private Entity(s). Maintenance Agreement(s) required.
3. All costs assumed by Private Entity(s). Maintenance Agreement(s) required.
4. Design and Construction costs by Private Entity. Maintenance costs covered by ODOT. No Maintenance Agreement required. Right-of-Entry Agreement may be necessary.
5. All costs assumed by **ODOT**. No Maintenance agreement. Right-of-Entry Agreement may be necessary.

In each of these scenarios the private drive can be warranted or unwarranted for signalization.

In all cases, if **ODOT** is requiring the signal due to **ODOT** concerns (e.g.: safety countermeasure), all costs are assumed by ODOT. No maintenance agreement is required, but a Right-of-Entry Agreement may be necessary. If additional features (e.g.: turn phases, additional lane on driveway) above and beyond the **ODOT** requirements are requested by the private entity (and approved by **ODOT**), the installation costs shall be borne by the private entity.

401-7.3 Signal Reconstruction

If an ODOT project (e.g.: widening) requires replacement of a signal or its components, all costs to do so shall be the responsibility of **ODOT**.

If signal or component replacement, repair or modification is required due to private entity actions (e.g.: widening, pavement milling, relocating drive, expansion of property, significant increase in traffic generation), these costs shall be the responsibility of the private entity.

If a signal must be replaced due to age and/or deterioration of its components, all costs shall be the responsibility of ODOT.

401-7.4 Signal Maintenance Agreements

There are two types of agreements which may be necessary:

1. A Maintenance Agreement is used if fees will be required of the private entity,
2. A Right-of-Entry Agreement is used if signal appurtenances are located on the private property and require access by **ODOT** to maintain. The Right-of-Entry agreement may be part of the maintenance agreement or may stand alone.

Only standard agreements approved by the **ODOT Chief Legal Office** should be used. Standard Agreements are provided on the network O:\Traffic\Signals\Agreements\Standard Agreements. The README.doc gives a brief description of each agreement and how it should be used.

Where a standard agreement must be modified, it shall be done in consultation with the **Office of Traffic Operations** and must be approved by the **Chief Legal Office**.

Agreements should be updated/amended when:

1. **ODOT** policy changes the terms of the existing agreement (e.g.: change in maintenance fees)
2. Private property changes ownership
3. Warranting conditions change affecting fee distribution (e.g.: formerly non-warranting public street becomes warranting or the classification (major/minor) of the generator changes.)

Agreements shall be memorialized in the "Miscellaneous Book" at the counties Record's Office. The district office responsible for creating the signal agreements will work with the district **Real Estate Office** to have the agreement recorded. Any costs for recording the Agreement should be paid for by the **District**. When required, the **District** and developer or local agency must sign and notarize the agreement prior to the agreement being recorded.

401-7.5 Agreement Distribution List

The original signed copy of the agreement will be filed by the creator with color scanned PDF format copy sent to the **District Auditor**/**Finance Office** and a scanned or paper copy to the district's signal maintenance file.

401-7.6 Maintenance Agreement Fees

The current annual maintenance fee is $3000 per Stop-and-Go intersection that involves a private entity.

Fees for Stop-and-Go traffic signals at opposing private drives are as follows:
Single Major Generator = $3000
Major Generator and Major Generator = $1500 / $1500

Major Generator and Minor Generator = $2250 / $750

A major generator is a private entity that generates sufficient traffic to warrant a Stop and Go traffic signal. A minor generator is a private entity that does not generates sufficient traffic to warrant a Stop and Go traffic signal

If the classification of a generator changes (minor to major or major to minor) or a generator is added to the intersection, any existing signal agreements should be updated accordingly.

401-7.7 Collection of Maintenance Agreement Fees

Annual maintenance fees shall be invoiced each January in advance of the year which maintenance is to be provided by the **District** in which the signal is located.

There will be situations where the **District** cannot collect the fees required by the agreement. This can be for any number of reasons including, but not limited to, the Private Entity cannot make or refuses to pay the required maintenance fees or the Owner of the property cannot be located. The **District** should make every attempt to locate the property owners and verify that they have not relocated or changed ownership. **Districts** should adhere to the following plan on delinquent invoices (providing **Central Office Finance** will all correspondence):

30 Days delinquent:	Follow up letter and/or email sent to the Private Entity
60 Days delinquent:	2nd follow up letter and/or email sent to the Private Entity
90 Days delinquent:	Phone call or personal visit to the Site
120 Days delinquent:	Conference call with central Office Finance on status

During the follow up process if payment is still not satisfied (120 Days delinquent), the **District** will install a SIGNAL UNDER STUDY FOR REMOVAL (W24-H2b) sign. At the conclusion of the study the signal should be removed if it does not create an unsafe condition to the general motoring public. Should at the **District's** discretion, the removal of the signal creates an unsafe condition to the general motoring public, **District Finance** will notify **Central Office Finance** and the balance of the invoice will be sent to the **Ohio Attorney General's Office** for further collections. **Central Office Finance** will act as **ODOT's** intermediary with the **AG's Office**. Once an invoice is sent to the **AG's Office** for collection, it shall not be counted against a **District** for QAR requirements. The **District** will continue to maintain the signal(s) in question until such a time that a decision is made to remove the signal or a resolution is provided by the **AG's Office**. Any action taken with the signal or a delinquent invoice will involve **District Finance, Central Office Finance** and the **Office of Traffic Operations**.

If the following year, a signal maintenance agreement invoice needs to be created for an invoice that is currently outstanding at the **AG's Office** from previous years, the process will start over again as a new invoice.

401-7.8 Property Transfer without Agreement

The new property owner will be sent a new agreement to sign. After the new agreement is signed an invoice will be sent to the owner for the prorated maintenance fee per the agreement. A letter should also be sent and include items similar to the following.

Located at the ingress and egress at the above location there is an existing traffic signal that was installed through a previous signal agreement with the **State of Ohio**. According to **State Law**, the **Ohio Department of Transportation** cannot install or maintain traffic signals on public, **State** and US routes to private driveways unless an agreement is entered into by both parties.

The agreement is a standard agreement developed by the **Departments Chief Legal Counsel** that cannot be modified. This agreement must be signed and returned to this office along with the proper payment no later than 30 days from receipt of this letter.

Failure to return the signed signal agreement and payment may result in the **District** performing a traffic engineering study of the subject location which could lead to the removal of the existing traffic signal.

401-7.9 Removal of Signal / Termination of Agreement

If failure to receive payment either due to refusal or inability to pay by the private entity or inability to locate the private entity by the **District** the following options should be pursued:

Notify the private entity(s) of pending signal (or signal phase) removal by letter with copies to all property tenants 30 days in advance of any removal action.

Post SIGNAL UNDER STUDY FOR REMOVAL signs (only if complete signal is proposed for removal) for two weeks with the signal in Stop-and-Go operation. Portable Changeable Message Signs (PCMS) may also be utilized.

Place signal on flash and follow signal removal process.

401-8 Open Architecture Traffic Signal Controllers

An open architecture traffic signal controller is a general purpose computer that is adapted for traffic signal control with software and input/output connections. An example of this type of traffic signal controller is the Model 2070. The software can be purchased separately from the controller and installed by the user. In certain instances, this can result in an agency using only one brand of software but obtaining competitive bids on the hardware.

ODOT has software licenses for 2070 controllers for any **District** to use. The licenses include local controller, master controller and personal computer interface software. The Model 2070 controller can be used with **NEMA** TS-1, **NEMA** TS-2 or **Caltrans** 332/336 cabinets.

401-9 Americans with Disabilities Act (ADA) Requirements

The **ADA** requirements are issued and regulated by the **US Justice Department**.
Generally, there are four major **ADA** requirements that effect traffic signal projects:

1. Accessible pedestrian signals;

2. Audible pedestrian pushbuttons (locator tones);

3. Curb ramps;

4. Truncated domes (tactile bumps on the curb ramp).

See ***Sections 404-3 and 440-8*** for details on these requirements. Web addresses for **ADA Accessibility Guidelines** information are shown in ***Table 197-1***.

401-10 Special or Off-Duty Law Enforcement Officer Operation of ODOT Traffic Signal Procedures

Before a special or off-duty law enforcement officer (LEO) can operate an **ODOT** traffic control signal, authorization shall be obtained from **ODOT**.

Applications for permission to operate an **ODOT** traffic control signal ***(Form 496-14)*** by a special or off-duty LEO shall be submitted to the **District Deputy Director** a minimum of 21 days prior to the event for which the permit is being requested. If it is determined that the operation is acceptable, a permit for the operation of the traffic control signal shall be issued ***(Form 496-15)***.

Application shall be made by the private employer hiring the special or off-duty LEO. Application by the special or off-duty LEO is unacceptable.

The operation of the traffic control signal by the special or off-duty LEO shall conform to the **Ohio Manual of Traffic Control Devices (OMUTCD)**.

Examples of events requiring a permit are church services, football or basketball games, midnight madness sales, farm science reviews and county fairs.

402 TRAFFIC CONTROL SIGNAL NEEDS STUDIES

402-1 General

All new or reconstructed signalized intersections shall be warranted based on **OMUTCD Chapter 4C**; however, for roadway projects that have a minor impact on the existing signals, signal warrants may not be necessary. An example is a pavement planing and resurfacing project which will destroy and replace loop detectors.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

An engineering study, performed by a firm prequalified by ODOT for signal design, if approved by the ODOT District, may be used to justifiy a new signal installation or retention of an existing signal that otherwise does not meet the published warrants. An example of such an instance is a traffic signal in proximity to a railroad crossing that serves to reduce queuing across the tracks.

Considerations such as geometrics and lack of sight distance generally have not been accepted in lieu of satisfying signal warrants. These considerations may allow an otherwise unwarranted traffic signal to be retained at 100 percent local cost.

402-2 Traffic Volumes

In addition to proper signal warrant analysis, good signal design requires recent volume data. Therefore, for existing intersections, actual turning movement counts should be used for signal warranting purposes. The traffic counts shall not be over three years old and should, at a minimum, include the 8 hours that contain the greatest percentage of daily traffic. ***Form 496-18*** provides an example of a chart used to display vehicular and pedestrian volumes.

If the actual turning movement counts fail to satisfy a signal warrant, it may be acceptable to use traffic volumes projected to the second year after project completion. The **Modeling and Forecasting Section** should provide the projected traffic volumes. Twenty-year design ADT or DHV (Design Hourly Volumes) shall not be used for signal warrants, rather the ADT volume 2 years after opening shall be interpolated between the opening year and design year forecasts provided by the **Modeling and Forecasting Section**, and the percentage of traffic occurring in the 8th highest hour, as obtained from the traffic count, shall be applied to ADT to obtain the forecast hourly volume for warrant analysis.

When actual side street volumes do not exist, such as at a proposed development or new road, an eighth highest hour factor may be used with the projected ADT for warrant purposes. This factor is obtained from the **Modeling and Forecasting Section** along with the ADT traffic projection , and usually ranges from 0.054 to 0.058 of the ADT. This request should be accompanied by a 24-hour machine count at the proposed intersection location, as well as any TIS or other studies conducted for proposed developments. Hourly distribution factors should not be used to develop 8 hours of warrant data from the ADT as hourly distribution factors vary greatly depending on the type of development surrounding an intersection.

Consideration should be given to operating a signal, which was warranted based on projected traffic, as a flasher until actual traffic volumes satisfy signal warrants and make signalization appropriate.

402-3 Signal Warrant Practices and Procedures

402-3.1 General

As noted above, the warrants used to evaluate the need for a traffic control signal at a particular location are described in **OMUTCD Chapter 4C**.

PC Warrants should be used for all **ODOT** Signal Warrant analysis.

402-3.2 Warrants 1, 2 and 3 (Volumes)

For determining the number of approach lanes, a short left-turn lane is not usually considered an approach lane **(OMUTCD Chapter 4C)**. Usually, the number of approach lanes refers to through lanes. An exception might be where a through lane develops into an exclusive turn lane or high-turning volumes require double turning lanes.

For new **ODOT** signals, Warrants 1, 2 and 3 shall be based on the 100 percent values (**OMUTCD Chapter 4C**) and right-turn reduction factors except in the following circumstance. If there are five or more crashes that can be corrected with the addition of a signal, and the speed exceeds 40 miles per hour on the major street, Warrants 1, 2 and 3 may be based on the 70 percent values combined with engineering judgment and right-turn reduction factors.

For retention of existing **ODOT** Signals, Warrants 1, 2 and 3 can be based on the 70 percent values **(OMUTCD Chapter 4C)** and engineering judgment, regardless of the speed on the major street and regardless of proximity to an isolated community with a populations of less than 10,000.

Signal warrants for local projects using State or Federal funding shall be included in the above criteria.

All **ODOT**-maintained signals warranted based on the 70 percent values **(OMUTCD Chapter 4)** shall require the approval of **OTO**.

Signals installed under Warrant 3 should be traffic-actuated.

402-3.3 Warrant 4 (Pedestrian Volume)

Intersections approved under this warrant shall utilize pedestrian signal heads. Signals based only on Warrant 4 or Warrant 5 should also control the minor street or driveway.

If installed at a non-intersection crossing the traffic control signal shall be pedestrian-actuated.

402-3.4 Warrant 5 (School Crossings)

Intersections approved under this warrant shall utilize pedestrian signal heads. Signals based only on Warrant 4 or Warrant 5 should also control the minor street or driveway.

The designer shall show that the intersection is used as a school crossing. This may include:

1. School route plan developed by the school system.
2. Count of pedestrians during the study period. **OMUTCD Section 4C.06** requires a minimum of 20 students during the highest crossing hour.
3. Presence of school crossing guards.
4. Map showing the location of the school relative to the intersection.

In order to show that there is less than one acceptable gap per minute, the designer shall present the following:

1. Street crossing time based on width and crossing speed.
2. The number of gaps in the traffic stream that exceed the minimum crossing time during the study period. These gaps may be measured in the field or approximated using two different equations to find the probability of a gap greater than the crossing time.

   t = required gap time (seconds) where

t=3 seconds + [Width of crossing (ft) ÷ 3.5 (ft./sec.)]
T = length of time period for which the volume V applies (seconds)
V = two way vehicular volume across the crossing path in time period T
e = base of the natural system of logarithms, having an approximate value of 2.718

The expected number of gaps per T which are equal to or greater than t will be:

$Ve^{-Vt/T}$

The expected number of t-second intervals per T which are free of cars will be:
$(T/t)e^{-Vt/T}$

402-3.5 Warrant 6 (Coordinated Signal System)

Warrant 6 shall not be used as the sole warrant in an ODOT signal warrant analysis.

402-3.6 Warrant 7 (Crash Experience)

Warrant 7 should only be used to warrant a signal if the 70 percent volume warrants are met.

Any traffic signal installed solely on this warrant should be semi-traffic-actuated with control devices which provide proper coordination if installed at an intersection within a coordinated system and normally should be fully traffic-actuated if installed at an isolated intersection.

The following types of accidents are susceptible to correction by traffic signal control:

1. Those involving substantially right-angle collisions or conflicts, such as occur between vehicles on intersecting streets.

2. Those involving conflicts between straight-moving vehicles and crossing pedestrians.

3. Those between straight-moving and left-turning vehicles approaching from opposite directions, if an independent time interval is allowed during the signal cycle for the left-turn movement.

4. Those involving excessive speed, in cases where signal coordination will restrict speed to a reasonable rate.

Traffic control signals cannot be expected to reduce the following types of accidents:

1. Rear-end collisions, which often increase after signalization.

2. Accidents involving pedestrians and turning vehicles when both move during the same interval.

3. Other types of pedestrian accidents, if pedestrians or drivers do not obey the signals.

4. Collisions between vehicles proceeding in the same or opposite directions, one of which makes a turn across the path of the other. This is particularly true if no independent signal interval is provided for these turn movements.

402-3.7 Warrant 8 (Roadway Network)

Warrant 8 shall not be used as the sole warrant in a **ODOT** signal warrant analysis.

402-3.8 Warrant 9 (Intersection Near Highway-Rail Grade Crossing)

The purpose of Warrant 9 is to provide a warrant for a traffic signal where a highway-rail grade crossing is in close proximity to an intersection and a traffic signal is not warranted under any of the other traffic signal warrants. This is especially beneficial where the clear storage distance (see ***Part 8)*** is less than a design vehicle length and gaps are infrequent on the road parallel to the track(s).

Signals installed based on Warrant 9 shall have minor street actuation, train preemption, and flashing-light grade crossing signals, and should also have automatic gates.

402-4 Unwarranted Existing Signalized Intersections

Every effort should be made to encourage removal of an existing unwarranted signal installation. The designer should realize that all existing unwarranted signals cannot always be removed, most often because of public or political pressures on the maintaining agency. If the removal of signals and the placement of STOP signs is agreed to, the work should be at normal project participation.

If the local agency insists that a large number of unwarranted signals be retained, the **State** should reevaluate if the project should continue. Reasons for retention of existing unwarranted signals shall be documented.

If an existing unwarranted signalized intersection is retained, the following applies:

1. All work and equipment at the intersection shall be at 100 percent local cost. Written confirmation is required from the local agency.

2. If within a system, signal control equipment shall be upgraded to be compatible with the system (same manufacturer for all controller software).

3. If within an area approved for special design considerations (such as mast arms, aesthetically designed poles, etc.), the unwarranted intersection shall be upgraded to these standards.

4. If it is not necessary to upgrade equipment except for the controller, the existing intersection signals, signs and pavement markings shall be in conformance with the **OMUTCD**. Deficiencies may be corrected by the project (at 100 percent local cost) or by the local maintaining agency. The intersection shall conform to the **OMUTCD** by the final inspection of the construction project.

402-5 Removing Right-Turn Vehicles from Signal Warrant Analysis

At intersections under **ODOT's** jurisdiction, the following procedure should be used to determine how much, if any, right-turning traffic from the minor street to remove from the signal warrant analysis. This does not apply to traffic signal warrant analyses on state route extensions in villages or on projects within local jurisdictions that require **ODOT** oversight.

From the “Minor Street Analysis Parameters” ***(see Tables 497-7 and 497-8)*** select the closest minor-leg lane configuration. Enter the configuration number under the MINOR STREET column on the “Right Turn Factorization Sheet” ***(see Forms 496-12 and 496-13)***. If both minor legs are being studied and have different configurations, include both and note next to the hour which leg or direction is being selected.

Note the number of lanes on the critical mainline approach. The critical mainline approach is the major-street leg whose through movement is in conflict with the right turn from the minor leg. Turn lanes on the major street are not usually considered a lane in this instance because a turn lane on the major route does not conflict with a right-turning vehicle from the minor leg.

Calculate the Critical Mainline Approach Volume per Lane. This is the hourly through volume of the critical mainline approach divided by the number of through lanes on the approach plus the hourly right-turning volume if it is not served by an exclusive right-turn lane on the mainline. Record this number in the Mainline Approach Volume per Lane column on the “Right Turn Factorization Sheet.”

Determine the Base Right Turn Reduction Percentage or Base Reduction. After determining which lane configuration best represents the leg that is being studied and based on the movements for each hour, calculate the percent reduction “R” or Base Reduction for each hour and record in the Base Reduction column on the “Right Turn Factorization Sheet.” Transfer this same number to the Base Right-Turn Reduction % column on the same sheet.

Calculate the Mainline Congestion Factor. This is a reduction of the Base Right-Turn Reduction. Its purpose is to allow for the vehicles which are unable to turn right during exceedingly high volume on the major street. This reduction is five percent for mainline approach volumes of 400 vehicles per hour per lane and is increased by five percent for every 100 vehicles per hour per lane. The Mainline Congestion Factors for Limiting Right-Turn Reductions are shown at the bottom of the “Minor Street Analysis Parameters” sheet. Select the appropriate reduction based on the mainline volume per lane and record the reduction in the Mainline Congestion Factor % column on the “Right Turn Factorization Sheet.”

Calculate the Adjusted Right-Turn Reduction. This is the Base Right-Turn Reduction minus the Mainline Congestion Factor. If less than 0, then the Adjusted Right-Turn Reduction equals 0%.

Record this number in the Adjusted Right-Turn Reduction % column for each hour.

Calculate the Adjusted Right Turns. This is (1 - % Adjusted Right-Turn Reduction) multiplied by the Right-Turn Volume from the selected minor leg. Record this number in the Adjusted Right Turns column.

Determine the new Adjusted Minor-Street Volume by adding the Adjusted Right Turns to the through and left-turn volumes for each hour. Record this number in Adjusted Minor-Street Volumes column on the “Right Turn Factorization Sheet” for each hour. This number shall be used in the signal warrant analysis.

Intentionally blank

403 TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION

403-1 General

OMUTCD Chapter 4D presents information on the design, location and use of traffic control signals. Construction details are shown on **Traffic SCDs TC-81.10 through TC-85.22**. Traffic signal equipment is specified in **C&MS Items 632 and 633**, and **C&MS 732 and 733**.

As noted in ***TEM Section 420-4.10***, dual-arrow signal sections shall not be used on **ODOT**-maintained highways.

403-2 Yellow Change and Red Clearance Intervals

The vehicle change interval (or phase change interval) described in **OMUTCD Section 4D** consists of the yellow change interval and the red clearance interval. A yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication. The function of the yellow change interval (Y) is to warn traffic of an impending change in the right-of-way assignment. For **ODOT**-maintained signals, the yellow change interval should be followed by a red clearance interval (AR) of sufficient duration to permit traffic to clear the intersection before conflicting traffic movements are released. The durations of the yellow change interval and the red clearance interval shall be predetermined.

The length of the phase change interval can be determined using the following equations:

$$Y = t + \frac{1.47Vy}{2a + 64.4g}$$

$$R = \frac{W + L}{1.47V_R} - 1$$

Y = yellow change interval (s)

R = red clearance interval (s)

t = perception/reaction time of driver (s) [typically 1s]

a = deceleration rate (ft/s^2) [typically 10 ft/s^2]

Vy = approach speed (mph); yellow change interval (see tables below)

V_R = approach speed (mph), all red interval (see tables below)

g = approach grade
average of approaching 400 feet using 100 ft increments (percent of grade divided by 100; negative for downgrade)

W = width of intersection (ft)
measured from the approach movement stop-bar to the far side of the intersection as defined by the extension of curb line, outside edge of the farthest travel lane, or the far side of the pedestrian cross-walk *

L = length of vehicle (ft) [typically 20 ft]

* A pedestrian crossing equipped with pedestrian signals on a receiving lane should not be considered unless the nearest crossing line is 40 feet or more from the extension of the farthest edge of the farthest conflicting traffic lane. If this condition exists, the intersection width should be measured from the back/upstream edge of the approaching movement stop line to the nearest pedestrian crossing lane.

Yellow change intervals should be between three and six seconds. Red clearance intervals should be between one and six seconds. Clearance intervals should be rounded to the nearest tenth of a second. See below for guidance if the maintaining agency has a rounding preference to the nearest whole or half second.

Yellow change interval approach speeds:

Movement	Speed study available	Speed study not available
Through	85th percentile speed	Posted speed limit + 7 mph
Left Turn	85th percentile speed	Posted speed limit – 5 mph

Red clearance interval approach speeds:

Movement	Speed study available	Speed study not available
Through	85th percentile speed	Posted speed limit + 7 mph
Left Turn	85th percentile speed of vehicles executing the left turn movement	25 mph

If engineering judgement determines that the approach speeds defined above are not representative of real world conditions, alternate speeds may be used in the yellow change and red clearance interval equations.

For opposing approaches with differing speed limits or 85th percentile speeds, use the higher speed approach to evaluate clearance intervals. Make the yellow and all red clearance intervals the same for all phases that may terminate concurrently to ensure the clearance intervals end at exactly the same time for both movements.

Modern digital traffic controllers are capable of programming values to one-tenth of a second (0.1s) for any interval; therefore, the timings for the yellow change and red clearance intervals can be calculated in tenths of a second. Using the equations to calculate the yellow change and red clearance interval durations, the resulting values should be rounded to the nearest 0.1 seconds. Values ending in 0.01 to 0.04 should be rounded down to the nearest tenth of a second whereas values ending in 0.05 to 0.09 should be rounded up to the nearest tenth of a second.

If an existing agency policy rounds these values to the nearest half-second (0.5s), then the following methodology is suggested:

- Values ending in 0.0 to 0.1 should be rounded down to the nearest whole number;
- Values ending in 0.2, 0.3, and 0.4 should be rounded up to the half-second;
- Values ending in 0.6 should be rounded down to the half-second; and
- Values ending in 0.7, 0.8, and 0.9 should be rounded up to the nearest whole number.

403-3 Flashing Operation of Traffic Control Signals

OMUTCD Sections 4D.11 and 4D.12 list requirements for flashing operations. When an ODOT-owned stop-and-go traffic signal is in flashing operation, red indications shall be used for all approaches. The **Office of Traffic Operations (OTO)** may approve special cases in which yellow indications can be used for major street approaches and red indications for all others.

ODOT-owned stop-and-go traffic signals shall not be placed in flash during off-peak hours.

403-4 Approach Monitoring

All **ODOT**-maintained traffic signals shall be designed to use an approach monitoring concept.

Approach monitoring makes use of the dual indication monitoring capabilities of the **NEMA** plus or

NEMA extended monitor. The approach monitoring concept will not function if the "plus" features in the monitor are disabled or not available. Intersections designed for approach monitoring permit the "plus" monitor to detect total loss of a signal color indication on an approach basis rather than a per phase basis. With approach monitoring, the loss of all green, yellow or red indications on an approach place the intersection into flash. **ODOT's** primary intent however is to catch the red out.

To detect a "no load" signal condition, a basic signal design is necessary. The approach monitoring design requires each approach to be wired separately. Each has its own load switch and its own monitor channel. The final equipment requirement is a **NEMA** plus monitor programmed to accommodate the approach monitor design.

403-5 Traffic Law Photo Monitoring, Automated Traffic Enforcement and Surveillance Devices

Senate Bill No. 342 (130th General Assembly), effective March 23, 2015, imposed certain conditions and responsibilities on local authorities who choose to use traffic law photo monitoring devices. ***Section 201-14*** addresses the local authority's duties, which include assuring that the yellow change interval exceeds by 1 second the yellow change interval determined in accordance with ***Section 403-2***.

As noted in ***Section 201-14***, no traffic law photo-monitoring, automated enforcement or surveillance device (including, but not limited to, red light cameras, speed cameras, license plate reader (LPRs) and electronic surveillance devices) shall be installed at any intersection or on any highway maintained by **ODOT**.

403-6 Emergency-Vehicle Preemption Control Systems

403-6.1 General

As noted in **OMUTCD Section 4D.27**, preemption systems are used to give certain vehicles control over traffic signals. These systems use devices located on an approaching vehicle to preempt the normal operation of signalized intersections. This Section provides a consistent method for funding traffic control signal preemption systems if needed.

Over the years, several methods of providing priority control of traffic signals have been developed. The first method, which is not covered by this Section, involves a hard-wired signal system. For example, personnel in the fire station can activate one or more circuits by pushbutton to preempt a series of signalized intersections. This system is usually not proprietary and is localized to the main arterial intersections near the fire station.

The intent of this Section is to cover a second method of priority control which involves equipping the vehicle with a preemption emitter and equipping the signalized intersection with preemption receivers. These systems tend to use proprietary equipment, and once a local governmental agency installs the equipment, the agency is restricted to the same brand and type of preemption equipment in order to have emitters and receivers work together.

Vehicle-activated systems can use light (optics), sound or radio signals (includes GPS systems) to activate a receiver at the intersection. Optical and sound-activated systems are extensively used in **Ohio**. The optical system uses a strobe-type light emitter mounted on the vehicle and sound-activated systems use the siren from the vehicle. Each system has benefits inherent in the type of signal used.

The decision to install and maintain a preemption control system shall be made by the maintaining agency. The cost for the installation and maintenance of a preemption control system at **ODOT** signals shall be assumed by the requesting agency.

403-6.2 Procedures

For new preemption systems, **ODOT** will participate at the normal project participation rate in the acquisition and installation of a generic preemption system as determined by the lowest contract bid price. In addition to obtaining generic bids, a local governmental agency may request alternate bids if they desire a specific brand of preemption equipment and agree to pay any extra cost above the generic bid price. A Plan Note specifying three different preemption systems by manufacturer and model is equivalent to a generic bid item.

When a municipality adds intersections to its existing preempt system, it can obtain the same type of equipment by either the use of alternate bids or, if justified, proprietary bids.

For proprietary bids to be considered justified, the existing preempt system must control an appreciable part of the municipality's intersections before it can be considered to represent the municipality's standard. As a measure of this standard, the existing system must constitute at least fifty percent of the signalized intersections of a municipality. If this test is met, a proprietary bid requested by the municipality will be given consideration. Otherwise, alternate bids may be used to limit **State** and **Federal** participation to the generic system costs.

403-6.3 Preemption Emitters

The quantity of vehicle hardware provided with the system shall be as determined by the municipality, but should not exceed three emitters for each signalized intersection which will be equipped with preemption as a part of the project. Only fire, emergency medical, police and transit vehicles are eligible to be equipped. If alternate bids are used and the desired system utilizes vehicle-mounted emitters, the cost of this hardware shall be included in the alternate bid cost for comparison to the generic bids.

403-6.4 Local Maintaining Agency Policies

As a requirement for inclusion of vehicle preemption equipment in the contract, the local governmental agency shall have policies for the use of preemption. For safety forces, the policies shall specify the types of emergency calls for which preemption may be employed and shall define any use of preemption when lights and sirens are not simultaneously employed. For transit vehicles, the policies shall define when and under what conditions the preemption may be employed.

When possible, municipalities are strongly encouraged to develop signal preemption policies which coordinate with surrounding **City**, **County** and **Township** forces. They should take into account mutual aid agreements, access to hospitals and transit where a vehicle operates outside of its normal jurisdiction.

403-7 Flashing Yellow Arrow (FYA) Operation

The **OMUTCD Section 4D.18** permits the use of a flashing yellow arrow (FYA) indication on applicable protected/permissive left-turn phases. However, the FYA indication shall not be used with traffic control signals on **ODOT**-maintained highways until such time as design and traffic signal cabinet standards approved by the **Offices of Roadway Engineering (ORE) and Traffic Operations (OTO)** have been developed and tested, and educational materials on the intended use of this new signal indication have been made available to the public.

Once the cabinet standards have been developed and tested, permission for pilot installation of the FYA may only be granted by **OTO** on a case-by-case basis to monitor and determine any crash and safety benefits. An education campaign shall be part of any project introducing this device in an area, and as noted in **OMUTCD Section 4D.18**, the LEFT TURN YIELD ON FLASHING YELLOW ARROW (R10-H12c) sign shall be used with the FYA for at least five years (see **OMUTCD Figure 4D-7**).

403-8 SIGNAL OPERATION CHANGED Sign (W23-H2a, W23-H2b)

Concurrent with the actuation of any new signal operation which alters the sequence of the signal displays from the existing operation, a SIGNAL OPERATION CHANGED sign (W23-H2a or W23-H2b) shall be installed. The signs shall be displayed for a minimum of fourteen days and a maximum of thirty days.

The W23-H2a sign shall be installed on all approaches to an intersection and the W23-H2b sign shall be installed on the span wire or mast arm adjacent to the signal heads.

The following are examples of signal operation modifications which would normally warrant installation of the sign:

1. Installation of a protected left turn
2. Switching from a lead to lagging left turn (or vice versa).
3. Installation of a split phase where two directions used to run together or removal of a split phase where two directions used to run separately.

The following are examples of signal operation modifications which normally do not warrant installation of the sign:

1. Installation of a NO TURN ON RED sign.
2. Actuated phase being set to min (max) recall due to detector malfunction. Any deviation shall be made only with approval from the **Office of Traffic Operations (OTO).**

403-9 <u>Yellow Trap</u>

Yellow Trap is a term used to describe a condition which occurs during certain yellow change intervals. During a Yellow Trap event, drivers facing a CIRCULAR YELLOW signal indication are mistakenly led to complete their movement in order to clear the intersection by the display of the CIRCULAR YELLOW signal indication. What they fail to realize is that opposing motor vehicles are facing a CIRCULAR GREEN signal indication and not a CIRCULAR YELLOW signal indication. This condition can occur under the following conditions:

1. When Protected/Permissive Left-Turn Signal Face Displays are used and the sequence is changing from a concurrent through movement to a through and left-turn movement in the same direction of travel (lagging left turn).

2. During a transition into preemption, with or without Protected/Permissive Left-Turn Signal Face Displays and the sequence is changing from a concurrent through movement to a through and left-turn movement in the same direction of travel (lagging left turn).

Depending on the nature of the yellow trap condition, it may be necessary to address the condition in order to implement the desired signal sequence. The following are examples of methods which may be used to resolve the yellow trap condition:

1. Left-turn signal face displays on an approach to the intersection where yellow trap occurs can be changed to Protected Only displays.

2. Opposing movements may be reconfigured to provide exclusive or “split” phase sequencing.

3. During a transition into preemption, the controller sequence may be designed such that both directions of travel transition to red before the display of a green indication on a single approach. This ensures that there is a simultaneous display of CIRCULAR YELLOW on both approaches prior to the display of green on a single approach.

The use of W25-1 and W25-2 signs (ONCOMING TRAFFIC HAS EXTENDED GREEN and ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN, respectively) are not recommended by **ODOT** to resolve a yellow trap condition.

The signal plans shall contain plan notes to omit calls to protected/permitted left-turn phases as necessary to resolve yellow trap conditions. The traffic signal controller programming shall incorporate this information to resolve yellow trap conditions.

Whenever preemption is provided, careful consideration must be given to the design of the signal sequence under all modes to prevent the display of yellow trap.

403-10 Railroad Preemption Control Systems

403-10.1 General

As noted in **OMUTCD Section 4D.27**, railroad preemption systems are used to give trains (both heavy and light rail) control over traffic signal operation. These systems use an interconnection between the railroad control system and the traffic signal controller to preempt the normal operation of signalized intersections. ***TEM Part 8*** provides detailed information regarding railroad preemption, standardized terminology and associated design requirements. This Section addresses minimum functional requirements for traffic signal control equipment to provide the proper operation required for railroad preemption.

Traditional railroad preemption interconnection relied on a single pair of wires which were normally closed through a relay in the railroad signal control equipment to provide a failsafe mode of operation. This normally closed circuit is required by **OMUTCD Section 8C.09**. If the connection between the wires was opened, the railroad preemption sequence in the traffic signal controller was initiated.

In recent years, much research has been conducted to further understand the operational needs transitioning into and during the railroad preemption sequence as well as the functioning of the interconnection circuit. The results of this research have led to significant changes in the **TEM** to implement new technology to further enhance safety at signalized intersections adjacent to railroad grade crossings.

ODOT has developed a required practice for the design and functionality of the railroad interconnection. This practice is contained in ***TEM Part 8***. It provides information on both the traffic signal controller interface and the railroad warning system interface ***(see Section 804-4)***. There is also a requirement for an indicator panel to verify that the railroad circuitry is activating the interface at the traffic signal controller cabinet.

403-10.2 Controller Functionality

In order to properly implement railroad preemption operation, additional requirements have been developed for the operation of railroad preemption in the controller unit. The functionality has been divided into a basic set of requirements and an enhanced set of requirements. All new controller units which are to be interconnected with a railroad warning system must provide the following basic operational features:

1. Per unit setting for alternate minimum green interval during entry into any railroad preemption sequence.

2. Per unit setting for alternate pedestrian walk interval during entry into any railroad preemption sequence.

3. Per unit setting for alternate pedestrian change interval during entry into any railroad preemption sequence.

4. Two independent railroad preemption sequences.

5. Three programmable sequence steps. The first step may be programmed to create an all red state for resolution of yellow trap. The first step is followed by up to two track clearance

green intervals per preemption sequence with an individual setting for minimum track clearance green for each interval. Each track clearance green interval shall be programmable for no phases (all red), a single phase, or a pair of non-conflicting phases. Each overlap shall be capable of being forced to red or green during each track clearance green interval. The gate down control input shall hold the second (final) track clearance green interval.

6. Ability to program railroad dwell interval as all red (no phase(s)), any phase or pair of non-conflicting phases or to provide limited sequence of programmed or permitted phases.

7. Ability to inhibit pedestrian movements per phase during railroad dwell interval.

8. In the event the controller unit is operating under manual control and either railroad preemption input goes false, the manual control shall be inhibited and the railroad sequence shall govern. Once the railroad preemption input goes true and the manual control input is active, manual control shall be restored.

9. A maximum preemption timer shall be provided for each preemption sequence. This timer shall have a minimum range of 0 to 10 minutes with a maximum 1 minute resolution. This timer shall begin to time whenever the railroad preemption input goes false. This timer is reset whenever the railroad preemption input returns to a true state. If the maximum railroad preemption expires and the railroad preemption input is still false, the controller unit shall exit the dwell sequence and transition to soft all-red flash. If the railroad preemption input returns to a true state after the controller unit has entered the flash state, the controller unit shall exit the all red flash state via a programmable steady all red period followed by the startup phase(s).

10. The following inputs shall be provided for railroad preemption:
    a. Railroad Preemption Sequence #1 Activation – This input is normally true with no train present. It is false whenever railroad preemption sequence #1 is in effect.

    b. Railroad Preemption Sequence #1 Supervision - This input is normally false with no train present. It is true whenever railroad preemption sequence #1 is in effect.

    These two inputs shall both change state whenever the railroad preemption sequence becomes active. If the two inputs are ever both true and both false at the same time, a railroad preemption error shall be logged and the controller unit should transition the signal display to soft all-red flash. The controller unit should exit the soft all-red flash state via a normal start-up sequence whenever the railroad preemption inputs resume a normal state.

    c. Railroad Preemption Sequence #2 Activation – This input is normally true with no train present. It is false whenever railroad preemption sequence #2 is in effect.

    d. Railroad Preemption Sequence #2 Supervision - This input is normally false with no train present. It is true whenever railroad preemption sequence #2 is in effect.

    These two inputs shall both change state whenever the railroad preemption sequence becomes active. If the two inputs are ever both true or both false at the same time, a railroad preemption error shall be logged and the controller unit should transition the signal display to soft all-red flash. The controller unit should exit the soft all-red flash state via a normal start-up sequence whenever the railroad preemption inputs resume a normal state.

    e. Railroad Preemption Sequence #1 Gate Down – This input is normally false with no train present. It is true whenever railroad preemption sequence #1 is in effect and the appropriate railroad gate or gates are down.

    f. Railroad Preemption Sequence #2 Gate Down – This input is normally false with no train present. It is true whenever railroad preemption sequence #1 is in effect and the appropriate railroad gate or gates are down.

i. If a single track clearance interval is used, the controller unit should time the programmed value for the track clearance green interval and then hold in the track clearance green interval.

ii. If two track clearance intervals are used, the controller unit should time the programmed value for the first track clearance green interval and then advance to the second track clearance green interval. The controller unit should time the programmed value for the second track clearance green interval and then hold in the track clearance green interval.

Once the track clearance hold state is reached, the controller unit should not leave until the proper gate down input is received. Once the gate down input is received and the track clearance green interval has completed timing its programmed value, the sequence should advance to the programmed dwell interval. If the gate down input is received prior to completion of the track clearance green interval, the track clearance green interval shall remain active until the timer has completed its programmed period of time.

iii If the sequence has advanced to the dwell interval and the gate down input is lost, the sequence should revert to the track clearance green hold interval until the gate down input is again received.

11. A hardware output for controller unit health shall be provided. This output shall be false whenever the controller unit has detected a fault, is in conflict flash or has a true input for stop timing. This output shall also be set false if the maximum preemption period timer has expired or a communication error is detected.

12. Any controller unit proposed for use on a project where railroad preemption is required shall be furnished to the **ODOT** signal shop for testing prior to acceptance if the controller will be owned or maintained by **ODOT.** (Local agencies may have their controllers delivered directly to the project.)

Controller units required to provide enhanced railroad preemption functionality must provide the following functions in addition to the basic features described above:

1. The controller unit shall have the ability to accept the preemption input and output functions via a serial port utilizing **IEEE** 1570 protocol. **IEEE** 1570 is the standard ITS HRI interface for railroad wayside devices and highway field devices. Information regarding the use and operation of this protocol is available from the **IEEE**. The following functionality is required:

   a. Communication port input for activation of railroad preemption sequence #1.

   b. Communication port input for activation of railroad preemption sequence #2.

   c. Communication port input for activation of the railroad warning system.

   d. Communication port input for railroad preemption sequence #1 gate down control.

   e. Communication port input for railroad preemption sequence #2 gate down control.

   f. Communication port input for railroad island occupancy.

   g. Communication port output for traffic signal health.

2. The following additional controller unit features shall be provided:

   a. Setting for the Maximum RWTT. Whenever the preemption activation input goes false, the controller unit shall calculate the actual RWTT. If the controller unit determines that surplus time is available prior to initiating track clearance, then the preemption sequence shall provide the ability to permit other movements to begin as long as adequate time remains to transition to track clearance green when required.

b. Dynamic RWTT adjustment on train restart. If the railroad warning system active input goes false prior to the completion of RWTT, any remaining alternate minimum green, alternate pedestrian walk or pedestrian change time shall be set to zero. This will assure the beginning of the track clearance green interval following the completion of any remaining green extension time, yellow change and red clearance time.

c. Comprehensive railroad preemption log throughout the railroad preemption sequence. Logging shall include eight controller state changes prior to the activation of the preemption sequence, all state changes throughout the preemption sequence and eight state changes following the completion of the preemption sequence. Each state change shall be logged including date and time (to one second resolution). The log shall include each phase green, yellow and red, each pedestrian walk, pedestrian change and DONT WALK, and each overlap green, yellow and red. In addition, the log shall include the state change of each preemption control input from the railroad.

3. Any controller unit proposed for use on a project where railroad preemption is required shall be furnished to the **ODOT** signal shop for testing prior to acceptance if the controller will be owned or maintained by **ODOT.** (Local agencies may have their controllers delivered directly to the project.)

403-10.3 Cabinet Functionality

In order to properly implement railroad preemption operation, design specifications have been developed which describe both the traffic signal controller cabinet and railroad warning system interconnection ***(see Section 804-4)***.

403-11 Conflict Monitors

403-11.1 General

Modern conflict monitors for traffic signals incorporate many useful features in addition to their basic functions of: 1) looking for incompatible signal display conflicts; 2) monitoring 24V cabinet power supply (using two independent inputs); and 3) monitoring the Controller Watchdog signal (**Caltrans**). Prequalification procedures for conflict monitors used with 2070 controllers are addressed in **Supplement 1076**, testing of conflict monitors on construction projects is addressed in ***Section 450-10***; and maintenance of this device is discussed in ***Sections 460-2 and 460-3***.

Section 403-11 addresses common conflict monitor features that should be enabled by default for each channel, unless specific operating conditions for a traffic signal require them to be disabled. Slight variations of option selection methods can be expected between particular models of conflict monitors, but the the most important features are discussed herein, and should provide guidance for setting features on all monitors.

ODOT uses both **NEMA** and **Caltrans** traffic signal equipment. Recommended settings for conflict monitors for both **Caltrans** 2010ECL Conflict Monitor Units (CMUs) and **NEMA** TS2 Malfunction Management Units (MMUs) are addressed.

As a general rule, **ODOT**-maintained conflict monitors and MMUs shall be set in the “most restrictive” manner, meaning that as many of the available monitoring features as possible are enabled. This assures that the traffic signal operation is monitored for the greatest number of potential fault conditions. The monitor parameters **should not** just be set restrictive enough to "get the signal out of flash." Instead, a conflict monitor should be set up in a very restrictive state as recommended below, and features selectively changed only as directed by the "Engineer," which for purposes of this Section is intended to refer to the **District** traffic engineer responsible for the design and operation of signals.

403-11.2 Settings for a (Caltrans) Model 2010ECL Conflict Monitor

The following are recommended settings for a **Caltrans** Model 2010ECL conflict monitor:

- **Red Fail** – is designed to assure that there is at least one active field input (R, Y, G) on a channel at all times. This feature puts the intersection into flash if all the field terminals on a given channel are dark when they should be lit. An obvious exception is a permissive left turn channel on a five-section head, whose channel has no red signal head. The Red Enable input to the monitor controls the Red Fail operation of all channels. **ODOT**-spec cabinets should be wired to assert the Red Enable input pin to the conflict monitor (by applying 120VAC), which enables the Red Fail feature for all channels that have not had Red Fail individually disabled by other means. In a **Caltrans** 33x cabinet, the Red Enable input is connected to the Load Switch Signal Bus. In this way, the Red Enable input signals to the CMU that the load switches are currently driving the field terminals. Red Fail is generally disabled by the monitor during flashing operation (via the EE input pin).

  There is no on-board 2010ECL monitor switch or jumper setting associated with the Red Enable input to the monitor. The information in the above paragraph is for support only. This pin is generally driven by the cabinet wiring through the red enable cable, so it is essential that the red enable be installed at all times.

- **RFSSM (Red Fail per SSM) DIP Switch should be OFF –** On **Caltrans** monitors (e.g., 2010ECL), this feature is enabled/disabled on a per-channel basis by the SSM switches only if the RFSSM ("Red Fail per SSM") DIP switch is ON. The most restrictive operation occurs when Red Fail monitoring is enabled by default on <u>all</u> channels. **Therefore, the RFSSM DIP switch should be OFF.** When the RFSSM switch is off, channels that do not have a load switch installed must have the corresponding Red Interface Board (RIB) channel jumper set in the "AC+" position.

- **RF (Red Fail) 2010 DIP Switch should be ON –** Timing of the Red Fail condition is affected by the "RF 2010" switch on the CMU (typically switch #1 of SW3). ***The "RF 2010" DIP switch should be set in the ON position.*** This corresponds to the 2010 Standard value of 1350 ms. In the OFF position, the Red Fail time is set to the 210E Standard value of 850 ms. 1350 ms is not the most restrictive setting, but is considered appropriate for **ODOT** signals.

- **Red Fail Monitoring of Pedestrian Displays –** Red Fail monitoring can be used for Pedestrian displays if the Red Interface Board (RIB) jumper for that channel routes the load switch output to the monitor by placing it in the "LS" position. This is the most restrictive condition and should be used unless directed otherwise by the Engineer. The Engineer may determine that putting the entire intersection into flash from a failed Pedestrian DONT WALK display is not desirable. If it is desired NOT to monitor pedestrian displays for Red Fail, then the corresponding RIB jumper should be set to the "AC+" position.
  There is no on-board 2010ECL monitor switch or jumper setting associated with this display, the information in the above paragraph is for support only.

- **G-Y-R Dual Indication –** detects the simultaneous display of more than one active field terminal on the same channel. This function is enabled and disabled on a per-channel basis in **Caltrans** monitors. There is also a related "G-Y Enable" switch (see below). The G-Y-R Dual Indication feature is enabled/disabled on a per-channel basis by the SSM DIP switches. **Therefore, unless directed otherwise by the Engineer, the SSM DIP switch**

should be enabled ("ON") for all channels that display red, yellow and green

- **G-Y Enable** – is a subset of G-Y-R Dual Indication Monitoring applies only to channels for which red monitoring has been disabled. It ignores R-Y and R-G duals. The paragraph above requires the use of per-channel G-Y-R monitoring on any channel that contains a red display, so the state of the G-Y Enable DIP switch is irrelevant in those cases. However, for a channel without a red display (e.g., permissive left turn on a five-section head), having G-Y Enable set causes the monitor to check for G-Y duals while ignoring the red. This is the most restrictive operation. Therefore, it is recommended that G-Y enable be set for all monitors. **Unless directed otherwise by the Engineer, the G-Y Enable DIP switch should be set to the "ON" position.**

- **Short Yellow (Clearance) –** times each channel's yellow change interval to assure it is displayed for a certain minimum time (nominal 3 seconds). The **OMUTCD** sets an absolute minimum of 3.0 seconds for yellow change intervals on vehicle signals. Pedestrian signals have no yellow display, so this function is typically disabled for pedestrian signal channels only. **Caltrans** conflict monitors use programming cards that allow per-channel disabling of the short yellow function. On **Caltrans** monitors (e.g., 2010ECL), the short yellow feature is enabled/disabled on a per-channel basis by the SSM switches, as well as by the jumpers on the Programming Card. **Therefore, unless directed otherwise by the Engineer, the SSM DIP switch should be enabled ("ON") for all vehicle and pedestrian channels. The preferred method for disabling short yellow monitoring on pedestrian channels is to have the programming card YELLOW DISABLE jumpers installed.**

- **Watchdog Monitoring** – looks for a signal from the Controller Unit that indicates to the monitor that the controller is operating. This is a logic-level signal that turns on and off at a 100-ms rate, generated by an interrupt service routine in the signal controller software. If the controller has a "computer glitch" that causes a malfunction, it is very likely that this routine would not be executed consistently, and the watchdog signal sensed by the monitor would stop changing state properly. For example, the controller could "hang" in a particular phase display and never advance, and as long as no conflicts were present, the monitor would not trip. Thus, the signal would remain in a sort of "stop time" state until a trouble call was reported and addressed. The resulting running of reds by motorists is considered to be more dangerous than going into monitor flash; therefore, it is required that watchdog monitoring be enabled to put the signal into flash any time the controller watchdog signal is not valid. On **Caltrans** monitors (e.g., 2010ECL), watchdog monitoring is a basic feature that can be enabled/disabled by a switch (called "WDT Enable") on the monitor printed circuit board. **The Watchdog (WD) Enable Toggle Switch should be in the "WD ENABLE" position**.

- **Watchdog Latch Select –** is available on **Caltrans** monitors only (2010ECL). It is a jumper that selects whether a power-restore after AC brownout will latch or not latch the controller Watchdog Fault (WDT) that sometimes occurs during a brownout condition. A latching WDT fault would hold the intersection in flash until the monitor is manually reset, and this is the most restrictive condition. If the WDT LATCH jumper (SEL1) is installed, this fault is latched. **Therefore, unless directed otherwise by the Engineer, the WDT LATCH Jumper (SEL1) should be installed.**

- **Recurrent Pulse** – is a proprietary feature of **EDI** brand monitors. It is basically an integrator that adds up the width of a series of very short fault pulses on a given channel. These pulses are too short to individually cause a fault using **Caltrans** or **NEMA** specified timing thresholds, but taken collectively can represent an equipment problem or a display fault. The Recurrent Pulse (RP) feature can be disabled by DIP switches labeled "RP DISABLE." Having Recurrent Pulse monitoring enabled is the more restrictive condition, so it should not be disabled. **Unless directed otherwise by the Engineer, the RP DISABLE DIP switch should be in the OFF position**.

- **LED-Specific Voltage Threshold Levels** – is a feature that sets voltage thresholds differently than the **Caltrans** (TEES) and **NEMA** (TS1, TS2) specifications. These revised thresholds match closely the **ITE** requirements for LED traffic signals, and at the same time are quite suitable for incandescent lamps as well. **ODOT** only uses LED signals; therefore, this feature should be enabled on all conflict monitors. On **EDI** brand 2010ECL monitors a DIP switch on the monitor board has a position labeled “LEDGuard.” **Unless directed otherwise by the Engineer, the LEDGuard internal DIP switch should be set to the ON position**.

- **Minimum Flash Time** – is a setting for the minimum amount of time the conflict monitor will hold in a flashing state after an AC power up. This should not be set too short for two main reasons: 1) to give the controller and other slow-booting devices time to safely begin their operation; and 2) to give a period of flashing operation for drivers using a previously-dark signal to become aware that the signal is now powered and may begin stop-and-go operation soon. **ODOT** recommends that the longest available minimum flash time be used, up to a value of about 16 seconds. In **Caltrans** spec monitors (e.g., 2010ECL), there is no default minimum flash time, but a minimum flash time jumper (SEL2) is available to assure that the flash time is a minimum of 6 to 10 seconds. **Unless directed otherwise by the Engineer, the Minimum Flash Time select jumper (SEL2) should be installed.**

- **Configuration Change Fault Select** – is available on **Caltrans** monitors only (2010ECL). The jumper (SEL3) determines whether a detected change in the programming card configuration will cause the cabinet to enter a fault condition (flash) or to continue in stop-and-go operation while logging the Configuration Change Fault. Given the importance of programming card information, **ODOT** recommends that any change in the card detected by the monitor should immediately be brought to the attention of the maintaining agency. This is done by causing the intersection to enter a monitor fault flashing condition. **Therefore, unless directed otherwise by the Engineer, the Configuration Change Fault Select Jumper (SEL3) should be installed.**

- **Red Interface Cable Fault Select** – is available on **Caltrans** monitors only (2010ECL). It determines whether or not the monitor will trip if the Red Enable Cable is not installed, after the cabinet door is closed. Note that **ODOT**-spec **Caltrans** cabinets are wired such that the monitor output relay is bypassed when the door is open, allowing the signal to continue stop-and-go operation without the monitor installed. If the monitor is not installed when the door is shut, the intersection will go into flash. Given the importance of the Red Interface Cable, it is recommended that the monitor be set to trip into flash if the door is shut without the cable installed. **Therefore, unless directed otherwise by the Engineer, the Red Interface Cable Fault Select Jumper (SEL4) should be installed.**

- **AC Brownout Select** – is available on **Caltrans** monitors only (2010ECL). It selects between two brownout dropout voltage levels. The more restrictive brownout voltage settings occur when the jumper SEL5 is installed. **Therefore, unless directed otherwise by the Engineer, the AC Brownout Select jumper (SEL5) should be installed**

- **EE Input Polarity Select** – selects the polarity of the EE input to the monitor that corresponds to a flashing condition in the cabinet. For standard **Caltrans** cabinet operation (Flash Transfer Relays and MC energized during flash), this jumper should be left in the open position. **ODOT**-spec **Caltrans** cabinets operate in this manner; therefore, **the EE Input Polarity Select jumper (SEL9) should be open.**

- **Watchdog Timing Option** – changes the default timing the monitor uses to sense a watchdog fault. This is selectable between 1.0 and 1.5 seconds, via OPTIONS switch SW3. In **ODOT’s** experience, the setting of this parameter is not critical, but occasionally the setting of 1.5 seconds may be required for certain controllers. The more conservative option is to select the 1.0 second timing parameter. **Therefore, the OPTIONS DIP switch SW3, labeled “WD 1.0 SEC” should be set to the ON position by default**.

- **Special Function #1 Polarity** – should be left in its factory-default position of OFF. Special

Function #1 is an input to the monitor that is very rarely used. **Therefore**, **SF#1 POLARITY DIP switch should be set to the OFF position.**

- **SEL6–SEL16 Jumpers.** SELECT JUMPER PROGRAMMING – The Signal Monitor also provides jumper options to modify the monitor operation. The select jumpers are labeled SEL1 through SEL16. **SEL6 through SEL16 are reserved for EDI configuration programming and should not be modified except by the factory.**

The following list summarizes the recommended settings as described in this Section. Every 2010**ECL** (and similar models such as 2010KCL, 2018ECL, etc.) should be set in a similar manner. FYA switches are only used when Flashing Yellow Arrow operation is required.

OPTION DIP SWITCHES:

RF 2010	ON
RP DISABLE	OFF
WD 1.0 SEC	ON
GY ENABLE	ON
SF#1 POLARITY	OFF
LEDguard	ON
RF SSM	OFF

FYA DIP SWITCHES:

FYA COMPACT	OFF
FYA1-9	OFF
FYA3-10	OFF
FYA5-11	OFF
FYA7-12	OFF

SSM DIP SWITCHES:

ALL CHANNELS	ON

SEL JUMPERS:

SEL1	INSTALLED
SEL2	INSTALLED
SEL3	INSTALLED
SEL4	NOT INSTALLED
SEL5	INSTALLED
SEL6-16	AS DELIVERED FROM FACTORY

WD ENABLE TOGGLE SWITCH: ON

YELLOW DISABLE (ON PROGRAMMING CARD):

CH13	INSTALLED IF PEDESTRIAN DISPLAY USED
CH14	INSTALLED IF PEDESTRIAN DISPLAY USED
CH15	INSTALLED IF PEDESTRIAN DISPLAY USED
CH16	INSTALLED IF PEDESTRIAN DISPLAY USED

403-11.3 Settings for a NEMA Malfunction Management Unit (MMU)

The following are recommended settings for for **Caltrans** Model 2010ECL conflict monitors:

- **Red Fail** – is designed to assure that there is at least one active field input (R,Y, G) on a channel at all times. This feature will put the intersection into flash if all the field terminals on a given channel appear inactive when they should be active. An obvious exception is permissive left turn channel on a five-section head, whose channel has no red signal head. The Red Enable input to the monitor controls the Red Fail operation of all channels. **ODOT**-spec cabinets should be wired to assert (by applying 120VAC) the Red Enable input pin to the MMU, which enables the Red Fail feature by for all channels that have not had Red Fail individually disabled by other means. In a **NEMA** cabinet, the Red Enable input is connected to the coil of the Main Contactor and is intended to signal to the monitor that the load switches are currently driving the field terminals. On **NEMA** Malfunction Management Units, Red Fail monitoring is enabled for all channels when Red Enable is active. Red Fail monitoring shall be used for Pedestrian displays. This is the most restrictive condition and should be used unless directed otherwise by the Engineer. If it is desired NOT to monitor Pedestrian displays for Red Fail, then individual per-channel Red Fail disables are available on most MMUs to do so. Some MMUs allow per-channel enable/disable of Red Fail through front panel menus and/or software interface to a laptop computer; however, **unless directed otherwise by the Engineer, per-channel disabling of Red Fail (if available) should not be done. Instead, any unused red inputs should be connected to AC+ using spade lug jumpers in the load switch slot, and the corresponding Field Check/Dual Enable switch should be disabled.**

- **Field Check Monitoring** – Field Check monitoring is used in TS2 Type 1 cabinets and ensures that the field signal states sensed by the MMU at the field terminals match the output state set by the Controller Unit. When any field signal state (R, Y or G) does not match the output state of the Controller Unit **and** the MMU is not in the Fault mode, then a cabinet hardware, or field hardware, failure has occurred. When all the field signal states (R, Y or G) do match the output state of the Controller Unit **and** the MMU is in the fault mode, then the Controller Unit has caused the fault (CU programming), or the MMU programming is not compatible with CU or cabinet configuration. **For channels that display red, yellow and green, unless directed otherwise by the Engineer, Field Check Monitoring should not be disabled. On channels which do not display a red, the Field Check/Dual Enable Switch should be disabled.**

- **G-Y-R Dual Indication** – On **NEMA** Malfunction Management Units, dual indication is enabled/disabled on a per-channel basis. On some models, this is done using the front panel FIELD CHECK/DUAL ENABLE DIP switches. On other models, the front panel menu and/or laptop interface is used. Note that on models with hardware switches, each switch affects both Dual Enable and Field Check functions. (See above paragraph on Field Check monitoring for more information.) **Therefore, unless directed otherwise by the Engineer, the FIELD CHECK/DUAL ENABLE function should be enabled ("ON") for all channels that display red, yellow and green.**

- **G-Y Dual Indication** – Applies to any channel for which G-Y-R Dual Indication monitoring has been disabled, such as Pedestrian display channels. **The G-Y Enable DIP switch should be set to the "ON" position. If this DIP switch is not present, each channel should be programmed by front panel or software for G-Y dual indication monitoring.**

- **Clearance (Short or Skipped Yellow)** – Clearance monitoring times each channel's yellow change interval to ensure that it is displayed for the minimum time of 3.0 seconds on vehicle signals, as required by **OMUTCD**. Pedestrian channels have no yellow, so it is common to disable this feature. On **NEMA** Malfunction Management Units short yellow monitoring is disabled on a per-channel basis using the Minimum Yellow Change Disable (MYCD) jumpers on the programming card. **MYCD jumpers on the Programming Card should not be installed except for Pedestrian channels or if directed by the Engineer.**

- **Controller Voltage Monitoring (CVM)** – On **NEMA** Malfunction Management Units the steady-state CVM signal (see below) has a similar function to the oscillating controller watchdog signal specified by **Caltrans**. There is no way to disable the CVM feature, although some monitor options exist that affect how a CVM fault is handled when it occurs (see CVM Latch Enable and CVM Log Disable below).

- **CVM Latch Enable** – is available on **NEMA** MMUs only (e.g., MMU-16E, MMU-16LE, MMU-1600). Recall that the CVM input to the monitor originates in the controller. If the controller is operating normally, this pin is asserted by being driven to 0VDC. If the controller is shut down or has some other malfunction, this monitor input will be pulled high (nominally 24VDC) and a CVM fault will occur. For example, at startup the controller will not assert its CVM output until all phase outputs are being actively driven. Like most monitor faults, CVM will latch the intersection into the fault state (flashing) until the Reset button is pushed. However, some CVM faults can be self-recovering, so the option exists to select between latching and non-latching operation. This is done using a jumper on the programming card. Enabling CVM latch is generally regarded as the more conservative option; therefore, **unless directed otherwise by the Engineer, the CVM Latch Enable jumper should be installed.**

- **CVM Log Disabling** – is a feature on **EDI** brand MMUs. It is generally used only when the signal is designed to go repeatedly into a programmed flash (such as nighttime flashing). As mentioned above, CVM can be thought of as a sort of DC-level controller watchdog circuit. If the controller is shut down or has some other malfunction, this monitor input will be pulled high (nominally 24VDC) and a CVM fault will occur. A controller can execute a nightly programmed flash by de-asserting its CVM output at the appointed hour and re-asserting it when returning to stop-and-go operation. By setting the "CVM LOG DISABLE" DIP switch to ON, logging of all CVM fault events is disabled. Very few **ODOT** signals operate by scheduled program flash. Also, disabling logging of CVM faults can impair troubleshooting of controller problems for signals that do not use scheduled flash operation. **Therefore, unless directed otherwise by the Engineer, the "CVM LOG DISABLE" DIP switch should be set to the OFF position**.

- **External Watchdog** – Although no controller watchdog feature is used in **NEMA** cabinets, **NEMA** MMUs do have available an **external** watchdog monitoring input called "External Watchdog" that can be enabled/disabled by a front panel DIP switch. It can be used to monitor a critical external device other than the controller (e.g., a modem, master controller, etc.). Note that external watchdog failure state will put the monitor into a Fault condition (intersection in monitor Flash). **Therefore, EXTERNAL WATCHDOG DIP switch should not be enabled unless: 1) connected to a critical device; and 2) directed by the Engineer**.

- **Recurrent Pulse** – is a proprietary feature of **EDI** brand monitors. It is basically an integrator that adds up the timing of a series of very short fault pulses on a given channel. These pulses are too short to individually cause a fault using **NEMA** specified timing thresholds, but taken collectively can represent an equipment problem or a display fault. The Repetitive Pulse feature can be enabled/disabled by a front panel DIP switch. **Unless directed otherwise by the Engineer, the RP DISABLE DIP switch should be in the OFF position.**
- **LED Voltage Threshold Option** – On **EDI** brand MMUs, a DIP switch on the front panel has a position labeled "LEDGuard." On **Reno** brand MMUs, a DIP switch on the front panel has a position labeled "LED THRESHOLDS." **The LEDGuard front panel DIP switch on EDI MMUs should be set to the ON position unless directed by the Engineer**. **Unless directed otherwise by the Engineer, the LED THRESHOLDS front panel DIP switch on Reno MMUs should be set to the ON position.**

- **24V Latch Enable** – is a selectable option only on some **NEMA** conflict monitors and all MMUs. **NEMA** TS2 requires the MMU programming card to have a jumper labeled "24V LATCH ENABLE." When a jumper is soldered into this position, any fault on either of the two 24V cabinet power supply inputs will cause a latching fault that must be reset by an assertion of the RESET button. If the jumper is not in place, then the CVM fault is non-latching. Enabling 24V latch is generally regarded as the more conservative option; therefore, **the 24V Latch Enable jumper should be installed on the Programming Card unless directed by the Engineer.**

- **Minimum Flash Time** – is a setting for the minimum amount of time the conflict monitor will hold in a flashing state after an AC power up. This should not be set too short for two main reasons: 1) to give the controller and other slow-booting devices time to safely begin their operation; and 2) to give a period of flashing operation for drivers using a previously-dark signal to become aware that the signal is now powered and may begin stop-and-go operation soon. The longest available minimum flash time should be used, up to a value of about 16 seconds. On **NEMA** MMUs, the Minimum Flash Time is typically set on the Programming Card using four available jumpers that select a range of 6 to 16 seconds. **Unless directed otherwise by the Engineer, all four programming jumpers for Minimum Flash Time should be installed on the Programming Card, to give a flash time of 16 seconds.**

403-12 Central Signal System Control Station (CSSCS)

403-12.1 Engineering Background

Note that controllers and interconnect may have to be updated to be compatible with the proposed CSSCS.

403-12.2 Guidelines and Review

Any proposed state or federally-funded Central Signal System Control Station installation must be reviewed and approved by the Administrator of the Office of Traffic Operations (OTO).

The request must come from the Local maintaining agency while in the Project Development Process (PDP). If approved, submit a Systems Engineering Review Form (SERF) or Systems Engineering Analysis (SEA) through the MPO/District for any project with state or federal funds. Additionally, once approved, it will be added to the Statewide ITS Architecture.

The following criteria should be met currently or after completion of the proposed project for a Central Signal System Control Station to be approved:

a. A mininimum of fifty (50) signalized intersections
b. 50% or greater signalized intersections with functioning interconnection
c. All interconnected controllers shall be compatible with the proposed CSSCS
d Dedicated engineering and/or traffic signal operations staff (internal or external)

Any proposed **ODOT** or federally-funded Central Signal System Control Station installation must be reviewed and approved by the Office of Traffic Operations (OTO).

403-12.3 Required Documentation

Required information to be sent to OTO for review and approval may include:

a. Intersection list
    1. Controller make, model, and firmware version at each intersection
    2. Connectivity to ODOT corridor or Interstate
b. Means of interconnect per intersection
    1. Ability to maintain communications—fiber, modems, high-speed radios (internal or external)
        a. Copy of active contract between Local and contractor (if external)
c. Names and qualifications of dedicated staff responsible for daily operations
    1. Copy of active contract between Local and Consultant (if using external)

404 PEDESTRIAN CONTROL FEATURES

404-1 General

Pedestrian signal indications (**see OMUTCD Figure 4E-1**) are special types of traffic signal indications intended for the exclusive purpose of controlling pedestrian traffic. Pedestrian signals are discussed in **OMUTCD Chapter 4E**. Construction mounting details are shown on **Traffic SCD TC-85.10**, and pedestrian signal equipment is specified in **C&MS Item 632** and **C&MS 732**.

404-2 Pushbuttons

OMUTCD Section 4E.08 addresses pedestrian detection, usually accomplished using pushbuttons.

On actuated signal phases, if there is a reasonable expectation of regular pedestrian use, the phase shall be equipped with pedestrian pushbuttons to provide access to all corners of the intersection with sufficient time to safely cross the highway; and countdown pedestrian heads, marked crosswalks, applicable signs and ADA ramps shall be provided.

This is especially important on side-street phases where the signal green time is usually based on a short initial green interval with the green time extended by signal actuations. The initial green interval is usually not long enough to allow a pedestrian to cross the mainline. The pedestrian pushbutton will initiate a guaranteed crossing time without input from vehicular traffic. The pushbutton will also provide the pedestrian with a means to cross the mainline when there is no side-street traffic to initiate the signal phase for the pedestrian crossing.

If pushbuttons are provided, they shall be wheelchair accessible according to current ODOT pedestrian design standards. Pedestrian signal heads and marked crosswalks shall be required whenever pushbuttons are provided. When pushbuttons are provided, pushbuttons shall allow pedestrians to reach all corners of the intersection. Designers should be aware of this requirement and consider the possible future location of crosswalks when locating stop bars and stop bar detectors at signals that do not presently include pedestrian facilities..

404-3 Accessible Pedestrian Signals and Locator Tones

As noted in ***Section 401-9***, use of accessible pedestrian signals and locator tones are major **ADA** requirements that affect traffic signals. Accessible Pedestrian Signals supplement visual WALK indications and are designed to aid visually impaired pedestrians; and Locator Tones enable pedestrians who have visual disabilities to locate the pushbutton.

The installation of Accessible Pedestrian Signals and/or Locator Tones may be considered at **ODOT**-maintained traffic signals when an engineering study, which considered the factors specified in **OMUTCD Sections 4E.09 and 4E.10**, has been conducted and the following minimum conditions are met:

1. The proposed intersection crosswalk must be signalized.

2. The audible devices should be retrofittable to the existing traffic signal hardware.

3. The signalized intersection should be equipped with pedestrian pushbuttons.

4. The selected crosswalk must be suitable for the installation of Accessible Pedestrian Signals and/or Locator Tones, in terms of surrounding land use and traffic patterns.

5. There must be a demonstrated need for the audible devices in the form of a request from an individual or group that would use the audible signal.

6. The individual or group requesting the device should agree to train the visually impaired users in the use of the Accessible Pedestrian Signals and/or Locator Tones, as appropriate.

Additional guidance is available in **OMUTCD Part 4.**

405 FLASHING BEACONS

405-1 General

Flashing Beacons are addressed in **OMUTCD Chapter 4L.**

405-2 STOP Signs and Intersection Control Beacons

A STOP sign shall be used with a flashing red Intersection Control Beacon.

405-3 Rectangular Rapid Flashing Beacon (RRFB)

On December 21, 2017 FHWA rescinded Interim Approval (IA-11) for Rectangular Rapid Flashing Beacons, for all new installations of these devices. Existing RRFB's may remain in place through the end of their useful life.

406 SPECIAL PURPOSE TRAFFIC CONTROL SIGNALS

406-1 General

OMUTCD Chapters 4G through 4L present information on miscellaneous types of highway traffic signals including signals for emergency-vehicle traffic, lane-use control, movable bridges, freeway entrance ramps and one-lane, two-way facilities.

406-2 Temporary Traffic Signals

Temporary traffic signals are currently addressed in **OMUTCD Section 4D.32**. Additional information about traffic signals used in temporary traffic control zones is provided in **OMUTCD Section 6F.84** and ***Part 6*** of this Manual.

406-3 Traffic Control Signals for Emergency Vehicle Access Guidelines

Traffic control signals for emergency vehicle access may be justified if the cross-corner sight distance is less than the appropriate value given in ***Figure 498-1***, or if the volume of traffic during an average day exceeds the values given below:

Number of Lanes	ADT (Both Directions)
4 or more	16,000
3	9,000
2	6,000

OMUTCD Chapter 4G presents information on the design and operation of traffic control signals for emergency vehicle access. Also, see ***TEM Section 403-6*** for information about Preemption Control Systems.

Intentionally blank.

407 OTHER ELECTRICAL DEVICES

407-1 General

This Chapter is used to address other traffic control electrical devices, including active signs, used on **ODOT**-maintained highways.

407-2 PREPARE TO STOP WHEN FLASHING Signs (W3-H4a)

407-2.1 General

The PREPARE TO STOP WHEN FLASHING (PTSWF) sign (W3-H4a) is used to provide drivers approaching a traffic signal with additional information concerning the changing of the traffic signal indication from green to yellow. Drivers who are past the dilemma zone will usually decide to continue through the intersection when the yellow indication is displayed, while drivers who have not yet entered the dilemma zone will decide to stop. This sign can also be used to provide advance information when the geometric design of the intersection approach prevents the signal display from being seen in time to stop.

407-2.2 Applications

Any proposed **ODOT** or federally-funded PTSWF sign installations must be reviewed and approved by the **Office of Traffic Operations (OTO)**. Installation of the PTSWF sign should only be implemented upon failure of the progressive application of countermeasures described in ***Section 407-2.3***. The following are typical applications for PTSWF signs:

1. A location (usually four-lane divided) with approach speed of 45 miles per hour or greater, a high rear-end accident rate, and evidence of rear-end conflicts (skid marks) at the intersection.
2. A remote rural location with approach speed of 45 miles per hour or greater where the presence of a signal is unexpected.
3. A location with approach speeds of 45 miles per hour or greater and diminished signal sight distance due to horizontal and/or vertical curves or structures.
4. A location with a high percentage of truck traffic traveling at 45 miles per hour or greater, with frequent violations of the clearance interval and excessive angle and rear-end accidents.

Installing PTSWF signs in corridors where multiple signals exist is not recommended.

The installation of a signal can be expected to significantly increase rear-end accidents even at locations without the above described characteristics. No signalized intersection is likely to be completely free of rear-end accidents. Consequently, restraint should be exercised in the use of PTSWF signs since the overuse of any warning device can reduce its effectiveness. It should also be noted that the use of this device reduces the efficiency and safety of the signal operation by delaying the termination of the green and compromising true gap-out phase transitions. Also, studies of PTSWF applications have shown that vehicle speeds through the intersection may increase.

407-2.3 Procedure / Reviewing Other Countermeasures

Prior to installation of the PTSWF signs, it should be determined that proper advance signing has been in place and that the detectors are operating correctly and are located beyond the dilemma zone for the approach speeds involved. Ideally, detection should exist at or upstream of the PTSWF sign. If the detectors and Signal Ahead (W3-3) signs are improperly located, this should be corrected and evaluated before installing PTSWF signs. Other detector design techniques to minimize dilemma zone exposure may also be employed.

Generally, the PTSWF sign should be used only where conventional traffic control devices have been tried and found ineffective in reducing accidents, or where operational problems related to rear-end, or other accidents caused by failure to stop, have occurred. The brightness and reliability of LED traffic signal lamps have improved the visibility distance of signal indications. For existing signalized intersections, the following progressive application of countermeasures should be utilized to address accidents caused by failure to stop:

1. Installation of a single Signal Ahead (W3-3) sign.
2. Dual W3-3 signs.
3. Oversized, dual W3-3 signs.
4. W3-3 signs with continuously flashing beacons.
5. Extended Call - Delay Call Loops (EC-DC Loops).
6. PTSWF (W3-H4a) signs, timed concurrently with the yellow change (YC) and all-red (AR) clearance intervals.
7. PTSWF signs, with advance warning time.

407-2.4 Operations and Placement

The PTSWF sign installation is addressed in **Traffic Plan Insert Sheet (PIS) 203020** and typically consists of the following equipment:

- PTSWF sign,
- Flashing beacons,
- Sign bracket assembly,
- Sign support with breakaway foundation,
- Flasher and flash control assembly, and
- Wiring to connect flashing beacons and controller.

Auxiliary equipment shall be provided in the signal controller to operate the PTSWF sign beacons. This equipment shall be set to: 1.) time concurrently with the YC and AR intervals or 2.) start the sign beacons flashing for a predetermined advance warning time (with variable settings) before the termination of green. Flashing operation of the PTSWF sign shall typically end when green is displayed to the approach. The beacons shall flash simultaneously. The beacons shall not be activated when the signal controller operation goes to “flash” mode. For high-speed applications at four-legged intersections, PTSWF signs shall be employed for both directions of a roadway unless there are factors which would dictate the need for one direction only. When PTSWF signs are used on four-lane divided highways, dual installation should be the default treatment.

When a PTSWF sign is added to an approach with W3-3 signs with beacons already in place, the beacons on the W3-3 signs shall be removed.

The symbolic Signal Ahead (W3-3) sign shall be used in conjunction with a PTSWF sign and governed by the following provisions:

- The W3-3 sign shall always be located in advance of the PTSWF sign.
- It shall be no closer than 200 feet to the PTSWF sign, and must also meet the minimum placement criteria described in **OMUTCD** **Section 2C.36**.
- If the PTSWF sign is installed after the W3-3 sign (which is usually the case), the W3-3 sign may require relocation to comply with the 200 foot sign spacing criteria.

The following factors are needed to determine PTSWF sign location (S) and timing (T):

t	=	1.0, perception-reaction time in seconds
1.47	=	conversion factor from miles per hour to feet per second,
V_1	=	85th-percentile approach speed (mph)
V_2	=	15th-percentile approach speed (mph)
f	=	.266 coefficient of friction (wet)
g	=	approach grade, percent/100
S	=	sign location from stop line (feet)
T	=	delay timing, sec.
a	=	100 feet, represent a zone in front of sign where drivers would be unable to perceive meaning of flashing sign
b	=	distance [$1.47V_2t$], space in front of the dilemma zone where most drivers would not attempt to stop.

S & T are calculated by:

$$S = 1.47\,V_1 t + \frac{{V_1}^2}{30(f \pm g)} = 1.47V_1 t + d_{stop85}$$

$$\text{where } d_{stop85} = \frac{{V_1}^2}{30(f \pm g)}\,, d_{stop15} = \frac{{V_2}^2}{30(f \pm g)}$$

$$\left.\begin{aligned} T_{15} &= \frac{S + a + b - DZ_{stop15}}{1.47V_2} \\ T_{85} &= \frac{S + a + b - DZ_{go85}}{1.47V_1} \end{aligned}\right\}$$

Generally, choose smaller of these two for Warning Time where DZ is the dilemma zone:

$$DZ_{stop} = 7.2V_x$$

$$DZ_{go} = DZ_{stop} - 200$$

$$T = \text{ smaller of } T_{15}, T_{85} \text{ if } T_{85} < T_{15}$$

$$T = \text{ mean of } T_{15}, T_{85} \text{ if } T_{85} > T_{15}$$

407-2.5 Typical PTSWF Advance Warning Times

The following table is provided for convenience and reflects level approach grades, 1.0 second perception-reaction time and 0.266 coefficient of friction:

	V_{85} (mph)					
V_{15}(mph)	45	50	55	60	65	70
45	4.0	4.5	5.0	5.6	5.8	6.0
50		4.1	4.6	5.2	5.8	6.0
55			4.3	4.8	5.4	6.0
60				4.5	5.1	5.7
65					4.7	5.3
70						5.0

407-2.6 Criteria for Removal

The following should be used as criteria for removal:

1. When there are two or more signalized intersections on the same route and the spacing between each signal is 0.5 mile or less.
2. When a signal becomes part of a coordinated system.
3. When the posted speed is reduced to less than 45 miles per hour.
4. Upon mitigation of the condition that caused the sight distance limitation where the PTSWF sign is installed.

Prior to removal of the PTSWF signs, the signs shall be covered and flashers disconnected for a minimum of ten days.

407-2.7 Alternatives to Removal

If existing PTSWF installations with advance warning time are to remain in place, the advance warning time should be eliminated. In this approach, signal operation is simplified by driving the PTSWF beacons concurrently with the associated phase yellow clearance and all red intervals. This is equivalent to reducing the PTSWF advance warning time to zero. The preferred zero-warning-time implementation shall use a separate load switch and/or flasher module to activate the PTSWF flasher using a wire of the yellow and red load switch outputs.

Older PTSWF installations with timing based on earlier **TEM** formulas should have the advanced warning time reduced to comply closely with the new formula. If a **District** decides the older PTSWF warning time must be maintained, then the control zone of the signal shall be extended to 100 feet upstream from the PTSWF sign to assure that no vehicles between the PTSWF sign and the next downstream detector are caught in the Dilemma Zone at the end-of-green. Consider using advanced dilemma zone radar detection with this alternative.

408 IN-ROADWAY LIGHTS

408-1 General

In-Roadway Lights **(see OMUTCD Chapter 4N)** are considered a type of Highway Traffic Signal. They are installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop. Typical uses for this device would be marked school crosswalks and marked midblock crosswalks. In-Roadway Warning Lights at crosswalks shall not be used at crosswalks controlled by YIELD signs, STOP signs, or Traffic Control Signals.

408-2 Use of In-Roadway Lights on State Highways

Because of the high speeds and volumes associated with state highways, an engineering study should be conducted to determine if other measures, such as increased signing and pavement marking, should be implemented before the use of in-roadway crosswalk warning lights on **ODOT**-maintained highways. Any engineering study pertaining to the installation of in-roadway lights on state highways should be coordinated with the **Offices of Roadway Engineering (ORE) and Traffic Operations (OTO)**.

The use of in-roadway lights at highway-rail grade crossings should also be coordinated with the **Ohio Rail Development Commission (ORDC)**.

Intentionally blank.

420 MATERIALS AND SIGNAL HARDWARE

420-1 General

Construction details are shown on **Traffic SCDs TC-81.10 through TC-85.20**. Traffic signal equipment is specified in **C&MS Items 632 and 633** and **C&MS 732 and 733**.

420-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is addressed in ***Section 120-4***.

420-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using Federal funds, ***Sections 120-5 and 120-6*** describe processes that have been established whereby local agencies can purchase such items through **ODOT**.

420-4 Vehicular Signal Heads

420-4.1 General

Standards related to vehicular signal heads are addressed generally in **OMUTCD Chapter 4D**.

For any project using **State** or **Federal** funds, louvered reflective backplates in accordance with **C&MS 732.22** are required for all new signal heads (backplates are required for both mast-arm and span-wire installations). It is recommended that signal heads be polycarbonate plastic and be tethered per **Traffic SCD TC-85.21** to minimize sway for span-wire type configurations. A signal support analysis should be performed on all existing strain poles and mast-arm type signal supports to insure they are structurally adequate for the proposed changes. If span-wire supports are found deficient for backplates in all directions, then the intersection should be analyzed for mainline or East/West backplates only. Written documentation and calculations are required if the proposed additions/changes cannot be implemented.

420-4.2 Signal Head Color

In **ODOT**-maintained traffic signal installations, the vehicular signal head housings and the outside of the visors shall be highway yellow or black. The two colors shall not be mixed within an intersection.

420-4.3 Vehicular Signal Indications

Vehicular signal indications shall be 8 inches or 12 inches in diameter, depending on the provisions of **OMUTCD Section 4D.07**. For **ODOT**-maintained traffic signal installations, they shall be LED modules and they should be 12 inches in diameter. The 8-inch size is typically used only for low-speed, urban applications.

420-4.4 Location of Five-Section Signal Heads for Protected/Permissive Turns

OMUTCD Sections 4D.17 through 4D.20 contain the requirements for signal head use for protected/permissive left turns. In protected/permissive signal phasing, the left (or right) turns can be made in both a protected (green arrow) and a permitted (circular green) signal phase.

“Shared” five-section signal face:

Because the circular signal indications in this five-section signal head apply to both the through and turning vehicles, the signal head should be located on an extension of the Channelizing

Line that separates the through and turn lanes. The “shared” type of five-section signal face is used extensively throughout **Ohio**.

Left-turn lanes on four-lane highways with wide medians are often separated from the through lanes by a large painted channelizing island in order to provide good alignment and sight distance for opposing left-turn vehicles. In this case, the five-section head should be located in front of the left-turn lane with an R10-12 sign, LEFT TURN YIELD ON GREEN, next to the signal head. Two additional three-section signal heads should be provided for the through-traffic lanes. The maintaining agency should monitor accidents for this type of operation with the wide median. **ODOT’s** experience in some parts of the **State** showed that left-turning drivers were not yielding on the circular green and the phase operation had to be converted to “protected only.”

420-4.5 Aluminum versus Polycarbonate

Vehicular signal heads are manufactured in either aluminum or polycarbonate plastic. The choice of which material to use will be made by the maintaining agency. Many urban jurisdictions prefer the use of polycarbonate, because they are much lighter and easier to handle. Because of the lighter weight, they are often used when adding left-turn signal heads to an existing signal support system. Polycarbonate signal heads are most often associated with rigid-mounted signal heads on mast arms where wind sway will not be a factor.

In **ODOT**-maintained traffic signal installations, aluminum signal heads should be used to reduce signal head sway in windy conditions unless rigid mounting or span-wire tethers are used. The preferred signal head material for any installation with backplates and tethers, per **Traffic SCD TC-85.21**, is polycarbonate.

420-4.6 Programmable Signal Heads

A programmable signal head utilizes a special optical lens that can be “programmed” to provide the signal display to only desired portions of the roadway. The programming is accomplished by masking (with tape) portions of the lens through the rear of the housing or by steerable LED arrays behind the lens. Applications for the use of programmable heads may be severely skewed roadways where the signals may be visible from more than one approach and closely spaced intersections, or closely spaced intersections.

Because the lens is programmed to be visible from certain areas, the signal head should be rigid mounted or tethered. Programmable signal heads are much more expensive than a regular signal head and, if programmed incorrectly, can create an unsafe condition. Signal designers should give careful thought to their use and provide plan sheets clearly showing the desired visibility cutoffs.

See ***Section 450-10.5*** for additional details on optically programmable signal heads.

420-4.7 Signal Indications on the Stem of a T Intersection

For through traffic, a minimum of two signal faces shall be provided and shall be continuously visible per the requirements of **OMUTCD Section 4D.11**.

On the stem of a T intersection, where there is no through traffic, at least one of the turning movements shall be provided with dual indications. If two three-section heads are used, one with a left-turn green arrow and the other with a right-turn green arrow, the approach does not meet the minimum requirements of the **OMUTCD**. Two circular greens are sufficient, or two circular greens with one or two arrows (four-section heads) are acceptable. The purpose of providing dual indications is to ensure that if one lamp fails, a second lamp will be provided to the predominant movement.

420-4.8 Signal Head Clearance

OMUTCD **Section 4D.15** requires that the bottom of the signal housing and any related attachments to a vehicular signal face located over a roadway shall be at least 15 feet above the pavement. The top of the signal housing of a vehicular signal face located over a roadway shall not be more than 25.6 feet above the pavement. For new construction using mast arm overhead attachment, **Traffic SCD TC- 85.20** requires a clearance of 17 to 19 feet above the pavement elevation at the center of the roadway. For new construction using span wire overhead attachment, **Traffic SCD TC-85.22** requires a clearance of 17 to 19 feet (including tether attachment) above the pavement elevation at all points of the roadway. If the installation cannot be adjusted to the proper clearance, the engineer, in consultation with the maintaining agency, may direct the use of drop pipes or waive the maximum clearances requirement for each head.

420-4.9 Use of Balance Adjusters Prohibited

Balance adjusters shall not be used on signal installations with backplates. Experience has shown that balance adjusters allow enough twisting motion in the signal head to produce tether wire fatigue at the tether attachment point.

420-4.10 Dual-Arrow Signal Section (Bi-Modal Arrow)

OMUTCD **Section 4D.06** allows for the use of a dual-arrow alternative display, also referred to as a bi-modal display, of a GREEN ARROW and a YELLOW ARROW. However, these dual-arrow signal sections shall not be used on **ODOT**-maintained highways.

420-4.11 Auxiliary Traffic Signal Heads

Approaches to traffic signals with high truck volumes (20% or greater) and/or high approach speeds (45 mph posted or greater) should include one or more auxiliary signal heads. Typical placement is on the right side signal support. Auxiliary heads improve signal indication visibility for motorists approaching the signal when one or more high trucks (e.g., tractor-trailers) are stopped at or are approaching the intersection. Motorists following high trucks often have their view of overhead signal indications blocked by the truck.

Installations with lower approach speeds and lower truck volumes should be considered on a case-by-case basis for auxiliary heads, especially in situations with sight distance restrictions due to horizontal or vertical curves, roadside or overhead obstructions et cetera.

420-5 Detector Loop Placement

420-5.1 General

Figures 498-3 through 498-5 illustrate suggested loop placements for traffic control signals in the following situations: Mainline vs. Large-Volume Side Street, Mainline vs. Ramp/T Intersection, and Mainline vs. Low-Volume Side Street, respectively. ***Section 450-10.7*** provides additional detail information about loop placement and wiring.

These are intended only as suggestions for detector placement and a naming convention. Actual placement will depend on individual conditions and **District** practices. Electronic copies of the drawings are available upon request.

420-5.2 Detection of Motorcycles and Bicycles

For any project using **State** or **Federal** funds, all stop line detection zones shall reliably detect motorcycles and bicycles, and all dilemma zone detectors shall reliably detect motorcycles. To assist the traffic signal designer, the following information is provided:

1. Motorcycles and bicycles are more easily detected by inductance loop detectors (ILDs) when traveling over a wire that is parallel or skewed to the direction of travel. Most loop configurations have a bicycle/motorcycle dead zone at their center.
2. Stop Bar Radar Detection (Item 809E69100) provides very good bicycle and motorcycle detection and its use is encouraged for new design.
3. Video stop line detection is usually a reliable detection system for motorcycles and bicycles. The detection zone at the stop line should be kept small so that motorcycles and bicycles will impact a larger percentage of the detection zone. Other detection zones may be added in advance of the stop line detection zone to provide large area detection. Locking of detection calls may be required during nighttime hours, especially at unlighted intersections.
4. An 8-foot wide rectangle or square ILD in a lane of 12 feet or less in width places the wires too close to the edge of pavement or adjacent lane to be considered a traveled path for motorcycles. A 6-foot wide ILD in a 12-foot wide lane will position the wires closer to the traveled path, increase sensitivity in the center of the zone, and allow the detector unit sensitivity setting to be increased while minimizing adjacent lane false calls.
5. The long rectangular stop line ILD is not a reliable detector of small vehicles. While the commonly used rectangular ILD has good detection of high-bed vehicles, the center dead zone does not reliably detect motorcycles and bicycles. Increasing sensitivity to a level that will detect motorcycles and bicycles may cause false calls in the adjacent lane.
6. For dilemma zone detection, the commonly used 6-foot diamond, square, or rectangle shape may not reliably detect motorcycles traveling in the center of the lane over the ILD corners. The Angular Design Detection (ADD) loop shown on **Traffic SCD TC-82.10** will provide more reliable detection.
7. To provide large area ILD detection at stop lines:
   a. The Powerhead configuration provides both motorcycle/bicycle and large area detection with a single loop. Shorter Powerhead loops (e.g., 6 x 20 feet) provide the best performance, with a maximum permissible length of 35 feet.
   b. A short quadrupole (10 feet or less) with 3-6-3 wire configuration can be used at the stop line for the detection of motorcycles and bicycles, with a longer rectangular or ADD ILD in advance of the quadrupole to detect other vehicles including high-bed vehicles. This arrangement provides better performance than a single Powerhead loop, but requires more detector module channels.
   c. A series of 6 foot rectangular ILDs can be used to provide a zone of coverage in advance of the stop line with the ILD at the stop line being either a short Powerhead or a short parallel quadrupole.
   d. The stop line ILD shall not be wired to any other loops and shall have its own detector channel.
   e. System loops may be 6 x 6 foot square or diamond shapes.

At locations of high bicycle use or where the outline of the ILD is not visible on the pavement, signing and pavement marking **(OMUTCD Section 9B.13 and Figure 9C-7)** may be used to denote the location on the ILD for the most reliable detection area after testing with a bicycle.

All stop line detection zones shall be tested for a bicycle target, and all dilemma detection zones tested for a motorcycle target for reliable detection. See ***Figure 498-27*** for the **ODOT** standard vehicle test targets. See **Traffic SCD TC-82.10** for bicycle-specific ILD's.

420-5.3 Video Detection Prohibited for Dilemma Zone Applications

Video detection shall not be used for advance (Dilemma Zone) detection on any approach with a posted or prevailing speed of 35 mph or greater. Video detection is suitable for stop line

420-5.4 Second-Car Detection

420-5.4.1 Background

The use of second-car detection eliminates timing of the associated protected left-turn phase when only one vehicle is waiting for service. This amounts to an “early return” of the opposing green through movement equal to the minimum duration for the left turn. In general, left turns have minimum times similar to those below, to be used for this example calculation:

1. Minimum Green: 7 seconds
2. Yellow Change: 4 seconds
3. All-Red Clearance: 1 second

The total for this minimum phase time is 12 seconds. The queue clearance time (QCT) in seconds is given by:
QCT = 4 + 2n (where n = the number of vehicles clearing from queue past the stop line).

Rearranging, we can calculate the number of vehicles (per opposing through lane) that move into the intersection during this interval: n = 0.5 (QCT – 4).

For the typical left-turn phase timings above, this gives: n = 0.5 (12 – 4) = 4.

Thus, only an additional four vehicles per lane are cleared in the opposing through phase by eliminating the protected left-turn movement using second-car detection. The signal designer is advised to consider this minor increase in through-phase service volume relative to the safety considerations associated with eliminating the protected left-turn interval.

420-5.4.2 Use of Second-Car Detection

The deliberate placement of protected/permissive left-turn presence loops and detection zones at locations with their trailing edge more than one vehicle length behind the stop line is sometimes used by signal designers. The rationale for this placement is the perceived increased efficiency obtained by skipping the associated left-turn phase if only one vehicle is present at the stop line, forcing that vehicle to make a permissive turn at some point during the adjacent green through phase. Such operation yields its greatest mainline efficiency benefit under moderate through-volume conditions. However, under heavy-volume conditions, the permissive left turn often cannot be made until the opposing phase termination. For higher-speed, multi-lane, divided highways, offset-left approaches and other conditions, this can be a dangerous vehicular movement, contributing to angular collisions.

For the reason noted above, left-turn second-car detection should not be used at **ODOT**-maintained signals under (but not limited to) the following conditions unless engineering judgment indicates such operation is acceptable.

1. Posted or prevailing speeds greater than 35 miles per hour.
2. More than two opposing through lanes regardless of approach speeds.
3. Median-divided highways.
4. Offset left-turn lanes.
5. Left-turn lanes with permitted U-turns.
6. An intersection with PREPARE TO STOP WHEN FLASHING advance warning flashers.
7. High-skew or other geometrics or conditions with limited visibility.

Intentionally blank.

421 SIGNAL SUPPORTS

421-1 General

MUTCD Section 4D.33 presents information on the lateral placement of signal supports. Construction details are shown on **Traffic SCDs TC-21.20, TC-81.10 and TC-81.21**. Signal supports are specified in **C&MS Item 632** and **C&MS 732**.

421-2 Signal Support Inspections

A statewide uniform practice for the periodic inspection of the structural components of **ODOT**-maintained signal supports is necessary to assure their structural integrity. All strain pole and mast arm supports should be periodically inspected. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked. The use of an inspection form is recommended. See ***Section 496-1*** for a Sample Signal Support Inspection Form which may be used as is or modified by the **District** as desired. A copy of this form may be downloaded from the **Office of Traffic Operations (OTO)** Forms web page.

Supports should be visually inspected from the ground. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means is not necessary on a routine basis, but may be used to more closely examine a defect that has been detected from the ground. Anchor bolts should be tested for structural integrity by sounding with a hammer. Non-destructive testing procedures, such as dye penetrant, ultrasonics, and magnetic particle, are not necessary on a routine basis, but can be used to define the extent of a defect that has been detected by visual means. Written documentation of all inspections should be kept.

Items to be inspected should include, but not be limited to, foundation concrete, soil around foundation, anchor bolts and nuts, structural members and structural connections.

Deficiencies to be inspected for should include, but not be limited to, cracks in concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, and corrosion.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Written documentation of corrective actions should be kept.

All signal supports shall be inspected at a maximum five-year interval. New signal supports shall be inspected at the time of construction.

430 PLANNING / PROGRAMMING

This Chapter has been reserved to address, as needed, planning and programming information related to traffic control signals.

The Systematic Signal Timing & Phasing Program (SSTPP) is funded by the ODOT Safety and Congestion Program. Its purpose is to systematically update the timing and phasing of signal systems at approved candidate intersections and/or corridors. See ***Section 1213-6*** for more information regarding this program.

440 DESIGN INFORMATION

440-1 General

The L&D Manual Volumes 1 and 3 and ***Chapter 140*** provide general background regarding design information for **ODOT** projects, including the three-stage review process typically used for traffic control plans. Additional design information has been provided in this Chapter, including checklists for Stage 2 and 3 submittals ***(see Section 440-7)***. See ***Chapter 441*** for additional information specifically related to plan preparation. Plan Notes are addressed in ***Chapter 442*** and ***Chapter 443*** provides a listing of related **C&MS** Items.

For information about fiber optic communication design requirments, see ***TEM Part 13, Intelligent Information System (ITS)***.

Designers should utilize the files and guidance provided in the Signal Design Reference Packet. See **Chapter 495** for additional information regarding the reference packet.

440-2 Electrical Power for Traffic Signals

Each signalized location should, whenever possible, be powered from a separate, independent power source point arranged with the power company. This should be a 120 volt (two-wire) service of adequate ampacity for the predicted loads. A 120/240 volt, three-wire, service should only be considered when it will also be used to power a few roadway luminaries at the intersection, and in this case, disconnects shall be arranged so that it is possible to disconnect the lighting circuit for repairs without disturbing signal operation.

Traffic SCD TC-83.10 addresses pole mountings for controllers and power service. **ODOT**-maintained signals shall use padlocks at all times to prevent unauthorized disconnect operation.

Provision of traffic signal power service will cover the same general considerations as designated for separate independent sign lighting power services ***(Section 240-7.7, 1 and 3).*** The availability of power at various locations in the intersection may tend to make some locations more favorable for the controller mounting.

Plan Note 442-2 ***(see Section 442-2)*** should be included on projects with traffic signals. The name and address of the power company and the voltage to be supplied shall be specified in the appropriate blanks.

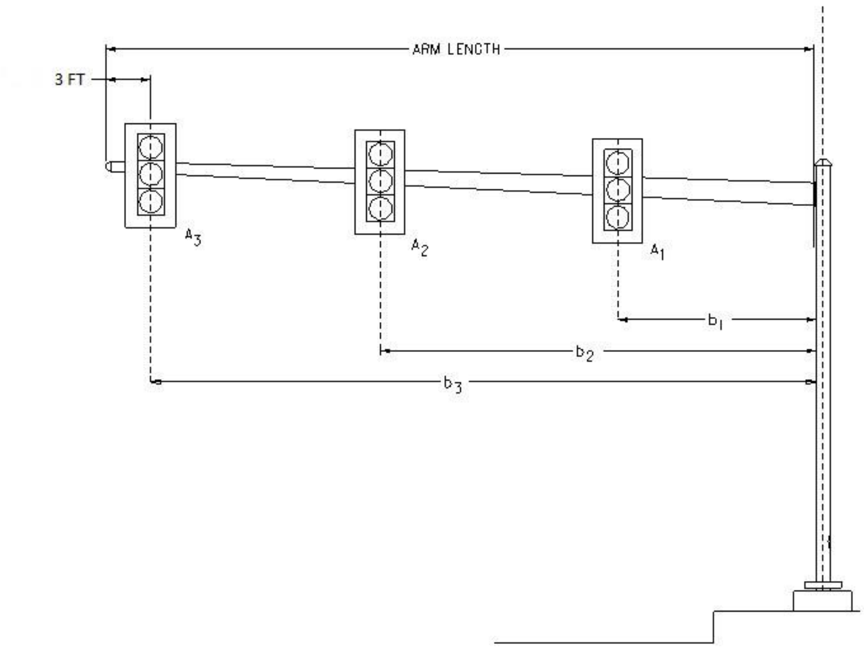
440-3 Single-Arm Overhead Signal Support

Various types of overhead signal supports are depicted in ***Table 497-4.*** In designing a single-arm overhead signal support, the following instructions are used in conjunction with Traffic SCD TC-81.21 for new supports:

1. Determine the approximate arm length as the horizontal distance from the pole flange plates to a point 3 feet beyond the center of the most remote signal attachment, or 1 foot beyond the furthest edge of the most remote sign attachment.
2. Locate each signal or sign on the arm. Select the proper area for each signal head from ***Table 497-5***, and for a sign.
3. Calculate the area moment design factor (K) by multiplying each area (A) by the distance (b) from its attachment point to the pole centerline and add the products.

   $$K= b_1A_1 + b_2A_2 + b_3A$$

   See figure shown on next page. Area moment for standard luminaires and bracket arms may be calculated as 3L, where L = length of bracket arm in feet.



4. For a new support, select the proper design based on maximum arm length (from **TC-81.21**) and area moment design factor (K) from the design chart shown below.

Design No.	1	2	3	4	11	12	13	14
K	637	787.5	937.5	1575	1780	1995	2380	2641
Max Arm Length (ft)	25	32	38	38	45	48	60	70

5. As long as the K value is not exceeded, it is acceptable to exceed the “Maximum Design Area” shown on **TC-81.21**.
6. When an existing **TC-81.20** (see **SCD Archive**) support is to be retrofitted with backplates and/or rigid-mounted signals, the following design chart shall be used.

Design No.	1	2	3	4	11	12
K	318.5	378	412.5	825	845.5	1045
Max Arm Length (ft)	25	32	38	38	45	48

7. The value should not exceed that listed for the selected design number. If the values are exceeded, the designer shall be responsible for determining the support size required.
8. Any mast arm length greater than 59 feet is required to have a wind damping system.
9. If the design numbers for the supports at a particular intersection are similar (for example, 2 design number 11 and 2 design number 12 at the same intersection), then the smaller supports may be changed to the larger design number in the plans.

The designer shall submit detailed structural calculations showing the adequacy of any proposed non-standard signal support design. The proposed design shall include the foundation. The plan designer shall include a **Plan Note** reflecting the non-standard signal support design requirements in this section. The note shall include requirements for an engineer’s seal on both structural calculations and shop drawings for the proposed structure.

Calculations must be submitted to the owner agency for approval prior to fabrication. Shop drawings may be provided at time of delivery of the structure.

The supports shall be designed using the **AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals**. The following criteria shall be used for the design:

Basic Wind Speed – 90 mph
Design Life – 25 years
Fatigue Category III

The support designs shall **not** include galloping or truck induced gust loading.

440-4 Two-Arm Signal Support Design

Various types of overhead signal supports are depicted in ***Table 497-4.*** To determine arm and pole sizes for the two-arm signal supports where the arms are approximately at 90 degrees (± 15 degrees), proceed as follows:

1. Considering each arm as a single arm signal support, follow the design instructions noted in ***Section 440-3*** for **Traffic SCD TC-81.21**.
2. Using the arm sizes detailed for the **SCD TC-81.21** design numbers selected in step 1, use the following chart to select the pole size required.

<table>
<tr><td rowspan="8">Arm "A"
Design No. TC-81.21</td><td>1</td><td rowspan="2">A</td><td colspan="7"></td></tr>
<tr><td>2</td><td></td><td colspan="6"></td></tr>
<tr><td>3</td><td colspan="3">B</td><td colspan="5"></td></tr>
<tr><td>4</td><td colspan="2">C</td><td></td><td rowspan="2">E</td><td colspan="4"></td></tr>
<tr><td>11</td><td colspan="3">D</td><td></td><td colspan="3"></td></tr>
<tr><td>12</td><td colspan="3">E</td><td colspan="2">F</td><td>G</td><td></td><td></td></tr>
<tr><td>13</td><td colspan="3">G</td><td colspan="2">H</td><td colspan="2">I</td><td></td></tr>
<tr><td>14</td><td colspan="4">I</td><td colspan="2">J</td><td>K</td><td>L</td></tr>
<tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>11</td><td>12</td><td>13</td><td>14</td></tr>
<tr><td></td><td></td><td colspan="8">Arm "B"
Design No. TC-81.21</td></tr>
</table>

Where the following defines the related pole designations:

Pole Designations		
A	TC-81.21	DES 3
B	TC-81.21	DES 4
C	TC-81.21	DES 11
D	TC-81.21	DES 12
E	TC-12.30	DES 5
F	TC-12.30	DES 6
G	TC-12.30	DES 7

Pole Designations		
H	TC-12.30	DES 8
I	TC-12.30	DES 9
J	TC-12.30	DES 10
K	TC-12.30	DES 11
L	TC-12.30	DES 12

3. The **SCD TC-81.21 or TC-12.30** design number for the pole shall be used in the plans as reference for the proper pole base and foundation details.
4. **SCD TC-81.21** will apply for arm details and arm attachments.

5. ***Section 441-10*** provides a recommended bid item description for a two-arm signal support.

440-5 Span Wire Signal Support Design Software (SWISS)

ODOT has developed a software program to calculate the moment at the base of a strain pole for various span wire configurations. The base moment is compared to **Traffic SCD TC-81.10** to select an adequately sized strain pole for the span wire configuration analyzed. The software program is available to consultants and local jurisdictions on the **Office of Roadway Engineering (ORE)** website.

Unless specifically necessary, all strain poles for a given span shall be the same design number. This is done by setting all pole designs in the plan to be the same design number as the largest pole indicated by the SWISS software.

The use of H-spans is discouraged in favor of the Box-With-Tails span configuration. Bullrings shall be located along imaginary diagonal lines between the poles. Questions about span wire configuration selection can be directed to the **ORE** staff.

See ***Table 497-6*** for the height from the bottom of the signal head to the messenger wire or mast arm.

440-6 Traffic Signal Timing Analysis

440-6.1 Traffic Signal Timing Software

ODOT currently uses version 10 of **Synchro** (signal timing and coordination) and **SimTraffic** (simulation) software.

440-6.2 Diamond Interchange Traffic Signal Timing

When developing traffic signal timing for diamond interchanges, the designer should also analyze the interchange using controller phasing operation developed by the **Texas Department of Transportation**. The interchange signal operation typically uses one controller to operate both ramp intersections. Two forms of the controller operation are available:

Three-phase diamond operation is best suited for wide interchanges (>400 feet) with adequate internal left-turn storage and heavy through movements usually associated with rural/suburban type interchanges. The 3-phase operation may provide better two-way arterial coordination than the 4-phase operation.

Four-phase diamond operation is best suited for interchanges where the ramp intersections are close together and have heavy left turning movements usually associated with urban type interchanges. This operation will usually reduce congestion within the interchange and should be considered where arterial left turn storage is inadequate.

The signal timing analysis for the diamond interchange is initially performed in **Passer III** which provides various signal timing/cycle length combinations with performance measures for each. **Synchro/SimTraffic** software is then used to analyze the arterial performance of the various cycle lengths to obtain the best match for the arterial system operation.

Traffic Plan Insert Sheets (PISs) are available for both the 3-phase and 4-phase operations that provide controller and detector information that can be included in the signal plans.

440-7 Stage 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage 2 and 3 plan submittals. The forms referred to in this Section are on-line in the **Signal Design Reference Packet** *(see*

Section 495-2), or on the **OTO** Forms web page.

1. Stage 2 Plan Requirements:

    a. Base plan drawn to a scale of 1:20 and it shall include roadway base lines.

    b. Traffic signal pole locations and skew angles, if required. Reference numbers for all poles.

    c. Signal head locations and direction; identify signal heads having turn arrows, louvers or special optically programmed features; signal head sizes; and reference numbers for all signal heads.

    d. Signal controller location and orientation.

    e. Detector locations, loop configurations and detector chart ***(Form 496-4)***.

    f. Underground conduit and pull boxes.

    g. Overhead sign locations, whether on signal spans, mast arms or located on separate supports.

    h. Legend for symbols used.

    i. Pavement marking pertinent to the signal operation.

    j. Signal phasing diagram ***(see Figure 498-46)***, method of addressing yellow trap (where applicable) or field hook-up chart ***(Form 496-16)*** and signal timing. See the **Signal Design Reference Packet** ***(Section 495-2)*** for typical signal timing charts and the field hook-up chart template ***(Form 496-16).*** Sample field hook-up charts are shown in ***Figure 498-47***.

    k. Handicap ramp locations.

    l. Right-of-Way lines.

    m. Corporation lines.

    n. Any existing features to be incorporated into the new signal. Any decision to reuse equipment must be based on a field check of the structural integrity and condition of the devices and agreement with the maintaining agency.

    o. Other physical features within the intersection and sidewalk area which may conflict with traffic flow, pedestrian flow or sight distance.

    p. **Synchro** files on CD.

    q. **SWISS** files on CD.

2. Stage 3 Plan Requirements:

    a. General Notes.

    b. Estimated quantities.

    c. Special details.

    d. Pole orientation chart.

    e. Wiring diagram. It shall indicate the type of cable and number of conductors connecting each signal head, pedestrian head, detector, push button, etc. See ***Figure 498-45*** for a sample diagram.

    f. Coordination timing. All coordination timings shall be in seconds.

The Traffic Signal Stage 3 check list is given in ***Form 496-2***.

440-8 ADA Requirements on Traffic Signal Projects

440-8.1 General

As noted in ***Section 401-9***, there are generally four major **ADA** requirements that affect traffic signal projects:

1. Accessible pedestrian signals;
2. Audible pedestrian pushbuttons (locator tones);
3. Curb ramps;
4. Truncated domes (tactile bumps on the curb ramp).

440-8.2 Accessible Pedestrian Signals and Locator Tones

Section 404-3 covers accessible pedestrian signals and locator tones at **ODOT-**maintained traffic signals. On traffic signal projects, local governmental agencies may install these devices at their intersections if it is part of their local policy/standards.

A common mistake made at rural type intersections is to provide a pedestrian pushbutton on a pole that is located far back from the roadway. When provided, pedestrian pushbuttons shall be accessible to the disabled. This may mean providing a paved pathway back to the pushbutton. Alternatively, a pedestal can be provided to put the pushbutton near the intersection.

440-8.3 Curb Ramps

Refer to **Location and Design Manual, Volume 1, Section 306** for basic guidelines for pedestrian facilities (curb ramps and sidewalks).

On traffic signal projects, **ADA** compliant curb ramps shall be provided at locations where work is being performed. This includes upgrading any existing curb ramps to meet current **ADA** design requirements. Generally, every intersection where a traffic signal is installed or upgraded shall be provided with **ADA** compliant curb ramps. In cases where an intersection is not disturbed, i.e., only running aerial interconnect, curb ramp work would not normally be required (though the locals may include the work). If the interconnect is being trenched through an intersection, curb ramps would be required as part of the project. The litmus test is if the work being proposed will disturb the intersection, then curb ramp work will be required. For maintenance type work, curb ramp work would not be required. Controller and cabinet upgrade only locations shall be considered substantial enough to require curb ramp upgrading.

440-8.4 Truncated Domes (TDs)

TDs are raised "bumps" used by people with vision impairments to be able to feel where the ramps are. All new, existing or upgraded curb ramps shall have truncated domes upon completion of a traffic signal project.

Roadway Engineering's SCD BP-7.1 addresses new ramps. For guidance in the use of this drawing, contact the **Office of Roadway Engineering**.

440-9 Paying Locals with Project Funds

On some projects, the local authorities desire to have one of their employees in attendance when the contractor is working in their traffic signal controller cabinets. This is a legitimate request and the plans should include a general note requiring the contractor to inform the local authorities prior to working in their traffic signal controller cabinets. The cost of providing the local employees shall be borne by the local authorities. Project funds shall not be used to pay the local representative's salary, either straight or overtime pay.

440-10 Span-Mounted Traffic Signal Support Structures

440-10.1 General

Various rigid span-mounted (non-cantilevered) traffic signal support structures may be used when required. These are not standard **ODOT** designs, but must be designed specifically for each instance. Such structures shall be designed according to **AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals**. A typical use of these structures is to support traffic signals above the roadway on a SPUI (Single-Point Urban Interchange).

These applications often involve placing the span-mounted signal support on an overpass or similar roadway structure. The rather concentrated base loads transferred into the roadway structure by the signal support structure must be considered early on in the design of the roadway structure. They differ from the usual bridge design loads. Because of their size, complexity, and potential for dynamic interaction with the supporting roadway structure, the designer must carefully consider a number of factors. These include but are not limited to:

- Width of signal support span.
- Size of signal support span members.
- Depth of signal support span truss.
- AASHTO Design Loads.
- Fatigue and vibration.
- Location of connection to highway structure.
- Routing of electrical conduits.
- Maintenance and inspection.

440-10.2 Width of Span

General requirements for the type of structure for a given span are as follows:

1. Up to 99 feet: monotube or 2-chord;
2. 100 to 139 feet: 2-chord;
3. 140 to 169 feet: 2-chord or 3-chord; and
4. Greater than 170 feet: box (4-chord).

440-10.3 Size of Members

The size of individual members varies with each design. However, it is suggested that individual horizontal members be restricted to less than 3 feet in diameter at their widest part. This is done so that the traffic signals, which are about 3 feet in height, will not be "lost" from the drivers' view amid the massive support structure. Backplates are required on all signals.

The **ODOT Bridge Design Manual (BDM)** sets the minimum pier cap width at 3 feet. Rigid span-mounted traffic signal supports often have embedded foundation dimensions of 4 feet or more. Therefore, it is recommended that cap widths and column diameters of at least 4 feet be provided early in the bridge design process. A bullnose type pier cap and wall or column may be used to meet this requirement.

Collision protection shall be provided for independent signal span supports and all piers anchoring signal span supports if located within 30 feet of the edge of pavement.

There are practical limits to the size of the individual span segments (which usually bolt together), both in span and chord depth. For example, there is a limit on the size of available galvanizing tanks. The designer shall contact prospective manufacturer for manufacturability guidelines.

The length of individual span members shall be kept small enough to ensure reasonable transportation requirements to the job site.

440-10.4 Depth of Span Truss

An arbitrary rule-of-thumb according to **AASHTO LRFD Bridge Design Specifications** is that any structural component with a length-to-depth ratio of 30 to 1 or higher is likely to be a wind-sensitive component.

Using the arbitrary guideline above, the general requirements for the minimum depth of trusses are as follows:

1. Up to 119 feet: 4 feet; and
2. 120 to 200 feet: 6 feet.

The mid-span diameter for monotube structures shall be at least 2.0 percent of span.

440-10.5 AASHTO Design Loads

The following **AASHTO** design criteria shall be used for rigid span-mounted traffic signal support structures. These criteria shall also be used to determine the minimum base service loads transferred into the roadway structure. Appropriate load factors shall be applied by the structural designer. Exposure height shall be considered in all calculations, and the **AASHTO** height and exposure factor adjusted accordingly.

1. **AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals;**
2. Basic Wind Speed: 90 miles per hour (this requirement in addition to standard bridge design wind resistance requirements);
3. Design Life: 50 Years;
4. Fatigue Category I;
5. Natural Wind Gust included; and
6. Truck-induced gust included.

440-10.6 Fatigue and Vibration

AASHTO LRFD Bridge Design Specifications consider fatigue of steel structural components only from the standpoint of live load Dynamic Load Allowances, using the design vehicle. This is not appropriate for dynamic loads transferred to the roadway structure through the base of a span-mounted traffic signal support. Such loads are more appropriately considered using the **AASHTO LRFD Bridge Design Specifications** defined under the section titled **Aeroelastic Instability**.

AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals Section 11 defines equivalent static wind loads to account for fatigue loads. Considering the Span-Mounted Traffic Signal Support to be a "structural component apt to be wind sensitive," these equivalent static loads shall be used to determine the magnitude of aeroelastic base loads transferred into the roadway structure, per **AASHTO LRFD Bridge Design Specifications**, unless an alternate analysis method is approved by the **ODOT** **Offices of Structural Engineering** and **Roadway Engineering**. The design aeroelastic base loads transferred shall be at least 15 percent of the highest design static base loads calculated for the span-mounted traffic signal support.

440-10.7 Location of Connection to Roadway Structure

Figure 498-44 shows several general anchor locations for rigid signal spans on roadway (bridge) structures. Regarding these anchor locations the **Office of Roadway Engineering** has the following guidelines:

1. Deck-mounting of signal supports shall not be used without permission of the **Office of Roadway Engineering**. If used, they shall be located directly above a pier and anchored to a pier wall or pier column though a concrete diaphragm between the girders.
2. Signal supports other than pedestals shall not be anchored into parapet walls or concrete barriers.
3. Signal supports other than pedestals shall not be anchored into pier cap overhangs.
4. Steel anchor bolt base plates shall not be used in place of full, headed anchor bolt embedment in concrete.
5. Signal supports shall not be anchored into T-Type pier overhangs.
6. The preferred attachment location to a roadway structure is an extended pier cap atop an extended wall or directly over a column. Anchor rods shall be continuous, vertical and at full required embedment depth through both the cap and the pier wall with minimum 3-inch cover. Pier cap and wall must be designed to withstand the loads imposed by **AASHTO** criteria listed above, and not merely an extension of a pier designed to meet bridge load requirements alone. Adequate primary and auxiliary longitudinal shear and torsional reinforcement steel shall be provided in the pier cap and column for these loads. Proportioning design documentation shall be provided by the Designer to both the **Office of Structural Engineering** and the **Office of Roadway Engineering**.
7. Independent structures are also permitted. With independent structures, the roadway and signal support structures are not connected. A separate cylindrical foundation should be used for the signal support, designed for the soil conditions at the site. This support foundation may be integral to or separate from the pier foundation.

440-10.8 Routing of Electrical Conduits

Electrical conduits at the base of the signal span support will occupy a significant portion of the space available for concrete and reinforcing steel and cannot be neglected in the design of the roadway structure. In general, allowance shall be made for at least one 4-inch and one ¾-inch (for grounding) Schedule 40 conduits. These conduits shall extend vertically into the mid-portions of the cap cross section and longitudinally thereafter for some distance, up to nearly the full cap length. It is anticipated that the influence of these conduits will be minimal with respect to reinforcing steel. However, their effect on cross section, especially in the compression zone, must be accommodated.

The preferred method of routing electrical cables to and from the signal span support shall be to exit the pole via a conduit access port. A short length of liquid-tight flexible metallic conduit (LFMC, in trade sizes up to 4 inches) shall be used to join to rigid conduit on the roadway structure. Only Heavy-Duty, Corrosion-Resistant Stainless Steel LFMC fittings shall be used. The LFMC shall be UV resistant, rated for outdoor use, suitable for direct burial, and have a minimum temperature range of -10 degrees Fahrenheit to +130 degrees Fahrenheit (wet). A separate internal equipment grounding conductor shall be used in all LFMC runs as part of the structure grounding system.

Power Service disconnect for the traffic signal shall not be located in the controller cabinet, but must be in a separate enclosure. This disconnect enclosure shall not be located on the superstructure.

440-10.9 Maintenance and Inspection

Safe access to the support shall be considered in the design. Frequent access by signal electrical maintenance personnel must be anticipated, with a corresponding need for well-placed electrical access panels and conduit runs. The following guidelines apply:

1. Hand holes shall be provided at the base of vertical supports, oriented for ease of access by maintenance personnel as far away from moving traffic as possible.
2. Hand holes shall be provided at mid-pole locations opposite any conduit fittings that provide a connection between the pole and the highway structure.
3. Hand holes shall be provided at the top of the pole opposite from the arm attachment, to provide access to electrical cables turning the corner from pole to span. One or more J-hooks shall be provided in the pole above this point for cable support.
4. Size of hand holes shall be as large as possible and proportional to the diameter of the structural tube at the point they are located.
5. Access for all routine signal maintenance tasks shall be possible without the use of a snooper truck. All such tasks must be possible using a standard **ODOT** 45-foot bucket truck.

Access by structural inspection teams must also be anticipated in the design:

1. The preferred method of access to pole base, pole top, and span for inspection purposes is a standard **ODOT** 45-foot bucket truck situated at a safe location in the median or shoulder below the highway structure and on the deck, with proper work zone traffic control.
2. Inspection access that can only be made by snooper truck is discouraged, but if it is unavoidable, safe placement of the snooper truck shall be provided in the Plans.

440-11 Solar-Powered Electrical Devices

Section 702-4 and **Plan Note 742-2** ***(Section 742-2***) address the use of solar-powered School Speed Limit Sign assemblies; and ***Section 940-2*** and **Plan Note 942-2** ***(Section 942-2)*** address solar-powered Crossing Sign assemblies.

Section 442-50 provides a generic **Plan Note** for use with other permanent electrical or electronic devices used with **ODOT** signs, signals or ITS projects that are powered by batteries and recharged by solar panels.

440-12 Signal Cable in Breakaway Transformer Base

Signal cable shall be continuous from the cabinet to the signal head. The only exception, to be made on a pole-by-pole basis, is when the roadside exposure of a signal head is such that frequent vehicle strikes, and breakaway knockdown of the support, is anticipated. For example, this sometimes occurs on small curbed islands with pedestrian signal heads on pedestals. Replacing the entire length of signal cable after every breakaway occurrence can become a nuisance maintenance issue for the District, and repeated pulling of replacement cable runs can damage other cables in comingled electrical raceways. If this situation is encountered, **Traffic PIS 208340** may be used to provide a probable separation point for the signal cable in the event of a breakaway event at the pole. Use of **PIS 208340** should only be under these very specific circumstances, and only with approval of the **District Traffic Engineer**.

441 PLAN PREPARATION / PRODUCTION

441-1 General

The **L&D Manual Volume 3** and ***Chapter 140*** generally describe **ODOT** plan preparation and production guidelines. Additional information is provided in this Chapter and ***Chapter 440*** regarding traffic signal items in plans. Also, designers should utilize the files and guidance provided in the **Signal Design Reference Packet** when preparing signal plans. See **Chapter 495** for information regarding the reference packet.

441-2 Reserved for Future Information

This Section is reserved for future information.

441-3 Signal and Sign Supports

The following location requirements apply to Stage 2 Plans:

1. Consider sight distance conflicts between signals and overhead signs included within the project, as well as other visibility obstructions. Signals take precedence for prime locations.

2. Combine signal, sign and/or light poles where practical; in so doing the support shall be a signal support bid item.

3. Distance from Stop Line to signal heads shall be in accordance with **OMUTCD** **Sections 4D.13 and Figure 4D-4**. Stop Lines shall be located to suit geometric conditions, then signal head locations provided to suit.

4. Minimum lateral clearances to pole or signal equipment attached thereto shall be as per **Section 600 of the L&D Manual Volume 1.**

5. Where sidewalks are encountered, signal poles and equipment shall be located behind them if physically possible.

6. Locate signal poles behind existing guardrail wherever possible, with a minimum clearance of 6.5 feet from the face of guardrail to the centerline of the support. Other signal equipment shall have a minimum clearance of 6 feet from the face of guardrail to the nearest edge of the equipment.

7. Determine the exact location by station to the nearest 1 foot. This information will be needed in Stage 3 Plans.

441-4 Power Service

Tentative power service locations shall be specified as needed on the plans either on the signal support or at separate service poles (separate bid item). The contractor's work will generally consist of providing sufficient length of two-wire power cable out of the weatherhead, to which the power company will make their attachments and connections. See ***Section 450-9*** for the measurement of power and service cables.

See ***Section 440-2*** for design information on electrical power for traffic signals. Prior to filing the tracings, the design agency shall confirm in writing, agreements made with the power company, to the **District Production Administrator** and **City Traffic Engineer** (if applicable).

441-5 Underground Facilities

Conduit runs shall usually be limited to 200 feet between pull boxes, but up to 400 feet may be used if the run is straight and not too full.

Conduit crossing bridge structures shall, if possible, be included in parapets. As an alternative, it may be attached to the underside of the parapet by means of clamps. Necessary flexible conduit at expansion joints shall be provided.

Conduit under the roadway shall be a minimum of 4-inch diameter. See ***Section 450-3.4*** for additional information.

441-6 Quantities

In the General Summary, all quantities should be shown in whole units of measurement, except concrete which shall be shown to a tenth of a cubic yard and any pavement marking item measured in miles, which shall be shown to a hundredth of a mile.

441-7 Bid Item Descriptions

Bid item descriptions are required to exactly match the descriptions published in the "Item Master." This "Item Master" is available from the **ODOT Design Reference Resource Center (DRRC)** web page.

When the standard bid item description is inappropriate, the words "As Per Plan" shall be added to the description, and a note shall be provided to describe the deviation from the standard specifications and/or details. See ***Chapter 442*** for examples of typical **Plan Notes**.

441-8 Signal Support, Detail Design Requirements

Figures 498-36, 498-37 and 498-38 provide examples of tables for presenting signal support information in the plans for support types described in **Traffic SCDs TC-81.10 and TC-81.21**.

Use of the sample tables is recommended as a means of uniformly presenting support information to the contractor or support manufacturer. The support designer should note that the orientation angles consist of:

- A field angle that establishes the angular relationship between the project centerline perpendicular and a pole feature (handhold or mast arm) which serves as an index.
- Angles for all pole appurtenances that are measured from this index pole feature.

Complete instructions for designing the single arm overhead signal support described in **Traffic SCD TC-81.21** are contained in ***Section 440-3***. Instructions for the design of two-arm signal supports are contained in ***Section 440-4***.

The following information relates to the detail design of signal supports for Stage 3 plans.

1. Foundation elevations and span wire attachment heights are optional for signal strain poles. Top and bottom foundation elevations should be provided if foundation dimensions are not as shown on **Traffic SCD TC-21.20**, or when steep roadside slopes or roadway superelevation would make foundation elevations difficult to otherwise determine.
2. Station and offset information is not necessary for signal strain poles in the strain pole table. Poles should be clearly labeled and locations dimensioned on the signal intersection sheets.
3. Do not give conduit angles for foundations because these will be field located by the contractor according to the plans and field conditions. An exception would be for unused, capped conduit ells for future use.
4. A column may be added to define the street from which the centerline and angles are determined.

5. For a project with many installations, a column for cross reference to the signal or sign plan sheet should be added.
6. A column may be added to define the street from which the centerline and angles are determined.
7. For a project with many installations, a column for cross reference to the signal or sign plan sheet should be added.
8. Elevation views of the signal spans are optional. However, if elevation views are not used, span dimensions between signal heads and signs shall be shown on each signal intersection sheet.
9. Strain poles **(Traffic SCD TC-81.10)** can typically be located with the base plate either square or at 45 degrees to the roadway centerline. The pole and foundation are designed for loading in any direction, but the anchor bolts should always be located in line with the resultant span wire load.
10. If two pedestrian signal heads are located on a pole, the designer must choose between a single mounting bracket for two heads or separate mounting brackets for each head. Also, **Traffic SCD TC-85.10** allows field installation of holes with alternate mounting methods instead of threaded blind half couplings. The maintaining agency's choice of mounting method should be clearly noted in the plans.
11. If luminaire bracket arm attachment plates are required, a column should be listed in the table to show the orientation angles. The plan should note whether one or two plates are required. The power company or maintaining agency should be contacted concerning any special mounting attachment requirements. **ODOT** standards are shown on **Traffic SCD HL-10.12**.

441-9 Service Cable

In **C&MS 732**, service cable is specified primarily as aluminum conductors. This was done because aluminum is typically most cost effective in these sizes, and more readily available. The specification allows the substitution of copper conductors of one size smaller. This is because the greater conductivity and lower resistance of copper approximately accounts for one wire size. For instance, a #8 AWG copper conductor with an ampacity of 45 AMPs may be substituted when the plan calls for a #6 AWG aluminum conductor which would have an ampacity of 50 AMPs.

This relationship is considered acceptably close for the required usage. The specifications call for appropriate connectors to match wire material.

There is a potential problem if the designer uses a specific size of copper service cable, out of habit, without recognizing that the change to aluminum has effectively reduced ampacity of these cables by 12 to 25 percent.

A similar relationship exists for cases where long runs of service cable require consideration of voltage drop.

Under **C&MS Item 632** and **C&MS 732**, service cables should be sized to the following minimums:

Total Control Load (AMPS)	Aluminum Wire Size (AWG)
20	#10
30	#8
45	#6
65	#4

Also note that aluminum service cable (duplex or triplex) is not readily available in smaller than #8 AWG.

441-10 Two-Arm Signal Supports

Section 440-4 describes the procedure for designing a two-arm signal support. As noted in that Section, the **Traffic SCD TC-81.21 or TC-12.30** design number for the pole may be used in the plans as reference for the proper pole base and foundation details. **SCD TC-81.21** will apply for arm details and arm attachments.

The bid item for the structure should be in the form:

> Item 632 (Combination) Signal Support, Type (TC-12.30 or TC-81.21) Design __ Pole, with Mast Arms TC-81.21 Design __ and TC-81.21 Design __

A detailed elevation view and any other special details required for the two-arm support that are not covered by the **SCD** should be included in the plans.

441-11 Guarantees

For projects not requiring detail guaranteeing, the requirements of **C&MS Item 633** will apply. On traffic control projects or other projects where the cost for traffic control is more than one-third of the total cost, a Plan Note based on ***Section 442-15*** may be included. The period of guarantee should be adjusted in relation to equipment complexity, i.e., 90 days for simple equipment, 120 days for traffic adjusted equipment and a maximum of 180 days for computerized control of many intersections. When the note is included, notice of the fact should be communicated in the transmittal of final tracings to **Central Office**, so that affected groups may make provision in the proposal for the extended completion date.

441-12 Alternate Bids

The use of alternate bidding procedures must be requested and the maintaining agency must agree in writing to the procedure. Alternate bids are typically used for projects where a particular type or brand of equipment is desired, usually the signal controller. ***Section 442-16*** presents an example of an alternate bid note **(Plan Note 442-16)** setting up an alternate bid item in the plans. This note should be placed in the plans at the end of the general notes for traffic signal items. In the general summary, the alternate bid item should be at the end of the list of traffic signal items.

442 PLAN NOTES

442-1 General

Typical **Plan Notes** have been consolidated here for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid item will be "as per plan". Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

442-2 Power Supply for Traffic Signals

Electric power shall be obtained from the ___________ at the location indicated on the plans. Power supplied shall be ____ volts.

Designer Note: See ***Sections 440-2 and 441-4***.

442-3 Signal Activation

Prior to activating the new traffic signal to stop-and-go mode and/or removing the existing traffic signal from service, all items in the proposed signal plan shall be fully completed, (i.e., vehicle detection, pedestrian signal heads, etc). If there are constructability issues (i.e., roadway widening, etc.) that prevent the signal from being completed prior to activation, it shall be brought to the attention of the Project Engineer and District Traffic Engineer. The District Traffic Engineer will then review, approve or reject proposals to activate the traffic signal prior to completion.

The Contractor shall notify the Project Engineer and District Traffic Engineer at least 10 working days prior to scheduling the final inspection of the signal installation. Final inspection is not considered complete until designated district traffic personnel inspect the traffic signal and issue written approval. If issues are found during the final inspection that effect the safety of the traveling public and/or the efficiency of the intersection, the signal shall not be activated on the proposed date. Any punch list items that are found shall be corrected and reinspected by district traffic personnel prior to final acceptance. ODOT forces shall only assume day to day maintenance of the traffic signal after final written acceptance has been issued.

Designer Note: Note shall be used for all new **ODOT** traffic signal installations.

442-4 632 Removal of Traffic Signal Installation

Traffic signal installations, including signal heads, cable, messenger wire, strain poles, cabinet, controller, etc., shall be removed in accordance with C&MS 632.26 and as indicated on the plans. Removed items shall be reused as part of a new installation on the project or stored on the project for salvage by (name of agency receiving stored items) in accordance with the listing given herein.

(Items to be reused)

(Items to be stored)

Removed items shall be delivered to the nearest ODOT facility whose address is listed below:

ODOT District X, Attn: Xxxxxx Xxxxx (Contact Phone Number)

Address Line 1
Address Line 2

In the event the items stored on the project for salvage by the local agency are not removed, the Contractor shall, when directed by the Engineer in writing, remove and dispose of the items at no additional cost to the project.

Designer Note: This note shall be included on projects where existing traffic signal installations are being removed. A listing of items to be reused and/or stored must be included. Pull boxes to be removed shall be itemized separately and paid for under Item 625 “Pull Box Removed”.

442-5 632 Interconnect Cable, Misc.: (by Size), with Support Messenger, As Per Plan

The Contractor will be permitted to use either of two types of interconnect cable construction and installation under this item as follows:

1. Integral messenger type interconnect cable meeting the requirements of C&MS 732.19. Under this method any sections of cable shown in the plans to be contained in controllers, cabinets, poles, conduits or supported on messenger wire installed for other purposes shall have the supporting messenger and jacket web neatly removed by the use of a tool specifically designed and sized for this purpose. Deviations from the cable routing shown in the plan, for the sole purpose of reducing the amount of messenger to be removed, will not be permitted. The cable shall be installed with approximately one twist for each 15 feet of span length.
2. Separate interconnect cable meeting the requirements of C&MS 732.19 plus a 1/4 inch messenger wire and lashing meeting the requirements of C&MS 732.18. Under this method the Contractor will install a separate 1/4 inch messenger to support the spans of interconnect cables in all locations where the plans show interconnect cable which is not otherwise supported by a signal messenger wire or other suitable support. Utilization of existing messenger wire, not provided by the project or designated therein as available for use, is prohibited. Deviation from the cable routing shown in the plans, for the purpose of reducing the need for separate messenger wire, will not be permitted.

In either case the number of splice locations shall be kept to a minimum.

Measurement will be based upon the number of feet of C&MS Item 632, "Interconnect Cable, Misc.: (by size), with Support Messenger, As Per Plan" in place in accordance with the method described in C&MS 632.29 and no separate payment will be provided for any separate messenger wire used to support interconnect cables.

Designer Note: This note may be used on projects with overhead interconnect cable, if acceptable to the maintaining agency.

442-6 632 Loop Detector Units, by Type, As Per Plan

In addition to the requirements of C&MS Item 632 and C&MS 732.07 or 732.08, loop detector units shall have the following requirements or features:

The output device shall be a relay, and all contacts shall be in the wiring harness.

The unit shall be self-tuning.

The unit's electrical connection plugs or wiring harness shall allow ready replacement with a single channel amplifier as described in C&MS 732.07.

Each unit shall be labeled to correspond to its phase and direction.

Delay inhibit shall be connected on all detector harnesses for their respective phase greens.

Designer Note: This note should be included for projects which will be maintained by **Districts** that use **NEMA** TS-1 controller cabinets. Bid items are not used unless detector units are installed in an existing cabinet.

442-7 Detection Maintenance

If vehicle detection becomes unexpectedly disabled, requires modification, or is scheduled to be temporarily removed during the construction project, the Contractor shall immediately notify the Project Engineer and District Traffic Engineer.

If the loss of vehicle detection is known prior to the start of construction, it shall be discussed at the preconstruction meeting. At such time, the District Traffic Engineer shall advise the Project Engineer and Contractor on the appropriate action to rectify any loss of vehicle detection. This may include placing the traffic signal on minimum or maximum recall, modifying the minimum green times, and removing the malfunctioning detection from service. Where non-intrusive detection (i.e. video, radar) already exists, the Contractor shall insure that detection is operating and maintained by reconfiguring the detection units accordingly during all construction phases. This is to avoid the signal from maxing out the effected signal phase and creating unnecessary delays.

Locations where non-intrusive detection is proposed and the existing vehicle detection is to be abandon, the non-intrusive vehicle detection shall be installed, configured and made fully functional prior to the existing detection being disabled. The Contractor shall continue to maintain and modify the detection until final acceptance of the traffic signal. This is to ensure vehicle detection remains fully functional throughout construction.

Designer Note: This note shall be used on all projects where a potential conflict exists that will effect vehicle detection.

442-8 Work Inspection

The Contractor shall provide the Project Engineer and District Traffic Engineer with 72 hour notice of any signal work to be performed at the intersection site(s) so that inspection services can be supplied.

Designer Note: The note should be used on all projects where signal modifications occur or new signals are constructed.

442-9 632 Loop Detector Lead-In Cable, Direct Burial

This work shall include furnishing and installing loop detector lead-in cable of the type required in C&MS 732.19. Installation shall be by cable plow or vibratory cable plow to a minimum depth of 18 inches. All entries into pull boxes, conduit systems, foundation or other enclosures shall be free of sharp edges and be covered by insulated bushings. Following installation, the ground surface shall be restored to the original contour and surface condition.

Designer Note: This method may be considered in lieu of cable in conduit to reduce project costs. It is applicable to long underground runs in tree lawns or grassed roadsides where minimal interference with driveways or utilities is expected, and where disturbance of the area due to construction is not contemplated. If the cable is to be routed up a pole, a conduit riser (extending below ground with an insulated bushing) should be called for and detailed.

442-10 632 Combination Signal Support, Type TC-81.21 and Sign Support, TC- (with Light Pole Extension)

This support shall consist of a TC- _______ Design ___ pole with a TC-81.21 Design ___ signal arm and a TC- _______ Design ___ sign support arm (with light pole extension). All signal support items required by C&MS Item 632 and all sign support items required by C&MS Item

630 shall be included as part of this support.

Payment will be at the contract unit price and will be full compensation for all labor, materials, tools, equipment and other incidentals necessary for each support furnished, in place, complete and accepted.

Designer Note: This note shall be used when combination traffic signal supports and sign supports are desired. The blanks shall be filled in with appropriate **SCD** numbers and designs.

442-11 632 Combination Strain Pole, Type TC-81.10 and Sign Support, Type TC- (with Light Pole Extension)

This support shall consist of a TC- ________ Design ___ pole with a TC- ________ Design___ sign support arm (with light pole extension). All signal support items required by C&MS Item 632 and all sign support items required by C&MS Item 630 shall be included as part of this support.

Payment will be at the contract unit price and will be full compensation for all labor, materials, tools, equipment and other incidentals necessary for each support furnished, in place, complete and accepted.

Designer Note: This note shall be used when combination traffic signal strain poles and sign supports are desired. The blanks shall be filled in with appropriate **SCD** numbers and designs. The following is a bid item example: Combination Strain Pole, Type TC-81.10 and Sign Support, Type TC-12.30 (with Light Pole Extension).

442-12 Strain Pole and Pedestal Foundation Elevations

Elevations shown in the plans for strain pole and pedestal foundations are for computational purposes only. The actual elevation of the foundation shall be in accordance with Traffic SCD TC-21.20 provided the existing slope is less than 6:1.

At locations where the existing slope is 6:1 or greater, the buried depth of foundation, as shown in SCD TC-21.20 shall apply to the low side of the slope. The top of the foundation shall be set 2 inches above the existing surface on the high side of the slope. The additional depth of foundation necessary to meet these requirements shall be added to the formed top.

Designer Note: This note shall be used when strain pole and pedestal foundations are located in slopes of 6:1 or greater.

442-13 632 Vehicular Signal Head, (LED), (By Type), As Per Plan

In addition to the requirements of C&MS 632 and 732, the following requirements shall apply:

1. Signal heads and visors shall be constructed of black polycarbonate plastic with visors as specified and meet ITE specifications.
2. Proper exterior colors shall be obtained by use of colored plastic material rather than painting.
3. All upper signal support hardware and piping up to and including the wire inlet fitting shall be ferrous metal.
4. The entrance fitting shall be of the tri-stud design with serrated rings in order to achieve positive locking.
5. All signal heads shall be rigidly mounted to the mast arm with the (color) module located in front of the mast arm.
6. Aluminum backplates shall be in accordance with the C&MS and include a fluorescent yellow reflective border.

7. The light emitting diode (LED) modules shall meet the requirements of C&MS 732.04-C. The Contractor shall provide ODOT, in writing, with the LED manufacturer name, serial number, part number, description of lamp, and date of manufacture for all LED units that are to be used in the signal head prior to installation, for acceptance and warranty purposes.
8. Signal heads shall have a minimum wall thickness of 0.117 inches.
9. Signal heads shall include cutaway type visors unless otherwise specified in the plans.
10. Apply a bead of silicone to the signal head, washer, and entrance adapter serrations to prevent water intrusion. Also, fill the space between concentric serration rings on the top of the signal head to completely exclude water from the space between the concentric rings.
11. Balance adjusters shall not be used on one-way heads or tethered heads.

Payment for item 632 Vehicular Signal Head, LED, (By Type), As Per Plan shall be made for complete signal head furnished and installed, including all labor, equipment, materials, and new attachment hardware.

Designer Note: This note should be included for all projects; however**,** the note shall be modified as required based on the type of signal support specified (see items 5 and 11).

442-14 <u>632 Covering of Vehicular Signal Head</u>

Cover vehicular signal heads if erected at intersections where traffic is maintained before energizing the signals. Use a sturdy opaque covering material specifically made for use with traffic signals, and ensure that the color of the cover is different than the signal head, tan or beige, so that it is clear to drivers the heads are covered, not dark. Use a method of covering to cover attachment and materials, including backplates, as approved by the Engineer. Covers are to be free of text, pictures, or any type of advertising. Maintain covers, and remove them when directed by the Engineer.

Designer note: This note should be used on all new signal installations and any project which will require the covering of vehicular signal heads.

442-15 <u>Guarantee</u>

The Contractor shall guarantee that the traffic control system installed as part of this contract shall operate satisfactorily for a period of _____ days following completion of the 10-day performance test. In the event of unsatisfactory operation the Contractor shall correct faulty installations, make repairs and replace defective parts with new parts of equal or better quality.

Equipment, material and labor costs incurred in correcting an unsatisfactory operation shall be borne by the Contractor.

The guarantee shall cover the following items of the traffic control system: controller, cabinet, uninterruptible power supply, vehicle detection equipment, LED lamp units, network and communication/interconnect equjpment.

Customary manufacturer's guarantees for the foregoing items shall be turned over to the state or the maintaining agency following acceptance of the equipment.

The cost of guaranteeing the traffic control system will be incidental to and included in the contract unit price of the various items making up the system.

Designer Note: See ***Section 441-11***.

442-16 <u>633 Alternate Bid Item</u>

Example of a standard bid item:

633 Controller Unit, Type___, with Cabinet, Type ___

Example of an alternate bid item:

633 Controller Unit, Type ___, with Cabinet, Type ___ (Acme) - Alternate Bid

The controller shall be a Model (xx-99 as manufactured by Acme Signal Company, Santoy, Ohio) and shall incorporate or be furnished with all the design features, auxiliary equipment, accessories, and prewired cabinet features as required in the standard bid item.

Payment will be at the contract unit price for each, in place, all connections made and wiring completed, tested and accepted.

(Example of an alternate bid item)

Designer Note: See ***Section 441-12***.

442-17 Reserved – Existing Note Deleted

The Plan Note for "632 Vehicular Signal Head, Color, Material, By Type (with Backplate), As Per Plan" is outdated and has been deleted; however, the number has been reserved for future information.

442-18 632 Pedestrian Signal Head (LED), (Countdown), Type D2, As Per Plan

In addition to the requirements of C&MS 632 and 732 the following shall apply:

1. Signal heads and visors shall be constructed of black polycarbonate plastic and meet ITE specifications.
2. Proper exterior colors shall be obtained by use of colored plastic material rather than painting.
3. Pipe, spacers and fittings constructed of polycarbonate plastic may be used in lieu of galvanized steel or aluminum.
4. The pedestrian signal head shall be of the LED countdown type.
5. New attachment hardware and fittings shall be used
6. The light emitting diode (LED) modules shall meet the requirements of C&MS 732.04-C. The Contractor shall provide ODOT, in writing, with the LED manufacturer name, serial number, part number, description of lamp, and date of manufacture for all led units that are to be used in the signal head prior to installation, for acceptance and warranty purposes.

Payment for item 632 Pedestrian Signal Head (LED), (Countdown), Type D2, As Per Plan shall be made for the number of complete signal head furnished and installed, including all labor, equipment, materials and new attachment hardware.

442-19 632 Relamp Existing Signal Section with LED Module, By Lens Type, As Per Plan

This item of work shall consist of replacing the 12-inch lens and incandescent lamp in an existing signal head section with a 12-inch LED module.

The light emitting diode (LED) modules shall meet the requirements of C&MS 732.04-C. An LED module shall be furnished and installed for the type of signal lens specified in the bid item description.

As Per Plan" by the number of complete units furnished and installed, and will include all hardware and lamps as specified.

Designer Note: Since maintaining agencies will use different combinations of LED/incandescent lamp and aluminum/polycarbonate signal sections, this note will allow the designer to choose the various options that will provide the maintaining agency with features that they prefer. Items that are enclosed in brackets [ ] should be carefully considered and retained or deleted based on maintaining agency preferences. Care should be taken not to include duplicate requirements for the same item.

442-20 633 Controller Unit, Type 2070E with SEPAC Software, with Cabinet, (By Type), As Per Plan

The controller unit shall be equipment manufactured in conformance to the California Department of Transportation (Caltrans) specifications titles "Transportation Electrical Equipment Specifications (TEES)." The controller unit, Model 2070E, shall be compliant with the 2070E manufacturer and build as per the Traffic Authrorized Products (TAP) List.

The 2070E controller unit shall include the following:

1. Unit Chassis
2. 2070-1E CPU module
3. 2070-2E Field I/O Module
4. 2070-3B Front Panel
5. 2070-4A Power Supply
6. 2070-7A Serial Communication Module

The controller shall be supplied with the following traffic signal intersection control software: SEPAC 3.34g.The 2070-1E CPU module shall be supplied with Microware Embedded OS-9 Release 1.3 or later with kernel edition #376 or later, as required by Caltrans TEES. For warranty purposes, a vendor-specific decal, as per ODOT C&MS 733.02 shall be applied to each controller unit at time of delivery to the project.

The Contractor shall not reassign the cabinet detector inputs in order to reduce the number of 2-channel detector units supplied, but shall use the standard Caltrans Input File designations.

Designer Note: This note should be used at signalized intersections using Type 2070E local controllers that are to be owned and maintained by **ODOT**. The 2070-1E CPU is not compatible with the Linux OS.

442-21 Reserved – Existing Note Deleted

The **Plan Note** for "633 Controller Unit, Type 2070L, with Cabinet, (By Type), As Per Plan" outdated and has been removed; however, the number has been resrved for future information.

442-22 Reserved – Existing Note Deleted

The **Plan Note** for "633 Controller, Master, Traffic Responsive, As Per Plan" is outdated and has been removed; however, the number has been reserved for future information.

442-23 Reserved – Existing Note Deleted

The **Plan Note** for "633 Controller, Master, Traffic Responsive, As Per Plan" is outdated and has been removed; however, the number has been reserved for future information.

442-24 633 Controller Unit, Type TS2/A2, with Cabinet, Type TS2, As Per Plan

The equipment provided as part of this contract shall be the on the Office of Traffic Operations traffic authorized products (TAP) list.

The ground-mounted cabinet shall be a NEMA TS2 cabinet size 7 and shall have a minimum of three shelves.

Each cabinet shall come equipped with two 16-channel cabinet detector racks (CDR) including bus interface units (BIU). The loop detector termination panel for the second detector rack shall be omitted.

Payment for item 633 Controller Unit, Type TS2/A2, with Cabinet, Type Ts2, As Per Plan will be at the contract bid price per each complete and in place including all connections tested and accepted.

Designer Note: This note shall be used for all **ODOT** projects requiring a larger than standard TS-2 cabinet, and it should be used where additional network/communication/interconnect equipment is specified.

442-25 633 Preemption

This item of work shall consist of furnishing and installing preemption equipment in the locations and local controllers as shown in the plans. The preemption shall conform to ODOT Specification 633 and shall utilize communications to identify the presence of an emergency priority vehicle. It shall cause the traffic signal controller to select a pre-programmed preemption plan that will display and hold the desired signal phase for the direction of the emergency vehicle.

The communications medium shall employ either sound, light or radio detection techniques to determine and log the presence of the emergency vehicle. The system shall detect the presence of the vehicle through an emitting device located on the emergency vehicle. The system shall activate the preemption sequence by applying a signal to one of the controller's preempt discrete inputs. The system shall be completely compatible with the controller.

The equipment shall be shelf or rack mounted and easily removable and replaceable within the cabinet. Supply equipment completely wired in the controller cabinet and tested. The system shall be capable of preempting and receiving priority for each approach to the intersection. It shall be possible to detect the emergency vehicle up to 1200 feet from the

Intentionally blank.

intersection.

Supply each intersection shown in the plans with the following components, each bid separately:

1. Preempt receiving unit.
2. Preempt detector cable.
3. Preempt phase selector assembly and interface wiring panel.
4. Confirmation light.

If a light-activated system is specified, the Contractor shall inventory the City's existing emitters to determine compatibility with the proposed system. If existing emitters are found to be not compatible, then the City shall be supplied (at costs incidental to the system) with the emitters, transmitters, switches, wiring and all required vehicle equipment for the following emergency vehicles. The City shall be responsible for installing vehicle equipment. The model supplied shall be Opticom manufactured by Global Traffic Technologies LLC, Strobecom II manufactured by Tomar Electronics Inc., or approved equal.

If a radio-activated system is specified, the Contractor shall supply the above emergency vehicles with emitters at cost incidental to the system. The model supplied shall be Opticom GPS manufactured by Global Traffic Technologies, LLC, Emtrac Priority Management System Model GPS manufactured by STC, Inc., or approved equal.

If a sound-activated system is specified, the Contractor shall inventory the above emergency vehicles to determine compatibility of the sirens with the system. Each vehicle that is determined to be not compatible shall be supplied with new sirens at cost incidental to the system. The model supplied shall be Sonem 2000 manufactured by Traffic Systems LLC, Right-O-Way manufactured by Wapiti Microsystems, or approved equal.

If a light, radio, or sound activated system is not specified, then Contractor may supply any of the three types.

The City shall be supplied with software required to calibrate, log, and operate the system. The software shall be capable of operating under Windows 7, 32-bit operating system. Two (2) operating and instruction manuals shall be supplied with the software.

The Contractor shall thoroughly test the installed system. As a minimum, the Contractor shall verify that all connections are properly made to the controller cabinets. The Contractor shall check that the range setting is proper for each intersection. The Contractor shall determine that all phase selectors are selecting the proper phase and timing accurately. The Contractor shall verify that all vehicle emitters are being properly detected.

If the proposed preempt system is not compatible with the existing system, the Contractor shall provide training for up to fifteen (15) persons in the operation of the system. It shall be provided within 48 hours of the installation of the system. It shall consist of hands-on instruction for a minimum of sixteen (16) hours. The Contractor shall provide training for up to four (4) persons in the installation and maintenance of the system. It shall consist of a minimum of eight (8) hours of instruction. Training shall be supplied within seven (7) days of the installation of the system. All training shall be held in a City supplied location. Training shall be conducted by someone who has performed this within the last year and does it on a regular basis. The cost of training, including course material, travel subsistence and related costs, shall be entirely borne by the Contractor and shall be incidental to the preemption equipment.

Payment for Item 633 “Preemption” shall be made at the contract unit price for each preemption in place and fully operational as shown in the plans, except for those items bid separately.

Designer Note: This note describes a generic bid item for preempt systems. The quantity in the plans should be one each for the system; not the number of intersections.

442-26 633 Preemption Receiving Unit

Receiving units shall consist of a lightweight, weatherproof and directional assembly. Each receiving unit shall be 360 degree adjustable. The receiving unit shall be capable of sending the proper electrical signal to the traffic signal controller via the preemption detector cable. Receiving units shall be supplied with mast arm mounting hardware as shown in the plans.

Furnish preemption receiving units with 60-month warranties or for the manufacturer's standard warranty whichever is greater. Ensure that the warranty period begins on the date of shipment to the project. Ensure that each unit has a permanent label or stamp indicating the date of shipment.

Payment for Item 633 "Preemption Receiving Unit" shall be at the contract unit for each receiving unit in place, completely installed at the location shown in the plans, wired, tested and accepted.

Designer Note: The note may be used when preemption is included for in the plans.

442-27 633 Preemption Detector Cable

This item shall consist of furnishing and installing preemption detector home run cable in the locations shown in the plans. It shall connect the preempt receiving units to the phase selectors in the local controller cabinet.

Preemption detector cable shall conform to ODOT Specification 632. Only one external splice shall be permitted between preemption receiver unit and controller cabinet. This splice shall meet the requirements of C&MS 632.23 using a waterproof epoxy splice kit. The cable shall be approved for both overhead and underground use. The jacket shall withstand exposure to sunlight and atmospheric temperatures and stresses reasonably expected in normal installations.

Payment for Item 633 "Preemption Detector Cable" shall be made at the contract unit price per foot for the cable furnished, in place, all connections made and wiring completed, tested and accepted.

Designer Note: This note may be used when preemption is included for in the plans.

442-28 633 Preempt Phase Selector

This item shall consist of furnishing and installing preempt phase selectors including wiring interface panels in the local controller cabinet and all other accessories that are necessary to make the preempt phase selectors completely functional and operational as shown in the plans. This item shall include the extra cabinet space necessary to be located in the local controller cabinets where indicated in the plans.

The phase selectors shall consist of a module or modules that will provide the necessary inputs to the controller. Phase selectors shall be supplied with sufficient quantities of channels to provide preemption for all approaches to the intersection separately. Power shall be obtained from the phase selector or phase selector power supply and not from the local controller timer.

The phase selectors shall have front panel indicators for active preempt channel status. It shall have test switches to activate all preempt channels.

Furnish preempt phase selectors with 60-month warranties or for the manufacturer's standard warranty whichever is greater. Ensure that the warranty period begins on the date of shipment to the project. Ensure that each unit has a permanent label or stamp indicating the date of shipment.

Payment for Item 633 “Preempt Phase Selector” shall be made at the contract unit price for each phase selector in place, completely installed in the local controller shown in the plans, wired, tested and accepted.

Designer Note: This note may be used when preemption is included for in the plans.

442-29 633 Preempt Confirmation Light, LED

This item shall consist of furnishing and installing preempt confirmation lights including hardware and all other accessories that are necessary to make the preempt confirmation light completely functional and operational as shown in the plans.

A confirmation light shall be supplied for each intersection to indicate that the emergency vehicle has achieved control of the traffic signal.

The confirmation light shall be a vapor tight aluminum lighting fixture. It shall be supplied with a clear globe, LED lamp and mounting hardware to attach to the traffic signal mast arm. The confirmation light shall be powered by a load switch in the traffic signal controller. Signal cable conforming to 732.19 shall be used for confirmation lights. A minimum of 4-conductor cable shall be used with the green wire serving as the safety ground conductor.

Payment for Item 633 “Preempt Confirmation Light, LED” shall be made at the contract unit price for each light in place, completely installed in the location shown in the plans, wired, tested and accepted.

Designer Note: This note may be used when requested by the maintaining agency. The signal cable is a separate pay item.

442-30 Pull Box, 24” x 35” x 26”

Pull boxes shall have nominal opening dimensions of 24 inches by 35 inches. Materials shall conform to 725.06, 725.07 or 725.08. The word “Traffic” shall be integrally cast as part of the cover or securely fastened with corrosion resistant hardware. The supplied pull boxes shall support a 20,000 pound minimum vertical loading without permanent damage or deflection to the unit. Dispose of surplus material and restore disturbed facilities and surfaces.

The largest bend radius possible shall be maintained for the fiber optic cable.

All costs resulting from the above requirements shall be included in the unit price bid per each for Item 625 “Pull Box, 24” x 35” x 26”.

Designer Note: The pull box cited in this note is bell shaped at the bottom to help maintain fiber optic cable minimum bend radii. Any pull box where a splice is required or a change in cable direction is made should use this larger pull box.

442-31 632 Pole Entrance Fitting

A pole entrance fitting shall be provided in accordance with the plan details to allow fiber optic cable entrance into both existing and proposed steel poles. In proposed poles the Contractor shall have the 2 inch entrance holes shown in the details pre-manufactured. Blind half couplings shall be welded into any new strain poles supplied as part of the project.

Existing strain poles shall require the Contractor to field locate the pole entrance hole and drill two pilot holes and use a hole saw to cut the 2 inch hole. All non-galvanized pole surfaces exposed after cutting the hole shall have three coats of zinc enriched paint applied.

No pole entrance fitting holes shall be located vertically within 24 inches of any other holes or blind half couplings.

All costs to provide a pole entrance including material, equipment and labor shall be included in the bid item price for each Item 632 “Pole Entrance Fitting”.

Designer Note: The maintaining agency may opt to have the Contractor route drop cables down the outside of strain poles.

442-32 Grounding and Bonding

The requirements of the Construction and Material Specifications (C&MS) and the TC series of Standard Construction Drawings are modified as follows:

1. All metallic parts containing electrical conductors shall be permanently joined to form an Effective Ground Fault Current Path back to the grounded conductor in the power service disconnect switch.
   a. Provide an equipment grounding conductor in metallic conduits (725.04) in addition to the conductors specified and bond the conduit to this grounding conductor.
   b. When an equipment grounding conductor is required in plastic conduit (725.05), the installation shall include a separate equipment grounding conductor in addition to the conductors specified.
   c. Metallic conduit carrying the loop wires from in the pavement to the pull box splice location will only be bonded at the pull box end, and will not contain an equipment grounding conductor.
   d. If multiple conduit runs begin and end at the same points, only one equipment grounding conductor is required.
   e. If an equipment grounding conductor is needed in conduit between signalized intersections for underground interconnect cable, the grounding system for each signalized intersection will be separated about midway between the intersections.
   f. The messenger wire at signalized intersections will be used as the conductive path from corner to corner if conduit is not provided under the roadway. When conduit connects the corners of an intersection, an equipment grounding conductor shall be used in the conduit.
2. Conduits.
   a. The 725.04 conduit shall have grounding bushings installed at all termination points. The bushing material shall be compatible with galvanized steel conduit and the grounding lug material shall be compatible for use with copper wire. Threaded or compression type bushings may be used.
   b. The 725.05 conduit shall have the inside and outside diameters of the conduit deburred at all termination points.
   c. Both ends of metallic conduit shall be bonded to the equipment grounding conductor.
   d. Metallic conduit may be bonded to metallic boxes through the use of conduit fittings UL approved for this type of connection, with the box bonded to the equipment grounding conductor.
3. Wire for grounding and bonding.
   a. Use insulated, copper wire for the equipment grounding conductor. Bonding jumpers in boxes and enclosures may be bare or insulated copper wire. Wire size shall be as follows:
      i. Use 4 AWG between the power service and supports, poles, pedestals, controller or flasher cabinets.
      ii. Use a minimum 8 AWG between loop detector pull boxes and the first conduit that requires a larger size as specified in 3.a.i above.

iii. Use a minimum 8 AWG between the “Prepare to Stop When Flashing” installation (including support) and the first conduit that requires a larger size as specified in 3.a.i above.

iv. The insulation shall be green or green with yellow stripe(s). For 4 AWG or larger, insulation may also be black with green tape/labels installed at all access points.

b. In a highway lighting system, the equipment grounding conductor shall be the same wire size as the duct cable or distribution cable circuit conductors, with the minimum conductor size of 4 AWG. Bonding jumpers will be minimum size 4 AWG.

4. Ground rod.

a. A 3/4 inch Schedule 40 PVC conduit will be used in foundations and concrete walls for the grounding conductor (ground wire) raceway to the ground rod. Should metallic conduit be used, both ends of the conduit shall be bonded to the grounding conductor.

b. The typical grounding conductor (ground wire) shall be 4 AWG insulated, copper.

5. The green conductor in signal cables (conductor #4) shall not be used to supply power to a signal indication. It will be connected to the signal body as an equipment ground in aluminum heads and it will be unused in plastic heads. Unused conductors shall be grounded in the cabinet. Typical use of conductors is as follows:

Cond. no.	Color	Vehicle signal	Pedestrian signal
1	Black	green ball	#1 Walk
2	White	AC neutral	AC neutral
3	Red	red ball	#1 DW/FDW
4	Green	equipment ground	equipment ground
5	Orange	yellow ball	#2 DW/FDW
6	Blue	green arrow	#2 Walk
7	White/black stripe	yellow arrow	not used

6. Power Service and Disconnect Switch.

a. At the power service location, the grounding conductor (ground wire) from the disconnect switch neutral (AC-) bar to the ground rod shall be a continuous, unspliced conductor. If spliced, it shall be an exothermic weld butt splice.

b. The service neutral (AC-) shall only be connected to ground at the primary power service disconnect switch.

i. NEMA controller cabinets: If a power service disconnect switch is located before the controller cabinet, the neutral (AC-) and the grounding bars in the controller cabinet shall not be connected together as shown in NEMA TS-2, Figure 5-4.

ii. If secondary disconnect switches are connected after the primary disconnect switch, the neutral (AC-) shall only be grounded at the primary switch. Equipment grounding conductors shall be brought to the primary switch, but shall be grounded at both secondary and primary switches.

7. Payment – All materials and work required to complete the Effective Ground Fault Current Path system are incidental to the conductors installed by contract.

Designer Note: This note shall be used on all projects with electrical items (631, 632, 633). ***Figures 498-39 through 498-42*** provide examples of wire sizes for equipment grounding conductor.

442-33 Underdrains for Pullboxes

Reference Traffic SCD HL-30.11 for details about draining pullboxes. Underdrains for pullboxes shall be used as directed by the Engineer and shall be provided where the length required for a satisfactory outlet does not exceed 20 feet. The following estimated quantity is carried to the general summary for this purpose:

Item 611 4" Conduit, Type E............XX ft.

Designer Note: This note should be used in areas that are prone to high water tables or as specified and required by **District** staff.

442-34 Reserved – Existing Note Deleted

The **Plan Note** for “804 Fusion Splicer” has been deleted because the information is now in a fiber optic supplemental specification.

442-35 Reserved – Existing Note Deleted

The **Plan Note** for “804 Cleave Tool” has been deleted because the information is now in a fiber optic supplemental specification.

442-36 Reserved – Existing Note Deleted

The **Plan Note** for “804 Optical Time Domain Reflectometer (OTDR)” has been deleted because the information is now in a fiber optic supplemental specification.

442-37 Reserved – Existing Note Deleted

The **Plan Note** for “804 Mechanical Splice Tool Kit” has been deleted because the information is now in a fiber optic supplemental specification.

442-38 Reserved – Existing Note Deleted

The **Plan Note** for “804 Fiber Optic Training” has been deleted because the information is now in a fiber optic supplemental specification.

442-39 Reserved – Existing Note Deleted

The **Plan Note** for “633 Advance/Dilemma Zone Detection System” has been deleted due to the fact that advance radar detection has been previously added to **Supplemental Specification 809**.

442-40 633 Uninterruptible Power Supply (UPS), Battery Replacement

In addition to the requirements of 733.09, provide four (4) batteries for each existing Uninterruptible Power Supply (UPS) cabinet location selected.

Batteries shall be provided from the Department’s Qualified Product List.

Furnish batteries certified by the manufacturer to operate over a temperature range of -13 °F to +165 °F.

Place all batteries on battery heater mats in the enclosure.

Batteries shall be warranted for full replacement for two (2) years from date of purchase.

The Department will pay for Item 633 Uninterruptible Power Supply (UPS), Battery Replacement at the contract price bid for each UPS location where the four (4) existing batteries are replaced. Payment shall be full compensation for all labor, materials, tools, equipment, disposal and other incidentals necessary to replace the UPS batteries complete, in place, and accepted.

Designer Note: This note is required if the maintaining agency wishes to replace the batteries in an existing Uninterruptible Power Supply as part of a project.

442-41 633 Uninterruptible Power Supply (UPS), 1000 Watt, As Per Plan

In addition to the requirements of C&MS 633 and 733, pole attachment hardware will be included for pole-mounted cabinets, and a cabinet riser (8 inch minimum) and anchor bolts will be provided for base-mounted cabinets. Before performing the work, the Contractor, the District Traffic Engineer and the Project Engineer will perform a site inspection to establish the location of the UPS cabinet and foundation.

The UPS cabinet shall include a generator power panel with a heavy duty power relay versus the line voltage generator switch. The generator inlet shall be a recessed panel with a door that is flush with the external side of the ups cabinet. It shall include a recessed plug, automatic transfer switch and a door that securely closes over the power cord.

The UPS output notifications for on battery, battery 2-hour timer, and low battery shall be wired into the traffic signal cabinet back panel to provide special status alarms for each output into the signal controller.

This item shall include a red LED status indicator lamp to allow maintenance personnel and law enforcement to quickly assess whether a traffic signal cabinet is being powered by a UPS. The LED housing shall be NEMA 4X, IP65 or IP66, rated for outdoor use and be tamper/ shatter resistant. It shall be a domed enclosure containing a red lens with LED that is visible from 100 foot minimum. The enclosure and LED module should be placed and centered on the top surface of the ups cabinet and sealed from water intrusion. It should be wired using minimum 20GA stranded, insulated hookup wire to the status relay outputs of the UPS. The wires shall be terminated by lugs at the display end and permanently labeled “BACKUP POWER STATUS DISPLAY,” with wire polarity indicated. The red LED shall only illuminate to indicate the cabinet is operating under UPS backup power (the “backup” operating condition). This item includes programming the UPS status relay outputs to produce the lamp status displays. These status displays will be solid 100% duty cycle (not flashing) displays. The operating voltage of the LED lamp shall be 120V AC unless otherwise indicated.

Designer Note: This note is intended to allow maintaining agencies to include an indicator lamp for visual confirmation of UPS status if desired. Maintaining agencies may change or omit the recommended display, if desired, on either new or existing cabinets. The specified domed lens has better visibility than a flat lens, but is slightly more vulnerable to vandalism. A flat indicator lamp may be specified instead, if visibility is good and/or vandalism is a concern. If vandalism is a specific concern, external indicator lamps should not be used. The lamp may be placed on the cabinet roof instead of the wall, if desired. The operating voltage may be changed if required.

442-42 Reserved for Future Use

442-43 Reserved – Existing Note Deleted

The **Plan Note** for “633 Stop Bar Detection Radar” has been deleted due to the fact that stop-bar radar detection has been previously added to the **Supplemental Specification 809**.

442-44 632 Signal Support Foundation

Prior to ordering the signal supports, the Contractor shall contact OUPS to have all the utilities located in the field then meet with the Project Engineer to locate the proposed support locations to insure there are no conflicts with utilities. If there are issues, the Project Engineer shall provide guidance as to the relocation of the support poles.

Payment will be at the contract unit price and will be full compensation for all labor, materials, tools, equipment and other incidentals necessary for each support furnished, in place, complete and accepted.

Designer Note: This note should be used when any new signal supports are to be installed.

442-45 632 Signal Support, Mechanical Damper for TC-81.21 Mast Arm (Greater Than 59' in Length), As Per Plan

This item shall consist of the Contractor installing a tuned mechanical stockbridge or mass-spring type damper on a TC-81.21 mast arm signal support to reduce the possibility of harmonic vibrations caused by wind loads. A mechanical damper shall be applied to all mast arms over 59 feet in length. The installed damper shall be capable of reducing the loaded maximum vertical movement at the tip of the arm to 8 inches measured from the highest to the lowest point of deflection at wind speeds of 5-20 mph.

All attachment hardware connections shall be stainless steel. Stockbridge-type dampers shall have a stainless steel safety chain anchored to the mast arm to prevent weights from falling should they become separated from the rest of the assembly. The damper shall be attached to the arm within 8 feet of mast arm tip. Installation shall be per the manufacturer's guidelines. Static dampers such as horizontal flat sign mountings shall not be used. Acceptable devices include the following or approved equal:

1. Union Metal Alcoa Damper Device – DWG. NO. 2G-1817-C1
2. Valmont Structures Alcoa Device – DWG. NO. OH104242P1
3. Valmont Structures Mitigator – Model TR1
4. Florida DOT Spring-Mass Damper – DRAWING INDEX NO. 17749
5. Pathmaster Damper Assembly – DWG. U2G-1817-C
6. Hubbell 607 Series Damper – Millerbernd DWG. NO. HUBBELL-6072014

Payment for Item 632 "Signal Support, Mechanical Damper for TC-81.21 Mast Arm (Greater Than 59 feet in Length), As Per Plan" shall be made at the contract unit price per each complete and in place, and shall include all labor, materials, and equipment necessary to complete the work.

Designer Note: This note is required on all projects installing **Traffic SCD TC-81.21** Mast Arms greater than 59 feet in length.

442-46 632 Signal Support, (By Type), As Per Plan

In addition to provisions of the ODOT C&MS, furnish and install signal poles as specified in the plans.

The signal support designer shall provide drawings of a signal support with structural aspects of the design and materials in compliance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. The signal support shall be ASTM A595 Grade A with a minimum yield strength of 50 ksi. The following design parameters shall be used:

1. Basic Wind Speed = 90 mph
2. Design Life = 25 years
3. Fatigue Category = III
4. Galloping: No
5. Truck Induced Gust: No

Submit, to the Engineer prior to incorporation: two copies of the signal support drawings and shop drawings, which identify and describe each manufactured signal support and signal support item which is being incorporated into the construction. The signal support drawings and shop drawings shall each be reviewed, sealed, stamped, and dated by two Ohio registered Professional Engineers.

Payment for Item 632 "Signal Support, (By Type), As Per Plan" shall be made at the contract unit price per each complete and in place, and shall include all signal support design, labor, materials, and equipment necessary to complete the work.

Designer Note: This note is required on all projects where non-standard signal supports are included in the plans.

442-47 632 Signalization, Misc.: Unlash and Relash Messenger Wire

The Contractor shall remove existing messenger wire lashing rods and reinstall them as necessary for the installation of any new cables on the existing intersection signal spans. The cables shall enter the existing strain pole through the pole cable entrance fitting and use the existing conduit system to get to the controller cabinet. The new cables shall be supported by a new cable support assembly at the top of the strain pole.

The new signal cables shall be bid by separate bid items.

Payment for Item 632 "Signalization Misc.: Unlash and Relash Messenger Wire" shall be made at the contract unit price per per foot and shall include all labor, materials, cable support assemblies and equipment to install new cables on existing signal span wire installations.

Designer Note: This note is intended for use on projects where unlashing and relashing the messenger wire is required in the plans. Typical use would be for a traffic signal retrofit, where a new signal head and associated cables are to be added to the existing span.

442-48 809 Advance Radar Detection

This item of work shall consist of furnishing and installing a Wavetronix Smartsensor advance detection unit (Model SS-200E). The detection unit shall include the following:

1. Power shall be provided from the traffic cabinet.
2. All required inputs cards shall be included in the traffic cabinet and shall be compatible with Caltrans, NEMA TS1 and NEMA TS2 detector racks. The cards shall provide true presence detector calls or contact closure to the traffic controller.
3. The unit shall be mounted directly to a pole or mast arm, as recommended by the manufacturer. Cable(s) shall be provided as required and recommended by the manufacturer.
4. Surge protection devices, as recommended by the manufacturer shall be included both at the pole where the unit is located to protect the unit and in the traffic cabinet to protect the cabinet electronics.
5. The manufacturer's representative shall be on site during installation and testing and shall provide onsite training on the setup, operation and maintenance of the unit.
6. A serial to Ethernet communications module and Ethernet cable (minimum 7 feet).
7. The power supply and communication modules shall be secured to a single panel that can be mounted interior to the traffic cabinet. The panel shall include modular-plug style connections for up to four (4) sensor cables. Additional sensors may be hard-wired to the communication modules, as necessary.

Payment for Item 809 Advance Radar Detection shall be made at the contract unit price for each unit, complete and in place including all required cabinet hardware, mounting brackets, cables, conduit, connections tested and accepted, and any other necessary hardware to establish a fully functional detection system.

Designer note: This note is to be used on **ODOT-**maintained signals only.

442-49 809 Stop-Bar Radar Detection

This item of work shall consist of furnishing and installing a Wavetronix Smartsensor matrix detection unit. The detection unit shall include the following:

1. Power shall be provided from the traffic cabinet.
2. All required inputs cards shall be included in the traffic cabinet and shall be compatible with Caltrans, NEMA TS1 and NEMA TS2 detector racks. The cards shall provide true presence detector calls or contact closure to the traffic controller.
3. The unit shall be mounted directly to a pole or mast arm, as recommended by the manufacturer. Cable(s) shall be provided as required and recommended by the manufacturer.
4. Surge protection devices, as recommended by the manufacturer shall be included both at the pole where the unit is located to protect the unit and in the traffic cabinet to protect the cabinet electronics.
5. The manufacturer's representative shall be on site during installation and testing and shall provide onsite training on the setup, operation and maintenance of the unit.
6. A serial to Ethernet communications module and Ethernet cable (minimum 7 feet).
7. The power supply and communication modules shall be secured to a single panel that can be mounted interior to the traffic cabinet. The panel shall include modular-plug style connections for up to four (4) sensor cables. Additional sensors may be hard-wired to the communication modules, as necessary.

Payment for Item 809 Stop-Bar Radar Detection shall be made at the contract unit price for each unit, complete and in place including all required cabinet hardware, mounting brackets, cables, conduit and connections tested and accepted.

Designer note: This note is to be used on **ODOT**-maintained signals only.

442-50 General Electrical Requirements for Solar-Powered Devices

Run requirements of this device are _______ hours per day, 7 days per week.

Utilize environmentally-sealed, high-efficiency LED light sources for this solar-powered application.

House the solar power supply controller and battery in one or two stainless steel or aluminum enclosures with a minimum NEMA 3 or 3X rating.

If the exterior size of the enclosure necessary to meet the requirements below is less than 1000 cubic inches, a single polymer enclosure rated NEMA 4 and listed as sunlight-resistant may be installed, with approval of the Engineer.

Seal enclosure conduit entries to prevent insect and/or rodent entry.

Provide metal enclosures with an exterior of bare or powder-coated aluminum, or stainless steel.

Provide a locking enclosure using either an integrated locking mechanism or a padlock per C&MS 631.06.

Small enclosures of 300 cubic inches or less (exterior) may be provided with security fasteners in lieu of a locking mechanism or padlock.

Separate the control electronics and battery, if contained within a single enclosure, to prevent damage to the control electronics if the battery envelope is compromised.

Provide sealed gel-cell or AGM (Absorbed Glass Mat) lead-acid batteries for all installations with instantaneous load requirements of 4 watts or above, regardless of duty cycle.

For installations with instantaneous load requirements of less than 4 watts, rechargeable NiCd, Li-ion, or NiMH batteries may be used instead of AGM or gel-cell, if approved by the Engineer.

Provide signed copies from the Solar Panel and/or Controller manufacturer of all calculations used to size the solar panel and batteries.

Include in these calculations the insolation value used and its reference source, the solar panel efficiency, charger/controller efficiency, inverter efficiency, proposed LED lamp and/or equipment load, and a figure representing anticipated miscellaneous losses.

Show calculations documenting a reserve capacity of two weeks operation under continuous worst-case (minimum) insolation figures (usually December) for the proposed geographic location, using a panel elevation angle appropriate to the site, at a sustained temperature of 25 degrees Fahrenheit (-4 degrees Celsius).

Deliver a copy of the calculations to the Engineer and another copy to the Office of Roadway Engineering for approval.

Provide documentation showing that the solar panel manufacturer tested the panel according to IEC61215 or equivalent approved standard.

Provide documentation showing that solar panel mounting is rated for 90 mph design wind and designed to resist vandalism.

Ensure NEC grounding and bonding requirements are met if voltages over 50V AC or DC are present.

Provide a timer (if required) that satisfies the requirements of C&MS 731.10 and is listed on the ODOT Qualified Products List.

Provide complete photo-controller specifications, including ON/OFF photometric switch points (typically given in foot-candles), if a photo-controller is utilized.

Designer Note:

As noted in ***Section 440-11***, School Speed Limit Sign assemblies and Crossing Sign assemblies are addressed separately in this manual. **Plan Note 442-50** is a generic template that may be applied to permanent electrical or electronic devices used on **ODOT** sign, signal or ITS projects powered by batteries and recharged by solar panels. This includes, but is not limited to, roadway signs and beacons, equipment utility/convenience lighting, remote monitoring stations and similar equipment. In addition to the text above, include in the As-Per-Plan Note a full description of the construction item and a method of measurement. This template is not intended for use on devices used for temporary traffic control since the requirements for those items are typically covered under their respective standards and/or specifications, and the devices are not retained by **ODOT** after construction.

443 SPECIFICATIONS

ODOT specifications for the furnishing and installation of traffic signal equipment are contained in the following **C&MS** sections, **Supplemental Specifications** and **Supplements**.

C&Ms Sections:

625 and 725	Trench, conduit, ground rods and pull boxes
632 and 732	Traffic signal equipment
633 and 733	Traffic signal controllers

Supplemental Specifications:

804 and 904	Fiber Optic Cable and Components
805 and 903	GPS (Global Positioning System) Clock Assembly
809	Intelligent Transportation System (ITS) Devices and Components
815 and 906	Spread Spectrum Radio
816 and 907	Video Detection System
819 and 919	Railroad Preemption Interface

Supplements:

1048	Loop Detector Sealant Prequalification Procedure
1063	Signal Construction Personnel Requirements (631, 632, 633)
1076	Conflict Monitors for Use with Model 170E and 2070 Controllers/Cabinets
1094	Certification Procedure for Fabricators of Signal Supports and Strain Poles
1095	Model 242 DC Isolator Prequalification Procedure
1097	LED Lamp Prequalification Procedure (vehicular and pedestrian signal lamps)
1099	Video Detection System Prequalification Procedure
1100	Spread Spectrum Radio Prequalification Procedure
1104	Model 2070E Controller with 2070-1E CPU Prequalification Procedure

C&MS sections, the **Supplemental Specifications** and **Supplements** related to specific traffic signal items are referenced individually as they are discussed in this Manual.

The **C&MS** may be viewed on-line, as well as copies of the **Supplemental Specifications** and **Supplements**.

450 CONSTRUCTION

450-1 General

Information in this Chapter is intended to serve as a guide for construction personnel where the contractor furnishes and installs traffic control devices and appurtenances. However, it may also be useful for maintenance personnel performing the same functions. Inspection procedures for the various type traffic control devices are outlined, mainly in the form of check lists to assist project personnel in performing their duties. This information points out the various important features of each device and references the applicable specification or standard drawing. Illustrations are used for easy recognition of the device or feature being discussed.

All **C&MS Item 632 and 633** devices should be checked against the Qualified Product List before they are incorporated into a project. This list may be viewed on-line at:
http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/QPL.aspx.

For purposes of this Chapter, see **C&MS 101.03** for definitions of the terms "contractor" and "engineer."

450-2 Foundations

See ***Section 250-3*** for additional information relative to concerns in the installation of foundations for poles and controller cabinets.

450-3 Electrical Appurtenances

450-3.1 General

This section will be used to provide additional information about various electrical appurtenances involved in the traffic signal installations, such as pull boxes, conduit and ground rods.

450-3.2 Pull Boxes

Pull boxes shall be of the specified sizes (see **Traffic SCD HL-30.11** and the plans), typically 18 inches or 24 inches, and the specified material.

The word on the cover should be "TRAFFIC" when the pull box is part of a traffic signal system unless the plans require the word "ELECTRIC" or other marking. The word shall be formed on the surface or displayed on an attached metal plate in accordance with **C&MS 725.06, 725.07, 725.08 or 725.12**.

The location of pull boxes shall be as shown on the plans. However, pull boxes in low drainage areas may be adjusted to eliminate drainage problems, or feasible methods of positive drainage may be used in accordance with **C&MS Item 611** and details on **Traffic SCD HL-30.11**, with the approval of the engineer.

Pull boxes located in sidewalks, traffic islands and curbed areas close to the roadway, where wide turning vehicles could drive over them, may be adjusted to eliminate the problem, or a concrete pull box with a heavy duty lid may be used with the approval of the engineer.

450-3.3 Trench

Trenching shall be in accordance with **C&MS 625.13** and as shown in ***Figure 498-7***. Any change in dimensions will require approval by the engineer.

Trenching may be in earth or in paved areas, according to plan details. Trenching and subsequent restoration of surfaces in paved areas shall be in accordance with **Traffic SCD HL-30.22**. Trenching work in paved areas shall be divided into two pavement depths for payment; less than 6 inches and 6 inches or greater, as described in **C&MS 625.22**.

The trench in paved areas may be 4 inches wide when cut by a Vermeer type trencher. In this case, the trench shall be backfilled with concrete full depth, except that the bottom 4 inches above the conduit may be **C&MS 625.13** tamped backfill.

450-3.4 Conduit

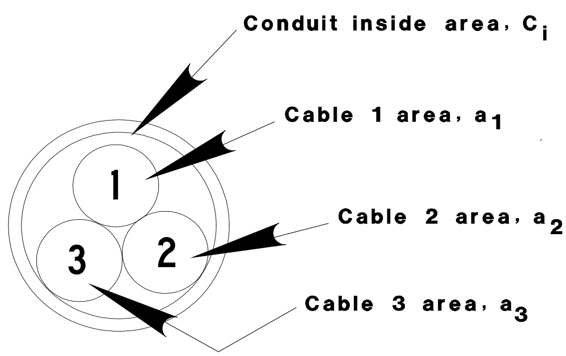
Metal conduit shall comply with **C&MS 725.04**, with sizes according to the plans. It shall be made from domestically produced steel, and the domestic steel content of the conduit shall be certified by the manufacturer or supplier before it is approved for installation.

The routing of loop detector wire in conduit through curb or under shoulder shall be as shown on **Traffic SCD TC-82.10**.

A conduit which will have cable or wire pulled into it during construction, or is to remain empty for future use, shall have a pulling tape or tracer wire installed in it in accordance with the requirements of **C&MS 625.12**. The ends shall be sealed according to **C&MS 625.12**.

Difficult pulling and possible jacket skinning may occur when an attempt is made to install too many cables or wires within a given conduit. The reason could be design error in new systems or attempts to insert an excess number or size of cable or wire in existing conduit.

The combined cross section of all cables and wire within a conduit should be less than (or equal to) 25 percent of the conduit inside area:



$a_1 + a_2 + a_3 + \text{etc.} \leq 0.25C_i$

a = cable or wire across section area, sq. in.
C_i = conduit inside area, sq. in.

A calculation can be made using the above formula. The cross section area of conduit, cable and wire is shown in ***Table 497-1***.

450-3.5 Ground Rod

A ground rod shall be driven below groundline near the foundation of every strain pole and overhead sign or signal support whether there is power in the vicinity or not, as shown on **Traffic SCD TC-21.20 and Traffic PISs 203210 and 203211**.

Ground rods shall comply with **C&MS 725.16** and be installed in accordance with **C&MS 625.16**. A ground wire of insulated 600-volt No. 4 AWG 7-strand soft drawn copper shall be attached by an exothermic weld. The typical exothermic weld procedure is described in ***Section 450-3.6***. Insulating varnish shall be applied to the weld and any exposed conductor.

450-3.6 Exothermic Weld

The following procedure is typical and may be used unless the manufacturer's instructions differ.

1. The end of the ground wire shall be in an unflattened, unbent, clean and dry condition to assure a good weld.

    a. Bent and out-of-round conductor wire will hold the mold open causing weld material leakage. A cable cutter should be used to make undeformed ends. If a hacksaw is used, the insulation should first be peeled, as the saw tends to coat the cable with plastic material which must be cleaned off.

    b. Corroded cable shall be cleaned. Oily or greasy cable should be cleaned with a solvent that dries rapidly and leaves no residue. Very greasy cable can be "cooked out" by dipping into molten solder.

    c. Wet cable can cause the blowing of molten metal out of the mold, and the cable should be dried by a hand torch or a quick drying solvent such as alcohol.

2. Ground rod ends which have been mutilated in driving can hold the mold open and should be cut off. Rod ends shall be clean and dry.

3. The weld mold shall be clean before use. Damp or wet molds can cause porous welds and should be dried by heating.

4. The cable shall be inserted into the side of the mold so the cable is 1/8 inch back from the center of the tap hole. The mold shall be placed on the ground rod so the cable sits on top of the rod **(see *Figure 498-8*)**. A clamp or locking pliers should be used on the rod to keep the mold from sliding down during the welding process, and the conductor should be marked at the mold surface so it can be verified that the conductor has not shifted before the weld is made.

5. The steel disk shall be inserted into the crucible and the cartridge contents poured on top, being careful that the disk is not upset. The cartridge should be tapped when pouring, to make sure the starting powder comes out and spreads evenly over the welding powder. A small amount of starting powder should be placed on the top edge of the mold under the cover opening for easy ignition.

    a. The proper cartridge size is marked on the mold tag and is the approximate weight of the powder in grams.

    b. If the proper cartridge size is not available, two or more small cartridges or part of a larger cartridge can be used.

6. The mold cover will be closed and the starting powder ignited with a flint gun. If it is necessary to hold down the cover during the flash of igniting powder, a long tool should be used and the hand should be kept away.

450-4 Power Service for Traffic Signals

450-4.1 General

Power service for traffic signals shall comply with **Traffic SCD TC-83.10** and the plans. It shall consist of the equipment needed to provide a pole-attached wiring raceway and disconnect switch, for use with separately furnished power cable routed from the service point to the controller cabinet. As shown in ***TEM Figure 498-9***, unless otherwise specified, the equipment includes a weatherhead, a conduit riser with necessary fittings and attachment clamps when required, and a disconnect switch with enclosure **(C&MS 632.24)**.

A thorough review of the plans should be made to determine that the specific requirements of the maintaining agency for power service have been satisfied.

A ground wire shall be used as shown on **Traffic SCD TC-83.10**, leading to a ground rod installed in accordance with ***Section 450-3.5.***

The LB type fitting under the controller cabinet **(SCD TC-83.10)** may have to be installed before erecting the pole because of interference with the foundation.

450-4.2 Electric Meter Base

When required, an electric meter base shall be furnished by the applicable utility and installed by the contractor as part of the power service work.

450-4.3 Conduit Riser and Weatherhead

Power cable is the only type cable or wire permitted through the power service conduit riser.

The conduit riser shall terminate at the meter base, if used; otherwise, termination shall be at the switch enclosure. From there conduit connection to the controller cabinet is as shown on the plans. Conduit connection could be: (a) immediately to the controller cabinet on the same pole; (b) downward by underground conduit and possibly a pull box to a nearby foundation-based controller cabinet; or (c) upward by another riser on the pole to spanwire and a remote cabinet location.

The conduit riser shall comply with **C&MS 725.04** and the plans, and the weatherhead shall be threaded aluminum or galvanized ferrous metal **(C&MS 732.16)**. Risers on painted poles shall be painted to match the poles.

450-4.4 Disconnect Switch

The disconnect switch shall be a **UL** listed single-throw safety switch or circuit breaker, meeting the voltage and capacity requirements of the specifications. The amperage rating of the fuse or circuit breaker shall be 5 to 10 amperes greater than the peak load rating of the equipment service. The enclosure shall be a **UL** listed water tight lockable stainless steel **NEMA** Type 4, supplied with **UL** listed conduit hubs, and the enclosure shall contain a solid neutral bar normally grounded to the enclosure **(C&MS 732.21)**.

450-5 Pole and Support Inspection - General

See ***Sections 250-4.2 through 250-4.4*** for information about pole and support inspection.

450-6 Traffic Signal Supports

450-6.1 General

This Section is used to provide additional information about traffic signal supports. Various types of overhead signal supports are also depicted in ***Table 497-4.***

450-6.2 Strain Pole Type Support

Strain poles shall comply with the certified drawings, **Traffic SCD TC-81.10** and the plans. They shall be galvanized. Paint may be applied over the galvanizing if specified in the plans. The general features should be inspected in accordance with ***Section 250-4.2.***

Strain poles shall be tapered tubes with a cross section which is circular or a regular polygon of six or more sides.

Strain poles used to support traffic signals or signs **(Traffic SCD TC-17.10)** shall be furnished with one or more span wire clamps with shackles for attachment of messenger wire **(see Traffic SCD TC-84.20).** Only messenger wire may be attached by wrapping twice around the pole and securing with a three-bolt clamp, as shown in **SCD TC-84.20**, when used on round, tapered steel strain poles. The tether wire shall not use the alternate wrap method.

Erection of these poles shall be in accordance with the general procedure given in ***Section 250-4.6***, except as noted in this section.

For the initial rake of strain poles, leveling nuts shall be adjusted to provide a rake of one-eighth to one-half inch per foot of pole in the direction opposite to the contemplated span wires and are to be made snug tight. Further adjustment may be necessary to assure that the strain poles are essentially vertical after the application of span wire load.

450-6.3 Single Arm Support

Single arm supports shall comply with the certified drawings, **Traffic SCD TC-81.21** and the plans. General features of the support shall be inspected in accordance with ***Section 250-4.2***, and except as noted in this section, erection of the support shall be in accordance with the general procedure given in ***Section 250-4.6***.

Welds shall be inspected according to ***Section 250-4.3*** and the galvanizing inspected according to ***Section 250-4.4***.

For arms of two telescoping pieces, a 15 inch overlap is required. The overlapped arms shall be secured with a stainless or galvanized steel through-bolt with hex head or nut(s).

Arm caps shall cover at least 50 percent of the end area **(C&MS 732.11)**.

An arm clamp with clevis shall be furnished at each signal position, as well as a hole with a rubber grommet for the outlet of signal cable.

The installation of small signs and their attachment to the arms should be checked. Any possible interference between swinging signals and signs should also be checked.

Blind half couplings shall be located on the pole of the support for mounting pedestrian signal heads or controller cabinets when required by the plans.

Signal heads shall be installed with a clearance above pavement elevation at the center of the roadway of 17 to 19 feet. Drop pipes should be used only when necessary to maintain the clearance between 17 to 19 feet. If the clearance without a drop pipe will be over 19 feet, the engineer will, in consultation with the maintaining agency, direct the use of drop pipes or waive the maximum clearance requirement for each head.

Initial rake shall be adjusted so that under the load of signals, the pole will assume an essentially vertical position and the arm rise be within the limits specified on **Traffic SCD TC-81.21**, i.e., 3 inches minimum and 30 inches maximum. Under ice load, signals shall not drop below 16 feet above the pavement.

450-7 Sag and Vertical Clearance

Figure 498-13 illustrates sag guidelines and vertical clearance standards for traffic signals.

450-8 Signal Span Messenger Wire and Appurtenances

450-8.1 General

This Section is used to provide additional information about signal span messenger wire and appurtenances.

Note that tether wire is distinct from messenger wire. Messenger wire supports a significant vertical load. Tether wire does not and is used to prevent swinging of hanging items.

450-8.2 Signal Messenger Wire and Cable

Messenger wire and accessories shall comply with **Traffic SCD TC-84.20** and **C&MS 732.18**. Messenger wire diameter shall be in accordance with the plans.

The height at which the messenger wire is to be attached to the pole will, in some instances, be shown on the plans. In cases where this is not shown, the contractor is responsible for determining the proper attachment height. This determination shall consider the relative elevation of pavement to pole foundation top, the desired clearance between pavement and the bottom of each signal, i.e., the sag in the messenger wire, and the height of each signal.

A preformed guy grip shall not be used for messenger wire attachment at the pole. Guy grips of the proper size may be used at bull rings (aerial corners).

Thimbles with a correct groove size for the messenger wire (or the wire and eye of guy grips) are to be used at anchor shackles and bull rings. When three-bolt clamps are used, the wire tail is to be served as shown in ***Section 450-8.3***. See ***Section 450-8.4*** for the installation procedure for preformed guy grips.

Messenger wire sag shall comply with **C&MS 632.22** and ***Section 450-7***.

The signal cable shall be attached to the messenger wire by lengths of preformed lashing rod. The lashing rod shall be the proper internal diameter to snugly hold the cable, but not cut into its jacket. See ***Section 450-8.6*** for further information.

A drip loop shall be formed in the signal cable at each weatherhead, and should extend at least 6 inches below the weatherhead **(see *Figure 498-14*).**

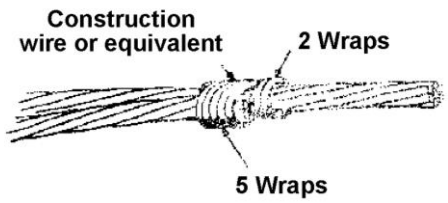
Cables or groups of cables up to a maximum of four, hanging within pole interiors, shall have their strain relieved by cable support assemblies as described in ***Section 450-8.7***, ***Figure 498-14*** and **Traffic SCD TC-84.20**.

Intentionally blank

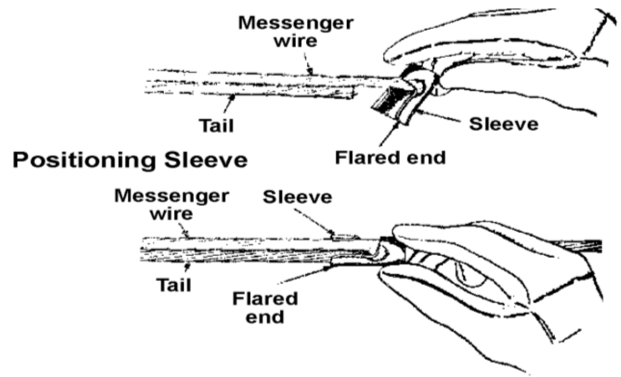
450-8.3 Messenger Wire Served Ends

Messenger wire may be attached to various accessories by looping the wire to make an eye.

The wire end shall be secured by a three-bolt clamp, and the cut wire end or tail shall be "served" with construction wire or clamped with a sleeve device as shown on **Traffic SCD TC-84.20**. The following illustrations show both serving methods for the wire tail:



Serving With Wire



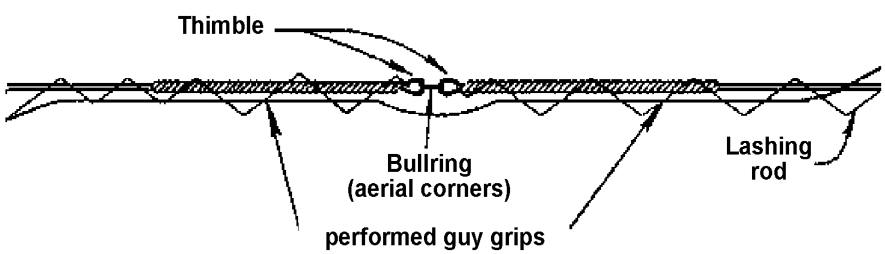
Sleeve in Position

Serving With Strand Sleeve

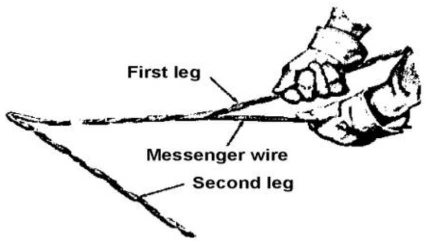
450-8.4 Preformed Guy Grips

Preformed guy grips are made of helically shaped high-strength steel wire. They are available in sizes fitting the outside diameters of messenger wire and form an eye permitting attachment to various accessories.

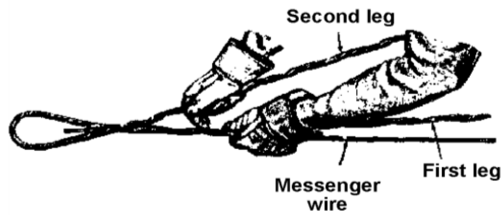
As shown in **Traffic SCD TC-84.20**, they should be used at bull rings of span wire aerial corners (see the following illustration). Thimbles are used in the eye of grips in accordance with standard details in the **SCD**.



Grips are installed on an end of the messenger wire by wrapping a first leg of the grip to the messenger wire. In most cases, the accessory to which the grip is to be attached must be inserted in the eye of the grip with a thimble before the second leg of the grip is wrapped. The second leg is then applied to the combined first leg and messenger wire. The following illustrations show the wrapping sequence:



Applying First Leg



Applying Second Leg

Guy grips shall not be used on messenger wire used for span wire sign supports. In this application, wind load on the signs can cause failure of the grips **(see Traffic SCD TC-17.10(3))**. Guy grips shall not be used for attachment to signal strain poles **(Traffic SCD TC-84.20(5)**).

450-8.5 Cable and Wire

In certain instances, the plans will assign a color code usage for each cable, or a typical usage by color code. All connections should be made observing these assignments, and any deviations, if determined necessary, should be recorded. When a color code usage is not provided, good electrical wiring practice would still dictate that color code wiring on the project be consistent. Typically, white is reserved for the neutral or common leg of a circuit. The following provides additional information about various types of cable and wire contained in **C&MS Table 732.19-1**:

1. **Signal cable** is used as the electrical connection between signal heads and the controller cabinet at an intersection. The cable may be either **IMSA 19-1**, which has a jacket of polyvinyl chloride, **IMSA 20-1**, which has a polyethylene jacket. The number of conductors and wire gage shall be as specified on the plans. Conductors shall be of copper and stranded, and conductor insulation shall be color coded. Splices are not permitted in signal cable **(C&MS 632.23)**, and the cable should be scanned to be sure that there are none. As temperatures decrease, signal cable gets stiffer and harder, becoming brittle when below freezing. In very cold weather, the cable should be handled with care so as not to damage the jacket or insulation when unreeling, flexing and installing. The method of measurement of signal cable is shown in ***Figure 498-16***.

2. **Interconnect cable** is used as the connection between intersections for systems of signals (although there is no significant difference between signal and standard interconnect cable). The cable may be either **IMSA 19-1** or **IMSA 20-1** as in signal cable, or twisted pair/shielded interconnect cable conforming to **RUS PE-39** may be required by the plans.

3. Twisted pair/shielded cables are less prone to pick up induced current as a result of nearby electrical devices or magnetic fields, and are necessary for certain types of communication systems which may be used to interconnect signals. The number of conductors and wire gage shall be as specified. It should be noted that in the case of twisted pair/shielded cable, the number of conductors is typically referred to as the number of pairs (pair count), i.e., six-conductor cable would be referred to as a three-pair cable. Conductors shall be of copper and are usually solid.

4. **Interconnect cable of the integral messenger type** is aerial self-supporting cable with a "figure 8" cross section. The cable may be either **IMSA 19-3**, which has a jacket of polyvinyl chloride, or **IMSA 20-3**, which has a polyethylene jacket. Shielded versions, **IMSA 19-4** and **IMSA 20-4**, may be required by the plans. The number of conductors and wire gage shall be as specified. Conductors shall be of copper and stranded, and conductor insulation shall be color coded.

5. Twisted pair/shielded interconnect cable of the integral messenger type conforming to **RUS PE-38** may also be required by the plans.

6. **Loop detector wire** is laid in turns in saw slots cut into the pavement and routed by the groove to the edge of pavement and to a pull box. The wire is single-conductor No. 14 AWG. The conductor shall be of copper and stranded. Loop detector wire consists of detector wire inserted into a flexible plastic tubing **(C&MS 732.19)** meeting specifications **IMSA 51-5**. The tubing shall encase the wire completely from the splice at the lead-in cable through the entire loop turns and back to the splice.

7. **Lead-in cable for detector loops** is spliced to loop wire and routed to detector units in the controller cabinet. The cable shall be two-conductor No. 14AWG meeting specifications IMSA 50-2. Each conductor shall be stranded copper. The conductor pair shall be twisted and shielded.

8. **Power cable** is used as the connection between the service pole or service drop and the controller cabinet. The cable normally is two-conductor and **UL**:RHH/RHW/USE type. The wire gage shall be as specified. Conductors shall be color coded, of copper and stranded. When specified, power cable may be three conductor. Single conductor cables may be substituted for a two (or three) conductor cable, but color coding should still be provided.

9. **Service cable** is used to bring power to the vicinity of an isolated intersection. The cable is normally two-conductor (duplex) and XHHW type or cross-linked polyethylene with a 0.045 inch minimum jacket. The wire gage shall be as specified. The cable is aerial self-supporting with one conductor being an uninsulated ACSR (aluminum conductor, steel reinforced) messenger wire. An insulated conductor of stranded aluminum is twisted around the messenger. Stranded copper with an AWG one gage higher (wire one size smaller) may be substituted for the aluminum conductor. Three-conductor (triplex) may be specified where two insulated conductors are twisted around the messenger wire. The uninsulated messenger serves as the grounded neutral of the power supply.

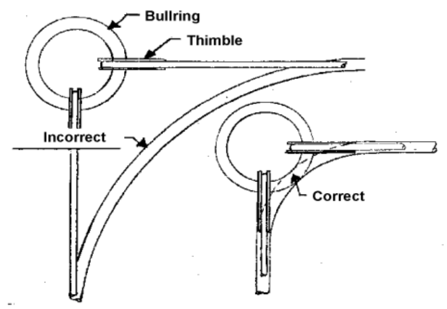
10. **Ground wire** is used to connect signal or sign supports to ground rods. The wire shall be single-conductor No. 4 AWG made of seven-strand soft drawn copper with white insulation and rated at 600 volts. The wire is used as part of the Ground Rod item **(see 625.16 Grounding)**.

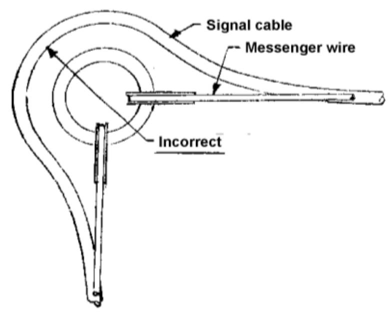
450-8.6 Lashing of Overhead Cable

A preformed helical lashing rod shall be of the proper internal diameter to tightly secure overhead cable(s) to the messenger wire. A lashing rod should not be loose or so tight as to be impressed deeply or cut into the cable jacket. If either deficiency is observed, the proper internal diameter may be determined by the following formula: C approx. = (0.85) (D+m), where C is the lashing rod internal diameter, D is the cable jacket diameter and m is the messenger wire gage (all dimensions in inches).

For groups of several cables of varying diameter, the internal diameter of the lashing rod may be best determined by a graphic layout to scale.

Signal cable routed on messenger wire should neatly pass the bull rings in its path. Also, signal cable routed around an aerial corner formed in the span wire at a bull ring should have a radius in its routing small enough to form a tangency with the bull ring.





450-8.7 Cable Support Assemblies

As shown in ***Figure 498-14***, a cable support assembly makes use of a flexible tubular wire mesh device called a cable grip which has a gentle holding action over its length and which is used to eliminate strain or damage to the jacket of cable(s) hanging in the interior of poles.

The support assembly consists of the grip attached to a single "U" eye support bale and a sling when necessary. The grip may be used on an individual cable or a group of cables up to a maximum of four **(C&MS 632.21).** The grip shall be the proper size and strength for the cable(s), of stainless steel or tin coated bronze, and may be either a "closed" or "split with rod" type. The split type is used when a cable end is not available. In this application, the grip mesh is not a continuous tubular weave, but is split for wrapping around the cable(s) and is secured by a rod which is inserted through alternate weaves at each side to form a tube.

The support's bale shall be hung over the pole J-hook if sufficient length is available; otherwise, a sling shall be made of messenger wire, clamps and thimbles. The sling wire is to be passed through the bale eye, adjusted to the proper length and hung on the J-hook.

Pole interiors should be checked by removing pole caps to verify that cable support assemblies are in place, hung on the J-hook and properly adjusted to eliminate cable jacket strain.

450-8.8 Aerial Interconnect Cable

For aerial interconnect cable, the following standards and guidelines apply:

1. Aerial interconnect cable and accessories shall comply with **Traffic SCD TC-84.20** (illustrated in part in ***Figure 498-15***). Interconnect cable may be supported on separate messenger wire or be the integral messenger self-supporting type with a "figure 8" cross section, if specified on the plans.

2. Metal poles with messenger wire supported interconnect cable are to be furnished with pole clamps. The pole clamp may provide clevis(es) to which the messenger is attached and terminated, or may provide a stud to which a clamp assembly can be bolted.

3. Messenger wire ends are to be looped and secured with three-bolt clamps or a messenger vise, or a preformed guy grip dead end may be used ***(see Section 450-8.4)***. If clamps or vises are used, the wire tail shall be served ***(see Section 450-8.3)***. Thimbles with a correct groove size for the messenger wire shall be used to connect to the clevis of the pole clamp.

4. When messenger wire is to be grounded to a metal pole, a ground clamp, an insulated ground wire and a bolt tapped into the pole shall be used (also see ***item 10*** in this section).

5. Wood poles with interconnect cable shall be fitted with through-bolts holding a clamp assembly or with a thimble eye-bolt to which the messenger may be attached and

terminated.

6. The clamp assembly shall be suitable to the type of cable support, either messenger wire or self-supported cable with "figure 8" cross section. Clamp assemblies for "figure 8" interconnect cable differ slightly from those intended for use with separate messenger, inasmuch as the clamp used with "figure 8" must allow a small gap for the web of the "figure 8" cable which joins the messenger to the cable.

7. When messenger wire or "figure 8" cable is to be grounded on a wood pole, a ground clamp and an insulated ground wire stapled to the pole and covered by a molding shall be used (also see Item 10 in this section). The ground clamp used with "figure 8" cable shall be a type with teeth to penetrate the jacket over the messenger. The ground wire shall be bonded to an existing ground wire or to a ground rod.

8. Standard interconnect cable shall conform to **C&MS Table 732.19-1** and have the number of conductors and wire gage specified. There is no difference between standard interconnect cable and signal cable, only in the application. Interconnect cable of the shielded type may be specified in the plans. The interconnect cable should be marked with the correct nomenclature. Solid conductors are not permitted **(C&MS 732.19)** unless specified in the plans. Splices may be used on long lengths of interconnect cable **(C&MS 632.23)** and shall be accomplished only in weathertight splice enclosures. Splice enclosures may be either aerially located on the messenger wire or be a pole-mounted box type **(see Traffic SCD TC-84.20)**. Where the aerial enclosure is clamped to the span, it should be within 2 feet of a pole to improve accessibility. No measurement allowance is given for splices.

9. Aerial interconnect cable is to have a sag between three to five percent of pole spans or is to match existing utility lines.

10. Messenger wire supporting interconnect cable, and the integral messenger of self-supporting type cable, is to be grounded in cable runs at the first and last poles and on intermediate poles at intervals not to exceed 1200 feet (also see ***item 4*** of this section for grounding on metal poles, and ***item 7*** for grounding on wood poles).

11. As temperatures decrease, interconnect cable gets stiffer and harder, becoming brittle when below freezing. In very cold weather, the cable should be handled with care so as not to damage the jacket or insulation when unreeling, flexing and installing.

12. Standard interconnect cable may be attached to supporting messenger wire by lengths of preformed lashing rod or by spinning wire. Lashing rods shall be of the proper internal diameter to snugly hold the cable but not cut into its jacket ***(see Section 450-8.6)***.

13. Aerial interconnect cable of the integral messenger self-supporting type (with a "figure 8" cross section) shall have its wind stability increased by being twisted or spiraled once every 15 feet of span. This is done by clamping the tensioned cable to every other pole and then going to intermediate poles and twisting the cable before tightening their attachment clamps.

When the interconnect cable is attached to a pole and continues in a relatively straight line past the pole, this is an intermediate support; whereas, if the interconnect cable turns at the pole, it is a corner or turning point. Certain types of clamps may be well suited for intermediate support applications, while other designs are required for corner clamps. The clamps shown on the left side in **Traffic SCD TC-84.20** are usually not suitable for corner clamps if the change of direction is more than about 10 degrees. See **Traffic SCD TC-84.21** when the change of direction is more than about 10 degrees.

450-8.9 Tether Wire and Appurtenances

Tether wire and accessories shall comply with **Traffic SCDs TC-85.21 and TC-85-22** and **C&MS 732.185.** S-hook wire diameter shall be in accordance with the strain pole Design Number, as shown in the plans.

The tether span, as shown in the standard drawings, is designed to yield under either high wind loads or vehicle snags. The S-hooks are designed to yield in a wind event, allowing the signal span to revert to a free-swinging configuration. The breakaway tether anchors are designed to release the tether in the event of a vehicle snag.

The use of a backplate and tethered span increase the frontal area of a 3-section signal head by a factor of approximately nine times that of a free-swinging signal head without backplates. Such an increase, in a design wind, will exceed **AASHTO** allowable stress levels in the strain pole. For this reason, it is important to provide a yielding element on the tether span that unloads the tether at the proper tether wire tension. For purposes of design, **ODOT** has chosen S-hook sizes based on the strain pole Design Number. The table in **SCD TC-85.21** gives the diameter of the S-hook corresponding to various pole Design Numbers. The S-hook must be galvanized mild low-carbon steel. High-strength alloy steels such as Grade 80, sometimes used for load-rated S-hooks in the rigging industry, are not acceptable. These are much too strong for the application and will overload the strain pole in a design wind.

The use of breakaway tether anchors to attach signal heads to tether wire is required. Designs which use an L-shaped clamp, as shown in **SCD TC-85.22**, are acceptable. These shall be properly installed, with the cable clamped below the pinch bolt, and with the opening facing downward. This allows the tether wire to slip out in the event of a vehicle snag.

The turnbuckle used at the end of the tether span is a tensioning and leveling device, to bring the tether into its proper configuration after erection. On all spans, the tether wire must remain essentially horizontal.

The guy grip end also serves as the anchor point for the safety tie. The safety tie is an accessory feature designed to prevent the loose end of a tether span from dropping into the roadway in the event of an S-hook yield. As such, the safety tie need not be particularly strong. In the event of a strong vehicle snag, the 1/8-inch safety tie is designed to yield at a lower load than the 1/4-inch tether wire. If a full-strength safety tie matching the tether wire diameter were used, the possibility would exist of a snagged tether wire overloading the pole. Since the safety tie is small-diameter wire rope, it is specified to be stainless steel, with stainless steel hardware, to minimize corrosion.

450-9 Method of Measurement for Cable and Wire

Figures 498-16 through 498-20 illustrate the method of measurement for signal cable, interconnect cable, detector lead-in cable, power cable and service cable, respectively. **C&MS 632.29** also specifies the method of measurement for cable and wire.

450-10 Signal Equipment and Wiring

450-10.1 General

This Section is used to provide additional information about other signal equipment and wiring.

450-10.2 Controller Cabinet

While the layout of controller cabinets may vary, the following requirements and guidelines apply:

1. The prewired cabinet should be checked against certified drawings, the wiring diagram for

the cabinet and the plans.

2. The cabinet should be fitted with a small door-in-door (police door) unless otherwise specified. The cabinet should be in good condition, revealing no evidence of damage, with its material free of cracks and pinholes. The doors and seals should fit properly. The cabinet exterior should appear as metallic aluminum unless a color is specified. The cabinet interior may be similar to the exterior or may be flat white. The method of cabinet mounting should be as shown on the plans and the cabinet should be securely mounted.

3. Cabinets equipped with solid state controllers shall be provided with a suitable number of sturdy adjustable metal shelves to mount the specified equipment and to provide the required space for designated future equipment **(C&MS 733.03)**.

4. The equipment shall be arranged for easy withdrawal and replacement, without the necessity of disturbing adjacent equipment. The permanent location of equipment within the cabinet, as well as the shelves themselves, should allow free circulation of air and not restrict air flow from fan ducts or vents. Components on shelves and devices on the door shall be arranged so that a 1 inch minimum space separates them when the door is closed. This minimum space shall not be compromised by plugs, wires, controls or similar items. Terminals and panel-mounted devices with exposed contact points located next to shelf-mounted equipment shall be provided with spacers, shelf lips or other means to assure that component units cannot be accidentally moved into contact with any exposed electrical terminal points. A minimum 4 inches clear area from the bottom of the cabinet should be reserved for the routing of cables. No shelf component or panel-mounted item shall be located in the bottom 6 inches (of cabinets, with the exception that terminal blocks only in pedestal or pole mounted cabinets may be installed as close as 4 inches to the bottom.

5. Ready accessibility should be provided for items such as load switches, flasher, relays, terminal blocks and fuses which are mounted on or plugged into panels on the cabinet back or sides. Switches, controls and indicator lights should be easily operable and visible without having to move equipment from their positions.

6. Major equipment items should bear a name plate, brand or indelible marking for identification as to type, model, catalog number and manufacturer’s name or trademark.

7. The furnished controller unit should be checked for the correct type, number of phases, and available control functions required by the plans. Controller units should be furnished with all auxiliary equipment necessary to obtain the operation shown in the plans.

8. When specified, other equipment may be a part of the prewired cabinet, such as: an on-street master, interconnection equipment, preemption equipment, video detection equipment, and special relays.

9. Furnished detector units should be checked to see if the correct quantity is installed, and the proper type used with each loop and each detector phase. When multi-channel detector units are furnished, the plans may require the provision of special cabinet wiring and an adapter harness to allow single channel detector units to be readily substituted.

10. The prewired cabinet should also be checked for the following auxiliary equipment:

    a. A forced air ventilating fan automatically controlled by a thermostat shall be furnished.

    b. A conflict monitor shall be furnished according to **C&MS 733.03(A.2.c.)**. The minimum number of monitor channels, related to the number of phases for the intersection, should conform to **C&MS 733.03**.

    c. Load switches should be provided in sufficient quantity for the interval sequence shown in the plans. The switches shall be solid state **NEMA** triple signal type with input indicator lamps. The minimum number of load switch sockets furnished, related to the number of phases for the intersection, shall conform to **C&MS 733.03**.

d. A flasher (or flashers) shall be solid state **NEMA** type.

e. Relays required for the proper operation of the specified equipment shall be furnished.

f. Lightning protection devices shall be furnished for the protection of solid state controllers. They should be located on the incoming power line and on loop detector leads where these connect to the terminal block. Interconnect cable shall be protected by devices across each conductor and ground **(see C&MS 733.03(A.2.f.))**.

g. A convenience outlet and lamp shall be furnished. The outlet should contain at least one standard three-wire plug receptacle of the ground-fault circuit-interrupting type. The lamp should be an incandescent type, located in the upper part of the cabinet, and controlled by a switch.

h. A main power breaker shall be furnished. The fan, convenience outlet and lamp should be wired on a branch of the AC+ power line preceding the main breaker, so that these may be operated independently of the main breaker control. This preceding branch should itself contain an auxiliary breaker rated at 15 amp.

i. A radio interference filter should be installed in the incoming AC+ power line between the main breaker and solid state equipment. If the equipment furnished does not provide signal and flasher circuit switching at the zero voltage point of the power line sinusoid wave form, filters should also be provided for the load switches and flasher.

j. A manual control cord with push button should be furnished only when the plans so require **(C&MS 733.03)**. The cord should be at least 5 feet long.

k. Switches required for the proper operation of specified equipment should be furnished and labeled as to function and setting position. The following switches should be grouped behind the small door-in-door (police door): signal shutdown switch, flash control switch and an automatic/manual transfer switch (when manual control is specified).

l. Terminal blocks should not be obstructed by other equipment. Terminal points should accept spade type wiring terminals except for incoming power terminal points which may be either the type to accept bare wire or spade terminals. Contact between adjacent terminal points may be either by bus bar or by wire jumpers with spade terminals.

11. The incoming power bus should be fed from the line side of the incoming 120 VAC power line after the circuit has passed through the main power breaker. A signal bus relay should control power to the bus supplying power for the signal load switches. The requirement for radio interference filters **(C&MS 733.03)** should be adhered to, with the buses supplying load switches and flashers being filtered if load switches do not switch at the zero voltage point of the power line sinusoid wave form. A common terminal bus insulated from the cabinet should be furnished for the connection of the neutral wire of the incoming 120 VAC power line. This common bus should have sufficient terminal points to accommodate all potential cabinet wiring as well as field wiring. A separate common terminal, insulated from the panel, should be used for the interconnect common (if interconnection is a part of the system).

12. The cabinet should include a ground bus bar with an adequate number (at least three) of ground terminal points **(C&MS 733.03)**. This bus bar should be grounded to the cabinet.

13. Wiring bundles should be neatly arranged and grouped as to voltage and function, and

they should be lashed or restrained so that they do not interfere with the access to equipment, including terminal blocks or buses. The harnesses should be of sufficient length and should be easily traced through the cabinet. All conductors should be stranded, with labeled spade type terminals or plug connectors. The wiring should be color coded, with solid white for the AC common, black for the AC line side power (AC+), and solid green or white with green stripes for the safety ground.

14. Incoming cable and wire should be identified by tags or bands **(C&MS 632.05)**. The size, material and method of tag or band identification should be in accordance with **C&MS 725.02**, except that marking may be by indelible pen on plastic tags instead of embossed letters. The identification on the tags or bands should conform to the wiring diagram for the cabinet and its intersection, with typical abbreviations in accordance with **C&MS Table 632.05-1**, which has been reproduced in this Manual as ***Table 497-2***.

15. Two copies of the schematic and wiring diagram for each cabinet and its intersection should be furnished by the contractor. The diagrams are to be updated to reflect any changes made during construction. The diagrams should be neat and legible, on durable paper, and folded in a moisture-proof envelope fastened to the cabinet interior.

450-10.3 Cable and Wire Identification

As noted in **C&MS 632.05**, cables and wires shall be identified as shown in **C&MS Table 632.05-1**, which has been reproduced in this Manual as ***Table 497-2***.

450-10.4 Vehicular Signal Heads and Wiring

Illustrations of the signal head visors and wiring discussed herein are presented in ***Figure 498-21*** and **Traffic SCD TC-85.21**.

1. Signal heads shall conform to the plans, **C&MS 732.01,** and **Traffic SCDs TC-85.20 and TC-85.22**. Signal heads shall be made up of the correct number of optical sections (one, three, four or five). Sections shall be of the correct module size, i.e., 8 or 12 inches, color and ball or arrow configuration. Arrow modules shall be the 12-inch size. It should be noted that arrow modules are made in Rights, Lefts and Throughs (up). The use of the proper arrow module should be checked.

2. Modules shall be aligned properly in their frames so their optical configuration directs most of the light to the forward sector.

3. As noted in ***Section 420-4.2***, signal heads shall have a yellow or black finish, unless otherwise specified in the plan.

4. Cutaway type visors **(C&MS 732.01)** shall be fastened to each optical section, unless open bottom tunnel visors or other types are specified, and the interior finish of the visors shall be flat black.

5. Signals should be clean and the assembly tight. Gaskets should be in good condition and module door hinges and latches should be in good working order. All openings not used for mounting purposes shall be closed by waterproof caps.

6. Five-section faces, arranged in accordance with **Traffic SCDs TC-85.20 and TC-85.22** and the plans, are to use galvanized pipe, elbows and tubular hardware, painted to match the signal head.

7. Swinging signals shall be installed in a plumb condition.

8. Swinging signals suspended from a mast arm shall be fitted with a universal hanger permitting swinging in both longitudinal and transverse directions.

9. When specified by the plans, disconnect hangers shall be used with signal heads.

10. Drop pipes, 1 1/2 inch diameter galvanized pipe, are a source of trouble and are aesthetically unattractive; therefore, they are intended to be used only when they are necessary. Signals supported by span wire, with sag required between 3 and 5 percent **(Traffic SCD TC-84.20)**, shall be brought to proper clearance by adjusting the attachment height of the span wire to the poles.

11. Backplates shall be fitted to signal heads, unless specified otherwise.

12. Signal cable shall be routed into the interior of heads through the entrance fitting using a grommet. The cable shall be routed to each face's terminal block, which is typically in the yellow indication section. Conductors shall be fitted with spade type terminals and shall be fastened securely to the correct terminal points. Conductors shall be identified according to the wiring diagram. Signal cable shall not be spliced, either between signals or in signal face interiors.

13. External signal cable shall to be fashioned into a drip loop extending at least 6 inches below the entrance fitting but shall not chafe on the signal.

14. Lamps shall be light emitting diode (LED) **(C&MS 732.04(C))**. All vehicular signal lamps shall be prequalified in accordance with **C&MS 732.04(C)**. As noted in ***Section 420-4.10***, although **OMUTCD 4D.06** allows for an alternative dual-arrow (bi-modal) display of a GREEN ARROW and a YELLOW ARROW, these dual-arrow signal sections shall not be permitted on **ODOT**-maintained highways.

15. Each face of a signal head shall be oriented to its approach of traffic and its locking device securely tightened. Orientation or aiming of standard signals should be done so that the maximum light intensity from a standard signal is directed slightly below the horizontal center; thus, on a level approach, the face of the signal should be essentially vertical. When an approach to a signal is on a grade, the signal may be tilted slightly to point the signal axis parallel to the grade of the approach. Horizontal aiming should orient the axis of signal display parallel to the centerline of the approach for straight approaches when the signal is over the roadway. When the approach roadway is curved, or when a signal is not over the roadway, the axis should be directed at a point on the approach which is 175 to 625 feet in advance of the intersection, the distance being dependent on the speed of approaching traffic. For convenience, **OMUTCD Table 4D-2** has been reproduced as ***TEM Table 497-3***.

16. When a vehicular traffic signal head has been erected and faces approaching traffic, it shall either be in operation as a stop-and-go signal or a flasher, or it shall be covered or bagged. This is an **OMUTCD** requirement **(OMUTCD Section 4D.01)** and cannot be ignored. Typically, the plans will contain an item for "Covering of Vehicular Signal Heads" which will require the contractor to cover, maintain the covering, and subsequently remove the covering when the signal is ready to commence operation.

17. Normally, the plans will provide the "covering" item for each new signal head, but will not provide them for any existing heads which are to be removed. The intent is that "covering" will be necessary for the new heads until they and their associated controller and wiring have been checked by circuit testing **(see *Section 450-11*)**, while any existing signals at the intersection will continue to control traffic. When the new signals are uncovered and placed in operation, the existing signals can be quickly removed. Specific maintenance of traffic requirements in any plan may require a different means to assure the unused signals are not exposed to traffic.

450-10.5 Optically Programmed Signal Heads

Programmed heads ***(see Section 420-4.6)*** shall conform to certified drawings, **C&MS 732**, and the plans. They are to have the correct number of optical sections making up each face. Programmed heads have many points of similarity to regular heads. ***Items 2, 3, 5, 11, 12, 13, 16 and 17 of Section 450-10.4*** also apply to these signal heads. For more detailed information, see publications by the manufacturer.

Each optical section shall be fitted with a visor and the interior surface of visors shall have a flat black finish.

Programmed heads shall be mounted in a manner permitting little or no motion. If mounted on a mast arm, a rigid adapter shall be used. Heads of more than three vertical sections mounted on a mast arm shall be fitted with pipe backbracing, as shown on **Traffic SCD TC-85.20**. The pipe shall be a minimum of 17 inches behind the signal center axis so that adequate clearance is provided for the programming procedure. If heads are supported by span wire, a tether messenger wire shall be attached to a fitting in the bottom of the signal's lower section.

Customarily the manufacturer's representative will program the signals, but in accordance with the plans, the contractor is responsible for the correct aiming and masking of the signal so as to be visible to drivers or pedestrians only in the area indicated on the plans.

450-10.6 Pedestrian Signal Heads

Pedestrian signal heads shall conform to **C&MS 732.05**, certified drawings, the plans and **Traffic SCD TC-85.10**. Signals shall have the correct type of light source and lettering height in accordance with the plans **(C&MS 632.08)**.

Housings shall have a black finish, unless otherwise specified (**C&MS 732.05**). Visors shall be fitted over each message, except one type may have the entire face protected by a flat black sunshade fastened close to the module. The interior surface of visors shall be flat black finish.

Signals should be clean and the assembly tight. Gaskets should be in good condition and module door hinges and latches in good working order.

Housings shall be positioned with a minimum set back of 2 feet from the curb and a height of 8 to 9 feet above the sidewalk for adequate clearance. The heads shall be oriented toward their crosswalk and locked securely in position.

Lamps for pedestrian signal heads shall be light emitting diode (LED) **(C&MS 732.04(C))**.

Pedestrian push buttons shall conform to ***Section 404-2***, certified drawings, and **C&MS 732.06**. Push button housings shall have a yellow finish, unless otherwise specified. The push button shall be positioned 3.5 to 4 feet above the sidewalk.

Push buttons on metal poles shall be installed over a 3/4 inch maximum field drilled hole with edge protected by two coats of zinc-rich paint and a rubber grommet inserted. The push button housing curved back shall be positioned over the hole, wiring routed through to the electrical mechanism and the housing secured by stainless steel screws. Unused holes in the housing shall be plugged. Push buttons on wooden poles shall have their wiring in conduit connected to a fitting of the signal support.

Signal head supports (conduit and fittings) on wooden poles shall be grounded, using a ground clamp and an insulated ground wire stapled to the pole and covered by a molding.

If specified in the plans, pedestrian signal heads may be covered in accordance with **C&MS Item 632.25**.

OMUTCD Section 2B.51 addresses standards for the signs used where push buttons are provided to actuate pedestrian signals. The sign legend shall conform to the plans.

450-10.7 Loop Detector Slot and Wire

Figures 498-23, 498-24 and 498-25 illustrate details related to the following discussion of loop detector slots and wiring.

1. Slots cut into the pavement forming rectangular detection loops shall be in accordance with the plans and **Traffic SCD TC-82.10**.

2. The slots shall be a minimum of 3/8 inch in width and shall have a minimum depth of 2 inches in concrete and 4 inches in asphaltic concrete. The maximum depth in concrete shall be 2.5 inches. **Traffic SCD TC-82.10** requires that loop corners be made at a drilled or bored hole, about 1 1/4 inches in diameter, and with the same depth as the saw slot. Any sharp edges at the saw slots and the holes shall be chiseled out.

3. The slot depth shall accommodate the specified number of turns of wire laid so that the uppermost wire has a covering of at least 3/4 inch. The number of wire turns shall comply with the plans and the table in **Traffic SCD TC-82.10** (also shown in ***Figure 498-23***). A separate slot leading from the loop to the pavement edge is typically cut for each loop.

4. When permitted by the engineer, loops installed in new asphaltic concrete may be sawed and the loop wire(s) embedded with sealant in a subsurface course with subsequent covering by the surface course.

5. Some plans may specify the use of preformed loops placed on the pavement for covering by a surface course of asphaltic concrete.

6. If the problem of loop installations in brick streets is encountered, the engineer should consult with the local traffic engineer for recommendations.

7. Loop locations may be adjusted to avoid manholes. Loops should not be placed across pavement joints. Instead, lateral and longitudinal adjustments should be considered, with the approval of the engineer. If joint crossing is unavoidable or major pavement cracks are encountered, the following techniques may be used ***(see Figure 498-24)***.

    a. In **Technique A**, the loop wires are laid over the joint or crack within a 3 inch square or circular hole cut to slot depth. The wires are laid in an “S” shape and the hole filled with elastic joint material or asphaltic concrete.

    b. In **Technique B**, the slot at the joint or crack is saw cut to twice normal width and depth. The wires are laid so as to conform to the deepened slot which is injected with soft-setting butyl rubber up to the depth of the original slot. The original slot depth and the remaining perimeter of the slots are embedded with standard sealant cured to a flexible state.

    c. In **Technique C**, the slot at the joint or crack is enlarged. The wires are encased in a length of plastic tubing which should be large enough to loosely hold all wires and may be slit lengthwise to facilitate construction. Before placing it in the slot, the ends and the longitudinal slit are to be taped shut to prevent the entry of loop sealant. The enlarged slot is then filled with loop sealant.

8. Before loop wire is placed, all slots shall be brushed, blown clean of loose material and completely dry.

9. Loop detector wire shall be single-conductor No. 14 AWG insulated wire, type **IMSA 51-5** with stranded copper conductors, unless otherwise specified. The wire should be marked at intervals with the wire gage, **UL** label and type. The detector wire is contained inside a flexible plastic tube, as required by **IMSA 51-5.**

10. The correct turns of loop wire ***(Figure 498-23)***, up to a maximum of six, shall be placed in the slots, to comply with **C&MS 632.23** and the plans. The wire shall be pushed to the bottom of the slots with a blunt wooden tool (or equivalent) to avoid damaging the insulation.

11. The wires with tubing at the pavement edge or curb shall be led into a conduit of the size shown in **SCD TC 82.10**. Care should be taken to prevent excessive slack at the point where the wires enter the conduit. The high end of the conduit shall be sealed in accordance with **SCD TC 82.10.**

12. The detector wire shall be twisted in the conduit leading from the pavement edge to the pull box. The flexible plastic tubing shall cover the wire completely from the splice at the lead-in cable, through the entire loop turns and back to the splice. The tubing provides extra protection from abrasion and allows the wire to slide inside the tubing in case of pavement shift or cracks, thus minimizing the possibility of breakage. Since wire/tubing includes an air pocket, it will tend to float to the surface when sealant is applied to the slot. For this reason it is usually necessary to wedge short lengths of the tubing, or similar devices, into the slot to wedge down the tubing/wire. These are usually needed at 1 to 2 foot intervals.

13. The slots shall be completely filled with approved sealant and left undisturbed until cured to a flexible state. Sealants on the **ODOT** prequalified list shall be used, in accordance with the manufacturer's recommendations. Materials which set up to a hard or brittle state are not acceptable.

14. Detector loops are measured as "each" loop installed and the item includes wire, pavement cutting, sealant, conduit and trenching to the pullbox.

450-10.8 Loop Detector Lead-In Cable

Unless otherwise specified, loop detector lead-in cable **(C&MS Table 732.19-1)** shall be two-conductor No. 14 AWG twisted pair shielded, Type IMSA 50-2 with conductors of stranded copper.

Within the pull box, loop wire ends shall be joined to the conductors of the lead-in cable by soldering and covered with insulating material ***(see Figure 498-25)***. An approved, poured epoxy waterproof splice kit shall be used. It is understood that epoxy splice kits are easily damaged by freezing temperatures encountered prior to mixing. Damaged epoxy components may sometimes be recognized if either of the components has turned or is streaked milky white.

Lead-in cable shall be routed to the controller cabinet, fitted with soldered spade type terminals and fastened to the correct points of the terminal block. The lead-in cable's shielding shall be grounded to the ground bus within the cabinet.

If a pull box is not specified on the plans, the splice between the loop wire and lead-in cable shall be made in the first entered pole or pedestal, except where the controller cabinet is mounted on the pole or pedestal. If the controller cabinet is mounted on the pole or pedestal, the loop wires may be routed directly into the cabinet and no lead-in cable is necessary.

Loop detector lead-in cable is measured in accordance with ***Section 450-9*** and ***Figure 498-18***. The poured epoxy splice in the pull box is included.

450-11 Signal Performance Tests and System Checks

450-11.1 General

Traffic control signal components and the entire system shall be tested as required by various specifications to assure proper operation before acceptance. Ground rods shall be tested for satisfactory low resistance to ground. A circuit test should be performed on all conductors to make sure there are no shorts, crosses and high resistance or other improper connections. A cable insulation or megger test shall be performed on all conductors to verify the integrity of the insulation covering. All traffic control equipment in the controller cabinet should be checked for correct settings and all controls manipulated for assurance of an operable system.

Finally, the traffic control system shall successfully pass a ten-day performance test, which will give an opportunity for any hidden flaws to reveal their presence. As a final "housekeeping" check, equipment should be observed for any evidence of unattached ground wire, unlatched or unbolted doors, etc.

The results of the various tests are to be entered by the contractor on test report forms ***(Form 496-6)*** as required by **C&MS 632.28**.

450-11.2 Ground Rod Test

All ground rods shall be tested by the contractor for earth resistance to ground, as required by **C&MS 632.28(B)**.

450-11.3 Short-Circuit Test

Before the performance of any cable insulation (megger) test or the ten-day performance test, a short-circuit test shall be performed by the contractor using a volt-ohmmeter or other approved instrument **(*Form 496-6* and C&MS 632.28(C))**. Short-circuit tests shall be conducted with all electrical loads, power sources, equipment grounds, and earth grounds disconnected ***(see Figure 498-28)***.

Signal cable routed to signal heads may be tested with connection made to the lamp sockets, but without the lamps being installed.

Each conductor shall be measured against every other conductor and ground to assure that no short-circuits, cross-circuits, or other improper connections exist. Continuity should not exist between any conductor and any other conductor including ground.

450-11.4 Circuit Continuity Test

Each circuit branch shall be disconnected and tested by the contractor for continuity by temporarily jumpering each branch at its termination and measuring the temporarily looped circuit for assurance that no open circuits exist **(*Form 496-6* and C&MS 632.28(D))**. This testing is illustrated in ***Figures 498-29 through 498-32***. Each circuit branch should be according to plan, with no high resistance connections and with the proper identification.

Lead-in cable for loop detector wire shall be tested before and after the cable is spliced to the loop wire.

Circuit continuity of signal cable may be done by applying 120 volts to each outgoing circuit and observing that only the specific lamps are lighted.

450-11.5 Cable Insulation Test (Megger Test)

This testing is illustrated in ***Figures 498-33 and 498-34***.

1. Each conductor of cable or wire terminating at the controller cabinet shall be tested by the contractor for insulation resistance measured to ground **(*Form 496-6* and C&MS 632.28(E))**. A listing of the resistance reading for each conductor is to be included in the test results furnished to the engineer.

2. Cable and wire insulation can be faulty but the imperfections can be easily overlooked,

leading to eventual electrical failure of the wiring. Weakening of insulation properties may be caused by poor storage conditions and stress due to rough handling during installation. Dirt is especially troublesome, since it is an electricity conductor and can penetrate small cracks in the insulation.

3. Insulation testing shall be performed with all conductors disconnected from their points on the terminal block in the cabinet so there is no chance of any voltage being present, and to prevent damage to any connected equipment. One megger instrument terminal shall be attached to a termination of jumpered together ends of conductors or to the end of a single conductor cable or wire undergoing testing. The other megger instrument terminal shall be attached to the cabinet ground bus bar.

4. Insulation resistance shall be measured for the wire of roadway loops after the embedding of the wire with sealant in slots.

5. The meter pointer of the megger instrument (or equivalent indication) should be adjusted to zero and the test switch activated. Test duration should be as recommended by the instrument manufacturer.

6. The insulation resistance measured to ground for each conductor shall not to be less than 10 megohms. Cable or wire not meeting this reading shall be replaced.

7. After completion of the cable insulation test, all cabinet wiring shall be connected in accordance with the wiring diagram. The contractor shall demonstrate to the satisfaction of the engineer that all circuits are continuous and operating correctly, free from shorts, crosses and unintentional grounds.

450-11.6 Functional Test

Before energizing the traffic signals the following functional checks should be made **(*Form 496-6* and C&MS 632.28(F))**:

1. The incoming AC voltage should be checked.

2. Operation of the following equipment should be checked: cabinet ventilating fan, fan thermostat, and convenience outlet with lamp (when furnished). The filter(s) used with the fan should be unobstructed.

3. Timing settings on solid state controllers should be varied over their ranges and all functions activated to verify that the controls are operable without fault.

4. Timing settings in accordance with the plans should now be entered on the controller, time clock, etc. and checked for corrections. On some projects, timing settings will be provided by the maintaining agency and are not listed in the plans.

5. An agreement should be reached with the contractor and the maintaining agency on the procedure to be followed in the event of a signal failure prior to acceptance.

6. Before signals are energized to control traffic, the maintaining agency should be notified and given an opportunity to check the installation and timing settings.

After energizing the traffic signals the following functional checks should be made. In the event the signals are controlling traffic at the time, these checks should be made with caution to protect the safety of workers, pedestrians and drivers.

1. The function of all cabinet switches should be checked, including the power on/off switch and manual control (when furnished).

2. The traffic signals (and controller indicator lights) should be observed to verify that the controller is timing consistently the intervals and phases set into the controls. A stopwatch is suggested, especially to check critical short intervals. All controller functions should be activated to verify that operation is proper.

3. The detector units should be investigated to determine which pavement loop(s) or other type sensor is associated with which unit. The visual indication of units (light, meter, etc.) should be observed to determine that each vehicle (truck, car, motorcycle, etc.) entering sensor areas is properly detected on the associated unit. All inductive loops shall have their sensitivity set to detect a small, high ground-clearance motorcycle (e.g., 200cc dual sport) at the minimum call strength indication. A loop test target equivalent to this small motorcycle should be fabricated as shown in ***Figure 498-27***. This loop test target should be held parallel to the traveled way, with the bottom at or near ground level in the most sensitive part of the loop (close to the saw cut) to simulate the inductive signature of the desired vehicle. For bicycles, a similar loop test target may be constructed, also shown in ***Figure 498-27***. Once the proper sensitivity is attained, the detector module may occasionally detect adjacent-lane vehicles (“splashover detection”). This is an acceptable condition in order to obtain reliable detection of small two-wheel vehicles. Properly designed and placed loops will exhibit minimal or no adjacent-lane detection, even with detector module sensitivities set for small target detection. (Additional information on loop design for detection of motorcycles and bicycles is available in ***Section 420-5.2***.) When a detector unit is set for "presence," a detection call should continue as long as a vehicle is positioned over the associated sensor. Concurrent with detection, the appropriate controller indicator should also exhibit the detection. Stop line loops shall be connected to separate detection channels.

4. The flasher switch should be activated to cause the signal heads to flash. Their indications should be checked to verify if they are correct. The flasher switch is then to be returned to the normal or signal mode and a check made of the resumption of normal stop-and-go-operation.

5. The conflict monitor should not be activated by normal signal operation or by the manipulation of cabinet switches. If at any time the monitor is activated, the contractor is required to determine the cause of the problem and make appropriate changes and adjustments before beginning the ten-day performance test. The contractor should test the conflict monitor by artificially causing a number of different conflicting indications and checking that at each test the monitor causes the signals to begin flashing and places the controller in a "stop timing" mode. Artificial conflict may be caused by touching a jumper wire between two load switch outputs that would signal a traffic conflict. Other methods of artificially caused conflicts may be used at the discretion of the contractor.

6. Signals which are interconnected should be observed to determine if offset relationships are maintained in accordance with settings during all periods of the day.

7. When preemption equipment is furnished as part of the cabinet installation, the proper functioning of the equipment should be checked. The equipment should be activated and observations made to determine if the required sequence of intervals and phases is called for in a correct and safe manner.

8. On projects having equipment furnished for future use only, the equipment should be checked to verify that it is properly installed and operable in a correct manner.

Some signal control equipment is intended to vary the timing patterns at different periods of the day or days of the week. To determine if these required changes are occurring at the proper times, it is necessary that observations be made to check the operation at transition times over a period of several days. The change in timing shall not be extremely drawn out or abrupt. The accuracy of time clocks and weekly programmers should be checked. Programmed changes should occur within one minute for clocks of the solid state type. No significant cumulative clock error should be noted during the ten-day performance test.

After successful completion of the ten-day performance test, and after a partial or final acceptance of a project, the contractor is to turn over to the engineer all manuals, diagrams, instructions, guarantees and related material, as required by **C&MS 632.05**. It is recommended that the engineer list this material in the project diary as a permanent record of the transfer. The engineer should transfer the material to the maintaining agency. For **ODOT**-maintained signals the material should be given to the **District Roadway Services Manager**.

After a traffic control system project has been accepted by **ODOT**, the engineer should immediately notify the maintaining agency that as of a certain exact time and date, the agency is responsible for the operation and maintenance of the system.

450-11.7 Ten-Day Performance Test

Before acceptance of the traffic control system, the contractor shall furnish all personnel and equipment required to successfully operate the system continuously for ten consecutive days without major malfunction or failure **(C&MS 632.28(G))**.

At least seven days prior to the beginning of the performance test, the contractor shall notify the engineer of the starting date. The engineer will notify the maintaining agency **(C&MS 632.28(G))**.

The contractor shall arrange with the utility supplying the power for purchase of the energy required to conduct the test. All costs of personnel, equipment, electrical energy and incidentals required to perform the test are to have been included in the contract unit prices for the respective items tested.

Minor failures such as lamps, a single detector or an individual signal head, etc. shall be immediately replaced or repaired and will not cause restart of the test.

A major malfunction or failure, such as a master or local controller, interconnect equipment, etc. will cause termination of the test, and after replacement or repair of the malfunctioning or failed equipment, the beginning of a new ten-day test.

Items which have been repaired or which are replacements are to be monitored by the contractor for a period of ten days to provide assurance of their reliability.

The complete test results are to be furnished to the engineer on test reporting forms in accordance with **C&MS 625.19**. The contractor is to record in the test results the beginning and end of the test, and the method and date of the correction of each fault.

The engineer should record the following events in the project diary: the date of the beginning of the ten-day performance test, a day-by-day record of faults as they occur during the test, and the date of the successful completion of the performance test.

450-11.8 Final Signal Installation Check

After all wiring is completed and all testing completed and accepted, a final inspection of the traffic control system should be performed to assure a neat and workmanlike appearance.

1. All spare conductors should be connected to the ground bus bar in the controller cabinet.

2. All ground wires should be properly connected.

3. The spade type ends of conductors should be sound. After all testing is complete, they should be reinstalled on their correct points of terminal blocks and tightened.

4. A visual check should be made for any signs of arcing, melted insulation, etc.
5. All debris from wiring work or packaging materials should be cleaned from the bottom of cabinets.
6. Cabinet vents should be checked to assure that they are unobstructed and all filters should be clean and in place.
7. Duct sealing material shall be used to seal the conduit entering the cabinet from the base.
8. All doors on the optical sections of vehicular and pedestrian signal heads shall be closed and latched.
9. No wires or cable should be visible under the base plates of poles and pedestals.
10. The handhole covers on poles and end-frames shall be securely fastened.
11. Pedestals with transformer type bases shall have the access door securely fastened.
12. The covers on pull boxes shall be securely bolted.

450-12 Controller Change Orders

Once a project is bid with 2070, **NEMA** or 170 controller technologies, it is not permissible to switch to a different technology after the project bids.

This is not allowed even if it is a no cost change order. This practice circumvents the competitive bidding practice and could lead to legal action being taken against **ODOT** by suppliers who were not afforded the opportunity to bid on the replacement technology type.

These types of change orders are not allowed even if the local maintaining agency requests it. They need to make their preference for controller technology known during the design so that it can be competitively bid.

460 MAINTENANCE / OPERATIONS

460-1 General

Because traffic signals by their very nature provide positive guidance to conflicting traffic movements, it is imperative that they be maintained in order for them to function reliably. The mean time before failure of a traffic signal installation can be dramatically reduced through proper maintenance practices. The consequence of poor maintenance practices are a reduction in safety to road users and an unnecessarily large exposure to liability claims. **District Roadway Services** personnel and signal maintenance contractors are required to perform maintenance on traffic signals according to a preset schedule.

460-2 Responsibilities

The **Office of Traffic Operations (OTO)** shall:

1. Staff and maintain a central repair facility for the purpose of repairing components of electrical traffic control devices.

2. Assist **Districts** in maintaining reasonable stock levels of all major electrical items, and their appurtenances, required for new installations and maintenance through the management of annual term contracts and spot purchase contracts.

3. Assist the **Districts**, through procedure manuals, training programs, inspections, and other methods, in providing quality maintenance.

The **OTO Signal Shop** shall:

1. Repair, check and make serviceable for installation all signal controllers, signal relays, detectors, flashers, conflict monitors and other associated items.

2. Provide the loop detectors and other miscellaneous parts to custom wire as per plan new controller cabinets purchased by the **Districts** or rewire/refurbish existing controller cabinets.

3. Periodically provide the **Districts** with technical information concerning old and new equipment, such as: a list of outdated equipment that will not be repaired by the **Signal Shop**, changes, problems, software updates and etc. for any equipment owned by **ODOT**, and other tips or tricks that may help the **District** personnel.

4. Distribute to the **Districts**, at least once per calendar year, a list of all equipment, parts, and services available from the **Signal Shop**.

Each **District** shall:

1. Maintain a stock of traffic control equipment and other spare parts sufficient for normal preventive maintenance and emergency field repairs.

2. Have a plan to support the extraordinary (i.e., severe storm damage) traffic control equipment needs of the **District**.

3. Evaluate, authorize and maintain records of all changes in the location or operation of electrical traffic control devices.

4. Transport defective controllers, detector relays, detectors, conflict monitors, etc., to the **OTO Signal Shop** (or approved contractor/vendor) for service, maintenance and repair, along with a **Signal Shop Order** and a tag indicating the exact type of malfunction. These units shall at all times be properly cushioned to prevent physical damage during shipping and handling.

5. Generate an “as built” drawing for each electrical traffic control device installation, including each new or upgraded intersection control beacon, school flasher or signal. The drawing shall be in MicroStation V8 or later format and shall include the following, if appropriate:

   a. Geometrics of the intersection.

   b. Materials list.

   c. Layout and location of the detectors, poles, pull boxes, cable runs, span wire, signal and pedestrian heads, controller, power service, phase diagram, detector operation, date of installation, revision block, and any other information which shows the intended operation.

   d. Changes which affect the geometrics of the intersection and/or the operation of the signal shall be added to the drawing as revisions.

   These electronic files shall be accessible to the **Central Office** in a read-only mode. Signal drawings which exist in a raster or single element format and cannot be modified shall be digitized or converted by other means when revisions become necessary.

6. Perform appropriate engineering studies, as needed, upon which revisions in signal operations, e.g., phasing may be based. When such revisions are required, an engineering report and necessary supporting data shall be submitted for approval to the appropriate **District** staff person.

   Some signalized intersections and/or signalized corridors may be eligible to apply for, and participate in, the Systematic Signal Timing & Phasing Program (SSTPP). See ***Section 1213-6*** for more information about this program.

460-3 Preventive Maintenance

460-3.1 General

ODOT-maintained traffic signal installations shall be inspected a minimum of one time annually. In addition to the annual traffic signal inspection, the following routine scheduled maintenance shall be performed by either **District Roadway Services** section personnel or a signal maintenance contractor.

460-3.2 Traffic Control Signals and Intersection Control Beacons

Every eight years, all standard-warranty (5-yr) LED traffic control signal lamps and intersection control beacons shall be replaced. A twelve-month compliance interval shall apply to this process such that no device shall be in service for more than eight years.

Every seventeen years, all extended warranty (15-yr) traffic control signals and intersection control beacons shall be replaced. A twelve-month compliance interval shall apply to this process such that no device shall be in service more than eighteen years.

Every twelve months the conflict monitor shall be tested with an automatic conflict monitor tester.

Conflict monitors that are over ten years old need to be removed from service.

The recommended replacement periods for traffic signal equipment are listed below, this does not preclude replacement of deficient items identified during periodic inspections:

Item	Replacement Period (years)
UPS Inverter	End of Life
UPS Batteries	8
Monitor	10
Controller Unit	15
Communication Equip.	15
Cabinet	30

Item	Replacement Period (years)
LED Lamp Modules (5-yr/15-yr warranty)	8/18
Ped./Veh. Signal Heads/ Blank-Out Signs	15
Wiring	30
Messenger/Tether Wire	30
Strain Poles/Mast Arms	30
Detection (Radar/ Video/Pavement Loops)	End of Life

When rebuilding a signal, do not reuse equipment that is beyond the replacement period.

460-3.3 Other Electrical Traffic Control Devices

For School Flashers, flashing and illuminated signs, and other electrical traffic control devices:

- Incandescent lamps shall no longer be used.
- Every four years mercury vapor lamps shall be replaced, and all reflectors, lenses, tubes and /or lamps shall be cleaned.

460-3.4 Signal Support Inspection

All signal supports shall be inspected at a maximum five-year interval. New signal supports shall be inspected at the time of construction. Refer to ***Section 421-2*** for additional information on signal support inspections.

460-4 <u>As Required Maintenance</u>

The following maintenance shall be conducted as required:

At signalized intersections, and for School Flashers and Intersection Control Beacons (overhead flashers):

1. Replace premature failure of lamps. Clean all reflectors, lenses, tubes and/or lamps.
2. Repaint painted steel poles, controller housings and signal heads as necessary to maintain good appearance and protection.
3. If required by local conditions of smoke, smog, etc., clean all reflectors, tubes and/or lamps using a mild detergent.

At flashing signs, illuminated signs, and other electrical traffic control devices:

1. Replace premature failure of lamps. Clean all reflectors, lenses, tubes and/or lamps.
2. Maintain and replace all other items as required.

Maintain all signs and pavement markings directly associated with any of these devices.

460-5 Malfunction Response

Each **District** shall seek the cooperation of the **Ohio State Highway Patrol (OSHP)**, local law enforcement, and **ODOT** work crews in reporting outages and malfunction of electrical traffic control devices. The **District** shall provide directions for reporting malfunctions twenty-four hours a day.

Upon becoming aware of a traffic signal malfunction (i.e., single red or yellow outage, power outage, signal on flash, and other malfunctions or damage as deemed necessary), the **District** shall be reasonably prompt in responding at all times, including outside normal working hours. Other repairs, especially green outages, may be made when practicable.

The **District** shall establish procedures for addressing malfunction responses. At a minimum these shall include:

1. If necessary, notify the **OSHP** or other appropriate law enforcement agencies, and ask for immediate assistance with traffic control until operation can be restored to a safe condition.

2. Assure that the signal is examined by a signal electrician or other qualified individual to verify that the signal was not damaged by the outage.

3. When a response is made to a reported traffic signal malfunction, the nature and time of malfunctions and corrective action taken shall be recorded.

4. All maintenance of traffic operations shall follow the requirements of the **OMUTCD** and ***Part 6*** of this Manual.

460-6 Record Retention

The **District** shall be responsible for retaining records on all traffic signal maintenance, installations, upgrades, transfers, and removals. These records shall be retained according to DAS record retention Schedule Number 17701678, available at the DAS website. These records shall include:

1. Date of lamp replacements and a description of all other signal maintenance and repairs preformed.

2. The record response to each reported traffic signal malfunction.

3. Documentation to reflect the history of the signals, shall also be maintained for each location. Copies of the original installation and each revision shall be retained either in paper or electronic form or both.

A current signal timing chart, current “as-built” plan, current programming chart for coordination if necessary, cabinet wiring diagram, and special function device diagrams in each controller housing and in the **District** office. If laptop computers are used instead of paper copies, a plan for updating all the signal electrician’s laptops shall be developed by the **District**.

460-7 Training

The **District** shall be responsible for training its personnel. The **Office of Training** and the **Office of Traffic Operations**, in cooperation with the **Districts**, will make the necessary classes and training available.

460-8 Reserved for Future Information

Since the **Traffic Signal Maintenance Organizational Performance Index (OPI)** is no longer used, the existing information on this subject has been deleted and this Section is reserved for future information.

460-9 Signal Databases

460-9.1 General

Two enterprise data systems have been created by the **IT Department** for traffic-related items. PC based programs have also been developed for accessing and reporting signal information. Internet and Intranet access have been discussed and details will be worked out as the traffic signal databases evolve.

460-9.2 Traffic Signal Maintenance

This database contains the information from the **Signal Inspection Form *(Form 496-7)*** and the resulting **OPI** points for the measurable maintenance items. The database allows **ODOT** to track signal maintenance inspections.

460-9.3 Traffic Signal Inventory

This database contains detailed information about every traffic signal installation and may include: location, timing, phasing, equipment information, digital pictures, and a repair history of individual pieces of equipment. The inventory will be completely compatible with the GIS system.

460-10 Signal Inspection Items

A sample **Signal Inspection Form** is presented in ***Form 496-7***. The PC based interface software will print out this form as either a blank form or with the header information filled in, if the signal installation has already been entered into the signal inventory database.

When a traffic signal installation is originally entered into the signal inventory database, an unique number will be generated by the computer system called the “ODOT signal system number.” This number will then become the primary tracking number for all information pertaining to this signal installation. The **District** may also retain the “signal file number” which has been in use for many years as an internal reference.

If the header information is printed out, the inspector should verify the controller and conflict monitor manufacturer and serial number for inventory purposes.

460-11 Dark Signals

ORC Section 4511.132 establishes a driver’s duties upon encountering a dark signal (signal not operating due to a power outage).

When responding to notice of a dark signal, the **District** has the following options available:

1. No action.
2. Generators.
3. Temporary ALL-WAY STOP signs (erected in accordance with **OMUTCD Section 6F.03)** – If it cannot be ensured that the signal will come back in all-red flashing mode in conjunction with the temporary STOP signs, STOP signs <u>shall not</u> be placed at the intersection.
4. Law enforcement officer to flag traffic.
5. **ODOT** personnel to flag traffic.

The **District's** response to a dark signalized intersection may be based on the following factors:

1. Utility company time estimate for repairs.
   a. Short term.
   b. Long term.

2. Power outage being wide area or localized area.

3. Number of roadway lanes or type of roadway.
   a. 2 lane and 2 lane.
   b. 4 lane and 2 lane.
   c. 4 lane and 4 lane.
   d. Freeway ramp, urban.
   e. Freeway ramp, suburban or rural.

4. Prioritized listing of intersections constructed from such factors as volume, roadway types, location, etc.

5. Law enforcement request.

The following devices are also available for responding to a dark signal. Some of these devices need to be in place before the power outage.

1. Battery back-up.

2. Signal head backplate with reflective yellow tape outline.

3. SIGNAL AHEAD sign(s).

470 OTHER CONSIDERATIONS

This Chapter is reserved for any material about other considerations that do not fit into the other Chapters in ***Part 4***.

480 RESEARCH

This Chapter is reserved for discussion of research related to traffic control signals.

495 REFERENCE RESOURCES

495-1 General

Various reference resources that may be useful have been noted in ***Chapters 193 and 194***.

495-2 Signal Design Reference Packet

The purpose of this packet is to provide guidance on designing and reviewing traffic signal plans. The packet and design files are available on the **Office of Traffic Operations** website.

Intentionally blank.

496 FORMS INDEX

496-1 Signal Support Inspection Form

Form 496-1 can be used for inspection of signal supports, as noted in ***Section 421-2***, and is available on-line from the **OTO** Forms web page.

496-2 Traffic Signal Stage 3 Check List

Form 496-2 is a sample Traffic Signal Stage 3 Check List, as noted in ***Section 440-7***.

496-3 Traffic Signal Controller Timing Chart for Actuated Signals

Form 496-3 is a sample Traffic Signal Controller Timing Chart for Actuated Signals, as noted in ***Section 440-7***. (This form is now shown only in the **Signal Design Reference Packet** and on the **OTO** Forms web page.)

496-4 Traffic Signal Detector Chart

Form 496-4 is a sample Traffic Signal Detector Chart, as noted in ***Section 440-7***. (This form is now shown only in the **Signal Design Reference Packet** and on the **OTO** Forms web page.)

496-5 Coordination Timing Chart

Form 496-5 is a sample Coordination Timing Chart, as noted in ***Section 440-7***. (This form is now shown only in the **Signal Design Reference Packet** and on the **OTO** Forms web page.)

496-6 Report of Electrical Tests

Form 496-6 is used for reporting the results of the standard electrical tests, as noted in ***Sections 450-11.2, 450-11.3, 450-11.4***, ***50-11.5*** **and** ***50-11.6***.

496-7 Signal Inspection Form

Form 496-7 is the Signal Inspection Form described in ***Sections 460-9.2 and 460-10***.

496-8 Application to Install and Operate a Traffic Control Signal

Form 496-8 is used by village authorities to obtain permission to install and operate Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the **OTO** Forms web page.

496-9 Application for Approval of Traffic Control Signal Operation

Form 496-9 is the operation plan for proposed village Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the **OTO** Forms web page.

496-10 Permit for Operation of a Traffic Control Signal

Form 496-10 is the Traffic Control Signal Permit as described in ***Section 401-6***, and is available on-line from the **OTO** Forms web page.

496-11 Application to Modify Operation of a Traffic Control Signal

Form 496-11 is for proposed modifications to village Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the **OTO** Forms web page.

496-12 Right Turn Factorization Sheet

Form 496-12 is used in the procedure described in ***Section 402-5*** for determining how much, if any, right-turning traffic from the minor street to remove from the signal warrant analysis. It is available on-line from the **OTO** Forms web page.

496-13 Example of a Completed Right Turn Factorization Sheet

Form 496-13 is a completed example of ***Form 496-12.***

496-14 Application for a Permit to Have a Special or Off-Duty Law Enforcement Officer (LEO) to Operate a Traffic Control Signal

Form 496-14 is the Application for a Permit described in ***Section 401-10***, and is available on-line from the **OTO** Forms web page.

496-15 Permit for a Special or Off-Duty LEO to Operate a Traffic Control Signal

Form 496-15 is the Permit described in ***Section 401-10***, and is available on-line from the **OTO** Forms web page.

496-16 Field Wiring Hook-Up Chart

Form 496-16 is the Field Wiring Hook-Up Chart described in ***Section 440-7***. (This form is now shown only in the **Signal Design Reference Packet** and on the **OTO** Forms web page.) Sample completed Field Wiring Hook-Up Charts are illustrated in ***Figure 498-2***.

496-17 Reserved for Future Use

Samples of completed Field Wiring Hook-Up Charts are now shown in ***Figure 498-2***.

496-18 Vehicular/Ped Volume Chart

Form 496-18 is an example of a Vehicular/Ped Volume Chart, as noted in ***Section 402-2***.

Form 496-1. Signal Support Inspection Form

Support Information

Support Identifier: ______________________________ Date: _________________________

Route: ____ Direction: ______________________

Intersection of: ___________________________________and ______________________________

Design No.: ___________________________

Support Type: _____ Strain Pole ____ Mast Arm _____ Sign _____ School

_____ Other: ____

Foundation

_____ Concrete Condition _____ Soil Condition _____ Anchor Bolts/Nuts

Comments: ____

____

Support Condition

_____ Galvanized _____ Painted ______ Wood

_____ Structural Members _____ Structural Connections ______ Down Guy

Damage? _____ Yes _____ No Pitting? _____ Yes _____ No

Surface Rust: _____ Minimal _____ Moderate _____ Severe

Comments: ____

____

Inspected by: ______________________________________ **Date:** _________________________

Form 496-2. Traffic Signal Stage 3 Check List

A. General: *Written justification required (see Section F) (DNA) - Does Not Apply

1. Are the following items being used in the project:

   a. *Optically programmed signal heads __________
   b. Mast arms __________
   c. *Thermoplastic markings (general) __________
   d. *Thermoplastic markings only at intersections __________
   e. Special control equipment
      I. Priority control __________
      II. RR preemption __________
      III. Traffic adjusted master__________
      IV. Interconnection __________ : Type __________
   f. Combination supports __________
   g. Overhead lane control supports __________
   h. Are all Stage 2 comments compiled with or otherwise
   i. explained? __________
   j. Other (list): __________

2. Who is:

   a. furnishing signs __________
   b. erecting signs __________
   c. applying thermoplastic markings __________
   d. applying painted markings __________
   e. removing existing signs __________
   f. removing existing markings __________
   g. provide, maintain, remove temporary markings __________

B. Warrants

1. Have signal warrants for all intersections been resolved?

2. Are all unwarranted signals being removed? If answer is no, list intersections and agreed action at each intersection.

3. If unwarranted signals are not being removed, who is doing the upgrading and interconnecting of these signals and when will work be done?

4. Are traffic signal permits involved (i.e., is any signal within a village and on a State Route)? (Village is incorporated area with population of less than 5000.)

C. Utilities

1. Have the utility companies reviewed the plans and approved of the work in writing?

2. Are utility poles being used for interconnect?

3. Is power service by flat rate contract or meter?

4. Are disconnect switches required at power service points?

5. Will the power company run power service to the signal poles or will triplex service cable be run from power pole to signal pole as part of this project?

Form 496-2. Traffic Signal Stage 3 Check List (Continued)

6. Are high voltage lines present in the area? 10 feet minimum clearance may be required. Check with power company for specific requirements.

7. Have proposed support locations been field checked for conflicts with overhead lines and underground facilities?

8. Do any lines go over/under railroad tracks?

D. Right-of-Way

1. Are any work agreements or easements required? (For placement of items such as loop detectors, pavement marking, etc. outside of the right-or-way limits.)

2. Are right-of-way (R/W) lines shown on signal intersection plan sheets for checking pole foundations, conduit runs, etc., and are all items within the R/W? Note: certain procedures require temporary easements, etc., even though actual construction is within the R/W (i.e., jacking conduit usually requires a jacking pit).

E. Equipment Responsibility

1. Existing signal installation - Does anyone besides contractor retain existing equipment? If answer is yes, name other parties involved.

2. Are any equipment items being reused? If yes, are these items clearly defined on plan sheets and has consultant field checked these items?

3. Has ownership of all items to be removed been established (control equipment, poles, luminaires, etc., by city, state, utility companies, etc.)?

4. Is the maintaining agency of each signal clearly discernible on the plans?

F. Justification

1. Is justification needed and who will submit it (refer to Section A)?

    a. Thermoplastic __________
    b. Optically programmed signal heads __________
    c. Combination supports (commitment on installment of lighting) __________
    d. Justification for proprietary items __________
    e. Other (list) __________

Form 496-3. Traffic Signal Controller Timing Chart for Actuated Signals

(This form is now shown only in the **Signal Design Reference Packet**
and on the **OTO** Forms web page.)

Form 496-4. Traffic Signal Detector Chart

(This form is now shown only in the **Signal Design Reference Packet**
and on the **OTO** Forms web page.)

Form 496-5. Coordination Timing Chart

(This form is now shown only in the **Signal Design Reference Packet**
and on the **OTO** Forms web page.)

Form 496-6. Report of Electrical Tests

DATE ___ / ___/ ___ **SHEET ____ OF _____**

PROJECT NO. _______________ COUNTY ________ ROUTE _____SECTION _____

Short Circuit Test 632.28(C)				Circuit Continuity Test 632.28(D) (Zero or Negligible Ohms Required)			
Pairs Measured	Ohms	Pairs Measured	Ohms	Pairs Measured	Ohms	Pairs Measured	Ohms

Form 496-6. Report of Electrical Tests (Continued)

Cable Insulation (Megger) Test 632.28(E)		
Locations	Type of	MegOhms

Ground Test For Traffic Signals	
Ground Rod Location:	Resistance

Functional Test: 632.28(F)	OK
Incoming AC 120 Volts	☐
Cabinet Fan, Thermostat, Convenience Outlet, and Lamp Operation	☐
Controller timing set as per plan or approved by the Engineer	☐
Switches	☐
Controller functions	☐
Detector Units detect all vehicles, including small motorcycles*	☐
Detector Units do not give frequent extraneous calls	☐
Flash Switch Transfer	☐
Monitor is not activated by normal operations	☐
Monitor is not activated by manipulation of cabinet switches	☐
Monitor activated by artificial conflict	☐
Signal transfers to flash when monitor is disconnected	☐

*See ***TEM Section 450-11.6***.

Form 496-7. Signal Inspection Form

TRAFFIC SIGNAL FILE NUMBER: LOCATION:
COUNTY AND ROUTE NUMBER: ODOT SIGNAL SYSTEM NUMBER:

DATE INSPECTED: _____/_____/______ TIME REQUIRED: __________
CONTROLLER TYPE: ______________________ ODOT NUMBER: ___________
MONITOR MODEL: ________________________ CM: ☐ ODOT NUMBER: ___________
MMU: ☐ COORDINATION TYPE:_____
INSPECTED BY: ____________________________________ TITLE: ____________________
INSPECTED BY: ____________________________________ TITLE: ____________________

1 TRAFFIC SIGNAL HEAD	**Satisfactory**	**Unsatisfactory**	**N/A**	**Repaired**
1.1 Alignment	☐	☐	☐	☐
1.2 Date re-lamp	Date re-lamped ____/_____/_____			
1.3 Clearance Height	Clearance Ft.______ In.________			☐
1.4 Condition including the following:	☐	☐	☐	☐

lens (dirty, burns, holes), lamp orientation, visors, lamps (all burning), signal head cable condition(splices/wear), Prepare to Stop When Flashing sign, above ground detection, water leaks

2 OVERHEAD SIGNAL SUPPORT SYSTEM

2.1 Condition including the following:	☐	☐	☐	☐

messenger wire for rust, grips, 3-bolt clamps, pole clamp bolts tight, wire entrance and pin wear, span wire signing, pole clamp assembly and clevis pin wear, lashing rods, signal cable

3 CONTROLLER & CABINET

3.1 Intersection documentation
☐ Present & Current ☐ Present & Not Current ☐ Not Present
3.2 Conflict Monitor or MMU (12 mo. inspection) Date: ____/_____/______
3.3 All detection operational** ☐ All working ☐ 1 Detector Failed ☐ 2 or more Failed

3.4 Wires and cables labeled	☐	☐	☐	☐
3.5 Cabinet sealed to foundation	☐	☐	☐	☐
3.6 Lock condition (including Power Service)	☐	☐	☐	☐
3.7 Filter Clean (Size___X____X____)	☐	☐	☐	☐
3.8 Cabinet lamp working	☐	☐	☐	☐
3.9 GFCI receptacle (test)	☐	☐	☐	☐
3.10 Wire terminations tight	☐	☐	☐	☐
3.11 Prepare To Stop When Flashing Timing (Ph.__= ____sec.) (Ph.__= ____sec.)	☐	☐	☐	☐
3.12 Load switch indicators lighting	☐	☐	☐	☐
3.13 Preemption	☐	☐	☐	☐
3.14 Cabinet earth ground (___ohms)	☐	☐	☐	☐
3.15 Lightning arresters	☐	☐	☐	☐
3.16 Housing conduit sealed	☐	☐	☐	☐
3.17 Cabinet fan / thermostat	☐	☐	☐	☐
3.18 Cabinet clean? need vacuuming?	☐	☐	☐	☐
3.19 Cabinet hinges, need lubricated?	☐	☐	☐	☐

Form 496-7. Signal Inspection Form (Continued)

		Satisfactory	Unsatisfactory	N/A	Repaired
4	**SIGNAL STRAIN AND WOOD POLES**				
4.1	Anchor bolts tight	☐	☐	☐	☐
4.2	Hand hole covers in place	☐	☐	☐	☐
4.3	Pole grounds	☐	☐	☐	☐
4.4	Pole cap in place	☐	☐	☐	☐
4.5	Concrete foundation	☐	☐	☐	☐
4.6	Down guys	☐	☐	☐	☐
4.7	Wood pole condition	☐	☐	☐	☐
5	**POWER SERVICE**				
5.1	Condition including: weather head, wire chaffing, splices at top of pole, switch box condition, meter box				
6	**LOOP DETECTORS & SEALANT**				
6.1	Cracks filled with sealant	☐	☐	☐	☐
6.2	No exposed wires	☐	☐	☐	☐
6.3	No pavement cracks (Note crack repair in comments for crack sealant repair crew scheduling)				
7	**PEDESTRIAN OPERATION**				
7.1	Including: pedestrian head aim/alignment, pedestrian headworking	☐	☐	☐	☐
8	**PULL BOXES**				
8.1	Condition including: all located, lids on all, draining properly, wires and cables labeled, wires and conduit in good shape, conduit sealed, lid marked **"Traffic"**	☐	☐	☐	☐

Item #	Comments

Form 496-8. Application to Install and Operate a Traffic Control Signal

APPLICATION
FOR PERMISSION TO INSTALL/MODIFY AND OPERATE
A TRAFFIC CONTROL SIGNAL

To: District Deputy Director   Date: ______________

District ___________

____

____

In accordance with the provisions of Sections 4511.10 and 11, Ohio Revised Code, the incorporated Village of _________________ does hereby request authority to install/modify and operate a traffic control signal at the intersection of __________________Street (State Route ____________________) and ____________________ Street (State Route ________________________).

The enclosed traffic engineering study performed by ____________________________________and dated ___________ indicates that the proposed signal is justified by warrant(s) ____________.

This application is made with the understanding that, if approved by you, the signal will comply with the requirements as stipulated by law.

Village of ___________________________

County of ___________________________

____

(Signature of Elected Official)

TRAFFIC CONTROL SIGNAL AUTHORIZATION

To: Village of ________________________

You are hereby authorized to install or modify a traffic control signal at this intersection. This is subject to approval, by the Ohio Department of Transportation of the Village-prepared operation plan (sample attached) with the understanding that the traffic control signal will comply with the requirements of the Ohio Manual of Uniform Traffic Control Devices.

The Operations Plan should be submitted as soon as possible because this authorization will automatically expire 180 days from the date issued unless otherwise extended by the Ohio Department of Transportation at the request of the Village.

__________________________________   ________________________________
Date   District Deputy Director

For a copy of this form, contact the **ODOT Office of Traffic Operations (OTO)**, or visit the OTO Forms web page.

Form 496-9. Application for Approval of Traffic Control Signal Operation

REQUEST FOR APPROVAL OF A TRAFFIC CONTROL SIGNAL OPERATION PLAN

To: District Deputy Director
District ________________
____
____

Date ______________

The traffic control signal we have proposed for the intersection of ____________________________ Street (State Route ___________) and ________________________Street (State Route _________) would function in accordance with the attached operation plan dated ________________.

Village of ___________________________

County of ___________________________

____
(Signature of Elected Official)

OPERATION PLAN APPROVAL

The operation plan has been approved/approved with modification (see explanation of modification below) and permission is hereby granted to proceed with the installation.

- Explanation of Approval with Modification -

____

____

____

___________________________ Date

___________________________ District Deputy Director

CERTIFICATION

Upon completion of the installation/modification as specified in the approved operation plan, fill in the certification below and return the attached copy to the District Deputy Director.

I hereby certify that the Village of ______________________________ has installed/modified, and will operate, the above described traffic control signal in accordance with the approved operation plan and OMUTCD standards. This signal was placed in operation on ____________________________.

Signed ____________________________

Title ____________________________

For a copy of this form, contact the **ODOT Office of Traffic Operations (OTO)**, or visit the **OTO** Forms web page.

Form 496-10. Permit for Operation of a Traffic Control Signal

STATE OF OHIO
DEPARTMENT OFTRANSPORTATION
OFFICE OF TRAFFIC OPERATIONS
1980 WEST BROAD STREET
COLUMBUS, OHIO 43223

Permit Number ____________________
Village ____________________
County ____________________
Intersection ____________________
____

PERMIT
FOR THE OPERATION OF A TRAFFIC CONTROL SIGNAL
ON A STATE HIGHWAY

Under authority of Sections 4511.10 and 11 of the Ohio Revised Code, the Director of Transportation, in response to the attached Application and engineering study dated ____________________, hereby approves, subject to the condition(s) and restriction(s) set forth herein, the operation of a traffic control signal at the location described below:

I. Location of Signal: ____

____

II. Operation:

This traffic control signal shall be operated in accordance with the Ohio Manual of Uniform Traffic Control Devices for Streets and Highways (OMUTCD). Signal phasing and hours of operation as a stop and go signal or a flashing signal shall be in accordance with the latest approved schedule. Initial settings shall be as submitted with the ARequest for Approval of a Traffic Control Signal Operation Plan.@ (Note: Signals maintained as ASchool Signals@ or ASeasonal Signals,@ those signals authorized to operate only during certain months of each year, shall be hooded or taken down during the period(s) such signals are not authorized to operate.)

III. Village authorities are responsible for periodic review of this signal.

The right is reserved to require the timing schedule of the signal, the days upon which it is operated, and the hours during which it is operated to meet the approval of the Director of Transportation. Revisions to the interval timing or hours of operation schedules shall be submitted to the District Deputy Director for approval. Any other aspect of the traffic control signal operation covered by this permit shall not be altered without the specific approval of the Director of Transportation, after proper application has been made by the permittee.

This permit is revocable upon thirty days notice by the Director of Transportation if in his opinion the signal is not being operated or maintained in a proper manner, or that traffic would be better served by its elimination.

____________________ ____________________
Date Director of Transportation

For a copy of this form, contact the **ODOT Office of Traffic Operations (OTO),** or visit the **OTO** Forms web page.

Form 496-11. Application to Modify Operation of a Traffic Control Signal

APPLICATION
TO MODIFY TIMING OR HOURS OF OPERATION
FOR A TRAFFIC CONTROL SIGNAL

To: DISTRICT DEPUTY DIRECTOR Date ____________________

Ref: Permit No. ________________

____

____

The incorporated Village of _______________________________ hereby requests authority to modify the □ timing and/or □ hours of operation of the traffic control signal at the intersection of _________________________ Street (State Route ____________) and __________________________ Street (State Route ____________), as noted on the attached timing chart.

The change(s) is/are requested for the following reasons:

1. ____

2. ____

3. ____

This application is made with the understanding that, if approved, the signal timing and hours of operation will comply with the timing chart which will be returned with the approved change.

Village of _________________________

County of _________________________ ______________________________________

(Signature of Elected Official)

To: Village of _______________________________________

The attached interval timing and hours of operation dated _______________________ are herewith approved.

_____________________________ ______________________________________

Date District Deputy Director

For a copy of this form, contact the **ODOT Office of Traffic Operations (OTO)**, or visit the **OTO** Forms web page.

Form 496-12. Right Turn Factorization Sheet

RIGHT TURN FACTORIZATION SHEET

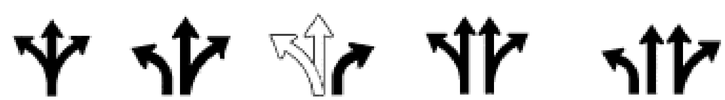
Intersection: ____________________

Municipality: ____________________ County: __________

		MINOR STREET Approach: ___EB___ Config: ___3___ Volumes				MAINLINE APPROACH VOLUME PER LANE	BASE RIGHT TURN REDUCTION %	MAINLINE CONGESTION FACTOR %	ADJUSTED RIGHT TURN REDUCTION %	ADJUSTED RIGHT TURNS	ADJUSTED MINOR STREET VOLUMES															
DIR	HOUR BEGIN	LEFT	THROUGH	RIGHT	TOTAL							LEFT	THRU	RIGHT	TOTAL	7A	35A	3T	T/3	(T+L)	(T+R)	3R	3L	T/2	T/4	BASE REDUCTION
	6:00																									
	7:00																									
	8:00																									
	9:00																									
	10:00																									
	11:00																									
	12:00																									
	13:00																									
	14:00																									
	15:00																									
	16:00																									
	17:00																									
	18:00																									
	19:00																									
	20:00																									
	21:00																									

Mainline Congestion Factors	
VOLUME	FACTOR (%)
0-399	0
400-499	5
500-599	10
600-699	15
700-799	20
800-899	25
900-999	30
1000-1099	35
1100-1199	40
1200-1299	45
1300-1399	50
1400-1499	55

REVIEW INFORMATION
Counts Used:
Count Dated:
Date Reviewed:
Reviewed By:



1 2 3 4 5

Any Configuration with an exclusive Right Turn Lane.

Form 496-13. Example of a Completed Right Turn Factorization Sheet

RIGHT TURN FACTORIZATION SHEET

Intersection: ____________________

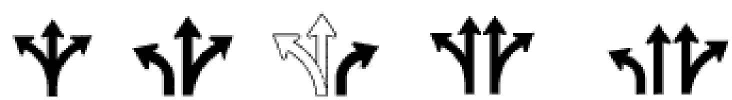
Municipality: ____________________________ County: __________

DIR	HOUR BEGIN	MINOR STREET Approach: EB Config: 3 Volumes LEFT	THROUGH	RIGHT	TOTAL	MAINLINE APPROACH VOLUME PER LANE	BASE RIGHT TURN REDUCTION %	MAINLINE CONGESTION FACTOR %	ADJUSTED RIGHT TURN REDUCTION %	ADJUSTED RIGHT TURNS	ADJUSTED MINOR STREET VOLUMES
	6:00										
	7:00										
	8:00	11	2	110	123	509	75	10	65	34	39
	9:00	13	4	144	161	494	75	5	70	43	43
	10:00	11	0	143	154	490	75	5	70	43	43
	11:00	14	1	154	169	526	75	10	65	54	54
	12:00	17	3	128	148	548	75	10	65	45	45
	13:00	13	2	118	133	563	75	10	65	41	41
	14:00	19	1	123	143	586	75	10	65	43	43
	15:00	13	1	110	124	639	75	15	60	44	44
	16:00	11	0	115	126	665	75	15	60	46	46
	17:00	12	3	86	102	699	75	15	60	34	50
	18:00	10	1	106	117	578	75	10	65	37	48
	19:00										
	20:00										
	21:00										

HOUR BEGIN	LEFT	THRU	RIGHT	TOTAL	7A	35A	3T	T/3	(T+L)	(T+R)	3R	3L	T/2	T/4	BASE REDUCTION
6:00															
7:00															
8:00	11	2	110	123	86	43	6	1	13	112	330	33	1	1	75
9:00	13	4	144	161	113	56	12	1	17	148	430	39	2	1	75
10:00	11	0	143	154	108	54	0	0	11	143	429	33	0	0	75
11:00	14	1	154	169	118	59	3	0	15	155	462	42	1	0	75
12:00	17	3	128	148	104	52	9	1	20	131	384	51	2	1	75
13:00	13	2	118	133	93	47	6	1	15	120	354	39	1	1	75
14:00	19	1	123	143	100	50	3	0	20	124	369	57	1	0	75
15:00	13	1	110	124	87	43	3	0	14	111	330	39	1	0	75
16:00	11	0	115	126	88	44	0	0	11	115	345	33	0	0	75
17:00	13	3	86	102	71	36	9	1	16	89	258	39	2	1	75
18:00	10	1	106	117	82	41	3	0	11	107	318	30	1	0	75
19:00															
20:00															
21:00															

Mainline Congestion Factors	
VOLUME	FACTOR (%)
0-399	0
400-499	5
500-599	10
600-699	15
700-799	20
800-899	25
900-999	30
1000-1099	35
1100-1199	40
1200-1299	45
1300-1399	50
1400-1499	55

REVIEW INFORMATION
Counts Used:
Count Dated:
Date Reviewed:
Reviewed By:



1 2 3 4 5

Any Configuration with an exclusive Right Turn Lane.

Form 496-14. Application for a Permit to Have a Special or Off-Duty Law Enforcement Officer (LEO) to Operate a Traffic Control Signal

To: District Deputy Director Date: _____________
District ________

In order to process your application for a Permit to operate a traffic control signal, please provide the following information:

1. ____
Name of Entity requesting permission to operate the traffic signal. (Permittee)

2. ____

____
Address

3. ____
Telephone Number, Fax Number and E-Mail Address

4. ____

____

____
Location of Traffic Signal(s)

5. ____
Date(s) and Time(s) of Operation

The following terms and conditions apply to the permit:

1. The permit is revocable at-will and non-assignable.

2. The permit expires upon termination of the event.

3. The Permittee warrants that the traffic control signal will be operated by a special or off duty law enforcement officer with the authority to make an arrest in the jurisdiction where the traffic control signal is located.

4. The Permittee agrees to indemnify and hold harmless the Ohio Department of Transportation (ODOT) and its employees from any and against all suits, costs (including attorneys fees, expenses, and court costs) claims, expenses, liabilities and judgments of every kind and from and against all damages and expenses to which ODOT and its employees may be subject to caused by, resulting from, or arising out of the Permittee’s operation of the traffic control signal. This obligation shall survive the expiration of the permit.

5. Provide a copy of the liability insurance which will cover any damage to ODOT property as a result of operating the traffic control signal.

Signed ______________________________________

Form 496-15. Permit for a Special or Off-Duty LEO to Operate a Traffic Control Signal

This permit is issued to ____________________________________(Permittee)

for the purpose of operating the traffic control signal located at _____________.

This permit shall be in effect from __________ until ______________.

_______________________________________ _______________

District Deputy Director Date

Form 496-16. Field Wiring Hook-Up Chart

(This form is now shown only in the **Signal Design Reference Packet**. Sample of completed versions of the form are shown in ***Figure 498-2***.)

Form 496-17. Reserved for Future Use

(See ***Figure 498-2*** for new sample Field Wiring Hook-Up Charts.)

Form 496-18. Vehicular/Ped Volume Chart

	VEHICULAR/PED PEAK HOURLY VOLUME											
PHASE	1	2	2/PED	3	4	4/PED	5	6	6/PED	7	8	8/PED
DIRECTION												
PLAN NO.	INTERSECTION NAME:											

Count Information

MONTH/YEAR:		DAY OF WEEK:	
TIME PERIOD(S):			
TOTAL NUMBER OF HOURS:			
METHOD OF OBTAINING COUNTS:			
TYPE OF COUNT:			

1. Volumes are per hour.
2. Vehicular Volumes include passenger, A commercial, and B & C commercial.
3. Counts older than three years may only be used with approval from the **Office of Traffic Operations (OTO)**.

497 TABLES INDEX

497-1 Cross Section Area of Conduit, Cable and Wire

Table 497-1 is used as described in ***Section 450-3.4*** to size conduit based on the number and size of the conductors contained in the conduit.

497-2 Cable and Wire Identification

Table 497-2 is referenced in ***Section 450-10.3*** and is a reproduction of **C&MS Table 632.05-1**.

497-3 Minimum Sight Distance

Table 497-3 is referenced in ***Section 450-10.4*** and is a reproduction of **Table 4D.1** from **OMUTCD, Section 4D.12**.

497-4 Types of Overhead Signal Supports

Table 497-4 depicts various types of overhead signal supports and is referenced in ***Sections 440-3, 440-4 and 450-6.1***.

497-5 Areas for Signal Heads

Table 497-5 presents areas used in ***Sections 440-3 and 440-4*** in designing overhead signal supports.

497-6 Height from Bottom of Signal Head to Messenger Wire or Mast Arm

Table 497-6 presents the height (in feet) from the bottom of the signal head to the messenger wire or mast arm and is referenced in ***Section 440-5***.

497-7 Minor Street Analysis Parameters – Minor Leg Lane Configurations and Right Turn Reductions

Table 498-7 presents parameters used in the procedure described in ***Section 402-5*** for determining how many right-turning vehicles to remove from the minor street traffic in a signal warrant analysis.

497-8 Minor Street Analysis Parameters – Mainline Congestion Factors for Limiting Right Turn Reductions

Table 497-8 presents mainline congestion factors used in the procedure described in ***Section 402-5*** for determining how many right-turning vehicles to remove from the minor street traffic in a signal warrant analysis.

497-9 Village Signal Permit Number Assignments

Table 497-9 assigns numbers to be used by **Districts** for Village Signal Permits ***(see Section 401-6)***.

Intentionally blank.

Table 497-1. Cross Section Area of Conduit, Cable and Wire

Specification or Material	Cable Use	No. of Conductors AWG	Cross Section Area, Sq. In.
IMSA 19-1 or 20-1	Signals	2/C # 14 3/C # 14 4/C # 14 5/C # 14 7/C # 14 9/C # 14 12/C # 14 15/C # 14 18/C # 14 25/C # 14	.10 .13 .16 .19 .22 .33 .41 .48 .55 .82
		2/C # 12 3/C # 12 4/C # 12 5/C # 12 7/C # 12 9/C # 12 12/C # 12 15/C # 12 18/C # 12 25/C # 12	.12 .16 .19 .23 .30 .40 .50 .58 .74 1.00
UL: RHH/RHW/USE	Lighting	1/C # 14 1/C # 12 1/C # 10 1/C # 8 1/C # 6 1/C # 4 1/C # 2	.053 .061 .075 .107 .138 .173 .229
Ethernet Cat 5e Armored	Communications	8/C # 24	.13
SmartSensor 6 Conductor	Wavetronix Radar	6/C # 20	.14
IMSA 50-2	Loop Lead-In	2/C # 14	.10
RG-6/V (COAX)	Video	1/C # 18	.06
RG-6/V With Power (COAX)	Video	1/C # 18 (COAX) 2/C # 16 (Power)	.16
RG-8/U (COAX)	Radio Antenna	1/C # 11	.13

Conduit Cross Section Area

Nominal Diameter, in.	1/2	3/4	1	1 1/4	1 1/2
Inside Diameter, in.	.622	.824	1.049	1.380	1.610
Inside Area, sq. in.	.30	.53	.86	1.50	2.04
Nominal Diameter, in.	**2**	**2 1/2**	**3**	**3 1/2**	**4**
Inside Diameter, in.	2.067	2.469	3.068	3.548	4.026
Inside Area, sq. in.	3.36	4.79	7.38	9.90	12.72

Table 497-2. Cable Wire and Identification

Cable	Tag
Ground Power (2 wire) 1 ι 120 volt	GND AC+ AC- or ACN
Power (3 wire) 1 ι 120/240 volt Neutral wire	AC+1 AC+2 AC- or ACN
Phase A Phase 1 Phase 1 northbound left turn lanes	ø A ø 1 ø 1 NBLT
Phase A, pedestrian signal	ø A PD
Overlap, phase A + C Overlap, phase 1 + 6	ø A + C ø 1 + 6
Detector lead-in, phase A Detector lead-in, phase 1 Detector lead-in, phase 1 northbound left turn lanes	DET A DET 1 DET 1 NBLT
Detector lead-in, phase A (call type) Detector lead-in, phase 1 (call type) northbound thru lanes	DET A CALL DET 1 CALL NB-THRU
Detector harness *	DET A
Interconnect	IC
Preemption, fire	PE FIRE
Preemption, railroad	PE RR

* For the detector harness, the tag shall be placed next to the MS plug at the detector amplifier.

Table 497-3. Minimum Sight Distance

85th- Percentile Speed (mph)	Minimum Sight Distance (feet)
20	175
25	215
30	270
35	325
40	390
45	460
50	540
55	625
60	715

Table 497-4. Types of Overhead Signal Supports

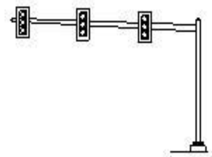
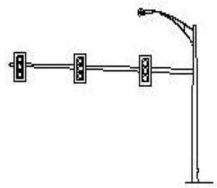
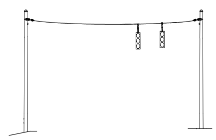
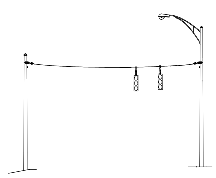
Support Type	Allowable Sign Area, Sq. Ft.	Span or Arm Length, Ft.	Configuration	Notes
TC-81.21 Signal Support Single Arm	(Small signs may be mounted.)	25 to 70		-----------
TC-81.21 Combination Signal Support	------------	----------		May be used to add a highway lighting and/or signing function to TC-81.21.
TC-81.10 Strain Pole & Messenger Wire Supported Signals	(Small signs may be mounted.)	-----------		See TC-84.20 for messenger wire details.
TC-81.10 Combination Strain Pole	(Small signs may be mounted.)	-----------		May be used to add highway lighting and/or signing function to TC-81.10.

Table 497-5. Areas for Signal Heads

Signal Head Type	Area (Sq. Ft.)[1]	
Inches	8	12
1 Section	2.8	4.0
3 Sections	5.6	8.7
4 Sections	7.0	11.0
5 Sections - Vertical	8.4	13.3
5 Sections - Cluster	7.8	12.4
5 Sections - Mixed	11.4	

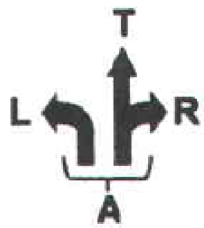
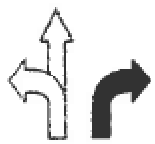
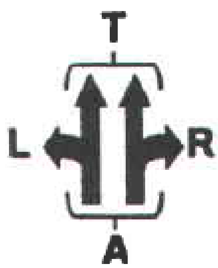
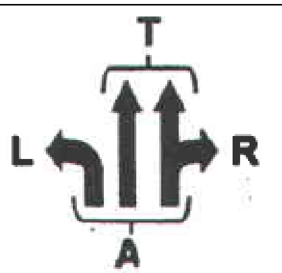
Note 1. Area includes 5-inch backplate.

Table 497-6. Height from Bottom of Signal Head to Messenger Wire or Mast Arm

FREE SWINGING			
Signal Head Type	Height (Feet)		
	8 in. Sections	12 in. Sections	12 in. Sections with Backplates
1 Section	1.7	1.9	—
3 Sections	3.7	4.2	4.7
4 Sections	4.7	5.4	5.9
5 Sections - Vertical	5.7	6.5	7
5 Sections - Cluster	—	4.5	5
5 Sections - Mixed	—	4.5	5

RIGID MOUNT			
Signal Head Type	Height (Feet)		
	Red Module Center		Yellow Module Center
	12 in. Sections	12 in. Sections with Backplates	12 in. Sections with Backplates
1 Section	—	—	—
3 Sections	2.9	3.4	2.3
4 Sections	4.1	4.6	3.4
5 Sections - Vertical	5.3	5.8	4.6
5 Sections - Cluster	3.2	3.7	2.6
5 Sections - Mixed	3.2	3.7	2.6

Table 497-7. Minor Street Analysis Parameters – Minor Leg Lane Configurations and Right Turn Reductions

<table>
<tr><td rowspan="3">1</td><td rowspan="3">
</td><td rowspan="3">IF</td><td>R > 0.7A</td><td rowspan="3">THEN</td><td>Reduce R by 60%</td></tr>
<tr><td>0.7A ≥ R > 0.35A</td><td>Reduce R by 40%</td></tr>
<tr><td>R ≤ 0.35A</td><td>Reduce R by 20%</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">
</td><td rowspan="3">IF</td><td>R > 3T</td><td rowspan="3">THEN</td><td>Reduce R by 60%</td></tr>
<tr><td>3T ≥ R > T/3</td><td>Reduce R by 40%</td></tr>
<tr><td>R ≤ T/3</td><td>Reduce R by 20%</td></tr>
<tr><td>3</td><td></td><td colspan="2">Any configuration with an exclusive right turn lane (usually ≥ to 600 ft. long)</td><td colspan="2">Reduce R by 75%
In all classes</td></tr>
<tr><td rowspan="6">4</td><td rowspan="6">
</td><td rowspan="6">IF</td><td>R > (T + L)</td><td rowspan="6">THEN</td><td>Reduce R by 65%</td></tr>
<tr><td>L > (T + R)</td><td>Use situation 2.</td></tr>
<tr><td>L≈ T ≈ R (± 10 veh)</td><td>Reduce R by 40%</td></tr>
<tr><td>L ≈ T > 3R</td><td>Reduce R by 20%</td></tr>
<tr><td>R ≈ T > 3L</td><td>Reduce R by 50%</td></tr>
<tr><td>All other classes</td><td>Reduce R by 30%</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">
</td><td rowspan="4">IF</td><td>R > T</td><td rowspan="4">THEN</td><td>Reduce R by 75%</td></tr>
<tr><td>T ≥ R > T/2</td><td>Reduce R by 50%</td></tr>
<tr><td>T/2 ≥ R > T/4</td><td>Reduce R by 30%</td></tr>
<tr><td>R < T/4</td><td>Reduce R by 15%</td></tr>
</table>

Legend:
L = number of left-turning vehicles **R = number of right-turning vehicles**
T = number of through vehicles **A = (L + T + R)**

Table 497-8. Minor Street Analysis Parameters – Mainline Congestion Factors for Limiting Right Turn Reductions*

Volumes per Lane	Reduction
0 – 399	0%
400 – 499	5%
500 – 599	10%
600 – 699	15%
700 – 799	20%
800 – 899	25%
900 – 999	30%
1000 – 1099	35%
1100 – 1199	40%
1200 – 1299	45%
1300 – 1399	50%
1400 – 1499	55%
1500 – 1599	60%
etc.	etc.

*Mainline = Approach which right-turns turn into.

Table 497-9. Village Signal Permit Number Assignments

Districts	Numbers
District 1	1200 - 1699
District 2	1700 - 2199
District 3	2200 - 2699
District 4	2700 - 3199
District 5	3200 - 3699
District 6	3700 - 4199
District 7	4200 - 4699
District 8	4700 - 5199
District 9	5200 - 5699
District 10	5700 - 6199
District 11	6200 - 6699
District 12	7000 - 7499

498 FIGURES INDEX

498-1 Emergency Traffic Signal Guidelines

Figure 498-1 illustrates the cross-corner sight distance criteria suggested for use in reviewing requests for Emergency Traffic Signals, as described in ***Section 406-3***.

498-2 Sample Field Wiring Hook-Up Charts

As noted in ***Section 440-7***, ***Figure 498-2*** shows sample Field Wiring Hook-Up Charts for 33X cabinet and **NEMA** cabinets.

498-3 Suggested Loop Placement for Mainline vs. Large-Volume Side Street

Figure 498-3 illustrates suggested loop detector placements as described in ***Section 420-5*** for an intersection with a large-volume side street.

498-4 Suggested Loop Placement for Mainline vs. Ramp/T Intersection

Figure 498-4 illustrates suggested loop detector placements as described in ***Section 420-5*** for an intersection with a ramp or T intersection.

498-5 Suggested Loop Placement for Mainline vs. Low-Volume Side Street

Figure 498-5 illustrates suggested loop detector placements as described in ***Section 420-5*** for an intersection with a low-volume side street.

498-6 Concrete Pull Box

Figure 498-6 illustrates a concrete pull box as described in ***Section 450-3.2***.

498-7 Trench Details

Figure 498-7 illustrates details of the different types of trench that are described in ***Section 450-3.3***.

498-8 Exothermic Weld

Figure 498-8 illustrates the equipment used for an exothermic weld as described in ***Section 450-3.6***.

498-9 Power Service

Figure 498-9 illustrates the mounting details for the power service components as described in ***Sections 440-2 and 450-4***.

498-10 Strain Pole Supports

Figure 498-10 illustrates details for signal strain poles as described in ***Section 450-6.2***.

498-11 Strain Pole Attachment Details

Figure 498-11 illustrates details for the attachment of span wires to a signal strain pole as described in ***Sections 450-6.2 and 450-8***.

498-12 **Single Arm Support**

Figure 498-12 illustrates a mast arm signal support as described in ***Sections 440-3 and 450-6.3***.

498-13 **Sag and Vertical Clearance Diagram**

Figure 498-13 illustrates sag and vertical clearance and is referenced in ***Section 450-7***.

498-14 **Cable Support Assembly**

Figure 498-14 illustrates the use of a cable support assembly to relieve cable strain inside of a pole as described in ***Sections 450-8.2 and 450-8.7***.

498-15 **Aerial Interconnect Cable**

Figure 498-15 illustrates attachment details for aerial interconnect cable as described in ***Section 450-8.8***.

498-16 **Method of Measurement for Signal Cable**

Figure 498-16 illustrates the calculation method for the measurement of signal cables as described in ***Sections 450-8.5 and 450-9***.

498-17 **Method of Measurement for Interconnect Cable**

Figure 498-17 illustrates the calculation method for the measurement of interconnect cable as described in ***Sections 450-8.5, 450-8.8 and 450-9***.

498-18 **Method of Measurement for Detector Lead-In Cable**

Figure 498-18 illustrates the calculation method for the measurement of detector lead-in cables as described in ***Sections 450-8.5, 450-9 and 450-10.8***.

498-19 **Method of Measurement for Power Cable**

Figure 498-19 illustrates the calculation method for the measurement of power cable as described in ***Sections 450-8.5 and 450-9***.

498-20 **Method of Measurement for Service Cable**

Figure 498-20 illustrates the calculation method for the measurement of service cable as described in ***Sections 450-8.5 and 450-9***.

498-21 **Vehicular Signal Heads**

Figure 498-21 illustrates hardware and wiring for signal heads as described in ***Section 450-10.4***.

498-22 **Pedestrian Signal Heads**

Figure 498-22 illustrates the mounting of pedestrian signal heads as described in ***Section 450-10.6***.

498-23 **Loop Detector Placement and Installation**

Figure 498-23 illustrates the installation details for loop detectors as described in ***Section 450-10.7***.

498-24 Loop Detector Slots and Wiring

Figure 498-24 illustrates the installation details for loop detectors as described in ***Section 450-10.7***.

498-25 Loop Detector Wiring

Figure 498-25 illustrates miscellaneous wiring details for loop detector wiring as described in ***Section 450-10.8***.

498-26 Magnetometer Probes and Lead-In

Figure 498-26 illustrates installation details for magnetometer probes as described in ***Section 450-10.9***.

498-27 Vehicle Loop Test Targets

Figure 498-27 illustrates the test targets described in ***Sections 420-5 and 450-11.6***.

498-28 Short-Circuit Test

Figure 498-28 illustrates the connections for the short-circuit test as described in ***Section 450-11.3***.

498-29 Circuit Continuity Test of Loop Wire (Before Splice to Lead-In Cable)

Figure 498-29 illustrates the connections for the continuity circuit test on loop detector wire as described in ***Section 450-11.4***.

498-30 Circuit Continuity Test of Loop Wire and Lead-In Cable

Figure 498-30 illustrates the connections for the continuity circuit test for the entire loop wire and lead-in cable installation after splicing as described in ***Section 450-11.4***.

498-31 Circuit Continuity Test of Signal Cable Disconnected from Heads or Other Cable

Figure 498-31 illustrates the connections for the continuity circuit test for signal cable disconnected from the signal heads and other cables as described in ***Section 450-11.4***.

498-32 Circuit Continuity Test of Signal Cable With Cable Connected to the Signal Heads and Lamps Installed

Figure 498-32 illustrates the connections for the continuity circuit test for signal cable connected to the signal heads with lamps installed as described in ***Section 450-11.4***.

498-33 Cable Insulation Test (Loop Detector Wire)

Figure 498-33 illustrates the connections for the cable insulation test for loop detector wire as described in ***Section 450-11.5***.

498-34 Cable Insulation Test (Signal Cable)

Figure 498-34 illustrates the connections for the cable insulation test for signal cable as described in ***Section 450-11.5***.

498-35 Reserved for Future Use

498-36 Plan Details for Strain Poles

Figure 498-36 presents a sample angle orientation chart for signal strain pole **(SCD TC-81.10)** appurtenances as described in ***Section 441-8***.

498-37 Plan Details for Signal Supports - Arm Lengths

Figure 498-37 presents a sample chart for mast arm signal supports **(SCD TC-81.21)** appurtenances as described in ***Section 441-8***.

498-38 Plan Details for Signal Supports - Mast Arm Orientation

Figure 498-38 presents a sample angle orientation chart for mast arm signal support **(SCD TC-81.21)** appurtenances as described in ***Section 441-8***.

498-39 Example of Wire Size for Equipment Grounding Conductor – PTSWF with Pedestrian Indications

Figure 498-39 presents an example of wire size for equipment grounding conductor as described in ***Section 442-32***.

498-40 Example of Wire Size for Equipment Grounding Conductor – PTSWF without Pedestrian Indications

Figure 498-40 presents an example of wire size for equipment grounding conductor as described in ***Section 442-32***.

498-41 Example of Wire Size for Equipment Grounding Conductor – Mast Arms

Figure 498-41 presents an example of wire size for equipment grounding conductor as described in ***Section 442-32***.

498-42 Example of Wire Size for Equipment Grounding Conductor – Span Wire

Figure 498-42 presents an example of wire size for equipment grounding conductor as described in ***Section 442-32***.

498-43 Dilemma Zone Graph

Figure 498-43 presents a graphical representation of the dilemma zone drivers face when approaching a signalized intersection.

498-44 Span Support Guidelines

Figure 498-44 presents a graphical representation of information in ***Section 440-10*** about the location of span-mounted traffic Signal supports ***(see Subsection 440-10.6)***.

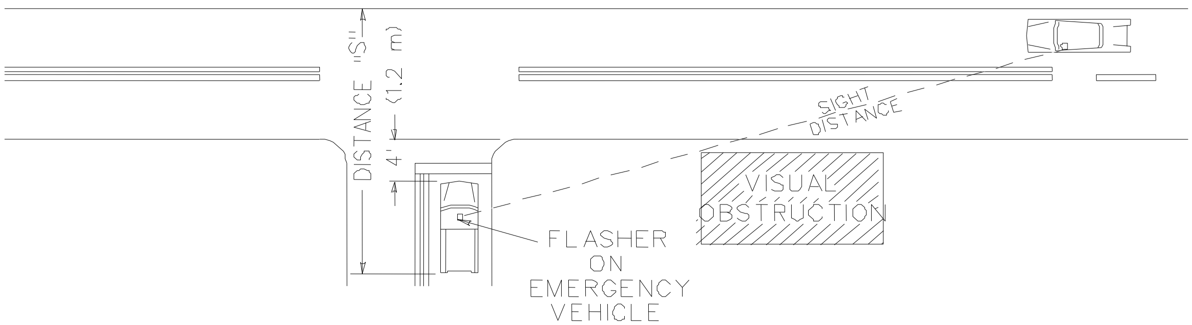
498-45 Example of Wiring Diagram

Figure 498-45 presents an example of a wiring diagram, as noted in ***Section 440-7***.

498-46 Example of a Phasing Diagram

Figure 498-46 presents an example of a phasing diagram, as noted in ***Section 440-7***.

Figure 498-1. Emergency Traffic Signal Guidelines



Minimum Cross Corner Sight Distance				
Approach Speed (MPH)	Distance "S"			
	40 ft	60 ft	80 ft	100 ft
25	230	260	290	320
30	280	315	345	380
35	330	370	410	450
40	370	420	460	500
45	420	470	520	570
50	460	520	580	640
55	510	570	640	700
60	560	630	700	760

Figure 498-2. Sample Field Wiring Hook-Up Charts

FIELD WIRING HOOK-UP CHART - 33X CABINET

SIGNAL HEAD	INDICATION	FIELD TERMINAL	FLASH
1A (EB LT)	<--R---	φ1 R	R
	<--Y---	φ1 Y	
	<--G---	φ1 G	
2A (WB RT)	R	φ2 R	Y
	Y	φ2 Y	
	G	φ2 G	
	---Y-->	φ7 Y/ LS 2P Y	
	---G-->	φ7 G/ LS 2P G	
2B, 2C (WB)	R	φ2 R	Y
	Y	φ2 Y	
	G	φ2 G	
3A (NB LT)	<--R---	φ3 R	R
	<--Y---	φ3 Y	
	<--G---	φ3 G	
4A, 4B (SB)	R	φ4 R	R
	Y	φ4 Y	
	G	φ4 G	
4C (SB LT)	R	φ4 R	R
	Y	φ4 Y	
	G	φ4 G	
	<--Y---	φ7 Y	
	<--G---	φ7 G	
LS = LOAD SWITCH			

SIGNAL HEAD	INDICATION	FIELD TERMINAL	FLASH
5A (WB LT)	<--R---	φ5 R	R
	<--Y---	φ5 Y	
	<--G---	φ5 G	
6A, 6B (EB)	R	φ6 R	Y
	Y	φ6 Y	
	G	φ6 G	
8A, 8B (NB)	R	φ8 R	R
	Y	φ8 Y	
	G	φ8 G	
PEDESTRIAN MOVEMENTS			
PED A	W	φ4 PED/ LS 4P G	OUT
	DW	φ4 PED/ LS 4P R	
PED B	W	φ6 PED/ LS 6P G	OUT
	DW	φ6 PED/ LS 6P R	
PED C	W	φ8 PED/ LS 8P G	OUT
	DW	φ8 PED/ LS 8P R	
OVERLAPS			
OLA	---Y-->	φ7 Y/ LS 2P Y	OUT
	---G-->	φ7 G/ LS 2P G	
OLA = LS 2P			

FIELD WIRING HOOK-UP CHART - NEMA

SIGNAL HEAD	INDICATION	FIELD TERMINAL	FLASH
1A (EB LT)	<--R---	φ1 R	R
	<--Y---	φ1 Y	
	<--G---	φ1 G	
2A (WB RT)	R	φ2 R	Y
	Y	φ2 Y	
	G	φ2 G	
	---Y-->	φ7 Y/ LS 13 Y	
	---G-->	φ7 G/ LS 13 G	
2B, 2C (WB)	R	φ2 R	Y
	Y	φ2 Y	
	G	φ2 G	
3A (NB LT)	<--R---	φ3 R	R
	<--Y---	φ3 Y	
	<--G---	φ3 G	
4A, 4B (SB)	R	φ4 R	R
	Y	φ4 Y	
	G	φ4 G	
4C (SB LT)	R	φ4 R	R
	Y	φ4 Y	
	G	φ4 G	
	<--Y---	φ7 Y	
	<--G---	φ7 G	
LS = LOAD SWITCH			

SIGNAL HEAD	INDICATION	FIELD TERMINAL	FLASH
5A (WB LT)	<--R---	φ5 R	R
	<--Y---	φ5 Y	
	<--G---	φ5 G	
6A, 6B (EB)	R	φ6 R	Y
	Y	φ6 Y	
	G	φ6 G	
8A, 8B (NB)	R	φ8 R	R
	Y	φ8 Y	
	G	φ8 G	
PEDESTRIAN MOVEMENTS			
PED A	W	φ4 PED/ LS 10 G	OUT
	DW	φ4 PED/ LS 10 R	
PED B	W	φ6 PED/ LS 11 G	OUT
	DW	φ6 PED/ LS 11 R	
PED C	W	φ8 PED/ LS 12 G	OUT
	DW	φ8 PED/ LS 12 R	
OVERLAPS			
OLA	---Y-->	φ7 Y/ LS 13 Y	OUT
	---G-->	φ7 G/ LS 13 G	
OLA = LS 13			

Figure 498-3. Suggested Loop Placement for Mainline vs. Large-Volume Side Street (1 of 4)

(For better legibility, portions of this sample layout have also been shown separately.)

Sample Page Layout

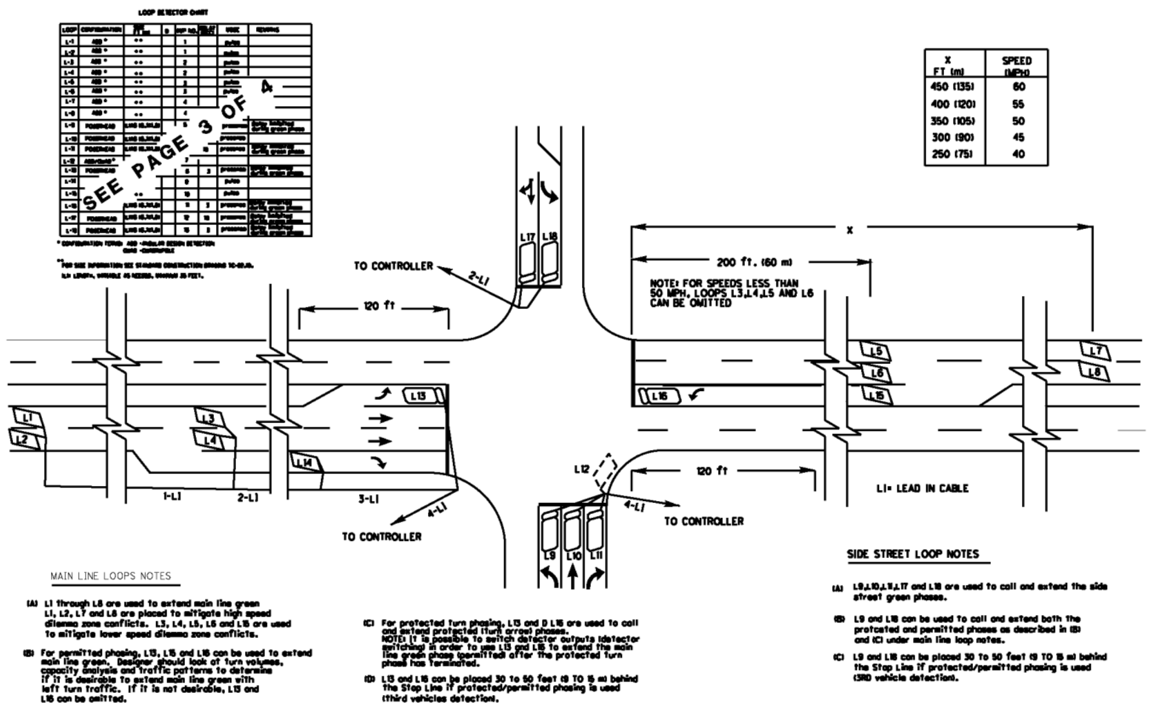


Figure 498-3. Suggested Loop Placement for Mainline vs. Large-Volume Side Street (2 of 4)

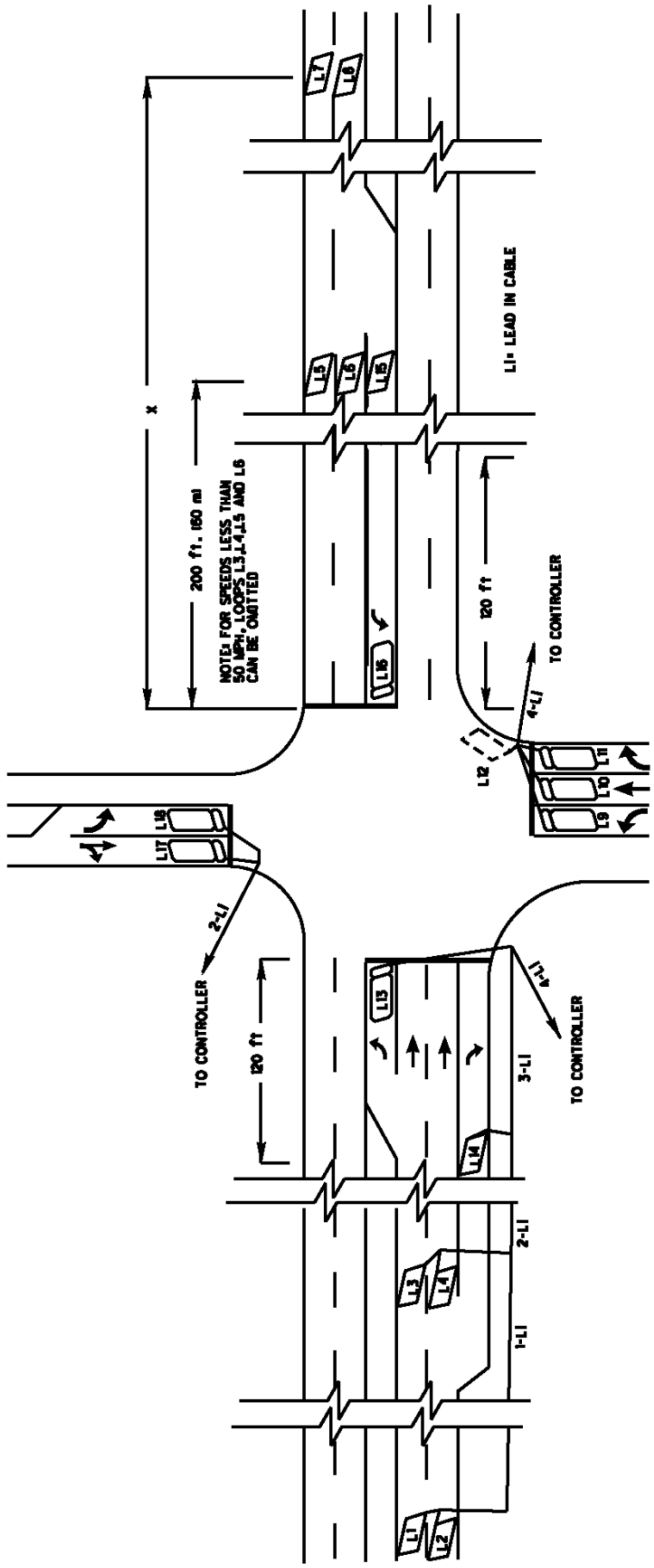


Figure 498-3. Suggested Loop Placement for Mainline vs. Large-Volume Side Street (3 of 4)

LOOP DETECTOR CHART

LOOP	CONFIGURATION	SIZE FT	Ø	AMP NO.	DELAY (SEC)	MODE	REMARKS
L-1	ADD[1]	SEE BELOW[2]		1		pulse	
L-2	ADD[1]	SEE BELOW[2]		1		pulse	
L-3	ADD[1]	SEE BELOW[2]		2		pulse	
L-4	ADD[1]	SEE BELOW[2]		2		pulse	
L-5	ADD[1]	SEE BELOW[2]		3		pulse	
L-6	ADD[1]	SEE BELOW[2]		3		pulse	
L-7	ADD[1]	SEE BELOW[2]		4		pulse	
L-8	ADD[1]	SEE BELOW[2]		4		pulse	
L-9	POWERHEAD	(L)x6 [2]		5	3	presence	delay inhibited during green phase
L-10	POWERHEAD	(L)x6 [2]		6		presence	
L-11	POWERHEAD	(L)x6 [2]		7	10	presence	delay inhibited during green phase
L-12	ADD/QUAD[1]	variable		7			
L-13	POWERHEAD	(L)x6 [2]		8	3	presence	delay inhibited during green phase
L-14	ADD[1]	SEE BELOW[2]		9		pulse	
L-15	ADD[1]	SEE BELOW[2]		10		pulse	
L-16	POWERHEAD	(L)x6 [2]		11	3	presence	delay inhibited during green phase
L-17	POWERHEAD	(L)x6 [2]		12	10	presence	delay inhibited during green phase
L-18	POWERHEAD	(L)x6 [2]		13	3	presence	delay inhibited during green phase

Notes:
1. Configuration Terms: ADD= Angular Design Detection; QUAD= Quadrupole
2. For size information see **Standard Construction Drawing TC-82.10**. (L)=Length, variable as needed, with maximum shown in the SCD.

X FT	SPEED (MPH)
450	60
400	55
350	50
300	45
250	40

Figure 498-3. Suggested Loop Placement for Mainline vs. Large-Volume Side Street (4 of 4)

MAIN LINE LOOP NOTES

(A) L1 through L8 are used to extend main-line green. L1, L2, L7 and L8 are placed to mitigate high-speed dilemma zone conflicts. L3, L4, L5, L6 and L15 are used to mitigate lower speed dilemma zone conflicts

(B) For permitted phasing, L13, L15 and L16 can be used to extend mainline green. The designer should look at turn volumes, capacity analysis and traffic patterns to determine if it is desirable to extend mainline green with left-turn traffic. If it is not desirable, L13 and L16 can be omitted.

(C) For protected turn phasing, L13, L15 and L16 are used to call and extend protected (turn arrow) phases. NOTE: It is possible to switch detector outputs (detector switching) in order to use L13 and L16 to extend the mainline green phase (permitted) after the protected turn phase has terminated.

(D) L13 and L16 can be placed 30 to 50 feet behind the stop line if protected/permitted phasing is used (3rd vehicle detection).

SIDE STREET LOOP NOTES

(A) L9, L10, L11, L17 and L18 are used to call and extend the side street green phases.

(B) L9 and L18 can be used to call and extend both the protected and permitted phases as described in (B) and (C) under mainline loop notes.

(C) L9 and L18 can be placed 30 to 50 feet behind the stop line if protected/permitted phasing is used (3rd vehicle detection).

Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection (1 of 4)

(For better legibility, portions of this sample layout have also been shown separately.)

Sample Page Layout

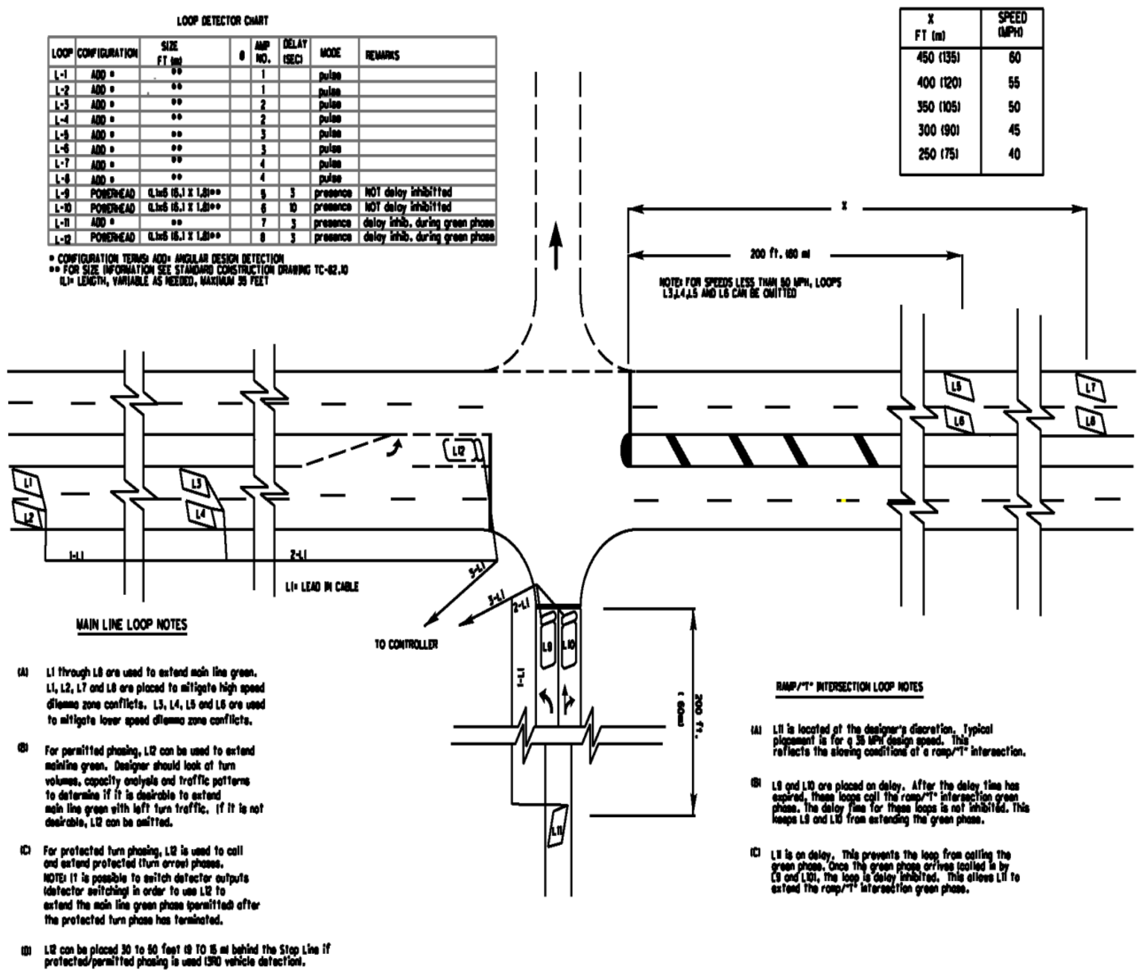


Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection (2 of 4)

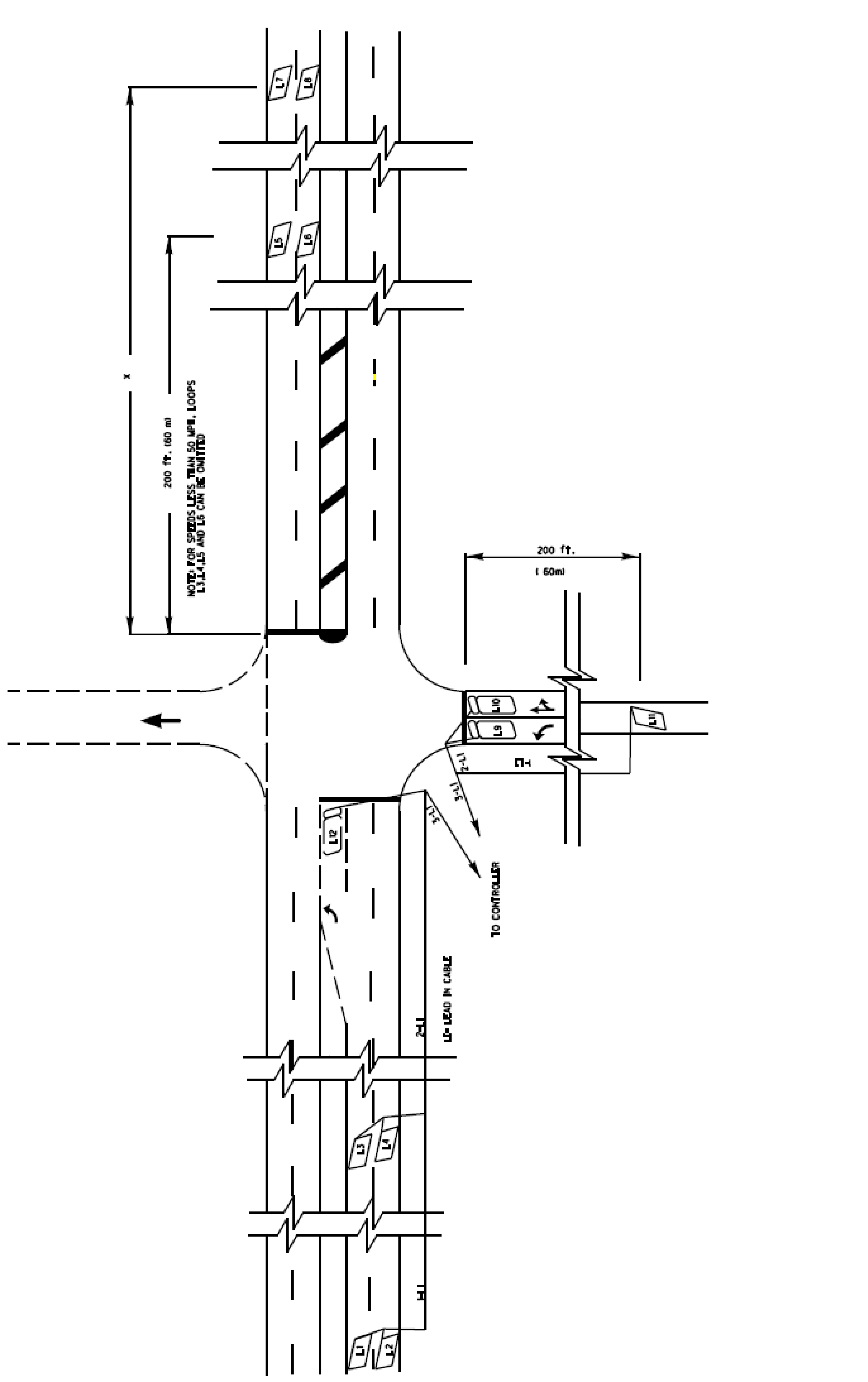


Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection (3 of 4)

LOOP DETECTOR CHART

LOOP	CONFIGURATION	SIZE FT	Ø	AMP NO.	DELAY (SEC)	MODE	REMARKS
L-1	ADD [1]	SEE BELOW[2]		1		pulse	
L-2	ADD [1]	SEE BELOW[2]		1		pulse	
L-3	ADD [1]	SEE BELOW[2]		2		pulse	
L-4	ADD [1]	SEE BELOW[2]		2		pulse	
L-5	ADD [1]	SEE BELOW[2]		3		pulse	
L-6	ADD [1]	SEE BELOW[2]		3		pulse	
L-7	ADD [1]	SEE BELOW[2]		4		pulse	
L-8	ADD [1]	SEE BELOW[2]		4		pulse	
L-9	POWERHEAD	(L)x6 [2]		5	3	presence	NOT delay inhibited
L-10	POWERHEAD	(L)x6 [2]		6	10	presence	NOT delay inhibited
L-11	ADD [1]	SEE BELOW[2]		7	3	presence	delay inhibited during green phase
L-12	POWERHEAD	(L)x6 [2]		8	3	presence	delay inhibited during green phase

Notes:
1. Configuration Terms: ADD= Angular Design Detection
2. For size information see **Standard Construction Drawing TC-82.10**. (L)=Length, variable as needed, with maximum shown in the SCD.

X FT	SPEED (MPH)
450	60
400	55
350	50
300	45
250	40

Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection (4 of 4)

MAIN LINE LOOP NOTES

(A) L1 through L8 are used to extend mainline green. L1, L2, L7 and L8 are placed to mitigate high-speed dilemma zone conflicts. L3, L4, L5 and L6 are used to mitigate lower speed dilemma zone conflicts

(B) For permitted phasing, L12 can be used to extend mainline green. The designer should look at turn volumes, capacity analysis and traffic patterns to determine if it is desirable to extend mainline green with left-turn traffic. If it is not desirable, L12 can be omitted.

(C) For protected turn phasing, L12 is used to call and extend protected (turn arrow) phases. NOTE: It is possible to switch detector outputs (detector switching) in order to use L12 to extend the mainline green phase (permitted) after the protected turn phase has terminated.

(D) L12 can be placed 30 to 50 feet behind the stop line if protected/permitted phasing is used (3rd vehicle detection).

RAMP/T INTERSECTION LOOP NOTES

(A) L11 is located at the designer's discretion. Typical placement is for a 35 mph design speed. This reflects the slowing conditions at a ramp/T intersection.

(B) L9 and L10 are placed on delay. After the delay time has expired, these loops call the ramp/"T" intersection green phase. The delay time for these loops is not inhibited. This keeps L9 and L10 from extending the green phase.

(C) L11 is on delay. This prevents the loop from calling the green phase. Once the green phase arrives (called in by L9 and L10), the loop is delay inhibited. This allows L11 to extend the ramp/"T" intersection green phase.

Figure 498-5. Suggested Loop Placement for Mainline vs. Low-Volume Side Street (1 of 4)

(For better legibility, portions of this sample layout have also been shown separately.)

Sample Page Layout

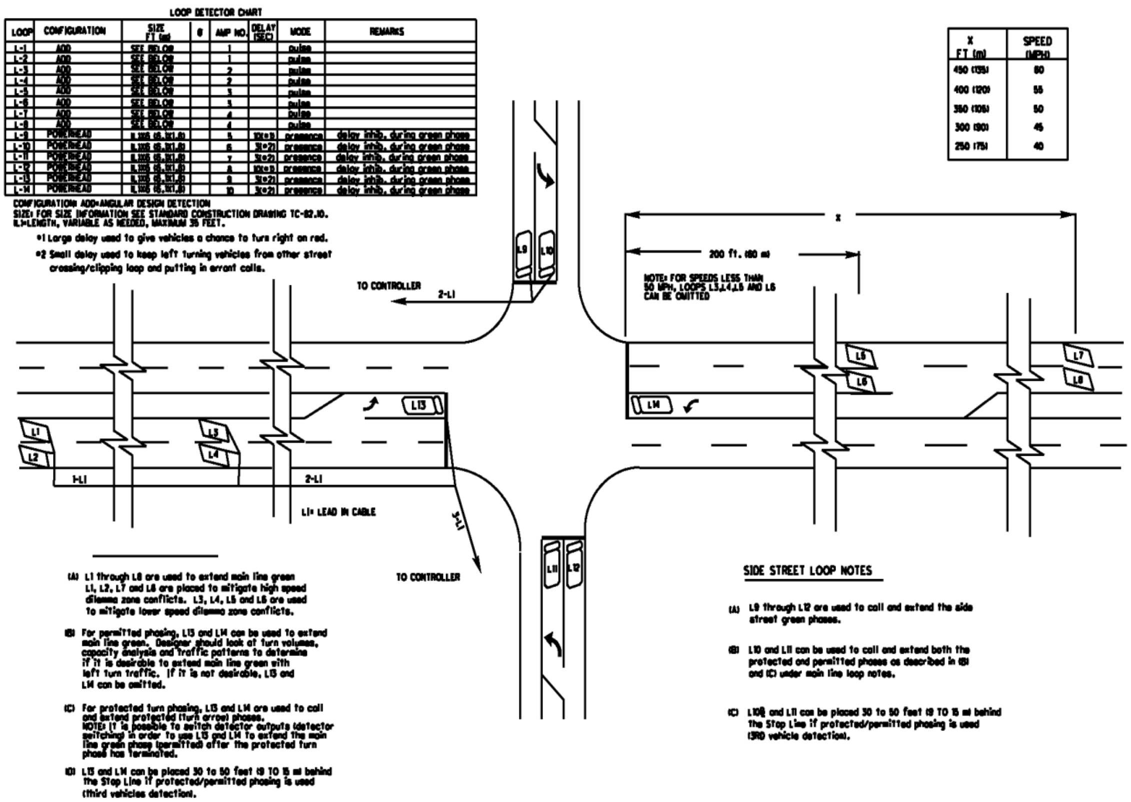


Figure 498-5. Suggested Loop Placement for Mainline vs. Low-Volume Side Street (2 of 4)

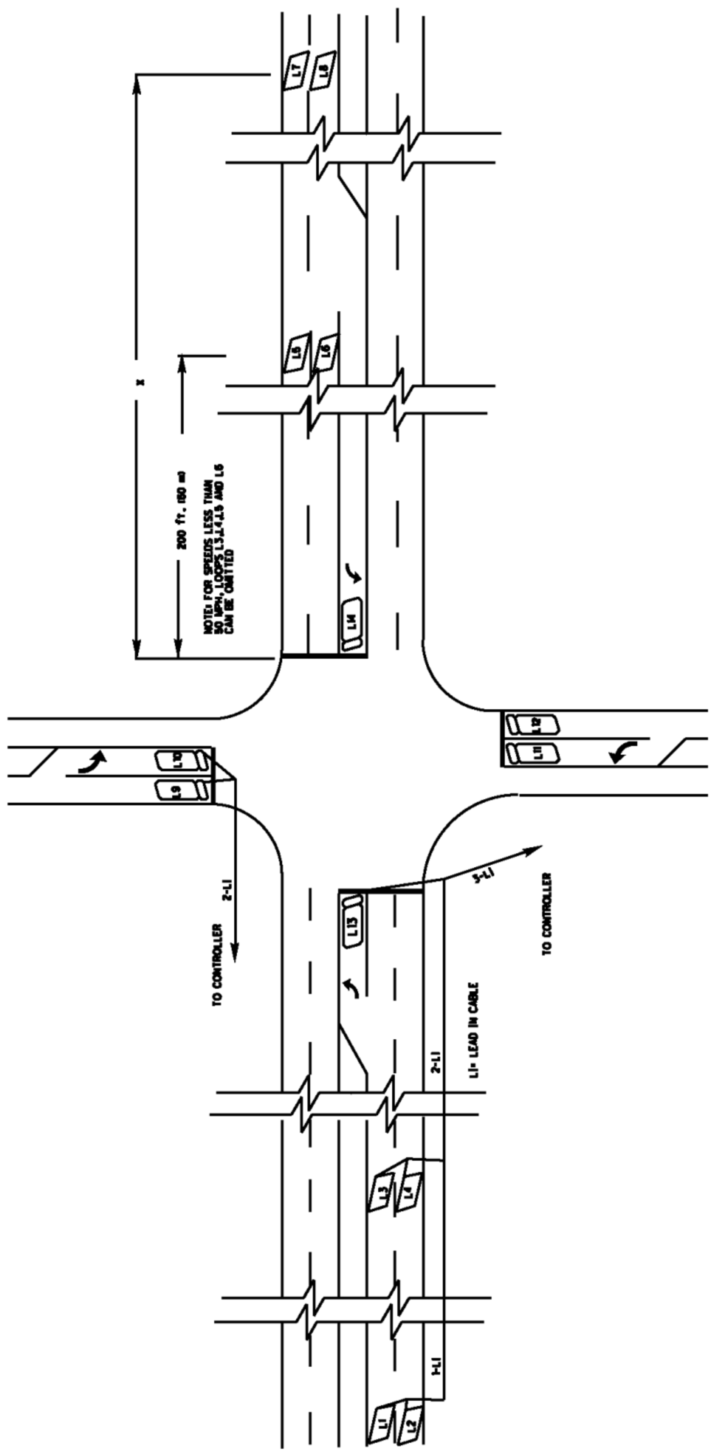


Figure 498-5. Suggested Loop Placement for Mainline vs. Low-Volume Side Street (3 of 4)

LOOP DETECTOR CHART

LOOP	CONFIGURATION	SIZE FT	Ø	AMP NO.	DELAY (SEC)	MODE	REMARKS
L-1	ADD[3]	SEE BELOW [4]		1		pulse	
L-2	ADD[3]	SEE BELOW [4]		1		pulse	
L-3	ADD[3]	SEE BELOW [4]		2		pulse	
L-4	ADD[3]	SEE BELOW [4]		2		pulse	
L-5	ADD[3]	SEE BELOW [4]		3		pulse	
L-6	ADD[3]	SEE BELOW [4]		3		pulse	
L-7	ADD[3]	SEE BELOW [4]		4		pulse	
L-8	ADD[3]	SEE BELOW [4]		4		pulse	
L-9	POWERHEAD	(L)x6 [4]		5	10[1]	presence	delay inhibited during green phase
L-10	POWERHEAD	(L)x6 [4]		6	3[2]	presence	delay inhibited during green phase
L-11	POWERHEAD	(L)x6 [4]		7	3[2]	presence	delay inhibited during green phase
L-12	POWERHEAD	(L)x6 [4]		8	10[1]	presence	delay inhibited during green phase
L-13	POWERHEAD	(L)x6 [4]		9	3[2]	presence	delay inhibited during green phase
L-14	POWERHEAD	(L)x6 [4]		10	3[2]	presence	delay inhibited during green phase

Notes:

1. Large delay used to give vehicles a chance to turn right on red.
2. Small delay used to keep left-turning vehicles from other street crossing/clipping loop and putting in errant calls.
3 Configuration Terms: ADD= Angular Design Detection
4. For size information see **Standard Construction Drawing TC-82.10**. (L)=Length, variable as needed, with maximum shown in the SCD.

X FT	SPEED (MPH)
450	60
400	55
350	50
300	45
250	40

Figure 498-5. Suggested Loop Placement for Mainline vs. Low-Volume Side Street (4 of 4)

MAIN LINE LOOP NOTES

(A) L1 through L8 are used to extend main-line green. L1, L2, L7 and L8 are placed to mitigate high-speed dilemma zone conflicts. L3, L4, L5 and L6 are used to mitigate lower speed dilemma zone conflicts

(B) For permitted phasing, L13 and L14 can be used to extend mainline green. The designer should look at turn volumes, capacity analysis and traffic patterns to determine if it is desirable to extend mainline green with left-turn traffic. If it is not desirable, L13 and L14 can be omitted.

(C) For protected turn phasing, L13 and L14 are used to call and extend protected (turn arrow) phases. NOTE: It is possible to switch detector outputs (detector switching) in order to use L13 and L14 to extend the mainline green phase (permitted) after the protected turn phase has terminated.

(D) L13 and L14 can be placed 30 to 50 feet behind the stop line if protected/permitted phasing is used (3rd vehicle detection).

SIDE STREET LOOP NOTES

(A) L9 through L12 are used to call and extend the side street green phases.

(B) L10 and L11 can be used to call and extend both the protected and permitted phases as described in (B) and (C) under the mainline loop notes.

(C) L10 and L11 can be placed 30 to 50 feet behind the stop line if protected/permitted phasing is used (3rd vehicle detection).

Figure 498-6. Concrete Pull Box

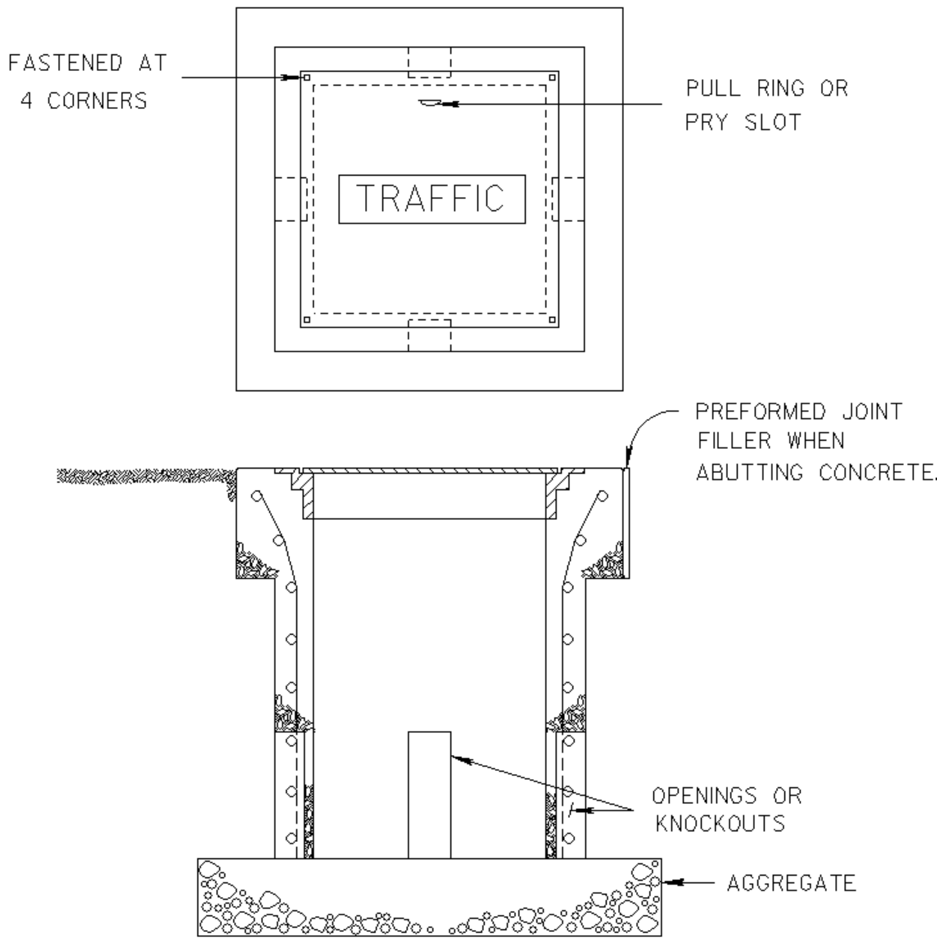
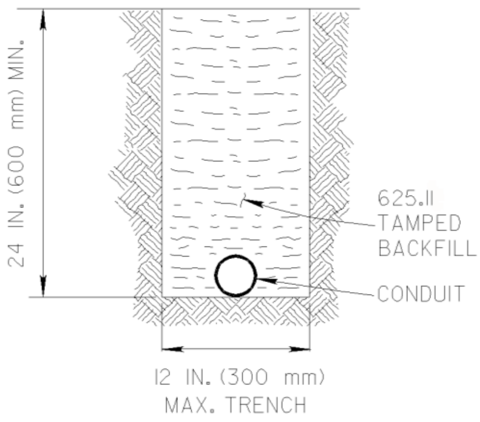
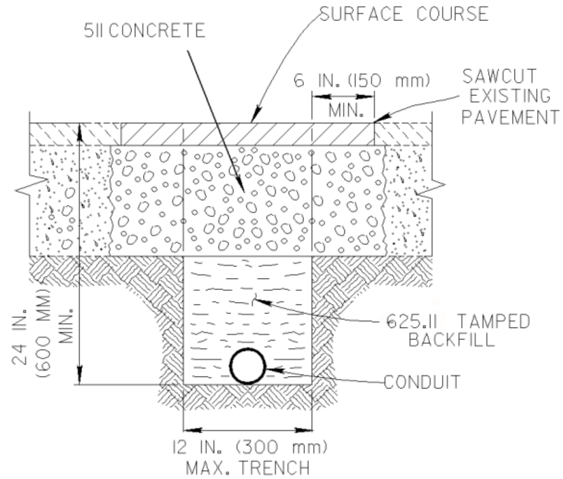


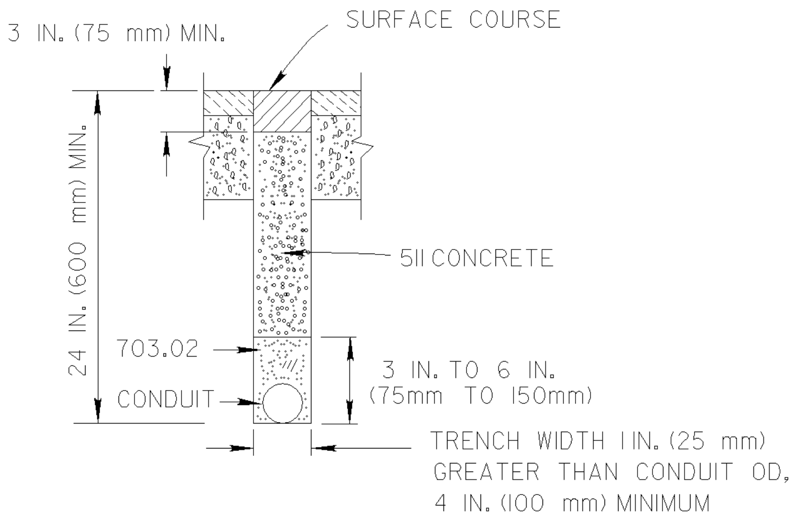
Figure 498-7. Trench Details



TRENCH



TRENCH IN PAVED AREAS



NARROW SLIT TYPE TRENCH

IN PAVED AREA

Figure 498-8. Exothermic Weld

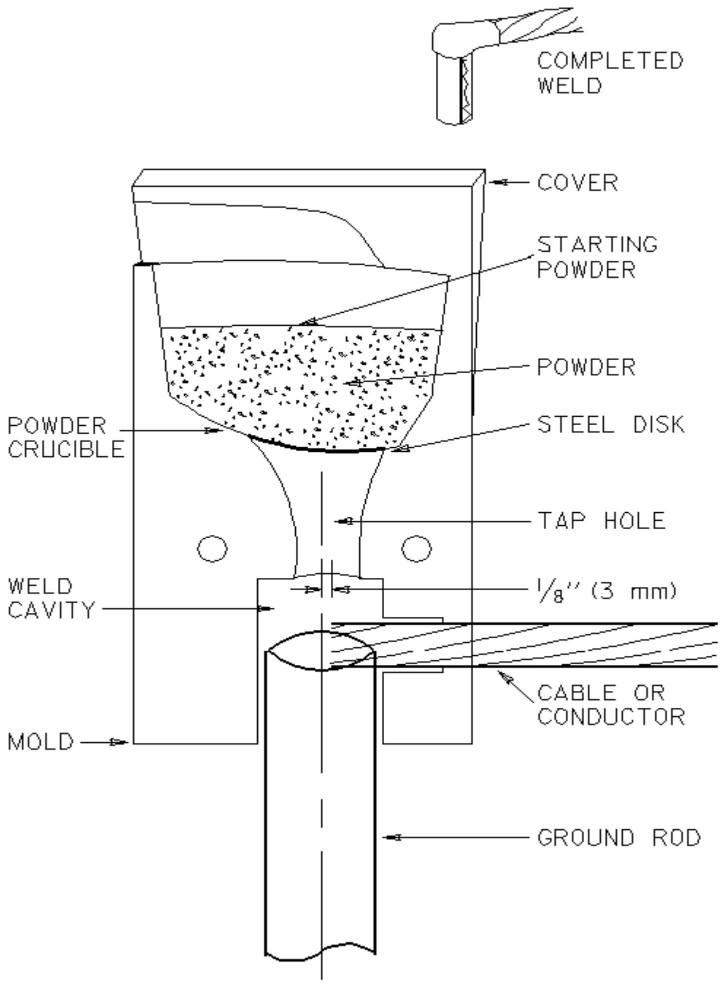
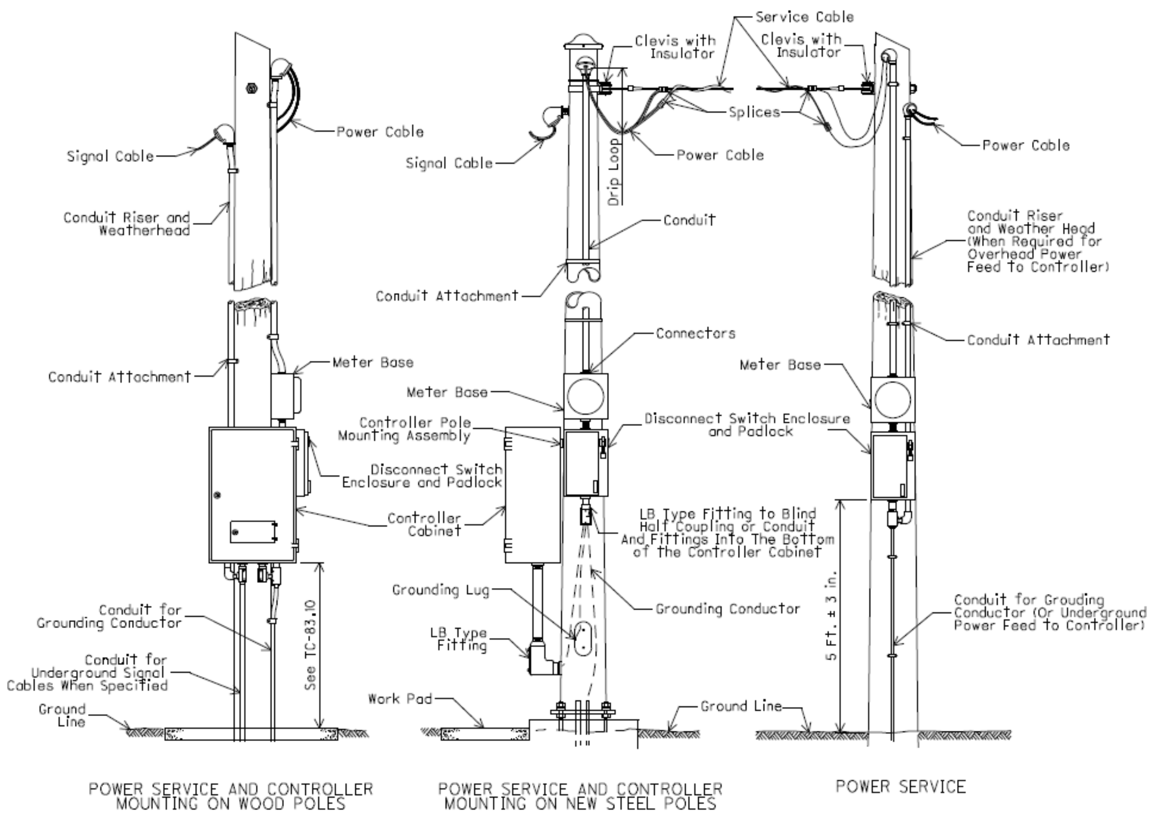
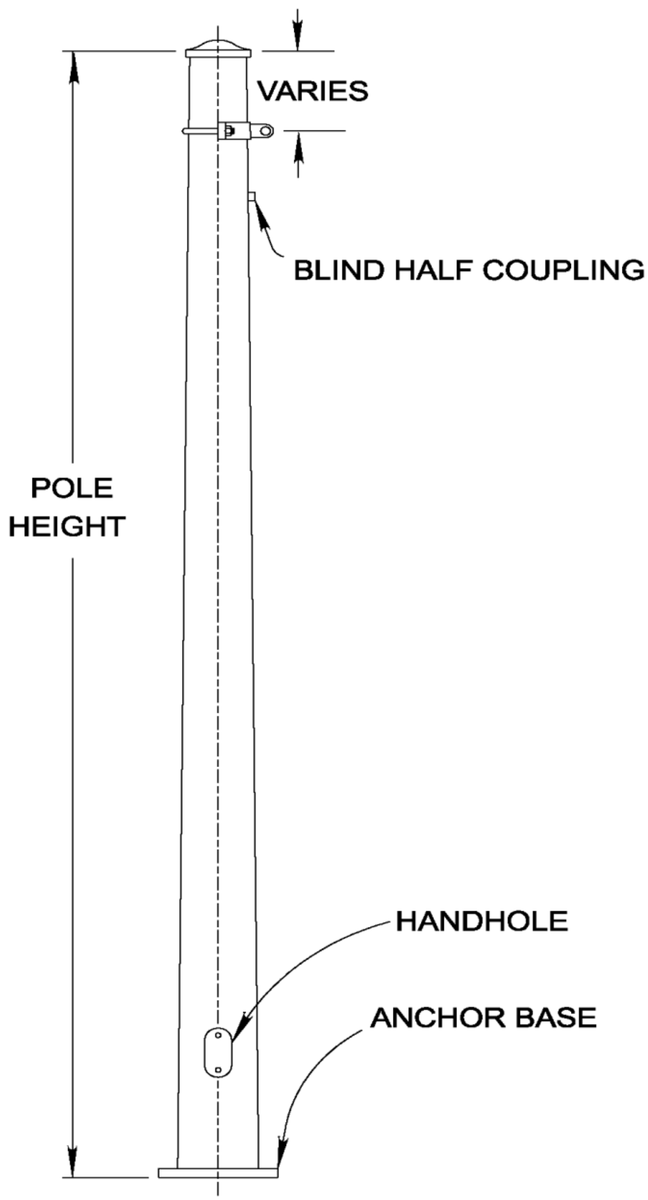


Figure 498-9. Power Service



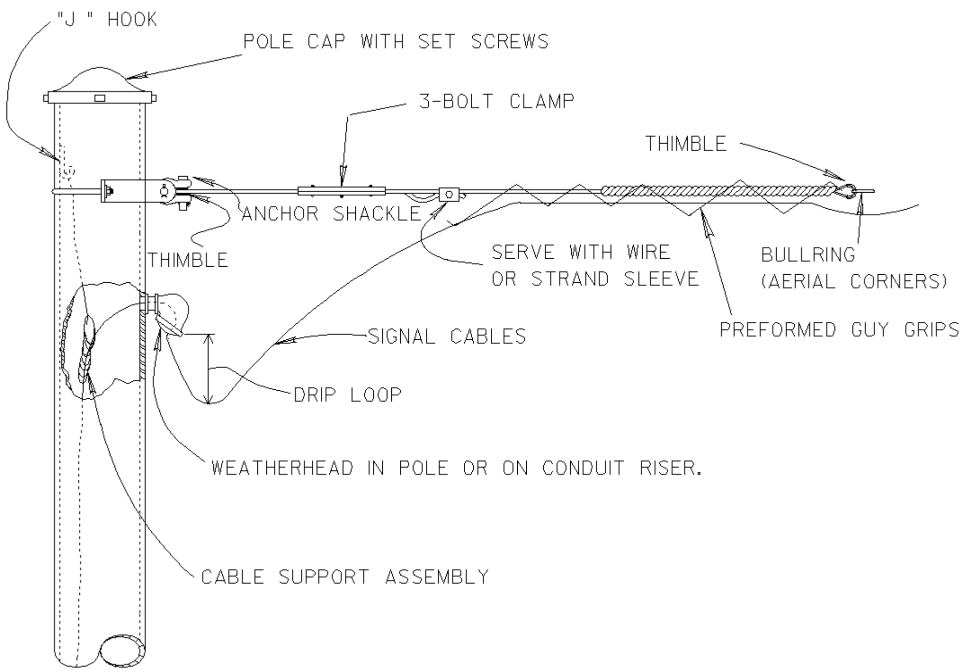
(See **Traffic SCD TC-83.10** for further details.)

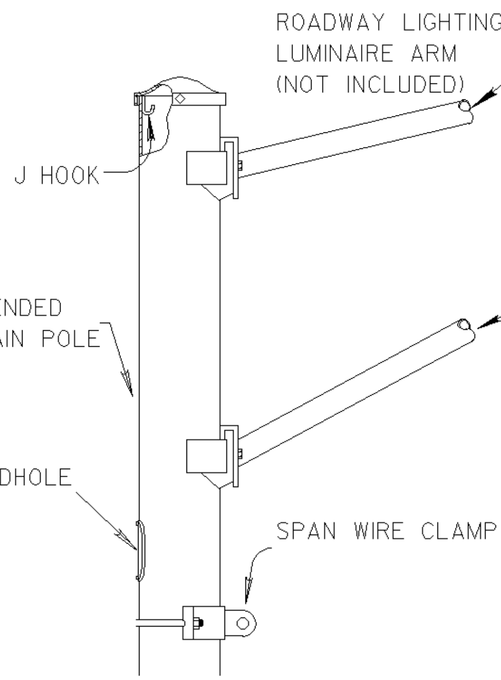
Figure 498-10. Strain Pole Supports



TAPERED TUBE

Figure 498-11. Strain Pole Attachment Details





COMBINATION POLE

Figure 498-12. Single Arm Support

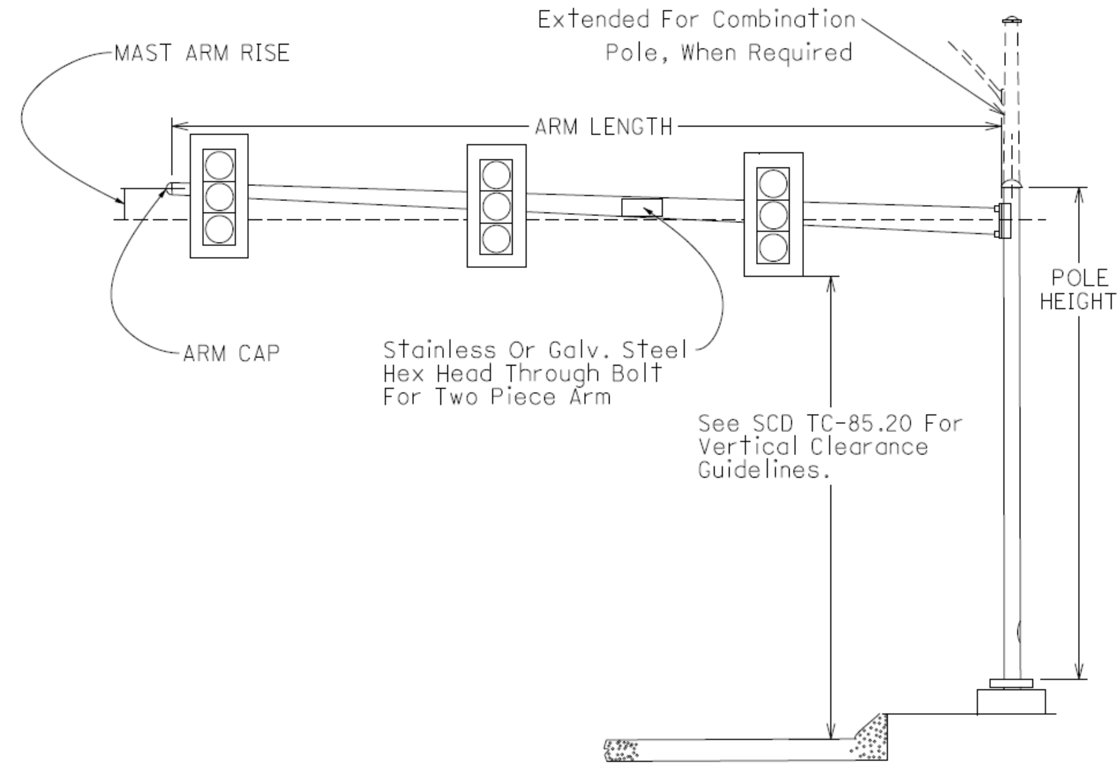
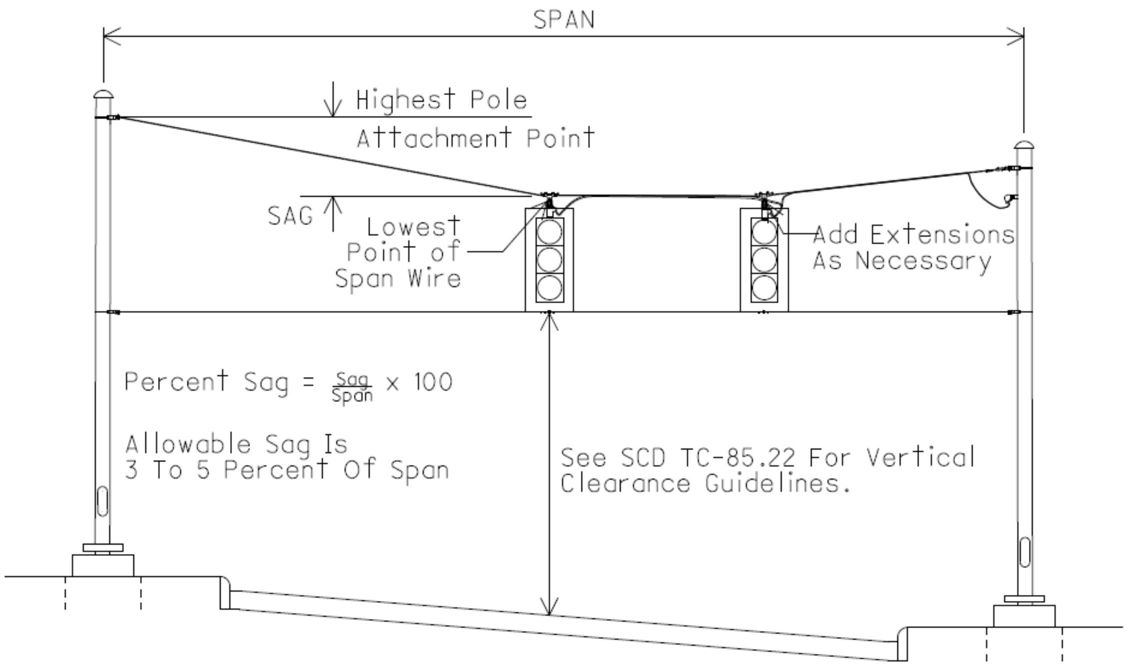


Figure 498-13. Sag and Vertical Clearance Diagram



Sag for Simple Spans

Figure 498-14. Cable Support Assembly

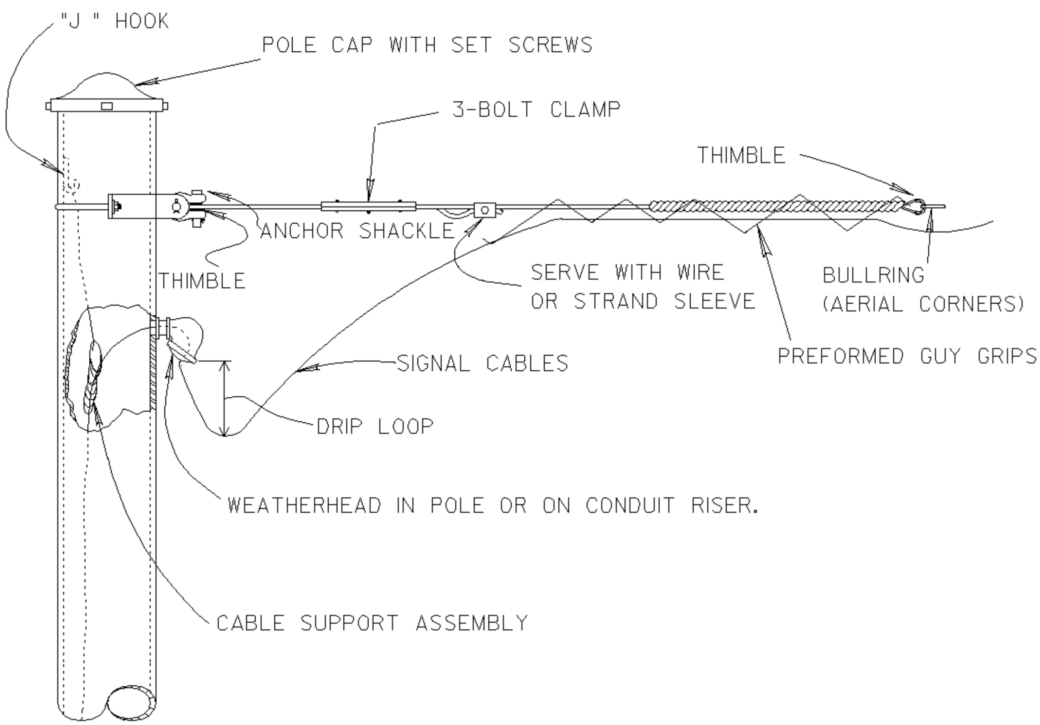
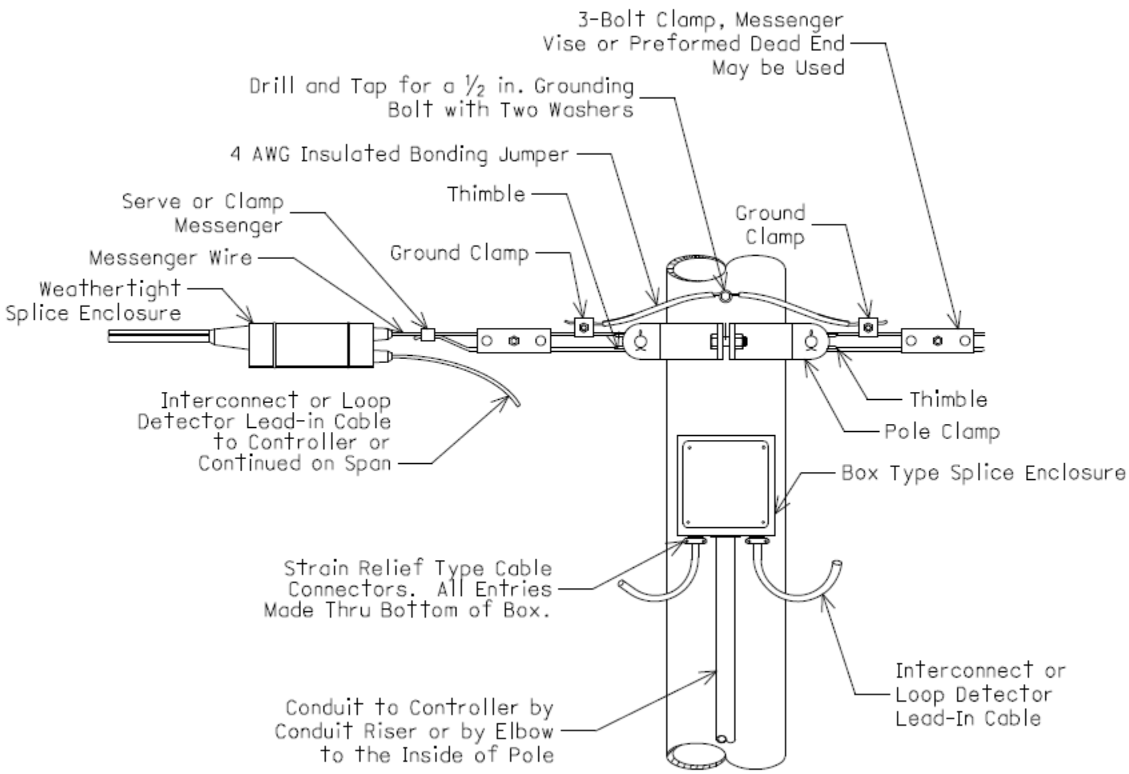


Figure 498-15. Aerial Interconnect Cable



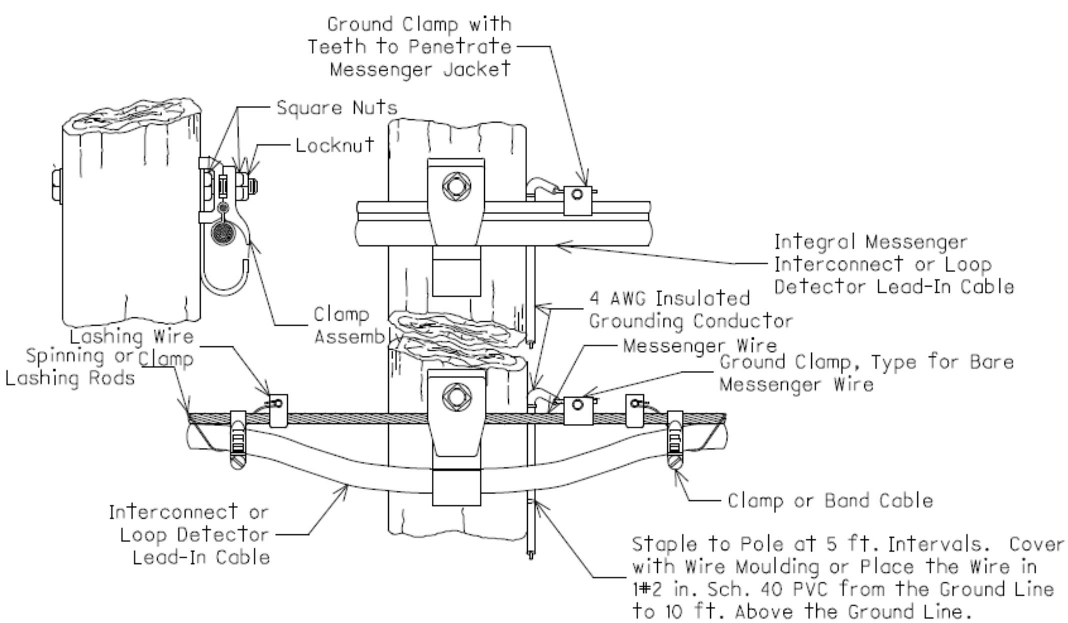
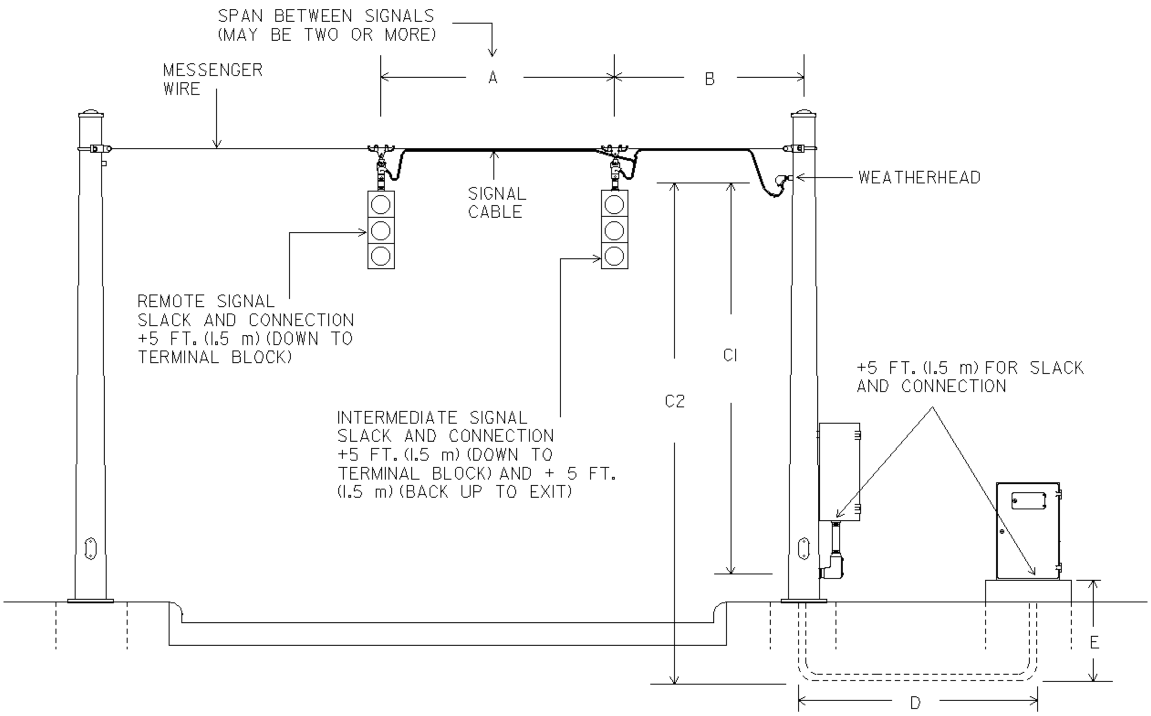


Figure 498-16. Method of Measurement for Signal Cable



Calculation for Pole-Mounted Cabinet:

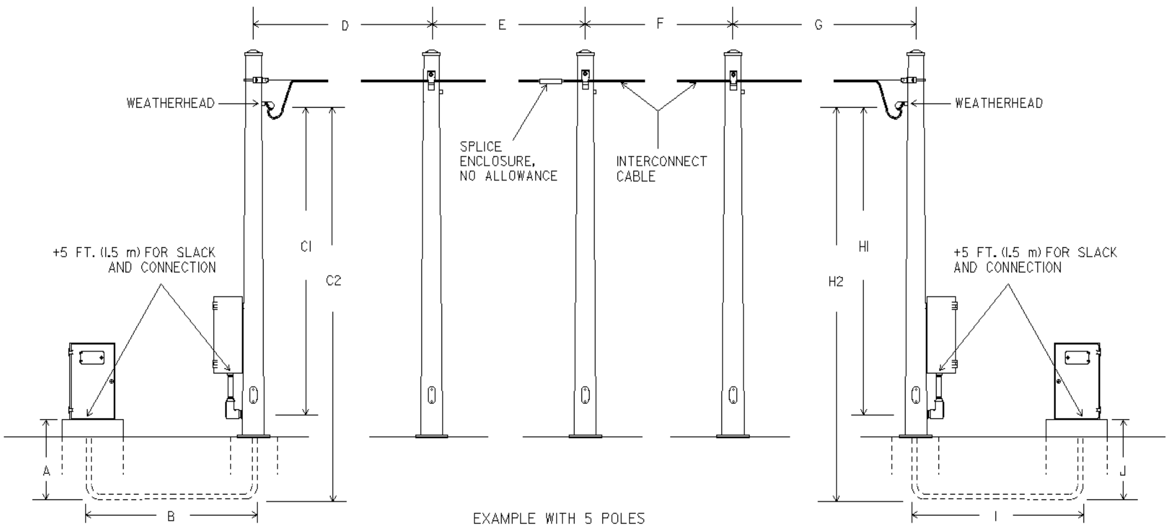
Length = 5 FT. + A + 10 FT. + B + C1 + 5 FT.

Calculation for Ground-Mounted Cabinet:

Length = 5 FT. + A + 10 FT. + B + C2 + D + E + 5 FT.

[Metric dimensions will be removed from the drawing later.]

Figure 498-17. Method of Measurement for Interconnect Cable



Calculation for Pole-Mounted Cabinet:

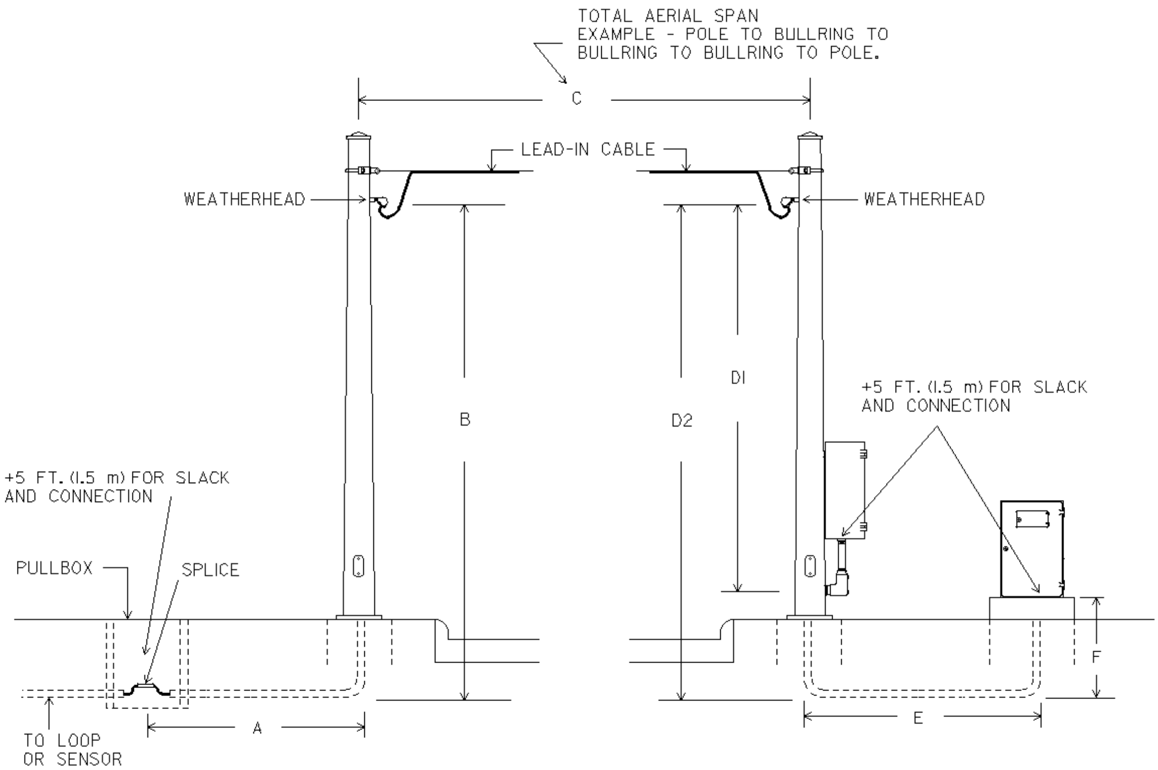
Length = 5 FT. + C1 + D + E + F + G + H1 + 5 FT.

Calculation for Ground-Mounted Cabinet:

Length = 5 FT. + A + B + C2 + D + E + F + G + H2 + I + J + 5 FT.

[Metric dimensions will be removed from the drawing later.]

Figure 498-18. Method of Measurement for Detector Lead-In Cable



Calculation for Pole-Mounted Cabinet:

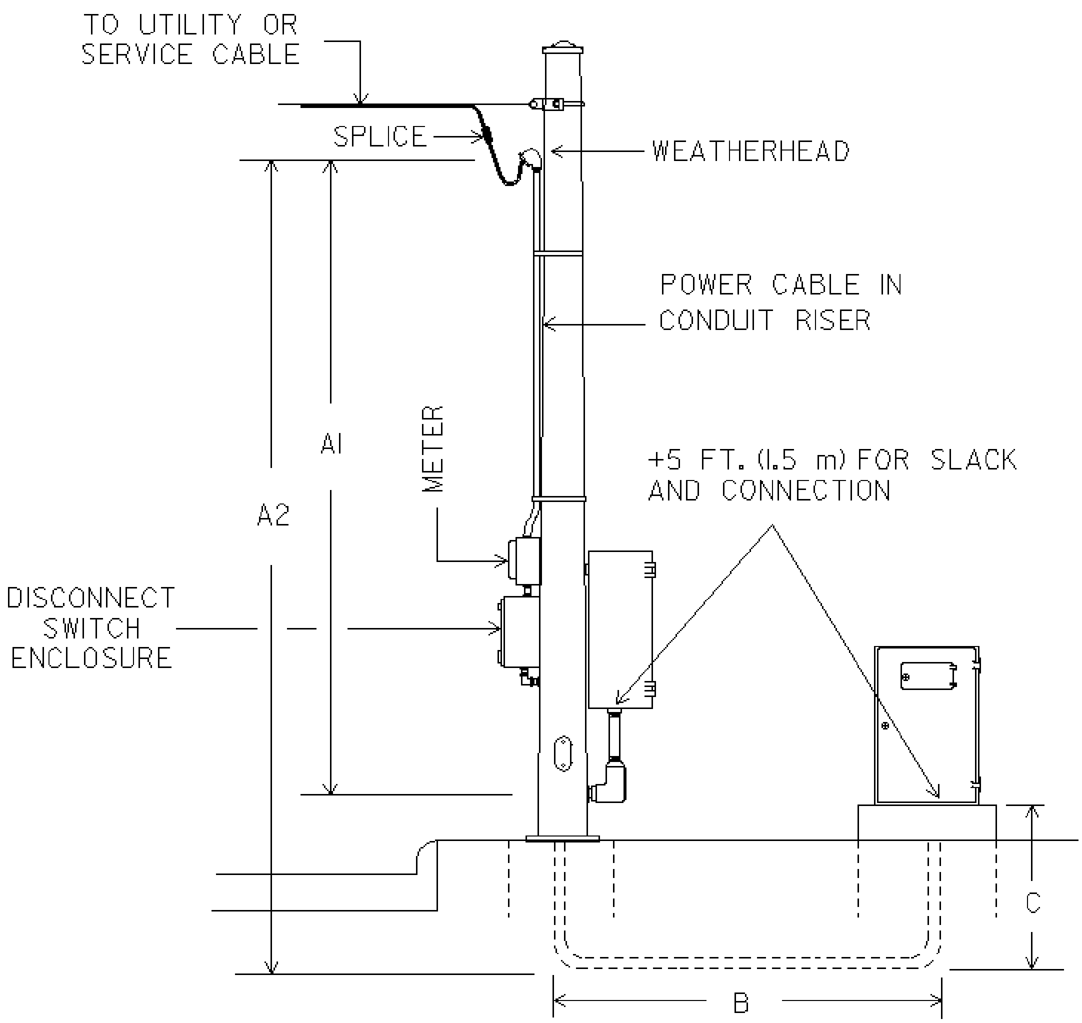
Length = 5 FT. + A + B + C + D1 + 5 FT.

Calculation for Ground-Mounted Cabinet:

Length = 5 FT. + A + B + C + D2 + E + F + 5 FT.

[Metric dimensions will be removed from the drawing later.]

Figure 498-19. Method of Measurement for Power Cable



Calculation for Pole-Mounted Cabinet:

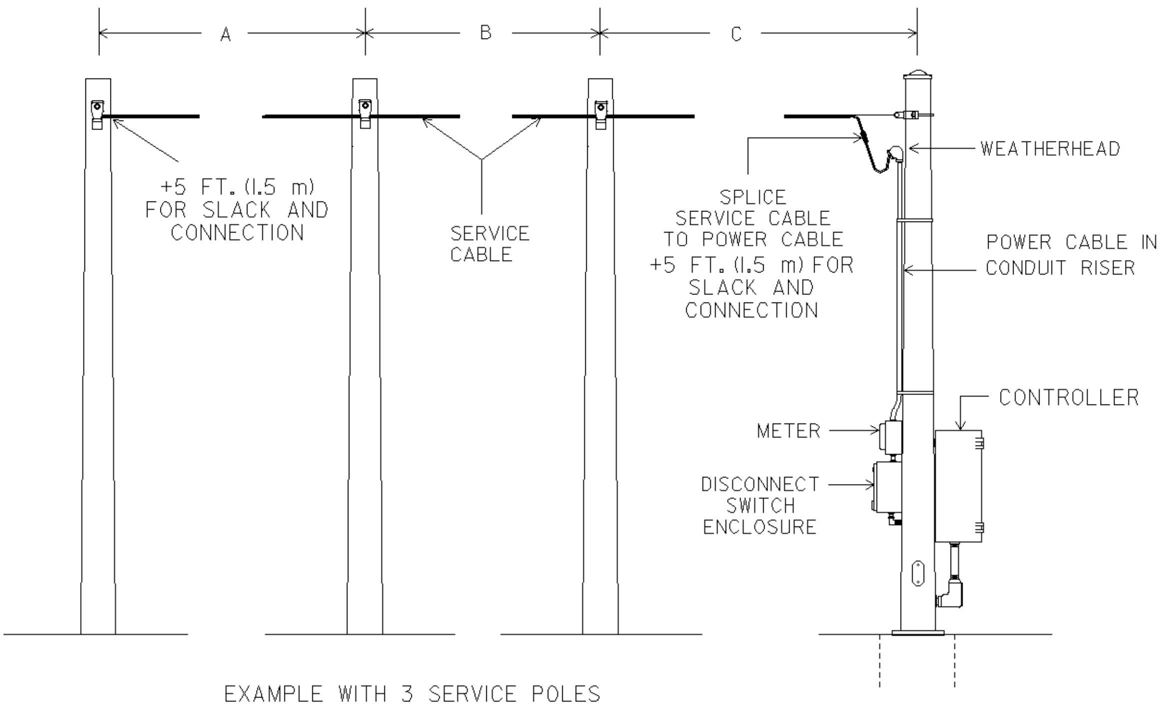
Length = 5 FT. + A1 + 5 FT.

Calculation for Ground-Mounted Cabinet:

Length = 5 FT. + A2 + B + C + 5 FT.

[Metric dimensions will be removed from the drawing later.]

Figure 498-20. Method of Measurement for Service Cable

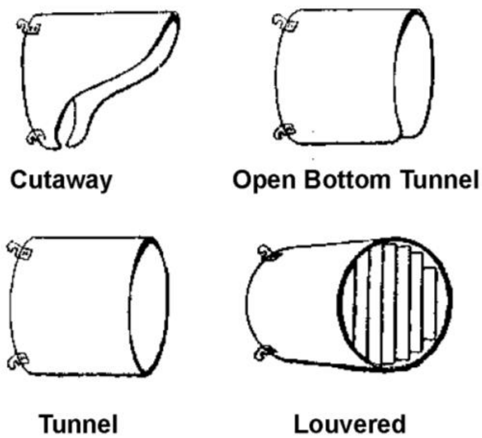


Calculation:

Length = 5 FT. + A + B + C + 5 FT.

[Metric dimensions will be removed from the drawing later.]

Figure 498-21. Vehicular Signal Heads



Visors for Signal Heads

Wiring a Signal Head

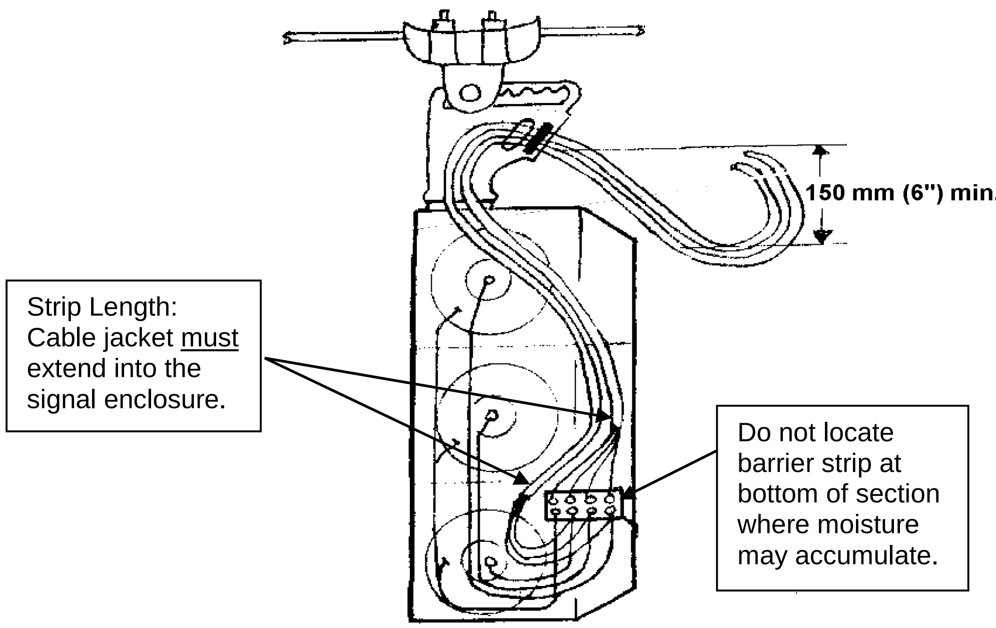


Figure 498-22. Pedestrian Signal Heads

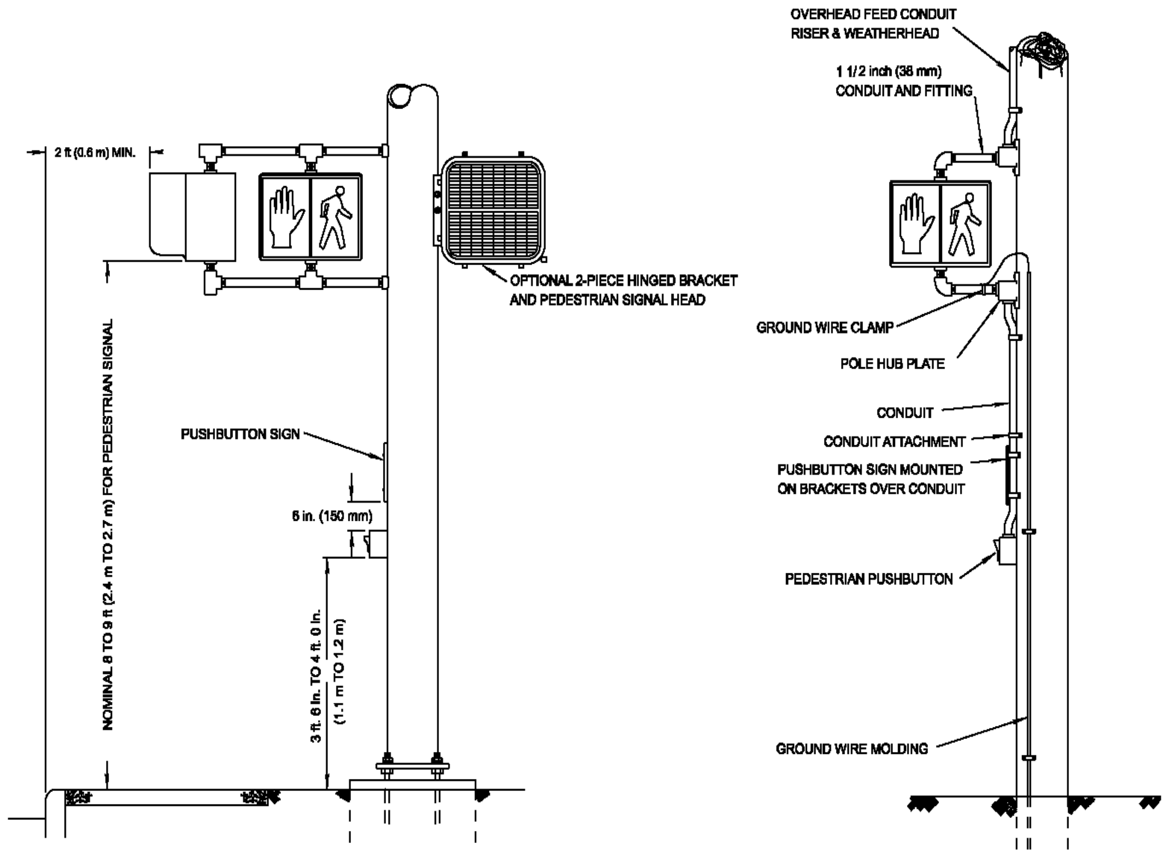
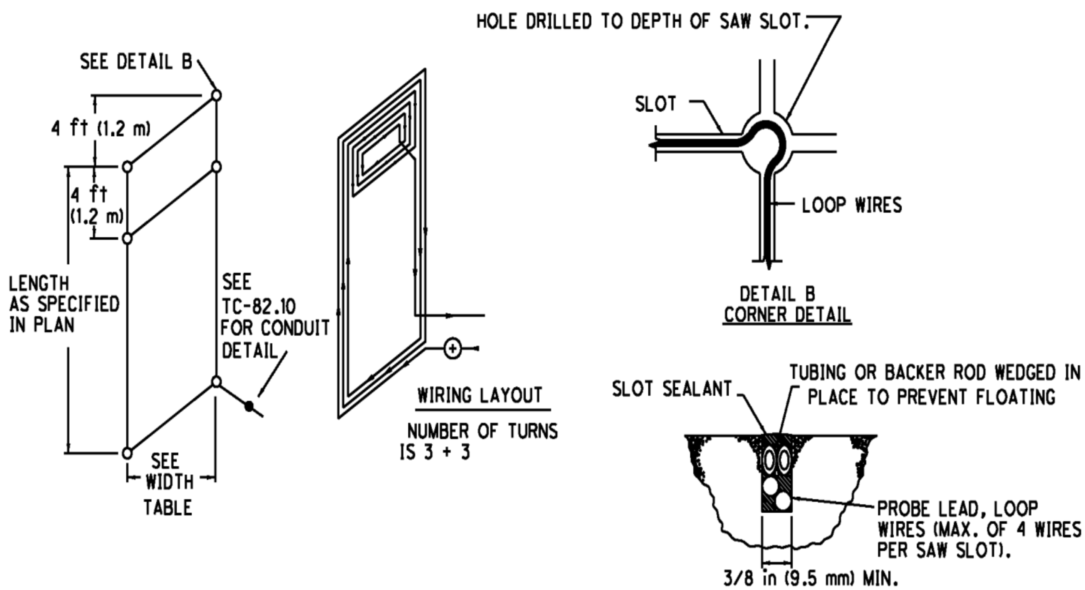


Figure 498-23. Loop Detector Placement and Installation



Width Table			
Lane Width	**Rectangular and Powerhead**	**Quadrupole**	**Angular Design**
11 FT and Larger	6 FT Width	6 FT Width	A= 4.5 FT
Less Than 11 FT	5 FT Width	6 FT Width	A= 4.0 FT

Figure 498-24. Loop Detector Slots and Wiring

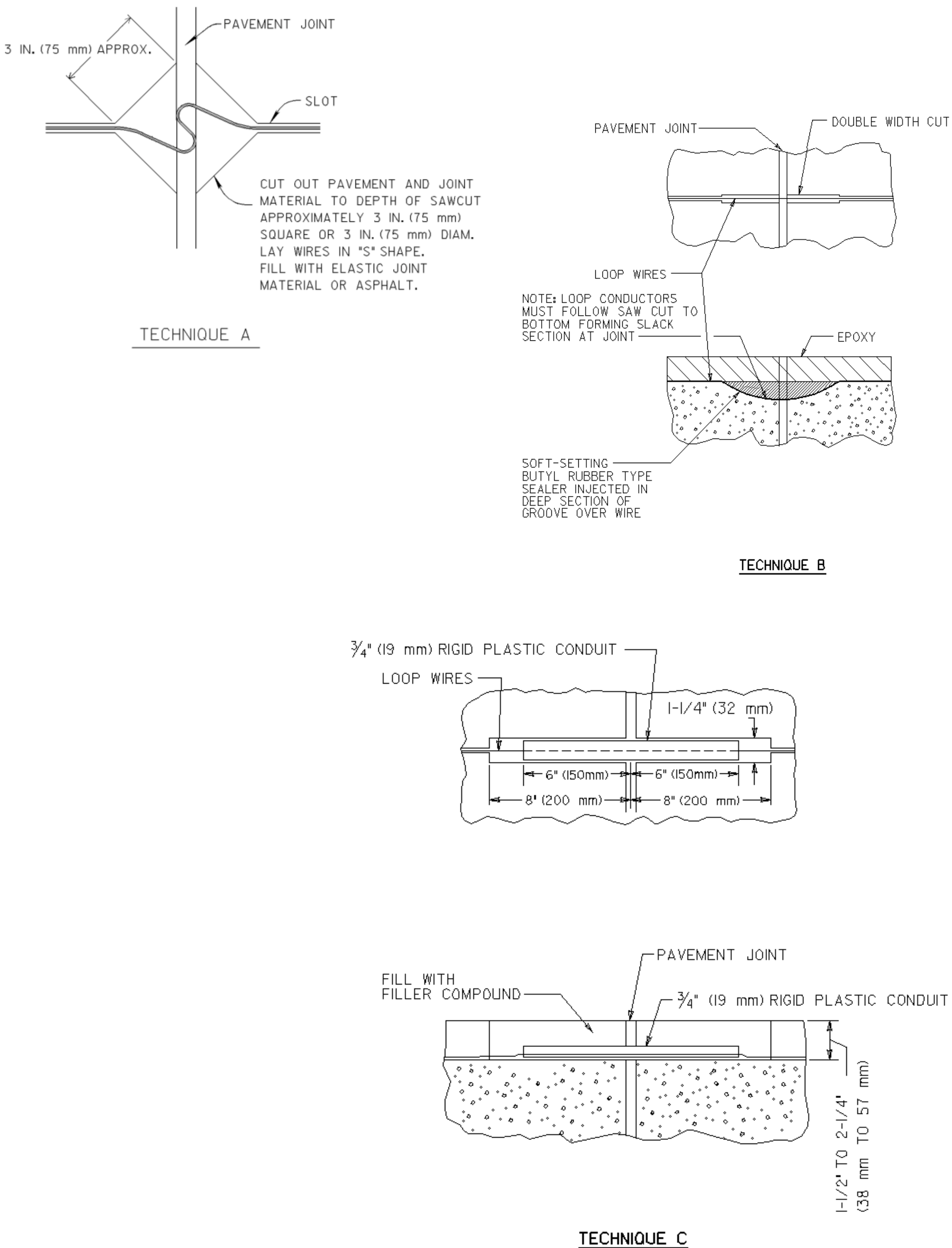
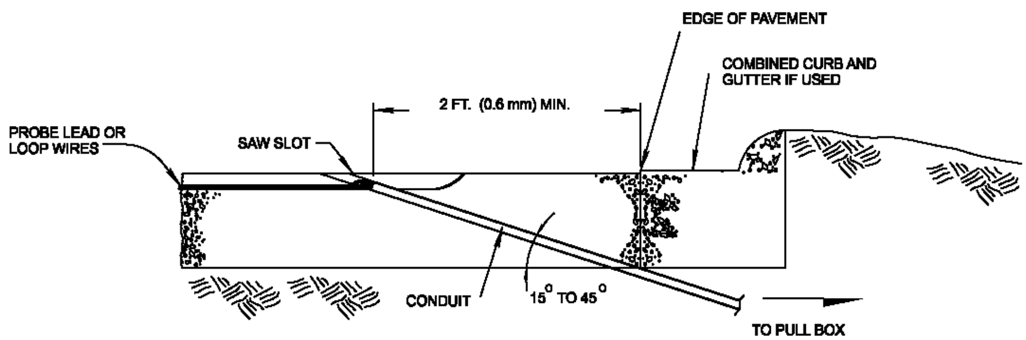
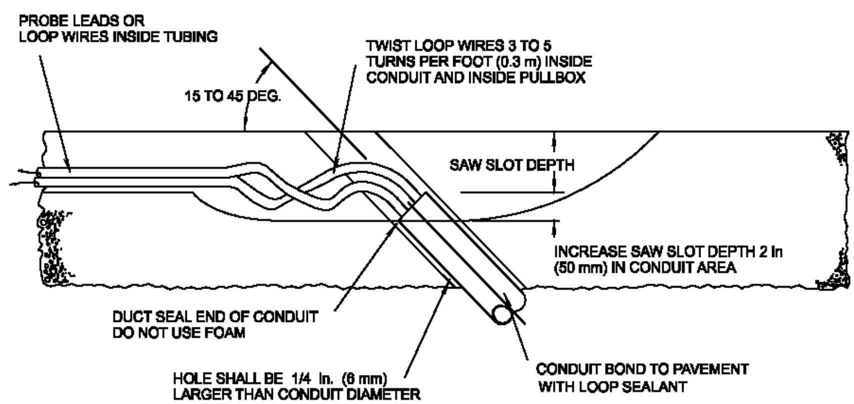
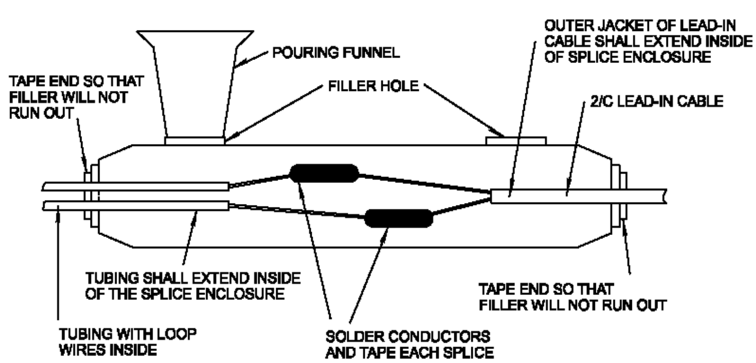


Figure 498-25. Loop Detector Wiring



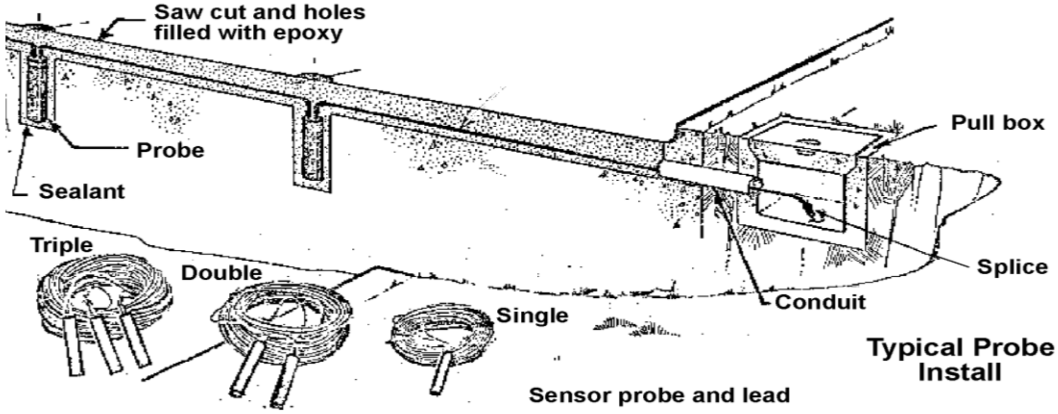


CONDUIT DRILLED HOLE DETAIL



SPLICE ENCLOSURE DETAIL

Figure 498-26. Magnetometer Probes and Lead-In



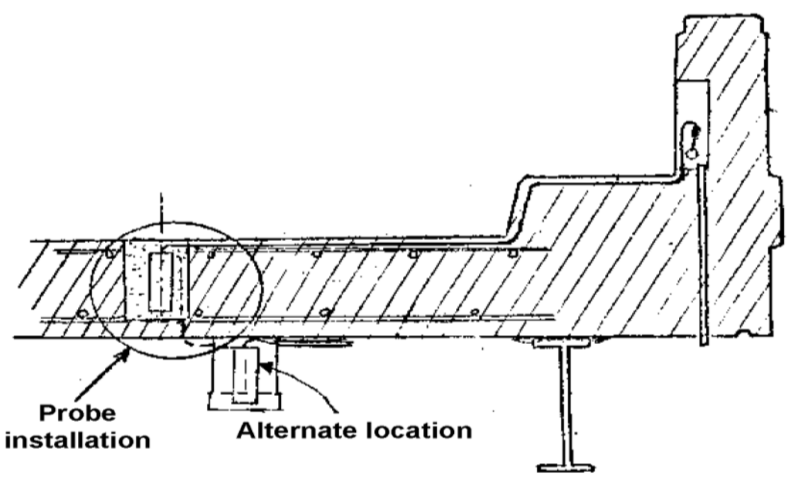
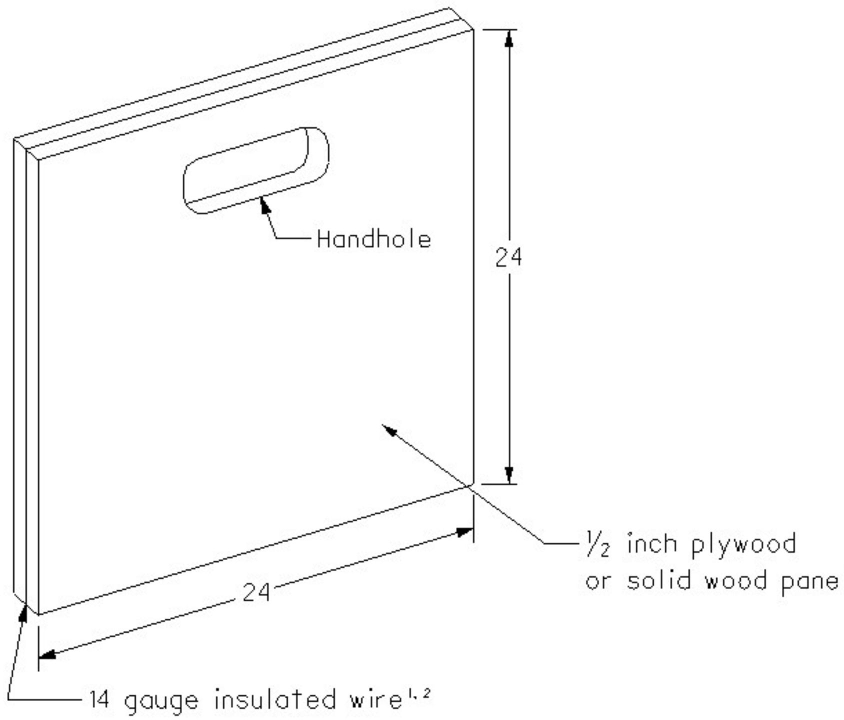


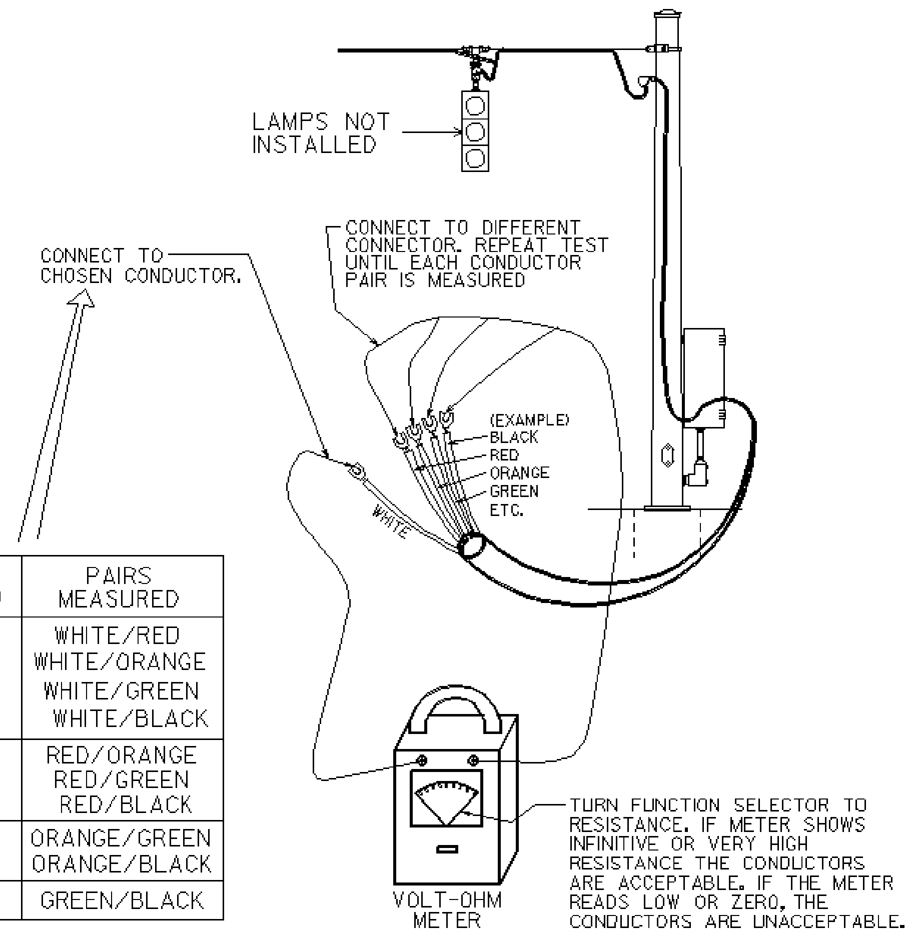
Figure 498-27. Vehicle Loop Test Targets



1. Two turns, ends shorted. Simulates a small motorcycle.
2. One turn, ends shorted. Simulates a bicycle.
3. Set vertically on or just above pavement to test detection areas and adjust sensitivity accordingly **(see *Section 450-11.6*)**.

Figure 498-28. Short-Circuit Test

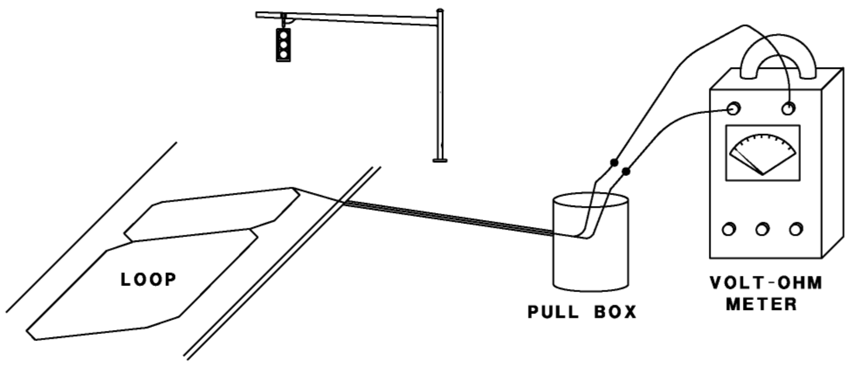
TESTING IS TO BE DONE WITH ALL ELECTRICAL LOADS, POWER SOURCES EQUIPMENT GROUNDS AND EARTH GROUNDS DISCONNECTED.



WIRE CONNECTED	PAIRS MEASURED
WHITE	WHITE/RED WHITE/ORANGE WHITE/GREEN WHITE/BLACK
RED	RED/ORANGE RED/GREEN RED/BLACK
ORANGE	ORANGE/GREEN ORANGE/BLACK
GREEN	GREEN/BLACK

CONDUCTORS MAY BE JUMPED TOGETHER FOR TESTING TO GROUND. IF A SHORT IS REVEALED, INDIVIDUAL CONDUCTORS MAY THEN BE TESTED TO GROUND TO ISOLATE THE FAULTY CONDUCTOR.

Figure 498-29. Circuit Continuity Test of Loop Wire (Before Splice to Lead-In Cable)



TURN FUNCTION SELECTOR TO RESISTANCE. A RESISTANCE OF ZERO OHMS SHOULD BE INDICATED. IF A HIGH RESISTANCE IS FOUND THE LOOP INSTALLATION IS UNACCEPTABLE.

Figure 498-30. Circuit Continuity Test of Loop Wire and Lead-In Cable

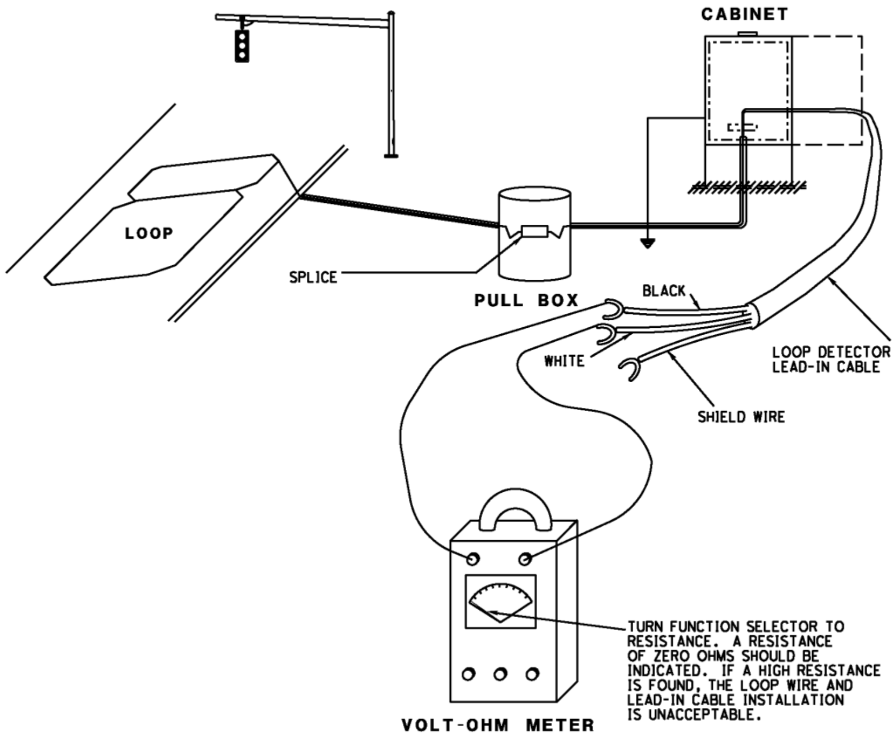


Figure 498-31. Circuit Continuity Test of Signal Cable Disconnected from Heads or Other Cables Such as Interconnect and Loop or Magnetometer Lead-In

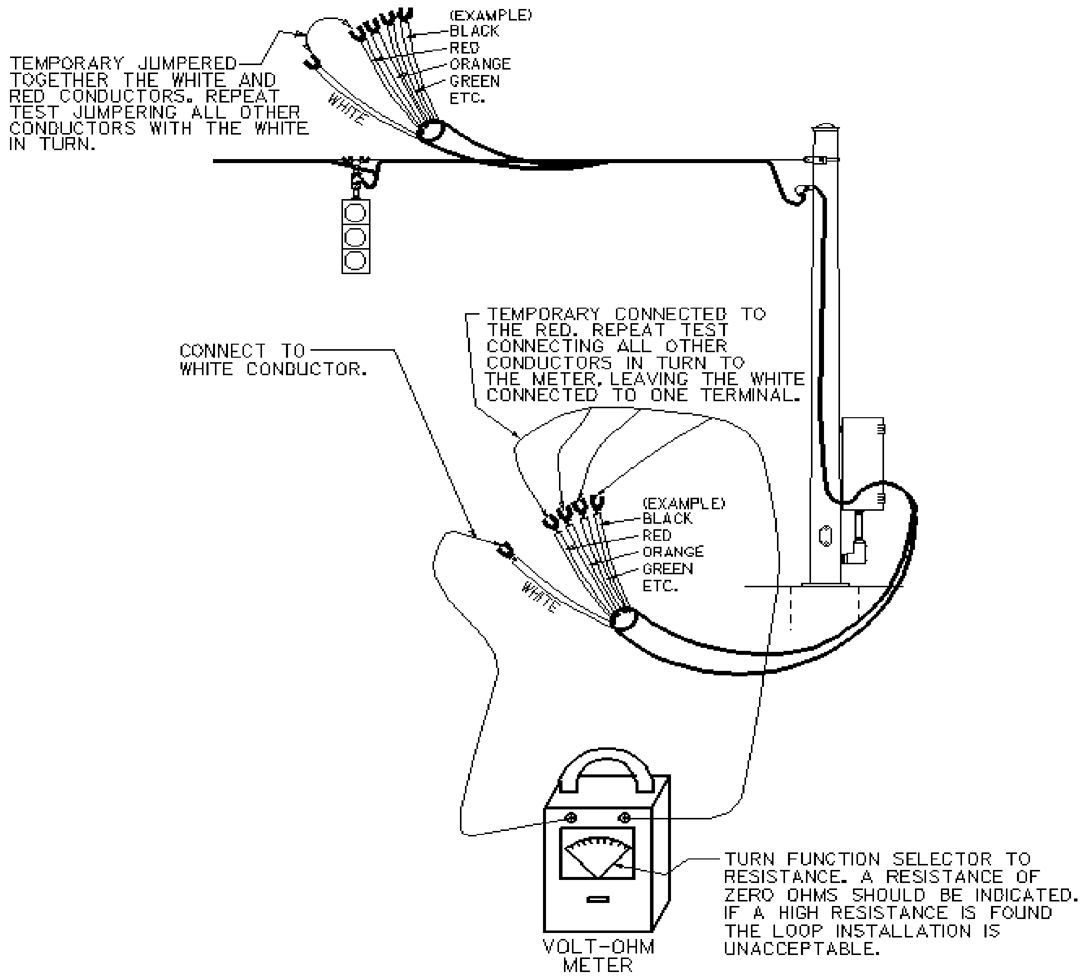


Figure 498-32. Circuit Continuity Test of Signal Cable With Cable Connected to the Signal Heads and Lamps Installed

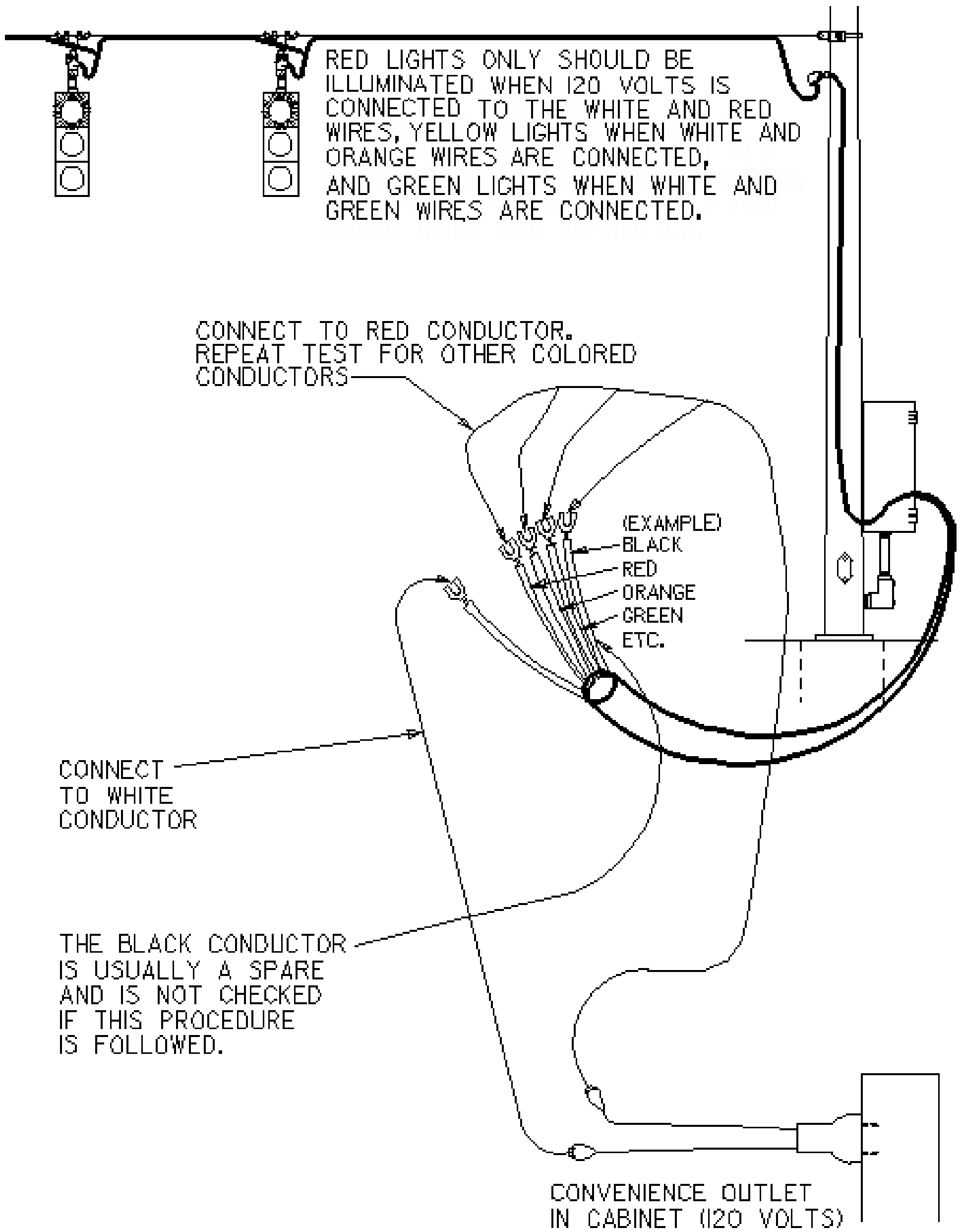


Figure 498-33. Cable Insulation Test (Loop Detector Wire)

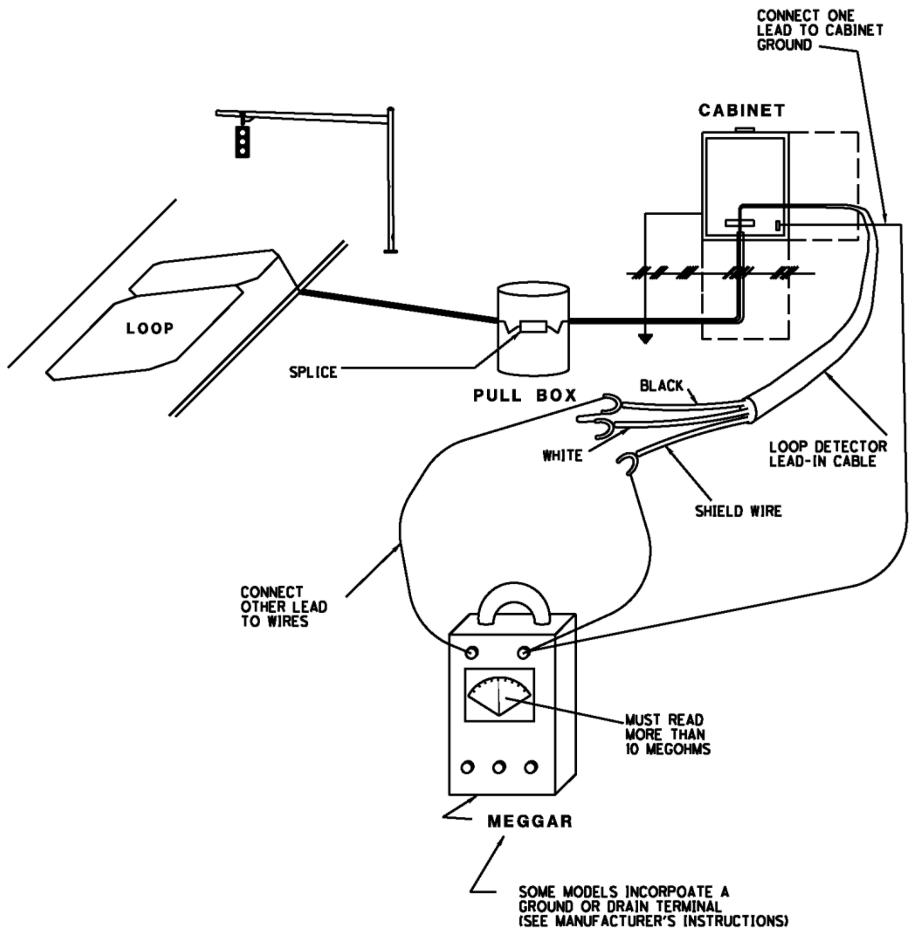


Figure 498-34. Cable Insulation Test (Signal Cable)

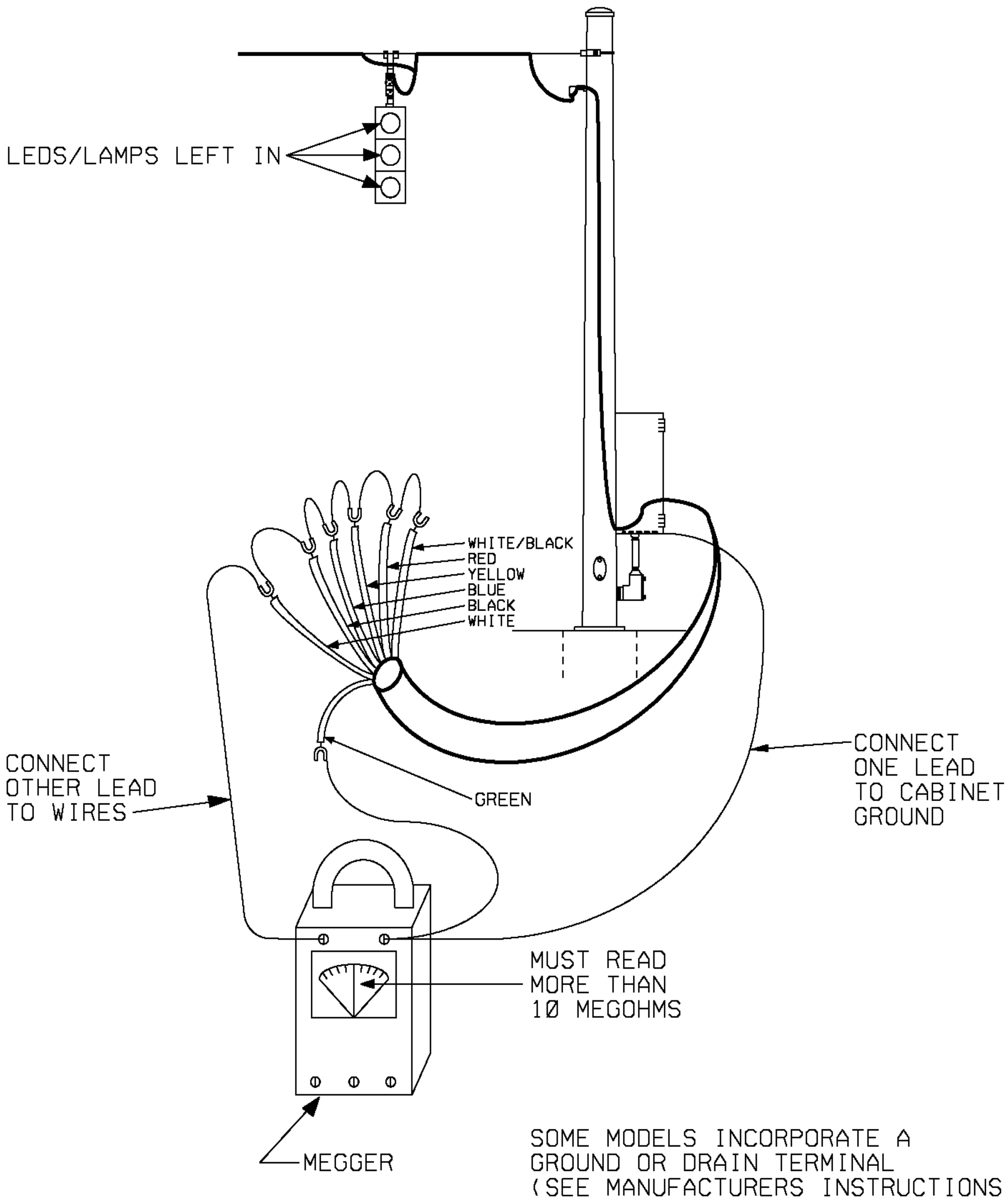


Figure 498-35. Reserved for Future Use

Figure 498-36. Plan Details for Strain Poles*

REFERENCE SHEET NO.*	STATION & OFFSET *	POLE NO.	DESIGN NO.	POLE HEIGHT FT	FOUNDATION ELEV. *	SPAN WIRE ATTACHED. HT. *	CABLE ENTRANCE DISTANCE FROM TOP (IN.)	INDEX LINE ANGLE (DEG.)	ANGLES (DEG.) FROM INDEX LINE							
									PEDESTRIAN SIGNALS	PEDESTRIAN PUSH BUTTONS	CONTROLLER	POWER SERVICE	CABLE ENTRANCE	LUMINAIRE BRACKET	INTERCONNECT POLE SPLICE BOX	2" CAPPED

See ***Section 441-8***.

Notes:
1. All angles are measured clockwise.
2. The index line goes through the center of the handhole.

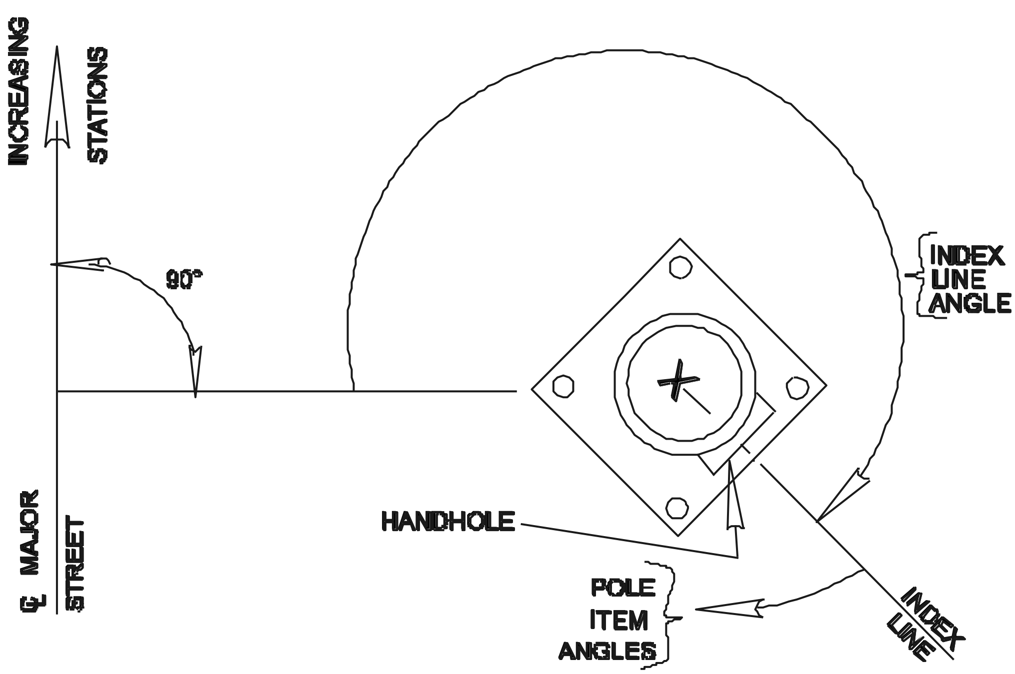
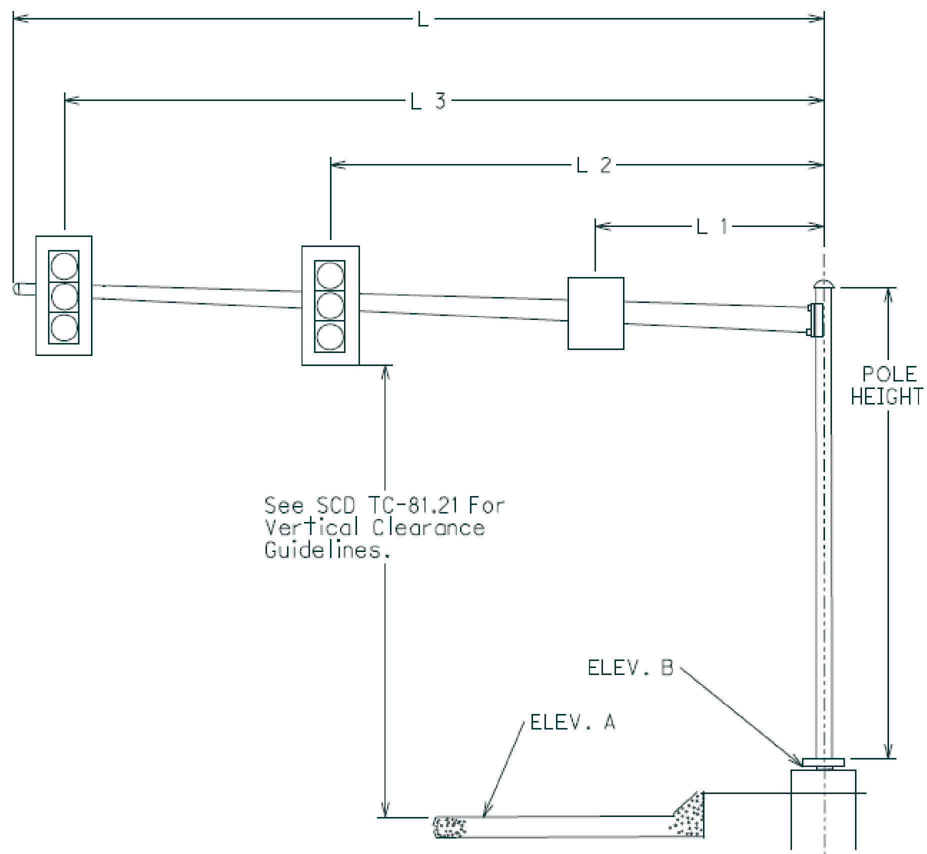


Figure 498-37. Plan Details for Signal Supports - Arm Lengths

(table is continued in Figure 498-38)

Minimum Typical Drawing

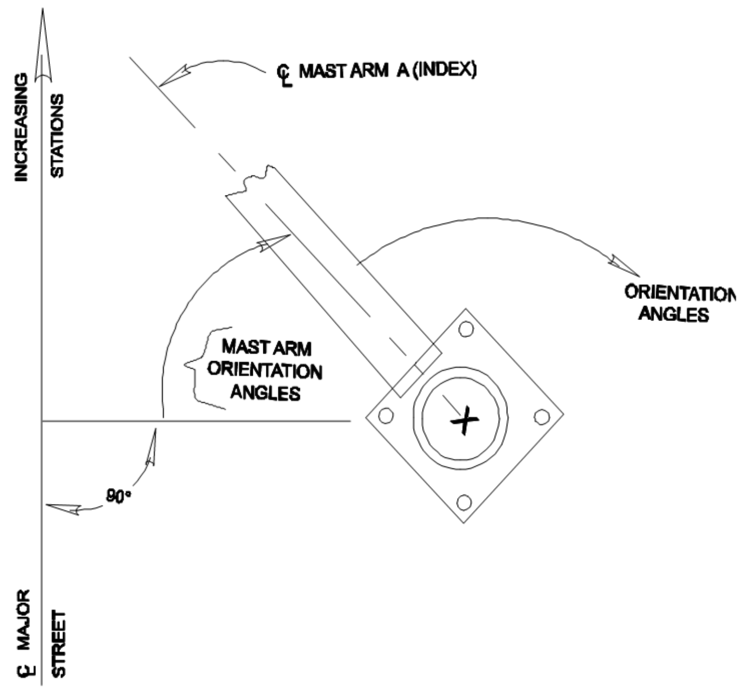


SUPPORT NO.	STATION	OFFSET	ELEVATION		SIGNAL SUPPORT DETAILS										
			A	B	DESIGN TYPE	DESIGN NO.	POLE HEIGHT FT	ARM HEIGHT FT	L FT	L1 FT	L2 FT	L3 FT	D1 FT	D2 FT	X FT

Note:

1. D1, D2, etc. are used for distance to Detection Unit.
2. X would be the length of a bracket arm.

Figure 498-38. Plan Details for Signal Supports - Mast Arm Orientation (table continued from Figure 498-37)



Notes:
1. All angles are measured clockwise.
2. Base plate is oriented square to Mast Arm A (largest arm) even if the support has two arms.

ORIENTATION ANGLES (DEG.) FROM MAST ARM								
MAST ARM A ANGLE	MAST ARM B ANGLE	PEDESTRIAN SIGNAL	PEDESTRIAN BUTTON	POWER SERVICE	CONTROLLER	BRACKET ARM	HANDHOLE	CABLE ENTRANCE 12" FROM TOP
DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG	DEG

Figure 498-39. Example of Wire Size for Equipment Grounding Conductor – PTSWF with Pedestrian Indications

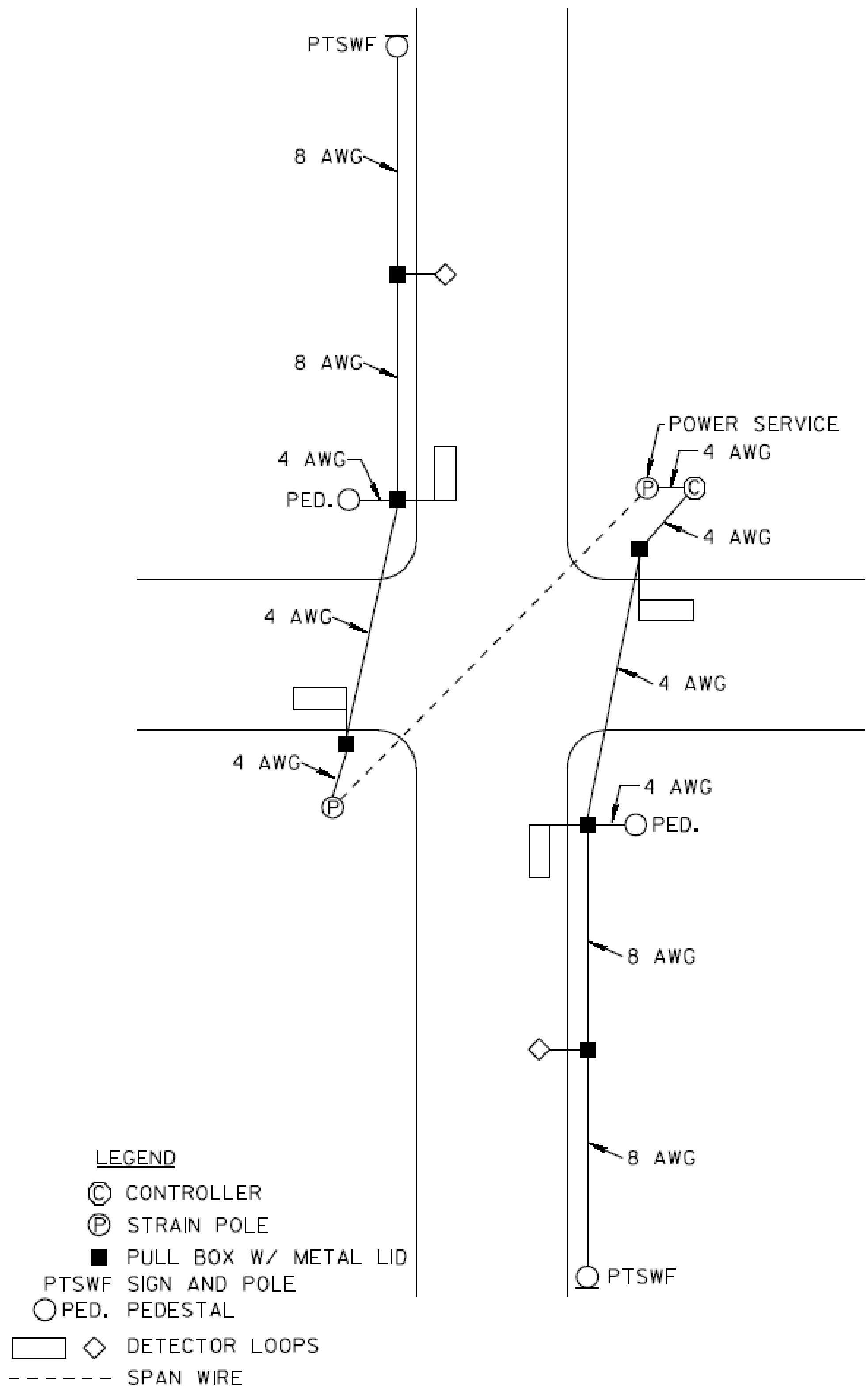


Figure 498-40. Example of Wire Size for Equipment Grounding Conductor – PTSWF without Pedestrian Indications

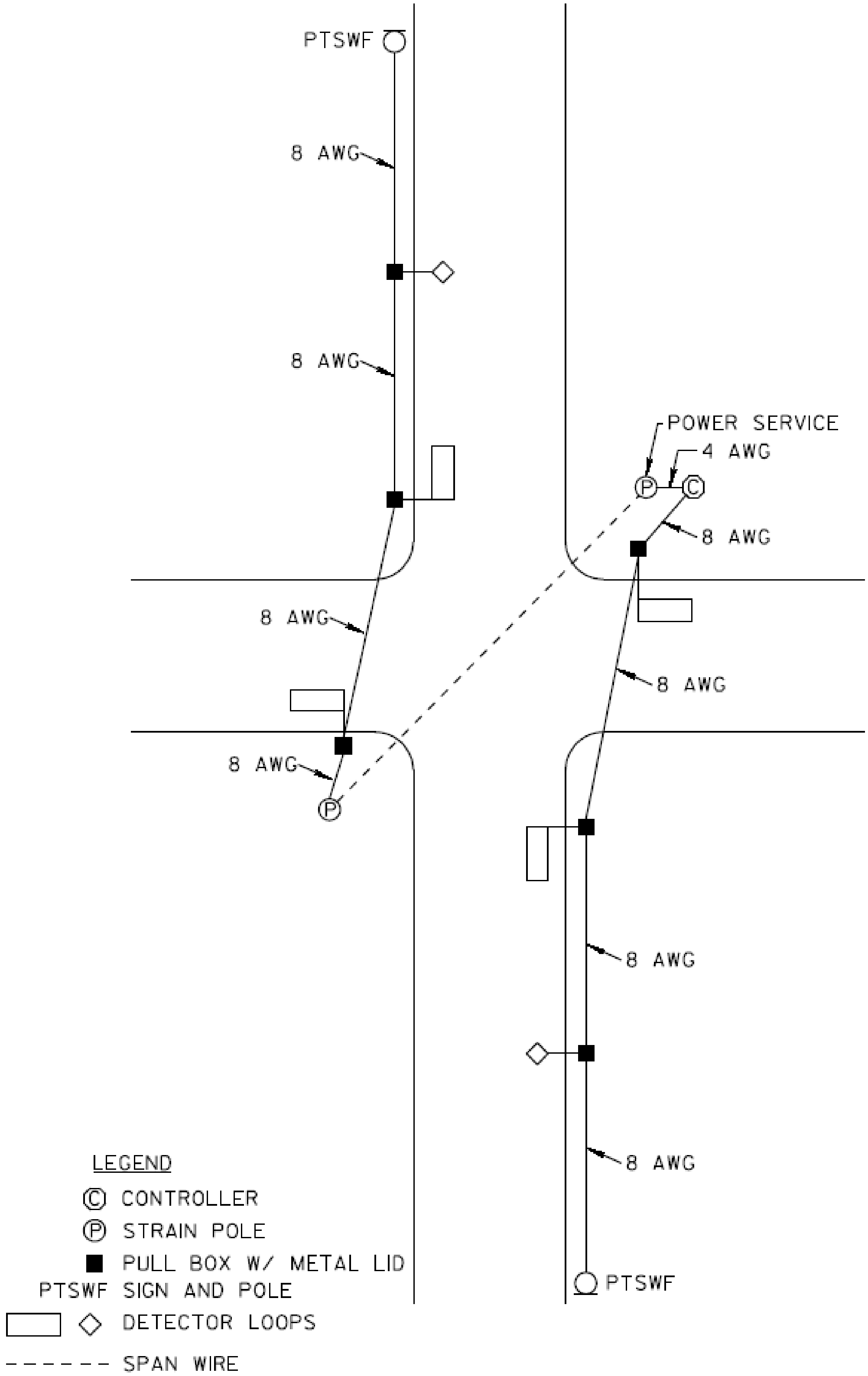


Figure 498-41. Example of Wire Size for Equipment Grounding Conductor – Mast Arms

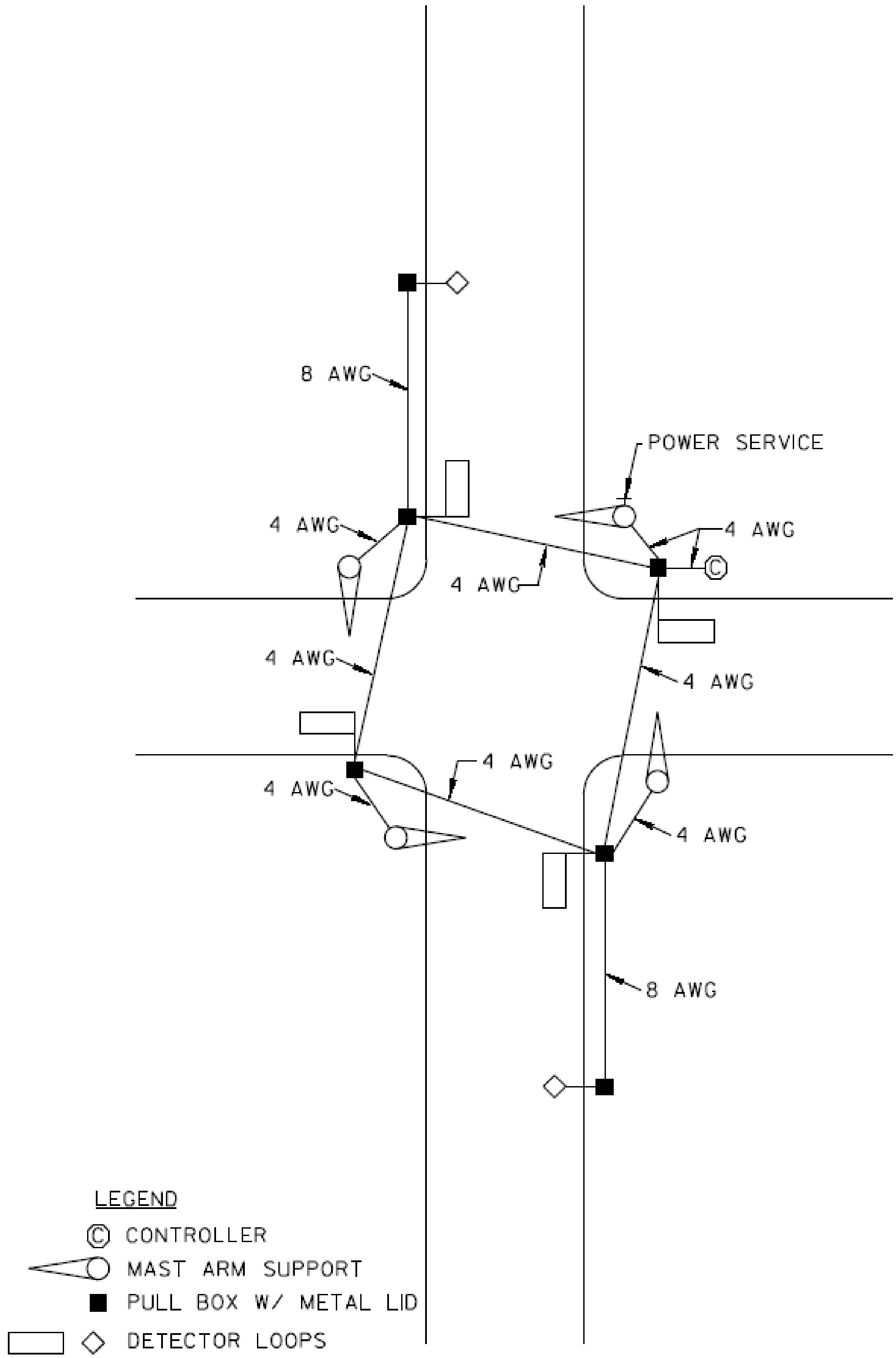


Figure 498-42. Example of Wire Size for Equipment Grounding Conductor – Span Wire

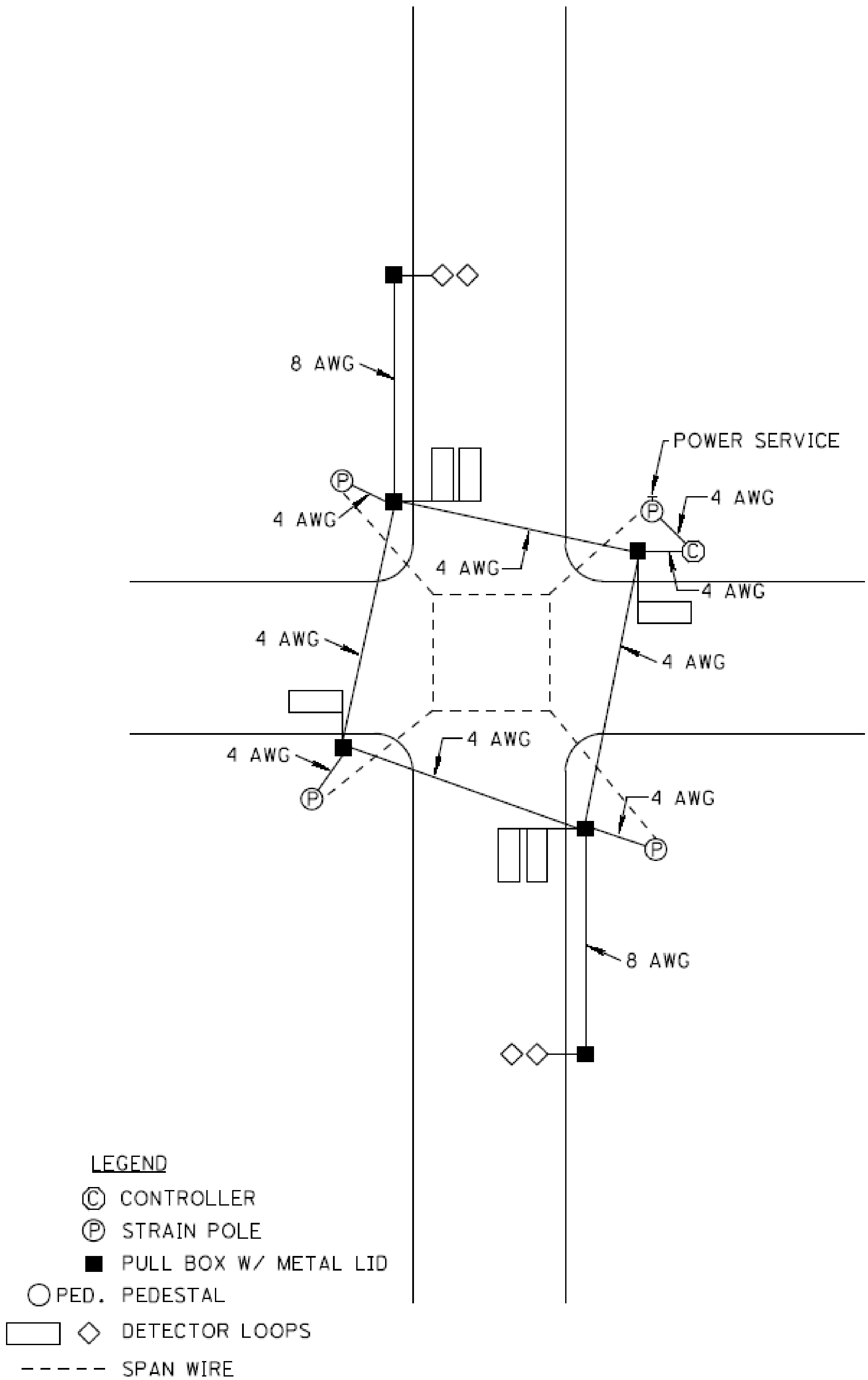
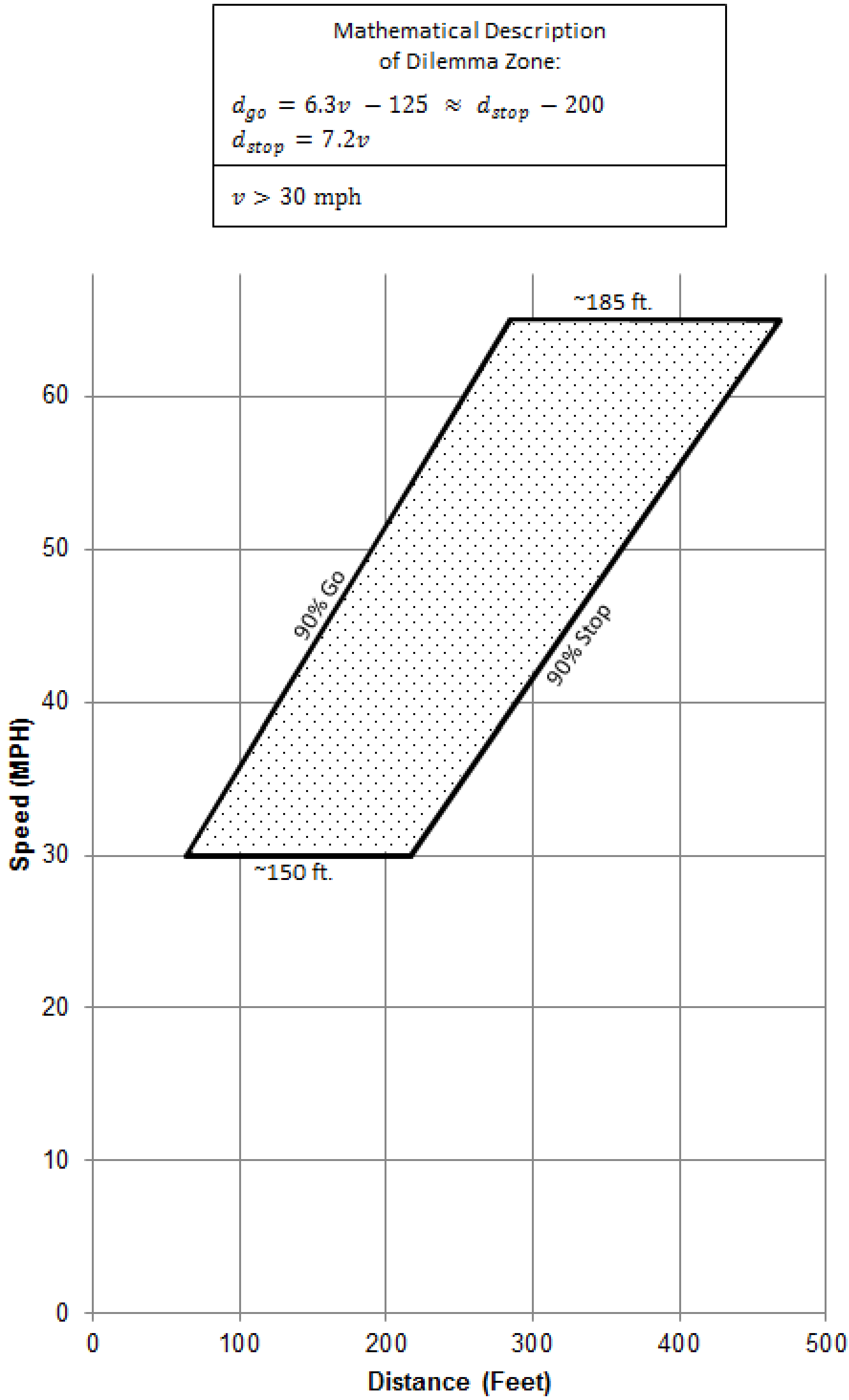
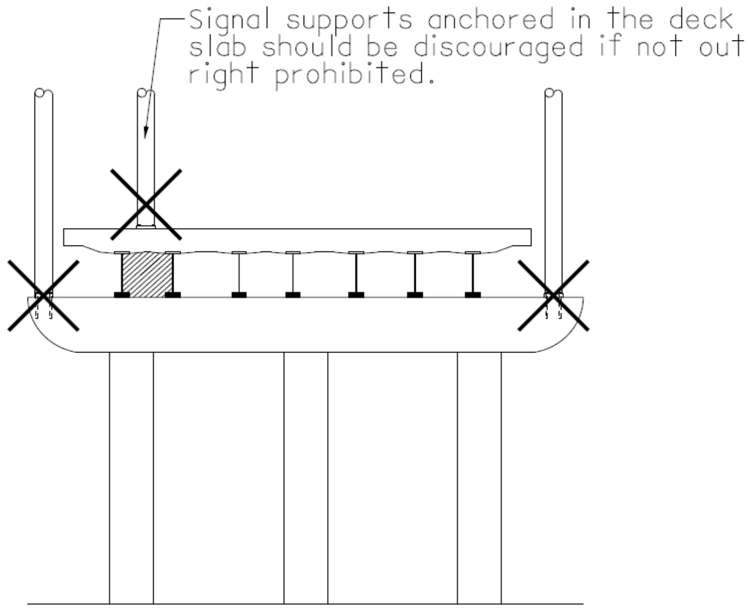


Figure 498-43. Dilemma Zone Graph

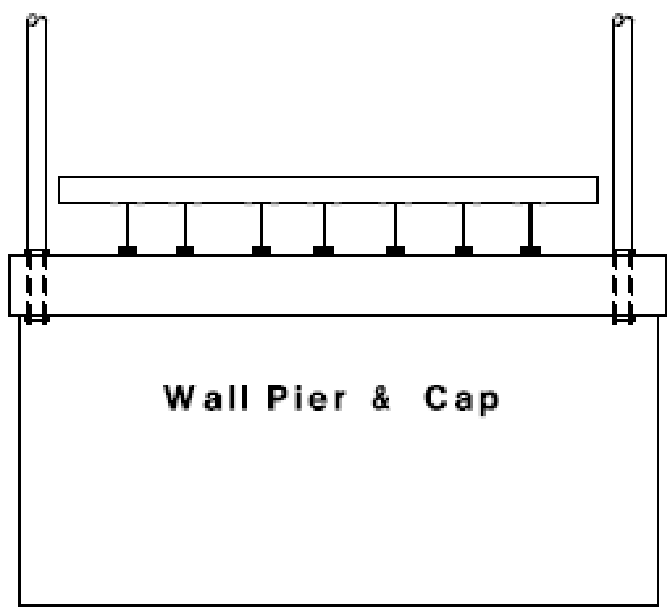


(Source: Adapted from Missouri DOT)

Figure 498-44. Span Support Guidelines (Sheet 1 of 2)

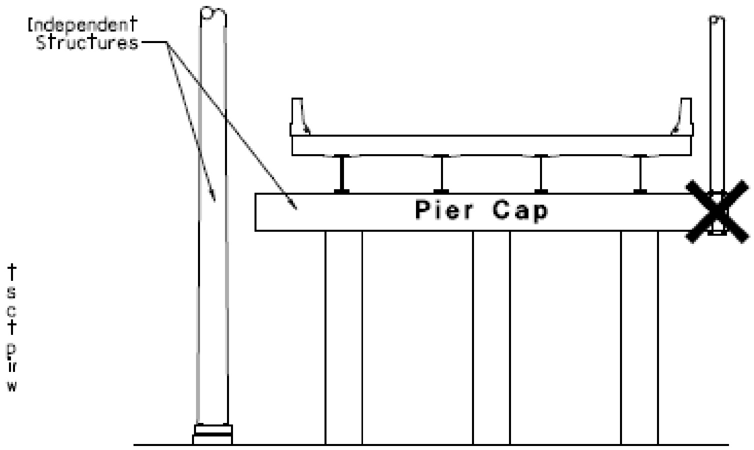


Cap and Column Pier with Cantilever Extension

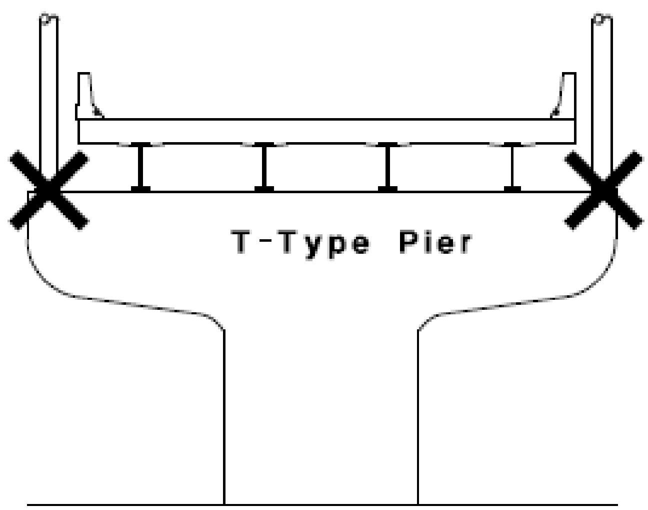


Preferred; however, there may be issues with conduits, structure grounding, design loads (AASHTO), independent supports and interence with drainage.

Figure 498-44. Span Support Guidelines (Sheet 2 of 2)



An independent structure is permitted. However, this may put the signal support centered in the median and where it might interfere with drainage.



Signal supports shall not be anchored into T-Type pier overhangs.

Figure 498-45. Example of a Wiring Diagram

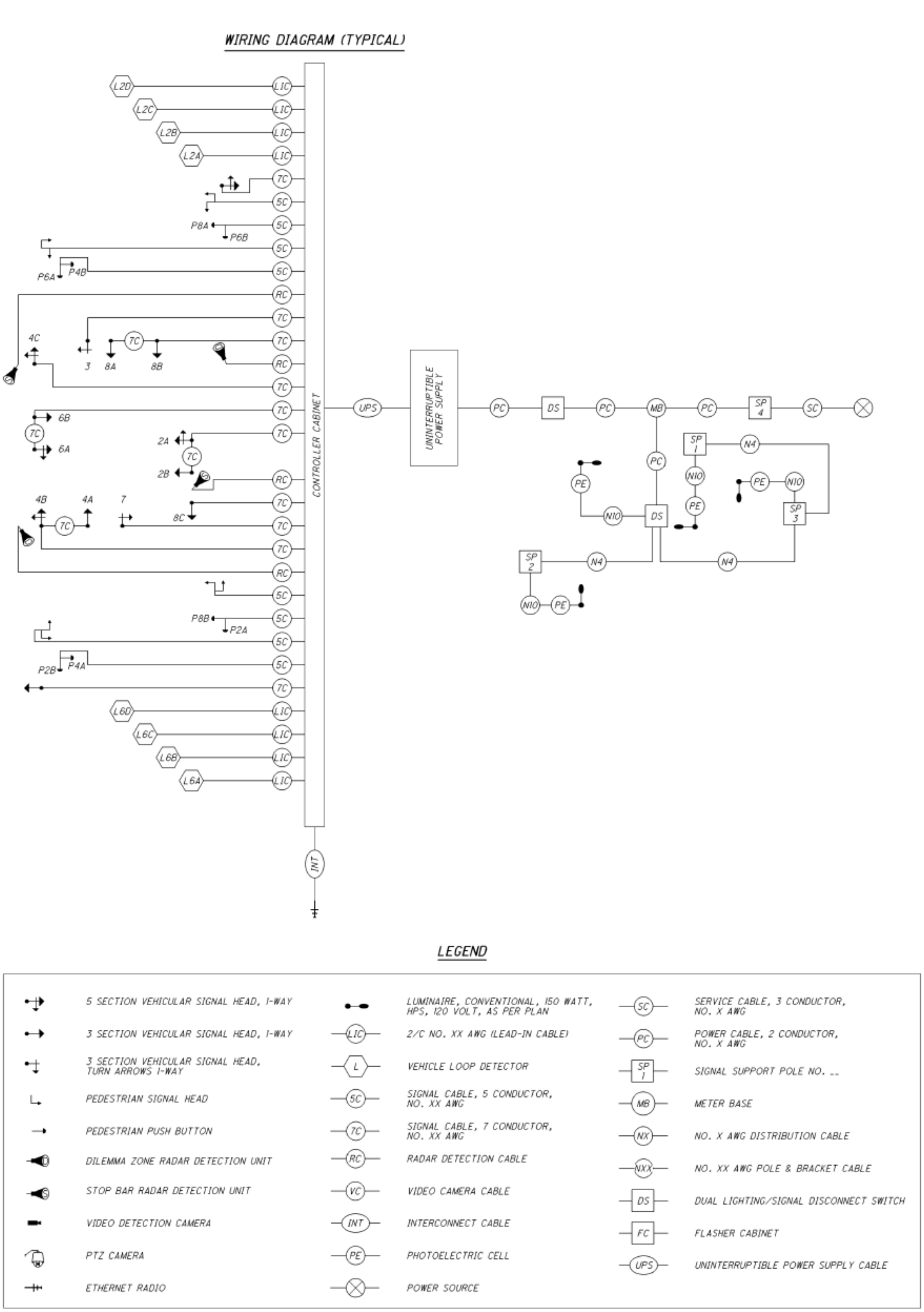
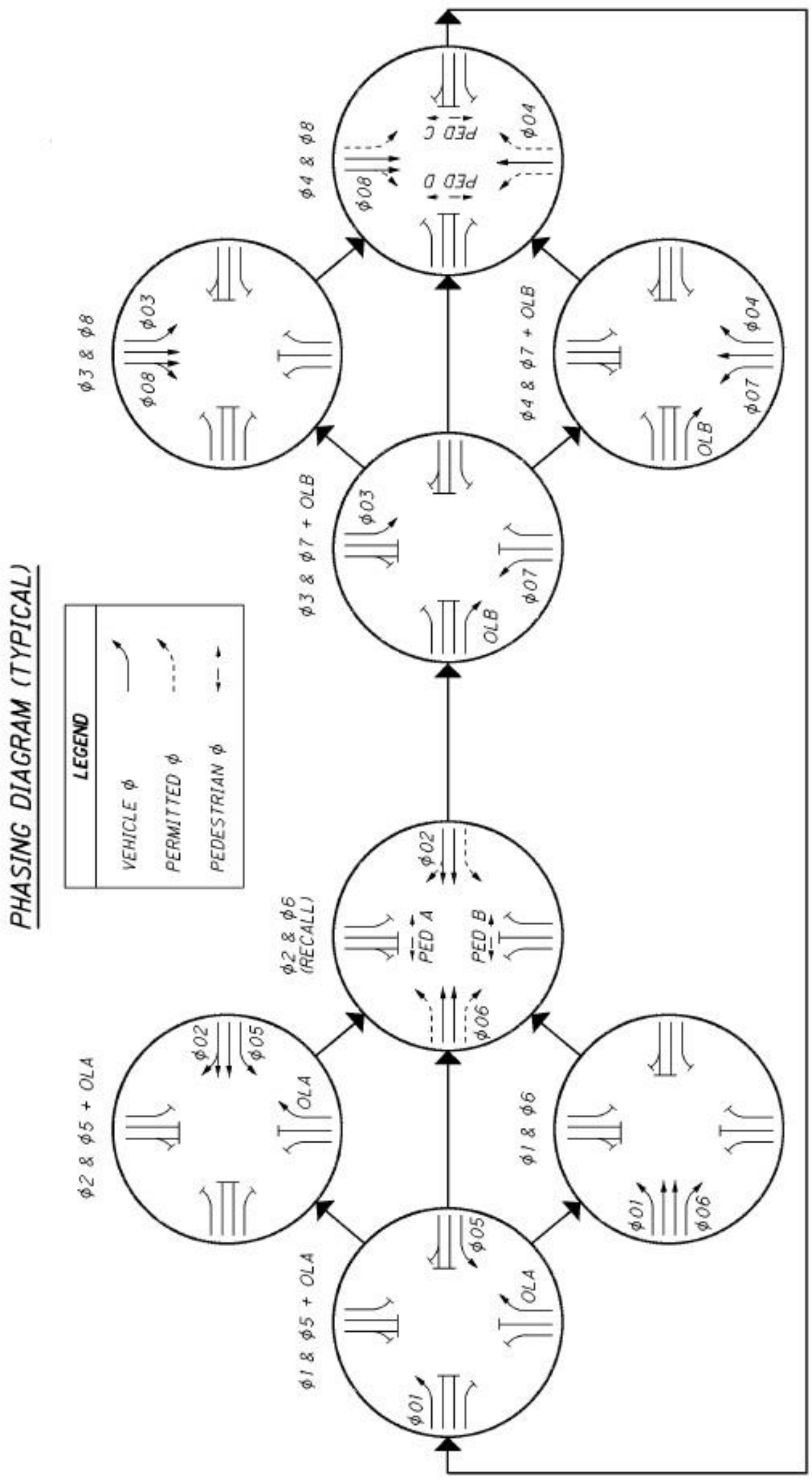


Figure 498-46. Example of a Phasing Diagram



Intentionally blank.

TABLE OF CONTENTS
Part 5 - LOW-VOLUME ROADS

Intentionally blank.

Part 5 - LOW-VOLUME ROADS

500 GENERAL

OMUTCD Part 5 is titled “Traffic Control for Low-Volume Roads,” and is intended to specifically supplement and reference the criteria for traffic control devices commonly used on low-volume roads. A low-volume road is defined as:

A low-volume road shall be a facility lying outside of built-up areas of Cities, towns, and communities, and it shall have a traffic volume of less than 400 AADT.

A low-volume road shall not be a freeway, expressway, interchange ramp, freeway service road, or a road on a designated State highway system. In terms of highway classification, it shall be a variation of a conventional road or a special purpose road as defined in **OMUTCD Section 1A.13**.

A low-volume road shall be classified as either paved or unpaved.

The **OMUTCD** standards apply as appropriate to all public highways and **OMUTCD Part 5** is available for reference in situations that may arise where engineering judgment indicates that some modification of the existing standard may be appropriate. ***TEM Part 5*** has been reserved to address, as needed, additional information on the subject. However, roads under **ODOT's** jurisdiction should not fall into this category since, by definition, low-volume roads cannot be on a designated State highway system.

595 REFERENCE RESOURCES

Various reference resources that may be useful have been noted in ***Sections 193 and 194***.

Intentionally blank.

TABLE OF CONTENTS

Part 6 - TEMPORARY TRAFFIC CONTROL

Intentionally blank

Part 6 - TEMPORARY TRAFFIC CONTROL

600 GENERAL

600-1 Introduction

The information provided in this Part of the **TEM** is intended to supplement **OMUTCD Part 6** by presenting **ODOT** policies, standards, guidelines, practices and procedures concerning the design and application of various types of temporary traffic control. Examples of situations which require temporary traffic control include highway construction and maintenance work, utility work, special events (e.g., tournaments and festivals) and incidents (e.g., traffic accidents and chemical spills).

In addition to typical methods for maintaining traffic through temporary traffic control zones, this Part also provides suggestions for when detours may be used and guidelines for the preparation of plans.

This Part does not address every conceivable temporary traffic control condition. Each situation is unique; therefore, the temporary traffic control used should take into consideration the individual characteristics of the particular situation.

One function of this Part of the **TEM** is to serve as a guide for the designer in developing strategies to maintain traffic during construction activity, and in preparing a set of maintenance of traffic plans for incorporation into a set of highway construction plans. ***Tables 697-1a through 697-1f*** present a review of the pros and cons of various temporary traffic control options.

Information on policies, guidelines and standards related to temporary traffic control devices and their use are located in the early Chapters of this Part. For example, ***Chapter 602*** addresses the various elements of a temporary traffic control zone, ***Chapter 604*** addresses flagger control, ***Chapter 605*** discusses the individual devices, and typical applications are addressed in ***Chapter 607***. Information specifically related to design, construction and maintenance functions is located in the later Chapters ***(Chapters 640 through 660)***.

600-2 Construction Projects

Chapter 150 addresses the general application of **ODOT** standards, specifications and **Standard Construction Drawings (SCDs)** to construction projects, while **TEM Part 6** provides additional detail information.

Coordination with other projects is necessary in order to minimize the inconvenience to road users ***(see Section 640-17)***. This may require communication among several government jurisdictions, various offices within **ODOT** and several contractors.

Projects should be scheduled to avoid routing a detour ***(Section 602-6)*** through another construction site. See ***Section 640-16*** for information regarding work on detours and alternate routes. ***Sections 640-17 and 640-18.2.5*** address signing for adjacent projects.

600-3 Force Account (ODOT Operations) Work

Districts performing force account work must comply with the requirements in the **OMUTCD** and this Manual. It is recommended that the **Districts** also follow the provisions in applicable **SCDs** and **Construction and Materials Specifications (C&MS)** sections. However, it should be recognized that information in the **SCDs** and **C&MS** does not necessarily provide the only method to achieve a given objective.

600-4 Public Communication

Communicating the details of highway improvement projects is desirable and necessary. The traveling public, businesses, schools and communities are all impacted by a construction project. In general, road users find it difficult to accept the disruption of travel caused by work activities; therefore, maintaining good public relations is very important, especially on major projects.

Public meetings, news releases and media alerts, among other communication tools, should be used to communicate to the public and to maintain good public relations. Involvement of the news media and local authorities in publicizing the existence of, and the reasons for, work activities can be of great assistance in keeping the public well informed.

600-5 High vs. Low-Volume Highways

Part 5 addresses traffic controls for the category of roads known as Low-Volume Roads (LVR). Generally, **ODOT**-maintained highways do not fall within the LVR category defined in ***Part 5***.

However, traffic volume is a useful criteria when addressing levels of traffic control appropriate in various situations. Therefore, the terms “low-volume” and “high-volume” are often used. For purposes of this **TEM** Part, unless defined otherwise for a specific situation, “high-volume” describes a highway with an ADT greater than 4,000, and a “low-volume” (or “lower-volume”) street or highway has an ADT of 4,000 or less.

600-6 Incident Management Areas

OMUTCD Chapter 6I and ***Chapter 608*** specifically address additional information about control of traffic through traffic incident management areas.

601 FUNDAMENTAL PRINCIPLES

601-1 General

The control of road users through a temporary traffic control zone is an essential part of highway construction, utility work, maintenance operations and incident management. However, the safety of those road users and workers in temporary traffic control zones shall also be an integral and high-priority element of every project from planning through design and construction. Maintenance and utility work should also be planned and conducted with the safety of drivers, bicyclists, pedestrians and workers considered at all times.

The objective of temporary traffic control in general is to provide for the safe and expeditious movement of traffic through work zones and incident areas by doing the following:

1. Alerting the road user;
2. Telling the road user what to do;
3. Guiding the road user through or around the site; and
4. Protecting the worker.

OMUTCD Section 6B.01 outlines various principles and procedures that experience has shown tend to enhance the safety of road users and workers in work zones and incident areas.

601-2 Work Zones on ODOT-Maintained Highways

As much as safely possible, methods for traffic control should produce the least possible effect on traffic operations by minimizing the frequency or time of hindrance to normal traffic flow.

In an attempt to minimize delay and increase safety for all road users, **ODOT** developed **Policy 21-008(P)** and **Standard Procedure 123-001(SP) for Traffic Management in Work Zones**. These documents establish standards for acceptable traffic queuing. Predicted queue lengths resulting from decreased capacity of the highway at a work site on all ODOT-maintained highways shall not exceed the standards set by this policy.

On the basis of this policy, the Permitted Lane Closure Schedule (PLCS) was established for each **District**. This information has been consolidated into a statewide system of schedules available from the **ODOT** website. There is also a link to this site from **ORE's Traffic Control** website. The scheduling information shall be reviewed periodically by the **Districts** and updated as needed. Use of the PLCS in the design process is described in ***Section 630-4***.

601-3 District Work Zone Traffic Manager (DWZTM)

The DWZTM is appointed by the District Deputy Director and is responsible for the implementation of **Policy 21-008(P)** and **Standard Procedure 123-001(SP), Traffic Management in Work Zones**. This person should possess a strong working knowledge of highway capacity theory, maintenance of traffic (MOT) strategies and performance, ODOT manuals, standards and practices, and traffic flow modeling tools. Field experience on multi-lane construction projects is highly desirable. The DWZTM is responsible for:

Project Planning and Plan Review
Using the Office of Roadway Engineering (ORE) Lane Closure Queue Analysis Tool, analyze all lane closures on interstates and other freeways proposed to be implemented outside the times allowed by the Permitted Lane Closure Schedule (PLCS). For queues that are predicted to exceed the Allowable Threshold, submit an Exception Request to the Maintenance of Traffic Exception Committee (MOTEC) or Project Impact Advisory Council (PIAC). See Standard Procedure 123-001(SP) for more details on the Allowable Threshold.

Ensure the Traffic Management Plans (TMPs) developed by consultants or internal project managers follow the policy and procedures for traffic management in work zones and meet the specific requirements set forth in the Ohio Manual of Uniform Traffic Control (OMUTCD), Traffic Engineering Manual (TEM), ODOT Standard Construction Drawings (SCD), Construction and Material Specifications (CMS), and other relevant guidelines or provisions.

For any project approved by a Maintenance of Traffic Exception Request, the DWZTM shall submit one copy of the TMPs to the ORE during detail design.

Update the PLCS annually and revise as needed to reflect current conditions.

Provide input during the development of the District Work Plan, development of Project Initiation Packages and to avoid or minimize construction projects on alternate routes.

Ensure that permit requests and plans submitted by local agencies for work on Interstates and other freeways complies with the Traffic Management in Work Zones Policy.

Review alternate MOT plans associated with Value Engineering Change Proposals (VECP) submitted by the contractor. The alternate plan shall be processed for approval in accordance with the requirements for contract and design-build projects. Work cannot begin until the alternate plan is approved by the District and/or Central Office.

Work Zone Review

Monitor the effectiveness of all aspects of work zones and paying close attention to ones with potential for adversely impacting the safe and efficient flow of traffic on interstates and other freeways.

Monitor work zone queues and compare against the predicted queues generated by the Lane Closure Queue Analysis Tool. If the work zone phase has been in place for longer than one week and is generating queues in excess of the predicted queue lengths, the DWZTM shall inform the ORE of the situation and of proposed corrective action. The cause for the discrepancy between the predicted queues and the actual queues will be investigated by the ORE in conjunction with the DWZTM.

Ensure that permit work by local agencies on state routes complies with Traffic Management in Work Zones Policy and this Standard Procedure.

Ensure that work zones are implemented in accordance with the approved TMPs as well as ODOT standards, policies and the OMUTCD and are implemented properly throughout the life of the construction project.

Communication

Maintain communication with the DWZTMs in adjoining districts and advise them of potential work zone impacts that may affect the adjacent district.

Coordinate work zone information, such as but not limited to lane and ramp closures, with the District Public Information Officer (PIO) to provide necessary work zone information.

Attend statewide DWZTM meetings to collaborate with other districts, foster statewide consistency and provide input to help guide MOT standards and guidelines.

Training

Provide guidance to the District personnel, County Managers and consultants in the use of the PLCS.

Provide training as needed for the Highway Technician Training series for the District.

602 TEMPORARY TRAFFIC CONTROL ELEMENTS

602-1 General

This Chapter addresses various basic elements of temporary traffic control, e.g., Temporary Traffic Control Plans (also known as Maintenance of Traffic Plans), definitions of the components of a traffic control zone, tapers and one-lane, two-way traffic control.

602-2 Temporary Traffic Control Plans

A Temporary Traffic Control (or Maintenance of Traffic) Plan describes temporary traffic control measures to be used for facilitating the road users through a work zone. These plans play a vital role in providing a continuity of safe and efficient traffic flow when a work zone, incident or other event, temporarily disrupts the normal flow of traffic. See ***Section 640-1*** for further information.

Depending on what's needed, these plans may range in scope from very detailed to simply a reference to a manual figure, a typical drawing or a sketch in the contract document.

602-3 Temporary Traffic Control Zones

As noted in **OMUTCD** **Section 1A-13**, a temporary traffic control zone is "an area of a highway where road user conditions are changed because of a work zone or incident by the use of temporary traffic control devices, flaggers, uniformed law enforcement officers or other authorized personnel."

A work zone is an area of a highway with construction, maintenance or utility work activities. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It extends from the first Warning Sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last temporary traffic control device.

A traffic incident management area is an area of a highway where temporary traffic controls are imposed by authorized officials in response to an emergency road user occurrence, a natural disaster, hazardous material spill, or other unplanned incident.

602-4 Components of Temporary Traffic Control Zones

602-4.1 General

The temporary traffic control zone established for a particular work activity or incident begins with the first advance warning device and ends at the point beyond the work area where traffic is no longer affected. As noted in **OMUTCD** **Section 6C.03**, most zones include the following elements: advance warning area, transition area, activity area and termination area. These four areas are described in **OMUTCD** **Sections 6C.04 through 6C.07 and Figure 6C-1**. Some of this information is repeated here in ***Sections 602-4.2 through 602-4.5, and Figure 698-1***.

602-4.2 Advance Warning Area

An advance warning area is the section of highway where road users are informed about the upcoming work zone or incident area. The advance warning area may vary from a single sign or flashing amber light on a vehicle to a series of signs starting a mile or more in advance of the transition area.

The advance warning area should be long enough to give road users adequate time to respond to conditions. For most situations, the length of the advance warning area should be:

1. One-half to 1 mile for freeways or expressways.
2. One-quarter mile for rural highways.
3. At least one block for urban streets.

Advance warning may be eliminated when the activity area is sufficiently removed from the road users' path so that it does not interfere with the normal flow.

602-4.3 Transition Area

When a lane or shoulder closure is used, or when traffic is shifted, a transition area shall be used to channel traffic from the normal travel lanes into the path required to move around the work area. The transition area should be obvious to road users, with the correct path clearly marked.

Transition areas usually involve strategic use of tapers ***(see Section 602-5)***, which because of their importance are discussed separately.

In mobile operations, the transition area moves with the work space.

602-4.4 Activity Area

602-4.4.1 General

The activity area is the section of the highway where the work activity takes place. It is comprised of the work space, the traffic space and the buffer space.

When work occurs on a high-volume, highly congested facility, an incident management vehicle storage space may be provided so that emergency vehicles (for example, tow trucks) can respond quickly to road user incidents. If used, this storage area should not extend into any portion of the buffer space.

602-4.4.2 Work Space

The work space is that portion of the highway closed and set aside for workers, equipment and material, and a shadow vehicle if one is used upstream. They are usually delineated for road users by channelizing devices or, to exclude vehicles and pedestrians, by temporary barriers.

Work spaces may remain in fixed locations or may move as work progresses.

There may be several work spaces within the project limits (even separated by several miles); however, each work space should be adequately signed to inform road users and reduce confusion.

602-4.4.3 Traffic Space

The traffic space is that portion of the highway in which road users are routed through the activity area.

602-4.4.4 Buffer Space

As shown in **OMUTCD** **Figures 6C-1 and 6C-2** and ***Figure 698-1***, the buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle. The activity area may contain one or more lateral or longitudinal buffer spaces.

The buffer space should be free of work activity, equipment, material, work or shadow vehicles, workers, and the workers' personal vehicles.

A longitudinal buffer space may be placed in advance of a work space. It may also be used to separate opposing road user flows that use portions of the same traffic lane, as shown in **OMUTCD Figure 6C-2**.

Typically, the buffer space is formed as a traffic island and defined by channelizing devices. When a formidable device, such as a shadow vehicle or an arrow board, is placed in such an island, only the area in front of (upstream of) the device functions as a buffer.

A longer buffer space should be used when high-speed highways or high truck volumes are involved, or when the work area is located around a curve, over a hillcrest or on a downgrade.

The lateral buffer space may be used to separate the traffic space from the work space, or from such areas as excavations or pavement-edge drop-offs. A lateral buffer space also may be used between two travel lanes, especially those carrying opposing flows. The width of a lateral buffer space should be determined by engineering judgment.

602-4.5 Termination Area

The termination area shall be used to return road users to their normal path. The termination area shall extend from the downstream end of the work space to the END ROAD WORK signs, if posted.

602-5 Tapers

602-5.1 General

Tapers are an important element of a temporary traffic control zone. They may be used in both the transition and termination areas. As noted in **OMUTCD Section 6C.08**, whenever tapers are to be used in close proximity to interchange ramps, crossroads, curves, or other influencing factors, it may be desirable to adjust the length of the tapers.

Tapers are created by using a series of channelizing devices and/or pavement markings placed to move the traffic out of or back to its normal path. Types of tapers are shown in **OMUTCD Figure 6C-2**.

The criteria for determining taper length (L) is shown in **OMUTCD Table 6C-3** and should be the minimum used. The minimum desirable taper lengths apply to roadway conditions of relatively flat grades and straight alignment. Longer tapers are not necessarily better than shorter tapers (particularly in urban areas characterized by short block lengths, driveways, etc.). Extended tapers tend to encourage sluggish operation and to encourage drivers to delay lane changes unnecessarily. The real test of taper length involves observation of driver performance after traffic control plans are put into effect.

The maximum space between devices in a taper should approximate the distance in feet of the speed in miles per hour (i.e., a 55 miles per hour road should normally have devices spaced about 55 feet apart). It is desirable to provide spacing which is less than the maximum allowable. The spacing is shown in **Traffic SCDs MT-95.30, 95.31 and 95.32**.

602-5.2 Merging Taper

A merging taper requires the longest distances because drivers are required to merge with an adjacent lane of traffic at the prevailing speed. The taper should be long enough to enable merging drivers to adjust their speeds and merge into a single lane before the end of the transition. An example of a merging taper is shown in **OMUTCD Figure 6C-2**.

602-5.3 Shifting Taper

A shifting taper is used when merging is not required, but a lateral shift is needed. The length L should be used for shift taper lengths when the speed is 50 miles per hour or greater. The length one-half L may be used for shift tapers when the speed is less than 50 miles per hour, except on freeways, expressways, and multi-lane divided or undivided highways, where L should be used for all shift tapers, regardless of speed. Where more space is available, it may be beneficial to use longer taper lengths. Guidance for changes in alignment may also be accomplished by using horizontal curves designed for normal highway speeds. An example of a shifting taper is shown in **OMUTCD Figure 6C-2**.

602-5.4 Shoulder Taper

A shoulder taper may be beneficial on high-speed roadways with improved shoulders that may be mistaken for driving lanes (when work is occurring in the shoulder area). If used, shoulder tapers approaching the activity area should have a length of about one-third L. If a shoulder is used as a travel lane either through practice or during a temporary traffic activity, a normal merging or shifting taper should be used. An example of a shoulder taper is presented in **OMUTCD Figure 6C-2**.

602-5.5 Downstream (Ending) Taper

The downstream (ending) taper may be useful in termination areas to provide a visual cue to the driver that access is available to the original lane or path that was closed. When used, a downstream taper should have a minimum length of 50 feet and a maximum length of 100 feet, with devices spaced about 20 feet apart. An example of a downstream taper is shown in **OMUTCD Figure 6C-2**.

602-5.6 One-Lane, Two-Way Taper

The one-lane, two-way traffic taper is used in advance of an activity area that occupies part of a two-way roadway in such a way that a portion of the road is used alternately by traffic in each direction. Traffic should be controlled by a flagger or a temporary traffic signal (if sight distance is limited), or a STOP or YIELD sign. A short taper having a maximum length of 100 feet, with channelizing devices at approximately 20-foot) spacings, should be used to guide traffic into the one-way section. **OMUTCD Figures 6C-3, 6H-10 and 6H-46** illustrate one-lane, two-way traffic control situations using flaggers.

602-5.7 Lane Width Transition

Often it is necessary to decrease the lane width in a work zone. The length of the lane width transition is calculated using the same criteria used in calculating a shifting taper ***(see Section 602-5.3)***.

602-5.8 Multiple Tapers

Occasionally it is necessary to close more than a single lane of pavement in order to perform the necessary work on the highway. This may be accomplished by closing or shifting multiple travel lanes, or by a combination of both. Any of these conditions creates a need for more than a single taper. Multiple tapers shall be separated by tangent sections. For example, if the number of open lanes in one direction of a multi-lane highway is to be reduced by two, then it will be necessary to provide two merge tapers, separated by a tangent section of length 2L as shown in **OMUTCD Figure 6H-37** (where L is the minimum permitted taper length of the associated tapers as indicated in **OMUTCD Table 6C-3**). If there is a reduction of one lane and a shift of the remaining open lanes, then one merge taper and one shift taper shall be provided. The merge taper and the shift taper shall be separated by a tangent section of length one-half L as shown in **OMUTCD Figure 6H-32**.

602-6 Detours, Alternate Routes and Diversions

A detour is a temporary rerouting of road users onto an existing highway in order to prohibit through traffic within the work zone. As noted in **OMUTCD Section 6G.10,** detours should be clearly signed over their entire length so that road users can easily use existing highways to return to the original highway. Normally, detours on the state highway system are provided by the **District**. See **OMUTCD Section 6F.50** for related signing, as well as ***Sections 605-7 and 605-8***. **OMUTCD Figures 6H-8, 6H-9, 6H-19 and 6H-20** provide examples of detours.

An alternate route is similar to a detour except that the work zone remains open to through traffic. The road user is able to choose between following the route through the work zone, or following the signed alternate route.

A diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work space, e.g., median crossovers, runarounds or lane shifts. **OMUTCD Figure 6H-7** is an example of a diversion.

Consideration should be given to other projects in the area, traffic patterns, traffic volumes, types of vehicles, local activities and special events when planning detour installations or diversions. This would require that adequate attention be given to proper scheduling of projects in order to avoid simultaneous construction or maintenance activity on parallel highways. Proper scheduling may require coordination between **Districts** or even within various offices in a single **District** ***(see Section 640.16)***.

Two **Standard Operating Procedures (SOPs)** maintained by the **Office of Maintenance Administration** (on their intranet Reference Materials webpage) should be consulted when detours are required:

1. **OPS-103, Detours** is to be used to determine whether work on an existing highway, be it by contract or by **ODOT** force account, will require the closing of the highway with provision for detours, temporary roads and temporary runarounds, or whether traffic will be maintained through all or portions of the construction project, and to establish reporting procedures.

2. **OPS-104, Maintenance & Repair of Local Roads and Streets Used as: Official Detours, Designated Local Detour Routes, or Haul Roads**, establishes the method for designating a local detour. A local detour is a route, other than the official detour, that is anticipated to be most used by traffic bypassing the closed portion of the highway. Only one local detour shall be designated for each official detour. These documents also discuss the need to coordinate with the local officials and financing procedures.

602-7 One-Lane, Two-Way Traffic Control

602-7.1 General

As noted in **OMUTCD Section 6C.10**, where traffic in both directions must, for a limited distance, use a single lane, “provision should be made for alternate one-way movement through the constricted section.” Some means of coordinating movements at each end shall be used to avoid head-on conflicts and to minimize delays. Control points at each end should be chosen to permit easy passing of opposing lines of vehicles. At a "spot" obstruction, however, such as an isolated pavement patch on roadways with lower speeds and adequate sight distance, the movement may be self-regulating. Alternate one-way traffic control may be accomplished as appropriate by flagger control **(OMUTCD Section 6C.11)**, a flag-carrying or official car **(OMUTCD Section 6C.12)**, a pilot car **(OMUTCD Section 6C.13)**, traffic signals **(OMUTCD Section 6C.14)**, or by using stop or yield control. This Section provides additional information regarding flagger control, the use of traffic signal and the use of STOP or YIELD signs (see **OMUTCD Section 6E.01** for flagger qualifications).

602-7.2 Flagger Method

This method of one-lane, two-way traffic control is described in general in **OMUTCD 6C.11**.

When a single flagger is used, the flagger should be stationed on the shoulder opposite the obstruction or work space, or in a position where good visibility and traffic control can be maintained at all times. When good visibility and traffic control cannot be maintained by one flagger station, traffic may be controlled by a flagger at each end of the section. One of the flaggers should be designated as the coordinator. Flaggers should be able to communicate with each other orally, electronically, or with manual signals. These manual signals should not be mistaken for flagging signals. The use of radios may also be desirable even though visual contact is possible.

602-7.3 Temporary Traffic Signal Method

As noted, traffic signals may be used to control vehicular traffic movements in temporary traffic control zones. They should be considered for half-width bridge reconstruction on low- to moderate-volume highways. When used, traffic signals shall be installed at each approach to the one-lane section, and drivers shall be apprised of their presence by means of the Signal Ahead sign preceded by appropriate Construction Warning Signs **(see OMUTCD Figure 6H-12)**.

602-7.4 Stop or Yield Control Method

STOP or YIELD signs may be used to control traffic on low-volume roads at a one-lane, two-way work zone when drivers are able to see the other end of the one-lane, two-way operation and have sufficient visibility of approaching vehicles. If the STOP or YIELD sign is installed for only one direction, then the STOP or YIELD sign should face road users who are driving on the side of the roadway that is closed for the work activity area. The approach to the side that is not closed must be visible (for a distance equal to the safe-passing sight distance for that approach) to the driver who must yield or stop **(see OMUTCD Figure 6H-11)**.

602-8 Work Vehicles

The general term “work vehicle” refers to any of the vehicles used in performance of the work (i.e., those used to do the work, haul material, equipment or workers and to provide traffic control). The term is also used to refer specifically to one of the two types of vehicles generally used in temporary traffic control, i.e., “work vehicles” and “shadow vehicles.”

When differentiating between the types of vehicles in the zone, “work vehicle” refers to those vehicles used to do the work or haul material, equipment, or workers.

A “shadow vehicle” is used for traffic control. It may be used within the traffic control zone to provide advance warning for traffic, or to guide traffic into the proper lane by the use of signs or a flashing arrow board. The shadow truck should be positioned a sufficient distance in advance of the workers or equipment being protected so that there will be sufficient distance, but not so much so that errant vehicles will travel around the shadow truck and strike the protected workers and/or equipment.

During working hours, the shadow vehicle shall display a yellow high-intensity rotating, flashing, oscillating, or strobe light. For additional protection, the shadow vehicle may be equipped with a truck-mounted attenuator (TMA) ***(see Section 605-15.3)***.

A shadow vehicle may also be placed, unoccupied, within the traffic control zone immediately in advance of the work space in a stationary operation. When a shadow vehicle is used in this way, a separate space should be provided for it. This space should be long enough to accommodate the vehicle itself, plus an open space in front of the vehicle to provide for the "roll ahead" which may occur following impact. This area is usually delineated by channelizing devices.

CMS 614.03 contains information about delineation requirements for work vehicles (also see **Supplemental Specification 800**). Also, the document described in ***Section 695-4***, **Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles,** provides illustrations of acceptable delineation for supply vehicles.

Intentionally blank.

603 PEDESTRIAN AND WORKER SAFETY

603-1 General

In addition to creating vehicular restrictions, work zones and incident areas may also cause conflicts for pedestrian traffic and workers. Pedestrians and workers are exposed to hazardous conditions from both the work activity and the traffic. This Chapter addresses the need to provide for pedestrian and worker safety in temporary traffic control zones. Also see **OMUTCD Chapter 6D**.

603-2 Pedestrian Considerations

Where pedestrian traffic is present, pedestrian safety and needs must be addressed. See **OMUTCD Sections 6D.01 and 6D.02**.

There are three threshold considerations in planning for pedestrian safety in temporary traffic control zones on highways and streets:

1. Pedestrians should not be led into conflicts with work vehicles, equipment, or operations.

2. Pedestrians should not be led into conflicts with vehicles moving through or around the work zone or incident area.

3. Pedestrians should be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks or footpaths.

In accommodating the needs of pedestrians, it should always be remembered that the range of pedestrians that can be expected is very wide, including the blind, the hearing impaired, and those with walking handicaps. All pedestrians need protection from potential injury and a smooth, clearly delineated travel path.

Therefore, every effort should be made to separate pedestrian movement from both work site activity and vehicular traffic. Whenever possible, signing should be used to direct pedestrians to safe street crossings in advance of an encounter with a temporary traffic control zone. Signs should be placed at intersections so that pedestrians, particularly in high-traffic-volume urban and suburban areas, are not confronted with mid-block activity areas that will induce them to skirt the temporary traffic control zone or make a mid-block crossing. It must be recognized that pedestrians will only infrequently retrace their steps to make a safe crossing. Consequently, ample advance notification of sidewalk closures is critically important. Refer to **OMUTCD Figures 6H-28 and 6H-29** for typical traffic control device usage and techniques for pedestrian movement through work areas. Traffic control for a pedestrian detour is also presented in **Traffic SCD MT-110.10**.

Cuts into work areas across pedestrian walkways should be kept to a minimum, because they often create unacceptable changes in grade and rough or muddy terrain. Pedestrians cannot be expected to traverse these areas willingly. They will tend to avoid the cuts by attempting non-intersection crossings.

The engineer in charge of traffic control for temporary traffic control zones should provide both a sense of security and safety for pedestrians walking past work sites and consistent, unambiguous channelization to maintain foot traffic along the desired travel paths. The activity area should be regularly inspected so that effective pedestrian temporary traffic control is maintained.

603-3 Worker Considerations

Equally as important as the safety of road users traveling through the work zone or incident area is the safety of workers **(see OMUTCD Section 6D.03)**. Temporary traffic control zones present temporary and constantly changing conditions that are unexpected by the road user. This creates an even higher degree of vulnerability for the personnel on or near the roadway.

Maintaining the temporary traffic control zones with road user flow inhibited as little as possible, and using temporary traffic control devices that get the road user's attention and provide positive direction are of particular importance.

The following are key elements of traffic control management that should be considered in any procedure for assuring worker safety:

1. Training - All workers should be trained in how to work next to vehicular traffic in a way that minimizes their vulnerability. Workers having specific temporary traffic control responsibilities should be trained in temporary traffic control techniques, device usage and placement.

2. Worker Safety Apparel - All workers exposed to the risks of moving roadway traffic or construction equipment should wear highly-visible safety apparel **(see OMUTCD Sections 6D.03 and 6E.02)**.

3. Temporary Traffic Barriers - Temporary traffic barriers should be placed along the work space depending on such factors as lateral clearance of workers from adjacent traffic, speed of traffic, duration of operations, time of day and volume of traffic.

4. Speed Reduction - Reducing the speed of vehicular traffic, mainly through regulatory speed zoning ***(see Section 640-18)***, funneling, lane reduction, or the use of law enforcement officials or flaggers should be considered.

5. Shadow Vehicle - In the case of mobile and constantly moving operations, such as pothole patching and striping operations, a shadow vehicle, equipped with appropriate lights, Warning Signs and/or a rear-mounted impact attenuator may be used to protect the workers from impacts by errant vehicles.

6. Road Closure - If alternate routes are available to handle road users, the road may be closed temporarily. This may facilitate quicker project completion and thus further reduce worker vulnerability.

7. Law Enforcement Use - In highly vulnerable work situations, particularly those of relatively short duration, law enforcement units may be stationed to heighten the awareness of passing vehicular traffic and to improve safety through the temporary traffic control zone.

8. Lighting - For nighttime work, consider lighting the temporary traffic control zone and approaches.

9. Special Devices - Judicious use of special warning and control devices may be helpful for certain difficult work area situations. These include rumble strips, changeable message signs, hazard identification beacons, flags and warning lights. Intrusion warning devices may be used to alert workers to the approach of errant vehicles. However, misuse or overuse of special devices or techniques may lessen their effectiveness.

10. Public Information - Improved driver performance may be realized through a well-prepared and complete public relations effort that covers the nature of the work, etc. ***(see Section 600-4)***.

604 FLAGGER CONTROL

604-1 General

This Chapter provides information supplementing that presented in **OMUTCD Chapter 6E** regarding the use of flaggers to provide temporary traffic control.

604-2 Qualifications for Flaggers

Because flaggers are responsible for public safety and make the greatest number of public contacts of all highway workers, they should be able to satisfactorily demonstrate the abilities described in **OMUTCD Section 6E.01**.

604-3 High-Visibility Safety Apparel

OMUTCD Section 6E.02 addresses the requirements for high-visibility safety apparel for flaggers. The same high-visibility safety apparel is recommended for law enforcement officers (LEOs) when they provide traffic control.

604-4 Hand-Signaling Devices

OMUTCD Section 6E.03 addresses the basic requirements for hand-signaling devices used to control road users through temporary traffic control zones. As noted in that Section, the STOP/SLOW sign paddle is the primary hand-signaling device.

In addition to the requirement for flag use described in **OMUTCD Section 6E.03**, flag use should be limited to emergency situations; however, they may also be appropriate at some intersections and at low-speed and/or low-volume locations which can best be controlled by a single flagger.

604-5 Automated Flagger Assistance Devices (AFADs)

604-5.1 General

Automated Flagger Assistance Devices (AFADs) enable a flagger(s) to be positioned out of the lane of traffic and are used to control road users through temporary traffic control (TTC) zones. These devices are designed to be remotely operated either by a single flagger at one end to the TTC zone or a central location or by separate flaggers near each device's location.

For requirements on AFADs, refer to **OMUTCD Section 6E.04** and **Supplemental Specifications 830** and **930**.

There are two types of AFADs:

1. An AFAD ***(Subsection 605-5.2)*** that uses a remotely controlled STOP/SLOW sign on either a trailer or a movable cart system and a gate arm or mast arm to alternately control right-of-way.
2. An AFAD ***(Subsection 605-5.3)*** that uses remotely controlled red and yellow lenses on either a trailer or a movable cart system and a gate arm to alternately control right-of-way.

AFADs should not be used for long-term stationary work. They might be appropriate under certain conditions for daytime work activities where they are set up and then removed each day or for some nighttime work activities. Typical applications include TTC activities such as, but not limited to:

1. Bridge maintenance;
2. Haul road crossings; and

3. Pavement patching.

AFADs used on **Ohio's** highways must be on **ODOT's** Approved List. Refer to **Supplement 1030** for the qualification procedure.

604-5.2 STOP/SLOW Automated Flagger Assistance Devices (AFADs)

A STOP/SLOW AFAD shall include a STOP/SLOW sign that alternately displays the STOP face and the SLOW face of a STOP/SLOW paddle without the need for a flagger in the immediate vicinity of the AFAD or on the roadway.

For information on the requirements and use of a STOP/SLOW AFAD, refer to **OMUTCD Section 6E.05** and **Supplemental Specification 930.02**.

604-5.3 Red/Yellow Lens Automated Flagger Assistance Devices (AFADs)

A Red/Yellow AFAD shall alternately display a steadily illuminated CIRCULAR RED lens and a flashing CIRCULAR YELLOW lens to control traffic without the need for a flagger in the immediate vicinity of the AFAD or on the roadway.

For information on the requirements and use of a Red/Yellow Lens AFAD, refer to **OMUTCD Section 6E.06** and **Supplemental Specification 930.03**.

604-6 Hand-Signaling Procedures

STOP/SLOW sign paddle and flag use are illustrated in **OMUTCD Figure 6E-3**. The signaling procedures used with the paddle or the flag shall be as described in **OMUTCD Section 6E.07.**

ATSSA publishes a pocket-sized **Flagger Handbook** which may be used for easy reference on flagging procedures ***(Section 695-3)***.

604-7 Flagger Stations

Except as noted below for a single flagger at a “spot” location, flagger stations shall be located far enough ahead of the work space, so that approaching traffic has sufficient distance to stop before entering the work space **(see OMUTCD Section 6E.08)**. **OMUTCD Table 6E-1**, which provides information regarding the stopping sight distance as a function of speed, may be used in determining the location of a flagger station. These distances may be increased for downgrades and other conditions that affect stopping distance.

As noted in **OMUTCD Section 6E.08**, the flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. A flagger should only stand in the lane being used by moving road users after the road users have stopped. The flagger should be clearly visible to the first approaching road user at all times. The flagger should also be visible to other road users. The flagger should be stationed sufficiently in advance of the workers to warn them (for example, with audible warning devices such as horns, whistles, etc.) of approaching danger by out-of-control vehicles. The flagger should stand alone, never permitting a group of workers to congregate around the flagger station.

At “spot” lane closures where adequate sight distance is available for the safe handling of traffic, the use of one flagger may be sufficient (**see OMUTCD Figure 6H-18** and accompanying notes). At such a "spot" obstruction, a position may have to be taken on the shoulder opposite the barricaded section to operate effectively.

Except in emergency situations, flagger stations shall be preceded by an advance Warning Sign(s). Under certain geometric and traffic situations, more than one flagger station may be required for each direction of traffic. Also, except in emergency situations, flagger stations shall be illuminated at night.

605 TEMPORARY TRAFFIC CONTROL ZONE DEVICES

605-1 General

The design and application of temporary traffic control devices used in temporary traffic control zones should consider the needs of all road users. All traffic control devices used on street and highway construction, maintenance, utility, or incident management operations shall conform to the applicable provisions of the **OMUTCD**.

OMUTCD Chapter 6F addresses the design and application of traffic control devices for use in temporary traffic control zones. Additional information on the standards and guidelines for the design and use of these devices is included in this Part of the **TEM**.

The traffic control devices discussed herein include signs, pavement markings, raised pavement markers, channelizing devices, lighting devices, beacons, warning lights, traffic signals, and other devices used to regulate, warn or guide traffic.

Chapter 607 provides additional information on the use of these devices in typical applications, ***Chapter 640*** provides additional design and plan preparation information, ***Chapter 650*** addresses construction issues, ***Chapter 660*** addresses maintenance issues, and ***Chapter 670*** addresses various other considerations.

Crashworthiness and crash testing information on temporary traffic control devices are found in **AASHTO's Roadside Design Guide (RSDG)** ***(see Section 193-4)***. Additional materials and hardware information, including NCHRP 350 information, is addressed in ***Chapter 620***.

As noted in **OMUTCD** **Section 6F.02**, where the color orange is required, fluorescent red-orange or fluorescent yellow-orange colors may also be used. The fluorescent version of orange provides higher conspicuousness than standard orange, especially during twilight.

605-2 General Characteristics of Signs

605-2.1 General

Temporary traffic control zone signs convey both general and specific messages by means of words or symbols and have the same three categories as all road user signs: regulatory, warning and guide described in **OMUTCD** **Part 2**.

Commonly used work zone signs are discussed in detail in **OMUTCD** **Chapter 6F** and in ***Sections 605-2 through 605-10***. Illustrations of temporary traffic control signs that are discussed in this Manual, but not shown in the **OMUTCD** are provided in ***Figure 698-2***.

The **OMUTCD** and this Part of the **TEM** also provide examples of common applications of these signs. **ODOT** standards for application of work zone signing on construction projects are provided in the **Traffic SCDs** and the **TEM**, and material requirements are addressed in ***Chapter 620*** and **C&MS 614**. Also see ***Part 2*** of this Manual for further signing information.

When standard orange flags or flashing warning lights are used in conjunction with signs, they shall not block the sign face.

605-2.2 Design

The colors for Regulatory Signs shall follow the standards in **OMUTCD** **Chapter 2B**. Warning Signs in temporary traffic control zones shall have a black legend on an orange background, except for the Railroad Advance Warning Sign **(OMUTCD Section 8B.04)**, and except for signs in **OMUTCD** **Chapter 2C** that are permitted to have yellow or fluorescent yellow-green backgrounds, and those in **OMUTCD Chapter 6I** permitted to have fluorescent pink backgrounds ***(also see Section 605-5.2)***. Colors for Guide Signs shall follow the standards in **OMUTCD Chapter 2D**, except for Guide Signs noted in ***Sections 605-7 and 605-8***.

As noted in **OMUTCD Section 6F.02**, existing yellow or fluorescent yellow-green Warning Signs already in place within temporary traffic control zones may remain in use when applicable. Color for other signs shall generally follow the standard for all highway signs.

605-2.3 Placement

Signs should be placed on the right side of the roadway unless otherwise specified in the **OMUTCD** or the **TEM**. On multi-lane divided highways, signs should be dual-mounted unless it is not physically possible to do so. **OMUTCD Section 6F.03 and Figure 6F-1** provide guidelines for height and lateral clearance of temporary post-mounted signs. **Traffic SCD MT-105.10** also addresses temporary sign supports. For increased visibility, a 7-foot mounting height may be used in rural areas.

As noted in **OMUTCD Section 6F.03**, signs mounted on portable supports may be placed within the roadway itself. Signs may also be mounted on or above barricades. Signs mounted on barricades and barricade/sign combinations shall be crashworthy.

Neither portable nor permanent sign supports should be located on sidewalks, bicycle lanes, or areas designated for pedestrian or bicycle traffic.

Methods of mounting signs other than on posts are illustrated in **OMUTCD Figure 6F-2**. Except as noted below for mobile operations, signs mounted on portable supports should not be used for a period of more than three days. Signs mounted on Type III barricades should not cover more than fifty percent of the top two rails or thirty-three percent of the total area of the three rails.

For information regarding signing for work zone speed zones see ***Section 640-18.2***.

For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the temporary traffic control zone or moving along with it. The work vehicle, the shadow vehicle, or the trailer may have an impact attenuator.

See ***Section 221-4*** for information about erecting signs on or near utility poles.

605-2.4 Sheeting for Temporary Traffic Control Signs and Hand-Signaling Devices

For flatsheet signs and hand-signaling devices, Type G, H or J retroreflective sheeting shall be provided for the background and for the retroreflective legends. As an exception, any hand-signaling devices in **ODOT** maintenance inventory with Type F sheeting may remain in use until they have reached the end of their service life. New Type F hand-signaling devices shall not be permitted.

605-3 Regulatory Signs

605-3.1 General

Regulatory Signs in temporary traffic control zones are addressed in **OMUTCD Chapter 6F**. ***Section 605-3*** will be used to provide additional information about Regulatory Signs discussed in the **OMUTCD** if needed. Information about Regulatory Signs used in temporary traffic control zones that are not currently addressed in the **OMUTCD** are discussed in ***Section 605-4***.

If a temporary traffic control zone requires regulatory measures different from those existing, the existing permanent regulatory devices shall be removed or covered and superseded by the appropriate temporary Regulatory Signs. **OMUTCD Sections 2B.13 and 2B.16** and ***Chapter 1203*** should be consulted before temporary traffic control zone regulatory speed limits are established.

605-3.2 ROAD CLOSED Signs (R11-2, R11-H4a)

These signs are addressed in **OMUTCD Section 6F.08**. The words BRIDGE OUT (or BRIDGE CLOSED) may be substituted for ROAD (STREET) CLOSED where applicable. Based on **ORC 4511.714,** another modification of the legend became effective for high water situations in March 2015. When the road becomes impassable due to high water conditions, the ROAD CLOSED HIGH WATER MAX FINE $2000 (R11-H4a) sign should be installed.

The signs should be erected at or near the center of the roadway on or above a Type III barricade that closes the roadway. They shall not be used where traffic is maintained, or where the actual closing is some distance beyond this sign.

OMUTCD Section 6F.09 addresses Local Traffic Only signing.

605-3.3 Weight Limit Signs (R12-1, R12-2, R12-3, R12-4, R12-H5, and R10-H20bP)

These signs are addressed in **OMUTCD Sections 2B.59 and 6F.10**. When weight restrictions are imposed, a marked detour shall be provided for vehicles weighing more than the posted limit. A supplemental distance plaque (R10-H20bP) shall be provided with the appropriate weight limit sign at the point where the detour is provided.

605-3.4 Work Zone Speed Limit Sign (R2-1)

Speed limit reduction through temporary traffic control zones shall be provided per ***Sections 640-18.2 and 1203-2.9.*** Where a speed limit reduction is applied, signing shall be as indicated in ***Section 642-24*** **(Plan Note 642-24)**.

605-4 Special Regulatory Signs

605-4.1 General

Section 605-4 is intended to address signs developed for use on **ODOT**-maintained highways that are not currently addressed in the **OMUTCD**. There may be a need for various Regulatory Signs that are not in the **OMUTCD**. They may eventually be incorporated into the **OMUTCD**; however, if their use is limited they may not be incorporated into that manual. Special Regulatory Signs should conform to the general requirements of color, shape and alphabet size and series. The sign message should be brief, legible and clear.

605-4.2 Work Zone Increased Penalties Sign (R11-H5a)

ORC Division 5501.27(A)(1) requires that the **Director of Transportation** “adopt rules governing the posting of signs advising motorists that increased penalties apply for certain traffic violations on streets or highways in a construction zone.”

ORC Division 5501.27(A)(2) requires that the Director also adopt “rules governing the posting of signs to be used pursuant to section 2903.081 of the Revised Code giving notice to motorists of the prohibitions set forth in sections 2903.06 and 2903.08 of the Revised Code regarding the death of or injury to any person in a construction zone as a proximate result of a reckless operation offense or speeding offense.”

ORC Section 4511.98, states in part: “The director of transportation, board of county commissioners, or board of township trustees shall cause signs to be erected advising motorists that increased penalties apply for certain traffic violations occurring on streets or highways in a construction zone. The increased penalties shall be effective only when signs are erected in accordance with the guidelines and design specifications established by the director under section 5501.27 of the Revised Code, and when a violation occurs during hours of actual work within the construction zone."

Chapter 5501:2-10 of the Ohio Administrative Code (OAC) documents the guidelines established by the **Director** pursuant to **ORC Section 5501.27**. For convenience, those guidelines are also presented in this Section. **Administrative Code Section 5501:2-10-02** requires that each agency adopt procedures pertaining to requiring a contractor, work crew, or utility to erect, maintain, and remove signs, in conformance with the these guidelines.

Work Zone Increased Penalty signs (R11-H5a) shall be used in construction zones on multi-lane divided highways where the work is expected to last thirty days or more, if the planned work length is at least 0.50 miles and if the construction zone is stationary. The signs may also be erected in any other construction zone at the discretion of the **Director**.

The signs may be erected for construction zones located on other highways meeting the foregoing requirements (i.e., thirty days, at least 0.50 miles in length, and stationary work) if required by the agency's procedures adopted under **5501:2-10-02(C)** or at the discretion of the **Director**.

The signs should be dual-mounted on a directional roadway of a divided highway, but need only be mounted on the right side of an undivided roadway or ramp.

The first R11-H5a sign shall be placed between the ROAD WORK AHEAD or other similar Warning Sign and the next sign in the sequence. Additional signs are required for long construction zones or where ramps or through streets junction within the construction project work limits. Signs shall be erected on each entrance ramp, near intersections of through roads to advise entering or turning traffic, and at least once every 2 miles through the construction work limits.

The signs shall be furnished, erected, maintained in good condition and/or replaced as necessary and subsequently removed by the entity which erects the traffic controls within the project. Signs shall be mounted at the appropriate offsets and elevations as prescribed by the **OMUTCD**. They shall be mounted on supports meeting current safety criteria.

Where construction activity affects only one directional roadway of a divided highway with a barrier or wide median, signs shall not be erected for traffic on the opposing directional roadway or ramp.

Signs shall be covered or removed when a construction zone is discontinued for a period of thirty days or more. Additionally the agency may require signs to be covered or removed for a specific shorter period.

Where a series of ROAD WORK AHEAD signs with supplemental distance plates are provided on **ODOT**-maintained highways, the R-11-H5a sign shall be placed following the final ROAD WORK AHEAD sign immediately preceding the location at which construction activity begins.

Erection of R11-H5a signs in a temporary traffic control zone on **ODOT**-maintained highways can be initiated in three different ways, depending on the nature of the construction:

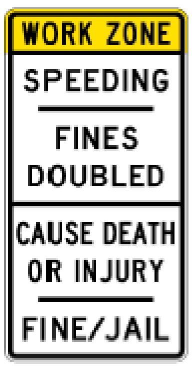
1. For **ODOT** construction projects, a determination will be made during the design phase as to whether the proposed construction activities will comply with requirements for the signs. When signs are required, they should be included in the construction contract plans for furnishing, erection, maintenance, covering, removal, etc. by the contractor. Prior to commencement of pertinent construction activities, the project engineer will assure that the assumptions concerning construction conditions are still valid and that the signing still applies in the manner originally determined.

The project engineer shall assure that signs are erected, maintained in good condition, covered, uncovered, repaired, replaced or removed by the contractor in a timely manner.

See ***Section 642-27*** **(Plan Note 642-27)** for more detail regarding erection of R11-H5a signs on multi-lane construction projects.

2. For maintenance work by **ODOT** forces, the **District Highway Management Administrator** shall identify those specific work areas which meet the criteria for erection of R11-H5a signs and arrange for furnishing signs, sign erection, maintenance covering and removal accordingly.

3. For non-**ODOT** construction, maintenance or utility work, a construction company, utility company or property owner may propose work within the right-of-way of a rural state highway and request a permit for such work under the requirements of **SOP PH-P-403.** At that time the company or property owner may also request permission to use R11-H5a signs for specified portions of the work. The request shall include a plan showing the proposed size, location and duration of erection of each sign. If approved, it is the responsibility of the company or owner to furnish the appropriate signs and erect, maintain, cover, uncover and remove them in accordance with the requirements of this Section.



Code No.	Route Type	Size Inches
R11-H5a	Conventional	24 x 48
R11-H5a	Major Conventional, Expressway & Freeway	48 x 96

605-5 Warning Signs

605-5.1 General

Warning Signs in temporary traffic control zones are addressed in **OMUTCD Chapter 6F**. ***Section 605-5*** will be used to provide additional information about Warning Signs discussed in the **OMUTCD** if needed. Information about Warning Signs used in temporary traffic control zones that are not currently addressed in the **OMUTCD** are discussed in ***Section 605-6***.

If a temporary traffic control zone requires Warning Signs different from those existing, the existing permanent Warning Signs shall be removed or covered and superseded by the appropriate temporary Warning Signs.

Signing in the advance warning area **(OMUTCD Figure 6C-1 and *Figure 698-1*)** must be adequate to inform the approaching road user of conditions downstream. The ROAD WORK AHEAD sign (W20-1), is normally provided and is followed by appropriate signing for the conditions at the site (see **OMUTCD Part 6** and the **MT series of Traffic SCDs**). When there is a need to provide notice for several miles in advance, it is necessary to repeat the ROAD WORK AHEAD sign every mile and to supplement it with a plaque to provide the distance to the beginning of the work. Where traffic queues are expected, advance notice of the potential for stopped traffic should be provided by the proper signing, such as BE PREPARED TO STOP (W3-4).

When it is necessary to provide a distance with a warning message, it is **ODOT** practice to provide this distance on a supplemental plaque mounted below the Warning Sign. The message on the Warning Sign will include the word "AHEAD" rather than the distance. Portable changeable message signs (PCMS) are very helpful in providing advance information to approaching traffic, particularly if this information is to be modified frequently. See ***Section 605-9*** for more information on PCMSs.

605-5.2 Design

As noted in **OMUTCD Section 6F.16**, with some exceptions, Warning Signs in temporary traffic control zones shall be diamond shaped with a black symbol or message on an orange background. Mounting or space considerations may justify a change from the standard diamond shape, but such variations require prior approval of the highway authority.

Warning Signs used for incident management may have either an orange background or a fluorescent pink background. However, in emergencies, available signs having yellow backgrounds may be used if neither fluorescent pink nor orange signs are readily available.

605-5.3 Sizes

Except as noted herein, signs used for temporary traffic control zones and incident areas shall be sized based on the provisions of **OMUTCD Chapter 6F**.

605-5.4 Spacing

Where highway conditions permit, Warning Signs should be placed at varying distances in advance of the work area, depending on the roadway type, condition and speed. Where a series of two or more Warning Signs is used, the closest sign to the work area should be placed approximately 100 feet away for low-speed urban streets to 1,000 feet away or more for expressways and freeways.

OMUTCD Table 6C-1 presents the suggested spacing of Warning Signs for four general roadway types: urban (low speed), urban (high speed), rural and expressway/freeway.

605-5.5 ROAD (STREET) CLOSED AHEAD Sign (W20-3)

As noted in **OMUTCD Section 6F.20**, the ROAD (STREET) CLOSED AHEAD sign (W20-3) should be used ahead of that point where a highway is closed to all traffic, or to all but local traffic. It may be used in conjunction with appropriate distance legends or with other Warning Signs. Where used on high-speed facilities, the 48-inch size sign shall be used. Where speeds are 40 miles per hour or lower and volumes are moderately low, the 36-inch size may be used.

605-5.6 ONE LANE ROAD AHEAD Sign (W20-4)

As noted in **OMUTCD Section 6F.21**, the ONE LANE ROAD AHEAD sign (W20-4) shall be used only in advance of that point where vehicular traffic in both directions must use a common single lane. Where used on high-speed facilities, the 48-inch size sign shall be used. Where speeds are 40 miles per hour or lower and volumes are moderately low, the 36-inch size may be used.

605-5.7 LANE(S) CLOSED AHEAD Sign (W20-5, W20-5a)

As noted in **OMUTCD Section 6F.22**, the LANE CLOSED AHEAD sign (W20-5) shall be used in advance of that point where one or more lanes of a multi-lane roadway are closed.

The sign may be used in repetition, in conjunction with appropriate distance legends, or with other Warning Signs. Where used on high-speed facilities, the 48-inch size sign shall be used. Where speeds are 40 miles per hour or lower and volumes are moderately low, the 36-inch size may be used.

605-5.8 Flagger Sign (W20-7, W20-7a)

As noted in **OMUTCD Section 6F.31**, the Flagger symbol sign (W20-7) should be used before any point where a flagger is stationed to control traffic. The sign may be used in conjunction with other Warning Signs, such as BE PREPARED TO STOP (W3-4). The 48-inch size sign shall be used regardless of highway classification.

605-5.9 SURVEY CREW AHEAD Sign (W21-H6)

As noted in **OMUTCD Section 6F.38**, the SURVEY CREW AHEAD sign (W21-H6) should be used to warn of survey crews working in or next to the roadway.

605-5.10 Blasting Zone Signs (W22-1, W22-2, W22-3)

As noted in **OMUTCD Sections 6F.40 through 6F.43**, Blasting Zone signing shall be used in advance of a temporary traffic control zone where explosives are being used.

605-5.11 Construction Arrow Sign (W1-H16)

The Construction Arrow sign (W1-H16) **(see OMUTCD Section 6F.50.1)** should be used where it is necessary to guide traffic through construction areas, or where road work is in progress. This sign is often placed along lane shifts where it may be determined that traffic guidance is necessary. Examples of use of the Construction Arrow sign are presented in **OMUTCD Figures 6H-31, 6H-32 and 6H-36** and in **Traffic SCDs MT-102.10 and 102.20**.

605-5.12 SHOULDER CLOSED Signs (W21-5a, W21-5b)

SHOULDER WORK signs are addressed in **OMUTCD Section 6F.37**. On expressways and freeways, the RIGHT (LEFT) SHOULDER CLOSED sign (W21-5a) and RIGHT (LEFT) SHOULDER CLOSED AHEAD sign (W21-5b) should be used in advance of the point where the shoulder work occurs and should be preceded by a ROAD WORK AHEAD sign (W20-1).

Code No.	Route Type	Size Inches
W21-5a & W21-5b	Conventional	36 x 36
W21-5a & W21-5b	Expressway & Freeway	48 x 48

605-5.13 Shoulder Drop-Off Sign (W8-17)

OMUTCD Section 6F.44 indicates that the Shoulder Drop-Off sign (W8-17) “should be used when a shoulder drop-off, adjacent to the travel lane, exceeds 3 inches in depth for a continuous length along the roadway, based on engineering judgment.” However, **Traffic SCD MT-101.90** has been developed to address shoulder drop-off situations on **ODOT**-maintained freeways, expressways and other highways with speeds of 45 mph or greater and minimal driveways. If the guidance in the **SCD** is followed, there should be no need for the W8-17 sign.

Where the sign is appropriate, it shall be installed by the end of the day in which the drop-off is created.

Code No.	Route Type	Size Inches
W8-17	Conventional	36 x 36
W8-17	Expressway & Freeway	48 x 48

605-5.14 UNEVEN LANES Sign (W8-11)

The UNEVEN LANES sign (W8-11) is addressed in **OMUTCD** **Section 6F.45**. It should be used during operations that create a difference in elevation between adjacent lanes.

Code No.	Route Type	Size Inches
W8-11	Conventional	36 x 36
W8-11	Expressway & Freeway	48 x 48

605-5.15 NO CENTER LINE and NO EDGE LINE Signs (W8-12, W8-H12a)

NO CENTER LINE and NO EDGE LINE signs (W8-12 and W8-H12a) are addressed in **OMUTCD** **Section 6F.47**. They should be used when the work obliterates the center or edge line. These signs should be placed at the beginning of the zone and repeated at 2-mile intervals in long zones to remind the road users. They should also be used at major connections, traffic generators, and/or at appropriate intervals as determined by the project engineer, to advise road users entering within the zone. For acceptable temporary pavement marking standards see ***Section 605-11.11***.

605-6 Special Warning Signs

605-6.1 General

This Section is intended to address signs developed for use on **ODOT**-maintained highways that are not currently addressed in the **OMUTCD**. As noted in **OMUTCD** **Section 6F.51**, there may be a need for various Warning Signs that are not in **OMUTCD Part 6**. Some of these will be found in **OMUTCD** **Part 2** and others may be developed because of special conditions not yet addressed in the **OMUTCD**. These "special" Warning Signs may eventually be incorporated into the **OMUTCD**; however, if their use is limited they may not be incorporated into that manual. Special Warning Signs should conform to the general requirements of color, shape and alphabet size and series. The sign message should be brief, legible and clear.

605-6.2 Notice of Closure Signs (W20-H13)

Notice of Closure signs (W20-H13) are intended to give advance notice to the road user of a scheduled road closure. The information provided on these signs includes the month and day, the number of days of the scheduled closure and a telephone number for information. The selected sign shall be erected at or near the point of closure except that more flexibility is acceptable in locating the signs on ramps. The sign should be erected prior to a scheduled road or ramp closure and in accordance with the Notice of Closure Time Table in Plan Note 642-8. The sign shall be erected on the right-hand side of the road or ramp, facing traffic. Additional details on placement of the Notice of Closure signs is provided in ***Section 642-8*** **(Plan Note 642-8)**. For closures of less than 7 days, portable changeable message signs may be substituted for the standard flat sheet signs.

W20-H13
60" x 36"

605-6.3 No Reentry Signing (W13-H7, W13-H8)

Some freeway and expressway projects require temporary closures of entrance and exit ramps in order to facilitate the work. This can create a situation where motorists are able to exit at an interchange, but are unable to reenter the freeway or expressway because of a temporary closure of the entrance ramp. This can create a situation where the exit and same direction entrance ramps are several miles apart. Since this is not the usual situation, it is not expected by drivers. Although trailblazing to the entrance ramp may be provided, the lack of direct reentry can be confusing and irritating, and some through drivers would choose not to exit at such an interchange if they were given advance warning.

The black on orange NO REENTRY _____ BOUND sign has been developed for this situation. When an entrance ramp closure may create a problem on freeways and expressways, this sign should be mounted as a supplemental panel with one or more of the Guide Signs for the exit. For signs less than 12 feet in width, the two-line sign (W13-H8) is available. The width of the W13-H7 or W13-H8 may be increased to match the width of the Guide Sign.

W13-H7

W13-H8

605-6.4 VARIABLE SPEED LIMIT AHEAD Sig(W3-H5b)

The VARIABLE SPEED LIMIT AHEAD (W3-H5b) sign should be used in advance of a speed zone using speed limits that vary. See ***Section 640-18,*** **Plan Note 642-24** ***(Chapter 642)*** and **Traffic SCD** **MT-104.10** for detailed information about the use of this sign.

W3-H5b
48” x 48”

605-7 Guide Signs

605-7.1 General

Guide Signs in temporary traffic control zones are addressed in **OMUTCD** **Chapter 6F**. ***Section 605-7*** will be used to provide additional information about Guide Signs discussed in the **OMUTCD** if needed. Information about Guide Signs used in temporary traffic control zones that are not currently addressed in the **OMUTCD** are discussed in ***Section 605-8***.

If a temporary traffic control zone requires guidance information different from that existing, the existing permanent Guide Signs shall be removed or covered and superseded by the appropriate temporary Guide Signs.

605-7.2 DETOUR Signs (M4-8, M4-8a, M4-8b, M4-9, M4-9a, M4-9b, M4-H9b, M4-9c, M4-10)

As noted in **OMUTCD** **Section 6F.59**, each detour shall be adequately marked with standard temporary Route Signs and destination signs.

A Route Sign or Street Name sign should be placed above or incorporated in the DETOUR sign to indicate the name of the route being detoured.

An End Detour sign (M4-8a or M4-8b) may be used to indicate that the detour has ended.

605-7.3 Advance Work Zone Information Signs

Advance Work Zone Information Signs may be required as part of the maintenance of traffic plan for major construction projects. The need for these signs is usually determined by the corridor management team during their review of the project. The signs are fixed message types and advise the road user of alternate routes, possible delays, etc. The signs are generally located at extreme distances from the work area.

To insure uniformity in the design and application of these signs, the following guidelines apply:

1. These signs shall be shown in the plans whether supplied by the contractor or by others (this choice shall be clearly indicated in the plans). The normal procedure is for the contractor to provide the signs.
2. The location of the signs shall be field checked by the designer to insure that there are no conflicts with existing features and other signs in the area. The designer will assure that signs are not blocked by being too close to other signs and that the road user has sufficient time to read, understand and act on the information provided by all of the signs.
3. The plans shall indicate the legend, level and size of the signs. The signs shall be considered Supplemental Guide Signs as described in **OMUTCD** **Section 2E.35**.
4. The signs shall be black on orange (including a black border). The layout shall conform to the **OMUTCD** and **ODOT** Guide Sign design standards **(see SDMM Appendix C)**.
5. Where appropriate, advance work zone information signs shall make use of the same exit numbers, route numbers, directions and destinations as shown on the permanent Guide Signs.
6. In some instances, instead of providing separate installations, it may be desirable to modify existing overhead Guide Signs. These changes are accomplished by providing black-on-orange overlays to cover portions of the existing signs. Letter size on these overlays should be the same as on the existing signs. When lane arrows are to be covered, a blank overlay should be placed over each of the affected arrows. When a ramp is being closed, rather than using a blank overlay to cover the entire sign, the legend “EXIT CLOSED” should be used on a diagonal overlay (lower left to upper right) on the sign. The size of lettering on overlays and the size of the overlay shall be indicated in the plans. The minimum letter size for the diagonal “EXIT CLOSED” overlay shall be 12”C.
7. When regulatory information is provided, it shall be displayed separately as a standard black-on-white sign. Mixing black-on-white regulatory information on a black-on-orange information sign is prohibited.
8. If the road user is being detoured, or if an alternate route is provided, the route should be signed with assemblies consisting of the appropriate black-on-orange (DETOUR OR ALT) markers with a standard Route Sign and arrow plate. If more target value is desired, this trailblazer information may be shown on an orange panel, M2-H3 type.

9. Route Sign assemblies shall be sized according to the type of road on which they are located in accordance with the **OMUTCD**.
10. Supports for sign installations shall conform to all existing standards for permanent signs.
11. These signs should not be attached to existing supports.
12. All advance work zone information sign installations located outside of the project work limits shall be paid for under appropriate **630 Items** (signs, supports, concrete, breakaway connection, overlays, removals, etc.). They shall not be included in the lump sum bid for **Item 614**. This requirement does not apply to Advance Warning Signs or to sign installations within the work limits.

605-8 Special Guide Signs

605-8.1 General

Section 605-8 is intended to address signs developed for use on **ODOT**-maintained highways that are not currently addressed in the **OMUTCD**. There may be a need for various "special" Information (Guide) Signs that are not in the **OMUTCD**. They may eventually be incorporated into the **OMUTCD**; however, if their use is limited they may not be incorporated into that manual. Special Guide Signs should conform to the general requirements of color, shape and alphabet size and series. The sign message should be brief, legible and clear.

605-8.2 TRUCK Marker (M4-4)

This sign shall be used with standard Detour signs when it is necessary to establish a detour for truck traffic, but not other vehicles.

605-8.3 Exit Open/Closed Signs (E5-2, E5-2a, E5-H2b, E5-H2c)

Use of these signs is addressed in **OMUTCD Section 6F.28 and Figures 6H-41 and 6H-42**.

605-9 Portable Changeable Message Signs (PCMSs)

Portable Changeable Message Signs (PCMS) **(see OMUTCD Section 6F.60)** are traffic control devices with the flexibility to display a variety of messages to fit the needs of road and street authorities. These signs are used most frequently on high density, urban freeways, but have applications on all types of highways where highway alignment, traffic routing problems or other pertinent conditions require advance warning and information.

In addition to the standards and guidelines in **OMUTCD Section 6F.60** and herein, additional guidelines for use of PCMSs can be found in ***Chapter 641*** of this manual, ***Section 642-41*** **(Plan Note 642-41)**, and the **Portable Changeable Message Sign handbook PCMS** by **FHWA, Report No.: FHWA-RD-03-066**.

As noted in **OMUTCD Section 6F.60**, when abbreviations are used, they should be easily understood **(see OMUTCD Section 1A.15)**.

Portable Changeable Message Signs will typically be placed in advance of any other temporary traffic control zone signing and should not replace any required signing. The location of the PCMS may have to be adjusted to keep the sign an appropriate distance in advance of traffic queues. Instead of relocating, an additional PCMS may be employed.

Diesel powered PCMSs should not be used in residential areas at night.

The Approved List of PCMSs for use on **ODOT** jobs can be found on the **ODOT** website.

605-10 Arrow Boards

605-10.1 General

An arrow board is a sign with a matrix of elements capable of either flashing or sequential displays **(see OMUTCD Section 6F.61)**. This sign shall provide additional warning and directional information to assist in merging and controlling road users through or around a temporary traffic control zone.

Arrow boards are used primarily on multi-lane highways to notify road users of the need to exit the presently occupied lane due to a lane closure. Under such conditions, the use of the arrow board shall be mandatory. Where a multi-lane closure is necessary, a separate arrow board shall be used for each closed lane.

On two-lane highways, the boards may be used only in the caution mode. Display of the arrow or chevron modes shall not be permitted on two-lane highways.

An arrow board should be used in combination with appropriate signs, channelizing devices, or other temporary traffic control devices. Arrow boards will not solve difficult traffic problems by themselves, but can be very effective when properly used to reinforce signs and other traffic control devices. Necessary signs, barricades and traffic control devices shall be used in conjunction with the arrow displays.

Diesel powered boards should not be used in residential areas at night.

The Approved List for arrow boards is posted on-line. **Supplement 1021** addresses the prequalification procedure for arrow boards.

605-10.2 Design

Arrow boards shall meet the minimum size, legibility distance, number of elements, and other specifications shown in **OMUTCD Section 6F.61 and Figure 6F-6** and in **Supplemental Specifications 821 and 921**.

Type A arrow boards are appropriate for use on low-speed ($\leq$ 40 miles per hour) urban streets. Type B arrow boards are appropriate for intermediate-speed (40 to 50 miles per hour) facilities and for maintenance or mobile operations on high-speed ($\geq$ 45 miles per hour) roadways. Type C arrow boards are intended to be used on high-speed, high-volume roadways.

For additional guidance and requirements on use of arrow boards, see **OMUTCD Section 6F.61.**

605-11 Channelizing Devices

605-11.1 General

Channelizing devices guide road users through the work zone, indicate hazardous areas, and exclude road users from the actual work space. The following Sections provide information on channelizing devices that is in addition to the standards and guidelines provided in **OMUTCD Chapter 6F.** For information on barriers, see **OMUTCD Sections 6F.70 and 6F.85** and ***Sections 605-11.7* and *605-14***.

Channelizing devices for use in temporary traffic control applications include cones, tubular markers, vertical panels, drums, barricades, and temporary raised islands. Barriers may also be used as channelizing devices. Intermixing of various types of channelizing devices (e.g., drums and cones) is not permitted.

Channelizing devices and their application shall conform to the **OMUTCD**, the following **TEM**

Sections and the **Traffic SCDs**. Temporary barriers are discussed in further detail in ***Section 605-14****.* Crash cushions are discussed in ***Section 605-15***. Temporary impact attenuators are discussed in ***Section 605-15.3***. Also see ***Section 640-2*** for a discussion of some exceptions.

605-11.2 Placement

As noted in **OMUTCD** **Section 6F.63**:

1. The spacing of channelizing devices in a taper should not exceed a distance in feet equal to the speed limit in miles per hour. For example, if the taper is on a roadway with an existing 55 miles per hour speed limit, the devices should be spaced at about 55 feet.
2. To keep traffic out of a closed lane on a tangent section, channelizing devices should be spaced a distance in feet of no more than two times the speed limit in miles per hour.
3. When channelizing devices have the potential of leading vehicular traffic out of the intended traffic space, the devices should be extended a distance in feet of two times the speed limit in miles per hour beyond the end of the transition area. This situation is illustrated for the "southbound" traffic in **OMUTCD** **Figure 6H-39**. In this typical application, the line of channelizing devices used for the "southbound" left-lane closing has been extended to help avoid the possibility that the devices used to delineate the crossover may also lead the traffic moving back into the "southbound" left lane into the median area.

When cones are used at night on freeways and other multi-lane highways maintained by **ODOT**, the maximum cone spacing shall be 40 feet

All channelizing devices (excluding barrier) used in maintaining traffic should have a minimum lateral offset from the edge of the traveled lane of 1.5 feet. A lateral offset of less than 1.5 feet may be used in instances when the project length is short. However, attempts to provide larger offsets should be made whenever possible. When barrier is used as a channelizing device the minimum lateral offset from the edge of the traveled lane to the barrier shall be 2.0 feet as indicated in ***Section 640-2***.

605-11.3 Cones

This Section addresses requirements for traffic cones that are in addition to those found in **OMUTCD** **Section 6F.64**.

Reflectorization of cones shall be as specified in **OMUTCD** **Section 6F.64**, and accomplished with bands of Type G reboundable retroreflective sheeting **(C&MS 730.191)**.

Except for pavement marking operations, the minimum height for cones shall be 28 inches. Cones used to protect the line during a pavement marking operation may be 18 inches **(see Traffic SCD MT-99.20)**.

In addition to the above requirements the following requirements shall apply:

1. Cones may be used on freeways and other multi-lane highways for either daytime or nighttime operations; however, they shall not be used continuously, day and night. Upon completion of work within the work period, the cones shall be removed. They may again be placed on the highway in order to resume work in the following such work period. Any lane closure which is expected to remain continuously, day and night, shall require the use of drums or barriers.

   Cones used at night on freeways and other multi-lane highways shall be at least 42 inches in height.

   Night use of cones on freeways and other multi-lane highways shall be limited to that portion of the closure which is beyond the transition taper area. Night channelization of such transition taper shall be by use of drums.

Maximum spacing of cones, when used at night on freeways and other multi-lane highways, shall be 40 feet.

2. On other highways, there are no restrictions on the duration of work for use of cones, day or night. On these roadways, night use of cones is permitted along the entire zone, along the transition taper and beyond.

605-11.4 Drums

605-11.4.1 General

Section 605-11.4 addresses requirements for drums used to warn or channelize road users. These are in addition to those found in **OMUTCD Section 6F.67**.

Drums shall be ballasted in accordance with the manufacturer's recommendations.

Drums shall be kept clean so that retroreflectivity is not compromised. Concrete sawing operations splash residue on sheeting, rendering it ineffective.

Owner identification markings on construction drums shall be no more than 1 inch in character height and located at least 2 inches below the retroreflective band or on the top or bottom horizontal surfaces of the drum.

Retroreflectorization of drums shall be provided by Type G reboundable sheeting complying with the requirements of **C&MS 730.191**. Additional information regarding use of drums is available in **C&MS 614.03**.

605-11.4.2 Lights on Drums

ODOT's use of warning lights **(OMUTCD Section 6F.83 and *TEM Section 605-12.5*)** on drums is limited to Type A flashing lights for identification of spot hazards. **ODOT** does not use Type C steady-burning warning lights on drums. Research projects sponsored by **ODOT** and **FHWA** demonstrated that benefits from steady-burn warning lights mounted on retroreflectorized drums are insignificant. Therefore, the use of these lights on retroreflectorized drums used as channelizing devices was terminated at the end of the 1991 construction season.

ODOT will not fund steady-burning (Type C) warning lights on drums used for the purpose of channelization on **ODOT**-administered projects. If a local agency desires to include lights on drums for channelization, the additional cost of the lights must be funded with local funds.

605-11.5 Barricades, Tubular Markers and Vertical Panels

This Section addresses requirements for tubular markers, vertical panels, and Type I, II and III barricades that are in addition to those found in **OMUTCD Sections 6F.65, 6F.66 and 6F.68**, respectively.

Faces of barricades and vertical panels shall be retroreflectorized with Type G or Type H sheeting complying with **C&MS 730.19 and 730.192**.

As with cones ***(Section 605-11.3)***, all tubular markers shall be retroreflectorized with bands of Type G sheeting. For details on band widths and sequencing see **OMUTCD Section 6F.65**.

605-11.6 Direction Indicator Barricade

The Direction Indicator Barricade **(see OMUTCD Section 6F.69 and Figure 6F-7)** may be used in tapers, transitions and other areas where specific directional guidance to road users is necessary. However, if used, Direction Indicator Barricades should be used in series to direct road users through the transition and into the intended travel lane.

The face of the barricade shall be retroreflectorized with Type G or Type H sheeting complying with **C&MS 730.19 and 730.192**.

605-11.7 Barrier Used as a Channelizing Device

Temporary traffic barriers **(see OMUTCD Section 6F.70)** shall not be used solely to channelize road users, but also to protect the work space. When used for channelization, temporary traffic barriers should be of a light color for increased visibility. For nighttime use, the temporary traffic barrier shall also be supplemented with delineation. For additional information, refer to **OMUTCD Section 6F.70** and ***Sections 605-14 and 605-19***.

605-11.8 Temporary Raised Islands

Temporary raised islands **(see OMUTCD Section 6F.75)** shall be used only in combination with pavement markings and other suitable channelizing devices. Except when recommended by an engineering study, they should only be used on roadways with speeds of 40 miles per hour or less.

605-11.9 Opposing Traffic Lane Divider

The Opposing Traffic Lane Divider sign **(see OMUTCD Section 6F.76)** is a delineation device used in a series to separate opposing vehicular traffic on a two-lane, two-way operation. Its use is limited to locations where speeds are 40 miles per hour or less. The Opposing Traffic Lane Divider sign (W6-4) is shown in **OMUTCD Figure 6F-4 (sheet 1 of 3)**.

605-11.10 Pavement Markings

605-11.10.1 General

Section 605-11.10 provides additional information and support for information in **OMUTCD Section 6F.77**. The provisions herein shall not be considered applicable for short-term, mobile or incident management temporary traffic control zones.

Either permanent or temporary pavement markings **(OMUTCD Section 6F.78)** shall be in place prior to opening the road or lane to road users. See ***Section 605-11.11*** for additional information on temporary pavement markings.

Adequate pavement markings shall be maintained along paved streets and highways in temporary traffic control zones. The intended vehicle path should be defined in day, night, and twilight periods under both wet and dry pavement conditions. The work should be planned and staged to provide the best possible conditions for the placement and removal of the pavement markings.

Road users should be provided pavement markings within a temporary traffic control zone comparable to the pavement markings normally maintained along such roadways, particularly at either end of the temporary traffic control zone. The following guidelines set forth the level of adequate markings, delineation and obliteration for various temporary traffic control zone situations.

1. All pavement markings shall be in accordance with **OMUTCD Chapters 3A and 3B**, except as indicated in ***Section 605-11.11***.
2. Pavement markings shall be maintained along highways in all long-term stationary temporary traffic control zones ***(see Section 606-3)***. The pavement markings shall match the markings in place at both ends of the temporary traffic control zone. Particular attention should be given to ramp gore areas.

3. Pavement markings shall be placed, along the entire length of any surfaced detour or temporary roadway prior to the detour or roadway being opened to road users.

4. Markings should be provided in intermediate-term stationary traffic control zones if practical ***(see Section 605-11.11, 605-13.2, and 641-12.2).*** Where pavement marking is not provided, another form of channelization such as drums shall be provided. On multi-lane highways, lane line markings may be necessary, as other forms of channelization may not be appropriate.

5. Warning Signs, channelizing devices and delineation shall be used to indicate required road user paths in temporary traffic control zones where it is not possible to provide a clear path by pavement markings.

6. For long-term stationary operations, pavement markings in the temporary traveled way that are no longer applicable shall be removed or obliterated as soon as practical. Pavement marking obliteration shall leave a minimum of pavement scars and shall remove old marking material. Painting over existing pavement markings with black paint or spraying with asphalt shall not be accepted as a substitute for removal or obliteration. Removable, nonreflective, preformed tape may be used where markings need to be covered temporarily ***(see Section 605-11.10.2)***.

7. All markings and devices used to delineate road user paths shall be carefully reviewed during daytime and nighttime periods.

605-11.10.2 Conflicting Pavement Markings

Conflicting pavement markings shall be removed by an approved method which will not scar the pavement or may be covered with removable, nonreflective, preformed tape which blends in with the existing pavement surface. Should it be decided to use the removable tape, the tape must be closely monitored, as it may be displaced due to traffic passing over it or inclement weather conditions. See ***Section 620-6*** and **C&MS 614.11 and 641.10**for additional information.

605-11.11 Temporary Pavement Markings

As noted in ***Section 605-11.10.1***, either permanent or temporary pavement markings shall be in place prior to opening the road or lane to traffic.

Temporary, or interim, pavement markings are those that are allowed to remain in place until the earliest date when it is practical and possible to install pavement markings that meet the **OMUTCD** **Part 3** standards for pavement markings. They should not be left in place for more than fourteen days unless justified by an engineering study.

In areas of long-line work such as resurfacing, where the roadway or lane remains open during construction, the new pavement marking shall be placed within fourteen days of removal or obliteration of the existing line(s). NO EDGE LINES (W8-H12a) signs shall be erected at locations lacking necessary edge lines.

All temporary pavement markings, including pavement markings for No-Passing Zones, shall conform to the requirements of **OMUTCD** **Chapters 3A and 3B** with the following exceptions:

1. All interim broken-line pavement markings shall use the same cycle length as permanent markings and be at least 4 feet long, except that half-cycle lengths with a minimum of 2-foot stripes may be used for roadways with severe curvature **(see OMUTCD Section 3A.06)**. This applies to white lane lines for traffic moving in the same direction and yellow center lines for two-lane roadways when it is safe to pass.

2. The center line shall either be full dimensional for No-Passing Zones, or an abbreviated Class II center line may be used for a maximum of three consecutive calendar days as long as DO NOT PASS (R4-1) and PASS WITH CARE (R4-2) signs are erected as required by **C&MS 614.04**. At the end of the three day time period, a center line consisting of full

dimensional no passing markings must be installed. Also, signs may be used instead of pavement markings on low-volume (as defined in ***Section 500***) roads for longer periods. These signs should be placed in accordance with **OMUTCD Sections 2B.28, 2B.29 and 2C.45**.

3. Edge lines shall be provided except for short periods (3 days maximum) at locations where another form of identification is provided, such as drums or cones.
4. Interim gore marking shall be continuous, white 24-inch lines in a chevron crosshatched pattern placed within the theoretical gore of an exit ramp or diverging roadway.

605-11.12 Raised Pavement Markers

The use of temporary raised pavement markers in temporary traffic control zones is addressed in **OMUTCD Section 6F.79, *Section 641-30* and in Traffic SCD MT-99.30**.

Raised pavement markers should be considered for use along center lines and lane lines on surfaced detours or temporary roadways, and other changed or new travel-lane alignments.

605-11.13 Delineators

As noted in **OMUTCD Section 6F.80**, delineators may be used in temporary traffic control zones to indicate the alignment of the roadway and to outline the required vehicle path through the temporary traffic control zone. When used, delineators shall be used in combination with, or be supplemental to, other traffic control devices.

Delineators shall be mounted on crashworthy supports so that the retroreflective unit is approximately 4 feet above the near roadway edge. The standard color for delineators used along both sides of two-way streets and highways and the right side of one-way roadways shall be white. Delineators used along the left side of one-way roadways shall be yellow. Spacing along roadway curves should be as set forth in **OMUTCD Section 3F.04**, and should be such that several delineators are always visible to the driver.

605-12 Lighting Devices

605-12.1 General

Lighting devices **(OMUTCD Section 6F.81)** should be provided in temporary traffic control zones based on engineering judgment. They may be used to supplement retroreflectorized signs, barriers and channelizing devices.

Five types of lighting devices are commonly used in temporary traffic control zones. They are floodlights, flashing warning beacons, warning lights, steady-burn electric lamps, and LED enhanced signs.

During normal daytime maintenance operations, the functions of flashing warning beacons are adequately provided by high-intensity rotating, flashing, oscillating, or strobe lights on a work vehicle. Vehicle hazard warning lights are permitted to be used to supplement these lights; however, they shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.

605-12.2 Floodlights

Standards and guidelines for the use of floodlights in temporary traffic control situations are addressed in **OMUTCD Section 6F.82**.

Lighting is often provided to illuminate the roadway at locations of significant geometric change. For example:

1. All temporary crossover areas shall be illuminated as shown in **Traffic SCD MT-100.00.**

2. Some projects involve special situations. If a project requires illumination for special situations, the **Office of Roadway Engineering (ORE)** should be contacted for guidance.

605-12.3 Flashing Warning Beacons

Flashing Warning Beacons **(see OMUTCD Section 4L.03)** are often used to supplement a temporary control device.

The temporary terminus of a freeway is an example of a location where Flashing Warning Beacons alert drivers to the changing roadway conditions and the need to reduce speed in transitioning from the freeway to another roadway type.

605-12.4 Steady-Burn Electric Lamps

As noted in **OMUTCD Section 6F.83**, steady-burn electric lamps are a series of low-wattage, yellow, electric lamps, generally hard-wired to a 110-volt external power source. They may be used in place of Type C steady-burning Warning Lights ***(see Section 605-12.5)***.

605-12.5 Warning Lights

Warning lights are portable, powered, yellow lens-directed, enclosed lights **(see OMUTCD Section 6F.83)**. They may be used in either flashing (Type A or B) or steady (Type C) modes. The light weight and portability of warning lights are advantages that make these devices useful as supplements to the retroreflectorization on signs and channelizing devices. See ***Section 605-11.4.2*** for additional information about the use of steady-burn warning lights with drums.

605-12.6 LED Enhanced Signs

LEDs may be embedded in standard warning signs and regulatory signs to outline either the sign itself or the words or symbols on the sign. The LEDs may be set to flash or operate in steady mode. LEDs may be illuminated 24 hours a day, or be activated by vehicles or pedestrians. The LED enhanced sign shall be OMUTCD compliant.

All projects using LED enhanced signs shall use **Plan Note 242-9**. When using the plan note, call out the specific sign(s) that will be LED enhanced.

605-13 Temporary Traffic Control Signals

605-13.1 General

It is often necessary to install temporary traffic signals in order to maintain traffic through temporary traffic control zones. As noted in **OMUTCD Section 6F.84**, temporary traffic control signals used to control road user movements through temporary traffic control zones and in other temporary traffic control situations shall meet the applicable provisions of **OMUTCD Part 4**. **Section 6F.84** and this Part of the **TEM** provide additional information on the use of traffic signals in temporary traffic control zones. ***Part 4*** of this Manual should also be reviewed for applicable information.

OMUTCD Figure 6H-12 and **Traffic SCDs MT-96.11, 96.20 and 96.26** address the use of temporary traffic signals to maintain two-way traffic in a single lane ***(see Section 641-12)***. Additional guidance on the design of temporary traffic control signals is provided in ***Section 605-13.2***.

The traffic signal system may either be constructed of standard signal components conforming to **Traffic SCDs MT-96.11, 96.20 and 96.26** ***(Section 641-12)***, or it may be a portable traffic signal (PTS) which is essentially self-contained and mounted on a trailer or pedestal ***(Section 605-13.3),*** per **ODOT's** Approved List for PTS.

For common procedures for maintaining traffic signals during construction, see the maintenance of traffic signals and flasher notes found in ***Chapter 642*****.**

Simple, two-phase traffic signal systems shall not be used for situations where traffic, including contractors' vehicles, will be entering the traffic stream, from the work site, between signals. Such intermediate access points shall be kept to a minimum, or avoided completely if possible. If traffic must enter the traffic stream at intermediate locations, an additional signal shall be located at each such location. Each such signal shall be traffic actuated.

When temporary traffic control signals are used, conflict monitors typical of traditional traffic control signal operations shall be used.

605-13.2 Duration of Work

For temporary traffic signals which will be in continuous operation for seventy-two hours or less, pavement marking shall be as shown in **Traffic SCDs MT- 96.11** ***(see Section 641-12)*** with the following exceptions and qualifications:

- Temporary pavement markings and temporary raised pavement markers are not required.
- Removal of existing conflicting pavement markings is not required if drums (or cones during daylight hours only) provide continuous positive guidance for vehicles.

605-13.3 Portable Traffic Signal (PTS)

Supplement 1050 and Supplemental Specification 961 establish the criteria for inclusion on **ODOT's** Approved List for Portable Traffic Signals. Portable traffic signals furnished on **ODOT's** projects shall be on **ODOT's** Approved List.

605-14 Temporary Traffic Barriers

605-14.1 General

Temporary traffic barriers are devices designed to help prevent penetration by vehicles while minimizing injuries to vehicle occupants, and designed to protect workers, bicyclists and pedestrians **(see OMUTCD Section 6F.85)**. More specific information on the use of temporary traffic barriers is contained in **AASHTO's Roadside Design Guide**.

Because the protective requirements of a temporary traffic control situation have priority in determining the need for temporary traffic barriers, their use shall be based on an engineering study.

At a minimum, temporary traffic barriers shall be considered in work zone situations that place workers at increased risk from motorized traffic, and where these barriers offer the highest potential for increased safety for workers and road users, such as:

1. The work zone provides no means of escape for workers (e.g., tunnels and bridges).Adjacent lanes, carrying traffic flowing in opposite directions on Interstates, freeways, and other high-speed (>45 miles per hour) multi-lane divided highways **(see Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73).**
2. Long-term work zones (e.g., two weeks or more).
3. Workers close to travel lanes open to traffic.
4. Drop-off areas **(see Traffic SCD MT-101.90)**.
5. Projects with high operating speeds and high traffic volumes.
6. Bridge decks where the parapet or guardrail is removed (see **SCD PCB-91** and the **Design Data Sheet PCBDD** on the **Office of Structural Engineering** Publications web page).

Warning lights or steady-burn electric lamps may also be mounted on temporary traffic barrier installations. When serving the additional function of channelizing vehicular traffic, temporary traffic barriers should be a light color for increased visibility.

605-14.2 Length of Need

The method used to design the length of need and location of barrier for maintenance of traffic applications should be as discussed in **L&D Manual Volume 1, Sections 602.1.2 and 602.1.3** for determining barrier length.

Length of need typically does not include attenuators, thus work zone design must take this into account.

605-14.3 Movable Barrier

A movable barrier is a linear system of connected barrier segments that can rapidly be shifted laterally by using a specially designed transfer vehicle. The transfer is accomplished in a manner that does not interfere with vehicular traffic in adjacent lanes. Applications of movable barriers include the following:

1. Closing an additional lane during work periods while maintaining the advantage of having the travel way separated from the work space by a barrier.
2. Closing an additional lane during off-peak periods to provide extra space for work activities without adversely impacting vehicular traffic flow; and
3. Creating a temporary reversible lane, thus providing unbalanced capacity favoring the major direction of vehicular traffic flow.

For more information on this device see **OMUTCD** **Section 6F.85 and Figure 6H-45**, and ***TEM Section 606-18***.

605-14.4 Temporary Guardrail

All guardrail used as a temporary barrier in maintenance of traffic applications shall conform to the same standards required for permanent guardrail in **L&D Manual Volume 1, Section 603.1.1**.

Guardrail should be as detailed in the current **Roadway Standard Construction Drawings**. Any variation from these standards shall be submitted for approval by the **Office of Roadway Engineering (ORE)** at the design stage, on a case-by-case basis.

Guardrail delineation shall be installed as described in ***Section 605-19*** and **Plan Note 642-52** in ***Chapter 642***.

605-14.5 Portable Barrier (PB)

Portable Barrier (PB) includes both portable concrete barrier (PCB) and portable steel barrier. (It does not include portable water-filled barrier.)

605-14.5.1 Portable Barrier Delineation and Glare Screens

Delineation of PB shall be provided by the use of delineation panels, barrier reflectors and object markers. ***See Sections 605-18 and 605-19*** for details.

Glare screen should be considered for use on PB in accordance with **L&D Manual Volume 1, Section 604.1**. See ***Section 605-18*** for additional information.

605-14.5.2 End Treatment

The exposed end of the PB should be located at a distance from the edge of the traveled way equal to the clear zone distance for the facility as discussed in **L&D Manual Volume 1, Section 600.2**. When this is not practical, impact attenuators shall be provided on the exposed ends of PB located within the clear zone.

Except as noted, exposed ends of PB located outside the clear zone shall be tapered. The leading end of PB does not need be tapered if shielded by another run of overlapping PB, permanent concrete barrier, or fully anchored guardrail (with anchor assembly). However, the PB should extend/overlap at least 50 feet with a guardrail end. Connections or field transitions to guardrail are not crashworthy and are not permitted. Abutting or connecting PB to permanent concrete barrier or parapets is non-standard and requires special anchoring and design details. See **Traffic SCD MT-101.80** for design guidance for transitioning portable concrete barrier (does not pertain to portable steel barriers) to permanent concrete barrier.

For acceptable flare rates for PB, see **L&D Manual Volume 1, Figure 602-1** and the **SCDs**. See ***Section 620-2*** for information on the **NCHRP 350** requirements.

605-14.5.3 Anchoring PB

Anchoring of PB may be considered to prevent excessive deflections of the barrier on the roadside, e.g., on bridge decks where a deflection could cause the PB to fall from the deck. Anchoring of PB located on bridges is required as shown in **SCD PCB-91.** Anchoring drawings for minimum deflection of portable steel barrier are shown in the Approved Products List maintained by **ORE**. Anchored PB is not intended for use where uni- or bi-directional traffic is running along both sides of the PB.

605-14.5.4 Grading of Cross Slopes

Where PB is located beyond the edge of the paved shoulder, the cross slope within the clear zone, including the surface on which the PB is placed, shall be graded at 10:1 or flatter. If the cross slope is steeper than 10:1, the PB shall be terminated on the paved or graded surface rather than on the cross slope. The PB shall be extended along the paved or graded surface as necessary to satisfy the length of need **(L&D Manual Volume 1, Section 602.1.2)**, and then terminated using an impact attenuator.

605-14.6 Plastic Water-Filled Barrier

A plastic water-filled barrier (PWFB) cannot be used as a direct substitute for PB. In locations where the water-filled barrier is used primarily as a channelizing device, the length of the barrier is determined in a manner similar to that for drums. They may also provide a higher level of channelization at certain locations where drums would normally be used, such as at exit ramps. When specifying a PWFB, the designer must consider the following factors:

1. There is assurance adequate clearance exists behind the barrier to accommodate the expected deflections.
2. The PWFB must meet the appropriate **NCHRP Report 350** Test Level and have an **FHWA** acceptance letter for that test level. For example, the Rhino Barrier does not meet TL-3, but it does meet TL-2. A complete listing of accepted devices is on-line.
3. Products have met crash testing criteria by testing with a number of interconnected units to achieve the necessary tension needed. Therefore, before a product can be specified, the designer must ensure this minimum length is provided in the plans, even if it greater than the length of need as calculated in ***Section 605-14.2***.
4. The PWFB shall be flared outside the clear zone unless terminated with a crashworthy end treatment.

The designer is encouraged to accommodate all of the products in a generic design. However, if the site has limitations, and only one or two PWFB will work on a project due to the limitations of the other products, the designer is obligated to specify only the appropriate PWFB. Unless the designer specified a particular PWFB, a contractor is free to choose any of the **FHWA** accepted **NCHRP Report 350** PWFB.

The contractor shall install the selected product as per the manufacturer's recommendations and in accordance with the factors stated above. All Test Level 3 products were crash tested by utilizing some sort of a steel cage, or connectors, so it is imperative the contractor install these "upgrade kits" to match the crash tested design.

605-14.7 Cable Barrier

1. Existing Cable Barrier

   If shifting traffic closer than 8 feet to existing cable barrier, portable barrier shall be added adjacent to opposing traffic for separation.

2. Proposed Temporary Cable Barrier

   Cable barrier shall not be installed for temporary applications.

3. Proposed Permanent Cable Barrier

   It is recommended to wait until the end of the project to install proposed permanent cable barrier. If separation is required prior to installation, use portable barrier for separation of opposing traffic per **L&D Manual Volume 1, Figure 601-2E and Section 603.1.4.6**.

605-15 Crash Cushions

605-15.1 General

As noted in **OMUTCD Section 6F.86**, crash cushions are systems that mitigate the effects of errant vehicles that strike obstacles, either by smoothly decelerating the vehicle to a stop when hit head-on, or by redirecting the errant vehicle. The two types of crash cushions that are used in temporary traffic control zones are stationary crash cushions and truck-mounted attenuators. Crash cushions in temporary traffic control zones help protect the drivers from the exposed ends of barriers, fixed objects, shadow vehicles and other obstacles. Specific information on the use of crash cushions can be found in **AASHTO's Roadside Design Guide *(see Section 193-4)***.

Crash cushions shall be crashworthy. They shall also be designed for each application to stop or redirect errant vehicles under prescribed conditions. Crash cushions shall be periodically inspected to verify that they have not been hit or damaged. Damaged crash cushions shall be promptly repaired or replaced.

605-15.2 Stationary Crash Cushions

Stationary crash cushions are used in temporary traffic control zones in the same manner as permanent highway installations to protect drivers from the exposed ends of barriers, fixed objects and other obstacles. Stationary crash cushions shall be designed for the specific application intended.

See ***Sections 642-30 and 642-31*** for related **Plan Notes** and additional information.

Sand barrel arrays may be used in work zones to provide temporary protection for wide hazards. For ease of moving, they may be mounted on pallets or skids that are 4 inches or less in height.

See **L&D Manual Volume 1, Section 603.4.4 and 603.4.5** for additional information.

605-15.3 Truck-Mounted Attenuators

Truck-mounted attenuators shall be energy-absorbing devices attached to the rear of shadow trailers or trucks and they should be used in accordance with the manufacturer's specifications. If used, they shall be located in advance of the work area, workers or equipment to reduce the severity of rear-end crashes from errant vehicles. Chapter 9 of **AASHTO's Roadside Design Guide** ***(see Section 193-4)*** and ***Section 602-8*** contain additional information regarding the use of shadow vehicles.

For more detail see **L&D Manual Volume 1, Section 603.2**.

605-16 Vehicle-Arresting Systems

Vehicle-arresting systems are addressed in **OMUTCD Section 6F.83**.

605-17 Rumble Strips

Rumble strips **(see OMUTCD Section 6F.87 and *TEM Section 1415*)** consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that alert drivers to unusual vehicular traffic conditions. Through noise and vibration they attract a driver's attention to such features as unexpected changes in alignment and to conditions requiring a stop.

The first rumble strip pad should be placed before the advance warning devices. The last pad should be placed a minimum of 250 feet in advance of the traffic condition.

A RUMBLE STRIPS sign (W8-H15a) warning drivers of the onset of rumble strips may be placed in advance of any rumble strip installation.

Although the intent of the rumble strips is to alert the road user, the noise may also attract the attention of non-road users on adjacent property. This would be unacceptable in residential areas.

Temporary portable rumble strips used for temporary traffic control shall follow requirements set forth in **SCD MT-97.20**.

605-18 Screens

Screens **(see OMUTCD Section 6F.88)** are used to block the road users' view of activities that can be distracting. Screens might improve safety and vehicular traffic flow where volumes approach the roadway capacity because they discourage gawking and reduce headlight glare from oncoming vehicular traffic. They can also help contain the work area and reduce the accumulation of dust and debris on the pavement.

On **ODOT**-maintained highways a glare screen shall be used at all crossover locations unless a 50-inch portable barrier (PB) is provided. The upper portion of the 50-inch portable barrier (PB) serves as a glare screen (see **Roadway SCD RM-4.1** for details).

Paddle, or intermittent, type glare screens may be mounted on the top of 32-inch PB.

Where glare screen is provided, the glare screen shall be equipped with vertical stripes on the paddles as shown in **Traffic SCD MT-101.70**.

See ***Section 642-21*** **(Plan Note 642-21)**, **L&D Manual Volume 1, Section 604** and **Traffic SCD MT-95.70 or MT-95.71** for additional guidance.

The choice of 32-inch PB, with screen, or 50-inch is often left to the contractor. However, glare screen can be a maintenance problem. If PB will be in place over the winter during plowing operations, or if the PB is otherwise expected to be hit a lot, the 50-inch PB should be specified. Plowing over the top of a 50-inch PB is possible; however, it is not preferred.

605-19 Barrier Reflectors and Object Markers

605-19.1 General

Materials used for barrier reflectors shall conform to **C&MS 626**. The minimum reflective surface area for the reflector portion of a barrier reflector should be 7 square inches.

Attachment of the reflector shall be by a suitable corrosion resistant fastener, bracket or adhesive. Barrier reflectors shall be the same color as the adjacent edge line. When adjacent to a reversible traffic direction lane, barrier reflectors shall be white on one side and yellow on the other side, such that regardless of the direction of travel of the road user, the yellow barrier reflectors will be visible to the road user's left side and white barrier reflectors will be visible to the road user's right side.

Object markers shall conform to **C&MS 614.03**. Barrier object markers shall be 6 inches wide and at least 12 inches high. They shall have orange (fluorescent red-orange or fluorescent yellow-orange) retroreflective sheeting (see **C&MS 614.03** for more information on materials). If used with two-way traffic, object markers shall be mounted in pairs facing traffic from each direction.

605-19.2 Delineation of Concrete Barriers, Bridge Parapets and Portable Barrier

Barrier reflectors and object markers shall be mounted on all portable barrier (PB) used for traffic control and on all concrete barrier (including bridge parapets) located within 5 feet of the edge of the adjacent travel lane (see **Plan Note 642-51** in ***Chapter 642***). When PB contains glare screen ***(see Section 605-18)***, three vertical retroreflective stripes shall be placed on consecutive paddles as described in **Traffic SCD MT-101.70**.

Barrier reflectors and object markers shall be installed as shown in **Traffic SCD MT-101.70, with a** maximum spacing for the barrier reflectors and object markers of 50 feet. Where both barrier reflectors and object markers are provided on the same device, these items shall be staggered.

See ***Section 641-22*** for more information about **Traffic SCD MT-101.70**.

605-19.2.1 Increased Barrier Delineation (Delineation Panels and Triple-Stacked Reflectors)

On freeway and expressway projects, one of the increased barrier delineation methods shown in **Traffic SCD MT-101.70** shall be installed on all portable and permanent barrier located within 5 feet of the edge of the traveled lane under either of the following conditions: along tapers and transition areas; or along curves (outside only) with degree of curvature greater than or equal to 3 degrees.

Delineation panels shall consist of panels of delineation, approximately 34 inches long and 6 inches wide and shall be "crimped" and shall be aligned horizontally. Panels shall be provided at the rate of one per section of portable barrier, or one panel every 10 feet on permanent barrier, spaced evenly along the length of the run. The panels shall be mounted such that the tops of the panels are 26 inches above the pavement. See **Plan Note 642-51** in ***Chapter 642*** and **Traffic SCD MT-101.70** for further details.

Triple-stacking of barrier reflectors shall consist of aligning three barrier reflectors vertically, at locations where a single barrier reflector would be otherwise attached. There shall be no open space between the adjacent barrier reflectors. The top of the middle barrier reflector shall be located 26 inches above the pavement. See **Plan Note 642-51** in ***Chapter 642*** and **Traffic SCD MT-101.70** for further details.

605-19.3 Delineation of Guardrail

Barrier reflectors shall be installed on all temporary guardrail used for traffic control and on all permanent guardrail located within 5 feet of the edge of the adjacent travel lane.

Object Markers shall be installed on all temporary and permanent guardrail located within 5 feet of the edge of the adjacent travel lane.

See **Plan Note 642-52** in ***Chapter 642*** for further details.

605-20 Future and Experimental Devices

The **States**, **FHWA**, **AASHTO**, the **Transportation Research Board (TRB)**, and other organizations conduct research and experimentation on new traffic control and safety devices.

The **TEM** may be used to distribute information on experimental devices that have been approved for use, and on new devices that have yet to be incorporated into the **OMUTCD**.

Intentionally blank.

606 TYPE OF TEMPORARY TRAFFIC CONTROL ZONE ACTIVITIES

606-1 General

Each temporary traffic control zone is different. Many variables, such as location of work, road type, geometrics, vertical and horizontal alignment, intersections, interchanges, road user volumes, road vehicle mix (buses, trucks and cars), and road user speeds affect the needs of each zone. The goal of temporary traffic control in work zones is safety with minimum disruption to road users. The key factor in promoting temporary traffic control zone safety is proper judgment.

Previous Chapters in this Part of the **TEM** have reviewed general policies, standards and guidelines regarding temporary traffic control zones and the related devices. ***Tables 697-1a through 697-1f*** provide a review of various options available in choosing the appropriate temporary traffic control. ***Chapter 606*** provides a general discussion about various types of temporary traffic control activities. ***Chapter 607*** and **OMUTCD Chapter 6H** provide more detailed guidelines about specific typical applications of temporary traffic control. ***Chapters 640, 641, 642 and 643*** include additional information intended to aid in preparing Temporary Traffic Control (Maintenance of Traffic or MOT) Plans.

The discussion in this Chapter regarding types of temporary traffic control activities has been organized into the same general categories used in **OMUTCD Chapter 6G**:

1. Work Duration.
2. Location of the Work.
3. Modifications to Fulfill Special Needs.
4. Work Outside of the Shoulder.
5. Work on the Shoulder with No Encroachment.
6. Work on the Shoulder with Minor Encroachment.
7. Work Within the Median.
8. Work Within the Traveled Way of Two-Lane Highways.
9. Work Within the Traveled Way of Urban Streets.
10. Work Within the Traveled way of Multi-lane, Nonaccess Controlled Highways.
11. Work Within the Traveled Way at an Intersection.
12. Work Within the Traveled Way of Expressways and Freeways.
13. Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway.
14. Crossovers.
15. Interchanges.
16. Movable Barriers.
17. Work Affecting Pedestrian and Bicycle Facilities.

18. Temporary Traffic Control During Nighttime Hours.

606-2 Typical Applications

The typical applications of temporary traffic control zones addressed in the **OMUTCD** and this Chapter are organized according to duration, location, type of work and highway type. **OMUTCD Table 6H-1** and the Figures Index for ***Chapter 698*** provide listings of the typical applications shown in these manuals. These typical applications address the use of various temporary traffic control methods, but do not include a layout for every conceivable work situation.

Typical applications for which **Traffic SCDs** have been prepared are discussed in ***Chapter 641***.

The typical applications should be modified, as necessary, to fit the conditions of a particular temporary traffic control zone. Other devices may be added to supplement the devices shown in the typical applications, while others may be deleted. The sign spacings and taper lengths may be increased to provide additional time or space for driver response.

Decisions regarding the selection of the most appropriate typical application to use as a guide for a specific temporary traffic control zone require an understanding of each situation. Although there are many ways that work zone applications could be categorized, four factors are used to generally characterize the typical applications addressed in ***Chapter 607*** and **OMUTCD Chapter 6H**. Those four factors are: work duration, work location, work type and highway type.

606-3 Work Duration

As noted in **OMUTCD 6G.02**, work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. The duration of a temporary traffic control zone is defined relative to the length of time a work operation occupies a spot location.

OMUTCD 6G.02 establishes the following five categories of work duration and discusses each one:

1. <u>Long-term stationary</u> is work that occupies a location more than three days.

2. <u>Intermediate-term stationary</u> is work that occupies a location more than one daylight period up to three days, or nighttime work lasting more than one hour.

3. <u>Short-term stationary</u> is daytime work that occupies a location for more than one hour within a single daytime period.

4. <u>Short duration</u> is work that occupies a location up to one hour.

5. <u>Mobile</u> is work that moves intermittently or continuously.

606-4 Location of Work

As noted in **OMUTCD 6G.03**, the choice of temporary traffic control needed for a temporary traffic control zone depends upon where the work is located. As a general rule, the closer the work is to road users, the greater the number of temporary traffic control devices that are needed. Procedures are described in **OMUTCD Chapter 6G** and herein for establishing temporary traffic control zones in the following locations:

1. Outside the shoulder;

2. On the shoulder with no encroachment;

3. On the shoulder with minor encroachment;

4. Within the median; and

5. Within the traveled way.

606-5 Modifications To Fulfill Special Needs

The typical applications in **OMUTCD Chapter 6H** and herein illustrate commonly encountered situations in which temporary traffic control devices are employed. Supplemental information provided in this Part of the **TEM** should also be consulted to insure compliance with **ODOT** standards. Other devices may be added to supplement the devices indicated in these figures. Device spacing may be adjusted to provide additional reaction time. When conditions are less complex than those depicted in the typical applications, fewer devices may be needed.

When conditions are more complex, typical applications should be modified by incorporating appropriate devices and practices from the list provided in **OMUTCD Section 6G.04**.

Temporary traffic barriers serving as temporary traffic control devices shall conform to requirements for such devices as set forth throughout **Part 6 of the OMUTCD and TEM**.

606-6 Work Outside of Shoulder

When work is being performed off the roadway (beyond the shoulders, but within the right-of- way), little or no temporary traffic control may be needed. See **OMUTCD Section 6G.06 and Figure 6H-1** for information on this situation.

In these situations, a single Warning Sign, such as SHOULDER WORK AHEAD (W21-H5), should be used. If the equipment travels on the roadway, the equipment should be equipped with appropriate flags, high-intensity rotating, flashing, oscillating, or strobe lights, and/or a SLOW MOVING VEHICLE symbol.

If work vehicles are on the shoulder, a SHOULDER WORK AHEAD sign may be used. For mowing operations, the MOWING AHEAD sign (W21-8) may be used. Where the activity is spread out over a distance of more than 2 miles, the SHOULDER WORK AHEAD sign may be repeated every 1 mile. A supplementary plaque with the message NEXT X MILES plate (W7-3a) may be used.

Caution is advised. The type of work being performed must be considered. If a drop-off is created within the clear zone, additional traffic control may be needed ***(see Section 640-6)***.

606-7 Work on the Shoulder with No Encroachment

Generally, when a highway shoulder is occupied or closed a SHOULDER WORK AHEAD sign (W21-H5) or the RIGHT (LEFT) SHOULDER CLOSED sign (W21-5a) is used. See **OMUTCD Section 6G.07 and Figures 6H-3, 6H-4 and 6H-5**.

When the shoulder is not occupied, but work has adversely affected its condition, the LOW SHOULDER (W8-9) or SOFT SHOULDER (W8-4) sign should be used, as appropriate. Where the condition extends over a distance in excess of 1 mile, the sign should be repeated at 1-mile intervals.

When used for shoulder work, arrow boards shall operate only in the caution mode.

606-8 Work on the Shoulder with Minor Encroachment

OMUTCD Section 6G.08 and Figure 6H-6 address situations where work on the shoulder encroaches slightly into the traveled way.

606-9 Work Within the Median

As noted in **OMUTCD Section 6G.09**, if work in the median of a divided highway is within 15 feet of the edge of the traveled way for either direction of travel, temporary traffic control should be used through the use of advance Warning Signs and channelizing devices.

606-10 Work Within the Traveled Way of Two-Lane Highways

Techniques for controlling vehicular traffic under one-lane, two-way conditions are described in **OMUTCD Section 6G.10** and ***Section 602-7***. For the **ODOT**-maintained system, the techniques used most often are:

1. Flaggers **(see OMUTCD Figure 6H-10 and Traffic SCDs MT-97.10, 97.11 and 97.12)**; and

2. Temporary traffic control signal **(see OMUTCD Figure 6H-12, *Section 607-13*, Traffic SCDs MT- 96.11, 96.20 and 96.26)**.

However, in low-volume situations STOP/YIELD sign control **(see OMUTCD Figure 6H-11 and *Section 607-12*)** may be considered.

Detour signs are used to direct road users onto another roadway. At diversions, road users are directed onto a temporary roadway or alignment placed within or adjacent to the right-of-way. Typical applications for detouring or diverting road users on two-lane highways are shown in **OMUTCD Figures 6H-7, 6H-8 and 6H-9.**

606-11 Work Within the Traveled Way of Urban Streets

In urban temporary traffic control zones, decisions are needed on how to control vehicular traffic, such as how many lanes are required, whether any turns should be prohibited at intersections, and how to maintain access to business, industrial and residential areas. See **OMUTCD 6G.11**.

If the temporary traffic control zone affects the movement of pedestrians, adequate pedestrian access and walkways shall be provided. ***Chapter 603***, and **OMUTCD Figures 6H-28 and 6H-29** contain additional information regarding controlling pedestrian movements near work zones.

If the temporary traffic control zone affects the movement of bicyclists, adequate access to the roadway or shared-use paths shall be provided. If a designated bicycle route is closed because of the work being done, a signed alternate route should be provided. Bicyclists should not be directed onto the path used by pedestrians. Additional information on bikeways may be found in **OMUTCD Part 9**, ***Part 9*** of the **TEM**, the **Guide for the Development of Bicycle Facilities** and from the **Office of Local Projects**.

606-12 Work Within the Traveled Way of Multi-lane, Nonaccess Controlled Highways

Work on multi-lane highways can be divided into right-lane closures, left-lane closures, interior-lane closures, multiple-lane closures and closures on five-lane roadways. These situations are addressed in **OMUTCD Section 6G.12 and Figures 6H-30, 6H-31, 6H-32, 6H-33, 6H-34, 6H-35 and 6H-37**. Related **Traffic SCDs** are discussed in ***Chapter 641***.

When a roadway must be closed on a divided highway, a median crossover may be used ***(see Section 606-16)***.

606-13 Work Within the Traveled Way at an Intersection

The typical applications for intersections are classified according to the location of the work space with respect to the intersection area (defined for this purpose by the extension of the curb or edge lines). The three classifications are near side, far side and in-the-intersection. Work spaces often extend into more than one portion of the intersection. For example, work in one quadrant often creates a near-side work space on one street and a far-side work space on the cross street. In such instances, an appropriate temporary traffic control plan is obtained by combining features shown in two or more of the intersection and pedestrian typical applications. **OMUTCD Section 6G.13 and Figures 6H-21 through 6H-27** address work within the traveled way at an intersection.

When traffic lanes are shifted through a signalized intersection with mast arms temporary span wire may need to be provided to move the signal heads over the lanes. Temporary mast arm attachment hardware may also be provided instead.

606-14 Work Within the Traveled Way of Expressways and Freeways

Temporary traffic control problems might occur under the special conditions encountered where vehicular traffic must be moved through or around temporary traffic control zones on high-speed, high-volume roadways. Although the general principles outlined in the **OMUTCD** and the **TEM** are applicable to all types of highways, high-speed, access-controlled highways need special attention in order to safely and efficiently accommodate vehicular traffic while also protecting workers. See **OMUTCD Section 6G.14 and Figures 6H-33 and 6H-35 through 6H-37** for information on this type of work.

Traffic SCDs to address lane closures on freeways and expressways have been developed, and lane closure procedures are also discussed in ***Chapter 641***.

Additional information is also provided in **Policy 21-008(P) Traffic Management in Work Zones (see *Section 601-2*)**.

OMUTCD Table 6C-3 provides information on the length of the merging and shifting tapers. Taper rates for shifts are also addressed in ***Section 602-5.3.***

606-15 Two-Lane, Two-Way Traffic on One Roadway of a Normally Divided Highway

OMUTCD Section 6G.15 addresses work involving two-lane, two-way traffic on one roadway of a normally divided highway.

OMUTCD Figure 6H-39 addresses the procedure for two-lane, two-way operation. Treatments for entrance and exit ramps within the two-way roadway segment of this type of work are shown in **OMUTCD Figures 6H-40 and 6H-41.** Related **Traffic SCDs** are discussed in ***Chapter 641***.

606-16 Crossovers

Crossover construction refers to the concept of maintaining two-way traffic operation on one side of a divided highway while the contractor performs work on the other side of the roadway. See **OMUTCD 6G.16 and Figure 6H-39**. As noted in ***Section 641-11.2***, design of crossover roadways is also addressed in ***Section 640-12 and Figures 698-4 through 698-7 and 698-12.*** There is also additional information on this work in ***Sections 607-12 and 607-13***, **Traffic SCDs MT-95.70, 95.71, 95.72, 95.73, and 99.30**.

One disadvantage of crossover construction is that in order to provide entrance and exit ramp access in the direction of travel of the shifted traffic, temporary pavement will be necessary at each interchange. Crossover construction is most beneficial on projects where ramp access is not mandatory. For further information on the advantages and disadvantages of crossover construction, see the compendium of options presented in ***Tables 697-1a through 697-1f***.

606-17 Interchanges

Work in the area of interchanges on limited-access highways is addressed in **OMUTCD 6G.17 and Figures 6H-40 through 6H-44**. Additional information is also provided in ***Sections 607-13 through 607-15***, and ***Figure 698-3***, and the **Traffic SCD MT-98 series**.

606-18 Movable Barriers

OMUTCD Section 6F.85 and Figure 6H-45 address a temporary reversible lane using movable barriers.

606-19 Work in the Vicinity of Highway-Rail Grade Crossings

OMUTCD Section 6G.18 addresses work in the vicinity of highway-rail grade crossings.

606-20 Control of Traffic Through Incident Areas

OMUTCD Chapter 6I and ***Chapter 608*** address control of traffic through incident areas.

606-21 Work Affecting Pedestrian and Bicycle Facilities

OMUTCD Section 6G.05 addresses work affecting pedestrian and bicycle facilities. **OMUTCD Chapter 6D and Sections 6F.74** and ***Chapter 603*** provide additional information regarding steps to follow when pedestrian and bicycle facilities are affected by the worksite.

606-22 Temporary Traffic Control Through Nighttime Hours

OMUTCD Section 6G.19 provides additional information regarding temporary traffic control through nighttime hours.

607 TYPICAL APPLICATIONS

607-1 General

Chapter 606 presented a general discussion of typical temporary traffic control activities. ***Chapter 607*** provides more detailed information about typical applications for a variety of situations commonly encountered.

Temporary traffic control applications are presented in **OMUTCD Chapter 6H**, in this **TEM** Chapter (and the related figures in ***Chapter 698***), and in the **Traffic SCD MT series**. Applications shown in the **OMUTCD** present minimum standards permitted within **Ohio**. Traffic control applications presented in the **Traffic SCDs** are intended for use on **ODOT** administered projects, and are more restrictive than the applications presented in the **OMUTCD**. As noted in ***Section 600-3***, applicable **SCDs** are also recommended for use in **ODOT** force-account work as much as practical. Additional guidance in proper application of temporary traffic control devices is presented in **C&MS 614**.

In addition to information in the **OMUTCD**, figures and tables found in this Part of the **TEM** provide information for the development of temporary traffic control plans. **OMUTCD Table 6C-3** is used for the determination of taper lengths, and **OMUTCD Table 6C-1** can be used for Warning Sign spacing for various areas and roadway types.

While not every situation is addressed, the information illustrated in the **OMUTCD**, the **TEM** and the **Traffic SCDs** can generally be adapted to a broad range of conditions. In many instances, an appropriate temporary traffic control plan is achieved by combining features from various typical applications. For example, work at an intersection might present a near-side work zone for one street and a far-side work zone for the other street. These treatments are found in two different typical applications, while a third typical application shows how to handle pedestrian crosswalk closures.

Procedures for establishing temporary traffic control zones vary with such conditions as road configuration, location of the work, work activity, duration of work, road user volumes, road vehicle mix (buses, trucks and cars) and road user speeds. Examples presented in the **OMUTCD** are guides showing how to apply principles and standards. Applying these guidelines to actual situations and adjusting to field conditions requires judgment. In general, the procedures illustrated represent minimum solutions for the situations depicted.

Other devices may be added to supplement the devices shown in the various applications presented in these documents. Device spacing may be adjusted to provide additional reaction time or delineation. Fewer devices may be used based on field conditions.

The legend for the symbols used in typical applications presented in the **OMUTCD** and the **TEM** is provided in **OMUTCD Table 6H-2**. In many of the typical applications, sign spacings and other dimensions are indicated by letters using the criteria provided in **OMUTCD Table 6C-1**. Most of the typical applications show temporary traffic control devices for only one direction.

The following are general comments regarding the use of **OMUTCD** typical applications for **ODOT** work:

1. References to “activated rotating, flashing, oscillating or strobe lights” shall be interpreted as “activated yellow rotating, flashing, oscillating, or strobe lights.”

2. The Construction Arrow sign (W1-H16) may be used instead of the arrow board for lane closures on low-volume, low-speed roads and urban streets. The Construction Arrow sign may be used to supplement the arrow board on high-volume roads.

3. Traffic control signing for lane closures on multi-lane highways may be supplemented by Changeable Message Signs.

4. In long-term situations, additional advance Warning Signs may be desirable.

5. Portable barrier is one method that may be used to close a lane. Use of a barrier should be based on the need determined by an engineering analysis. The layout of the barrier should prevent vehicles from impacting the ends of the barrier. According to the **Roadside Design Guide (RSDG)** ***(Section 193-4)***, the barrier should be flared beyond the clear zone. An alternative procedure is to place an impact attenuator to protect traffic from the end of the barrier ***(see Section 605-14)***.

6. Where ramps exist within the limits of the project, the EXIT OPEN, EXIT OPEN AHEAD, EXIT CLOSED, and EXIT CLOSED AHEAD signs shall be used, as shown in the **Traffic SCD MT-98** series.

7. Where entrance ramps are located within the project limits and the mainline gaps are insufficient to provide proper merging, consideration should be given to closing the ramps.

607-2 Blasting Zone (OMUTCD Figure 6H-2)

On a divided highway, the signs should be mounted on both sides of the directional roadways.

607-3 Road Closed with Off-Site Detour (OMUTCD Figure 6H-8)

For unnumbered routes, the M4-9 DETOUR sign may be used instead of the M4-8 DETOUR.

607-4 Lane Closures on Low-Volume, Two-Lane Road (OMUTCD Figure 6H-11)

In long-term operations, a double-yellow No-Passing Zone should be added on the approach for the closed lane. The No-Passing Zone shall have a length of “A” as determined from **OMUTCD Table 6C-1.**

607-5 Lane Closure on Two-Lane Road Using Traffic Signals (OMUTCD Figure 6H-12)

For high-volume applications, consideration should be given to installation of the BE PREPARED TO STOP sign (W3-4) in advance of the Signal Ahead sign (W3-3).

607-6 Temporary Road Closure (OMUTCD Figure 6H-13)

When the temporary road closure occurs at night, Type A flashing lights should be used on advance Warning Signs and the flagger station shall be illuminated, except in an emergency.

607-7 Detour for One Travel Direction (OMUTCD Figure 6H-19)

A DETOUR sign with an advance arrow (M4-9) may be used in advance of a turn. On multi-lane streets, a DETOUR sign with an advance turn arrow should be used in advance of a turn.

607-8 Right Lane Closure - Far Side of Intersection (OMUTCD Figure 6H-22)

For long-term operations, pavement markings may be used to highlight the right-only movement.

607-9 Mobile Operation on Multi-lane Road (OMUTCD Figure 6H-35)

Shadow vehicle 2 in this figure may be equipped with a truck-mounted attenuator.

607-10 Lane Shift on Freeway (OMUTCD Figure 6H-36)

Additional signing should be provided as shown in **Traffic SCDs MT-102.10, MT-102.20 and MT-102.30**. This signing includes the TRUCKS USE LEFT (RIGHT) LANE sign (R-4-5, R-4-H5a) if the use of the shoulder is involved and it cannot adequately accommodate trucks. The Construction Arrow sign (W1-H16) should be used to supplement the drums used along the approaching shift taper.

Traffic SCD MT-99.30 addresses additional requirements for delineation along lane shifts.

607-11 Interior Lane Closure on Freeway (OMUTCD Figure 6H-38)

OMUTCD Figure 6H-38 cannot be used on **ODOT** freeways as shown. For work on projects which include **ODOT** funding or administering, an adjacent lane shall also be closed. This adjacent lane may serve to give the contractor additional work space for equipment and work vehicles transportation, or it may serve as a lateral buffer.

607-12 Median Crossover on Freeway (OMUTCD Figure 6H-39)

OMUTCD Figure 6H-39 shows signing for closure of the right lane in advance of the crossover. A left-lane closing may be used instead. For example, a left-lane closure is shown in **Traffic SCD MT-95.70 *(see Section 641-11)*.**

Additional information regarding crossovers is referenced in ***Section 606-16***.

607-13 Median Crossover for Entrance Ramp (OMUTCD Figure 6H-40)

OMUTCD Figure 6H-40 and *Figure 698-3* address traffic control for a median crossover to maintain access for an entrance ramp. Additional information regarding crossovers is referenced in ***Section 606-16***. The following additional guidelines should be used with this application:

1. This typical application should be used for accessing an entrance ramp across a closed directional roadway of a divided highway.

2. The crossover shall be designed for each specific location and incorporated into the construction plans. A temporary acceleration lane that provides adequate Decision Sight Distance (DSD) for merging traffic should be provided. If the required DSD cannot be provided, consideration should be given to closing the ramp. See ***Table 697-8*** for the required DSD. Additional DSD information is available in **Figure 201-6 of the L&D Manual Volume 1.**

   Should physical restrictions exist that preclude these minimums being provided, engineering judgment should be used to determine if a safe merging operation can be provided. Factors such as volumes, gap availability, sight distance, percent trucks, availability of alternate routes, and emergency access should be considered. Documentation should be kept on file supporting the decision to provide a merge with less than the DSD in ***Table 697-8***. The use of STOP (R1-1) or YIELD (R1-2) signs shown should only be considered when the required distances shown in ***Table 697-8*** cannot be provided and it is impossible or impractical to close the entrance ramp.

3. A broken edge line (dotted line) may be carried across the temporary entrance ramp to assist in defining the through vehicular travel lane.

4. When a temporary traffic barrier is used to separate opposing vehicular traffic, the Two-Way Traffic signs (W6-3) and the DO NOT ENTER signs (R5-1) may be eliminated.

607-14 Partial Exit Ramp Closure (OMUTCD Figure 6H-43)

An additional ROAD WORK AHEAD sign (W20-1) should be added if traffic backs up onto the mainline.

607-15 Work in Vicinity of Entrance Ramp (OMUTCD Figure 6H-44 and Traffic SCDs MT-98.10 and 98.11)

OMUTCD Figure 6H-44 provides traffic control information for work in the vicinity of an entrance ramp. **Traffic SCDs MT-98,10 and 98.11** depict an alternative designs that has been developed to provide additional geometric information pertaining to the required Decision Sight Distance (DSD) for long-term work zones ***(see Table 697-8)***. The following additional guidelines should be used with these figures:

1. The left diagram in **OMUTCD Figure 6H-44** can be used for both short and long-term work zones where it is acceptable to close the outside mainline lane.

2. The right diagram in **OMUTCD Figure 6H-44** should only be used for short-term operations where engineering judgment indicates that a safe merging operation can be provided. Factors such as volumes, gap availability, sight distance, percent trucks, availability of alternate routes and emergency access should be considered when deciding to provide this method of traffic control or closing the entrance ramp.

3. When used, the YIELD sign (R1-2) shown in the right diagram of **OMUTCD Figure 6H-44**, should be located so that ramp vehicular traffic has adequate sight distance of oncoming mainline vehicular traffic in order to select a safe gap in the mainline vehicular traffic flow. Also. a longer acceleration lane should be provided beyond the sign to reduce the gap size needed. If insufficient gaps are available, consideration should be given to closing the ramp.

4. Where a mainline lane is closed, the closure should be sufficiently in advance to stabilize vehicular traffic flow before encountering the merge.

5. For **OMUTCD Figure 6H-44** the mainline merging taper with the arrow board at its starting point should be located sufficiently in advance so that the arrow board is not confusing to drivers on the entrance ramp, and so that the mainline merging vehicular traffic from the lane closure has the opportunity to stabilize before encountering the vehicular traffic merging from the ramp.

6. If the ramp curves sharply to the right, Warning Signs with Advisory Speed plaques located in advance of the terminal should be placed in pairs (one on each side of the ramp).

7. Where the acceleration distance is significantly reduced, a supplemental plaque may be placed below the Yield Ahead sign (W3-2a) reading NO MERGE AREA (W4-5P).

8. **Traffic SCD MT-98.10 or 98.11** ***(see Section 641-14)*** should typically be used when designing long-term on-ramp merges with a mainline work zone. See ***Table 697-8*** for the required Decision Sight Distance (DSD). Additional DSD information is available in **Figure 201-6 of the L&D Manual Volume 1**.

   Should physical restrictions exist that preclude these minimums being provided, engineering judgment should be used to determine if a safe merging operation can be provided. Factors such as volumes, gap availability, sight distance, percent trucks, availability of alternate routes, and emergency access should be considered. Documentation should be kept on file supporting the decision to provide a merge with less than the DSD in ***Table 697-8***. The use of STOP (R1-1) and YIELD (R1-2) signs shown in the the **OMUTCD** should only be considered when the required distances shown in ***Table 697-8*** cannot be provided and it is impossible or impractical to close the entrance ramp.

608 Incident Management

608-1 General

Traffic incidents are unpredictable, unique occurrences which restrict traffic flow. They are unplanned events such as emergencies and crashes, and each must be addressed individually. Effective incident management can help to increase safety at an incident scene, reduce costs associated with incidents and quickly restore traffic to its original flow.

OMUTCD **Chapter 6I** and ***TEM Chapter 608*** describe various incident management tools that can be effective in handling different types of incidents. Typically, each incident will require a unique approach and solution.

608-2 Ohio QuickClear Program

The **Ohio** QuickClear Program is an effort by **ODOT**, **ODPS** and various interested organizations to develop a checklist for incident responders and a best practice guide for incident management. The Program is “committed to maintaining the safe and effective flow of traffic during emergencies as to prevent further damage, injury or undue delay of the motoring public.” The idea behind QuickClear is to get traffic moving as safely and quickly as possible, through the timely removal of disabled vehicles from traffic lanes to the shoulder, or, if possible, to the nearest interchange to decrease severe congestion delay and secondary crashes caused by incidents.

QuickClear focuses on the ideas of multiple agency cooperation. Each first response agency has different goals and agendas. For law enforcement the focus is on preserving the scene for the collection of evidence to determine negligence, while the fire department is concerned with protecting the scene including the victims and personnel. Along with these agencies, **ODOT** and other transportation organizations direct their efforts on traffic management and incident clearance, while towing companies are responsible for the removal of vehicles from the incident scene. It is essential for all of these agencies to work together using QuickClear methods to ensure that everyone can complete their job as safely, quickly and efficiently as possible.

While most of the emphasis about QuickClear in **Ohio** has been on urban freeways, QuickClear practices can also provide benefits on rural highways as well. These methods can help reopen rural roads in a timely manner, avoiding or minimizing the use of extensive detours or road blocks.

More detailed information on the Ohio QuickClear Program and QuickClear practices can be found on the web using the QuickClear link from the **ODOT** homepage, or using the link provided here.

Information about the Ohio QuickClear Program is currently being presented to first responders, **Emergency Management Agencies (EMA),** local jurisdictions and other groups around the **State.** This effort is intended to improve awareness of the program and further relationships and dialogue among the various agencies. Presentations can be scheduled through the QuickClear website mentioned above. All first responders are encouraged to use QuickClear methods to provide safer and more efficient roadways.

For effective incident management, including QuickClear procedures, debriefing or after-action meetings should be held after incidents resulting in excessive closures. It is desirable for all agencies involved in the management of the incident to participate in the meeting. These meeting are intended to ensure that continued improvements are being made in regard to incident management techniques and that all parties involved in incident response are aware of new practices by other agencies.

608-3 Incident Logging

To help with overall incident management, it is a important to log traffic incidents. These logs can be reviewed at a later date to help improve incident management techniques, or they can be used for secondary crash research purposes. Whatever the reason, all incidents that result in freeway closures should be logged. The route, mile marker, time of closure, time of opening, duration and cause of closure should always be documented in some way.

All Freeway Management Systems (FMSs) ***(see Chapter 1303)*** have incident logging capabilities through the Statewide Traffic Management Center (TMC) ***(Section 1303-2)***. TMC operators log incidents as they detect them across the six major metropolitan areas covered.

608-4 Permitted Lane Closure Schedule (PLCS)

The Permitted Lane Closure Schedule (PLCS) for freeway/expressway and roadway segments should be evaluated for every incident. For more information on the **ODOT** PLCS see ***Section 630-4***. The PLCS is contained on the **ODOT** website. Ideally, such schedules would be established for all highways to manage delays due to incidents and recurring congestion. Additional benefits of using PLCS requirements include reducing exposure of fire personnel, EMAs, law enforcement, and other responders to traffic hazards, and reducing the danger of secondary crashes to the public. Priority should be given to PLCS segments for all types of incidents, including crashes and diesel spills. It may not be possible to expedite the opening of PLCS segments for every incident (for example, some hazardous material (HazMat) incidents and unusual circumstances). However, all agencies should make every effort to follow the protocols and attempt to open lanes as soon as possible, particularly in order to not violate PLCS closure restrictions.

608-5 Detour Playbook

The **ODOT** Detour Playbook, usually referred to simply as the Playbook, is a set of predetermined detour routes for PLCS segments across the **State**. Each detour is referred to as a Play. Originally, the detours were developed by each **District** individually. The detours for each **District** were compiled and stored in a variety of ways available in hard copies and/or electronically. These detours or "Plays" were consolidated by **Central Office** and integrated into the Playbook. Currently, the Playbook can only be accessed by **ODOT**, using this link. In the future, the Playbook may be made available to other non-**ODOT** agencies, but the process for this distribution is still being developed.

For incidents that result in excessive closures, it is suggested that a Play (detour) be enacted. This will help to reduce congestion around the incident scene and will help to protect first responders. It should be noted that only PLCS segments will have Plays available. If a non-PLCS is expected to be closed for an extended amount of time it is recommended that a detour also be established to assist with traffic, but this detour will need to be created and implemented at the incident scene. If an incident results in a Play being used, the various agencies in the area should review the effectiveness of the chosen Play during the debriefing, or after-action meeting. At the debriefing, improvements to the Play and overall incident response should be discussed. See ***Section 608-2*** for more information on debriefings.

When the **Districts** draft new Plays or revise old ones, the affected local jurisdictions should be consulted to review the plan, provide comment, and exchange or update contact information. Each **District** should update their Plays prior to each construction season to reflect any necessary revisions that may be caused by construction or changes to the roadways.

608-6 Hazardous Materials (HazMat)

Currently, **ODOT** is developing procedures for HazMat spills. Although HazMat incidents constitute a small percentage of the incidents occurring on **Ohio's** roadways, they are responsible for a large portion of the delay. Several endeavors are underway to address these incidents. At this time, **ODOT** is to contact a contractor or HazMat Team to perform the cleanup. However, a specific HazMat contract may be developed by the **Office of Traffic Operations (OTO)** to help facilitate this process in the future.

608-7 Diesel Spills

608-7.1 General

The cleanup of diesel spills is a reoccurring problem in **Ohio**. In the past, small scale spills (less than 300 gallons) have caused roadways to be closed for hours. Through task force discussions, it was estimated by the **Ohio Environmental Protection Agency (OEPA)** that approximately ninety percent of freeway closures are the result of spilled or leaked diesel fuel from commercial vehicles. After examining these incidents, it was determined that a new set of procedures needed to be established to help facilitate the timely cleanup of diesel spills.

Deisel spills have often resulted in travel lanes remaining closed to motorists for an extended period. These delays are most commonly attributed to the fact that the trucking company responsible for the cleanup cannot be contacted or cannot provide cleaning operations in a timely manner.

ODOT has established a uniform statewide procedure, overseen by the **Division of Operations**, to provide for removal of small diesel fuel spills from freeway travel lanes by **ODOT** staff. This procedure shall only apply to those areas covered under the PLCS (see ***Sections 608-4 and 630-4).*** See ***Section 608-7.3*** for guidelines on how to handle diesel spills on Non-PLCS roadways.

608-7.2 For PLCS Segments

608-7.2.1 General

The diesel spill cleanup activities are intended to expedite the opening of freeways and freeway lanes to traffic that are closed due to crashes, where:

1. Only a small quantity of diesel fuel has leaked or been spilled on the roadway surface, and
2. No other reasonable means is available to quickly and safely open the lanes.

These cleanup operations are in addition to performing **ODOT's** usual traffic control activities, and will be performed under the supervisor's direction. It is anticipated that the **ODOT** Highway Technician (HT) supervisor will be the **County Manager** and that the Freeway Service Patrol (FSP) operators' supervisor will be the **FSP Manager** or the **Highway Management Administrator (HMA)**. Supervisors and managers are required to direct staff to perform activities only within each person's training capability, in cooperation with the first responders, and within the Incident Command System (ICS). See ***Section 608-8*** for more information on ICS.

The following restrictions and criteria apply to **ODOT** diesel fuel spill cleanup activities, and are described in further detail later in this Section:

- Only personnel trained for diesel cleanup may participate in the handling of absorbent materials and diesel spill cleanup activities.
- The cleanup is limited to diesel fuel only.
- The cleanup is limited to 300 gallons of diesel fuel or less.
- This is a quick clean and is an expedient measure to quickly and safely open travel lanes to traffic.
- **ODOT** personnel will not use plugging material on tanks without additional required training.
- Follow the ICS. **ODOT** will cooperate with first responders and follow the ICS (see ***Section 608-8)***.

- Cooperate with first responders and **OEPA** at the **County Manager's** direction.
- No contaminated material may be brought back to an **ODOT** facility.

608-7.2.2 Diesel Spill Training

Training is required for each **ODOT** Highway Technician assigned to a county with a PLCS segment of freeway and/or expressway. It is recommended that **County Managers** and other **ODOT** staff involved with incident management also attend the diesel spill training. The **ODOT Office of Training**, in cooperation with the **Ohio Fire Academy** will provide the diesel spill training, which will be presented in two parts. Part 1 consists of the HazMat and WMD (Weapons of Mass Destruction) Awareness training course provided by the **Ohio Fire Academy**. Part 2 consists of **ODOT** training, provided through the **ODOT Office of Training**. Part 2 will focus on **ODOT**-specific diesel spill cleanup initiatives and provides hands-on instruction.

Part 1 of the training is complete for all current HTs in counties with PLCS segments, and Part 2 will be implemented within the next several months. Additional training sessions will be provided as necessary for new hires. Questions concerning training and procedures may be referred to the **Division of Operations**.

It is recommended that **County Managers**, **FSP Managers**, and **HMAs** attend ICS training to help facilitate more effective diesel spill cleanups and incident management in general. HT staff will work under the supervision of their usual supervisors, all working within the ICS approach ***(Section 608-8)***.

608-7.2.3 Cleanup Procedures

ODOT's diesel spill activities include evaluation of the material and quantity spilled or leaked, clearance from first responders and consideration of other options for spill removal. These activities are regulated to provide safety to **ODOT** staff and criteria for efficient cleanup.

Incident notification is to remain unchanged. **Districts** will receive notification of an incident in the usual manner. Activities related to diesel spills will be initiated based upon requests from first responders or **ODOT** incident management staff, when first responders confirm that no other hazardous materials are likely to present a danger to **ODOT** responders.

HT staff who encounter a leaking fuel tank are to follow the established safety procedures listed below, and will follow the instructions provided during the HazMat and WMD Awareness training course, including evaluating placarding, consulting the **Emergency Response Guide (ERG)** and exercising appropriate caution. HT staff will not approach a vehicle which appears to contain materials which may endanger them.

Freeway Service Patrol (FSP) operators or other staff may encounter hazardous materials incidents as part of their normal activities, or **ODOT** may receive a request for assistance from a responding agency. When **ODOT** receives notification of a fuel spill, the following factors shall be addressed:

1. Is the spill diesel fuel? If the truck is placarded for hazardous materials and first responders are not available or are not able to verify that the only leaking material is diesel, the HT staff will not approach the vehicle. HT staff shall not cleanup gasoline and other non-diesel fuel spills. However, HT staff may provide absorbent material and other supplies and equipment to first responders to use in the cleanup of non-diesel spills. Examples of absorbent material include clay (kitty litter), special purpose fuel absorbers (e.g. Floordry or Petesorb), or hydrophobic mat or roll material.
2. Is the spill reportable? A reportable spill is 25 gallons or more or any amount in a waterway. While the party responsible for the spill is required by law to report it to

OEPA, **ODOT** should report a spill to **OEPA** even if other agencies indicate that it has been reported.

3. Is the spill quantity 300 gallons or less, which is defined as an incidental spill? As an aid in estimating the spill quantity, a typical full saddle tank contains 150 gallons. If both of a semi-tractor trailer's saddle tanks were full and began leaking, the leak would not be more than 300 gallons. If the incident involved a tanker carrying diesel fuel cargo with a cargo tank leak, it should be assumed that the leak is more than 300 gallons. In that case, **ODOT** HT staff would not be allowed to participate in cleanup activities. However, once again, HT staff may provide absorbent material and other supplies and equipment to first responders to use in the cleanup of releases larger than 300 gallons.

If a truck's saddle tank is leaking diesel fuel, in addition to using absorbent material, the HT staff may place a collection pool under the leak to contain it.,. However, HT staff may not use leak plugging products (referred to as Plug and Dike) without attending the applicable, more extensive training. For more information, contact the **ODOT Office of Employee Development**. HT staff may provide leak plugging materials or other supplies and equipment to first responders who have been trained to use it in stopping the leak.

608-7.2.4 Removal and Disposal

After the diesel fuel spills have been contained and absorbed, the used absorption material shall be moved to the shoulder or berm, placed in a barrel or placed on and covered with visqueen sheetsl, as appropriate. Weight shall be placed on the visqueen sheets to prevent wind or water from disturbing the material. After removing the diesel fuel and absorbent material, coarse sand shall be applied to the roadway surface to provide traction. Under no circumstances shall the used absorbent material or other material with diesel fuel to be brought to an **ODOT** facility. **ODOT District** personnel shall follow up to ensure that **OEPA** requires the responsible party to remove the absorbent material and other incident debris.

The **ODOT** diesel spill cleanup is a statewide initiative to provide a safe and quick option for opening freeway travel lanes to traffic when diesel is involved. This initiative is not intended to replace cleanup by the trucking company, its insurer or a cleanup service for the insurer. This procedure is intended for those situations in which the closure violates the PLCS or the **County Manager** determines that the closure is excessive due to lack of available cleanup services. The goal is to safely and efficiently restore traffic flows.

608-7.2.5 Documentation

As noted in ***Section 608-3***, it is important to log traffic incidents. The **ODOT** HT or FSP staff who responds to a diesel spill incident shall document the incident. Some **Districts** may choose to use existing documentation for this and some may create a special diesel spill response form. For recommendations, contact the **Office of Traffic Operations (OTO).** The information collected shall be as complete as possible for each spill addressed by **ODOT** and shall be maintained in a **District** file. The information listed below should be documented for each spill.

- Time/date.
- Location (Roadway, County, milepost location).
- Estimated amount of diesel on roadway.
- Weather conditions.
- Responders on site (**ODOT**, **OEPA**, etc.).
- Name of trucking company.
- License plate number.
- Driver's name.

- Fire/Police incident number.
- Time/Date on and off site.
- Information for cost recovery (material used) – type and amount.

Any reporting and documentation required by **OEPA** should also be followed. See the **OEPA** homepage for more information.

608-7.2.6 Additional Requirements

It is recommended that a copy of the **Emergency Response Guide (ERG)** be available to each spill responder. **Districts** may decide to keep the documents in **State** vehicles, to require each HT employee to carry them when on duty, or use other means of making them readily available. Training for use of the **ERG** is provided in the HazMat and WMD Awareness training course (Part 1) and copies are provided to HT staff at the Part 2 training. The **ERG** provides critical information for isolation zones and other criteria for use by anyone who encounters an incident involving a HazMat.

Each county with PLCS is expected to have ready access to diesel spill equipment and supplies. Counties with PLCS segments in which an **Emergency Management Agency (EMA)** routinely provides hazardous material cleanups may request a waiver from the **ODOT Division of Operations** **Deputy Director**, based on a **District's** agreements with the local **EMA** that will exempt them from the storage of diesel spill cleanup material.

608-7.2.7 Program Evaluation

ODOT will use QARs to verify that personnel have current knowledge of policies and procedures, and to share best practices information.

608-7.3 For Non-PLCS Segments

On non-PLCS highway segments, the usual cleanup methods apply. These include response by the trucking company, its agent, the fire department or other responding agency. In some situations, the **County Manager** or **District** may decide that traffic volumes or other circumstances warrant an **ODOT** response. The various limitations on **ODOT** response (maximum of 300 gallons of diesel fuel, diesel fuel only, etc.) noted in ***Section 608*** shall also apply under these circumstances.

608-8 Incident Command System (ICS)/National Incident Management System (NIMS)

As noted in ***Subsection 608-7.2.1***, all **ODOT** personnel working on an incident scene will be required to follow the Incident Command System (ICS). In the ICS there is an **Incident Commander (IC)** who functions as the leader for the incident response. Usually this role is held by the fire chief for large incidents, but other high ranking first responders may hold the position as well. Also, the position may change hands, from one **IC** to another, based on the stage of the incident clearance. For example, the fire chief may be in charge until all the victims have been removed from the scene. At this point, a police officer may take control to facilitate the vehicle removal process.

The ICS can also be classified under a unified approach. This means that there will be many leaders on the incident scene who will take charge of different tasks that need to be accomplished. All of these leaders will then report to one central **IC** who will help to facilitate the overall operation and who will not have to worry about the details of individual aspects of the incident response.

Incident management responders should also use the guidelines set forth by the **National Incident Management System (NIMS)**. Training for both the ICS and NIMS can be obtained through **ODOT**. Contact **OTO** for more information on these programs.

608-9 Freeway Service Patrol (FSP)

608-9.1 General

Freeway Service Patrols (FSPs) are another important component of incident management. Incidents have a negative impact on the efficient operation of freeways and FSPs help to minimize this impact. The mission of FSPs is to improve traffic safety and maintain traffic flow by efficiently clearing freeway travel lanes and shoulders of obstructions, and by assisting in traffic control around incidents. FSP services are currently being provided for the following metropolitan areas:

Toledo	District 2
Akron	District 4
Columbus	District 6
Dayton	District 7
Cincinnati	District 8
Cleveland	District 12

FSP operations are generally funded by **Districts**; however, one **District** has contracted out their FSP using outside funding. Also, some **Districts** have elected to provide limited FSP services in work zones in rural areas, particularly during holiday weekends and other peak travel times, to reduce the impacts of crashes and other incidents in areas with reduced capacity.

For any metropolitan area with a Traffic Management Center (TMC) ***(see Section 1303-1),*** which included **Columbus** and **Cincinnati** as of 2007, the FSP operators interact closely with TMC staff to exchange incident locations and pertinent information.

608-9.2 FSP Hours of Operation

The hours of operation for FSPs are anticipated to approximate the hours of peak traffic demand, since the FSP services provide the most benefit during this timeframe. **Districts** may elect to provide FSP coverage beyond the hours of the local TMC and beyond the areas covered by a Freeway Management System (FMS.) However, in these cases, **Districts** shall provide a plan for the safety and direction of the FSP operators when they do not have radio communication or direct supervision from the **District**. There shall also be a redundant facility(ies) which will provide limited coordination and assistance to the FSP, during any FSP hours extending beyond TMC hours.

608-9.3 Duties of FSP

The FSP operators shall assist assist with traffic control for major incidents, remove debris from travel lanes, address small diesel spills and assist motorists (with the same restrictions as the HTs; see ***Section 608-7***), and tag for future removal abandoned vehicles which are not blocking travel lanes.

FSP operators also need to be alert to traffic as well as the subject vehicle, maintain cell phone or radio communication with the TMC, record license plates before approaching a vehicle, and use caution and safe operating procedures to ensure their own safety. Communication with law enforcement and other FSP operators is essential, particularly in areas without a TMC or during times without **District** radio communication.

FSP operators shall document their activities. This log information is entered into a database for future use. The logs of incidents, summarized in the database to provide the necessary performance reviews, shall contain at least the following information:

- Driver and vehicle.
- Incident location and type.

- Start time and end time of assistance provided.
- Type of assistance provided.

If a vehicle is blocking a travel lane, the FSP operator should assess the situation by pushing or pulling the vehicle from the travel lanes onto the off ramp, when practical, or the shoulder, and then call for law enforcement assistance, as needed. If a motorist refuses to allow the vehicle to be moved, the FSP operator should explain that they are causing a hazard not only to oncoming motorists, but to themselves as well. If the motorist still refuses, the FSP shall promptly contact law enforcement and wait for them to enforce the removal.

608-9.4 Evaluation

Each **District's** FSP program will be evaluated quarterly to review conformance to general **ODOT** policies as well as specific FSP guidelines. The quarterly review will include:

- Conformance to policies, in regard to routes and time per assist. Any assist exceeding 15 minutes duration (unless **ODPS**, the fire department or police are involved) shall be documented to evaluate need and appropriateness of time spent.
- Conformance to general **ODOT** policy regarding employee conduct, safe vehicle operation, FSP operator safety, incident response procedures, correct data entry, etc.
- Review procedures for courteous and safe motorist assistance, distribution of customer response cards, etc

The response data shall be recorded for evaluation and identification of areas exceeding requirements or needing improvement. The **Statewide TMC** supervisors, FSP operators and the **Office of Traffic Operations (OTO)** will work together to further develop minimum and desirable levels of service through the QAR process.

608-10 OHGO Website

The **OHGO** website, previously known as Buckeye Traffic, offers snapshots of the video provided by CCTV cameras ***(see Section 1303-3)***, traffic, construction, weather and incident information.

The website provides information on travel delays and current lane closures to the public. Intercity travelers have the benefit of this information in their trip planning and decision making. Advance knowledge of road conditions and incidents may influence travelers to reroute, postpone or cancel a trip. If changes are not an option, the system lets drivers who do not alter their plans know to expect delays and they are able to plan accordingly. Historical information is only available to **ODOT** personnel at this time.

Districts are required to report all lane closures and enter them into the system. This includes both partial and full highway closures. Knowledge of these closures is critical for improvement. It also provides an essential ability to compare incidents to find similarities, and in turn enhancements, that need to be made to the incident management process. It is **ODOT's** goal to keep the roads safe and open to the public, but sometimes, partially or completely closing the roadway is necessary. In these cases, the extent and duration of the closure should be minimized. Events such as this may be identified using **OHGO**.

608-11 Evacuation Plans

Currently, **ODOT** is developing evacuation route plans for the metropolitan cities in **Ohio**. It is anticipated that many of the plans will include contraflow operations on freeways in the evacuation areas. These route plans will be combined with procedures from other first response agencies in the future to help build an actual evacuation plan. Emergency plans will be coordinated with local jurisdictions and will be updated as new information becomes available.

Intentionally blank.

Intentionally blank.

620 MATERIALS AND HARDWARE

620-1 General

Many features along a roadway, and particularly within work zones, present a hazard to the traveling public. These may be fixed objects, drop-offs, severe slopes, opposing traffic, construction materials and equipment, etc. In these instances, a positive means of separating traffic from these hazards must be employed.

Portable barrier, portable water-filled barrier, and guardrail are appropriate positive barriers for maintenance of traffic applications. However, the use of these positive barriers must be carefully considered on non-freeway / expressway routes due to property access concerns.

620-2 Safety Criteria

620-2.1 National Cooperative Highway Research Program (NCHRP) 350 Criteria

Work zone safety features, including barriers and impact attenuators, installed on the **National Highway System (NHS)** must demonstrate satisfactory crashworthy performance based on the **National Cooperative Highway Research Program (NCHRP) 350 Report, Recommended Procedures for Safety Performance Evaluation of Highway Features**, to be accepted by **FHWA**. The dates for mandatory compliance vary with different types of equipment. ***Section 620-7*** provides a detailed discussion of **NCHRP 350** compliance.

ODOT has determined that the **NCHRP 350** criteria shall apply to any **ODOT**-maintained highway regardless of whether or not the highway is on the **NHS**. The **NCHRP** safety criteria can be found on the **FHWA** website under the Programs handled by the **Safety Section**.

620-2.2 Other Safety Criteria

In addition to the **NCHRP 350** criteria, any work on **ODOT**-maintained highway shall meet the requirements of the **OMUTCD** and **TEM**.

Materials and equipment used on projects in the **State of Ohio** which are neither on the **NHS** nor on the state highway system must meet the criteria of the **OMUTCD**.

620-3 Sheeting

Faces of construction signs shall be retroreflectorized with Type G or Type H sheeting complying with **C&MS 730.19 and 730.192**. Except for Warning Signs used in incident management areas, the background color of all construction Warning and Guide Signs shall be fluorescent orange as per **C&MS 614.03.** For information regarding sheeting on other signs, see ***Section 220***.

For Warning Signs in incident management areas, the background color may be fluorescent pink.

Guidelines for sheeting quality are provided in **ODOT's Quality Guidelines for Temporary Traffic Control Devices** ***(Section 695-4)***.

620-4 Temporary Sign Supports

Temporary sign supports shall meet **NCHRP 350** guidelines ***(Sections 620-2 and 620-7)*** as well as the requirements of **Traffic SCD MT-105.10**.

620-5 Roll-Up Signs

Roll-up signs shall conform to **ASTM D 4956 Type VI**, and shall be retroreflective fluorescent orange or pink, as appropriate. The wind resistant sign supports shall meet the crash testing requirements in the **NCHRP Report 350**, and be approved for use by **FHWA**.

620-6 Pavement Markings

620-6.1 General

Work zone pavement markings shall conform to **C&MS 614.11**. Additional information on pavement markings in temporary traffic control zones is provided in **OMUTCD** **Section 6F.77** and ***Sections 605-11.10 and 605-11.11***.

620-6.2 Materials

Either **C&MS 642** (temporary paint) or **C&MS 740.06** (temporary tape) may be used on any surface which will either be removed or covered by another surface in a subsequent maintenance of traffic phase. Temporary pavement marking which would conflict with final traffic lanes shall be removable **C&MS 740.06** (Type I tape).

620-6.3 Dimensions

The line dimensions shall be as specified in **C&MS 614.11**. Line dimensions wider than those specified may be used in cases where increased delineation is necessary.

620-7 NCHRP 350 Compliance

620-7.1 History of NCHRP Report 350

The **Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)** required the **Secretary of Transportation** to institute measures to enhance the crashworthy performance of roadside features to accommodate vans, mini-vans, pick-up trucks and 4-wheel drive vehicles. In recognition of this requirement, the 1993 **National Cooperative Highway Research Program (NCHRP) Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features,"** contained guidance for testing highway features with vehicles to access the safety performance of those features. The Federal rule making of 1993 adopted this report as the safety criteria to be used in the evaluation of all new installations of applicable highway features included in projects advertised for bids or installed by **State** forces or under force account work as the national standard on the **National Highway System (NHS)**. The resulting nominal deadline for full compliance with the recommended guidelines in the **NCHRP 350 Report** was set at August 16, 1998. The safety criteria established by **NCHRP 350** will be implemented on all roadways maintained by **ODOT**. The local public authorities at their own discretion can adopt **NCHRP 350** as the safety standard on their roadways. However, all roadways maintained by local public authorities that are on the **NHS** must comply with **NCHRP 350** requirements.

620-7.2 Categories

The following is a list of the categories, and examples of devices in each category:

1. **Category 1** includes those items that are small and lightweight, such as channelizing and delineating devices. Included are items that have been in common use for many years and are known to be crashworthy by crash testing of similar devices or from years of demonstrable, safe performance. These include cones, tubular posts, flexible delineator posts, and plastic drums with or without lights.
2. **Category 2** includes devices that are not expected to produce significant vehicular velocity change but may otherwise be hazardous. Examples of items in this category are barricades, portable sign supports, intrusion alarms, and the following devices with lights mounted on them: vertical panels and cones.
3. **Category 3** includes hardware that is expected to cause significant velocity changes or

other potentially harmful reactions to impacting vehicles. Examples are concrete protection barriers, fixed sigh supports (mass > 100 lbs.), crash cushions, and other work zone devices not meeting the definitions of Category 1 or 2.

4. **Category 4** includes portable or trailer-mounted devices such as arrow boards, temporary traffic signals, area lighting supports, and portable changeable message signs.

620-7.3 Responsibilities

620-7.3.1 Office of Roadway Engineering (ORE)

All NCHRP 350 issues not specifically listed here as the responsibility of the **Office of Structural Engineering** or the **Office of Construction Administration** are **ORE's** responsibility.

620-7.3.2 Office of Structural Engineering (OSE)

Permanent bridge railing and bridge-mounted portable barriers are the responsibility of the **Office of Structural Engineering**. The implementations of these items have been addressed in their **Bridge Design Manual** in **Sections 304.1, General** and **304.3.4, Portable Concrete Barrier PCB-91**.

620-7.3.3 Office of Construction Administration (OCA)

The provisions of **NCHRP 350** also apply to safety hardware and temporary traffic control devices used on construction projects. This information has been incorporated into the **Construction and Materials Specification** book in section 614 Maintaining.

620-7.3.4 Districts

All work zone devices purchased for use by maintenance crews after the implementation dates shall be **NCHRP 350** compliant. The **District** should require all suppliers to provide a copy of the acceptance letter for all Category 1, 2, and 3 devices before any purchase is finalized if not on the **Office of Materials Management's** website of approved devices.

A listing of **NCHRP 350** compliant traffic devices may be found on this on-line "Documents" page.

Intentionally blank.

630 PLANNING / PROGRAMMING

630-1 General

The information in this Chapter is provided to assist planners and designers in the planning phase of a project or work assignment. For example, **Section 1400 of the L&D Manual Volume 3** indicates that a Maintenance of Traffic Alternative Analysis (MOTAA) will be performed and that is addressed in ***Section 630-5***. Various tools that are available are also addressed herein and this information is intended to help in making the choice of which tool to use and how.

630-2 Compendium of Traffic Control Options

Tables 697-1a through 697-1f provide a summary of various traffic control strategies/options used to maintain traffic through work zones or to direct traffic around work zones, along with advantages and disadvantages of these strategies. These options should be reviewed in the initial stages of any project.

630-3 Detours

Because temporary traffic control is an essential part of the overall project design and can often affect the design of the facility itself, the decision to either maintain traffic on the existing facility or to utilize a detour must be made early in the planning process. Some of the items that should be considered are:

1. Type of project.
2. Length of project.
3. Duration of project.
4. Volume and type of traffic.
5. Availability of detours or alternate route.
6. Length and adequacy of detour route.
7. Anticipated delays/backups.
8. Geometric requirements.
9. Capacity of reduced-width roadways.
10. Effect on local activities and residents.
11. Construction techniques.
12. Pavement types.
13. Economics.
14. Bridge Limitations - width/height/weight.
15. Adequacy of adjacent highways for use as detours, and the prohibition of construction and maintenance work along the detours while in use.
16. Railroad Grade Crossings.

In general, projects with detours shorten construction time, are less expensive to construct, and are safer for construction personnel. On the other hand, maintaining traffic generally is more convenient for the road user and has a less detrimental effect on local activities.

630-4 Permitted Lane Closure Schedule (PLCS)

Lane closures on Interstate and other freeways and expressways shall meet the minimum criteria presented in **Policy 21-008(P)** ***(see Section 601-2)***

On the basis of this policy, **ODOT** developed a series of lane closure schedules. These schedules indicate the hours of the day in which a lane closure is permitted at a subject work zone location. Maintenance of Traffic (MOT) plans shall be in conformance with the permitted lane closure schedule (PLCS). However, as discussed in the policy, exceptions may be permitted, based on results of a queue length study or by exception request. ***(see Section 601-2)***.

If it is found that lane-closure requirements cannot be met at a reasonable cost at the subject work zone, the **District** has the option of applying for an exception or modification of the lane closure restrictions at the site. If such exception is not approved, the maintenance of traffic plans shall be revised to meet the requirements of the PLCS.

The PLCS is available on the **ODOT** website.

630-5 Maintenance of Traffic Alternative Analysis (MOTAA)

As noted in ***Section 630-1***, **Section 1400 of the L&D Manual (Volume 3)** indicates that a Maintenance of Traffic Alternative Analysis (MOTAA) will be performed. This analysis shall be submitted during the Preliminary Engineering Phase for review and approval for any projects following Paths 4 or 5 of the Project Development Process (PDP). For PDP Path 3 projects, only work zones on the Interstate or Interstate look-alike system need to be analyzed. Like many analyses, the MOTAA may not be applicable to certain projects. Specifically on urban/downtown projects, the consultant should meet with **Central Office** and **District** personnel to determine how the MOTAA should be completed.

The purpose of the MOTAA is twofold. First, it provides **ODOT** with information for use in determining if, primarily, a part-width construction or crossover construction, or secondarily (and if deemed necessary), a contraflow construction, or hybrid construction scenario is better for a given work zone. Secondly, the MOTAA identifies potential problems, i.e., “constraints” with the various scenarios and allows **ODOT** to make an informed decision on how to address these problems prior to the actual detailed design of plans.

A Maintenance of Traffic Alternative Analysis (MOTAA) shall address the following requirements:

1. For Non-Interstate and Non-Interstate Look-alike Work Zones (Projects on PDP Paths 4 or 5):
   a. Investigate maintenance of traffic for each alternative.
   b. Include an evaluation of maintenance of traffic for ramps, local roads and cross streets.
   c. For each alternative determine:
      i. Number of lanes to be maintained.
      ii. Type of maintenance of traffic (i.e., signalized, detoured, part-width, runaround, crossover, etc.).
      iii. Lane widths.
      iv. Typical sections.
2. For Interstate and Interstate Look-alike Work Zones (Projects on Paths 3, 4, or 5):

   Analyze the maintenance of traffic (MOT) for both part-width construction and crossover construction. Should the part-width and crossover alternatives prove to have significant MOT constraints, or prove impractical or otherwise not possible to construct, the analysis should then include a contraflow and a hybrid construction technique as additional alternatives. Although individual project needs vary, the additional alternatives are more likely to be necessary due to constraints or practicality in replacement-type projects rather than widening-type projects.

   a. Provide a Lane Configuration Diagram (schematic or sketch) covering the entire project length. Include the following information on each Diagram ***(see Figure 698-8)*** :
      i. Arrows showing lane use, including merging and diverging ramps in relation to work areas and barriers.

ii. All bridges.

b. Provide cross sections between every interchange, on every bridge, at merge and diverge points (ramps), where overpass piers are present, and at other “pinch” points. Where bridge widths vary, show the narrowest part of the bridge. Cross sections shall be shown for all phases of all construction alternatives. Existing cross sections shall also be included ***(see Figure 698-8)***.

The following shall be used to create the above cross sections.

i. The number of lanes to be provided during construction shall satisfy **ODOT’s Policy 21-008(P), Traffic Management in Work Zones** ***(see Section 601-2)***.

The number of lanes required by this work zone policy is a starting point for the analysis. It is not meant to imply that a work zone policy exception will never be needed. In fact, ability to meet the work zone policy is one of the constraints that will be specifically examined in ***2c***. As noted in ***Sections 601-2 and 630-4***, the permitted lane closure schedules (PLCS) on **ODOT’s** website define what hours a lane reduction is allowed on any segment of **Ohio’s** Interstate and Interstate Look-alike system. Any work zone that violates the PLCS will require a detailed queue analysis per the work zone policy and an exception request, if necessary, depending on the outcome of the queue analysis.

ii. Typically show 11-foot lanes unless a narrower lane(s) provides significant benefits in terms of mitigating maintenance of traffic constraints as discussed in ***2c***. It is permissible to utilize 10 foot lane(s) on bridges where insufficient space cannot provide for all lanes to be 11 foot; however, the wider lanes are preferred whenever feasible. Show lane widths on cross sections.

iii. All exit and entrance ramps are to be maintained with the same number of lanes during construction as pre-construction.

iv. A minimum 2-foot clearance will be provided between lanes and barrier toes and between the barrier toe and the work. Show all clearance/buffer widths on cross sections.

v. Show existing beam spacing on bridge decks.

vi. Show bridge deck cut lines in relationship to existing beams. Give the length of cantilevered section of bridge deck after the cut line.

vii. Show a 2-foot paved shoulder where possible; and indicate locations where this is not possible.

c. Provide a table of constraints for each alternative in the form of a “Constraint Table” ***(see Form 696-1a)***. In addition to this table, highlight any areas where the cross section required by **ODOT’s Policy** cannot be provided (e.g., cannot provide a 2-foot paved shoulder in a particular area.)

All of the constraints should be explicitly covered in the analysis. Do not provide general responses such as “no difference between options.” In addition, if a constraint is identified, indicate the magnitude where appropriate.

Providing the required number of lanes, entrance ramp merge distance and maintaining the same number of exit ramps are important emphasis areas. Should it not be feasible or financially prudent to provide them, explain in detail the issues that preclude them from being provided.

The Constraint Table ***(Form 696-1a)*** shall include the following categories:

i. Ability to comply with Work Zone **Policy 21-008(P)** ***(see Section 601-2)***.

ii. Ability to maintain all entrance and exit ramps.

iii. Ability to provide required entrance ramp merge decision sight distance ***(Sections 607-13 and 607-15, and Table 697-8)***.

iv. Right-of-way impacts.

v. Environmental impacts.

vi. Bridge widths.

vii. Significant impacts for construction duration and construction costs.

viii. Significant impacts to earthwork, retaining walls, shoulder buildup, pier clearances, profile differences, etc. Ability to maintain existing drainage and lighting systems.
ix. Constructability and construction equipment access.
x. Location of crossovers.
xi. Access impacts to important traffic generators such as hospitals, fire departments, industries, sports arenas, etc.
xii. Longitudinal joints for concrete pavement.
xiii. Estimated Maintenance of Traffic costs.

It is not the intent of the MOTAA to require a detailed design of each alternative's work zone. It is intended to identify and compare major potential constraints of the work zone alternatives.

The MOTAA may be a factor in choosing the preferred alternative and will serve as the basis for scoping the project's work zone design. The analysis should be a comparison of alternatives that documents maintenance of traffic constraints. It should address the benefits and problems between the alternatives.

The analysis shall be submitted concurrently to the **District** and the **Office of Roadway Engineering**. The analysis shall include a project description indicating the type of work. For Non-Interstate and Non-Interstate Look-alike Work Zones (Major Projects only) the information required in ***Item 1*** of this Section shall also be provided. For Interstate and Interstate Look-alike Work Zones, the following shall be included in the submission:

- **Background Information and Description of Alternatives.**
- **Lane Configuration Diagrams and Cross Sections.** Lane Configuration Diagrams (schematic or sketch) for the entire project length as described in ***2a*** of this Section. The cross sections shall be provided for the locations called for in ***2b***. In the Lane Configuration Diagram, along with each roadway schematic or sketch, the corresponding cross sections shall be displayed on the same sheet. Each cross section location shall have its own identifier, i.e., do not repeat section 'AA' at a different location(s). If a cross section is provided at the same location in several phases, it shall be identified the same in each phase to provide easy identification.
- ***Form 696-1a, Work Zone Constraints.*** This form shall be incorporated into the analysis report. The content of each box in the form should indicate if that work zone constraint will be an issue with each alternative and the level of impact: Low, Medium or High for Cost, Duration and Constructability. Where a constraint is identified, it should be clear in which phase(s) of construction the constraint will be present. The constraint shall also be explained with sufficient information for **ODOT** to determine the magnitude of the constraint (see ***Form 696-1b*** for an example).
- ***Form 696-2a*, Bridge Information**. This form shall be incorporated into the analysis report if any bridges are included within the project limits. This includes underpasses and overpasses as well as pedestrian and bicycle bridges. The form shall include the extent of work being completed on the bridge, type of bridge (e.g., overpass, underpass), length of bridge, existing pier spacing, existing bridge widths, bridge widths needed for each MOT alternative, future bridge width, and additional costs associated with the MOT for each bridge in each MOT scheme. Columns may be added to the table as needed (see ***Form 696-2b*** for an example).
- ***Form 696-3a*, Ramp Information**. This form shall be incorporated into the analysis report. The table shall include the ramp designation, number of lanes, ramp volume, ramp truck volume, decision sight distance, whether the ramp will be open or closed (if closed – duration of closure), and detours for closures. Columns may be added to the table as needed (see ***Form 696-3b*** for an example).
- ***Form 696-4a*, Cost Comparison**. A table comparing the cost and project duration for each alternative analyzed shall also be included. The costs are just best available engineering estimates. Major cost differences between alternatives should be noted (e.g. temporary bridge widening, temporary pavement, portable barrier, additional right-of-way, retaining walls, etc. (see ***Form 696-4b*** for an example).

- **Rolled Plans for Complex Projects.** For complex projects, **ODOT** requires a set of rolled plans showing the entire length of the project. Each construction phase with its corresponding traffic phase should be color coded. A legend shall be provided showing different colors for permanent roadway, permanent bridge, temporary roadway, temporary bridge, etc. Cross-hatching shall be shown on each construction area that is critical for the next phase. Other items to be denoted using colors or symbols include ramp closures, structures to be removed or demolished, color coding for traffic routing, and arrows showing direction of traffic flow.

  A rolled plan shall also be included showing the existing profile and the proposed final profile of the entire project.

Complex projects, for this purpose, are defined as all urban projects, and non-urban projects which involve temporary pavements, significant localized alignment modifications from phase to phase, etc. Projects which involve significant modifications to interchanges, with a high number of sub-phases, are also considered complex projects. Any project which involves more than two phases and a possible third phase to upgrade the shoulder could also be considered a complex project.

The MOTAA shall include a summary. It is not the responsibility of the design team to determine if one alternative is not feasible and therefore should not be analyzed. The alternatives should be analyzed and the information included in the report. **ODOT** will determine, based upon the analysis, which is the preferred alternative.

630-6 Conceptual Maintenance of Traffic

Section 140-7 and **Section 1400 of the L&D Manual** **Volume 3** note that a Maintenance of Traffic (MOT) Conceptual Plan is required as part of the project development. This plan shall be based on the preferred alternative determined by **ODOT** after reviewing the MOTAA ***(see Section 630-5)***.

The MOT Conceptual Plan should include a stick drawing (schematic or sketch) of the preferred alternative covering the entire project. The drawing should include some, if not all, of the information listed in ***Section 630-5(2b)***. The information in ***Section 630-5(2c)*** shall be used to create the cross/transverse sections.

Intentionally blank.

640 DESIGN INFORMATION

640-1 General

The goal of any maintenance of traffic strategy should be to safely route traffic through or around a construction area while providing room for the contractor to work effectively. Ideally this should be done while keeping the geometrics and traffic control as close to those for normal operating conditions as possible. This frequently requires the engineer to balance the needs of the contractor to construct the project with the needs of the traveling public to minimize delay, maintain safety and maximize cost-effectiveness. In order to adequately serve both the contractor and the traveling public, various maintenance of traffic strategies should be analyzed before determining the final strategy. The plans should have some built-in flexibility to accommodate delays or unforeseen changes in the work schedule, field conditions or traffic patterns. The impact on land owners must also be considered.

Per **23 CFR 630.1006**, every plan shall have a Traffic Control, or Maintenance of Traffic (MOT), Plan ***(see Section 602-2)*** commensurate with the project's scope. This Chapter provides guidelines and references used in designing this MOT Plan. Generally, the Plan should include references to related **SCDs** and show details, notes, sequences, procedures, limitations, equipment, materials and other items required to maintain traffic. ***Chapter 641*** provides additional design information related to specific typical applications and **SCDs**. Standard **Plan Notes** for temporary traffic control items are provided in ***Chapter 642.***

Capacity constraints are vital considerations in preparing MOT Plans. In the following Sections, capacity constraints are discussed for various types of facilities. The traffic volumes used in each discussion of capacity are maximum values for which the corresponding lane closures can be used. Where traffic exceeds the constraining volumes, consideration should be given to limiting work to non-peak hours, establishing alternate routes or using the shoulder as a traffic lane. See other appropriate Sections, including ***Section 630-4*** (Permitted Lane Closure Schedules), for further discussion on these considerations.

The designer must use engineering judgment in combining these guidelines with site-specific conditions to create a safe and efficient work zone environment. **L&D Manual Volume 3, Section 1306** also provides the designer some guidance in developing MOT plans.

640-2 Geometrics

The following discussion of geometrics should be used as a guide where maintenance of traffic is to be accomplished using the existing facility. Geometric criteria to be used in designing and utilizing temporary roads are discussed in ***Section 640-11***.

It is desirable to maintain lane widths equal to those on the existing facility. A reduction in the lane width will result in a reduction in lane capacity. The desired lane width on freeways and expressways is 12 feet. A 1.5-foot clearance from the edge line to the channelizing devices is also desirable. Where longitudinal concrete barrier is provided, a minimum clearance of 2.0 feet between the barrier and the adjacent travel lane and between the barrier and work area shall be provided.

If lane width reduction on freeways and expressways is necessary, it is desirable to maintain a minimum width of 11 feet. Widths should not be less than 10 feet on any highway unless the lane widths on the existing facility are less than 10 feet. In no case shall the lane width be less than 9 feet. See ***Table 697-4*** for required lane widths when the degree of curvature exceeds 10 degrees (horizontal curve radius is less than or equal to 500 feet). These lane width criteria shall also apply to freeway and expressway ramps. See the **Traffic SCD** **MT-98** series.

Although the above criteria are considered to be desirable minimums, any additional pavement width should be made use of to provide 12-foot lanes and additional shoulder width, if possible, to maximize road-user safety.

On freeways and expressways, the lengths of acceleration lanes should be maximized to provide safe merging. See ***Section 641-14*** and **Traffic SCDs** **MT-98.10 and 98.11**.

See ***Section 630-5*** for guidance in determining appropriate geometric criteria during the Project Development Process.

Channelizing device offsets, discussed in ***Sections 605-11.2***, should be provided in addition to lane widths. Attempts to provide larger offsets should be made whenever possible.

On spot improvement locations of very short length, such as bridge replacements or bridge reconstruction, where the clear roadway width (face to face of barrier or channelizing device) criteria stated above cannot be provided, lateral clearance requirements to barriers and channelizing devices may be reduced. However, at no time on such a project shall the distance face-to-face of barrier and/or channelizing devices be less than 12 feet on multi-lane highways ≥ 45 mph or 11 feet on other facilities. See ***Table 697-4*** for requirements on sharp curves (curve radius is less than or equal to 500 feet).

Where the horizontal alignment is to be altered from that of the existing roadway, the maintenance of traffic horizontal alignment shall conform to the criteria in **L&D Manual Volume 1, Sections 202.1 and 202.2**. The designer should also ensure that the minimum stopping sight distance criteria in **L&D Manual Volume 1, Section 201.2** and the vertical clearances from **L&D Manual Volume 1, Section 302.1** are satisfied. Vertical clearance may particularly become a problem in situations where a lane is shifted to use the shoulder and/or if work on an overhead bridge creates a reduced vertical clearance. If the existing clearance over the through lanes cannot be maintain, the **Office of Maintenance Operations' Special Hauling Permit Section** should be consulted to identify other minimum bridge heights in the area (upstream, etc.) and maximum heights they permit through the corridor. Each situation will need to be considered on a case-by-case basis, and potential treatments will vary depending on the conditions. This could range from establishing and signing for a nearby alternate route able to accommodate vehicles over the restricted height, to no additional treatment being needed. See ***TEM Section 202-7*** for additional information on when Low Clearance signs (W12-2 or W12-2a) are required to alert drivers of the condition.

640-3 Sequence of Operation

The maintenance of traffic notes should include a sequence of construction activities to coordinate the maintenance of traffic details, especially on complex projects. The sequence should include any planned stages, phases or steps as well as particular procedures if appropriate.

A stage typically identifies a period in which work is concentrated in one section of the project site. Each stage may appear as a separate construction project, as the work in one section of the project site is completed before the work in another section of the site is begun. Consideration should be given to relocating advance Warning Signs with each stage change. Stages of construction may be separated by periods of inactivity. For example, this would be the case if the contractor is required to complete one stage by the end of one construction season, and is not permitted to begin the next stage until the beginning of the next construction season. Implementation of multi-stage construction is typically limited to large projects.

A phase typically identifies the duration of a specific traffic control set up. That is, at the point in time when one phase is ended and another phase is begun, a change in traffic control set up is involved. On freeway upgrading or resurfacing projects, the first phase often calls for traffic to be maintained on existing pavement while the shoulder is being improved for use as a travel lane in later phases. The final phase often calls for traffic to be maintained on the final pavement surface while miscellaneous work is being completed beyond the shoulder.

A step typically identifies a sub-phase. Often it becomes necessary to make modifications to the traffic control set up in one location within the project while the set up in general remains unchanged. There may be a small change in the construction activity taking place in one location, there may be a change in the location of the activity or the change in traffic control set up might be temporary. Any of these could be considered as an individual step if the designer finds a need for specifically identifying the set up.

On complex, multi-year Maintenance of Traffic (MOT) Plans consideration may be given to identifying project stages, phases and/or steps.

640-4 Lane Closure

Roadway construction often requires a reduction in the number of available lanes. This may require only a reduction in lane width or it may require complete lane closure. Lane closure may be required not only of the lane in which the activity is taking place, but also an adjacent lane in order to provide a barrier or a buffer between the workers and the vehicular traffic.

When there is a need to perform roadway maintenance or reconstruction in the interior lane of a freeway, an adjacent lane shall be closed in addition to the lane in which the maintenance or reconstruction is necessary. This additional lane may serve to provide access to construction traffic or equipment, or it may serve as a lateral buffer, see **OMUTCD** **Figures 6H-37 and 6H-38.** Caution is advised in the use of **Figure 6H-38**. Although this figure may be used to determine proper signing for splitting directional through movement, it does not provide for closure of the additional lane. Interior lane closure on **ODOT** projects shall be modified accordingly.

Before incorporating lane closures into the design of the MOT Plan, the effect of the lane closure on the traffic flow must be analyzed to insure that delay to the road users is kept within an acceptable range ***(see Section 640-13)***.

A minimum distance between adjacent lane closures should be provided. Suggested minimum distances are 2 miles in high-volume locations and 1 mile in low-volume locations. If the suggested distance cannot be provided, it is suggested that the lane closure be extended between the adjacent locations to form one continuous lane closure.

640-5 Use of Shoulders

640-5.1 General

Many maintenance of traffic situations require the use of either the full width or part-width of the paved shoulder as a traffic lane. Capacity, traffic characteristics, bridge width, work area location and existing shoulder characteristics all play a role in determining the extent of modifications and use of paved shoulders.

Any shoulder use for maintaining traffic requires evaluating the integrity of the shoulder pavement. The District Pavement Engineer and District Work Zone Traffic Manager shall be consulted in this evaluation. Engineering judgment should be used in making this evaluation. The designer should consider the percentage of truck traffic, duration of shoulder use, and the existing pavement condition, including the composition.

Traffic SCDs MT-102.10, 102.20 and 102.30 are examples of use of the shoulder as a traffic lane.

640-5.2 Provisions for Use of Shoulders

When a shoulder is to be used as a traffic lane certain provisions shall be made:

1. Lane width, in accordance with ***Section 640-2***, shall be maintained. This may require widening the existing shoulder.
2. The designer shall evaluate the strength of the shoulder and consider strengthening it or replacing it with temporary pavement.
   a. Shoulders used for maintaining traffic, which are determined to be of insufficient

strength, should be completely removed and replaced in accordance with the requirements of **L&D Manual Volume 1, Section 301.2** and the **Pavement Design Manual** ***(see TEM Section 194-9)***.

b. Shoulders used for maintaining traffic, which are determined to be structurally sufficient, should also provide smooth travel. Provisions should be made to recondition shoulder surfaces that are rutted, raveled or otherwise insufficient.

3. The designer shall examine structures to ensure that sufficient width and height are maintained.

4. The designer should evaluate the roadside for obstacles which may require protection. Temporary protection may be required at obstructions that were not previously protected. In such a situation, the clear zone values for the facility under normal conditions **(L&D Manual Volume 1, Figure 601-1)** may be reduced by 12 feet, but shall never be reduced to less than 2 feet.

During any sequence of operations where traffic is to be maintained within 2 feet of the edge of the paved shoulder, the graded shoulder area adjacent to the paved shoulder should be considered for strengthening. A bituminous aggregate base placed 8 inches deep, or a composition with similar structural characteristics, should be specified for 2 feet beyond the edge of the temporary traveled lane. This treatment should be placed in conjunction with final graded shoulder treatments when such shoulder use is required on final surface course pavements. This treatment may be left in place.

Part-width use of shoulders may be required when either work or channelizing devices encroach upon the traveled lane adjacent to the shoulder.

Minimum clearance from existing obstructions may be reduced by 12 feet when traffic is shifted onto the shoulder.

640-5.3 Emergency Pull-Offs

When shoulders are used to maintain traffic over long distances, consideration should be given to providing emergency pull-offs in an attempt to minimize capacity reduction due to vehicle malfunction. This is particularly important when traffic is limited to only one lane in each direction. Signing for such pull-offs shall be erected in order to provide advance notice to the road user of the emergency pull-offs. These signs should be rectangular in shape, with black legend on orange background.

640-5.4 Existing Rumble Strips on Shoulders

Permanent, longitudinal rumble strips are often provided on freeway shoulders to alert the road user who diverts from the travel lane. Longitudinal rumble strips create a dilemma when providing lane-shifts in temporary traffic control zones. It may be necessary to remove or resurface longitudinal rumble strips when providing lane shifts. Or, if the temporary lanes can be aligned such that the wheels of the vehicles can straddle the rumble strip, it may be adequate to limit the rumble strip removal to the shift tapers.

640-6 Work Zone Drop-Offs

A pavement edge drop-off occurs when there is a vertical difference in height between adjacent road surfaces. Treatments for pavement edge drop-offs in construction work zones are shown on **Traffic SCD MT-101.90**. The drawing may be used as a designer's tool for determining the appropriate measures to specify in the plans for treatment or protection of drop-off conditions. The designer may also use it to develop designs or sequences of operations that would avoid or minimize drop-offs.

The treatments indicated on the **SCD** are intended for high-volume projects. For low-volume situations, a one-level drop in protection may be used, e.g., use drums instead of PB. For low-speed situations, protection may not be needed. In all situations, engineering judgment should be used to select the most appropriate treatment for each work zone. (See ***Section 605-5.13*** and **OMUTCD** **Section 6F.44** for additional information.)

Maintenance of traffic **Plan Notes** should address the treatment of any anticipated open trench areas. Whenever possible, it should be stipulated that trench excavating operations will not remove any more material than can be replaced by the end of each day's work. In areas where this is not possible, or where adverse conditions prevent it, overnight trench openings shall be temporarily backfilled. See **Plan Notes 642-14 and 642-15** in ***Chapter 642*** for additional information.

640-7 Ramp Closure

640-7.1 Volume Considerations

In urban areas, consideration may be given to closing some entrance ramps. This can reduce the volume of traffic using the highway and minimize the negative effect on mainline traffic capacity caused by the ramp traffic merging onto the highway. Such closures could significantly improve traffic flow on the freeway; however, detours must be provided on the surface street system to handle the diverted traffic volume.

640-7.2 Geometric Considerations

Geometric conditions on ramps often make it difficult to perform work on the ramp while maintaining traffic. Consideration should be given to temporarily closing ramps and providing detours in such cases.

640-8 Detours

When a detour has been designated for a project ***(see Section 602-6)***, provisions must be made for erecting adequate Detour signing along with other appropriate traffic control devices. The plans shall specify all necessary detour traffic control in accordance with the **OMUTCD** and the **TEM** (also see related typical applications in ***Chapters 607 and 698***). The plans shall provide the appropriate traffic control information, for installation by **ODOT** or the contractor (as specified by the District). On local or other projects where detour traffic control cannot be provided by the maintaining agency, the plans shall provide for installation by the contractor.

Reassurance Detour signing in rural areas should be erected at intervals not to exceed 2 miles. In urban areas, Detour signing should be spaced no more than two blocks apart.

640-9 Construction Access Points

The traffic control plan shall address the need for construction access to the work zone. This is important for all work zones, but is a particularly critical issue on freeways, expressways, and multi-lane highways with original posted speed limits of 45 miles per hour or greater in order to provide a safe means of interaction between project-related vehicles and the traveling public by providing dedicated areas outside the traveled lanes for the deceleration and acceleration of project vehicles. The designer must address the question of how to get equipment and material into and out of the work zone safely. The following should be considered:

1. Type of work zones likely to create ingress/egress problems (e.g., median work spaces that will require vehicles to merge into and out of high-speed traffic, work activities that require frequent delivery of materials such as paving projects).
2. Temporary acceleration and deceleration lanes for work vehicles should be provided.
3. The location of the construction access point should provide good sight distance for oncoming traffic while avoiding locations such as just beyond sharp horizontal curves and crest vertical curves, on overhead structures, on upgrades, within one-quarter mile in advance of an exit ramp or beyond an entrance ramp, etc.

4. In extreme conditions, lane closures may need to be considered.
5. Openings in barrier walls on multi-lane highways with original posted speed limits under 45 miles per hour, and on two-lane facilities shall be planned to ensure the ends are properly protected, and the barrier wall should not create sight distance issues.
6. Special warning signs may be necessary.
7. The use of Portable Changeable Message Signs may be considered.

The number of construction access points shall be kept to a minimum with consideration given to relocating the construction access points during the project as necessary to accomplish construction activities.

Acceptable locations for openings in barrier walls on freeways, expressways and multi-lane highways with original speed limits of 45 miles per hour or greater shall be designed into the plans and laid out as directed in **Traffic SCD MT-103.10**. See ***Section 641-33*** for additional information on **MT-103.10**.

640-10 Private Driveway Access

Except as noted herein, where private drives exist within the work area, access to the drives shall be maintained. It may be necessary to adjust the work procedures to work around the drives as much as possible and to provide temporary access to the drives when normal access cannot be provided.

At urban residential locations, access to residential driveways may be denied for a few hours at a time after adequate advance notice of closure has been provided to the residents of the property involved.

640-11 Temporary Roads

640-11.1 General

A temporary road is any crossover, runaround, ramp, roadway, etc., whose sole purpose is to temporarily maintain traffic during construction. After construction is complete, temporary roads are typically removed.

Temporary roads are required when the existing roadway is inadequate to properly accommodate both the work and the traffic. They may also be required in certain cases where bridge construction or reconstruction does not facilitate part-width construction or realignment to the extent that the existing facility can serve as the temporary road. The use of runarounds and temporary structures in such cases shall be evaluated by the designer for cost-effectiveness and public service.

640-11.2 Design Speed

The design speed used in designing temporary roads shall be that which is discussed in ***Section 640-18.1.***

640-11.3 Geometrics

The geometric design of temporary roads should be commensurate with the chosen design speed. Pavement design criteria are provided under **C&MS 615**. Typical roadway plans for temporary roadway are provided in **L&D Manual Volume 3, Figures 1306-6s and 1306-7s**.

The horizontal alignment of temporary roads shall comply with the criteria discussed in **L&D Manual Volume 1, Sections 202.1 and 202.2**. Superelevation of temporary roads is discussed in ***Subsection 640-11.4***. Spirals are not required.

Crest and sag vertical curves on temporary roads should comply with **L&D Manual Volume 1, Section 203.3** using minimum criteria. Maximum allowable grades are the values shown in **L&D Manual Volume 1, Figure 203-1** under hilly terrain for the appropriate design speed.

Stopping sight distances shall meet or exceed the minimum criteria discussed in **L&D Manual Volume 1, Section 201.1** and pavement cross slopes shall be as discussed in **L&D Manual Volume 1, Section 301.1.5**.

The designer shall also ensure that vertical clearances in conformance with **L&D Manual Volume 1, Section 302.1** (existing structures to remain) are provided.

Additional general information regarding geometric design is provided in ***Section 640-2.***

640-11.4 Superelevation

Except as noted in ***Section 640-12***, superelevation on temporary roads should conform to the requirements shown in **L&D Manual Volume 1, Figure 202-8** for design speeds greater than or equal to 50 miles per hour and **L&D Manual Volume 1, Figure 202-9** for design speeds less than 50 miles per hour.

640-11.5 Lane Width

Lane widths of temporary roads should conform to the requirements discussed in ***Section 640-2.***

Where horizontal curve geometrics are less than adequate for the temporary road conditions (D_c>10 degrees), curve widening should be provided as called for in ***Table 697-4***.

640-11.6 Guardrail Offset and Sideslopes

C&MS 615.04, permits a minimum guardrail offset of 1.5 feet and a maximum side slope of 1.5:1. These dimensions are appropriate for absolute minimum design, but design above these values should be provided when feasible. For design speeds over 40 miles per hour, a minimum shoulder width and guardrail offset of 6 feet is desired and 4:1 side slopes are desired where right-of-way is available.

Barrier placement along temporary roads shall conform to the appropriate requirements of **L&D Manual Volume 1, Section 600**.

640-11.7 Pavement

C&MS 615.05, provides Class A and Class B pavement designs for temporary roads. These designs are intended to be specified on projects with large traffic volumes where the proposed project pavement design is stronger than either of these two designs. A temporary road pavement should not normally be stronger than the permanent pavement design of the project.

For a temporary road pavement design that is weaker than Class A or B, the design should be based on the anticipated total equivalent 18-kip single axle-load applications and determined from information contained in the **Pavement Design Manual** published by the **Office of Pavement Engineering.**

For temporary road pavement that is to be used for a short time (less than two months) by moderate traffic volumes (2000 ADT or less), **C&MS Item 410** Traffic Compacted Surface, stabilized with **C&MS Item 616**, may be provided.

640-12 Crossover Construction

640-12.1 General

For general information regarding crossover construction, see **OMUTCD Section 6G.16 and** ***Section 606-16***. Further detail information on traffic control for crossovers is provided in the following Sections and in **OMUTCD Figures 6H-39 and 6H-40**, ***TEM Sections 607-12 and 607-13, Figure 698-3*** and **Traffic SCDs MT-95.70 and MT-95.71**.

All temporary crossover areas shall be illuminated as shown on **Traffic SCD MT-100.00**, and the transition areas for temporary crossovers shall be delineated in accordance with **Traffic SCD MT-99.30.**

All temporary crossovers shall be removed at the completion of the current proposed work unless retention for future use is recommended and justified by the **District**. Any crossover which is to remain for future use or left in place without use between construction seasons shall be camouflaged with an earth overlay so that the crossover area appears as part of the normal median.

640-12.2 Traffic Separation

The use of breaks in the traffic separation runs, to permit access, should not normally be allowed. For unusual circumstances where breaks are necessary, each end of the barrier shall be protected by a temporary impact attenuator. Such breaks for access shall not be created for construction access.

640-12.3 Considerations for Reversed Flow

When a traffic diversion requires that two-way operation be maintained on a roadway which normally carries one-directional traffic, as is the case in crossover construction, the designer shall provide temporary barrier protection from hazards that are in the clear zone of the reversed movement. The designer should evaluate the project to ensure the proper barriers, bridge terminal assemblies, and guardrail end treatments, and to specify the appropriate changes or additions to barrier protection **(see Traffic SCD MT-95.82)**. It is not necessary to change the lap in the existing guardrail.

640-12.4 Crossover Geometric Design

For guidance on traffic control for crossovers, see ***Section 640-12.1*** and **Traffic SCDs MT-95.70, MT-95.71, MT-95.72, and MT-95.73**. ***Figures 698-4 through 698-7*** provide geometric detail information for two-lane crossovers. ***Figure 698-12*** provides geometric detail information for one-lane crossovers. For single-lane crossovers, decrease all pavement widths by 12 feet, providing one 12-foot lane with 3-foot paved shoulders. Superelevation for these curves shall be limited to 0.016 sloped toward the inside of the curves. Variations in design due to mainline curvature will be considered on a case-by-case basis.

The plans should detail temporary crossovers, including locations, horizontal alignment, typical sections, profiles, and pavement transitions to the existing pavement.

Crossover locations should be very carefully selected with traffic needs being the primary consideration. A tangent section on flat terrain is the most desirable location for constructing a crossover. The designer should field check possible crossover locations to select the optimum site and not necessarily choose the project limits as their location. Crossovers should also be located away from interchange decision points.

Regarding lane width on single-lane crossovers, there has been some debate in the past as to the proper width of the single lane. It was determined that this lane should be 12 feet wide, with 3 feet of paved shoulder and 2 feet of aggregate shoulder on each side. This provides for the same typical section as does the two-lane crossover design provided in **Figures 698-4 through 698-7**, except that the pavement width is decreased by 12 feet. In the past, this drawing called for a 16-foot lane, as is typical of a permanent single-lane ramp, with a 1-foot shoulder on each side. However, a 12-foot lane width is adequate for a properly designed single-lane median crossover and will contribute to providing uniformity in temporary work zone geometrics among **ODOT** work zones.

640-13 Capacity

640-13.1 General

Capacity restrictions shall be evaluated for each project. The capacity criteria below have been developed to assist in identifying when traffic volumes may cause delays and/or backups during construction phases.

1. On two-lane highways where the ADT is greater than 6,000 (two-way) or where the peak hour traffic is greater than 600 vph (two-way).
2. On multi-lane non-freeway/non-expressways (more than two lanes, divided or undivided) where the directional ADT is greater than 14,000 per lane of traffic being maintained, or where the peak hour traffic is greater than 1,400 vph per lane of traffic being maintained.
3. On freeways and expressways, where lane closures do not meet the minimum criteria presented in the Permitted Lane Closure Schedule (PLCS), discussed in ***Sections 601-2 and 630-4****.* Development of the PLCS is based on a simplified capacity calculation based on the Highway Capacity Manual.

When the capacity criteria is exceeded, the Procedures set forth in **ODOT Policy 21-008(P)** shall be followed. Mitigation measures should also be considered in preparing Maintenance of Traffic Plans. These include re-sequencing construction to allow additional lanes to be used, use of shoulders as traffic lanes, temporary pavement, providing additional advance Warning Signs, use of alternate routes and corresponding signing, use of Portable Changeable Message signs or detours, Work Zone Intelligent Transportation Systems, and night work.
If there is a need to deviate from the PLCS provided for a specific location, the Lane Closure Queue Analysis Tool, discussed in **Section 640-13.2**, shall be used.

640-13.2 Queue Length Predictions for Freeways and Expressways

Apart from exception approval from the **Maintenance of Traffic Exception Committee (MOTEC) or the Project Impact Advisory Council (PIAC)**, queue lengths on freeways and expressways shall not exceed the maximum thresholds set forth in **ODOT Policy 21-008(P)** ***(see Section 601-2)***. An analysis of traffic patterns within freeway and expressway sections shall be performed in order to develop maintenance of traffic strategies which attempt to meet these queuing thresholds. The queuing thresholds set forth in the **Policy** are as follows:

Queue Length	Maximum Duration
≤ 0.75 miles	Allowable
> 0.75 miles	Not allowable

The Lane Closure Queue Analysis Tool, was developed by Cleveland State University and has been adopted by ODOT to calculate queue lengths in work attributed to the reduction in available lanes. A copy of this spreadsheet and the user manual are available for downloading from the **Office of Roadway Engineering** website**.**

The tool's final output provides length of queue and delay by hour of day.

640-14 Considering Holidays and Special Events

The designer should, in conjunction with the **District Work Zone Traffic Manager**, investigate the use of lane closure restrictions on Interstates and other freeways during holiday and other significant events.

The plan shall require the contractor to have all existing lanes (a number of traffic lanes equal to the existing highway) open to traffic during specifically designated periods. These requirements are in addition to the requirements identified in the Permitted Lane Closure Schedules discussed in ***Section 630-4*** and the requirements identified in **ODOT Policy 21-008(P)** ***(see Section 601-2)***.

Lane closure restriction schedules for urban locations may differ from schedules for rural locations. Where rural location would be expected to carry high traffic volumes during holiday weekends, some urban routes, such as radial freeway segments leading to a central business district, may be found to carry less traffic during holiday weekends. An analysis of traffic patterns shall be made to determine whether or not it is appropriate to restrict lane closures for designated periods including holiday weekends.

The designated "lane closure restriction" periods shall be identified in the plan and may include, but are not limited to:

1. National holidays and holiday weekends:

   New Years,
   Memorial Day,
   Fourth of July,
   Labor Day,
   Thanksgiving, and
   Christmas.

2. Weekends with greater than normal travel:

   Easter,
   Mother's Day, and
   Other weekends, or periods, when regional travel is significant.

3. Periods involving local events having attendance greater than 75,000 persons per day or event, or a lesser attendance for events producing mass arrivals or departures, such as football games.

4. Periods when snow accumulation is probable. During these periods daily isolated lane closures may be used during non-peak hours, weather permitting.

A "holiday weekend," for traffic maintenance purposes, begins at noon on the last normal weekday preceding the weekend. Traditionally, the "holiday weekend" has been considered to end at noon on the first normal weekday following the holiday; however, the designer should review the traffic patterns at the specific location. Traffic data shows that at many locations, the traffic on the following weekday morning is not significantly different from a typical weekday morning. In such cases it is suggested that the holiday weekend be considered to end at 6:00 AM or earlier to allow the contractor a full day of normal operation. A day between the holiday and Saturday or Sunday is considered part of the weekend.

Section 630-4 contains information regarding Permitted Lane-Closure Schedule (PLCS) which are intended for use in the scheduling of part-time lane closures.

640-15 Project Length Restrictions

Although **ODOT** has no written policy limiting the length of lane closures, consideration should be given to potential effects on traffic flow, and the potential negative public reaction to closures of extensive length. These factors are of concern primarily where only a single lane remains open in each direction of travel. In rolling to hilly terrain where underpowered vehicles tend to slow traffic flow, the length of one-lane operations should be minimized. In flat terrain, the length of reduced-lane operations is less critical; however, the designer should give consideration to the type of activities to be performed, and what effect these activities might have on traffic movement. Access to accident sites by tow trucks and emergency vehicles on one-lane operations may become especially difficult if concrete barrier is present on both sides of the lane. Sections of open roadway between adjacent lane closures should meet the lengths suggested in ***Section 640-4.***

The public reacts negatively to seeing lane closures in areas of no activity. To avoid such situations on projects of considerable length, it may be desirable to concentrate activity in one section of the project at a time, and to minimize the lengths of lane closures accordingly. On multi-year projects, concentrating work in a portion of the project each construction season may allow an added benefit of opening the entire highway during the inactive winter months.

The designer should not overlook the advantage of scheduling adjacent corridor improvements simultaneously, if this would minimize the time period for inconveniencing road users. For example, two adjacent projects, requiring only one season each to construct, could be constructed in the same construction season (rather than in consecutive seasons) to minimize the inconvenience to one season rather than two.

640-16 Work on Detour and Alternate Routes

Work along designated detours and alternate routes is strongly discouraged. These routes carry volumes which may be significantly increased over the volumes carried under normal conditions. The potential for traffic queue development would be greater than if the work were performed prior to implementation, or following elimination, of the detour or alternate route.

Work along a designated detour or alternate route can also create a negative public response. Under such conditions the road user would be directed around one construction project, only to be directed through another one. See ***Section 640-17*** regarding project coordination.

640-17 Coordination With Adjacent Projects

Coordination of signing between adjacent projects is recommended in order to minimize presenting misleading information to the road user. If proper location of advance signing for one project results in this signing being located within the limits of another construction project, then consideration should be given to treating the two projects as one project for the purpose of signing.

For more information about coordinating speed reductions and increased fines policies, see ***Sections 600-2, 605-4.2, 640-18.2.5 and 640-18.3*****.**

640-18 Speeds in Work Zones

640-18.1 Design and Advisory Speeds

The design speed for maintaining traffic through a construction zone should remain at the original posted legal speed limit, except as indicated in ***Section 640-18.2.3***. If necessary, reductions in design speed should be accomplished gradually, in increments of 5 or 10 miles per hour. Sudden changes in design speed and the related geometrics should be avoided. With the October 2015 changes in ***Section 640-18.2*** more projects will need to be designed to the original posted speed limit, rather than a work zone speed limit. For point locations that cannot be designed to the original posted speed limit, advisory speed signing should be considered for use.

Advisory speed signing (W13-1P) should be provided in accordance with **OMUTCD Sections 2C.08 and 6F.52 and *TEM Chapter 641***.

Where design speed becomes an issue on ramps in relation to maintenance of traffic in work zones, a reduced ramp design speed limit can be used as provided in **L&D Manual Volume 1 Section 503.2 and Figure 503-1**. Ramp design speeds used from this table shall be limited to those classified as Upper Range speeds.

640-18.2 Speed Limit Reductions

640-18.2.1 General

Any portion of a work zone with an approved speed limit reduction is considered to be a Work Zone Speed Zone (WZSZ). As noted in ***Section 1203-2.9***, the standard WZSZ process applies to work zones located on multi-lane highways with a pre-construction speed limit of ≥ 55 mph and with a work zone condition at least 0.5 mile in length that reduces the existing functionality of the travel lanes or shoulders (as defined in ***Section 1203-2.9.1***) and has an expected work duration of at least three hours. If the work zone meets these minimum criteria, it should be analyzed to determine if it qualifies for a work zone speed limit reduction using the process established in ***Chapter 1203*** and ***Table 1297-7.*** Resarch completed by **Texas A&M Transportation Institute** titled "Evaluation of Ohio Work Zone Speed Zones Process" conducted for **ODOT** in July of 2014 indicates that motorists will only reduce their speed if they clearly perceive a need to do so.

Depending on the original posted speed limit, the type of temporary traffic control used (with or without positive protection), and whether or not workers are present, a warranted WZSZ will vary in the approved speed limit to be posted over time. In other words, all WZSZ are variable in nature and all WZSZs will frequently fluctuate between two approved reduced speed limits or between an approved reduced speed limit and the original posted speed limit. One of two signing strategies may be used to implement a WZSZ. The primary signing strategy uses Digital Speed Limit (DSL) Sign Assemblies. The secondary strategy uses traditional temporary flatsheet Speed Limit signs (R2-1). The designer must indicate the signing strategy selection by inclusion of the appropriate pay item (only one pay item to be included, not both).

640-18.2.2 Process

The overall process for Speed Zoning is addressed in ***Chapter 1203***. ***Section 1203-2.9***, ***Figure 1298-1*** and ***Table 1297-7*** address the specific process, guidelines and forms used for review and approval of a Work Zone Speed Zone (WZSZ) on high-speed multi-lane highways. ***Section 1203-2.9.1*** addresses general information about WZSZs.

Work zone speed limit revisions for construction projects should be completed during the design phase ***(see Section 1203-2.9.2)***. However, requests for WZSZs may also be initiated during the construction phase if the need for one was not determined during the design phase, or if new conditions have been identified that subsequently warrant their implementation ***(see Section 1203-2.9.3)***. WZSZs for operations/maintenance work are addressed in ***Section 1203-2.9.4***.

640-18.2.3 Guidelines

Whenever an approved WZSZ is implemented, the design speed for the layout of the temporary traffic control devices (TTCD) shall remain at the original posted speed limit on initial approaches to the work zone. Within the work limits, the design speed should match whichever speed limit is in effect at the time and location. This means that the placement of the TTCDs shall either be adjusted each time the speed limit is changed or, if adjustment is unreasonable, the more conservative design speed parameters must be used. For example, the higher speed limit is used for the taper rates, buffers, clear zone, etc.; and the lower speed limit is used for the device spacing, etc.

The WZSZ shall be limited to only the portion of the project and the work that warranted the work zone speed limit reduction. S*ee* ***Section 1203-2.9.1*** for details.

When the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders (as defined in ***Section 1203-2.9.1***), the speed limit shall return to the original posted speed limit.

The two directions of a divided highway are considered separate highway sections (see **C&MS Item 614.02(B))**. Therefore, if the work on a multi-lane divided highway is limited to only one direction, a speed reduction in the direction of the work does not automatically constitute a speed reduction in the opposite direction. Each direction shall be analyzed independently.

When a work zone qualifies for a speed limit reduction, **Plan Note 642-24** ***(Section 642-24)*** and **Traffic SCD MT-104.10** ***(Section 641-34)*** shall be included in the plans. The **Plan Note** shall document the WZSZ Revision Number. If DSL Sign Assemblies will be used to implement the WZSZ, **Supplemental Specifications (SS) 808** and **908** shall also be included in the plans.

When the need for the WZSZ has ended, it shall be withdrawn in accordance with the procedures described in ***Section 1203-4*** (Withdrawal of Authorization).

640-18.2.4 Overall Signing Requirements

The WZSZ is not in effect and enforceable until all of the existing Speed Limit signs within 1 mile in advance of and inside the WZSZ are removed or covered, and the WZSZ Speed Limit signs are in place with the appropriate legends displayed. Legends reflecting a speed limit in accordance with ***Table 1297-7*** shall only be displayed when the work zone condition in place reduces the existing functionality of the travel lanes or shoulders. At all other times (when the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders) the original posted speed limit shall be displayed.

The research indicates that to be effective the initial WZSZ Speed Limit signs should, generally, be located such that the driver can see the work and thus recognize the need to slow. Therefore, the first WZSZ Speed Limit sign(s) should be located in advance of the warranting work zone condition by approximately 500 feet on freeways and expressways, and approximately 250 feet on major conventional highways **(see Traffic SCD MT-104.10)**.

The VARIABLE SPEED LIMIT AHEAD (W3-H5b) sign shall be used to warn of the upcoming WZSZ ***(see Section 605-6.4)***. It should be placed approximately 1,250 feet in advance of the first reduced speed limit sign (DSL Sign Assembly or temporary flatsheet Speed Limit sign) on freeways and expressways, approximately 500 feet on major conventional highways, and on each open entrance ramp within the WZSZ.

A temporary flatsheet Speed Limit sign (applicable R2-1, R2-H2a, etc.) indicating resumption of the original posted speed limit shall be erected 300 feet downstream from the point where there is no longer the work zone condition that warranted the speed limit reduction.

640-18.2.5 Adjacent Projects and Speed Zones

Whenever a reduced speed limit is to be used within a section that has more than one original posted speed, the areas should be evaluated as separate sections. If there is not enough room (lengthwise) to implement the separate WZSZs, consideration may be given to lowering consecutive work zone speed zones to the lower approved work zone speed limit.

Where adjacent projects exist, any WZSZs shall be coordinated. If the distance between the limits of the WZSZs on the separate adjacent projects is less than 1 mile, then the upstream work zone shall omit the temporary flatsheet Speed Limit sign indicating the resumption of the original posted speed limit at the end of the WZSZ.

640-18.2.6 Work Zone Speed Zones (WZSZs) Using Digital Speed Limit (DSL) Sign Assemblies

As noted in ***Section 1203-2.9.1, Table 1297-7*** is used to determine if a work zone qualifies for a standard WZSZ based on the presence of specific work zone conditions and factors.

See **Traffic SCD** **MT-104.10, Plan Note 642-24, SS 808** and **908** for the requirements and proper use of Digital Speed Limit (DSL) Sign Assemblies. As noted in ***Section 640-18.2.1***, DSL Sign Assemblies are the preferred method for implementing a WZSZ. If temporary flatsheet Speed Limit signs are used to accomplish a WZSZ (if no DSL Sign Assemblies are on the Approved List or are not available), see ***Section 640-18.2.7***. For WZSZs using temporary flatsheet Speed Limit signs, the speed limit displayed will still need to be appropriately changed per ***Table 1297-7*** as the work zone conditions and factors change. The designer must indicate the signing strategy selection by inclusion of the appropriate pay item (only one pay item to be included, not both).

The DSL Sign Assemblies should be repeated every 1 mile. They should also be placed immediately after each open entrance ramp (or intersection) within the WZSZ but beyond the ramp lane merge taper if applicable.

WZSZs shall not be used for Moving/Mobile activities, as defined in **OMUTCD Part 6**.

All qualifying projects (construction or maintenance) using WZSZs with DSL Sign Assemblies shall use **Plan Note 642-24, SS 808, SS 908** and **Traffic SCD** **MT-104.10**.

Supplement **1108** and **SS** **908** establish the criteria for inclusion on **ODOT's** Approved List for DSL Sign Assemblies. DSL Sign Assemblies furnished on **ODOT** projects shall be on **ODOT's** Approved List.

Detailed and accurate tracking information regarding the use of each DSL Sign Assembly is necessary to provide a historical record of what specific speed limits were in effect at which location and which date/time. This documentation is to be provided on ***Form 1296-18***. (Note that the DSL Sign Assemblies are not able to electronically provide the necessary information. This information will need to be populated by the user on the separate form as the speed limits changes occur in the field.)

Speed feedback signs are not regulatory devices and shall not be used within the project limits of a project with a WZSZ using DSL Sign Assemblies. Use of both devices may lead to driver confusion or may negatively impact the compliance of the regulatory DSL Sign Assemblies.

640-18.2.7 Work Zone Speed Zones (WZSZs) Using Temporary Flatsheet Speed Limit Signs

As noted previously, ***Table 1297-7*** is used to determine if a work zone qualifies for a standard WZSZ based on the presence of specific work zone conditions and factors.

See **Traffic SCD** **MT-104.10** and **Plan Note 642-24** for the requirements and proper use of temporary flatsheet Speed Limit signs to accomplish WZSZs. This signing strategy is available for use if no DSL Sign Assemblies are on the Approved List or are not available. For WZSZs using temporary flatsheet Speed Limit signs, the speed limit displayed will still need to be appropriately changed per ***Table 1297-7*** as the work zone conditions and factors change. The designer must indicate the signing strategy selected (DSL Sign Assemblies or temporary flatsheet speed limit signs) by inclusion of the appropriate pay item (only one pay item to be included, not both).

The temporary flatsheet Speed Limit signs (R2-1) shall be changed to display the appropriate warranted speed limit no earlier than 1 hour before workers arrive and no later than 1 hour after workers depart from a warranted work zone condition.

The temporary flatsheet Speed Limit signs shall be repeated every 1 mile for WZSZs for Freeways and Expressways and every 0.5 mile for WZSZs on Major Conventional roadways. The signs shall also be erected immediately after each open entrance ramp (or intersection) within the WZSZ but beyond the ramp lane merge taper if applicable.

WZSZs shall not be used for Moving/Mobile activities, as defined in **OMUTCD** **Part 6**.

All qualifying projects (construction or maintenance) using WZSZs with temporary flatsheet Speed Limit signs shall use **Plan Note 642-24** and **Traffic SCD** **MT-104.10**.

Detailed and accurate tracking information regarding the use of each temporary flatsheet Speed Limit sign is necessary to provide a historical record of what specific speed limits were in effect at which location and which date/time. This documentation is to be provided on ***Form 1296-18***.

640-18.3 Work Zone Increased Penalty Signs (R11-H5a)

The Work Zone Increased Penalty sign can be used to address speeding concerns on projects independent of work zone speed zones. See ***Section 605-4.2*** for details on the use of these signs. When these signs are used on a project **Plan Note 642-27 (*Section 642-27*)** shall be included.

640-19 Law Enforcement Officers (LEOs)

640-19.1 Law Enforcement Officers (LEOs) for Assistance During Construction Operations

Law enforcement officers (LEOs) with patrol cars are effective for slowing traffic speed through work zones. Their use shall be specifically identified in the construction plans. Their primary purpose is to ensure the safe, efficient and orderly movement of traffic. They are not to be used for the convenience of the contractor at project cost.

In general, LEOs should be positioned to direct traffic at the point of lane restriction or road closure and to manually control traffic movements through intersections in work zones.

For lane closures, the use of LEOs should be required during initial set up periods, tear down periods, substantial shifts of a closure point or when new lane closure arrangements are initiated. Use of LEOs is required during the entire advance preparation and closure sequence where complete blockage of traffic is required, and during traffic signal installation when impacting the normal function of the signal or the flow of traffic or when traffic needs to be directed through an energized traffic signal contrary to the signal display. LEOs should not be used where the **OMUTCD** intends that flaggers be used.

Use of LEOs by contractors other than the uses specified above shall not be permitted at project cost.

State Highway Patrol Officers may be specified on rural Interstate projects.

For additional information, see **Plan Note 642-55** in ***Chapter 642***.

640-19.2 Reserved for Future Information

640-20 Temporary Traffic Control Devices

The design and application of standard traffic control devices for temporary traffic control zones are addressed in **OMUTCD Part 6**, ***TEM Chapters 605, 607, 641 and 642***, the **Traffic SCDs** and in **C&MS 614.04**.

640-21 Removal of Logo (Specific Service) Signs and Tourist-Oriented Directional Signs (TODS)

The Ohio Business Logo Sign Program, also known as the Specific Service Sign Program, permits eligible businesses which provide fuel, food, lodging, camping or attraction services to road users to have their Logo Sign Panels placed on Specific Service Signs. Mainline Logo Sign Panels are placed in advance of eligible interchanges, and directional Logo Sign Panels are placed along the exit ramps. The Logo Sign Program is operated by a private company **(Program Manager)** under contract with **ODOT.** See ***Section 207-2*** for more information on the Logo Sign Program.

Information regarding removal, temporary re-erection, and permanent re-erection of Logo Signs and Tourist-Oriented Directional Signs due to construction and maintenance activities is addressed in **C&MS 614.07 and 630.09**.

640-22 Temporary Lighting

For guidance in the use of temporary lighting for crossovers, see **Traffic SCD** **MT-100.00** and **Plan Note 642-35** ***(Section 642-35 in Chapter 642)***. For floodlighting see **Plan Note 642-29** in ***Chapter 642***. ***Part 11*** of the **TEM** provides additional guidance for general lighting design principles.

See **Plan Note 642-39** in ***Chapter 642*** for when temporary traffic signals are provided for closing one lane of a two-lane highway.

If a project requires illumination for special situations, the **Office of Roadway Engineering** **(ORE)** should be contacted for design guidance.

On contract work, the contractor is responsible for obtaining power for temporary lighting. Power shall not be obtained from an existing nearby highway lighting system.

640-23 Reserved for Future Information

The information in this Section has been incorporated into other Sections; however, the number has been reserved for future use.

640-24 Disincentives

640-24.1 Requirements/Guidelines

Disincentives may be assessed against the contractor for failure to complete his work on schedule. They may also be assessed for failing to reopen a closed lane within an allowable timeframe. The disincentives should be based upon costs incurred by the public as a result of the contractor's delay in completing the project. Various methodologies are available for analyzing the cost incurred by the public depending on the specific circumstances.

640-24.2 Calculating Costs of Delay (Road User Cost Spreadsheet.)

One methodology, which is frequently used on Interstate and other freeway reconstruction projects where the number of existing traffic lanes is reduced for maintenance of traffic purposes during construction or the lanes are closed and a detour is provided, is to determine the cost of the additional delay to the road user as a result of the reduction in the number of available traffic lanes or closure. As an aid the **Road User Cost Spreadsheet** can be used to calculate the associated costs of delay.

The cost of delay calculated by the Road User Cost Spreadsheet, or some lesser amount, may be used as the disincentive. Also, ***Section 642-6*** contains a table of acceptable disincentive amounts that may be applied to lane closures on Interstates and Interstate Look-alikes.

640-24.3 Other Considerations

Additional methods available to encourage the contractor to complete his work on schedule include Lane Rental, Incentive/Disincentives, and A + B Bidding. Guidelines on use of these concepts is presented in the Compendium of Traffic Control Options in ***Section 630-2*** and ***Tables 697-1a through 697-1f****.*

The Lane Rental concept calls for the contractor to be charged for keeping a lane closed longer than called for in the plans.

The incentive/disincentive concept is typically applied to the completion of a phase of a project.

With A + B Bidding, the contractor bids on the cost of the project and on the time required to complete the project.

The **Innovative Contracting Manual** contains additional information on all of these methods. This manual is maintained by the **Office of Construction Administration.**

640-25 Pedestrian Considerations

Planning and design for maintaining pedestrian traffic should consider both the characteristics of that traffic and the type of construction activities. An analysis of trip origins, destinations and travel paths is useful for providing adequate temporary facilities. Also see **OMUTCD** **Chapter 6D** for additional information about accommodating pedestrians in temporary traffic control zones.

Pedestrian accommodations within work zones should be provided: where sidewalks existed prior to construction; where the work zone is located along a route to a school or park; where there is evidence of pedestrian usage (where well-worn paths exist, for example); or where existing land use generates pedestrian traffic.

In residential and commercial areas, adequate pedestrian access should be provided to properties abutting a work zone.

Use of increased pedestrian crossing times at signalized intersections (based on a walking speed of 3.5 feet per second) may be necessary, particularly in locations where the percentage of elderly pedestrians is expected to be significant. See ***Section 603-2*** for additional information on pedestrian issues that should be considered.

The following general principles should be followed when designing pedestrian facilities:

1. If a sidewalk or bridge that carries pedestrians is closed, provide a temporary walkway (concrete or asphalt) around the work area or direct the pedestrians to an alternate route. Do not force pedestrians to walk through the work area or into traveled lanes.
2. Passageways for pedestrians, especially elderly and disabled, should be well defined and safe for use by these groups. Ramps should be provided for access to streets.
3. All signs or devices should be set up so that they do not cause a hazard for pedestrians. All signs mounted near or over sidewalks should have a minimum 7 foot vertical clearance.
4. Minimum width of walkway shall be 5 feet. Wider walkways are required in areas of high pedestrian activity.
5. Pedestrian walkways shall be free of any obstructions or hazards (holes, debris, mud, etc.). It is especially important to cover or repair any holes and to have broken or damaged sidewalks repaired quickly.

6. Lighting should be provided for temporary walkways if the existing facility was lighted.
7. Fixed walkway and canopy-type pedestrian protection should be provided in the case of long-duration building projects involving construction, demolition and repair activities located close to the street.
8. The design of a temporary pedestrian structure shall be approved by the **Office of Structural Engineering**. The following criteria shall be used:
   a. Live Loading - 85 psf
   Maximum Allowable Live Load Deflection - 1/800 of the span with no allowable increase for temporary structure.
   b. Minimum Width - 5 feet face to face of railing.
   Railing - 5 feet high with chain link fence fabric.

Traffic SCD **MT-110.10** provides detail for maintaining or detouring pedestrian traffic. However, it is the responsibility of the designer to provide site-specific detail when necessary. For example, although **MT-110.10** (in Note 5B) calls for a maximum grade of 5 percent and a maximum cross slope of 2 percent for temporary walkways, there could be specific locations where the profile of the existing street and sidewalk are at 5 percent or greater. In such a case, the designer should specify in the plans the appropriate criteria to be applied at the specific site. It is suggested that under conditions where pedestrians are detoured into the curb lane, the elevation of the temporary walkway be raised to that of the sidewalk in order to eliminate the need for ramps between the sidewalk and the roadway elevations.

640-26 Advance Work Zone Information Signs

Advance work zone information signs may be required as part of the maintenance of traffic plan for major construction projects. Their need is usually determined by the **Corridor Traffic Management Team** during their review of the project. These signs are fixed message types and advise the road user of alternate routes, possible delays, etc. The signs are generally located at extreme distances from the work area.

To ensure uniformity in the design and application of these signs, the following guidelines will apply:

1. These signs shall be shown in the plans whether supplied by the contractor or by others. This choice shall be clearly indicated in the plans. The normal procedure is for the contractor to provide the signs.
2. The location of the signs shall be field checked by the designer to ensure that there are no conflicts with existing features or with other signs in the area. The designer will assure that signs are not blocked by being too close to other signs and that the motorist has sufficient time to read, understand and act on the information provided by all the signs.
3. The plans shall indicate the legend, level and size of the signs. The signs shall be considered Supplemental Guide Signs as described in the **OMUTCD** **Section 2E.35 and Tables 2E-2 and 2E-4.**

   The signs shall be black on orange, including a black border. The layout shall conform to the **OMUTCD** **and** **SDMM** **Appendix C**.
4. Where appropriate, advance work zone information signs shall make use of the same exit numbers, route numbers, directions and destinations as shown on the permanent Guide Signs.
5. In some instances, instead of providing separate installations, it may be desirable to modify existing overhead Guide Signs. These changes are accomplished by providing black-on-orange overlays to cover portions of the existing signs. Letter size on these overlays should be the same as on the existing signs. When lane arrows are to be covered, a blank overlay should be placed over each of the affected arrows. When a ramp is being closed, rather than using a blank overlay to cover the entire sign, the legend “EXIT CLOSED” (W20-H15) should be used on a diagonal overlay (lower left to upper right) on the sign. The size of lettering on overlays and the size of the overlay shall be indicated in the plans. The minimum letter size for the

diagonal “EXIT CLOSED” (W20-H15) overlay shall be 12" C.

6. When regulatory information is provided, it shall be displayed separately as a standard black-on-white sign. Mixing of black-on-white regulatory information on a black-on-orange information sign is prohibited.
7. If the road user is being detoured or if an alternate route is provided, the route should be signed with assemblies consisting of the appropriate black-on-orange (DETOUR or ALT) marker with a standard Route sign and arrow plate (see **OMUTCD Sections 2D.32 and 6F.59)**. If more target value is desired, this trailblazer information may be shown on an orange panel, M2-H3 type **(see SDMM Chapter 4d)**.
8. Route Sign assemblies shall be sized according to the type of road on which they are located in accordance with the **OMUTCD**.
9. Supports for sign installations shall conform to all existing standards for permanent signs. These signs should not be attached to existing supports.
10. All advance work zone information sign installations located outside of the project work limits shall be paid for under appropriate **C&MS 630** items (signs, supports, concrete, breakaway connection, overlay, removal, etc.). This requirement does not apply to advance Warning Signs or to sign installations within the work limits.

640-27 Retiming of Existing Traffic Signals

Work Zones can affect the normal operation of signalized intersections. In these cases, the MOT plans shall provide updated signal timing to accommodate the new traffic volumes and patterns caused by the work zone at ALL of the signals impacted by the work zone, without regard to their proximity to the physical work.

The following are typical situations that will require the MOT plans to provide signal timing:

1. On arterial streets or ramps where the number of lanes or lane use has been altered by the work zone;
2. Significant volume or traffic pattern changes caused by the work zone (e.g., closure of a ramp or street);
3. Along routes which are designated as detour or alternate routes:
4. Where temporary signals are used.

It is the intent of this requirement for the project plans to provide signal timing to accommodate the traffic impacts caused by work zones for each construction phase. Where the affected signals are part of a coordinated signal system, the MOT plans shall provide revised coordination timing plans (i.e., not just local timing parameters). In the case of a coordinated signal system, all of the signals in a system shall be provided updated coordination timing without regard to their proximity to the physical work zone. The number of coordinated timing plans shall match the number of plans being used prior to the start of the construction project.

For isolated (i.e., non-coordinated) traffic signals that are impacted, as described above, new local timing plans shall be provided for each construction phase.

640-28 Freeway/Expressway Termination (“Permanent”)

Occasionally there may be a need for “permanent” termination of a freeway/expressway. Such termination will be located at an interchange, forcing all traffic to exit at that point. This is not a work zone. Such a condition differs from that which is discussed in ***Section 641-19*** in that this termination point would be somewhat “permanent.” Construction of a section of new roadway may have been built and open to traffic while the adjacent section of roadway is not yet built and may not be built for several years, if at all.

If it is expected that the construction of a section of new highway will create such a condition upon completion, it will be the responsibility of the designer to address this condition in the permanent traffic control plans for the project.

The designer may use **Traffic SCD** **MT-99.50** as a guide to develop the permanent traffic control plan at such location. Taper rates for lane closures and shifts shall be as shown in **MT-99.50.** Advance signing shall be by use of extrusheet Guide Signs as shown in **MT-99.50.** However, the arrow boards and portable changeable message signs shown in **MT-99.50** will not be appropriate for use in this or any other permanent traffic control condition.

Use of drums in permanent situations is not appropriate. A section of pavement which is to be permanently closed shall be separated from the open traveled lanes by use of PB. The PB shall be located parallel to and offset approximately 4 feet from, the edge line along the shifting taper. Upstream from the shifting taper, the PB shall be continued at the same taper rate as the shifting taper.

Where the PB is located parallel to and within 5 feet of the traveled lane, object markers shall be provided on the PB at 50-foot spacing.

Any pavement between the edge line and the PB shall be marked with transverse lines at 100 foot spacing. It is recommended that raised pavement markers be provided along the edge line where the PB does not run parallel to the edge line.

The designer should keep in mind that, as this is not a work zone, orange is not generally an appropriate color for any traffic control devices under such conditions. For example, barricades, under such conditions, shall contain red and white diagonal stripes rather than orange and white.

640-29 Work Zone Intelligent Transportation Systems

640-29.1 Work Zone Queue Detection Warning System

A Work Zone Queue Detection Warning System (WZQDWS) may be used on projects to detect queues though the project area. The systems utilize non-intrusive traffic sensors in order to detect slow moving traffic and warn upstream drivers via Portable Changeable Message Signs (PCMS). WZQDWS are recommended for use in locations where there is potential for queuing and are required for some locations with an approved MOTEC/PIAC exception.

There are two classes of WZQDWS. Class I devices are more sophisticated devices meant to be used in long term work zones. The Class II systems are meant for short duration projects and for use in operations such as nightly lane closures.

A WZQDWS plan must be prepared as part of the design process and shall include a detail showing the proposed locations of all WZQDWS devices. Note any changes that could be necessary due to stage changes or other factors relating to the project.

For a lane closure application, it is recommended to use a sensor at the beginning of the taper, a sensor at 0.5 miles from the taper, a sensor at 1 mile from the taper, and then sensors spaced at 1 mile from there. For all other applications 0.5 miles, 1 mile, or a combination or 0.5 miles and 1 mile sensor spacing is recommended depending on the expected queueing. For all applications, there should be at a minimum one PCMS for every four sensors.

All projects using WZQDWS shall use **Plan Note 642-57** and **Supplemental Specifications** **896 and 996**.

640-29.2 Work Zone Egress Warning System

A Work Zone Egress Warning System (WZEWS) should be used on any project that has construction egress points as detailed in Maintenance of Traffic Standard Construction

Drawing (SCD) MT-103.10. The systems utilize non-intrusive traffic sensors in order to detect construction vehicles as they drive into Opening B of SCD MT-103.10 and warn upstream drivers via a WZEWS Sign Trailer.

All projects using WZEWS shall use **Plan Note 642-59** and **Supplemental Specifications 829 and 929**

Intentionally blank

641 PLAN PREPARATION / PRODUCTION

641-1 General

The **L&D Manual Volume 3** describes **ODOT** plan preparation and production guidelines and standards. Maintenance of Traffic (MOT) plans are addressed in ***Chapter 1306*** of that manual. Additional information specific to MOT plans is provided in this Chapter and ***Chapter 640***. The detail needed in MOT plans depends on the complexity of the project. Adjustments in the field may be necessary when unforeseen circumstances arise.

The following sections provide information about various components of the Temporary Traffic Control (or MOT) Plan, including detail information about **Traffic SCDs and PISs**.

641-2 Temporary Traffic Control / Maintenance of Traffic (MOT) Plans

641-2.1 General

As noted in ***Section 602-2***, Temporary Traffic Control (or MOT) Plans are used to describe the temporary traffic control measures that are to be used for facilitating the road users through a work zone. These plans play a vital role in assuring a continuity of safe and efficient traffic flow through the work zone.

641-2.2 Plan Sheets

The traffic control plan may include plan sheets for each sequence of operation, to show all temporary signing and pavement marking applicable to the phase. Additionally, removal or covering of non-applicable signs should be indicated on the plan.

641-2.3 Plan Notes

Standard maintenance of traffic **Plan Notes** are in ***Chapter 642***. Additionally, the designer must provide notes to explain any requirements of the contractor which are not covered in the standard notes or elsewhere in the plans or the specifications.

641-2.4 Sequence of Operation Notes

The designer should also provide sequence of operation notes in order to insure that the traffic is maintained as may have been agreed upon by **ODOT** and the public. For additional information regarding development of a sequence of operation, see ***Section 640-3.***

641-2.5 Designer Notes

In addition to the information found throughout this Part of the **TEM**, Designer Notes specifically related to the **Standard Construction Drawings (SCDs)** have been included in this Chapter. Designer Notes have also been included with the **Plan Notes** in ***Chapter 642***.

641-2.6 Quantities

As shown in **C&MS 614** and in the **Item Master**, many of the traffic control quantities should be itemized, including signing, pavement marking and concrete barriers. (The **Item Master** and the **Summary of Contracts Awarded** are both available from the **Office of Estimating**.) Non-itemized quantities will be paid for as **Item 614 Maintaining Traffic**.

641-2.7 Plan Reviews

The Stage 2 MOT plans for projects that have a MOTAA and the subsequent stage MOT Plans for projects with an exception request shall be submitted per **Policy 21-008(P), the PDP, and the L&D Manual Volume 3, Section 1306 *(see Section 601-3)***.

Other MOT plans may be submitted to the **Office of Roadway Engineering (ORE) Traffic Control Design Section** for review/advice.

641-2.8 Exception Approval

Lane closures shall meet the requirements of the permitted lane-closure schedule provided in ***Section 630-4***. Any request for exception to this lane-closure schedule shall be submitted for exception approval. Any exception request, if not submitted for review and approval during the planning stage, should be submitted as soon as possible during the design stage so that the MOT plan can be developed accordingly.

641-3 Traffic Plan Insert Sheets (PISs)

Traffic PISs are addressed in general in ***Chapter 104***. They are addressed as appropriate throughout the text of this Manual; and this Chapter provides specific information about the application of most of the **Traffic PISs**. **Traffic PISs** are used in a plan as a plan sheet. They can be used as is or modified as needed. They are available from the **ORE** website and through the **Design Reference Resource Center (DRRC)**.

641-4 Traffic Standard Construction Drawings (SCDs)

Traffic SCDs are addressed in general in ***Chapter 103***. They are addressed as appropriate throughout the text of this Manual; and this Chapter provides specific information about the application of most of the **Traffic SCDs**. Applicable **SCDs** are listed on the plan title sheet. The **SCDs** are available from the **Traffic Standard Construction Drawings (SCDs)** website and through the **Design Reference Resource Center (DRRC)**.

641-5 Closing Right or Left Lane of a Multi-lane Divided Highway (MT-95.30, 95.40 and 95.50)

641-5.1 General

Traffic SCD MT-95.30 depicts traffic control for closing one or two of the right or left lanes of a multi-lane divided highway using drums. **MT-95.40** is used when construction procedure or the condition requires that the work area be protected by portable barrier (PB) in accordance with **Section 605-14**. **MT-95.50** incorporates Speed Limit signing and Increased Penalty signing with the lane-reduction signing called for in **MT-95.30** and **MT-95.40**. **MT-95.50** also provides additional Advance Warning Sign Groups. These sign groups, when used, are in addition to the advance signing provided in **MT-95.30** and **MT-95.40**.

The designer should check the existing median width to determine if sufficient width exists for erection of the median signs. If not, a smaller size median sign should be specified in **C&MS 614 Maintaining Traffic**.

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), and truck-mounted or self-contained impact attenuators. When required, these units must be specifically identified in the plans. When included, these items shall have separate notes and/or details as well as separate pay items.

641-5.2 Advance Warning Sign Groups

Traffic SCD MT-95.50 allows the designer to require extra Advance Warning Sign Groups (AWSGs) when traffic is expected to back-up beyond the standard advance Warning Signs. Whenever this **SCD** is specified in a plan, the designer should analyze the anticipated traffic demand, peaking characteristics, capacity and expected queue lengths, and include this analysis with the preliminary Maintenance of Traffic submission. If the queue is expected to extend beyond the normal ROAD WORK AHEAD sign (W20-1), extra AWSGs should be specified in the **Item 614 Maintaining Traffic Plan Note** ***(see Sections 642-2 and 642-33)***. The first extra AWSG should be located a distance, in whole miles, in advance of the lane taper which is at least equal to the longest anticipated queue length. Additional AWSGs should be located at 1 to 2 mile intervals between the first AWSG and the normal Warning Signs location. AWSGs would typically be specified for 2 miles, 3 miles, 5 miles and 8 miles up to the distance needed to deal with the anticipated queue.

If the construction will extend over a holiday period, or any other anticipated period of unusually high traffic demand, a separate queue length analysis should also be made for that period. This condition may require more AWSGs and **Plan Note 642-34** ***(Section 642-34)*** would be used.

The **Plan Note** ***(Section 642-33 or 642-34)*** added within **Item 614 Maintaining Traffic** should specify the distance (in whole miles) on the W16-3a Distance plaque which is placed below the RIGHT/LEFT LANE CLOSED AHEAD sign (W20-5, W20-5a). This sign should be located approximately 1 mile in advance of the calculated end of the queue. The distance shown on the plate should be the distance to the beginning of the lane taper.

641-5.3 Advisory Speed Plaque (W13-1)

Advisory Speed Plaques are described in **OMUTCD Sections 2C.08 and 6F.52.** The designer may specify the use of the Advisory Speed plaque (W13-1) by a **Plan Note** in **Item 614 Maintaining Traffic**. Unless specified, this plaque would only be used when directed by the project engineer. The designer may also specify the speed to be shown. An advisory speed reduction, if any, would normally be 10 miles per hour. If the speed is not specified, the speed is as directed by the project engineer. See ***Section 640-18.1*** (Design and Advisory Speeds) for additional information.

641-5.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) shall be used if the lane closure is greater than 3 days. The use should be specified in the **Item 614 Maintaining Traffic Plan Note** with an estimated quantity carried to the General Summary. See the notes on **Traffic SCD MT-95.30** or **MT-95.40**, and **C&MS 614.11** for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure, sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, the type of work, the geometrics in the area, and the relative cost of paint and work zone tape.

641-5.5 Illumination

In cases of unusual horizontal/vertical curvature, the designer may want to provide illumination of the taper area(s) depending on traffic volumes, accident history or patterns (particularly those involving crossing of the center line). See ***Part 11*** of this Manual for general lighting design principles. For guidance in unusual situations, the **Office of Roadway Engineering (ORE)** should be contacted.

For guidance in use of temporary lighting for crossovers, see **Traffic SCD MT-100.00** and **Plan Note 642-35** in ***Chapter 642.*** For floodlighting see **Plan Note 642-29** in ***Chapter 642.***

641-5.6 Bid Items

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums, Arrow Board(s), Warning Lights and Shadow Vehicle.

The following items will be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class 1 (By Type)	Mile
Item 622,	Portable Barrier, ___”	Foot

Item 614,	Barrier Reflector	Each
Item 614,	Work Zone Impact Attenuator	Each
Item 614,	Object marker, ____-way	Each

641-6 Closing Right or Left Lane of a Multi-lane Undivided Highway (MT-95.31, 95.32 and 95.41)

641-6.1 General

Traffic SCDs **MT-95.31 and 95.32** depict traffic control for closing the right and left lane, respectively, of a multi-lane undivided highway using drums. **MT-95.41** is used to close the right or left lane on a multi-lane undivided highway when construction procedure or the condition requires that the work area be protected by portable barrier (PB) in accordance with ***Section 605-14***.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics (including lane and shoulder widths), the type of work being performed during the various construction stages and any additional width required for location of drums or cones and for work zone edge line when used. Depending upon the available lane width of the right lane, for the left-lane closing in **Traffic SCD** **MT-95.32**, it may be necessary to shift traffic onto the shoulder using drums or cones and/or work zone edge line. In this case, consideration should be given to removal of the existing right edge line.

For the right and left-lane closings shown in **Traffic SCDs** **MT-95.31 and 95.32**, if the traffic or any of the traffic control devices are expected to encroach on or over the center line, it may be necessary to close the left lane of opposing traffic, in accordance with **MT-95.32**. For short-term daylight closures, it may be possible to narrow the opposing lanes or shift them onto the shoulder using cones for guidance. Engineering judgment is necessary to determine the best solution. This evaluation should include consideration of the geometrics, traffic volumes and speeds, traffic composition and duration of the work.

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), and truck-mounted or self-contained impact attenuators. These units when required must be specifically itemized in the plans. When included, these items shall have separate notes and/or details as well as separate pay items.

641-6.2 Advance Warning Sign Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis should indicate the need for this group, see ***Section 641-5.2***. In this case, **Traffic SCD** **MT-95.50** shall be included in the plan with a reference in the **Item 614 Maintaining Traffic Plan Note** requiring additional AWSGs as shown on **MT-95.50**, except that median-mounted signs would not be used.

641-6.3 Advisory Speed Plaque (W13-1)

Advisory Speed plaques are described in **OMUTCD** **Sections 2C.08 and 6F.48.** The designer may specify the use of the Advisory Speed plaque (W13-1) by a note in **Item 614 Maintaining Traffic *(Section 642-2)***. Unless specified, this plaque would only be used when directed by the project engineer. The designer may also specify the speed shown **(see OMUTCD Section 6F.48)**. An advisory speed reduction, if any, would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer. See ***Section 640-18.1*** (Design and Advisory Speeds) for additional information.

641-6.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) shall be used if the lane closure is greater than 3 days. The use should be specified in the **Item 614 Maintaining Traffic Plan Note *(Section 642-2)*** with an estimated quantity carried to the General Summary. See the notes on **Traffic SCD MT-95.31, MT-95.32 or MT-95.41**, and **C&MS 614.11** for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure, sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, the type of work, the geometrics in the area, and the relative cost of paint and work zone tape.

641-6.5 Bid Items

The following items would normally be included with the lump sum bid for **614 Maintaining Traffic**: Signs, Cones, Drums, Arrow Board(s), Warning Lights and Shadow Vehicle.

The following items will be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class 1, (By Width), (By Type)	Mile
Item 622,	Portable Barrier,___"	Foot
Item 614,	Barrier Reflector	Each
Item 614,	Work Zone Impact Attenuator	Each
Item 614,	Object marker, ____-way	Each

641-7 Closing Right or Left Shoulder of a Multi-lane Divided Highway (MT-95.45)

641-7.1 General

Traffic SCD MT-95.45 depicts traffic control for closing the left of right shoulders of a multi-lane divided highway using portable barrier.

The designer should check the existing median width to determine if sufficient width exists for erection of the median signs. If not, a smaller size median sign should be specified in **C&MS 614 Maintaining Traffic**.

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), and truck-mounted or self-contained impact attenuators. When required, these units must be specifically identified in the plans. When included, these items shall have separate notes and/or details as well as separate pay items.

641-7.2 Advance Warning Sign Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis should indicate the need for this group, see ***Section 641-5.2***. In this case, **Traffic SCD MT-95.50** shall be included in the plan with a reference in the **Item 614 Maintaining Traffic Plan Note** requiring additional AWSGs as shown on **MT-95.50**, except that median-mounted signs would not be used.

641-7.3 Bid Items

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums, and Warning Lights.

The following items will be shown as separate quantities in the plans, when required:

Item 622,	Portable Barrier, ___"	Foot
Item 614,	Barrier Reflector	Each
Item 614,	Work Zone Impact Attenuator	Each
Item 614,	Object marker, ____-way	Each

641-8 Closure of a Two-Way Left Turn Lane (MT-95.60)

641-8.1 General

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), and truck-mounted or self-contained impact attenuators. When required, these units shall have separate notes and/or details as well as separate pay items.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics (including lane and shoulder widths), the type of work being performed during the various construction stages and any additional width required for the location of drums or cones and temporary edge lines when used. Depending upon the available lane width of the right lane, it may be necessary to shift traffic onto the shoulder using drums or cones and/or a temporary edge line. In this case, consideration should be given to removal of the existing right edge line.

641-8.2 Advance Warning Signs Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis indicates the need for this group, it would have to be included in the plan with a reference in **Item 614 Maintaining Traffic** that the additional AWSG(s) shall be included as part of the signing required for **Traffic SCD** **MT-95.60** ***(see Section 641-5.2)***.

641-8.3 Advisory Speed Plaque (W13-1)

Advisory Speed plaques are described in **OMUTCD** **Sections 2C.08 and 6F.52.** The designer may specify the use of the Advisory Speed plaque (W13-1) by a **Plan Note** in **Item 614 Maintaining Traffic**. Unless specified, this plaque would only be used when directed by the project engineer. The designer may also specify the speed to be shown **(see OMUTCD Section 6F.52)**. A speed reduction would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer. See ***Section 640-18.1*** (Design and Advisory Speeds) for additional information.

641-8.4 Bid Items

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums, Warning Lights and Shadow Vehicles.

641-9 Closure of Right Lane of Three-Lane Section with Two-Way Left-Turn Lane (MT-95.61)

641-9.1 General

For some work area locations, it may be desirable to provide additional safety devices such as portable changeable message signs (PCMSs), and truck-mounted or self-contained impact attenuators. When required, these units shall have separate notes and/or details as well as separate pay items.

The designer should evaluate the possibility or extent of encroachment into open traffic lanes. This evaluation should include consideration of the existing geometrics, including lane and shoulder widths, the type of work being performed during the various construction stages, and any additional width required for the location of drums or cones and work zone edge lines, when used. Depending upon the available lane width of the lane, it may be necessary to shift traffic onto the shoulder using drums or cones and/or work zone edge line. In this case, consideration should be given to removal of the existing right edge line.

641-9.2 Advance Warning Signs Groups

Additional Advance Warning Sign Groups (AWSGs) should not normally be required. If an analysis indicates the need for this group, it would have to be included in the plan with a reference in **614 Maintaining Traffic** that the additional AWSG(s) shall be included as part of the signing required for **Traffic SCD** **MT-95.61** ***(see Section 641-5.2)***.

641-9.3 Advisory Speed Plaque (W13-1)

Advisory Speed Plaques are described in **OMUTCD** **Sections 2C.08 and 6F.52.** The designer may specify the use of the Advisory Speed plaque (W13-1) by a **Plan Note** in **614 Maintaining Traffic**. Unless specified, this plaque would only be used when directed by the project engineer. The designer may also specify the speed to be shown **(see OMUTCD Section 6F.52)**. A speed reduction would normally be 10 miles per hour. If the speed is not specified, the speed would be as directed by the project engineer. See ***Section 640-18.1*** (Design and Advisory Speeds) for additional information.

641-9.4 Pavement Markings

The work zone edge line parallel to the roadway (i.e., beyond the taper edge line) shall be used if the lane closure is greater than 3 days. The use should be specified in the **Item 614 Maintaining Traffic Plan Note** with an estimated quality carried to the General Summary. See the notes in **Traffic SCD** **MT 95.61** and **C&MS** **614.11** for the type of work zone line to specify. Use of this line should be based on engineering judgment and include consideration of the length of the work, time of the closure, sequence of the work, including any need to remove the line in subsequent phases, encroachment on other lanes or the shoulder, type of work, geometrics in the area, and the relative cost of paint and work zone tape.

641-9.5 Bid Items

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums, Warning Lights and Shadow Vehicle.

The following item will be shown as a separate quantity in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width) (By Type)	Mile

641-10 Reserved for Future Use

641-11 Median Crossover Operation (MT-95.70, 95.71, 95.72, 95.73, 95.82 and 100.00)

641-11.1 General

Median crossover operation using continuous PB, as shown in **Traffic SCDs** **MT-95.70, MT-95.71, MT-95.72 and MT-95.73** is a relatively sophisticated method of traffic control which is only suited to certain types of construction activities. Median crossovers shall be lighted, either by an existing lighting system or by provision of a temporary lighting system **(MT-100.00)**. **Traffic SCD** **MT-95.82** also provides additional information for this operation. These traffic control and lighting drawings supplement the temporary roadway plans for the crossovers.

Portable barrier (PB) details shall be included in the plan by reference to **SCDs RM 4.1 and RM-4.2**.

Median crossover operations shall be designed with the number of lanes necessary to provide adequate traffic capacity in each direction.

MT-95.70 presents the appropriate design for a single-lane crossover; and **MT-95.71** presents the appropriate design for a multi-lane crossover. These designs are basically identical except that along single-lane operations greater than 3 miles in length the SINGLE LANE (W6-H3b) sign is to be erected at 1 mile intervals to keep the road users informed as to the distance remaining to the point where multi-lane operation will be resumed. Additionally, **MT 95.70** provides for lane reduction prior to the crossover by closing the left lane. **ODOT's** practice is to close the left lane when a lane reduction is necessary in advance of a crossover. **MT-95.71** assumes that there is no lane reduction; however, if a lane reduction is provided in advance of a multi-lane crossover, both drawings should be included in the plans.

Traffic SCDs MT-95.72 and MT-95.73 present a hybrid design, where one lane is detoured across the median while the remaining lanes are maintained to the right of the median through an area of part-width construction. This method of traffic control may have limited uses, but may be appropriate where bridge widths are not adequate to provide the minimum capacity by implementing standard part-width or standard crossover traffic control. As shown in **SCD MT-95.73**, if exit ramps are located within a section of highway where the hybrid design is in use, it will be necessary to include appropriate level 1 signing in the plans to provide adequate guidance to these exit ramps. If no exit ramps are located within the highway section, the signing shown in **SCD MT-95.72** should be provided. All guide signs, including diagrammatic signs, for **SCDs MT-95.72 and MT-95.73** should be level 1 designs **(see OMUTCD Section 2E.02 and Table 2E-3, and Appendix C of the SDMM)**.

Operations which are forced to include a ramp or other complicating factor should usually result in the use of a **Plan Insert Sheet** specifically modified to show the individual situation.

Normally, the need for a median crossover operation will be determined from the Maintenance of Traffic Alternative Analysis (MOTAA).

641-11.2 Crossover Design

The design of crossover roadways is addressed in ***Sections 606-16 and 640-12***. Careful choice of crossover locations is extremely important to the safe and efficient operation of this system. They should be located in tangent, level sections with both roadways on about the same profile elevations. They should avoid bridges, other structures and should be well spaced from interchanges, rest areas or other ramps. Existing signs in the area may have to be relocated, covered or overlayed. All crossover sites should be field checked to the extent that crossovers, tapers and advance signing are approximately located in the field.
Crossovers are normally located as a pair to facilitate their use on adjacent construction sections, but they may be separated in order to provide improved operational locations. Consideration should be given at this time to the extent of backups expected and any extra advanced warning which may be necessary due to queues of slow moving traffic.

641-11.3 Advisory Speed Plaque (W13-1)

Advisory Speed plaques are described in **OMUTCD Sections 2C.08 and 6F.52.** The Advisory Speed plaques (W13-1) shown in **Traffic SCDs MT-95.70, MT-95.72, and MT-95.73** will not normally be used on a project. Current practices, as discussed in ***Section 640-18.1***, make a strong effort to assure that the design (i.e., speed of the crossover) is comparable to the statutory speed limit of the highway. Careful choice of crossover locations, as discussed in ***Subsection 641-11.2***, should eliminate any need to display the W13-1. However, in exceptional cases, where a local speed reduction may become necessary, Advisory Speed plaques may be added to the W1-4, W1-4b or W1-4c sign to warn the road users of the appropriate travel speed for the local conditions.

641-11.4 Pavement Markings

Notes in the drawing address the need to maintain appropriate pavement markings and eliminate conflicting ones. See ***Sections 605-11.10 and 605-11.11*** and **C&MS Item 614.11** for additional information on work zone pavement markings. Also, see ***Section 605-11.12* and**

C&MS Item 614.115 for information about work zone raised pavement markers.

641-11.5 Illumination

Traffic SCD MT-100.00 is intended for use to provide a lighting system for work zone median crossovers. The system is designed to light the entire width of the divided highway, from outside edge to outside edge of the permanent pavement, including the median in the vicinity of the temporary crossover.

SCD MT-100.00 provides for non-breakaway poles to be located beyond the clear zone, preferably 40 feet from the edge of pavement. This is acceptable only if fill slopes do not exceed 8:1, which they do not on most Interstate and other divided highways. If side slopes of greater than 8:1 are encountered without existing guardrail, see **L&D Manual Volume 1** for increased setback.

The designer shall review the probable location of crossover lighting units in the field to assure reasonable placement with respect to ditches or other features. A work zone crossover lighting system shall be provided when an existing lighting system is not present. When a work zone crossover lighting system is to be provided, **Plan Note 642-35** ***(Section 642-35)*** should be used.

The designer may develop a site-specific lighting plan for the crossover; however, the lighting plan must be approved by the **Office of Roadway Engineering (ORE)**.

641-11.6 Provisions for Reverse Flow and Use of the Shoulder

The reverse traffic flow will be exposed to obstacles which do not affect the normal traffic flow direction **(see Traffic SCD MT-95.82)**. Downstream bridge parapet ends, guardrail ends, etc. must be treated. Normally, additional lengths of temporary guardrail, turn-down anchors and appropriate guardrail to bridge parapet connections will be needed and should be provided separately in the plans. Normally temporary guardrail of this type will be removed to minimize future guardrail maintenance costs. Keep in mind that some existing guardrail-to-bridge parapet connections which are suitable for normal traffic flow direction are unsafe when traffic flow is reversed. The new approach end of the guardrail needs to be refit with an approved end treatment. Turn-down end treatments are not allowed in the clear zone. Where traffic flow is reversed, additional Type 3 Object Markers (OM-3) and barrier reflectors should be provided to guide this traffic. Type 3 Object Markers, also known as Bridge End Markers, are addressed in **OMUTCD Section 2C.63**; and barrier reflectors are addressed in more detail in ***Chapter 307, Section 605-19*** and **C&MS 626 and 720.04**.

The designer shall field review the section of road since traffic will be flowing in the opposite direction from normal, and if a paved shoulder will be used as a traffic lane, the review should determine:

1. If any bridge parapets, safety curbs, etc. restrict the width available for the lane throughout the remainder. If this construction would bring the available lane width to less than 10 feet, the shoulder should not normally be used. Even if 10-foot or more lanes are still provided, the obstruction should be well delineated. Bridge End Markers (OM-3) and barrier reflectors on guardrail or parapets will usually be desirable and may be reduced to 25 foot spacing when very close to the traffic lane. When old style safety curbs are encountered, they should be painted (retroreflective curb markings) on the approach ends and trailing ends, and barrier reflectors should be applied to the top of the curb to delineate it.
2. If existing signs need to be moved. Existing signs within 12 feet of the temporary lane should be reviewed.
    a. Signs behind guardrail: Those at least 4 feet behind face of guardrail will not be a problem, and probably as little as 2 feet behind rail will be acceptable. Signs closer than 1 or 2 feet to face of rail <u>and</u> less than 6 feet from the temporary lane are likely to

be damaged and, if possible, should be moved further from the road.

b. Signs not behind guardrail: Major signs on breakaway supports (not behind guardrail) are usually located 30 feet or more from the edge of the through lane and will not normally be a problem. Any major sign which is closer than 12 feet to a temporary lane should be considered for moving back to 30 feet or more from the permanent lane if conditions permit. Since moving signs back enhances overall safety, this work should not be considered incidental to maintaining traffic but should be defined with normal permanent sign plan requirements (elevation views, bid items, removal of sign, removal of support, (new) sign support, signs, breakaway connections, etc.).

c. Major signs in the median: Major signs on breakaway supports located in the median will not function properly if struck by counter-flow traffic. When these signs are within 30 feet of traffic lanes and not otherwise shielded from counter-flow traffic the following steps should be considered:

   i. In many cases, the legend may not be considered essential during construction (County or City Limit signs, etc.) and the sign can be removed, safely stored and later re-erected.

   ii. Some breakaways can be modified by replacing the hinge plates with additional fuse plates (fuse plates on both sides of beam).

d. Minor signs (on drive posts) are normally located 6 feet from edge of shoulder and this is considered adequate. Any found to be less than 6 feet from the paved shoulder should be considered for relocation.

   In some cases, signs can be relocated longitudinally to put them behind guardrail provided for other purposes.

3. If the shoulders are adequate. Shoulders which will be used for traffic flow should be checked to determine if they will support the anticipated loads without becoming too rough to be serviceable. Overlays, and possibly full-depth shoulder replacement, may be needed.

When two lanes will be provided in one direction by using the shoulder, the line separating them will be coincidental with the permanent edge line. Rather than require a contractor to remove parts of an existing white edge line to convert it to a standard dashed lane line, it is permissible to allow it to remain as a solid white lane line **(OMUTCD Section 3B.04)**.

641-11.7 Bid Items

It is intended that separate bid items be included for the following items:

Item 614,	Object Marker, ____-way	Each
Item 614,	Work Zone Pavement Markings (by Class), (by width), (by type)	Foot or Mile, as applicable
Item 614,	Work Zone Raised Pavement Marker	Each
Item 614,	Temporary Impact Attenuator	Each
Item 622,	Portable Barrier, ____”	Foot
Item 614,	Work Zone Crossover Lighting System	Each
Item 614,	Barrier Reflectors (by type)	Each
Item 630,	Signs (Permanent)	
Item 630,	Supports (Permanent)	

The lump sum for **Item 614 Maintaining Traffic** will cover all other work needed to place, maintain and remove the TLTWO including the following items:

Temporary Signs and Supports
Drums and other channelizing devices
Flashers and lights on signs
Arrow boards
Removal and replacement of raised pavement marker reflectors
Removal of conflicting existing or work zone pavement markings (this is specifically incidental

to **Item 614 Work Zone Pavement Markings**)
Temporary Guardrail, Type 5
Temporary Bridge Terminal Assemblies

641-12 Signalized Closing, One-Lane of a Two-Lane Highway (MT-96.11, 96.20 and 96.26)

641-12.1 General

This standard drawing is to be used where it is necessary to close one lane of a two-lane highway and where the longer length of time of the closure would not lend itself to the use of a flagger. Hazards under these conditions are typically protected by concrete barrier as shown in the drawing. A typical application of this drawing would be part-width bridge construction. However, if the work does not result in the development of significant drop-offs or other significant hazards to the workers or the road users, the designer may consider calling for drums to be used.

The end of a concrete barrier, if not treated properly, can represent the most hazardous part of the installation. Therefore, wherever practical, the exposed end of the PB should be terminated outside the clear zone. When the design speed is greater than 40 miles per hour and the barrier is located within the clear zone, consideration should be given to terminating the barrier with a work zone impact attenuator.

Where PB is located beyond the edge of the paved shoulder, the cross slope within the clear zone, including the surface on which the PB is place, shall be graded at 10:1 or flatter. If the cross slope is steeper than 10:1, the PB shall be terminated on the paved or graded surface rather than on the cross slope. The PB shall be extended along the paved or graded surface as necessary to satisfy the length of need **(see L&D Manual Volume 1, Section 602.1.2)**, and then terminated using an impact attenuator.

In the majority of the cases, it will be necessary to construct temporary pavement or rebuild the shoulders to maintain a minimum desirable lane width. This lane width should be the width of the approach lane, but in no case less than 10 feet. Wherever possible the lane width shall be in addition to a 1 foot offset (preferably 2 feet) from any guardrail or concrete barrier. A separate sheet will be required in the plan to show the details necessary to construct the temporary pavement, as well as the actual width of the pavement to be closed.

These signalized closing treatments provide high visibility of one side of the single lane (PB with reflective panels, barrier reflectors and object markers, or retroreflectorized drums). However, similar night visibility is not assured for the roadside away from the work. If a hazard beyond the shoulder, or a constriction such as a bridge parapet or guardrail, exists on that side, additional devices (retroreflective panels, barrier reflectors, etc.) should also be specified on that side to provide a more balanced outline of the maintained lane.

If adequate room is not available to set up the zone because of driveways or intersections, revision will be required as a separate Maintenance of Traffic Plan Sheet, with the provisions of the **SCD** being adhered to wherever possible.

Where pedestrians are likely to try to pass through the construction area, reasonable provision shall be made for them. If pedestrian traffic is significant, a designated path may be necessary. See ***Sections 603-2 and 640-25*** for further information on accommodating pedestrians.

Simple, two-phase traffic signal systems shall not be used for situations where traffic, including contractors' vehicles, will be entering the traffic stream, from the work site, between signals. Such intermediate access points shall be kept to a minimum, or avoided completely if possible. If traffic must enter the traffic stream at intermediate locations, an additional signal shall be located at each such location. Each such signal shall be traffic actuated.

The traffic signal system may either be constructed of standard signal components conforming to **Traffic SCDs** **MT-96.11, 96.20 and 96.26**, or it may be a portable traffic signal (PTS) which is essentially self-contained and mounted on a trailer or pedestal ***(see Section 605-13.3)*** per **ODOT's** Approved List for PTS.

641-12.2 Duration of Work

As noted in ***Section 605-13.2*** for temporary traffic signals which will be in continuous operation for seventy-two hours or less, pavement marking shall be as shown in **Traffic SCD** **MT- 96.11** ***(see Section 641-12)*** with the following exceptions:

1. Temporary pavement markings are not required.
2. Removal of existing conflicting pavement markings is not required if drums (or cones during daylight hours only) provide continuous positive guidance for vehicles.

641-12.3 Capacity and Flow Rates

The maximum length of one-lane operation for one-way traffic signal control is determined by the capacity required to handle the peak-hour demand. ***Table 697-2*** summarizes these conditions.

The hourly rate of flow figures shown in ***Table 697-2*** may not be readily available during the initial analysis of signal timing. In those cases, ADT data from readily available reports published by the **Office of Innovation, Partnerships and Energy** may be used to develop hourly rates of flow. Two factors should be used in this conversion: the peak hour factor (PHF) and "K."

The peak hour factor (PHF) relates the average peak hourly flow to the peak 15-minute flow during the peak hour. If other information is not available, PHF= .90 may be assumed.

"K" relates the peak hour volume to the average daily traffic. If other information is not available, K=0.10 may be assumed.

Using these factors, an approximate hourly rate flow can be determined:

Approximate Hourly Rate of Flow = ADT x K/PHF

EXAMPLE: 9000 (ADT) x 0.1(k)/0.9 (PHF) = 1000 vehicles per hour

This flow rate can then be used in ***Table 697-2*** by finding the approximate hourly rate of flow in the proper column which defines the length of the one-lane operation (from Stop Line to Stop Line). Moving to the left in the table, the total signal cycle length is determined. If the cycle length is considered acceptable, it can be used to help determine the individual signal interval times.

A more accurate method of determining hourly rates of flow is necessary when the closure length is long or traffic volumes are high. When the estimated traffic ADT and closure length exceeds that shown in ***Table 697-6***, collection of more detailed traffic data and more refined analysis of signal timing is recommended.

In these cases, actual current traffic counts should be obtained and analyzed to identify various peak periods for weekdays and weekends, noting particularly any directional imbalances occurring during the peaks. Where traffic patterns are determined to be repetitious and there is significant disparity between peak and off-peak traffic, or there are major differences between various peak periods, then a signal controller capable of adjusting timing to suit the anticipated traffic flows should be selected.

This can be accomplished in either of two ways:

1. Use of a multi-plan, time-of-day (TOD) controller and time clock to provide preselected

timing patterns to suit the various peaks and off-peak times. As compared to the following alternate, this system is less expensive in terms of hardware and installation, but it requires more accurate (and expensive) traffic data collection and analysis to choose appropriate timing patterns and their hours of operation. One, or perhaps two weeks of hourly, directional counts may be needed to develop reasonably reliable timing plans. Once implemented, this system will usually be relatively maintenance free, but if traffic patterns change during construction, additional data collection and retiming may be necessary. The **District** should be prepared to monitor the system operation and provide data collection and timing changes when warranted.

2. A traffic-actuated controller with detectors in advance of each end of the work zone will also compensate for changing traffic patterns. Fully traffic-actuated operation is normally employed once carefully selected controller timing is implemented. The units should adapt to most changes in traffic volume and provide good operation. When compared to the first alternate above, the hardware and installation costs for detection will increase initial installation costs. Also, detectors can be expected to fail or require readjustment during construction, thus increasing maintenance costs. On the other hand, unexpected changes in peak-period demand or timing will usually be accommodated automatically, thus negating the need for signal retiming. The **District** should still be prepared to monitor the signal operation for failure or inappropriate timing.

Where analysis of the traffic data shows that peak periods are not predictable in terms of magnitude, predominant direction of flow or time of occurrence, actuated operation will be the most appropriate choice.

Any existing traffic signals within one-half mile must be taken into account when determining the effect of signal operation. Coordination, or modification of the existing signal, may be appropriate in cases where queues from one signal may interfere with the operation of the other.

Analysis of signal timing and traffic capacity should assure that the anticipated traffic can be accommodated, or signalized operation of this sort should not be included in the project.

Plan Notes 642-36 and 642-37 ***(Sections 642-36 and 642-37)*** should be included in the plansto obtain multi-plan, time-of-day or an actuated controller when appropriate.

641-12.4 Traffic Signal Details

Traffic SCDs MT-96.20 and 96.26 will be required when **MT- 96.11** is used. **Supplemental Specification 961** and **Supplement 1050** for portable traffic signals will also be required.

Under light traffic the signal will normally operate in a pretimed mode using a simple pretimed controller, or using an actuated control in a pretimed mode (no detectors, recalls on). However, under certain conditions it may be desirable/necessary to use actuated control with detection or to require a multi-plan pretimed control **(see Traffic SCD MT-96.20)**.

The plan shall show necessary signal timing ***(see Tables 697-3 and 697-5)***.

Sheet 2 of **MT-96.11** provides information regarding signalization of intermediate side-road approaches located within the limits of the two-way operation of the single lane. Two locations are shown for the side-approach signal heads; a near-side location “A,” and a far-side location “B”; the far-side location being the preferred location. At least one of the signal heads per side approach shall be located as per **OMUTCD Figure 4D-4**. The stop line shall be located accordingly.

The detection on the side approach should be set in the lock mode. For the mainline approaches to the single-lane operation, consideration should be given to setting these approaches on recall.

At special locations, such as where an intersection is located immediately in advance of the lane reduction, as shown at the left side on Sheet 2 of **MT-96.11**, a special site-specific detail should be provided in the plans. A conventional simple span might be appropriate at such locations. It is the responsibility of the designer to design an appropriate signal for such sight-specific locations.

641-12.5 Pavement Markings

Work Zone pavement markings are required in all cases, except as noted otherwise in ***Section 641-12.2***, as follows:

1. Work Zone Stop Lines, Class I: at each end of the work.
2. Work Zone Center Lines, Class I: double solid for 150 feet from each Stop Line.
3. Work Zone Edge Lines, Class I: 740.06, Type I tape, white, along the merge tapers.
4. Work Zone Edge Lines, Class I, white, along the single-lane, two-way operation. Paint may be used if not on the final surface course. Type I tape, 740.06, shall be used if on the final surface course.

The requirements for work zone pavement markings are contained in **C&MS 614.11**.

641-12.6 Driveways and Side Roads

Driveways and side roads intersecting within or close to the one-lane portion of the temporary traffic control zone should be considered and treated uniformly. The following alternatives should be considered, with the earlier being considered more desirable than those later on the list:

1. If the drive or street is very close to one end of the one-lane, two-way segment, determine if the signals and Stop Line can be relocated sufficiently to place the intersection outside of the one-lane area.
2. Where drives or streets have low to moderate traffic volumes, consider erecting signs (a STOP sign plus a No Left/Right Turn sign) to allow traffic to only turn away from the central area of the work zone. This treatment is only feasible if cross-corner sight distance in both directions is good and if the near-end of the one-lane segment can be easily seen.
3. Where a residential drive or minor commercial drive is involved, if the work length is very short (perhaps less than 200 feet) and a driver stopped on the drive has good visibility to both ends of the work and both approaches, it may be reasonable to impose only stop control on the drive traffic.
4. Where a public road or alley is involved, consider closing that approach to the intersection, or possibly making it one way away from the work area. This will require discussion with the local agency responsible for the side road. Provisions shall be made for additional ROAD CLOSED signs, Detour signs, ONE WAY signs, DO NOT ENTER signs and other Regulatory Signs.
5. If a driveway serves a business, group or property which also has another usable drive, close the drive in question, after informing owners and tenants of the intended action. Minor widening or improvement of the alternate drive may be considered to provide similar access and to avoid major complaints or litigation.
6. Provide a temporary driveway or minor relocation of the side street to move the entering traffic away from the one-lane segment.
7. If less intrusive methods are not feasible, consider providing another actuated signal phase, complete with at least two signal heads, for the side street or drive. Prior to approval of this method, the designer must obtain projected hourly traffic data for a typical weekday (and weekend if traffic is critical) in order to perform capacity analysis for critical periods.

Capacity analysis resulting in poor levels or service will normally preclude use of this treatment.

8. Provision of flagger or control by law enforcement officers.

641-12.7 Lighting

Typically lighting will not be required for signalized closings 1 lane or a 2-lane highway. However there may be some locations where the designer may find a special need to provide lighting. Examples of need for such lighting might be the existence of an intersection at the point of the lane closure, or poor geometrics or poor sight distance at the point of the lane closure.

The Plan Note for Work Zones Lighting System, found in ***Section 642-39***, shall be included in the plans when lighting is required at the points of lane closure.

When lighting is called for, it shall be paid for as Work Zone Lighting System. Quantities shall be provided in the sub-summary for each phase of maintenance of traffic. If it is expected that lighting will be of the conventional type, the lighting shall be paid for per Each.

641-12.8 Field Reviews

A field review, by the designer, is required to verify the proposed locations of PB, drums, pavement markings, signal heads, signs and other features for each phase of the project. Each element shall be tentatively located according to the requirements of the **SCD** and plans to assure adequate visibility and to assure that the controls will be effective. Signal heads shall be visible no less than 215 feet in advance for 25 mile per hour approaches, 325 feet for 35 mile per hour; 460 feet for 45 mile per hour and 625 feet for 55 mile per hour approaches. Signs shall be visible at least 250 feet in advance. Reviews should consider the effects of summer foliage. Any existing traffic controls or other physical features which will detract from safe and efficient operation should be dealt with in the plans. The field check shall also verify that there will be adequate room to perform construction behind barriers or channelizing devices, and that available pavement widths will be sufficient to maintain traffic. The need for temporary pavement or pavement strengthening to carry maintained traffic shall be considered. Changes deemed necessary as a result of this field check shall be incorporated into the MOT Plans by providing details or descriptive notes in the plans. These may include revised locations for signs, signals, pavement markings, PB or other devices. They may also include requirements to use overhead-mounted signals or additional signals or other control devices and could include requirements to remove foliage on the right-of-way.

When actuated signals are necessary, **Plan Note 642-37** ***(Section 642-37)*** should be included in the plans.

When overhead-mounted signals are necessary, **Plan Note 642-38** ***(Section 642-38)*** should be included in the plans.

641-12.9 Bid Items

In an effort to obtain consistency in the bidding procedure the following pay items should be used, as required:

Item 615,	Pavement for Maintaining Traffic, Class _____	Sq. Yd.
Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Center Line, Class I	Mile
Item 614,	Work Zone Stop Line, Class I	Foot
Item 622,	Portable Barrier, ____”	Foot
Item 614,	Barrier Reflector	Each
Item 614,	Object Marker, ____-way	Each
Item 614	Work Zone Lighting System	Each

All other items will be included in **Item 614 Maintaining Traffic**.

641-13 Flagger Closing One Lane of a Two-Lane Highway (MT-97.10, 97.11, 97.12 and 97.20)

Traffic SCD **MT-97.10** depicts a typical application using a flagger to close one lane of a two-lane highway for a stationary operation. The distance (“A”) provided from the Flagger symbol sign (W20-7) to the flagger assumes light to moderate traffic with no substantial back-up, thus the distance allows for a typical back-up of cars plus adequate distance to slow from the approach speed to a stop at the end of the queue. Other locations with heavier traffic or a longer work area will increase the queue length build-up just before traffic is released. The designer should increase distance “A” by **Plan Note** when calculations show the need. Further, **MT-97.10**, allows the project engineer to increase sign spacing based on expected or actual field conditions at any time.

Traffic SCDs **MT-97.11 and 97.12** were developed specifically for use during a paving operation on a two-lane road. Therefore, one shall be included with each two-lane resurfacing plan. **MT-97.11** should be used with all non-Federal two-lane resurfacing projects. **MT-97.12** shall be used with all Federal two-lane resurfacing projects.

MT-97.11 and 97.12 provide guidance for traffic going through a paving operation by the use of flaggers and traffic cones. They provide for the use of cones placed laterally across the lane being paved at roads intersecting the closure, and attempt to keep the work area length to a minimum and keep the advance signing and the flagger grouped together.

Traffic SCD **MT-97.20** depicts the use of temporary portable rumble strips and is intended to be used as a supplement to **MT-97.10**. It is not intended to be used as a standalone drawing.

All items shown on these drawings will be included in the lump sum bid for **Item 614 Maintaining Traffic**.

641-14 Lane Closure at Entrance Ramp (MT-98.10 and 98.11)

Traffic SCDs **MT-98.10 and 98.11** generally address lane closures in the vicinity of entrance ramps. **MT-98.10** applies primarily to major reconstruction work, where the work extends beyond the acceleration lane, upstream and downstream on the mainline and upstream on the ramp. **MT-98.11** applies to isolated work areas located primarily on the mainline, in the through lane adjacent to the acceleration lane of the entrance ramp.

Each of these **SCDs** includes separate details drawings. Work location determines which detail is used.

Traffic SCD **MT-95.30**, which pertains to lane closures on the mainline, shall be used as a companion drawing whenever **MT-98.10** or **98.11** is used.

The designer should exercise care when using **MT-95.30** in the area of an entrance ramp. The placement of signs for closing the right lane contained in **MT-95.30** may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition exists, the designer shall provide positive guidance for the road user. This may involve showing the exact placement of all signs and tapers noted in **MT-95.30** within both interchanges on a separate drawing, rather than relying on the **SCD**.

If the paved shoulder must be used to achieve minimum lane width, it may require that the shoulder be reconstructed or strengthened to accommodate the additional load. A separate sheet would be required in the plan detailing the shoulder work.

In order to work on an entire entrance-ramp, it will be necessary to use both detail drawings from the applicable **SCD**. Traffic operation under the detail shown on the second page of each of these drawings may be significantly restricted, and poorer operation can be anticipated. Therefore, the design and project implementation should attempt to do as much of the work as possible using the detail shown on the first page of each of these **SCDs**. This should minimize the time and traffic restrictions involved when the work area is as shown in the detail on the second page of the drawing. Consideration should be given to providing temporary pavement to locate the merge/shift area in the first detail shown at a point downstream, which will then allow for adequate acceleration distance to be provided when the work area shifts and the second detail is used.

Adequate decision sight distance should be provided where possible. See ***Section 607-15 and Table 697-8***. If adequate decision sight distance cannot be provided, this should be documented, explaining the reason for non-compliance. Consideration should also be given to closing the ramp.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD** **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic:** Signs, Cones, Drums and Warning Lights.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Lane Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I (By Type)	Feet

641-15 Lane Closure at Exit Ramp (MT-98.20 and 98.21)

Traffic SCDs **MT-98.20 and 98.21** generally address lane closures in the vicinity of exit ramps. **MT-98.20** addresses lane closures using drums. **MT-98.21** addresses lane closures using portable barrier (PB). **MT-98.21** also addresses the use of impact attenuators in the exit gore. Otherwise, both drawings are basically the same.

Each of these **SCDs** includes separate details drawings. Work location determines which detail is used.

Where the impact attenuator is intended to apply to two barriers within the gore, one from the mainline and one from the ramp, the two barriers shall be joined to form one unit using a PCB “Y” connector segment. See the **Roadway Plan Insert Sheet** for details on this PCB “Y” connector segment. This insert sheet shall be provided in the plans. When using steel barrier, a double wide attenuator shall be used instead of a “Y” connector.

Traffic SCDs **MT-95.30 and 95.40**, which pertain to lane closures on the mainline, shall be used as companion drawings to **MT-98.20 or 98.21,** respectively.

The designer should exercise care when using **Traffic SCD** **MT-95.30 or MT-95.40** in the area of an interchange immediately upstream of the work site. The placement of signs shown in **MT 95.30 or MT-95.40** for closing the right lane may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition exists, the designer shall provide positive guidance for the exiting road user. This may include showing the exact placement of all signs and tapers noted in **MT-95.30 or MT-95.40** within both interchanges on a separate drawing, rather than relying on the **SCD**.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. The designer should check the speed of any proposed Advisory Exit or Ramp Speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

The opening to the ramp shall have a minimum length of 200 feet. Within this space, the exiting vehicle must shift laterally to enter the exit ramp. Based on the **1985 Highway Capacity Manual**, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour. Consideration should be given to providing temporary pavement at the upstream end of the deceleration lane for use in the second detail of each of these **SCDs** if necessary in order to provide adequate ramp openings.

Traffic SCDs **MT-98.20 and 98.21** show an opening of 420 feet each, which is associated with a 70 miles per hour exiting speed. Openings longer than 420 feet should be used whenever conditions permit. When conditions will not allow a 420 foot opening, shorter values (but not less than 200 feet) may be used. When shorter openings (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (W13-1) shall be provided.

See **OMUTCD** **Section 6C.08** and ***Section 602-5*** for a discussion of taper rates.

If the paved shoulder must be used to achieve minimum lane width on the ramp, as noted in **MT-98.20 and 98.21**, it may be necessary to reconstruct or strengthen the shoulder to accommodate the additional load. A separate sheet would be required in the plan detailing this shoulder work.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD** **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Channelizing Line, Class I, (By Width), (By Type)	Foot
Item 614,	Work Zone Dotted Line, Class I (By Type)	Foot

641-16 Lane Closure in Deceleration Lane (MT-98.22)

Traffic SCD **MT-98.22** addresses closure of the deceleration lane, with an opening located near the gore to provide access from the freeway/expressway to the ramp.

The opening to the ramp shall have a minimum length of 200 feet. Within this space, the exiting vehicle must shift laterally to enter the exit ramp. Based on the **1985 Highway Capacity Manual**, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour.

Traffic SCD **MT-98.22** shows an opening of 420 feet each, which is associated with a 70 miles per hour exiting speed. Openings longer than 420 feet should be used whenever conditions permit. When conditions will not allow a 420 foot opening, shorter values (but not less than 200 feet) may be used. When shorter openings (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (W13-1) shall be provided. See **OMUTCD** **Section**

6C.08 and ***Section 602-5*** for a discussion of taper rates.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. The designer should check the speed of any proposed advisory Exit or Ramp Speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

Advance Warning Signs should be placed in locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use **OMUTCD** **Table 6C-1** to determine dimensions A, B and C.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD** **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I (By Type)	Foot

641-17 Typical Lane Closures for Ramps (MT-98.28 and 98.29)

Traffic SCD **MT-98.28** shall be used when work along an exit ramp leaves at least one lane open to ramp traffic.

The **SCD** includes two separate details drawings. Work location determines which detail is used. The first is intended for use when the work is in the inside portion of the ramp curve, with traffic to be routed along the outside portion of the curve. The second is intended for use when the work is in the outside portion of the ramp curve, with traffic to be routed along the inside portion of the curve.

Traffic SCD **MT-98.29** shall be used when work requires that the exit ramp be entirely closed.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. When the ramp will remain open, the designer should check the speed of any proposed advisory exit or ramp speed signs to avoid contradictory speed posting with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

When **MT-98.29** is included in plans, treatment of the permanent Guide Signs in accordance with the guidelines for Advance Work Zone Information Signs shall be considered. The need for a detour and related signing must also be addressed.

Advance Warning Signs should be placed in such locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use **OMUTCD** **Table 6C-1** to determine dimensions A, B and C.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See OMUTCD **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I (By Type)	Foot

641-18 Traffic Control for Long Line Pavement Marking Operations (MT-99.20)

Traffic SCD **MT-99.20** is applicable to all projects with long line markings (center, edge or lane line except in the following situations:

1. Where the markings will be applied while the area is closed to traffic for other reasons;
2. Where the work area is so short (+/- one-half mile) that the required sequence of vehicles cannot be assembled while the marking vehicle travels the length of the project; or
3. Where the plans require another form of protection.

Also see C&MS **614.11** for additional traffic control requirements for long line pavement marking operations.

If the work will require a lane closure as designated in the table on **MT-99.20**, the plans should include the appropriate lane closure details.

The 18-inch cones are permissible only to protect a wet painted line. The larger, 28- inch cones shall be provided if they will be used to close off a lane (in daylight), either in the closure transition or through the work area.

641-19 Freeway/Expressway Closure in Work Zones (MT-99.50)

641-19.1 General

Traffic SCD **MT-99.50** is intended for use where a freeway or expressway is closed within a work zone or in an emergency. It is not intended for use in conjunction with "permanent" closures which remain upon completion of the contract. For "permanent" closures see ***Section 640-28*.**

MT-99.50 may be appropriate for "weekend" closures, particularly at diamond interchanges for painting or other work within an interchange. In such situations, all traffic will be required to exit at the exit ramp and then re-enter at the entrance ramp. The cross highway shall be closed in order to allow continuous movement from the exit ramp to the entrance ramp. Appropriate signing and channelization shall be provided in order to maintain traffic flow along the ramps and to designate a detour for the cross-highway traffic. This additional traffic control should be detailed in the plans.

MT-99.50 may also be appropriate for emergency situations. Additional site-specific message boards may be appropriate in order to provide detour signing, directing traffic back to the freeway/expressway.

641-19.2 Signing

Signing used for this type of work will typically consist of flatsheet Warning Signs and arrow boards. Use of existing extrusheet major Guide Signs, with overlays, in lieu of the flatsheet signing may be used. The designer shall specify which type of signing is to be used. If existing extrusheet Guide Signs are to be overlaid, the designer shall locate these signs in the field and show the signs in the plans accordingly.

If existing supports are not available, breakaway supports or supports behind guardrail shall be individually designed.

Portable Changeable Message Signs (PCMSs) may also be used to supplement the flatsheet or extrusheet signs. If PCMSs are to be used, the designer shall specify the quantity of signs and provide the appropriate legends to be displayed.

641-19.3 Channelization Devices

Typically, the closure is identified by use of drums; however, PB is shown in **Traffic SCD** **MT-99.50** for use when called for in the plans. A drop-off condition is an example of a situation that might constitute a need for PB (see ***Subsection 605-5.13*** and **Traffic SCD** **MT-101.90**). The designer shall determine whether or not the additional protection provided by PB is necessary and shall provide the appropriate quantity.

Taper rates of drums shall be as called for in Table II in **Traffic SCD** **MT-99.50**. These taper rates are intended to be similar to those shown in **OMUTCD** **Figure 6H-32**.

The flare rate of the PB shall also be as called for in Table II of **Traffic SCD** **MT-99.50**. The flare rate may be applied at the exit gore; however, if the contractor will be working in the vicinity of the provided shift taper, the designer should consider specifying in the plans that the PB shall be located parallel to the edge line.

The drum/PB combination is intended to be similar to that shown in **Traffic SCD** **MT-95.40** and in **OMUTCD** **Figure 6H-34.**

641-19.4 Multiple Lane Closures

If a freeway/expressway has three or more directional lanes and it is necessary to close more than one lane, insert a tangent section (equal in length to twice the taper) between the end of the first lane closure and the beginning of the second. Dual ground-mounted W4-2-48 signs (W9-H4-144 signs if using extrusheet signing) shall be placed along the tangent, in advance of the taper for the second lane closure, at approximately a distance equal to the length of the taper **(also see OMUTCD Figure 6H-37).** If additional lanes are closed, the same process shall be repeated.

If the signs shown as dashed at the ramps do not exist, the designer may require them or similar signs as a part of the work.

641-19.5 Portable Barriers and Impact Attenuators

1. The impact attenuator treatment will typically not require any additional grading of the median; however, foreslopes of 10:1 or flatter from the edge of the shoulder to the PB shall be required. This may require drainage changes.
2. The impact attenuator treatment should typically be more economical.
3. The offset "E" to the beginning of the PB may not always be sufficient **(see L&D Manual Volume 1, Section 307).** If the roadway curves to the right, and the curvature exceeds 2.5 degrees (radius is less than 4100 feet), the offset shall be increased in accordance with ***Table 697-7***.

The length of PB beyond the shoulder shall also be increased proportionately to maintain the flare rate relative to the edge of pavement, per Table II.

The designer, not the contractor, must determine when to use each type of end treatment and note this in the MOT Plan.

641-19.6 Bid Items

For **Traffic SCD** **MT-99.50**, all items will be included for payment under **Item 614 Maintaining Traffic**, except the following:

Item 630, Sign, Extrusheet	Square Foot
Item 630, Sign, Overlay	Square Foot
Item 630, Ground Mounted Supports, ________ Beam	Foot
Item 630, Breakaway Beam Connection	Each
Item 630, Ground Mounted Beam Support Foundation	Each
Item 614, Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614, Work Zone Raised Pavement Marker	Each
Item 622, Portable Barrier, ____"	Foot

641-20 Short Term Closure of Multi-Lane Divided Highway (MT-99.60)

641-20.1 General

Traffic SCD **MT-99.60** shall be used to close (traffic slowed to 25 MPH or less) multi-lane divided highways for a maximum of 15 minutes to preform operations such as stringing a cable across the travel lanes, bridge demolition, etc.

This SCD covers situations where LEOs slowly bring traffic to a stop in front of the work area.

641-20.2 Signing

Signing used for this type of work will typically consist of flatsheet Warning Signs equipped with Type B flashing warning lights and orange warning flags and a Portable Changeable Message Sign (PCMS).

If existing supports are not available, breakaway supports or supports behind guardrail shall be individually designed.

641-21 Road Closure Using Type 3 Barricades (MT-101.60)

The type of closure shown in **Traffic SCD** **MT-101.60** will typically be used in two different situations:

1. The closure seals off a road from which through traffic has been detoured upstream. In this case, only local traffic is expected on the approach to the closure, although this traffic might still be appreciable if the detour begins some distance upstream. Any traffic approaching the closure must be adequately warned and given ample opportunity to stop. The minimum advance warning treatment is three signs. They are supplemented with Type A flasher warning lights. The signs will be dual installations on a four-lane divided road and the designer may insert a **Plan Note** requiring dual installations on other roads.
2. The closure is accompanied by some form of a runaround, directing traffic away from the barricade closure. The runaround may be any one of several types: it may be a true run-around as provided in **OMUTCD Figure 6H-7**; it may be a median crossover as provided in **Traffic SCD** **MT-95.70**; or, it may be a complete closure of a limited-access highway, requiring all of the traffic to exit upstream of the barricade closure, such as is shown on **Traffic SCD** **MT-99.50.**

All elements of the barricade closure, including any advance Warning Signs, will be included in the lump sum of **Item 614 Maintaining Traffic**.

641-22 Barrier and Impact Attenuator Delineation (MT-101.70)

Traffic SCD **MT-101.70** shall be used when PB is specified in the plans, or when permanent barrier (including bridge parapets) is within 5 feet of the edge of the traveled lane. The drawing presents several methods for delineating barrier as well as an impact attenuator nose cone delineation detail. Typically, barrier is delineated using object markers and barrier reflectors at 50-foot intervals, with the object markers and the barrier reflectors offset at 25 feet. This method of delineation is applicable to 32-inch barrier as well as to 50-inch barrier. **Plan Note 642-51** (***Chapter 642)*** shall be included in the plans when this method of delineation is to be provided.

See ***Sections 605-14.5 and 605-19*** for more information on portable barriers, barrier reflectors and object markers. See ***Sections 605-14.4*** **and 605-19.3**, and **Plan Note 642-52** ***(Chapter 642)*** for more information on guardrail delineation.

Where glare screen is provided ***(see Section 605-18)***, the use of object markers is not practical. In such cases, the glare screen shall be delineated by providing reflective sheeting stripes on glare screen panels. The stripes shall be placed in sets of three, on consecutive glare screen panels, at 50-foot intervals, center-to-center.

The standard barrier delineation methods typically used are presented in the upper half of **MT-101.70**. In the bottom half of the drawing, two additional barrier delineation methods are presented for the purpose of providing increased delineation of the side of the barrier.

One increased barrier delineation method is to provide delineation panels (3M^{TM} Scotchlite^{TM} Linear Delineation System (LDS) or approved equal). The delineation panels shall be provided in 6 x 34 inch sections, placed horizontally and at 10-foot intervals.

An alternative to using delineator panels for increased barrier delineation is to provide barrier reflectors at the normal 50-foot spacing, except that for increased impact, the barrier reflectors are stacked vertically in sets of three, rather than singly.

Either the delineation panels or the triple stack method of delineation shall be used within freeway and expressway work zones on all portable or permanent barrier located within 5 feet of the edge of the traveled lane under either of the following conditions:

- Along tapers and transition areas; or
- Along curves (outside only) with degree of curvature greater than or equal to 3 degrees.

Plan Note 642-51 (***Chapter 642)*** shall also be included in the plans when one of these increased barrier delineation methods is used.

These methods of increased barrier delineation may also be specified in the plans for additional use.

The nose cones of impact attenuators shall have a retroreflective surface as specified in **MT-101.70.**

641-23 Impact Attenuator Placement (MT-101.75)

Traffic SCD **MT-101.75** provides requirements for impact attenuator placement. This drawing shall be used on all projects with portable barrier.

641-24 Reserved for Future Use

641-25 Drop-Offs in Work Zones (MT-101.90)

Where drop-offs occur in work zones, adequate protection shall be provided to protect the road user. Typically the method of protection to be used will be specified in the plans in accordance with

Section 605-14. However, occasionally drop-offs that are not addressed in the plans will develop in the field. The purpose of this drawing is to provide instruction to the contractor regarding appropriate methods for protection from drop-offs within work zones where specific instructions have not been provided in the plans.

This drawing is intended primarily for use with work on freeways and expressways, as described under Conditions I and II; however, Conditions I and II may also be applied to other multi-lane highways with speed limits of 45 miles per hour or greater with minimal driveways. Methods of drop-off protection provided in the table for Condition II are to be considered as minimums.

Use of portable barrier (PB) may be appropriate in locations where Table II calls for a lesser form of drop-off protection, as the PB serves not only as protection from drop-offs, but also provides protections from the contractor's activities and from fixed objects such as utility poles and stored equipment. The designer may want to consider the expected duration of the maintenance of traffic stage as an additional factor in determining the need for providing a higher level of protection.

Also included in the drawing is Condition III, which is applicable to locations behind curb where the legal speed is 40 miles per hour or less. At such speeds, curbs of adequate height, typically 6 inches, have an effect on the lateral placement of moving vehicles. Therefore, the need for channelizing devices to protect the road user from the drop-off is reduced (see the table in the drawing under Condition III). Also see **L&D Manual Volume 1, Sections 305.3.1 and 601.1.4**.

For conditions other than those described in this drawing, engineering judgment shall be used to determine the appropriate method of drop-off protection to be provided. Examples of such conditions are highways where driveway access is a major concern, or low-speed highways where curb is not provided **(see the L&D Manual Volume 1, Section 601.1.4)**. The time period during which such drop-offs remain in existence should be minimized. Consideration should be given to providing fill material at the end of the work day to create a desirable foreslope of 3:1 or flatter, with 2:1 as maximum. However, if engineering judgment indicates that use of PB is appropriate, then the maintenance of traffic should be designed based on use of PB.

641-26 Transition Plans for Use of Shoulder (MT-102.10, 102.20 and 102.30)

When the work involves closing a lane(s) and a capacity analysis indicated that it is necessary to maintain more lanes of traffic than would remain after closing the lane(s), this drawing provides for use of the shoulder to maintain traffic. If the encroachment into the traveled lane is 2 feet or less, use a lane width reduction.

Lane use cross sections should be shown in the plan indicating the number of lanes and the width of each. Normally, all lanes should be shifted.

To help keep the traffic in the proper lanes, Work Zone Channelizing Lines are used through the transition area, and extended 300 feet in each direction beyond the transition area. Lane Lines may be provided within the tangent sections beyond these points if the length of Lane Line would be 600 feet or greater. However if the length of the Lane Line section would be less than 600 feet in length, the Channelizing Line shall be continued through the tangent section. Pavement marking and delineation details shall be provided in the plans (see **Traffic SCD** **MT-99.30** and ***Section 641-30***).

Traffic SCD **MT-102.10** addresses the use of this shoulder transition to maintain traffic when portable barrier (PB) is used, and **Traffic SCD** **MT-102.20** addresses the use of this traffic control when drums are used to close off the work area. The choice between using PB or drums should be based on the drop-off policy as well as consideration of traffic volumes, truck volumes, speed, duration of work and consideration of the degree of hazard. **Traffic SCD** **MT-102.30** incorporates Speed Limit signing and Increased Penalty signing with the shift signing called for in **MT-102.10** and **MT-102.20.**

The transition should be designed to maintain the original legal speed limit or an appropriate speed limit as discussed in ***Sections 640-18.1 and 640-18.2.3.*** However in exceptional cases, where a local speed reduction may become necessary, advisory speed plaques should be added to the W1-4, W1-4b or W1-4c sign to warn the road users of the appropriate travel speed for the local conditions.

The existing shoulders must be checked for smoothness, structural adequacy and clearance to structures. Reconstruction may be necessary to assure that they are adequate for the traffic. Plans should provide details of the shoulder work needed. Appropriate bid items shall be included in the plan.

Truck lane-use signs R4-5 and R4-H5a are shown in the Traffic SCD **MT-102** series. As indicated in the notes for **MT-102.10**, **102.20** and **102.30**, use of these signs should not be automatic. The stability of the shoulder on the specific project should be reviewed to determine whether it is adequate to carry the truck loads which travel on the specific roadway segment. If the shoulder stability is adequate, it should be clearly specified in the plans that the signs are not required. It should be general practice to keep signing to a minimum, as over-signing may create clutter. Use of these signs may be appropriate during one Maintenance of Traffic phase, but may not be appropriate in another phase of the job. For example, such might be the case where a rather unstable existing shoulder is used to carry traffic in Phase 1 while a stable new shoulder is used to carry traffic in Phase 2.

It is intended that separate bid items be included for the following items:

Item 614,	Work Zone Lane Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Channelizing Line, Class I, (By Width), (By Type)	Foot
Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 622,	Portable Barrier, ____",	Foot
Item 614,	Work Zone Lighting System	Each
Item 614,	Barrier Reflector (By Type)	Each
Item 614,	Object Marker	Each

The lump sum for **Item 614 Maintaining Traffic** will cover all other work needed to place, maintain and remove the shoulder transitions including:
- Temporary signs and supports
- Drum and other channelizing devices
- Flashers and lights on signs
- Removal and replacement of raised pavement marker reflectors
- Removal of conflicting existing or work zone pavement markings
  (this is specifically incidental to **Item 614 Work Zone Pavement Markings**)

When traffic will be on a shoulder near structure parapets or guardrail, plan quantities may also be needed for Bridge End Markers and additional barrier reflectors (spacing of 25 feet when traffic is close to these barriers).

641-27 Temporary Sign Support (MT-105.10)

Traffic SCD **MT-105.10** provides requirements for temporary sign supports. This drawing shall be used on all projects.

Normally, all temporary sign support items will be incidental to the lump sum bid for **Item 614 Maintaining Traffic**.

The designer should field check proposed sign locations which may be required to implement the various traffic control schemes shown in the plans. The check should determine if the site will be adequate for an appropriate temporary support and should consider any potential conflicts with existing signs. The plans may require the removal, covering or modification of the legend of existing signs, particularly overhead signs which establish lane use.

641-28 Detour of Pedestrians (MT-110.10)

Pedestrian considerations are addressed in ***Section 603-2 and 640-25***. When it has been determined that a detour should be provided for pedestrian traffic, Traffic SCD **MT-110.10** shall be used.

Traffic SCD **MT-110.10** provides detail for maintaining or detouring pedestrian traffic. However, it is the responsibility of the designer to provide site-specific detail when necessary. For example, although **MT-110.10** (in Note 5B on Sheet 2 of 2) calls for a maximum grade of 5 percent and a maximum cross slope of 2 percent for temporary walkways, there could be specific locations where the profile of the existing street and sidewalk are at 5 percent or greater. In such a case, the designer should specify in the plans the appropriate criteria to be applied at the specific site. It is suggested that under such conditions where pedestrians are detoured into the curb lane, that the elevation of the temporary walkway be raised to that of the sidewalk in order to eliminate the need for ramps between the sidewalk and the roadway elevations.

641-29 New or Revised Traffic Control Signals (MT-120.00)

Prior to activating a new traffic signal, the public shall be given advance notice of the activation by use of special signing. This signing is shown in Traffic SCD **MT-120.00**. **MT-120.00** is to be provided in all plans which require the activation of a new traffic signal.

641-30 Work Zone Delineation (MT-99.30)

641-30.1 General

Traffic SCD **MT-99.30** addresses **ODOT's** procedures for providing raised pavement marking in work zones located in projects on multi-lane highways ≥ 45 mph. Although this standard drawing is intended for maintenance of traffic schemes expected to remain in place for at least thirty days, consideration should also be given to including this drawing for all long-term work (greater than three days). **MT-99.30** specifies the use of raised pavement markings as appropriate for a specific surface type, asphalt or concrete.

Specifications are provided for delineation within transition areas and also for delineation beyond transition areas (within tangent areas). Transition areas are applicable to lane-shifts tapers of ≥ 4 feet and to median crossovers. Lane-shifts of less than 4 feet shall be treated as tangent areas.

The transition area for a lane shift is generally considered to begin 300 feet in advance of the beginning of the shift taper and to end 300 feet beyond the termination of the shift taper. The transition area for a crossover is generally considered to begin 300 feet in advance of the beginning of the crossover geometrics and to end 300 feet beyond the termination of the crossover geometrics. If it is necessary to revise the lengths of these approach distances, the revisions shall be specified in the plans. If the approach distances vary among the several approach distances within the plans, the limits of each transition area within the plans shall be specified individually.

Raised pavement markers used in work zones shall conform to C&MS **614** or to C&MS **621** as specified in ***Sections 641-30.2*** and ***641-30.3***. As specified in ***Sections 641-30.2*** and ***641-30.3***, use of Work Zone Raised Pavement Markers conforming to C&MS **614** is not permitted during the snow-plowing season. The limits of the snow-plowing season at the project site should be determined by the **District** and specified in the Plans. If dates are not specified, the default dates of snow-plowing season shall be as per C&MS **614.115C** (October 15 to April 1) regarding installation of WZRPMs.

641-30.2 Asphalt Surfaces and Temporary Concrete Surfaces

Within transition areas, the plans shall call for Raised Pavement Markers (RPMs) to be provided along edge lines and channelizing lines. Spacing shall be at 20-foot increments. Beyond transition areas, the plans shall call for RPMs to be provided along the lane lines at

120-foot spacing. The plans should specify that RPMs intended to be in place during the snow-plowing season shall conform to C&MS **621.** During other times of the year, the contractor should be permitted to provide RPMs which conform to either C&MS **621** or C&MS **614. Plan Note 642-48 or 642-49** shall be included in the plans.

Upon removal of RPMs complying with C&MS **621**, the resulting holes shall be filled as per C&MS **621.08.** Prior to application of the surface course on the project, the existing pavement within the transition area shall be removed to a depth equivalent to a depth necessary to reach the level of the intermediate course of the proposed pavement, as determined by the Engineer. Resurfacing of the transition area shall be performed at the time that the surface course is being applied to the entire project.

The following bid items should be included in the plans:

Item 254	Pavement Planing, Asphalt Concrete	Square Yards
Item 614	Work Zone Raised Pavement Marker, as per plan	Each

The appropriate quantity of surface course material for resurfacing the transition area should also be provided.

Temporary work zone marking (edge lines, lane lines, etc.) shall be paid for under the appropriate Item 614 pavement marking item.

Item 614	Work Zone Lane Line, Class I, (By Width), (By Type)	Mile
Item 614	Work Zone Channelizing Line, Class I, (By Width), (By Type)	Foot
Item 614	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile

641-30.3 Permanent Concrete Surfaces

RPMs applied to permanent concrete surfaces shall conform to C&MS **614.** The plans shall specify that RPMs shall not be provided during the snow-plowing season. During other times of the year, the contractor shall provide **Item 614** Work Zone Raised Pavement Markers. Within transition areas, RPMs shall be provided along edge lines and channelizing lines. Spacing shall be at 20-foot increments. Beyond transition areas, RPMs shall be provided along the lane lines at 120-foot spacing. The appropriate Plan Note from ***Chapter 642,*** for installation of RPMs in work zones on permanent concrete surfaces, shall be included in the plans.

Work Zone Raised Pavement Marking shall be paid for as follows:

Item 614	Work Zone Raised Pavement Marker	Each

Temporary work zone marking (edge lines, lane lines, etc.) shall be paid for under the appropriate Item 614 pavement marking item.

Item 614	Work Zone Lane Line, Class I, (By Width), (By Type)	Mile
Item 614	Work Zone Channelizing Line, Class I, (By Width), (By Type)	Foot
Item 614	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile

641-31 Longitudinal Channelizer (PIS 2010180)

The design of the longitudinal channelizer may vary from manufacturer to manufacturer. It shall consist of two main components: a base component consisting of interlocking units and a vertical reboundable marker/channelizer component. The shape of the vertical component may vary from manufacturer to manufacturer. The width shall be approximately 8 to 9 inches for elliptical designs and 4 to 6 inches for round (tubular) designs. The height of the vertical component shall be within the range of 36 inches minimum to 48 inches maximum.

The vertical component shall be equipped with retroreflective sheeting or with retroreflective stripes. Where stripes are used, the stripes shall consist of two 3-inch wide bands placed a maximum of 2 inches from the top with a maximum of 6 inches between the bands. The base component shall be equipped with reflectors.

The longitudinal channelizer may be useful at entrance ramp merges, either to help direct traffic into its designated lane(s) around curves, or to maximize sight distance at the merge. Use of the longitudinal channelizer in a set of plans should be determined, based on engineering judgment, during the design stage of project development. However, occasionally the need for implementing the longitudinal channelizer may be determined in the field during construction. In such a case, it may be appropriate to add the longitudinal channelizer to the plans by change order.

When the longitudinal channelizer is to be used **Traffic PIS** **2010180** and **Plan Note 642-53** shall be included in the plans.

641-32 Typical Closures at Entrance Ramp and Turn Bay Closures (MT-98.30)

Traffic SCD **MT-98.30** shall be used when work requires that the entrance ramp be entirely closed.

The SCD includes two separate details drawings. Lane configuration of the intersecting street determines which detail is used. The first is intended for use when the intersecting street has a dedicated turn lane to the entrance ramp. The second is intended for use when the intersecting street has a drop lane directly to the entrance ramp.

Treatment of the permanent Guide Signs and Lane Control Signs shall be considered. The need for a detour and related signing must also be addressed.

Advance Warning Signs should be placed in such locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use Table I to determine dimensions A, B and C.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for more than three days, all Item 614 Class I markings shall be provided. If the markings are to remain for three days or less, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD** **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614, Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614, Work Zone Dotted Line, Class I (By Type)	Foot

641-33 Construction Access Points (MT-103.10)

Construction access considerations are addressed in ***Section 640-9.*** When portable barrier is used on projects on freeways, expressways and multi-lane highways with original posted speed limits of 45 miles per hour or greater, **Traffic SCD** **MT-103.10** shall be used to provide a safe means of interaction between project related vehicles and the traveling public by providing dedicated areas outside the traveled lanes for the deceleration and acceleration of project vehicles.

When work requires project vehicles to enter or exit adjacent open lanes of traffic on facilities meeting the aforementioned conditions, construction ingress and egress shall only occur at established construction access points that include proper signing, acceleration and deceleration lane, and delineation. It is important for the designer to anticipate the general need for construction access and identify within the plans acceptable locations that facilitate the ability to utilize construction access points per **Traffic SCD** **MT-103.10**. The location of the access points needs to be considered when developing project staging since the pavement within the access area typically cannot be replaced while actively being used as a construction access point. The number of construction access points shall be kept to a minimum; however, they may be relocated during the project as necessary to accomplish construction activities.

641-34 Work Zone Speed Zones for High-Speed (≥55 MPH) Multi-Lane Highways (MT-104.10)

The process for review and approval of Work Zone Speed Zones is addressed in ***Section 1203-2.9***. Based on criteria discussed in ***Sections 1203-2.9 and 640-18,*** some construction projects may warrant a Work Zone Speed Zone (WZSZ). **Traffic SCD** **MT-104.10** and **Plan Note 642-24** shall be used on qualifying projects that are approved to use a WZSZ. WZSZs using DSL Sign Assemblies also require the use of **Supplemental Specifications** **808** and **908**.

Intentionally blank.

642 PLAN NOTES

642-1 General

Typical **Plan Notes** have been consolidated here for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid items will be "as per plan." Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency. Each note is accompanied by a "Designer Note" in an attempt to give some guidance as to when the note should be used.

In keeping with the traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

642-2 Item 614, Maintaining Traffic

The text of this note will depend on specifics of the project.

Designer Note: Most traffic control plans should include an "Item 614, Maintaining Traffic note that contains the following:

1. A description of how traffic will be maintained throughout the construction life of the project, including any limitations or restrictions.
2. Descriptions of all items that are to be performed under **C&MS Item 614**.
3. A closing paragraph indicating the method of payment ***(see Plan Note 642-12)***.

642-3 Item 614, Maintaining Traffic (At All Times)

A minimum of ___ lane(s) of traffic in each direction shall be maintained at all times by use of the existing pavement, the completed pavement, Item 502 Structure for Maintaining Traffic, Item 615 Pavement for Maintaining Traffic, Item 615 Roads for Maintaining Traffic, and temporary surfaces using Items 410 and 614.

Designer Note: This note should be edited to include only items pertinent to each specific project.

642-4 Item 614, Maintaining Traffic (Time Limitation on a Detour)

A minimum of one lane of traffic in each direction shall be maintained at all times, except for a period not to exceed ______ consecutive calendar days, when through traffic may be detoured as shown on sheet _____. A disincentive shall be assessed in the amount of $ ______ per day for each calendar day the roadway remains closed to traffic beyond the specified limit.

Designer Note: This note shall be used if there is a time limitation placed on the detour. The dollar amount of the disincentive shall be calculated as directed by the **Innovative Contracting Manual**. The **Innovative Contracting Manual** is available for download. The official detour route should be used in the calculation of road user costs.

642-5 Item 614, Maintaining Traffic (Winter Time Limitations)

All existing lanes, including ramps, shall be open and available to traffic in the original or proposed final alignment between [October 15] and [April 1]. Should the contractor fail to meet these requirements, a disincentive shall be assessed in the amount of $______ per calendar day.

Designer Note: This note shall be used when winter traffic limitations are required. The dollar amount of the disincentive shall be calculated as directed by the **Innovative Contracting Manual** which is available on-line for downloading. Winter Time dates should be determined by the **District**. If dates specific to the project site cannot be determined, the default dates of Winter Time shall be October 15 to April 1 to align with WZRPM **(614.115C)** requirements.

642-6 Item 614, Maintaining Traffic (Lanes Open During Holidays or Special Events)

No work shall be performed and all existing lanes shall be open to traffic during the following designated holidays or events:

Christmas	Fourth of July
New Years	Labor Day
Memorial Day	Thanksgiving
	(Other Holiday or Event)

The period of time that the lanes are to be open depends on the day of the week on which the holiday or event falls. The following schedule shall be used to determine this period:

Day of holiday or event	Time all lanes must be open to traffic
Sunday	12:00N Friday through 6:00 AM Monday
Monday	12:00N Friday through 6:00 AM Tuesday
Tuesday	12:00N Monday through 6:00 AM Wednesday
Wednesday	12:00N Tuesday through 6:00 AM Thursday
Thursday	12:00N Wednesday through 6:00 AM Friday
Thursday (Thanksgiving only)	6:00 AM Wednesday through 6:00 AM Monday
Friday	12:00N Thursday through 6:00 AM Monday
Saturday	12:00N Friday through 6:00 AM Monday

Should the Contractor fail to meet any of these requirements, the Contractor shall be assessed a disincentive in the amount of $_____ for each minute the above described lane closure restrictions are violated.

Designer Note: This note shall be used when lanes must be open to traffic during holidays or special events. The dollar amount of the disincentive should be based on the rates specified in the below table:

ADT in most heavily traveled segment of project			
0-50,000	50,000-75,000	75,000-100,000	>100,000
$50/min	$75/min	$100/min	$125/min

If a larger disincentive is desired, written documentation of the reason and justification for the disincentive shall be submitted to **ORE's Traffic Control Design Section**.

642-7 Item 614, Maintaining Traffic (Lane Closure/Reduction Required)

Length and duration of lane closures and restrictions shall be at the approval of the Engineer. It is the intent to minimize the impact to the traveling public. Lane closures or restrictions over segments of the project in which no work is anticipated within a reasonable time frame, as determined by the Engineer, shall not be permitted. The level of utilization of maintenance of traffic devices shall be commensurate with the work in progress.

Designer Note: This note shall be added to the **Item 614 Maintaining Traffic** note ***(Section 642-2)*** if lane closures, or restrictions are required.

642-8 Item 614, Maintaining Traffic (Notice of Closure Sign)

Notice of Closure signs (W20-H13) shall be erected by the Contractor prior to the scheduled road or ramp closure in accordance with the Notice of Closure Time Table below. [At the approval of the Engineer, portable changeable message signs may be used in lieu of the standard flatsheet sign for closure durations of less than 1 week.]

The signs shall be erected on the right-hand side of the road/ramp facing traffic. They shall be placed so as not to interfere with the visibility of any other traffic control signs. On roadways, they should be erected at or near the point of closure. The signs may be erected anywhere on ramps as long as they are visible to the motorists using the ramp. On entrance ramps, the sign shall be erected well in advance of the merge area to avoid distracting motorists.

Notice of Closure Sign Time Table

Item	Duration of Closure	Sign Displayed to Public
Ramp &	>= 2 weeks	14 calendar days prior to closure
Road	> 12 hours & < 2 weeks	7 calendar days prior to closure
Closures	< 12 hours	2 business days prior to closure

The sign shall display the date of the closure in MMM-DD format and the number of days of the closure. The last line of the W20-H13 sign lists a phone number which a motorist may call for additional information. This is to be a specific office within the District rather than the general switchboard number.

Designer Notes: The use of Notice of Closure signs (W20-H13) in the plan and this note is required for all road and ramp closures to satisfy NEPA regulations as set forth in the ODOT Public Involvement Manual published by the Office of Environmental Services. Details of these closure signs must be in conformance with the **OMUTCD** and **Sign Designs and Markings Manual** and be included in the plans.

The designer or other person designated by the District who is familiar with the design details of the project, closure and detour should prepare a one-page closure summary of critical project data including a map showing the closure and planned detour route. Information shown should include, but is not limited to, project identification number, scheduled completion date of project, type of improvement, why the closure is necessary, closure date and time, closure duration, official detour route and any other data which would help a motorist deal with the construction. For future reference, this one-page closure summary should be given to the person responsible for the phone number listed on the sign and is typically someone in the District Office of Communications. A standard template of the one-page summary is available on the ODOT Roadway Engineering website.

642-9 Item 614, Maintaining Traffic (Estimated Quantities)

The following estimated quantities have been included in the General Summary for use as determined by the Engineer for the maintenance of traffic.

Item 410, Traffic Compacted Surface, Type A or B	______	Cu. Yd.
Item 410, Traffic Compacted Surface, Type C	______	Cu. Yd.
Item 614, Asphalt Concrete for Maintaining Traffic	______	Cu. Yd.
Item 616, Water		M. Gal.

Designer Note: This note shall be used when quantities of **C&MS Items 410, 614, 616**, or other items, are added to the plan to be used as directed by the Engineer. Such estimated quantities for maintaining traffic are normally required when through or local traffic is being maintained on a facility during construction. Quantities of **C&MS Item 614** Asphalt Concrete or **C&MS Item 410** will depend on the number of drives and pavement cuts required because of drainage or utilities. Generally, every 50 cubic yards of **C&MS Item 410** will require 1 M. Gal. of **C&MS Item 616**, Water (minimum of 50 M. Gal.).

642-10 Item 614, Maintaining Traffic (ROAD CLOSED Sign)

The Contractor shall provide, erect and maintain standard 48 x 30 inch ROAD CLOSED signs, sign supports, barricades and lights, as detailed in SCD MT-101.60 at the following locations during periods in which the affected roads are closed to traffic.

(List locations, example - Loyal Road just west of SR 1000 intersection.)

Designer Note: Unless shown in a detail elsewhere in the plan, this note should be included in the **Item 614 Maintaining Traffic** note ***(Section 642-2)*** on projects where ROAD CLOSED signs are to be used on major relocation projects in rural areas where crossroads are located an appreciable distance from the project. Normally, these signs are positioned at the first crossroad on each side of the relocation.

642-11 Item 614, Maintaining Traffic (Signs and Barricades)

The Contractor shall provide, erect and maintain signs and sign supports, as detailed in the Ohio Manual of Uniform Traffic Control Devices, and Type III barricades of the type and location as follows:

(List the type and locations.)

Designer Note: Unless shown in a detail elsewhere in the plan, this note should be included in the **Item 614 Maintaining Traffic** note ***(Section 642-2)*** on projects where signs and barricades are to be provided.

642-12 Item 614, Maintaining Traffic (Closing Paragraph for Note)

All work and traffic control devices shall be in accordance with C&MS 614 and other applicable portions of the specifications, as well as the Ohio Manual of Uniform Traffic Control Devices. Payment for all labor, equipment and materials shall be included in the lump sum contract price for Item 614, Maintaining Traffic, unless separately itemized in the plan.

Designer Note: This note should be used as a closing for the **Item 614 Maintaining Traffic** note ***(Section 642-2)***.

642-13 Placement of Asphalt Concrete

Two-way traffic shall be maintained at all times except that one-way traffic will be permitted for minimum periods of time consistent with the requirements of the specifications for protection of completed asphalt concrete courses.

Designer Note: This note shall be used on projects involving resurfacing while traffic is maintained.

642-14 Trench for Widening

Trench excavation for base widening shall be only on one side of the pavement at a time. The open trench shall be adequately maintained and protected with drums or barricades at all times. Placement of proposed subbase and base material shall follow as closely as possible behind excavation operations. The length of widening trench which is open at any one time shall be held to a minimum and shall at all times be subject to approval of the Engineer.

Designer Note: This note shall be used on widening projects where traffic is maintained. The designer should refer to **Traffic SCD MT-101.90**, Drop-offs in Work Zones, to determine the necessary treatment or protection to be specified in the plan.

642-15 Overnight Trench Closing

The base widening shall be completed to a depth of no more than _____ inches below the existing pavement by the end of each work day. No trench shall be left open overnight except for a short length (25 feet or less) of a work section at the end of the trench. In case work must be suspended because of inclement weather or other reasons, the trench for the uncompleted base widening shall be backfilled at the direction of the Engineer.

Designer Note: This note shall be used for projects involving base widening where traffic is maintained. The allowable depth is calculated to the bottom of the first surfacing course. The designer should refer to **Traffic SCD MT-101.90**, Drop-offs in Work Zones, to determine the necessary treatment or protection to be specified in the plan.

642-16 Concrete Median Barrier Replacement

Removing, grading and installing the replacement barrier in a continuous operation shall be limited to _____ linear feet and shall at all times be subject to the approval of the Engineer. The Engineer shall be satisfied that all installations will afford maximum protection for traffic.

Designer Note: This note shall be used when replacing existing concrete median barrier. The length of this operation should be decided in conjunction with the **District Highway Management Administrator**.

642-17 Drum Requirements

In addition to the requirements of the plans, specification and proposal, drums furnished by the Contractor shall be new and unused at the time of arrival on the project. Any drums brought on the project, which have previously been used elsewhere, will not be accepted.

Payment for drums shall be included in the lump sum price bid for maintaining traffic unless separately itemized.

Designer Note: This note may be included in the plans for multi-year projects on Interstate and Interstate Look-alike projects at the discretion of the **District**. The note shall not be used on other projects. The intent of this note is to minimize the need to replace drums within the duration of the project.

Payment for drums called for in this note shall be included in the lump sum price bid for maintaining traffic.

When included in the plans, this note shall be in addition to **Plan Note 642-23, Replacement Drums**.

642-18 Reserved for Future Information

See **Plan Note 642-55** ***(Section 642-55)*** for information regarding Law Enforcement Officers (LEOs) used in work zones (formerly addressed in this Section).

642-19 Dust Control

The Contractor shall furnish and apply water for dust control as directed by the Engineer. The following estimated quantities have been included for dust control purposes:

Item 616, Water ______ M. Gal.

Designer Note: For every cubic yard of earthwork (embankment plus excavation), use between 0.002 M. Gallon and 0.004 M. Gal of water. The lower rate should be used for small and/or rural projects and the larger rate should be used for large and/or urban projects.

642-20 Work Zone Markings and Signs

The following estimated quantities have been carried to the General Summary for use at locations identified by the Engineer for work zone pavement markings and signs per the requirements of C&MS 614.04 and 614.11.

Designer Note: A breakdown of the various types of signs and pavement markings should be included (examples: Item 614, Work Zone Marking Sign; Item 614, Work Zone Lane Line, Class ___, ___, ___, Item 614, Work Zone Stop line, Class ___, ___, etc.).

642-21 Item 622, Portable Barrier, 50", As Per Plan

This work shall consist of furnishing, maintaining, and subsequently removing a 50-inch Portable Barrier at the locations shown on the plans. For details, see SCD RM-4.1.

Portable steel barrier is an approved alternative to portable concrete barrier. For information on approved vendors, see the Approved Products List maintained by the Office of Roadway Engineering.

Portable Barrier, 32 inches high with an 18-inch minimum height glare screen may be used at the option of the Contractor. The glare screen shall be constructed using one of the screens provided on the approved list, available on the Office of Roadway Engineering website.

Paddle or intermittent type glare screens shall be designed using a 20 degree cut-off angle based on tangent alignment. That spacing shall be used throughout the barrier length without regard to barrier curvature.

The glare screen system shall be securely fastened to the 32-inch Portable Barrier using the hardware and procedures specified by the manufacturer.

For directions on how to install the glare screen and the barrier, see the manufacturer's instructions.

Payment shall include all labor, material, and equipment necessary to perform the work and shall be paid for at the contract price per foot for Item 622, Portable Barrier, 50", As Per Plan.

Designer Note: A plan detail will be required for this item.

642-22 Item 614, Replacement Sign

Flatsheet signs furnished by the Contractor in accordance with the requirements of the plans, specifications and proposal which become damaged by traffic for reasons beyond the control of the Contractor shall be replaced in kind when ordered by the Engineer. Replacement signs shall be new. Other materials may be in used, but good, condition subject to approval by the Engineer.

Payment for the new signs shall be made at the contract price per Each for Item 614, Replacement Sign, and shall include the cost of removing and disposing of damaged signs, hardware and supports, and providing the necessary replacement hardware, supports, etc.

An estimated quantity of _____ Each has been provided in the General Summary.

Designer Note: This note shall be used on all four-lane, high-speed projects which will last longer than six months, and on other projects where there is a high probability that a number of signs will be damaged during construction.

642-23 Item 614, Replacement Drum

Drums furnished by the Contractor in accordance with the requirements of the plans, specifications and proposal which become damaged by traffic for reasons beyond the control of the Contractor shall be replaced in kind when ordered by the Engineer. Replacement drums shall be new.

Payment for the new drums shall be made at the contract price per each for Item 614, Replacement Drum, and shall include the cost of removing and disposing of the damaged drum, and providing and maintaining the replacement drum in accordance with the contract requirements for the original drum.

An estimated quantity of _____ each has been provided in the General Summary.

Designer Note: This note shall be used on all four-lane high-speed projects which will last longer than six months, and on other projects where there is a high probability that a number of drums will be damaged during construction.

642-24 Work Zone Speed Zones (WZSZs)

The following Work Zone Speed Zone (WZSZ) Speed Limit Revision(s) have been approved for use on this project when work zone conditions and factors are met as described below:

WZSZ Revision Number	County & Route	Direction
WZ-		
WZ-		
WZ-		
WZ-		

Potential WZSZ locations shall have an original (pre-construction) posted speed limit of 55 mph or greater, a qualifying work zone condition of at least 0.5 mile in length, an expected work duration of at least three hours, and a work zone condition in place that reduces the existing functionality of the travel lanes or shoulders (i.e., lane closure, lane shift, crossover, contraflow and/or shoulder closure). The length of the work zone condition is measured from the beginning of the taper for the subject work zone condition impacting the travel lanes and/or shoulder to the end of the downstream taper, where drivers are returned to typical alignment. An expected work duration of at least three hours is required to balance the additional exposure created by installing and removing WZSZ signing with the time needed to complete the work.

If the work zone meets these minimum criteria, it shall be analyzed further using Table 1 below to determine if and when it qualifies for a speed limit reduction. Depending on the original posted speed limit, the type of temporary traffic control used, and whether or not workers are present, a warranted WZSZ will vary in the approved speed limit to be posted over time.

C&MS Item 614, Paragraph 614.02(B), indicates that two directions of a divided highway are considered separate highway sections. Therefore, if the work on a multi-lane divided highway is limited to only one direction, a speed limit reduction in the direction of the work does not automatically constitute a speed limit reduction in the opposite direction. Each direction shall be analyzed independently from each other.

All WZSZs fluctuate between two approved reduced speed limits or between an approved reduced speed limit and the original posted speed limit. Only one of two signing strategies shall be used to implement a WZSZ.

[WZSZs using DSL Sign Assemblies shall be in accordance with this note, Approved List, Supplemental Specifications (SS) 808 and 908, and Traffic SCD MT-104.10.]

[WZSZs using temporary flatsheet Speed Limit signs shall be in accordance with this note and SCD MT-104.10. Additionally payment may be removed, or a disincentive applied, for WZSZs using temporary flatsheet Speed Limit signs the same as described in the most recent publication of SS 808 in regards to WZSZs using DSL Sign Assemblies (see SS 808.06

paragraphs 4 through 7, including Table 1).] Only one warranted speed limit applies at any one time; speed limit reductions are not cumulative. WZSZs shall not be used for Moving/Mobile activities, as defined in OMUTCD Part 6.

When looking up the warranted work zone speed limits, always use the original, pre-construction, posted speed limit. Do not use a prior or current work zone speed limit as a look up value in the table. Positive Protection is generally regarded as portable barrier or other rigid barrier in use along the work area within the subject warranted work zone condition. Without Positive Protection is generally regarded as using drums, cones, shadow vehicle, etc., along the work area within the subject warranted work zone condition. Workers are considered as being present when on-site, working within the subject warranted work zone condition. When the work zone condition reducing the existing functionality of the travel lanes or shoulders is removed, the speed limit displayed shall return to the original posted speed limit.

Table 1: Warranted Work Zone Speed Limits (MPH) for Work Zones on High-Speed (55 mph or greater) Multi-Lane Highways

Original Posted Speed Limit	WITH Positive Protection		WITHOUT Positive Protection	
	Workers Present	Workers NOT Present	Workers Present	Workers NOT Present
70	60	65	55	65
65	55	60	50	60
60	55	60	50	60
55	50	55	45	55

The following estimated quantity has been carried to the General Summary.

[Item 614, Work Zone Speed Limit Sign ______ Each]
[Item 614, Digital Speed Limit (DSL) Sign Assembly ______ Sign Mnth]
[Assuming ______ DSL Sign Assembly(ies) for ______ Month(s)]

Designer Note:

All WZSZs on high-speed multi-lane highways are considered variable. See ***Sections 1203-2.9 and 640-18*** for additional information regarding qualifying criteria and warranted work zone conditions and factors.

The designer must indicate the signing strategy selected by including the appropriate pay item (only one pay item to be included, not both).

Only include the sixth or seventh paragraph in the plan note based upon the signing strategy selected. Do not include both.

WZSZs using DSL Sign Assemblies (primary) –

This note, **SS 808, 908** and **Traffic SCD MT-104.10** shall be included in projects where speed limits are reduced in accordance with ***Section 640-18.2.6*** for WZSZs Using DSL Sign Assemblies. Quantities will be estimated and reported in accordance with **SS 808** and **MT-104.10**. If there are no DSL Sign Assemblies on the Approved List, or if DSL Sign Assemblies are not available, WZSZ shall be implemented using temporary flatsheet Speed Limit signs.

WZSZs using temporary flatsheet Speed Limit signs (secondary) –

When implementing WZSZs using temporary flatsheet Speed Limit signs, the signage will need to be changed frequently to appropriately fluctuate between the approved speed limits, as is done with DSL Sign Assemblies. This Plan Note and **Traffic SCD MT-104.10** shall be included in projects where speed limits are reduced in accordance with ***Section 640-18.2.7*** for WZSZs using temporary flatsheet Speed Limit signs. Quantities will be estimated as described below.

All installations, relocations and removals of supplemental signs (W3-H5bs and R2-1s indicating the resumption of the legal speed limit at the end of the warranting work zone condition), including signs and necessary supports, shall be included in the pay item for the Work Zone Speed Limit Signs. Covering and uncovering a previously installed sign without need to remove or relocate it shall be incidental to the pay item.

Sufficient numbers of the Work Zone Speed Limit signs shall be included to fulfill all approved WZSZs within the entire project at the spacing required by **Traffic SCD MT-104.10** plus the sign(s) for each entrance ramp, for each applicable direction. For example, for a 2.33 mile work zone speed zone (EB only; reduced to 55 mph) on a 6 mile project on an Interstate freeway with 2 open entrance ramps, what is the number of signs needed for this approved speed zone?

Spacing = 1.0 miles
2.33/1.0 = 2.33 signs or 3 signs
Both sides of roadway (dual mounted) = 3 x 2 = 6 signs
One direction of roadway (e.g. EB only) = 6 x 1 = 6 signs
Plus two open entrance ramps (assuming dual mounted necessary) = 6 + 4 = 10 signs
Number of Work Zone Speed Limit signs for this work zone speed zone = 10
(Then multiply by the number of times the speed limit will fluctuate based on ***Table 1297-7***.) Only include the times where the signs will be installed, removed or relocated. Do not include times where the signs will simply be covered and uncovered.

Repeat for each anticipated approved WZSZ for the project (based on ***Table 1297-7***) to calculate a total number of Work Zone Speed Limit signs needed for the project. If a Work Zone Speed Limit Sign is removed and re-erected at another location within the project due to changes in the WZSZ, it shall be considered another unit. Additionally, remember that each time the approved speed limit fluctuates with the conditions and factors in ***Table 1297-7*** (e.g., goes from a reduced speed limit to the original speed limit or from the original speed limit to a reduced speed limit) it shall be considered another unit if the unit is installed and removed with each fluctuation. Simply covering and uncovering the sign is incidental to the pay item.

642-25 <u>Designated Local Detour Route</u>

In addition to the official, signed Detour Route, a local route has been determined to be the secondary, unsigned Detour Route or "designated local Detour Route." This route is shown on Sheet No. ____. During the time that traffic is detoured, the Contractor shall maintain this route in a condition which is reasonably smooth and free from holes, ruts, ridges, bumps, dust and standing water. Once the detour is removed and traffic returned to its normal pattern, the designated local Detour Route shall be restored to a condition that is equivalent to that which existed prior to its use for this purpose. All such work shall be performed when and as determined by the Engineer.

The following estimated quantities are provided for use as determined by the Engineer to maintain and subsequently restore the designated local Detour Route.

Item 301, Asphalt Concrete Base, PG 64-22	______Cu. Yd.
Item 304, Aggregate Base	______ Cu. Yd.
Item 448, Asphalt Concrete Surface Course, Type 1, PG 64-22	______ Cu. Yd.
Item 407, Tack Coat	______ Gal.
Item 408, Prime Coat	______ Gal.
Item 614, Asphalt Concrete for Maintaining Traffic	______ Cu. Yd.
Item 616, Water	______ M. Gal.
Item 617, Compacted Aggregate, Type A	______ Cu. Yd.
Item 617, Water	______ M. Gal.
Item 642, Center Line	______ Mile

Designer Notes:

1. Procedures relative to Detours and designated local Detour Routes are set forth in **SOP**

OPS-103, Detours and **SOP OPS-104**, Maintenance & Repair of Local Roads and Streets Used as Official Detour Routes, Designated Local Detour Routes, or Haul Roads. These documents are available on the Maintenance Administration website via the Intranet.

2. The list of payment items is included for example purposes only. It is not meant to be all-inclusive of the Items that might be required. The designer must provide items for each individual project as may be appropriate for the work involved.

3. All pay items listed in the above note should be carried to the General Summary under the Maintenance of Traffic heading.

642-26 Reserved – Existing Note Deleted

The **Plan Note** for "Variable Work Zone Speed Zones (VWZSZs) Using Digital Speed Limit (DSL) Sign Assemblies has been deleted. See **Plan Note 642-24** ***(Section 642-24)***.

642-27 Work Zone Increased Penalties Sign (R11-H5a)

R11-H5a-48 signs shall be furnished, erected, and maintained in good condition and/or replaced as necessary and subsequently removed by the Contractor. Signs shall be mounted at the appropriate offsets and elevations as prescribed by the Ohio Manual of Uniform Traffic Control Devices. They shall be maintained on supports meeting current safety criteria.

The signs may be erected or uncovered no more than four hours before the actual start of work. The signs shall be removed or covered no later than four hours following restoration of all lanes to traffic with no restrictions, or sooner as directed by the Engineer. Temporary sign covering and uncovering due to temporary lane restorations shall be guided by the four-hour limitations stated above. Such lane restorations should be expected to remain in effect for 30 or more consecutive calendar days, such as during winter shut-downs.

(The signs on the mainline shall be dual mounted unless not physically possible. The first sign shall be placed between the ROAD WORK AHEAD (W20-1) sign and the next sign in the sequence. Signs shall be erected on each entrance ramp and every 2 miles through the construction work limits. Signs on the mainline shall be R11-H5a-48. Signs used on the ramps shall be R11-H5a-24. R11-H5a-24 signs may be used in the median in lieu of R11-H5a-48 signs if it is not physically possible to provide R11-H5a-48 signs in the median.)

The R11-H5a-48 signs shall be mounted on 2 No. 3 posts when located within clear zones.

The Contractor may use signs and supports in used, but good, condition provided the signs meet current ODOT specifications. Sign faces shall be retroreflectorized with Type G sheeting complying with the requirements of C&MS 730.19.

Work Zone Increased Penalties signs and supports will be measured as the number of sign installations, including the sign and necessary supports. If a sign and support combination is removed and reerected at another location as directed by the Engineer, it shall be considered another unit.

Payment for accepted quantities, complete, in place will be made at the contract unit price. Payment shall be full compensation for all materials, labor, incidentals and equipment for furnishing, erecting, maintaining, covering during suspension of work, and removal of the sign and support.

Item 614, Work Zone Increased Penalties Sign ______ Each

Work Zone Increased Penalties signs will be placed at the following locations:

Designer Note: As noted in ***Section 605-4.2***, this sign shall be used for construction zones on multi-lane divided highways where the work is expected to last thirty days or more, the work length is at least 0.50 miles, and the work is stationary. See ***Section 605-4.2*** for other information about the use of this signing.

The third paragraph shall only be used when the sign locations are not itemized in note.

642-28 Earthwork for Maintaining Traffic

The following quantities have been included in the plan for information only.

Excavation for Maintaining Traffic _____ Cu. Yd.
Embankment for Maintaining Traffic _____ Cu. Yd.

When undercuts are necessary for mainline pavement or embankment construction, evaluate the need for temporary road undercuts if within a close proximity to the mainline undercuts. A geotechnical evaluation should be considered to determine if the existing soil conditions are adequate to support the temporary road. Additional soil borings along the temporary road are not normally required.

Designer Note: This note should be used in conjunction with **C&MS Item 615**, Roads for Maintaining Traffic. The calculations for the above quantities may be shown on the cross-sections or on a separate letter-size sheet that is attached to the LD-4 form.

642-29 Floodlighting

Floodlighting of the work site for operations conducted during nighttime periods shall be accomplished so that the lights do not cause glare to the drivers on the roadway. To ensure the adequacy of the floodlight placement, the Contractor and the Engineer shall drive through the work site each night when the lighting is in place and operative prior to commencing any work. If glare is detected, the light placement and shielding shall be adjusted to the satisfaction of the Engineer before work proceeds.

Payment for all labor, equipment and materials shall be included in the lump sum contract price for Item 614, Maintaining Traffic (Plan Note 642-2).

Designer Note: The note shall be used on projects that will have work performed during the nighttime hours.

642-30 Item 614, Work Zone Impact Attenuator for 24" Wide Hazards (Unidirectional or Bidirectional)

This item shall consist of furnishing and installing a non-gating impact attenuator. Furnish an impact attenuator from the Office of Roadway Engineering's approved list for Work Zone Impact Attenuators, from the Roadway Standards Approved Products web page.

Installation shall be at the locations specified in the plans in accordance with the manufacturer's specifications.

The Contractor shall repair or replace a damaged unit within 24 hours of a damaging impact.

When bidirectional designs are specified, the Contractor shall supply appropriate transitions.

When gating impact attenuators are desired, the Contractor shall submit documentation to the Engineer for acceptance.

The cost for the additional barrier required for a gating impact attenuator shall be included in the cost of the gating impact attenuator.

Payment for the above work shall be made at the unit price bid and shall include all labor, tools, equipment and materials necessary to construct and maintain a complete and functional impact attenuator system, including all related backups, transitions, leveling pads, hardware and grading, not separately specified, as required by the manufacturer.

Designer Notes:

1. This note should be used for temporary protection of Type 5 Barrier Design Guardrail, Concrete Median Barrier, Temporary Traffic Barrier and other narrow hazards (24 inches or less in width) When a work zone impact attenuator is needed to protect wider hazards, the designer should specify **Item 614 Work Zone Impact Attenuator for Hazards Over 24" and Less Than 36" Wide, (Unidirectional or Bidirectional)** and add the corresponding note to the plans ***(see Section 642-31)***.
2. A minimum 75 x 20 foot recovery area shall be provided behind each impact attenuator. The recovery area shall be free of workers or any other hazards. Additional work area may be required beyond the recovery area. The designer should refer to **Traffic MT-101.75** ***(see Section 641-23)***, Impact Attenuator Placement for further guidance.
3. The length of need point is at the nose of the system; therefore, the entire length of the non-gating impact attenuator can be deducted from the calculated length of need for the barrier.
4. Any of the attenuators can be installed on a concrete pad or asphalt pavement. Consult the manufacturer's specifications for minimum pavement thicknesses and anchoring requirements.
5. Pre-approved shop drawings are posted on the **Office of Roadway Engineering's** website with the Roadway Approved Products List.
6. If cross slopes are steeper than 8 percent (12:1), or if the cross slope varies by more than 2 percent (1 degree) over the length of the unit, a leveling pad may be used.
7. Provisions shall be made for the rear fender panels to slide 30 inches rearward upon impact.
8. Bidirectional impact attenuators should be specified for locations where traffic is expected to be in opposing directions on either side of the attenuator. Unidirectional shall be specified when traffic is expected in the same direction on both sides of the attenuator.
9. For gating impact attenuators, the following shall apply:
   a. The recovery area described in note 2 shall be provided from the start of the temporary traffic barrier. The area behind the gating impact attenuator shall be an extension of the recovery area.
   b. The length of need for a gating impact attenuator is at the back of the attenuator; therefore, the impact attenuator shall not be included as part of the calculated length of need.
   c. Gating impact attenuators shall not be used as a bidirectional attenuator.

642-31 Item 614, Work Zone Impact Attenuator for Hazards Over 24" and Less than 36" Wide (Uni-directional or Bi-directional)

This item shall consist of furnishing and installing a non-gating impact attenuator. Furnish an impact attenuator from the Office of Roadway Engineering's approved list for Work Zone Impact Attenuators, from the Roadway Standards Approved Products web page.

Installation shall be at the locations specified in the plans, in accordance with the manufacturer's specifications.

The Contractor shall repair or replace a damaged unit within 24 hours of a damaging impact.

When bidirectional designs are specified, the Contractor shall supply appropriate transitions.

Payment for the above work shall be made at the unit price bid and shall include all labor, tools, equipment and materials necessary to construct and maintain a complete and functional impact attenuator system, including all related backups, transitions, leveling pads, hardware and grading, not separately specified, as required by the manufacturer.

Designer Notes:

1. This note should be used for temporary protection of Type 5 Barrier Design Guardrail, Concrete Median Barrier, Temporary Traffic Barrier, and other fixed objects located in work zones where hazards are wider than 24 inches, but less than 36 inches.

   The designer should refer to **Traffic MT-101.75** ***(see Section 641-23),*** Impact Attenuator Placement for further guidance.
2. The length of need point is at the nose of the system; therefore, the entire length of the unit can be deducted from the calculated length of need for the barrier.
3. Any of the attenuators can be installed on a concrete pad or asphalt pavement. Consult the manufacturer's specifications for the minimum pavement thicknesses.
4. Pre-approved shop drawings are posted on the **Office of Roadway Engineering's** website with the Roadway Approved Products List.
5. If cross slopes are steeper than 8 percent (12:1), or if the cross slope varies by more than 2 percent (1 degree) over the length of the unit, a leveling pad may be used.
6. Provisions shall be made for the rear fender panels to slide 30 inches rearward upon impact.
7. Bidirectional should be specified for locations where traffic is expected to be in opposing directions on either side of the attenuator. Unidirectional shall be specified when traffic is expected to move in the same direction on both sides of the attenuator.

642-32 Approved Maintenance of Traffic (MOT) Policy Exception(s)

Portions of the MOT plans as described below have been approved by the MOT Exception Committee (MOTEC) or the Project Impact Advisory Council (PIAC) per Traffic Management in Work Zones Policy (21-008(P)) and Standard Procedure (123-001(SP)).

Approved MOT Exception(s) include:
[_______ *Insert a list of specific temporary traffic control setups approved by MOTEC and/or PIAC, as provided by the DWZTM.* _______]

A maintenance of traffic meeting shall be held a minimum of [__30__] calendar days prior to implementation of each approved MOT Exception. This meeting shall include the District Work Zone Traffic Manager and [______ *Insert applicable local agency(ies)* ______] as well as the Contractor, Worksite Traffic Supervisor (WTS) and any subcontractors involved with temporary traffic control.

In addition to any notifications required in other notes, the Contractor shall notify the Project Engineer at least 3 business days in advance of implementation of the approved MOT Exception(s) referenced above so that the Project Engineer can send email notification to the Office of Roadway Engineering, Statewide TMC, DWZTM and Special Hauling Permits at least 2 business days in advance of the implementation of the approved MOT Exception(s) referenced above. Reference "Exception Request Approval dated [____/____/____] for PID [________]" in the notification and other correspondence.

Any changes to the MOT that impact the previously approved MOT Exception(s) listed above shall be approved in writing by the applicable ODOT Central Office committee (MOTEC or PIAC). In the event that such changes are proposed, the request shall be coordinated through the District Work Zone Traffic Manager (DWZTM) a minimum of 30 calendar days prior to the desired implementation date. If the District agrees with the proposed changes the DWZTM shall seek approval from the applicable ODOT Central Office committee. In the event the proposed changes are approved in writing, the closures are still subject to notification requirements within this note prior to implementation.

Designer Note: This note shall be used on all projects with an approved MOT Exception by MOTEC or PIAC. Information within brackets ("[" and "]") shall be filled in by the designer based upon information from the District Work Zone Traffic Manager (DWZTM). Include any specific limitations and/or required mitigation measures.

In the event that more than one MOT Exception was approved for a particular project, include each one as a separate item in the list in the second paragraph along with the respective MOTEC and/or PIAC approval dates. In addition modify the last sentence of the fourth paragraph to list the references for each individual approved MOT Exception.

The minimum number of calendar days the maintenance of traffic meeting is to be held prior to the implementation should be as determined by the **District**. If the minimum number of days specific to the project cannot be determined, the default minimum number of days shall be 30.

For additional information see ***Sections 601-2, 601-3, 630-4 and 640-13***.

642-33 Extra Advance Warning Signs (Note A)

An Extra Advance Warning Sign Group consists of two W20-1 (ROAD WORK AHEAD) signs, two W20-5 (RIGHT /LEFT LANE CLOSED AHEAD) signs with W16-3a Distance plates, and two W3-H7 (WATCH FOR STOPPED TRAFFIC) signs and required warning lights.

The Contractor shall provide, erect, maintain and remove Extra Advance Warning Sign Groups as shown on Traffic SCD MT-95.50 at the following distances in advance of the lane tapers with the appropriate W16-3a distance plates:

1) Lane Taper No. ______, Station ________, Phases ______ &______; provide sign groups at ______ miles _______ miles and _______ miles.
2) Lane Taper No. ______, Station _______, Phases _______ & _______; provide sign groups at ______ miles, ________ miles, _______ miles, and _______ miles.

(*Optional paragraph* - The Contractor shall have an additional Extra Advance Warning Sign Group (6 signs and 2 distance plates) available for use when directed by the Engineer. The distance plates for this group shall be able to be modified in the field to show appropriate whole miles to the lane taper.)

Payment for providing, erecting, maintaining and removing Extra Advance Warning Sign Groups shall be included in the lump sum bid for Item 614, Maintaining Traffic.

Designer Note: As noted in ***Section 641-5.2***, this note should be used to require extra Advance Warning Sign Groups if the queue resulting from a lane closure on a multi-lane divided highway is expected to extend beyond the normal ROAD WORK AHEAD sign (W20-1). See ***Section 641-5.2*** for further information.

642-34 Extra Advance Warning Signs (Note B)

An Advance Warning Sign Group consists of two W20-1 (ROAD WORK AHEAD) signs, two W20-5 (RIGHT/LEFT LANE CLOSED AHEAD) signs with W16-3a Distance plates, and two W3-H7 (WATCH FOR STOPPED TRAFFIC) signs and required flashing lights.

The Contractor shall provide, erect, maintain and remove an Extra Advance Warning Sign Group as shown on Traffic SCD MT-95.50. The W16-3 Distance plates shall read "___ MILES". The Right (Left) Lane Closed Ahead signs shall be located _____ miles from the beginning of the lane taper. Spacing of the other signs shall be as shown on Traffic SCD MT-95.40.

The Contractor shall provide, erect, maintain and remove an additional Extra Advance Warning Sign Group to provide additional warning for the anticipated traffic increase during the following national holidays: (appropriate holidays to be filled in as defined by policy and the specific needs of the project). These signs shall be erected no later than 1:00 p.m. the third day preceding the holiday or holiday weekend and not removed before 9:00 a.m. the third day subsequent to the holiday or holiday weekend. The signs shall be removed during the periods between holidays. The W16-3a Distance plates shall read "_______ MILES" with the W20-5 signs located ______ miles from the beginning of the lane taper. Spacing of the other signs shall be as shown on Traffic SCD MT 95.30 or 95.40.

(Optional paragraph - The contractor shall have a third Extra Advance Warning Sign Group (6 signs and 2 distance plates) available for use when directed by the Engineer. The distance plates for this group shall read "_________ MILES.")

Payment for providing, erecting, maintaining and removing Extra Advance Warning Sign Groups shall be included in the lump sum bid for Item 614, Maintaining Traffic.

Designer Note: As noted in ***Section 641-5.2***, this note should be used to require extra Advance Warning Sign Groups in situations involving work that will extend over a holiday or any other anticipated period of unusually high traffic demand, if the queue resulting from a lane closure on a multi-lane divided highway is expected to extend beyond the normal ROAD WORK AHEAD sign. See ***Section 641-5.2*** for further information.

642-35 Item 614, Work Zone Crossover Lighting System

This work shall consist of furnishing, erecting, operating, maintaining and removing a work zone lighting system for a single crossover, or overlapping a pair of crossovers. The system shall be as shown on Traffic SCD MT-100.00. The Contractor shall arrange for and pay for power. All materials and construction shall comply with applicable portions of 625 and 725 except: The Performance test of 625.19F, and certified drawing requirement of 625.04, are waived and used materials in good condition are acceptable.

Poles which are not protected by guardrail or portable barrier shall be located outside the clear zone, and should be located at least 30 feet (preferably 40 feet) from the edge of pavement when possible. Additional pole lines, cables and appurtenances necessary to furnish power to the lighting system shall be included in this item. Service poles shall be positioned with the same constraints as the lighting poles as a minimum.

Payment will be made at the unit price per each for Item 614, Work Zone Crossover Lighting System throughout all phases of work when the crossover roadways are used.

Designer Note: As noted in ***Section 641-11.5***, this note should be included in the plan when a work zone crossover lighting system is provided.

642-36 Multi-Plan, Time-of-Day Operation of Work Zone Signal

The work zone signal control required for this project and shown on sheets __________ and Traffic SCDs MT-96.11, 96.20, and 96.26 shall be capable of providing multiple timing patterns chosen on a time-of-day basis.

Traffic control equipment shall be capable of time-of-day/day-of-week programming; with a minimum of three-dial, three offsets and three splits, or a minimum of fifteen separate timing plans.

	Timing Plan (Seconds)		
Approach	**A**	**B**	**C**
Northbound Green	31.0	41.0	16.0
Northbound Yellow	3.5	3.5	3.5
Northbound All Red (Internal Clearance)	18.0	18.0	18.0
Southbound Green	30.0	20.0	15.0
Southbound Yellow	3.5	3.5	3.5
Southbound All Red (Internal Clearance)	19.0	19.0	19.0
Total Cycle Length	105.0	105.0	75.0

Provide timing appropriate for the signal location under consideration.

Time of Day	SUN	MON	TUE	WED	THUR	FRI	SAT
Midnight - 7:00 a.m.	C	C	C	C	C	C	C
7:00 a.m. - 9:00 a.m.	C	A	A	A	A	A	C
9:00 a.m. - 4:00 p.m.	A	C	C	C	C	C	A
4:00 p.m. - 6:00 p.m.	C	B	B	B	B	B	A
6:00 p.m. - Midnight	C	C	C	C	C	C	C

Payment is incidental to the lump sum bid for Item 614, Maintaining Traffic.

Designer Note: This note should be included in the plan when a signalized one-lane, two-way closing is used. The values and Time of Day schedule above are strictly for example purposes only.

642-37 Fully-Actuated Operation of Work Zone Traffic Signal

The work zone signal control required for this project and shown on sheets ___________ and Traffic SCDs MT- 96.11, 96.20 and 96.26 shall be fully traffic-actuated and operate in a manner similar to that described in Section 733.02 of the Construction and Material Specifications.

The initial controller timing shall be as follows:

	Phase			
	1 (All Red) Dummy Phase	**2 Mainline (direction)**	**3 (All Red) Dummy Phase**	**4 Mainline (direction)**
Min. Green		10		10
Extension		4		4
Max. Green		30		30
Yellow		3.5		3.5
All Red	X		X	
Recall	On	Off	Off	Off

Provide timing appropriate for the signal location under consideration. Typical flow rates are displayed in ***Table 697-2*** in the ODOT Traffic Engineering Manual (TEM).

The Contractor shall also design, furnish, install and maintain a traffic detector on each traffic approach which will reliably detect all legal traffic approaching (but not leaving) the signal as it passes or waits in the designated detector zone shown in the plans. Detector designs which do not provide reliable detection, free from false calls, shall be immediately replaced by the Contractor.

Designer Note: This note should be included in the plan when a signalized one-lane, two-way closing is used. The chart is intended to show the timing for the signal location under consideration. Phases shown in the chart match those shown in **SCD MT-96.20**. Add more phases as needed to accommodate side streets, driveways, etc. Usually, the desired internal clearance time for phase 1 is the same as the desired internal clearance time for phase 3. The direction should be indicated for the mainline green. The values above are strictly for example purposes only.

642-38 Overhead-Mounted Work Zone Signals

Signals shall be overhead mounted in accordance with the details shown on Traffic SCD MT-96.20.

Designer Note: This note shall be provided if there is a reason to prohibit side-mounted signal heads. See OMUTCD Table 4D-1 for minimum number of overhead mounted primary through signal faces for approaches with posted speed limits of 45 mph or higher. Exclusively side-mounted signal heads may only be used on facilities with posted speed limits of 40 mph or lower.

642-39 Lighting

Lighting shall be provided at each end of the lane closure for the closing of one lane of a two-lane highway.

Lighting shall be by conventional methods, with luminaire arms attached to the signal supports. Area illumination shall be provided by using 150 watt minimum high pressure sodium luminaries or 250 watt minimum mercury luminaries. The minimum height of the luminaire shall be 27 ft from the ground surface.

Payment for lighting shall include delivery, erection, maintenance and removal as called for in the plans. Payment shall be per Each.

Designer Note: This note may be included in the plans if the designer finds that there is a special need for the lighting at the project location. Examples of need for such lighting might be the existence of an intersection at the point of the lane closure, or poor geometrics or poor sight distance at the point of the lane closure.

Item 614	Work Zone Lighting System	Each

642-40 Maintenance of Canoe Traffic

Canoe traffic shall be maintained throughout construction of the project either through existing river channel or through portage trail approved by the Engineer.

Adequate signing both upstream and downstream shall be installed and maintained by the Contractor. The following type signs are considered to be minimum treatment:

1. Approximately one-quarter mile upstream, advanced warning type signs on both banks;
2. Approximately 300 feet upstream, signs specifying actions required of canoeist on both banks;
3. Approximately one-quarter mile downstream, advance warning type signs on both banks; and
4. Approximately 300 feet downstream, signs specifying actions required of canoeist of both banks.

The above signing shall be mounted in such a way as to be a minimum of 4 feet above the water level, unobstructed by tree branches, and properly angled for maximum visibility from the main clear channel. The method of supporting the signs shall be approved by the engineer prior to installation. Upon completion of the project, the signs and support systems shall be completely removed from the river channel. The Contractor shall notify local canoe liveries using this portion of the river at least 10 days prior to any changes affecting canoe traffic. Portage trails if used shall be constructed and maintained by the Contractor with the least possible disturbance to the surrounding area. The trail shall be adequately marked in both directions. The Contractor shall be responsible for obtaining the right-of-way for the portage trails if required.

In the event pipes are used to divert or carry river water, both the inlet and outlet ends shall be adequately protected by grates or fence so that people or canoes are not drawn through or held by them.

642-41 <u>Item 614, Portable Changeable Message Signs, As Per Plan</u>

The Contractor shall furnish, install, maintain and remove, when no longer needed, a changeable message sign. The sign shall be of a type shown on a list of approved PCMS units available on the Office of Materials Management web page. The list contains Class A and B units with minimum legibility distances of 800 feet and 650 feet, respectively.

Each sign shall be trailer-mounted and equipped with a functional dimming mechanism, to dim the sign during darkness, and a tamper and vandal proof enclosure. Each sign shall be provided with appropriate training and operation instructions to enable on-site personnel to operate and troubleshoot the unit. The sign shall also be capable of being powered by an electrical service drop from a local utility company. The PCMS shall be delineated in accordance with C&MS 614.03.

The probable PCMS locations and work limits for those locations are shown on sheet(s) ___ of the plan. Placement, operation, maintenance and all activation of the signs by the Contractor shall be as directed by the Engineer. The PCMS shall be located in a highly visible position yet protected from traffic. The Contractor shall, at the direction of the Engineer, relocate the PCMS to improve visibility or accommodate changed conditions. When not in use, the PCMS shall be turned off. Additionally, when not in use for extended periods of time, the PCMS shall be turned away from all traffic.

The Engineer shall be provided access to each sign unit and shall be provided with appropriate training and operation instructions to enable ODOT personnel to operate and troubleshoot the unit, and to revise sign messages, if necessary.

(The Contractor shall implement a system whereby changeable messages will be implemented within ______ hours following telephone notification from the Project Engineer to a designated phone.)

All messages to be displayed on the sign will be provided by the Engineer. A list of all required pre-programmed messages will be given to the Contractor at the project preconstruction conference. The sign shall have the capability to store up to 99 messages. Message memory or pre-programmed displays shall not be lost as a result of power failures to the on-board computer. The sign legend shall be capable of being changed in the field. Three-line presentation formats with up to six message phases shall be supported. PCMS format shall permit the complete message for each phase to be read at least twice.

The PCMS shall contain an accurate clock and programming logic which will allow the sign to be activated, deactivated or messages changed automatically at different times of the day for different days of the week.

(The PCMS shall contain a cellular telephone data link which will (in active cellular phone areas) allow remote sign activation, message changes, message additions and revisions to time of day programs. The system shall also permit verification of current and programmed messages. One remote data input device (laptop computer plus modem or equivalent) shall be furnished for use by the District Traffic Engineer, or equivalent, and shall be insured against theft.)The

PCMS unit shall be maintained in good working order by the Contractor in accordance with the provisions of C&MS 614.07. The Contractor shall, prior to activating the unit, make arrangements, with an authorized service agent for the PCMS, to assure prompt service in the event of failure. Any failure shall not result in the sign being out of service for more than 12 hours, including weekends. Failure to comply may result in an order to stop work and open all traffic lanes and/or in the Department taking appropriate action to safely control traffic. The entire cost to control traffic, accrued by the Department due to the Contractor's noncompliance, will be deducted from moneys due, or to become due the Contractor on his contract.

The Contractor shall be responsible for 24-hour-per-day operation and maintenance of these signs on the project for the duration of the phases when the plan requires their use.

Payment for the above described item shall be at the contract unit price. Payment shall include all labor, materials, equipment, fuels, lubricating oils, software, hardware and incidentals to perform the above described work.

Item 614, Portable Changeable Message Sign, as per plan ________ Sign Month
Assuming ______ PCMS Sign(s) for ______ Month(s)

Designer Note: Portable changeable message signs (PCMSs) are trailer-mounted programmable message units which can be utilized to provide advance information about upcoming traffic conditions or diversion routing schemes to road users ***(see Section 605-9)***. PCMS units are supplemental information devices and shall not be utilized as alternates to standard fixed signing or arrow boards.

On major construction projects, PCMS units can provide real benefits to road users. These benefits include increased work zone capacity resulting from advance warning of lane closures, and improved corridor capacity resulting from diversion schemes implemented in reduced capacity situations.

PCMSs are intended to have a high impact on the motorist and to convey timely, pertinent, driver oriented information which could not be provided by fixed-message signs. For this reason, if no important message needs to be displayed, the sign shall be turned off. The display of non-priority messages is discouraged as drivers tend to become familiar with these and overlook priority messages displayed later.

The use of PCMS should be reserved for situations where signs must be changed frequently and/or where the next required message cannot be predicted in advance. When a message is known in advance or when it could be determined before there is a need to display it, then a fixed-message sign is appropriate. Certainly, messages such as LEFT/RIGHT LANE CLOSED AHEAD should not be considered for PCMS display because there are standard signs readily available for this purpose and emphasis can be added with flashers or flags at a nominal cost. Similarly, non-standard messages such as ROAD WORK WILL CLOSE TWO (2) LANES BEGINNING APRIL 20, 2012 can normally be determined well in advance of need and included in the plans as fixed-message signs. Even where sign messages must change periodically, a fixed-message sign with flip-up panel may be more appropriate.

Sign messages shall be limited to a maximum of two sequential displays or phases, each consisting of a maximum of three, eight-character lines.

The Approved List of Portable Changeable Message Signs can be found on **the Office of Materials Management** website. This list contains the PCMS approved for use on **ODOT** projects. The pre-qualified list currently contains two classes of PCMS, Class A and Class B. The Class A unit, with legibility distance of 800 feet is intended for use on roadways where the speed limit is 45 mph or greater. The Class B unit, with legibility of 650 feet is intended for use on roadways where the speed limit is 40 mph or less.

The fifth paragraph in this **Plan Note** is optional. This paragraph is to be included in the plans when it is intended that time-of-day/day-of-week programming capability is to be provided. This feature allows for certain messages to be pre-selected for anticipated critical times, and also allows the unit to be automatically turned off when there is no significant message to convey.

The eighth paragraph in this **Plan Note** is also optional. This paragraph is to be used when it is necessary to require cellular phone data link programming of PCMS operation and messages. This should be included only when potential maintenance of traffic problems justify its use; and only when procedures have been developed to assess travel problems on a current basis and an operating agency (e.g., **District Traffic Department**, **City Traffic Department**, **OSHP** or **City Police Department**) is prepared to monitor and operate the system on a real-time basis with current information. Further, the cellular phone option should not be invoked unless the designer has assured that cellular phone services are available in the proposed sign area. Generally, PCMS units should be located well in advance of the situation to which they relate. In the case of diversion schemes, the PCMS units should be located well in advance of the upstream interchange where the alternate route begins. The desired location(s) for deployment of PCMS units shall be established by means of a Plan Note listing the specific locations where the contractor is to install, maintain and remove the PCMS units(s) and the duration the PCMS unit is to function. Designers should field review potential sites to find those with good visibility and a level, accessible area, preferably behind existing guardrail. The **Plan Note** also permits the project engineer to relocate the sign to improve visibility or to accommodate changing conditions.

642-42 Maintenance of Traffic Signal/Flasher Installation

The Contractor shall be responsible for maintaining traffic signal/flasher installations within the project under the following conditions:

1. Existing signal/flasher installations which the plans require the Contractor to adjust, modify, add onto or remove, or which the Contractor actually adjusts, modifies or otherwise disturbs. The Contractor shall be responsible for the entire installation (at an intersection) from the time his operations first disturb the installation until the installation has been subsequently removed or modified and the work is accepted.

2. New or reused signal/flasher installations or devices, installed by the Contractor. The Contractor shall be responsible for maintenance of these from the time of installation until the work is accepted.

The Contractor shall correct as quickly as possible all outages or malfunctions. He shall provide the maintaining agency and the Engineer such addresses and phone numbers where his maintenance forces can be contacted. The Contractor shall provide one or more persons to receive all calls and dispatch the necessary maintenance forces to correct outages. Such a person or persons may be used to perform other duties as long as prompt attention is given to these calls and a person is readily available continuously 24 hours a day, 7 days a week. All lamp outages, cable outages, electrical failures, equipment malfunctions and misaligned signal heads shall be corrected to the satisfaction of the Engineer with the signal back to service within four hours after the Contractor has been notified of the outage.

In the event new signals are damaged prior to acceptance, all damaged equipment except poles and control equipment shall be replaced by the Contractor to the satisfaction of the Engineer with the signal back in service within 8 hours after the Contractor's notification of the outage. The Contractor shall arrange for full traffic control until the signal is back in operation.

If poles and/or control equipment are damaged and must be replaced, the Contractor shall make temporary repairs as necessary to bring the signal back into full operation within the allowed 8-hour period, and shall make permanent repairs or replacement as soon thereafter as possible.

None of the above shall be construed as collective or consecutive outage time periods at any one location. That is, where more than one outage occurs at any one location then the allotted time limit shall be for the worst single outage.

Where outages are the direct result of a vehicle accident the response of the Contractor shall be as outlined above. The Contractor shall be responsible for collection of any compensation for this work from those parties responsible for the damage.

Where the Contractor has failed to, or cannot respond to, an outage or signal equipment malfunction, at these locations within his responsibility, within periods as specified above, the Engineer may invoke the provisions of Section 105.15 and any subsequent billings to the State or the City of ____________ for Police Services and maintenance services by City forces shall be deducted from monies due or to become due the contractor in accordance with provisions of Section 105.15.

The Contractor shall provide the maintenance service entirely with his forces or he may choose to enter into a cooperative understanding with the local maintaining agency to provide the maintenance. The Contractor shall inform the Engineer, in writing, of the maintenance method selected.

The Contractor shall be responsible for any damage to any traffic signal components required to be handled during the relocation of poles and revisions to the signal system. When a traffic signal must be taken out of service by the Contractor, due to construction procedures, this outage shall not exceed ___ hours and shall not include the hours of ___ to ___. Any signalized intersection, where the signal is out of service due to construction procedures, or due to an outage or malfunction of equipment as described above, shall be protected, by the Contractor, by the installation of temporary "STOP" signs, except for the following intersections which shall be protected by off-duty City of __________ Police, hired by the Contractor:

1.

2.

3.

Any vehicular traffic signal head, either new or existing which will be out of operation shall be covered in the manner described in 632.25.

The Contractor shall maintain complete records of malfunctions including:

1. Time of notification of malfunction;
2. Time of work crews arrival to correct the malfunction;
3. Actions taken to correct the malfunction, including a list of parts repaired or replaced;
4. A diagnosis of reason for the malfunction and probability of reoccurrence;
5. Time of completion of the repair and system restored to full service.

A copy of these records shall be provided to the Engineer within three (3) working days following completion of each repair.

All costs resulting from the above requirements shall be considered to be included in the lump sum price bid for Item 614, Maintaining Traffic.

Designer Note: This note may be used when existing signals are to be maintained.

642-43 **<u>Advance Work Zone Information</u>**

Advance work zone information signs, as used in this note, are fixed message types. The signs are to be located at extreme distance from the work area, as shown in the plans.

The signs shall be black on orange (including a black border). The layout shall be in conformance with TEM Chapter 211.

When regulatory information is provided, it shall be displayed separately as a standard black-on-white sign. Mixing of black-on white regulatory information on a black-on-orange information sign is prohibited.

If the motorist is being detoured or if an alternate route is provided, the route should be signed with assemblies consisting of the appropriate black-on-orange DETOUR or ALT marker with a standard route marker and arrow plate. If more target value is desired, this trail blazer information may be shown on an orange panel (OMUTCD Section 2D.32).

Route Sign assemblies shall be sized according to the type of road on which they are located in accordance with the OMUTCD.

Supports for sign installations shall conform to all existing standards for permanent signs. These signs should not be attached to existing supports.

Where the plans call for an overlay to cover a portion of an existing sign, the overlay shall be black-on-orange. Letter sizes should be the same as on the existing signs. When lane arrows are to be covered, a blank overlay should be placed over each of the affected arrows. When a ramp is being closed, rather than using a blank overlay to cover the entire sign, the legend “EXIT CLOSED” (W20-H15) should be used on a diagonal overlay (lower left to upper right) on the sign. The size of lettering on overlays and the size of the overlay are indicated in the plans. The minimum letter size for the diagonal “EXIT CLOSED” (W20-H15) overlay shall be 12" C.

All advance work zone information sign installations located outside of the project work limits shall be paid for under appropriate 630 items (signs, supports, concrete, breakaway connection, overlays, removals, etc.).

Designer Note: This note may be used when it is necessary to provide advance information on fixed signs, as discussed in ***Section 640-26***.

642-44 Worksite Traffic Supervisor

Subject to approval of the Engineer, the Contractor shall employ and identify (someone other than the superintendent) a certified Worksite Traffic Supervisor (WTS) before starting work in the field. The WTS shall be certified from one of the following organizations:

1. American Traffic Safety Service Association (ATSSA), phone number 1-800-272-8772, certified Traffic Control Supervisor (TCS).
2. The Ohio Contractors Association, Traffic Control Supervisor (OCA/TCS) work zone class, only if taken after May 5, 2004, phone number 1-800-229-1388.
3. Ohio Laborers’ Training, Traffic Control Supervisors Class, phone number 1-740-599-7915.

A copy of each WTS’s certification and 24-hour contact information shall be provided to the Engineer at the preconstruction conference. If the designated WTS will not be available full time (24/7), the Contractor may designate an alternate WTS to be available when the primary is off duty. Each WTS shall have a WTS certification containing the date of issue and shall be from any of the approved organizations. At the time of the preconstruction conference, the WTS certification date of issue shall be within the 5 years prior to the Original Completion Date of the project.

The WTS position has the responsibility of monitoring traffic control deficiencies for the entire work zone. The duties of the WTS are as follows:

1. Be available on a 24-hour per day basis, and be able to be on site for all emergency traffic control needs within one hour of notification by police or project staff and be prepared to effect corrective measures immediately on existing work zone traffic control devices.
2. Attend preconstruction meeting and all project meetings where traffic control management is discussed.
3. Be available for meetings or discussions with the Engineer upon request or within 36 hours.
4. Coordinate a Traffic Incident Management meeting each year before construction work begins with ODOT and the Safety Forces that will respond to incidents on the project. Items to be discussed will be the:
   a. Traffic Incident Management Plan (TIMP);
   b. Emergency Response and Notification;
   c. Project work/phasing concerns (e.g., ramp closures); and
   d. Responders concerns.
5. Be aware of, and coordinate if necessary, all traffic control operations, including those of subcontractors and suppliers.
6. Coordinate project activities with all Law Enforcement Officers (LEOs). A WTS shall also be the main contact person with the LEOs while they are on the project.
7. Coordinate meetings with ODOT personnel, LEOs and other applicable entities before each plan phase switch to discuss work zone traffic control.
8. Ensure compliance with the contract documents for signs, barricades, temporary concrete barrier, pavement markings, portable message signs, and other traffic control devices on a daily basis; and facilitate any corrective action necessary.
9. Notify the Contractor of the need for cleaning and maintenance of all traffic control devices, including the covering and removal of inapplicable signs.
10. Inspect, evaluate, propose necessary modifications to, and document the effectiveness of, the traffic control devices and/or traffic operations on a DAILY BASIS (7 days a week).In addition, a weekly night inspection of the work zone setup for daytime work operations; and one daytime inspection per week for nighttime projects. This shall include (but not be limited to) documentation on the following project events:
    a. Initial traffic control setup (day and night review).
    b. Daily traffic control setup and removal.
    c. When construction staging causes a change in the traffic control setup.
    d. Crash occurrences within the construction area.
    e. Removal of traffic control devices at the end of a phase or project.
    f. All other emergency traffic control needs.
11. Complete the Department approved Long Term Inspection form (CA-D-8) after each inspection as required in # 10 and submit it to the Engineer the following work day. These reports shall include a checklist of all traffic control maintenance items to be reviewed. A copy of the form will be provided at the pre-construction meeting. Any deficiencies observed shall be noted, along with recommended corrective actions and the dates by which such corrections were, or will be, completed. A copy of this document can be found in the current revision of the Department of Transportation Construction Inspection Forms Manual.
12. Verify that all flagging operations are being conducted per the Ohio Manual of Uniform Traffic Control Devices.
13. Have copies of the ODOT Temporary Traffic Control Manual and applicable standards and specifications included in the contract documents available at all times on the project.

14. Identify and contact all possible response personnel; preplan and keep an updated roster with phone numbers:

    a. Federal, State, and local transportation agencies (Traffic Management Center);
    b. Regional, county or local 911 dispatch; and
    c. Towing and recovery providers.

15. Comply with the provisions of OMUTCD Chapter 6I, Control of Traffic Through Traffic Incident Management Areas.

16. Propose a response/action plan to:

    a. Establish alternate route plans per the provided ODOT Playbook;
    b. Remove traffic demand from impacted roadway(s);
    c. Divert traffic to routes that can accommodate demands;
    d. Detour traffic away from sensitive areas (such as schools, hospitals, etc.);
    e. Discuss methods of determining a staging area for responders within or near the construction zone; and
    f. Discuss methods of developing ingress and egress sites within the construction zone.

    The response/action plan shall be submitted to ODOT for acceptance before the Contractor's first day of work.

17. Perform, at a minimum, the following functions in incident detection and verification:

    a. Call 911/ notify Traffic Management Center and provide the following:

        i. Location – including milepost number and direction of travel.
        ii. Number and type of vehicles involved.
        iii. Estimated extent of damage or injury.
        iv. Estimated number of patients involved.
        v. Any potential hazardous conditions.
        vi. The placard number on any hazardous materials placard from a safe distance.

    b. Initiate traffic management / provide traffic control.
    c. Assist motorist with disabled vehicles.
    d. Recommend roadway repair needs.
    e. Provide repair resources.

18. Attend post-incident debriefings if required.

The Department will deduct the prorated daily amount of the unit price bid for the WTS for any day on which the Contractor fails to perform the duties set forth above. Should the Contractor's failure to perform any of the duties described above result in a maintenance of traffic safety issue, the Department will deduct the prorated daily amount for Item 614 Maintenance of Traffic from the Contractor's next scheduled estimate.

If three or more failures to perform the duties set forth above occur, the WTS shall be immediately removed from the work in accordance with C&MS 108.05.

The following estimated quantity has been included for the Worksite Traffic Supervisor:

Item 614 Worksite Traffic Supervisor _______ Months

Designer Note: The Worksite Traffic Supervisor note shall be used on Interstate or Interstate look-alike projects that include: contraflow, one-mile long crossover(s), multi-year work duration, or significant continuous impact to mainline traffic (e.g., reduced shoulder and/or lane widths, closed ramps, etc.). While not intended for use with resurfacing projects, this note may be considered for use when complex maintenance of traffic issues are anticipated.

642-45 Reserved for Future Information

Plan Note 642-45, Item 614 – Maintaining Traffic has been deleted; however, the Section (and **Plan Note**) number has been reserved for future information.

642-46 Reserved – Existing Note Deleted

Intentionally Blank

642-47 Speed Measurement Markings

The Contractor shall place a series of Speed Measurement markings on the roadway to assist in the enforcement of speed regulations within the work zone. Each Speed Measurement Marking shall consist of one white transverse 24-inch line, 4 foot in length. The markings shall be placed at one-quarter mile intervals over a 1 mile length of roadway, at locations as shown in the plans or as directed by the Engineer. Speed Measurement Markings shall not be located within 0.5 mile of a taper, shift, crossover, entrance or exit ramp. Speed Measurement Markings are typically located such that they extend 2 feet on either side of the center line or the edge line, or are located entirely on the shoulder; however, in work zones it may be necessary to center these markings within a lane.

The markings shall be laid out by a registered surveyor.

The following quantity has been carried to the General Summary to be used as directed by the Engineer:

Item 614 Special - Air Speed Zone Marking _______ Each

Designer Note: This note shall be used when it is intended that an Air Speed Check Zone be provided within a work zone.

The following procedure should be followed for installing Air Speed Check Zones in work areas:

ODOT and the Local **Ohio State Highway Patrol (OSHP) Posts** shall discuss desires for placing Air Speed Check Zones in the work zone. When it has been agreed that there will be an Air Speed Check Zone within the work zone, the **OSHP Aviation Section Headquarters** shall be contacted for their assistance in enforcing the Air Speed Check Zone.

The agreement to assist by the **Aviation Section Headquarters** shall be forwarded to the appropriate **ODOT District Highway Management Administrator**.

Upon termination of the work zone, any Speed Measurement Marking which is not eliminated by pavement removal or resurfacing shall be allowed to wear out.

642-48 Item 614 - Work Zone Raised Pavement Marker, As Per Plan

Work Zone Raised Pavement Markers, As Per Plan, and their installation shall conform to C&MS 614 or C&MS 621 as specified herein.

- Raised Pavement Markers in use during the snow-plowing season shall conform to 621.
- Raised Pavement Markers in use during the non-snow-plow season shall conform to either 614 or to 621.

The snow-plowing season shall run from ________________ through _________________.

If project delays, not the fault of ODOT, cause the work to extend into the snow-plowing season, the contractor shall be responsible for replacing Work Zone Raised Pavement Markers (WZRPMS) conforming to C&MS 614, with Raised Pavement Markers conforming to 621, as determined by the Engineer, at the contractor's expense.

This item shall include purchase, installation and removal of Item 614 Work Zone Raised Pavement Marker, As Per Plan, including filling of any depressions created in the pavement as per C&MS 621.08.

Resurfacing of the transition areas shall be performed at the time that the surface course is being applied to the entire project. Prior to application of the surface course on the project, the existing pavement within the transition area shall be removed to a depth necessary to reach the level of the intermediate course of the pavement, as determined by the Engineer.

The following bid items should be included in the plans:

Item 254	Pavement Planing, Asphalt Concrete	Square Yards
Item 614	Work Zone Raised Pavement Marker, as per plan	Each

Payment for resurfacing within the transition area shall be paid for under the appropriate bid items for the work required, as provided for in the plans.

Designer Note: This note shall be included in the plans on freeway and expressway projects when raised pavement marking is to be provided on asphalt surfaces and/or temporary concrete surfaces in temporary traffic control zones. Snow-plowing season at the project site should be as determined by the **District**. If dates specific to the project site cannot be determined, the default dates of snow-plowing season shall be as per **C&MS 614.115C** (October 15 to April 1) regarding installation of WZRPMs.

The appropriate quantity of surface course material for resurfacing the transition area shall also be provided.

642-49 Item 614 - Work Zone Raised Pavement Markers on Permanent Concrete Surfaces

Raised pavement markers in work zones, installed on permanent concrete surfaces, shall be Item 614 Work Zone Raised Pavement Markers. WZRPMs are intended for use only during the non-snow-plowing season. WZRPMs shall not be provided during the snow-plowing season.

The snow-plowing season shall run from ______________ through _________________.

Where a temporary alignment will remain in use through the winter, the WZRPMs shall be removed prior to the beginning of the snow-plowing season and replaced approximately April 1, or as otherwise determined by the Engineer.

This item shall include purchase, installation and removal of Item 614 Work Zone Raised

Pavement Markers.

An estimated quantity of _______ Each of Item 614 Work Zone Raised Pavement Marker has been provided and carried to the General Summary.

Designer Note: This note shall be included in the plans when raised pavement marking is to be provided on permanent concrete surfaces in temporary traffic control zones. Snow-plowing season at the project site should be as determined by the **District**. If dates specific to the project site cannot be determined, the default dates of snow-plowing season shall be as per **C&MS 614.115C** (October 15 to April 1) regarding installation of WZRPMs.

642-50 Reserved – Existing Note Deleted

The **Plan Note** for "Barrier Delineation, As Per Plan" has been deleted and the information incorporated into revised **Plan Note 642-51**.

642-51 Delineation of Portable and Permanent Barrier

Barrier Reflectors and Object Markers shall be installed on all Portable Barrier (PB) used for traffic control and on permanent concrete barrier (including bridge parapets) located within 5 feet of the edge of the adjacent travel lane.

Barrier Reflectors shall conform to C&MS 626, except that the spacing shall be as per Traffic SCD MT-101.70. Object Markers and their installation shall conform to C&MS 614.03 and SCD MT-101.70. When the PB contains glare screen, one set of three vertical stripes of sheeting shall be considered equivalent to an object marker, one-way.

[Increased barrier delineation, as specified herein, shall be installed on all PB and concrete permanent barrier located within 5 feet of the edge of the traveled lane under either of the following conditions: along tapers and transition areas; or along curves (outside only) with degree of curvature greater than or equal to 3 degrees.]

[The increased barrier delineation shall consist of either delineation panels or the triple stacking of work zone barrier reflectors.]

[Delineation panels shall consist of panels of delineation, approximately 34 inches long and 6 inches wide and shall be "crimped." Panels shall be installed and spaced per Traffic SCD MT-101.70.]

[Triple-stacked barrier reflectors shall consist of aligning three barrier reflectors vertically, at locations where a single barrier reflector would be otherwise attached. There shall be no open space between the adjacent barrier reflectors. The triple-stacked barrier reflectors shall conform to C&MS 626, except that they shall be spaced and aligned per Traffic SCD MT-101.70.]

The following estimated quantities have been included in the plans and carried to the General Summary:

Item 614, Barrier Reflector, Type 1 (One-Way or Bi-Directional)	______ Each
Item 614, Object Marker, ____-way	______ Each
[Item 614, Increased Barrier Delineation	______ Feet]

Payment shall be full compensation for all material, labor, incidentals and equipment necessary for furnishing, installing, maintaining and removing each of the above items.

[Along runs of increased barrier delineation where this item is provided, the quantity shall be measured as the entire length of the run of increased barrier delineation, including the spaces between the individual delineation panels or stacks of barrier reflectors.]

Designer Note: This note shall be added whenever portable barrier use is specified for traffic control, or when permanent concrete barrier (or a bridge parapet) is located within 5 feet of the edge of the adjacent travel lane for projects located on freeways or expressways. (For delineation of permanent guardrail, see **Plan Note 642-52**.)

The third through sixth paragraphs, the last paragraph, and the Item 614, Increased Barrier Delineation line item within this **Plan Note** shall only be included when the conditions in the third paragraph are applicable. When this is the case, it is intended that either the delineation panels or the triple stacking of barrier reflectors be provided, at the contractor's discretion.

Each time portable barrier is moved to a new location a new quantity of barrier reflectors, object markers and increased barrier delineation (if applicable) shall be provided in the plans.

642-52 **Delineation of Temporary and Permanent Guardrail**

Barrier Reflectors shall be installed on all temporary guardrail used for traffic control and on all permanent guardrail located within 5 feet of the edge of the adjacent travel lane. Barrier Reflectors shall conform to C&MS 626.

[Object Markers shall be installed on all temporary and permanent guardrail located within 5 feet of the edge of the adjacent travel lane. Guardrail-mounting of Object Markers shall be made by installing the object markers on the extension blocks rather than directly onto the guardrail itself. Object markers shall conform to C&MS 614.03 and the spacing shall be approximately 50 feet.]

The following estimated quantities have been included in the plans and carried to the General Summary:

Item 614, Barrier Reflector, Type (2, 3, 4, or 5) (One-Way or Bi-Directional)	_____ Each
[Item 614, Object Marker, _-Way	_____ Each]

Payment shall be full compensation for all material, labor, incidentals and equipment necessary for furnishing, installing, maintaining and removing the above item(s).

Designer Note: This note shall be included in the plans when temporary guardrail use is specified for traffic control, or when permanent guardrail is located within 5 feet of the edge of the adjacent travel lane, for projects located on freeways or expressways. (For delineation of portable and permanent barrier, see **Plan Note 642-51**.)

The second paragraph and Item 614, Object Marker, _-Way line item within the **Plan Note** shall only be included when temporary or permanent guardrail is located within 5 feet of the edge of the adjacent travel lane.

Each time guardrail is installed in a new location a new quantity of barrier reflectors and object markers (if applicable) shall be provided in the plans.

642-53 **Item 614, Longitudinal Channelizer**

Longitudinal Channelizers shall be provided as called for in the plans. A Longitudinal Channelizer consists of a combination of vertical components and longitudinal base components, fit together to create a continuous channelizing device, as detailed in Traffic PIS 2010180. Use of tubular markers, as identified in the OMUTCD, Figure 6F-7, shall not qualify for use as a longitudinal channelizer.

The vertical component shall be equipped with two 3-inch wide retroreflective bands, placed a maximum of 2 inches from the top, with a maximum of 6 inches between the bands. The longitudinal base components shall be equipped with reflectors.

Longitudinal Channelizers shall comply with the requirements contained within **Traffic PIS 2010180**.

Furnish Longitudinal Channelizers from the Approved List found on the **Office of Materials Management** website. For installation procedures, follow the manufacturer's instructions.

Longitudinal Channelizers shall be monitored to determine whether there is significant damage from errant vehicles.

Payment for providing, installing, maintaining and removing Longitudinal Channelizers will be made at the unit price per foot for:

Item 614, Longitudinal Channelizer ____ Foot

Designer Note: This note and **Traffic PIS 2010180** shall be included in the plans when Longitudinal Channelizer is called for in the plans.

642-54 Item 614 – Business Entrance (M4-H15) Sign, As Per Plan

The Business Entrance (M4-H15) sign should be provided at each temporarily relocated commercial Driveway for which the relocation is not obvious to the motorist. The project Engineer shall determine whether or not the driveway relocation is, or is not, obvious and whether or not a sign should be provided. Only one sign per Business shall be permitted. The sign shall be 36 inch X 48 inch in size with Type G or Type H orange retroreflective sheeting. The sign legend shall be placed on both sides of the sign (back to back). The sign shall have the standard M4-H15 legend with the word "BUSINESS" on the top line, except under unusual circumstances where it may not be intuitive that a driveway serves a specific business. In such unusual cases, the actual business name may be substituted for the word "BUSINESS".

The sign shall be mounted on two #3 posts or on temporary posts in accordance with SCD MT-105.10 and in accordance with the Ohio Manual of Uniform Traffic Control Devices, latest edition. The sign shall be clearly visible and shall clearly identify the location of the driveway. The sign should be positioned at 90º to the direction(s) of traffic. The sign may need to be moved for each Phase of the Maintenance of Traffic operations.

Payment for all costs associated with manufacturing, mounting, relocating, and removing the sign, including all labor, materials and equipment shall be included in the contract price per Each for Item 614-Business Entrance sign.

The following estimated quantity has been carried to the general summary for this item.

Item 614, Business Entrance Sign Each

Designer Note: This note may be included in the plans when business entrances are temporarily relocated. It is intended that this note be used on projects where there are isolated business locations.

The sign should be the standard M4-H15 legend with the word "BUSINESS" on the top line. Under unusual circumstances where it may not be intuitive that a driveway serves a specific business, the actual business name may be substituted for the word "BUSINESS."

642-55 Item 614 - Law Enforcement Officer (With Patrol Car) for Assistance During Construction Operations

Use of Law Enforcement Officers (LEOs) by contractors other than the uses specified below will not be permitted at project cost. LEOs should not be used where the OMUTCD intends that flaggers be used.

In addition to the requirements of C&MS 614 and the OMUTCD, a uniformed LEO with an official patrol car (car with top-mounted emergency flashing lights and complete markings of the appropriate law enforcement agency) shall be provided for the following traffic control tasks:

- During the entire advance preparation and closure sequence where complete blockage of traffic is required.

- During a traffic signal installation when impacting the normal function of the signal or the flow of traffic, or when traffic needs to be directed through an energized traffic signal contrary to the signal display (e.g., directing motorists through a red light).

In addition to the requirement of C&MS 614 and the OMUTCD, a uniformed LEO with an official patrol car (car with top-mounted emergency flashing lights and complete markings of the appropriate law enforcement agency) should be provided for the following traffic control tasks as approved by the Engineer:

- For lane closures: during initial set-up periods, tear down periods, substantial shifts of a closure point or when new lane closure arrangements are initiated for long-term lane closures/shifts (for the first and last day of major changes in traffic control setup).

In general, LEOs should be positioned in advance of and on the same side as the lane restriction or at the point of road closure, and to manually control traffic movements through signalized intersections in work zones.

LEOs should not forgo their traffic control responsibilities to apprehend motorists for routine traffic violations. However, if a motorist’s actions are considered to be reckless, then pursuit of the motorist is appropriate.

The LEOs work at the direction of the Contractor. The Contractor is responsible for securing the services of the LEOs with the appropriate agencies and communicating the intentions of the plans with respect to duties of the LEOs. The Engineer shall have final control over the LEOs’ duties and placement, and will resolve any issues that may arise between the two parties.

The LEO shall report in to the Contractor prior to the start of the shift, in order to receive instructions regarding specific work assignments during his/her shift. The LEO is expected to stay at the project site for the entire duration of his/her shift. The LEO shall report to the Contractor at the end of his/her shift. Should it be necessary to leave the project site, the LEO shall notify the Engineer. The Contractor shall provide the LEO with a two-way communication device which shall be returned to the Contractor at the end of his/her shift.

LEOs (with patrol car) required by the traffic maintenance tasks above shall be paid for on a unit price (hourly) basis under Item 614, Law Enforcement Officer (With Patrol Car) for Assistance. The following estimated quantities have been carried to the General Summary.

Item 614, Law Enforcement Officer With Patrol Car for Assistance ______ Hours

The hours paid shall include any minimum show-up time required by the law enforcement agency involved.

Any additional costs (administrative or otherwise) incurred by the Contractor to obtain the services of an LEO are included with the bid unit price for Item 614, Law Enforcement Officer With Patrol Car for Assistance.

Designer Note: See ***Section 640-19*** for additional information. The plans shall clearly specify when and where the LEO is to be utilized. This note should be edited to conform to the project requirements.

642-56 Reserved – Existing Note Deleted

642-57 Work Zone Queue Detection Warning System

The Contractor shall furnish, install, and maintain an approved Work Zone Queue Detection Warning System (WZQDWS) as per Supplemental Specification 896.

The probable initial locations of the WZQDWS devices are shown on sheet(s) ____ of the plan. It is expected that these locations will vary based on planned or unplanned phase and traffic pattern changes. Placement, operation, maintenance and all activation of the devices by the Contractor shall be directed by the engineer.

The following traffic sensor thresholds and Portable Changeable Message Signs (PCMS) messages shall be used:

Greater than or equal to 50 MPH – Use four corner flashing caution mode
Between 50 MPH and 25 MPH – TRAFFIC AHEAD XX MPH / SLOW DOWN
Below or equal to 25 MPH – TRAFFIC AHEAD XX MPH / PREPARE TO STOP

Four corner flashing caution mode shall consist of the use of one asterisk in each corner of the PCMS display (4 total asterisks).

XX shall be rounded up to the nearest multiple of 5 mph minus 1. Occupancy may be directed to be used based on certain traffic conditions and scenarios. ODOT will direct the contractor of the thresholds to be used for those areas where occupancy is directed to be used.

The following estimated quantity has been carried to the General Summary.

Item 896, Portable Non-Intrusive Traffic Sensor, Class ____ Sign Month
Assuming_______Sensor(s) for______Month(s)
Item 896, Portable Changeable Message Sign, as per plan ________ Sign Month
Assuming ______ PCMS Sign(s) for ______ Month(s)

Designer Note: This note shall be used when use of Work Zone Queue Detection Warning Systems are required by the District or Central Office. Use only in accordance with ***Section 640-29.1***

642-58 Notification of Traffic Restrictions

Throughout the duration of the project, the Contractor shall notify the project engineer in writing of all traffic restrictions and upcoming maintenance of traffic changes. The Contractor shall ensure the written notification is submitted in a timely manner to allow the project engineer to meet the required time frames set forth in the table below to inform the **Special Hauling Permits Section** (Hauling.Permits@dot.ohio.gov) and the **District Public Information Office (PIO)**. This notification shall be received by the project engineer prior to the physical setup of any applicable signs or message boards.

Information should include, but is not limited to, all construction activities that impact or interfere with traffic and shall list the specific location, type of work, road status, date and time of restriction, duration of restriction, number of lanes maintained, number of lanes closed, minimum vertical clearance, minimum width of drivable pavement, detour routes, if applicable, and any other information requested by the project engineer.

Notification Time Table

Item	Duration of Closure	Notice Due to Permits & PIO
Ramp &	>= 2 weeks	21 calendar days prior to closure
Road	> 12 hours & < 2 weeks	14 calendar days prior to closure
Closures	< 12 hours	4 business days prior to closure

Lane Closures & Restrictions	>= 2 weeks	14 calendar days prior to closure
	< 2 weeks	5 business days prior to closure
Start of Construction & Traffic Pattern Changes	N/A	14 calendar days prior to implementation

Any unforeseen conditions not specified in the plans requiring traffic restrictions shall also be reported to the project engineer using the Notification Time Table.

Designer Note: The use of this note is required on all plans to satisfy NEPA regulations as set forth in the ODOT Public Involvement Manual published by the Office of Environmental Services. If ramp or road closures are intended to be implemented in the project, the TEM 642-8 plan note shall also be included in the plans.

642-59 Work Zone Egress Warning System

The Contractor shall furnish, install, and maintain an approved Work Zone Egress Warning System (WZEWS) as per Supplemental Specification 829.

The probable initial locations of the WZEWS devices are shown on sheet(s) ____ of the plan. It is expected that these locations will vary based on planned or unplanned phase and traffic pattern changes. Placement, operation, and maintenance and all activation of the devices by the Contractor shall be directed by the Engineer.

WZEWS shall be used in accordance with MT-103.10.The following estimated quantity has been carried to the General Summary.

Item 829, Work Zone Egress Warning System Sign Month
Assuming ______ Work Zone Egress Warning System(s) for _______ Month(s).

Designer Note: This note shall be used when use of Work Zone Egress Warning Systems are required by the District or Central Office. Use only in accordance with **Section 640-29.2.** This note shall not be added to any plans until there is at least one approved product on the Work Zone Egress Warning System (WZEWS) Approved List Supplement 1129.

643 SPECIFICATIONS

ODOT specifications discussed in this Part of the **TEM** for furnishing and installing temporary traffic control devices and material for work zones are contained in the following **C&MS** sections:

108 Prosecution and Progress
410 Traffic Compacted Surface
614 Maintaining Traffic
615 Roads and Pavements for Maintaining Traffic
622 Concrete Barrier
641 Pavement Marking - General

630 and 730 Traffic Sign and Support Material
631 and 731 Sign Lighting and Electrical Signs

Supplemental Specifications 808 and **908** address Digital Speed Limit (DSL) Sign Assemblies; **Supplemental Specifications 821** and **921** address Arrow Boards; and **Supplemental Specifications 830** and **930** address Automated Flagger Assistance Devices (AFADs).

Supplement 1021 addresses the prequalification procedure for Arrow Boards; **Supplement 1030** addresses the prequalification procedure for AFADs; and **Supplement 1108** addresses the prequalification procedure for Digital Speed Limit (DSL) Sign Assemblies.

650 CONSTRUCTION

650-1 General

This Chapter is intended to provide additional information on temporary traffic control that would be helpful particularly to construction personnel. However, it may also be useful for maintenance personnel performing the same functions. Inspection procedures for temporary traffic control devices will be addressed in this Chapter. Inspection procedures for other types of traffic control devices are outlined in the other Chapters related to the various types of traffic control devices.

For information about removal of Logo or Tourist-Oriented Directional Signs (TODS) see ***Section 640-21***.

650-2 Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles

The **ODOT** publication **Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles** shall be used to determine the acceptability of work zone traffic control devices. This document also addresses acceptable delineation methods for work vehicles and supply vehicles

643 SPECIFICATIONS

ODOT specifications discussed in this Part of the **TEM** for furnishing and installing temporary traffic control devices and material for work zones are contained in the following **C&MS** sections:

108 Prosecution and Progress
410 Traffic Compacted Surface
614 Maintaining Traffic
615 Roads and Pavements for Maintaining Traffic
622 Concrete Barrier
641 Pavement Marking - General

630 and 730 Traffic Sign and Support Material
631 and 731 Sign Lighting and Electrical Signs

Supplemental Specifications 808 and **908** address Digital Speed Limit (DSL) Sign Assemblies; **Supplemental Specifications 821** and **921** address Arrow Boards; and **Supplemental Specifications 830** and **930** address Automated Flagger Assistance Devices (AFADs).

Supplement 1021 addresses the prequalification procedure for Arrow Boards; **Supplement 1030** addresses the prequalification procedure for AFADs; and **Supplement 1108** addresses the prequalification procedure for Digital Speed Limit (DSL) Sign Assemblies.

650 CONSTRUCTION

650-1 General

This Chapter is intended to provide additional information on temporary traffic control that would be helpful particularly to construction personnel. However, it may also be useful for maintenance personnel performing the same functions. Inspection procedures for temporary traffic control devices will be addressed in this Chapter. Inspection procedures for other types of traffic control devices are outlined in the other Chapters related to the various types of traffic control devices.

For information about removal of Logo or Tourist-Oriented Directional Signs (TODS) see ***Section 640-21***.

650-2 Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles

The **ODOT** publication **Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles** shall be used to determine the acceptability of work zone traffic control devices. This document also addresses acceptable delineation methods for work vehicles and supply vehicles

660 MAINTENANCE / OPERATIONS

660-1 General

The consequence of poor maintenance practices are a reduction in safety to road users and an unnecessarily large exposure to liability claims. **District Roadway Services** personnel are responsible for establishing and maintaining temporary traffic control zones for **District** maintenance work and force account operations projects. Additional information is provided separately in this Manual regarding maintenance activities related to signing, markings, traffic signals, lighting and temporary traffic control.

For information about removal of Logo or Tourist-Oriented Directional Signs (TODS) see ***Section 640-21***.

660-2 Reserved for Future Information

The OPI and QAR procedures previously described in this Section are no longer in place; therefore, the text has been deleted.

660-3 Temporary Traffic Control (TTC) for Pothole Patching

660-3.1 General

As noted in ***Section 600-3***, **ODOT** maintenance work zones shall "comply with the requirements in the **OMUTCD** and this Manual." While recognizing that the **ODOT** "**SCDs and C&MS** do not necessarily provide the only method to achieve a given objective," ***Section 600-3*** indicates that **Districts** should "also follow the provisions in applicable **SCDs** and **Construction and Materials Specifications (C&MS)** sections."

As noted in ***Section 606-1***, the general goal in work zone TTC is "safety with minimum disruption to road users." However, as noted in **OMUTCD Section 6A.01** another goal of TTC is to provide for the efficient construction and maintenance of the highway, as well as efficient resolution of traffic incidents that may occur. Judgment is a key factor in balancing these goals, and determining what control is needed/appropriate. **OMUTCD Chapter 6B** provides a review of the fundamental principles of TTC.

OMUTCD Section 6G.02 and ***TEM Chapter 606*** address work duration as a factor in determining the devices used in TTC zones.

For pothole patching, it may take longer to set up and remove the TTC zone than to perform the work. This can significantly increase the delay for road users and increase workers' exposure to road hazards. Therefore, simplified control procedures may be warranted. The **OMUTCD** allows a highway agency some discretion in determining the TTC to provide. However, the agency's application of these devices should be consistent and commensurate with the conditions present in order to minimize risk to workers and the traveling public.

Permitted lane closure schedules (PLCS) have been established for **Interstates** and Interstate look-a-likes as well as other multi-lane roads deemed to be major or important by the **District** *(see **Section 630-4**)*. The PLCS designates hours where volumes are low enough that work can be performed in a closed lane and still provide sufficient capacity for the lower traffic volumes. Whenever possible, any work hours should conform to the restrictions of the PLCS. However, it is recognized that this is not always possible (e.g., emergencies).

For pothole patching on **ODOT**-maintained highways, the TTC procedures described in this Section should be followed to the extent practical.

660-3.2 Incident Management/Emergency Work Zones

Emergencies affecting the health and safety of the traveling public can occur that necessitate action on **ODOT's** part before all the necessary equipment and personnel can be gathered to establish TTC per the **OMUTCD**, **Traffic SCDs** and **TEM** (see **OMUTCD Chapter 6I** and ***TEM Chapter 608***). Circumstances such as these call for judgment in regards to the initial TTC devices deployed (based on availability) when using less than what is desirable. For emergency pothole patching on **ODOT**-maintained highways, the TTC procedures described in this **Section** should be followed to the extent practical.

660-3.3 Pothole Patching on Multi-Lane Facilities that Will Violate the Permitted Lane Closure Schedule (PLCS)

The following procedure is for pothole patching that occupies one location up to an hour (Short Duration per **OMUTCD Section 6G.02** and ***TEM Section 606-3***) on multi-lane facilities during times that are in violation of the PLCS.

Below is a hierarchy list of preferred methods for addressing TTC needs while pothole patching under these conditions:

1. Schedule the work to be completed during times that do not violate the PLCS ***(see Section 660-3.4)***. All non-emergency work should be scheduled for times that will not violate the PLCS.

2. Dispatch workers and equipment to close the lane in which work will be performed per **OMUTCD Figure 6H-33** (and/or the appropriate lane closure **Traffic SCD**).

3. Dispatch workers and equipment to close the lane in which work will be performed per **Figure 698-9**.

When working in the interior lane(s) of a directional roadway with three or more lanes, multiple lanes should be closed per **OMUTCD Figure 6H-37** to remove the unique safety hazards to workers and motorist that are created by an interior-lane only closure. For emergency pothole patching necessitating an interior-lane closure, the **District** should use the resources available and LEOs to comply with **OMUTCD Figure 6H-37** to the extent practical.

Refer to **OMUTCD Chapter 6G**, **OMUTCD Figure 6H-35** and ***TEM Chapter 606*** for other pothole patching work durations such as Mobile, etc., and the associated TTC for these work conditions.

660-3.4 Pothole Patching on Multi-Lane Facilities that Will Not Violate the Permitted Lane Closure Schedule (PLCS)

The following procedure is for pothole patching that occupies one location up to an hour (Short Duration per **OMUTCD Section 6G.02** and ***TEM Section 606-3***) on multi-lane facilities during times that are <u>not</u> in violation of the PLCS. For locations where the roadway facility is not addressed by the PLCS, non-emergency pothole patching work should be scheduled to occur during non-peak/lower volume hours.

Below is a hierarchy list of preferred methods for addressing TTC needs while pothole patching under these conditions:

1. Dispatch workers and equipment to close the lane in which work will be performed per **OMUTCD Figure 6H-33** (and/or the appropriate lane closure **Traffic SCD**).

2. If the **OMUTCD Figure 6H-33** cannot be achieved during emergency pothole patching work, or to close a lane using this application is not practical due to the very short work

duration, dispatch workers and equipment to close the lane in which work will be performed per ***TEM Figure 698-10*, Detail A**. (This lane closure method is not intended to be used for Mobile Operations (see **OMUTCD 6G.02**, **OMUTCD Figure 6H-35** and ***Section 606-3***). Factors such as volume, terrain or lack of shoulder should be considered when deciding on the use of truck-mounted attenuators and/or the need to request the presence of a law enforcement vehicle with flashing lights.

3. If factors such as volume, terrain or lack of shoulder do not necessitate the need for a shadow vehicle (or the need for a LEO) as in ***Figure 698-10*, Detail A**, then dispatch workers and equipment per ***Figure 698-10*, Detail B**.

4. On non-interstate multi-lane roads where there are very low volumes, providing sufficient gaps to perform very short duration work, the use of high-intensity rotating, flashing, oscillating or strobe lights only may suffice. The work vehicle would be positioned on the shoulder. This method of TTC is only intended for use on very low-volume multi-lane highways (e.g., rural US 30, Appalachian highways, etc.) where the pothole patching work duration is very short and the roadway geometry and terrain do not necessitate additional measures (shadow vehicle, TMA, LEO, etc.).

When working in the interior lane(s) of a directional roadway with three or more lanes, multiple lanes should be closed per **OMUTCD Figure 6H-37** to remove the unique safety hazards to workers and motorist that are created by an interior-lane only closure. For emergency pothole patching work necessitating an interior-lane closure, the **District** should use the resources available and LEOs to comply with **OMUTCD Figure 6H-37** to the extent practical.

Refer to **OMUTCD Chapter 6G**, **OMUTCD Figure 6H-35** and ***TEM Chapter 606*** for other pothole patching work durations such as Mobile, etc., and the associated TTC for these work conditions.

660-3.5 Pothole Patching on Two-Lane/Other Facilities

The following procedure is for pothole patching that occupies one location up to an hour (Short Duration per **OMUTCD Section 6G.02** and ***TEM Section 606-3***) on two-lane/other facilities. Non-emergency pothole patching work should be scheduled to occur during non-peak/lower volume hours.

Below is a hierarchy list of preferred methods for addressing TTC needs while pothole patching under these conditions:

1. Dispatch workers and equipment to close the lane in which work will be performed per **OMUTCD Figure 6H-10** (see also **OMUTCD Sections 6C.10 and 6G.10**, and ***Section 606-10***) OR for low-speed, low-volume facilities per **OMUTCD Figure 6H-18** (see also **OMUTCD Sections 6C.10 and 6G.10**, and ***Section 606-10***).

2. On two-lane/other facilities where there are very low volumes, providing sufficient gaps to perform very short duration work, the use of high-intensity rotating, flashing, oscillating or strobe lights only may suffice. The work vehicle would be positioned on the shoulder or as far off the roadway as possible. This method of TTC is only intended for use on very low-volume two-lane/other facilities where the pothole patching work duration is very short and the roadway geometry and terrain do not necessitate additional measures (shadow vehicle, TMA, LEO, lane closure, etc.).

Refer to **OMUTCD Chapter 6G**, **OMUTCD Figure 6H-17** and ***TEM Chapter 606*** for other pothole patching work durations such as Mobile, etc., and the associated TTC for these work conditions.

670 OTHER CONSIDERATIONS

670-1 General

This Chapter has been reserved for information on other considerations that should be noted, but for various reasons have not been addressed in the other Chapters. For example, it may at times be used to expedite incorporating information that will later be consolidated into other Chapters.

670-2 Bikeways

As noted in ***Section 606-11***, if the temporary traffic control zone affects the movement of bicyclists, adequate access to the roadway or shared-use paths shall be provided. Additional information on bikeways may be found in **OMUTCD** **Part 9**, ***TEM Part 9***, and the **Guide to the Development of A Bicycle Facility**.

670-3 Waterways

On projects involving construction or major reconstruction of structures over navigable waterways, provisions should be made to inform and/or guide watercraft traffic through the construction area.

Projects that close rivers or streams for construction purposes should provide a safe portage for light watercraft along with appropriate Guide and Warning Signs in each direction.

Projects that do not close rivers or streams, but alter existing portages or create otherwise hazardous conditions for watercraft passage, should provide adequate Guide and Warning Signs and protection, where appropriate, along the waterway.

Additional information on watercraft traffic and navigable waters can be obtained through the **Ohio Department of Natural Resources, Division of Watercraft. ODNR's** website for the **Division of Watercraft** is http://watercraft.ohiodnr.gov.

670-4 Motorcycles

Motorcycles are more susceptible to variations or obstacles in the road surface than are other vehicles. If a potential hazard cannot be eliminated, motorcyclists should receive a warning of the hazard well in advance of the affected area. **C&MS 614.055** contains information on signing required for planed surfaces. ***TEM Section 202-12*** contains information on signing required for longitudinally grooved pavement sections. Warning Signs should be considered for other potential hazards, especially for pavements that contain rumble strips ***(TEM Section 605-17)***, loose gravel **(OMUTCD Figure 2C-4)** or pavement edge drop offs.

670-5 Towing Operations

Towing operations shall be performed in a safe manner. Short-duration towing operations shall follow the guidelines applicable to short-duration maintenance operations ***(see Section 606-3.5)***.

All towing vehicles shall display a yellow high-intensity flashing, rotating, oscillating or strobe light, regardless of any other devices that may be mounted on the vehicles.

670-6 Rest Areas

670-6.1 General

When rest areas exist within a temporary traffic control zone, a decision must be made at an early stage as to whether the rest area will remain open or whether it will be closed during the work. Rest area closures will simplify the traffic control plan.

When rest areas remain open during construction, traffic control at the rest area entrance and exit ramps should be implemented as shown in **MT-98 series** of the **Traffic SCDs**.

670-6.2 Rest Area Closures

Rest areas shall not be closed to the public without approval of the **District Deputy Director**. Approvals of temporary rest area closures called for within construction projects become effective with the **District Deputy Director's** signature on the title sheet.

All advance Rest Area signs (D5-H1, D5-H2, D5-H2a, D5-H6) shall have the action message covered by an overlay bearing the legend "CLOSED." This panel shall have a black legend on a retroreflective orange background. The overlay for the D5-H1 and D5-H2a signs shall be 8 x 1.5 feet. The overlay for the DH5-2 and D5-H6 signs shall be 4 x 1.5 feet. Supplemental panels (TELEPHONE, TOURIST INFO, Handicapped symbol, etc.) located under mainline Rest Area signs shall be removed or covered when the rest area is closed. On conventional highways, the overlay panel size shall be 28 x 10 inches.

Distance information provided on the NEXT REST AREA XX MILES sign (D5-H7), located in advance of the upstream rest area, shall be modified to provide the distance to the next open downstream rest area. This modification shall be accomplished by providing a black on orange overlay to cover the distance provided on the sign.

As shown in **Traffic SCD MT-98.29**, the entrance ramp to the rest area shall be closed by use of drums. The exit ramp from the rest area shall be closed in a similar manner. On major standard highways where a median opening may exist to permit access to and from the rest area, this opening shall also be closed in a similar manner.

Where rest area lighting exists, it shall be maintained in proper condition to provide optimum illumination.

670-6.3 Restroom Closures

Rest areas shall not be closed because of restroom failure. If restrooms are closed because of mechanical failure or any other reason except routine maintenance, the REST ROOMS CLOSED sign (D5-H33), black legend on retroreflective orange background, shall be used to inform the road user of the closure. On freeways and expressways a D5-H33-48 sign, 48 x 48 inches, shall be installed below the Advance Rest Area sign (D5-H1), and may be installed below the (D5-H2) and D5-H2a signs; however, it shall not be installed at the D5-H6 gore sign. On conventional highways, the D5-H33-24 sign shall be installed below the Advance Rest Area sign (D5-H1) and may be installed below the D5-H2 sign.

670-7 Railroad Crossings

An important design consideration in the development of temporary traffic control plans involving railroad grade crossings is the potential for vehicles queuing onto the railroad tracks. Adjusting the transition area and/or buffer space might be appropriate so that downstream congestion caused by a lane drop, for example, does not reach the railroad crossing.

When the grade crossing is equipped with an active traffic control system, the normal sequence of highway intersection signal indications should be preempted upon approach of trains to avoid entrapment of vehicles on the crossing by conflicting aspects of the highway traffic signals and the grade crossing signals. Temporary traffic control signals near grade crossings should be operated so that vehicles are not required to stop on the tracks. See **OMUTCD Part 8** and ***Part 8*** of the **TEM** for additional information.

Guidance on traffic control near railroad crossings is provided in **OMUTCD Part 8, Section 6G.18 and Figure 6H-46** and ***TEM Section 606-19 and Part 8***.

670-8 Transit Considerations

Provision for effective continuity of transit service needs to be incorporated into the temporary traffic control planning process. Oftentimes, public transit buses cannot efficiently be detoured in the same manner as other vehicles (particularly for short-term maintenance projects). On transit routes, the traffic control plan ***(Section 602-2)*** should provide for features such as temporary bus stops, pull-outs and waiting areas for transit patrons.

695 REFERENCE RESOURCES

695-1 General

Various reference resources that may be useful have been noted in ***Chapters 193, 194 and 195*.**

695-2 Temporary Traffic Control Manual (reprint of OMUTCD Parts 1, 5 and 6)

OMUTCD Parts 1, 5 and 6 have been reprinted as a separate document for use in the field. The book is titled the **"Temporary Traffic Control Manual"**; however, it is also known as the Construction Manual or the Orange book, since it has an orange cover. It can be viewed or downloaded from the **TTCM** website and paper copies are available from the **Office of Contracts**. The manual is free to **ODOT** and other **State** agencies; ***Table 197-4*** provides information on the charge to others.

695-3 Flagger Handbook

As noted in ***Section 614-5***, the **Flagger Handbook** published by **ATSSA** is a pocket-size booklet, intended for use by field staff for easy reference to proper flagging procedures.

695-4 Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles

This document sets standards for acceptability of conditions of temporary traffic control devices. It is intended to provide uniformity in condition of traffic control devices on the public highway system. These standards are intended to address the day-to-day needs of traffic control within a work zone and are not meant to cover needs of emergency situations. This document is directly referenced in **C&MS 614**. This quality standard is available from the **ORE** website.

This document also addresses acceptable delineation methods for work vehicles and supply vehicles.

695-5 Guidelines for the Use of Portable Changeable Message Signs

The **ATSSA** publication, **Guidelines for the Use of Portable Changeable Message Signs**, is recommended as guidance for use in determining how to make use of PCMSs to inform road users of traffic conditions due to construction activity.

695-6 Guidelines for Traffic Control in Work Zones (Pocket Guide)

As noted in ***Section 195-2,*** the **Guidelines for Traffic Control in Work Zones** is a pocket-sized consolidation of information regarding temporary traffic control. The information is based on that in the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**, but some additional guidelines/handbook information is included. **Districts** can also get paper copies of if from the **Office of Contracts**, and it can be purchased by others for $2.50 plus tax and shipping (based on the quantity ordered) from the **Office of Contracts**, or the **LTAP Office**.

696 FORMS INDEX

696-1a Work Zone Constraints

Form 696-1a is submitted as part of the Maintenance of Traffic Alternative Analysis (MOTAA) described in ***Section 630-5*** for projects involving Interstates and Interstate Look-alikes. Electronic (.pdf and Excel formats) copies of the form are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-1b Example of a Completed Work Zone Constraints Form

Form 696-1b is an example of a completed ***Form 696-1a***. Electronic (.pdf and Excel formats) copies of this example are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-2a Bridge Information

Form 696-2a is submitted as part of the MOTAA described in ***Section 630-5***. Electronic (.pdf and Excel formats) copies of the form are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-2b Example of a Completed Bridge Information Form

Form 696-2b is an example of a completed ***Form 696-2a***. Electronic (.pdf and Excel formats) copies of this example are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-3a Ramp Information

Form 696-3a is submitted as part of the MOTAA described in ***Section 630-5***. Electronic (.pdf and Excel formats) copies of the form are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl)

696-3b Example of a Completed Ramp Information Form

Form 696-3b is an example of a completed ***Form 696-3a***. Electronic (.pdf and Excel formats) copies of this example are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-4a Cost Comparison

Form 696-4a is submitted as part of the MOTAA described in ***Section 630-5***. Electronic (.pdf and Excel formats) copies of the form are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

696-4b Example of a Completed Cost Comparison

Form 696-4b is an example of a completed ***Form 696-4a***. Electronic (.pdf and Excel formats) copies of this example are available from the **ORE Traffic Control Design** website (www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl).

Intentionally blank.

Form 696-1a. Work Zone Constraints

<table>
<tr><th colspan="5">Work Zone Constraints</th></tr>
<tr><th rowspan="2">Constraint</th><th colspan="4">Work Zone Alternatives</th></tr>
<tr><th>Part-Width</th><th>Crossover</th><th>ContraFlow</th><th>Hybrid</th></tr>
<tr><td>Ability to meet Work Zone Policy</td><td colspan="4">Indicate areas where the policy (# lanes, widths of lanes/shoulders, etc.) can and cannot be maintained. Include information on what is needed to meet the policy and associated costs.</td></tr>
<tr><td>Ability to Maintain all Entrance Ramps and Exit Ramps</td><td colspan="4">Include a Ramp Table. This table shall include ramp designation, number of lanes, ramp volume, ramp truck volume, decision sight distance, whether the ramp will be closed or open for each phase of construction, duration of closure, and detour for closure. If the ramp operates with more than one lane and this will be reduced in any phases of MOT, include this information as well. if a detour is noted - can ramps being used handle additional traffic or will modifications be needed such as widening on the ramp and/or signal work at ramp termini.</td></tr>
<tr><td>Ability to Provide Required Entrance Ramp Merge Decision Sight Distance</td><td colspan="4">Provide the proposed decision sight distance at each entrance ramp for each phase in the ramp table. If it does not meet the required DSD in the TEM, how much does it not meet by or what will it take to meet it? This information should be included in the ramp table described above.</td></tr>
<tr><td>Right-of-way impacts</td><td colspan="4">Explain the project ramifications of overcoming this constraint (e.g. cost of additional ROW, cost of retaining walls used). Include associated impacts to the schedule.</td></tr>
<tr><td>Environmental impacts</td><td colspan="4">Indicate areas where additional widening, bridge widening, etc. would cause impacts to streams, rivers, etc. Cost impacts and schedule impacts shall be included.</td></tr>
<tr><td>Bridge widths</td><td colspan="4">Include a Bridge Table. This table shall include extent of work being completed, length of bridge, type of bridge, existing pier spacing, existing bridge width, bridge width needed for each phase of MOT, future bridge width, and additional cost of width needed for each MOT scheme.</td></tr>
<tr><td>Significant impacts for construction duration and/or construction costs</td><td colspan="4">Include an estimated time of construction for each alternative. Describe additional costs for each alternative.</td></tr>
<tr><td>Significant impacts to earthwork, retaining walls, shoulder buildup, pier clearances, profile differences, etc.</td><td colspan="4">Include information such as amount of retaining wall needed, cost of retaining wall, significant fills or cuts and associated costs, etc. Indicate if the existing shoulders are strong enough to maintain traffic based on analysis results. If they are not adequate, provide proposed improvements.</td></tr>
<tr><td>Ability to maintain existing drainage and lighting systems</td><td colspan="4">Include information such as removal of median lighting, temporary wedging to allow for drainage, etc. Include any additional costs associated with concerns.</td></tr>
<tr><td>Constructability; and construction equipment access</td><td colspan="4">Discuss issues and costs associated with contractor access and ability to construct the project. If alternatives vary greatly in cost or time describe why.</td></tr>
<tr><td>Location of crossovers (e.g., Can crossovers be located near the project?)</td><td colspan="4">How do the locations of the crossovers on each end of the project affect existing ramps? Are bridge structures going to be constraints in areas of crossovers?</td></tr>
</table>

Table 696-1a. Work Zone Constraints (Continued)

What are the access impacts to important traffic generators such as hospitals, fire departments, industries, sports arenas, etc.	Indicate if any ramp closures impact major traffic generators or emergency services in the area. If so, how may this be handled during closure.
For concrete pavements, the longitudinal joints must be located at the lane lines.	
Estimated Maintenance of Traffic Cost	Include a Cost Comparison Table with the major costs differences between the alternatives analyzed. A total cost for each alternative shall also be included.

Note: All constraints that require any additions need to have a cost estimate associated with the alternative.

Form 696-1b. Example of a Completed Work Zone Constraint Form

Work Zone Constraints			
Constraint	Work Zone Alternatives		
	Part-Width	Crossover	ContraFlow
Ability to Meet the Work Zone Policy	**Impact: Medium** Policy can be met if some ramp and work area reductions can be tolerated due to ramp fly-over column constraint at 275+00 (the lanes have been shifted towards the existing median leaving a pinch point between Phases 1 and 2. This pinch point may not allow for reasonable cut lines between existing and proposed beam lines.)	**Impact: Medium** Policy can be met if some ramp and work area reductions can be tolerated due to ramp fly-over column constraints at 275+00 (during Phases 1 and 2, NB shoulder width will need to be reduced.)	**Impact: None** Policy can be met.
Ability to Maintain all Entrance and Exit Ramps	**Impact: Medium** The policy cannot be fully met. On I-75, all required lanes will be open. However, 3 ramps will need to be closed during parts of some phases.(Phase 1 - I-75 NB ramp to US 35 can be maintained but the proposed profile is 4 ft lower in this area requiring a pavement wedge. US 35 to I-75 SB ramp can be maintained with part-width methods. However, doing the same with US 35 to Stewart St. ramp becomes very complex due to maintaining both ramps around work in the same area of project (same in Phase 2.)) (Phase 2 - both ramps at 232+00 will be buried under the fill needed for the termporary pavement to shift traffic back to normal operations). *See Ramp Table.*	**Impact: Medium** The policy cannot be fully met. On I-75, all required lanes will be open. However, 3 ramps will need to be closed during parts of some phases. (Phase 1 - fill needed for temporary pavement to cross traffic back to lanes will bury the I-75 SB ramp to Edward C. Moses Blvd. Ramp from US 35 to I-75 SB can be maintained using part width methods. However, maintaining the US 35 ramp to Stewart St will make the part-width methods extremely complex due to this ramp and the US 35 to I-75 SB ramp both needing to shift around work in the area. Ramp from US 35 to I-75 SB could be run in the contra flow fashion to reduce temporary widening needs.) (Phase 2 - fill needed for temporary pavement to cross traffic back to lanes will bury the Edwin C. Moses Blvd ramp to I-75 NB. Ramp from I-75 NB to US 35 can be maintained part-width. Profile difference of 4 ft will require temporary wedge to return ramp to proper elevation. This ramp can be run in a contra flow fashion to reduce termporary widening needs.) *See Ramp Table.*	**Impact: Medium** The policy cannot be fully met. On I-75, all required lanes will be open. However, 3 ramps will need to be closed during parts of some phases. See Part Width Option description. *See Ramp Table.*
Ability to Provide Required Entrance Ramp Merge Decision Sight Distance	**Impact: None** Provided for open ramps. See Ramp Table.	**Impact: None** Provided for open ramps. See Ramp Table.	**Impact: None** Provided for open ramps. See Ramp Table.
Right-of-Way Impacts	**Impact: Medium** Relatively significant temporary widening needs on high fill may create a need for temporary right-of-way or wall construction to eliminate this need. Costs between part-width and crossover are not expected to be significant.	**Impact: Medium** Relatively significant temporary widening needs on high fill may create a need for temporary right-of-way or wall construction to eliminate this need. Costs between part-width and crossover are not expected to be significant.	**Impact: None** No impacts expected.
Environmental Impacts	**Impact: Low** Temporary right-of-way needs may create a need for some environmental field reviews. However, the highly urban nature of the surrounding environment is not expected to produce signifcant issues. (Phase 1 - widening will be into the fill slope for the I-75 NB to US 35 ramp.)	**Impact: Low** Temporary right-of-way needs may create a need for some environmental field reviews. However, the highly urban nature of the surrounding environment in not expected to produce signifcant issues. (Phase 1 - widening will be into the fill slope for the I-75 NB to US 35 ramp.)	**Impact: None** No impacts expected.
Bridge Widths	**Impact: Very High Cost and Duration** Existing bridges will require significant widening with substructures that will affect the roadway below. Proposed bridge widths will be affected and types cannot be determined without knowledge of MOT widening needs. (Phase 2 - temp. structure at 240+00 will close the sidewalk on Cincinnati St. and be very close to roadway - may require lane reduction or closure on Cincinnati St. Temporary widening at structures 240+00 and 247+00 may create clearance issues. Changes in substructure will not allow a common cut line (b/w existing and proposed deck) making the requirement for spacing b/w phases potentially larger than shown leading to additional temporary pavement and substructure.) **Cost: $14,800,000**	**Impact: Very High Cost and Duration** Existing bridges will require significant widening with substructures that will affect the roadway below. Proposed bridge widths will be affected and types cannot be determined without knowledge of MOT widening needs. (Phase 1 - temporary bridge widening at structures 240+00 and 247+00 may create clearance issues. About 20 ft of widening is needed with 2 decks at 240+00 and 255+00. Deck widening may cause clearance issues. A closure of one lane in each direction on I-75 will eliminate 95% of widening.) (Phase 2 - temporary structure for bridge widening at 240+00 will close the sidewalk on Cincinnati St and be very close to roadway - may require lane reduction or closure on Cincinnati St. **Cost: $13,200,000**	**Impact: Low Cost and Duration** Existing bridge widths are adequate except for relatively minor widening. Future bridge widths may be slightly wider in some areas but not to a significant enough amount to affect type selection or cost/schedule. **Cost: $1,400,000**
Significant Impacts for Construction Duration and Construction Costs	**Impact: Very High Cost, Duration and Constructability** Part-width construction of existing T-type substructures will be costly, delicate, and expensive beyond the rules-of-thumb used for temporary substructures placed for temporary widening. A cut line well off the center of the T-type substructure may be impractical. This will also affect bridge design. Significant temporay widening on high fill will affect costs and duration. Fill will be borrow during Phase 1 adding to costs; transport of materials will also be an issue. MOT for surface streets under bridges will be relatively substantial. The nature of part-width construction will make a 2-year construction period difficult. **Cost: See Cost Comparison Table**	**Impact: Very High Cost and Duration; Very Low Constructability** Significant temporay widening on high fill will affect costs and duration. Fill will be borrow during Phase 1adding to costs; transport of materials will also be an issue. MOT for surface streets under bridges will be relatively substantial. **Cost: See Cost Comparison Table**	**Impact: Very High Duration and Constructability; Very Low Cost** Part-width construction of existing T-type substructures will be costly, delicate, and expensive beyond the rules-of-thumb used for temporary substructures placed for temporary widening. A cut line well off the center of the T-type substructure may be impractical. This will also affect bridge design. With the 4-phase nature of this scenario, a 2-year construction period may be difficult due to the time needed for part-width construction and to build a crossover. **Cost: See Cost Comparison Table**

Form 696-1b. Example of a Completed Work Zone Constraint Form (Continued)

Work Zone Constraints			
Constraint	Work Zone Alternatives		
	Part-Width	Crossover	ContraFlow
Significant impacts to earthwork, retaining walls, shoulder buildup, pier clearances, profile differences, etc.	**Impact: Very High Cost and Duration; Very Low Constructability** Borrow or retaining walls will be needed for temporary widening. Profile differences will make some ramp maintenance costly, time consuming and challenging. Differences in profile of greater than 2 ft will require more widening or temporary shoring. Pavement cores were taken and the shoulders are adequte to sustain traffic loads for the duration that shoulders will be used for MOT. **Cost: See Cost Comparison Table**	**Impact: Very High Duration; Medium Cost and Very Low Constructability** Borrow or retaining walls will be needed for temporary widening. Profile differences will make some ramp maintenance costly, time consuming and challenging. Pavement cores were taken and the shoulders are adequte to sustain traffic loads for the duration that shoulders will be used for MOT. **Cost: See Cost Comparison Table**	**Impact: Medium Duration; Very Low Cost and Constructability** Profile differences will make some ramp maintenance costly, time consuming and challenging. Differences in profile of greater than 2 ft will require more widening or temporary shoring. Pavement cores were taken and the shoulders are adequte to sustain traffic loads for the duration that shoulders will be used for MOT. **Cost: See Cost Comparison Table**
Ability to Maintain Existing Drainage and Lighting Systems	**Impact: Medium Cost and Duration; None Quality and Constructability** Existing lighting can be maintained in Phase 1. However, temporary lighting may be necessary in Phase 2 due to median reconstruction. Some drainage structures (e.g. catch basin at 240+25, 241+00, and 247+00). Also significant temporary widening sloping to the outside could speed runoff and overload the off pavement system. Median inlets can be maintained in Phase 1 (where traffic will be.) **Cost: $20,000**	**Impact: Medium Cost and Duration; None Quality and Constructability** Existing lighting can be maintained in Phase 1. However, temporary lighting may be necessary in Phase 2 due to median reconstruction. Some drainage structures (e.g. catch basin at 240+25, 241+00, and 247+00). Also significant temporary widening sloping to the outside could speed runoff and overload the off pavement system. Median inlets can be maintained in Phase 1 (where traffic will be.) **Cost: $61,000**	**Impact: Low Cost and Duration; None Quality and Constructability** Existing lighting can be maintained during Phase 1, 2 and 3. However, temporary lighting may be necessary in Phase 4 due to median reconstruction. Drainage structures can be maintained until Phase 4, but at that time traffic will be on pavement sloping outward. **Cost: $0**
Constructability and Construction Equipment Access	**Impact: High Cost, Duration and Constructability** As mentioned above, T-type demolition and construction part-width will be a major issue. Borrow for the temporary widening will likely not be allowed to use surface streets creating safety issues if they enter and exit I-75 directly and access issues due to providing access down 2:1 slopes to create fill. Maintaining the US 35 ramps on the south side of the interchange will inhibit the contractor from traveling from the north end to the south end of the project. If local streets are not an option, they will have to enter and exit I-75 work zone traffic to make this movement, creating safety issues. **Cost: See Cost Comparison Table**	**Impact: High Cost, Duration and Constructability** As mentioned above, T-type demolition and construction part-width will be a major issue. Borrow for the temporary widening will likely not be allowed to use surface streets creating safety issues if they enter and exit I-75 directly and access issues due to providing access down 2:1 slopes to create fill. Maintaining the US 35 ramps on the south side of the interchange will inhibit the contractor from traveling from the north end to the south end of the project. If local streets are not an option, they will have to enter and exit I-75 work zone traffic to make this movement, creating safety issues. **Cost: See Cost Comparison Table**	**Impact: High Duration; Medium Cost and Constructability** The 4 Phase nature of this alternative will constantly shift access points to the work area. Maintaining the US 35 ramps on the south side of the interchange will inhibit the contractor from traveling from the north end to the south end of the project. If local streets are not an option, they will have to enter and exit I-75 work zone traffic to make this movement, creating safety issues. **Cost: See Cost Comparison Table**
Location of Crossovers	**Impact: None** No crossover needed.	**Impact: Low** Yes. Some creative crossover placement will be needed on the north end of the job in Phase 2.	**Impact: Low** Yes. Some creative crossover placement will be needed on the north end of the job in Phase 3 and 4.
Access Impacts to Important Traffic Generators such as Hospitals, Fire Departments, Industries, etc.	**Impact: Medium** Downtown Dayton has all these generators plus others. Closed exits may cause confusion to non-local traffic or delays following a lengthy or complex detour.	**Impact: Medium** Downtown Dayton has all these generators plus others. Closed exits may cause confusion to non-local traffic or delays following a lengthy or complex detour.	**Impact: Medium** Downtown Dayton has all these generators plus others. Closed exits may cause confusion to non-local traffic or delays following a lengthy or complex detour.
Longitudinal Joint Locations for Concrete Pavement	**Impact: Low** Joints on lane lines will probably not be possible unless additional temporary widening is used.	**Impact: None** Concrete pavement in an option.	**Impact: None** Concrete pavement is an option.
Estimated Maintenance of Traffic Cost	See Cost Comparison Table for all the major cost generators and total Maintenance of Traffic Estimated Cost.	See Cost Comparison Table for all the major cost generators and total Maintenance of Traffic Estimated Cost.	See Cost Comparison Table for all the major cost generators and total Maintenance of Traffic Estimated Cost.

Form 696-2a. Bridge Information

								Part-Width Construction			Crossover Construction			Contra flow Construction		
BRIDGE NAME	STATION	EXTENT OF WORK	TYPE OF BRIDGE	LENGTH OF BRIDGE	EXISTING PIER SPACING	EXISTING BRIDGE WIDTH	FUTURE BRIDGE WIDTH	WIDTH NEEDED FOR PART-WIDTH	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING	WIDTH NEEDED FOR CROSSOVER	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING	WIDTH NEEDED FOR CONTRA FLOW (crossover lane/contra flow lane)	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING

Form 696-2b. Example of a Completed Bridge Information Form

								Part-Width Construction			Crossover Construction			Contra flow Construction		
BRIDGE NAME	STATION	EXTENT OF WORK	TYPE OF BRIDGE	LENGTH OF BRIDGE (ft)	EXISTING PIER SPACING	EXISTING BRIDGE WIDTH (ft)	FUTURE BRIDGE WIDTH (ft)	WIDTH NEEDED FOR PART-WIDTH	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING	WIDTH NEEDED FOR CROSSOVER	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING	WIDTH NEEDED FOR CONTRA FLOW (crossover lane/contra flow lane)	COST OF 32" PCB BRIDGE MOUNTED	COST OF ADDITIONAL BRIDGE WIDENING
Cincinnati St (L)	239+75	Deck Replacement	Overpass	160	46'-64-46'	54	69	80	$9,344	$520,000	74	$4,672	-	52' / 27'	$9,344	-
Cincinnati St (R)	239+75	Deck Replacement	Overpass	160	46'-64-46'	53.5	57	80	$9,344	$530,000	74	$4,672	$410,000	52' / 27'	$9,344	-
Stewart St (L)	247+25	Replace substructure and superstructure	Overpass	199	44'-100'-44'	54	69	80	$11,622	$64,830,220	74	$5,811	-	52' / 27'	$11,622	-
Stewart St (R)	247+25	Replace substructure and superstructure	Overpass	199	44'-100'-44'	53.5	57	80	$11,622	$659,188	74	$5,811	$509,938	52' / 27'	$11,622	-
Abandoned RR Crossing (L)	262+25	Eliminated	Overpass	145	44'-53'-44'	84	Bridge Eliminated	80.5	$8,468	$0	74	$4,234	-	52' / 27'	$8,468	-
Abandoned RR Crossing (R)	262+25	Eliminated	Overpass	145	44'-53'-44'	41.5	Bridge Eliminated	80.5	$8,468	$706,875	74	$4,234	$589,063	52' / 27'	$8,468	$56,333
Albany St (L)	268+75	Replace substructure and superstructure	Overpass	125	35'-50'-35'	40	57	59	$7,300	$296,875	52	$3,650	-	41' / 16'	$7,300	$4,625
Albany St (R)	268+75	Replace substructure and superstructure	Overpass	125	35'-50'-35'	40	57	59	$7,300	$296,875	52	$3,650	$187,500	41' / 16'	$7,300	$4,625
US 35 (L)	275+35	Replace superstructure	Overpass	97	46'-46'	50	54.5	55.5	$5,665	$66,688	52	$2,832	-	41' / 16'	$5,665	-
US 35 (R)	275+35	Replace superstructure	Overpass	97	46'-46'	54.5	54.5	57	$5,665	$8,973	52	$2,832	-	41' / 16'	$5,665	-
Washington St/CSX (L)	282+00	Replace substructure and superstructure	Overpass	686	51'-64'-74'-104'-104'-57'-83'-82'-58'	41	60	58	$40,062	$1,457,750	52	$20,031	-	41' / 16'	$40,062	-
Washington St/CSX (R)	282+00	Replace substructure and superstructure	Overpass	686	51'-64'-74'-104'-104'-57'-83'-82'-58'	40	60	58	$40,062	$1,543,500	52	$20,031	$1,029,000	41' / 16'	$40,062	$25,382
Washington St/CSX (L)	286+00	Replace substructure and superstructure	Overpass	686	51'-64'-74'-104'-104'-57'-83'-82'-58'	64	84	58	$40,062	$0	96	$20,031	$1,029,000	63' / 38'	$40,062	-
Washington St/CSX (R)	286+00	Replace substructure and superstructure	Overpass	686	51'-64'-74'-104'-104'-57'-83'-82'-58'	64	84	58	$40,062	$0	96	$20,031	$2,744,000	63' / 41'	$40,062	-
Edwin C. Moses (L)	294+75	Replace substructure and superstructure	Overpass	605	77'-117'-59'-59'-117'-100'-66'	64	84	80	$35,332	$1,210,000	96	$17,666	$907,500	63' / 41'	$35,332	-
Edwin C. Moses (R)	294+75	Replace substructure and superstructure	Overpass	605	77'-117'-59'-59'-117'-100'-66'	64	84	80	$35,332	$1,210,000	96	$17,666	$2,420,000	63' / 41'	$35,332	-

Form 696-3a. Ramp Information

RAMP DESIGNATION	NUMBER OF LANES	RAMP VOLUME (% TRUCKS)	RAMP CLOSURE																DETOUR
			PART-WIDTH				CROSS-OVER				CONTRA FLOW				HYBRID				
			PHASE 1		PHASE 2		PHASE 1		PHASE 2		PHASE 1		PHASE 2		PHASE 1		PHASE 2		
			DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF THE CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	

Form 696-3b. Example of a Completed Ramp Information Form

RAMP DESIGNATION	NUMBER OF LANES	RAMP VOLUME (% TRUCKS)	RAMP CLOSURE																DETOUR
			PART-WIDTH				CROSS-OVER				CONTRA FLOW				HYBRID				
			PHASE 1		PHASE 2		PHASE 1		PHASE 2		PHASE 1		PHASE 2		PHASE 1		PHASE 2		
			DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF THE CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	DURATION OF CLOSURE	DECISION SIGHT DISTANCE (FT)	
I-75 NB Entrance from Edwin C. Moses	1	8950 (11)	N/A	1100	N/A	1100	N/A	1100	N/A	1100	N/A	1100	N/A	1100	N/A	1100	N/A	1100	Ramp will be open.
I-75 SB Exit to Edwin C. Moses	1	10460 (11)	N/A	1050	N/A	1050	N/A	1050	N/A	1050	N/A	1050	N/A	1050	N/A	1050	N/A	1050	Ramp will be open.
I-75 NB exit to US 35	1	19890 (10)	N/A	1300	N/A	1300	N/A	1300	N/A	1300	N/A	1300	N/A	1300	N/A	1300	N/A	1300	Ramp will be open and shifted around the work with a wedge to reach new profile when needed.
I-75 SB entrance to US 35	1	20300 (10)	N/A	1500	N/A	1500	N/A	1500	N/A	1500	N/A	1500	N/A	1500	N/A	1500	N/A	1500	Ramp will be open and shifted around the work with a wedge to reach new profile when needed.
Stewart St from US 35	1	-	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	6-8 mos	1220	This ramp can not be totally detoured on state roadways. Discussions with Dayton are required.
I-75 NB entrance from Albany St	1	Permanent Closure	Forever	1600	Forever	1600	Forever	1600	Forever	1600	Forever	1600	Forever	1600	Forever	1600	Forever	1600	No detour - permanent closure.
I-75 SB exit to Albany St	1	Permanent Closure	Forever	1060	Forever	1060	Forever	1060	Forever	1060	Forever	1060	Forever	1060	Forever	1060	Forever	1060	No detour - permanent closure.
I-75 NB entrance from US 35	2	15490 (10)	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	8-10 mos	1230	US 35 EB detour: US 35 EB , I-675 NB, I-70 WB, US 35 WB detour: This detour will utilize some local routes, discussions with Dayton will follow.
I-75 SB exit to US 35	2	20820 (10)	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	8-10 mos	1280	I-75 SB, I-675 NB
I-75 NB exit to Third St	1		N/A	1270	N/A	1270	N/A	1270	N/A	1270	N/A	1270	N/A	1270	N/A	1270	N/A	1270	Ramp will be open.

Form 696-4a. Cost Comparison

	Part-Width Construction	Crossover Construction	Contra Flow Construction
	Cost	Cost	Cost
Additional Right-of-Way			
Retaining Walls			
Additional Bridge Structure			
Cut/Fill/Shoring			
Lighting			
Drainage			
Temporary Pavement			
Portable Concrete Barrier			
Subtotal:			
15% Contingency			
MOT RELATED COST			
Project Duration			

Form 696-4b. Example of a Completed Cost Comparison Form

	Part-Width Construction	Crossover Construction	Contra Flow Construction
	Cost	Cost	Cost
Additional Right-of-Way	$20,000	$22,000	$0
Retaining Walls	$150,000	$175,000	$0
Additional Bridge Structure	$14,800,000	$13,200,000	$1,400,000
Cut/Fill/Shoring	$1,300,000	$1,000,000	$0
Lighting	$0	$41,000	$0
Drainage	$20,000	$20,000	$0
Temporary Pavement	$4,000,000	$4,500,000	$114,000
Portable Concrete Barrier	$310,000	$150,000	$310,000
Subtotal:	$20,500,000	$19,108,000	$1,824,000
15% Contingency	$3,100,000	$2,900,000	$274,000
MOT RELATED COST	**$23,600,000**	**$22,008,000**	**$2,098,000**
Project Duration	30 months	26 months	32 months

697 TABLES INDEX

697-1a Construction / Traffic Maintenance Strategies

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1a*** addresses construction and traffic maintenance strategies in general.

697-1b Corridor Options Outside Work Zones

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1b*** addresses corridor options outside the work zone.

697-1c Traffic Flow Options Inside Work Zones

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1c*** addresses traffic flow options inside work zones.

697-1d Time Limitations With Disincentive Option

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1d*** addresses time limitations with a disincentive option.

697-1e Contracting Procedure Options

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1e*** addresses contracting procedures options.

697-1f Administrative Options

As noted in ***Sections 606-16, 630-2 and 640-24.3***, ***Tables 697-1a through 697-1f*** present a Compendium of Traffic Control Options of various traffic control strategies and traffic control options. ***Table 697-1f*** addresses various administrative options.

697-2 Rate of Flow (Two-Way) for a Signalized One-Lane, Two-Way Closing

As noted in ***Sections 641-12.3***, ***Table 697-2*** provides rate of flow (two-way) information for use in designing a signalized one-lane, two-way closing related to the length of the one-lane operation.

697-3 Initial Timing Chart

As noted in ***Section 641-12.4***, ***Table 697-3*** presents an example of a timing chart that could be used in a plan involving a signalized one-lane, two-way closing to indicate specified signal timing.

697-4 Minimum Lane Widths for Maintaining Traffic on Curves (Where D>10 degrees)

As noted in ***Section 640-2***, ***Table 697-4*** establishes minimum lane widths for maintaining traffic on sharp curves (degree of curvature exceeds 10 degrees).

697-5 Sample Phasing Chart for Actuated Signal Control

As noted in ***Section 641-12.4, Table 697-5*** presents a sample phasing table that can be used in the plan.

697-6 Maximum Closure Lengths

As noted in ***Section 641-12.3***, ***Table 697-6*** provides guidance in designing a signalized one-lane, two-way closing. These values are used as a guide as to when a more detailed analysis of the traffic is needed.

697-7 Barrier Offset on Curved Roadways

As noted in ***Section 641-19***, ***Table 697-7*** summarizes required offsets for barriers on curved roadways.

697-8 Decision Sight Distance for Entrance Ramp Applications

As noted in ***Sections 607-13 and 607-15***, ***Table 697-8*** provides the decision sight distance information used in the applications addressed in those Sections.

Table 697-1a. Construction / Traffic Maintenance Strategies Compendium of Traffic Control Options

Strategy & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Part Width Construction	Easier design. Cheaper MOT cost. No detour to follow. Ramps can remain open.	Contractor access interference. May sacrifice quality. More difficult to construct. Narrow lanes and less safe. Longer to construct. Barrier could still be required for some dropoffs.	Minimum lane widths sometimes tough to obtain. Conflict between width of roadway and width needed for work.	When existing two lanes can remain with use of shoulder. Minor work with short duration. One lane may handle only 20,000 ADT with normal backup.	This is the basis of comparison for alternate strategies, the “defacto” standard.
Close & Detour **(Unusual on Interstates and expressway routes)** **3**	Safety/ speeds up construction with full access. Easier and better construction. No distracting traffic.	Public can’t get there the “usual” way. Access to businesses. Cost to motorist (time & fuel). Signing. Lost road users complaints. Damage of local roads.	Short distance and ramp access. Local agencies must accept detour and public information is emphasized (i.e., by TMP in urban area). Locations of ramps and intersections. Detour must be adequately signed and may require capacity improvements.	If it produces accelerated construction, alternates are available and drivers are fairly warned.	CC↓, MTC↑, RUC↑ Cheap if only signs are used; but will cost more if alternate route modifica-tions are required. Detours-usually signed by ODOT.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety

Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑ = Cost Increase; ↓ = Cost Decrease; CC + MTC = Contract Cost

Table 697-1a. Construction / Traffic Maintenance Strategies - Compendium of Traffic Control Options (Continued, 2 of 3)

Strategy & Objectives	Pros	Cons	Restrictions	When to Use	Cost
<u>Crossover Construction</u> **3, 4**	Safety for workers, familiarity of road user. Easier and better construction. Wider traveled lanes. If left in place, useful in emergency. Should increase contractor productivity. Should increase quality. Could reduce traffic interference as a result of increased contractor productivity leading to shorter phase. Completion dates are mandated.	Ramp interference. Cost. Requires time for crossover construction and removal. Long crossovers less acceptable in rolling to hilly terrain.	Duration of project. Location of crossover depends on ramps, lighting, structure and grade. Phasing limits may impact use. Length of work zone may affect acceptability.	<u>Whenever</u> possible, especially where not many ramps interfere. Long stretches of pavement reconstruction or rehabilitation. Bridge work not conducive to keeping one lane open. One lane each direction should handle about 30,000 ADT with limited backups.	CC↓, MTC↑, RUC↓ Minimum $3 to 2 million per pair.
<u>Temporary Pavements (Runaround)</u> **1, 2, 3, 4**	Separates work from traffic.	Expensive and time consuming while constructing. Inefficient use of materials.	Must have sufficient right-of-way.	No adequate detour is available.	MTC↑, RUC↑

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety

Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1a. Construction / Traffic Maintenance Strategies - Compendium of Traffic Control Options (Continued, 3 of 3)

Strategy & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Temporary Structures **(Allows closure of structure, but no detour for the public)** **1, 2**	Traffic remains on routes.	Cost. Time to design and construct. Inefficient use of materials.	Right-of-Way.	When volumes warrant. No detour available.	MTC↑, RUC↓
Detour of One Direction of Mainline **(Assumes detour for closed direction)** **3, 4**	Work moves faster. Only half of the traffic detoured at any time. Improves safety of project personnel.	Detour maintenance.	Short distance and ramp access. Local agencies must accept detour routes and public information is emphasized (i.e., by TMP in urban area). Locations of ramps and intersections. Detour must be adequately signed and may require capacity improvements.	Often. Urban/ suburban freeway is amenable to this when suitable detour is available.	MTC↑ Could require detour improve-ments.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1b. Corridor Options Outside Work Zone Compendium of Traffic Control Options

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Temporary Signals **(At ramps and on expressways, includes construction vehicle crossing and ramp metering)** **1, 2, 4**	Helps maintain ramp and detour capacity.	Change traffic patterns on cross roads.	Should be warranted.	When additional capacity is needed for the short term.	Low.
Reversible Lanes **(May use movable barriers)** **2**	Flexible to accommodate fluctuations in traffic peak flow direction.	Confusing to infrequent user. Labor intensive.	Need majority commuting traffic.	Large variances in directional volumes between AM & PM; and number of lanes limited.	MTC↑, RUC↓
Movable Barrier Systems **2, 3, 4**	Ability to provide for peak flow capacity.	More costly than drums and fixed barriers.	Shift distance must be a constant. Must determine appropriate end treatment.	When you have a need for repeated barrier shifts.	CC↑, RUC↓
Signed Alternate Routes **(Eligible for Federal money)** **1, 2, 4**	Reduces congestion. Lessens congestion on mainline.	Hard to get people to use. Signing. Not always used by public.	Must be just as quick or close. Shouldn't go through other construction zones. Local officials must approve.	With good arterials (parallel). When construction expected to backups. Project is of long duration.	Low cost unless alternate route improve-ments are required.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety

Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1b. Corridor Options Outside Work Zone - Compendium of Traffic Control Options (Continued, 2 of 2)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Unsigned Alternate Routes **(Not eligible for Federal money)** **(Logical unsigned alternate may be eligible for State money)** **1, 2**	Reduces congestion. Lessens congestion on mainline.	Difficult to get people to use.	Alternate routes shouldn't go through other construction zones.	When construction expected to produce backups and good parallel arterials are available.	
Highway Advisory Radio **1**	Provides real time information to motorists.	Limited ranges. Low usage rate by motorists due to difficulty tuning in station.	Information needs to be current. May work best with repeat drivers. Should be limited to project specific information.	When alternate routes are available. Long duration of construction.	Low cost.
Advanced Signing (Time or Distance) **1, 2, 4**	A great tool for information to motorists. Gives public advance warning to make decisions.	If project is delayed, sign is wrong.	Need to keep information up to date.	Anytime. Advanced warning/PR is great always.	Low cost for fixed signs. Higher cost for PCMS.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1c. Traffic Flow Options Inside Work Zones
Compendium of Traffic Control Options

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
<u>Temporary Pavements</u> **<u>(Widen)</u>** **1, 2, 4**	Allows for more lanes to stay open. Creates greater capacity through the construction zone - less backups.	Expensive and time consuming while constructing.	Bridges and other roadway items.	When volumes warrant keeping all lanes open. When construction is expected to produce backups. When project is of long duration.	MTC↑, RUC↓
<u>Use Existing Shoulders</u> **1, 2**	Keeps flow normal. Allows wider work space or increases capacity. Low cost. Quick.	Requires more maintenance. Trucks may damage weak shoulders. No room for breakdowns/ emergency stops unless parking lots created. Closer to guardrail, embankment and piers.	Must have full shoulder widths, level bridges. Bridges must be able to accommodate. Put trucks in left lane if possible. Must coordinate with District Pavement Engineer to evaluate shoulders during design. Should have full width approach slabs.	High volume. When backups expected. Moving projects.	

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1c. Traffic Flow Options Inside Work Zones - Compendium of Traffic Control Options (Continued, 2 of 4)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Temporary Signals **(At ramps and on express-ways includes construction vehicle crossing and ramp metering)** **1, 2, 4**	Helps maintain ramp and detour capacity.	Change traffic patterns on cross roads.	Should be warranted.	When additional capacity is needed for the short term.	Low.
Reversible Lanes **(May use movable barriers)** **2**	Flexible to accommodate fluctuations in traffic peak flow direction.	Confusing to infrequent user. Labor intensive.	Need majority commuting traffic.	Large variances in directional volumes between AM and PM; and number of lanes limited.	MTC↑, RUC↓
Movable Barrier Systems **2, 3, 4**	Ability to provide for peak flow capacity.	More costly than drums and fixed barriers.	Shift distance must be a constant. Must determine appropriate end treatment.	When you have a need for repeated barrier shifts.	MTC↑, RUC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1c. Traffic Flow Options Inside Work Zones - Compendium of Traffic Control Options (Continued, 3 of 4)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Ramp Closures **2, 3, 4**	Can pave/repair ramp full width. Better, safer construction. See "Close & Detour." Reduces mainline congestion. Reduces cross road congestion. Easy to sign in rural area.	Blocks traffic pattern. See "Close & Detour." Forces new traffic pattern. Moves congestion elsewhere. In urban area, may have negative impact on next intersection.	Should give definite time limit. See "Close & Detour." Best if only two ramps at a time (to and from directional pairs).	When other ramps are close by, or when bridges on mainline are too close to utilize exit and/or entrance ramps. See "Close & Detour." Use when you have high-traffic volumes. In areas where alternate routes exists.	Relatively cheap. See "Close & Detour."
Glare/Gawk Screens **2, 4**	Effective way to separate work and keep traffic moving. Safer for work. Reduce rubber-necking.	Longer to set up than drums. Higher cost than 32 inches. Maintenance of glare screen, if used. If present on both sides, may reduce drive speed. Barrier can interfere with wide loads.	Widths in certain areas. Sight restrictions at intersections and ramps.	When view of intense construction is likely to reduce capacity. With all part-width construction at restricted areas to control headlight glare.	MTC↑

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1c. Traffic Flow Options Inside Work Zones - Compendium of Traffic Control Options (Continued, 4 of 4)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Highway Advisory Radio **1**	Provides real time information to motorists.	Limited ranges. Low usage rate by motorists due to difficulty tuning in station.	Information needs to be current. May work best with repeat drivers. Should be limited to project specific information.	When alternate routes are available. Long duration of construction.	RUC↓
Owner Imposed Design Restrictions **1, 3**	Can reduce actual construction duration.	Requires advance planning during design. Could increase cost.		For certain time critical phases.	
Use of Owner Supplied or Stockpiled Materials **1, 3**	Can reduce actual construction duration.	Requires advance planning.		For time-critical phases to shorten duration.	Inexpensive.
Control of Contractor's Access to the Work **(By location or time of day.)** **2, 4**	Eliminates potential conflicts between construction traffic and motorist. Improves through put of motorists.	May reduce contractor productivity.	Must provide reasonable access for contractor.	Where capacity is critical. Where conflicts between contractor's equipment and motorists is expected to impact capacity and safety, possibly on grades or locations with poor sight distances.	CC↑, RUC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1d. Time Limitations with Disincentive Options Compendium of Traffic Control Options

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
<u>Temporary Lane Closures or Restrictions</u> **1, 2**	Prevents contractor from keeping lanes closed longer than necessary. Prevents work during specified hour.	May surprise repeat drivers. May be more expensive. More setups and take downs which can reduce construction time.	Rush hour considerations. Use only if work will allow. Give public notices.	Mainline paving on basic freeway lanes. When desired to prohibit closures during specified times.	CC↑, MTC↑, RUC↓ Cheap (cone in daylight; drums at night). Possibly higher cost than permanent closure.
<u>Night Work</u> **(Hours of day a specific phase of work is or required to be performed)** **2, 3**	Good PR. Lower cost to motorist. May shorten project duration.	Costly for labor. Lower efficiency. Personnel are isolated. Possibly poorer quality work and inspection difficulty. Difficult to get some materials at night. Increased hazard potential. Difficult to access management or supervision for problem solution.	Residential areas. Work must be able to be accomplished in this time. Urban noise ordinances.	High-volume areas. When extensive backups expected to be created.	CC↑, MTC↑, RUC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1d. Time Limitations with Disincentive Options - Compendium of Traffic Control Options (Continued, 2 of 2)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Weekend Work (Only) **2, 3, 4**	Lower cost to motorist.	Costly - needs inspection on overtime also. Impacts traveler who is less familiar with alternate routes. Difficult to get some materials on weekends.	Work must be able to be accomplished in this time.	More amenable in urban areas. High volume of commuter traffic expected to be delayed.	CC↑, RUC↓
Lane Rental **(Many variations)** **(Contractor loses money for duration of specific lane closures)** **1, 2, 3**	Work done in the most cost effective and timely manner. Should minimize construction time. Provides incentive to minimize use of road space.	Expect disagree-ments. New application in Ohio.	Requires careful timekeeping. Too many variables.	Paving freeways.	CC↑, RUC↓
Interim Completion Dates, By Phase **3 (possibly 4)**	A good tool for timeliness. Prevents contractor from having lanes closed or restricted when not desired.	Only works if enforced by increased disincentives.	Schools, weather, plowing, etc. Must require early consideration and follow-up. Must be updated when a sale date is established or revised.	To open roads before winter, specified events.	Cheap.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1e. Contracting Procedure Options
Compendium of Traffic Control Options

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Incentives/ Disincentives **(Usually applies to a phase of a project)** **1, 3**	Timeliness. Quicker construction.	More arguments on time extension. Our people must resolve issues quickly. Requires CPM schedule.	None known. Need good plans and a project with the work well defined in advance. Work must be able to be accomplished in allotted time, must follow the incentive/ disincentives guidelines.	High volume that truly impacts motorists without good detour or alternate route.	CC↑, RUC↓ Must budget for maximum incentive.
A + B Bidding **(Construction cost plus construction time)** **1, 3**	Work done in the most cost effective and timely manner. Should minimize construction time.	May pay more for the work. Expect disagreements.	Limit to high impact projects. Currently limited to test projects. Need very good plans and no expected changes. Need reasonable completion times.	High volume that truly impacts motorists without good detour or alternate route.	CC↑, RUC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety

Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1e. Contracting Procedures Options - Compendium of Traffic Control Options (Continued, 2 of 2)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
<u>Lane Rental</u> **(Many variations)** **(May be combined with A+B Bidding)** **(Contractor loses money for duration of specific lane closures)** **1, 2, 3**	Work done in the most cost effective and timely manner. Should minimize construction time. Provides incentive to minimize use of road space.	Expect disagreements. New application in Ohio.	Requires careful timekeeping.	Paving freeways.	CC↑, RUC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1f. Administrative Options
Compendium of Traffic Control Options

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Traffic Management Program **(Area, corridor or project)** **(May include enforcement, demand management, public information, public perception adjustment)** **1, 2, 4**	Keeps checks on conflicts. Helps with consistency. Coordinates all projects, develops a forum for discussion of construction problems.	Not welcomed by some. Takes extra time and planning. Tends to be expensive. Additional funding required from Districts and Locals. Project outside area boundaries may cause public relation problems. Requires more staff time.	Takes extra time and planning. Area must be large enough to make worthwhile.	Anytime. Most often used in larger urban areas and particularly (eight MPO's) with large projects.	CC↑, MTC↑, RUC↓ Personnel only (mainly). Typical program is $500,000 to $1 million per year.
Enforcement **1, 2, 4**	Expedited, orderly traffic flow, incident support.	Cost.		When incident support is required, or enforcement presence is desired.	Medium high.
Incident Management **1, 2, 3, 4**	Minimizes effect incidents have on traffic flow.	Cost of standby incident response personnel and vehicles; administrative cost.		Freeway sections with high v/c ratio and high likelihood of incidents.	High.

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-1f. Administrative Options - Compendium of Traffic Control Options (Continued, 2 of 2)

Option & Objectives	Pros	Cons	Restrictions	When to Use	Cost
Demand Management **1, 2, 3, 4**	Shifts some demand from highway under construction. Good PR.	Requires advance planning and coordination. Cost.	Alternative routes and modes must be available.	Large urban and suburban projects in congested corridor.	High.
Contractor Proposed Options **3**	May result in shorter construction duration.	Contractor may not be as familiar with recommended procedure as claimed. Usually requires rush reviews by ODOT.	Requires adequate lead time for PR and permits.		CC↓

Legend:
Objectives: 1 = Reduce Complaints; 2 = Maximize Corridor Capacity; 3 = Minimize duration of motorist inconvenience; 4 = Maximize motorist / worker safety
Cost: CC = Construction Cost; MTC = Maintenance of Traffic Cost; RUC = Road User Cost; ↑= Cost Increase; ↓= Cost Decrease; CC + MTC = Contract Cost

Table 697-2. Rate of Flow (Two-Way) for a Signalized One-Lane, Two-Way Closing

Total cycle length		Length of One-Lane Operation feet						
Minutes	Seconds	400	500	600	700	800*	900*	1000*
1.0	60	450	310	170	35			
	70	570	445	320	200	80		
	80	690	579	475	365	260	155	
1.5	90	810	715	625	530	440	350	225
	100	870	780	700	615	530	445	340
2.0	120	990	915	844	788	712	638	572
3.0	180 *	1154	1117	1075	1027	983	934	890
4.0	240 *	1247	1215	1184	1151	1118	1081	1048
5.0	300 *	1302	1276	1253	1226	1200	1170	1144

This table assumes a 12-foot lane width. If the lane width is 11 feet, reduce the rate of flow by using a factor of 0.97 and for a 10 foot lane width, reduce the rate of flow by using a factor of 0.93.

* Cycle lengths greater than three minutes should be considered only in unusual cases. It is important to remember that a road user encountering a signal staying red for more that two minutes is very likely to become impatient and/or assume the signal is malfunctioning. This is particularly true if the motorist cannot see that opposing traffic is using the open lane. For the same reasons, closure lengths greater than about 800 feet should not be used until carefully evaluated. Where relatively short closure lengths are involved but high peak traffic volumes tend to support the need for a longer cycle length, it will probably be appropriate to employ a technique which will allow a shorter cycle length to be used during lower traffic periods. Traffic actuated operation and/or multi-plan time-of-day operation should be considered.

Table 697-3. Initial Timing Chart

	Timing Plan (Seconds)		
Approach	**A**	**B**	**C**
Northbound Green	31.0	41.0	16.0
Northbound Yellow	3.5	3.5	3.5
Northbound All Red (Internal Clearance)	18.0	18.0	18.0
Southbound Green	30.0	20.0	15.0
Southbound Yellow	3.5	3.5	3.5
Southbound All Red (Internal Clearance)	19.0	19.0	19.0
Total Cycle Length	105.0	105.0	75.0

Provide timing appropriate for the signal location under consideration.

Time of Day	SUN	MON	TUE	WED	THUR	FRI	SAT
Midnight - 7:00 a.m.	C	C	C	C	C	C	C
7:00 a.m. - 9:00 a.m.	C	A	A	A	A	A	C
9:00 a.m. - 4:00 p.m.	A	C	C	C	C	C	A
4:00 p.m. - 6:00 p.m.	C	B	B	B	B	B	A
6:00 p.m. - Midnight	C	C	C	C	C	C	C

Table 697-4. Minimum Lane Widths for Maintaining Traffic on Curves (Where D >10 degrees)

	Predominant Traffic Type **		
RADIUS feet	Type A feet	Type B feet	Type C feet
> 500	10	10	10
500	10	10.5 *	11.5 *
300	10	11.0 *	12.5 *
200	10	11.5 *	13.5 *
150	10 *	12.0 *	14.5 *
100	10 *	13.5 *	17.0 *

** Type A - Passenger cars govern design.

Type B - Single unit trucks govern design.

Type C - Semitrailer vehicles (WB-50) govern design. Larger units may need to be rerouted if their required width cannot be accommodated.

Note: Widths shown in excess of 10 feet are based on the width of wheel track plus a 1.5 foot allowance for maneuverability. Minimum barrier offset in addition to the widths shown is 2.0 foot. Values marked by an asterisk (*) are those situations where minimum barrier clearance cannot be waived.

Table 697-5. Sample Phasing Chart for Actuated Signal Control

	Phase*			
	1	**2**	**3**	**4**
Initial	7	10	8	10
Vehicle	4	3	4	3
Maximum	11	30	12	30
Yellow **	3	3.5	3	3.5
All Red **	2	2	2	2
Recall	ON	OFF	ON	OFF

* Phases as shown on **Traffic SCD MT-96.20** for Actuated Control. Provide timing for the signal location under consideration.
** Calculate clearance times in accordance with ***Section 403-2***.

Table 697-6. Maximum Closure Lengths

MAXIMUM ADT	MAXIMUM CLOSURE LENGTH Feet
10,000	200
9,000	400
8,000	600
7,000	800
5,000	1200
4,000	1600
3,000	2000

Table 697-7. Barrier Offset on Curved Roadways

Degree of Curvature (Radius)	Required Offset From Edge of Pavement Feet	Minimum Width of Median Required Feet
2.5 to 3.5	36	66
3.6 to 4.5	42	72
4.6 to 5.5	48	78

Table 697-8. Decision Sight Distance for Entrance Ramp Applications

(see Sections 607-13 and 607-15)

Posted Mainline Speed (MPH)	Rural (Feet)	Urban (Feet)
45	675	930
50	750	1030
55	865	1135
60	990	1280
65	Diamond Ramp = 1050 Loop Ramp = 1220	1365
70	Diamond Ramp = 1105 Loop Ramp = 1275	1445

698 FIGURES INDEX

698-1 Component Parts of a Traffic Control Zone

As noted in ***Sections 602-4.1, 602-4.4.4 and 605-5.1***, ***Figure 698-1*** illustrates the components of a traffic control zone.

698-2 Temporary Traffic Control Signs

As noted in ***Section 605-2.1***, ***Figure 698-2*** illustrates Regulatory, Warning and Guide Signs discussed in this Manual that are not shown in the **OMUTCD**.

698-3 Median Crossover for Entrance Ramp

Figure 698-3 illustrates a typical application involving a median crossover for an entrance ramp. ***Section 607-13*** provides additional information directly related to this application. ***Section 606-17*** also provides additional information about work near interchanges.

698-4 Two-Lane Crossover Design (Existing 4-Lane Facility)

Figure 698-4 illustrates a two-lane crossover design for an existing four-lane facility. ***Sections 606-16, 607-12 and 640-12*** address crossovers.

698-5 Example of Typical Sections (Existing 4-Lane Facility)

Figure 698-5 illustrates typical sections for a median crossover on an existing four-lane facility. ***Sections 606-16, 607-12 and 640-12*** address crossovers.

698-6 Two-Lane Crossover Design (Existing 6-Lane Facility)

Figure 698-6 illustrates a two-lane crossover design for an existing six-lane facility. ***Sections 606-16, 607-12 and 640-12*** address crossovers.

698-7 Example Typical Sections (Existing 6-Lane Facility)

Figure 698-7 illustrates typical sections involving a median crossover for an existing six-lane facility. ***Sections 606-16, 607-12 and 640-12*** address crossovers.

698-8 Sample Lane Configuration Diagrams and Cross Sections

Figure 698-8 provides a couple of samples of Lane Configuration Diagrams and Cross Sections described in ***Section 630-5*** as part of an MOTAA.

698-9 Pothole Patching on Multi-Lane Facilities That Will Violate the PLCS

Figure 698-9 is an example of TTC guidelines established in ***Section 660-3.3*** for pothole patching on **ODOT**-maintained multi-lane facilities that will violate the PLCS.

698-10 Pothole Patching on Multi-Lane Facilities That Will Not Violate the PLCS

Figure 698-10 is an example of TTC guidelines established in ***Section 660-3.4*** for pothole patching on **ODOT**-maintained multi-lane facilities that will not violate the PLCS.

698-11 WTS Daily Inspection Report

Figure 698-11depicts the daily inspection **Form CA-D-8** noted in item 10 of the list of **Worksite Traffic Supervisor** duties outlined in **Plan Note 642-44** ***(Section 642-44)***. A copy of this document can be found in the current revision of the **Department of Transportation Construction Inspection Forms Manual.**

698-12 One-Lane Crossover Design (Existing 4-Lane Facility)

Figure 698-12 illustrates a one-lane crossover design for an existing four-lane facility. ***Sections 601-16, 607-12 and 640-12*** address crossovers.

Figure 698-1. Component Parts of a Traffic Control Zone

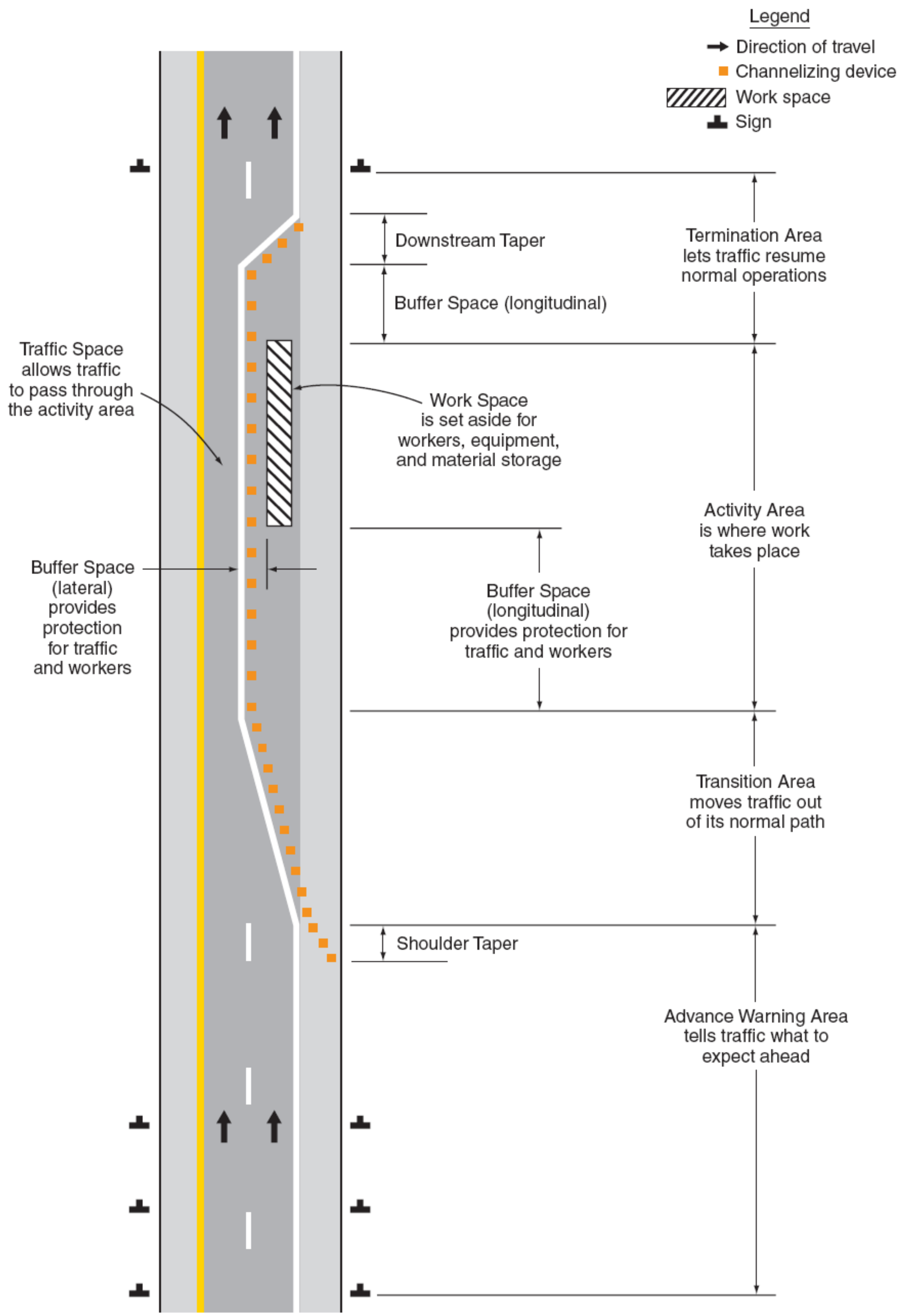


Figure 698-2. Temporary Traffic Control Signs

M2-H3
605-7.3

M4-9 advance right turn
605-7.2

R11-H5a
605-4.2

W3-H7
642-33

W8-H15a
605-17

W9-H4R
641-17

W9-H5
641-17

W9-H6
641-17

W20-H13
605-6.2

W20-H13
605-6.2

W21-H5
606-6

W21-H6
605-5.9

W21-H8
606-6

Figure 698-3. Median Crossover for Entrance Ramp
(See Section 607-13 for related details.)

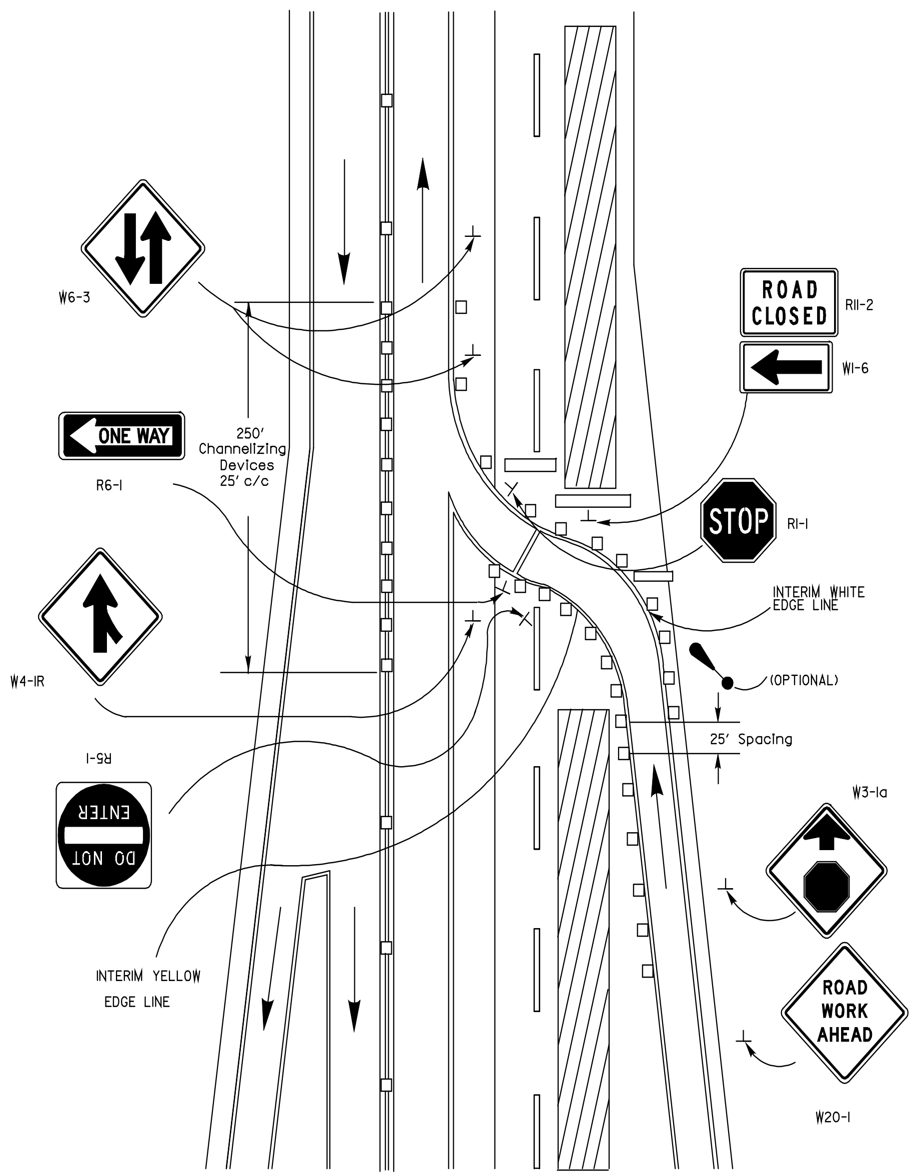
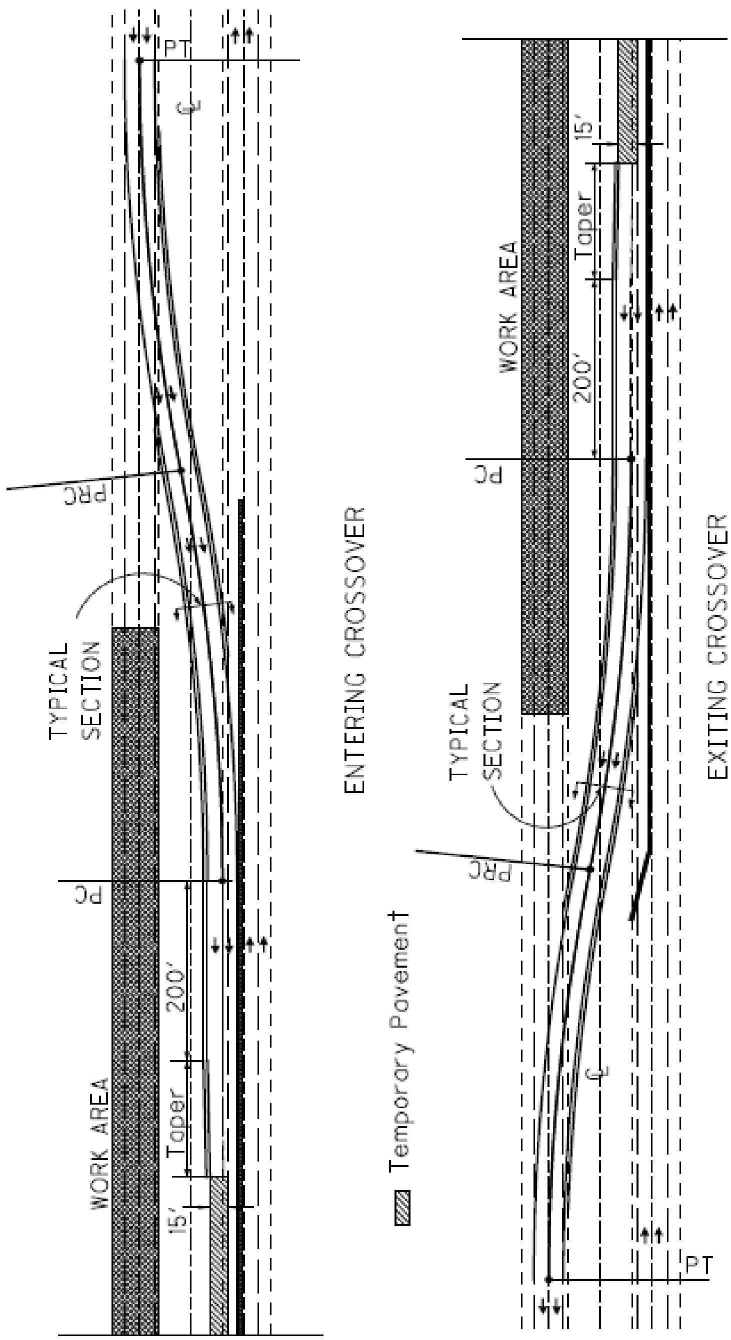
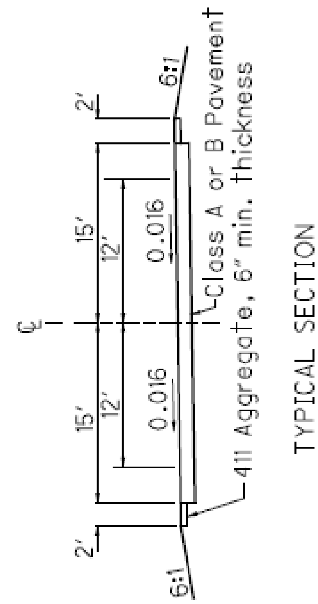


Figure 698-4. Two-Lane Crossover Design
(Existing 4-Lane Facility)





	DESIGN CRITERIA					
	70 MPH	65 MPH	60 MPH	55 MPH	50 MPH	45 MPH
Dc	1°-30'	1°-50'	2°-30'	3°	4°	5°
Taper	70:1	65:1	60:1	55:1	50:1	45:1

NOTE: LANES ARE 12' DOWNSTREAM OF TAPER. LANES TRANSITION FROM 11' TO 12' WITHIN TAPER.
LANES WITHIN WORKZONE ARE 11'.

Figure 698-5. Example Typical Sections
(Existing 4-Lane Facility)

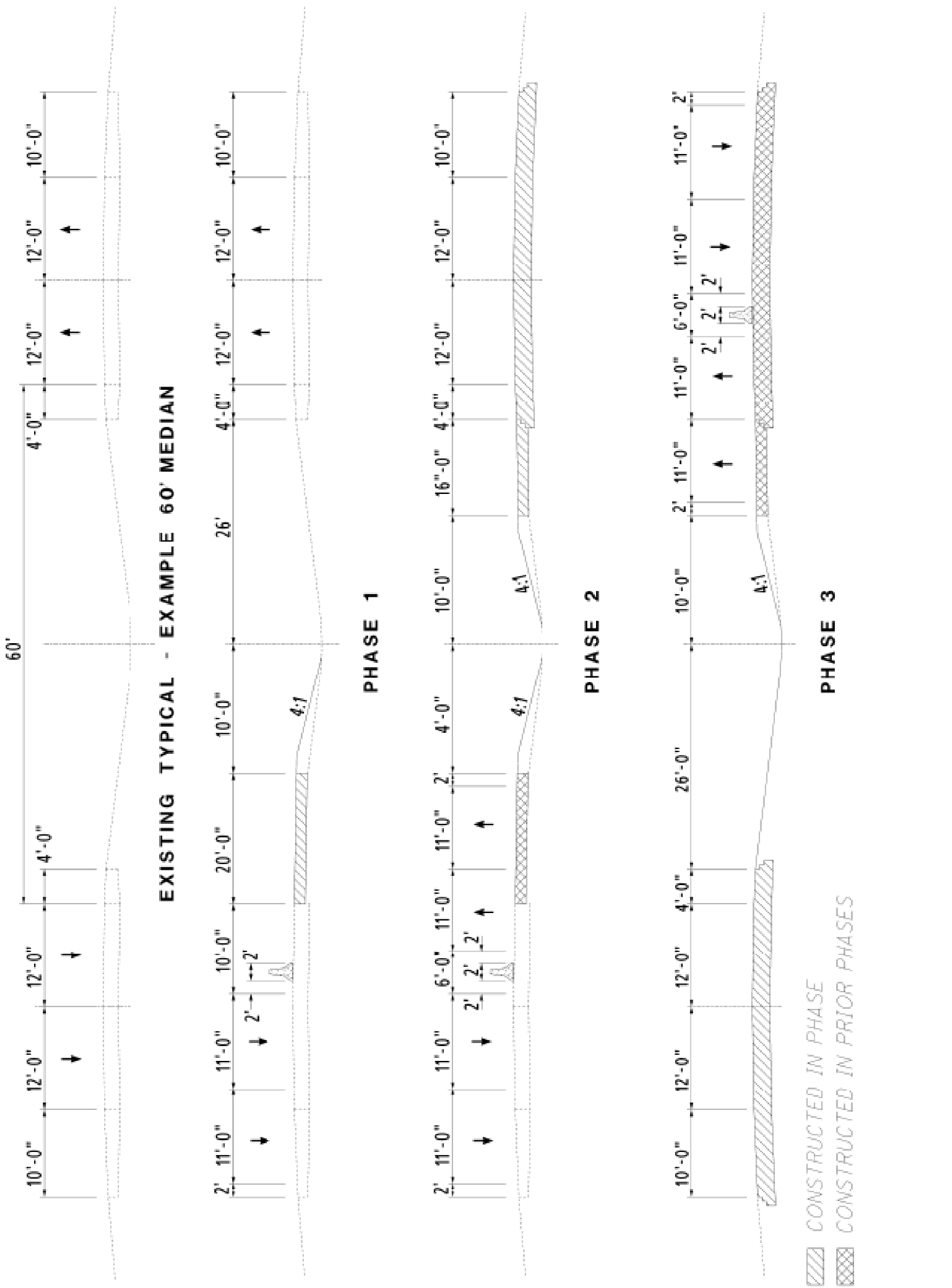
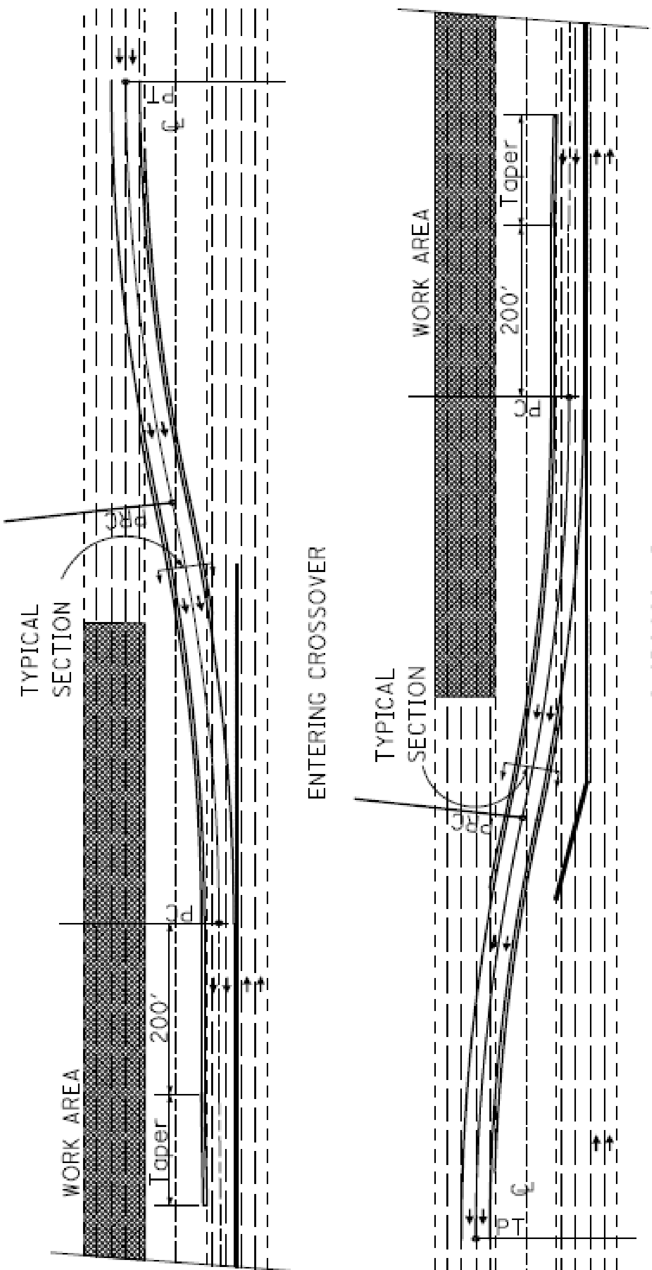
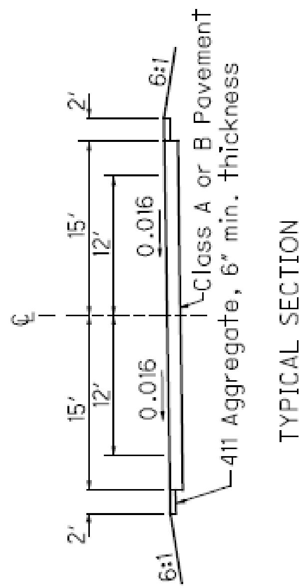


Figure 698-6. Two-Lane Crossover Design
(Existing 6-Lane Facility)





DESIGN CRITERIA

	70 MPH	65 MPH	60 MPH	55 MPH	50 MPH	45 MPH
Dc	1°-30'	1°-50'	2°-30'	3°	4°	5°
Taper	70:1	65:1	60:1	55:1	50:1	45:1

NOTE: LANES ARE 12' DOWNSTREAM OF TAPER. LANES TRANSITION FROM 11' TO 12' WITHIN TAPER.
LANES WITHIN WORKZONE ARE 11'.

Figure 698-7. Example Typical Sections
(Existing 6-Lane Facility)

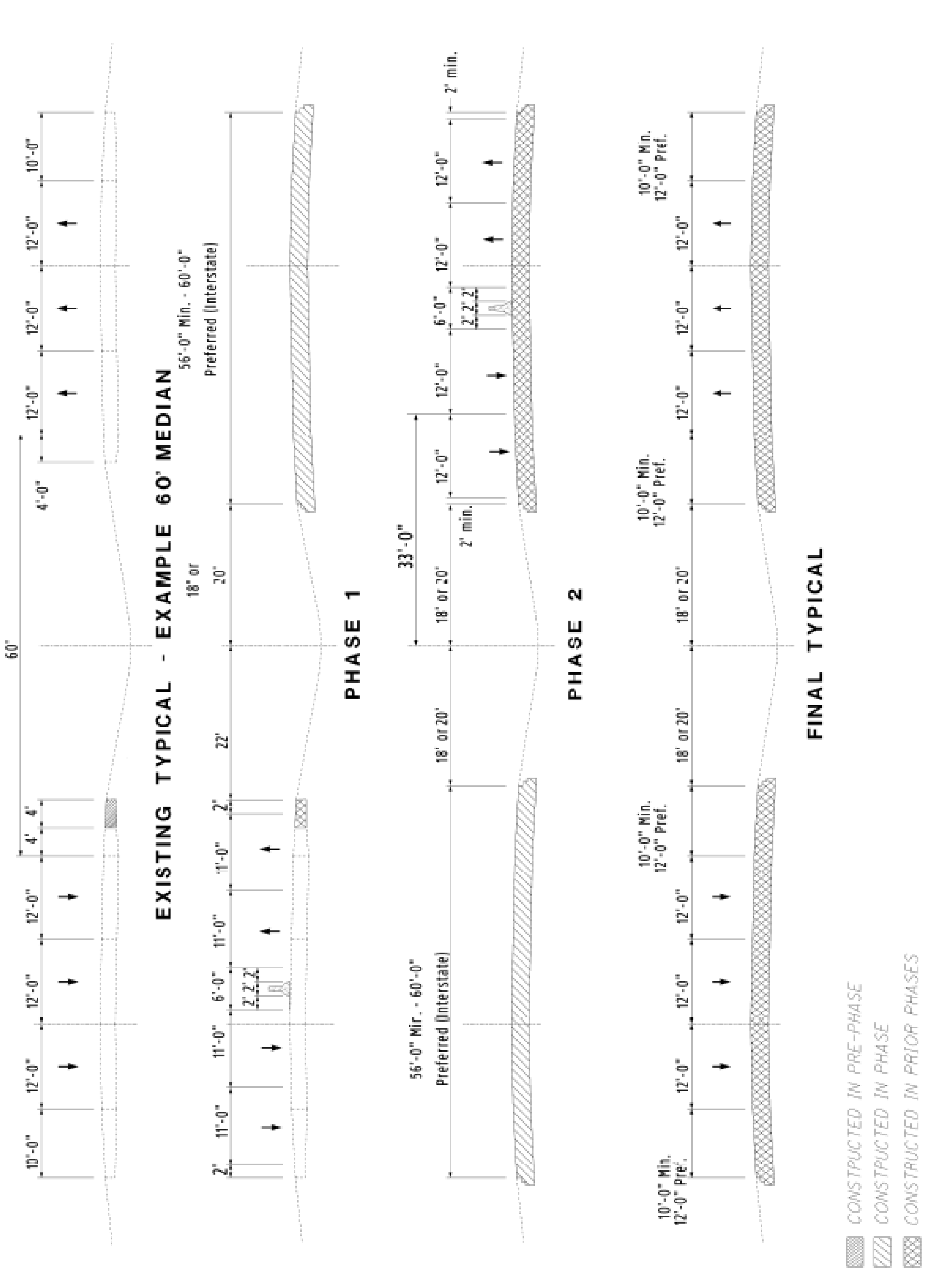
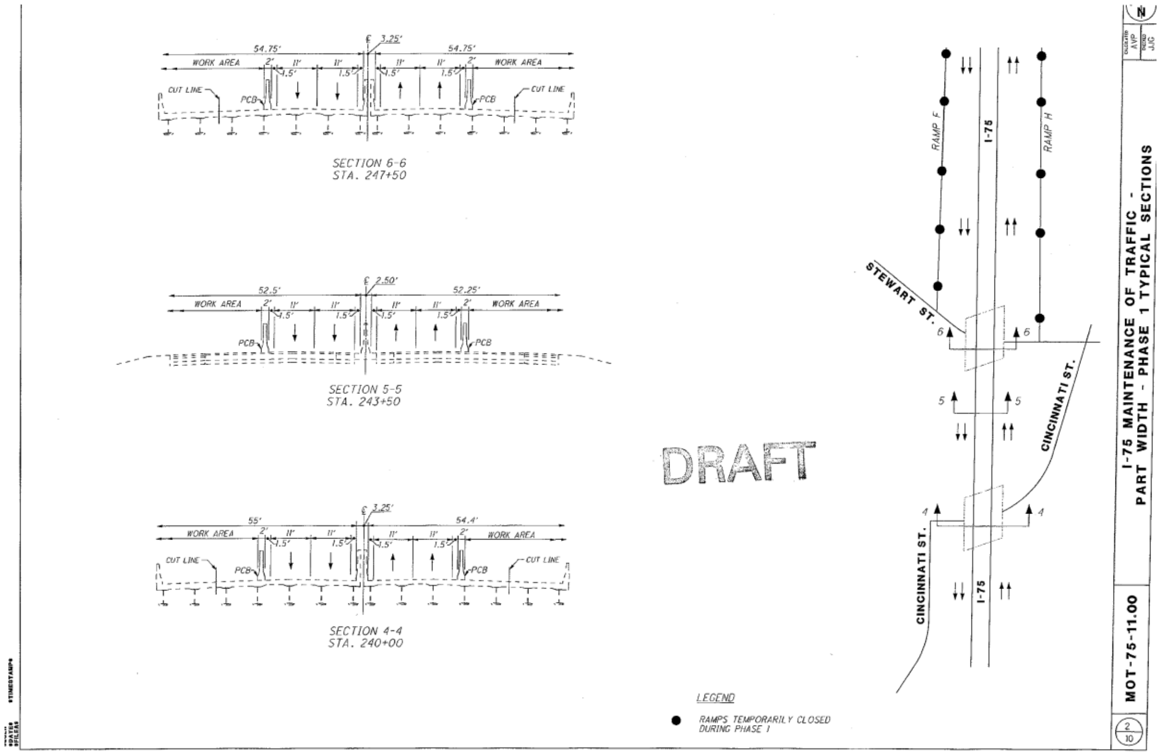


Figure 698-8. Sample Lane Configuration Diagrams and Cross Sections



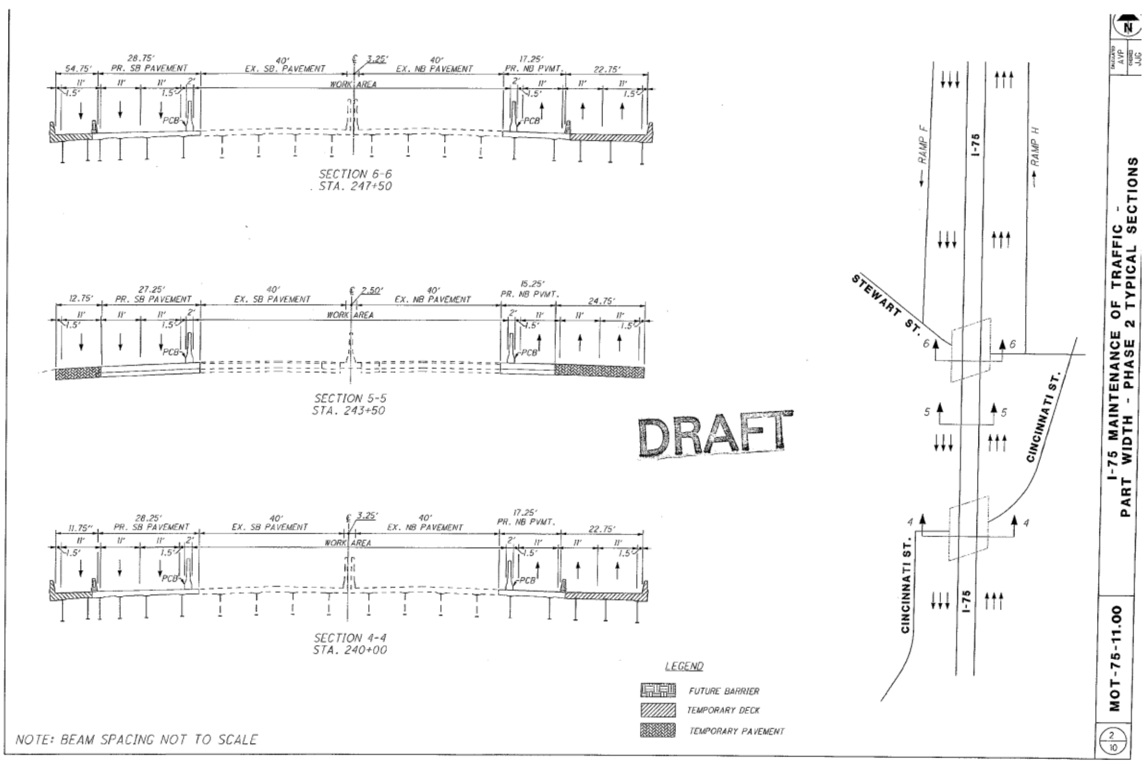
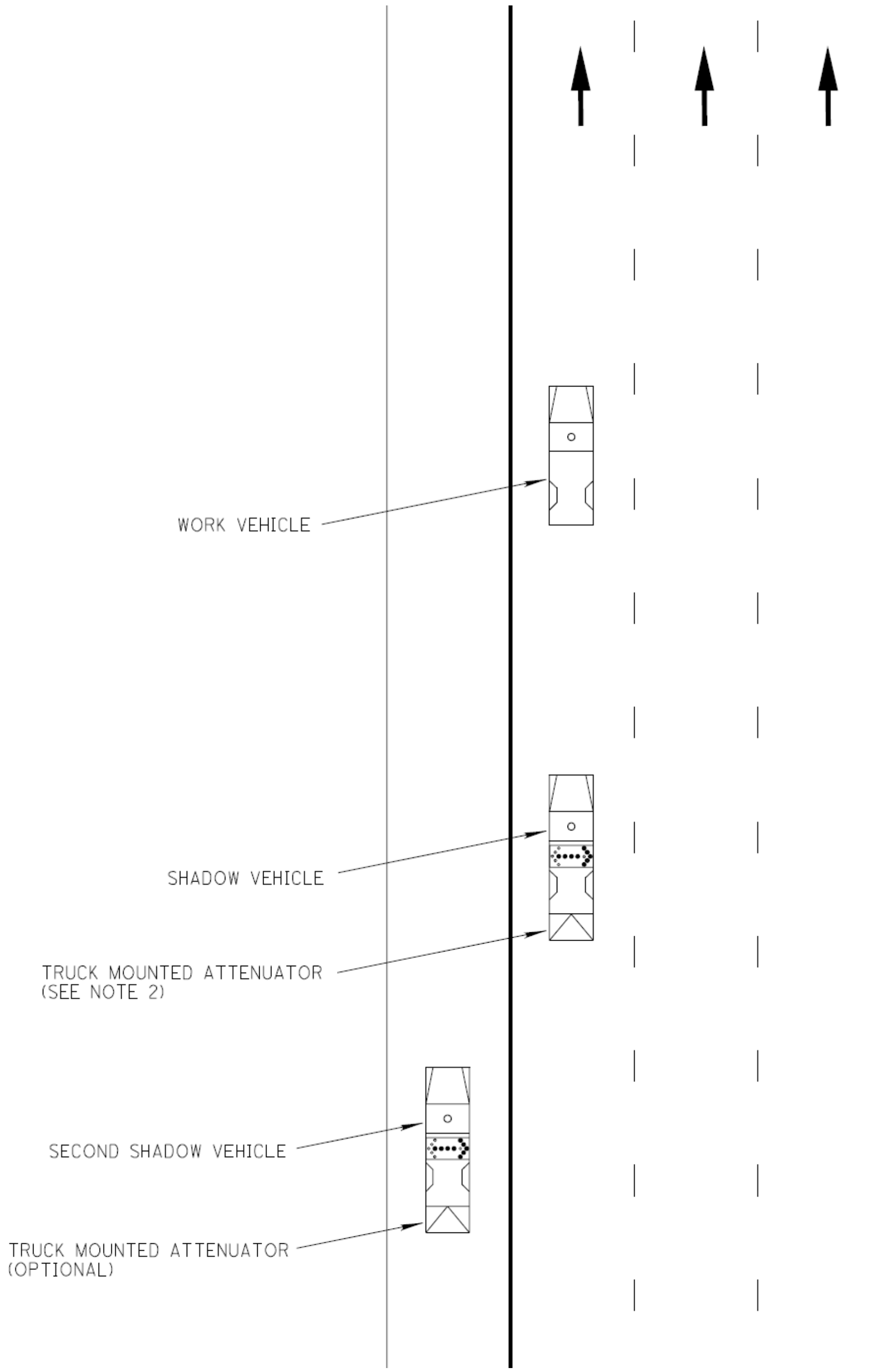
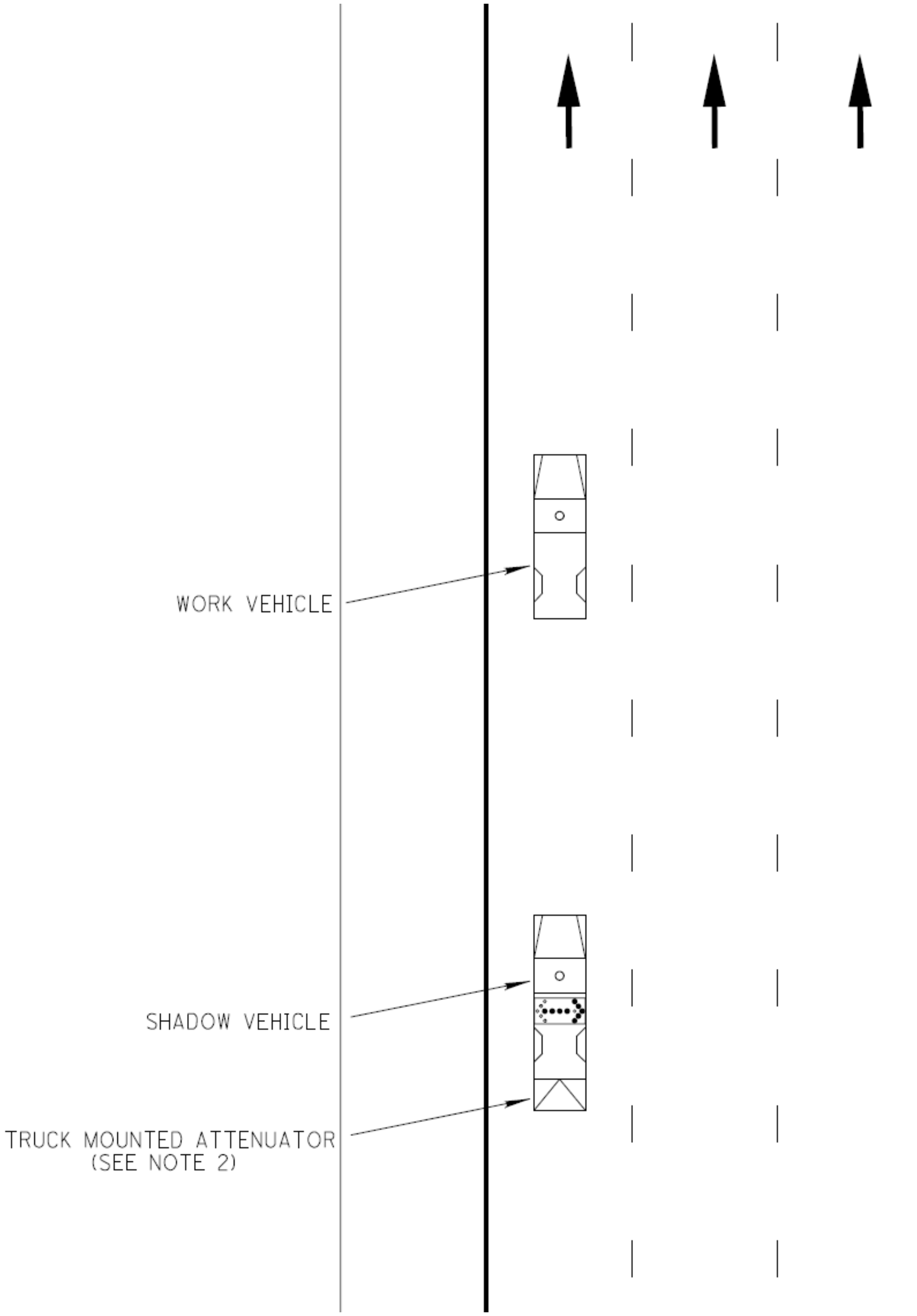


Figure 698-9. Pothole Patching on Multi-Lane Facilities That Will Violate the PLCS



Notes:
1.) All vehicles shall be equipped with high-intensity rotating, flashing oscillating or strobe lights.
2.) Preferred location of work vehicle and the first shadow vehicle is in the lane adjacent to the shoulder when the shadow vehicle has a TMA.
3.) Both shadow vehicles shall be equipped with arrow boards.
4.) The second shadow vehicle may be replaced by a law enforcement officer (LEO).

Figure 698-10. Pothole Patching on Multi-Lane Facilities That Will Not Violate the PLCS (Sheet 1 of 2)

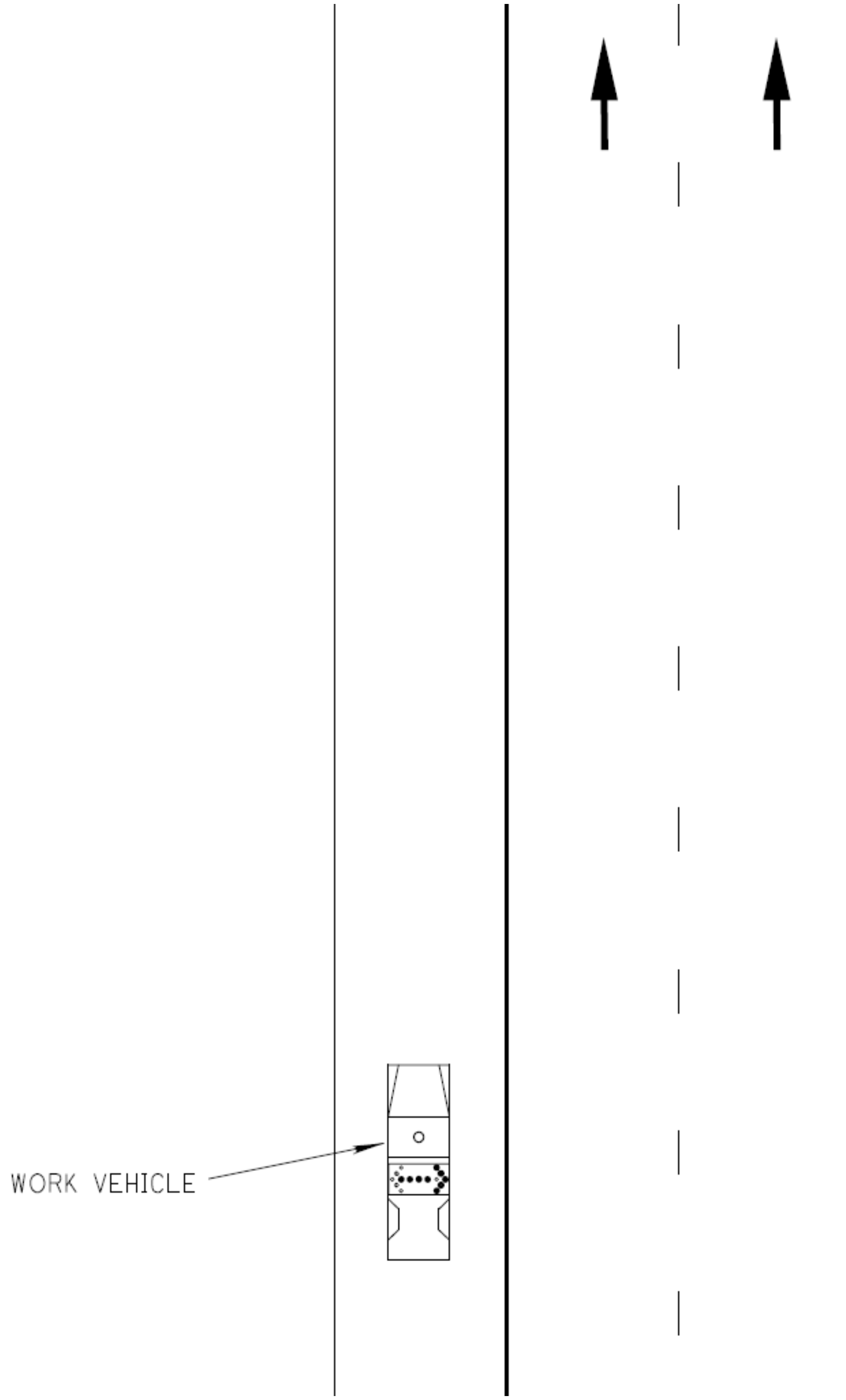


Detail A

Notes:

1. The shadow vehicle shall be equipped with an arrow board.
2. The preferred location of the work vehicle is in the lane adjacent to the shoulder.
3. If a TMA is not available, the work vehicle and shadow vehicle should be located on the shoulder.
4. All vehicles shall be equipped with high-intensity rotating, flashing, oscillating or strobe lights.

Figure 698-10. Pothole Patching on Multi-Lane Facilities That Will Not Violate the PLCS (Sheet 2 of 2)



Detail B

Notes:
1. This drawing is only intended to be used for low-volume multi-lane highways where roadway geometry and terrain do not necessitate the use of a shadow vehicle, TMA, LEO, etc.
2. The work vehicle shall be equipped with a truck-mounted arrow board and high-intensity rotating, flashing, oscillating or strobe lights.

Figure 698-11. WTS Daily Inspection Report

CA-D-8
Page 1 of 2

WORKSITE TRAFFIC SUPERVISOR (WTS)
DAILY INSPECTION REPORT
rev Jan '08

ODOT PROJECT NO: ____________ CONTRACTOR: ____________

DATE: ____________ WEATHER: Clr / Ptly Cldy / Cldy / Rain / Sunny

TIME: ____________ VISIBILITY: ____________

RECEIVED BY: ____________ (ODOT) DATE: ____________

A. DRIVE THRU/TRAFFIC	YES	NO	N/A
Work zone free of difficult or unexpected maneuvers?	☐	☐	☐
Adequate warning of hazards?	☐	☐	☐
Signing clear/uncluttered and properly spaced?	☐	☐	☐
Traffic control devicies sufficiently visible?	☐	☐	☐
Is project free of traffic accidents?	☐	☐	☐
If no, list Accident Report Number and describe on Page 2			
Equipment/materials properly stored off roadway?	☐	☐	☐
Are congestion points absent from within project limits?	☐	☐	☐
Work vehicles properly interacting with traffic?	☐	☐	☐
B. SIGNS/LIGHTS			
Working properly/visible?	☐	☐	☐
Are all permanent/temporary signs consistent with one another?	☐	☐	☐
Proper Size?	☐	☐	☐
C. PORT.CHANGABLE MESS.SIGNS/ARROW PANEL			
Application meets guidelines?	☐	☐	☐
Correct Placement?	☐	☐	☐
Delineated with cones/drums?	☐	☐	☐
Dimmed at night?	☐	☐	☐
All boards/signs working properly (bulbs correctly aligned, no bulbs out, etc.)?	☐	☐	☐
D. DRUMS/BARRICADES/PCB/IMPACT ATTENUATORS			
Acceptable taper length?	☐	☐	☐
Spacing acceptable?	☐	☐	☐
Properly aligned/cleaned/secured?	☐	☐	☐
Adequate number of devices?	☐	☐	☐
Object markers/barrier reflectors in-place/visible?	☐	☐	☐
Attenuators in place?	☐	☐	☐
Attenuators secured and in good condition?	☐	☐	☐
E. PAVEMENT MARKINGS / RAISED PAVEMENT MARKERS (RPM)			
Pavement markings visible and in good condition?	☐	☐	☐
Is striping free of conflict?	☐	☐	☐
RPM's in good condition, proper number and correspond to pavement markings?	☐	☐	☐

NOTES/COMMENTS FROM CHECKLIST: ____________

VIDEOS/PHOTOS OF WORKZONE: YES ☐ NO ☐ N/A ☐

NAME OF PHOTOGRAPHER/VIDEOGRAPHER: ____________

CORRECTIVE ACTION NEEDED? ***YES*** ☐ **NO** ☐

Figure 698-11. WTS Daily Inspection Report (Continued)

CA-D-8
Page 2 of 2

WORKSITE TRAFFIC SUPERVISOR (WTS)
DAILY INSPECTION REPORT
rev Jan '08

DESCRIBE TRAFFIC ACCIDENTS (IF ANY):

____

____

____

____

____

____

DAMAGED OR MISSING MOT ITEMS: ______________________

____

____

____

____

LANE CLOSURES/ROLLING ROAD BLOCKS: ______________________

____

____

____

____

____

____

NO. OF LEO'S: ______________ **TOTAL LEO HOURS** ______________

LEO ACTIVITIES ______________________________

____

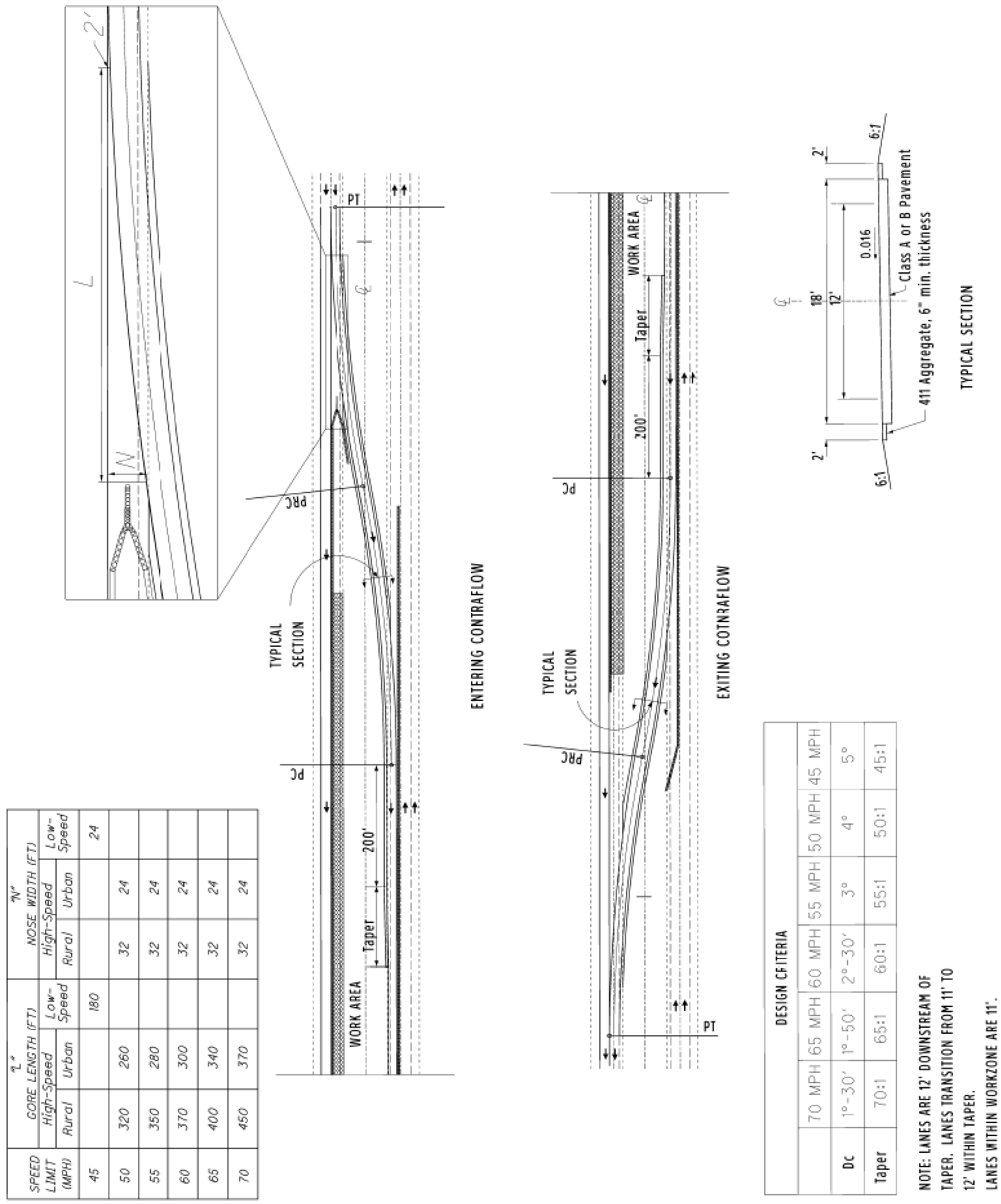
____

____

I certify that this document and all attachments submitted are, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information.

INSPECTED BY: ______________________ (CONTRACTOR) **DATE:** ______________

Figure 698-12. One-Lane Crossover Design
(Existing 4-Lane Facility)



SPEED LIMIT (MPH)	"L" GORE LENGTH (FT) High-Speed Rural	"L" GORE LENGTH (FT) High-Speed Urban	"L" GORE LENGTH (FT) Low-Speed	"N" NOSE WIDTH (FT) High-Speed Rural	"N" NOSE WIDTH (FT) High-Speed Urban	"N" NOSE WIDTH (FT) Low-Speed
45			180			24
50	320	260		32	24	
55	350	280		32	24	
60	370	300		32	24	
65	400	340		32	24	
70	450	370		32	24	

DESIGN CFITERIA

	70 MPH	65 MPH	60 MPH	55 MPH	50 MPH	45 MPH
Dc	1°-30'	1°-50'	2°-30'	3°	4°	5°
Taper	70:1	65:1	60:1	55:1	50:1	45:1

TABLE OF CONTENTS
Part 7 - SCHOOL AREAS

Intentionally blank.

Part 7 - SCHOOL AREAS

700 GENERAL

OMUTCD Part 7 addresses traffic controls for school areas. Part 7 of the **Traffic Engineering Manual (TEM)** provides additional guidance for use of traffic control devices for school areas.

701 SCHOOL ROUTES AND ESTABLISHED SCHOOL CROSSINGS

As noted in **OMUTCD Section 7A.01**, it is important to have a uniform approach to school area traffic controls. A School Route Plan Map can be useful in identifying recommended walking routes to school. **OMUTCD Section 7A.02 and Figure 7A-1** also address school route plans.

Currently, the Safe Routes to School Program is coordinated by the **Office of Systems Planning & Program Management**, and information about this program, including the School Travel Plan guidelines, can be accessed on-line at www.dot.state.oh.us/saferoutes.

702 SCHOOL SIGNS

702-1 General

School-related signing is generally addressed in **OMUTCD Chapter 7B**. Additional information about school-related signing is provided herein.

702-2 Use of Fluorescent Yellow-Green Retroreflective Sheeting

Standard school area signs shall use fluorescent yellow-green sheeting. ***Section 220-7*** describes the process **ODOT** has established to transition to fluorescent yellow-green sheeting.

702-3 School Speed Limit Signs

A School Speed Limit sign is a regulatory traffic control device (see **OMUTCD Section 7B.10)**. It may be a passive device (sign only) or an active one (sign with Speed Limit Sign Beacons). However, when used in conjunction with an active SCHOOL ENTRANCE sign assembly ***(see Section 702-5),*** an active School Speed Limit Sign with Beacons ***(see Section 702-4)*** should be used to help clarify when the 20 mile per hour requirement is in effect.

702-4 School Speed Limit Sign with Beacons

702-4.1 General

A School Speed Limit Sign with Beacons is an active device which consists of a School Speed Limit sign with a pair of alternately flashing yellow beacons, and may have an illuminated "20." Further details about the beacons are addressed in **OMUTCD Sections 7B.10, and 4L.04**.

Section 702-6 addresses the division of responsibilities and duties related to installation, operation and maintenance of these devices.

Also, ***Section 742-2*** provides **Plan Note 742-2** for use with solar-powered School Speed Limit Sign assemblies.

702-4.2 School Speed Limit Sign with Rear-Facing Beacon

A rear-facing beacon is a single flashing amber beacon that is installed on the back of a School Speed Limit sign equipped with forward-facing beacons. The rear-facing beacon is intended to reinforce the location of the end of the school zone or to notify road users that the forward-facing beacons are operating. The rear-facing beacon is an optional treatment that may be considered in school zones where motorist compliance with the School Speed Limit through the end of the zone is low.

Rear-facing beacons should be considered upon receipt of a written communication from a school official requesting their installation. Any one of the following conditions (not shown in priority order) may be considered to determine if rear-facing beacons would be beneficial:

1. Excessively long school zone.

2. STOP sign or traffic signal controlled intersection within the school zone.

3. High-volume access point (i.e., driveway) within the school zone.

If used, the rear-facing beacon shall conform to **OMUTCD Section 4L.04**, and an END SCHOOL SPEED LIMIT (S5-3) sign **(OMUTCD Section 7B.10)** shall be mounted with it, supplementing the right-hand mounted END SCHOOL SPEED LIMIT sign.

Rear-facing beacons may be used selectively in a particular school zone. The installation of a rear-facing beacon at one end of a school zone does not necessitate the installation of rear-facing beacons at other locations within that same school zone.

The rear-facing beacon shall only operate when the forward-facing beacons are operating.

702-5 <u>SCHOOL ENTRANCE Sign (S3-H3)</u>

A SCHOOL ENTRANCE sign (S3-H3) may be used to help identify a school entrance and/or driveway where there is poor sight distance or a fairly large volume of traffic entering or exiting the driveway. It may be a passive device (sign only) or an active device (sign with flashing yellow warning beacon(s)). When the traffic is seasonal, the sign should be removed, folded or covered during the period the entrance is not in common use.

When supplemented with one or two flashing yellow warning beacons **(see OMUTCD Section 4L.03)**, this sign can be used to provide advance warning of the location and the related traffic at times when the School Zone speed limit is not in effect.

SCHOOL ENTRANCE signs may be either ground or overhead mounted. When supplemented with beacons, the sign is operated either manually, or by a timer, usually programmable, which is typically located in a cabinet on the highway right-of-way, or alternatively off the highway right-of-way in the school building.

Although this sign is not shown in the **OMUTCD**, it can be found in the **Sign Designs and Markings Manual (SDMM)**.

Section 702-6 addresses the division of responsibilities and duties related to installation, operation and maintenance of these devices.

702-6 <u>Responsibilities for School Signs with Beacons</u>

This Section defines the responsibilities and division of duties of those concerned with the installation, operation and maintenance of school signs with beacons on **ODOT**-maintained highways. The provisions herein also apply to rural state highway extensions within the municipal corporation limits of **Villages** which have requested assistance from **ODOT** in accordance with **ORC Section 5521.01**, and have an executed **Form MR 689** on file with **ODOT**. (The M&R Forms are available on the **ODOT** intranet at http://portal.dot.state.oh.us/Divisions/Operations/MaintAdmin/Pages/MandR.aspx.)

For purposes of this discussion a "school sign with beacons" refers to a School Speed Limit Sign with Beacons ***(see Section 702-4)*** or a SCHOOL ENTRANCE sign with beacons ***(see Section 702-5)***.

The following responsibilities and division of duties shall apply:

1. The **District** will bear the cost and:

    a. determine where school signs with beacons are justified,

    b. develop the plans for the installation of school signs with beacons,

    c. furnish, install, maintain and repair all school signs with beacons and other related appurtenances located within the highway right-of-way (this does not apply to the emergency maintenance of school signs with beacons located in **Villages**, which are the responsibility of the **Village** in accordance with the provisions of the **Form MR 689**),

    d. program and operate timers located within the highway right-of-way, in accordance with **ORC Section 4511.21** and the **OMUTCD**, and in accordance with the times of operation determined by the school with the concurrence of the **District** (***Form 796-2*** depicts a sample letter that may be used to have the schools annually provide school schedule and timings for the new school year), and

    e. remove school signs with beacons and other related appurtenances located within the highway right-of-way whenever it is determined by the **District** that their installation is no longer justified.

2. The **School** will bear the cost and:

    a. furnish, install, maintain and repair all appurtenances located on the school's property,

    b. furnish the electric energy required for the operation of the school signs with beacons and other appurtenances,

    c. determine appropriate times of operation of the school signs with beacons in accordance with the **ORC Section 4511.21**,

    d. obtain concurrence from the **District** regarding the times of operation, and

    e. manually operate the school signs with beacons, or program and operate timers located on the **School's** property, in accordance with the **ORC** and **OMUTCD**.

Arrangements other than those described herein are permissible provided they are agreed upon and are acceptable to all involved parties, do not conflict with the **ORC** or **OMUTCD**, and the **District's** responsibilities do not exceed those described in this Section.

It is recommended that a written agreement be executed between the **District** and the **School** (and the **Village** if appropriate) describing the provisions described herein. ***Form 796-1*** is a sample agreement that can be used. The **Director's** name should be signed by the **District Deputy Director**. A copy of the agreement should be kept at the **District** and the **School** (and the **Village** if appropriate). The agreement should be retained as long as the school signs with beacons are in place.

702-7 School Bus Stop Ahead Sign (S3-1); SCHOOL BUS TURN AHEAD Sign (S3-2)

As noted in **OMUTCD Sections 7B.14 and 15**, these signs should be used in advance of locations where a school bus, when turning or stopped to pick up or discharge passengers, is not visible for an adequate distance in advance. **Ohio Administrative Code Section 3301-83-13 B(4)** states, "School bus stops shall be located at a distance from the crest of a hill or curve to allow motorists traveling at the posted speed to stop within the sight distance. If the line of sight is less than five hundred feet in either direction, an approved "School Bus Stop Ahead" sign shall be installed at least five hundred feet in advance of the school bus stop."

To avoid unnecessarily perpetuating these signs, a procedure should be established in each **District** whereby a record is kept when these signs are erected, documenting the location and date of the installation. This record should be checked regularly to assure that there is still a need for the sign. ***Form 796-3*** depicts a sample letter used to have the schools annually reaffirm the need for these signs and/or to request signs for a new location.

704 SCHOOL AREA MARKINGS

704-1 General

School area pavement markings are described in **OMUTCD Sections 3B.20 and Chapter 7C**, and **SCD TC-71.10**.

704-2 SCHOOL Pavement Markings

As noted in **OMUTCD Section 7C.03**, when used, SCHOOL markings should be placed at least 100 feet in advance of the School Zone.

On **ODOT**-maintained highways, the SCHOOL marking shall be installed on paved approaches in advance of all School Zones. The preferred placement of the SCHOOL marking is adjacent to the School Zone Advance sign, and center or lane lines shall not pass through the SCHOOL word marking.

See **SCD TC-71.10** for additional details.

705 SCHOOL ZONES

705-1 General

ORC Section 4511.21(B)(1)(c) defines the term "school zone." Except as noted in **ORC Section 4511.21(H**), there are no exceptions to the existence of a School Zone. **ODOT** does not have discretion (e.g., based on the lack of pedestrians, the presence of fencing, etc.) to not install School Speed Limit signs for School Zones established per **Section 4511.21** **(see OMUTCD Section 7B.09)**.

The provisions of **ORC Section 4511.21(H)** (the speed zoning process) do apply to School Zones, and if the **Director** determines on the basis of a geometric and traffic characteristic study that the school speed limit is less than reasonable or safe under the conditions found, the 20 mile per hour School Zone may be excepted, with School Zone signing not installed. Locations where the implementation of a 20 mile per hour School Zone might cause serious safety problems in the traffic stream, with little or no benefit to students attending the adjacent school, should be the only basis for retaining the existing speed limit. Locations where the 20 mile per hour provision is just an "inconvenience" to road users, or those locations where the school officials prefer something other than the 20 mile per hour School Zone, do not fit into this category.

Since the law requires 20 miles per hour at all School Zones, it is very important that any studies conducted be thoroughly documented and retained in the **District's** files. Although the Speed Warrant sheet will probably not be applicable in these situations, approval of these studies should follow the normal Speed Zone study approval process. Should any future litigation be filed against **ODOT** due to any incidents that might occur at one of these locations, the documentation will be very critical in defending the **District's** actions in not installing the 20 mile per hour School Zone signing.

705-2 Requesting a School Zone Extension

Although the traditional School Zone boundaries are defined by projecting the school property lines, **ORC 4511.21(B)(1)(c)** also allows that, upon request, the **Director** may extend the traditional School Zone boundaries.

Requests for School Zone Extensions are submitted to the **District** using the School Zone Extension Request Form ***(Form 796-4)***.

If the request involves an **ODOT**-maintained highway, the **District** shall document the background for the extension request; prepare a description of the School Zone Extension for the **Director's** approval using the School Zone Extension Request Form ***(Form 796-4)***; and following approval, the **District** shall erect or relocate the appropriate School Zone signs and notify the school, the **Ohio State Highway Patrol (OSHP)** and other law enforcement agencies as appropriate.

School Zone Extension requests involving local roads, shall be submitted to the **District** using the School Zone Extension Request Form ***(Form 796-4)*** and all appropriate documentation shall be included. The **District** shall determine reasonable and safe School Zone limits based on the documentation provided with the request and a field study (to document and confirm the physical features). If this determination is substantially different from that which was requested, the local authorities may be asked to further substantiate their original request and a new determination may be made. The **District** shall notify the school, local authorities, and the **OSHP** and other law enforcement agencies, as appropriate, of **ODOT's** final action on the proposed School Zone Extension.

For purposes of requesting School Zone Extensions, rural state highway extensions within the municipal corporation limits of **Villages** are considered "local roads," even if the **Village** has requested assistance from **ODOT** in accordance with **ORC Section 5521.01**, and has an executed **MR 689** form on file with **ODOT**.

705-3 Withdrawing a School Zone Extension

The withdrawal of a School Zone Extension is accomplished in generally the same manner as establishment of the extension ***(Section 705-2)***. The School Zone Extension Withdrawal Form ***(Form 796-5)*** is used to document the withdrawal.

705-4 Documentation

Table 797-1 establishes the School Zone Number Assignments to be used by **Districts** for School Zone Extensions. This number shall be used on ***Forms 796-4 and 796-5***.

The **District** shall retain paper or electronic copies of the reports used in establishing the School Zone Extensions in their permanent files. Paper or electronic copies of the official document authorizing or withdrawing the regulation, as well as any paper or electronic copies of local requests or resolutions, shall also be retained permanently in **District** files.

Information from the School Zone Extension reports shall be uploaded by the **District** to the Traffic Regulations Database Management System (TRDMS), a statewide inventory and historical record maintained by the **Office of Traffic Operations (OTO)**. This inventory is available on the **OTO** website (see Misc. Applications, Documents, Projects and Programs/Regulations).

742 PLAN NOTES

742-1 General

The number used for the **Plan Note** will be the same as the Section number used herein. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **CMS**, both the note and the bid items will be "as per plan." Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with the traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

742-2 631 School Speed Limit Sign Assembly, Solar-Powered, As Per Plan

This specification applies to school sign flashers powered by batteries and recharged by solar panels.

The entire school zone flasher and sign assembly shall conform to the Contract Documents and meet the requirements set forth in the OMUTCD. The sign size shall be ______" x _______" and sign code ____________.

The flasher control and battery will be housed in one or more stainless steel or aluminum enclosures with a NEMA rating of at least 3X. Enclosure exterior surfaces shall be bare or powder coat aluminum or stainless steel. The enclosure interior surfaces shall be the same as the exterior.

If contained in a single enclosure, the control electronics and battery shall be separated in a manner to prevent damage to the control electronics if the battery envelope is compromised.

A pair of LED signal beacons, one above and one below the sign, meeting the current ITE Vehicle Traffic Control Signal Heads (VTCSH) standard will be used unless otherwise specified. The manufacturer of the signal beacon shall be listed on the Department's Qualified Products List for LED signal lamps.

The Solar Panel and/or Controller manufacturer will provide signed copies of calculations used to size the solar panel and batteries. Included in these calculations will be the insolation value used and its source, the solar panel efficiency, charger/controller efficiency, inverter efficiency, proposed LED lamp load, and a figure representing anticipated miscellaneous losses.

Solar panel manufacturer must test panel according to IEC61215 or equivalent approved standard. Solar panel mounting must be rated for 90 mph design wind.

Run requirements are 4 hours per day for two weeks under continuous worst-case (minimum) insolation figures (usually December) for the proposed geographic location, using a panel elevation angle appropriate to the site latitude, at a sustained temperature of 25 degrees Fahrenheit (-4 degrees Celsius).

If voltages over 50V AC or DC are present, grounding and bonding requirements specified in the ODOT CMS will be followed.

Any timer included in the assembly must satisfy the requirements of 731.10 and be listed on the Department's Qualified Products List.

Payment for 631 School Speed Limit Sign Assembly, Solar Powered, As Per Plan, shall be made at the contract unit price bid per each. Payment shall be full compensation for all labor, materials, tools, equipment, testing, certifications and other incidentals necessary to furnish the solar powered school zone flasher complete in place, including the sign, all connections made, wiring complete, tested and accepted.

Designer Note: This note should be included when the maintaining agency requests a Solar Powered School Speed Limit Sign Assembly.

796 FORMS INDEX

796-1 Agreement for School Signs with Beacons

As noted in ***Section 702-6***, ***Form 796-1*** is a sample that can be used in establishing an agreement for the maintenance of school signs with beacons.

796-2 Letter Confirming Operation of School Signs with Beacons

As noted in ***Section 702-6***, ***Form 796-2*** is a sample letter that can be used to have a school confirm annually the school schedule and timings for operation of school signs with beacons.

796-3 Letter Confirming School Bus Stop Ahead / SCHOOL BUS TURN AHEAD Signs

As noted in ***Section 702-7***, ***Form 796-3*** is a sample letter that can be used to have a school annually confirm the need for School Bus Stop Ahead / SCHOOL BUS TURN AHEAD signs.

796-4 School Zone Extension Request Form

As noted in ***Section 705-2***, ***Form 796-4*** is used when submitting a request to extend the boundaries of a School Zone beyond the traditional boundary limits.

796-5 School Zone Extension Withdrawal Form

As noted in ***Section 705-3***, ***Form 796-5*** is used for withdrawal of an established School Zone Extension.

Form 796-1. Agreement for School Signs with Beacons

Agreement for School Signs with Beacons

THIS AGREEMENT is made and entered into by and between the STATE OF OHIO, DEPARTMENT OF TRANSPORTATION (hereinafter called "THE STATE"), the ___________ School District (hereinafter called "THE SCHOOL") and the Village of ___________ (hereinafter called "THE VILLAGE").

WITNESSETH THAT:

FOR AND IN CONSIDERATION of mutual covenants hereinafter contained and for the purposes of regulating traffic on ____________ for the ___________ School District in ___________ County, the parties hereby covenant and agree to the following:

1. THE STATE shall bear the cost and develop the plans for the installation of school signs with beacons, and furnish, install, maintain and repair all school signs with beacons and appurtenances located within the highway right-of-way.

2. THE SCHOOL shall bear the cost and furnish, install, maintain and repair all appurtenances located on THE SCHOOL's property. [Note: Eliminate this item for installations located entirely within the highway right-of-way.]

3. THE SCHOOL shall furnish the electric energy required for the operation of the school signs with beacons and appurtenances.

4. THE SCHOOL shall determine appropriate times of operation of the school signs with beacons in accordance with the Ohio Revised Code, and obtain concurrence from THE STATE.

5. THE SCHOOL shall manually operate the school sign with beacons in accordance with the times of operation determined by THE SCHOOL and agreed upon by THE STATE, and in accordance with the Ohio Revised Code and the Ohio Manual of Uniform Traffic Control Devices. [Note: For use with manually operated signs.]

   or

   THE SCHOOL shall program and operate the timer in accordance with the times of operation determined by THE SCHOOL and agreed upon by THE STATE, and in accordance with the Ohio Revised Code and the Ohio Manual of Uniform Traffic Control Devices. [Note: For use with timers located in the school building.]

   or

   THE STATE shall program and operate the timer in accordance with the times of operation determined by THE SCHOOL and agreed upon by THE STATE, and in accordance with the Ohio Revised Code and the Ohio Manual of Uniform Traffic Control Devices. [Note: For use with timers located on the highway right-of-way.]

6. THE STATE will remove school signs with beacons and appurtenances located within the highway right-of-way whenever it is determined by THE STATE that their installation is no longer justified, and this agreement shall thereupon terminate.

7. THIS AGREEMENT shall be binding upon and inure to the benefit of the parties hereto, their respective successors and/or assigns.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed by their duly authorized officers or agents.

______________________ **School District**

by _________________________________ Title _______________________________

Witness _____________________________ Date _______________________________

Village of ___________________________

by _________________________________ Title _______________________________

Witness _____________________________ Date _______________________________

THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION

by _________________________________ Title _______________________________

Witness _____________________________ Date _______________________________

Notes:

For installations located outside of **Village** corporation limits, eliminate references to THE VILLAGE.

The form should be modified as necessary. Three wording options are provided for item #5 to address different types of installations.

Form 796-2. Letter Confirming Operation of School Signs with Beacons

(DATE)

(ADDRESS)

RE: (2013-2014) School Clock Schedule

Dear Superintendent,

Would you please send us a copy of your **(2012-2013) school year calendar** for the school signs with beacons that ODOT signal electricians maintain on U.S. or State Routes in your school district. **Please complete and return the enclosed Daily School Clock Schedule Form by (date)**, indicating when you wish to have the school flashers operate, including recess times.

We will input this information into the programmable time clocks that control the school flashers at each of the school locations. Your cooperation in this matter will allow us to have each location programmed and ready when school begins next fall. Please forward the information to me at the above address.

If you should have any questions concerning this request, please contact me at the above listed telephone number, (extension).

Respectfully,

Enclosure

c: file

Form 796-3. Letter Confirming School Bus Stop Ahead / SCHOOL BUS TURN AHEAD Signs

(DATE)

(ADDRESS)

Dear (Superintendent or Transportation Coordinator),

Each year the Ohio Department of Transportation receives numerous requests from school personnel and parents requesting SCHOOL BUS STOP AHEAD and SCHOOL BUS TURN AHEAD Warning Signs.

If you have locations on rural state highways where your bus drivers have indicated, or in the future indicate the need for such signs, we will be happy to investigate the location. These signs are intended for use in areas where sight distance is limited to less than 500 feet. A copy of the portion of the Ohio Manual of Uniform Traffic Control Devices relating to these signs is enclosed for your information.

Many times it is much safer for the bus driver to stop at a location not directly in front of a residential driveway, or to turn around at a location not quite convenient, i.e., on top of the hill or around the curve. Where this is possible, we request that this be done rather than having a sign erected, which the road user may not notice.

Since this will also involve the parents, any requests received by this office from parents for these signs will be referred to your office for initial review and approval.

We also ask your assistance in updating the existing signs on the rural state highway system within your school district. We request a review of your existing signs with your bus drivers to determine signs that are no longer needed due to student graduation or a family moving to a new residence. By eliminating unneeded signs drivers will gain respect for the signs that have already been erected. Please provide a listing of the SCHOOL BUS STOP AHEAD and SCHOOL BUS TURN AHEAD Warning Signs needed in your school district, noting any new requests. Also, please provide a list of any existing signs that can be removed.

We share your concern about pupil transportation safety and wish to thank you in advance for your cooperation in this matter. If you have any questions, please contact this office,

Respectfully,

Enclosure

cc: file

Form 796-4. School Zone Extension Request Form

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

SCHOOL ZONE EXTENSION FORM

In accordance with the provisions of Section 4511.21, Ohio Revised Code, it is hereby requested that the Director of Transportation approve the appropriate distance for the school zone described below:

School Name: ____________________ County: ____________________
Address: ____________________ Township: ____________________
____________________ Municipality: ____________________
____________________ Street Name: ____________________
School District: ____________________ Route Number: ____________________

(print) School Official: ____________________ *(print)* Title: ____________________

(sign) School Official: ____________________ Date: ____________________
Maintaining Agency *(print)* Official: ____________________ *(print)* Title: ____________________
Maintaining Agency *(sign)* Official: ____________________ Date: ____________________

(Attach Drawing/Sketch of School Zone to Form)

(For Department Use Only)

District: ______ School Zone No.: __________ Maintaining Agency: ____________________

Under Authority of Section 4511.21(B)(1)(c) and (d), the following distances have been approved for the School described above:

APPROVED SCHOOL ZONE DISTANCES

From	To	Direction				Extension Distance
		NB	SB	EB	WB	

Signs giving notice of approved 20 mile per hour school speed limits shall be erected immediately. Such signs shall conform to the Ohio Manual of Uniform Traffic Control Devices for Streets and Highways.

____________________ Director of Transportation ____________________ Date

Immediately after erection of the 20 mph speed limit signs, return a copy of this form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above school speed limits were erected on ____________________.

Signed: ____________________

Title: ____________________

Form 796-4

Form 796-5. School Zone Extension Withdrawal Form

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

WITHDRAWAL OF APPROVED SCHOOL ZONE EXTENSIONS

District: ____ **School Zone No.**: __________ **Name of Street**: ______________________________

Municipality: ___________________________ **County**: _____________________________________

State Route No.: __________________ **Name of School**: ______________________________

Under Authority of Section 4511.21(B)(1)(c) and (d) of the Ohio Revised Code, the following described School Zone Extension(s) approved by the Director of Transportation on ______________________, has been determined, on the basis of a traffic and engineering investigation, to be unreasonable and approval of the same is hereby withdrawn.

LOCATION OF SCHOOL ZONE DISTANCES

From	To

Signs relating to the School Zone Extension shall be immediately removed.

Date: _____________________________ ____
Director of Transportation

Immediately after removal or relocation of School Zone signs, return the attached copy of this School Zone Extension Withdrawal form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above School Zone Extension were removed

on ____________________________ Signed ____

Title ____

797 TABLES INDEX

797-1 School Zone Number Assignments

As noted in ***Section 705-4***, ***Table 797-1*** assigns numbers to be used by **Districts** when submitting/reviewing School Zone Extension requests.

Table 797-1. School Zone Number Assignments

District	School Zones
District 1	10000 - 14999
District 2	15000 - 19999
District 3	20000 - 24999
District 4	25000 - 29999
District 5	30000 - 34999
District 6	35000 - 39999
District 7	40000 - 44999
District 8	45000 - 49999
District 9	50000 - 54999
District 10	55000 - 59999
District 11	60000 - 64999
District 12	65000 - 69999

TABLE OF CONTENTS
Part 8 - RAIL GRADE CROSSINGS

Part 8 – RAIL GRADE CROSSINGS

800 GENERAL

OMUTCD Part 8 addresses traffic controls at highway-rail grade crossings and highway-light rail grade crossings. Very few, if any routes under **ODOT's** jurisdiction involve traffic control at highway-light rail transit (LRT) grade crossings.

Part 8 of the **Traffic Engineering Manual (TEM)** provides additional guidance for use of traffic control devices at these crossings. *See* ***TEM Part 4*** (Signals) for additional information about traffic controls at rail grade crossings, including Signal Preemption and Warning System Interconnection design guidelines. The **FHWA Railroad-Highway Grade Crossing Handbook** ***(see Section 895-2)*** also provides useful guidance when evaluating and prioritizing improvements to highway-rail grade crossings.

801 SIGNING

801-1 General

Signs used at highway-rail grade crossings are addressed in **OMUTCD Chapter 8B**.

801-2 STOP Signs at Highway-Rail Grade Crossings

801-2.1 General

ORC Section 4511.43 defines the obedience required to a STOP or YIELD sign, and **ORC Section 4511.61** addresses the use of STOP and YIELD signs at railroad grade crossings. Effective July 2013, the STOP sign basically became the primary regulatory traffic control device at passive railroad grade crossings. The YIELD sign is used only at selected locations with the approval of the **ODOT Director**. Also, the highway agency is now responsible for installation of the STOP or YIELD sign.

Normally, the STOP sign will be on the same post as the Crossbuck; however, as noted in the **OMUTCD**, there may be some situations where it has been erected on a separate support. If the STOP sign is posted on railroad property, it will be the Railroad company's responsibility to maintain it.

ODOT and the **Ohio Rail Development Commission (ODRC)** have established a program to address the statewide changeover of YIELD sign at passive highway-rail grade crossings, to STOP signs. This program will essentially involve the review of every public passive grade crossing in the **State**. Those for which an exemption is not granted will have STOP signs installed. The goal is to have a list of exemption-eligible crossing compiled by March 1, 2014, and after that date initiate a program to install STOP signs at any crossing not identified and approved by **ODOT** for an exemption.

Every passive public highway-railroad grade crossing in **Ohio** is now required to have a Crossbuck sign and either a STOP or YIELD sign at the crossing itself. It is intended that each passive highway-railroad grade crossing in **Ohio** will be marked with a minimum of the Crossbuck sign and a STOP sign at the crossing, unless a STOP sign exemption ***(see Section 801-2.2)*** is requested and granted, as noted in **ORC Section 4511.61(C)(2**).

OMUTCD Sections 8B.04 and 8B.05 provide additional information about the use of STOP signs at railroad and LRT crossings.

If a local highway authority (LHA) determines that it wants to install STOP signs at a crossing not on the list of those identified for an exemption and does not want to wait for the statewide program, the LHA may do so as long as the installation meets the same installation standards. However, the LHA must also notify **ORDC** of this action so that the records for the statewide program can be updated.

801-2.2 Application Process for STOP Sign Exemption

Except as noted in ***Subsection 801-2.1*** for the interim statewide changeover program, if an LHA desires an exemption from the placement of STOP signs, the LHA shall submit a written request to the **District**. The **District** shall review the request and forward it with recommendations to the **Office of Traffic Operations (OTO). OTO** shall review the STOP sign exemption request with the **District** and the **Ohio Rail Development Commission (ORDC)**. **OTO** will make recommendations to the **ODOT Director** and subsequently notify the LHA of the exemption status. When reviewing the exemption request the following should be considered:

1. The existence and condition of traffic control devices near the crossing, and any potential conflicts and delays that may occur at nearby locations if a STOP sign is installed at the grade crossing, such as a queue of vehicles backing up into the intersection.

2. Cross-corner sight distances for both approaches to the crossing. Location and type of visual obstructions (check for permanent and seasonal obstructions). Can the driver adequately detect trains without coming to a stop?

3. Geometrics and approximate relative elevations.

4. Average daily traffic at the crossing (cars and trains). For example, without a compelling reason, STOP signs should not be used if there is less than one train per day. Also, STOP signs are generally impractical if the ADT is over 4,000 cars per day.

Highway-rail grade crossing locations on **ODOT**-maintained highways shall be evaluated using this same process and criteria.

801-2.3 Grade Crossings Identified for Lights and Gates – Interim STOP Sign Policy

During the interim changeover program described in ***Section 801-2.1***, when a highway-rail grade crossing has been identified by the **Ohio Rail Development Commission (ORDC)** or the **Public Utilities Commission of Ohio (PUCO)** as warranting flashers and gates, temporary STOP signs should be installed at the crossing unless the highway agency involved determines that the STOP signs present more of a hazard to the traveling public than YIELD signs. The same factors noted in ***Subsection 801-2.2*** should be used in evaluating the location.

The **ORDC** and/or **PUCO** shall notify the highway agency involved of this interim STOP sign policy at the crossing being upgraded to active warning devices at the diagnostic review. If the highway authority fails to attend the diagnostic review, the **ORDC** or **PUCO** shall notify the local authority of the policy in writing following the diagnostic review. Should the highway authority determine that a STOP sign should be installed, they shall instruct the railroad to remove the YIELD sign (if present), and the LHA shall install the STOP signs (and Stop Ahead signs if needed).

When the flasher and gates are installed, the STOP and Stop Ahead signs shall be removed.

802 MARKINGS

802-1 General

The general standards for markings at rail grade crossings are addressed in **OMUTCD Chapter 8B and Figures 8B-6 through 8B-9**.

802-2 Railroad Pavement Marking Symbol

As noted in **OMUTCD Figure 8B-6**, the highway-rail grade crossing pavement marking symbol consists of the “RXR and two 24-inch wide transverse lines.” However, for contract plan payment purposes, the “railroad symbol marking” is described in **C&MS Item 641.08** as including the crossbuck, two “R”s, two transverse lines and a stop line. The symbol is also illustrated in **Traffic SCD TC-71.10**.

The highway-rail grade crossing alternative (narrow) pavement markings shown in **OMUTCD Figure 8B-7** (detail B) should not be used on **ODOT**-maintained routes unless a narrow roadway makes the standard symbol impractical.

803 ILLUMINATION

When an engineering study determines that better nighttime visibility of the train and the highway-rail grade crossing is needed, illumination at and adjacent to the highway-rail crossing may be installed. Standards and guidelines for highway lighting highway-rail grade crossings are in ***Part 11*** of this Manual.

804 FLASHING LIGHT SIGNALS, GATES & TRAFFIC CONTROL SIGNALS

804-1 General

Signals and gates used at highway-rail grade crossings are addressed in **OMUTCD Chapter 8C**. The interconnection and preemption of Highway Traffic Signals with Highway-Rail Grade Crossing Warning Systems are addressed in **OMUTCD Chapter 8C.10**, but substantial additions and clarifications are contained in the ***TEM Parts 1, 4, and 8*** for use within the **State of Ohio**.

In ***Part 8*** also see ***Chapters 830 and 840*** for additional information about preemption and interconnection with highway-rail grade crossing warning systems.

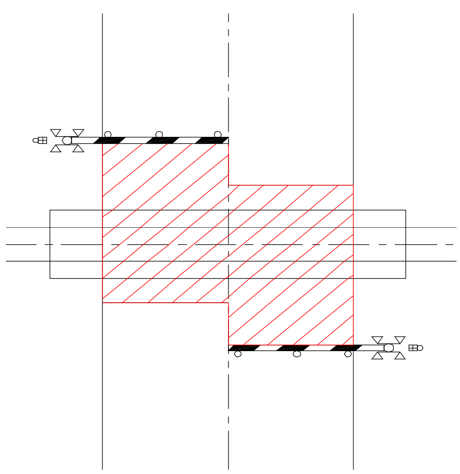
804-2 Definitions

"To promote understanding of common terminology between highway and railroad signaling issues," **OMUTCD Section 1A.13** provides definitions of a number of related terms, such as preemption, interconnection, simultaneous preemption, advance preemption, advance preemption time, minimum track clearance distance, clear storage distance, right-of-way transfer time, queue clearance time, separation time, maximum preemption time, minimum warning time, and pre-signal. ***Section 1501-3*** also provides other definitions.

This ***TEM*** Section includes several more definitions, and for clarification, provides additional information about several of the **OMUTCD** definitions:

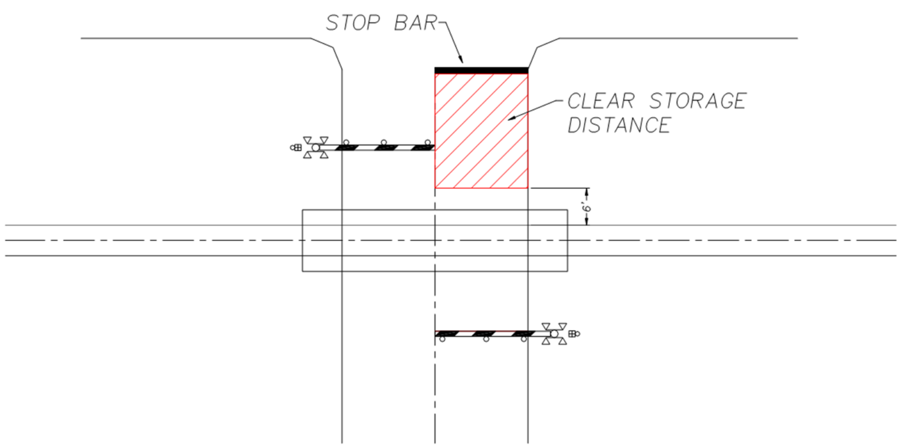
Minimum Track Clearance Distance (MTCD) – is defined in **OMUTCD Section 1A.13** as: "for standard two-quadrant railroad warning devices, the minimum track clearance distance is the length along a highway at one or more railroad or light rail transit tracks, measured from the highway stop line, warning device, or 12 feet perpendicular to the track centerline, to 6 feet beyond the track(s) measured perpendicular to the far rail, along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. For Four-Quadrant Gate systems, the minimum track clearance distance is the length along a highway at one or more railroad or light rail transit tracks, measured either from the highway stop line or entrance warning device, to the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the centerline or edge of the highway, as appropriate, to obtain the longer distance."

The MTCD is indicated by the shaded area:



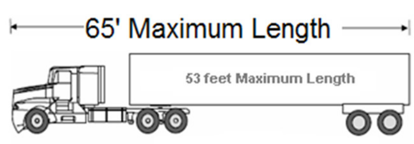
Clear Storage Distance – is defined in **OMUTCD Section 1A.13** as: "…the distance available for vehicle storage measured between 6 feet from the rail nearest the intersection to the intersection stop line or the normal stopping point on the highway. At skewed grade crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used, the distance available for vehicle storage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the centerline or edge line of the highway, as appropriate, to obtain the shorter distance."

The following diagram illustrates this clear storage distance:



Design Vehicle – is defined in **OMUTCD Section 1A.13** as "the longest vehicle permitted by statute of the road authority (State or other) on that roadway."

ORC Section 5577.05(C)(6) prescribes the maximum length of combination vehicles as sixty-five feet.



Diagnostic Team – is defined in **23 U.S.C. 646.204(d)** as: "a group of knowledgeable representatives of the parties of interest in a railroad-highway crossing or group of crossings."

The diagnostic team includes the highway agency or authority with jurisdiction, the regulatory agency with statutory authority and the railroad. Their charge is to determine the need and selection of traffic control devices at a highway-rail grade crossing in accordance with **ORC Sections 4511.61, 4513.40, 4907.47, 4907.471, 4907.476, 4907.48, 4907.49, 4907.52 and 4955.33**.

Constant Warning Time System – is defined as a type of equipment designed to detect both the motion of a train and the approximate speed of the train in order to predict the arrival of the train at the crossing and to provide a relatively uniform warning time in accordance with a pre-set value.

Indicator Panel – is defined as an electrical enclosure, mounted on the traffic signal support, strain pole, or similar location, that provides a visual indication of railroad preemption status.

Interface Panel – is defined as an electrical device panel located within the traffic signal cabinet that contains all necessary relays, connectors, wires and labels to implement the required interconnection between traffic signal equipment and railroad crossing equipment; this includes devices used to drive the indicator panel.

Railroad Dwell Interval – is defined as the component of highway traffic signal preemption that follows the Track Clearance Green Interval for the duration of the train movement through the highway-rail grade crossing.

Railroad Warning System – is defined as the active traffic control devices and train detection circuitry installed at a highway-rail grade crossing for the purpose of warning road users of the approach of a train.

Track Clearance Green Interval – is defined as one interval of the highway traffic signal preemption sequence when the signal faces which control the movement of motor vehicles through the Clear Storage Distance and the Minimum Track Clearance Distance display CIRCULAR GREEN and GREEN ARROW indications.

Train Control Signal – is defined as a signal operated by the railroad that is analogous to a roadway traffic signal. It informs a train operator when to proceed, stop, slow down, etc.

804-3 Railroad Preemption of Traffic Signals

804-3.1 General

Railroad preemption is a special control mode designed to clear motor vehicles from, or prohibit motor vehicles from entering, a portion of the roadway known as the Minimum Track Clearance Distance (MTCD), which crosses over or is in close proximity to railroad tracks or rails. Railroad tracks or rails include those rails operated in semi-exclusive rights-of-way for the use of light rail vehicles or streetcars.

The preemption and interconnection of traffic signals with a railroad warning system requires a systems approach in order to ensure the proper functioning of the individual systems as a combined system. No single standard system of traffic control devices is universally applicable for all highway-rail grade crossings.

The need for preemption and its corresponding operation is developed through a diagnostic team which conducts an engineering study to determine the appropriate system.

See ***Section 804-4*** for a standardized design guideline to define the requirements of the interconnection between the railroad and traffic signal controller.

See ***Form 896-1*** for a standardized form to transmit preemption functional and time requirements to the railroad company.

804-3.2 When to Preempt

OMUTCD Section 8C.09, states:

> "If a highway-rail grade crossing is equipped with a flashing-light signal system and is located within 200 feet of an intersection or midblock location controlled by a traffic control signal, the traffic control signal should be provided with preemption in accordance with Section 4D.27."
>
> "Coordination with the flashing-light signal system, queue detection, or other alternatives should be considered for traffic control signals located farther than 200 feet from the highway-rail grade crossing. Factors to be considered should include traffic volumes, vehicle mix, vehicle and train approach speeds, frequency of trains, and queue lengths."

The distance between the railroad and the adjacent intersection which establishes the need for preemption is 200 feet. The predominant factor to consider when determining whether or not to preempt is the queue length. Field observation of queue length during critical traffic periods can provide guidance. Queue arrival and dissipation studies or capacity analysis may be beneficial in further refining the observed queue lengths.

The vehicle usage over the crossing may also form a basis to determine whether to preempt or not. Vehicles which haul hazardous materials, school buses or public transportation vehicles may further influence the decision to preempt at locations which fall just outside the maximum distance and queuing length observations.

804-4 Highway-Rail Grade Crossing Warning System Interconnection Design Guidelines

804-4.1 Purpose

The purpose of this design guideline is to define the required interface between a highway-rail grade crossing warning system and a traffic control signal for the purpose of railroad preemption. It defines the standard interface to provide the operation as specified by the **Ohio Rail Development Commission (ORDC)** for each interconnected highway-rail grade crossing.

Interface hardware specifications are given in **ODOT Supplemental Specification (SS) 919**. Construction requirements are given in **ODOT SS 819**.

804-4.2 Operation

The interface shall provide the following functions:

1. Advance Preemption. This circuit will notify the traffic signal controller of an approaching train prior to the operation of the active warning devices.

2. Simultaneous Preemption. This circuit will notify the traffic signal controller of an approaching train at the point the active warning devices begin their operation. This circuit is commonly known as an “XR” circuit.

3. Island Occupied. This circuit will notify the traffic signal controller of the occupancy of the island circuit by the train.

4. Gate Down. This circuit will notify the traffic signal controller when the gate(s) controlling access to the track(s) is lowered to within 5 degrees of horizontal.

5. Gate Up. This circuit will notify the traffic signal controller when all gates at the crossing are raised. This circuit is commonly known as the “GP” circuit.

6. Traffic Signal Health. This circuit will notify the railroad warning system whenever the traffic signal has entered conflict flash or the power has failed.

804-4.3 Traffic Signal Interface

The traffic signal controller shall be provided with either a relay based interface, a solid state interface using DC isolator cards, a dedicated railroad preemption interface card, or a serial data interface using the IEEE 1570 protocol. If not specified on the plans, a basic controller unit with a cabinet relay interface shall be provided. The interface shall function as defined in **ODOT SS 919**.

804-4.4 Traffic Signal Controller Unit

The **Office of Traffic Operations (OTO)** shall maintain a list of approved traffic signal controllers for Railroad Preemption.

Refer to ***TEM Part 4*** for additional controller unit requirements.

804-4.5 Railroad Interface

If requested by the railroad or another agency, consideration will be given to the use of the **IEEE 1570** serial data interface in lieu of the relay interface described in **SS 919.** Final determination as to the use of the **IEEE 1570** jointly rests with **ORDC** and **ODOT** based on the availability of a traffic signal controller unit which supports the **IEEE 1570** interface.

If a traffic control signal is located on both sides of the crossing and two independent interconnection circuits are required, the railroad shall supply isolated relay contacts for each interconnection circuit. All functions may share common relays with the exception of "Gate Down." Additionally, two traffic signal health relays will be required, one for each intersection.

If the railroad has determined to provide non-motion sensing circuits such as DC or Style C circuits, then a means should be provided to cancel the operation of the warning devices and corresponding preemption request in the event a train stops within the approach to an interconnected warning system. Either an automatic timing circuit or a cutout and a restart pushbutton switch shall be provided for use by the train crew. Operating rules shall require the crew to operate the cut-out or allow the timing circuit to deactivate the warning devices and preemption operation whenever the train is stopped not occupying the crossing for a period of five minutes or greater. If a cut-out pushbutton switch is provided, its operation shall be canceled by operation of the restart pushbutton switch or the occupancy of the island circuit. A cut-out circuit or automatic timing circuit shall not function if the island is occupied.

805 RUMBLE STRIPS

Rumble strips ***(see TEM Chapter 1415)*** may be used as an audible and vibratory warning device at highway-rail grade crossings after all other appropriate standard traffic control devices have been considered.

830 PLANNING / PROGRAMMING

830-1 General

This Chapter is intended to provide planners and designers assistance in the planning phase of a project or work assignment.

See ***TEM Chapter 804*** for additional information and guidelines on railroad preemption of traffic signals and interconnection with grade crossing warning systems.

830-2 Grade Separation Program

The Railroad Grade Separation Program was developed to mitigate the impacts of increased rail traffic in **Ohio**. It is governed by a subcommittee of the **Transportation Review Advisory Council (TRAC)**. The subcommittee appointed a technical advisory group (TAG) comprised of representatives from **ODOT**, **ORDC**, **PUCO, the Ohio Emergency Management Agency (OEMA)**, **FHWA**, and the **CSX and Norfolk Southern Railroads**. This committee prepares the initial feasibility study. This in turn is ranked by the subcommittee of the **TRAC** for final acceptance. Details of the process are found in the **Railroad Grade Separation Program Policies and Procedures Manual *(Section 895-1)***.

830-3 New or Upgrade Highway Traffic Signal Projects

When a new or upgrade project for a highway traffic signal is planned and it has been determined that preemption is required, it is of the utmost importance to involve the railroad as quickly as possible. In virtually every case, the implementation of preemption will require additional warning time above the minimum time of twenty seconds required by **OMUTCD Section 8C.08** from the railroad. The project planner or designer should coordinate with the **ORDC** and/or **PUCO** to establish a diagnostic team inspection at the proposed location **(see *Section 804-2)***. Once the diagnostic inspection has been held and the preemption operation and timing requirements have been established, the railroad will be able to provide an estimate of cost for the work required ***(see Section 804-3 and 804-4)***. The following items should be considered in the project planning process:

1. The time required for the estimate process may take several months. In many cases, once the diagnostic team inspection has been completed, the railroad will be required to determine the impact not only at the proposed project location, but also at adjacent crossings. In many cases, the diagnostic team will be required to view the railroad requirements on a “corridor” basis. This may be necessitated based on the number of crossings impacted and the type of train detection circuits already in place.

2. The railroad shall determine the types of circuitry which will operate properly based on the condition of the track. In certain cases, track conditions or crossing surfaces may create limitations which will prohibit the use of certain train detection systems. This may necessitate the need to provide special design considerations to address proper operation of the train detection system.

3. The cost required to provide the required warning time may greatly exceed the cost of the traffic signal or roadway project.

4. When facing significant costs to provide the required warning time, changes at the intersection may play a significant role in reducing project costs.

5. Railroad signal material procurement and construction time may be lengthy. Generally, these projects must be completed within nine months, but in certain cases, site specific needs create delays outside the control of the railroad which may further add to the time required to complete the project.

6. Remember that crossing consolidation and closure may be an alternative.

7. Any new traffic signal or upgrade to an existing traffic signal that is or will be interconnected shall require the installation of a backup power system to maintain operation of the traffic signal during periods of commercial power outage. The backup power supply should have sufficient capacity to assure continued operation of the traffic signal for a minimum period of 2.5 hours.

830-4 New or Upgrade Railroad Warning System Projects

When a new or upgrade project for a railroad warning system is planned, the **ORDC** or **PUCO,** upon notification of the project, will contact the appropriate roadway authority to schedule a diagnostic team inspection ***(see Section 804-2)***. If a new or upgrade project for a railroad warning system is proposed by another government agency or a private developer, the agency or developer must establish contact with the **ORDC** and **PUCO** to initiate the diagnostic team inspection. If, during the course of the diagnostic team inspection it is determined that a highway traffic signal may require preemption, a plan will be developed to establish the need for preemption and identify any traffic signal upgrades which may be necessary. Some of the items which will be considered will include the following:

1. What are the capabilities of the existing traffic signal equipment and is it capable of providing preemption operation in accordance with the requirements of the **TEM**?

2. Is the current phasing and signal operating plan capable of displaying the track clearance green interval?

3. Are the vehicular signal faces capable of displaying the appropriate indications during the preemption sequence?

4. What provisions exist for pedestrians within the intersection?

5. Are turn prohibitions required during preemption?

6. Does the proposed operation create a “yellow trap” condition during the transition into preemption?

7. Are geometric changes to the intersection necessary or desirable?

8. Should certain pedestrian movements be prohibited?

9. Can U-Turn movements add additional delay to the effective beginning of the track clearance green interval?

See ***Section 804-3 and 804-4*** for additional information about railroad preemption of traffic signals and highway-rail grade crossing warning system interconnection design guidelines, respectively.

840 DESIGN INFORMATION

840-1 General

Design information regarding highway-rail grade crossings is found in the **L&D Manual Volume 1, Section 700**, and in **AASHTO's A Policy on Geometric Design of Highways and Streets, Chapter 9**. For projects involving railroads, it is important to get early coordination with the railroad companies and **ORDC**. Additional information about the coordination needed when planning new or upgrade highway signal projects and railroad system warning projects is provided in ***TEM Chapter 830***.

See ***Chapter 804*** for additional information, including definitions, and guidelines on railroad preemption of traffic signals and interconnection with grade crossing warning systems.

840-2 Design of Locations with Railroad Preemption

840-2.1 General

When planning the design of a highway traffic signal which is to be interconnected with and preempted by a railroad warning system, the following items must be addressed and resolved prior to completion of the design. See ***Chapters 804 and 830*** for more information. Also, definitions of some of the terms used here are provided in ***Section 804-2***.

840-2.2 Railroad Warning Devices

The following information is required from the railroad in order to proceed with a railroad warning device project. Ideally, the request for this information should be submitted to the railroad prior to the diagnostic team meeting. Having this information available at the time of the diagnostic team inspection will expedite the data collection process and aid in the process of determining the proper train detection circuitry ***(see Chapters 804 and 830)***.

1. The railroad company responsible for the design and maintenance of the railroad warning system. **ORDC** can provide this information upon request.

2. The Maximum Authorized Speed (MAS) of trains using the line.

3. Do passenger trains use the line or are there plans to add passenger service to the line?

4. If passenger trains use the line, is there a station stop in place or planned for 3 miles either side of the crossing?

5. Is the line equipped with train control signals?

6. If the answer to the above question is yes, explain how the signal controls are handled?

    a. Overhead line circuits
    b. Underground cable
    c. Coded track
    d. Data radio

7. Does the line support the installation of constant warning time circuitry?

8. Are there any overlapping grade crossings located within 2 miles either side of the proposed location?

9. If the answer to the above questions is yes, provide the following information:

    a. The name and **DOT** number of each overlapping crossing.

b. The type of train detection circuitry installed at each overlapping crossing.
c. The frequencies of all equipment installed at any overlapping crossing.
d. The Minimum Warning Time provided for each overlapping crossing.

10. Are there any wayside signals located within 2 miles either side of the proposed location?

11. Are there any control points or interlockings located within 2 miles either side of the proposed location?

12. If the answer to the above question is yes, identify the following:

    a. The configuration and signal layout at the interlocking.
    b. If the interlocking is a railroad crossing at grade, how is the interlocking controlled?
    c. What is the maximum speed through any diverging routes?
    d. Are there any pending changes to the control point or interlocking which would impact this project?

13. Are there any switching moves or unusual operating issues conducted within 2 miles either side of the proposed location?

14. What is the Gate Delay time? The gate delay time is the number of seconds the flashing lights operate prior to the descent of the gate.

15. What is the Gate Descent time? The gate descent time is the period of time in seconds required for all gates controlling the movement of motor vehicles into the MTCD moving toward the signalized intersection to be fully lowered.

840-2.3 Highway Traffic Signal

The public agency responsible for the design and maintenance of the highway traffic signal must be consulted in order to address and resolve numerous issues regarding the design and operation of the highway traffic signal and the intersection geometrics. The following items should be addressed with the public agency as a part of the preemption planning process. Having this information available prior to the diagnostic team inspection will expedite the process ***(see Chapters 804 and 830)***.

1. The proposed phasing for the traffic signal may require modification in order to provide proper operation during the preemption sequence. The following items must be addressed regarding the traffic signal phasing:

    a. Are the movements over the track capable of being operated independently of other movements? If the signal is proposed to operate with concurrent movements crossing the track, separate phases must be provided even though the movements normally occur simultaneously.

    b. Are pedestrian movements planned? If so, have pedestrian pushbuttons or other pedestrian detectors been provided for every pedestrian movement?

2. The proposed signal displays for the traffic signal may require special considerations. The following items must be addressed regarding the traffic signal displays:

    a. During the track clearance green interval, a GREEN ARROW shall be displayed to motor vehicles exiting the MTCD. This indication is required even if it is not displayed during the normal or non-preempted sequence.

    b. In many cases, the entrance into the track clearance green interval will create a yellow trap condition. Refer to ***Section 403-8*** for additional information regarding yellow trap.

c. Have provisions been made to address turning movements toward the tracks during preemption? **OMUTCD Section 8B.08** states:

> "At a signalized intersection that is located within 200 feet of a highway-rail grade crossing, measured from the edge of the track to the edge of the roadway, where the intersection traffic control signals are preempted by the approach of a train, all existing turning movements toward the highway-rail grade crossing should be prohibited during the signal preemption sequences."

Engineering judgment is required to determine the appropriate measures to be used to address turning movements toward the tracks. As a general rule, the shorter the CSD, the greater the need to prohibit turning moves toward the tracks during preemption. The intent is to keep the intersection clear of motor vehicles during the preemption sequence.

Turning movements may be prohibited during preemption through the use of illuminated LED "blank-out" signs, additional railroad warning devices, protected only signal displays, or a combination of any of these devices. Any blank-out sign used to establish a turn restriction during railroad preemption should contain the illuminated word TRAIN in 4- inch white letters below the symbol.

d. The use of countdown pedestrian signals shall be evaluated to determine their operation during the transition into preemption. If the right-of-way transfer time (RWTT) provided does not provide for the full Pedestrian Change interval, then strong consideration should be given to using conventional non-countdown displays or other means to provide notification to pedestrians regarding the approach of the train.

3. Use of Pre-Signals - The design of Pre-Signals is specified in ***Section 840-3***. It should be noted that pre-signal use may decrease the capacity of the signalized intersection. As a result, careful consideration should be given to the use of pre-signals and the overall impact on the intersection. Improper use of pre-signals may result in driver disregard and a decrease in credibility. The use of pre-signals at a highway-rail grade crossing shall be considered if one or more of the following conditions is satisfied.

   a. Where the CSD is less than 80 feet and there is little opportunity for a design vehicle to make a right turn on red due to geometric limitations or infrequent gaps in conflicting traffic.

   b. Where frequent numbers of vehicles using the crossing are carrying hazardous materials.

   c. On a multi-lane approach where overhead obstructions or other physical constraints limit the number of railroad flashing lights to less than one pair per lane.

4. Use of Queue Cutter Signals - The use of queue cutter signals ***(see Section 840-4)*** should be considered as an alternative to interconnection and preemption where the CSD exceeds 450 feet. A queue cutter signal is installed and located in a manner similar to a pre-signal, but it is not connected to or operated as a part of the signalized intersections. A queue cutter signal requires its own controller and vehicle detection system. The length of the queue determines when the queue cutter signal changes. Its normal state is green. Only when a train approaches or a queue forms approaching the MTCD does the indication change to red. Queue cutter signals and their associated control systems require careful planning and design to assure that appropriate fail safe principles are used. A fail-safe vehicle detector (**Reno A&E** U-1400 or equivalent) must be used to provide a self-check function to verify proper queue detector operation. This is due to the fact that the queue cutter is the only device which will keep the queue clear of the tracks when a train approaches. A queue cutter signal is interconnected with the railroad

warning system for advance preemption. Queue cutter signals may also be effective in other applications where a downstream restriction creates a queue to form toward the MTCD.

5. The operation and timing of the traffic signal require consideration in order to avoid conflicts with the preemption operation. The following items should be considered:

   a. If the traffic signal is proposed to operate in a coordinated system, preempted locations should be designed so as not to utilize pedestrian recall on any phases. In addition, the use of rest in walk should never be implemented.

   b. The traffic signal timing information is necessary in order to calculate the preemption time requirements. This information must be available prior to the diagnostic team inspection.

   c. In order to properly implement railroad preemption, special functionality is required in the controller unit and the operating software. Refer to ***Section 403-10*** for additional information regarding the controller unit railroad preemption functionality.

840-2.4 Intersection Geometrics and Configuration

Certain intersection geometrics can have a significant impact on the design and installation of railroad warning devices as well as some of the time required for preemption. The following items should be considered as a part of the geometrics and configuration of the intersection:

1. The length of crosswalks is a key component in determining the right-of-way transfer time (RWTT). Because the pedestrian change interval is a function of crosswalk length, it can be costly to provide the required period of time. Consideration should be given to the potential use of pedestrian refuge islands or right turn channelization where crosswalks exceed 60 feet in length.

2. The crosswalk parallel and closest to the railroad track is the most critical in the transition to track clearance green. Strong consideration should be given to the elimination of this crosswalk in order to reduce the RWTT.

3. Another factor in determining RWTT is the amount of minimum green time provided during the transition into track clearance green. The appropriate design and placement of vehicle detection should be provided in order to minimize the need for extended minimum green intervals.

4. The length of the gates used at highway-rail grade crossings is limited to 32 feet. Where multiple lanes are proposed at a highway-rail grade crossing, consideration should be made to providing center islands in order to permit the installation of a median gate. This will reduce the overall length of a single gate arm.

5. The right turn radius can also have a significant impact on gate arm length. Where a large radius is required, consideration should be given to the installation of a separate channelized right-turn lane with a separate gate in order to reduce gate arm length.

840-3 Design of Pre-Signals

Pre-signals can be used to stop motor vehicles approaching the intersection before such vehicles reach the railroad crossing. Pre-signals are typically considered only when one or more of the conditions listed in ***Section 840-2.3, item 3,*** is satisfied. Use of pre-signals for longer clear storage distances must carefully consider the violation of driver expectancy for stopping traffic well in advance of the normal stopping point for the intersection as well as the inherent inefficiency of pre-signal operation. The placement of pre-signals does not replace the need for a proper track clearance green interval.

1. The stop line location must be 40 feet in advance of the pre-signals to comply with **OMUTCD Section 4D.15**. Pre-signals can be located upstream or downstream from the railroad crossing. Locating the pre-signals downstream from the crossing (between the crossing and the intersection) should be considered so that the stopping point for the pre-signals is the same as the stopping point for the railroad warning device(s). As a general rule, driver compliance with a downstream pre-signal is greater than driver compliance with an upstream pre-signal. Note that at locations where the angle of the tracks is skewed or more than two tracks exist, the placement of a downstream pre-signal may create a condition where drivers stop on the tracks for the pre-signal. This generally occurs where the stop line to pre-signal face distance is greater than 70 feet. In this case, either an upstream pre-signal should be provided or the pre-signal should be eliminated.

2. The pre-signals and support structures shall be located to maintain visibility of the railroad flashing lights. In some cases, downstream pre-signals may require the use of horizontally aligned signal heads.

3. As required by **OMUTCD Section 8C.09**, a STOP HERE ON RED (R10-6) sign shall be installed near the pre-signal or stop line.

4. Whenever a pre-signal is utilized, one or more NO TURN ON RED (R10-11) sign(s) is/are required. A pre-signal identifies a separate stopping point on the roadway in advance of the signalized intersection requiring the prohibition of right turn on red.

5. The pre-signal intervals should be progressively timed with the downstream signal intervals to provide adequate time to clear vehicles from the track area and the downstream intersection with each cycle of the normal traffic signal operation. Vehicles that are required to make a mandatory stop at the crossing, such as school buses and vehicles hauling hazardous materials, should be considered when determining the progressive timing to ensure they will not be stopped within the minimum track clearance distance. Vehicle detection for the through phase(s) should be placed on the roadway in advance of the pre-signal. Consideration should be given to installation of vehicle detection within the clear storage distance to extend the pre-signal green clearance interval to prevent vehicles from being trapped within the minimum track clearance distance.

6. Left-turn phasing considerations shall be carefully evaluated when using pre-signals. In many cases the pre-signals will need to include signal faces for the through phase as well as the left-turn phase if leading left-turn phasing is used. The use of a lagging left-turn phase to provide the progressive clearance interval may require that the left turn opposing the track clearance be a protected only left-turn phase in order to prevent a yellow trap condition. As an alternative, the opposing movements may be split.

7. The downstream traffic signal faces at the roadway intersection that controls the same approach as the pre-signal shall be programmable-visibility heads or louvered as appropriate to prevent vehicles stopped at the railroad crossing stop line from seeing the distant green signal indication during the track clearance interval. The downstream signal heads shall be mounted on rigid supports or tethered to maintain the effectiveness of the programmed visibility or louvers.

840-4 Design of Queue Cutter Signals

A queue cutter signal is a traffic signal installed at a highway-rail grade crossing in a manner similar to a pre-signal. A queue cutter signal differs from a pre-signal in that it is not connected to or operated as a part of a downstream signalized intersection. The queue cutter signal is a form of coordination between the railroad warning system and a downstream signalized intersection which operates independently of the intersection. The use of a queue cutter signal is beneficial whenever the normal advance preemption time is so lengthy that it is not practical to obtain. Generally, a queue cutter signal is installed where the CSD exceeds 450 feet. It is interconnected with the railroad warning system with a 3 to 5 second advance preemption time. A queue cutter signal consists of the following elements:

1. A “safety critical” vehicle detection system using self-check capabilities shall be used to activate the queue cutter control system. This system is necessary due to the fact that the queue cutter signal is the only device keeping the MTCD clear of vehicles and the system must be known to be operating at all times.

2. The vehicle detection system shall detect the buildup of a queue of vehicles before the queue reaches the MTCD. This requires placement of the detectors sufficiently far enough downstream from the crossing to detect the lack of a gap, provide for a yellow change interval and permit a design vehicle which has lawfully crossed the stop line (entered at end of yellow) to have adequate room to cross over and clear the MTCD.

3. A queue cutter signal control system shall have battery backup which is capable of operating for a period of time equal to or greater that the associated railroad warning system.

4. Any fault of the queue cutter system shall result in a flashing red display.

5. The stop line location must be 40 feet in advance of the queue cutter signals to comply with **OMUTCD Section 4D.14**. Queue cutter signals can be located upstream or downstream from the railroad crossing. Locating the queue cutter signals downstream from the crossing (between the crossing and the intersection) should be considered so that the stopping point for the queue cutter signals is the same as the stopping point for the railroad warning device(s). As a general rule, driver compliance with a downstream queue cutter signal is greater than driver compliance with an upstream queue cutter signal. Note that at locations where the angle of the tracks is skewed or more than two tracks exist, the placement of a downstream queue cutter signal may create a condition where drivers stop on the tracks for the queue cutter signal. This generally occurs where the stop line to queue cutter signal face distance is greater than 70 feet. In this case, an upstream queue cutter signal should be used.

6. The queue cutter signals and support structures shall be located to maintain visibility of the railroad flashing lights. In some cases, downstream queue cutter signals may require the use of horizontally aligned signal heads.

7. A STOP HERE ON RED (R10-6) sign shall be installed near the queue cutter signal or stop line.

843 SPECIFICATIONS

ODOT specifications discussed in this Part of the **TEM** for furnishing and installing a railroad preemption interface are addressed in **Supplemental Specifications 819 and 919**.

895 REFERENCE RESOURCES

895-1 Railroad Grade Separation Program Policies and Procedures Manual

The **Railroad Grade Separation Program Policies and Procedures Manual** provides information on the program history, an overview of the annual process to select projects, the initial feasibility study process, project development activities, and financial and project management

895-2 Railroad-Highway Grade Crossing Handbook

The **Railroad-Highway Grade Crossing Handbook**, published by **FHWA**, presents guidelines for prioritizing improvements to railroad-highway grade crossings and information on the various types of improvements that can be made to the crossing. The handbook also provides guidelines to determine which crossing improvement is the most cost effective for the site.

895-3 AREMA Communication & Signal Manual

The **AREMA Communication and Signal Manual of Recommended Practice** is a valuable resource to gain additional understanding and insight into the design and operation of railroad warning systems. This publication is available on-line through **AREMA (American Railway Engineering and Maintenance-of-Way Association)** at http://www.arema.org/.

Intentionally blank.

896 Forms Index

896-1 Highway-Rail Grade Crossing and Timing

Form 896-1 is issued by the **Ohio Rail Development Commission (ORDC)** to establish railroad configuration and timing requirements for the railroad ***(see TEM Section 804-3)***.

Form 896-1. Highway-Rail Grade Crossing Warning System Railroad Configuration and Timing Requirements

OHIO DEPARTMENT OF TRANSPORTATION
OHIO RAIL DEVELOPMENT COMMISSION

HIGHWAY-RAIL GRADE CROSSING WARNING SYSTEM INTERCONNECTION

RAILROAD CONFIGURATION AND TIMING REQUIREMENTS

Railroad: ____

DOT: ___________________________

Crossing Name: ____

Date: ___________________________

Issued By: _____________________________(Local Highway Authority)

<u>This crossing warning system is proposed to be interconnected with an adjacent highway traffic control signal.</u> In some cases, the warning system may be interconnected with two highway traffic control signals, usually one on each side of the grade crossing. The #2 interconnect circuits are only required if indicated below.

The purpose of this document is to advise the railroad of the number of interconnection circuits required and the type and timing requirements of each circuit. The railroad should refer to the Chapter 804 of the ODOT Traffic Engineering Manual (TEM), Subsection 804-4 for details concerning the requirements of the interface to be provided by the railroad.

TYPE OF INTERCONNECTION	INTERCONNECT #1	INTERCONNECT #2
ADVANCE * (SUPERVISED)		
SIMULTANEOUS		
GATE DOWN (Typ. Required)		
ISLAND (Optional)		
GATE UP (Optional)		
NOT REQUIRED		
* Advance Preemption Time Per AREMA 3.3.10		

898 Figures Index

898-1 Example of an Interconnection Warning Label

Figure 898-1 displays an example of the warning label used on the inside of the signal controller cabinet and the railroad bungalow to indicate the interconnection between the two systems.

Figure 898-1. Example of an Interconnection Warning Label

WARNING!

Highway-Rail Grade Crossing Warning System

and Highway Traffic Signals

are Interconnected.

BEFORE MODIFICATION is made to any operation which connects to or controls the timing of an active railroad warning system and/or timing and phasing of a traffic signal the appropriate party(ies) shall be notified and, if necessary, a joint inspection conducted.

U.S. DOT/AAR Crossing Number: ___________________________

1. **Highway Agency:** _____________________________________

   Phone Number: ______________________________________

2. **Railroad:** ____

   Phone Number: ______________________________________

3. **Other:** ____

   Phone Number: __________________________________

(An alternate might also use florescent orange or yellow background with black letters.)

TABLE OF CONTENTS
Part 9 - BICYCLE FACILITIES

Intentionally blank.

Part 9 - BICYCLE FACILITIES

900 GENERAL

900-1 General Background

OMUTCD Part 9 and ***TEM Part 9*** address concerns about traffic controls for bicycle facilities. However, as with other areas of traffic control, questions periodically arise that are not addressed by the basic standards and guidelines established in these publications. When this occurs, the **Office of Roadway Engineering (ORE)** or the **Office of Statewide Planning & Research, Division of Planning** should be contacted. The two offices will then coordinate a response.

OMUTCD Section 1A.13 includes definitions for such bicycle-related terms as Bicycle **(ORC Section 4511.01G)**, Bicycle Lane, Bikeway, Designated Bicycle Route, Shared-Use Path and Shared Roadway. For additional information on each type of facility, see the current **AASHTO Guide for the Development of Bicycle Facilities.**

Please note that the **OMUTCD** definitions related to bicycles are based on definitions in the national **2009 MUTCD**. Both of these manuals, and the **Ohio Revised Code**, define the term “roadway” as excluding the shoulders. The **AASHTO** definitions include the shoulder in the definition of “roadway.” This can easily result in confusion in the use of terms related to the types of bicycle facilities.

ODOT owns bicycle lanes only if they are added to rural sections of a state highway; however, other agencies **(Local Public Agencies (LPAs)**, such as, **ODNR, County Engineers, Metro Parks, Cities**) can initiate and sponsor these or any other type of bicycle project. Bicycle lanes in urban areas, bicycle paths, and bicycle routes are sponsored by other agencies. Funding sources include a variety of federal, **State**, local and private sources. The planning, construction and maintenance operation of completed facilities are the responsibility of the sponsor regardless of the funding source.

900-2 Designated Bicycle Routes

Designated Bicycle Routes involve designation of a system of bikeways as a bicycle route and the posting of bicycle directional and informational signs with or without specific route numbers. More information about **Ohio** bicycle facilities is available from the **Division of Planning’s** website at www.dot.state.oh.us/Divisions/Planning/SPR/bicycle.

901 SIGNING

901-1 General

General standards and guidelines for signing are provided in **OMUTCD Part 2** and ***TEM Part 2***. Signing specifically related to bicycle facilities is addressed in **OMUTCD Chapter 9B**.

901-2 Bicycle 3-Foot Clearance Sign (R3-H16)

ORC Section 4511.27 addresses the overtaking and passing of vehicles proceeding in the same direction. It states, in part, "When a motor vehicle….passes a bicycle, three feet or greater is considered a safe passing distance."

The R3-H16 sign should be used at locations where a problem or crash history between motor vehicles and bicyclists exists, and may be used at other locations based on engineering judgment.

R3-H16

902 MARKINGS

902-1 General

General standards and guidelines for markings are provided in **OMUTCD Part 3** and ***TEM Part 3.*** Markings specifically related to bicycle facilities are addressed in **OMUTCD Chapter 9C**. **Plan Insert Sheet (PIS) 207000, Bikeway Pavement Marking Details** also provides details about these markings.

902-2 Bike Box

A Bike Box is a device that is used to place bicyclists directly in front of vehicles stopped at an intersection, to assure that motorists see them. As traffic proceeds through the intersection, the bicyclists then move back to the right side, preferably in a bike lane.

In October, 2016 FHWA issued an Interim Approval (IA-18) regarding this device and any agency wishing to use it will have to follow the procedure established in **OMUTCD Section 1A.10**.

930 PLANNING / PROGRAMMING

930-1 Planning

ODOT is required by federal law to develop a statewide transportation improvement plan **(STIP)** that facilitates the safe and efficient management, operation, and development of surface transportation systems that will serve the mobility needs of people and freight and includes accessible pedestrian walkways and bicycle transportation facilities. The **STIP** is developed in cooperation with **State** metropolitan planning organizations **(MPOs)** and in consultation with non-metropolitan local officials, Indian Tribal governments, the **Secretary of the Interior**, **State**, Tribal, and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation. Collaboration and consultation with these stakeholders will ensure prioritization of projects is consistent with the goals and objectives identified by the **State**, **MPOs** and locals.

It is the responsibility of each project sponsor to review existing **State** plans, as well as area bikeway and thoroughfare plans, to ensure an appropriate level of accommodation is constructed on the specific project they are programming, developing and/or managing. Each project sponsor is encouraged to contact their **ODOT District** and **MPO**. Early identification and engagement with stakeholders during the public involvement process is strongly encouraged.

The **Project Development Process** requires project sponsors to evaluate the need for bicycle and pedestrian accommodation during several stages of the project development for their project. This includes assessment of need during completion of the Project Initiation Package and the Categorical Exclusion documents, and consideration of multi-modal options during the scoping process, the Feasibility Study and the Alternative Evaluation Report.

Also see the **Division of Planning's** website for additional information about Bike & Pedestrian Programs. www.dot.state.oh.us/Divisions/Planning/SPR/bicycle.

930-2 Funding

There are many simple and cost-effective ways to integrate non-motorized users into the design and operation of our transportation system, by including bicycle and pedestrian accommodation as an incidental part of larger ongoing projects. Examples include:

- Providing paved shoulders on new and reconstructed roads.
- Restriping roads (either as a stand-alone project, or after a resurfacing or reconstruction project) to create a wider outside lane or striped bike lanes.
- Building sidewalks and trails, installing traffic calming, and marking crosswalks or on-street bike lanes as a part of new highways or roadways.
- Requiring new transit vehicles to have bicycle racks and/or hooks installed, and providing pedestrian and bike facility connections within a reasonable radius of bus stops.

Federal surface transportation law provides tremendous flexibility to **States** and **MPOs** to fund bicycle and pedestrian improvements from a wide variety of programs. Virtually all the major transportation funding programs can be used for bicycle and pedestrian-related projects. When considering ways to improve conditions for bicycling and walking, metropolitan planning organizations **(MPOs)** and local governments should review and use the most appropriate funding source for a particular project and not rely primarily on Transportation Enhancement activities. Many bicycle and pedestrian projects can be eligible and meet the goals of other programs, such as the Congestion Mitigation and Air Quality Improvement Program, the Surface Transportation Program, the Safe Routes to School Program, the Clean Ohio Funds Program, the State and Local Capital Improvements Program, the Recreational Trails Program, Community Development Block Grants, and the Federal Transit, Capital, Urban & Rural Program.

Most funding programs require a local dollar match and the amount will differ depending on the program. It is usually encouraged to provide above the minimum required amount and pair other funding sources in order for a local government to be competitive. Funding programs are administered by several agencies including the **Ohio Department of Transportation**, **Ohio Department of Natural Resources**, **Ohio Public Works Commission**, **Ohio Department of Development**, regional **MPOs**, regional transit authorities, and **Housing and Urban Development** entitlement Cities & Counties.

All projects receiving Federal funding for projects owned or maintained by the **Ohio Department of Transportation** must adhere to the **ODOT Policy on Accommodating Bicycle and Pedestrian Travel on ODOT Owned or Maintained Facilities (Policy 20-004(P)),** which is available on-line at http://portal.dot.state.oh.us/Groups/policies/Policies/20-004(P).pdf.

940 DESIGN INFORMATION

940-1 General

Refer to the current **AASHTO Guide for Development of Bicycle Facilities, and ODOT PIS 207000, Bikeway Pavement Marking Details** for additional design information

District personnel perform all preliminary reviews of plans during the final stages of preparation.

The addition of a paved shoulder to a narrow roadway can permit bicycles and other vehicles to share the roadway without compromising the level of service and safety for either vehicle.

Rumble strips, speed bumps/humps and raised pavement markers can interfere with a bicycle's operation. This should be a consideration on projects that involve bicycle facilities. This is addressed in further detail in the current **AASHTO Guide for Development of Bicycle Facilities**.

940-2 Solar-Powered Crossing Sign Assembly

Plan Note 942-2 ***(Section 942-2)*** should be used when a solar-powered Crossing Sign Assembly is included in the plan.

On **ODOT**-maintained highways, these Crossing Sign assemblies shall not be actuated, but will operate continuously. Night dimming of the beacon is permitted.

942 PLAN NOTES

942-1 General

Typical **Plan Notes** are consolidated here for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid item will be "as per plan." Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

942-2 631 Crossing Sign Assembly with Warning Beacon, Solar Powered

This item of work shall consist of furnishing and installing a crossing sign assembly, with supplemental warning beacon, powered by batteries and recharged by solar panels.

The sign assembly and flasher shall meet the requirements set forth in the OMUTCD. The sign size shall be ______" x _______" and sign code ____________.

The flasher control and battery shall be housed in one or more stainless steel or aluminum enclosures with a NEMA rating of at least 3R. Enclosure exterior surfaces shall be bare or powder coat aluminum or stainless steel. The enclosure interior surfaces shall be the same as the exterior.

If contained in a single enclosure, the control electronics and battery shall be separated in a manner to prevent damage to the control electronics if the battery envelope is compromised.

LED signal beacons meeting the current ITE Vehicle Traffic Control Signal Heads (VTCSH) standard shall be used unless otherwise specified. The manufacturer of the signal beacon shall be listed on the Department's Qualified Products List for LED signal lamps. A minimum 8-inch beacon shall be used.

The solar panel or solar panel controller manufacturer shall provide signed copies of calculations used to size the solar panel and batteries. Included in these calculations shall be the insolation value used and its source, the solar panel efficiency, charger/controller efficiency, inverter efficiency, proposed LED lamp load, and a figure representing anticipated miscellaneous losses.

The solar panel manufacturer shall test the panels according to IEC61215 or equivalent approved standard. Solar panel mounting must be rated for 90 mph design wind.

Run requirements for assemblies are 24 hours per day for two weeks under continuous worst-case (minimum) insolation figures (usually December) for the proposed geographic location, using a panel elevation angle appropriate to the site latitude, at a sustained temperature of 25 degrees Fahrenheit (-4 degrees Celsius).

If voltages over 50V AC or DC are present, grounding and bonding requirements specified in the ODOT TEM shall be followed.

The solar panels shall be placed such that each receives full available sunlight at all times, and shall not be obstructed by trees, signs or other objects.

Payment for 631 Crossing Sign Assembly with Warning Beacon, Solar Powered shall be made at the contract unit price bid per each. Payment shall be full compensation for all labor, materials, tools, equipment, testing, certifications and other incidentals necessary to furnish the solar powered school zone flasher complete in place, including all connections made, wiring complete, tested and accepted.

Designer Note: This note should be included when the maintaining agency requests a solar-powered Bicycle or Pedestrian Crossing sign assembly.

Use of assemblies with bicycle detectors, including pushbuttons, shall not be permitted on **ODOT**-maintained installations.

950 CONSTRUCTION

A paved shoulder bicycle lane can be constructed independently of work on the roadway, or it can be included with the roadway work. Therefore, different construction techniques and work zone layouts may be required.

A shared-use path is a bikeway outside the traveled way and physically separated from motorized vehicular traffic. They are narrower than highways; therefore, contractors can utilize older equipment bought when road lane standards were narrower.

960 MAINTENANCE / OPERATIONS

Neglecting routine maintenance on a bicycle facility will eventually render it unridable, and such deteriorating facilities will become a liability. The jurisdictions responsible for operating, maintaining and policing bicycle facilities should be established prior to construction.

995 REFERENCE RESOURCES

995-1 General

Various reference resources that may be useful have been noted in ***Sections 193 and 194***.

A map and list of bikeways in **Ohio,** as well as other bicycle related material, is available online from the **Division of Planning** at www.dot.state.oh.us/Divisions/Planning/SPR/bicycle ***.***

995-2 ODOT Design Guidance for Bicycle Facilities

As noted in ***Section 193-5***, the **AASHTO Guide for the Development of Bicycle Facilities** is published by **AASHTO** and provides information on the development of facilities to enhance and encourage safe bicycle travel. This guide provides information to help accommodate bicycle traffic in most riding environments. It is not intended to set forth strict standards, but, rather, to present sound guidelines that will be valuable in attaining good design sensitive to the needs of both bicyclists and other highway users.

The **Location & Design Manual** is being updated to incorporate bicycle design information.

Intentionally blank.

TABLE OF CONTENTS
Part 10 - Reserved for Future Use

Intentionally blank.

TABLE OF CONTENTS
Part 11 - HIGHWAY LIGHTING

Part 11 - HIGHWAY LIGHTING

1100 GENERAL

1100-1 Introduction

This **TEM** Chapter provides guidelines for use in developing standard, uniform lighting systems. ***Chapters 1140 and 1141*** provide design and plan production information, respectively. Additional highway lighting design information is found in the HL series of traffic control **Standard Construction Drawings (SCDs)**, and as noted in ***Chapter 1143***, the related specifications are addressed in **C&MS Item 625 and C&MS 725**.

1100-2 Construction Projects

Chapter 140 addresses the general application of **ODOT** standards, specifications and standard construction drawings to construction projects. ***Chapter 1150*** provides additional construction related information specific to highway lighting.

1100-3 Force Account (ODOT Operations) Work

Districts performing force account lighting work must comply with the requirements in the **OMUTCD** and this Manual. It is recommended that the **Districts** follow the provisions in the applicable markings related **SCDs** and **Construction and Materials Specifications (C&MS)** sections as well. It should be recognized, however, that the information in the **C&MS** and **SCDs** does not necessarily provide the only method to achieve a given objective.

Chapter 1160 addresses **ODOT** preventive maintenance guidelines and standards for highway lighting.

Intentionally blank.

1101 DISTRICT SYSTEM LIGHTING PLAN (DSLP)

Each **District** should develop and maintain a **District System Lighting Plan (DSLP)**. This is typically a GIS thematic map that uses a systematic approach to show both the **District's** existing and future highway lighting. The **DSLP** is intended to provide for a uniform system and to improve maintenance efficiency with regard to factors such as partial, complete, conventional, high-mast and composite/hybrid designs. It allows the **District** to set priorities for the allocation of available funding for roadway lighting projects, and should be used as a guide in making Light B Don't Light decisions.

The **DSLP** is composed of county maps merged into a district-wide map. The twelve **DSLPs** make up a **Statewide System Lighting Plan (SSLP)**. Through the use of the **DSLP** and **SSLP** a consistent systematic treatment can be insured. Each **DSLP** database should be updated a maximum of every five years.

GIS requires a database made up of the existing physical inventory records. Suggested data and codes that should be used in the **DSLP** are shown in ***Tables 1197-1 and 1197-2***, respectively.

There are a number of decisions to be made to create the **DSLP**. These decisions will involve not only the examination of each of the various intersections, interchanges and roadways in the highway system, with regard to the engineering merits of lighting that particular location, but they will also involve insuring equality of treatment of similar locations, prioritizing the planned changes, and forecasting the availability of resources.

1102 JURISDICTIONAL BOUNDARIES

Care should be exercised in defining the limits of highway lighting and individual circuits in regards to jurisdictional boundaries. Existing ownership and maintenance of various roadways and other facilities should be considered. Layout and extent of circuits will determine maintenance and power usage charge responsibilities.

These issues should be addressed through appropriate planning and design of the lighting system, and appropriate prearranged agreements with local jurisdictions.

Where lighting systems cross jurisdictional boundaries to serve a complete area, additional circuits and control centers should be utilized to cleanly separate the units between maintenance areas. This will simplify billing practices.

Where jurisdictional boundaries cross lighting systems, consideration should be given to assigning (by written agreements) maintenance responsibilities to one entity.

Intentionally blank.

1103 WARRANTS and GUIDELINES

1103-1 General

Lighting warrants are based on the need for highway lighting and the benefits derived from lighting. In justifying lighting, many factors should be considered, including traffic volume, speed, nighttime road use, night accident rate, road geometrics, general night visibility, economic benefits and future increase in capacity or changes in road use.

1103-2 Warrants for Highway Lighting

Warrants for freeway and interchange lighting are shown in ***Table 1197-3***. These are derived from the **AASHTO** publication titled **An Informational Guide for Roadway Lighting**. The ability to satisfy these warranting criteria does not, in itself, necessitate that lighting be installed. Warranting criteria determine location eligibility for lighting; however, there are numerous other factors which must be considered.

For each of the levels of highway lighting shown in ***Table 1197-3*** only one of the Cases need be achieved to meet warrants. However, consideration should be given to whether a location meets only one or all warranting conditions.

1103-3 Accident History

Several factors may contribute to an increase in night accidents, such as:

1. Lack of adequate visual information.

2. Glare from background lighting and headlights.

3. Problems with vehicle lighting.

4. Driver fatigue.

5. Increased use of alcohol and other drugs.

6. Declining visual capability, especially with older drivers.

There is little research on the impact that lighting has on reducing accidents. However, lighting can provide an increase in highway safety by impacting the above mentioned factors.

1103-4 Land Use

The area surrounding a proposed lighting facility must be taken into account when considering the different types and intensities of light needed for a lighting plan. **American National Standard Practice for Roadway Lighting (RP-8)** sponsored by the **Illuminating Engineering Society (IES)** defines three general categories for land use: commercial, intermediate and residential:

1. Commercial - Commercial areas tend to create a heavy area of background lighting. High-mast or low-mast towers are well suited to these type of areas. Towers will blend in more with the surrounding area and yet still light the roadway to the needed level.

   In ***Table 1197-4***, “commercial” refers to that portion of a municipality in a business development where ordinarily there are large numbers of pedestrians and a heavy demand for parking space during periods of peak traffic, or a sustained high pedestrian volume and a continuously heavy demand for off-street parking space during business hours. This definition applies to densely developed business areas outside of, as well as those that are within, the central part of a municipality.

2. Intermediate - These areas have a blend of commercial or residential types of land use. Multi-family residential rental property owners are much like industrial and commercial property owners in that lighting, while at lower levels, is still needed for security. Therefore, they are usually not bothered by any light trespass from adjacent highway lighting units.

   Low-mast towers or conventional poles tend to work best in these areas. High-mast towers will work, but the designer must consider the impact they will cause to the residential area. Common complaints are heavy light trespass on non-roadway areas and perceived glare from the visible part of the light bulb or fixture (the part not under a metal shroud).

   In ***Table 1197-4***, “intermediate” refers to that portion of a municipality which is outside of a downtown area, but generally within the zone of influence of a business or industrial development, often characterized by a moderately heavy nighttime pedestrian traffic and somewhat lower parking turnover than is found in a commercial area. This definition includes densely developed apartment areas, hospitals, public libraries and neighborhood recreational centers.

3. Residential - Owners of single family residential property are more sensitive to light trespass from adjacent highway lighting units, especially if the owner occupies the property. The needs of the traveling public must be balanced with the concerns of the surrounding residents. Low-mast towers and conventional lighting offer the best solution for this type of area. Low-mast towers in conjunction with one or two luminaires will generally light the area within the highway right-of-way and have very little light trespass. They also do not tend to cause the classic light tunnel effect produced when using conventional lighting.

   At times, these residents are also concerned with the aesthetics of highway lighting units that stand above the surrounding area or have drop glass refractors. If high-mast lighting is proposed, it is recommended that a public meeting be held to generate local input.

   In ***Table 1197-4***, “residential” refers to a residential development, or a mixture of residential and commercial establishments, characterized by few pedestrians and a low parking demand or turnover at night. This definition includes areas with single family homes, townhouses, and/or small apartments. Regional parks, cemeteries and vacant lands are also included.

1103-5 Background Lighting

Background lighting has several effects on a lighting system that should be noted.

When the surrounding light is minimal, the transition from lighted sections to unlighted sections should be gradual. Sudden changes in lighting can cause a visual blind spot. The driver’s eyes must be given sufficient time to adjust to the new lighting level.

In commercial areas where the surrounding light is more prevalent, lighting should be increased to more closely match the existing commercial lighting. This will help overcome the light trespass from the surrounding area.

1103-6 Special Locations

1103-6.1 General

There are a number of locations other than freeways and interchanges for which lighting may be considered. Specific warrants are not available for these other locations. Primary concerns are typically related to safety issues. Quite often illumination levels for these locations will differ from standard freeway and interchange lighting.

1103-6.2 Intersections

Lighting may be provided at intersections to enhance safety and to improve visibility of the intersection and approaches.

Intersections with a high percentage of night accidents or a high volume of pedestrian traffic during the hours of darkness should be considered for lighting.

Intersections with sight distance limitations, unusual or complicated geometrics, channelization, skewed approaches, high volumes, unusual traffic patterns, turning roadways, protected turning lanes or driver recognition problems may benefit from illumination.

Lighting units should be combined with signal and sign supports wherever feasible to minimize clutter and obstacles within the intersection and approaches. When lighting is utilized at channelized intersections and at intersections on turning roadways, units should be placed to illuminate protected turning lanes, at radius points and at approaches to divided areas and traffic islands.

1103-6.3 Pedestrian Walkways

Walkway lighting may be considered for security and aesthetic reasons. Walkway lighting may also include landscape or decorative lighting. Lighting of walkways may significantly increase use during the hours of darkness. Lower voltages (120 volts), vandal-proofing and safety issues should be taken into consideration. For example, control centers should be securely padlocked, wiring and anchor bolts enclosed and sharp edges and corners should be eliminated.

1103-6.4 Weigh Stations

Lighting and levels of lighting provided at weigh stations should take into account the full range of activities and needs of the various agencies utilizing these facilities for enforcement. Besides weighing, various degrees of inspection may be conducted. Temporary storage of detained cargo may also require lighting for security reasons.

Exit and entrance ramps at these facilities should be provided with at least partial interchange lighting (as defined in ***Section 1105-5***). The weigh lane from intersection to intersection over the scale and the inspection and parking area behind the scale house should be lighted with the intensity and uniformity normally provided for continuous freeway lighting, with additional low-mounted floods provided for the reading of vehicle markings, observation of vehicle undercarriages and position on the scales from the operator's position within the scale house.

1103-6.5 Park and Ride Facilities

Park and ride lots present two lighting requirements. The first is for the mixing of vehicular and pedestrian movements. The other is for security if the lot remains open late (after the evening peak and before the morning peak). Lighting for these facilities should be divided into three areas: drive intersections with adjacent highways, the drives themselves and the parking areas.

1103-6.6 Bicycle Facilities

Bike paths are facilities which are independent of the roadway. They may double as pedestrian or recreational corridors. For these facilities, lighting is more of a security measure and decisions are made based on the amount of night use to be permitted or encouraged.

A bicycle lane is a dedicated lane provided contiguous to the lanes for motor vehicles, as part of a roadway. In this case, the visibility of the bicyclist and lane becomes more important. Lighting should be considered both: 1) to assist the motorist to detect and allow for the bicyclist; and 2) to assist the bicyclist in detecting and avoiding debris in the bike lane, and in compensating for or avoiding pavement irregularities.

1103-6.7 School Zones / Crossings

School Zone lighting may be considered where a significant pedestrian volume exists. Accident prevention should be considered if a significant volume of turning or stopping vehicles are in potential conflict with pedestrian movements.

Appropriate School Zone signing should be in place before lighting is installed. See ***Part 7*** for further information about School Zones.

1103-6.8 Sign Lighting

It is common practice to power the luminaries for sign lighting from the roadway lighting circuits. See ***Chapter 212*** for further information on sign lighting.

1103-6.9 Underpasses and Tunnels

1103-6.9.1 Underpasses

Underpasses should be evaluated to determine if existing underpass illumination is adequate or needs to be supplemented. Artificial illumination is normally not needed for underpasses that are less than 75 feet in length. However, both skewed underpasses and parallel underpasses less than 40 feet apart may need underpass lighting regardless of their length. Each underpass should be evaluated on its own merits.

The evaluation of lighting intensity and uniformity for the underpass and adjacent highway should be made under both daytime and nighttime conditions. When the length of the structure limits the amount of light from natural daylight or adjacent luminaires located outside the structure, the need for lighting units should be evaluated. Factors to consider include lighting design criteria ***(see Chapter 1140)*****,** the extent, if any, that shadows are produced, and the extent, if any, that lighting intensity and uniformity are compromised. The limited adaptability of older drivers to changes in illumination should also be a factor in determining the need for lighting.

Determination of the need for lighting units for new construction should be made on the basis of design criteria as well as direct comparisons with existing underpasses, to assure consistency of underpass lighting treatment within an area.

Additional guidance is available in the latest version of **ANSI/IES Recommended Practice for Tunnel Lighting (RP-22)**, the **AASHTO Roadway Lighting Design Guide (GL-6),** and the **NFPA Standard for Road Tunnels, Bridges, and Other Limited Access Highways (NFPA 502).**

1103.6.9.2 Tunnels

All ODOT design projects should require use of the **TEM** and **RP-22** for tunnel lighting design. This requirement should be in the project **Scope of Services**. Lighting design assistance for underpasses and tunnels is available from the Office of Roadway Engineering.

The definition of a “tunnel” can vary, depending upon the particular engineering application and standards documents referenced. For highway lighting, ODOT defines a tunnel using definitions very similar to the definition in Chapter 5 of the **AASHTO Roadway Lighting Design Guide (GL-6)**.

> **Tunnel**: A structure of any type that surrounds a vehicular roadway and is longer than an underpass (e.g., greater than 75 feet), and requires supplementary daytime lighting.

Short Tunnel: A tunnel is considered “short” if its length from portal to portal is equal to or less than the wet-pavement minimum stopping sight distance (**SSD**) as recommended by the **AASHTO Policy on Geometric Design of Highways and Streets** for the vehicle operating speeds of the tunnel roadway and approaches. A short tunnel has only one lighting zone.

Long Tunnel: ODOT defines a “long” tunnel as one whose length from portal to portal is greater than the wet-pavement minimum stopping sight distance (**SSD**). A long tunnel has two or more lighting zones.

1103.6.9.3 Warrant for Daytime Tunnel Lighting

Designers should use RP-22 Chapter 6 by default for tunnel lighting design. However, for Short Tunnels only, ODOT allows the following alternative procedure to help determine if the installation of daytime lighting is warranted. This procedure derives from the **AASHTO Roadway Lighting Design Guide (GL-6),** Chapter 5, and the **British Standard Code of Practice for the Design of Road Lighting Part 2 (BS 5489-2:2003)**, Annex C. This procedure is generally simpler than the RP-22 procedure and suitable for low-speed, low-traffic-volume applications. ODOT accepts this design method only with approval from the **Office of Roadway Engineering**, and usually only for lower design speeds.

1. Assume the entire tunnel entrance portal is in view from the perspective of an approaching motorist. Place the driver no closer than one Stopping Sight Distance **(SSD)** from the entrance portal. That gives the driver ample distance to stop if there is a visible obstruction in the tunnel without passing into the entrance portal.
2. Create a perspective drawing from the driver’s point of view that shows both the entrance and exit portals. Calculate the area ratio of the exit portal to the entrance portal from this drawing.
   a. For approach speeds of less than 35mph, if the exit portal area is less than 50% of the entrance portal area, daytime lighting should be installed.
   b. For approach speeds of 35mph or more, if the exit portal area is less than 80% of the entrance portal area, daytime lighting should be installed.
   c. Curvature of the structure must be considered. Some structures, such as curved underpasses, will warrant daytime lighting at shorter lengths than similar straight structures.

1103.6.9.4 Need for Tunnel Fire Protection

All ODOT design projects should require use of the **TEM** and **NFPA 502** for tunnel fire-protection design. This requirement should be in the project **Scope of Services**. Fire protection can include both alarm and suppression facilities. Contact the **Office of Structural Engineering** and the **Office of Roadway Engineering** for assistance. Additional design information on fire protection is located in 1140-4.6.

It is important to note that the **Authority Having Jurisdiction** (**AHJ**) determines the applicability of **NFPA 502** to a given structure. As defined by **NFPA 502**, the **AHJ** is a broad term. The **AHJ** typically includes a local fire department as well as ODOT, and sometimes includes other agencies.

NFPA 502 Table 7.2, Road Tunnel Fire Protection Reference, is a convenient tabulation of Fire Protection System requirements. Copies of the table are available from the **Office of Roadway Engineering.** Both planners and designers should consult this Table whenever a tunnel of any length is part of a project. **NFPA 502** categorizes tunnels by length. Most tunnels in Ohio will be NFPA Category X (less than 300 feet) or Category A (between 300 feet and 800 feet). Planners and designers should note that a Category A tunnel carries a mandatory requirement for a fire protection standpipe and water supply.

1103.6.9.5 Need for Tunnel Traffic Control and ITS Devices

NFPA 502 has requirements for traffic control devices to stop approaching traffic during certain events (e.g., a fire). This may include traffic control devices on the adjacent roadway network. Contact the **Office of Roadway Engineering** for assistance.

In addition, there is often a need for CCTV tunnel monitoring cameras and other devices requiring integration with ODOT's ITS architecture, such as Dynamic Message Signs and Ramp Signals. Contact the **Office of Traffic Operations** for assistance. Additional design information on traffic control and ITS devices is located in 1140-4.6.

1103-6.10 Long, High Bridges

Bridges have a tendency to freeze before the roadway and typically do not have the clear zone recovery areas of adjacent pavement. Roadways on bridges of such height and length that the normal highway background reference is lost against the sky or water can benefit from highway lighting even though the adjacent roadway is unlit.

1103-6.11 Rest Areas

Rest areas have a considerable mixing of both vehicle-to-vehicle and vehicle-to-pedestrian traffic. Therefore, parking lots and sidewalks between parking areas and service buildings should be lighted for night use. The "green space" surrounding the parking areas and service buildings should have security lighting for the protection of motorists and for deterrence of unauthorized or criminal use.

Rest areas which are characterized by high exit speeds from the roadway, served by long ramps from the exit to the parking areas, and/or with considerable truck parking along the ramps should have fully lighted ramps. These types of conditions are commonly found at rest areas along freeways, but may be found on other highways. Higher exit speeds and the presence of large trucks parking along the ramps, legally or otherwise, create the need for special care in the placement of the poles and luminaries. The poles should have sufficient offset from the ramp pavement to prevent pole knockdowns by tractor-trailers attempting to parallel park. Luminaries should extend over the ramp pavement to eliminate shadows from parked trucks which would obscure ramp pavement and pedestrians walking along the ramp.

Rest areas which are characterized by lower exit speeds, served by driveways or shorter ramps, and without truck parking, should normally not require lighted driveways. These types of conditions are commonly found at rest areas located on highways other than freeways. Lighting should be provided at the intersections of the driveway and the highway. Lighting should be considered when the driveways are of extreme length or large truck parking occurs along the driveway.

1103-6.12 Miscellaneous Lighting

There are other unique applications where lighting may be considered which are not detailed by this Manual, such as for landscaping or for architectural and aesthetic considerations.

1104 CONSISTENCY OF TREATMENT

1104-1 General

Lighting warrants and guidelines are discussed in general in ***Chapter 1103*** and the warrants for freeways and interchanges are specifically addressed in ***Table 1197-3***. The purpose of warrants is to justify lighting at a particular location. The decision to actually install lighting, and to what extent, is dependent on many other factors, such as, **District** priorities, project cost and participation, available funding, public input, and economic benefits and public safety. It is also desirable to be consistent in treating similar situations in a similar manner. This desire for consistency makes the **DSLP** approach described in ***Chapter 1101*** particularly helpful.

1104-2 System Consistency

The **District System Lighting Plan (DSLP)** and **Statewide System Lighting Plan (SSLP)** described in ***Chapter 1101*** should be used to promote and insure a consistent and systematic treatment. The **DSLP** graphically displays lighting information, and allows those familiar with the locations in the area covered by the map to easily find the disparities between similar locations and to determine the action required to mitigate any disparities.

1104-3 Fixture Consistency

In all areas where **ODOT** is responsible for the operation and maintenance costs (whether directly or by reimbursement agreement) of highway lighting, the standard design should be based upon a High Pressure Sodium (HPS) light source employed at the highest practical mounting height consistent with the geometry and land use of the area being lighted.

In other areas, such as along service roads or city streets, where a local jurisdiction will be responsible for operations and maintenance costs, they may request use of other light sources to maintain consistency with existing street lighting systems. However, in view of the emphasis on energy conservation, extensive use of light sources other than HPS should be discouraged ***(see Section 1130-6)***.

Intentionally blank.

1105 LEVELS OF LIGHTING

1105-1 General

For purposes of discussion, various levels of lighting service have been identified and are described in the following sections. General warrants and guidelines for highway lighting are discussed in ***Chapter 1103.*** The warrants for freeway and interchange lighting are shown in ***Table 1197-3***.

1105-2 Continuous Freeway Lighting (CFL)

This type of lighting is the installation of fixed light sources along a section of freeway to provide uniform illumination along its length. This type of lighting is more desirable in urban areas where development exists and traffic speed changes occur due to diverging and merging lanes. Continuous freeway lighting should be designed to provide initial horizontal illumination levels as prescribed in ***Chapter 1106.***

1105-3 Complete Interchange Lighting (CIL)

This type of lighting is used to provide uniform lighting throughout an interchange, including all points of the diverging and merging traffic lanes, turn lanes and mainlines within the interchange. Interchange lighting should be designed to provide initial horizontal illumination levels as prescribed in ***Chapter 1106***.

1105-4 Intermediate Interchange Lighting (IIL)

Intermediate interchange lighting is a design in which the initial lighting units to be installed are considered to be the preliminary stage of a complete lighting system. Intermediate interchange lighting should be considered in urban, and occasionally rural, areas where complete interchange lighting is not yet warranted under ***Table 1197-3.*** This type of lighting should be utilized if there is reasonable probability that complete interchange lighting (CIL) will eventually be warranted based on the land use guidelines in ***Table 1197-3***. Consequently, lighting designed under this procedure should complement eventual complete interchange lighting. Thus, the lighting layout for each interchange under this scenario should include the future proposed light locations.

1105-5 Partial Interchange Lighting (PIL)

Partial interchange lighting differs from complete and intermediate interchange lighting in that later stages of more fully developed lighting are not anticipated during the expected life of the initial system. Partial lighting will generally occur in rural areas, and occasionally urban areas. Lighting provided under this concept will generally be limited to diverging lanes, merging lanes and ramp intersections. Lighting intensity and uniformity under ***Section 1106-2*** will not be satisfied.

Intentionally blank.

1106 LIGHTING CRITERIA

1106-1 General

The following sections reflect design values for illuminance levels. There may be conditions under which somewhat different levels are desired or necessary. The lighting designer should use all available pertinent information in reaching a decision regarding the level to be used for any specific street or highway.

There are many locations where very high levels of illuminance are provided for streets in the central business district. The reason is usually a commercial consideration directed towards making the downtown business area more appealing to shoppers. Generally, levels considerably higher than those shown in ***Table 1197-4*** (which is based on **AASHTO** criteria) must be justified on some basis other than solely for the safe and efficient flow of traffic.

1106-2 ODOT Lighting Criteria

1106-2.1 General

The following criteria should be used for **ODOT** highway lighting projects. However, since projects may be developed for special purposes, and since **FHWA** reserves the right of approval on an individual project basis, the designer should coordinate proposed criteria with the **Office of Roadway Engineering** early in the development of planning for highway lighting.

1106-2.2 Intensity

The initial average intensity for lighting **ODOT**-maintained freeways shall be 1.0 to 1.2 footcandles, and all lighting design should attempt to approximate the 1.2 value without exceeding it, except where this limitation results in an unacceptable uniformity ratio as specified in ***Section 1106-2.3***. For non-freeway lighting, reference should be made to ***Table 1197-4*** for recommended average maintained horizontal illumination levels.

1106-2.3 Uniformity

The design uniformity ratio for interchange lighting or for continuous freeway lighting shall be between 3:1 and 4:1. However, where partial or intermediate interchange lighting is being designed, it is obvious that the desired uniformity cannot be obtained until all initially-omitted lighting units are installed in accordance with a complete interchange lighting plan based upon the stated design ratios.

The 3:1 ratio of uniformity is acceptable in all cases, and the 4:1 ratio should not be exceeded. Tower lighting is typically in the range of 2:1 to 3:1.

1106-3 Local Criteria

Various jurisdictions may have different criteria from what is listed in this Manual. The local jurisdiction must provide **ODOT** with the approved policy, ordinance or established standard and obtain approvals prior to the beginning of the design of the project.

Intentionally blank.

1107 GUIDELINES FOR REDUCTION/REMOVAL OF EXISTING LIGHTING

1107-1 General

Where an existing highway lighting system is no longer warranted or cost effective, it should be considered for either a reduction in the lighting level or removal of the lighting. Where light levels are reduced, they should not be reduced below the criteria for partial interchange lighting.

After the decision has been made to remove or reduce the lighting system, the appropriate lights should be turned off but left in place for a period of one to four years. For all highway lighting systems, an accident analysis study will be required during this time period to determine the effects of the reduced lighting.

1107-2 DSLP Evaluation

If an existing lighting system is not cited in the **DSLP** as a location that should be lit, or is lit to a greater extent then what the **DSLP** recommends, the location should be studied. If the guidelines recommend partial or no lighting, the lighting should be reduced to the level specified in the **DSLP**.

1107-3 Change in Land Use

At an interchange, where a major traffic generator has permanently closed or other significant highway or land use changes have occurred, the existing interchange lighting should be studied for meeting the lighting guidelines. If the guidelines are not met, the lighting system should be reduced or removed as specified in the **DSLP**.

1107-4 User Objections

1107-4.1 General

If a substantial percentage of residents and local business owners are objecting to the lighting, verification shall be made that the lighting guidelines are still met and that the lighting coincides with the **DSLP**.

1107-4.2 Existing Complete Interchange Lighting

If the warrants for complete interchange lighting ***(Table 1197-3)*** are met and the **DSLP** recommends complete interchange lighting in this area, other methods should be investigated for reducing the lighting impact outside of the right-of-way (i.e., glare shields). If the guidelines for partial interchange lighting are met or the **DSLP** recommends it, the location should be reduced to partial interchange lighting.

1107-4.3 Existing Partial Interchange Lighting

If the warrants for partial interchange lighting ***(Table 1197-3)*** are met and the **DSLP** recommends lighting, other methods should be investigated for reducing the lighting impact outside of the right-of-way (i.e., glare shields). If the warrants are not met, or the **DSLP** does not recommend lighting in this area, the lighting should be removed.

1107-4.4 Agricultural Areas

Some crops (notably soybeans) can be affected by light trespass. The physiological phenomenon, known as *photoperiodism*, is limited to small portions of agricultural fields near lighting installations. Typically, only high mast lighting installations create enough light trespass to affect agricultural crops. In Ohio, the only commodity agricultural crops affected by light trespass are soybeans (*Glycine Max*). This effect does not change the overall yield of the soybean field, but it does delay flowering, which subsequently delays maturity. The resulting non-uniform bean maturation within the field can result in difficult harvesting operations (combine clogging, delays in harvesting portions of the same field), higher average crop moisture readings (grain elevator moisture penalties), or drop losses in the unaffected beans if the producer waits for the affected beans to fully mature before harvesting the entire field. Producers can often modify their harvesting operations slightly to allow complete harvest of the affected field with no net loss: occasional partial or full-width combine swaths are made through the less mature areas of the field, thus mixing the higher-moisture grain with drier grain from combine swaths taken in more mature areas of the field.

The photoperiodic effect for soybeans is typically limited to within a few hundred feet of the base of a high mast light tower, so the total area affected within a typical agricultural field is quite small. The observed effect in Ohio is limited to areas of the field experiencing more than 0.1fc illumination. Therefore, ODOT recommends that lighting designers allow no more than 0.1fc of light trespass into adjacent agricultural fields. Asymmetric luminaires, shields, tilting of luminaires, use of low-mast or conventional supports, and careful placement of high mast supports can all be used by designers to meet this trespass criterion.

1120 MATERIALS AND HARDWARE

1120-1 General

There are several different types of hardware available for highway lighting. All new **ODOT** owned and maintained lighting systems should be three-wire grounded design. Also, highway facilities that are **ODOT**-maintained should utilize the standard lighting hardware of high-mast, low-mast or conventional poles.

1120-2 Patented or Proprietary Materials, Specifications or Processes

The use of patented or proprietary materials, specifications or processes is discussed in ***Section 120-4***.

1120-3 Purchasing Materials for Installation and Use by Local Agencies

To help encourage uniformity and provide a method whereby local agencies can buy traffic control materials and equipment using Federal funds, ***Sections 120-4 and 120-5*** describe processes that have been established whereby local agencies can purchase such items through **ODOT**.

1120-4 Aesthetics

The area that is to be lighted should be considered when a lighting project is initiated. If a project will only affect a small portion of an existing lighting system, (i.e., one or two poles) the same brand of hardware and luminaire should be specified in the plan. If a project will effect a larger portion of an existing lighting circuit (i.e., one or more circuits), the designer should evaluate the situation, and with the agreement of the maintaining agency, require either that:

1. Use the same brand of hardware and luminaire as the existing lighting system; or
2. Replace the entire existing system with a different brand of hardware and/or luminaire.

This will prevent a lighted area from having different lighting patterns resulting from the use of different brands of luminaires and also prevent a lighted area from having different styles of poles.

1120-5 Local Preferences

See ***Section 120-4*** for more information about local preferences and proprietary bids.

In order to be in compliance with **C&MS 106.09** (domestic steel), the **Office of Materials Management** has created an Approved List for decorative steel light poles. Only poles listed may be specified for decorative lighting. There are no exceptions for projects that use Federal and/or State monies. The use of alternate or proprietary bids does not provide an exception. Foundations and conduits for non-approved poles that would be provided by the locals at their own cost are not eligible for participation.

1120-6 Operating Voltage

In 600 volt class circuits, the line to line voltage may not exceed 600 volts and the line to ground voltage may not exceed 300 volts. Industry standard voltages are, therefore, 120, 208 and 277 volts line to ground and 240 and 480 volts line to line. Highway lighting power drops from the utility company are generally single phase, thus the practical operating voltages are limited to 120 or 240 volts line to ground and 240 or 480 volts line to line.

When a three-phase service from the power company feeds the lighting control center, designers shall limit load imbalance to 15 percent or less of the total connected load kVA.

1120-7 Ballasts

Where ballasts are to be wired line to line (three-wire system), ballasts having an isolated primary winding must be used. Where ballasts are to be wired line to ground (two-wire system), auto-transformer ballasts may be used. When the use of other than conventional (i.e., ovate or cobra head) or high-mast or low-mast luminaires is contemplated, and the luminaire is to be wired line to line, the vendors should be contacted and ask to confirm in writing that the luminaires under consideration are available with a ballast having an isolated primary winding.

1120-8 Solid-State (LED) Luminaires

ODOT has specifications and an Approved List for Solid-State (LED) Luminaires for highway lighting. These specifications are given primarily by **Supplemental Specifications** **813 and 913**. Procedures for manufacturers and vendors to get Solid-State (LED) Luminaires onto the Approved List are documented in **Supplement** **1114**. The Approved List is published by the **ODOT Office of Materials Management** on their website.

1130 PLANNING / PROGRAMMING

1130-1 General

The following sections are provided to assist planners and designers in developing standard uniform lighting systems. These sections discuss various aspects of lighting that should be taken into account when planning new, or rehabilitating existing, lighting systems. The following are guidelines and are not meant to override a planner's engineering judgment.

1130-2 Programming of Projects

Before a lighting project is programmed, whether alone or in conjunction with a roadway project, a preliminary study should be completed. A preliminary study should include the following: Verifying that the project meets lighting warrants where available and is in conformance with the **DSLP** ***(Chapters 1101 and 1103)***; verifying what types of funding will be used ***(Section 1130-3)***; deciding what type of lighting is to be used ***(Chapter 1120)***; verifying who will maintain the system ***(Chapter 1102)***; and deciding what type of power supply is to be used ***(Section 1120-6)***. For temporary lighting see ***Part 6***.

1130-3 Funding Considerations

1130-3.1 General

The programming should specify all funding types used on the project. Federal funding for highway lighting is governed by **FHWA** policy. In general, highway lighting is eligible for Federal participation when warrants and criteria satisfy **AASHTO** and **ANSI** requirements ***(see Chapter 1106)*** and the project is on a Federal-aid highway system. There may also be occasional special programs involving Federal aid which require approval from offices other than the **Ohio Division Office of FHWA**. Under such circumstances, it is essential that requests for participation be initiated at the programming stage. **State** participation in lighting projects shall be as specified in ***Section 1130-4***.

1130-3.2 New Installation

If the proposed lighting system is in more than one funding jurisdiction, all agencies must agree in writing on their portion to be paid. For example, if an interchange that is to be lighted is within the boundaries of two incorporated areas, the funding would typically follow the corporation boundaries. If only a small portion of an interchange is in an incorporated area, an attempt should be made in the design of the lighting to avoid placing any material or equipment within this area.

1130-3.3 Upgrade/Retro-fit

If the existing lighting system is in more than one maintenance jurisdiction, all agencies must agree in writing on their portion to be paid. Any changes in corporation limits from the original installation should be reflected in the funding split of the project and in the new maintenance agreement. It should also be remembered that lighting circuits do not necessarily stop at the project limits and therefore the project's lighting needs may be greater than expected if only the area inside the project limits is considered.

1130-3.4 Maintenance

If the existing lighting system is in more than one maintenance jurisdiction, each jurisdiction should have independent circuits that do not trespass into other jurisdictions. Each jurisdiction should have a separate control center. The maintenance agreements should be initiated in the planning stages.

1130-4 State Participation

ODOT participation in highway lighting projects shall be as follows:

1. On limited-access highways and freeways, **ODOT** will participate in the cost of all lighting system items that are necessary to complete the lighting system. **ODOT** participation will be limited to the cost of a system to provide an average initial intensity in the range of 1.0 to 1.2 foot candles. If a system to provide higher intensities is provided at the insistence of any political subdivision, the added cost of construction and maintenance resulting therefrom shall be borne by that political subdivision.

2. Existing lighting systems on crossroads and streets which cross limited-access highways and freeways without interchange facilities will be rearranged and/or replaced with similar styles and types of systems and equipment to provide a light intensity equal to that provided by the existing system. However, if the rearrangement of the existing road or street creates a need for a greater intensity for the safety of the traveling public, or requires changes in types and styles of system and equipment, modifications to the extent necessary to meet such need and requirements may be included subject to approval by the **Assistant Deputy Director of the Development Design Administration**.

3. On major improvements of existing highways within municipal corporations, existing lighting systems will be rearranged or replaced, if necessary, to restore light intensities to those previously existing, and in any event, to provide not less than the minimum average maintained intensity as recommended by **AASHTO** for expressways and highways, and as established by **ANSI** for urban streets.

4. **ODOT** participation in the eligible costs of such construction, rearrangement, and replacement will be the same as **ODOT** participation in the other construction costs of the project.

5. **ODOT** will not participate in the cost of extensions and betterments to existing publicly-owned lighting systems included in the **ODOT** construction contract at the request of a municipality or other political subdivision.

1130-5 FAA Requirements

The programmer shall verify the location of the project in relation to all airports or heliports. If the project is within a 20,000 feet radius of a public-use or military airport or heliport, the programmer shall perform an Airway/Highway Clearance Analysis to determine if **FAA** notification is required **(see L&D Manual Volume 3, Section 1404.1)**.

1130-6 Light Fixtures

As noted in ***Section 1104-3***, the standard design for highway lighting on **ODOT**-maintained facilities should be based on High Pressure Sodium (HPS) fixtures.

Where a municipality desires to maintain aesthetic consistency for existing street lighting systems by using distinctive unit designs or by painting light poles, specific justification for such designs shall be submitted for **ODOT** approval before Federal funds are authorized. In general, such justification must demonstrate that the municipality is not requesting Federal funding for designs which exceed the **City** standard, and that the distinctive design is used consistently through a reasonably large or historical area within the **City**.

1130-7 Maintenance Concerns

Prior to the programming of the lighting project, the programmer should verify that the **City** or **Village** will be able to maintain the lighting. Typically small **Cities** and **Villages** have lighting provided for and maintained by the local power company. Prior to the programming of a project to replace the existing utility-maintained lighting with **City** or **Village**-maintained lighting, **ODOT** should verify that the **City** or **Village** is capable of maintaining the proposed lighting or that they are willing to contract out the maintenance of the proposed lighting.

1130-8 Scope Preparation for Specific Projects

For each intersection, interchange and roadway affected by the project, the highway lighting should be described as it is to be upon the completion of the project. It should be stated whether the new lighting is to be part of the project or provided by others in conjunction with the project, including a statement that there is to no lighting at the particular intersection or interchange, or on the roadway section if that is the case.

Intentionally blank.

1140 DESIGN INFORMATION

1140-1 General

Chapter 140 provides general background regarding design information for **ODOT** projects, including the three-stage review process typically used for traffic control plans. Additional information about lighting design has been provided in this Part.

This Chapter provides the designer with information to satisfy the requirements of **ODOT** relative to highway lighting construction plans. It is not intended to substitute for nationally-accepted criteria and standards nor to relieve the designer of the responsibility for using personal skills and ingenuity in developing the best possible plan for a specific project. Rather, it is intended to supplement more formal design references and knowledge by explaining policies, criteria, design considerations and plan procedures which experience has indicated are pertinent to the state highway system.

1140-2 General Theory

To properly understand the effects of roadway lighting, one must have a basic understanding of the theory of lighting and the design of roadway lighting. The following sections will outline some basic theory and design principles followed by plan preparation elements. Those wishing to gain a fuller understanding of lighting theory should consult the **Illuminating Engineering Society (IES) of North America's American National Standard Practice for Roadway Lighting ANSI/IES RP-8**.

1140-3 Lighting Theory

1140-3.1 General

The act of seeing involves three separate elements: the eye, the visual task and light. Light emitted by a source strikes an object, the object reflects some of the light toward the eye, and the object is seen. Except when light sources themselves are being observed, seeing is by reflected light. Light which enters the eye directly from the source is of no value in the effort to see an object; in fact, it will actually impair vision.

At the low levels of illumination involved in highway lighting, objects are often seen by silhouette rather than by light reflected from the object itself. In this case, the primary concern is surrounding or background brightness, rather than illumination or brightness of the object. For maximum effectiveness, discernment by silhouette depends upon the degree of brightness difference, or contrast between the object and its background.

In highway lighting, as contrasted with interior lighting, the objects to be perceived are relatively large, and visual acuity, or the ability to distinguish fine detail is not involved as a general rule. The most important objective is to create or enhance the brightness contrast between an object and its background, or the roadway surface itself. In all highway lighting, objects are made visible by a combination of two or more methods of discernment. For example, on a well-lighted highway:

1. Distance objects are seen by direct silhouette.
2. Projections above the pavement (the upper portions of pedestrians and vehicles) usually are seen by reverse silhouette.
3. Traffic signs and very close objects are seen by surface detail.
4. Many objects produce glint or highlights on irregular or specular surfaces.

The same light that produces visibility on the highway also produces a negative result known as glare. Glare is any brightness in the field of view that causes discomfort, annoyance, eye fatigue or interference with vision. It may best be described as negative light or light out of place. Glare is a function of intrinsic brilliancy, candlepower toward the eye, distance, contrast, and angular displacement with the line of sight.

Roadway luminaires are classified by the way they transmit and distribute light. The use of various types of reflectors and refractors permits the lighting designer to produce an efficient and aesthetic design. Luminaire classifications are defined in terms of vertical light distribution, lateral light distribution, and the control of distribution above maximum candlepower, known as cutoff. Vertical and lateral light distributions apply primarily to the shape of the roadway area to be illuminated. Both of these distributions can be important when determining the amount of light trespass from a source. ***Figure 1198-1*** illustrates five basic lateral distributions of highway lighting fixtures.

The control of the distribution above the maximum candlepower, known as the cutoff, is important for determining the amount of glare emitted by a fixture. A non-cutoff roadway fixture typically has a dropped lens (a refractor). This allows the light to be more easily distributed from the fixture and permits the illumination design to be less precise; however, it produces more undesirable glare. A full cut-off fixture typically has the dropped refractor replaced with a flat glass, while the reflecting elements inside the fixture have been redesigned to provide control of the light output. This provides much better glare control; however, the illumination design must be much more precise to maintain lighting uniformity. ***Figure 1198-2*** illustrates the effect of non-cutoff and full cut-off luminaires.

The **Illuminating Engineering Society (IES)** is the recognized authority for the setting of various illumination recommendations, including those for roadway lighting. These standards, as listed in **ANSI/IES, RP-8**, have been well researched and established as the minimum requirements for the safety of roadways. Several studies have been undertaken in recent years involving test targets placed on roadways. The **IES** standards have been confirmed during these studies as the minimum requirements for proper illumination with respect to stopping sight distances. To give some idea of the scale of illuminance required for various roadways refer to ***Table 1197-4***.

1140-3.2 Illuminance

1140-3.2.1 General

Illuminance (or illumination level) is defined as the amount of light being transmitted upon a certain area. The English unit for illuminance is the footcandle, which is equal to one lumen per square foot. Illuminance is governed by the inverse square law. The illuminance of an area or object diminishes as the square of the distance.

Highway lighting is generally designed as the illuminance of the area in question. It is based on the premise that, by providing a given level of illumination and a uniformity of distribution, satisfactory visibility can be achieved. The basic calculation for roadway illuminance is as follows:

$$E_{ave} = \frac{(L \times CU \times LLF)}{S \times W}$$

Where:

E_{ave} = average illuminance of the area in horizontal footcandles
L = luminous flux of the source in lumens
CU = coefficient of utilization of the luminaire (obtained from a photometric data chart supplied by the manufacturer and dependent on the width of the road and the mounting height)
LLF = light loss factor (the amount of light that will be lost over time due to dirt accumulation on the luminaire and lamp depreciation - typically 0.7 to 0.8)
S = spacing of the streetlight poles
W = width of the pavement to be illuminated

For example, a roadway with a pavement width of 33 feet and a light pole spacing of 164 feet utilizing a luminaire which has an output of 25,000 lumens, a coefficient of utilization of 45 percent, and a light loss factor of 70 percent will have an average illuminance of:

$$I = \frac{25000 \times 0.45 \times 0.7}{164 \times 33} = 1.46 \text{ footcandles}$$

1140-3.2.2 Point-by-Point Analysis

Point-by-point calculations are used to determine the illuminance at a specific location from a “point” source of light. This assumes the source behaves as a point source; consequently, this method cannot be used for linear and area sources. This computational process utilizes a candlepower distribution curve. The inverse square law is used to determine from the values on the distribution curve the levels of illumination at various points on the interchange or area to be lighted.

The illumination in horizontal footcandles at a grid point resulting from one high-mast assembly can be computed by using the formula:

$$E_h = \frac{cp \cos \theta}{d^2}$$

Where:

E_h = illumination at the point in horizontal footcandles
cp = candlepower at angle θ
θ = the angle from the vertical axis through the system to the point in question
d = the distance from the light source to the point in questions in feet

The total illumination at each of the grid points is the sum of the contributions of illumination from the high-mast assemblies within an effective range of the point in question.

Because of the time involved with hand calculations in the point-by-point method, and due to the number of trials which may be required, the point-by-point method is usually accomplished by computer. Generally, computer programs are built around the point-by-point method. Manufacturers have these type programs available and will normally provide design layouts.

1140-3.3 Luminance

1140-3.3.1 General

Luminance is the brightness of an object that has been illuminated by a source. The luminance of an object depends on its material characteristics and reflectance. For example, under the same illuminance conditions a dark object will look less bright than a light object. Since luminance refers to the amount of light reflected back by an object, this object in effect acts as a new source. There is a direct relationship between the luminance of a viewed object and the resulting illuminance of the image on the retina of the eye. The unit of luminance is the footcandle.

Highway lighting may also be designed by calculating the luminance of the roadway surface. This involves determining the reflective properties of the pavement, which can vary dramatically depending if the surface is concrete or asphalt. Although considered superior to the illuminance method, the luminance method is complex and because it involves reflective properties of the pavement, is subject to change over time due to aging of the pavement as well as change associated with weather.

1140-3.3.2 Small Target Visibility (STV)

The visibility of an object is that property which makes it discernable from its surroundings and depends on a combination of the following factors: (1) the difference in luminance between the object and its immediate background (contrast); (2) the angular size of the object at the eye of the observer; (3) the luminance adaptation level to which the eye is exposed; and (4) the duration of the observation. The object that is used for STV is a 7 x 7 inch target. The observer is located on a line parallel to the centerline of the roadway at a distance of 273 feet. Using the four measurements stated above and a series of equations, the visibility level (VL) of the target can be calculated. Visibility models must also incorporate age-related changes in visual processing efficiency that have notable effects on target visibility.

STV is included in the **IES Recommended Practice (RP) 8**, as one of three methods for demonstrating compliance. Until further study and development of computer programs to more definitively analyze the various factors affecting the visibility level (VL) of the target, **ODOT** continues support of the illuminance method.

1140-3.4 Headlamps

If we drive in an “empty” road situation (i.e., just one car on the roadway), a proper level of STV is all that is required. High beam headlights produce a very low level of pavement luminance at 200 to 300 feet ahead, yet we can drive quite safely with them as long as we are the only car on the road. The same light that produces visibility on the highway, also produces a negative result known as glare.

In the driving task the most commonly experienced glare is probably that from approaching headlamps on an unlighted highway. The effect is one of shock; the eye has been adapted to relatively low brightness and suddenly is confronted with an extremely bright source, often close to the normal line of sight. The effect may be sufficiently severe to contract the iris, which further reduces the ability to see. The same headlamp fails to glare when encountered in the daytime, although its candlepower is the same day and night. The glare effect is due to excessive brightness contrast, because of the dark surroundings at night.

When the roadway is not “empty,” a reasonably high level of pavement luminance is essential to reduce the adverse effect of glare from the headlights of oncoming vehicles. An adequate level of STV can be achieved with fixed lighting, which also provides much higher level of pavement luminance than do headlights alone.

1140-3.5 Middle Third

The preferred location for overhead sign supports is in the middle third of the design spacing for the lighting units. When the desired location criteria for a sign support does not result in its falling within the preferred area, the following minimum separation between overhead sign installations and lighting units should be maintained:

Mounting Height for Lighting Unit Feet	Minimum Separation Feet
32.5	40
40	60
50	90

If the lighting unit or the sign support locations cannot be adjusted to maintain the above minimum separation, the lighting unit may be placed immediately in advance of the sign support when a 40 or 50-foot mounting height is used for lighting. However, such a position cannot be used effectively for a 32.5-foot mounting height, and consideration should be given to raising such mounting heights for several units in the general vicinity of the sign support.

1140-3.6 Illumination Criteria

1140-3.6.1 General

In designing a new highway lighting system, the quantity and quality of illumination must first be established.

1140-3.6.2 Average Illumination

The quantity of illumination is that average illumination level which has been established through experience in the lighting profession that represent economic and practical restraints. The quantity of light is referred to as the "average maintained horizontal illumination" and is a function of the classification of the roadway and the area which is served by the lighting system. Breaking this term into its parts, the first term, "average," refers to the method of measuring the illumination level, and means that this is a mean value of all points within the area being lighted. The second term, "maintained," refers to the illumination value at some point in time after the system is installed. Maintained illumination takes into account reductions in luminous output due to factors such as lamp lumen depreciation (LLD factor) and luminaire dirt depreciation (LDD factor). Thus, a lighting system begins within an initial illumination level and depreciates to some level less than this. For this reason, the initial design level of illumination is higher than the maintained value. The final term, "horizontal," refers to the surface on which the illumination is measured, in this case, a horizontal plane, such as the roadway surface.

Average maintained illumination levels currently recommended by the **IES** for various areas and facilities are shown in ***Table 1197-4***.

1140-3.6.3 Uniformity

The illumination concept of lighting design defines an average quantity of illumination over the pavement surface. This average quantity of illumination can, however, be accomplished by either producing a generally uniform level of illumination over the area or by producing relatively high and low areas of illumination. The latter is not desirable. As a driver passes through areas of relatively high and low illumination levels, his eyes must adapt.

The uniformity of illumination is considered a qualitative means of defining highway lighting. The term used to quantitatively describe uniformity is the uniformity ratio. As the name implies, it is a ratio of various illumination values. Current practice makes use of the Average Level-to-Minimum Point method (average-to-minimum ratio) of calculating uniformity, in which the average illumination is divided by the lowest illumination point encountered within the traveled portion of the roadway. For example, a street with an average illumination level of 2.0 footcandles and a minimum point of 0.5 footcandle would have an average/ minimum uniformity ratio of 4:1. Current **ODOT** criteria requires 3:1 or better for high speeds and high conflict areas, and 4:1 for low speeds and low conflict.

The Maximum-to-Minimum Point method uses the maximum and minimum values within the traveled portion of the roadway. It is felt that the use of a maximum/minimum uniformity ratio more accurately portrays the degree of uniformity, because it takes into account the full effects of the differences of illumination on the lighted roadway. Current **ODOT** criteria requires a 10:1 or better max/min uniformity ratio.

1140-3.7 Critical Location

Roadways have many areas where the problems of vision and maneuvering of vehicles are complex and require lighting units at critical locations. These locations are in addition to what are commonly called key unit locations at intersections, acceleration and deceleration lanes, underpasses, overpasses, pedestrian bridges and on structures. Key and critical unit locations must be identified for each project prior to developing a traditional (non-high mast) layout where light poles are relatively close to the traveled way. These locations are the basis for the ultimate design with additional units filling in the gaps. See ***Sections 1140-4.4 and 1140-4.6*** for specific information.

1140-4 Luminaires and Sources

1140-4.1 General

The design of a highway lighting system involves consideration of visibility, economics, aesthetics, safety and environmental conditions, as well as appropriate material and equipment. The first major step in the design process involves the selection of tentative luminaires and light sources and the selection of one or more tentative lighting system geometric arrangements (conventional or high mast), including mounting heights and lateral luminaire positions, that may provide an acceptable design based on the required uniformity criteria (i.e., average maintained footcandles, ave/min uniformity ratio and max/min uniformity ratio).

As noted in ***Section 1120-8***, **ODOT** has specifications and Approved Lists related to various types of luminaires.

1140-4.2 Luminaire Placement

1140-4.2.1 General

On freeways or expressways, through lanes normally should be lighted with luminaires having **IES** Type III medium semi-cutoff distribution as discussed in the **American National Standard Practice for Roadway Lighting (RP-8)**, published by **ANSI**. Ramps or directional roadways having two lanes or less should have **IES** Type II medium semi-cutoff distribution luminaires. The Type II distribution should generally be used where the pavement width is less than 1.25 times the mounting height. For wider pavements, the Type III distribution should be used.

ODOT-maintained lighting systems should use high pressure sodium or solid-state (LED) luminaires.

1140-4.2.2 High-Mast Lighting

High-mast lighting, or light towers, have frequent applications, especially in interchange areas and along major freeways. In **Ohio**, lighting units are considered to be high masted, or towers, when the height of the luminaires is 70 feet or more above the supporting foundation. The more obvious advantages of towers over conventional lighting units are as follows:

1. Because of their increased height and number of luminaires (up to six luminaires per tower), illumination distribution is improved to the extent that a single tower will usually replace from four to eight conventional lighting units. While the increased height of luminaires in itself does not necessarily guarantee lower disability glare, careful system design with towers can result in reducing glare and increasing comfort as the installation is approached and driven through. In general, greater uniformity of illumination can be achieved by a well-designed tower system.
2. Towers are significantly safer than conventional lighting units from the viewpoints of the road user and the maintenance forces. Since towers are located as far as practicable from traveled pavement, the opportunities for impact by errant vehicles are greatly reduced. Maintenance vehicles, equipment and personnel are remote from traffic lanes during servicing operations, which may eliminate the need for temporary traffic control devices and allow for complete concentration on maintenance activities, without fear of interference or distraction from moving vehicles. Since **ODOT** specifications require that towers be equipped with luminaire lowering devices, the most common maintenance operations are performed at ground level.

3. Daytime aesthetics are improved because of the fewer numbers of poles and their greater distance from the roadway.

C&MS Item 725.21 discusses detailed requirements for light towers, and the designer should be familiar with that specification when evaluating proposals relative to tower lighting.

1140-4.2.3 Solid-State (LED) Luminaires

For an LED lighting system, the designer shall strive to find three interchangeable solid-state (LED) luminaires. If this is not possible, it may be necessary to request a proprietary bid. ***Section 120-4*** describes the for approval of patented or proprietary materials. A Proprietary Bid Request for Solid-State (LED) Luminaires shall be made in writing to the **Office of Roadway Engineering's Traffic Control Engineer,** with a copy to the **District**. If the proprietary bid is not granted, and three interchangeable solid-state (LED) luminaires cannot be found, then three separate lighting designs (one for each luminaire) shall be submitted by the designer, each constituting an Alternate Bid. These shall be called Roadway Lighting Design A, B, and C, and shall apply project-wide. In addition to the three Alternate Bids, the designer shall specify one of the three designs as the generic bid. The generic bid design will generally be the design among A, B and C that has the highest luminaire count; this helps assure that the Alternate Bid designs can compete on their own merits, often on the basis of having a lower overall luminaire count or power consumption.

1140-4.3 Conventional

1140-4.3.1 General

ODOT projects scoped for lighting will generally specify whether conventional or high-mast units are to be used in the design. Currently, conventional units refer to a "cobra head" roadway fixture mounted on round tapered poles at a mounting height of nominally 30 to 50 feet. The units are widely used, readily available and economically attractive.

1140-4.3.2 Mounting Height and Wattage

The standard mounting height and luminaire rating combinations used by **ODOT** can be found in ***Table 1197-5***.

The designer should always check with the maintaining agency for mounting height and luminaire rating preferences due to replacement stock standardization.

The designer should also note that the mounting height and the support height (as defined in the HL Series of the **Traffic Standard Construction Drawings (SCDs)**) may differ, depending on the pole base type required, and affects the Item Description/Light Pole Design Number, used in the construction plan Lighting General Summary.

1140-4.3.3 Spacing

In designing a lighting system, maximizing spacing of luminaires consistent with good illumination design should be emphasized. From the standpoint of economy and safety, the minimum number of luminaires and supports should be used while satisfying the illumination quantity and quality criteria. Spacing of lighting units will be influenced by mounting heights, lamp sizes, luminaire arrangements, uniformity ratios, illumination levels (footcandles), and special roadway features such as variable pavement widths, sign supports, bridges and other structures, intersection, ramps and utility locations.

Luminaire spacing is calculated using the following equation:

$$\text{Luminaire Spacing} = \frac{LL \times CU \times LLD \times LDD}{E_h \times W}$$

Where:

LL = Initial lamp lumens
CU = Coefficient of utilization
LLD = Lamp lumen depreciation factor
LDD = Luminaire dirt depreciation factor
E_h = Average maintained level of illumination, footcandle
W = Width of lighted roadway, feet

As this formula is usable in both the English and metric systems of measure, either units can be used. The resultant luminaire spacing will, of course, be obtained in units corresponding to the system units used.

In general, luminaires should be located along the right in the direction of travel.

On undivided highways and streets, the use of one-sided arrangements should be limited to pavement having overall widths of less than 1.25 times the mounting height.

1140-4.3.4 Pole Location

1140-4.3.4.1 Lateral Placement

See **L&D Manual Volume 1, Section 600** for lateral placement requirements. Where guardrail is not provided, the normal offset distance of the pole from the edge of pavement may be the same as if guardrail were provided if frangible bases are used in accordance with the latest **AASHTO** safety requirements.

For improved safety, where the typical section of the roadway will allow a greater setback, poles should be located farther from the pavement edge, consistent with available bracket arm lengths and frangible base capacities.

1140-4.3.4.2 Bracket Arm Length

Currently, conventional light poles are available with extended bracket arm lengths of 18, 20, 25 and 30 feet. These are in addition to the standard lengths of 4, 6, 8, 10, 12 and 15 feet. Poles with increased arm lengths should not be used intermittently except in unusual circumstances, such as may occur in a flare guardrail area in which the guardrail is not readily adjustable to accommodate the lighting units. In general, in the interest of consistency, increased setbacks should not be used for less than 5 or 6 pole spacings.

The bracket arm length should normally be no less than the pole offset; however, in certain situations such as on the inside of a sharp curve (i.e., on a loop ramp), better distribution will result from setting the light source slightly inside the vertical projection of the pavement edge. The actual bracket arm length and pole offset from the pavement should be established after a careful review of the pavement geometry.

Typical bracket arm lengths for given pole offsets from the edge of pavement can be found in ***Table 1197-6***.

1140-4.3.5 High Mast

ODOT projects scoped for high-mast lighting generally utilize 400 watt high pressure sodium fixtures mounted on 70-foot or higher poles. Fixtures may be symmetric (**IES** Type V), asymmetric (**IES** Type II or III), or asymmetric “long and narrow” (**IES** Type I). Each high-mast pole supports two to six luminaires in a symmetrical arrangement. See **C&MS**

725.21 for additional information on luminaires for light towers.

1140-4.3.6 Low Mast

An **ODOT** project utilizing a low-mast lighting system is made up of 50-foot poles supporting single 400 watt high pressure sodium fixtures. The fixture is generally symmetric (Type V) and is supported by a Style III or "shepherd's crook" pole **(see Traffic SCD HL-10.11)** which is barrier-mounted between opposing lanes of traffic. This method is ideal for lighting sections of freeway with three to five lanes of traffic in each direction without the daytime "visual clutter" of twin-arm conventional units or the nighttime light trespass to areas adjacent to the roadway resulting from high-mast units.

1140-4.3.7 Decorative

Occasionally, a project will require the use of decorative poles and fixtures in order to maintain or establish the aesthetics of an area, such as replacement of a bridge in an area already utilizing fluted post-top units, or lighting the pedestrian/picnic areas of a rest area or Welcome Center.

Since most projects requiring decorative poles will be in an urban (i.e., curbed) area, the minimum offset to maintain 2 feet minimum lateral clearance from curb face will apply, with consideration given to overhead and underground utilities. Decorative post-top pole placement in the pedestrian/picnic area of a rest area varies with the individual layout, but an offset of 5 feet from the edge of the sidewalk is often used.

1140-4.4 Partial Lighting

1140-4.4.1 Interchange - General Information

Partial lighting is the process of lighting only the parts of the interchange that are considered most critical to the night driver. Partial interchange lighting implies that later stages of more fully developed lighting are not anticipated during the expected life of the initial system. Partial interchange lighting will generally apply in rural areas, and occasionally in suburban areas, to the lighting of interchanges on otherwise unlighted freeways for which ADT traffic satisfies warrants under Case PIL-1 or Case PIL-2 ***(see Table 1197-3)***. Lighting provided under this concept will generally be limited to diverging lanes, merging lanes and ramp intersections as described in the following section.

The following information is intended to provide guidance in determining the number and locations of lighting units for partial interchange lighting. The procedures outlined are generally applicable under the conditions stated; however, it does not necessarily follow that lighting at a given level will automatically be approved simply because conditions satisfy the warrants.
The typical luminaire arrangement for partial interchange lighting as shown in ***Figure 1198-3*** should be used in the following situations.

1. All diverging roadways, including exit ramps, ramp divergences, directional roadways, etc., should be lighted, particularly in the gore point areas. Normally, four units will suffice for partial lighting; however, when the taper is shorter than the normal unit spacing, the unit at the beginning of the taper may be omitted.
2. All converging roadways, including ramp acceleration lanes, ramp convergences, directional roadways and C-D roads, should be lighted. Normally, three units will suffice for partial lighting; however, the number of units may be adjusted in proportion to the taper length when it varies substantially from the standard 1200-foot ramp entrance length.
3. Combined accel-decel lanes (weaving lanes) should be lighted as combinations of the above two treatments. The seven units normally used may be adjusted to a fewer

number depending on the length of the lane.

4. All ramp intersections with crossroads and all crossroad intersections within the general interchange area should be lighted in accordance with typical arrangements shown in ***Figure 1198-3***.

In general, key unit locations for ramps are controlled by their speed change lanes and/or their intersections with side roads. However, overpasses and underpasses are not uncommon on ramps, and it will be necessary to adjust unit spacing in such cases to accommodate the various structure related items ***(see Section 1140-4.6)***. On partially lighted interchanges, the ramp proper is usually left unlighted for the initial installation; however, where loop ramps are involved, and the loop is entered from roads with high operating speeds, full loop ramp lighting may be provided.

The first unit on an exit ramp is normally placed 195 feet from the key unit on the deceleration lane. This normal spacing should be adjusted downward to provide a uniform spacing for the ramp units ahead. On curving ramps of short radius, for luminaires mounted on the inside of the curve, the spacing should be 0.55 times the normal straight line spacing; and for luminaires on the outside of the curve, the spacing should be 0.70 times the normal straight line spacing.

Where ramp merges with the mainline are gradual and space between the mainline and ramp pavements is limited, or where a narrow median not feasible for the location of lighting units is used to separate a collector-distributor road from a nominal two-lane directional roadway, the mainline must be lighted from units mounted along the right of the ramp (in the direction of travel) or C-D road. Under such circumstances, the ramp units should be at least of the same type, size and mounting height as the normal mainline units. Spacing for such units should be based upon a theoretical pavement width which includes the space between the merging pavements, i.e., the total width from the left edge of the mainline pavement to the right edge of the ramp or C-D road pavement.

Key unit locations for acceleration lanes or merging pavements should be at the point of the convergence of the right edge of mainline traveled pavement and the left edge of the subordinate traveled pavement (oriented in the direction of travel).

At deceleration lanes or diverging pavements, the key unit location should be 40 feet in advance of the transverse joint which ends the gore area traveled pavement.

Key unit locations for combined accel-decel lanes and for relatively short auxiliary lanes should be treated at each end in accordance with the above, and reference should be made above for lighting the mainline pavement from the right of the added lane.

When calculating lighting unit spacing along tapers or variable width pavement, the pavement width at the key location (as located in the above discussion) should be used to determine the spacing for the succeeding, or second, location. The spacing from the second to the third unit should be determined from the pavement width at the second unit position. The spacing from the third to the fourth unit should be determined from the pavement width at the third position, and so on, until the pavement width and the spacing become uniform.

The following procedures should be followed in establishing key unit locations and subsequent spacing for partial interchange lighting.

1. Normally, the key unit location at the entrance nose for a ramp or merging lane will be installed in the future ***(see Figure 1198-3)***. The unit spacing to the second unit (or first unit to be installed initially) should be computed on the basis of the pavement width at the entrance nose. The spacing calculations should then be continued, as discussed previously in this section, proceeding toward the end of the acceleration taper, and

alternating the initial and future units until the desired unit locations for the initial

installations have been satisfied. If the entrance nose occurs on or immediately adjacent to a bridge, the nose unit should be installed initially, and the alternating of future and initial units as shown in ***Figure 1198-3*** should be reversed (i.e., units labeled “F” should be installed initially, and vice versa).

2. For exit ramps or diverging lanes, the key unit should be installed initially at a point 40 feet in advance of the gore point as shown in ***Figure 1198-4***. From this key unit location, spacing calculations should be continued toward the beginning of the exit taper, using the pavement width at the key location to determine the spacing to the second (future/full) location. Using the pavement width at that location as a basis for spacing to the next unit (future/full) location, the process should be repeated as necessary as previously discussed for tapered areas. The unit within the tapered area nearest the beginning of the taper should be installed initially, as shown in ***Figure 1198-4***. Reference should also be made to ***Figure 1198-4*** for location of the first mainline unit beyond the exit gore and for spacing along the ramp proper.

3. Lighting units at ramp intersections should be installed with the initial lighting project ***(see Section 1140-4.6.2)***.
4. Unit locations for future/full lighting on interchange separation structures or other major structures within the interchange area should be determined as discussed in ***Section 1140-4.6***, and grounding, conduit, pilasters, etc., for these units should be provided with the initial bridge construction to facilitate the future addition of bridge lighting.

1140-4.4.2 Diamond Interchanges

An illustration of partial lighting applications to a basic diamond interchange is shown in ***Figure 1198-5***.

1140-4.4.3 Partial Cloverleaf and Cloverleaf Interchanges

For the intersections to work safely they should be designed properly with channelization to discourage/prohibit wrong movements, adequate signing to reaffirm the design, and lighting to give the driver the ability to see the geometry of the intersection.

At partial cloverleaf interchanges, in addition to the merge-diverge areas and the intersections with the highway, critical points include the loop ramps.

Full cloverleaf interchanges generally do not involve partial lighting since most of the interchange is composed of critical areas.

1140-4.4.4 Intersection

Partial lighting will alert the driver to an approaching intersection. In general, all lighting units for intersections may be considered key units. Severely skewed intersections, or those having more than four approaches, will require special consideration to assure that the apron areas and traffic control devices are discernable at night and that appropriate lateral clearances are available in the interest of safety. Unit locations for the more common intersection types are as follows:

1. On two-lane road intersections, including T intersections, use two units - one to the right (in the direction of travel of the higher-volume road) and 40 feet beyond the far edge of the intersecting pavement, or at the point of curvature (PC) of the far radius return of the intersecting pavement; and the other in a similar manner for the opposite direction of travel. These locations may require adjustment if the normal design spacing is exceeded (for a continuously lighted roadway) or if the light pole is to be used in combination as a support for traffic control devices.
2. Intersections on four-lane roads will generally require four units - one in each quadrant

to the right (in the direction of travel) at the PC or 40 feet beyond the intersection, whichever is greater (the "intersection" is considered to be the theoretical point where the projected edges of the two pavement edges in a given quadrant would intersect).

3. At channelized intersections or where turning roadways are involved, such as at ramp intersections with multiple-lane side roads, lighting units should be located so as to illuminate protected turning lanes, approaches to divided areas or traffic islands, and at radius points as discussed above. ***Figure 1198-7*** illustrates typical luminaire placement for intersections. Key unit locations in such situations may be similar to those discussed for merging and diverging pavement gores in ***Section 1140-4.4.1*****.**

Using a single light source at an intersection is generally undesirable because it may create a "brightness barrier." This "brightness barrier" is the same problem we experience when we attempt to see beyond the headlights of an oncoming vehicle. Multiple light sources at an intersection increase the lighted area and reduce the need to see beyond until the driver is inside the lighted area looking out.

1140-4.4.5 Combination Supports

In the interest of reducing costs and the number of support poles in intersection areas, light poles and traffic signal or overhead sign supports are often combined when practical. This practice is encouraged to minimize the clutter effect of numerous supports which could hamper sight distance and increase the opportunity for vehicle impact with obstacles.

The designer should always check with the maintaining agency of the traffic signals prior to combining signal/light poles. This is especially important if the lighting system is 480 volts. Many agencies do not desire signal maintenance crews working with live high voltage lighting cables in the signal poles, pull boxes and conduits. In this event, the designer should attempt to maintain at least 10 feet separation between signal and lighting supports for aesthetic reasons, if possible. If combination signal/light poles are to be used, the signal and lighting designer(s) should carefully locate the supports so as to satisfy traffic and lighting needs, such as pedestrian push button and signal indication locations, vehicular signal locations, mast arm length, luminaire location and bracket arm length.

1140-4.5 Full Lighting

1140-4.5.1 Interchange

On simpler interchanges, it is assumed that the driver will be able to visualize the layout of the interchange by viewing the critical points. When interchanges become more complicated such that the driver will need to be able to see the ramps, turning roadways, and the various elements of the interchange to get the visual picture, it may be necessary to light the entire interchange. This is known simply as complete or full interchange lighting. Full interchange lighting is generally associated with freeways and expressways where the mainline is lighted; however, it can be used in rural or suburban locations where there is a need to light the interchange, but not necessarily a need to light the mainline. In such instances, the need usually arises from the complex nature of the interchange.

With conventional lighting, luminaires are located at regular spacings along the ramps and turning roadways of the interchange. High-mast lighting is often used, especially at large or complex interchanges for the economic, safety and aesthetic reasons mentioned in ***Section 1140-4.2***. High-mast unit locations vary with every interchange due to the geometrics; however, along the on and off-ramps, they are generally located on the outside (driver's right side) of the ramp. At interchange intersection areas, the high-mast units are usually best located inside the interchange.

The latest interchange configuration, the Single Point Urban Interchange (SPUI), generally utilizes full interchange lighting due to the extremely wide intersection area with the crossing arterial and the unfamiliar geometrics involved. High-mast units are ideal for this application.

1140-4.5.2 Street

Instead of partial lighting along a street (i.e., intersection lighting, as discussed in ***Section 1140-4.4.4***), continuous or full street lighting may be required for a project. First, the pole arrangement and spacing must be determined based on the street width and illumination level, as discussed in ***Section 1140-4.3.3*** The “one-side,” “staggered” and “opposite” arrangements ***(Figure 1198-8)*** are used when it is impossible or inadvisable to use a median-mounted configuration. The choice among the three options depends mainly on the width of the facility to be lighted. The “one-side” arrangement is for narrow, one-way streets; two-way, two or three-lane streets; and other situations where the street is no wider than one to one and a half times the mounting height of the luminaire. The “staggered” arrangement is for streets of medium width (one and a half to two times the mounting heights). The “opposite” arrangement is used for streets which are extremely wide and where medians are too wide to effectively accommodate median lighting. In this latter case, the arrangement is actually two independent “one-side” arrangements.

Once the arrangement and spacing have been determined, the critical or key units at the intersections are chosen as shown in ***Section 1140-4.4.4***. Finally, the pole locations between intersections are determined based on the arrangement and calculated spacing, with minor spacing adjustments as needed.

1140-4.6 Specific Cases

1140-4.6.1 Exit and Entrance Gores

See ***Section 1140-4.4.1*** for information about lighting exit and entrance gore areas.

1140-4.6.2 Intersections

In general, all lighting units for intersections may be considered key units. In the interest of reducing costs and the number of support poles in intersection areas, light poles, traffic signal, or overhead sign supports, are often combined when practical. This practice is encouraged to minimize the clutter effect of numerous supports which could hamper sight distance and increase the opportunity for vehicle impact with obstacles. Severely skewed intersections, or those having more than four approaches, will require special consideration to assure that the apron areas and traffic control devices are discernible at night and that appropriate lateral clearances are available in the interest of safety. Unit locations for the more common intersection types are as follows:

1. Two-Lane Road - On two-lane road intersections, including T intersections, use a minimum of two units:

   a. One to the right in the direction of travel on the higher-volume or through roadway, and 40 feet beyond the far edge of the intersecting pavement, or at the PC (point of curvature) of the far radius return of the intersecting pavement, and

   b. The other unit is placed in a similar manner for the opposite direction of travel.

   These locations may require adjustment if the normal design spacing is exceeded (for a continuously lighted roadway) or if the light pole is to be used in combination with a support for traffic control devices.

2. Four-Lane Road - Intersections on four-lane roads will generally require four units:

   One in each quadrant to the right in the direction of travel at the PC (point of curvature), or 40 feet beyond the intersection, whichever is greater. The "intersection" is considered to be the theoretical point where the projected edges of the two pavement edges in a given quadrant would intersect.

3. Channelized Intersections - At channelized intersections or where turning roadways are involved, such as at ramp intersections with multiple-lane side roads, lighting units should be located so as to illuminate protected turning lanes, approaches to divided areas or traffic islands, and at radius points as discussed above. Key unit locations in such situations may be for merging and diverging pavement gores.

Also see ***Section 1140-4.4.4*** for information about highway lighting at intersections.

1140-4.6.3 Bridges Over Highways

Light poles on overpasses should be located as near to piers as possible to reduce pole vibration, and midway between construction joints where feasible. If abnormal pole vibration is anticipated, consideration should be given to the use of special pole mountings such as pier cap extensions or other structural modifications; or special padding material may be desirable between the pole base and pilaster support to dampen the effect of vibration.

Lighting units should not be installed within approach slab areas, nor within 10 feet of approach slabs. When the length of the bridge and approach slabs, plus the 20 feet for approach slab clearance, results in a length less than the design spacing for the lighting, the lighting units should be located uniformly at each end of the structure. If a staggered arrangement is being used, the units should be located at the far end of the structure on the right in the direction of travel.

When the length of the bridge and approach slabs, plus the 20 feet for approach slab clearance, results in a length greater than the design spacing, the first lighting unit associated with the structure must be located at least 10 feet in advance of the beginning of the approach slab. Subsequent units should follow design spacing across the bridge. See ***Figure 1198-9*** for overpass key unit locations.

1140-4.6.4 Pedestrian Bridges

Generally, all pedestrian bridges should be lighted. Since approaches to pedestrian bridges are not always accessible to maintenance vehicles, and since pedestrian bridge lighting is highly susceptible to vandalism, special consideration should be given to the location and protection of this type of lighting design.

1140-4.6.5 Overhead Signs

See **Section 1140-3.5** for information about lighting overhead signs.

1140-4.6.6 Street Trees

Since many projects involve modifying the typical section of an urban or suburban roadway and include the replacement or addition of street lighting and street trees, coordination in the placement of the light poles and street trees is essential. The location and spacing of the light poles is of primary concern. Street trees can then be placed between pole locations with adequate spacing from lighting units to allow for the illumination of the pavement. Consideration should be given to mounting height, bracket arm length and type of tree, as well as the tree trimming maintenance issue.

1140-4.6.7 Underpasses

Underpass luminaires may be required beneath any structure whose transverse width (between outer edges of parapets) is 75 feet or more. For underpass lighting design purposes, twin structures having less than 40 feet between adjacent parapets should be considered as a single structure. When the separation between twin structures is between 40 and 60 feet, consideration should be given to the use of post-mounted underpass units located between the two structures at a mounting height of approximately 20 feet.

Occasionally, skewed structures less than 75 feet in width will require underpass units, especially where the omission of such units would result in a serious compromise of the uniformity criteria. Underpass lighting may be required when a structure prevents adjacent roadway units from providing lighting on the roadway beneath the underpass to the average intensity and uniformity of that provided for the roadway outside of the underpass. Each underpass must be evaluated on its own merits. However, installations employing luminaire mounting heights of 50 feet or less with underpasses whose length (structure width) is less than 1.5 times the luminaire mounting height and which are located in the middle third of the space between the roadway luminaires will not normally require underpass lighting units.

Adjacent underpasses may be located in such proximity that the roadway beneath the underpass structures must have supplemental lighting during daylight hours. In these cases, guidance will be found in the **IES's Recommended Practice 22 (RP-22)**. This possibility should be considered when the length of the underpass exceeds 80 feet.

When underpass luminaires are not required, and the conventional unit mounting height exceeds the vertical clearance of the structure, lighting units should be provided in advance of and/or beyond the outer edge of the parapet of the overpassing structure at a distance conforming with the following conditions:

Mounting Height Feet	Distance from Light Unit to Parapet Feet
32.5	40
40	60
50	90

When a staggered arrangement is used, luminaires should be located to the right in the direction of travel at the exit end of the underpass.

When the above separation distance cannot be provided, the designer should check the need for glare shields to protect the overpassing traffic.

When underpass luminaires are used, their effect should be considered relative to adjacent conventional units, and distances between the overpassing structure parapets and the nearest conventional units should be established accordingly.

When the overpassing structure clearance is greater than the mounting height, conventional highway light poles may be used under the structure, or the units may be mounted on piers or abutments. Under such circumstances, the above distances need not apply. See ***Figure 1198-10*** for underpass key unit locations.

1140-4.6.8 Tunnels

Planners and designers should review ***Section 1103-6.9, Underpasses and Tunnels***, for definitions, warrants, and other information related to tunnels. The goal of tunnel lighting is to provide for good driver visibility and a safe environment within a tunnel, day and night. The many factors that contribute to or detract from visibility need to be identified and their specific importance determined for each tunnel. The factors include:

1. Characteristics of the roadway approaches.
2. Characteristics of the tunnel roadway, walls and ceiling.
3. Characteristics of the area surrounding the tunnel portal.

4. Atmospheric and environmental conditions.
5. Characteristics of vehicular traffic operations.
6. Orientation of the tunnel with respect to sun and sky.

Since the need for design of tunnel lighting is relatively rare in **Ohio**, the designer should reference the **ANSI/IES Tunnel Lighting (RP-22)** publication for an in-depth discussion on how these factors relate to each other. The publication contains information that will assist in determining lighting needs, providing solutions and evaluating resulting visibility within vehicular roadway tunnels.

1140-4.6.8.1 Tunnel Lighting Design Guidance

Tunnel lighting design is done using luminance criteria (units of cd/m^2) instead of the illuminance criteria (units of fc) typically used by ODOT for lighting design on open roadways. Designers should be aware that luminance-based tunnel design usually requires special software (e.g., AGi32™) not commonly used for open-roadway lighting design.

The following list includes specific design guidance for tunnel lighting design on ODOT projects. Contact the **Office of Roadway Engineering** for additional guidance.

A. An early step in tunnel lighting design is to obtain the required threshold luminance level (L_{th}). **RP-22** gives several methods for this in Part 6.4.
   a. For short tunnels, the use of **RP-22** Part 6.4.1, which determines preliminary design L_{seq} and L_{th} values, will often be acceptable to ODOT as a final design value as well.
   b. For long tunnels, the more involved **RP-22** Part 6.4.2 method of determining L_{seq} should be used. Essentially, the designer first calculates an equivalent veiling luminance (L_{seq}) for the general area seen by the driver approaching the tunnel under worst-case (bright sun) conditions. Next, L_{th} is obtained by multiplying L_{seq} by a ratio. The ratio value is determined by a subjective criterion known as the Safety Rating Number (SRN). Note that ODOT recommends the use of SRN = 5.

B. Long tunnels are rare in Ohio. However, if the tunnel is long, then following the threshold lighting zone will be one or more additional lighting zones of gradually decreasing design luminance values. **RP-22** Part 6.4.3 presents two methods for calculating the transition zone luminance values, either of which are acceptable to ODOT, but the Step-Down Method is preferred.

C. Choose the nighttime luminance levels per **RP-22** Part 6.4.5.

D. Some tunnels require switching steps that vary the internal luminance in response to the external luminance changes created by the weather and changes in the position of the sun. The following guidelines apply to ODOT projects:
   a. Provide a PLC conforming to ODOT Supplemental Spec 818 for the control system.
   b. Provide a control system enclosure conforming to ODOT Supplemental Spec 820. Locate the enclosure in an area that will not be in direct sunlight or provide a shelter, because the enclosure is passively cooled (unless active cooling is approved by ODOT). Provide all conduit entries with O-ring sealed hubs.
   c. Obtain entrance portal measurements with one or more luminance meters compatible with the PLC inputs. An analog output is preferred, and this signal should be filtered and appropriately time-averaged at the PLC.
   d. Dim tunnel luminaires using a 0-10VDC dimming signal obtained from the PLC. Buffer the signal as necessary. Provide a separate control signal for each zone.

E. Provide communications conforming to Supplemental Specification 809 for monitoring the tunnel conditions. The set of tunnel condition parameters that require remote monitoring will vary from project to project. Contact the **Office of Traffic Operations**, ITS Section, for additional guidance.

   a. The preferred method of monitoring tunnels that do not have fire alarm control panels is by CCTV. Unless the tunnel is short enough for the CCTV camera to see completely through, provide a CCTV camera at each entrance and exit portal.
   b. For tunnels equipped with fire alarm control panels, coordinate with the District and any other authority having jurisdiction (**AHJ**) to determine communication requirements for the project. See also **NFPA 502**, Part 4.5.

F. If used, provide conduit bodies made of cast steel or malleable iron, with wedge-type malleable iron cover (not sheet steel), both triple-coated (electroplated or hot-dip zinc base coat, chromate intermediate coat, and epoxy finish coat), neoprene seal material, and all stainless steel hardware.

G. Provide metal conduit per **NFPA 502** Part 12.3.1. If stainless steel conduit is not specified, provide Rigid Metallic Conduit per ODOT CMS 725.04. Exposed PVC conduit is not permitted in tunnels, per **NFPA 502** Part 12.3.2.

H. Assure all electrical devices used in exposed areas are UL-Listed for Wet Locations.

I. Assure that all electrical and electronic devices in exposed locations operate over the following environmental conditions, within their respective enclosures:
   a. Temperature: -30°F to +165°F.
   b. Humidity: 0-100% RH.

J. Assure all circuit breakers are labeled for 100% load continuous use.

K. Do not locate luminaires or junction boxes directly under roof joints because the joints sometimes leak.

L. Provide LED tunnel lighting, emergency lighting and auxiliary lighting conforming to Supplemental Specification 813.

M. Assure that the lowest point of each conduit run is equipped with a conduit drain with a stainless steel screen, except drains located in areas subject to wash-down, which shall be rated NEMA 4X or IP66. Long horizontal conduit runs shall be equipped with such drains at a spacing not to exceed 50 feet and located on a short stub below the run.

N. Assure that each electrical pull box or manhole located above the tunnel level is equipped with a drain conduit routed to a suitable protected outlet location not subject to damage by mowers and other sources. Provide a varmint screen at the conduit drain outlet. Locate the outlet at least 1.5 feet above the bottom of a ditch, wall, slope or swale, or route to a suitable roadway drainage conduit. For conduit drain outlets in diches, slopes or swales, install a 12-inch square flat-panel marker sign on two U-channel posts that straddle the conduit at the outlet, to help locate and protect it. The sign message shall be "CONDUIT DRAIN" in 2-inch green letters on a white field using 730.18 Type F sign sheeting, with a 1-inch green stripe across the top, and facing the roadway. Mount the bottom of the sign panel at least 5 feet above grade.

1140-4.6.8.2 Tunnel Fire Protection Design Guidance

Tunnels shall conform to **NFPA 502, Road Tunnels, Bridges, and Other Limited-Access Highways**, including all documents referenced therein. **NFPA 502** provides fire protection and life safety requirements for tunnels. If a fire alarm system is required by **NFPA 502** or other project documents, then designers should pay particular attention to **NFPA 72,** National Fire Alarm and Signaling Code, and **NFPA 70 (NEC)** Article 760, Fire Alarm Systems.

Because tunnel fire-protection system and tunnel lighting design tasks are interrelated, this section of the Traffic Engineering Manual lists a number of fire-protection design guidelines below.

A. The fire alarm control panel enclosure will be separate from the tunnel lighting control system enclosure.
   a. Do not locate the enclosure in direct sunlight or mount directly to a wall.
   b. Provide all conduit entries to the enclosure with O-ring sealed hubs.

c. Equip the enclosure with a vent-drain placed in the lowest point of the enclosure.
d. Do not mount enclosures containing electrical or electronic components, switches, shunts, or similar devices susceptible to internal condensation directly onto concrete walls. Instead, the designer should specify suitable concrete anchors and standoffs to leave at least one inch of air space between the enclosure and the wall. Provide stainless steel standoff hardware.
e. Do not expose any touch-panel or monitor screens directly to the weather; provide a transparent, snap-latch, weather-tight UV-resistant access door.
f. Provide external labels of 630.02 Reflective Sheeting, Type F, silk-screened, with red letters on white background.

B. If used, provide conduit bodies made of cast steel or malleable iron, with wedge-type malleable iron cover (not sheet steel), both triple-coated (electroplated or hot-dip zinc base coat, chromate intermediate coat, and epoxy finish coat), neoprene seal material, and all stainless steel hardware.
C. If stainless steel conduit is not specified, provide Rigid Metallic Conduit per ODOT CMS 725.04.
D. Provide stainless steel clamps and hardware for all conduit wall and ceiling attachments.
E. Unless specified otherwise, use linear heat detector cable for automatic detection.
  a. Provide stainless steel hanger hardware for linear detectors. Route all linear detector cable direction changes as gradual sweeps conforming to the manufacturer’s bend specifications.
  b. Provide stainless steel junction boxes conforming to Supplemental Specification 820 for all linear detector circuits. Do not locate any junction boxes over traveled lanes.
  c. Provide all locking enclosures (including test shunts) with a stainless steel latching hardware and marine brass lock core with weatherproof tab.
  d. Provide O-ring sealed hubs for all conduit entries into junction boxes.
F. Provide LED alarm indicators for each manual fire alarm box. Provide stainless steel wall supports at each end of any conduit used to mount indicators directly to the manual fire alarm box.
G. Traffic control and ITS construction items (beacons, signs, dynamic message signs, etc.), used to control traffic approaching the tunnel portal and direct approaches, shall meet all applicable sections of the ODOT CMS, in particular Parts 625, 630, 631, 632, 633, Supplemental Specification 809, and other Supplemental Specifications as required.
H. Water supply construction items shall meet the requirements of the Authority Having Jurisdiction (**AHJ**) and ODOT CMS Part 638.
I. Designers shall pay particular attention to NFPA 502 Chapter 12, Electrical Systems during all stages of electrical system design.

1140-4.6.9 Median Mounted

When median-mounted lighting is used, the system will require supplemental units along the outside of the roadway when the effective width of the directional pavement is excessive. For example, if the directional pavement exceeds 48 feet, and a 40-foot mounting height is used, supplemental units will be needed; or if the directional pavement exceeds 60 feet and a 50-foot mounting height is used, supplemental units should be added.

High-mast units can also be very effective along freeways when median mounted, either in a grass median with proper lateral clearance or barrier mounted.

1140-4.6.10 Roundabouts

All roundabouts shall be lighted. Roundabout lighting shall be designed according to **IES DG-19-08, Design Guide for Roundabout Lighting**, published by the **Illuminating Engineering Society**. In general, **ODOT**-maintained roundabouts shall have lighting design limits extending beyond the approach tapers, as shown in **IES DG-19-08 Figure 3**.

Typical installations shall have a minimum of eight pole locations: four illuminating the circulatory roadway and pedestrian areas and four illuminating the approach tapers. Design lighting levels and uniformity shall comply with **IES DG-19-08 Table 1**, which is based on functional class of the intersecting roadways and pedestrian demand. This Table is reproduced below.

Illumination for Roundabouts				
Functional Classification	Maintained Average Horizontal Illuminance in Lux/fc on the Pavement Based on Pedestrian Area Classification			E_{avg} / E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3:1
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3:1
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3:1
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4:1
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4:1
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6:1

1140-4.7 Placement Adjustments

Once all pole locations have been determined for a given design area, individual poles may require slight adjustment longitudinally or laterally to avoid interference with utilities, minor structures (e.g., catch basins, headwalls), drive aprons and ditches. In urban areas where building faces are often at the back of the sidewalks, attention should also be given to doorways to buildings, overhead canopies and signs, basements and utility vaults under sidewalk areas, and heated sidewalks. Such adjustments should normally not exceed a 5 to 6-foot shift per location.

1140-5 Circuit Design

1140-5.1 General

Proposed circuitry, including service pole locations, is a basic requirement of any lighting system. The following sections reflect general **ODOT** standard materials and methods; however, the lighting designer should always check with the specific **District** (or local maintaining agency) for confirmation of standards or preferred alternate materials and/or methods.

1140-5.2 Voltage

1140-5.2.1 General

Generally, lighting systems maintained by **ODOT** are 480-volt systems. Occasionally, stand-alone intersections utilizing combination poles will be lighted using 120 volt fixtures. If the maintaining agency is other than **ODOT**, the system voltage must be determined early in the design process.

1140-5.2.2 Voltage Drop

After formal approval of proposed service pole locations has been obtained from the power supplying agency and the proposed lighting layout has been approved by **ODOT** for detailed design, voltage drop calculations should be completed and included in the Stage 3 review submittal. The calculations should indicate the voltage at each lighting unit, at each lighted sign installation, at each “wye” in each circuit, and at the end of each circuit.

The allowable voltage drop in each circuit is 5 percent. Reference should be made to ***Figure 1198-12*** for a sample voltage drop calculation for a 480-volt, two-wire grounded neutral system (current **ODOT** standard is 480-volt, three-wire grounded neutral but the voltage drop calculation method is unchanged.).

1140-5.3 Control Center

1140-5.3.1 General

The principle type of lighting control center used by **ODOT** is the pole-mounted type with the photoelectric control mounted near the top of the wood pole. The designer should contact the individual **District** (or maintaining agency) to determine if a meter is required.

1140-5.3.2 Load

As part of the construction plan preparation, the designer should include a Control Center Data chart ***(Figure 1198-11)*** with all the required information. Details of the enclosures and how they are wired and mounted are shown in the **Traffic SCD HL Series**.

Designers should limit lighting branch circuit loads to 30A or less, if possible, to allow wires to be terminated and bent into position in the support base volume. Up to six (6) branch circuits can emanate from a typical HL-60.31 Lighting Control Center. Designers should strive to use no larger than #2 AWG in branch circuits, if possible. See ***1140-5.4.2***.

1140-5.3.3 Location

Service facilities should be located outside interchange areas, but within right-of-way limits. Where safety criteria applies, the supporting poles should be located more than 30 feet from the edge of the traveled pavement. Special care should be taken in the location of service facilities to assure reasonable accessibility by maintenance personnel and equipment during wet weather. Areas such as at the toe of a steep slope below the access roadway and deeply swale areas should be avoided, especially if they are subject to temporary flooding or drifting snow. Cross section data and right-of-way information shall be examined for each service pole and control center location to facilitate evaluation of its suitability relative to adjacent terrain. Each location shall also be formally cleared with the power supplying agency, and copies of all correspondence relative to electrical service shall be furnished to the **District** reviewing the lighting plan. During the initial contact withthe power supplying agency, special offset requirements for service poles should be discussed, the supplying agency's system power requirements should be determined, and policies with respect to secondary lightning arrestor locations, grounding, metering, etc., should be clearly understood. Where local governmental agencies require that service pole areas be enclosed by fence, the designer should determine if grounding of the enclosure fence is required.

1140-5.4 Cable

1140-5.4.1 General

All new or completely replaced lighting systems maintained by **ODOT** shall be three-wire systems utilizing distribution cable rated at 2400 volts. On projects that are within existing lighting systems, the new distribution cable should match the existing distribution cable.

1140-5.4.2 Cable Size

The preferred size of circuit cable is No. 4 **AWG**. If necessary to avoid an excessive voltage drop, larger cable may be used between the control center and the first lighting unit within a given circuit. If this procedure still results in a voltage drop exceeding 5 percent, the circuit cable size should be increased to No. 2 **AWG**, or larger in rare instances. Uniformity in circuit cable size and type of connector kit is highly desirable in a given project area. Reference should be made to ***Section 1140-5.2.2*** for documentation requirements for circuitry voltage drop calculations.

Pole and bracket cable, used and itemized separately with conventional units, should be No. 10 **AWG** and extends from the connector kits in the pole base to the lighting fixture.

1140-5.4.3 Cable Type

There are two types of circuit cable, distribution cable and duct cable. Distribution cable is single conductor wire with polyethylene insulation, while duct cable is a factory preassembled cable in a coilable, high-density polyethylene pipe-type duct (typically 1.5-inch diameter) with the specified number and size of insulated conductors.

1140-5.4.4 Cable Applications

Duct cable is often used within an interchange area since it is easily installed, cost efficient, and there is generally a reduced risk of it being disturbed since the interchange is within limited access right-of-way. Duct cable is generally not used along a highway where sign post installation, utility work, plantings and new curb/driveway cuts are apt to damage the cable.

Distribution cable is installed in conduit ***(Section 1140-5.5)*** along highways, under streets and ramps, and through bridges and concrete barrier.

1140-5.5 Conduit

1140-5.5.1 Conduit Type

Buried conduits should generally be rigid ferrous metal without encasement, including those which are specified for embedment in structure concrete; however, under the following conditions, buried conduits should be concrete encased:

1. Between primary service sources and distribution transformers.
2. Circuit interconnections on embankment slopes adjacent to separation structures.
3. On any slope steeper than 3:1.

1140-5.5.2 Conduit Size

The a list of conduit sizes appropriate for the usage indicated can be found in ***Table 1197-7***; however, the nominal size may be increased where necessary to provide adequate space for the circuitry proposed.

1140-5.5.3 Conduit Fill

The required conduit size is determined by the number and sizes of cable to be contained in the conduit. The conduit should not be filled to more than 40 percent. The fill areas are determined by adding the cross-sectional areas of all cables to be contained in the conduit and compared to the 40 percent fill area of the conduit.

1140-5.6 Splice Types

1140-5.6.1 Connections Unfused Permanent

Connections unfused permanent are used in pull boxes to splice circuit wires together in the following situations:

1. Where a circuit branches.
2. Where a circuit enters the pull box adjacent to a lighted sign installation.
3. Where a circuit must change from duct cable to distribution cable (e.g., on either end of a structure and at the base of the service pole).

Although the connections are water resistant, connections in pull boxes should be kept to a minimum due to the inherent moisture problems which result.

1140-5.6.2 Connections Non-Permanent

Connections of several types, are described in **C&MS 725**. The most routinely used connections are the fused and unfused pull-apart types, used to connect circuit cable with the pole and bracket cable in a conventional or post-top light pole base.

1140-5.7 Pull Box

1140-5.7.1 General

The **ODOT** standard pull box is detailed on **Traffic SCD HL-30.11**. The 18-inch diameter pull box is intended for one circuit or for a maximum of three connections; and the 24-inch diameter pull box is intended for two or three circuits, or for a maximum of six connections. If more than three circuits are involved, consideration should be given to the use of two boxes or a box of special design. Pull boxes, when used, are generally located within the alignment of the normal longitudinal trench.

City standard pull boxes may be used where consistent with the practices and policies of the maintaining agency.

In general, the use of pull boxes is discouraged because experience has indicated that inherent moisture problems results in more disadvantages than advantages. If flow lines within approximately 20 feet of a pull box location will permit drainage, a positive drainage system using 4-inch shallow underdrains, should be installed.

1140-5.7.2 Pull Box Types

The **ODOT** standard pull box is concrete **(C&MS 725.08)**; however, plastic **(C&MS 725.07)** may be used in urban lawn areas where there is no chance of vehicles driving over the box. Steel pull boxes, although used in highway and interchange areas in the past due to their low cost, are no longer used because of the lids being difficult to secure in place. The pull box then fills with water and debris and/or becomes a safety issue with mowing equipment and maintenance personnel.

1140-5.7.3 Placement

Acceptable locations for pull boxes are as follows:

1. At the base of a pole used to mount a control center or disconnect switch, if located lower than the roadway proper.
2. At each end of a structure which carries electrical utility lines across the structure (approximately 10 feet beyond the ends of the parapet).
3. At the conduit riser for underground lighting circuits.
4. For connection of illuminated signs or underpass lighting to a lighting circuit.
5. At any split or tap in a lighting circuit that cannot be provided in the transformer base of a light pole.
6. At a minimum, at one end of a conduit jacked under pavement.

In urban areas, the designer should avoid placing pull boxes within curb ramps, curb ramp landing areas, or too close to intersection radii where large turning vehicles will disturb the pull box or cover.

1140-5.8 Junction Box

Junction boxes, as detailed in **Traffic SCDs HL-20.13 and HL-20.14**, are intended for use in concrete barrier and on structures, respectively. The designer should check with the **District** before using them. There is some concern that unless structure junction boxes are required for cable pulling purposes due to an excessively long conduit run (in excess of 300 to 400 feet), junction box lids end up missing because of screws becoming loose, and screws lost or not replaced during maintenance operations. The box becomes an easy access point for water, rodents and debris.

1140-5.9 Trenching

1140-5.9.1 General

The normal longitudinal trench alignment for distribution cable or duct-cable installations will be parallel to the controlling pavement edge or base line and in a direct line from pole to pole, as detailed on **Traffic SCD HL-20.11**.

1140-5.9.2 Trench in Paved Areas - Jacking

When circuits require crossing under existing ramp, mainline or arterial pavement open to traffic, steel conduit (3-inch minimum diameter) is often jacked or pushed under the pavement to minimize disruption to traffic and the pavement itself. Push pits must be dug behind guardrail or beyond the back of the paved berm, as shown on **Traffic SCD HL-30.22**. Concrete pull boxes are usually installed at the ends of the jacked conduit for cable splicing purposes.

1140-5.9.3 Trench in Paved Areas - Open Cut

The alternative to jacking conduit under pavement is laying conduit in an open cut trench. This method is used when conditions are such that finding areas for push pits is difficult because of numerous utilities, right-of-way constraints, walls, sidewalks, etc., or if construction phasing is such that traffic can be satisfactorily maintained when trenching. In paved areas either a T trench or "narrow slit type" trench is used as shown in **Traffic SCD HL-30.22**. The cost of open cut trench (including conduit and replacement backfill and pavement) is generally one-third more than jacking the same size conduit.

1140-6 Foundations

1140-6.1 Foundation Types

1140-6.1.1 Conventional

1140-6.1.1.1 General

The standard conventional light poles is a transformer base type. All poles located within 30 feet of the edge of traveled pavement shall include a cast aluminum transformer base meeting current **AASHTO** safety requirements for frangibility, with the following exceptions:

1. Poles located along streets or roadways with design speeds less than 40 miles per hour and with adjacent pedestrian traffic shall be mounted on steel transformer bases.
2. High-mast (tower) poles, and light poles mounted on concrete barrier medians or certain walls and structures, shall be anchor base types.
3. Light poles located on bridges shall have steel transformer bases.

1140-6.1.1.2 Drilled Shaft

Since roadways are normally constructed on stable subgrades, foundations for conventional light poles may be designed for the following minimum depths unless unstable soil conditions are suspected:

Light Unit Mounting Height Feet	Min. Foundation Depth Feet
Less than 40	6
40 - 44	8
45 - 55	10

1140-6.1.1.3 Median Mounted

Conventional light poles mounted on concrete barrier median shall be anchor base poles. The poles shall have drilled shaft foundations as shown above except that the depth shown shall be the depth extending below the base of the median barrier. The **SCDs** show additional details.

Traffic SCD HL-10.15 is available for use on projects where the height of an existing concrete median barrier is being increased by at least 8 bolt diameters. It allows for the extension of existing anchor bolts using a coupling nut. This drawing does not constitute a general foundation and/or anchor bolt repair method; such methods shall be developed on a project-specific basis by a qualified structural engineer.

1140-6.1.1.4 Pilasters

Conventional light poles mounted on a bridge shall have steel anchor bases and are mounted on a projection beyond the normal outside face of parapet, or pilaster. Poles on pilasters should be located as near to piers as possible to reduce pole vibration. Where fencing separates the lighting pilaster from the bridge proper, a suitable handhold should be provided in the fencing to allow access to the pole handhole.

1140-6.1.2 High Mast

1140-6.1.2.1 General

Since light towers are usually located more than 30 feet from the traveled roadway, it is unlikely that the compaction for the roadway would have the same influence as for conventional light pole sites. Consequently, the design of foundations for towers will require a procedure involving soil classification at the site. Where soils profiles and/or reasonably accurate soils data are available from existing highway plans or other reliable sources, the soil classification and related foundation design process may proceed without the need for individual soil borings at each proposed site. However, designers are expected to exercise prudent engineering judgment in the event there is reason to suspect that existing soils information is not reliable for the tower site or if the information available indicates that the allowable lateral soil resistance is not compatible with design guide tables and charts. In such cases, individual soils borings should be obtained for each tower site which is suspect, and specific designs should be prepared for each tower foundation.

Reference should be made to the suggested procedure for light tower foundation design in ***Section 1140-8***. This procedure is applicable to projects where reasonably reliable soils data is available.

1140-6.1.2.2 Maintenance Platforms and Grade Flattening

Maintenance platforms and grade flattening have been found to be traps for debris. The steepened slopes above and below the flattened area or the diversion of water along the wall of the platform are sources of slope erosion. These areas also require the manual trimming of vegetation since chemical control only leaves bare ground which is even more susceptible to erosion. These negative aspects and the resulting increased maintenance are more detrimental than the nicety of the flat area about the base of the high-mast lighting unit. Therefore, the use of these features is no longer recommended.

1140-6.1.2.3 Median Mounted

Light towers mounted on, or more correctly, incorporated into, concrete barrier median are treated similar to overhead sign supports. Their foundation size (usually 36-inch diameter) requires a widening of the median barrier by use of 40-foot transitions as shown in the **Roadway SCDs**. When considering median-mounted tower lighting, the designer must consider the shoulder width on either side of the median. An adequate width shoulder must be available for the maintenance vehicle and the lowering of the luminaire mounting ring.

1140-6.1.3 Low Mast

1140-6.1.3.1 General

Generally, low-mast lighting (defined as a single high-mast luminaire or as a dual-high mast luminaire (2-foot offset) mounted on a pole with a 50-foot nominal mounting height) requires a 2-foot diameter by 10 feet deep foundation in non-sloping areas. Deeper foundations should be considered in steeper sloping areas or areas of poor soils.

1140-6.1.3.2 Median Mounted

Low-mast units are frequently mounted on concrete barrier median separating two-lane groups of traffic each having three or four lanes plus shoulders. The anchor base units utilize a rectangular pole base plate mounted on top of 50-inch barrier. The foundation extends 10 feet minimum below the base of the barrier as detailed in **Traffic SCD HL-20.13**.

1140-6.1.4 Decorative

Decorative poles should be looked at on an individual basis when determining foundations. Often, the standard 6, 8 or 10-foot depths can be used for poles 50 feet in height or less with possible modifications of the formed top 6 inches to accommodate larger decorative bases or sidewalk paver areas. Foundations for decorative units over 50 feet in height should be determined by a soils engineer furnished with soils information, pole heights and luminaire weights, quantities and effective projected areas.

1140-6.2 Locations

1140-6.2.1 Conventional

Along uncurbed sections of roadway, the normal location of conventional light poles is 6.5 feet behind the face of guardrail. Where guardrail is not provided, the normal offset distance of the pole from the edge of pavement should be the same as if guardrail were provided, and frangible bases should be used in accordance with the latest **AASHTO** safety requirements.

In curbed areas, the normal location of conventional light poles is 2.5 feet behind face of curb (2 feet minimum clear), but no closer than adjacent utility poles near the curb.

For improved safety, where the typical section of the roadway will allow a greater setback than normal, poles may be located farther from the pavement edge, consistent with available bracket arm lengths.

1140-6.2.2 High Mast

1140-6.2.2.1 General

High-mast units must have 30 feet minimum clearance from the edge of pavement/traveled way (i.e., painted edge line) on freeways and expressways in the absence of guardrail. A 40-foot clearance is preferred if maintenance access is not compromised. The designer should be aware of culverts, ditches, fences, right-of-way/limited access limits, and underground and overhead utilities when selecting high-mast pole locations. Guardrail should not be installed solely to "protect" a high-mast unit unless absolutely necessary as the guardrail itself becomes an object for road users to strike. If guardrail or concrete barrier will be required to protect bridge columns or overhead cantilever or truss signs, the guardrail may be extended no more than 75 feet to include a high-mast pole.

1140-6.2.2.2 Maintenance Platforms

The use of maintenance platforms is discussed in ***Section 1140-6.1.2.2*** When used, the clearance from the edge of pavement to the nearest edge of the platform wall must conform to the minimum offsets in the **ODOT L&D Manual Volume 1**.

1140-6.2.3 Low Mast

Unless mounted on concrete barrier median, low-mast units may be mounted on breakaway transformer bases or anchor bases, in which case, offsets must comply with those described for conventional poles ***(Section 1140-6.2.1)*** or high-mast poles ***(Section 1140-6.2.2)*** as appropriate.

1140-6.2.4 Decorative

Since most projects requiring decorative poles will be in an urban (i.e., curbed) area, the minimum offset to maintain 2 feet minimum lateral clearance from curb face will apply, with consideration given to overhead and underground utilities. Decorative post-top pole placement in the pedestrian/picnic area of a rest area varies with the individual layout, but an offset of 5 feet from the edge of the sidewalk is often used.

1140-7 Grounding

1140-7.1 Towers

Two ground rods are required (and separately itemized in the plan) for each high-mast pole. The second ground rod is associated with the lightning protection system required with each tower.

1140-7.2 Conventional

1140-7.2.1 General

All conventional, decorative and low-mast poles require one ground rod. This includes poles mounted on concrete barrier median. Details for pole grounding are shown on **Traffic SCDs HL-20.11 and HL-20.13** (median mounted).

1140-7.2.2 Pilasters

Poles mounted on bridge pilasters are grounded via grounding bushings in the steel conduit to interconnect structure conduit system with structure grounding system. **Traffic SCDs HL-20.14 and HL-50.21** provide details.

1140-7.3 Bridges

A structure grounding system (described in **C&MS 625.16** and detailed in **Traffic SCD HL-**

50.21) shall be paid with each bridge as part of the lighting plan quantities. Although the structure grounding system pay item is composed of several ground rods, cable, etc., the callout location on the lighting plan for the pay item is at the centerline station of a fixed pier.

1140-7.4 Fences

Where overhead power lines cross a fenced roadway right-of-way, or where overhead transmission lines rated 110 KV or higher are parallel to roadway fences and the transmission line easement is contiguous to the roadway right-of-way, the roadway fences shall be grounded as shown and described on **Traffic SCD HL-50.11**.

1140-8 Suggested Procedure for Light Tower Foundation Design

The following information is intended to be used in determining caisson lengths for tower foundations without the need for an extensive soil investigation at each tower location.

Regardless of the type of foundation used, information on soil classifications and soil strengths which resist the lateral movement must be established for the foundation design and also to determine the lateral soil pressure. In most cases the subsurface investigations and soil borings made for the Project Soils Profile and bridges will be sufficient to determine the soils classification and strength. However, the determination of soil parameters should be made by a soils engineer. If the soil strength and classification are relatively uniform on a given project site, one value for lateral soil pressure can be used, and the need for extensive soil investigations at each tower location can be avoided. Recommended lateral soil pressure values are shown on ***Table 1197-9***.

In addition to the lateral soil pressure, load reactions on the tower, horizontal shear, uplift and overturning moments shall all be taken under consideration when designing foundations. The foundations shall be designed for loads equal to, or greater than, the maximum loads of the tower design, with considerations given to economics and construction feasibility.

Design calculations to determine load reactions and horizontal shear on light towers shall comply with applicable **AASHTO** requirements as set forth in the latest issue of **Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals**, except that the design wind load shall be based on wind speed of 90 miles per hour, with a maximum load of six luminaires, each weighing 75 pounds (35 kilograms), with a maximum actual projected area of 3.5 square feet and mounted in one horizontal plane.

When the values for allowable lateral soil pressure, total lateral force, and total moment about the resisting surface of the tower have been determined, the required embedded depth can be found using the Foundation Embedment Nomograph in ***Table 1197-10***, which is based on E. Czerniak's recommendations for lateral soil pressure of various soil strengths and classifications. This nomograph satisfies foundation criteria currently used for **Ohio** designs and is valid for caisson type foundations where the embedded depth does not exceed ten times the foundation diameter.

Values for lateral force and overturning moment must be adjusted to a value per foot of caisson width prior to using the nomograph. The normal tower foundation diameter shall be 36 inches unless the tower anchor base plate and bolt circle requires a diameter of 42 inches.

Since the foundation embedment obtained from the nomograph is the depth below the resisting surface of the earth and not from the ground line, the total required foundation length can be obtained by increasing the graph value by 1 or 2 feet (0.3 or 0.6 meter) . For design purposes, the foundation length determined from the graph should be increased to the next longer length that is a multiple of five (English units only).

The foregoing design procedure provides a suitable design method for determining the required caisson length as functions of soil classification, shear force and overturning moment. The soils likely to be encountered have been categorized into six values of allowable lateral soil pressures. Where existing soils information will permit identification for strength and classification, it will not be necessary to use refined design procedures involving extensive soil exploration.

Another acceptable method of design is the Broms method. The Office of Roadway Engineering makes an Excel spreadsheet available on its webpage to assist with the application and documentation of the method. Using only three basic soil parameters 1) undrained shear strength, 2) friction angle, and 3) effective unit weight, design foundation depths may be obtained for cohesive or cohesionless soils. For the many Ohio soils that do not clealy fall into the categories of purely cohesive or cohesionless, it is recommended that the designer use each case, which have separate calculation sheets; the cohesionless calculation will represent drained condition and the cohesive calculation will represent undrained condition. The designer applies a factor of safety representative of the site and loading uncertainties, with a minimum value of 1.5 for very well-known conditions. When conditions are less well known, a factor of safety of 3-4 should be used.

Table 1197-11 presents recommended tower foundation depths calculated for structures with round tapered shafts designed in accordance with the **1975 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals** for a 90 miles per hour wind zone when supporting the following load:

- Six cylindrical luminaires with projected area of 3.5 square feet (C_D = 0.5) and weighing 75 pounds each.

- One cylindrical head from assembly with projected area of 5.3 square feet (C_D=1.0) and 340 pounds top latched lowering device.

1141 PLAN PREPARATION / PRODUCTION

1141-1 General

The **L&D Manual Volume 3** generally describes **ODOT** plan preparation and production guidelines and standards, including plan sheet format (sheet layout, text size, symbols, line weights, file-naming conventions, etc.). For reference, **Figures 1314-8S through 1314-10S of the Sample Construction Plans** produced by the **Office of CADD and Mapping Services** are sample Lighting Plan sheets. Additional information is provided in this Chapter and ***Chapter 1140*** regarding lighting items in plans.

1141-2 Coordination with Utilities

Existing underground and overhead utility lines shall be shown in the lighting plan. Proposed utilities lines shall also be shown. Many utility companies are members of the **Ohio Utility Protection Service (OUPS)**. Utility companies that are not members of **OUPS** shall be contacted individually. However, when the lighting improvement is but part of a larger project, the lighting designer should coordinate with the other designer(s) to avoid multiple requests for the same information.

The power company which will be supplying power should be contacted early in the design process to confirm that power will be available at the location(s) being considered for power services. The designer will also need to obtain from the power company any company requirements for customer services along with the costs that the power company expects to bill for their work in providing each service. The designer should later confirm with the power company the details for service at each of the points finally chosen. Written documentation signed by both the designer and the power company representative should be provided in the supporting documents accompanying the review submissions.

1141-3 Plan Composition

1141-3.1 General

For a normal **ODOT** project, the documentation of the work to be done will consist of the **Construction and Material Specifications (C&MS),** the **Supplemental Specifications** listed on the Title Sheet of the Plans**,** the **Standard Construction Drawings (SCDs)** listed on the Title Sheet of the Plans and the **Proposal.**

The highway Lighting Plan is usually a portion of a larger highway construction project. In such cases, the Lighting Plan will be a section of the plan for the overall improvement and listed as such in the index of sheets which appears on the title sheet. However, at times highway lighting will constitute the entire project. In those cases, items normally not included in the lighting plan must be added. Field offices, construction layout stakes and provisions for maintenance of traffic during construction are some of the things that may be needed.

The lighting portion of a plan usually consists of the following subdivisions which are to appear in the order listed.

1. General Notes.
2. General Summary of Lighting Items.
3. Sub Summaries.
4. Schematic Index.
5. Plan Views.
6. Special Details.
7. Circuit Diagrams, if used.
8. Tower Cross Sections, if used.

A title sheet is added as the first sheet of the plan only in those projects where the only work is the highway lighting improvement.

1141-3.2 General Notes

General Notes should be limited to explanations required to clarify details of the proposed work which are not satisfactorily covered in the **Specifications**, **Supplemental Specifications**, **Standard Construction Drawings** or elsewhere in the plans. General Notes are also commonly used for standard bid items which require supplemental information not otherwise shown in the plans or specifications, such as the specific luminaires that are to be installed or the method of maintaining the existing lighting. When a pay item varies from the standard definition to the point that it becomes an "as per plan" item, or an "item special" is used to cover work for which no standard item exists, a **Plan Note** is required to define the work and materials that are included in the price bid for that particular item. ***Chapter 1142*** contains **Plan Notes** for a number of commonly encountered situations.

1141-3.3 General Summary

The lighting quantities can be placed in the project General Summary under the heading "Highway Lighting." However, since the lighting portion of the plan is frequently prepared separately, they are often located in the lighting section of the plan with a cross reference under the heading in the project General Summary. The format of the Highway Lighting General Summary follows that of the project General Summary. From left to right columns are used as follows: columns to the left of the sheet bring forward the subtotals from each sub-summary sheet using one column per sub-summary sheet; the next group of columns sub-totals the units by funding participation split; the final group of columns contains item number, item extension number, grand total, unit of measurement, and item description information. The **ODOT Item Master** (available on-line from the **ODOT Design Reference Resource Center** web page) is a list of commonly used bid items including the item extension number, unit of measurement and description for each item listed. Blank lines should be used to separate the line entries into groups of five lines.

1141-3.4 Sub-summaries

Sub-Summary Sheets compile the pay items for each node and link of the highway lighting improvement. **L&D Manual Volume 3 Sample Plan Sheets, Figure 1314-10S** is for a sample highway lighting sub-summary sheet.

1141-3.5 Schematic Index

L&D Manual Volume 3 Sample Plan Sheets, Figure 1314-8S is for a sample highway schematic index sheet.

1141-3.6 Plan Sheets

See **L&D Manual Volume 3 Sample Plan Sheets, Figure 1314-9S** for a typical plan sheet. Plans shall be prepared using the English unit system. Plan sheets for tower lighting are usually prepared at a scale of 1:100 (1:1000). Plan sheets for other types of lighting are normally prepared at a scale of 1:50(1:500). However, lighting plans may be prepared to other scales when appropriate and agreed to by the **District**. Each lighting plan sheet should include the following information:

1. Pavement and paved shoulder edges.
2. Curb lines, curb ramps, raised medians and islands and painted islands or similar channelizations.
3. The beginning and the end of the tapers used at the start of each deceleration lanes.

4. The end of each acceleration lane.
5. Bridge structures and retaining walls, including pier and abutment locations, and length of approach slabs. Include **ODOT** structure number when appropriate.
6. Drainage culverts and flow lines.
7. Existing and proposed overhead and underground utilities. Show width and/or boundaries of the utility right-of-way or easement and fence grounding points where overhead electrical lines are involved.
8. Type, wattage or lumen rating, and ownership of existing lighting in the project area, and planned disposition.
9. Maintenance jurisdiction boundaries.
10. Funding participation boundaries.
11. Future lighting unit locations needed to portray the coordination between adjacent improvements.
12. A north arrow, located on the upper right corner of the sheet.
13. A legend, or reference to the plan layout sheet showing the legend. The legend shall indicate by appropriate symbol the various nodes (e.g., light poles, light towers, pull boxes, junction boxes, power services, etc.) and links (e.g., conduits with distribution cable, unitized cable in duct assemblies, etc.) to be installed.
14. The location of each light pole foundation, conduit crossover, pull box, control center, tower, etc., by centerline or baseline station and offset distance from the controlling pavement edge. Include the maintenance platform type, if any.
15. Existing and proposed rights-of-way (R/W).
16. Guardrails and barriers.
17. Illuminated signs. Show an appropriate symbol, the sign installation number, the centerline station and the total wattage of the installation.
18. Combination supports. Clearly indicate the nature of the combined support (e.g., Sign & Luminaire, Signal & Luminaire) and show all applicable data for electrical service and the separate bid items necessary to provide the lighting components. Add a cross-reference to the Traffic Control Plan sheet showing the support details.
19. Begin Project and End Project, along with work limits for the mainline and for each crossroad.
20. Match lines. Avoid the use of match lines along the centerline of any illuminated roadway.
21. Station equations. Show the station equations along lines of survey, between centerline of route and baselines of roadways, crossings between routes and intersections of roadways.
22. If landscaping is part of the project, proposed trees in areas adjacent to the proposed light poles should be shown.

1141-3.7 Special Details

Special detail sheets should show only those details which are not covered in the **SCDs**, the **C&MS** or the **Supplemental Specifications**. In cases where modification of a standard detail is necessary, variations from the standard should be clearly identified. Clearly indicate the location(s) to which the detail applies especially if it does not apply to all locations within the project. The designer should carefully review the latest edition of the **Traffic SCD HL series** to determine if a particular detail has been covered before creating of a special detail drawing.

If the lighting plan includes underpass lighting, the following should be included for each lighted underpass: a detail view indicating the location of each luminaire; the disconnect for the underpass lighting; and the routing of all conduits comprising the service to underpass lighting from the pull box or junction box that is the point of connection of the main lighting circuit.

1141-3.8 Circuit Maps

When the lighting installation is large and circuits continue across several sheets, a map of each circuit in abbreviated detail should be included. The Control Center Data Chart ***(Figure 1198-11)*** should be included on the map of the first circuit (numbered “1” or “A”) radiating from the service point. The maps of all other circuits radiating from that service point should contain a cross reference to the sheet on which the data table for that particular service appears. If circuit maps are not being prepared for an installation, then the Control Center Data chart should be located on the plan view sheet showing the location of the service.

1141-3.9 Tower Cross Sections

To support the pole height selected for each tower, the designer will usually provide pavement elevation(s) for the roadway(s) lighted by each tower and finished grade at the base of the tower in tabular form on supplemental worksheets and no cross sections will be drawn.

In some cases, this will be illustrated by a cross section drawn from the edge of pavement out through the location of the tower, or if the tower lights multiple roadways, a cross section will be drawn from each roadway out through the tower location.

1141-3.10 Wiring and Circuit Designations

In plan preparation, it is very important to describe existing and proposed circuits correctly. Wiring for lighting circuits requires the following information in order to be completely described:

1. Number of wires;
2. Number of Conductors;
3. Nominal voltage (typically, L-N and L-L shown);
4. The phrase “with ground” as required; and
5. Wire size (guage) as required.

Note that the Ground wire (grounding conductor) of a system is not counted as a *conductor* (because it does not carry load current), but it is counted as a *wire*. The Neutral wire is the grounded conductor.

Some example wiring and circuit designations are shown below. The designation in parentheses is the terminology per **NEC-2011 Art. 250.26**, which applies to circuits that use a grounded conductor; it is also helpful in describing the circuit.

1. 2-wire, 2-conductor, 240/480V
   — L1 (240V) —
   — L2 (240V) —
2. 2-wire, 2-conductor, 480V (a single-phase, 2-wire system)
   — L1 (480V) —
   — N —
3. 3-wire, 2-conductor, 120V, with ground (a single-phase, 2-wire system)
   — L1 (120V) —
   — N —
   — G —
4. 3-wire, 2-conductor, 240V, with ground (a single-phase, 2-wire system)
   — L1 (240V) —
   — N —
   — G —

5. 3-wire, 2-conductor, 277V, with ground (a single-phase, 2-wire system)
   — L1 (277V) —
   — N —
   — G —
6. 3-wire, 3-conductor, 120V/240V (a single-phase, 3-wire system)
   — L1 (120V) —
   — L2 (120V) —
   — N —
7. 3-wire, 3-conductor, 240V/480V (a single-phase, 3-wire system)
   — L1 (240V) —
   — L2 (240V) —
   — N —
8. 4-wire, 3-conductor, 240V/480V, with ground (a single-phase, 3-wire system)
   — L1 (240V) —
   — L2 (240V) —
   — N —
   — G —
9. 5-wire, 4-conductor, 480Y/277, with ground (a three-phase system)
   — L1 (277V) —
   — L2 (277V) —
   — L3 (277V) —
   — N —
   — G —

1141-4 Submissions and Project Development Reviews

1141-4.1 General

L&D Manual Volume 3, Chapter 1400 and ***Section 140-7*** contain general information about the various submissions required and reviews conducted during the development of the plan for a project. The Scope of Service may also contain specific requirements for the project at hand. Normally, reviews of the highway lighting portion of the plan will be conducted at Stage 2 and Stage 3 of the Plan Development Process.

1141-4.2 Project Development Process Stage 2

At Stage 2, the Lighting Plan is not complete, but the essentials are in place. The location of each luminaire and support is known. The calculations supporting those locations have been made. The possible power service points have been found and those with the best fit selected. Circuits have been laid out and preliminary checks made to determine that cable sizes will not be excessive. A rough estimate of the load at each power service point has been made to determine that the equipment will be of an acceptable size. The serving utility company has been contacted, and written confirmation obtained from the company that service will be made available at the desired location(s) and that the service will be of the concept envisioned by the lighting designer.

Two sets of full-size (22 x 34 inches) prints of the preliminary highway lighting plans should be submitted to the appropriate **District** as part of the entire Stage 2 submittal process. Each of the full size sets is to be accompanied by a half-size (11 x 17 inches) set of the roadway plan view sheets. The roadway plan views are not reviewed during the lighting review, but are for the lighting reviewer’s reference.

Two copies of the computations and/or computer analyses used to support the illumination design should also be included with the Stage 2 submission. A separate analysis for each of the proposed luminaire packages is required. Normally, a package will consist of luminaires from a single manufacturer. Normally, there will be three luminaire packages. The luminaires commonly used in the design of **ODOT** highway lighting installations may be obtained from the

Office of Roadway Engineering.

Additional half-size sets of the highway Lighting Plan may be required if any of the lighting will be turned over to a local government to maintain. Normally, these half-size sets will not be accompanied by a set of the roadway plan views or by the illumination calculations.

The exact number of review sets and the composition of each review set (full or half-size, the supporting documents to accompany each set, etc.) should be verified with the **District** prior to making the submission.

1141-4.3 Project Development Process Stage 3

At Stage 3, the Lighting Plan is now complete. All that remains is to clean up the CADD files and print the tracings. Notes have been written; Summaries are completed; and details have been drawn. The serving utility has committed in writing to the details of each service. All utility companies, either directly or through their respective protection services, have confirmed that clearances are adequate. Comments from previous review have been resolved. Nothing has been omitted.

Two sets of full-size (22 x 34 inch) prints of the highway Lighting Plans should be submitted to the reviewing **District**. Each of the full-size sets is to be accompanied by a half-size (11 x 17 inch) set of the roadway plan view sheets. The roadway plan views are not reviewed during the lighting review, but are for the lighting reviewer's reference.

Two copies of the computations and/or computer analyses used to support the design are also to be included with the Stage 3 submission. The illumination calculations may be omitted if there has been no revision since the previous submission and the previously submitted calculations were approved as adequate. If the luminaire placement calculations are omitted, this should be stated and the reason noted in the letter of submission. Support height calculations (tower height calculations) and cable sizing calculations (voltage droop or drop calculations) normally come in for review for the first time at this point. A written response to the comments and recommendation from the previous review is to be included.

Additional half-size sets of the highway Lighting Plan may be required if any of the lighting will be turned over to a local government to maintain. Normally, these half-size sets will not be accompanied by a set of the roadway plan views or by the illumination calculations.

The exact number of review sets and the composition of each review set (full or half-size, the supporting documents to accompany each set, etc.) should be verified with the **District** prior to making the submission.

1141-4.4 Review Checklists

1141-4.4.1 General

The following checklists were developed to aid **ODOT** design reviewers; however, they should be helpful to original designers in preparing plans for submission for approvals.

1141-4.4.2 Stage 2 Plans

General items to check for Stage 2 plans:

1. Is the plan drawn to a scale of not less than 1:200?
2. Does the plan show the edge of the pavement, the edge of paved shoulder, the beginning and end of the taper at the start of parallel deceleration lanes, the end of the taper on acceleration lanes, raised medians and islands, painted islands, and all structures?
3. Are drainage ditches, flowlines, culverts and catch basins shown?

4. Are pier and abutment locations shown for all interchange structures?
5. Are corporation lines shown?
6. Are existing and proposed overhead electrical and communications lines and underground utilities shown?
7. Does the submission show the **IES** distribution, lamp type and wattage or lumen rating, mounting height and ownership of each existing lighting unit in and adjacent to the project area?
8. Is the location for each proposed lighting unit shown?
9. Are future lighting unit locations, which must be coordinated with the proposed lighting, shown?
10. Is the proposed power service(s) shown?
11. Is the proposed circuit(s) shown?
12. Does the submission include supporting documentation showing that the lighting design criteria have been met, with regard to such things as initial intensity, uniformity ratios, mounting heights, luminaires and lamps, etc.? For complex projects at Stage 2, straight-line, simplified design tool outputs (e.g., Visual™ Roadway Tool) are acceptable.

1141-4.4.3 Stage 3 Plans

1. General items to check for Stage 3 plans:
    a. Are symbol legends uniform for the entire Lighting Plan? Do tower lighting symbols indicate which are symmetrical, which are asymmetrical, and which are long and narrow distributions?
    b. Have all guardrails and barriers been shown on the Lighting Plan sheets?
    c. Have applicable structure numbers for each bridge been shown on the Lighting Plans?
    d. Are the pertinent jurisdictional boundaries such as **State**, **County**, **Township**, **City** or Power Company Service Area shown?
    e. Has consideration been given to the need for glare shields? Where required, is their use clearly warranted?
    f. Where existing or proposed overhead power transmission, power distribution, or telephone lines are located in the vicinity of light poles, light towers, or overhead signs, do the vertical and horizontal clearances from the proposed lighting installations meet the requirements of the **National Electrical Safety Code** and the requirements of the utility companies? Are all overhead lines shown in lighting plan?
    g. Are tower pole locations located beyond clear zones established in **L&D Manual Volume 1, Section 600.2**? If not, has the hazard created been properly mitigated?
    h. Have **FAA** glide path clearance requirements been met when the project is near an airport?
    i. Are all service pole and control center locations accessible for maintenance purposes, particularly during wet weather and winter seasons? Where these facilities must be located at ground elevations below connecting conduit systems, have pull boxes been provided at the base to prevent any incoming water from rising into the control equipment?
    j. Is circuitry clearly delineated?
    k. Are pilasters, junction boxes, conduit, etc. shown on the bridge and retaining wall plans?
    l. Are pilasters and conduit systems included on structures where provisions for future lighting are required?

m. Have structure grounding systems been included on all bridges requiring same?
n. Are locations of special trenching (deeper or wider than normal) clearly delineated on the plans?Are fence grounds needed?
o. Are items with other than normal project funding clearly indicated both on the plan sheets and in the summaries and are the participation splits for each item defined?
p. Has supporting documentation for the height of each light tower been provided?
q. Has supporting documentation for the depth of each tower foundations been provided?
r. Have cable sizing (voltage droop or drop) calculations been provided?
s. Has the serving power company committed in writing to provide service of the type proposed at each service point being proposed?
t. Is there a need to maintain existing lighting on the project? If so, has the "Maintain Existing Lighting" Plan Note been included.
u. Are required lighting **Standard Construction Drawings** listed on the title sheet of the plans with appropriate dates?
v. Have **District** and Local preferences been incorporated into the plan?

2. Details to check:

a. Are there any poles which need to be of special heights to compensate for the pole being mounted significantly higher or lower (e.g., on a tall retaining wall, on ground below a bridge and reaching above the bridge, etc.) than the roadway?
b. Are voltage and type of service furnished by the power supplying agency shown?
c. Has the Control Center Data Chart been shown?
d. Where fencing is to be installed around a control center, have the necessary dimensions, notes, and grounding and other details been shown, and provisions made for payment?
e. Are all conduits included in lump sum bid items clearly identified and the material specified?
f. Are sizes and locations of all cable clearly shown?
g. Are complete design output results shown, with legible point illuminance values and summary statistics tables?

3. General Notes:

a. Are the Plan Notes listed in **Chapter 1142** included, when applicable?
b. Where reference has been made to specific products, has the "or equal approved by the Engineer" phrase has been include?
c. Where there are median mounted poles, does the roadway plan provide the proper barrier?

4. Summaries:

a. Are sub-summaries in accordance with the Sample Plan Sheet?
b. Where a combination support is proposed, is the separation of bid items between the highway Lighting Plan and the signal or signing portion of the plan clear and coordinated?
c. Have anchor bolts been separately provided for poles where the standard anchor bolts supplied with the pole will not be available (i.e., relocated poles) or will not fit the mounting condition (i.e., bridge or retaining wall) encountered?
d. Has trenching been separated according to depth?
e. Is conduit to be encased in concrete before closure of the trench separated from that which will not?
f. Is each conduit to be placed in an area where the surface is not to be disturbed being installed by jacking or boring?

g. Are items with other than normal project participation in the funding properly identified and in separate line items from those with normal project funding?

h. For special bid items, are methods of measurement and basis of payment clear?

   Have all necessary notes and details been shown? Does description of the item clearly indicate that component parts not specifically mentioned, but required for satisfactory operation shall be furnished and considered paid for as part of the item?

i. Have sub-summary sheet totals been properly carried to the General Summary?

j. Does the item description of each line item comply with the requirements of the **Item Master**? Are the item number and item extension number correct for the description and unit of measurement used?

1142 PLAN NOTES

1142-1 General

This area is reserved for sample/typical **Plan Notes** that have been developed for highway lighting.

1142-2 625, Pull Box Cleaned

This item of work shall consist of cleaning an existing pull box by removing any existing cables not being reconnected, and debris so that new cables can be installed. Any unused openings shall be closed. Disturbed areas near the pull box shall be cleared of weeds or debris and shall be fully restored. Material removed shall become the property of the contractor and shall be properly disposed of off of the project site.

Payment will be made at the unit price bid under C&MS Item 625, “Pull Box Cleaned" for each pull box cleaned which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-3 625, Conduit Cleaned and Cables Removed

This item shall consist of cleaning an existing conduit by removing existing cables, mud and debris so that new cable can be installed. Incidental to the cleaning is the installation of bushings and/or couplings on the ends of existing conduit as required. Materials removed shall become the property of the contractor for proper disposal off of the project site. Disturbed areas shall be properly restored.

Payment will be made at the unit price bid under C&MS Item 625, “Conduit Cleaned and Cables Removed" per foot of conduit cleaned which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-4 625, Anchor Bolt and Concrete Repair

This item consists of restoring concrete median barriers and foundations after field repairs are made to flawed anchor bolts. Perform anchor bolt field repairs according to a written procedure provided by the anchor bolt manufacturer, and only after obtaining signature approval of the procedure by the Engineer.

1. For newly-constructed joints kept continuously damped (e.g., overnight work pauses, etc.):
    a. Workmanship: 2016 C&MS 511.09 and 511.10 should govern the joint, with the exception that a “keyway” can be provided by a suitably rough interface, which is provided chipping away the old barrier concrete from around the anchor bolts and preparing the surface.
    b. Materials: should be the same concrete item as for the original median barrier or foundation (e.g., QC1); assure that the Engineer is able to subject this repair material to all the same material tests required of the original concrete.
    c. C&MS 625.10 calls for QC Misc. or QC1 concrete for foundations.
    d. Speed of set is not usually important for barrier wall and foundation repairs, because they do not carry traffic. Consult with the Engineer if any variation in C&MS 511.14 Curing and Loading is anticipated.

2. For “old” joints (more than a few days if kept continuously damp), follow 2016 C&MS 256, noting the following:
    a. This is a procedure designed for pavement repair, usually (but not always) using bonding grout at the interface (see 256.07.A-C).

b. The repair material is not concrete in kind, but patch material per 256.07. Coarse aggregate should be added, as needed, to extend the patch material if the repair volume and gaps are large enough.

Payment for this item will be made at the bid price, for each foundation repaired, regardless of the number of anchor bolts contained in the foundation.

1142-5 Luminaire, High Mast, As Per Plan

The luminaire arrays and associated illumination test areas specified in C&MS 725.11 are hereby waived. Instead, the luminaires for high-mast lighting shall meet the following requirements:

Luminaires for high-mast lighting units with symmetric distribution shall be Holophane "HMST" with photometric distribution 36383, General Electric "HM" with photometric distribution 6312, or Cooper "HMX" with photometric distribution HMX4SDW, or equal as approved by the Engineer.

Luminaires for high-mast lighting units with asymmetric distribution shall be Holophane "HMST" with photometric distribution 46973, General Electric "HM" with photometric distribution 7349, or Cooper "HMC" with photometric distribution HMC4S3D, or equal as approved by the Engineer.

Luminaires for high-mast lighting units with long narrow distribution shall be Holophane "HMST" with photometric distribution 36801, General Electric "HM" with photometric distribution 8946, or Cooper "HMC" with photometric distribution HMC4S1DL, or equal as approved by the Engineer.

In addition, other luminaires will be considered if the designed intensity and uniformity are provided using the designed pole locations and the designed number and type of fixtures per pole.

1142-6 Luminaire, Low Mast, As Per Plan

The luminaires shall be as specified for high-mast luminaires in C&MS 725.11 except that the luminaire arrays and associated illumination test areas are hereby waived. In addition, the luminaires for low-mast lighting shall meet the following requirements:

Luminaires for low-mast lighting units with symmetric distribution shall be Holophane "HMST" with photometric distribution 36383, General Electric "HM" with photometric distribution 6312, or Cooper "HMX" with photometric distribution HMX40SXXDW, or equal as approved by the Engineer.

Luminaires for low-mast lighting units with asymmetric distribution shall be Holophane "HMST" with photometric distribution 46973, General Electric "HM" with photometric distribution 7349, or Cooper "HMC" with photometric distribution HMC4S3D, or equal as approved by the Engineer.

Luminaires for low-mast lighting units with long narrow distribution shall be Holophane "HMST" with photometric distribution 36801, General Electric "HM" with photometric distribution 8946, or Cooper "HMC" with photometric distribution HMC4S1DL, or equal as approved by the Engineer.

In addition, other luminaires will be considered if the designed intensity and uniformity are provided using the designed pole locations and the designed number and type of fixtures per pole.

1142-7 625, Luminaire, Conventional, As Per Plan

In addition to the requirements of ODOT'S Construction and Material Specifications, luminaires for conventional lighting units shall be as follows:

Luminaires for conventional lighting units with an IES II-M-SC distribution and 200 Watt high pressure sodium lamps shall be American Electric "Series 126" with photometric distribution

AE3849I (adjust lumen value for 200w HPS), Cooper "OVX" with photometric distribution OVX25SXX2DF (adjust lumen value for 200w HPS), General Electric "M-400" with photometric distribution 1014 (adjust lumen value for 200w HPS), or equal as approved by the Engineer.

Payment will be made at the unit bid price for each C&MS Item 625, "Luminaire, Conventional, As Per Plan (add supplemental description)" for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-8 625, Luminaire, Post-top, As Per Plan

In addition to the requirements of **ODOT**'s **Construction and Material Specifications**, luminaires for post-top lighting units used in green spaces of rest areas shall be as follows:

Luminaires shall be American Electric "Contempo Series 245/246" with photometric distribution P5236, Cooper "USA Style King" with photometric distribution USA1S55, General Electric "PM16/PM17" with photometric distribution 6928, or equal approved by the Engineer.

Luminaire refractors may be of glass, polycarbonate, or acrylic.

Payment will be made at the unit price bid under C&MS Item 625, "Luminaire, Post-Top, As Per Plan (add supplemental description)" for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-9 625, Luminaire, Underpass, As Per Plan

In addition to the requirements of ODOT's Construction and Material Specifications, luminaires for underpass lighting shall be as follows:

Luminaires for underpass lighting units shall be American Electric "Sidelight series 582" with photometric distribution AE2081I, Cooper "Wall Light" with photometric distribution WPK15SXX, General Electric "Versaflood II Wallighter" with photometric distribution 8578, Holophane "Wallpack II" Test with photometric distribution 33263, or equal as approved by the Engineer.

Luminaires for underpass lighting unit which are wall mounted shall be furnished with an integral fuse holder and 10-ampere fuses.

Payment will be made at the unit price bid under C&MS Item 625, "Luminaire, Underpass, AsPer Plan (add supplemental description)" for each luminaire which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-10 625, Luminaire, Installation Only, As Per Plan

This item of work shall consist of installing an existing luminaire removed from a previous location on the project or supplied to the project site by others.

The luminaire shall be cleaned, repairs to ensure that it is in good serviceable condition made, adjustments to the optical components to ensure that the specified distribution is being produced made, and a new lamp installed if the light source is a lamp.

Payment will be made at the unit price bid under Item 625, "Luminaire, Installation Only, As Per Plan" for each luminaire installed and shall be full compensation for all material, labor, equipment and incidentals necessary to complete this item in a workmanlike manner.

1142-11 Lamps

High pressure sodium lamps shall be General Electric "Lucalox," Osram Sylvania "Lumalux," Philips "Ceramalux," or equal approved by the Engineer.

1142-12 625, Light Pole, Installation Only, As Per Plan

This item of work shall consist of installing an existing light pole removed from a previous location on the project or supplied to the project site by others.

The light pole shall be cleaned and repairs needed for the pole to be in good serviceable condition made. The existing pole number decal shall be removed if it is in poor condition or the pole number has changed. A pole number decal shall be supplied and applied if the existing decal is removed or missing.

When required, new anchor bolts shall be furnished as part of this item.

Payment will be made at the unit price bid under Item 625, “Light Pole, Installation Only, As Per Plan” for each pole installed and shall be full compensation for all material, labor, equipment and incidentals necessary to complete this item in a workmanlike manner.

1142-13 625, Light Tower, Installation Only, As Per Plan

This item of work shall consist of installing an existing light tower removed from a previous location on the project site or supplied to the project by others.

When required, additional luminaire bracket arms shall be added to the existing luminaire brackets relocated along with the necessary adjustments and additions to the luminaire wiring to enable the luminaires to be mounted symmetrically around the luminaire mounting ring.

Where the tower will be installed on a new foundation, new anchor bolts shall be furnished.

The tower and lowering mechanism shall be cleaned and lubricated.

Any repairs and adjustments necessary to return the tower and mechanism to good operating condition shall be made.

The existing light tower identification decal shall be removed, and a new decal for the new identification number furnished and installed.

Payment shall be made at the unit price bid under C&MS Item 625, “Light Tower, Installation Only, As Per Plan” for each tower re-erected which shall include all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-14 Light Pole Anchor Bolts On Structures

When a light pole is mounted on a pilaster on a bridge parapet or on a retaining wall, the required anchor bolts may differ in length and/or shape from those required when the pole is mounted on a cast-in-place drilled shaft foundation. The cost differential for furnishing such bolts is included herein.

In addition, there is no foundation construction item in which to include the setting of the anchor bolts. Thus, the setting of the anchor bolts into the pilaster is also part of this work.

Payment will be made at each such pole location at the unit price bid for each C&MS Item 625, “Light Pole Anchor Bolts On Structure” and shall be full compensation for furnishing and placing the set of anchor bolts required.

1142-15 Reserved for Future Information

This Section is reserved for future information.

1142-16 Conduit Expansion and Deflection

Expansion fittings shall be OZ Type AX, Crouse Hinds Type XJG, Appleton Type AX, or equal approved by the Engineer. Each expansion fitting shall provide either 4 or 8 inches total movement as specified by the plan details and shall have an external copper bonding jumper, unless specified otherwise by the plan details.

Deflection couplings shall be OZ Type DX, Crouse Hinds Type XD, Appleton Type DF, or equal approved by the Engineer. Each deflection coupling shall have an external copper bonding jumper, unless specified otherwise by the plan details.

1142-17 625, Power Service, As Per Plan

In addition to the requirements of the Specifications, the following is added.

The power supplying agency for this project is:

Power Company ___________________________

Address __________________________________

Phone # __________________________________

Contact Name _____________________________

The Engineer shall ensure that each power service electrical energy account is in the name of and that the billing address is to the maintaining agency noted in the plans. This shall be done not only for each new power service established by this project but also for each existing power service, since there may be a reassignment of the responsibility for an existing service as a result of the work performed by this project.

Payment will be made at the unit bid price for each C&MS Item 625, “Power Service, As Per Plan” which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-18 Special, Power Service Fence

This item of work shall consist of installing a new chain link fence, with gate, around a power service. The fence and gate shall be installed as specified in C&MS 607 and in the plan. The fence shall be 8 feet in height, and one gate of 4 feet in width shall be included, except as specified herein unless detailed otherwise in the plan.

Where the power service is adjacent to the right-of-way fence and there is reasonable access to the power service from outside the highway right-of-way, the fence around the power service shall utilize the right-of-way fence line as a portion of the fence line of the enclosed area. The right-of-way portion of the fence shall include a second access gate.

The gate hasp of each gate shall be secured by a steel rod, with one end drilled for the maintaining agency padlock and the opposite end drilled for the power company padlock.

Payment will be made at the unit price bid under Item Special, “Power Service Fence" for each area fenced which shall be full compensation for all labor, materials and incidentals required to complete this item in a satisfactory and workmanlike manner.

1142-19 High Voltage Test Waived

The high voltage test shall not be performed on the circuits constructed by this project, since the test could damage the portion of the completed circuit which has been in service prior to this project.

1142-20 Padlocks and Keys

Padlocks furnished shall be either brass or bronze, equal to Master No. 4BKA or Wilson Bohannan 660A, and shall be keyed in accordance with C&MS 631.06. Payment shall be included in the bid for the item(s) being locked.

1142-21 Special, Maintain Existing Lighting

Existing roadways which are to remain open to traffic during construction of this project and which are lighted shall have the lighting maintained as described herein.

Before any work is started in the immediate vicinity of the existing lighting circuits, representatives of ODOT, the Maintaining Agency and the Contractor shall make a visual inspection of the existing roadway lighting circuits to be maintained. During this inspection, a written record of the condition of existing lighting shall be made by ODOT'S representative. This written report shall note individual luminaires which are not in working order, individual poles which are not standing, and individual circuits which are not in working order. The completed report shall be signed by the representatives of ODOT, the Maintaining Agency and the Contractor.

If, as a result of this inspection, it is determined that the condition of the existing system is below that required for the safety of the traveling public, then the Maintaining Agency shall make the repairs necessary to return the system to an acceptable condition. Following these repairs, the system shall again be inspected and a report shall be made and signed as outlined herein.

When the existing system is in an acceptable condition, it shall be turned over to the Contractor who shall then be required to maintain the existing lighting to the condition outlined in this report with the exception of knockdowns due to traffic accidents.

Replacement of knocked downed units shall be done only when the Engineer has determined that the replacement of the knocked down unit is necessary and shall be paid separately on a unit basis.

Betterments shall be covered in items of work pertaining to the construction of permanent improvement.

When the sequence of construction activities requires, or should the Contractor desire, the removal of the existing lighting before the new lighting is operational, the Contractor shall be responsible for providing temporary lighting of this portion of the roadway.

Prior to installing such lighting, the Contractor shall prepare and submit four sets of the temporary lighting plan to the Engineer for review and approval.

This plan shall show locations of poles, lengths of bracket arms, styles of luminaires, mounting heights, wiring methods and other pertinent information. The temporary lighting shall provide an average initial intensity of 1.2 footcandles with an average to minimum uniformity not to exceed 3:1. Mounting height of temporary luminaires shall not be less than 30 feet, and the minimum overhead conductor clearance shall be 20 feet. Temporary overhead construction shall not be less than Grade "B" for strength requirements as defined by the National Electric Safety Code. Wood poles with overhead wiring may be used. However, temporary lighting shall meet Federal and State safety criteria. If breakaway poles are used to meet these criteria, then underground wiring shall be used. Reconditioned or used materials may be furnished for temporary lighting.

All materials necessary to complete the temporary lighting shall be furnished and installed by the Contractor. When no longer needed, the temporary lighting installation shall be removed and properly disposed of by the Contractor.

The Maintaining Agency will pay for electrical energy consumed by existing power services and by proposed permanent power services after acceptance of the lighting work. The Contractor will pay for electrical energy, installation, removal and maintenance of any temporary power services.

The lump sum price bid for Item Special "Maintain Existing Lighting" shall include payment for all labor, equipment, materials and incidentals necessary to maintain the existing lighting as specified herein.

The unit price bid for Item Special "Replacement of Existing Lighting Unit" shall be full payment for the replacement of an existing lighting unit which has been knocked down after the aforementioned inspection and shall include all labor, equipment, materials and incidentals necessary to provide a replacement for such unit.

1142-22 625 Lighting, Misc.: FAA Type L-864 Obstruction Lighting, LED

This item consists of installation and testing of FAA L-864-compliant obstruction lighting for marking of structures over 150 feet. Location and wiring shall be as shown in the Bridge Plans.

Each obstruction lamp shall utilize Light Emitting Diodes (LEDs). The obstruction lamp shall have a written minimum 5-year manufacturer warranty. The lamp shall be ETL verified to FAA Advisory Circular AC150/5345-43F, Type L-864 and shall be one of the following or approved equal:

1. Specialty Tower Lighting Model RB-LED
2. International Tower Lighting Model IFH-1710
3. Point Lighting Model PFB-37001
4. Pharos Marine Automatic Power Model FA-250LED L-864.

Each obstruction lamp shall have its own controller, housed in its own metal enclosure accessible by maintenance personnel standing at floor level. The controller shall operate at 120VAC, 60Hz and have its own dedicated circuit breaker in a nearby panelboard as detailed in the Bridge Plans. The controller shall produce the appropriate FAA-required flashing rate, and the obstruction lamp shall operate continuously twenty-four (24) hours per day, with no intervening photocell control. The controller shall provide at least one unused alarm status output in the form of a dry-contact or solid-state relay closure that responds to defective or inoperative obstruction lamp conditions. At least one relay with complete contacts (Normally Open, Normally Closed, and Common) shall be provided. Alarm relay contact ratings shall be at least 500 mA resistive at 120VAC/30VDC. The controller shall provide at least one visible alarm status indicator for lamp failure indication. This indicator shall be in the form of a panel-mounted red dome-type LED visible from the outside of the enclosure.

The controller enclosure shall utilize a vertically hinged, swing-open door, and be rated NEMA 3R, minimum. Enclosure shall include at least one commercial grade NEMA 5-15 receptacle to accommodate wireless communication equipment to be installed later by ODOT for alarm status monitoring. An integral shelf shall be provided for this equipment inside the enclosure, and shall provide an open, accessible space for equipment measuring at least twelve (12) inches wide, eight (8) inches deep, and six (6) inches in height.

The Contractor shall fully test the system and arrange for acceptance inspection of the Obstruction Lighting installation by ODOT District signal maintenance personnel after the system is operational. During acceptance inspection, the Contractor shall demonstrate the proper operation of all lamps and alarms. Contractor shall provide written manufacturer warranty and all operating manuals for obstruction lighting controller and lamp to ODOT District signal maintenance personnel at the time of inspection.

The Department shall measure LED FAA Type L-864 Obstruction Lighting by each individual obstruction light, complete and installed including any control devices and all wiring and conduits.

Designer Note: Although obstruction lighting is thought of as an incidental bridge item, this note appears in the **TEM** as a 625 Item because bridge lighting maintenance typically falls to **District** signal and lighting electricians. **FAA** regulations require daily visual monitoring of obstruction lighting by the operator (**ODOT**) if they are not equipped with automatic monitoring. Very fast notification and response times are required for repair of malfunctioning obstruction lights. The use of LED lighting significantly reduces **ODOT's** maintenance operations and provides much better reliability by eliminating the frequent outages and routine lamp changes associated with obstruction lights using older incandescent lamp technology. The use of cellular modems for automatic monitoring is recommended and is coordinated through the **Office of Traffic Operations**.

1142-23 625 Lighting, Misc.: Bridge-Mounted Marine Navigation Lighting, LED

This item consists of installation and testing of IALA/AISM-compliant, U.S. Coast Guard approved marine navigation lighting for marking of structures over navigable waters. Location and wiring shall be as shown in the Bridge Plans.

Each marine navigation lamp shall utilize Light Emitting Diodes (LEDs). The marine navigation lamp shall have a written minimum 5-year manufacturer warranty. The lamp shall meet the color, brightness (range), sectoring, and divergence requirements as shown in the Plans and approved by the applicable Coast Guard District. The lamp shall be manufactured by one of the following manufacturers or an approved equal:

1. Tideland Signal Corporation, Houston, TX
2. B&B Roadway, Russellville, AL
3. Pharos Marine Automatic Power, Houston TX

Each marine navigation lamp shall have its own controller/power supply, housed in its own metal enclosure accessible by maintenance personnel, as shown on the Bridge Plans. The controller shall operate at 120VAC, 60Hz and have its own dedicated circuit breaker in a nearby panelboard as detailed in the Bridge Plans. The marine navigation lamp shall operate continuously twenty-four (24) hours per day, with no intervening photocell control. The controller shall provide alarm status output in the form of a blue LED confirmation light visible to ODOT maintenance personnel from deck level to indicate defective or inoperative marine navigation lamp conditions.

The Contractor shall fully test the system and arrange for acceptance inspection of the Marine navigation Lighting installation by ODOT District signal maintenance personnel after the system is operational. During acceptance inspection, the Contractor shall demonstrate the proper operation of all lamps and alarms. Contractor shall provide written manufacturer warranty and all operating manuals for marine navigation lighting controller and lamp to ODOT District signal maintenance personnel at the time of inspection.

The Department shall measure Bridge-Mounted Marine Navigation Lighting by each individual marine navigation light, complete and installed including any control devices and all wiring and conduits.

Designer Note: Although marine navigation lighting is thought of as an incidental bridge item, this note appears in the **TEM** as a 625 Item because bridge lighting maintenance typically falls to **District** signal and lighting electricians. The use of LED lighting significantly reduces **ODOT's** maintenance operations and provides much better reliability by eliminating the frequent outages and routine lamp changes associated with marine navigation lights using older incandescent lamp technology.

1142-24 625 Decorative Post-Top Luminaire, Solid-State (LED), Lantern Style, 3000K, Black Finish.

This item consists of supplying and installing decorative post-top LED luminaires for street and/or sidewalk illumination.

A lantern style luminaire consists of a four discrete flat sloping sides, per HL-10.11, with or without glass or polymer panels, and a rounded or pointed top and a small cupola. Provide a luminaire with a B-U-G up-lighting rating of U2 or less.

The luminaire is intended for external on/off control and shall not include a photocell socket.

Assure the luminaire has a nominal power of 65-85 watts and a nominal color temperature of 3000K.

Provide a luminaire with factory-applied black finish.

Supply one of the following luminaires, or an approved equal:

1. AEL Valient
2. Eaton UTLD
3. GE Salem

Designer Note: Use this text as a plan note template for streetscape and other decorative lighting applications. The goal of the note is to assist designers by listing several models of similar luminaires when no specific requirements are set forth in the project scope. Also, the note provides for a reasonable expenditure of public funds, serving as the Base Bid for which Alternate Bid Items may be included in the Plans. The note describes functional decorative LED luminaires in the most popular style category, without excessive decorative trim. The luminaires listed in this note are similar in aesthetic and photometric properties, provide adequate horizontal illuminance (per IES RP-8) for a representative decorative lighting scenario, and meet material and workmanship requirements similar to those of ODOT SS 813. The "generic" lighting installation used to establish this note consists of luminaires on 17-foot mounting heights (16-foot pole) on each side of a two-lane (12') roadway with on-street parallel parking, 2-foot setback from curb, a 10-foot sidewalk, major street classification, and medium pedestrian conflict classification, yielding a longitudinal pole spacing of at least 120 feet. Lighting installations with different geometry than the “generic” installation should be designed using the same luminaires, perhaps with different distributions, mounting heights and lumen outputs, as guided by the Project Scope of Services and the specific conditions of the site. The design veiling luminance ratio shall be per RP-8. Because this note only lists a few representative models, it must always include the “or approved equal” clause so that competing models that meet the specifications may be used. The poles used to support the luminaires are not specified in this note, but should be finished black per SS 916. Colored finishes other than black shall be Alternate Bid items. The designer must assure at least three luminaires are specified in the Plans, and shall provide illumination design documentation for each.

1143 SPECIFICATIONS

ODOT specifications for the furnishing and installation of highway lighting equipment are contained in **C&MS 625** and **C&MS 725**.

1150 CONSTRUCTION

1150-1 Introduction

1150-1.1 General

The following information does not alter or supersede the contract documents. It is provided as a guide for the **ODOT** personnel assigned to a project to help them with their work.

Electrical construction work must adhere to the contract documents which commonly include proposal notes, project plans, standard drawings, and the **Construction and Material Specifications**. In addition there may be building or electrical codes or change orders that must be followed.

1150-1.2 Contractor Prequalification

Only contractors prequalified by the **ODOT Office of Contracts** for Work Type 43 Highway Lighting shall be allowed to do the highway lighting items of work on the project.

1150-1.3 Respect for Contractor

Contractors are prequalified for specialized work types. They bring expertise to the project and an independent perspective from the project management team. As the contractor reviews plans and specifications, he wants to ensure that he can install material that will ultimately operate as the designer intended. The contractor relies on the engineer to guide the project, to approve materials and work, and to ensure that he will be paid for work completed. It is important to remember that even when the roles of the project team and the contractor conflict successful completion of the project relies on all those involved and the maintenance of good working relationships.

1150-1.4 Protection of Utility Lines

The contractor is to notify all utilities before construction work begins. Names and addresses of these utilities are given in the project plans. It is also the contractor's responsibility to contact the **Ohio Utility Protection Services** (1-800-362-2764) to have utility locations marked in all areas where digging is involved.

1150-1.5 Plan Discrepancy, Design Ambiguity, Consultation with Designer

When there is a question regarding the intent of the plan, the engineer should:

1. Define the discrepancy or ambiguity.
2. Determine if more than the highway lighting is affected.
3. Identify the standard drawings and specifications pertinent to the situation.
4. Determine potential solutions.
5. If the issue involves the location of the luminaires or light poles, the mounting height of the luminaires above the pavement, the luminaire to be used or the lamp to be used; the engineer should consult **ODOT's** design office and the designer to ensure that the performance goals for the lighting system will still be met by the solution under consideration.
6. Consider the maintenance of the installation if the solution is implemented. Will parts not normally stocked by the maintaining agency be required, or will tools and equipment not normally at the disposal of the maintenance crews be required, or will special training of the workers be required?
7. Evaluate potential solutions for safety. Consider measures needed to keep errant vehicles from striking the item, the danger to those who must maintain the installation, the danger to traffic from the maintenance activities.

8. Determine if applicable codes and regulations will be met. Commonly involved will be the **National Electric Code**, **The National Electric Safety Code** and utility company requirements. There may also be **State** and local building codes.

1150-2 Materials

1150-2.1 General

Highway lighting items are found in **Section 625** of the **ODOT Construction and Material Specifications (C&MS)** with detailed descriptions of materials in **Chapter 725 (C&MS).**

In general, all material furnished shall be new and of first quality (unless otherwise noted in the plans) and shall be identified either by a permanently attached name plate or by an indelible marking.

Before installation, all material shall be checked to determine that it is indeed the material that has been specified, that the appropriate material process has been completed and that all paperwork is in hand.

Four procedures are commonly used to ensure that the correct materials are installed.

1. Qualified Product List (QPL)
2. **ODOT** Plant Sampling and Testing Plan (TE 24 Certification)
3. Certified Drawings or Certified Catalog Cuts
4. Project Inspection of Material

1150-2.2 Qualified Products List

Lighting material which may be on a Qualified Product List:

1. Pull Box
2. Junction Box
3. Conduit
4. Wire and Cable
5. Ground Rod
6. Photocell

The **Office of Materials Management** maintains the Qualified Product Lists. The engineer can verify that the material is on a Qualified Product List (QPL) through **ODOT's Construction Management System (C&MS)**. After verifying that the material being supplied is that specified by the contract and on such a list, the project may accept the material.

1150-2.3 TE-24 Material Certification

Lighting material for which TE 24 Certification may be obtained:

1. Pull Box
2. Junction Box
3. Anchor Bolt

The **ODOT** Plant Sampling and Testing Plan (TE-24 system) is administered by the **Office of Materials Management**. This system was designed to allow certain material to be sampled, tested, approved and stocked for future use on **ODOT** projects. The material is inspected at the manufacturing or distribution site. Each approved lot of material is assigned a certification number and documented on Form TE-24. Material from the approved lot may then be transferred directly to an **ODOT** project or it can be transferred to other warehouses, such as a contractor's storage facility, then transferred to a project at a later date.

1150-2.4 Certified Drawings

Lighting material requiring certified drawings (shop drawing or catalog cuts):

1. Luminaires
2. Luminaire Supports (Towers, Lowering Devices, Poles, Bracket Arms)

3. Power Service Equipment
4. Portable Power Units
5. Temporary Lighting Systems

The contractor shall submit two copies of the certified drawings prior to the installation of the material. The submittal ensures that the **State** has a good record of the material installed in case there are any questions about the material meeting criteria, or should additional or replacement units be required.

Each submittal shall identify the project and the bid reference number under which the item is being provided. Certified drawings shall be clearly marked by circling or underlining to indicate the exact item and options being supplied. If a given item is to be supplied under multiple bid item reference numbers, separate and complete documentation packages shall be submitted for each bid item reference number. If multiple items are to be supplied under a single bid reference number, all the items to be supplied under said reference number shall be submitted as a package. The contractor's cover letter for each package is to certify in writing that each manufactured item in the package conforms to all contract requirements for that item.

The submittal of certified drawings does not relieve the contractor from furnishing additional information concerning the material as deemed necessary by the **State**.

1150-2.5 Project Inspection of Material

The following materials are normally manufactured to standards that meet **ODOT** criteria and therefore do not have a **QPL**, do not normally have a **TE-24** and certified drawings are not normally required:

1. Exothermic Welds
2. Insulating Varnish
3. Split Bolt Connector
4. Expansion Fittings
5. Connector Kits
6. Splice Kits
7. Copper Crimps and Compression Connectors
8. Light Pole Decals
9. Circuit Identification Tags
10. Cable Grips
11. Wood Service Poles
12. Fuses for Control Center and Connector Kits
13. Photoelectric Cell and Bracket
14. Secondary Lightning Arrestor
15. Guy Anchors and Anchor Rods
16. Weather Heads
17. Watertight Hubs
18. Remote Ballast Enclosures and Mounting Brackets

Project inspection of material is used to verify that the material at hand is that listed on a **QPL,** or described on a **TE-24,** or for which certified drawings have been received, and that the material complies with the requirements of the contract documents. For material not on a **QPL** which does not have a **TE-24**, and for which certified drawings are not required, the project inspection of material is limited to comparing the material at hand with the requirements of the contract documents.

1150-3 Luminaires

1150-3.1 General

A luminaire consists of a housing containing the reflector, refractor, lamp socket and lamp. Unless specified otherwise, the housing will also contain the ballast components (core and coil, capacitor, starter) required for the lamp being used. The housing may also have optional components such as fuses or a photocell when such has been specified. The housing is fitted with the necessary clamps or other provisions for attaching the luminaire to its support and terminal block for the incoming power.

Verify that the luminaire installed at each location is one of the luminaires listed in the plan for that location. Verify that the distribution, lamp type and lamp wattage are as specified in the plans. Instructions packed with the luminaire will explain the distributions that the luminaire is capable of producing and how to set any adjustments in the luminaire to provide each distribution. Verify that ballast is compatible with the circuit voltage and lamp.

1150-3.2 Conventional Luminaire

The conventional luminaire used by **ODOT** is also known in the trade as an “Ovate” or “Cobra Head” fixture. It may be equipped with a flat or a dropped style refractor as specified.

Verify that the luminaire is properly leveled according to the instructions packed with the luminaire.

1150-3.3 Side-Mount Roadway Luminaire

This luminaire reminds one of a floodlight.

Verify that the “tilt” has been set as specified in the plan according to instructions packed with the luminaire. Verify that the luminaire is oriented “normal” to the line of survey for the roadway being lighted unless the plans stipulate otherwise.

1150-3.4 High-Mast Luminaire

These luminaires are mounted on tall structures equipped with devices to bring the luminaires to ground level for servicing.

Verify that the luminaire is not “twisted” with regard to its bracket arm. There are three distributions commonly used. If the luminaire has a rotatable refractor, verify that it has been aligned properly.

1150-3.5 Low-Mast Luminaire

Low-mast luminaires are the same luminaire as a high-mast luminaire but installed as a fixed unit on a pole of more traditional height.

Verify that the luminaire is not “twisted” with regard to its bracket arm. There are three distributions commonly used. If the luminaire has a rotatable refractor, verify that it has been aligned properly.

1150-3.6 Underpass Luminaire

Underpass luminaires are used to light roadways beneath bridge decks. Commonly they are wall mounted on a pier cap or abutment. Sometimes they may be ceiling mounted on the underside of the deck or to a panel attached to the deck supporting beams or pendant mounted on suspension pipes attached to the structure. Occasionally, they will be post-top mounted on short poles.

Verify that the luminaire has been attached to the structure at the location and in the manner specified.

1150-4 <u>Lamps</u>

Verify that the lamp is one of the brands listed in the plan. Verify that the lamp type and wattage is compatible with the luminaire and its ballast. Unless specified otherwise for a particular installation, the lamps are to have clear envelopes. Do not substitute lamps with “frosted” envelopes. Verify that the installation date has been properly marked on the base of the lamp. Instructions packaged with the lamp explain how to use the dating provision built into the base.

1150-5 Supports

1150-5.1 General

The inspection of the supports (poles, arms, towers, lowering devices, brackets, etc.) consists of two phases: inspection of the components and inspection of the completed assembly. While these may be done together, it is better if the components are inspected upon arrival at the project since there is then more time to obtain replacements or correct faults.

1150-5.2 Inspection of Support Components

Three areas are examined in this phase: welding, galvanizing and compliance with certified drawings.

1150-5.2.1 Inspection of Welds

Examine each weld to verify the following:

1. Each of the welds called for by the certified drawings is present and there is no weld present that is not shown on said drawings.
2. There is no misalignment of the parent material being joined by the weld.
3. There has been no warping of the parent material by the weld.
4. Each weld is of the type, size and continuity shown on the certified drawings.
5. Each weld is of full cross section without excessive concavity or convexity.
6. There is no over filling or cratering at either the beginning or the end of the weld.
7. There is no undercutting (a shallow groove melted into the base metal adjacent to a weld and left unfilled by weld metal) along any weld.
8. There is no porosity (pitting or pinholes) in any weld.
9. There is no crack or discontinuity in either the base metal or weld material along any weld.

1150-5.2.2 Inspection of Galvanizing

Examine the galvanizing to verify the following:

1. There are no spots where the galvanizing is missing or loose and can be flaked off with a penknife.
2. There is no ash that has been picked up from the top of the bath, which usually appears as coarse lumps.
3. There are no pimples from entrapped bath scum particles.
4. There are no blisters from hydrogen gas absorbed during pickling being released and rupturing the surface of the galvanizing.
5. There are no flux inclusions from flux picked up from the top of the bath during dipping and burned on during immersion.
6. There are no lumps or runs of excess zinc from delayed run off of molten metal trapped near surface discontinuities such as joints, seams or holes as the part was lifted from the bath.
7. There are no rust stains from impurities from the pickling process weeping at seams and folds.
8. There is no general overall roughness from over pickling or of excess zinc bath temperature and/or immersion time.
9. There are no patches of dull gray coating from slow cooling of the heavier cross sections of the part after immersion.
10. The galvanizing has a uniform appearance.

Excessive galvanizing faults and gross imperfections or overall poor workmanship may be cause for rejection of the support. Minor scratches in galvanized surfaces may be accepted.

1150-5.2.3 Compliance with Shop Drawings

Supports are frequently shipped to the job site and stored prior to assembly and erection as components which give opportunity for the components to get mixed up, leading to improper assemblies since the basic design often does not prevent errors. Therefore, prior to beginning the assembly of a given support, it is necessary to check the major dimensions of the various components against the certified drawing for the support to verify that this has not occurred.

On poles, verify the length, base diameter, top diameter and wall thickness of each pole or section of the pole for poles shipped in multiple sections that are field assembled. Verify the length, width and thickness of the base plate along with the bolt circle diameter, bolt hole size and number of anchor bolt holes provided.

On bracket arms for conventional supports, verify the arm length and arm rise.

On lowering devices, verify the diameter of the luminaire mounting ring and number of luminaire arms on the ring. Also, verify the length of the power cord along with the wire size and number of conductors in the cord. Verify the diameter and length of each piece of hoisting cable.

1150-5.3 Assembly of Supports

Support components stored in the field should be kept off the ground to prevent finish blemishes where the components lay in contact with a damp surface, earth or water. Support components and assembled supports should be loaded, transported, unloaded, stored and erected in a manner avoiding damage to the factory applied surface finishes.

On multi-piece poles, verify that the sections to be assembled are the correct pieces for the pole at hand. Before tightening each telescopic joint between the sections, verify that the sections are properly oriented and that the male section has been marked to indicate when full insertion has been achieved. Verify that the process used for tightening the joint between sections is approved by the pole manufacturer and that the pole is not bent during the tightening process.

On each steel light pole used with an aluminum transformer base, verify that both the bottom of the pole base plate and the top of the transformer base were given a coat of zinc rich paint prior to assembly.

On each light pole, verify that the cable grip in the light pole is properly installed as shown in **Traffic SCD HL-10.12** to prevent damage to the pole and bracket cable.

On each light tower, verify that the luminaire ring has the correct number of mounting arms and that each arm is attached such that when the tower is erected the arms will be in the positions relative to the roadway as shown on **Traffic SCD HL-10.31**. If the lowering device is equipped with top latches, verify that when the luminaire mounting ring is fully raised and latched, the latch indicator on each latch will be in the “extended” or “visible” position. Verify that all moving parts on the head frame assembly and hoist mechanism have been lubricated in accordance with the manufacturer’s instructions.

Verify that all parts are in place and that all fasteners have been properly installed according to the manufacturer’s instructions.

Verify that each handhole door or cover closes with no excessive gaps.

Verify that a light amount of anti-seize or grease lubricant has been worked into the threads of each fastener holding each removable cover in place.

1150-5.4 Erection of Supports

Prior to erection, verify that nuts can be easily turned by hand onto the threads of each anchor bolt.

When leveling nuts are to be used, verify that the leveling nuts are level before beginning the lift to set the support.

Each support should be lifted and set by crane with the hoist line attached at a point as far above the center of gravity of the support as possible, with a tethering cable from the lifting point to the base of the pole. The lifting point on poles made up of sections slip fitted together should be above the uppermost joint. Hoisting should be smooth and continuous without abrupt jerks. Light tension should be maintained in the hoist lines until an anchor nut has been threaded onto each anchor bolt far enough that the bolt is projecting though the nut by a full thread.

Verify that each support with a transformer base has been plumbed using leveling shims approved by the base manufacturer, installed between the base and the foundation according to the base manufacturer's instructions and limitations, and that the anchor nut on each anchor bolt has been properly tightened.

Verify that each support with an anchor base installed directly on a foundation without leveling nuts has been plumbed using leveling shims approved by the pole manufacturer installed between the base and the foundation according to the pole manufacturer's instructions and limitations, and that the anchor nut on each anchor bolt has been properly tightened.

Verify that each support with leveling nuts is plumbed by adjusting the leveling nuts, and that both the anchor nut and the leveling nut on each anchor bolt have been properly tightened.

Verify that a light tower has been plumbed early in the morning when there is minimum heat effect from the sun.

Verify that each support has been plumbed when there is no appreciable wind.

Verify that the space between the top of the foundation and the base of the support has NOT been grouted.

When a high-mast support (light tower) is equipped with a lowering device that has top latches, verify that the ring engages all latches simultaneously. This is often referred to as "leveling" the ring. It should be done following the manufacturer's directions. Generally, the procedure is to place a block on each hoisting cable that is attached to the ring a few inches above the ring in such a manner that the block will slide along the cable when the block contacts the portion of the mechanism at the top of the tower. The ring is then raised until all blocks have made contact, but not fully raised. The ring is then lowered and the distance between each block and the ring measured. Hoisting cables are then adjusted to make the measurements equal. The process is repeated until no further adjustments are required. The blocks are removed and the lowering device operated several times through its full cycle watching all latches for proper operation.

Verify that support identification decals have the proper legend and that the decals are located approximately 7 feet above the base of the pole facing oncoming traffic.

1150-6 Foundations

1150-6.1 General

Foundation inspection normally consists of three parts: location, excavation and concrete placement.

1150-6.2 Foundation Location

After the location of each foundation has been staked, verify that the location is that specified in the plan and that **Ohio Utility Protection Service** and all utilities in the area have been allowed at least 48 hours to mark their utility locations relative to the proposed foundation. Then verify that the location appears logical. Be alert for the following:

1. Installing the lighting item at the staked location will require removal of vegetation that shields adjacent property owners from the highway.
2. Installing the lighting item at the staked location will locate the item at the top of the back slope, in a cut cross section or at the bottom of the fill in a filled cross section where

guardrail is to be used to keep errant vehicles from going down the slope.

3. Installing the lighting item at the staked location will place the item under an overhead utility line or over an underground utility line.
4. Installing the lighting item at the staked location will require a graded access drive for the construction that has not been addressed in the plan.

The designer should be consulted prior to relocating any support more than 10 feet or if two or more adjacent supports need to be relocated.

1150-6.3 Excavation

Foundations are to be placed only in undisturbed soil or compacted embankment.

If a minor cave-in should occur, the contractor may, with the approval of the engineer, continue excavating using sleeving or casing. When bedrock is encountered, the engineer may reduce the specified foundation depth.

If construction crews must leave the job site with a hole unfilled, it shall be covered and marked with cones, barrels or warning tape.

1150-6.4 Placement of Concrete

Verify that the top of the foundation will be at the proper elevation.

Tops of foundations shall be finished smooth and level to enable proper plumbing of the light pole.

Verify that the anchor bolts are of the correct size and number, and that each bolt is securely held in the correct position. The use of an anchor bolt setting template is encouraged. Verify that each anchor bolt will project the proper distance from the foundation.

Verify that conduit ells are present and that each ell is of the correct size and material, and that each is properly oriented.

Verify that all reinforcing bars are present and that each is of the correct size and shape.

Verify that all items to be cast into the foundation, along with any forming aids, are secured in such a manner that they will not move out of position during the placement of concrete.

Verify that water encountered in the foundation excavation is pumped out before concrete placement. If this is not feasible, verify that the concrete is placed by the tremi-tube method.

Verify that the concrete is of the proper design, has been properly mixed, has the correct slump, and is properly handled during placement. Verify that the concrete is vibrated to eliminate voids.

Verify that the top of the foundation is properly finished and that the concrete is properly cured.

1150-7 Pull Boxes (Manholes)

Verify that each pull box is of the size and material specified.

Verify that each pull box is at the planned location unless the planned location puts the box in a low spot with respect to the surrounding surface. In such cases, notify the engineer so that the engineer, in consultation with the designer if necessary, may attempt to move the box to a location where it will be less likely to hold water.

Verify that a light amount of anti-seize or grease lubricant has been work into the threads of each fastener holding the cover in place.

1150-8 Junction Boxes (Handholes)

Verify that each junction box is of the correct size and material, and securely fastened in the correct location. Verify that a light amount of anti-seize or grease lubricant has been work into the threads of each fastener holding the cover in place.

1150-9 Conduit

Verify that each conduit run is of the correct size and material.

Verify that each cut end on each piece of conduit is reamed to remove rough edges.

Verify that all field cut threads on galvanized conduit have been coated with zinc-rich paint.

Verify that each expansion or deflection fitting has a bonding strap for ground continuity when used with metal conduit.

Verify that each conduit run has been properly fastened in place.

Verify that the contractor shall check each run of conduit by rodding (pushing a mandrel through the empty conduit) or pulling a cleaning puck through the conduit.

Verify that each run of new conduit with cables contains a flat woven polyester pulling tape, rated for 600 pound minimum, in the conduit.

Verify that each run of conduit being left empty for future use contains an HDPE insulated copper tracer wire, 12 AWG minimum, in the conduit.

Verify that each end of each conduit run is terminated either in a box connector that contains an integral bushing or with a separate bushing to protect cable pulled into the conduit.

1150-10 Trench

Verify that the trench did not deviate more than 6 inches from the line designate unless such deviation has been approved by the engineer.

Verify that the sidewalls and bottom of the trench do not have any protruding sharp rocks.

When duct cable is installed in the trench, verify that the backfill material within 2 inches of the duct cable does not contain pieces larger than one-half inch.

Verify that the backfill is placed in compacted layers not to exceeding 4 inches in thickness.

When caution tape is specified, verify that the tape is installed 6 to 8 inches below grade.

1150-11 Power Service

Power service includes all equipment from the connection point to the utility company to the beginning point of the individual lighting circuits.

Verify that the power service location will be readily accessible both to maintenance personnel and to utility company personnel. There should be a safe parking area for service vehicles since the site will be visited regularly. The location should not be prone to standing or flowing water during rain events or to drifting snow. If the location appears unreasonable, involve the designer and the utility company as soon as possible, since moving a power service often means redesigning the lighting circuits.

Verify that the contractor has been in touch with the utility company and become aware of any utility company requirements which may differ from the requirements of the Contract Documents.

Verify that the photocell is facing the north sky, unless otherwise stipulated by the plan, and that no artificial lighting source is disrupting its proper operation.

Verify that the conduits are neatly routed and fasten securely in place.

Verify that enclosures are securely mounted.

Verify that enclosure covers are in place and that fasteners for the covers have had anti-seize or grease worked into the threads.

Verify that moving parts of the switch gear have been lubricated and operate smoothly.

Verify that no debris has been left in enclosures and that the wiring in each enclosure is neat, orderly and tied into place where appropriate.

1150-12 Grounding

1150-12.1 General

The conducting portions of those items containing electrical conductors are to be connected to each other and to earth electrodes to lessen the chance of injury and damage from unwanted electrical currents. Connecting the various conducting portions together to form the continuous path for the flow of stray electrical currents, often referred to as bonding, in **ODOT'S** projects is generally an incidental to the construction. Installation of the earth electrodes and the connection of the conducting portions to those electrodes is often referred to as grounding and in **ODOT'S** projects payment is somewhat related to the electrodes installed.

1150-12.2 Ground Rods

Verify that the ground rods specified have been installed. When additional rods have been added to lower the resistance, verify that the installation of each rod was approved prior to its installation.

Verify that the connection between the ground rod and the grounding cable is an exothermic weld. When additional rods have been added to reduce the resistance, verify that the additional connections are exothermic welds.

The normal ground rod item is for one rod driven into earth and the lead between the rod and the first connection and the associated connections. The earth resistance is then checked. When said resistance exceeds the specified limit, an additional rod is to be driven and connected to the first. The earth resistance of the pair is then checked. The process is repeated until the resistance of the group is lower than the specified limit. Payment is then made at the per rod price for each rod installed.

ODOT has reserved the right to approve the use of each additional rod before it is installed and may decline to install additional rods; thereby stopping the process at any point. When **ODOT** stops the installation of additional rods, it may decide to take another course of action to lower the earth resistance. If no additional action is taken, then by default the earth resistance becomes acceptable as it stands.

1150-12.3 Exothermic Welds

An exothermic weld often has a rougher surface texture on the weld metal than one may be used to seeing, but the weld is not to have other signs of a poor quality weld such as porosity, cratering, cracking or undercutting.

1150-12.4 Structure Grounding

Verify that each grounding electrode is acceptable before structure construction makes modification of the electrode or the installation of additional electrodes along side impractical. Remember that if some of the electrodes are driven rods, that such rods are incidental to the structure grounding system, not separate items. However, if due to high resistance, additional rods are driven, those rods are not incidental to the structure grounding system.

Verify that the necessary bonding jumpers are in place and functioning correctly before structure construction makes the installation of additional jumpers impractical.

Structures present special needs. Not only is it not practical to have a separate ground rod for each light pole or similar item mounted upon the structure, but also there are elements of the structure itself that need grounding. Thus the normal practice is to use bonding jumpers to connect all exposed metal items together and thence to the several electrodes frequently utilizing the main conducting portions of the structure as the main grounding buss. This means that electrodes are often under footers and bonding jumpers are frequently embedded in the structure. If something is left out or does not function as intended and it is not discovered until the final stages of construction, the grounding can become expensive, unsightly and less than desired. Unfortunately, structure designers all to often include little in the way of specific details for the structure grounding. Therefore, it is imperative to be constantly thinking ahead to fully understand where each electrode and jumper is to be located and to verify that it is in place and functioning correctly at each stage.

1150-12.5 Bonding Along Circuits

Verify that all of the conducting items containing the conductors of each circuit are bonded to form a continuous path back to the source of the circuit.

At light poles, verify that metal conduits entering the base of the pole are bonded to the pole.

At pull boxes, verify that the metal conduits entering the pull box are bonded together and that the metal lid and lid frame are bonded to the metal conduits.

At junction boxes, verify that the metal conduits entering the junction box are bonded to the box.

At the expansion and deflection joints in conduits of conducting materials, verify that a bonding strap has been install across the joint.

When non-conducting conduit or duct is used, verify that a grounding conductor has been installed to provide for the continuous grounding path when necessary.

1150-13 Wiring and Cabling

1150-13.1 General

Field wiring of highway lighting circuits is broken into three types, pole and bracket cable, distribution cable and duct cable.

1150-13.2 Pole and Bracket Cable

Pole and bracket cable is the insulated single conductor used in a light pole (but not in a light tower) to connect from the distribution cable, up the pole and out the bracket arm to the light fixture (in a tower the electrical wiring from the base of the tower to the luminaires is a component of the lowering device).

Verify that each run of cable is of the size and type specified. The wire size and insulation are to be indelibly marked on the insulating jacket at frequent intervals along the length of the cable.

Verify that each run of cable is installed in a continuous piece without inline splices between the terminations shown on the plan.

Verify that the insulating jacket was not nicked nor portions shaved away as the cable was pulled into place.

Verify that the cable was not stretched as it was pulled into place. If the cable can be pulled back and forth by hand enough to move both ends, stretching probably did not occur.

Verify that a cable support was installed at the upper end of the vertical run of cable up the pole.

Verify that there is enough length on each end of the run for the cable to be routed properly to its termination and still remain slack.

1150-13.3 Distribution Cable

Distribution cable is the insulated single conductor used to construct lighting circuits from the control equipment of the power service to the disconnect kits of a light pole, the terminal block of a light tower, or the disconnect switch for underpass or sign lighting.

Verify that each run of distribution cable is of the size and type specified. The wire size and insulation are to be indelibly marked on the insulating jacket at frequent intervals along the length of the cable.

Verify that each run of cable is installed in a continuous piece without inline splices between the terminations shown on the plan.

Verify that the insulating jacket was not nicked nor portions shaved away as the cable was pulled into place.

Verify that the cable was not stretched as it was pulled into place. If the cable can be pulled back and forth by hand enough to move both ends, stretching probably did not occur. Unfortunately, for the larger wire sizes and the longer runs commonly encountered in highway lighting circuits, the cable cannot be pulled by hand. Thus, the most common indication of stretching is when the length of pulling lead exiting the raceway is greater than the length of cable entering the raceway or the pulling forces are greater than normally encountered; both of which are not easily detected by other than experienced installers.

Verify that there is enough length on each end of the run for the cable to be routed properly to its termination and still remain slack.

All cables shall be labeled in accessible enclosures (pull boxes, hand holes, transformer base, device housing, etc.). A minimum of 5 feet of extra cable shall be provided for each conductor at all terminal points.

1150-13.4 Duct Cable

Duct cable consists of insulated conductors, of the type used for distribution cable, installed into a duct and shipped as an assembly to the project. It is used in place of conduit and distribution cable to speed the installation of underground circuits.

Verify that the temperature of the duct cable was above 32 degrees Fahrenheit throughout the installation process.

It is permissible to install duct cable when the outdoor air temperature is actually below those temperatures, but the Contractor must obtain authorization from the engineer. The contractor shall submit in writing his method of heating the duct cable and maintaining the duct cable at a uniform temperature throughout the installation process. To assure that the duct cable is heated uniformly, the heating process shall keep the temperature of the duct cable above 32 degrees Fahrenheit a minimum of 24 hours prior to installation. Under conditions such as the preceding where the temperature of the duct cable can be expected to vary widely during the installation process, the expansion and contraction of the duct cable must be taken into consideration. Typically, the duct cable length will decrease (or increase) 1 foot per 1000 feet for each 10 degree Fahrenheit decrease (or increase) in temperature.

Verify that the duct of the installed duct cable extends out of any conduit sleeve through which it passes enough to allow for the expansion and contraction in the duct due to seasonal changes in temperature. Typically a projection of 2 to 3 inches is appropriate at the usual installation temperatures for the lengths of run typical in **ODOT'S** installations.

As received on the reel from the manufacturer, it will appear that the cables inside the duct and the duct are equal in length but in reality the cables are shorter than the duct. In order to reel the assembly onto the shipping spool both the cables and the duct were anchored to the spool. As the duct cable assembly is unrolled from the shipping spool, the cables will be drawn into the duct resulting in empty duct at the start of the run. For the assemblies typically used in **ODOT**'s projects, leaving 25 feet of duct for each 1,000 feet of run to be installed at the start of the run, in addition to that required as slack for connections at the start of the run, will compensate for this. At the end of the run, only the slack amount for connections is required.

Verify that the insulating jacket of each cable within the duct has not been damaged when the duct was stripped to allow the connections to be made. Often the length of duct to be stripped is such that no protection can be slid over the cables and into the end of the duct which means that the cables within are saved from damage only by the skill of the person stripping the duct.

When a duct cable assembly has been passed through a conduit sleeve, verify that the duct has been sealed to each end of the sleeve by means of a molded boot or wrapped sealing pad.

Verify that the seal installed between the able and the duct is installed in the same location and in the same manner as outlined under the installation of distribution cable into conduits.

Verify that there is enough length on each end of the run for each cable to be routed properly to its termination and still remain slack.

1150-13.5 Conductor Identification

At each access point (pole base, pull box, junction box, switch gear enclosure, etc.) each conductor of each run of the field wiring (pole and bracket cable, distribution cable, duct cable) of each circuit is to be identified by applying a tag to the conductor indelibly marked to indicate the circuit and the use of that conductor within the circuit.

1150-14 Connections

1150-14.1 General

This covers the connection of the field installed wire and cable to other such wire and cable and to the various items of equipment.

1150 14.2 Sizing Conductor to Device Terminal

When the circuit conductor is of a larger size than the device terminals can accommodate, verify that the connection has been made by splicing a short piece of smaller wire onto the end of the large wire and then connecting the smaller wire to the device terminal. The smaller wire is normally identical to the larger wire in all aspects except for size. The smaller wire must be large enough to carry the current that the circuit protection will allow. It is not acceptable to cut back some of the strands of a conductor, so that the remaining stranded will fit into the terminal.

1150-14.3 Crimped Compression Connections

Verify that the die in the compression tool was for the connector applied and that the connector is sized to match the wire to which it was applied and that the tool used was of a type that did not release the connector from the die once compression started until full compression was achieved.

1150-14.4 Pull-Apart and Bolted Connections

Verify that the internal connector is properly applied to the conductors.

Verify that the insulating cover was cut to proper step for a snug fit over the insulation on each entry to the housing.

Verify that the internal parts are all present in good condition and are fully seated into the housing.

Verify that the male half of the housing is a snug fit and fully inserted into the female half of the housing.

Verify that a thin coating of the kit manufacturer’s approved non-conducting grease has been used at the joint between the two halves of the housing, between the housing and each cable entering the housing, and on other internal parts as shown in the manufacturer’s instructions, to allow the parts to slide smoothly into place and help seal out water.

Verify that there are no sharp bends in each cable where the cable enters the housing sufficient to cause the housing to pull away from the insulating jacket on the cable.

When the kit is to contain a fuse, verify that the fuse is of the proper ampacity.

Where the kit contains bolted connections, verify that the connections were properly tightened before the housing was closed.

Verify that there is sufficient slack in the cables being connected to permit bringing the connector kit outside of the pole, transformer base or junction box in which it is housed for servicing.

1150-14.5 Unfused Permanent Connections

Verify that the internal connection is via a proper crimp compression connector.

Verify that the mold surrounding the connection is completely filled with resin.

Verify that the connection is positioned within the mold such that the resin properly surrounds the connection.

Verify that there are no voids in the resin.

Verify that no fillers have been used.

Verify that the resin has properly set.

1150-15 Test Procedures

1150-15.1 General

There are a number of tests normally utilized to ascertain that the lighting installation has been well constructed and is in good operational order. For a particular test to have meaning, it must be properly conducted and the results properly interpreted.

Verify that the equipment used to conduct the test is in working order and calibration.

1150-15.2 Grounding Electrodes

Verify that each specific grounding electrode meets the requirements of the earth resistance test.

The first key to conducting a successful test of a grounding electrode is to understand what constitutes the electrode. A single driven rod is an electrode. When that rod fails the earth resistance test and another rod is added, the electrode then becomes both rods together. However, in the case of a light tower where two rods are typically specified, the initial electrode is the two rods together rather than each rod separately. In structure grounding, the cluster of driven piles at the end of a pier footer should be considered as a single electrode with the cluster at the other end of that same footer considered as a separate electrode. A continuous grid of mesh, bars or cables laid beneath a footer is one electrode, but separate grids under different portions of the same footer are separate electrodes. Wires buried in a radial pattern from a single pole constitute an electrode.

The second key to successful ground resistance is to understand the limitations of the various test instruments and procedures. The chosen procedure must be appropriate for both the electrode under test and the conditions in which the electrode is installed, and the instrument must be capable of producing valid results for the situation at hand.

1150-15.3 Circuit Continuity

The key to the proper checking of circuit continuity is to remember the objective and to test one conductor at a time. The objective is to see that the conductor is connected to the desired device point and that the conductor has not been connected to any other devices. The difficulty is that the devices are scattered over a large area thus requiring the other conductors of the same circuit to be used as returns for the test signal. For the test to be of use often means that testing must start at one node in the circuit and test all connections along an isolated link from that node. Additional nodes and links are then added one at a time and the continuity of the conductors rechecked until the entire circuit has been verified.

1150-15.4 Cable Insulation

This test is designed to verify that the insulation of each conductor in the circuit and permanent and bolted connections in that conductor are in good conditions be impressing a much higher than normal voltage on the conductor using the change in leakage current over time. Care must be used not to impress the test voltage on devices normally connected by the circuit since the devices would probably be damaged. Since the other conductors in the circuit must often be used as the return path, it is necessary to use care to ensure that the other conductors are not damaged while serving as signal returns and careful interpretation of the results to determine whether the leakage is from a conductor failing the test or from a failure in the return path.

1150-15.5 Lowering Device Operation

This test is simply repeated operation of the lowering device on a light tower to verify that it operates smoothly and correctly throughout its full range cycle of motions.

1150-15.6 System Performance

The test uses the concept "Infant Mortality" to determine if the equipment is likely to operate satisfactorily throughout the projected life of the installation. The concept is the equipment is most likely to fail from manufacturing defects and installation in the first few hours of use and that once these hours are past it is likely to run the rest of its life with only normal maintenance. In conducting the test, it is important to recognize the significance of each component malfunction encountered and to properly interpret whether the malfunction indicates a need to extend the test period.

1150-16 Provide Information to Maintaining Agency

Ensure that each maintaining agency receives the documents pertinent to the maintenance and operation of the lighting units for which it is responsible. Typically included are:

1. A copy of the plan marked to show any changes made during the construction.
2. A copy of each certified drawing.
3. A copy of each instruction or parts manual supplied by each manufacturer.

1150-17 Documentation Requirements

1. Luminaires
   a. Each luminaire has the distribution, lamp and aiming stipulated in the Contract Documents.
   b. Each luminaire has been" leveled".
2. Supports
   a. Each support is the one stipulated for that location by the Contract Documents.
   b. Each support is comprised of the correct components according to the certified shop drawings.
3. Pull boxes
   a. Each pull box is the size and type stipulated for that location by the Contract Documents.
   b. Each pull box supplied under plant sampling and testing program, that it has a TE 24.
   c. Each drain is documented on form CAP 1.
4. Conduit
   a. The conduit is the size stipulated for that location by the Contract Documents.
   b. The conduit is of the material stipulated for that location by the Contract Documents.
   c. The measurement of the length installed.
5. Trench
   a. The location and depth is as stipulated by the Contract Documents.
   b. There are no sharp rocks in backfill adjacent to duct.
   c. The backfill is placed in 4-inch lifts and mechanically tamped.
   d. The measure length installed.
6. Grounding electrodes
   a. Each electrode is installed as stipulated for that location by the Contract Documents.
   b. Each grounding conductor is connected to ground rod with exothermic weld.
   c. Each document ground resistance.
7. Wire and Cable.
   a. Wire size and insulation is as stipulated for that location by the Contract Documents.
   b. Measurement of the length installed.

1160 MAINTENANCE / OPERATIONS

1160-1 General

It is not enough to simply install highway lighting and leave it exposed to the ravages of the elements. The public expects **ODOT** to protect the dollars invested in the lighting by making sure that the lighting is operable so that it can be used by those traveling the highway when natural light is inadequate. This chapter addresses **ODOT'S** lighting maintenance policies and practices.

The **District Highway Management Administrator** through the **Roadway Services Manager** is responsible for ensuring that highway lighting units that **ODOT** is responsible for within the **District** are in proper operating order. The physical work required to fulfill this responsibility may be contracted out to other governmental entities, utility companies and private contracting companies, or performed by **ODOT** forces.

1160-2 Lighting Maintenance Practice Process

A contact point shall be established by each **District** for receiving notification from law enforcement personnel, emergency response and maintenance units, other governmental entities, utility companies, and the traveling public of damage to, and malfunction of, highway lighting. Periodic inspection of lighting installations shall also be made.

The information obtained from these notifications and inspections shall be used to document the damage or failures, and the date of discovery. Based on the nature of the damage or failure, the **District Roadway Services Manager** will ensure that the appropriate responses are made, the incident tracked until repairs have been completed, and the date of completion of repairs documented.

Each **District** shall also see that preventive maintenance is performed to forestall failures, to facilitate repairs during responses to damage and failure, and to provide proper general housekeeping of the installations.

The use of "hot sticks" is not allowed.

1160-3 Determination of Responsibility

1160-3.1 ODOT and Local Jurisdictions

To avoid conflicts during design and construction, planners should included the lighting responsibility in the project scope, since the designer must split the electrical service and circuits between the various agencies. Unless transferred to another entity by a properly executed and approved agreement, the responsibility for the maintenance of, and energy for, the operation of each highway lighting unit is as shown in ***Table 1197-12***.

The responsible party may through an approved agreement or contract arrange for another party to provide materials and equipment, and to perform the actual work. However, agreements and contracts to provide materials and to perform the actual work shall not transfer the responsibility.

1160-3.2 ODOT and the Power Companies

1. Overhead Power Feed via a Weatherhead
   a. ODOT is responsible for the circuit from the weatherhead into the control center and subsequent lighting circuits.
   b. If the circuit is damaged between the weatherhead and the control center, or within the control center itself, **ODOT** must contact the power company to shut off the power feed so **ODOT** forces can make necessary repairs. Once repairs are complete, the power company shall be contacted to turn the power service back on.
   c. If the circuit is damaged down from the control center, the power shall be shut off at the control center by **ODOT** forces, and perform lock-out, tag-out procedures, and proceed repairing the circuits.

d. No work shall be performed on live circuits.

2. Underground Power Feed

a. ODOT is responsible for the circuit from and including the control center.
b. If the control center is damaged, the power company shall be contacted to shut off the power prior to any repair work being done.
c. If the circuit is damaged down from the control center, the power shall be shut off at the control center by **ODOT** forces, and perform lock-out, tag-out procedures, and proceed repairing the circuits.
d. No work shall be performed on live circuits.

1160-4 Emergency Maintenance

Downed or damaged supports that could pose a danger to the traveling public shall be removed as soon as practical, either off the right-of-way or outside the clear zone as defined by the **L&D Manual Volume 1, Chapter 600**.

Exposed live wires shall be secured as soon as possible after discovery.

1160-5 Reactive Maintenance

The maintenance operations are expected to keep the number of working luminaires at a satisfactory level.

To be considered as working, a luminaire must not only be lighted but must be properly aimed. A satisfactory level is when the total number of working luminaires meets or exceeds 90 percent of the total number of luminaires for which the **District** is responsible.

1160-6 Periodic Inspection

Each **District** should periodically inspect all highway lighting units and sign lighting luminaires for which it is responsible. This shall include the units maintained using **District** forces, as well as those maintained for the **District** by other entities such as contractors, power companies or cities.

1160-7 Required Preventive Maintenance

Exposed Equipment - Each cover on a support, junction box, pull box, or piece of power service switch gear shall be secured in the closed position. Any such cover which is missing shall be replaced. Fence gates shall be secured in the closed position.

1160-8 Recommended Preventive Maintenance

Re-lamping - Sodium vapor (highway lighting) lamps should not remain in service longer than four years, as measured by the date code marked on the lamp at the time of installation.

Housekeeping - The following preventative maintenance measures are recommended while performing spot maintenance work and should be performed annually on those pieces of equipment that did not receive the measures during the previous twelve months as part of spot maintenance.

1. Whenever a moving part, latch or lock is accessed it should be lubricated, if in need. For lubrication of electrical switchgear parts, such as those found in power service disconnects and lighting control centers, the Office of Roadway Engineering (ORE) recommends use of CRC HV Switchgear Lubricant, Part # 02060. Make sure electrical equipment is de-energized before using aerosol lubricant sprays. For lubrication of enclosure door gaskets, ORE recommends 3M Silicone Lubricant spray (UPC 021200-85822). For lubrication of padlocks and key-lock mechanisms, ORE recommends an extra-fine dry powdered (not dry-film) graphite such as Superior Graphite Tube-O-Lube.
2. Whenever a threaded cover fastener is accessed, an appropriate anti-seizing agent should be applied or redistributed.
3. Damaged or missing fasteners should be repaired or replaced.
4. Debris should be removed from in and around the base of each light pole and vegetation cut back. Debris and vegetation cuttings should be properly disposed and not left piled at the site.

5. For frangible poles, adjustments to grade should be made to ensure that the pole foundation is flush with grade on the up slope side, and that the top of the foundation is not below grade.
6. For non-frangible poles, adjustments to the grade should be made to ensure that the top of foundation is above grade.
7. Debris should be removed from in and around each power service (and power service enclosure fence, if used) and vegetation cut back. Debris and vegetation cuttings should be properly disposed and not left piled at the site.Debris should be removed from in and around each pull box and the grade adjusted whenever the pull box is opened. Debris and vegetation cuttings should be properly disposed and not left piled at the site.
8. Eroded and sunken areas adjacent to foundations pull boxes and control sites, or over cable trenches, should be filled, seeded and covered with erosion resistant material to slow the flow of runoff and promote vegetative growth.

1160-9 Replacement Luminaires

A replacement luminaire should be of such similar photometric distribution that the intensity and uniformity of the lighting system is not unduly compromised from the installed design. In addition, the weight and effective area of the replacement luminaire shall not exceed the capacity of the support. Where the support is equipped with a mechanical device for lowering the luminaires, the luminaires shall be replaced in the quantity needed to keep the mechanism in balance if necessary.

Replacement supports shall maintain the luminaire mounting height and overhang or underhang.

1160-10 Failure Analysis

The **District** should use historical inspection reports to discover locations experiencing repeated knock downs, pull box locations with repeated cover or box damage, or other patterns of damage that may suggest mitigating actions.

1160-11 Repairing Broken Conduit and Duct Cable

1160-11.1 General

The following procedures should be followed when performing repairs on an existing electrical system.

All damaged cables shall be replaced, except when the distance between terminal points is determined to be excessive in length. In this case pulling of new cables is not recommended because the cable insulation may be damaged. The repair should be accomplished by strategically installing a new pull box to minimize the length of cable to be replaced. Cable splice kits, as specified in **C&MS 725.15**, will be stored in the pull box.

No direct buried splices are allowed. No splices are allowed inside the duct since that violates the National Electric Code.

1160-11.2 Repair Damaged Duct Cable

Duct cable repair shall be accomplished by splicing the duct at the break point in one of the following methods:

Repair with Compression Fittings.

After the duct break is exposed, the damaged cable shall be removed. The duct is prepared for splicing by cutting the duct square to remove the rough edges off each end of the duct. Use either a hacksaw or plastic pipe cutter. Burrs shall be removed from the cut ends and the duct cleaned of dust, dirt, etc. Two compression fittings (such as E-lock or Duraline's Comfit) and a short length of duct are needed to complete the repair. One compression fitting is placed on each cut end and the length of duct is fit between the two fittings. Test fittings to make sure the duct fit is tight. Pull in new wire and complete cable connections.

Repair with PVC Coupling.

PVC couplings use a standard piece of Schedule 40 PVC conduit to replace the missing section of duct cable. After the duct break is exposed, the damaged cable shall be removed. The duct is prepared for splicing by cutting the duct square to remove the rough edges off each end of the duct. Heat shrink tubing should be placed over the PVC before the duct cable is inserted in the PVC coupling. The PVC coupling shall be sufficiently long to replace the missing section of duct. Heat shrink tubing shall extend at least 6 inches on each side of each seam. Heat shrink tubing should be heated with a heat gun or hair dryer. Applying heat with an open flame will damage the tubing and shall not be permitted.

PVC cement will not adhere to duct cable and should not be used.

1160-11.3 Repair PVC Conduit

PVC conduit shall be repaired using PVC couplings and PVC cement in the procedures normally followed during initial installation.

1160-11.4 Repair Rigid Conduit

Rigid conduit shall be repaired using rigid conduit and threadless couplings.

1160-12 Troubleshooting Lamps

1160-12.1 General

Before attempting any troubleshooting, the electrician should verify the circuit operation and path. Lock out/tag out procedures and other safety procedures for 480 volt systems should be followed and documented. The following sections outline possible causes and corrective action for various problems.

1160-12.2 Lamp Will Not Start

Possible Causes	Corrective Maintenance
Lamp loose in socket.	Screw lamp firmly into socket until good contact is made. **STOP!** Excess torque may cause lamp to shatter at neck.
Incorrect lamp.	Check and compare data on ballast or fixture name plate with lamp electrical characteristics.
Incorrect or loose wiring.	With power off, check wiring against wiring diagram; check for loose connectors and loose terminal screws; check for broken insulation. Check circuit continuity with ohm meter.
End of ballast life.	Check for charred spots and/or swollen capacitors.
Photoelectric control inoperative.	With power **ON**, cover photocell. Wait the few minutes generally required for an operative photocell to apply power to the fixture. Replace if inoperative.
Supply voltage to fixture or ballast output voltage is low.	Check supply voltage and ballast output voltage.
HPS starter circuit failure.	Check lamp on Discharge Lamp Checker or try known good lamp. Replace starter.

1160-12.3 Short Lamp Life

Possible Causes	Corrective Maintenance
Incorrect lamp.	Check and compare data on ballast or fixture nameplate with lamp electrical characteristics.
Shorted ballast.	Check electrically for a shorted ballast.
Over wattage operations.	Check ballast or fixture rating for lamp type and wattage. Check operation for correct voltage and

current at socket terminals.

1160-12.4 Flickering

Possible Causes	Corrective Maintenance
Supply voltage to fixture is low.	Check both supply and ballast output voltage with lamp operating.
Incorrect ballast.	Check and compare data on ballast or fixture nameplate with lamp electrical characteristics.
High operating voltage.	Check lamp voltage at socket terminals while operating.
Low ballast output voltage.	Check ballast output and supply volts without lamp in circuit.
Variable voltage.	Use recording voltmeter to check degree and duration of voltage variation. Check to determine other electrical loads on lamp circuit. Remove lighting circuit from lines with large electrical loads.
Bad lamp.	Replace lamp.
Loose wiring.	Check wire connections.

1160-12.5 Blown Fuses

Possible Causes	Corrective Maintenance
High momentary line current at turn "**ON**."	Check ballast literature for recommended rating of circuit protective devices. Circuit protective devices should have time delay elements when used with reactor or auto-transformer ballasts.
Overloaded circuit.	Check total load on circuit; lamps and ballasts plus other connected equipment.
Shorted wires.	Locate shorted wires and repair.
Old or worn fuses.	Replace with new and correct fuses.
Lightning induced peak.	Replace fuse. Check for other damage.

1160-12.6 Lamp Light Output Low

Possible Causes	Corrective Maintenance
Lamps near end of life.	Replace lamp.
Supply voltage to fixture is low.	Check both supply and ballast output voltage with lamp operating.
Incorrect ballast	Check and compare data on ballast or fixture name plate with lamp electrical characteristics.
Low ballast voltage.	Check ballast output and supply volts without lamp in circuit.
Dirt accumulation.	Clean luminaires and lamps.
No refractor.	Install refractor.

1160-12.7 Lamp Starts Slowly

Possible Causes	Corrective Maintenance
Supply voltage to fixture is low.	Check both supply and ballast output voltage with lamp operating.
Low ballast output voltage.	Check both ballast output and supply volts without lamp in circuit.

Lamp is defective causing a hard start.	Replace lamp **IF** other system components are **OK**.

1160-12.8 Blackened Arc Tube

Possible Causes	Corrective Maintenance
Incorrect ballast.	Check and compare data on ballast or fixture name plate with lamp electrical characteristics.
Lamp life used up.	Replace lamp.
Low voltage at socket.	Check ballast for voltage.

1160-12.9 Abnormal Lamp Color Difference

Possible Causes	Corrective Maintenance
Low supply voltage.	Check supply voltage and ballast output voltages with lamp operating.
Low ballast output.	Check ballast output and supply volts without lamp in circuit.
Variation in light distribution.	Check luminaire. To test, interchange lamps between suspected and normally performing luminaires. Check refractor and glass lens.
Dirt accumulation.	Clean luminaires and lamps.
Illumination color differences.	Variations in environmental color-walls, tunnels, bridges, etc., can cause illumination-color illusions.

1160-12.10 Whole Circuit Off

Possible Causes	Corrective Maintenance
Control Center problems.	Check supply voltage and output voltage. Check fuses. Check contactor.

1160-13 Pole Replacement/Foundation Repair

1160-13.1 General

Before new poles and transformer bases are installed on existing foundations they shall be checked for the following:

1. Anchor bolt threads shall not show signs of excessive rusting that could later deteriorate to a point where they could become a safety hazard should they fail.
2. Foundation concrete does not indicate excessive deterioration whereby it is impossible for the transformer base to be properly installed and leveled.
3. Check to determine if the foundation has shifted or tilted to the extent that the pole cannot be properly plumbed.
4. Top of foundation shall not protrude above ground level on the upslope side.
5. All painted light poles shall be checked for excessive rusting. If it is determined that they are unsafe, they should be replaced with either new or used galvanized steel or aluminum poles.
6. Pull boxes extending more than 1 inch above the existing grade should be reset, flush with the existing grade level.

When a light pole falls down, the pole and foundation should be inspected and the best method for repairing the installation determined. If a material deficiency in the pole or foundation was fully or partially responsible for the failure, the materials should be examined closely for defects, corrosion and vandalism. The probable cause of the failure should be noted.

When a pole falls, the simplex weld for the bracket arm should be inspected by looking down the inside of the top of the pole to see if the impact has cracked the weld. If the weld is cracked, the pole should not be reinstalled.

1160-13.2 Anchor Bolts Sheared

Standard light pole foundations can be repaired by jack hammering out the concrete to 1 foot below grade, using threaded couplings and threaded bolt extensions on the anchor bolts, recapping the foundation (with the threaded coupling encased in concrete), and erecting a new pole/base.

It is also possible to extend the anchor bolts with a special cadweld instead of threaded couplings. The bolt extension could be welded on and the weld embedded in the new concrete. Welded extensions would be necessary if the remaining anchor bolt did not have enough thread to receive the threaded coupling. This may also be necessary if repairing a tower foundation. In the case of welding on bolts, the concrete foundation would likely need to be removed to a depth greater than 1 foot below grade.

1160-13.3 Anchor Bolt Bent

When a bolt is bent by the impact of a knockdown, it can be repaired by straightening the bolt using physical force (sledgehammer) or by heating it. Consider the location of the bolt (tension or compression side) and the amount of bending necessary when assessing if a repair is possible. If the concrete around the anchor bolt has been cracked by the impact, consider replacing the foundation.

1160-13.4 Cracked Concrete in Foundation

Most cracked foundations should be replaced with new foundations. A repair would involve removing the concrete at least 1 foot below grade and recapping the foundation.

1160-13.5 Anchor Bolt Adapter Plates

When a foundation has a unique anchor bolt configuration which is not matched by any other current pole manufacturer, the foundation can be used for a new pole by manufacturing a specialized anchor bolt adapter plate. The adapter plate would mount on the existing bolts and provide a new bolt circle (typically 15-inch bolt circle) for mounting a new pole.

1160-14 Bracket Arm Repairs

When a bracket arm falls down, the pole and arm should be inspected to determine the best method for repairing the installation. If a material deficiency in the pole or arm was fully or partially responsible for the failure, the materials should be examined closely for defects, corrosion and vandalism. The probable cause of the failure should be noted.

Replacement bracket arms should closely match the style, length and rise of the bracket arm being repaired.

Before installing a replacement arm on an existing simplex hanger, the simplex weld should be inspected by looking down the inside of the top of the pole to see if the weld is cracked. If the weld is cracked, the arm should not be installed on that hanger. Bracket-type or banding-type attachments should be used instead.

If the arm fell because the simplex bolt sheared off, but the hanger and weld are in good condition, the bolt hole can often be redrilled and a new bolt installed.

Intentionally blank.

1196 FORMS INDEX (no forms at this time)

1197 TABLES INDEX

1197-1 Suggested Data for the District System Lighting Plan

As noted in ***Chapter 1101***, ***Table 1197-1*** lists suggested data for use in preparing the database used to develop a **District System Lighting Plan (DSLP)**.

1197-2 Codes for Use in the District System Lighting Plan

As noted in ***Chapter 1101***, ***Table 1197-2*** lists codes to be used in the **DSLP**.

1197-3 Warrants for Freeway and Interchange Lighting

As noted in ***Chapter 1103***, ***Table 1197-3*** lists warrants for freeway and interchange highway lighting.

1197-4 Average Maintained Luminance Design Values

As noted in ***Sections 1103-4, 1106-1, 1106-2.2, 1140-3.1 and 1140-3.6.2***, ***Table 1197-4*** shows average illuminance design values.

1197-5 Nominal Mounting Height and Wattage

As noted in ***Section 1140-4.3.2***, ***Table 1197-5*** shows mounting heights with wattages.

1197-6 Typical Bracket Arm Lengths

As noted in ***Section 1140-4.3.4.2***, ***Table 1197-6*** shows typical bracket arm lengths.

1197-7 Recommended Conduit Sizes

As noted in ***Section 1140-5.5.2***, ***Table 1197-7*** shows recommended conduit sizes.

1197-8 Lighting Load Table

Table 1197-8 shows a sample circuit lighting load table.

1197-9 Recommended Lateral Soil Pressures for Foundations

As noted in ***Section 1140-8***, ***Table 1197-9*** shows recommended soil pressures for foundations.

1197-10 Foundation Embedment Nomograph

As noted in ***Section 1140-8***, ***Table 1197-10*** shows the recommended depth for foundation embedment.

1197-11 Allowable Lateral Soil Resistance

As noted in ***Section 1140-8***, ***Table 1197-11*** shows allowable lateral soil resistance based on tower height.

1197-12 Determination of Responsibilities

As noted in **Section 1160-3, Table 1197-12** shows maintenance and energy responsibilities for highway lighting.

Intentionally blank.

Table 1197-1. Suggested Data for the District System Lighting Plan

Luminaires	Pole or Tower	Control Center	Circuits	Maintenance Costs
Voltage	Tower or Pole Number	Energy Account Number	Number	Energy Units Consumed
No. of Units	Height	Power Company	AWG	Lamp Life Cycle
Manufacturer	Foundation Diameter & Depth	Capacity Current & Future	Two or Three-wire	Direct Labor
Wattage	Manufacturer	Service Type		
Ballast	Lowering Device Type	Supply Voltage		
Shields	Bracket Arm Length	Voltage Drop & Circuit		
IES Distribution	Pole Base Type	Amperage		
IES Photometric #	Installation Year	Meter Type & Number		
Re-lamp Date	Control center	Latitude & Longitude		
	Circuit number	Owner or Maintaining Agency		
	Latitude & Longitude	Control Center ID Number		

Table 1197-2. Codes for Use in the District System Lighting Plan

Code	Description
B - Blue	Isolated intersections which are not part of an interchange.
G - Green	Interchanges which have partial interchange lighting.
O - Orange	Interchanges which have full interchange lighting.
P - Pink	Roadways which are not within an interchange area, but which are between interchanges or intersections which have continuous lighting.
F - Future	Unlighted locations to be lighted.
U - Upgrade	Lighted locations to received more comprehensive lighting (e.g., partial interchange to full interchange).
D - Downgrad	Lighted locations to be downgraded to less comprehensive lighting (e.g., full interchange to partial interchange).
R - Remove	Lighted locations to become unlighted.

Table 1197-3. Warrants for Freeway and Interchange Lighting

\

Continuous Freeway Lighting (CFL)[1] (CFL-1 and CFL-2 must both be satisfied)	
Case CFL-1	Requires 60,000 or more ADT and three or more through lanes in each direction
Case CFL-2	Requires that three or more interchanges be located with an average spacing of 1.5 miles or less.
Case CFL-3	Not used.
Case CFL-4	Not used.
Complete Interchange Lighting (CIL) (Except per CIL-1 and CIL-2 below, new CIL should be installed only as an upgrade to existing PIL)	
Case CIL-1	The interchange is a System Interchange (freeway to freeway)
Case CIL-2	If one or more of the adjacent freeway segments qualify for CFL (Note 1)
Case CIL-3	Not used.
Case CIL-4	Not used.
Partial Interchange Lighting (PIL)[2] (All new Service Interchange lighting, when called for, shall initially be PIL, to be upgraded to CIL later if necessary)	
Case PIL-1	Requires that the average AADT ramp traffic entering and leaving the freeway at the interchange in question exceeds 2000. Ramps not meeting this AADT may remain unlit.
Case PIL-2	Requires that the ADT for the through lanes on the freeway exceeds 35,000.
Case PIL-3	Not used.

[1] Where there is continuous freeway lighting, there should be complete interchange lighting (CIL). If continuous freeway lighting is warranted, but not initially installed, then partial interchange lighting is considered to be justified under CFL-1 or CFL-2.
[2] Interchanges with side-by-side entrance/exit lanes (e.g., folded diamonds) or individual ramps with 2000+ ADT shall have ramp intersection lighting.
[3] All volumes should be current or opening-day volumes.

Table 1197-4. Average Maintained Luminance Design Values

Average Illuminance on the Pavement [1]			
Roadway and Walkway Classification [2]		Foot-Candles	Uniformity (avg./min.)
Freeway (including ramps)[3]		0.9	3:1
Expressway (including ramps)[3]	Commercial	1.3	3:1
	Intermediate	1.1	
	Residential	0.8	
Major[3]	Commercial	1.6	3:1
	Intermediate	1.2	
	Residential	0.8	
Collector[3]	Commercial	1.1	4:1
	Intermediate	0.8	
	Residential	0.6	
Local[3]	Commercial	0.8	6:1
	Intermediate	0.7	
	Residential	0.4	
Sidewalks	Commercial	1.3	3:1
	Intermediate	0.8	4:1
	Residential	0.4	6:1
Pedestrian Ways and Bicycle Paths[4]		2.0	3:1

Notes:

1. Based upon R3 pavement classification, i.e. asphalt road surface, rough texture, Q_0 =0.07.
2. The terms “commercial,” “intermediate” and “residential” are defined in ***Section 1103-4***. See **Chapter 1301** for definitions of the other terms.
3. Adapted from **American National Standard Practice for Roadway Lighting ANSI/ES RP-8, 1983: Illuminating Engineering Society of North America.** Used by permission.
4. This assumes a separate facility. Facilities adjacent to a vehicular roadway should use the illuminance levels for that roadway.

Table 1197-5. Nominal Mounting Height and HPS Wattage

Mounting Height (Nominal) Feet	Luminaire Rating (HPS Lamp Wattage)*
32.5	200
35	200
40	200
50	310

* Lumens, not wattage, is the best rating method for LED luminaires, but a rough rule-of-thumb is tht LED drop-in replacements for HPS luminaires will use almost 50% of the nominal HPS wattage.

Table 1197-6. Typical Bracket Arm Lengths (HPS)

Location	Guardrail Offset Feet	Pole Offset Feet	Bracket Arm Length Feet
Mainline	10	16.5	18
	12	18.5	20
Ramps	4	10.5	12*
	6	12.5	15*
	8	14.5	15*

*Shorter lengths should be considered on the inside of sharp curves, as discussed above.

Table 1197-7. Recommended Conduit Sizes

Usage	Nominal Size (ID) Inches
Pavement Crossovers	3
Bridge and Concrete Barrier Raceways	2
Longitudinal Conduit in Shoulder Areas	3
Structure Grounding - Embedded	1 1/4
Underpass Lighting Service	1 1/4
Conduit Ells	Same as connecting conduit, or 2 1/2 minimum for duct cable
Service Pole Pull Box to First Roadway Pull Box or Lighting Unit	3 (minimum)

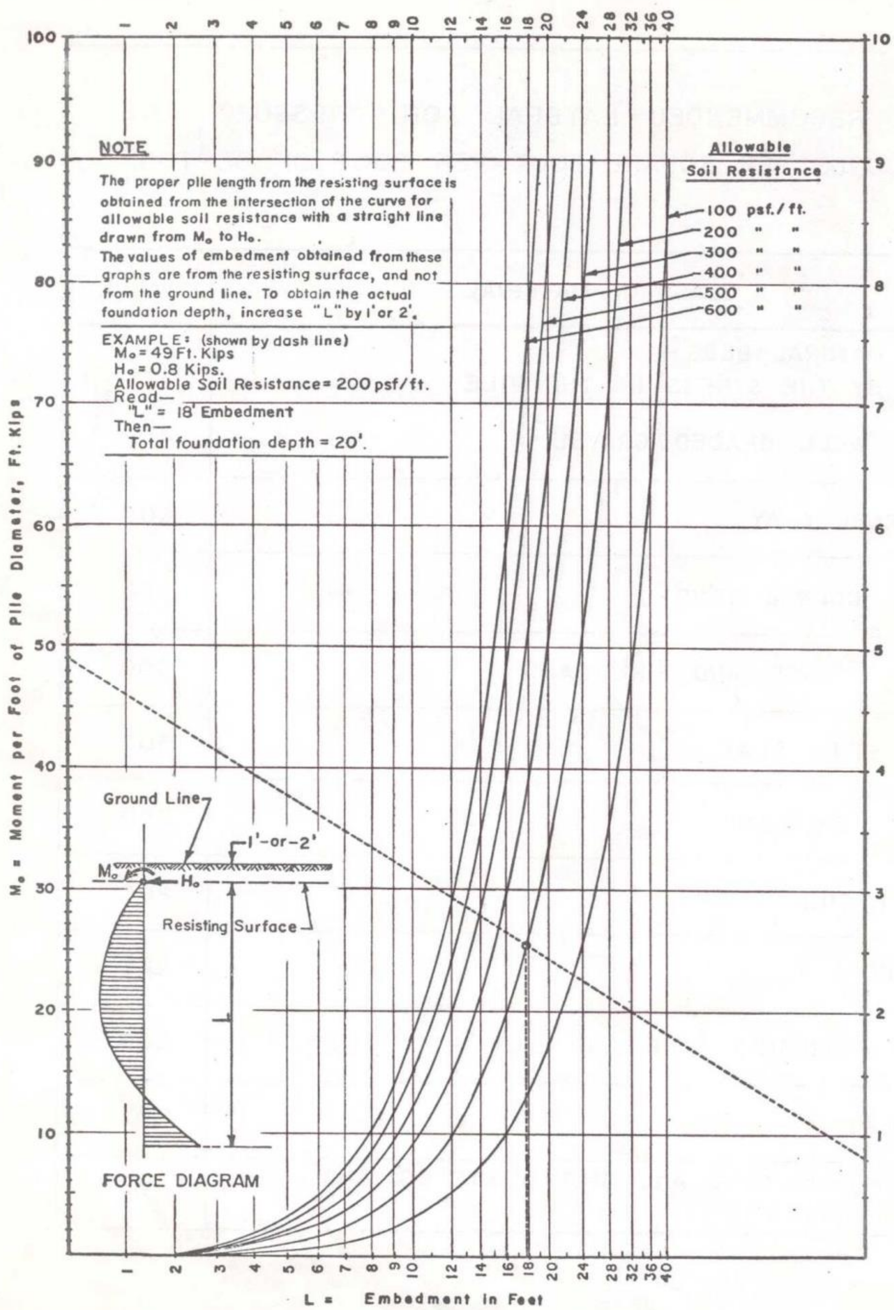
Table 1197-8. Lighting Load Table

Circuit N	34 - 400 W =	13,600 W	**Circuit S**	34 - 400 W =	13,600 W
Sign No. 5	2 - 175 W =	350 W		4 - 200 W =	800 W
Sign No. 7	1 - 100 W =	100 W	**U.P. Lights**	3 - 100 W =	300 W
		14,050 W	**Sign No. 3**	1 - 175 W =	175 W
			Sign No. 8	1 - 100 W =	100 W
			Sign No. 1	1 - 100 W =	100 W
			Sign No. 18	7 - 175 W =	1,225 W
					16,300 W
Circuit E	34 - 400 W =	13,600 W	**Circuit W**	28 - 400 W =	11,200 W
U.P. Lights	3 - 100 W =	300 W		5 - 200 W =	1,000 W
Sign No. 12	2 - 175 W =	350 W	**Exist. Sign No. 101**	1 - 175 W =	175 W
Sign No. 13	4 - 175 W =	700 W	**Exist. Sign No. 102**	7 - 175 W =	1,225 W
		14,950 W			13,600 W

Table 1197-9. Recommended Lateral Soil Pressures for Foundations

Recommended Lateral Soil Pressure (Pounds Per Square Foot Per Foot of Depth)	
CLASS OF MATERIAL	**Value**
Rock in Natural Beds - Limited by the Stress in the Pile	
Compact Well Graded Gravel	400
Hard Dense Clay	400
Compact Coarse Sand	350
Compact Coarse and Fine Sand	300
Medium Stiff Clay	300
Compact Fine Sand	250
Ordinary Silt	200
Sandy Clay	200
Compact Inorganic Sand and Silt Mixtures	200
Soft Clay	100
Loose Organic Sand and Silt Mixtures and Muck or Bay Mud	0

Table 1197-10. Foundation Embedment Nomograph



FOUNDATION EMBEDMENT NOMOGRAPH

Table 1197-11. Allowable Lateral Soil Resistance

Tower Height (Feet)	Foundation Diameter (Feet)	Allowable Lateral Soil Resistance (psf/ft. of depth)					
		100	200	300	400	500	600
		Foundation Depth (Feet)					
70	3	25	20	15	15	15	15
80	3	25	20	15	15	15	15
90	3	25	20	20	15	15	15
100	3	30	25	20	20	15	15
120	3	30	25	20	20	20	20
130	3.5	30	25	25	20	20	20
140	3.5	35	25	25	20	20	20

Table 1197-12. Highway Lighting Responsibilities

Facility	Area	
	Unincorporated	Incorporated
Interstate[1]	State	State
U.S. Route[1]	State	Municipal Corporation[2]
State Route[1]	State	Municipal Corporation[2]
County Road	County	Not applicable
Township Road	Township	Not applicable
Public Street	Not applicable	Municipal Corporation
Private Street	Street Owner	Street Owner

Notes:

1. Where the facility is of freeway design, only the mainline and ramps are considered to be part of the facility.

2. The highway lighting maintenance and energy costs shall be borne by the municipal corporation.

Intentionally blank.

1198 FIGURES INDEX

1198-1 Roadway Lighting Fixture Distribution

As noted in ***Section 1140-3.1***, ***Figure 1198-1*** illustrates five basic distributions of highway lighting fixtures.

1198-2 Effects of Full Cut-Off and Non Cut-Off Luminaires

As noted in ***Section 1140-3.1***, ***Figure 1198-2*** illustrates the effects of full cut-off and non cut-off luminaires.

1198-3 Typical Luminaire Placement Partial Interchange Lighting (PIL)

As noted in ***Section 1140-4.4.1***, ***Figure 1198-3*** illustrates typical luminaire placement for a partial interchange.

1198-4 Detail of Luminaire Placement for Class I Exit Terminal (PIL)

As noted in ***Section 1140-4.4.1*** and ***Figure 1198-3***, ***Figure 1198-4*** illustrates detail information regarding luminaire placement for an exit ramp terminal.

1198-5 Partial Lighting Applications to the Basic Diamond Interchange

As noted in ***Section 1140-4.4.2***, ***Figure 1198-5*** illustrates typical luminaire placement for a basic diamond interchange.

1198-6 Reserved for Future Information

Figure deleted but the space has been saved for now.

1198-7 Intersection Lighting Examples

As noted in ***Section 1140-4.4.4***, ***Figure 1198-7*** illustrates typical luminaire placement for intersections.

1198-8 Luminaire Mounting Arrangements

As noted in ***Section 1140-4.5.2***, ***Figure 1198-8*** illustrates different luminaire arrangements for street lighting.

1198-9 Overpass Key Unit Locations

As noted in ***Section 1140-4.6.3***, ***Figure 1198-9*** illustrates overpass key unit locations.

1198-10 Underpass Key Unit Locations

As noted in ***Section 1140-4.6.7***, ***Figure 1198-10*** illustrates underpass key unit locations.

1198-11 Control Center Data Chart

As noted in **Sections 1140-5.3.2 and 1140-3.8, Figure 1198-11** illustrates a chart used in the plans to provide information needed about the control center.

1198-12 Voltage Drop Study

As noted in **Section 1140-5.2.2, Figure 1198-12** illustrates calculation and analysis methods for producing lighting designs.

Intentionally blank.

Figure 1198-1. Roadway Lighting Fixture Distribution

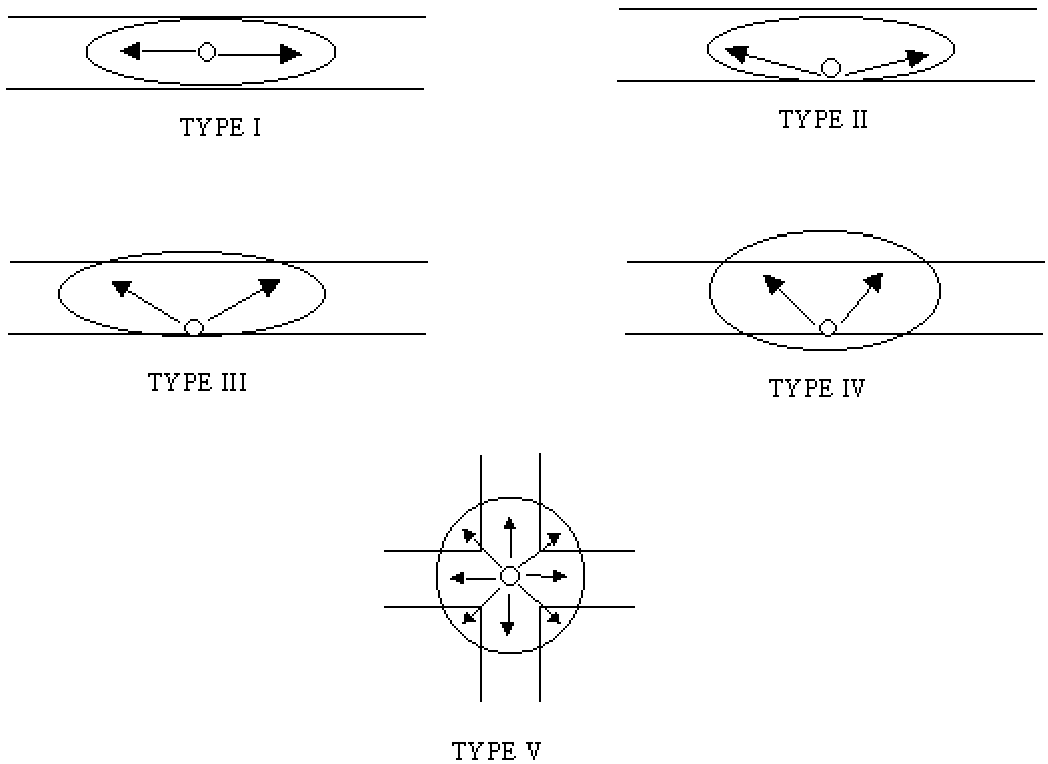


Figure 1198-2. Effects of Full Cut-Off and Non Cut-Off Luminaires

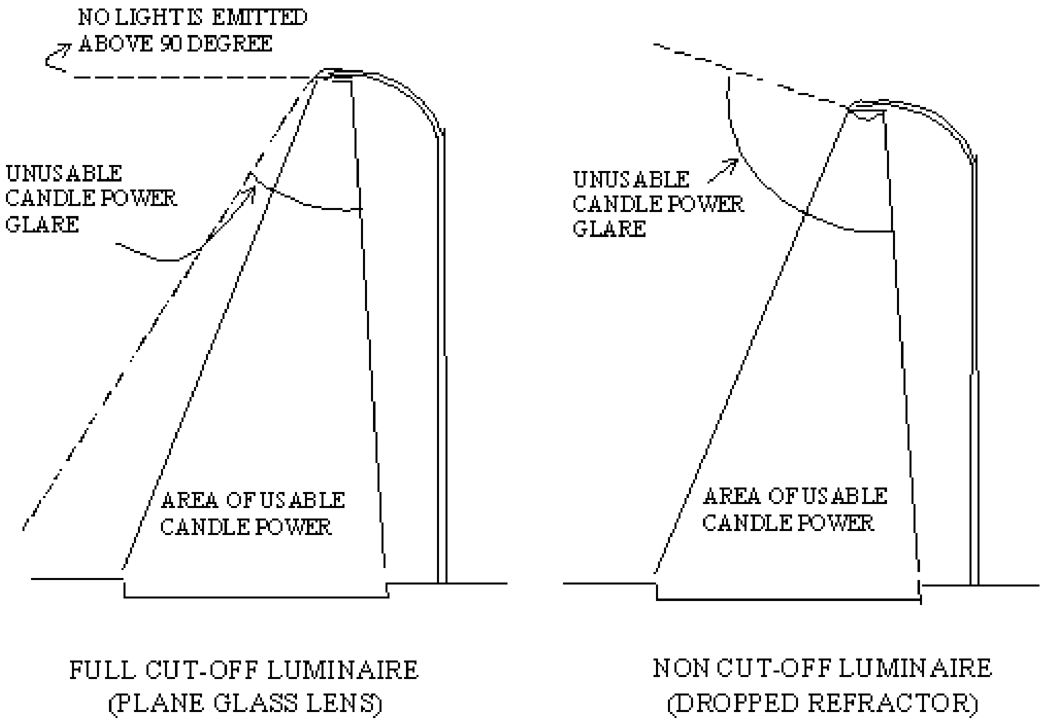
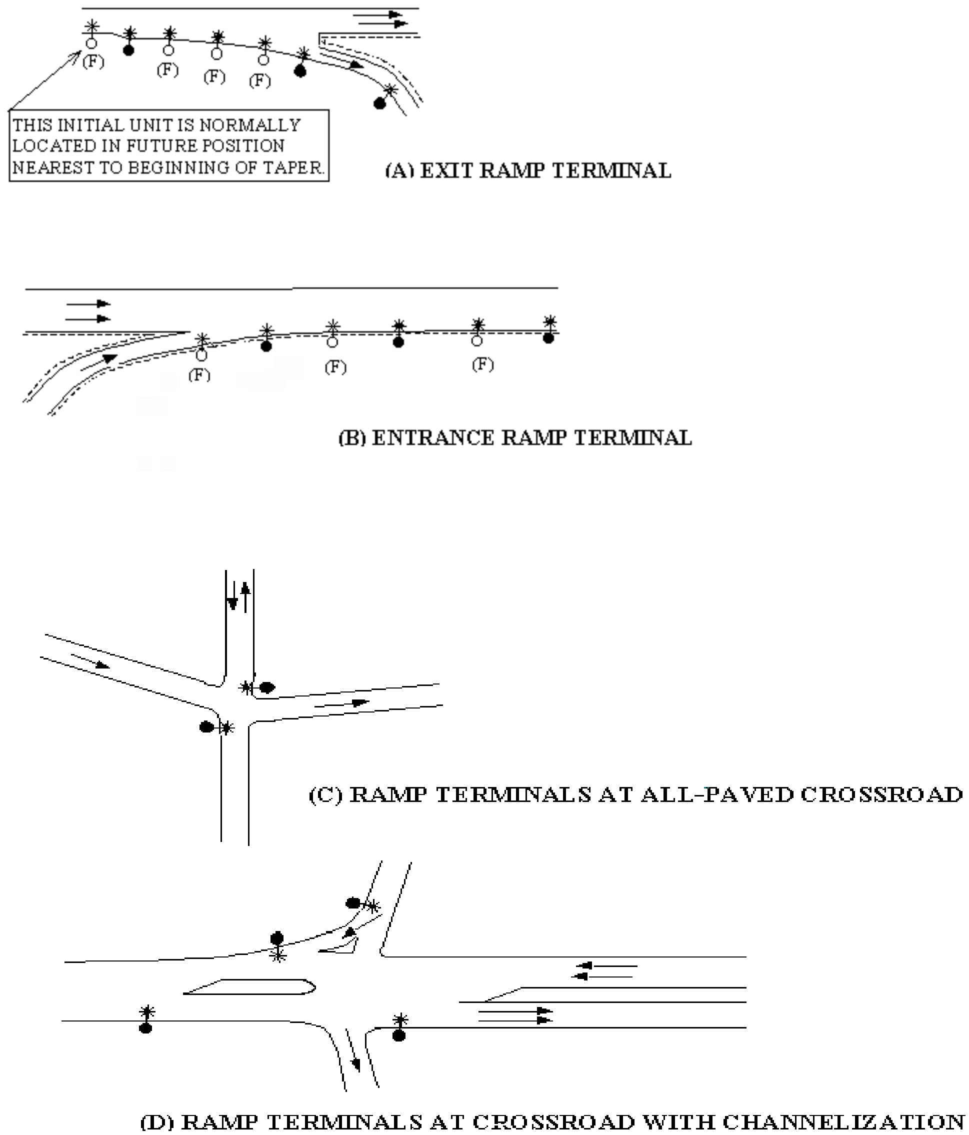
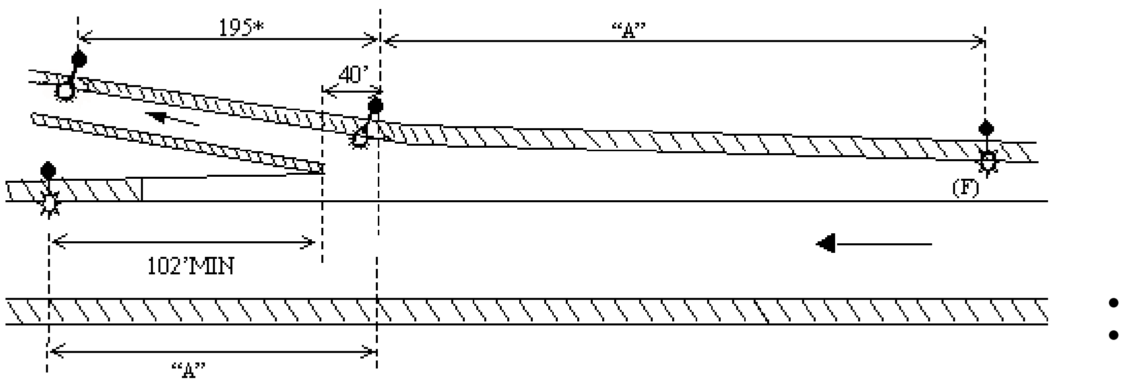


Figure 1198-3. Typical Luminaire Placement Partial Interchange Lighting (PIL)



Notes:
1. For additional details of sketch (A), see ***Figure 1198-4***.
2. (F) denotes additional unit, when future/full lighting is provided.
3. Unit spacing varies with pavement width.
4. Number of units depends upon the length of the speed-change lane.

Figure 1198-4. Detail of Luminaire Placement for Class I Exit Terminal (PIL)



NUMBER OF DIRECTIONAL THROUGH LANES	DIMENSION "A" LUMINAIRE SIZE & MOUNTING HEIGHT	
	200 W~32.5FT	310W~40.0FT
2 3 4	142 - -	174' 150' 142'

* This spacing may be less on a sharply curved ramp, or when the design uniformity exceeds 4.0 to 1.0.

Notes:

1. This layout is based on an average initial intensity of 1.2 foot candles and a maximum uniformity of 4.0 to 1.0.
2. (F) denotes additional unit when future/full lighting is provided.

Figure 1198-5. Partial Lighting Applications to the Basic Diamond Interchange

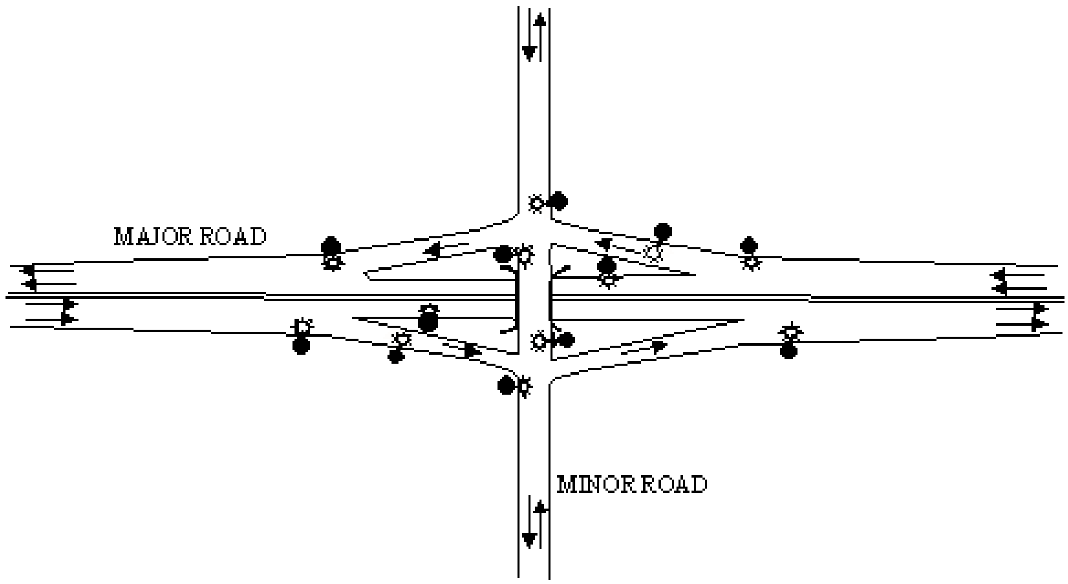


Figure 1198-6. Reserved for Future Information

Figure has been deleted; however, for now the space has been saved for a future revision.

Figure 1198-7. Intersection Lighting Examples

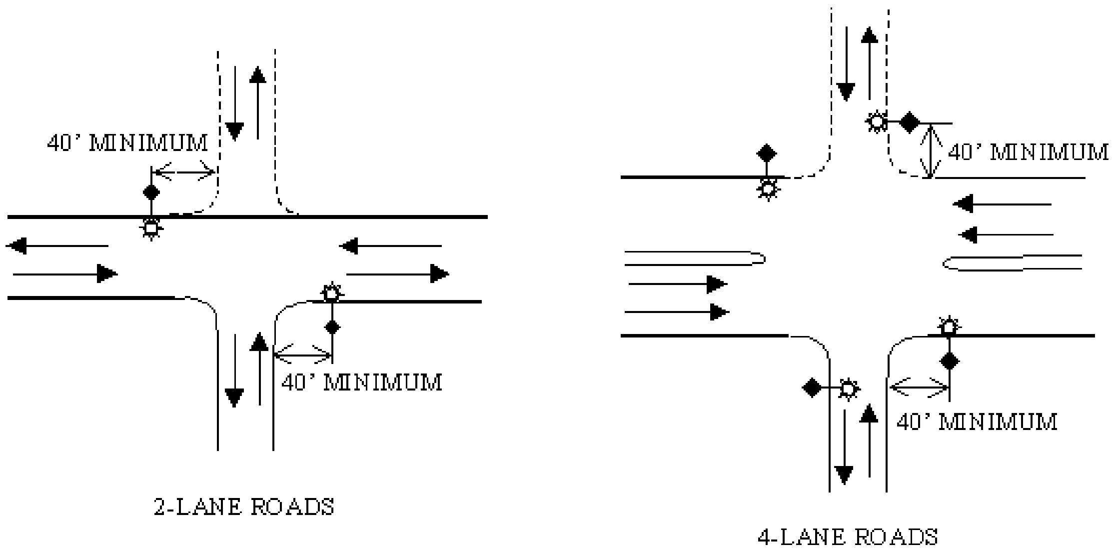
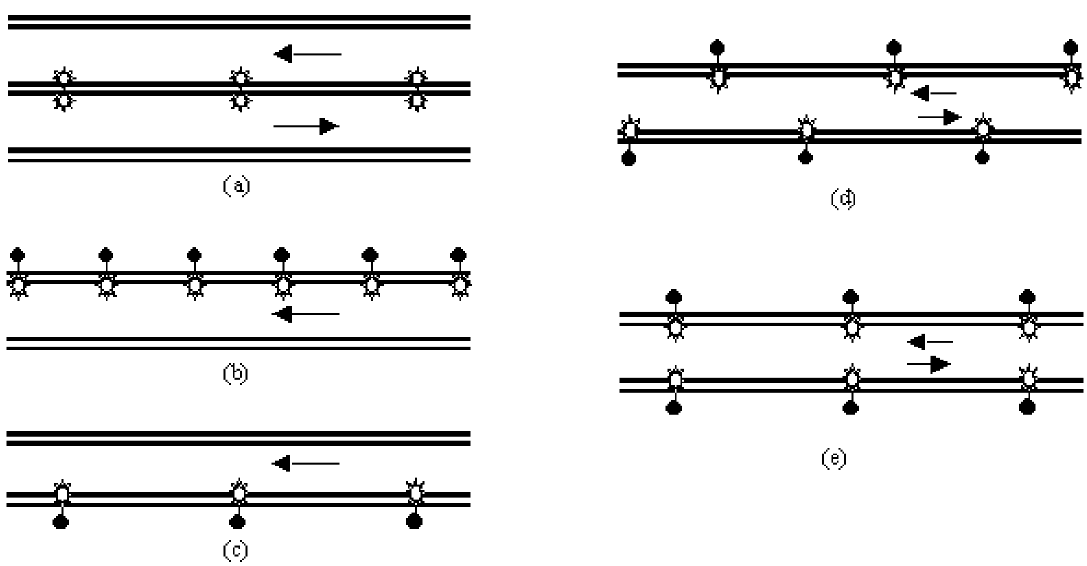


Figure 1198-8. Luminaire Mounting Arrangements



Luminaire mounting arrangements: (a) Median; (b) Right-side; (c) Left-side; (d) Staggered; and (e) Opposite.

Figure 1198-9. Overpass Key Unit Locations

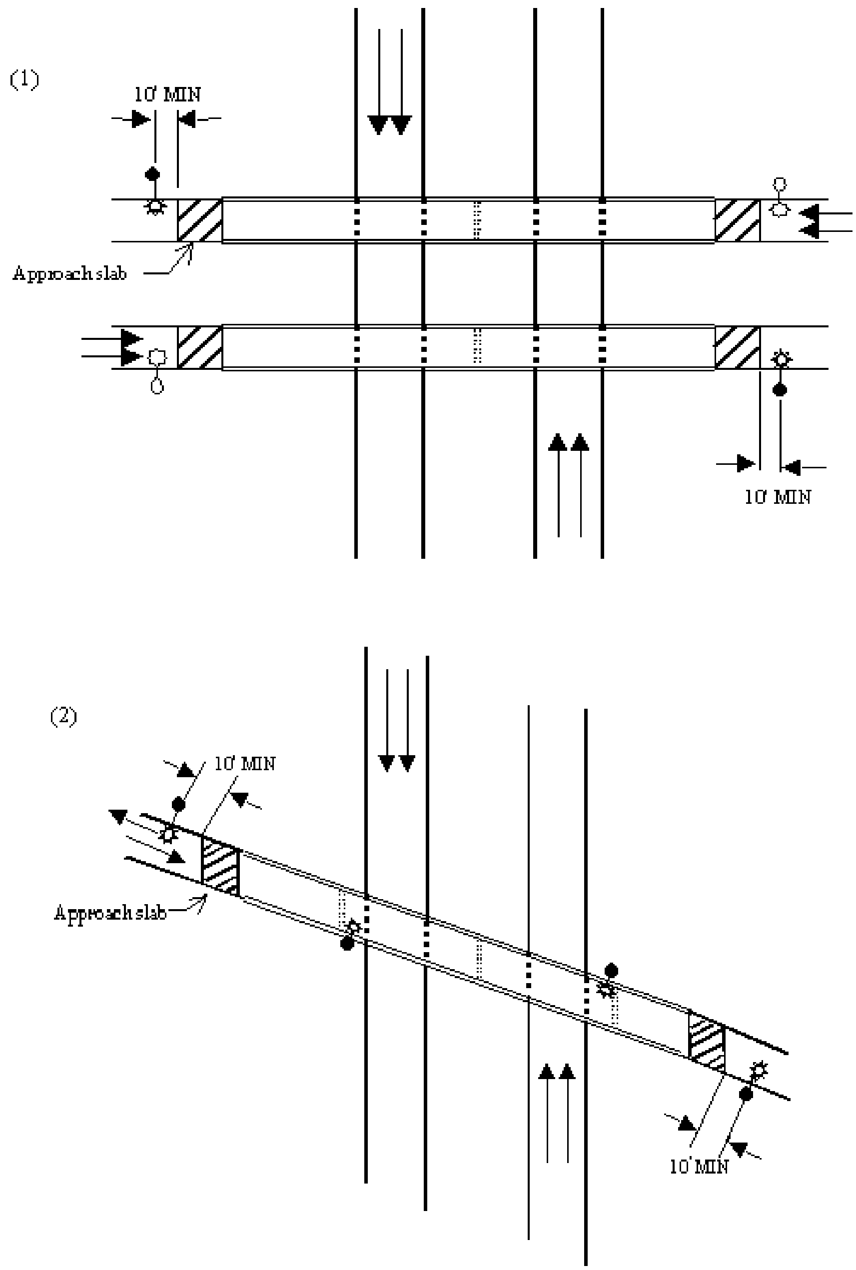
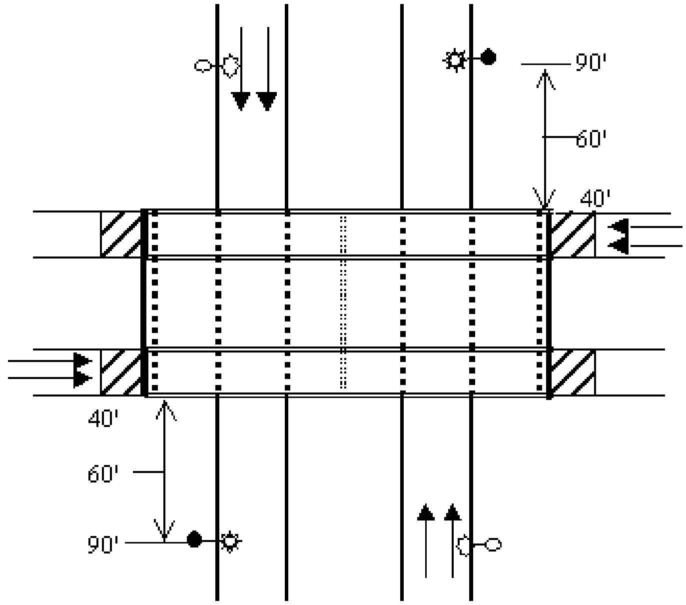


Figure 1198-10. Underpass Key Unit Locations

(1)



(2)

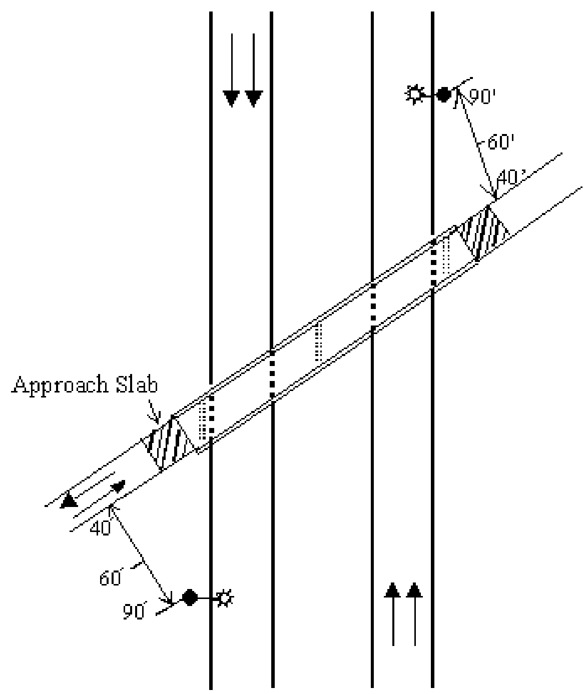


Figure 1198-11. Control Center Data Chart

<table>
<tr><th colspan="10">CONTROL CENTER DATA</th></tr>
<tr><th>CONTROL CENTER DESIGNATION</th><th>LINE VOLTS</th><th>CONNECTED LOAD (KVA)</th><th>SERVICE ENTRANCE CONDUCTOR SIZE - AWG [1]</th><th>ENCLOSURE RATING (AMPS) [2]</th><th>CIRCUIT NO.</th><th>CIRCUIT LOAD AMPS</th><th>CIRCUIT FUSE SIZE AMPS [3]</th><th>CIRCUIT CABLE SIZE AWG</th><th>MAINTAINING AGENCY</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td></td><td></td><td></td><td></td><td rowspan="3"></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td></td><td></td><td></td><td></td><td rowspan="3"></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="10">Note: For additional control center details, see Standard Drawings.</td></tr>
</table>

Notes:

1. See NEC 230 Part IV for requirements related to service-entrance conductors. 230.42 (2011) has specific requirements on conductor size; in general, ampacity shall be a minimum of 125% of the continuous lighting load of the control center.

2. Refers to the ampere rating of the disconnect as specified by the manufacturer. NEC Art. 225 requires the Rating of Disconnect to be not less than the calculated load. Consideratoin should be made of future expansion of the lighting system, but at a minimum the rating shall be equal to the ampacity of the service-entrance conductors. The Short-Circuit Current Rating (SCCR) should be calculated using the power service equipment as provided by the power company. It is the Contractor’s responsibility to assure enclosure SCCR compatibility per NEC Art. 110.

3. Nominal fuse size should be a minimum of 125% of the calculated load, up to a value equal to the ampacity of the wire protected by the fuse. Standard ampere reatings for fuses are given in NEC Art. 240.

Figure 1198-12a. Voltage Drop Study – Cable Sizing Calculation Notes

1. Voltage drop on circuit not to exceed 5% nominal circuit voltage in steady state since equipment can generally tolerate a voltage variance of 10%.

   Because of the small wire sizes involved and the high power factor of the lighting load, the reactance is considered to be negligible in this computation. (**AIEE** publication No. 952 dated October, 1956)

2. Operating current for typical luminaires in **ODOT** HPS Highway Lighting Systems:
   Line Amperes Operating = (Lamp watt + Ballast watts)/Line voltage
   Ballast watts may be as much as 30% lamp watts for tertiary winding ballast.

Lamp Wattage	Line Amps. Operating		
	480 Volts	240 Volts	120 Volts
100	0.27	0.54	1.1
150	0.41	0.81	1.6
200	0.54	1.1	2.2
250	0.68	1.4	2.7
310	0.84	1.7	3.4
400	1.1	2.2	4.3
1000	2.7	5.4	11

3. Obtain wire resistance from published data (engineering handbooks, manufacturers' data sheets, etc. The following values are taken from **NEC** (2011) Chapter 9, Table 9:

Wire Size	Ohms per 1000 feet
14	3.1
12	2.0
10	1.2
8	0.78
6	0.49
4	0.31
2	0.19
1/0	0.12
2/0	0.10
4/0	0.079

4. Voltage drop in a Lighting Circuit Section = Amperes in and beyond the Section x [(Length of the Section in feet x 2 wires)/1000] x Resistance wire per 1000.

   Include in length of a section an allowance for connection at each end and slack. Frequently this is done by allowing 5-10 feet at each end and rounding up section lengths in increments of 5 feet.

5. To simplify calculations ***(see Figure 1198-12c)***: Lighting unit lead and voltage drop is computed only to the base of the support; underpass lighting load and voltage drop is computed only to the disconnect switch; and the sign lighting load and voltage drop are computed only to point of connection to the lighting circuit.

Figure 1198-12b. Voltage Drop Study – Sample Circuit Layout

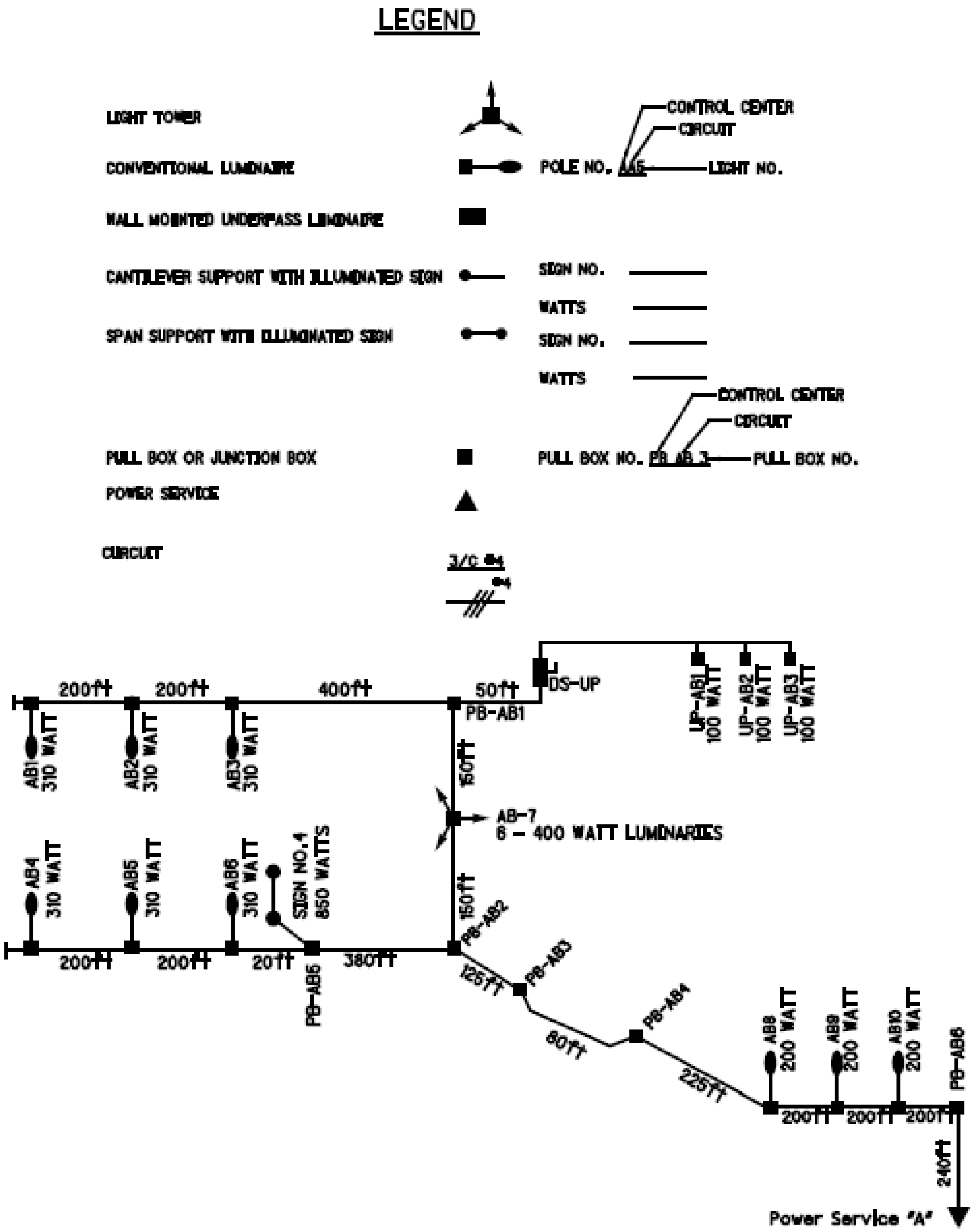


Figure 1198-12 c. Voltage Drop Study – Sample Voltage Drop Calculation

Co. FRA Rte. 99 Sec. 1.23
Power Service "A" Circuit B
Supply Voltage: 240/480 3-wire GND NEU
Wire Resistance Used: No. 4 AWG. 0.2582
No. __ AWG.

Sheet 1 of 1 Sheets
No. of Wires for Calculation Purposes: 2

SECTION [1] [2]			AMPERES		AWG	VOLTAGE DROP			
From	To	Feet	At Point	Accum.		In Sec.	Accum.	% Drop[5]	At Points[5]
AB1	AB-2	200	0.84	0.84	4	0.087	12.02	2.5	AB-1
AB2	AB-3	200	0.84	1.68	4	0.174	11.93		
AB3	PB-AB1	400	0.84	2.52	4	0.521	11.76		
DS-UP[3]	PB-AB1	50	0.81	0.81	4	0.021	11.26		
PB-AB1	AB-7	150	0	3.33	4	0.258	11.24		
AB-7	PB-AB2	150	6.6	9.93	4	0.769	10.18		
AB-4	AB-5	200	0.84	0.84	4	0.087	11.44		
AB-5	AB-6	200	0.84	1.68	4	0.174	11.36		
AB-6	PB-AB5	20	0.84	2.52	4	0.026	11.18		
PB-AB5[4]	PB-AB2	380	2.3	4.82	4	0.946	11.16		
PB-AB2	AB-8	430	0	14.75	4	3.275	10.21		
AB-8	AB-9	200	0.54	15.29	4	1.579	6.93		
AB-9	AB-10	200	0.54	15.83	4	1.635	5.36		
AB-10	PB-AB6	200	0.54	16.37	4	1.691	3.72		
PB-AB6	AB-10	240	0	16.37	4	2.029	2.03		

1. To avoid repetition, the power service designation "A" is omitted in the point designation.
2. Lighting unit lead and voltage drop is computed only to base of support to simplify calculation.
3. Underpass lighting load and voltage drop is computed only to disconnect to simplify calculation.
4. Sign lighting load and voltage drop are computed only to the point of connection to lighting circuit to simplify calculation.
5. These columns are normally only computed for the point of maximum voltage drop.

TABLE OF CONTENTS
Part 12 - ZONES AND TRAFFIC ENGINEERING STUDIES

Part 12 – ZONES AND TRAFFIC ENGINEERING STUDIES

1200 GENERAL

This Part of the **TEM** addresses **ODOT** standards, policies, guidelines and procedures for Traffic Control Zones ***(see Chapter 1201)*** and traffic engineering studies ***(see Chapter 1210).***

1201 TRAFFIC CONTROL ZONES

Traffic Control Zones include School Zones, Speed Zones, Parking Control Zones, Pedestrian Safety Zones, Loading Zones, No-Passing Zones and Temporary Traffic Control Zones (Work Zones).

ORC Section 4511.21 addresses Speed Zones and School Zones, and Section 4511.22 addresses Slow and Minimum Speeds. For additional information: see ***Chapter 1202*** of this Manual regarding School Zones and School Zone Extensions; ***Chapter 1203*** regarding Speed Zones; and ***Chapter 1204*** regarding Parking Control Zones at locations not covered by existing law **(ORC Sections 4511.66, 4511.68, 4511.681 and 4511.69)**. ***Chapter 1205*** addresses other zones.

No-Passing Zones and Temporary Traffic Control Zones are addressed in **OMUTCD Parts 3 and 6**, respectively, and additional information may be found in ***TEM Parts 3 and Part 6****.*

1202 SCHOOL ZONES

OMUTCD Section 7B.09 addresses School Zones and School Zone Extensions. ***Chapter 705*** of this Manual describes the procedures for requesting and withdrawing School Zone Extensions. The related forms are shown in ***Part 7*** of this Manual. Full-size copies of the forms are also available for downloading from the Forms page on the **Office of Traffic Operations (OTO)** website.

1203 SPEED ZONES

1203-1 General

A Speed Zone is a section of street or highway where, on the basis of a “geometric and traffic characteristic study” or “an engineering and traffic investigation,” the prima facie speed limit set forth in **ORC 4511.21 (B)(1)(a) to (D)** is determined to be greater or less than is reasonable or safe and the **Director** and/or appropriate local authorities have declared a reasonable and safe prima facie speed limit and erected signs in accordance with **ORC 4511.21.** This “study” or “investigation” is typically referred to as a Speed Zone Study. The processes for requesting and authorizing Speed Zones, and some “short form” alternative studies and forms, are described in ***Section 1203-2***. Details related to conducting a full “traditional” Speed Zone Study are addressed in ***Section 1203-3***. It should be noted that Warning Signs and Advisory Speed signs in accordance with the **OMUTCD** should be considered before speed zoning based solely on roadway characteristics.

As noted in **OMUTCD Section 2B.11**, **ORC Section 4511.21** establishes speed limits for all streets and highways within the **State**. It also provides that the **Director** may alter speed limits, and that local authorities may request that the **Director** determine and declare a reasonable and safe speed limit on certain highways under their jurisdiction.

When circumstances that were part of the justification for an altered speed limit change, it may be necessary to "withdraw" the authorization for the Speed Zone, e.g., a Corporation Line moves. ***Section 1203-4*** describes the withdrawal process.

Under **ORC Division 4511.21 (K)**, a **Board of Township Trustees** may, by resolution and based on "an engineering and traffic investigation," declare a prima-facie speed limit on unimproved highways and also on highways under their jurisdiction which are within residential and commercial subdivisions ***(see Section 1203-2.3)***.

In altering speed limits, the minimum length of a new zone not contiguous to an existing Speed Zone should be greater than or equal to 0.5 miles; however, extensions of existing warranted zones may be shorter.

Occasionally, to promote safe and efficient operations on the highway system, it may be determined that the speed limit should temporarily be reduced due to a construction work zone ***(see TEM Section 1203-2.9*** and **ORC Section 4511.98*)*.**

Speed limits shall not be altered on a seasonal basis for winter conditions.

Additional regulations on speed limits can be found in **ORC Sections 4511.211** (Speed limit on private residential road or driveway), **4511.23** (Speed regulations on bridges) and **4511.24** (Emergency vehicles excepted from speed regulations).

Speeds are currently only posted in English units (miles per hour); therefore, all studies related to speed limits shall be conducted and calculated in English units. This will simplify the study process and also eliminate any possibility of errors in the final determined speed caused by either additional calculations or the use of conversion factors.

1203-2 Procedures for Requesting and Authorizing Speed Zones

1203-2.1 General

Requests for Speed Zones needing the approval of the **Director of Transportation** are submitted to the **District Speed Zoning Coordinator (DSZC)** for review and approval using one of the forms and procedures described in this Section.

All the forms described herein and shown in ***Chapter 1296*** are also available from the Forms webpage on the **OTO** website. For certain situations, "short form" alternative studies have been developed: for rural roads with a width of 16 feet or less or an ADT of 400 or less, see ***Section 1203-2.6***; for unimproved County Roads and residential or commercial subdivision streets see ***Section 1203-2.7;*** for freeways and high-speed multi-lane divided highways see ***Section 1203-2.8***.

The procedure and forms for speed zones in temporary traffic control zones (work zone speed zones) are addressed in ***Section 1203-2.9***.

A quick reference guide is provided below as to what situation each of the forms addresses:

Form No.	Section No.	Form Title
1296-1	1203-2.6	Speed Zone Request for Narrow & Low-Volume Rural Roads
1296-2	1203-3.3	Speed Zone Warrant Sheet (for situations not covered by the alternative forms)
1296-14	1203-2.8	Freeway & Expressway Speed Zone Evaluation Sheet
1296-15	1203-2.7	Speed Zone Request for Unimproved Highways & Residential and Commercial Subdivision Streets
1296-17	1203-2.9	Work Zone Speed Zone (WZSZ) Evaluation Sheet for High-Speed (≥ 55 mph) Multi-Lane Highways

1203-2.2 ODOT-Maintained Highways – General Procedure

All proposals for alterations of speed limits on **ODOT**-maintained highways shall be documented with the appropriate Speed Zone Study as outlined in ***Section 1203-3*** or using an appropriate alternative process or form described in ***Section 1203-2***. For temporary traffic control situations (WZSZs), see ***Subsection 1203-2.9***.

Once a determination has been made to alter a speed limit, the **District** should forward the proposed speed limit reduction to the appropriate **Ohio State Highway Patrol (OSHP) District Office** for review and comment. ***Form 1296-19*** is a sample form that can be used to help expedite this review. The information at the top of the form would be completed by the **District** as appropriate for the specific zoning proposal, so that the form just has to be signed and returned to the **District** after **OSHP** review.

Following resolution of the **OSHP** comments, if any, the **District** shall prepare a description of the Speed Zone for the **Director's** approval using ***Form 1296-6*** (Speed Limit Revision).

The revised speed limit is not in effect until the appropriate signs have been erected. Therefore, erection of the new Speed Limit signs, and their removal if/when the zone is withdrawn, must be documented to verify when the Speed Zone is in effect. See ***Section 1203-5*** for further details on the documentation process.

1203-2.3 Local Roads – General Procedure

As noted in ***Section 1203-1***, a **Board of Township Trustees** may, by resolution and based on "an engineering and traffic investigation," declare a prima-facie speed limit on unimproved highways and also on highways under their jurisdiction which are within residential and commercial subdivisions. The terms unimproved highway, and residential and commercial subdivision are defined in **ORC Division 4511.21(K)**. It is recommended that the **Townships** document the reasons for these Speed Zones and when the Speed Limit signs are erected. ***Form 1296-15*** is an example of a form that can be used for such documentation.

Except as provided in **ORC 4511.21(K)** for Township Roads, all requests for reduced speed limits on local roads (i.e., roads under the jurisdiction of a highway authority other than **ODOT**) shall be submitted to the **District** using one of the forms described herein. The request shall be accompanied by the appropriate resolution or ordinance from the local authorities. The appropriate Speed Zone Study, as outlined in ***Section 1203-3***, shall be included with all such requests unless the request qualifies for one of the abbreviated processes or forms described in ***Section 1203-2***. Concurrence from the appropriate enforcement agency should be included with the study. All requests shall be acknowledged, and the local authorities shall be notified whether additional data will be necessary to substantiate their request.

For temporary traffic control situations (WZSZs), see ***Subsection 1203-2.9***.

Based on the information received and a field review conducted by **ODOT** personnel (if appropriate), the **District** shall determine a reasonable and safe speed limit. If this determination is substantially different from that which was requested, the local authorities may be asked to further substantiate their original request, and a new determination may be made.

Following resolution of any comments, the **District** shall prepare a description of the Speed Zone for the **Director's** approval using ***Form 1296-6*** **(Speed Limit Revision)**.

The **District** shall notify the local authorities of **ODOT's** final action on the proposed Speed Zone.

The revised speed limit is not in effect until the appropriate signs have been erected. Therefore, erection of the new Speed Limit signs, and their removal if/when the zone is withdrawn, must be documented to verify when the Speed Zone is in effect. See ***Section 1203-5*** for further details on the documentation process.

1203-2.4 Split Jurisdictions

ORC Division 4511.21(N) addresses situations where the boundary of two local authorities rests on the centerline of a highway and both authorities have jurisdiction over the highway. Aside from **Division 4511.21(N)** and the speed zoning process, there is currently no provision to address the inconsistency and confusion caused when responsibility for a section of highway is split between different jurisdictions. The speed limit on the road may differ depending on which side of the road you are traveling. This can be confusing to motorists. When this occurs on **ODOT**-maintained highways, using the speed zoning process, the **District** should work with the local jurisdiction(s) to try to address the differences. This may involve:

1. Raising the lower speed limit to match the higher statutory speed.
2. Lowering the higher speed limit to match the lower statutory speed.
3. Determining an altered speed limit in between the existing speed limits that both jurisdictions can agree is appropriate.
4. Leaving the statutory speed limit on each highway section.

Although this process will usually involve the **District** reviewing a speed zoning request submitted by the local jurisdiction, the **District** should periodically review sections where this split jurisdiction situation occurs on **ODOT**-maintained highways to consider making a change in the speed limit on the **ODOT** portion of the highway. The **District** may also initiate discussions with the local jurisdiction about jointly determining an appropriate altered speed limit for the section of highway.

If a local jurisdiction is going to submit a speed zoning request for a roadway section that involves split jurisdictions, the jurisdiction initiating the request shall first contact the adjacent jurisdiction(s) to see if a compromise request can be developed. The speed zone request submitted to the **District** shall include copies of the related Resolutions (or Ordinances) from all jurisdictions involved.

1203-2.5 Speed Zone Tracking Application

When the Speed Zone Study has been properly prepared the review process should take no more than 90 days from the date the **District** received the request to the date the **District** notifies the local jurisdiction of **ODOT's** final determination on the proposed Speed Zone. The **District** will notify the local jurisdiction upon receipt of the Speed Zone Study. The local jurisdiction will also receive a progress report from **ODOT** after 45 days. If the initial request is incomplete or if the **District** later in the review process requires additional information, this 90-day period begins again when the **District** receives the information.

A software application was implemented in January 2008 to track the status of Speed Zoning requests from local authorities as they are processed by **ODOT**. Each **District** enters the required data as requests are received and updates the records as each request is processed. As the 90-day deadline approaches for each request, email reminder notices are sent to key **District** personnel.

1203-2.6 Narrow and Low-Volume Rural Roads *(Form 1296-1)*

For rural roads with a width of 16 feet or less or an ADT of 400 or less, ***Form 1296-1*** may be used to request a reduced speed limit. The data required for a Speed Zone Study for roads in these categories has been reduced and the form has been streamlined. A Speed Check is not required. The form was developed as a Microsoft Excel program; however, it may also be completed by hand.

The first sheet of the short form for Narrow and Low-Volume Roads is basically for data input. In the Excel file, when the mouse cursor hovers over the characteristics designations A1, B1, etc. a text description of that category pops up. There are also links to graphic examples of the characteristics categories and crash data samples. The second sheet in the file is a more traditional version of the warrant form: it includes the formulas and makes the calculations, based on the data entered on the first sheet. The third sheet provides a graphic illustration of the roadway characteristics information; and the last sheet provides a sample crash diagram for the roadway section showing which types of crashes should be included when performing a speed study.

Table 1297-6 provides additional information about the Roadway Characteristics categories used with this form, and ***Figures 1298-3 through 1298-5*** provide aerial view illustrations to help describe these categories.

If the Excel software isn't available, sheet 1 or 2 may be copied, completed by hand and submitted.

A Comments section has been provided on the form in case there is additional information the requesting agency wants to bring to the reviewer's attention ***(see Section 1203-3.5)***.

1203-2.7 Unimproved Highways and Residential and Commercial Subdivision Streets *(Form 1296-15)*

As noted in ***Sections 1203-1 and 1203-2.3***, the **Ohio Revised Code** allows **Townships** (based on "an engineering and traffic investigation") to alter by Resolution the speed limit on unimproved highways and residential and commercial subdivision streets to less than 55 miles per hour, but not less than 25 miles per hour. **ODOT** has established an abbreviated speed zoning request form to allow the **Counties** to do the same, by submitting a copy of ***Form 1296-15*** to the **ODOT District** with a Resolution from the **Board of County Commissioners**. The definitions for "unimproved highway," "residential subdivision" and "commercial subdivision" shall be as shown in **ORC Division 4511.21(K),** except that they will apply in this case to County Routes.

The Comments portion of the form can be used to document information from the study made to support the speed reduction.

As noted in ***Section 1203-2.3,*** it is recommended that **Townships** document the reasons for the Speed Zones they establish on unimproved highways and residential and commercial subdivision streets, and when the Speed Limit signs are erected. ***Form 1296-15*** is an example of a form that can be used for such documentation.

1203-2.8 Freeways and High-Speed Multi-Lane Divided Routes

Since the basic Speed Zone Warrant Sheet ***(Form 1296-2)*** is not set up to address situations involving speed limits over 60 miles per hour, other methods have been developed for reviewing situations involving freeway and other high-speed multi-lane divided highways when they arise.

For freeways and rural expressways, ***Form 1296-14*** may be used to submit requests for changes in the speed limit. The ADT/lane is intended to be vehicles per continuous lane.

Generally, 65 miles per hour is considered appropriate for expressways with no driveways. For controlled access non-expressways with no driveways, 60 miles per hour is generally considered a more appropriate speed limit; and 55 miles per hour is considered more appropriate when there is no access control and driveways are present. However, these guidelines are not intended to be rigid. It is recognized that there may be cases where exceptions are appropriate. For example, a single drive added in a several mile section of an expressway would not be considered sufficient by itself to warrant lowering the speed limit to

60 miles per hour. Also, for a non-expressway section with no driveways between two expressway sections, it may be appropriate to consider a 65 miles per hour speed limit. As with other speed zoning situations, there may be a need to go 5 miles per hour one way or the other to address other considerations, such as those noted in ***Section 1203-3.5***.

1203-2.9 Speed Zones in Temporary Traffic Control Zones (Work Zone Speed Zones)

1203-2.9.1 General

Research has shown that motorists will only reduce their speed if they clearly perceive a need to do so. However, a speed limit reduction may be desirable in temporary traffic control zones that involve work on or near the traveled way, particularly on high-speed multi-lane highways. The Work Zone Speed Zone (WZSZ) process described herein applies to any work zone located on a multi-lane highway with a pre-construction speed limit of $\geq$ 55 mph and with a work zone condition at least 0.5 mile in length that reduces the existing functionality of the travel lanes or shoulders and has an expected work duration of at least three hours.

For purposes of the WZSZ process: the conditions that would “reduce existing functionality” of the travel lanes or shoulders are lane closures, lane shifts, crossovers, contraflow and/or shoulder closures; and the length of the work zone condition is measured from the beginning of the taper for the subject work zone condition impacting the travel lanes and/or shoulder to the end of the downstream taper, where drivers are returned to typical alignment.

The three-hour duration requirement is used to balance the additional exposure created by installing and removing WZSZ signing with the time needed to complete the construction or maintenance work.

Speed zones in construction work zones should be reviewed and approved as early as possible in the planning process. ***Sections 1203-2.9.2 through 1203-2.9.4*** address details of the process as applied to construction projects in the design phase and during construction, as well as Operations/Maintenance projects. ***Sections 1203-2.9.6 and 1203-2.9.7*** provide additional information used to navigate and complete the process.

At this time, Work Zone Speed Zones (WZSZs) on other streets and highways will be considered on a case-by-case basis, and must be submitted individually to the **District Work Zone Traffic Manager (DWZTM) and District Speed Zoning Coordinator (DSZC)** using one of the other applicable processes described in ***Section 1203-3.*** Before the **District** may approve such request, concurrence shall be obtained from the **Office of Roadway Engineering (ORE)**. If approved, the WZSZ must still be established and documented through a Speed Limit Revision Form, implemented in the field and tracked using principles consistent with the WZSZs on high-speed ($\geq$ mph) multi-lane highways, and withdrawn when completed.

A WZSZ is not in effect and enforceable unless all of the existing speed limit signs within 1 mile in advance of and inside the WZSZ are removed or covered and the WZSZ Speed Limit signs are in place with the appropriate legends displayed. Legends reflecting a speed limit in accordance with ***Table 1297-7*** shall only be displayed when the work zone condition in place reduces the existing functionality of the travel lanes or shoulders. At all other times (when the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders) the original posted speed limit shall be displayed.

For further details about information that needs to be addressed regarding WZSZs, see ***Sections 605-3.4, 605-6.4, 640-18, 641-34 and 642-24***.

When the need for the WZSZ has ended, the WZSZ signage shall be removed and the original (pre-construction) speed limit signage restored. The related Work Zone Speed

Limit Revision shall be withdrawn **(see *Section 1203-4)*.**

See ***Section 1203-5*** for further information about documentation of WZSZs. This includes the required documentation of when and where the signs are erected, what speed limit is displayed, and when they are removed.

1203-2.9.2 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Construction Projects – During Design (Figure 1298-1a)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for construction projects during design, including design build projects, are described in ***Figure 1298-1a, Work Zone Speed Zoning Process for Construction Projects – Design Phase***.

As noted above, Speed Zones in construction work zones should be reviewed and approved as early as possible.

1203-2.9.3 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Construction Projects – During Construction (Figure 1298-1b)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for construction projects during construction, are described in ***Figure 1298-1b***, **Work Zone Speed Zoning Process for Construction Projects – During Construction**.

1203-2.9.4 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Operations/ Maintenance Work (Figure 1298-1c)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for operations and maintenance work on high-speed (≥55 mph) multi-lane highways are described in ***Figure 1298-1c*, Work Zone Speed Zoning Process for Operations/ Maintenance Work**.

1203-2.9.5 Reserved for Future Information

The new WZSZ process eliminated the need for the **Work Zone Speed Zone Justification Report *(Form 1296-16*)*.*** Therefore, the form and related text has been deleted. This Section is reserved for future use.

1203-2.9.6 Warranted Work Zone Speed Limits for Work Zones on High-Speed (≥ 55 mph) Multi-Lane Highways (Table 1297-7)

Table 1297-7 is used to determine the warranted speed limit value(s) during qualifying work zone conditions (defined below and in ***Section 1203-2.9.1***) for multi-lane highways with a pre-construction speed limit of 55 mph or higher. All WZSZs are variable in nature, with the warranted work zone speed limit fluctuating with the conditions and factors in place at the time.

The table provides the warranted speed limit for each of the specific conditions given. Only one warranted speed limit applies at any one time; speed limit reductions are not cumulative. As conditions in the work zone change, the work zone speed limit shall adjust accordingly per ***Table 1297-7***. WZSZ shall not be used for Moving/Mobile activities, as defined by the **OMUTCD**.

The following are definitions and additional information for use with ***Table 1297-7***:

<u>**Work Zone Condition**</u> – A qualifying work zone condition is one that is at least 0.5 mile in length (as defined in ***Section 1203-2.9.1***), with an expected work duration of at least three hours, and reduces the existing functionality of the travel lanes or shoulders. As noted in

Section 1203-2.9.1, the conditions that would "reduce existing functionality" of the travel lanes or shoulder are lane closure, lane shift, crossover, contraflow and/or shoulder closure.

<u>Original Posted Speed Limit</u> – The original, pre-construction, speed limit prior to any WZSZ. When determining a warranted work zone speed limit for a new or revised work zone condition in which there is a pre-existing work zone speed limit in place, always use the original (pre-construction) speed limit. Do not base a new work zone speed limit upon a prior work zone speed limit. Speed limit reductions are not cumulative.

<u>Positive Protection</u> - Positive protection is generally regarded as portable barrier or other rigid barrier in use along the work area within the subject qualifying work zone condition. A work zone Without Positive Protection is generally regarded as using drums, cones, shadow vehicle, etc., along the work area within the subject qualifying work zone condition. For work zones that are utilizing a combination of Temporary Traffic Control Devices (TTCDs), the designation of "with" or "without" positive protection should be based upon the type of devices used for the qualifying work zone condition being considered. If there is a combination of TTCD within the qualifying work zone condition being considered, engineering judgement should be used in determining the designation with consideration being given more towards the area in which workers will be located.

<u>Worker Presence</u> – Workers are considered as being present when on-site, working within the subject qualifying work zone condition.

The following are two examples demonstrating how to determine warranted work zone speed limit values from ***Table 1297-7***:

<u>Example 1</u>

An Interstate with an original, pre-construction, posted speed limit of 70 mph will have a lane shift of 10-feet (>0.5 mile in length) in place 24/7 for several weeks using portable barrier. The work zone speed limit while the lane shift is in place when workers are present is 60 mph (65 when workers are not present, but the lane shift remains in place). For one night there will also be a lane closure (> 0.5 mile in length) for six hours using drums; and the closed lane will be restored (reopened) before the end of the work shift, while the lane shift remains in place. The work zone speed limit during the lane closure is 55 mph and would only be applicable for the length of the lane closure. Once the closed lane was restored, the work zone speed limit in that area would go back to 60 mph while workers and the lane shift were still present.

<u>Example 2</u>

An Interstate with an original, pre-construction, posted speed limit of 65 mph will have a nighttime lane closure (>0.5 mile in length) in place for seven hours using drums, and the closure will be repeated nightly for three days. When workers are not present, all lane and shoulder functionality is restored. The work zone speed limit during times when the lane closure is in place and workers are present would be 50 mph. When workers are not present (and the condition impacting the existing functionality of the lane and shoulder is not present) the work zone speed limit would be the original, pre-construction, speed limit of 65 mph.

*See **Section 1203-2.9.7** for information regarding an optional form for assistance in working with **Table 1297-7**.*

1203-2.9.7 WZSZ Evaluation Sheet for High-Speed (≥55 mph) Multi-Lane Highways (Form 1296-17)

Form 1296-17 is an optional form available to assist in navigating the information in ***Table 1297-7***. The form is used in the same way as ***Table 1297-7,*** to determine the warranted work zone speed limit values during qualifying work zone conditions on multi-lane highways with original (pre-construction) speed limits of 55 mph or higher. See ***Section 1203-2.9.6*** for definitions and additional information that applies to the use of ***Form 1296-17***.

1203-3 Speed Zone Studies

1203-3.1 General

Generally, a Speed Zone Study used to support a request for alteration of a speed limit should include ***Forms 1296-2*** (Speed Zone Warrant Sheet), and ***Form 1296-5*** (Speed Check Form) and a scaled area map, sketch, or aerial view to identify the location of the proposed zone. Alternative abbreviated study procedures have been developed to address certain situations involving: narrow or low-volume rural roads, unimproved County Roads, residential and commercial **County** subdivision streets, freeways, rural expressways and high-speed divided highways, and temporary traffic control zones on high-speed (≥55 mph) multi-lane highways. These are addressed in ***Sections 1203-2.6, 1203-2.7, 1203-2.8 and 1203-2.9***, respectively.

If conditions are not relatively consistent throughout the section under study, consideration should be given to splitting the study area into shorter sections. Turning lanes, or other special lanes, are not normally used in this calculation.

1203-3.2 Field Review

A field review of the roadway section shall be made noting various physical conditions along and adjacent to the highway and identifying where crashes have occurred. The Speed Study Data Sheet (***Form 1296-3***) or a similar document may be useful in consolidating this information. (***Form 1296-4*** provides a completed sample of this form, using symbols from ***Table 1297-1***.) The field review should consider:

1. Roadway width, width of lanes, width of berm, setbacks of the buildings, distances to any fixed objects within 10 feet of the pavement edge, and type and condition of the pavement surface should also be shown.
2. On **ODOT**-maintained routes, SLM log points shall be used. A 1 inch = 0.1 mile scale should be used along the centerline of the roadway. Lateral dimensions need not be scaled.
3. The review should consider features 500 feet beyond each end of the proposed zone.
4. Pavement marking or restricted sight distances less than 600 feet, signals and flashers, and Warning and Regulatory Signs.
5. The number of, and point at which, more than five pedestrians per hour cross or walk on the pavement.
6. The number and type of crashes that occurred in the last three years.
7. Test runs should be made; however, these will also be conducted by the **District** personnel reviewing requests submitted to **ODOT**.
    a. Test runs should be made by driving as fast as it is comfortably safe.
    b. Test runs should be made in such a way that other traffic will not delay the test car.
    c. The speed should be recorded at a range of 0.10 to 0.25 mile interval or more.
    d. The average speed of three test runs should be determined in each direction.

1203-3.3 Speed Check *(Form 1296-5)*

Except when using one of the abbreviated study procedures described in ***Sections 1203-2.6 through 1203-2.9***, or a summary sheet resulting from a mechanical speed check device and its associated software, a speed check using ***Form 1296-5*** (Speed Check Form) or a similar form, shall be included in the study.

1. Speed checks may be taken with any device that will indicate vehicle speed with an accuracy of $\pm$10 percent.
2. Record speeds of 100 vehicles for each direction of travel (observation need not exceed one hour even if less than 100 vehicles are recorded traveling in each direction).
3. Speed checks should be taken at the 1/3 points (total of four checks) for zones 0.25-1.00 mile in length, and at 0.5-0.75 mile intervals for zones over 1 mile in length.

1203-3.4 Speed Zone Warrant Sheet *(Form 1296-2)*

1203-3.4.1 General

Form 1296-2 should be used in analyzing speed reduction requests that do not fall into the categories discussed in ***Sections 1203-2.6 through 1203-2.9*** for the abbreviated Speed Zone request procedures. The data collected from the field review of the location and the information discussed in ***Subsection 1203-3.4.2*** are used to complete ***Form 1296-2***.

The current form was developed as a **Microsoft Excel** file; however, it may also be completed by hand.

The first sheet of ***Form 1296-2*** is basically for data input. In the Excel file, when the mouse cursor hovers over the characteristics designations A1, B1, etc. a text description of that category pops up. There are also links to graphic examples of the characteristics categories and crash data samples. The second sheet in the file is a more traditional version of the warrant form: it includes the formulas and makes the calculations, based on the data entered on the first sheet. The third sheet provides a graphic illustration of the roadway characteristics information; and the last sheet provides a sample crash diagram for the roadway section showing which types of crashes should be included when performing a speed study.

The roadway characteristics information and “types of crashes” illustration used with this form are the same as those introduced with the Narrow and Low-Volume Roads short form in 2008. ***Table 1296-7*** provides additional information about the Roadway Characteristics categories used with this form, and ***Figures 1298-3 through 1298-5*** provide aerial view illustrations to help describe these categories.

If the Excel software is not available, sheet 1 or 2 may be copied, completed by hand, and submitted.

A Comments section has been provided on the form in case there is additional information the requesting agency wants to bring to the reviewer’s attention ***(see Subsection 1203-3.5)***.

1203-3.4.2 Information Used in Completing Form 1296-2

The following data is used in completing the Warrant Sheet:

1. **Highway Development** consists of evaluating the extent of building development and classification of intersections. These components are described in ***Table 1297-2***. Intersections at the end of the study area should not be counted.

   The building development and intersection classification calculations are added and then the total is divided by the length (in miles) of the zone.

2. **Roadway Features** consists of evaluating the roadway design characteristics including lane width, shoulders curves and grades. ***Table 1297-3*** defines the Roadway Feature components.

   It is recognized that shoulder features may not be consistent throughout the roadway section under study. A judgment will need to be made to determine the most prominent design, unimproved or improved, and width.

The names of the crossroads should be noted in the Comments section.

3. **85th-Percentile Speed** can be determined by taking spot speed observations during weekday off-peak periods. Spot speed checks should be taken to reflect only free-flowing vehicles. A vehicle is considered free flow if there is a minimum of five seconds gap (headway) from the other vehicle ahead of it, and it is not accelerating or decelerating for other reasons. If it is not possible to observe free-flow conditions, then the 85th-percentile speed of all vehicles should be increased 5 to 10 miles per hour to approximate the free-flow 85th-percentile speed. If the 85th-percentile speed of several speed checks varies considerably and is in more than one range in the warrant analysis, average the speed or select the most representative speed.

   Another option for determining 85th-percentile speed involves the use of probe-based data. Traffic information is collected from **ODOT-**maintained roads, then data analytics is used to determine the 85th-percentile speed. The **Office of Traffic Operations (OTO)** has created detailed instructions for downloading the data and calculating the 85th-pecentile speed using an **OTO** developed program. This information is available from the “Regulations” web page on the **OTO** website.

4. **Pace** is the ten mile per hour range of speeds containing the greatest number of observed speeds. If the paces of several speed checks vary considerably and are in more than one range in the warrant analysis, average the pace or select the most representative pace.

5. **Crashes/MVM** - intersection crashes not on the approach to the section under study should not be included in the evaluation; and crashes at horizontal curves should be considered only after all appropriate Warning and Advisory Speed signs are in place.

   Caution needs to be exercised in applying the crash experience if there is an over representation of crashes caused by situations essentially independent of the permanent speed limit. Therefore, in determining a permanent speed limit, crashes caused by animals, impaired drivers, vehicle defects, load shifts, construction and environmental conditions, such as snow and ice, should not be included in the crash experience.

   It is desirable to consider a review of crashes over a three-year period; however, crash data for one year is acceptable if more is not available. Copies of the crash reports, or a list documenting the location and type of each crash, shall be submitted with the request.

6. **Test Run** data is recorded by the **District** when reviewing the speed zoning request and the information is shown on the form because the average test run speed is beneficial in supporting the spot speed data as reflecting free-flow conditions. Also it is beneficial in comparing or matching the fit of the spot speed data to the full length of the section under study.

1203-3.5 Additional Information/Considerations

There may be a need to consider adjusting the speed limit more than normal rounding to the nearest five miles per hour of the calculated speed as reflected in the speed study. Therefore, each Speed Zone request form includes a provision for noting “Comments/Additional Information.” This space has been provided for the requestor to note any additional information that might be of interest to the reviewer in considering the request. Items to consider or additional information to provide when recommending a speed limit different than the calculated value may include:

1. A study area near or adjacent to an incorporated area or other warranted speed reduction(s).

2. Maintaining uniformity of speed limits within a contiguous section of highway.
3. Truck volumes along with the lane width should be considered, i.e., Volumes:

< 5%	Low impact/consideration
5% to 10%	Moderate impact/consideration
> 10%	High impact/consideration

   An effective width of 20 feet is considered adequate only for low-volume roads where meeting and passing are infrequent and the truck volumes are low.
4. Land along the study area is generally fully developed based on local zoning and/or local subdivision regulations.
5. Other conditions:
   a. A large number of driveways with limited visibility.
   b. The results of the test runs are not representative of the 85th-percentile or calculated speed.
   c. Abnormal traffic volume flows.
   d. A large number of horizontal and vertical curves requiring speed reductions.
   e. The use of the road as related to access vs. mobility (e.g., functional classification).
   f. An unincorporated area that looks to the driver the same as an incorporated area.
   g. Large number of items that affect the assured clear stopping distance of the driver.
   h. Volume of pedestrian traffic and/or official signed bike routes.
   i. Proximity to a school.
   j. Extreme geometric or other rare or unique work zone feature(s) that cannot otherwise be modified or mitigated and are not otherwise taken into consideration elsewhere in the process (for Work Zone Speed Zones that are on facilities other than high-speed, ≥55 mph, multi-lane highways).
6. Photographs may also be helpful in describing features of particular concern.

1203-4 Withdrawal of Authorization

The withdrawal of the authorization for a Speed Zone requires a traffic engineering study/investigation and, insofar as is applicable, shall be accomplished in the same manner in which it was established. ***Form 1296-7a*** (Withdrawal of Issued Speed Zone Authorization) is used to document the withdrawal of any Speed Zone approved by **ODOT**. ***Form 1296-7b*** is used for withdrawal of work zone speed zones established in accordance with ***Table 1297-7***, described in ***Section 1203-2.9***.

When an unimproved highway is improved, any Speed Zones established for it based on it being "unimproved" shall be withdrawn, basically using the same process by which the zone was established. ***Form 1296-15*** can be used, with the explanation noted in the Comments section.

If a road is improved so that it no longer qualifies as a "narrow road" for speed zoning purposes, any Speed Zones established on it as a "narrow road" shall be withdrawn. The fact that the speed limit had been lowered previously because it was a narrow road, can be noted in the Comments portion of the Speed Zone request form if a speed reduction is requested for the improved highway. This would also apply if the ADT on a road increases to where it would no longer be classified as a low-volume road.

See ***Section 1203-5*** for additional information on documentation of the withdrawal of an authorized Speed Zone.

1203-5 Documentation and Records Management

1203-5.1 General

Table 1297-4 shows the range of Revision Numbers to be used by each **District** for Speed Zones. These numbers shall be used on forms where indicated. For speed zones in temporary traffic control zones, the prefix "WZ" shall be used with the number.

For further information on the documentation of Speed Zones within temporary traffic control zones (work zone speed zones) see ***Section 1203-5.2***,

Following approval of a regular, "permanent" speed zone on **ODOT**-maintained highways, the **District** shall erect the appropriate Speed Limit signs, record the dates of sign erection on ***Form 1296-6a***, and notify the **OSHP** and other law enforcement agencies as appropriate.

Following approval of a regular, "permanent" speed zone for a local jurisdiction, the **District** shall send the local authority the Speed Limit Revision authorization ***(Form 1296-6a)***. After erecting the related Speed Limit signs, the local authorities shall complete the bottom portion of the form, certifying that the signs were erected and when, and return the form to the **District**. Upon receipt of the completed ***Form 1296-6a***, the **District** shall notify **OSHP** and other law enforcement agencies as appropriate.

As noted in ***Section 1203-4***, withdrawal of an authorized Speed Zone basically follows the same process used to authorize it originally. The **District** uses ***Form 1296-7a*** to approve withdrawal of a Speed Zone, and the jurisdiction involved then uses the bottom portion of the form to certify that the related Speed Limit signs have been removed and when. The **District** shall notify **OSHP** and other law enforcement agencies as appropriate.

1203-5.2 Documentation for Work Zone Speed Zones (WZSZs)

Approval of a WZSZ for a temporary traffic control zone in accordance with ***Table 1297-7*** is documented on ***Form 1296-6b, Work Zone Speed Limit Revision Form***. The **OSHP** and other law enforcement agencies shall be notified by the **District** (or local agency) as appropriate.

As noted in ***Subsection 1203-2.9***, the WZSZ is not in effect and enforceable unless all of the existing Speed Limit signs within 1 mile in advance of and inside the WZSZ are removed or covered and the WZSZ speed limit signs are in place with the appropriate legends displayed. Legends reflecting a speed limit in accordance with ***Table 1297-7*** shall only be displayed when the work zone condition in place reduces the existing functionality of the travel lanes or shoulders. Therefore, records must be kept to document when WZSZs are in effect. This requires documentation of when the related work zone speed limit signs are actually erected and removed, or activated, digitally changed and deactivated.

Form 1296-18, Work Zone Speed Zone (WZSZ) Tracking Report was developed to document all WZSZs, whether using DSL Sign Assemblies or temporary flatsheet Speed Limit signs. On **ODOT** projects, this form shall be completed, signed and submitted to the project engineer (if applicable), **District Work Zone Traffic Manager (DWZTM)** and **District Speed Zoning Coordinator (DSZC)** weekly for all WZSZs.

All WZSZ documentation for **ODOT** construction projects is retained in the **District** Construction Project files (or **District Highway Management** files) and Speed Zoning files.

When the need for the WZSZ in accordance with ***Table 1297-7*** has ended, a withdrawal of the authorization shall be processed, using ***Form 1296-7b***. The **OSHP** and other law enforcement agencies shall be notified as appropriate.

1203-5.3 Records Management and Retention

The **District** shall retain paper or electronic copies of the documentation used in establishing and tracking Speed Zones in their permanent files. Paper or electronic copies of the official document authorizing the issuance or withdrawal, as well as any paper or electronic copies of local requests or resolutions, shall also be retained permanently in **District** files.

When a corporation limit, or other feature, that was used as a terminus for an authorized Speed Zone moves, the existing Speed Zone should be withdrawn ***(Section 1203-4)*** and a new one established. However, if a road used as a reference point is renumbered or the name changes, it is not necessary to withdraw and reestablish the Zone. The changes may be noted in the documentation for the Zone. A typing error may also just be noted in the documentation.

If a road/route name changes but the road/route number does not, a new study and Speed Zone request (and withdrawal of the existing one) should not be needed if there is no change in the speed zone. However, the name change should be documented on or with the existing Revision form.

If a route is removed, but the road remains a State Route (for example, in an overlap situation), the Speed Zone does not have to be withdrawn and reestablished unless the speed limit should change.

Basically, an altered speed limit remains in effect until it is withdrawn. For example, inside a **City**, when a route has been removed from a street (as in the case of a bypass), the speed limit on the street reverts back to the statutory speed limit only after withdrawal of the Speed Zone.

Information from the speed zone report shall be uploaded by the **District** to the Traffic Regulations Database Management System (TRDMS), a statewide inventory and historical record that the **Office of Traffic Operations (OTO)** shall maintain. This Regulations inventory is available from the **OTO** website (see Misc. Applications, Documents, Projects and Programs/Regulations).

1204 PARKING CONTROL ZONES

1204-1 General

As noted in **OMUTCD Section 2B.46**, **ORC Section 4511.68** establishes certain parking prohibitions and **ORC Section 4511.69** notes additional provisions related to parking locations and provisions. In addition, **Section 4511.66** addresses the prohibition of parking upon the paved or main traveled part of the highway, and **4511.681** addresses the prohibition of parking on private property.

Special legal authority is required to establish parking controls at any type of location not covered under existing laws. For rural state highways, these Parking Control Zones must be authorized by the **Director**. In municipalities, such authority is granted by an Ordinance passed by the **Council** or by other local legal authority. The adoption of a Resolution by **County Commissioners** or **Township Trustees** provides similar authority in rural jurisdictions.

Any regulation established other than those specified in **ORC Sections 4511.66, 4511.68 and 4511.99 A through C** shall be indicated by the use of signs.

1204-2 Procedure for Authorizing Parking Control Zones

As noted in ***Section 1204-1***, **ODOT** has no responsibility for Parking Control Zones on local roads or private property.

Requests for Parking Control Zones on **ODOT**-maintained highways are submitted through the **District** office. As noted in ***Section 1204-3***, an engineering study is conducted to determine if a Parking Control Zone is appropriate.

Once a determination has been made to establish a Parking Control Zone, the **District** shall forward the parking control proposal to the appropriate **OSHP District Office** for review and comment. ***Form 1296-19*** is a sample form that can be used to help expedite this review. The information at the top of the form would be completed by the **District** as appropriate for the specific zoning proposal, so that the form just has to be signed and returned to the **District** after **OSHP** review.

Following resolution of the **OSHP** comments, if any, the **District** shall prepare a description of the Parking Control Zone for the **Director's** approval using ***Form 1296-9*** (Establishment of No-Parking Restrictions).

Following approval, the **District** shall erect the appropriate Parking Control signs, record the dates on ***Form 1296-9***, and notify the **OSHP** and other law enforcement agencies as appropriate.

1204-3 Engineering Study

Chapter 1204 (Parking Control Zones) should be reviewed prior to submitting the study. The engineering study used to support a request for a Parking Control Zone shall include a field survey conducted to acquire necessary data to complete ***Form 1296-8*** (Field Report on Parking Practices). It should also include a sketch of the location and/or photographs to document the physical conditions noted in the survey report.

1204-4 Withdrawal of Authorization

The withdrawal of the authorization for a Parking Control Zone requires an engineering study and, insofar as is applicable, shall be accomplished in the same manner in which it was established. ***Form 1296-10*** (Withdrawal of Issued No-Parking Restrictions) is used to document the withdrawal.

1204-5 Documentation and Records Management

Table 1297-4 establishes Revision Numbers to be used by each **District** for Parking Control Zones. These numbers shall be used on ***Forms 1296-9 and 1296-10***.

The **District** shall retain paper or electronic copies of the reports used in establishing the Parking Control Zone in their permanent files. Paper or electronic copies of the official document authorizing the regulation shall also be retained permanently in **District** files.

When a corporation limit, or other feature, that was used as a terminus for an authorized Parking Control Zone moves, the existing Parking Control Zone should be withdrawn ***(Section 1204-4)*** and a new one established. However, if a road used as a reference point is renumbered or the name changes, it is not necessary to withdraw and reestablish the Zone. The changes may be noted in the documentation for the Zone. A typing error may also just be noted in the documentation. Other documentation and records management concerns are addressed in ***Section 1203-5***.

Information from the Parking Control Zone reports shall be uploaded by the **District** to the Traffic Regulations Database Management System (TRDMS), a statewide inventory and historical record maintained by the **Office of Traffic Operations** (**OTO)**. This Regulations inventory is available from the **OTO** website (see Misc. Applications, Documents, Projects and Programs/Regulations).

1205 OTHER ZONES

As noted in ***Chapter 1201***, Traffic Control Zones also include Pedestrian Safety Zones, Loading Zones, No-Passing Zones and Temporary Traffic Control Zones (Work Zones). No-Passing Zones are addressed in **OMUTCD Part 3**. Temporary Traffic Control Zones are addressed in **OMUTCD Part 6** and ***TEM Part 6****.*

1210 TRAFFIC ENGINEERING STUDIES

As noted in ***Section 130-2***, **OMUTCD Section 1A.09** states that the decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment. An engineering study is also required in various sections of the **Ohio Revised Code (ORC)**. Definitions of the terms “engineering study” and “engineering judgment” are provided in **OMUTCD Section 1A.13**.

The scope of the study will depend on the specifics of a particular situation. The **ITE Manual of Transportation Engineering Studies** ***(see Section 193-9)*** is useful in providing guidance on preparing, conducting and analyzing different types of traffic studies. Additional information about specific types of studies (e.g., Safety Studies, Speed Studies, Ball Banking Studies and the Systematic Signal Timing & Phasing Program) is provided in this Part of the **TEM**.

Engineering studies related to Speed Zones and Parking Zones are discussed in ***Chapters 1203 and 1204***, respectively. Safety Study guidelines are addressed in ***Chapters 1211 and 1212***, and various other traffic engineering studies, including ball banking of curves, delay studies, the Systematic Signal Timing and Phasing Program and Road Safety Audits, are addressed in ***Chapter 1213***.

Intentionally blank.

1211 SAFETY STUDY GUIDELINES

1211-1 What is a Safety Study?

1211-1.1 General

A highway safety study is a type of engineering study **(OMUTCD Section 1A.13)** that provides an analysis of roadway and traffic-related data to determine the possible cause of an identified crash pattern at an intersection or highway section. The study also addresses alternative countermeasure(s) meant to mitigate the crash pattern(s).

Highway safety issues (and how to mitigate them) are an important consideration for the Department and the communities it serves. **ODOT** has one of the largest safety programs in the country. The department funds one of the largest safety programs in the country for engineering improvements at high-crash or severe-crash locations. This funding can be used by **ODOT District Offices** or local governments to improve safety on any public roadway.

A properly developed highway safety study can provide the factual basis for good decision making and facilitate the timely implementation of necessary improvements. Specifically, a highway safety study should document the following:

- A method to provide an organized approach to the identification, analysis and mitigation of crash patterns and frequency at highway safety priority locations.
- A systematic approach to evaluate contributing factors to crashes and identify strategies for improvement with the greatest potential to benefit safety.
- A method to estimate the effectiveness of the proposed countermeasure(s).
- If applying for safety funds, a means to justify the proposed countermeasures and project.

The safety study guidelines outlined herein are for use by **ODOT** personnel, consultants and local jurisdictions conducting safety studies and preparing reports. By establishing a uniform format for **ODOT** safety studies and providing direction for completing safety study reports, these guidelines are intended to assure the completeness of a study and to expedite review and analysis of the reports.

1211-1.2 Safety Study Initiation

The safety study process is typically initiated by an **ODOT District**, **MPO** or local government in response to the need to study and address a priority crash location. The first step to any safety study involves a scoping/project kick-off meeting with the **District Safety Review Team (DSRT)** to define study area and scope. The consultant (or **LPA**, in the case of locally-sponsored safety studies and funding applications) should come prepared to discuss the study/project purpose and need in detail and, if appropriate, present a recommended study area and scope to the **District Safety Coordinator/District Safety Review Team (DSRT)**.

Requests for crash data or other traffic data (such as traffic volumes) should be prepared in draft form for review during the meeting. The **District Safety Coordinator/DSRT** and the consultant (or **LPA**) will discuss and agree upon the time frame for which the crash data will be evaluated for the study area or project. However, in general this time frame will typically consist of the most recent and available three-year calendar period.

The level of detail and determination of whether a full or abbreviated study is required will be determined at the scoping/project kick-off meeting. More information will be needed for projects with greater complexity and higher cost. Multi-disciplinary staff should be included at the scoping/kick-off meeting for projects expected to follow the Minor project classification as defined by the **Project Development Process (PDP)**. The consultant and/or **LPA** should coordinate with the **District Safety Coordinator** or **DSRT** in advance of the meeting to determine the appropriate staff for attendance. The **District Safety Coordinator** shall be responsible for inviting **ODOT** staff and coordinating the schedule of the meeting so that necessary staff can attend.

Safety studies are completed during the Planning Phase of the **Project Development Process (PDP)** and are used in the Preliminary Engineering Phase, if needed, to aid in the selection of alternatives. Safety studies provide supporting data for the Feasibility Study and/or Alternative Evaluation Report, when warranted.

1211-1.3 Safety Study Process

The **ODOT** safety study process consists of five steps. The process is intended to be iterative, with steps 2 through 4 repeated as necessary to facilitate the identification and evaluation of countermeasures that best address the particular safety needs of the site/project.

Step 1: Collect Data and Diagnose Crash Patterns. The activities included in this step provide an understanding of crash patterns, past studies and physical characteristics of the study site or project area prior to identification of potential countermeasures. As part of this step, the consultant and/or **LPA** should review historical studies and reports, existing condition data, and crash data and prepare necessary documentation, including collision diagrams and physical condition diagrams, in order to perform the site diagnosis and aid in identification of potential countermeasures. The GCAT and TIMS tools can be used to query crash data and roadway inventory data for the site. A field review should be performed to supplement the data and identify and/or confirm crash patterns and potential contributing factors. Information such as the presence of skid marks on the pavement, damaged roadside objects such as guardrail, posts, delineation, utility poles, bushes or trees, and any other evidence of potential safety issues (tire tracks, wearing of roadway/shoulder material, vehicle debris) within the study area should be photographed and documented in the safety study narrative.

It is important that the data collection include consideration of the various **Highway Safety Manual (HSM)** site subtypes so that appropriate data can be collected from field visits. Data collection should be performed based on segmentation as defined by the **HSM** methods. Estimation of the potential for safety improvement (Step 2) requires analyses be performed utilizing predictive models that estimate the frequency of crashes for a site which has been divided into homogeneous segments and intersections. A homogeneous roadway segment is a section of continuous traveled way that provides two-way traffic operation, is not interrupted by an intersection, and consists of homogeneous geometric and traffic control features. The following list summarizes the various data elements that should be collected during the field review by homogeneous segment and intersection.

Segment Data Requirements

- Length of segment, L (miles)
- AADT (vehicles/day)
- Lane width (feet)
- Shoulder width (feet)
- Shoulder type
- Median width (feet)
- Side Slopes
- Length of horizontal curve (miles)
- Radius of curvature (feet)
- Spiral transition curve (present/not present)
- Superelevation variance (feet/feet)
- Grade (%)
- Driveway density (driveways/mile)
- Centerline rumble strips (present/not present)

Intersection Data Requirements

- Intersection type (3ST, 4ST, 3SG, 4SG)
- AADT major (vehicles/day)
- AADT minor (vehicles/day)
- Intersection skew angle (degrees)
- Intersection lighting (present/not present)
- Number of approaches with left-turn lanes
- Number of approaches with right-turn lanes
- Number of approaches with left-turn signal phasing
- Type of left-turn signal phasing
- Number of approaches with right-turn-on-red prohibited [for 3SG, use maximum value of 3]
- Intersection red light cameras (present/not present)

Passing lanes [present (1 lane) /present (2 lane) / not present]
Two-way left-turn lane (present/not present)
Roadside hazard rating (1-7 scale)
Segment lighting (present/not present)
Auto speed enforcement (present/not present)
Roadway type (divided/undivided)
Auto speed enforcement (present / not present)
Major commercial driveways (number)
Minor commercial driveways (number)
Major industrial/institutional driveways (number)
Minor industrial/institutional driveways (number)
Major residential driveways (number)
Minor residential driveways (number)
Other driveways (number)
Speed Category
Roadside fixed object density (fixed objects/ mile)
Offset to roadside fixed objects (feet) [If greater than 30 or not present, input 30]
Sum of all pedestrian crossing volumes (PedVol) -- Signalized intersections only
Maximum number of lanes crossed by a pedestrian (nlanesx)
Number of bus stops within 1,000 feet of the intersection
Schools within 1,000 feet of the intersection (present/not present)
Number of alcohol sales establishments within 1,000 feet of the intersection
Type of on-street parking (none/parallel/angle)
Proportion of curb length with on-street parking

General information on the segmentation of sites can be found in the **HSM Part C Introduction**, as well as for the individual site types of Rural Two-way, Rural Multi-lane, and Urban/Suburban Arterials in **HSM Chapters 10, 11, and 12**, respectively. While the **HSM** does not specify a minimum length for a homogenous segment, for the purposes of **ODOT** Safety Study analysis, the minimum length of homogenous segment to be used for estimating the potential for safety improvement at a site is 0.10 mile. Segment lengths of less than 0.10 mile may be considered in special circumstances, but only with advanced approval by **ODOT**.

Step 2: Identify Potential for Site Safety Improvements and Possible Countermeasures. Once the necessary roadway and crash data has been collected and inventoried, an analysis should be performed using **HSM** methods or the Economic Crash Analysis Tool (ECAT), to determine the potential for site safety improvements that exists within the study area. This process involves calculating the predicted crash frequency for peer sites (similar to the study site) and the expected crash frequency for the actual site considering historical (actual) crash experience utilizing a mathematical modeling process as defined in the **HSM**. The difference between the predicted and expected crash frequencies, as expressed in expected excess crashes, is the potential for site safety improvement that could be addressed through the implementation of safety countermeasures. The ECAT tool developed by **ODOT's Office of Program Management** facilitates the completion of this analysis.

Upon determination of the potential for site safety improvement(s), both the predicted and actual crash performance of the site should be reviewed to identify potential safety countermeasures for evaluation, and potential implementation at the site. Review of crash data, roadway inventory and supplemental data collected during the field review can aid in identification of safety issues and crash patterns existing at the site. The results of the **HSM** analysis and comparison of calculated values for crash frequency, severity and type will provide insight into how the site is performing relative to its peers, and if there are any notable differences which also can be used to aid in identification of potential countermeasure treatments. Identification of potential countermeasures for evaluation should include consideration of each of the three general categories of contributing factors, human, vehicle, and roadway/environment, and should consider how each of these may influence the sequence of events that occurs before, during, and after a crash. For more information on these concepts, and for guidance in developing a framework for relating the series of events in a crash to the general categories of crash-contributing factors, refer to the **HSM, Chapter 3**.

The **ODOT ECAT** tool contains information on potential countermeasures that can be referenced when diagnosing site issues and identifying potential countermeasure for evaluation. Additionally, **HSM Part D, Chapters 13-17** can serve as a resource and should be referenced for additional information on potential countermeasure treatments, including insight on the effectiveness of various safety countermeasure or treatments under consideration.

Step 3: Perform Relevant Traffic Studies. To support the evaluation of potential countermeasures recommended for evaluation in Step 2, it may be necessary to collect supplemental data and/or perform additional supplemental studies. Examples of the types of supplemental analyses or studies that may be needed include the following:

Volume Studies
Traffic Control Device Studies
Signal Warrant Analysis
Signal Timing/Phasing Analysis
Spot Speed Studies
Travel Time and Delay Studies
Roadway/Intersection Capacity Analysis
Gap Analysis
Traffic Lane Occupancy Study
Queue Length Study
Sight Distance Study
Skid Resistance Study
Highway Lighting Study
Horizontal Curve (Ball Bank) Study
Turning Path Analysis
Parking Study
Bicycle or Pedestrian Study

Resources available to assist in performing these studies include **ODOT's Traffic Engineering Manua**l, the **ITE Traffic Engineering Handbook**, the **ITE Manual of Traffic Engineering Studies**, the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**, **FHWA's Highway Safety Engineering Studies Procedural Guide**, and the **AASHTO Highway Safety Manual.** Consultation with the **District Safety Coordinator/DSRT** prior to initiation of any supplemental studies for verification of need, determination of scope, and approval to proceed is required for all **ODOT** sponsored safety studies and strongly recommended for locally sponsored projects.

Step 4: Evaluate Countermeasures – After completing Steps 2 and 3, the **HSM** analysis methods will again be used to estimate the safety effectiveness, and develop an estimate of the relative cost to safety benefit for each proposed countermeasure or combination of countermeasures. Calculations to determine the expected crash frequency for the site/project with incorporation of the proposed countermeasures are performed similar to calculations performed for the existing condition analysis of the site, as described in Step 2.

The final recommended countermeasure, or combination of countermeasures, should represent a cost effective treatment, or combination of treatments, resulting in lower expected crash frequencies of the site. Expected crash frequencies should approach, or be less than, the predicted crash frequency of the existing condition. Both the calculation of the expected crash frequency for the proposed condition and the economic cost to benefit analysis can be accomplished using either the **HSM** or the **ECAT**. The amount that crashes can be reduced will be based on the results of the benefit-cost analysis.

When analysis of the proposed countermeasure does not result in a reasonable reduction of crash frequency relative to cost, as reflected by the cost to benefit analysis, it may be necessary to revisit the Step 2 site diagnosis and potential countermeasure identification, and/or Step 3 supplemental studies, to reassess the safety needs and identify other safety improvements for evaluation. Step 4, evaluation of the new countermeasures, would then be repeated. Low cost, short-term improvements should always be among the first series of evaluated countermeasures when performing the Step 4 evaluation process.

Step 5: Develop Plan and Finalize Report. Steps 1-4, including recommended countermeasures and treatments, should be documented in the form of a Safety Study Report.

The format, either full or abbreviated, will have been determined during the scoping of the project. Recommendations should be based upon the potential for safety improvement and should consider treatments from the full range of safety strategies, including engineering, enforcement, driver education and/or other factors. When developing the implementation strategy, the consultant or **LPA** should consider whether a combination of improvements may be the best plan for addressing a location.

Final plan recommendations should be based on knowledge of the effectiveness of the proposed improvement and should be considered within the context of the traffic and site conditions. All practical recommendations, including “do nothing” should be identified, considered, and analyzed for safety so that no feasible alternative is overlooked. Solutions of low-cost, short-term improvements with high benefit-to-cost values should be given higher priority and should always be considered within the first tier of recommended solutions of any implementation plan.

1211-2 Table of Contents

Full safety study reports shall have a Table of Contents ***(see Figure 1298-6)***. An abbreviated safety study may be completed with the approval of the DSRT. In an abbreviated safety study, only those elements of the full safety study Table of Contents should be completed that are pertinent to describe the crash patterns of the location.

1211-3 Title Page

The report should have a Title Page and it should show the **District**, **County**, Route, Section, Safety Analyst Rank (#), the Safety Annual Work Program (SAWP) Year (if applicable), study completion date, a location map ***(see Figures 1298-7 and 1298-8)***, and the name of the **District**, consultant and/or **LPA** that prepared the report.

1211-4 One Page Project Summary

The report shall have a One Page Project Summary including basic project information and a site map. This one-page summary will identify the major crash trends, patterns and recommended solutions, and should directly reflect the countermeasures being presented for a safety funding request. ***See Figures 1298-9 and 1298-10*** for a sample One Page Project Summary.

1211-5 Executive Summary

Any report over twenty-five pages shall include an Executive Summary, which can be used as an overall summary of the report. The Executive Summary should be no longer than two or three pages (excluding figures) and present a summary of the information documented in detail within the main body of in the report. It should generally adhere to the outline shown in ***Figure 1298-11***.

1211-6 Purpose and Need Statement

This part of the Safety Study Report is used to identify the location being studied and provide reasons for conducting the safety study. At a minimum, the purpose and need statement should identify the Safety Analyst Ranking or local priority, summarize the existing conditions, crash patterns, and crash analysis that support the need for conducting the study, and confirm the potential for site safety improvement as determined through the analysis process described in Step 2 of the Safety Study Process ***(Section 1211-2.3)***.

Example 1

This study analyzes SR 3 at the TR 105 (Plumb Road) intersection. This intersection is ranked #XX in ODOT's 20XX listing of rural intersection locations. The purpose of this report is to study this location and analyze the crashes to determine what, if any, actions can be taken to reduce the high percentage of angle and rear-end crashes occurring in the study area.

Example 2

The location addressed in this study was identified as HAM-US 50 1.05. The study area is the intersection of US-50 and Lawrenceburg Road, a mile from the Indiana state border. This location was ranked 13th on the safety analyst list of top rural intersections. The purpose of this study is to analyze the crash trends at this location and recommend countermeasures to mitigate any safety or congestion issues.

Example 3

The purpose of this study is to evaluate the existing safety conditions and to identify potential countermeasures at the intersection of SR-64 (log point 0.46) and IR-75 SB exit/entrance ramp in Wood County. This intersection is a priority location for the City of Bowling Green, and has been approved for study by the District 2 DSRT. The current lane configuration leads to long queues which extend beyond the adjacent intersection with very poor lane utilization. Secondary crashes result from this queuing and can be seen as far down as Alumni Drive. Bowling Green State University is in close proximity to this intersection and during special events, the traffic on the southbound off-ramp routinely backs onto the IR-75 mainline, creating hazardous speed differentials. Lastly, pedestrian accommodation throughout this corridor is a priority for both the City of Bowling Green and Bowling Green State University.

1211-7 Existing Conditions

1211-7.1 Background

This section of the report is used to identify the location being studied, (County/City/Township, Route and Section), type of facility (Functional Classification, number and direction of lanes), existing traffic control, history of safety problems or crashes, and reason for the study. If applicable, information summarizing previous or planned improvements to mitigate crashes should be documented.

Example 1

This approximately 1.16 mile section of S.R. 56 is located in Pickaway County. It is part of the rural state highway system under the jurisdiction of District 6 of the Ohio Department of Transportation (ODOT). The section under study, log point 26.44 to 27.60, begins at the intersection of S.R. 159 and S.R. 56 and extends in an easterly direction just beyond and including the Township Road (T.R.) 62 and S.R. 56 intersection. The project limits extend longitudinally 1000 feet along the center line at intersections and 200 feet laterally from the center line along the entire length of the study area. Based on information supplied by District 6, PIC-56-26.92 to 27.41 was ranked #XX on the 2013 Priority List for rural intersections.

Example 2

Main Street (U.S. Route 40) is a six (6) lane asphalt roadway with turn lanes being provided at major intersections. The current posted speed limit for Main Street is 35 mph. According to information obtained from the Ohio Department of Transportation's (ODOT's) website, Main Street is classified as an urban principal arterial. The calculated ADT on Main Street to the east of its intersection with McNaughten Road is approximately 38,000 vehicles per day and the ADT to the west is approximately 46,000. In the study area, Main Street is a straight, flat roadway which has enclosed drainage and concrete curbs on both sides of the roadway. Street lighting exists on the north side of the roadway and the only sidewalk is a short length on the north side of the street, immediately east of McNaughten Road.

McNaughten Road is a two (2) to four (4) lane asphalt roadway in the vicinity of the intersection. The current posted speed limit for McNaughten Road is 35 mph. According to information obtained from ODOT's website, McNaughten Road is classified as an urban minor arterial. The calculated ADT on McNaughten Road to the north of its intersection with Main Street is approximately 16,000 vehicles per day and the ADT to the south is approximately 17,000. In *the study area, McNaughten Road is a straight, flat roadway which has enclosed drainage and concrete curbs on both sides of the roadway. Street lighting does not exist along the roadway and some short sections of sidewalk are provided on both sides of the roadway just north of the McNaughten Road intersection.*

Example 3

The location under study is the intersection of State Route 164 and State Route 558 located in Columbiana County (District 11). State Route 164 (SR 164) is a two-lane, undivided roadway classified by ODOT as a Rural Minor Collector with a statutory speed limit of 55 miles per hour oriented in the north-south direction. SR 164 is located 1,000 feet west of and runs parallel to State Route 11, a limited access facility. State Route 558, (SR 558) is a two-lane undivided roadway classified by ODOT as a Rural Minor Arterial with a statutory speed limit of 55 miles per hour oriented in an east-west direction. The land use is primarily agricultural with a limited number of placed residential units in the project vicinity.

State Route 164 intersects SR 558 as a two-way stop-controlled intersection with stop control for the SR 558 approaches. There are no exclusive turn lanes at the intersection. Current daily traffic volumes on SR 164 range between 1,990 and 2,120 vehicles per day with 4 percent daily truck traffic. Current daily traffic volumes on SR 558 range between 1,240 and 1,550 vehicles per day (5 -6 % trucks).

A review of crash data provided by the Ohio Department of Transportation (ODOT) yielded a total of 26 reported crashes within the intersection influence area (500 feet on each approach) during a 3-year period between 2009 and 2011. The following notable crash types and conditions are present at the SR 164/ SR 558 intersection:

- *Angle: 16 crashes or 61.5 percent*
- *Fixed Object: 7 crashes or 26.9 percent*
- *Sideswipe Meeting: 2 crashes or 7.7 percent*
- *Road condition - Snow: 4 crashes or 15.4 percent*

No fatalities were reported at the intersection during the study period.

ODOT currently has plans to modify pavement markings in the spring of 2013 to adjust the stop line locations on the SR 558 approaches to SR 164. The existing stop lines on the stop controlled approaches of SR 558 are positioned 35 feet (eastbound approach) and 28 feet (westbound approach) from the edge line of the intersecting street (SR 164). The position of these stop lines are planned to be moved to a distance of 15 feet from the edge line of SR 164.

1211-7.2 Condition Diagram(s)

The condition diagram is a “to scale” drawing of the most important physical conditions of an intersection or section of a roadway. It is used to relate the crash patterns found on the collision diagram, with their probable causes, to physical features on and near the roadway. It also documents the site conditions that exist. It is often helpful to utilize aerial imagery as the base layer for creation of the existing conditions diagrams. It provides easy points of reference as well as information regarding the development in the project area.

As noted previously, it is important that the data collection include consideration of the various **HSM** site subtypes so that appropriate data can be collected from field visits. At a minimum, the following items should be included in the Physical Condition Diagram, condition write-up, or documented within one of the appendices in the report. Refer to ***Section 1211-1.2*** for more details on the specific data elements that are required to complete the analysis required for the safety study.

Roadway Features Required –

The following features should be shown in the drawing or in the related descriptive text:

1. Intersections: Identify by name, type of pavement (if applicable) and width of street.
2. Traffic Control Devices (signs, signals and pavement markings).
3. Section: Identify by county, route and log point in the title block of the drawing.
4. North arrow and match line if more than one page.
5. Pavement Markings: Center Line, No Passing Zones, Auxiliary Markings, Stop Lines, Crosswalks, etc.
6. Signs: All signs within the right-of-way, including non-OMUTCD signs, sign sizes (optional).
7. Pavement and shoulder widths, shoulder types and any surface irregularities.
8. Speed limits.
9. Driveways: Identify type of pavement of drive (concrete, asphalt, grass or gravel), and use (residential or commercial) when applicable.
10. Show Corporation Lines.
11. Curb: Identify type of curb, height, etc. (detailed information about the curb is optional).
12. Median: Identify type of median (grass, concrete, asphalt, etc.) and width.
13. Curves: Include approximate radius of curvature.
14. Roadside features: physical object within the right-of-way including approximate offset, grades and ditch locations along the roadside (but not behind guardrail).
15. Cross-corner sight distance at intersection or driveway with crashes.
16. Bridges and culverts, if involved in the accident.
17. Legend is required when using symbols on the diagram.
18. Other items that may be contributing factors.

Roadway Features, If Applicable –

When applicable to the site (i.e., where site type dictates this data is required for analysis, or where a roadway feature appears to be related to or contributing to crash patterns in the area) the following items should also be included:

1. Show evidence of parking (official or unofficial) within the right-of-way, if any.
2. Utility/Strain Poles: location and offset.
3. Guardrail: Include distance from edge of pavement, type of end treatment and height of guardrail (distance and height of guardrail optional).
4. Fire Hydrants: location and offset.
5. Highway lighting: location and offset.
6. Location and widths of drive, street number address (optional): Commercial or residential, any restricted movement.
7. Catch basins (optional).
8. Manholes (optional).
9. Vegetation: If contributing factor to the crash problem.
10. Trees in the right-of-way: Identify by diameter if contributing to crash problem.

All physical condition information should be located by reference to a benchmark that can be identified in the field at any time. A title block identifying the location shall be used consistently in all drawings. While not required, sketch level typical sections offer an effective means to document cross section information in order to complete required crash analysis. See ***Figure 1298-12*** for an example of an existing condition diagram for a roadway section and ***Figure 1298-13*** for an intersection.

1211-7.3 Physical Condition Write-up

The Physical Condition Write-up expands upon the information presented in the background section and physical conditions diagram and explains in more detail the type of location, type of roadway, traffic control devices in place, traffic and any operational or geometric conditions unique to the location. This section should also be used to document existing conditions information collected during the field review and highlight details that would not otherwise be captured in the existing conditions diagram.

Example 1

Based on field observations, the pavement at the intersection appears to be in good condition with minor cracking that has been sealed. The pavement markings also appear to be in good condition except for the stop bars on Plumb Road on either side of SR 3, where they are very faded. The paved shoulder in the southeast corner of the intersection is starting to crumble. Additionally, there are no speed limit signs on SR 3 near this intersection; the closest one is located several miles away. No pedestrians or bicyclists were observed during the field activities, and no 'goat paths' (worn areas alongside the roadway) were observed along the sides of any of the roadways. So there are no indications that pedestrians are walking in the project area with any regularity.

Example 2

US-50 is classified as a rural minor arterial. The posted speed limit through this section is 45 miles per hour. The 2009 reported ADT is 10,580 with 6% trucks. This section of US-50 is 2 lanes in both directions. There are no turn lanes at the intersection on US-50 but southbound Lawrenceburg Road has a right-turn lane and a thru-left lane.

There is 1 signal head per lane in all directions. Eastbound traffic has an extra head on an opposite span to drivers coming around the curve to see the signal. The signal heads are in fair condition. There is a flashing signal ahead sign on eastbound 50 and a regular signal ahead sign on westbound 50. Finally, the pavement and pavement markings are in fair condition.

Example 3

S.R. 56 is a rural two-lane roadway. The layout of S.R. 56 within the study area consists of horizontal and vertical curves, residential drives and a commercial drive. The driveways in the study section were counted and their distance from S.R. 159 measured. Standard center line and edge line markings exist throughout the study area. The curves between S.R. 159 and T.R. 62 are marked with warning signs and Advisory Speed Plaques. A number of vehicle types travel this roadway, including semi-trucks, farm equipment and horse-drawn buggies.

The intersection of S.R. 56 and S.R. 159 is a four-way stop with an all-way red intersection flasher. Each leg of the intersection is 21 feet in width from edge line to edge line with a 2-foot paved berm and varying gravel berm beyond the edge of the paved berm. The two State Routes come together to form an approximate 90 degree intersection. Stop lines and Stop Ahead signs are on all four approaches of the intersection. D-1 assemblies and standard route direction and confirmation markers are also on each approach of the intersection.

The intersection of SR 43 and SR 183 is under the control of a NEMA Control Cabinet and monitor, operating a 3 phase signal sequence. The signal is pre-timed with a total cycle length *of 92 seconds. The traffic signals are mounted on a span wire that uses two wooden poles for support. There is a minimum of 16 ft. of vertical clearance under the signal heads.*

1211-7.4 Photos

Include relevant photos taken during the field review that provide insight to or identify and/or confirm crash patterns and potential contributing factors. Photographs taken during Step 1 should document existing conditions or evidence of safety issues such as the presence of skid marks on pavement, damaged roadside objects such as guardrail, posts, delineation, utility poles, bushes, or trees, or and any other evidence of potential safety issues (tire tracks, wearing of roadway/shoulder material, vehicle debris) as observed during the field review. No specific requirement exists for the number, frequency, or location of photographs to be taken. Photographic detail should be sufficient to visually document the intended feature or condition. A brief narrative describing the photo location and subject should be included either individually with each picture or listed and summarized in tabular form.

1211-7.5 Other Issues and Data

Other relevant data and information are included when such information is essential in garnering support of the study and the countermeasures being recommended. Relevant information may include proposed developments, schools, shopping malls, public concerns/ petitions, newspaper articles, and public and law enforcement officer’s concerns.

1211-8 Crash Data and Analysis

1211-8.1 Crash Data Summaries, Graphs and Tables

Crash data helps identify crash patterns which are indicative of possible safety problems. A minimum of three years of the latest crash data shall be used for review of crash data and analysis. In general, crash data summaries should include crash type, severity and contributing factors. In addition to these attributes, select summaries such as environmental conditions, time periods, and driver related information may be provided if it indicates a pattern that a safety countermeasure may address. Providing all of the standardized charts from the Crash Analysis Module is often not necessary to support the project. Rather, what is included in the Safety Study Report (including appendices) should be limited to only what is useful or necessary for easy comparison and trend analysis. Examples are provided in ***Figures 1298-17 and 1298-18***.

1211-8.2 Collision Diagram(s)

A collision diagram is a schematic drawing that has been compiled from a series of individual crash reports relative to a specific location (intersection or section). A collision diagram shows the direction the vehicles traveled prior to contact, the type of crash which occurred, and non-motorists such as pedestrians or cyclists whose presence contributed to a collision. A minimum of three years of the latest crash data should be used to draft the collision diagram. See ***Figures 1298-14 and 1298-15*** for sample intersection collision diagrams and ***Figure 1298-16*** for a roadway section collision diagram. Collision diagram(s) shall be completed for both full and abbreviated safety studies.

The following information should be included in the collision diagram:

1. Title box with county, route, section, Priority List and Rank (if applicable), and crash data time period (e.g., 2010-2012). The title box should also have the initials of the person it was drawn by and the date it was completed.
2. Schematic of location: Each approach should be labeled and the north arrow shown.

3. Each crash should include the following information as a minimum: date, time and pavement conditions. This information is typically shown on the line for the driver at fault. Any other pertinent information about the accident, or driver at fault, should also be shown (e.g., injury, intoxicated, ran STOP sign or red light, etc.).
4. Legend key to denote all symbols used must be included in the collision diagram.
5. When possible, aerial imagery should be used as the base map of the collision diagrams.

It provides easy reference points and allows improvements to be easily connected to the crash patterns at the site.

1211-8.3 Crash Summary Narrative

The crash analysis procedures include the study and analysis of the crash characteristics of a site based on the historical crash data. The characteristics such as crash type, severity, contributing factors, environmental conditions and time period are analyzed. The detailed analysis of these characteristics is conducted to identify safety problems, contributing factors and will serve to inform the selection of the range of potential countermeasures.

Example 1

From 2010-2012, 24 crashes occurred within the study area. In 2010 there were 10 crashes; in 2011 there were 8 crashes; and in 2012 there were 6 crashes. Of the total crashes, 21% resulted in injury. The most prominent type of crashes was rear end crashes with 58% followed by sideswipe passing crashes with 25%. Approximately 20% of the crashes occurred in wet conditions. Please see Appendix A for the crash analysis and Appendix B for the crash diagram.

Fridays had the highest occurrence of crashes with 42%. The afternoon hours of 2pm and 5pm each had 21% of the crashes. Eastbound drivers were involved with 58% of the crashes. After reviewing the crash data for this study area, the following observations and trends were compiled:

- *EB sideswipe passing crashes: 4 in 2010, 1 in 2011; 3 from the left lane; 2 from the right lane*
- *EB rear end crashes: 2 in 2010; 1 in 2012; 2 in left lane; 1 in right lane*
- *WB rear end crashes: 2 in 2010; 5 in 2011; 2 in 2012; 6 in left lane; 3 in right lane*
- *There was only 1 left turn crash at the intersection involving a westbound driver turning in front of an eastbound driver who was passing another eastbound left-turning car on the outside*

Example 2

A total of 18 crashes over the three-year period from 2009-2011 were logged within the study area. Detailed crash data and related graphs are included in Appendix B, however, an overview is shown below:

Crash reports from January 1, 2009 through December 31, 2011 were obtained. During this three-year period, a total of 18 crashes were located within the study limits with a low crash rate of 1.39 crashes per million entering vehicles. Figure 5 ***[see TEM Figure 1298-17]*** *shows the collision diagram, which details the locations of these crashes. Almost half of the crashes (44%) are angle crashes, 28% are rear end crashes, and 17% are left turn crashes – all of which resulted from vehicles unsuccessfully crossing this unsignalized intersection; the remaining include sideswipe meeting (1) and head on (1).*

For the angle crashes, all were caused by drivers on Plumb Road failing to yield to SR 3 traffic or failing to stop. These crashes include the one fatal crash at the intersection, and all of the remaining angle crashes were injuries, indicating a pattern of severe, high speed crashes. The fatal crash occurred late on a Saturday night; it was dark and the pavement was wet. The eastbound vehicle (car) failed to yield to the southbound vehicle (motorcycle). Alcohol was a factor for both drivers; the driver of the motorcycle was the fatality.

The rear end crashes mostly occurred from vehicles on SR 3 that were unable to slow down for vehicles slowing in front of them to make a turn onto Plumb Road. Two of the three left turn crashes also occurred from vehicles on SR 3 that failed to successfully turn left in front of oncoming traffic. A combination of high traffic volumes and high speeds appear to be contributing to the angle, rear end and left turn crashes. In addition, 39% of the crashes occurred in wet or snowy conditions. After further analysis, no crash pattern emerged related to adverse weather conditions, but these conditions can contribute to already identified crash problems in the project area.

Most crashes occurred during the day on dry pavement under no adverse weather conditions, so weather, pavement condition and lighting do not appear to be a factor in the crashes. The crashes peaked during the morning, noon, and evening rush hours when more traffic is traveling these roadways thus making traversing the intersection more challenging. An additional peak did occur late at night in dark conditions, including the fatality, of which the driver was driving under the influence of alcohol.

Example 3

From 2009-2011, 296 crashes occurred within the study area. In 2009 there were 101 crashes; in 2010 there were 97 crashes; and in 2011 there were 98 crashes. Of the total crashes, 30% resulted in injury and there was 1 fatality. The most prominent type of crashes were rear end crashes with 58% followed by animal crashes with 9%, sideswipe passing crashes with 9%, and angle crashes with 7%. Approximately 31% of the crashes occurred in wet, snow or ice conditions. The highest contributing factor to the crashes was following too closely. Please see Appendix B for the crash analysis and Appendix C for the crash diagrams. Note that only 2011 crashes were plotted in the crash diagrams.

Wednesdays had the most crashes with 20%, followed by Thursday's with 17%, Saturday's with 15% and Friday's with 14%. Most of the crashes occurred in the am peak between 6am-9am (22%) and in the pm peak between 3pm-6pm (33%). The light condition was daylight for 75% of the crashes and dark-no lights for 16% of the crashes. The month with the highest number of crashes was October (13%) followed by May (11%) but they were all pretty equal.

Half (50%) of the crashes involved drivers who were westbound on US-35 and 43% of the crashes involved drivers who were eastbound on US-35. The estimated speed was 20mph and under for 33% of the crashes even though the posted speed limit is 55mph.

Figure 6 ***[see TEM Figure 1298-18]*** *shows the breakdown of where crashes occurred (log points) from 2009-2011 and the type of crash that occurred. It shows that most of the crashes happened at signalized* intersections.

1211-8.4 Site Diagnosis and Identification of Potential Countermeasures

The crash data and analysis section of the report should include a summary of the site diagnosis (Step 1) and results of the determination of the potential for site safety improvements (Step 2). Summary results of the potential for safety improvement which can be obtained from the report output of the ECAT tool, see ***Figure 1298-19***, should be summarized in the Safety Study Report narrative. Detailed output from the ECAT (print of ECAT Report Tab) should be included within the document appendices.

It is appropriate to include observations on potential contributing factors, notable crash patterns, and geometric deficiencies relating to the safety issues that have been identified: through review of existing crash patterns, roadway conditions, traffic control, traffic volumes, vehicle speeds, etc.; or through the evaluation of the potential for site safety improvements and comparison of the expected crash performance of the site relative to the predicted performance of peer sites.

Example 1

The possible causes or deficiencies in the intersection were identified through a detailed analysis of the crash patterns, roadway conditions, existing traffic control, traffic volumes and traffic speeds. The calculated expected crash frequency indicated a need for further investigation, and possible implementation of traffic control measures.

We have identified possible safety items at the intersection as follows:

- *Poor lane utilization and excessive queuing that occur EB in the driving lane causes secondary crashes at the adjacent private drives west of the intersection with cars pulling through the queue.*
- *The left hand turn lane on the northbound approach gets backed up due to a high number of vehicles waiting to turn left at the intersection. This prohibits people that want to turn right from accessing the right hand turn lane. Vehicles were observed using the right shoulder, to go around vehicles waiting on the left turn, to access the right turn lane. Vehicles that were backed up in the left turn lane that wanted to turn left onto Coral Rd., which is very close to the intersection, were observed going north in the southbound lane trying to beat southbound traffic and quickly turn onto Coral Rd.*
- *Coral Rd. intersects SR 43 just to the south of the intersection. Vehicles traveling east on Coral Rd. are prohibited from making a left turn (north) onto SR 43. Several vehicles ignored the prohibited left turn sign and turned left.*

Example 2

State Route 164 intersects SR 558 as a two way stop-controlled intersection with stop control for the SR 558 approaches. There are no exclusive turn lanes at the intersection. Field observations suggest a high level of truck traffic on both study roadways. In the northwest and southeast quadrants of the intersection, tread marks outside of the paved surface suggest that southbound and northbound right turning radii are insufficient.

Example 3

The results of the existing conditions crash analysis indicate a potential for site safety improvement of 8.2 crashes per year and the majority of the expected excess crashes (5.9 crashes/year) are expected to be rear-end. This indicates that the site is experiencing a higher overall frequency of crashes than would be expected for similar sites and suggests that the priority crash type to address and mitigate should be rear-end. Actual site data also indicates that there is a pattern of angle crashes occurring when northbound vehicles strike vehicles turning left from southbound to westbound. Based on this information and information obtained in a field review of the site several observations were made about the operation of the intersection:

- *Congestion in combination with insufficient signal timing may make it difficult for vehicles to clear the intersection within the allotted clearance interval.*
- *There are an insufficient number of gaps in the northbound traffic stream for southbound traffic to cross during the permissive left signal phase likely contributing to the observed angle crash pattern at this location.*

- *There is limited visibility of the signal heads on the northbound approach to the intersection forcing vehicles to make sudden stops once the signal becomes visible and likely leading to the pattern of rear end crashes on the northbound approach.*
- *A comparison of the expected number of night time crashes for the site to the predicted crash frequency for peer sites indicates that this site is experiencing more night time crashes than would generally be predicted for this type of intersection.*

This section should identify and describe the (potential) countermeasures identified for consideration based on the results of the ECAT analysis (potential for safety improvement) and site diagnosis and document the justification for evaluation of these countermeasures as potential solutions to the site safety issues.

The cost of a countermeasure is the cost of improvement through force account or contract work, and should be calculated for every potential countermeasure. The estimated improvement costs include those expected costs required for implementation and maintenance of the countermeasure of the estimated safety countermeasure based on an estimate.

1211-8.5 Design Evaluation (If Applicable)

In addition to traffic-related issues that influence the recommendations of the safety study, there may be non-traffic design issues that have an impact on project scope, schedule and cost. When developing the recommended solutions for a safety study, these design issues should be evaluated at a conceptual level to determine their impacts on the project.

The design evaluation section of the safety study should summarize any design issues which should be considered in future plan development activities or that are likely to have a significant impact on project cost.

Example 1

Using 12' lanes and 8' graded shoulders may have an impact on a possible wetland on the south side of S.R. 56 approximately 0.5 miles west of Shaker Road. The area should be evaluated to determine if a wetland is present. If this area is determined to be a wetland, the designer should investigate minimizing impacts by widening to the north.

Example 2

Due to the number of residential homes located in close proximity to the roadway on both sides of S.R. 13, it is desired to use a closed drainage system to minimize right-of-way impacts caused by widening the roadway. If significant impacts are encountered using a closed drainage system and full graded shoulder criteria, the designer should evaluate the use of a reduced graded shoulder width and obtaining a design exception.

Example 3

The existing bridge cannot be utilized for part width construction due to the configuration of the existing substructure. In order to facilitate maintenance of traffic, the proposed alignment should be established such that it does not fall within the limits of the existing bridge. In this way, the existing bridge can be used to maintain traffic during construction of the proposed bridge.

1211-8.6 Proposed Countermeasure Evaluation

This section of the report should include a summary of the results of the proposed countermeasure evaluation. Crash analysis results including the predicted and expected crash performance of the exiting site conditions and relative potential for safety improvement, as well as the calculation of the expected crash frequencies of the proposed countermeasures, can be obtained from the report output of the ECAT tool, upon completion of the countermeasure evaluation step ***(Figure 1298-20)***. It may be necessary to perform more than one set of analyses using separate ECAT spreadsheets if multiple independent countermeasures, or combinations of countermeasures, are being evaluated. A summary of the results of the proposed countermeasure evaluation(s) should be presented in this section of the Safety Study Report narrative. Detailed output (print of ECAT Report Tab) from the ECAT can be included within the document appendices. A copy of each ECAT spreadsheet used to perform the analysis (existing and proposed conditions) should be provided to **ODOT** with the draft safety study document for review.

1211-8.7 Conclusions

The conclusions section should summarize all countermeasures evaluated and provide comparison of the site safety performance with the proposed countermeasure or countermeasures to the predicted performance of peer sites and the expected performance of the actual site. A summary of the crash analysis results for the predicted and expected crash performance of the existing site conditions and the expected crash frequencies of the proposed countermeasures can be obtained from the report output of the ECAT Tool ***(Figure 1298-20)***. The conclusions should include a discussion of the potential for safety improvement and how each countermeasure or package of countermeasures performs in terms of reducing crash frequency at the site. This section should also identify and explain any countermeasures that were dismissed from consideration.

1211-9 Summary of Supplemental Traffic Studies

This section should include a summary of the results of any other transportation analysis or supplemental traffic studies conducted per Step 3 of the safety study process. A copy of the full documentation of each supplemental study should be included in the appendices.

1211-10 Recommendations and Prioritization

1211-10.1 Countermeasure Recommendations and Implementation Plan

A recommended countermeasure is a highway safety treatment designed to address a safety concern and/or potential for safety improvement at a given site. The final countermeasure recommendations included in the safety study should be based upon the safety enhancements identified as appropriate for the location and as documented through the crash analysis and proposed countermeasure evaluation process.

There are many factors to consider when developing countermeasures and recommendations. For example, they may include engineering, enforcement, driver education or a combination of factors. The recommendations should be based on knowledge of the effectiveness of the improvement being recommended in similar situations and should consider the needs of all users. Improvements should be based upon the traffic and site conditions. A combination of improvements may be the best practical countermeasure for a location. All practical improvements, including “do nothing,” should be identified, considered and analyzed for safety so that no feasible alternative is overlooked.

A benefit-cost analysis using the ECAT should be performed to further evaluate and prioritize the proposed countermeasure(s). The benefit-cost ratio is a comparison of the estimated net present value of safety benefits to the estimated project cost for the proposed safety countermeasure, or a combination of safety countermeasures. The net present value of the countermeasure is the expected dollar value of safety benefits in terms of crashes prevented. The cost-benefit ratio analysis establishes the benefits expected to be obtained by an improvement and should be included for every recommended alternative. A benefit-cost ratio greater than 1.0 is the desired condition and means that the present value of the safety benefits exceeds the present value of the construction cost. Where the benefit-cost ratio is less than 1.0, the present value of the safety benefits are less than the present value of construction costs. This is not preferred and when encountered, indicates that other alternative countermeasures should be considered and evaluated.

The safety study should include recommendations of a countermeasure or countermeasures based on the results of the crash analysis and economic (benefit-cost) analysis. The countermeasure evaluation calculations and benefit-cost analysis is required for any safety funding application submitted for the recommended countermeasures. Countermeasure(s) recommended by a safety study may result in a project that follows the **Project Development Process (PDP)**. Depending on the scope of work, these projects may result in work that only requires a Path 1 level of work compared to the more complex Path 2-5 level projects. The recommendations should indicate priority of implementation, a discussion on the implementation approach and also briefly summarize the scope of work expected within the Project Development Process Path for each proposed countermeasure. See Attachment B for an example of summary output and countermeasure recommendations/implementation plan.

1211-10.2 Proposed Condition Diagrams

Proposed condition diagrams should be prepared to detail the proposed countermeasure or countermeasure treatments recommended for funding and implementation ***(Figure 1298-21 and Figure 1298-22)***.

1211-11 Appendices (If Completed or Authorized)

The appendix will include related material such as that shown below to further document and enhance the quality of the safety study. The references shown for the different topics are just a guide and are not meant to be the only source. These topics are covered by many traffic engineering manuals, including **ITE** handbooks, and those should be used as a source for reference.

1. Traffic Volume Count: Required.

   This is discussed elsewhere in ***TEM Part 12*** and in Chapter 2 of the **ITE Manual of Transportation Engineering Studies**.

2. Crash Summaries: Required.

3. ECAT tool analysis results in report format: Required.

4. Aerial and Other Photos of the Location: If applicable.

5. Field Review Notes: If applicable.

   See the Field Review Forms developed as part of the **ODOT** research report Rural Highway Safety Advisor (RITA).

6. Traffic Speed Studies: If applicable.

   This is discussed in ***TEM Section 1203-3*** and in Chapter 3 of the **ITE Manual of Transportation Engineering Studies**.

7. Traffic Signal Warrants: If applicable.

   See ***TEM Section 402-3*** and **OMUTCD Part 4** for further information about traffic signal warrants.

8. Other Traffic Studies and Analyses: If applicable.

   See ***TEM Chapters 1202, 1203, 1204 and 1213*** and the **ITE Manual of Transportation Engineering Studies** for information about other traffic studies and analyses that may be applicable. Also see **OMUTCD Section 1A.11** and ***TEM Part 1*** for information on additional studies that may be performed to supplement data and support the analysis performed in the safety study.

Intentionally blank.

1213 OTHER TRAFFIC ENGINEERING STUDIES

1213-1 General

This Chapter includes information about various other traffic engineering studies.

1213-2 Determining Curve Advisory Speeds

1213-2.1 General

OMUTCD Section 2C.08 addresses Advisory Speed (W13-1P) plaques, when to use them (see **OMUTCD Table 2C-5**) and methods for determining the speed to be displayed. The most common method used to determine the speed shown on an Advisory Speed plaque is a Ball Bank Indicator (BBI)

1213-2.2 Ball Bank Indicator

The ball bank indicator (BBI) should be mounted in a passenger car and carefully calibrated per the manufacturer's specifications. Several test runs are made in determining the speed to use. For each test run, the driver should:

1. Appraise the curve under observation to determine the approximate safe speed that may be maintained throughout the curve.
2. Conduct the first test at a speed 10 miles per hour below the appraised speed.
3. Make each succeeding test at a speed 5 miles per hour greater than the last one.
4. Attain the trial run speed on each test at a distance of at least one-quarter mile from the beginning of the curve.
5. Maintain a course throughout the curve precisely in the center of the lane and at uniform speed.

Form 1296-11 is a sample form for use in recording the results of this curve study and determining the recommended advisory speed. A full-size copy of the Curve Study Sheet is available from the **Office of Traffic Operations'** website.

1213-2.3 Calculation Method to Determine Curve Advisory Speed

The advisory speed indications for horizontal curves may also be calculated by inserting the curve data into the following equation relating superelevation, pavement friction, radius of curvature and vehicle speed:

$$Vmph = \sqrt{(e+f)15R}$$

Where V = speed of vehicle in miles per hour
e = superelevation in feet per foot of horizontal width
f = transverse coefficient of friction
R = radius of curvature in feet.

The recommended values of transverse coefficient of friction are as follows:

Operating Speed	Transverse Coefficient of Friction
30 mph	0.16
40 mph	0.15
50 mph	0.14
60 mph	0.13

1213-3 Delay Studies

This Section is reserved to address information available regarding delay studies. In the interim, contact **ORE** for such information if needed.

1213-4 Systematic Signal Timing & Phasing Program (SSTPP)

1213-4.1 General

The Systematic Signal Timing & Phasing Program (SSTPP) is funded by the **ODOT** Safety Program. Its purpose is to systematically update the timing and phasing of signal systems at approved candidate intersections and/or corridors. Requests can be submitted to the **Safety Program Manager** through the local **District** office. Applicants can contact the local **District Safety Coordinator**.

1213-4.2 Benefits

Safety Benefits - The following safety benefits can be realized by updated signal timing. The **Texas Transportation Institute (TTI)** cites the following crash reduction factors associated with improved signal timing and phasing:

- Properly timed addition of all red clearance interval = 25 % crash reduction factor
- Properly timed yellow clearance interval = 4-31 % crash reduction factor (all crashes)
- Adding protected/permitted left turn phase at existing signal = 40-60 % crash reduction factor (left-turn crashes)

Congestion Benefits - In addition to the safety benefits of good signal timing, a more obvious benefit is an improvement of mobility throughout the signalized corridor.

Ohio's Major New Program will go a long way to addressing congestion on **Ohio's** freeways. The Systematic Signal Timing & Phasing Program (SSTPP) is a complimentary program addressing congestion on surface street facilities. Numerous signal timing case studies have shown a reduction in stops of 10 to 20 percent, with a similar reduction in delays. As a result of reduced congestion, comparable decreases in fuel consumption and emissions are also realized. Case studies have shown that properly timed traffic signals reduce fuel consumption 10 to 15 percent when compared to poorly timed traffic signals. Most obvious to drivers is a significant decrease in travel times.

The tables shown in ***Figure 1298-2*** show examples of the benefits of improved signal timing and phasing that were realized through projects initiated in the **ODOT** Safety Program:

1213-4.3 Eligibility

The following intersections/corridors would be eligible for the SSTPP funding:

1. Intersections or corridors identified by **ODOT** as being high crash and relevant planned countermeasures will not be constructed within one year.

2. Intersections or corridors identified as being congested by **ODOT's** Congestion Model **(Office of Statewide Planning and Research)** and relevant planned countermeasures will not be constructed within one year.

3. Intersections or corridors identified by an **MPO** as being high crash or congested. See *Subsection 1213-4.4* for documentation requirements.

4. Intersections or corridors identified by a local government as being high crash or congested. See *Subsection 1213-4.4* for documentation requirements.

5. Corridors that span more than one local agency that could benefit from a unified signal system operation and were not previously operating as one system.

6. Others as recommended by the **ODOT District Safety Review Team (DSRT)**.

All potential corridors will be reviewed and approved by the **DSRT** then sent to the **Safety Program Manager** for final approval. **ODOT** maintains a pool of consultants that can conduct signal timing analysis and implement recommended improvements.

Every signalized intersection in a corridor that meets the above criteria would be eligible for funding, even if a specific signalized intersection does not meet the criteria.

The physical termini of traffic signal systems should not necessarily be defined by municipal boundaries. They should be logically determined based upon the operational characteristics of a corridor. Corporation limits should not be an artificial barrier to providing effective operations. Where it would be beneficial for a signal system, an attempt should be made to have multiple agencies enter into a joint operational agreement.

In the absence of an actual inter-agency agreement being adopted, every attempt should be made to coordinate signal operations across incorporated boundaries via time-based coordination. It is not necessary to have the cooperation of adjacent agencies to receive funding; however, it is required to attempt to cooperate with traffic operations when the signal system would benefit from having termini in multiple jurisdictions. If an agreement cannot be reached between agencies, an explanation shall be provided with the application for funding to the Safety Program.

1213-4.4 MPO & Local Documentation Requirements

MPO and Local project requests based upon safety and congestion (Eligibility Criteria 3, 4 and 5 in ***Subsection 1213-4.3***) will need to provide documentation of need to the **DSRT**. The requesting agency will need to contact the **DSRT** about the extent of documentation for each funding request.

For safety related requests, the documentation may be as simple as noting how many crashes and crash types occur in the corridor, emphasizing those crash types related to signal timing. The requesting agency may provide the information from its own records or ask the **District** if an **ODOT** CAM tool analysis would be available to provide the information (CAM tool is an internal **ODOT** crash analysis program).

Congestion problems are more difficult to quantify because the effort will typically require much the same information that is required to re-time the signals (volumes, computer analysis, existing geometric information, etc.). Documentation for congestion can be as simple as pictures or video of the corridor operation or a field visit by the **DSRT**. Some corridors will be infamous for their congestion issues and will require very limited documentation. Alternatively, a congestion model run by the **MPO** could serve as the basis of documenting the project need.

The **DSRT** can provide specific guidance on need documentation for each funding request.

1213-4.5 Project Scope

See the **Office of Traffic Operations** website for the Traffic Signal Timing Scope.

1213-5 Road Safety Audits (RSAs)

1213-5.1 General

A Road Safety Audit (RSA) can be an effective tool to reduce injuries and fatalities on **Ohio's** roadways. An RSA is a formal performance examination of an existing or future road or intersection by an independent and multi-disciplinary team that includes representatives of EMS, Engineering, Education and Enforcement (the 4 E's) as appropriate. For planned roads, the RSA should be conducted at the earliest stage possible (planning or preliminary design), when all roadway design options and alternatives are being explored. RSAs can be used on any size project from minor intersection and roadway retrofits to mega-projects.

1213-5.2 Purpose

The aim of an RSA is to answer the following questions:

- What elements of the road may present a safety concern: to what extent, to which road users, and under what circumstances?
- What opportunities exist to eliminate or mitigate identified safety concerns?

The RSA is not meant to be a replacement for traditional safety studies; rather, it is another tool that can be utilized for improving safety. An RSA may be used in addition to or in lieu of a traditional safety study. When used in lieu of a traditional study, prior approval must be provided by the **District Safety Review Team (DSRT)** as well as the **ODOT Safety Program Manager** if the location is listed on the annual safety work plan. Results (countermeasures) identified in an RSA would be eligible for Safety funding through the normal funding application process.

ODOT, like most **State DOTs**, has established traditional safety review processes. However, a road safety audit and a traditional safety review are different processes. It is important to understand the difference between the road safety reviews that are commonly performed and newer road safety audits. The main differences between the two are shown below:

Differences between an RSA and a Traditional Safety Review	
Road Safety Audit	**Traditional Safety Review**
Performed by a team independent of the project.	The safety review team is usually not completely independent of the design team.
Performed by a multi-disciplinary team that includes people inside and outside of **ODOT**.	Typically performed by **ODOT** safety staff and reviewed by an internal multi-disciplinary team.
Always generates a formal RSA report.	Always results in a formal report, but typically requires more data collection, such as detailed existing conditions, traffic volume and capacity analysis.
A formal response report is an essential element of an RSA.	Often does not generate a formal response report.

Additional information regarding RSAs can be found on-line at http://safety.fhwa.dot.gov/rsa/.

1296 FORMS INDEX

1296-1 <u>Speed Zone Request for Narrow and Low-Volume Rural Roads</u>

Form 1296-1 is used to document geometric and roadway characteristics when submitting a Speed Zone request for a road with an ADT of 400 or less or a width of 16 feet or less. This form is described in detail in ***Section 1203-2.6***.

1296-2 <u>Speed Zone Warrant Sheet</u>

Form 1296-2 is used for a full-scale Speed Zone Warrant analysis. The procedure for using this form is described in ***Section 1203-3.4*****.**

1296-3 <u>Sample Speed Study Data Sheet</u>

Form 1296-3 may be used to record data used in the Speed Zone Warrant Analysis ***(see Section 1203-3.2)***. See ***Table 1297-2*** for determination of Intersection Class and Building Type.

1296-4 <u>Completed Sample Speed Study Data Sheet</u>

Form 1296-4 is a sample of a completed version of ***Form 1296-3***.

1296-5 <u>Speed Check Form</u>

Form 1296-5 is used to record speed information to determine the 85th-percentile and pace speeds ***(see Section 1203-3.3)***.

1296-6a <u>Speed Limit Revision</u>

Form 1296-6a is used to establish a revised speed limit ***(see Section 1203-2)***. Note that the established limit becomes effective when appropriate signs giving notice thereof are erected.

1296-6b <u>Work Zone Speed Limit Revision for High-Speed (≥ 55 mph) Multi-Lane Highways</u>

Form 1296-6b is used to establish a Work Zone Speed Zone ***(see Section 1203-2.9)*** in accordance with ***Table 1297-7***. Note that the established work zone speed limit(s) do not become effective until all of the existing speed limit signs within 1 mile in advance of and inside the WZSZ are removed or covered and the WZSZ speed limit signs are in place with the appropriate legends displayed. Legends reflecting a speed limit in accordance with ***Table 1297-7*** shall only be displayed when the work zone condition in place reduces the existing functionality of the travel lanes or shoulders. At all other times (when the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders) the original posted speed limit shall be displayed.

1296-7a <u>Withdrawal of Issued Speed Limit Revision</u>

Form 1296-7a is used to withdraw a revised speed limit ***(see Section 1203-4)***.

1296-7b <u>Withdrawal of Issued Work Zone Speed Limit Revision for High-Speed (≥ 55 mph) Multi-Lane Highways</u>

Form 1296-7b is used to withdraw a Work Zone Speed Zone ***(see Section 1203-4)*** in accordance with ***Table 1297-7***.

1296-8 <u>Field Report on Parking Practices</u>

Form 1296-8 is used to request a No-Parking Zone. The procedure for using this form is described in ***Section 1204*****.**

1296-9 Establishment of No-Parking Restrictions

Form 1296-9 is used to establish a No-Parking Restriction ***(see Section 1204-2)***. Note that the restriction becomes effective when appropriate signs giving notice thereof are erected.

1296-10 Withdrawal of Issued No-Parking Restrictions

Form 1296-10 is used to withdraw an established No-Parking Restriction ***(see Section 1204-4)***.

1296-11 Curve Study Sheet

Form 1296-11 is used in the Ball Banking Study described in ***Section 1213-2.*** to determine the recommended maximum speed to use on the Advisory Speed plate.

1296-12 Reserved – Deleted the Existing Form

1296-13 Reserved – Deleted the Existing Form

1296-14 Freeway and Rural Expressway Speed Zone Evaluation Sheet

Form 1296-14 is used to document a request for a change in the speed limit on a freeway or rural expressway ***(see Section 1203-2.8)***.

1296-15 Speed Zone Request for Unimproved Highways and Residential and Commercial Subdivision Streets

Form 1296-15 is used to document a request for a reduction of the speed limit on unimproved **County** highways and residential and commercial subdivision streets ***(see Section 1203-2.7)***. The form may also be used by **Townships** to document Speed Zones they establish based on **ORC Division 4511.21(K)**.

1296-16 Reserved – Deleted the Existing Form

The **Work Zone Speed Zone (WZSZ) – Justification Report** has been deleted. The new WZSZ process eliminated the need for this form. This form number is reserved for future use.

1296-17 WZSZ Evaluation Sheet for High-Speed (≥ 55 mph) Multi-Lane Highways

The **WZSZ Evaluation Sheet for High-Speed (≥55 mph) Multi-Lane Highways** is an optional form that may be used to determine the warranted work zone speed limit values during qualifying work zone conditions on multi-lane highways with pre-construction speed limits of 55 mph or higher (as defined by ***Section 1203.2.9.1***). Information in this form is based upon ***Table 1297-7***. The procedure for using this form is described in ***Section 1203-2.9***.

1296-18 Work Zone Speed Zone (WZSZ) Tracking Report

Form 1296-18 is used to document and log the date, time, location and other detailed information regarding implementation of all WZSZs.

1296-19 Sample OSHP Concurrence Sheet

Form 1296-19 is a sample of a form used to submit Speed Zone and Parking Control Zone requests to the **Ohio State Highway Patrol (OSHP)** for concurrence ***(see Sections 1203-2 and 1204-2).***

Form 1296-1. Speed Zone Request for Narrow and Low-Volume Rural Roads (Sheet 1 of 4)

Ohio Department of Transportation
WARRANT FOR SPEED ZONE

Improved County and Township Roads with ADT of 400 or less; or Roadway Width of 16' or less **Rev. 1/16/15 (revision is on sheet 4)**

Complete all areas in Green.

ROAD NAME:		ROAD No.		DATE:		
COUNTY:		TOWNSHIP:				
BEGIN STUDY AT:		END STUDY AT:				
LENGTH:	Miles	Average Daily Traffic (ADT):		Existing Speed Limit		

For further guidence in completing this form, see the Traffic Engineering Manual, Chapter 1203.

Number of Homes or Farms		Must have direct access to the roadway being studied.
Number of Businesses		Must have direct access to the roadway being studied.
Number of Intersections		Do not include intersections at the beginning or end of the section
Road Width (round down to nearest foot)		Average or dominant road width, measured from / to edge of traveled way.
Shoulder Width (round down to nearest foot)		Average improved shoulder width, including compacted gravel.
Average number of crashes per year (one yr. min)		Only include crashes within the section, excluding animal and side street crashes. Example
Roadway Characteristics (click here for examples)		Hold cursor over alphabetic value below to view description then enter letter.

Roadway Characteristics Examples	C	B3	B2	B1	A3	A2	A1

Calculated Speed	**#DIV/0!**	**MPH**
Requested Speed Limit		**MPH**

Approved Speed Limit **MPH**

Test Runs*

* Completed by ODOT for comparision or verification of calculated speed limit.

Study by: **Include the related Resolution(s) when submitting this form.**

Additional considerations and comments:

Form 1296-1. Speed Zone Request for Narrow and Low-Volume Rural Roads (Sheet 2 of 4)

Ohio Department of Transportation

WARRANTS FOR SPEED ZONES

For Improved County and Township Roads with ADT of 400 or less; or Roadway Width of 16' or less Rev. 6\20\08 (with 6/10/09 minor correction)

ROAD NAME	0	ROAD No.	0	DATE:	
COUNTY:	0	TOWNSHIP:	0		
BEGIN STUDY AT:	0	END STUDY AT:	0		
LENGTH:	0.00	ADT:	0		

(End Log minus Begin Log)

I. ROADSIDE DEVELOPMENT

(A) BUILDING DEVELOPMENT

(B) INTERSECTION INVOLVEMENT (Only include crashes within the section under study, excluding animal and side street crashes)

No. of HOUSES OR FARM	0	X 1 =	0	No. OF INTERSECTIONS	0	X 3 =	0
No. of BUSINESSES	0	X 2 =	0				
	TOTAL TYPE (A)		0		TOTAL CLASS (B)		0

HIGHWAY DEVELOPMENT = (A) 0 + (B) 0 / 0 (Length) = #DIV/0!

II. ROADWAY FEATURES

FACTORS		8	9	10	11	12	
1) ROAD WIDTH, FEET	0	< 12	12 - 14	15 - 17	18 - 20	> 20	8
(Average or dominant road width)							
2) SHOULDER WIDTH, FEET	0	< 2		2-4		> 4	8
(Average width of improved shoulder, including compacted gravel)							
CRASH RATE, ACC/MVM (from calculation below)		>11.0	8.2 - 11.0	5.3 - 8.1	2.8 - 5.3	<2.8	#DIV/0!
					TOTAL ROADWAY FEATURES =		#DIV/0!

CRASH RATE CALCULATION: 2740 X 0 ACC. / 0 ADT X 1 YR. X 0.00 MILES = ACC./ MIL. VEH. MILES = #DIV/0!

Speed Limit Factors Summary

Factors		45	55	64	73	82	91	100	
I. ROADSIDE DEVELOPMENT		>60	51-60	41-50	31-40	21-30	10-20	<10	#DIV/0!
II. ROADWAY FEATURES		24	25-26	27-28	29-30	31-32	33-34	35-36	#DIV/0!
III. ROADWAY CHARACTERISTICS	0	C	B3	B2	B1	A3	A2	A1	No Data

(Hold cursor over cell for description)

TOTAL FACTORS = #DIV/0!

CALCULATED SPEED = = TOTAL FACTORS X 55 / 3 X 100 = #DIV/0! X .183 = #DIV/0! MPH

TEST RUN, AVERAGE = MPH

Existing Speed Limit = MPH **Approved Speed Limit =** **MPH**

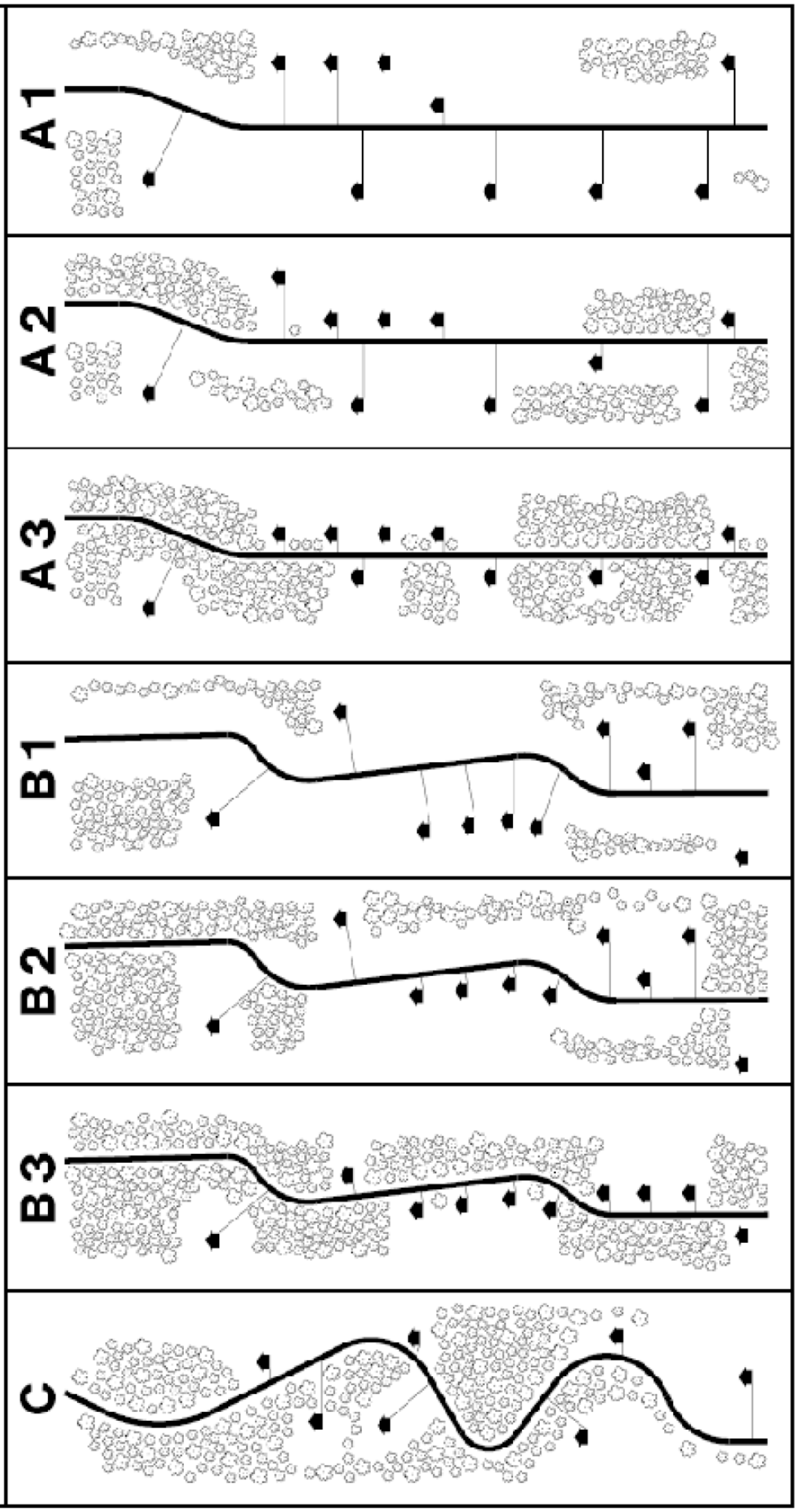
Study by: Requested Speed Limit

Additional considerations and comments:

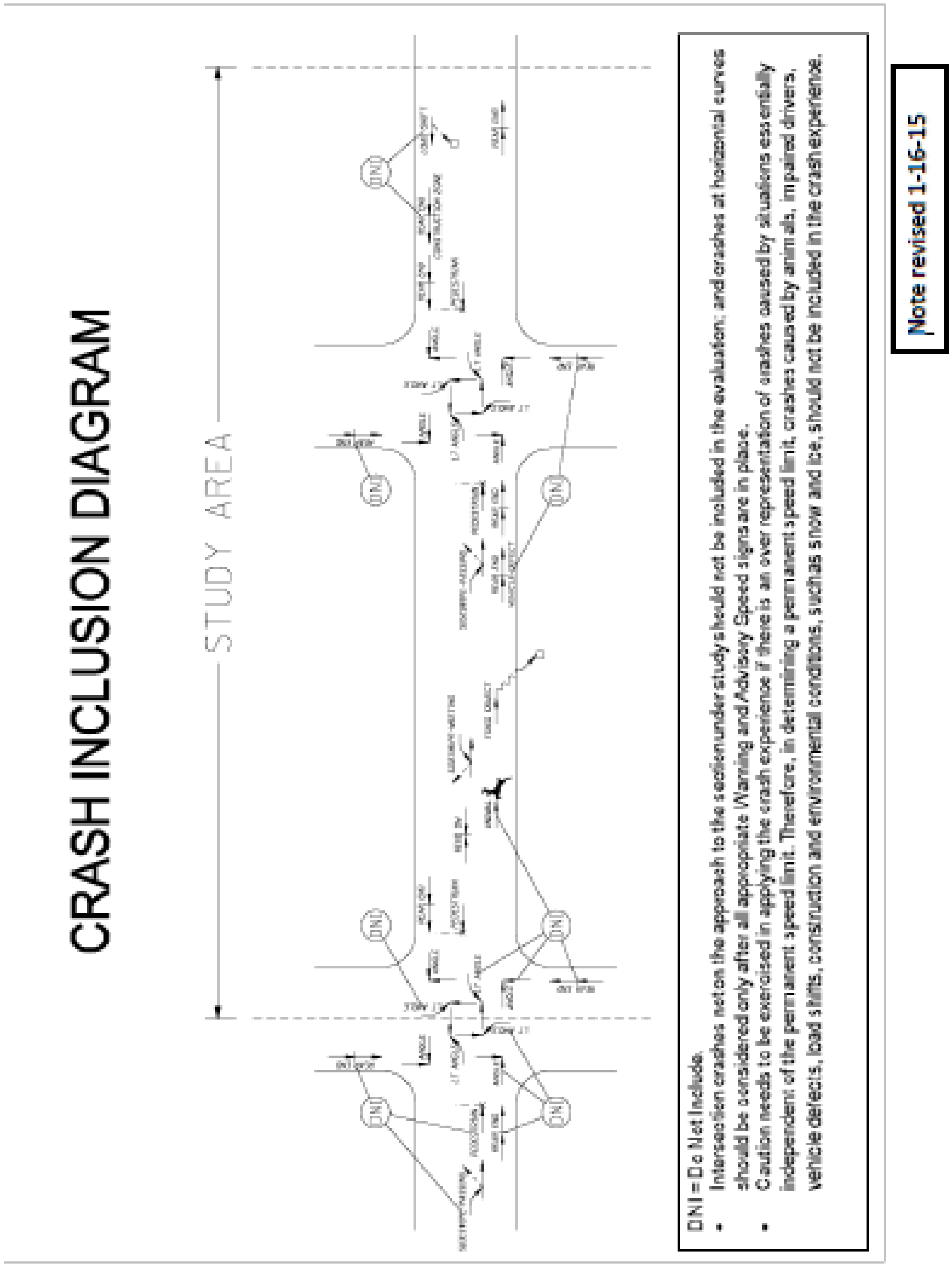
Form 1296-1. Speed Zone Request for Narrow and Low-Volume Rural Roads (Sheet 3 of 4)

ROADWAY CHARACTERISTICS

- The vertical/horizontal alignment of the road governs the se ection of A, B or C, while the degree to which ateral sight distances are restricted by features close to the road governs the selection of 1, 2 or 3 (the level of development is not a factor in selecting a category). Travel speeds on a road designated as "C" are so dictated by the alignment of the road that the lateral sight distance need not be defined as 1, 2 or 3.
- Refer to ***Table 1297-6*** for the Roadway Characteristic definitions.
- For more examples ***see Figures 1298-3, 1298-4, 1298-5***.



Form 1296-1. Speed Zone Request for Narrow and Low-Volume Rural Roads (Sheet 4 of 4)



Form 1296-2. Speed Zone Warrant Sheet
(Sheet 1 of 4)

Ohio Department of Transportation

SPEED ZONE EVALUATION SHEET

FOR NON-FREEWAY and NON-EXPRESSWAY HIGHWAYS

TEM FORM 1296-2

COMPLETE ALL GREEN SHADED AREAS

ROUTE NAME:		ROUTE NUMBER:	
COUNTY:		TOWNSHIP:	
MUNICIPALITY:		JURISDICTION:	
BEGIN STUDY AT:		BEGIN LOGPOINT:	
END STUDY AT:		END LOGPOINT:	
DIVIDED HIGHWAY:		LENGTH (MILE):	
AVERAGE DAILY TRAFFIC (ADT):		EXISTING SPEED LIMIT (MPH):	

For further guidance in completing this form, see the Traffic Engineering Manual, section 1203.

No. of Houses or Farms			Must have direct access to the roadway being studied.
No. of Small Businesses, Apts./Condos			Must have direct access to the roadway being studied.
No. of Medium Businesses, Apts./Condos			Must have direct access to the roadway being studied.
No. of Major Businesses, Apts./Condos			Must have direct access to the roadway being studied.
No. of Minor Street Intersections			Subdivision, Residential, or Other streets serving the residents of that street.
No. of Major Street Intersections			Streets which serve both the residents and commuters of the area.
No. of Signalized Intersections			Do not include intersections at the beginning or end of the section.
No. of Interchange Ramps			Do not include Loop ramps at the beginning or end of the section.
Lane Width (Round down to nearest foot)			General width of through traffic lanes throughout the section.
Shoulder Width (Round down to nearest foot)			General width of paved and\or non-paved shoulder throughout the section.
Crashes (Latest three years of data)			Only include crashes within the section, excluding animal and side street crashes.
85^{th}% Speed of Traffic			Average 85th% Speed of all speed samples that were taken.
10-mph Pace Speed of Traffic		to	Average Pace Speed of all speed samples that were taken.
Roadway Characteristics			CATORGORIES: C B3 B2 B1 A3 A2 A1 DIV

To View Calculation Sheet or Examples of Roadway Characteristics and Crashes to Include, use Buttons Below.

CALCULATION SHEET | ROADWAY CHARACTERISTICS | CRASHES TO INCLUDE

CALCULATED SPEED: ______ MPH REQUESTED SPEED: ______ MPH

Additional considerations and comments:

STUDY BY: ______ DATE: ______

INCLUDE THE RELATED RESOLUTION(S) WHEN SUBMITTING THIS FORM

BELOW FOR ODOT USE ONLY

CHECKED BY: ______ TEST RUN: ______ MPH APPROVED SPEED: ______ MPH

Rev. 4/21/16 ARC

Form 1296-2. Speed Zone Warrant Sheet
(Sheet 2 of 4)

Click Here to Return to 'Full Study Warrant Form' (Data Input Page)

OHIO DEPARTMENT OF TRANSPORTATION

SPEED ZONE CALCULATION SHEET

LOCATION

Road Name:		Road Number:		County:	
Begin Study At:		Begin Log Point:		Jurisdiction:	
End Study At:		End Log Point:		Divided Highway:	
Average Daily Traffic:		Length:		Existing Speed Limit:	

HIGHWAY DEVELOPMENT

(A) BUILDING DEVELOPMENT				INTERSECTION INVOLVEMENT (B)			
Houses or Farms		X 1 =		Minor Street Intersections		X 2 =	
Small Business		X 2 =		Major Street Intersections		X 3 =	
Medium Business		X 3 =		Signalized Intersections		X 4 =	
Major Business		X 4 =		Interchange Ramps		X 1 =	
		TOTAL TYPE (A)				TOTAL CLASS (B)	

TOTAL HIGHWAY DEVELOPMENT: (A) ___ + (B) ___ / Length ___ miles = ___

ROADWAY FEATURES

CRITERIA		FACTORS							
		7	8	9	10	11	12	13	TOTAL
Lane Width (feet)			<8'	8' to <9'	9' to <10'	10' to <11'	11' to <12'	>=12'	
Shoulder Width (feet)				<2'	2' to <4'	4' to <6'	6' to <8'	>=8'	
Crash Rate (Crashes/MVM)		>6.2	>5.1 - 6.2	>4.0 - 5.1	>3.4 - 4.0	>2.8 - 3.4	>2.2 - 2.8	<= 2.2	

TOTAL ROADWAY FEATURES: ___

CRASH RATE (Crashes/MVM): ___ Crashes X 1,000,000 / ___ ADT X 365 X 3 YR. X ___ miles = ___

SPEED CALCULATION

CRITERIA			FACTORS									
			25	30	35	40	45	50	55	60	65	TOTAL
Highway Development			>70	>60 - 70	>50 - 60	>40 - 50	>30 - 40	>20 - 30	>10 - 20	>5 - 10	≤5	
Roadway Features			24	25	26 - 28	29 - 31	32 - 33	34 - 35	36 - 37	38	39	
85th Percentile (mph)			≤27	28 - 32	33 - 37	38 - 42	43 - 47	48 - 52	53 - 57	58 - 62	≥63	
Pace Speed			13 -27	18 - 32	23 -37	28 - 42	33 - 47	38 - 52	43 - 57	48 - 62	53 - >67	
Characteristics			C	B3	B2	B1	A3	A2	A1	DIV		

TOTAL SPEED FACTORS: ___

CALCULATED SPEED: Total Speed Factors / No. of Speed Criteria = ___ / 5 = ___ MPH

REQUESTED SPEED LIMIT: ___ MPH

ADDITIONAL INFORMATION AND COMMENTS:

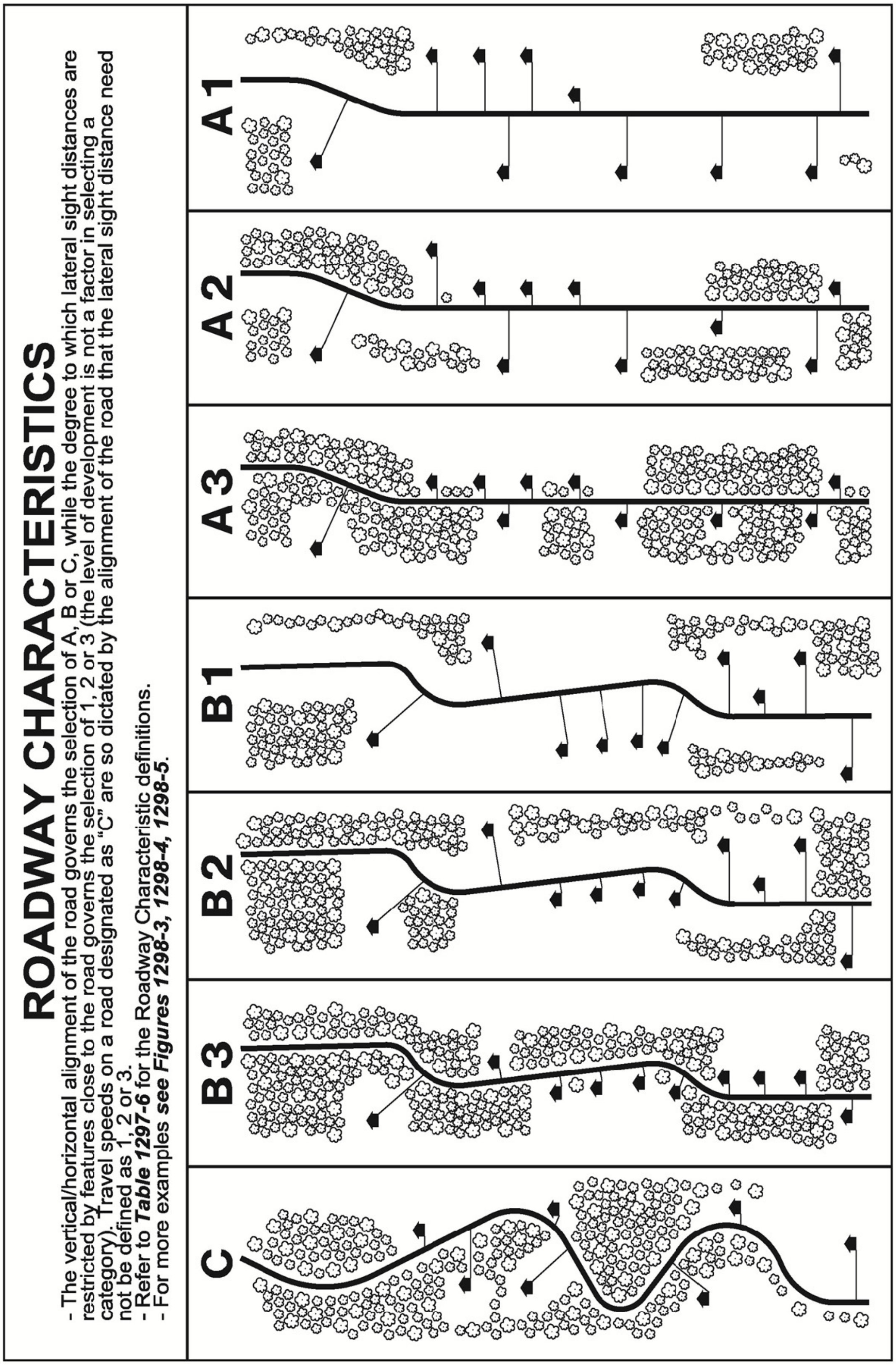
STUDY BY: ___ DATE: ___

BELOW FOR ODOT USE ONLY

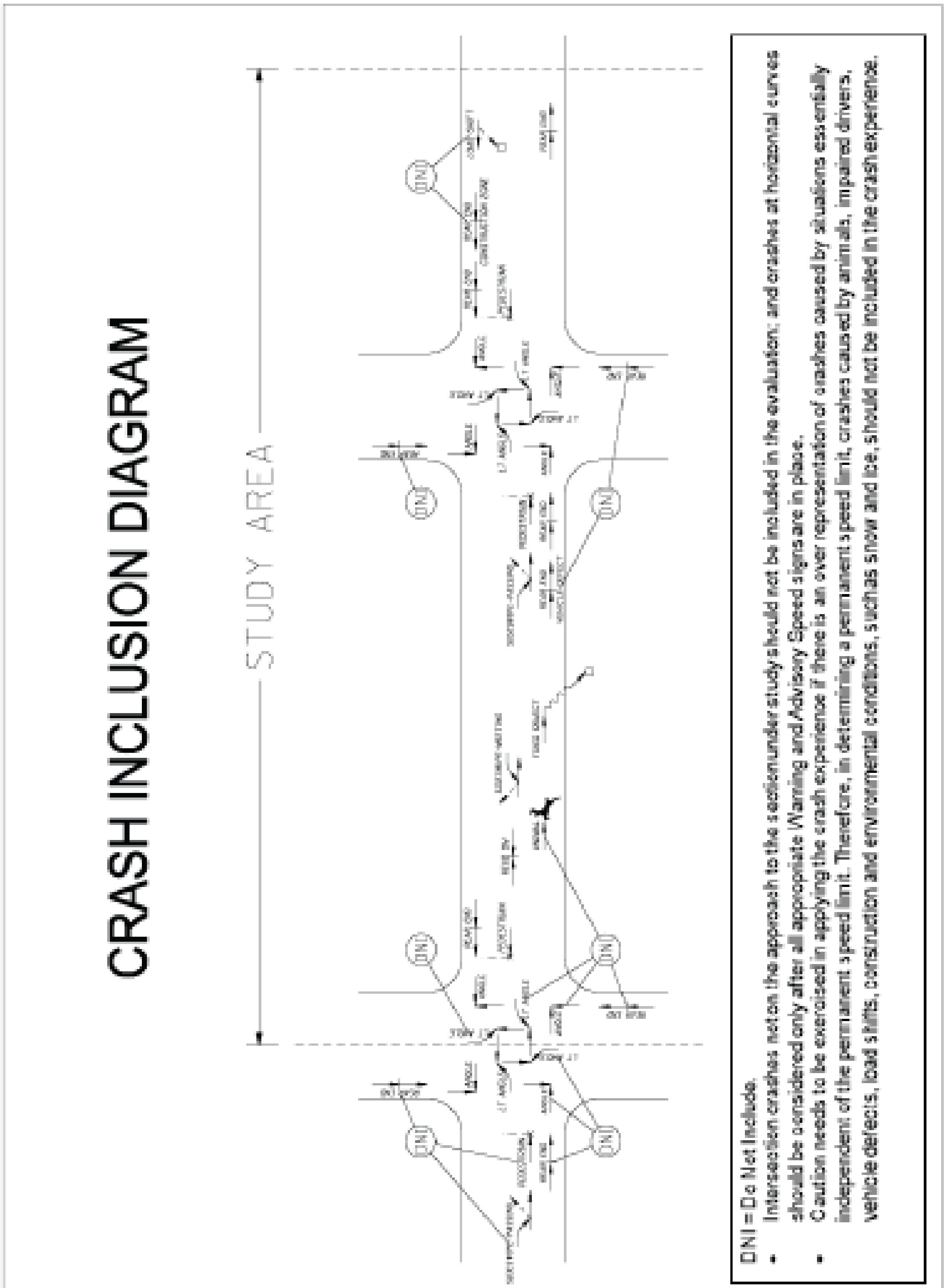
CHECKED BY: ___ TEST RUN SPEED: ___ MPH APPROVED SPEED: ___ MPH

Rev. 4/21/16 ARC

Form 1296-2. Speed Zone Warrant Sheet
(Sheet 3 of 4)



Form 1296-2. Speed Zone Warrant Sheet
(Sheet 4 of 4)



Note revised 1-16-15

Form 1296-3. Sample Speed Study Data Sheet

SPEED STUDY DATA SHEET

Date______ County______ Highway Name______ Route Number______

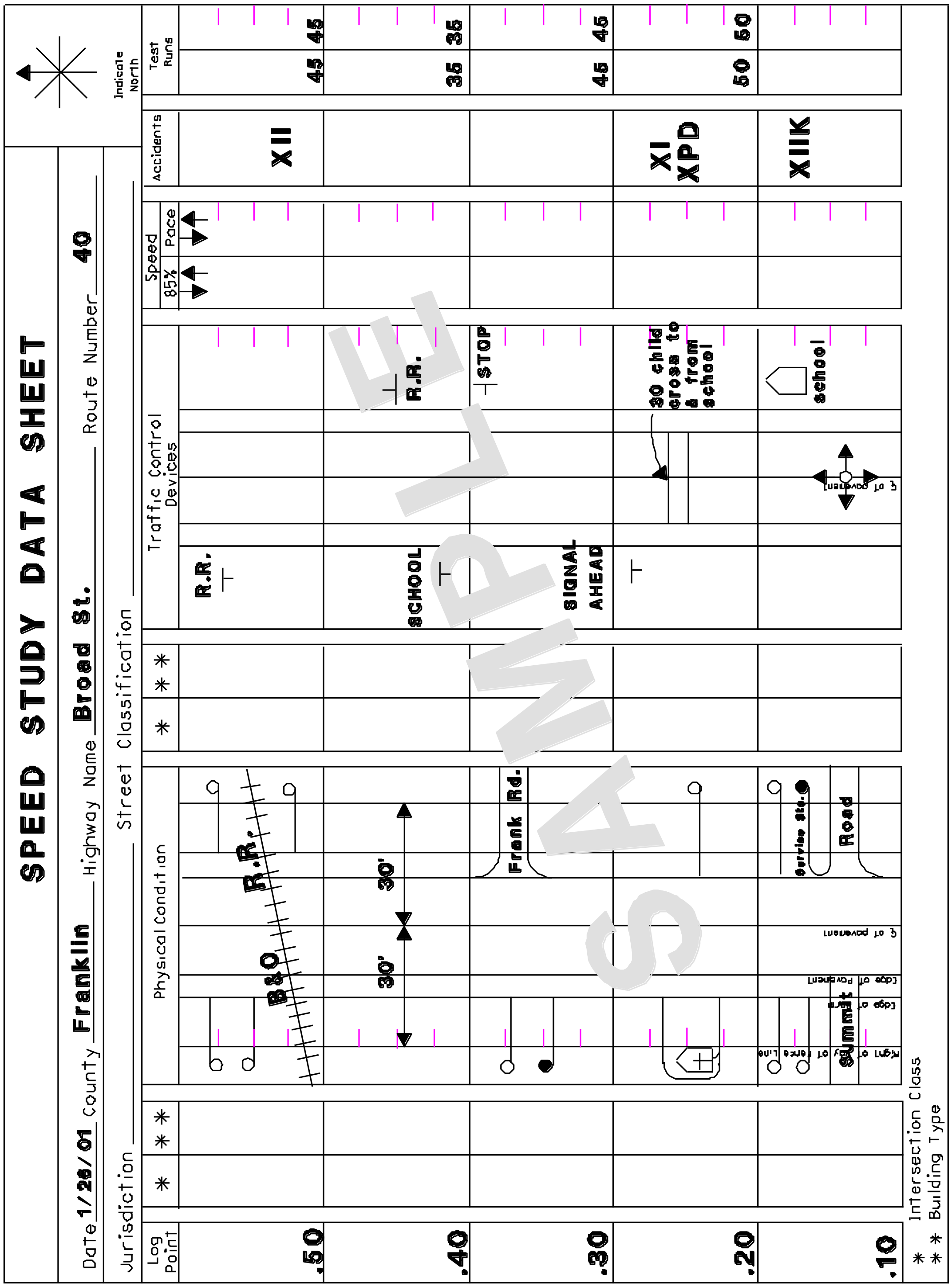
Jurisdiction______ Street Classification______

Indicate North

Test Runs					
Accidents					
Speed Pace					
Speed 85%					
Traffic Control Devices					℄ of pavement
**					
*					
Physical Condition					℄ of pavement Edge of Pavement Edge of Berm Right of Way of Fence Line
**					
*					
Log Point					

* Intersection Class
** Building Type

Form 1296-4. Completed Sample Speed Study Data Sheet



Form 1296-5. Speed Check Form

Speed Check

Location: ______________________________________

Date: _________________ Day: __________ County: _______________

Observer: ____

Type Pavement: _________ Dry: ____ Wet: ____ Condition: _________ Width: _________

Weather: ______________________________ Temperature: _________

_____ Bound, Time: ______M to ______M					mph	_____ Bound, Time: ______M to ______M				
			Vehicles			Vehicles				
Com. %	Cum. Total	No.	Passenger Cars	Commercial		Passenger Cars	Commercial	No.	Cum. Total	Com. %
					Over					
					90.0					
					88.0					
					86.0					
					84.0					
					82.0					
					80.0					
					78.0					
					76.0					
					74.0					
					72.0					
					70.0					
					68.0					
					66.0					
					64.0					
					62.0					
					60.0					
					58.0					
					56.0					
					54.0					
					52.0					
					50.0					
					48.0					
					46.0					
					44.0					
					42.0					
					40.0					
					38.0					
					36.0					
					34.0					
					32.0					
					30.0					
					28.0					
					26.0					
					24.0					
					22.0					
					20.0					
					18.0					
					16.0					
					14.0					
					Below					
					Totals					

NOTE:

Minimum recorded observations per direction is 100 or one hour duration, whichever comes first
Free flow speeds during off-peak weekday hours are to be recorded
Minimum headway for free flow is five seconds; there should be no acceleration or deceleration
For zones 0.25 miles in length, observations should be near the center
For zones 0.25 miles to 1.00 miles in length, observations should be near the one third points
For zones over 1.00 miles in length, observations should be taken at 0.50 to 0.75 mile intervals

Form 1296-5.

Form 1296-6a. Speed Limit Revision

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

SPEED LIMIT REVISION

Location of Alteration:

District: ______ **Revision No.:** ___________ **Name of Street:** ________________________________

Municipality: _________________________ **County:** _______________________________________

State Route No.: ______________________ **Co. Rd./Twp. Rd.:** _______________________________

Under Authority of Section 4511.21 of the Ohio Revised Code, the following revised prima facie speed limits, which have been determined upon the basis of a traffic and engineering investigation to be reasonable and safe, are hereby established for the streets and highways described herein. The prima facie speed limit or limits hereby established shall become effective when appropriate signs giving notice thereof are erected.

LOCATION OF REVISED PRIMA FACIE SPEED LIMITS

From	To	Direction				Approved Speed Limit (in MPH)
		NB	SB	EB	WB	

Signs giving notice of approved speed limits shall be erected immediately. Such signs shall conform to the Ohio Manual of Uniform Traffic Control Devices for Streets and Highways.

This authorization is revocable by the Director of Transportation whenever any altered prima facie speed becomes, in the Director's opinion, unreasonable; and upon such withdrawal and notification, such altered prima facie speed shall become ineffective and the signs relating thereto shall be immediately removed by the local authorities.

Date: _________________________ ____

Director of Transportation

____

Immediately after erection of the appropriate speed limit signs, return a copy of this form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above prima facie speed limits were erected

on ____________________________ Signed ____

Title ____

Form 1296-6b. Work Zone Speed Limit Revision for High-Speed ($\geq$ 55 mph) Multi-Lane Highways

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

WORK ZONE SPEED LIMIT REVISION

Location of Alteration:

District: ______ **Revision No.: WZ -** ________ **Name of Street:** __________________________________

Project No. ________________ **PID:** _____________________ **Original Speed Limit:** ______**MPH**

Municipality: ____________________________ **County:** ____

State Route No.: _________________________ **Co. Rd./Twp. Rd.:** ________________________________

Under Authority of Sections 4511.21 and 4511.98 of the Ohio Revised Code, work zone speed limit(s), are hereby established for the streets and highways described herein. The work zone speed limit reductions authorized are those in the most recent publication of the Traffic Engineering Manual (TEM) Table 1297-7 (at the time of signature of this form) based upon the applicable work zone conditions and factors present at any given point in time on the project. The work zone speed limit(s) hereby established shall become effective only where and when appropriate signs giving notice thereof are erected.

Signs giving notice of authorized work zone speed limits shall be erected when, and where, the work zone condition and associated factors warranting the speed limit reduction are present. Such signs shall conform to the Ohio Manual of Uniform Traffic Control Devices for Streets and Highways as well as any other applicable standards and specifications established by the Department of Transportation. During periods where the warranting work zone condition(s) and associated factors are no longer present, the original speed limit(s) (prior to construction) shall be in effect.

LOCATION(S) OF AUTHORIZED WORK ZONE SPEED LIMIT REDUCTIONS PER TEM TABLE 1297-7
(Place a checkmark or "X" in the direction(s) in which TEM Table 1297-7 is authorized to be used.)

From	To	Direction			
		NB	SB	EB	WB

This authorization is revocable by the Director of Transportation whenever any work zone speed limit reduction(s) are determined by the Director to no longer be necessary; and upon such withdrawal and notification, such work zone speed limit reduction(s) shall become ineffective and any remaining signs relating thereto shall be immediately removed.

Date: _________________________ ____
Director of Transportation

The Work Zone Speed Zone Tracking Report (Form 1296-18) shall be used to document where and when the signs are in place and the applicable speed limit reduction is in effect, and also when the signs have been removed, covered or digitally changed to the original speed limit (as appropriate) so that the speed limit reduction is not in effect.

Form 1296-7a. Withdrawal of Issued Speed Limit Revision

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

WITHDRAWAL OF ISSUED SPEED LIMIT REVISION

Location of Alteration:

District: _____ **Revision No.:** ____________ **Name of Street:** _____________________________

Municipality: ___________________________ **County:** ____________________________________

State Route No.: _______________________ **Co. Rd./Twp. Rd.:** ___________________________

Under Authority of Section 4511.21 of the Ohio Revised Code, the following revised prima facie speed limit(s) approved by the Director of Transportation on _______________________, has been determined, on the basis of a traffic and engineering investigation, to be unreasonable and approval of the same is hereby withdrawn.

LOCATION OF REVISED PRIMA FACIE SPEED LIMITS

From	To	Direction					Approved Speed Limit (in MPH)
		NB	SB	EB	WB		

Signs relating to the altered prima facie speeds shall be immediately removed and the prima facie speed limit or limits after such removal shall be as specified in the Ohio Revised Code.

Date ________________________ ____

Director of Transportation

____

Immediately after removal of the speed limit signs, return a copy of this form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above prima facie speed limits were removed

on ____________________________ Signed ____

Title ____

Form 1296-7b. Withdrawal of Issued Work Zone Speed Limit Revision for High-Speed (≥ 55 mph) Multi-Lane Highways

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

WITHDRAWAL OF ISSUED WORK ZONE SPEED LIMIT REVISION

Location of Alteration:

District: ______ **Revision No.: WZ-** ____________ **Name of Street:** ______________________________

Project No. ________________ **PID:** _____________________ **Original Speed Limit:** ______**MPH**

Municipality: ________________________________ **County:** ____________________________________

State Route No.: _____________________________ **Co. Rd. / Twp. Rd.:** ___________________________

Under Authority of Sections 4511.21 and 4511.98 of the Ohio Revised Code, the following work zone speed limit(s) authorized by the Director of Transportation on ________________________, have been determined to no longer be necessary and approval of the same is hereby withdrawn.

LOCATION(S) OF FORMERLY AUTHORIZED WORK ZONE SPEED LIMIT REDUCTIONS
PER TRAFFIC ENGINEERING MANUAL (TEM) TABLE 1297-7
(Place a checkmark or "X" in the direction(s) in which TEM Table 1297-7 was formerly authorized.)

From	To	Direction			
		NB	SB	EB	WB

Any remaining signs relating to the work zone speed limit reduction(s) shall be immediately removed and the prima facie speed limit(s) after such removal shall be the original speed limit(s) prior to construction.

Date: ________________________ ____
Director of Transportation

The Work Zone Speed Zone Tracking Report (Form 1296-18) shall be used to document where and when the signs were in place, the applicable speed limit in effect at any given time, and when they were last removed. A copy or electronic link to the tracking report or log showing the final removal of the signs related to the work zone speed limit reduction(s) shall accompany the request to withdraw the Work Zone Speed Limit Revision; however, the tracking report or log shall reside within the project files.

Form 1296-8. Field Report on Parking Practices

State of Ohio
Department of Transportation
Field Report On Parking Practices

Date Reviewed:		Time Reviewed:		Weather:	

Location

County:		If Ramp, enter Interchange ID Number and Ramp Identifier:			
Route:		Side of Road			
Begin Log:			North		East
End Log:			South		West

Highway Features at Point of Study

Pavement Type:		Berm Type:	
Pavement Width:		Berm Width:	
Total Number of Lanes:			
Other Features:			

Roadside Culture

The major portion of the area included in this study should be described as:					
	Residential Rural		Industrial		Business
Properties which abut the highway are used for the following purposes:					

Traffic Control

At the present time, the following traffic control measures are in use:		
Signals:		
Signs:		
Pavement Markings:		
Other:		
The legal Speed Limit is now		MPH

Parking Practices

There is evidence of the following parking practices:

Conclusion: *(Place "X" beside opinion and fill in the pertinent information)*

	It is the opinion of this observer that these parking practices constitute a traffic hazard for the following reasons:
	It is the opinion of this observer that these parking practices do **NOT** constitute a traffic hazard for the following reasons:

Recommendations: *I have reviewed the attached data and make the following recommendations:*

	I recommend the establishment of a No-Parking restriction at the following location:				
County:		Type of Restriction (e.g., Any Time, Specific Times, Specific Distance from road, Vehicle Height, etc...)			
Route:					
Begin Log:		Side of Road			
End Log:			North		East
Total Length (FT):			South		West

	I do **NOT** recommend the establishment of any No-Parking restrictions.
I recommend the following corrective measures:	

Attached is a diagram and/or photographs showing the physical conditions outlined above.					
Other attachments include:					
Printed Name:		District:		Title:	
Signature:				Date:	

Form 1296-9. Establishment of No-Parking Restrictions

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

ESTABLISHMENT OF NO-PARKING RESTRICTIONS

Revision No. : ____________________ County: ____________________

District: ____________________ State Route No.: ____________________

Section: ____________________

Under Authority of Sec. 4511.10 - 4511.68 of the Ohio Revised Code, the following described No-Parking Zone is established. No person shall park or leave standing any vehicle, whether attended or unattended within the right-of-way within the No-Parking Zone indicated herein when appropriate signs giving notice thereof have been erected.

LOCATION OF NO-PARKING LIMITS

FROM	TO	ALONG
(SLM)	**(SLM)**	
Total Length =		

This restriction shall become effective immediately upon the erection of signs giving notice thereof. Signs giving notice of the approved restriction shall be erected immediately.

____________________ Director of Transportation ____________________ Date

Immediately after the erection of appropriate No-Parking signs, return the attached copy of this No-Parking restriction form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above No-Parking restriction were erected

on ____________ (Date) ____________ (Year) Signed: ____________________

Title: ____________________

Form 1296-9

Form 1296-10. Withdrawal of Issued No-Parking Restrictions

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION

WITHDRAWAL OF ISSUED NO-PARKING RESTRICTIONS

No. ____________________

District: _______________ **County:** ______________________________________

State Route No.: ____________________ **Section:** ______________________________________

Under Authority of Section 4511.10 - 4511.68 of the Ohio Revised Code, the following described No-Parking restriction(s) approved by the Director of Transportation on ______________________, has been determined, on the basis of a traffic and engineering investigation, to be unreasonable and approval of the same is hereby withdrawn.

LOCATION OF NO-PARKING LIMITS

From	To	Along

Signs relating to the parking prohibition shall be immediately removed.

Date: _______________________ ____
Director of Transportation

Immediately after removal of the No-Parking signs, return the attached copy of this No-Parking Restriction Withdrawal form to the ODOT District Deputy Director or his designee, with the following certification properly executed.

I hereby certify that appropriate signs, giving notice of the above No-Parking restriction were removed

on ____________________________ Signed ____

Title ____

Form 1296-11. Curve Study Sheet

STATE OF OHIO

DEPARTMENT OF TRANSPORTATION

CURVE STUDY

COUNTY: ________ **ROUTE:** ________ **SLM:** ________

DATE: ________ **REVIEWED BY:** ____________________

TANGENT DISTANCE BETWEEN CURVES ______ FEET
(REVERSE CURVE IF LESS THEN 600 FEET)

DIRECTION:		LENGTH:				DIRECTION:		LENGTH:			
BALL BANK CRITERIA	TEST SPEED	BALL BANK ANGLE				BALL BANK CRITERIA	TEST SPEED	BALL BANK ANGLE			
		# 1	# 2	# 3	AVG			# 1	# 2	# 3	AVG
≤12°	55 MPH					≤12°	55 MPH				
	50 MPH						50 MPH				
	45 MPH						45 MPH				
	40 MPH						40 MPH				
	35 MPH						35 MPH				
>12° ≤14°	30 MPH					>12° ≤14°	30 MPH				
	25 MPH						25 MPH				
>14° ≤16°	20 MPH					>14° ≤16°	20 MPH				
	15 MPH						15 MPH				
	10 MPH						10 MPH				
RECOMMENDED ADVISORY SPEED						RECOMMENDED ADVISORY SPEED					

REMARKS: ____________________

____

DIRECTION:		LENGTH:				DIRECTION:		LENGTH:			
BALL BANK CRITERIA	TEST SPEED	BALL BANK ANGLE				BALL BANK CRITERIA	TEST SPEED	BALL BANK ANGLE			
		# 1	# 2	# 3	AVG			# 1	# 2	# 3	AVG
≤12°	55 MPH					≤12°	55 MPH				
	50 MPH						50 MPH				
	45 MPH						45 MPH				
	40 MPH						40 MPH				
	35 MPH						35 MPH				
>12° ≤14°	30 MPH					>12° ≤14°	30 MPH				
	25 MPH						25 MPH				
>14° ≤16°	20 MPH					>14° ≤16°	20 MPH				
	15 MPH						15 MPH				
	10 MPH						10 MPH				
RECOMMENDED ADVISORY SPEED						RECOMMENDED ADVISORY SPEED					

REMARKS: ____________________

____

Form 1296-12. Reserved – Existing Form Deleted

Form 1296-13. Reserved – Existing Form Deleted

Form 1296-14. Freeway and Rural Expressway Speed Zone Evaluation Sheet

Ohio Department of Transportation

FREEWAY AND RURAL EXPRESSWAY* SPEED ZONE EVALUATION SHEET

*GREATER THAN 10 MILES IN LENGTH AND WITH MORE THAN 50% CROSSROADS GRADE SEPARATED [ORC 4511.01 (ZZ)]

COMPLETE ALL AREAS IN GREEN

Rev. ARC 5/14/15

ROUTE NUMBER:		BEGIN STUDY AT:		LENGTH (MILES):	ERROR
COUNTY:		ODOT SLM:		AVERAGE DAILY TRAFFIC (ADT):	
TOWNSHIP(S):		END STUDY AT:		NUMBER OF LANES:	
MUNICIPALITY(S):		ODOT SLM:		EXISTING SPEED LIMIT (MPH):	

ACCESS POINTS:

NUMBER OF CROSSROADS:		NUMBER OF SIDEROADS:		NUMBER OF DRIVEWAYS:		NUMBER OF RAMPS:	
ACCESS POINT WEIGHTED VALUES: CROSSROADS x 4, SIDEROADS x 3, DRIVEWAYS x 2, RAMPS x 1						TOTAL WEIGHTED ACCESS POINTS:	0

Speed Limit Factors		1	2	3	4	5	6	FACTORS
Apparent Design Speed (mph) - Horizontal curvature as primary design factor (from construction plans).		≤50	55	60	65	70	≥75	ERROR
Access Points/Mile - Number of ramps, intersections & driveways intersecting mainline lanes divided by length of study section.	ERROR	>7	7 - 5	<5 - 3	<3 - 2	<2 - 1	<1	ERROR
ADT/Lane - Current AADT (weighted)/average number of through lanes in section.	ERROR	>26K	26K - 20K	<20K - 14K	<14K - 8K	<8K - 4K	<4K	ERROR
Speed of Traffic - 85%tile speed of traffic		<53	53 - 57	58 - 62	63 - 67	68 - 72	≥73	ERROR
							TOTAL FACTORS =	ERROR

CALCULATED SPEED = TOTAL FACTORS / 4 = ERROR = ERROR MPH

1 = 50 mph 2 = 55 mph 3 = 60 mph 4 = 65 mph 5 = 70 mph 6 = 75 mph

TEST RUN* = MPH

*Completed by ODOT for verification of calculated speed

APPROVED SPEED LIMIT = MPH

ADDITIONAL CONSIDERATIONS & COMMENTS:

Note: The actual form is a **Microsoft Excel** file and the fields shown above with an "Error" message fill in as the information is added in the fields shown in green.

Form 1296-15. Speed Zone Request for Unimproved Highways and Residential or Commercial Subdivision Streets

Ohio Department of Transportation

DOCUMENTATION FOR SPEED ZONES

on Unimproved Roads and Residential and Commercial Subdivision Streets

ROAD NAME:		ROAD No.		DATE:	
COUNTY:					
BEGIN STUDY AT:		END STUDY AT:			
LENGTH:	Miles	Existing Speed Limit		Requested Speed Limit	

Check the appropriate road description(s) below.Definitions of the terms are provided. They are the same as shown in ORC 4511.21(K)(1) and 4511.21(K)(5) for Township Roads.ORC 4511.21(K) allows the Board of Township Trustees to declare by resolution a reasonable and safe prima-facie speed limit of less than fifty-five but not less than twenty-five miles per hour, when they determine upon the basis of an engineering and traffic investigation that the speed permitted by ORC 4511.21(B)(5) on any part of an unimproved highway under the Township's jurisdiction and in the unincorporated territory of the Township is greater than is reasonable or safe under the conditions found to exist at the location. ODOT has agreed to apply the same provisions to County Roads. The full Speed Zone Study using the long form is not necessary; however, documentation for these speed zones is required. Note below or attach information justifying the speed zone. For County Roads, this documentation must be submitted to ODOT, and the zone will not be effective until the standard Speed Zone Approval Form is completed and returned to ODOT with notice that the signs have been erected.

	Unimproved highway[1]		Residential Subdivision[2]		Commercial Subdivision[3]

Note reason(s) for request (e.g., accidents, complaints, etc.) and any other additional information or comments (e.g., other jurisdictions involved).

1 - Any of the following: (a) Unimproved earth; (b) Unimproved graded and drained earth; (c) Gravel.

2 - Any platted territory outside the limits of a municipal corporation and fronting a highway, where, for a distance of three hundred feet or more, the frontage is improved with residences or residences and buildings in use for business, or where the entire length of the highway is less than three hundred feet long and the frontage is improved with residences or residences and buildings in use for business.

3 - Any platted territory outside the limits of a municipal corporation and fronting a highway where, for a distance of three hundred feet or more, the frontage is improved with buildings in use for commercial purposes, or where the entire length of the highway is less than three hundred feet long and the frontage is improved with buildings in use for commercial purposes.

Include the related Resolution(s) when submitting this form. Rev. 5/30/08

Form 1296-16. Reserved – Deleted the Existing Form

Form 1296-17. Work Zone Speed Zone Evaluation Sheet for High-Speed (≥ 55 mph) Multi-Lane Highways

The Ohio Department of Transportation

Work Zone Speed Zone Evaluation Sheet (Form 1296-17)

for High-Speed (≥ 55 mph) Multi-Lane Highways

County-Route-Section	
PID	
State Project Number	
Original Speed Limit (Pre-Construction)	
Length of Work Zone Condition (As defined by TEM 1203-2.9.1)	
Duration the Work Zone Condition is to remain in place	
Work Zone Condition* that reduces the existing functionality of the travel lanes or shoulders (i.e., lane closure, lane shift, crossover, contraflow and/or shouder closure)?	
Is there positive protection for workers? (As defined by TEM 1203-2.9.6)	
Will the qualifying Work Zone Condition and associated TTCDs remain in place when workers are not present?	

WARRANTED WORK ZONE SPEED LIMIT(S)

MPH

MPH

Notes:

Positive Protection is generally regarded as portable barrier or other rigid barrier along the work area.

Without Positive Protection is generally regarded as using drums, cones, shadow vehicles, etc, along the work area.

Only one warranted speed limit applies at any one time. Speed limit reductions are not cumulative.

TTCD = Temporary Traffic Control Device

See TEM Section 1203-2.9.6 for definitions and additional guidance.

*Moving/Mobile activities (as defined by the OMUTCD) are not included. WZSZ shall not be used for these activities.

Form Revised: 10/16/15

Form 1296-18. Work Zone Speed Zone (WZSZ) Tracking Report

(An example form with a few entries can be found with the electronic copies of the forms.)

Ohio Department of Transportation

Work Zone Speed Zone (WZSZ) Tracking Report

District:		Project Number:		Project ID (PID):		WZ Speed Limit Revision No:	WZ-
Location (County, Route & Section):					Original Posted Speed Limit (MPH):		
Contractor:				Project Engineer/County Mgr:			
Reporting From Date:		Reporting To Date:		Type of Signs Used (Choose One):	DSL Sign Assemblies or Temp. Flatsheet SL Signs		

Location of Each Posted Speed Limit Sign			Begin (Install)		Work Zone Speed Limit Posted (MPH)	Work Zone Speed Limit Beacon Status* (On/Off; N/A)	End (Remove)		Person Reporting (Printed Name and Signature)
Route	Log Point/ Mile Marker	Direction of Traffic	DATE (MM/DD/YY)	TIME (Example: 10:55 PM)			DATE (MM/DD/YY)	TIME (Example: 5:20 AM)	

*Only applicable when DSL Sign Assemblies are used. When temporary flatsheet speed limit signs are used enter “N/A”.

DWZTM = District Work Zone Traffic Manager; DSZC = District Speed Zoning Coordinator

This report is to be filled out by the Contractor (or County Mgr, or designee, for operations/maintenance work) and submitted to the Project Engineer (or DWZTM and DSZC for operations/maintenance work) beginning 7 calendar days after initial installation of the first temporary flatsheet speed limit sign or DSL Sign Assembly, and weekly (every 7 calendar days) thereafter until all speed limit changes have been submitted. The Project Engineer forwards a copy of the form to the DWZTM and DSZC.

Form 1296-19. Sample OSHP Concurrence Sheet

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

Ohio State Highway Patrol Concurrence Sheet

Speed Zones and Parking Restrictions

Type of Zone		Warranted Speed Limit	
Description of Zone			
County	Athens	Route	
Section	From		
	To		

I have reviewed the studied zone and concur with the findings.

Name ____________________________ Title _________________________________

Signature ____ Date: _____________

I have reviewed the studied zone and **DO NOT** concur with the findings.

Reasons for not concurring:

____

____

____

____

Name ____________________________ Title _________________________________

Signature ____ Date: _____________

Please return this form to Matt First at the ODOT District 10 Office:

Ohio Department of Transportation
District 10
338 Muskingum Dr.
Marietta, Oh 45750

You may also fax the form to (740) 373-7317, or scan and email this form to matthew.first@dot.state.oh.us

1297 TABLES INDEX

1297-1 Symbols For Use with the Speed Study Data Sheet

Table 1297-1 depicts the symbols mentioned in ***Section 1203-3.2*** that are used to represent physical features along the highway when completing the Speed Study Data Sheet ***(Form 1296-3)***.

1297-2 Speed Zone Warrant Analysis - Highway Development

Table 1297-2 defines components used in Highway Development portion of ***Form 1296-2*** for the Speed Zone Warrant Analysis ***(see Section 1203-3.4)***.

1297-3 Speed Zone Warrant Analysis - Roadway Features

Table 1297-3 defines components used in the Roadway Features portion of ***Form 1296-2*** for the Speed Zone Warrant Analysis ***(see Section 1203-3.4)***.

1297-4 Speed and Parking Zone Revision Number Assignments

Table 1297-4 assigns numbers to be used by **Districts** when submitting/reviewing a Speed or Parking Zone request ***(see Sections 1203-5 and 1204-5)***.

1297-5 Reserved for Future Information

"2000 – 2005 Average: Ohio Interstate Crash Data" has been deleted, but this number/space has been reserved for future information.

1297-6 Speed Zone Warrant Analysis – Roadway Characteristics

Table 1297-6 provides descriptions of the roadway characteristics categories used in ***Form 1296-1 (see Section 1203-2.6)***.

1297-7 Warranted Work Zone Speed Limits for Work Zones on High-Speed (≥55 mph) Multi-Lane Highways

Table 1297-7 is used to determine the warranted speed limit value(s) during qualifying work zone conditions on multi-lane highways with pre-construction speed limits of 55 mph or higher ***(see Section 1203-2.9)***. The procedure for using this table is described in ***Section 1203-2.9 and Figures 1298-1a through 1298-1c.*** Definitions of terms used in this table are available in ***Section 1203-2.9.6.***

Intentionally blank.

Table 1297-1. Symbols for Use with the Speed Study Data Sheet

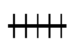
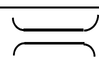
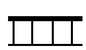
Symbol	Feature
	Residence
	Business
	School
	Church (or other house of worship)
	Intersection
——	Driveway
}	Traffic Sign
- - - -	Painted Lane and Center Line
—	No Passing Line
	Railroad
	Bridge Underpass
	Sidewalk
	Guardrail
ϕ	Signal or Flasher

Table 1297-2. Speed Zone Warrant Analysis - Highway Development

Building Development	
Type 1	residential, small apartment, commercial or public building, or other low volume generator
Type 2	Medium size commercial, public building, light industrial and multi-unit apartment type generators with traffic activity meeting one of the following general descriptions: a. Continuous, but light; b. Moderate at certain times, as opening, noon, or closing hours; c. Substantial on infrequent occasions.
Type 3	Substantial traffic generated by industry, shopping center or similar type large facility.
Type 4	Very large shopping mall, industrial park, major industry or similar large traffic generators with substantial, continuous volume. If the drive is signalized, it counts as a Class C intersection (instead of a Type 4 building development).
Intersection Classification	
Class A	Subdivision/residential type streets, low-volume Township Roads, and low-volume County Roads.
Class B	Through streets, through Township Roads, through County Roads, and State Routes.
Class C	Signalized intersections.

Table 1297-3. Speed Zone Warrant Analysis - Roadway Features

Roadway Feature		Definition
Lane Width, in feet		Consider average or most dominant lane width. Two feet may be deducted from the lane width in curbed sections.
Shoulder: (see Notes)	**Unimproved**	Unimproved shoulders are sod or loose aggregate.
	Improved	Shoulders are considered improved when paved, surface treated or compacted aggregate. Curbed sections shall be considered improved <2 feet (Factor = 9 on the form).
Characteristics: (see Notes)	**(A) Very Good**	Essentially level and tangent, with minimal intersection involvement, minimal sight distance restrictions.
	(B) Good	Curves and/or grades resulting in minor speed reduction, few intersections, mostly good sight distance.
	(C) Average	Curves and/or grades resulting in moderate speed reduction, some restrictive sight distance problems, some intersection involvement.
	(D) Adverse	Curves and/or grades resulting in substantial speed reduction, frequent sight distance and intersection problems.
	(E) Poor	Curves and/or grades resulting in excessive speed reduction, limited sight distance a dominant factor.
Volume (ADT/Lane)		If the volumes are not relatively consistent throughout the section under study, it may be necessary to evaluate shorter sections. This feature uses vehicles per continuous lane and turning lanes, or other special lanes, are not normally used in this calculation.

Notes:

It is recognized that shoulder features may not be consistent throughout the section under study. A judgment will need to be made to determine the most dominate design.

The characteristics noted are generalized descriptions which can be used to describe various roadway design characteristics in evaluating optimal operating speeds. Warning Signs with appropriate Advisory Speed signs should be considered before speed zoning for roadway characteristics.

Table 1297-4. Speed and Parking Zone Revision Number Assignments

Districts	Speed Zones	Parking Zones
District 1	10000 - 14999	10000 - 14999
District 2	15000 - 19999	15000 - 19999
District 3	20000 - 24999	20000 - 24999
District 4	25000 - 29999	25000 - 29999
District 5	30000 - 34999	30000 - 34999
District 6	35000 - 39999	35000 - 39999
District 7	40000 - 44999	40000 - 44999
District 8	45000 - 49999	45000 - 49999
District 9	50000 - 54999	50000 - 54999
District 10	55000 - 55999	55000 - 55999
District 11	60000 - 64999	60000 - 64999
District 12	65000 - 69999	65000 - 69999

Table 1297-5. Reserved for Future Information

"2000 – 2005 Average: Ohio Interstate Crash Data" has been deleted but the number/space has been reserved for future information.

Table 1297-6. Speed Zone Warrant Analysis – Roadway Characteristics
(also see Figures 1298-3, 1298-4 and 1298-5)

Alphabetic Value	Description
A1	Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Basically free of roadside obstructions and features that restrict lateral sight distance.
A2	Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Occasional roadside obstructions and features that randomly restrict lateral sight distance for short distances within the study area.
A3	Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Frequent or constant roadside obstructions limiting lateral sight distance through most of the study area.
B1	Gentle curves and/or straight-aways with level to moderate grades, interspersed with sharp curves and/or hillcrests that affect travel speeds and limit longitudinal sight distance in much of the study area. Basically free of roadside obstructions and features that restrict lateral sight distance.
B2	Gentle curves and/or straight-aways with level to moderate grades, interspersed with sharp curves and/or hillcrests that affect travel speeds and limit longitudinal sight distance in much of the study area. Occasional roadside obstructions and features that randomly restrict lateral sight distance for short distances within the study area.
B3	Gentle curves and/or straight-aways with level to moderate grades, interspersed with sharp curves and/or hillcrests that affect travel speeds and limit longitudinal sight distance in much of the study area. Frequent or constant roadside obstructions limiting lateral sight distance through most of the study area.
C	Constant, tightly-spaced, sharp curves and/or hillcrests that affect travel speeds and/or severely restrict longitudinal sight distance in nearly all of the study area. The sharp alignment of a "C" road dictates travel speeds to such an extent that lateral sight distances need not be a factor.
DIV	Four-lane divided highway as defined in ORC 4511.35.

Note: As an aid in selecting the most appropriate Road Characteristics, it is suggested that the alignment first be identified as most resembling the first sentence of "A," "B" or "C" in the above descriptions. If the alignment is determined to be an "A" or a "B," it should then be determined which description of the amount and proximity of roadside obstructions (1, 2 or 3) most closely resembles the conditions along the road being studied. If the alignment is determined to be "C," a description of roadside obstructions is not required.

Table 1297-7. Warranted Work Zone Speed Limits for Work Zones on High-Speed (≥55 mph) Multi-Lane Highways

(Also see *Section 1203-2.9*.)

This Table is used in the process described in ***Section 1203-2.9*** for Speed zones in Temporary Traffic Control Zones (WZSZs). This WZSZ process applies to any work zone located on a multi-lane highway with a **pre-construction speed limit of ≥ 55 mph** and with a work zone condition **at least 0.5 mile in length that reduces the existing functionality of the travel lanes or shoulders**, and has an expected **work duration of at least three hours.** For purposes of the WZSZ process, the conditions that would "reduce existing functionality" of the travel lanes or shoulders are lane closures, lane shifts, crossovers, contraflow and/or shoulder closures. See ***Section 1203-2.9.1*** for more details.

All WZSZs are variable in nature with the warranted work zone speed limit fluctuating with the conditions and factors in place at the time.

The Table below provides the warranted speed limit for each of the specific conditions given, depending on the presence of workers and "positive protection." When looking up warranted speed limit values in this Table, **always use the original, pre-construction, posted speed limit**. Do not use a prior or current work zone speed limit as a look-up value in this Table. Only one warranted speed limit applies at any one time. Speed limit reductions are not cumulative. As conditions in the work zone change, the work zone speed limit shall adjust accordingly per this Table. WZSZs shall not be used for Moving/Mobile activities, as defined by the **OMUTCD**.

Speed limits in accordance with this Table shall only be used when the work zone condition meets the criteria established in ***Section 1203-2.9***, which is also summarized in the first paragraph above. At all other times (when the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders) the original posted speed limit shall be displayed.

See ***TEM Section 1203-2.9.6*** for additional information regarding this Table, including definitions and additional guidance selecting the appropriate conditions and factors.

Warranted Work Zone Speed Limits (mph) for Qualifying Conditions and Factors

Original Posted Speed Limit	WITH Positive Protection		WITHOUT Positive Protection	
	Workers Present	Workers NOT Present	Workers Present	Workers NOT Present
70	60	65	55	65
65	55	60	50	60
60	55	60	50	60
55	50	55	45	55

As noted in ***Section 1203-2.9.6***:

"With Positive Protection" is generally regarded as portable barrier or other rigid barrier in use along the work area within the subject qualifying work zone condition. "Without Positive Protection" is generally regarded as using drums, cones, shadow vehicle, etc., along the work area within the subject qualifying work zone condition. For a work zone with a combination of "with" and "without" positive protection, see ***TEM Section 1203-2.9.6*** for additional guidance.

Workers are considered to be "present" when on-site and working within the subject qualifying work zone condition.

Intentionally blank.

1298 FIGURES INDEX

1298-1a Work Zone Speed Zoning Process for Construction Projects – Design Phase

Figure 1298-1a provides a flowchart illustrating the work zone speed zoning process for construction projects with the process starting during the design phase of the job, including design build projects ***(see Section 1203-2.9)***.

1298-1b Work Zone Speed Zoning Process for Construction Projects – During Construction

Figure 1298-1b provides a flowchart illustrating the work zone speed zoning process or construction projects where the request originates during the construction phase of the job ***(see Section 1203-2.9)***.

1298-1c Work Zone Speed Zoning Process for Operations/Maintenance Work

Figure 1298-1c provides a flowchart illustrating the work zone speed zoning process for **ODOT** operations/maintenance jobs ***(see Section 1203-2.9)***.

1298-2 Examples of Signal Timing and Phasing Improvements

Figure 1298-2 provides illustrations of the benefits of improved signal timing and phasing that were realized through projects initiated in the **ODOT** Safety Program described in ***Section 1213-4***.

1298-3 Examples of Type A Roadway Characteristics for Speed Zoning

Figure 1298-3 provides aerial view examples to help illustrate the Type A category of roadway characteristics used in ***Form 1296-1 (see Section 1203-2.6)***.

1298-4 Examples of Type B Roadway Characteristics for Speed Zoning

Figure 1298-4 provides aerial view examples to help illustrate the Type B category of roadway characteristics used in ***Form 1296-1 (see Section 1203-2.6)***.

1298-5 Examples of Type C Roadway Characteristics for Speed Zoning

Figure 1298-5 provides aerial view examples to help illustrate the Type C category of roadway characteristics used in ***Form 1296-1 (see Section 1203-2.6)***.

1298-6 Sample Full Safety Study Table of Contents

Figure 1298-6 shows a sample Table of Contents for a Safety Study, as discussed in ***Section 1211-2***.

1298-7 Title Page – Example 1

Figure 1298-7 shows a sample Title Page for a Safety Study, as discussed in ***Section 1211-3***.

1298-8 Title Page – Example 2

Figure 1298-8 shows another sample Title Page for a Safety Study, as discussed in ***Section 1211-3***.

1298-9 One Page Project Summary - Example 1

Figure 1298-9 shows a sample project summary, as discussed in ***Section 1211-4***.

1298-10 One Page Project Summary - Example 2

Figure 1298-7 shows a sample project summary, as discussed in ***Section 1211-4***.

1298-11 Executive Summary Outline

Figure 1298-11 shows an outline of a typical executive summary, as discussed in ***Section 1211-5***.

1298-12 Existing Conditions Diagram – Roadway Section

Figure 1298-12 shows a sample existing condition diagram for a roadway section, as discussed in ***Section 1211-7.2***.

1298-13 Existing Conditions Diagram – Intersection

Figure 1298-13 shows a sample existing condition diagram for an intersection, as discussed in ***Section 1211-7.2***.

1298-14 Intersection Collision Diagram – Example 1

Figure 1298-14 shows a sample collision diagram for an intersection, as discussed in ***Section 1211-8.2***.

1298-15 Intersection Collision Diagram – Example 2

Figure 1298-15 shows a sample collision diagram for an intersection, as discussed in ***Section 1211-8.2***.

1298-16 Roadway Section Collision Diagram Example

Figure 1298-16 shows a sample collision diagram for a roadway section, as discussed in ***Section 1211-8.2***.

1298-17 Summary of Crash Pattern Tables

Figure 1298-17 shows an example of crash patterns summarized, as discussed in ***Section 1212-3***.

1298-18 Crash Histogram

Figure 1298-18 shows a sample crash histogram for a project corridor, as discussed in ***Section 1212-8.3***.

1298-19 ECAT Project Safety Performance Summary Report – Existing Conditions

Figure 1298-19 shows an existing analysis report from the ECAT Excel analysis tool, as discussed in ***Section 1212-8.4***.

1298-20 ECAT Project Safety Performance Summary Report – Proposed Safety Improvements

Figure 1298-20 shows a proposed analysis report from the ECAT Excel analysis tool, as discussed in ***Section 1212-8.4***.

1298-21 Proposed Conditions Diagram – Example 1

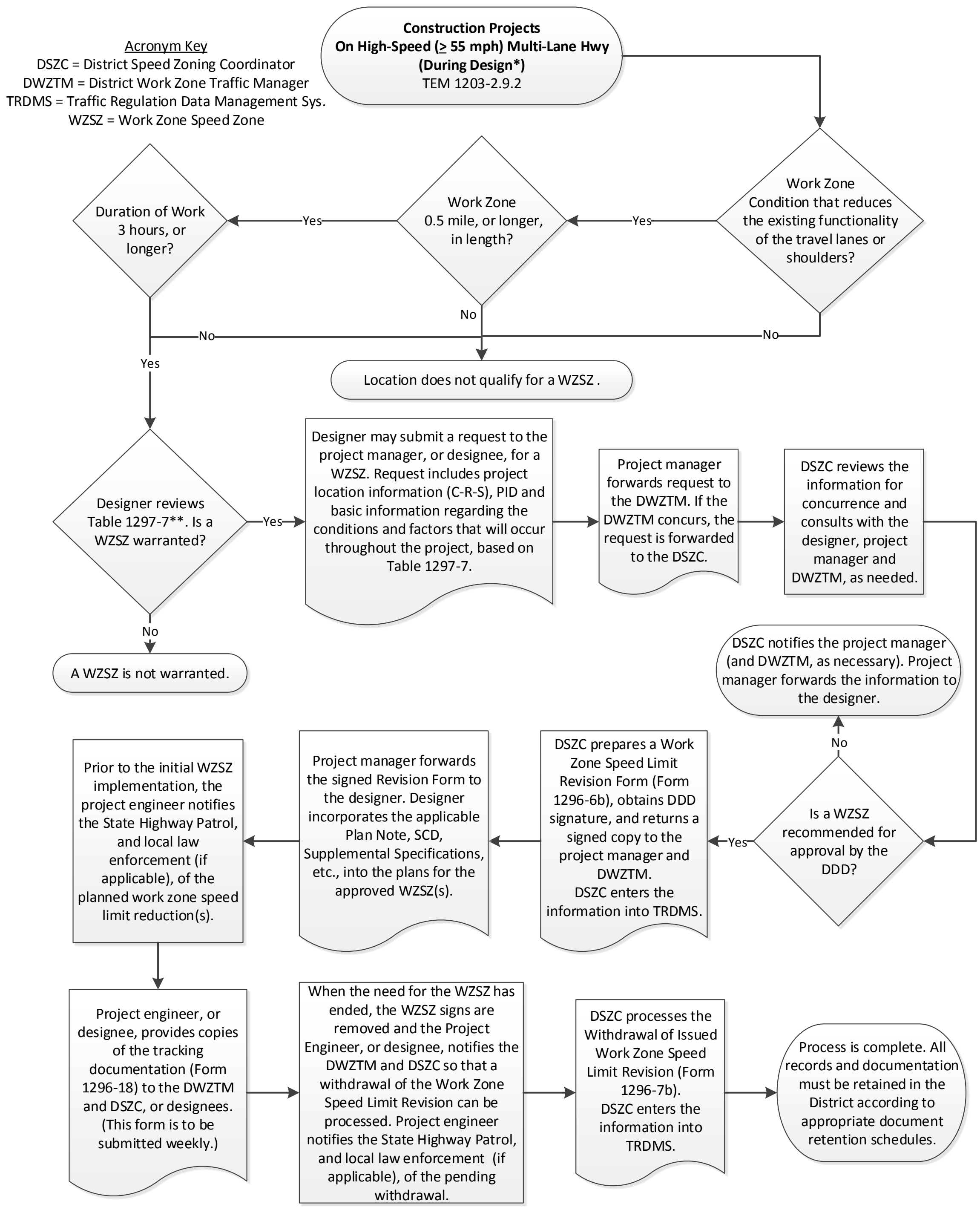
Figure 1298-21 shows an example of a proposed conditions diagram, as discussed in ***Section 1212-10.2***.

1298-22 Proposed Conditions Diagram – Example 2

Figure 1298-22 shows an example of a proposed conditions diagram, as discussed in ***Section 1212-10.2***.

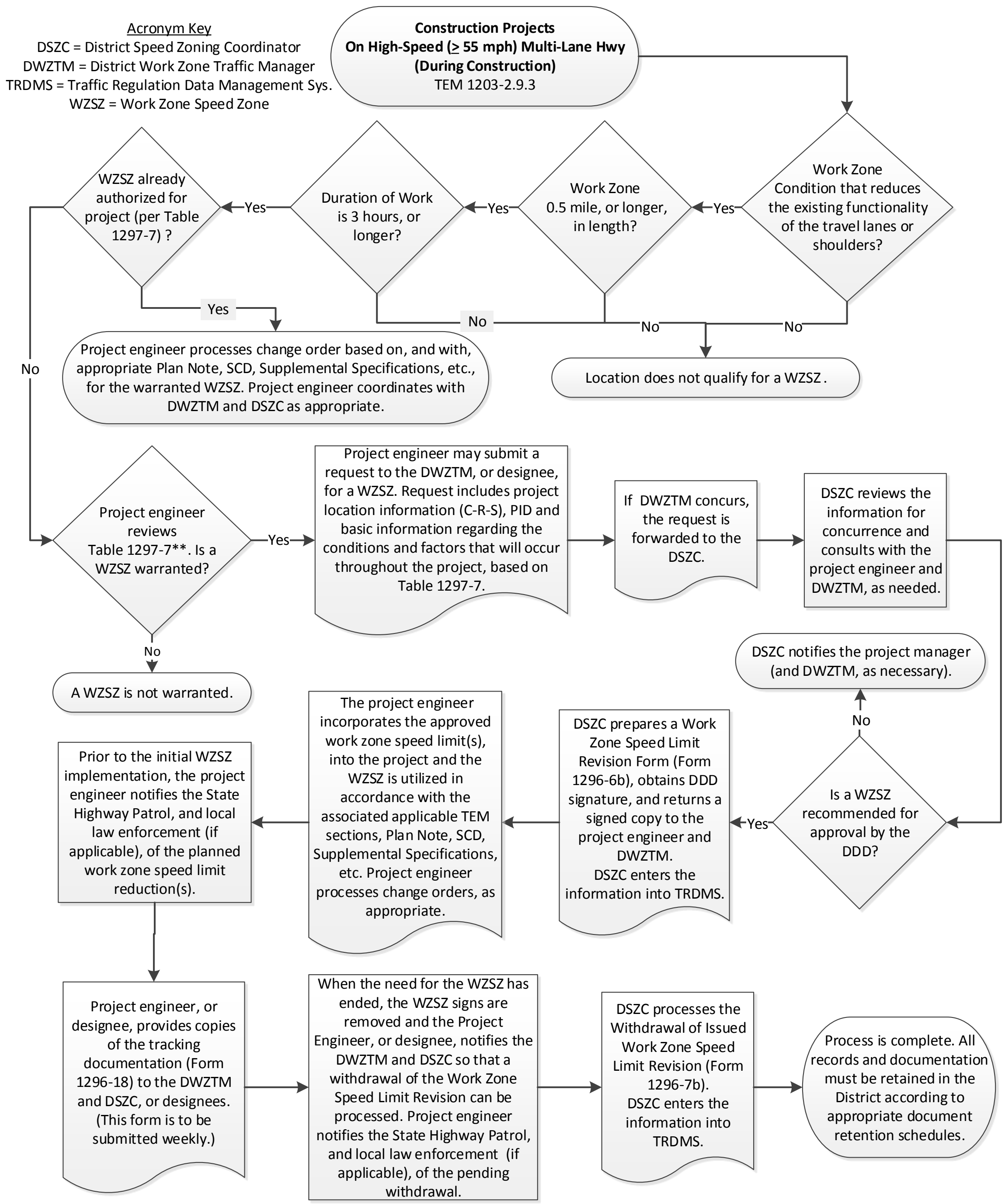
Intentionally blank.

Figure 1298-1a. Work Zone Speed Zoning Process for Construction Projects – Design Phase



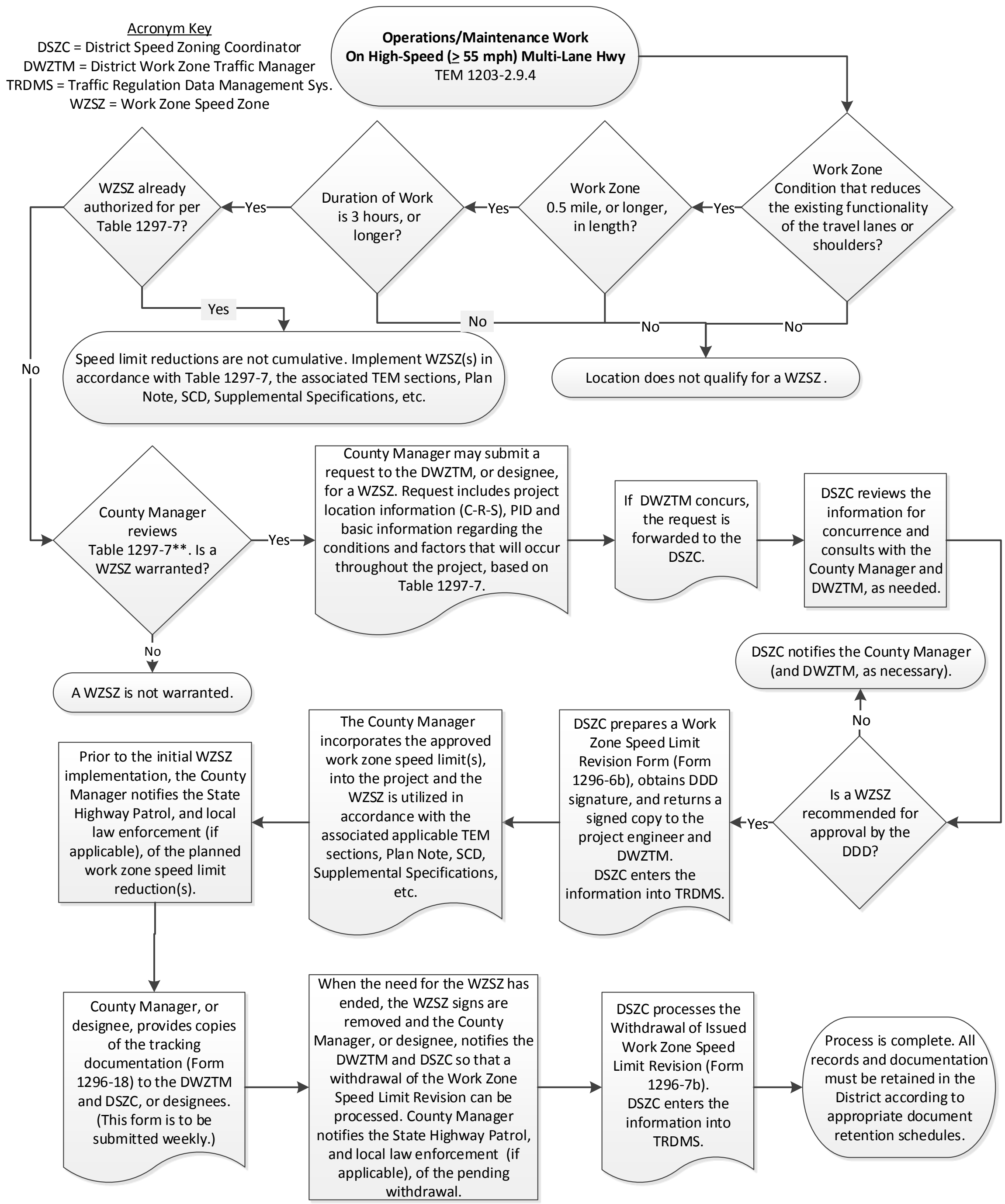
* Includes Design Build
** Form 1296-17 may be used to assist in the evaluation.

Figure 1298-1b. Work Zone Speed Zoning Process for Construction Projects – During Construction



** Form 1296-17 may be used to assist in the evaluation.

Figure 1298-1c. Work Zone Speed Zoning Process for Operations / Maintenance Work



** Form 1296-17 may be used to assist in the evaluation.

Figure 1298-2. Examples of Signal Timing and Phasing Improvements

(See ***Section 1213-4*** for related text,)

S.R. 32 Network MOE's - PC Travel Time Study Results			
AM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	357.6	340.6	-5%
Average Speed (mph)	29.4	31.1	6%
Total Delay (hr)	127.6	109.6	-14%
Number of Stops	2.4	1.9	-21%
Mid-Day Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	332.5	319.9	-4%
Average Speed (mph)	32.8	33.7	3%
Total Delay (hr)	103.7	89.7	-14%
Number of Stops	1.9	1.7	-11%
PM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	544.8	269.6	-51%
Average Speed (mph)	22.6	38.8	72%
Total Delay (hr)	317.6	43.0	-86%
Number of Stops	8.2	1.8	-78%
Off-Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	435.4	318.7	-27%
Average Speed (mph)	27.6	37.5	36%
Total Delay (hr)	171.2	64.6	-62%
Number of Stops	4.0	1.9	-53%

S.R. 28 Network MOE's - PC Travel Time Study Results			
AM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	143.8	125.1	-13%
Average Speed (mph)	22.6	28.2	25%
Total Delay (hr)	71.4	51.4	-28%
Number of Stops	1.8	0.9	-50%
Mid-Day Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	170.4	131.5	-23%
Average Speed (mph)	19.5	28.8	48%
Total Delay (hr)	97.0	57.5	-41%
Number of Stops	2.2	1.3	-41%
PM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	243.2	169.5	-30%
Average Speed (mph)	15.2	26.0	71%
Total Delay (hr)	164.0	87.1	-47%
Number of Stops	3.8	1.7	-55%
Off-Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	206.8	166.6	-19%
Average Speed (mph)	18.6	22.0	18%
Total Delay (hr)	127.2	85.1	-33%
Number of Stops	2.6	2.1	-19%

U.S. 27 Network MOE's - PC Travel Time Study Results			
AM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	842.6	781.2	-7%
Average Speed (mph)	26.9	29.0	8%
Total Delay (hr)	325.8	266.4	-18%
Number of Stops	7.4	7.0	-5%
Mid-Day Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	991.2	1039.6	5%
Average Speed (mph)	23.2	22.2	-4%
Total Delay (hr)	469.0	518.0	10%
Number of Stops	9.4	10.0	6%
PM Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	1281.0	1126.8	-12%
Average Speed (mph)	18.2	20.5	13%
Total Delay (hr)	756.4	601.2	-21%
Number of Stops	17.4	11.2	-36%
Off-Peak Hour			
Measures of Effectiveness	Before Conditions	After Conditions	% Change
Travel Time	1493.0	1281.0	-14%
Average Speed (mph)	15.4	18.0	17%
Total Delay (hr)	972.8	761.8	-22%
Number of Stops	22.8	15.4	-32%

Figure 1298-3. Examples of Type A Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 1 of 3)

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC A1

Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Basically free of roadside obstructions and features that restrict lateral sight distance.

Figure 1298-3. Examples of Type A Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 2 of 3)

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC A2

Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Occasional roadside obstructions and features that randomly restrict lateral sight distance for short distances within the study area.

Figure 1298-3. Examples of Type A Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 3 of 3)

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC A3

Relatively straight and level road that generally provides good longitudinal sight distance, but may have a random hillcrest and/or curve that affects travel speeds in only a small part of the study area. Frequent or constant roadside obstructions limiting lateral sight distance through most of the study area.

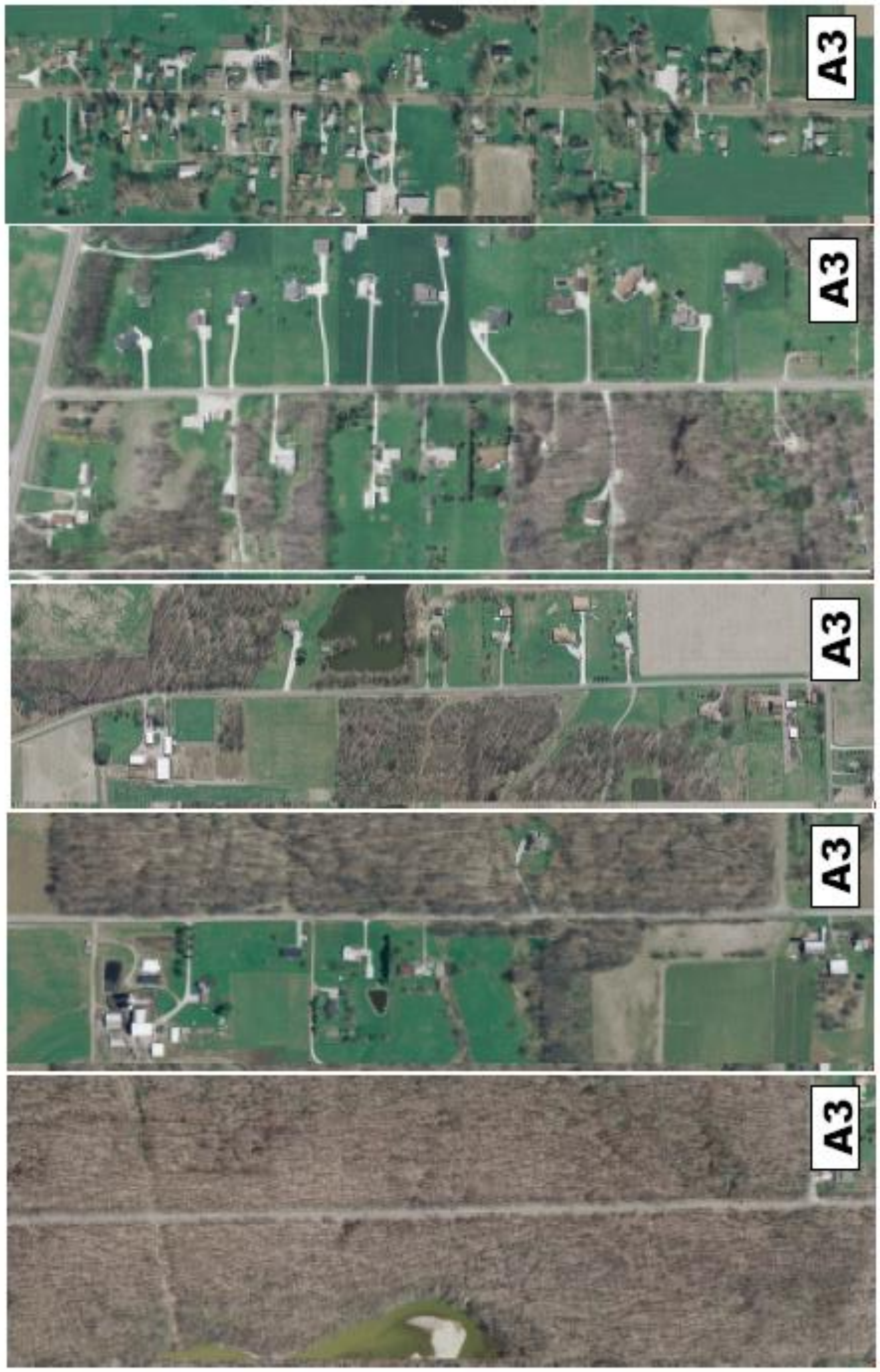


Figure 1298-4. Examples of Type B Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 1 of 3)

Figure 1298-4. Examples of Type B Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 2 of 3)

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC B2

Gentle curves and/or straight-aways with level to moderate grades, interspersed with sharp curves and/or hillcrests that affect travel speeds and limit longitudinal sight distance in much of the study area. Occasional roadside obstructions and features that randomly restrict lateral sight distance for short distances within the study area.

Figure 1298-4. Examples of Type B Roadway Characteristics for Speed Zoning for *Form 1296-1* (Sheet 3 of 3)

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC B3

Gentle curves and/or straight-aways with level to moderate grades, interspersed with sharp curves and/or hillcrests that affect travel speeds and limit longitudinal sight distance in much of the study area. Frequent or constant roadside obstructions limiting lateral sight distance through most of the study area.

Figure 1298-5. Examples of Type C Roadway Characteristics for Speed Zoning for *Form 1296-1*

VARIOUS EXAMPLES OF ROADWAY CHARACTERISTIC C

Constant, tightly-spaced, sharp curves and/or hillcrests that affect travel speeds and/or severely restrict longitudinal sight distance in nearly all of the study area. The sharp alignment of a "C" road dictates travel speeds to such an extent that lateral sight distances need not be a factor.

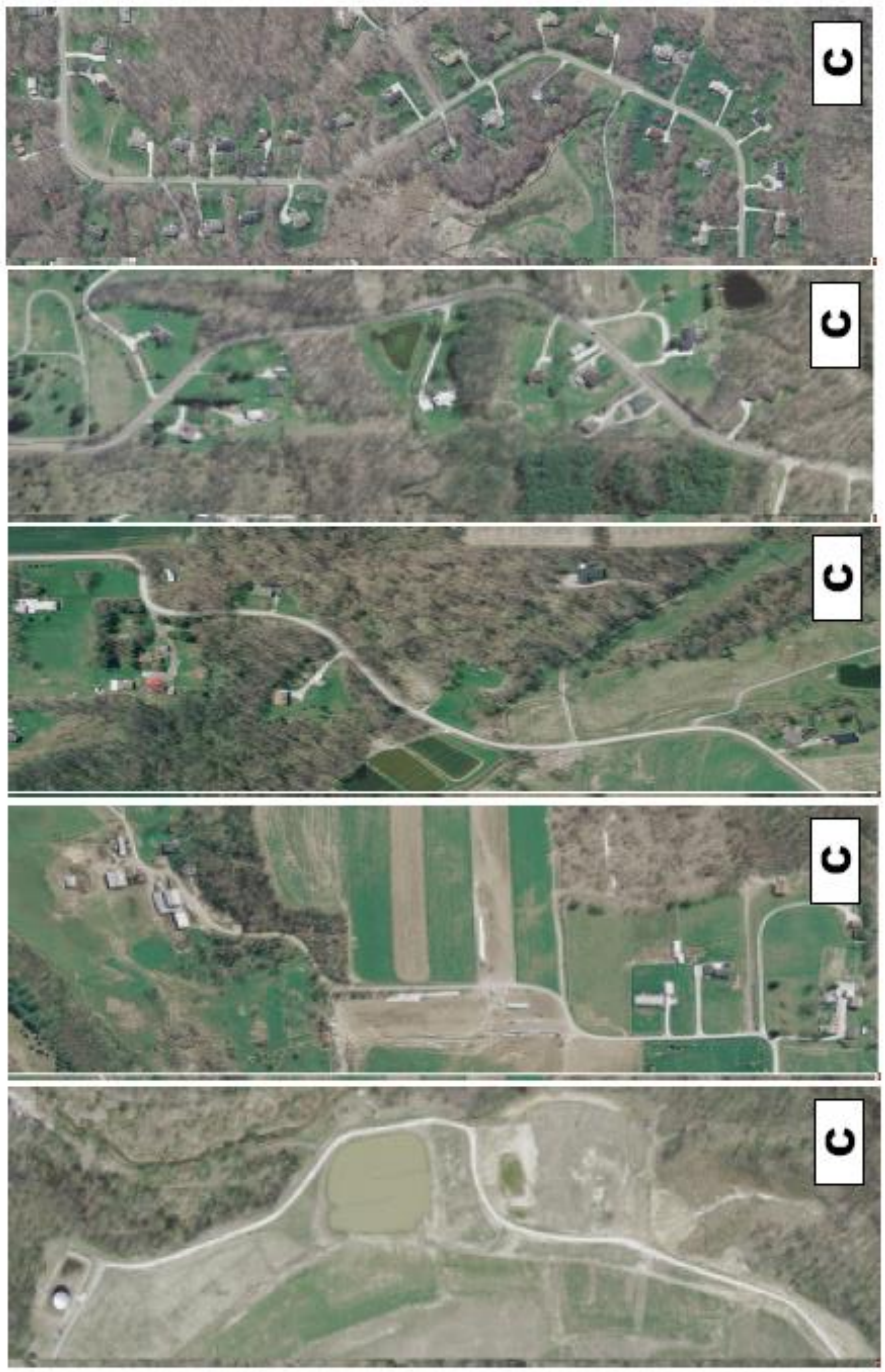


Figure 1298-6. Sample Full Safety Study Table of Contents

Table of Contents

I. Title Page
II. One Page Project Summary
III. Executive Summary
 A. Background
 B. Purpose and Need
 C. Overview of Possible Causes
 D. Recommended Countermeasures & Related Costs
IV. Purpose and Need
V. Existing Conditions
 A. Background
 B. Conditions Diagram
 C. Physical Condition Write-up
VI. Crash Data
 A. Crash Data Summaries
 B. Collision Diagram(s)
 C. Crash Graphs and Tables
 D. Crash Analyses
 E. Design Evaluation (if applicable)
 F. Identification of Potential Countermeasures
 G. Conclusions
VII. Summary of Supplemental Traffic Studies
VIII. Proposed Countermeasure Evaluation
IX. Conclusions
X. Recommendations & Prioritization
 A. Countermeasure Recommendations and Implementation Plan
 B. Proposed Conditions Diagram(s)
Appendices

Figure 1298-7. Title Page – Example 1

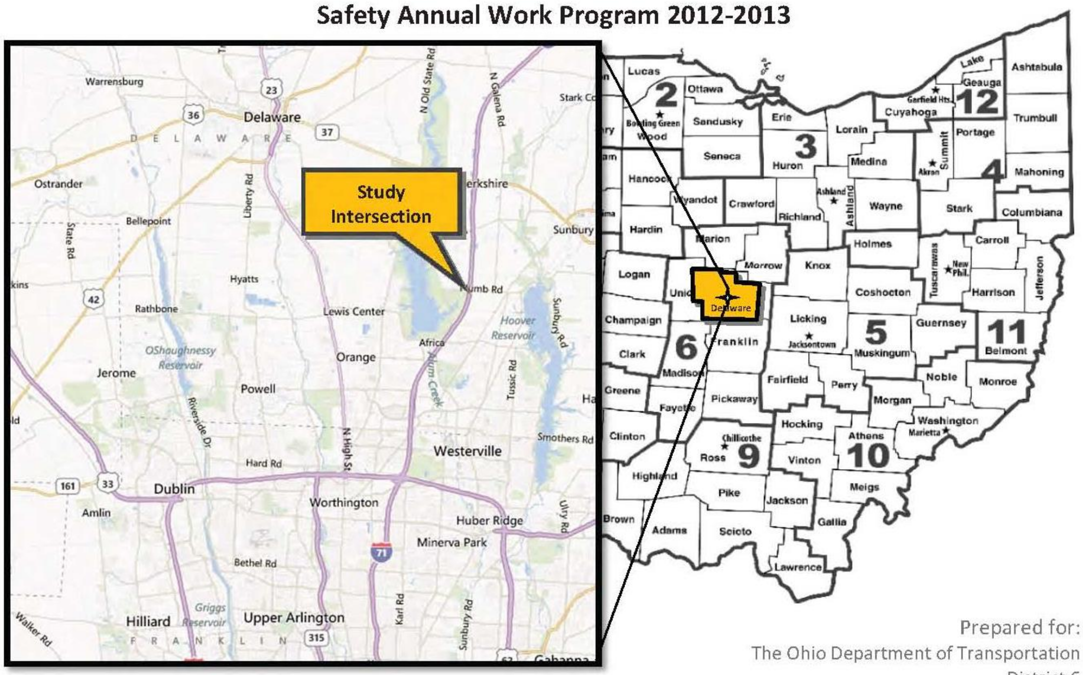
FINAL REPORT
MAY 2013

DLZ
OHIO,
INC.

DEL-3-5.41 | SAFETY STUDY

SR 3 AT PLUMB ROAD

Safety Analyst #16, Rural Intersection
Safety Annual Work Program 2012-2013



Prepared for:
The Ohio Department of Transportation
District 6
400 E. William Street
Delaware, Ohio 43015
740. 833.8000

OHIO DEPARTMENT OF TRANSPORTATION

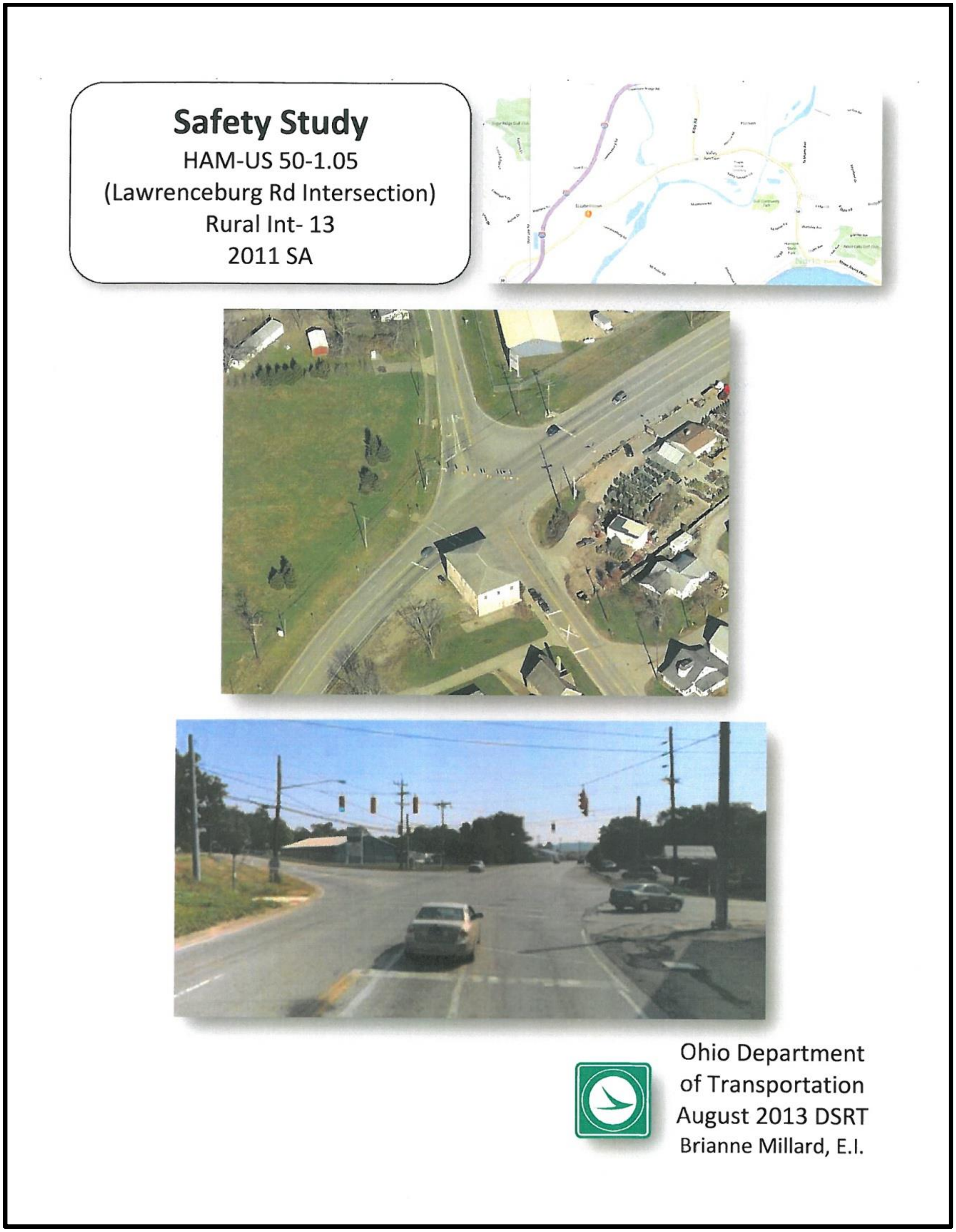
Prepared by:
Burton Planning Services, LLC
252 Electric Avenue
Westerville, OH 43081
614.392.2284
www.burtonplanning.com

BPS

DLZ Ohio, Inc.
6121 Huntley Road
Columbus, OH 439229
614.888.0040

DLZ

Figure 1298-8. Title Page – Example 2



Safety Study
HAM-US 50-1.05
(Lawrenceburg Rd Intersection)
Rural Int- 13
2011 SA

Ohio Department
of Transportation
August 2013 DSRT
Brianne Millard, E.I.

Figure 1298-9. One Page Project Summary – Example 1

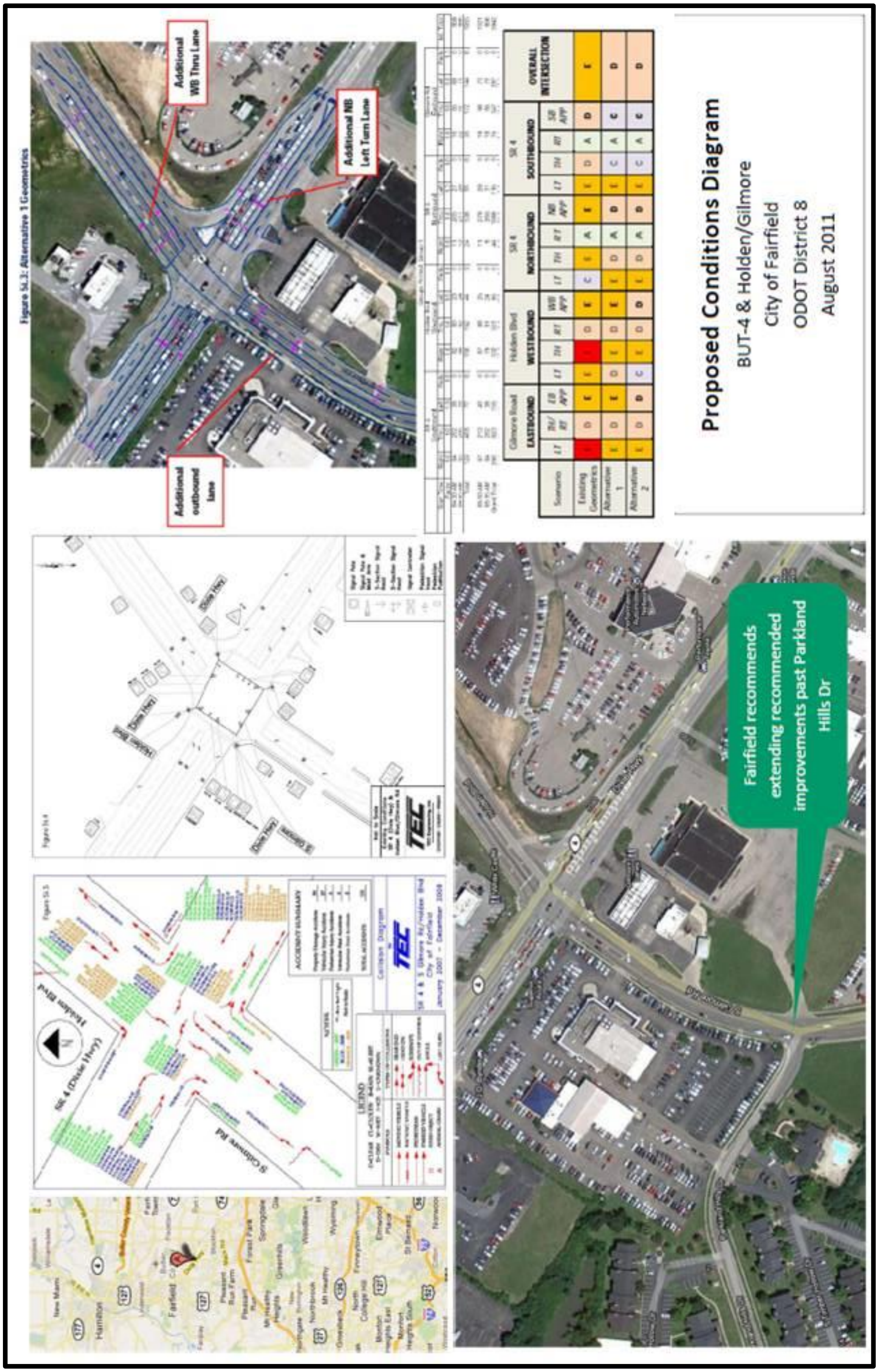


Figure 1298-10. One Page Project Summary – Example 2

SAFETY APPLICATION SUMMARY

LOR - SR 18 - 6.41

SR 18/SR 58 Intersection

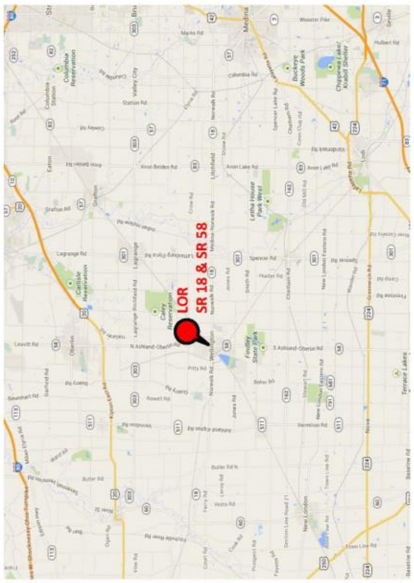
Village of Wellington, Lorain County

September 2013

OHIO DEPARTMENT OF TRANSPORTATION

Description

- Full replacement of existing traffic signal to reduce congestion and queues
- Project includes: LED signal heads, backplates, vehicle detection, ped heads, mast arms, improved phasing, left turn alignment, and remarked crosswalks



Project Priority

- SR 18/SR 58 ranked no. 46 on 2011 SA Rural Intersection Peak Searching Excess Locations

Funding

Project Phase	Fiscal Year	Other Funding	Previous Safety	New Safety	Total
Safety Study	2013	$0	$0	$0	$0
Environmental/PE					
Detailed Design	2014	$0	$0	$25,000	$25,000
ROW/Utilities	2015	$0	$0	$30,000	$30,000
Construction	2016	$95,000	$0	$150,000	$245,000
	Total:	$95,000	$0	$205,000	$300,000

Crash Data

Crash Frequency	24	3
Crash Rate (AMVM)	1.55	2
Relative Severity Index	35,464	15
Equiv. Property Damage	3.74	0
Percent Trucks	14	2
Volume to Capacity Ratio	0.54	0
Rate of Return	14.8	2
Application Score		**24**

Looking at intersection from south approach

Figure 1298-11. Executive Summary Outline

I. Project Background

- History of problems or crashes
- Include previous improvements to mitigate crashes
- Reason for study

II. Project Purpose and Safety Need

- Safety Analyst Priority List & Ranking
- Analyze crashes
- Potential for Safety Improvement

III. Overview of Safety Issues and Possible Causes

- Crash patterns
- Roadway conditions
- Existing traffic control
- Contributing factors
- Traffic volumes

IV. Recommended Countermeasures & Related Costs

- Summarize All that are Applicable
  - Short-term countermeasures
  - Medium term countermeasures
  - Long-term countermeasures
- Identify Recommended Countermeasure(s) and Implementation Approach
- Summary of Request for Safety Funding – should relate directly to recommended countermeasure(s)

Figure 1298-12. Existing Conditions Diagram – Roadway Section

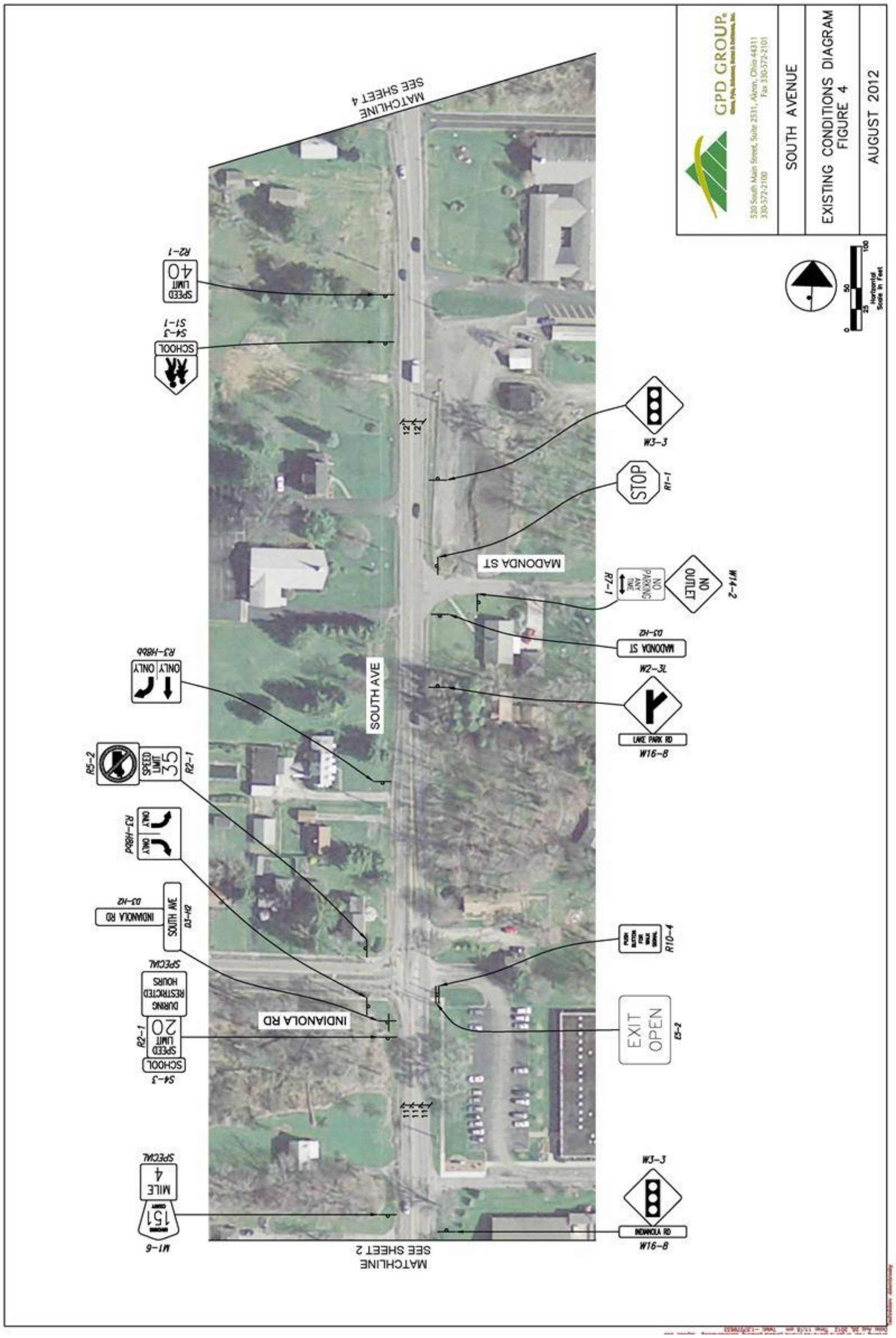


Figure 1298-13. Existing Conditions Diagram - Intersection

Figure 1298-14. Intersection Collision Diagram – Example 1

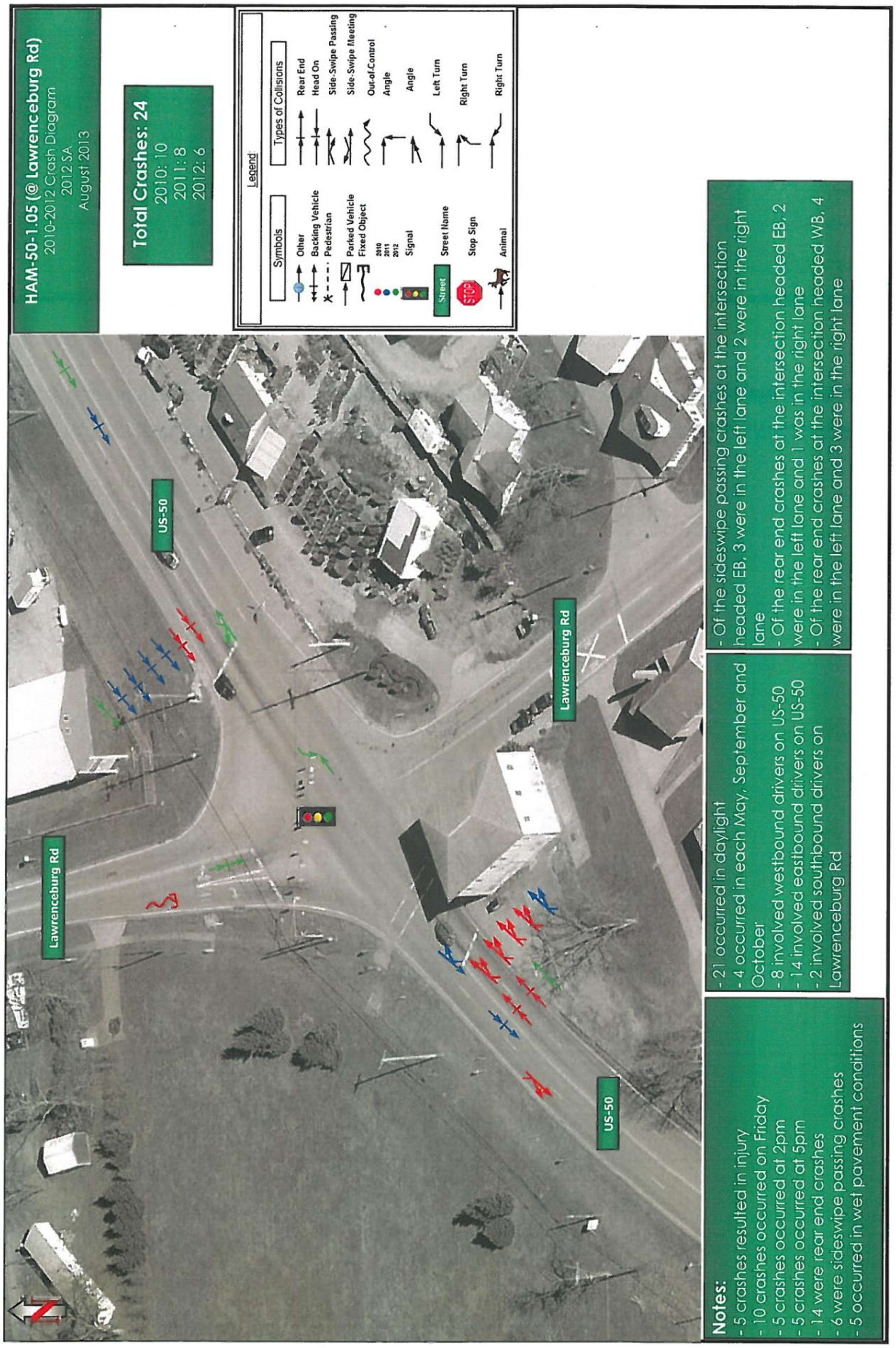


Figure 1298-15. Intersection Collision Diagram – Example 2

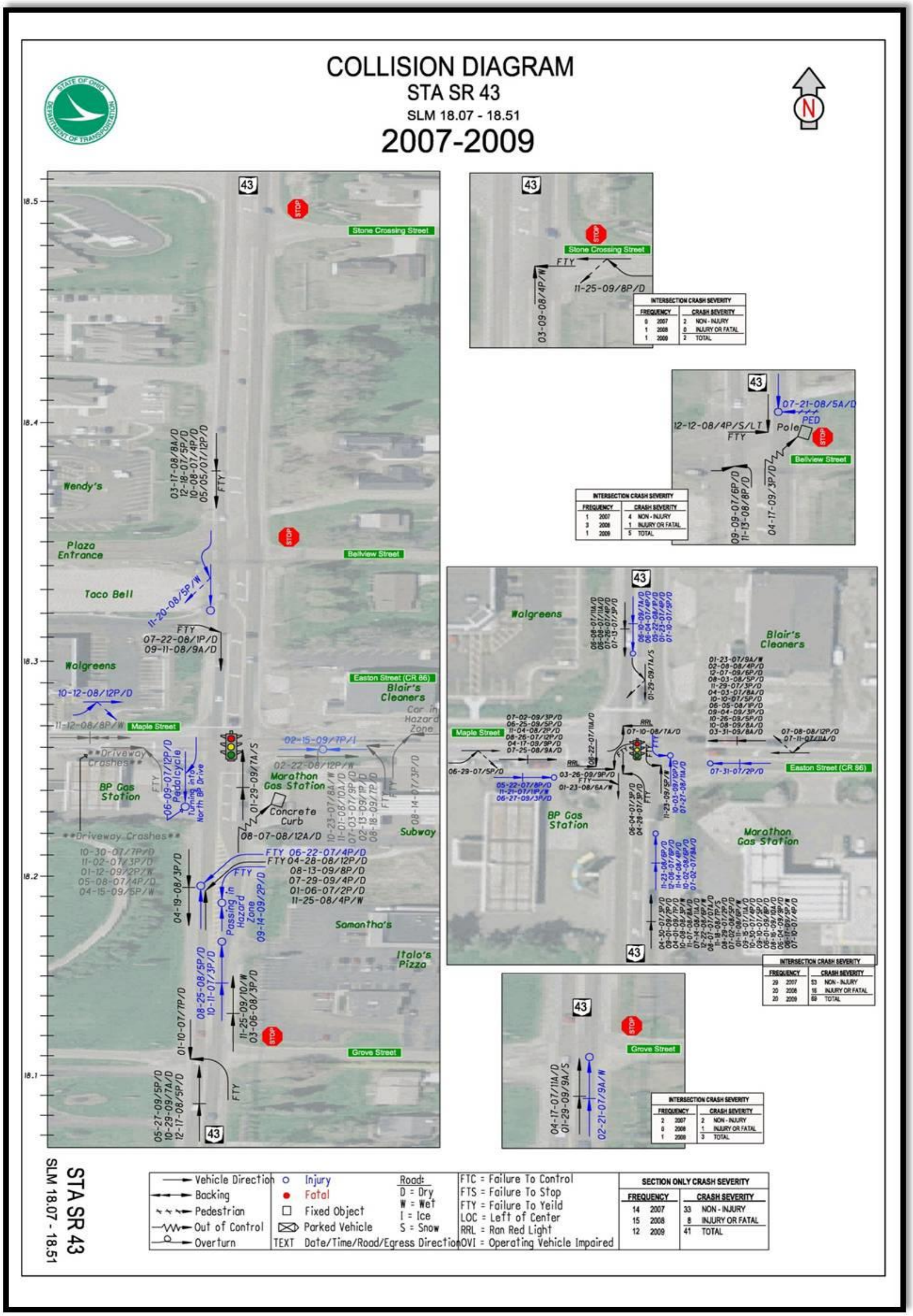


Figure 1298-16. Roadway Section Collision Diagram Example

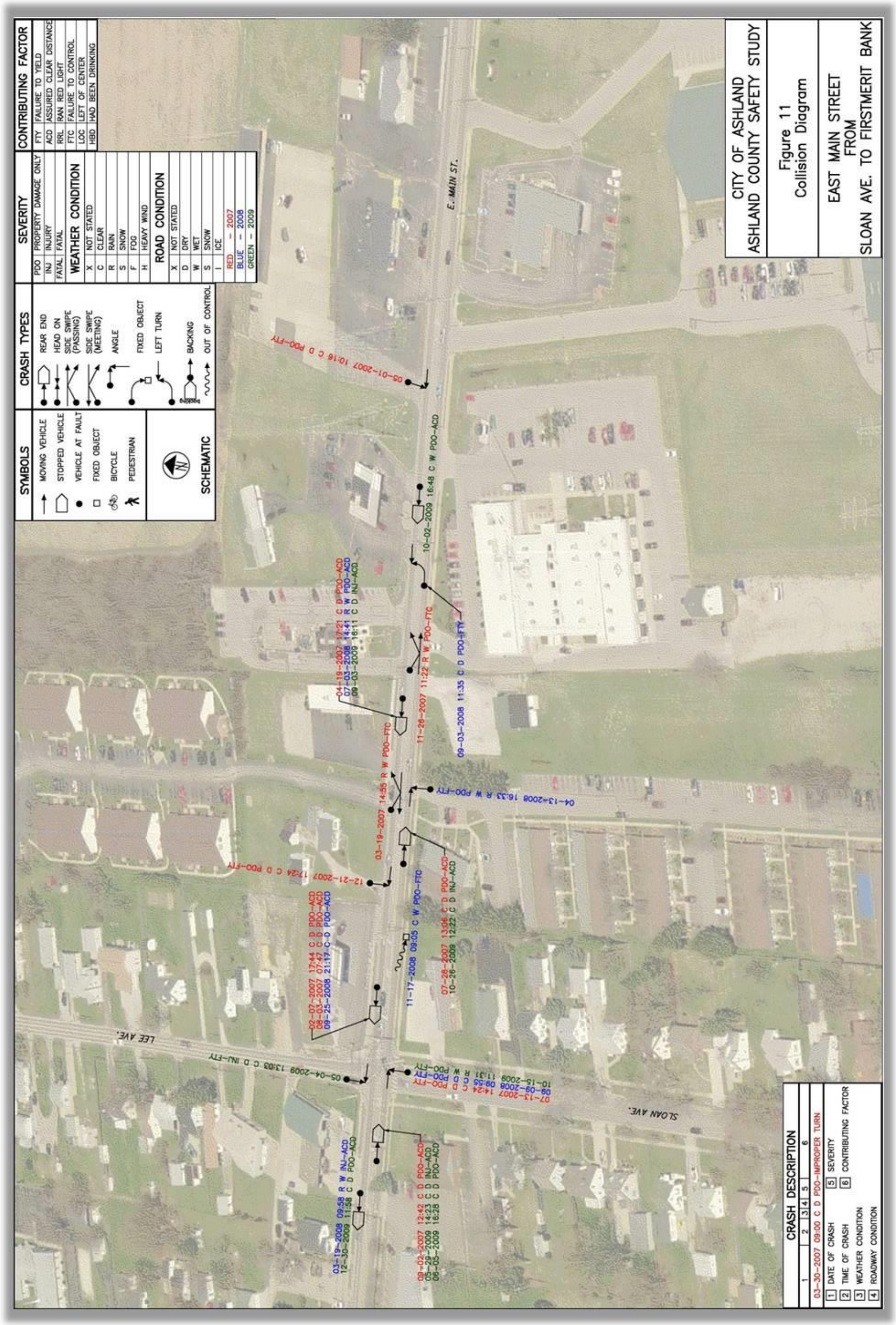


Figure 1298-17. Summary of Crash Pattern Tables

All Crashes

CRASH YEAR	Number	%
2009	4	53.3%
2010	6	26.7%
2011	8	20.0%
Grand Total	18	100.0%

CRASH SEVERITY	Number	%
FATAL CRASH	1	5.6%
INJURY CRASH	10	55.6%
PROPERTY DAMAGE CRASH	7	38.9%
Grand Total	18	100.0%

ROAD CONDITION	Number	%
ROAD - DRY	10	55.6%
ROAD - WET	4	22.2%
ROAD - SNOW	3	16.7%
ROAD CONDITION NOT STATED	1	5.6%
Grand Total	18	100.0%

ROAD CONTOUR	Number	%
STRAIGHT - LEVEL	16	88.9%
STRAIGHT - GRADE	1	5.6%
CURVE - LEVEL	1	5.6%
Grand Total	18	100.0%

LIGHT CONDITION	Number	%
DAYLIGHT	14	77.8%
DARK - NO LIGHTS	4	22.2%
Grand Total	18	100.0%

CONTRIBUTING FACTOR	Number	%
FAILURE TO YIELD	9	50.0%
FOLLOWING TOO CLOSE	4	22.2%
FAILURE TO CONTROL	2	11.1%
NO DRIVER ERRORS	1	5.6%
RAN STOP SIGN OR YIELD SIGN	1	5.6%
IMPROPER TURNING	1	5.6%
Grand Total	18	100.0%

LOCATION	Number	%
INTERSECTION	18	100.0%
Grand Total	18	100.0%

TYPE OF CRASH	Number	%
ANGLE	8	44.4%
REAR END	5	27.8%
LEFT TURN	3	16.7%
SIDESWIPE - MEETING	1	5.6%
HEAD ON	1	5.6%
Grand Total	18	100.0%

HOUR OF DAY	Number	%
7:00	3	16.7%
8:00	1	5.6%
13:00	3	16.7%
14:00	1	5.6%
15:00	1	5.6%
16:00	4	22.2%
17:00	1	5.6%
21:00	1	5.6%
22:00	3	16.70%
Grand Total	18	100.00%

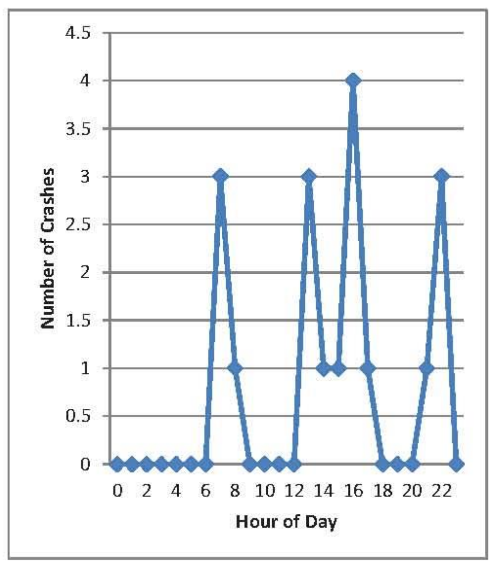


Figure 1298-18. Crash Histogram

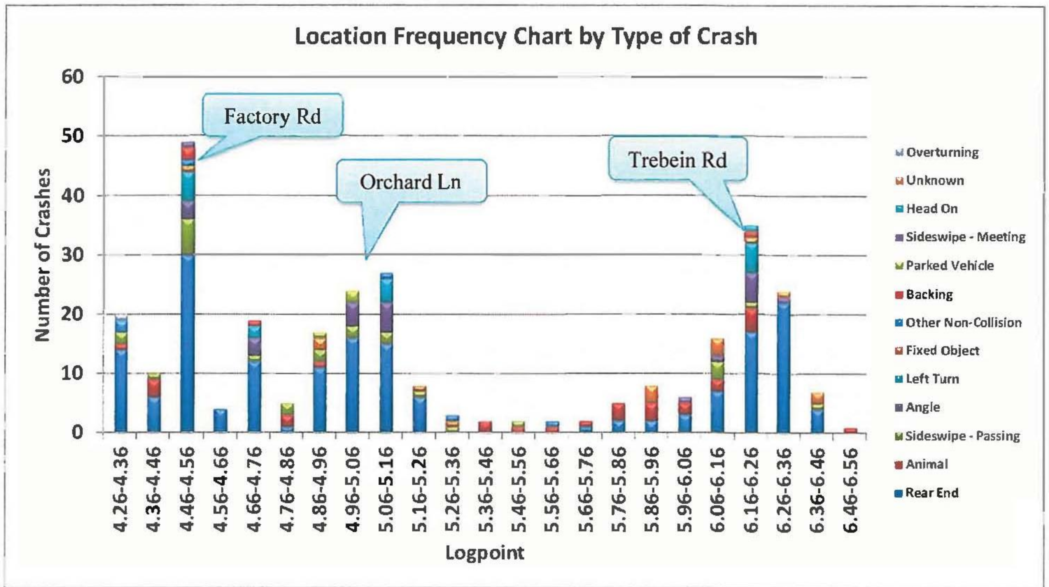


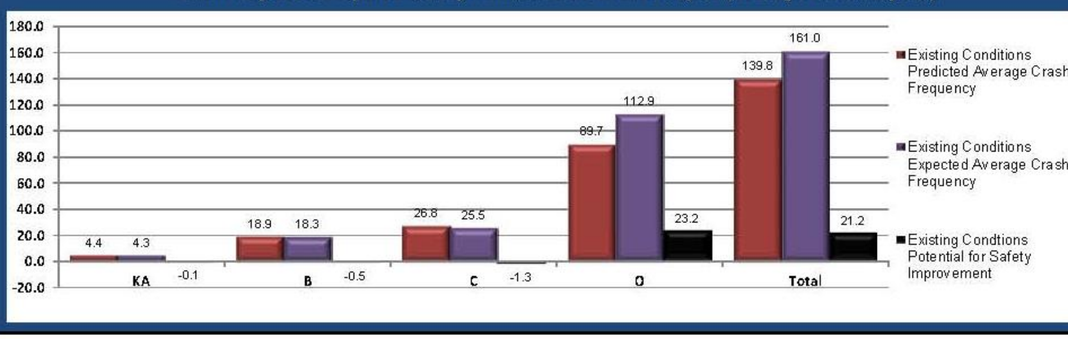
Figure 1298-19. ECAT Project Safety Performance Summary Report – Existing Conditions

Project Safety Performance Summary Report

General Information

Project Name	Hilliard Rome Widening Project	Contact Email	derek.troyer@dot.state.oh.us
Project Description	Franklin County PID 14538	Contact Phone	(614) 387-5164
Reference Number	Traffic Academy Test	Date Performed	12/4/2012
Analyst	Derek Troyer	Analysis Year	2011
Agency/Company	ODOT SPPM		
Perform Benefit Cost Analysis?	Yes	Design Exception Analysis?	Yes

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project EB Method Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$	4.3696	18.8822	26.8336	89.7138	139.7992
$N_{expected}$ - Existing Conditions	4.2654	18.3480	25.5352	112.8715	161.0201
$N_{potential\ for\ improvement}$ - Existing Conditions	-0.1042	-0.5342	-1.2984	23.1577	21.2209

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
CR3; 13.75-13.92	Renner Road to Westpointe Plaza	0.0274	0.0949	0.1652	0.7393	1.0268
CR3; 13.93-14.05	Westpointe Plaza to Westchester Woods Blvd	0.0187	0.0655	0.1137	0.5093	0.7072
CR3; 14.06-14.23	Westchester Woods Blvd to Sam's Club/Giant	0.0419	0.1342	0.1976	0.9194	1.2931
CR3; 14.24-14.47	Sam's Club/Giant Eagle to Tanglewood Park B	0.0544	0.1725	0.2552	1.1754	1.6575
CR3; 14.48-14.7	Tanglewood Park Blvd to Nike Dr	0.0457	0.1459	0.2119	0.9901	1.3936
CR3; 14.71-14.85	Nike Dr to Reebok Dr/ Avia Dr	0.0317	0.1007	0.1482	0.6851	0.9657
CR3; 14.86-15.16	Reebok Dr/ Avia Dr to Kroger Drive	0.074	0.2356	0.3488	1.6106	2.269
CR3; 15.17-15.32	Kroger Drive to Roberts Rd	0.041	0.1785	0.1696	0.9359	1.325
CR3; 13.75	Renner Road	0.7659	3.462	4.9839	15.874	25.0858
CR3; 13.93	Westpointe Plaza	0.5377	2.3924	3.4146	11.1419	17.4866
CR3; 14.06	Westchester Woods Blvd	0.4622	2.0609	2.9401	9.7805	15.2437
CR3; 14.24	Sam's Club/Giant Eagle	0.4591	2.0672	2.9613	9.8495	15.3371
CR3; 14.48	Tanglewood Park Blvd	0.4246	1.7857	2.4845	8.0485	12.7433
CR3; 14.71	Nike Dr	0.3673	1.6322	2.3271	7.6326	11.9592
CR3; 14.86	Reebok Dr/ Avia Dr	0.1351	0.5822	0.8388	2.1496	3.7057
CR3; 15.17	Kroger Drive	0.4671	1.9453	2.6935	8.7403	13.8462
CR3; 15.32	Roberts Rd	0.4158	1.8265	2.5796	8.9318	13.7537

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

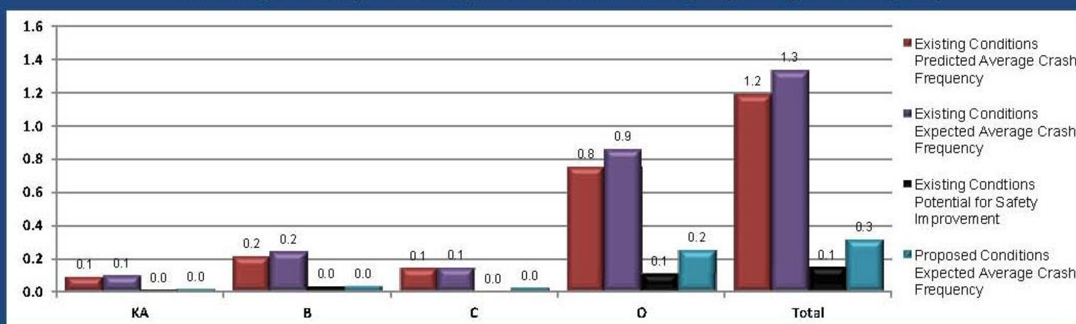
Project Element ID	Common Name	Crash Severity Level				
		KA	B	C	O	Total
CR3; 13.75-13.92	Renner Road to Westpointe Plaza	-0.0002	-0.0036	0.0284	0.0584	0.083
CR3; 13.93-14.05	Westpointe Plaza to Westchester Woods Blvd	-0.0001	-0.0018	-0.0091	-0.0995	-0.1105
CR3; 14.06-14.23	Westchester Woods Blvd to Sam's Club/Giant	-0.0002	-0.0034	-0.0101	-0.0423	-0.056
CR3; 14.24-14.47	Sam's Club/Giant Eagle to Tanglewood Park B	-0.0005	-0.0062	-0.0184	-0.1541	-0.1792
CR3; 14.48-14.7	Tanglewood Park Blvd to Nike Dr	0	0.027	-0.0109	0.2541	0.2702
CR3; 14.71-14.85	Nike Dr to Reebok Dr/ Avia Dr	0.0017	-0.0021	-0.0062	0.0596	0.053
CR3; 14.86-15.16	Reebok Dr/ Avia Dr to Kroger Drive	-0.0006	0.0149	-0.0276	1.4826	1.4693
CR3; 15.17-15.32	Kroger Drive to Roberts Rd	-0.0001	-0.0042	-0.0052	0.1769	0.1674
CR3; 13.75	Renner Road	-0.023	0.0049	0.3644	15.5676	15.9139
CR3; 13.93	Westpointe Plaza	-0.0187	-0.3583	-0.678	-5.0695	-6.1245
CR3; 14.06	Westchester Woods Blvd	-0.0145	0.0372	0.238	7.476	7.7367
CR3; 14.24	Sam's Club/Giant Eagle	-0.0143	-0.155	-0.6769	-4.1163	-4.9625
CR3; 14.48	Tanglewood Park Blvd	-0.0145	-0.1552	-0.2317	3.4115	3.0101
CR3; 14.71	Nike Dr	-0.0085	-0.1028	-0.021	2.7492	2.6169
CR3; 14.86	Reebok Dr/ Avia Dr	0.011	0.0819	-0.0938	1.1054	1.1045
CR3; 15.17	Kroger Drive	-0.0183	-0.188	-0.3481	-2.7564	-3.3108
CR3; 15.32	Roberts Rd	-0.0034	0.2805	0.2078	3.0545	3.5394
						0

Figure 1298-20. ECAT Project Safety Performance Summary Report – Proposed Safety Improvements

Project Safety Performance Summary Report

General Information			
Project Name	WOO-SR 199 & Roachton Rd.	Contact Email	Cory.Hopwood@dot.state.oh.us
Project Description	Install Roundabout, warning signs, rasied pavement markings	Contact Phone	(614) 387-0112
Reference Number	201305D02-06	Date Performed	7/5/2013
Analyst	Cory Hopwood	Analysis Year	2011
Agency/Company	ODOT SPPM		
Perform Benefit Cost Analysis?	Yes		

Summary of Anticipated Safety Performance of the Project (average crashes/year)



Project EB Method Summary Results (Without Animal Crashes)

	KA	B	C	O	Total
$N_{predicted}$	0.1	0.2	0.1	0.8	1.2
$N_{expected}$ - Existing Conditions	0.1	0.2	0.1	0.9	1.3
$N_{potential\ for\ improvement}$ - Existing Conditions	0.0	0.0	0.0	0.1	0.1
$N_{expected}$ - Proposed Conditions - Parts C & D	0.0	0.0	0.0	0.2	0.3

Existing Conditions Project Element Predicted Crash Summary (Without Animal Crashes

Project Element ID	Common Name	Crash Severity Level KA	B	C	O	Total
SR199; 27.91	SR 199/RoachtonRd	0.087	0.2108	0.1404	0.7543	1.1925
						0

Existing Conditions Project Element Potential for Safety Improvement Summary (Without Animal Crashes)

Project Element ID	Common Name	Crash Severity Level KA	B	C	O	Total
SR199; 27.91	SR 199/RoachtonRd	0.0077	0.0307	0.0017	0.1052	0.1453
						0

Proposed Conditions Project Element Expected Crash Summary - Parts C & D (Without Animal Crashes

Project Element ID	Common Name	Crash Severity Level KA	B	C	O	Total
SR199; 27.91	SR 199/RoachtonRd	0.0123	0.0314	0.0185	0.2493	0.3115
						0

Figure 1298-21. Proposed Conditions Diagram – Example 1

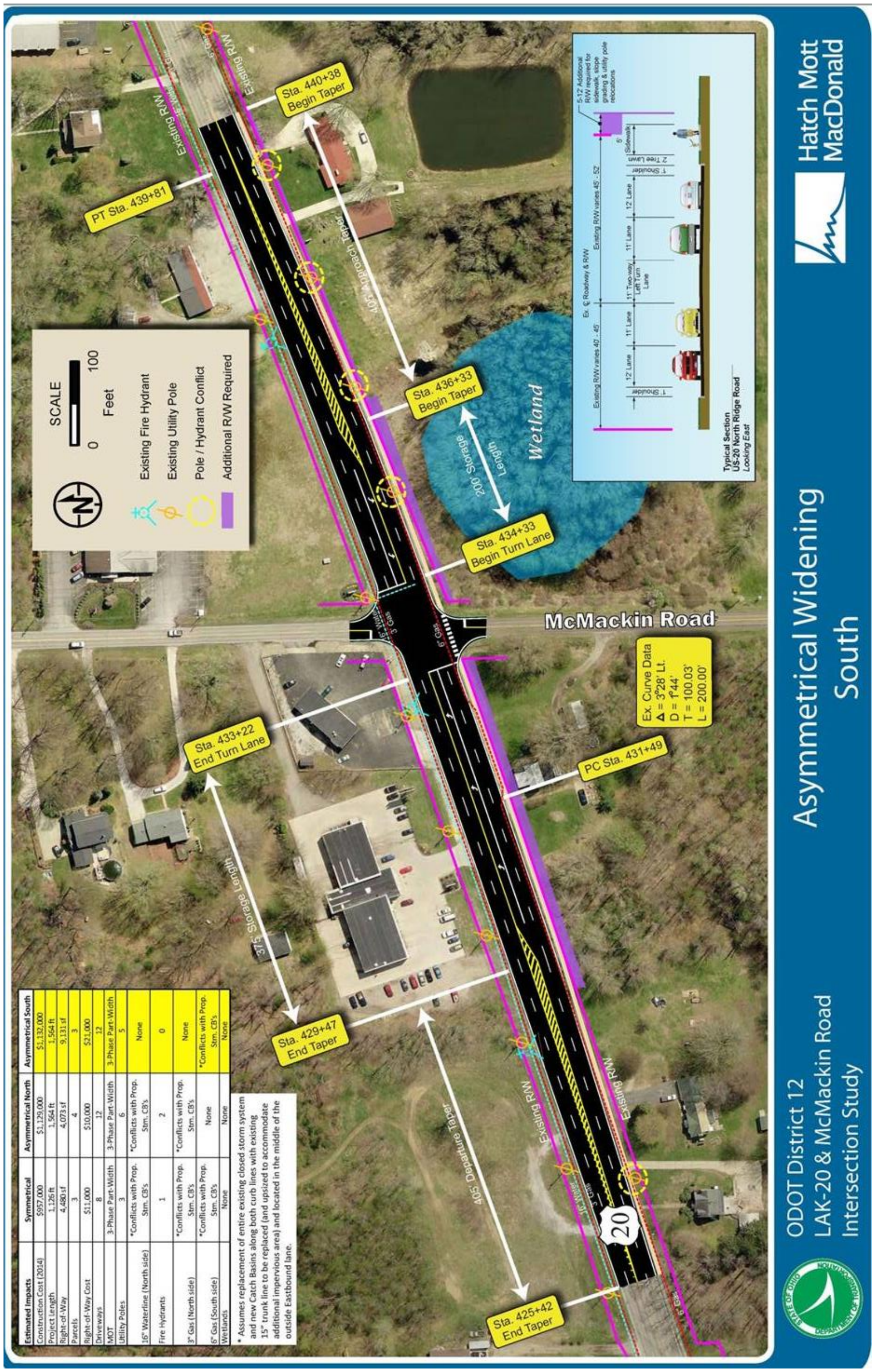


Figure 1298-22. Proposed Conditions Diagram – Example 2

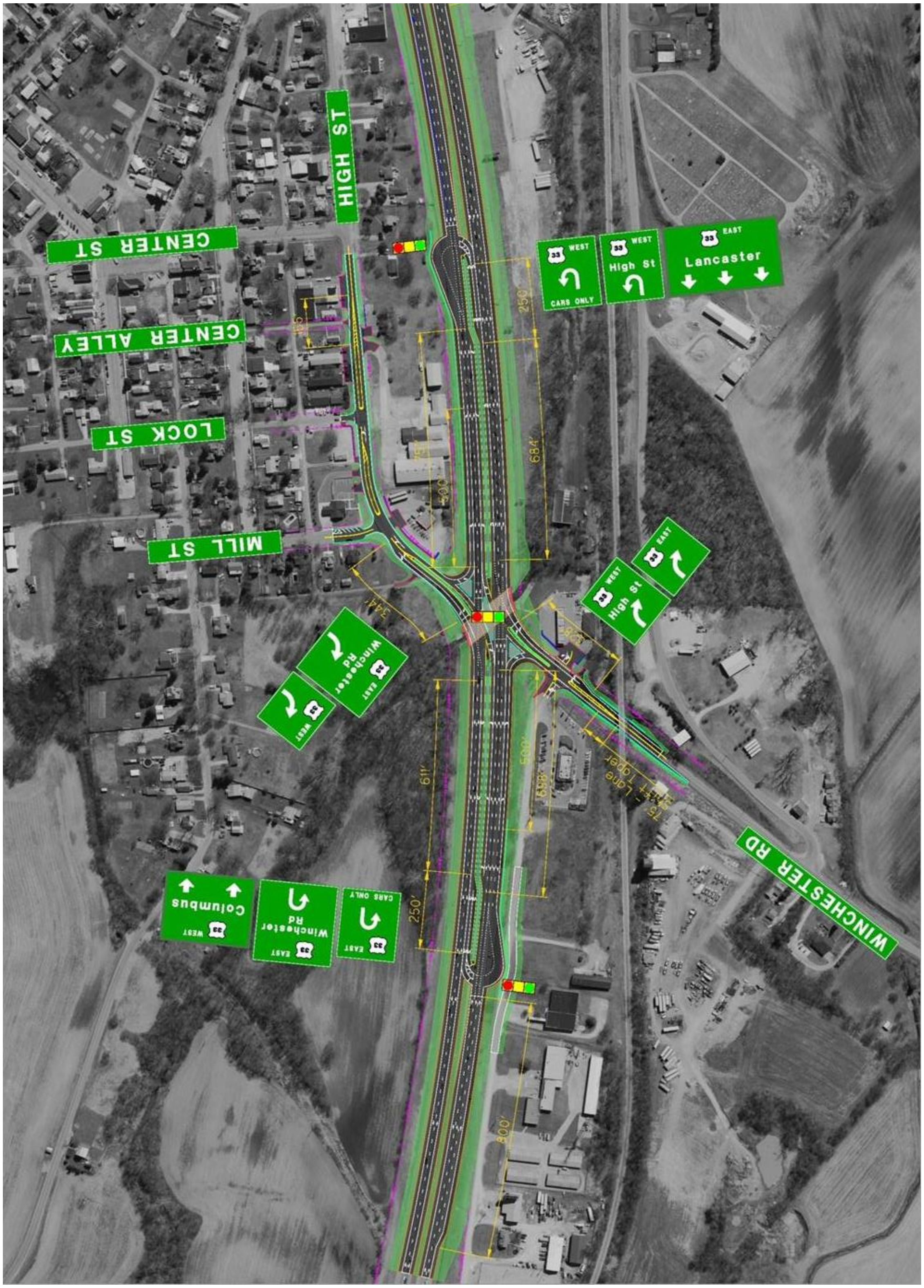


TABLE OF CONTENTS
Part 13 - INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

Part 13 - INTELLIGENT TRANSPORTATION SYSTEMS

1300 GENERAL

This Part of the **TEM** addresses policies, guidelines, standard procedures, etc. related to Intelligent Transportation Systems (ITS), which in this context means electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

Deployment and operation of these systems requires specialized coordination, design and device specifications, procurement/construction, and management. The **Office of Traffic Operations (OTO)** shall provide implementation plans for ITS and policies for ITS operation.

1301 23 CFR 940 Compliance

1301-1 General

1301-1.1 Background

Federal Regulation **23 CFR 940** requires ITS projects and traditional projects with ITS components funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. The **Ohio Procedures for Implementing ITS Regulations (23 CFR 940)** documents the requirements to be used in **Ohio** for any ITS project utilizing Federal funds. These requirements apply to the ITS components.

The **Ohio** procedures incorporate guidance from several sources, including **23 CFR 940**, the **Programmatic Agreement for ITS Systems Engineering Analysis** between the **Federal Highway Administration's (FHWA) Ohio Division Offices** and **ODOT** and the **Federal-Aid Highway Program Stewardship and Oversight Agreement**. **ODOT's** interpretation of the Federal policy provides a streamlined process to address project definitions, ITS architecture modifications, and systems engineering. This approach will permit **ODOT** and **FHWA** to establish concurrence in the level of ITS assessment and documentation needed.

As this is a Federal requirement for funding, it is imperative for **ODOT** to effectively administer this process so as to not adversely affect project delivery. **ODOT** will collaborate with the **Ohio Division of FHWA** to guide **ODOT District** offices and local agencies through the documentation for ITS projects.

The requirements in **23 CFR 940** include provisions for interoperability and future integration of equipment, software and systems. This **FHWA** requirement is similar to other separate and distinct Federal requirements which are accepted and are an inherent part of the project development process. This section provides guidance for using **ODOT's Project Development Process (PDP)**, **L&D Manual** and **TEM** for mainstreaming these requirements.

A major component of the **CFR 940** documentation is the testing plan. The **Programmatic Agreement for ITS Systems Engineering Analysis** utilizes a risk-based approach to establish a streamlined process for the required Systems Engineering Analysis documentation. See ***Section 1301-3*** for information on the risk-based Systems Engineering Analysis.

1301-1.2 Introduction and Scope

These requirements apply to Federal Aid projects, as required by **23 CFR 940**, the **Programmatic Agreement for ITS Systems Engineering Analysis** between **FHWA's Ohio Division** and **ODOT** and the **Ohio Federal-aid Highway Program Stewardship and Oversight Agreement.** It is recommended that **State**-funded projects follow the same process for regional consistency.

In accordance with **23 CFR 940**, ITS projects funded through the highway trust fund shall conform to the National ITS Architecture and applicable standards. **23 CFR 940** also stipulates that "conformance with the National ITS Architecture is interpreted to mean the use of the National ITS Architecture to develop a Regional ITS Architecture, as applicable, and the subsequent adherence of all ITS projects to that Regional ITS Architecture." This section outlines the **ODOT** procedures for implementing these requirements. The level of documentation should be commensurate with the project scope. The flowchart in ***Figure 1398-1*** further illustrates the procedures described below.

ODOT-administered ITS projects shall follow the **Programmatic Agreement for ITS Systems Engineering Analysis** between **FHWA's Ohio Division** and **ODOT** and the current **Ohio Federal-aid Highway Program Stewardship and Oversight Agreement** with regard to oversight of the projects. Local agency project coordination for ITS projects will be through the **ODOT District** with coordination through the **ODOT Office of Traffic Operations** and **FHWA Ohio Division Office**, as applicable, for concurrence in the level of ITS assessment and documentation required.

1301-1.3 General Criteria

In accordance with **23 CFR 940.3**, an ITS project is "any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture" and summarized in ***Table 1397-2***. In **Ohio,** a project would be considered to be an ITS project if it meets any of the following:

1. It requires the integration of multiple separate systems.
2. It is a project that has significant potential to involve the integration of technologies on a multi-jurisdictional level.
3. It replaces existing or installs new centrally controlled software.

For non-Freeway Management System projects, a project, even one meeting the above criteria illustrated by the examples below and in ***Table 1397-1***, would not be considered an ITS project if it is an expansion of an existing system and does not add functionality. However, expansion of a Freeway Management System through additional phases is always considered an ITS project. Enforcement systems and systems used primarily to gather and archive data not directly used for operational purposes are not generally considered to be ITS.

ITS projects come with various risk factors, such as cost overruns, not meeting agency needs and system failure. The level of risk varies depending on the presence of the following factors:

1. Number of jurisdictions and/or modes involved.
2. Extent of new, unproven software creation.
3. Extent of new, unproven hardware and communication technology being used.
4. Number and level of complexity of new interfaces to other systems.
5. Level of detail needed in defining the functional requirements.
6. Level of detail needed in defining the operations and management procedures.

7. Service life of the equipment and software technology.

The risk-based Systems Engineering Analysis approach classifies ITS projects into three types: Exempt, Low-Risk and High-Risk.

For examples of Exempt, Low-Risk and High-Risk projects see ***Table 1397-1***. The decisive factor in this determination is the scale and complexity of the project.

1301-2 Architecture

1301-2.1 General

In areas served by a Metropolitan Planning Organization (**MPO)**, the **MPO** needs to identify potential transit and highway ITS projects to the **ODOT District** when reviewing local programs for inclusion in the Transportation Infrastructure Plan TIP. In areas not served by an **MPO**, the **ODOT Local Project Administrator (LPA)** needs to perform this identifying function. It shall be the responsibility of the **ODOT District** to determine if a project is an ITS project, and if so, to identify it as an Exempt, Low-Risk or High-Risk. ITS Project. If the determination of whether a project is ITS or non-ITS, or whether a project is an Exempt, Low-Risk or High-Risk.ITS Project is not obvious, the project shall be discussed with the **Office of Traffic Operations** to make a determination. The **District** will notify the **MPO** and the **project sponsor** of the determination in writing.

An ITS Project will require a more comprehensive effort that analyzes several options for each type of technology selected, since these types of projects tend to be multifaceted. Generally, there are several elements that need to be evaluated and more options are analyzed in an ITS Project. If a consultant is used for an ITS Project, these procedures should be included in the consultant's Scope of Work.

1301-2.2 Architecture Conformity

To ensure conformity with **23 CFR 940**, several requirements must be met. The rule stipulates that conformance with the National ITS Architecture is interpreted to mean the use of the National ITS Architecture to develop a Regional ITS Architecture, and the subsequent adherence of all ITS projects to that Regional ITS Architecture.

According to **23 CFR 940.3**, a Regional ITS Architecture is "a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects." It documents data flows and subsystems, roles and responsibilities, operating agreements, and ITS Standards to be used for a particular region. In **Ohio**, Regional ITS Architectures generally encompass an **MPO** area. A Statewide ITS Architecture is a form of a Regional ITS Architecture. **Ohio** is currently developing a statewide ITS architecture. See ***Table 1397-3*** for a listing of Regional ITS Architectures in **Ohio**.

1301-2.3 Project Level ITS Architecture

A Project Level ITS Architecture, according to **23 CFR 940.3** is a framework that identifies the institutional agreement and technical integration necessary to interface an ITS project with other ITS projects and systems. The Project Level ITS Architecture indicates the data flows and subsystems that the project will implement. To achieve the significant benefits derived from the documentation, a Project Level ITS Architecture needs to be developed for all ITS Projects. For further information, refer to ***Subsection 1301-3.2***, Systems Engineering Analysis Documentation.

1301-2.4 If a Regional ITS Architecture Exists

If an ITS project falls within the boundaries of a Regional ITS Architecture (see ***Table 1397-3***) the Project Level ITS Architecture should be developed as follows:

1. <u>If the project functions exist in the Regional ITS Architecture:</u> Copy the appropriate pages from the Regional ITS Architecture and use a highlighter to highlight the data flows that will be implemented by the project. This highlighting will satisfy the requirements for a Project Level ITS Architecture.
2. <u>If some project functions do not exist in the Regional Architecture:</u> The Project Level ITS Architecture must supplement the Regional ITS Architecture with any missing data flows. Copy the appropriate pages from the Regional ITS Architecture and use a highlighter to highlight the existing data flows that will be implemented by the project and add the additional data flows that will be implemented. The **MPO** maintaining the Regional ITS Architecture also needs to be notified of the changes, for purposes of updating the Regional ITS Architecture.
3. <u>If none of the project functions exist in the Regional ITS Architecture:</u> A Project Level ITS Architecture shall be created, using as a base the Regional ITS Architecture and the National ITS Architecture. The **MPO** maintaining the Regional ITS Architecture shall be notified of the changes, for purposes of updating the Regional ITS Architecture.

The final design of all ITS projects shall accommodate the interface requirements and information exchanges as specified in the Regional ITS Architecture. If the final design of the ITS project is inconsistent with the Regional ITS Architecture, then the discrepancies shall be reconciled and the Regional ITS Architecture or the project shall be modified as appropriate.

1301-2.5 If a Regional ITS Architecture Does Not Exist

In the future, when a statewide ITS architecture is available (see ***Section 1301-2.2***) if an ITS project falls in an area not covered by the boundaries of a Regional ITS architecture (see ***Table 1397-3***), the statewide provisions will apply. Currently, if an ITS project falls in an area not covered by the boundaries of a Regional ITS Architecture, a few additional procedures will be required in the development of the Project Level ITS Architecture.

First, determine if the ITS project should be added to an existing Regional ITS Architecture. The decision should be based upon geographic, stakeholder, and system function considerations.

If the new ITS project will not be added to an existing Regional ITS Architecture, then Project Level ITS Architecture will need to be created using the National ITS Architecture as a basis.

If this is the first ITS project in the area, the timeframe for developing a Regional ITS Architecture begins, and the Region will have four years from the date that the project advances to final design to create a Regional ITS Architecture that is “Ready for Use.” Final design is defined as entry to Stage 3 Design at the appropriate step of the **PDP**.

For subsequent projects in the Region, until the four years have passed or the Regional ITS Architecture is developed, whichever is earlier, Project Level ITS Architecture shall use the National ITS Architecture as a basis.

<u>For Federal funds to be considered once the four years have passed, the Regional ITS Architecture must be completed for ITS projects to be authorized for construction.</u>

1301-3 <u>Systems Engineering Analysis (SEA)</u>

1301-3.1 General

In **Ohio**, all ITS projects shall be based on a Systems Engineering Analysis (SEA). This is a process or a structured approach which can control costs, lead to reduced risks, maintain the project schedule, satisfy user needs, and meet the requirements of **ODOT** and the **Federal** regulation. The SEA effort will vary based on the level of risk associated with the ITS project. ITS Projects are classified into three types: Exempt, Low-Risk and High-Risk.

Exempt ITS Projects do not require Systems Engineering Analysis documentation, nor any ITS-specific approval action, as long as they only affect one maintaining agency. Exempt ITS projects affecting multiple agencies are also considered exempt if there is an Operations and Management Agreement between the affected agencies that details the procedures and resources necessary for the operations and management of the system. Projects affecting multiple agencies without such an agreement are considered High-Risk and require a project-specific Systems Engineering Analysis be completed and approved. See ***Table 1397-1*** for projects that classify as Exempt ITS Projects.

Low-Risk ITS projects shall utilize a **Systems Engineering Review Form (SERF)** to assess the level of risk and confirm that it is indeed “low risk”. If all of the questions on the SERF are answered in the affirmative, i.e. “Yes”, then the project can be considered Low-Risk. The SERF will also document that the project is in conformance with the Functional Requirements document for that particular project category and the Systems Engineering Analysis requirements of **23 CFR 940.11**. See ***Table 1397-1*** for projects that classify as Low-Risk ITS Projects. See ***Section 1396-3*** for information on completing a **Systems Engineering Review Form (SERF)** for these projects.

High-Risk ITS projects require a project-specific Systems Engineering Analysis be completed and approved. These types of projects typically involve new or unproven technology, multiple maintaining agencies and/or new hardware, software or interfaces. See ***Table 1397-1*** for projects that classify as High-Risk ITS Projects.

For High-Risk ITS projects, an SEA will provide:

- a description of the scope of the ITS project (the general location, conceptual alternative, and logical termini or service area of the proposed project);
- a concept of operations that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS project;
- functional requirements of the ITS project;
- interface requirements and information exchanges between the ITS project and other planned and existing systems and subsystems; and
- identification of applicable ITS standards.

The scale of the analysis should be commensurate with the project scope of the ITS portion of the project. In **Ohio,** the full SEA is comprised of twelve Items to be addressed, which further describe these elements. The twelve items are elaborated in ***Subsection 1301-3.2***, Systems Engineering Analysis Documentation.

ITS projects are required to follow the **Project Development Process (PDP)**, see ***TEM Figure 1398-1.*** The various SEA documents (see ***Subsections 1301-3.2 and 1301-3.3***) are to be developed and submitted at the appropriate point in the project.

For Design-Build projects, reference the **Office of Traffic Operations** in the Plan Notes with the following contact information:

Office of Traffic Operations
Phone: 614-387-4113
Fax: 614-887-4134
Email: cen.its.lab@dot.state.oh.us

1301-3.2 Systems Engineering Analysis Documentation

All submissions required by the **PDP** **(see *Sections 140-7* and L&D Manual Volume 1)** shall be required for ITS projects.

A Project Level ITS Architecture and a Systems Engineering Analysis (SEA) are required for any High-Risk ITS project. The documentation is expected to be commensurate with the scope of the ITS work. Both the Project Level ITS Architecture and the SEA must be completed and approved prior to authorization of construction funding. For examples of how to address SEA Items 1-12 for some projects, refer to ***Form 1396-1**.* For clarity, page breaks should be inserted between each of the twelve items. The SEA will consist of providing items 1 through 12, listed below:

SEA Item #1 - Define the scope of work for the project (the general location, conceptual alternative, and logical termini or service area of the proposed project). Scoping shall also include inter-agency coordination and possible effects on neighboring jurisdictions.

Define the scope of work for the overall project and the ITS components (the general location, conceptual alternative, level of development and logical termini or service area of the proposed project) Scoping shall also include inter-agency coordination and possible effects on neighboring jurisdictions. Include the PID, location, project description from ELLIS or other sources, description of the ITS work, and the project background (summary of purpose and need).

Be as descriptive as possible and briefly address any proprietary equipment/software requirements.

SEA Item #2 - Identify portions of the Regional ITS Architecture being implemented.

Identify portions of the Regional ITS Architecture being implemented or, if a Regional ITS Architecture does not exist, the applicable portions of the National ITS Architecture. Include identification of the ITS User Services which will apply to the project and a graphic from the Regional ITS Architecture illustrating the data flows that will be incorporated. Inclusion of SEA Item #2 will satisfy the Project Level ITS Architecture requirements. The use of the **FHWA** software product ***TurboArchitecture*** is highly recommended. This software can be downloaded free of charge from the **FHWA**.

If no Regional ITS Architecture exists for the project area, contact the **ODOT Office of Traffic Operations (OTO)**.

SEA Item #3 - Provide a list of all stakeholders, including the roles and responsibilities of each and the Operational Concept and Concept of Operations.

Provide a list of stakeholders that have a direct role in the project.

Provide an Operational Concept. The Operational Concept is a high level description of the roles and responsibilities of the primary stakeholders and the systems they operate.

Provide a Concept of Operations. The Concept of Operations is a more detailed description of how the system will be used. It should discuss what the project is to accomplish, including identifying stakeholder needs and resources that stakeholders can provide. It is non-technical and provides a bridge between the needs motivating the project and the specific technical requirements. The greater the expected impact on operations, the more detailed explanation will be required. For complex projects, operational scenarios may be necessary to illustrate the operations.

SEA Item #4 - Define the functional requirements of the project.

The functional requirements of the project describe how the project will be built and operated and typically are based upon the ITS Market Packages. High level functional requirements should be listed and can further be used to develop specific contract specifications language. Provide interface/communication requirements for all stakeholders in the project. This includes the existing systems already deployed in the region.

Functional requirements are statements of the capabilities that a system must have ("functions"), geared to addressing the *business needs* that a system must satisfy. *Business needs* are the objectives for which the system is built. These functional requirements will be traced through the life of the project.

A key aspect of the functional requirements is that they address what a system must do, but does not address how the system should accomplish the what. In other words, a functional requirement should not go into the details of how to implement the function.

For more information on functional requirements, see the **USDOT** publication "Developing Functional Requirements for ITS Projects" which is available on the **FHWA** website.

SEA Item #5 - Provide analysis of alternative system configurations and technology options to meet requirements, including rationale for technology selection.

Describe the basis of the project scope and how it was developed. Identify any proprietary items and explain the necessity and rationale for these items. Show the link between the system design concept and the operations and maintenance of the constructed project.

SEA Item #6 - Provide analysis of procurement methods considered including rationale for selected option.

Describe possible procurement methods for the design, construction, and operations/ maintenance (as applicable) of the project and why the preferred method was selected. In some cases, the procurement methods may be determined by **State** law.

SEA Item #7 - Identify the existing ITS Standards that will be used in the project. An explanation is required for not using the applicable Standards.

ITS Standards are available on-line from the **FHWA** website. List all ITS Standards which may be applicable to the project, indicate if the Standard is to be used in the project, and if not used, provide an explanation of why they are not being used.

SEA Item #8 - Identify the testing procedures to verify compliance with the standards as well as the requirement for interoperability.

The testing procedures verify the individual elements of the project comply with the project specifications. The specifications are based upon the high level functional requirements identified in SEA Item #4. For some projects, the testing procedures may be provided by a product vendor.

Project submittal cut sheets, laboratory reports and precertification may be substituted for some field testing. Devices on a Qualified Providers List (QPL) do not need to be tested. Other devices or additional functionality will be included on the traceability matrix for field testing.

SEA Item #9 - Provide a traceability matrix for documenting compliance with the above.

Provide a traceability matrix for documenting compliance of the testing procedures. The traceability matrix provides a mechanism for ensuring that each functional requirement is tested and that each item to be tested has been addressed in the specifications.

A sample traceability matrix applicable to an emergency vehicle preemption project is shown as part of ***Form 1396-2*** and is available on the **OTO** Forms web page. The form may be modified as necessary.

The traceability matrix will be included in the contract documents for use during construction. The completed traceability matrix will include the results of the test and any necessary work to address failures during the test and will be included in the project construction records.

SEA Item #10 - Provide change management control.

Provide a description of the change management control. Describe what changes were made during project development, how changes were accommodated, and how change orders will be processed and managed during construction, including identifying necessary approvals. In many cases standard procedures used by the agency will incorporate many of these items.

This item requires documentation of changes in design, construction, and operations.

SEA Item #11 - Provide a Maintenance Plan and a funding analysis for the maintenance, operation and funding of the system after completion. This includes an analysis of cost, personnel, and anything further required to maintain and operate.

Provide a Maintenance Plan and a funding analysis for the maintenance and operation of the system after completion. This includes an analysis of cost, personnel, software, utilities and anything further required to maintain and operate the system, typically on an annual basis. Examples of this item are available on the **OTO** website.

SEA Item #12 - Provide documentation for revising the Regional ITS Architecture.

Provide documentation for revising the Regional ITS Architecture after project construction. Contact the appropriate MPO for preferred or required formats for submitting this information.

1301-3.3 Additional Requirements

The **Programmatic Agreement for ITS Systems Engineering Analysis** and the **Ohio Federal-Aid Highway Program Stewardship and Oversight Agreement** between **ODOT** and **FHWA** establishes **FHWA** involvement on ITS projects.

It is anticipated that the SEA documentation will be prepared by the local agency or its consultant, for submission to the appropriate **ODOT District**, to be forwarded on to **OTO**. For **ODOT** projects, it is anticipated that the documentation will be prepared by the **ODOT District** for submittal to **OTO**.

Local agencies shall submit all appropriate documents to the appropriate **ODOT District** for review and approval per the existing project administration procedures. **OTO** will then coordinate with and forward submittals to **FHWA** per the **Federal-aid Highway Program Stewardship and Oversight Agreement**.

In addition, when the project is covered by a Regional ITS Architecture, the as-built Project Level ITS Architecture with any modifications noted, shall be submitted by the local agency to the appropriate **MPO** for updating the Regional ITS Architecture.

Contact **OTO** for preferred documentation formats. ***Forms 1396-1 and 1396-2*** provide sample documents that can be used, including a simplified form for Emergency Vehicle Preemption projects. These forms are available on the **OTO** Forms web page. The forms may be modified as necessary. For signalized intersections within about 200 feet of a highway rail intersection, additional work may be needed. A simplified form for Railroad Preemption projects is available from the **OTO** upon request.

Project documentation shall be retained by the **District** in their project files. For Low-Risk ITS Projects, a copy of the completed SERF shall be kept in the project files. For Low-Risk or Exempt Projects that affect multiple agencies, a copy of the Operations and Management Agreement shall be kept in the project files. For High-Risk ITS Projects, a project-specific Systems Engineering Analysis shall be kept in the project files.

ODOT shall designate the ITS applicability of every Federal-aid project on its web-based application for project management (currently Ellis). See ***Section 1301-4*** for Ellis requirements.

If any uncertainty exists regarding design requirements, standards or forms, or other ITS requirements, the project sponsor should contact the **District**.

1301-4 Ellis Requirements for ITS Projects

ITS projects shall utilize one of the two following Ellis Project Report Codes as appropriate to document progress toward completion of the required **CFR 940** documentation. The report codes should be created and updated throughout the project beginning at the time the project is scoped.

During PS&E approval of a project, Ellis will be referenced to determine if documentation is required. If an ITS project does not have the proper documentation, authorization for funding of the project could be delayed at PS&E.

Ellis Report Codes:

- CFR 940 Exempt ITS Project
- CFR 940 Low-Risk ITS Project
- CFR 940 High-Risk ITS Project
- N/A

Intentionally blank.

1303 FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS.

1303-1 General

A primary goal of the Freeway Management System (FMS) is to provide reliable and timely travel information. This shall be achieved through the provision of route and segment-based travel times. Valid travel times are to be provided in real time, providing easily accessible information about delays.

Information dissemination will be accomplished using a variety of methods including:

- OHGO.com
- Dynamic Message Signs (DMS)
- Highway Advisory Radio (HAR)
- **Ohio** 511 telephone number
- Radio and television broadcasts (private-sector leveraging FMS information)

It is the intended that **ODOT**'s statewide FMS deployment will provide full coverage of six of the metropolitan areas with full instrumentation and communication to a central **Traffic Management Center (TMC)**, in accordance with the Regional Architecture prepared by the **MPO** in cooperation with **ODOT** and **FHWA**. The Regional Architectures are defined in the Detailed Project Plans, prepared under the direction of these same agencies.

See ***Chapter 1343*** for information about the related **C&MS** sections and **Supplemental Specifications**.

The information provided herein is intended to provide designers all necessary details needed to develop a thorough plan for the ITS infrastructure.

1303-2 Traffic Management Center (TMC)

The **ODOT's Statewide Traffic Management Center (TMC)** operates traffic management and traveler information systems on **Ohio's** Interstates, other freeways, expressways and state highways. The mission of the **TMC** is to increase transportation safety, reduce congestion, and increase efficiency on **Ohio's** state highways. Housed in **ODOT's Central Office** building, the **TMC** monitors traffic in each of the State's major metropolitan areas including Akron/Canton, Cincinnati, Cleveland, Columbus, Dayton/Springfield, and Toledo. **TMC** operators can control cameras and post traveler information messages to **ODOT's** Dynamic Message Signs, Highway Advisory Radios, and to the OHGO website. The **TMC** operators can also act as liaisons between the Freeways Service Patrol and various other public agencies that respond to the scenes of vehicle incidents.

1303-3 Closed Circuit Television (CCTV)

CCTV cameras provide an opportunity for congestion and incident management verification. FMS areas function very efficiently with the use of CCTV cameras. They provide views of the highway system that can only be otherwise obtained by first hand viewers and provide a great amount of information to **Traffic Management Center (TMC)** operators. CCTV camera placement is expected to be at approximately 1-mile spacing to provide full coverage of the freeways. Cameras are usually located at interchanges which afford an opportunity to view not only the freeway mainline, but the ramps and cross routes as well. The viewing angle of the camera shall give preference to the freeway mainline with arterial coverage included to the extent possible. Each CCTV camera should be oriented so that minimal roadway is occluded. **OTO** prefers that a section in the middle of a ramp be chosen as the occluded area.

All CCTV cameras installed for use in the FMS shall be of the pan-tilt-zoom type. General area CCTV cameras shall be of the dome-type. CCTV cameras used in tunnels, trenches, or other areas where the cameras may have a high probability of being succumbed to moisture-spray from vehicles shall be tunnel/wall-mount cameras and/or thermal imaging cameras. Both of these cameras are referenced in the **ODOT 809 Supplemental Specification**.

The CCTV cameras are also in demand for use by local jurisdictions and other agencies, the media, and the public (via the internet). The central video control system is designed to accommodate external feeds of camera images. In cases where a non-internet connection is used to access video feeds from the **TMC**, external users of the video will be required to sign a CCTV License Agreement. There shall be no fee for use of **ODOT** FMS video although the users must arrange for their own communication pathway to the **TMC** video server.

Information about operation of the CCTV cameras by **TMC** personnel, as well as remote access by authorized users, will be available from **OTO**. This will include general rules for routine use of the cameras such as limitations on zoom functions during incidents and scenes involving solely private property. When CCTV cameras are being manipulated or are zoomed in to assist with an incident, the video signal from the server is generally blocked. It may be necessary to disable the video feed manually, or it may be an automatic software function, depending on the FMS software version. Generally, CCTV camera images will be recorded for a period of three days and then automatically overwritten.

When designing a CCTV site, the designer shall take note of the layout of the surrounding area and make sure that the camera location has the following attributes:

1. Prior to adding a camera to any **ODOT**-maintained location, coordinate with the **OTO** to ensure the appropriate design layout is considered and performed.
2. CCTV will have good view of all roadways. CCTVs placed at curvatures in the road should be placed on the outside of curves so that both directions can be seen.
3. CCTVs located in interchanges should be centrally located so that both on ramps can be viewed. This will provide monitoring for future ramp metering.
4. CCTVs should be located on relatively flat ground for ease of work pad installation and site maintenance. If site conditions present at condition where flat ground is not accessible a sloped work pad should be installed. Details on the sloped work pad can be obtained from OTO.
5. CCTVs should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and CCTV within 35 feet of maintenance vehicle accessible area.
6. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

The designer shall utilize ***Table 1397-4*** to design CCTV sites using the appropriate pay items, and including the appropriate **Traffic Standard Construction Drawings (SCDs)** and **Supplemental Specifications** on the plan cover sheet. The following is a more descriptive listing of the information provided in the table:

1. The appropriate CCTV Camera shall be chosen.
   a. For most installations along the freeway the **809E60000 CCTV IP-Camera System, Dome-Type** shall be utilized.
   b. For installations where the camera is to be located inside a tunnel and/or wall-mounted the **809E60010, CCTV IP-Camera System, Type HD, Wall/Tunnel** shall be utilized. This type of camera allows for dirt to be removed from the lens more easily and also tends to be less maintenance extensive in this type of installation.
2. The appropriate CCTV pole height shall be chosen.
   a. The standard installation requires the use of 70 foot concrete poles, utilizing pay item **809E61000, CCTV Concrete Pole with Lowering Unit, 70 FT.**

   b. The use of 50 feet poles is not allowed unless directed by **OTO**. During the review process, **OTO** will review the plans and if necessary, may advise the designer to utilize item **809E61010, CCTV Concrete Pole with Lowering Unit, 50 FT** in some locations.

3. The appropriate ITS cabinet type shall be chosen.

   a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted.**

   b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by **OTO**.

4. Appropriate grounding and power services shall be designed.

   a. For instances where one power service is providing power to multiple cabinets, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall mount power transformers.

Also see **Plan Note 1342-2** ***(TEM Section 1342-2)***.

1303-4 Communication

FMS communication systems are critical to successful operation. **ODOT** has determined that the most effective (high-level) system requirement for FMS communications is to mimic the **ODOT** network. Therefore, field device communications shall use Ethernet and other devices compatible with equipment routinely used by **ODOT**. The FMS network shall be separate from the **ODOT** network although there will be connectivity between the two systems. **ODOT** network interoperability is coordinated with the Network Operations Center of the **ODOT Division of Information Technology (DoIT)**.

Fiber optic cable is the medium of choice although many "last-mile" and point-to-point applications require wireless or other forms of wire-line communications (e.g. T-1, POTS, Coax, CDMA). Communications redundancy in the field is desired and shall be designed accordingly. Redundancy in some areas will be limited until additional funding is available or new techniques are developed. **TMC** operational redundancy shall be provided via backup Buckeye Traffic Servers.

To facilitate standardized communication protocols, NTCIP-compliant devices will be used when possible. Field device communication represents a significant cost in the design, deployment and operation of an FMS. **ODOT** systems will use a hybrid of Ethernet-based fiber optic and wireless communications to maximize bandwidth for the least cost to support the field infrastructure. Connectivity is desired for remote operations and "pushing" video and data to a number of external users/agencies. The central software system shall be designed to provide flexibility in the provision of access by others outside the **TMC** and the FMS/**ODOT** networks. An internet connection to the FMS network will be the most effective means of providing access to the system.

When designing plans that include fiber optic cable as a communication method, figures shall be included to show how the fiber optic cable is to be terminated / spliced at each location. These figures include one figure per field cabinet ***(e.g., Figure 1398-2: Node Cabinet Assembly),*** one figure per splice enclosure ***(e.g., Figure 1398-3: Underground Splice Enclosure)***, and one figure showing a high-level splicing scheme for the entire project ***(e.g., Figure 1398-4: Fiber Backbone Splice Chart)***, and a high-level device communication plan for the entire project ***(e.g., Figure 1398-5: ITS Device Communication Diagram)***.

When designing projects for current or future ITS deployments, the designer shall incorporate infrastructure containing conduit and fiber optic cable. While it may not always be possible or feasible to install fiber optic cable with projects, all effort should be made to include conduit infrastructure so that fiber optic cable can be installed with minimal effort in the future. The following parameters shall be followed when installing communications infrastructure.

1. All median wall construction shall include two 4-inch multi-cell Schedule 40 conduits. Median wall pull boxes shall be installed at a maximum of 1000 feet apart and on each side of bridge structures. Refer to **Plan Note 1342-11** ***(TEM Section 1342-11)*** for median junction box notes. Contact the **Office of Traffic Operations** for Typical Plan Drawings to be included in the plans.
2. Lateral crossings out of medians (barriers and grass) shall be installed at a maximum of every 4500 feet and at all interchanges for future and existing device communications, as well as slack storage locations. The lateral crossing shall include two 4-inch multi-cell Schedule 80 conduits. A 32-inch pull box shall be installed in the shoulder of each lateral crossing. Contact the **Office of Traffic Operations** for Typical Plan Drawings to be included in the plans.
3. Within metropolitan areas, conduit infrastructure buried in earth shall contain two 4-inch multi-cell conduits, and 32-inch pull boxes with maximum spacing of 500 to 750 feet **(see Traffic SCDs ITS-14.10 and 14.11)**.
4. For multi-cell conduit refer to **Plan Note 1342-7** ***(TEM Section 1342-7)***.
5. For fiber optic installations in long haul installations, such as on interstates between metropolitan areas, a combination of air-blown fiber and micro-duct pathway shall be utilized. Refer to **ODOT Supplemental Specification 804/904** for details regarding this method.
6. For fiber optic installations on signalized corridors, where there is not ample right-of-way to install fiber optic cable traditionally, as specified in 3. above, air-blown/pushable fiber optic cable shall be installed by saw cutting the pavement and installing a micro-duct pathway.
7. All newly installed buried conduit shall contain tracer wire. If conduit is for future fiber optic cable, 20 feet of slack in each direction should be left in each pull box. This will allow for tracer wire to be run inside of fiber optic cable markers to be installed when fiber is installed. For tracer wire specifications, refer to **Plan Note 1342-8** ***(TEM Section 1342-8)*** to be included in plans.
8. Fiber optic cable markers shall be used whenever fiber optic cable is installed. Refer to **Plan Note 1342-9** ***(TEM Section 1342-9)*** for specification to be included in plans.
9. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.
10. Any conduit installed within 6 feet of guardrail shall be concrete-encased.

The following list outlines additional requirements:

1. For fiber optic design, the general rule of thumb is that any fiber cable having 48 strands or less should be routed through the cabinets and all splicing shall be performed in the cabinets. No splicing on this cable shall be performed in splice enclosures.
2. All fiber optic cables having more than 48 strands shall be spliced in pull boxes closest to the cabinet locations and drop cable shall be utilized to connect to the cabinet. The general practice is to use drop cable to connect to one buffer tube in each direction of the trunk cable and terminate the drop cable into the cabinet.
3. Locations identified as Node sites by the **Office of Traffic Operations (OTO)** during review will generally have more than one buffer tube terminated at them. The designer will be directed by **OTO** as to which fibers will terminate at which cabinets during review.

1303-5 Dynamic Message Signs (DMSs)

Dynamic Message Signs (DMSs) are a key component to an effective FMS. The installation of DMSs can help to reduce traffic congestion during incidents and will help to provide travelers with real time traffic information.

DMSs shall be installed at strategic locations on urban freeways to advise drivers of incidents and warn of congestion or stopped traffic. Generally, no alternate route will be specified, although the messages on the signs may suggest the use of alternate routes. When no particular incidents are worthy of mention, the default message, with travel time through key segments of the urbanized area, shall be displayed. Messages for DMSs shall be chosen from a DMS message library unless a different message is truly needed. If a different message is needed it shall be created by the appropriate party. When resources limit full deployment of DMSs in accordance with Detailed Project Plans and FMS design guidelines, first priority will be given to sites on routes inbound to a central business district, deferring outbound DMSs to subsequent phases. The design plans must be in accordance with the Detailed Project Plan.

When designing a DMS site, the designer shall take note of the layout of the surrounding area and make sure that the DMS location has the following attributes:

1. DMS shall be located at points in the roadway that allow for motorists to view the sign at the greatest distance away. Most DMS have a viewing distance of approximately 1,100 feet. DMS should be located in an area that provides a straight roadway for that distance.
2. DMS cabinets should be located on relatively flat ground for ease of work pad installation and site maintenance. If site conditions present a condition where flat ground is not accessible, a sloped work pad should be installed. Details on the sloped work pad can be obtained from **SCD's**.
3. DMS should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and DMS within 35 feet of maintenance vehicle accessible area.
4. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.
5. All DMS require 120/240 VAC power service and typically require up to 90 amps by the manufacturer.

The designer shall utilize ***Table 1397-5a or 1397-5b*** to design DMS sites using the appropriate pay items, and including the appropriate standard drawings and **Supplemental Specifications** on the plan cover sheet. ***Table 1397-6*** provides similar information for Destination DMS (DDMS) installations. The following list outlines additional requirements:

1. The appropriate DMS Type shall be chosen.
   b. For most installations along the freeway the **809E63000, DMS Full-Size Walk-In** shall be utilized.
   c. For Queue Warning System installations, the standard installation requires a smaller sign than typically used for freeway DMS. The appropriate sign pay item is **809E63001, DMS Front Access.**
2. The appropriate mount type shall be chosen.
   a. Truss Mount is typically chosen when the roadway is more than 3 lanes in the direction of the DMS and the placement of the DMS is needed over the inside lanes. This mount is also used when little to no shoulder is available for the placement of a pedestal mount sign. The truss will need to be sized accordingly for the location.
      i. The related pay item for the catwalk is **630E70051, Catwalk, DMS Truss, As Per Plan** and **Plan Note 1342-10** ***(TEM Section 1342-10)***.
      ii. The DMS Truss pay items are **630E70001, 630E70021, 630E70041** for the various lengths of trusses.
      iii. Truss foundation pay items are **630E70070, Concrete Barrier Median Overhead Sign Support Foundation, DMS Truss** and **630E70080, Overhead Sign Support**

Foundation, DMS Truss.

b. Pedestal mounted signs are generally used more often and are usually less expensive and affect traffic less when installation is being performed.

   i The related pay item for the catwalk is **630E70061, Catwalk, DMS Pedestal, As Per Plan.**

   ii. The DMS pedestal pay item is **630E70045, Overhead Sign Support, DMS Pedestal, As Per Plan**.

   iii. The pay item for the foundation is **630E84511, Rigid Overhead Sign Support Foundation, As Per Plan.** Plans should also include **Plan Note 1342-10** ***(TEM Section 1342-10).***

3. The appropriate ITS cabinet type shall be chosen.

   a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted.**

   b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by **OTO**.

4. Appropriate grounding and power services shall be designed.

   a. For instances where one power service is providing power to multiple cabinets, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall mount power transformers.

Also see **Plan Note 1342-3** ***(TEM Section 1342-3)***.

1303-6 Vehicle Detection or SFRD

For an FMS, the conventional form of vehicle detection is side-fired radar detector (SFRD) with algorithms which manipulate the detector to develop speed, volume and occupancy or density. This data can be used for both the calculation of travel times and incident identification. In many states, the use of fixed-point detection for incident detection has proved to be costly and ineffective. Various types of detectors have been implemented with varying degrees of success. Numerous installations are likely to use other technologies such as video image detection, and acoustic detection for acquiring traffic flow information. The current practice for obtaining travel-time information is through the use of Doppler radar along urban Interstate and Interstate look-alike routes as well as cellular phone GPS data for all other types of routes.

Various technologies are available to provide travel times. The incidents are verified and travel times can be corroborated using CCTV.

The main use of SFRD is for ramp metering. The detectors provide traffic data to both the local ramp meter and central software, and allow for dynamic ramp metering along corridors and localized traffic-responsive ramp metering at spot locations.

When designing a SFRD site, the designer shall take note of the layout of the surrounding area and make sure that the SFRD location has the following attributes:

1. SFRDs are typically located 500 feet or more downstream of the merge point on new ramp meter installations.
2. SFRDs are typically located near existing or proposed ITS cabinets with network communications.
3. SFRDs should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and SFRD within 35 feet of maintenance vehicle accessible area.

4. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

The designer shall use ***Table 1397-7*** to design SFRD sites using the appropriate pay items, and including the appropriate standard drawings and **Supplemental Specifications** on the plan cover sheet. The following list outlines additional requirements:

1. The appropriate SFRD Type shall be included.
   a. For all installations, pay item **809E68900, Side-Fired Radar Detector** shall be included in the plans.
2. The appropriate mount type shall be chosen.
   a. Typically SFRD's are mounted to steel poles with break-away bases.
   b. The proper pay items are **625E10491, Light Pole, Conventional, Each, As Per Plan** and **625E14501, Light Pole Foundation, As Per Plan.**
3. The appropriate ITS cabinet type shall be chosen.
   a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted.**
   b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by **OTO**.
4. Appropriate grounding and power services shall be designed.
   a. For instances where one power service is providing power to multiple cabinets, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall-mount power transformers.

Also see **Plan Note 1342-4** ***(TEM Section 1342-4)***.

1303-7 Highway Advisory Radio (HAR)

Highway Advisory Radio (HAR) is an element to the FMS which, if utilized properly, can provide a great public benefit. The HAR system provides near-real time information on the freeway system during operational hours. When systems are unattended, other valuable traveler information will be broadcast such as construction activities on-going or special events that may impact traffic.

It is essential that the HAR is reliable 24/7 and provides accurate, timely information. Similar to DMS system, when no particular incident or congestion-related information is applicable, the HAR will provide an accurate and timely announcement of that fact. The HAR shall be automated so that when travel times increase a pre-determined amount for a particular section of roadway, the HAR will provide travel-time information for that particular section of roadway only.

When designing an HAR site, the designer shall take note of the layout of the surrounding area and make sure that the HAR location has the following attributes:

1. HAR are typically located at major interchanges and/or in areas that can be identified as separate quadrants of a major urban area.
2. HAR should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and HAR within 35 feet of maintenance vehicle accessible area.
3. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.
4. HAR Flashing Beacons are located on major routes around each HAR Transmitter Site. The purpose of a flashing beacon site is to provide the AM frequency for motorists to tune to for

traffic information and to provide a method of alerting motorists of important traffic messages through the use of flashing LED beacons.

The designer shall use ***Table 1397-8*** to design HAR sites using the appropriate pay items, and including the appropriate standard drawings and **Supplemental Specifications** on the plan cover sheet. The following list outlines additional requirements:

1. The appropriate HAR Type shall be included.
   a. For all HAR installations, pay item **809E64000, Highway Advisory Radio (HAR) Assembly** shall be used.
   b. For all HAR Flashing Beacons. Pay item **809E64010, Highway Advisory Radio (HAR) Flashing Beacon System** shall be used.
2. The appropriate ITS cabinet type shall be chosen.
   a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted.**
   b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by **OTO**.
3. Appropriate grounding and power services shall be designed.
   a. For instances where one power service is providing power to multiple cabinets, Item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall-mount power transformers.

More information on HAR signing is available in ***Section 206-5***. Also see **Plan Note 1342-5** ***(TEM Section 1342-5)***.

1303-8 Travel Time

Travel times are calculated along segments of **Ohio** roadways using various sources of speed data. These travel times are then displayed on DMS, HAR, 511, and the OHGO website as a means of communicating to the public the expected travel time to and from select destinations. All travel time calculations are generated by the **Office of Traffic Operations (OTO).**

1303-9 Road Weather Information System (RWIS)

A Road Weather Information System (RWIS) is comprised of Environmental Sensor Stations (ESS) in the field, a communication system for data transfer, and central systems to collect field data from numerous ESS. These stations measure atmospheric, pavement and/or water level conditions for flood information. Central RWIS hardware and software are used to process observations from ESS to develop forecasts, and display or disseminate road weather information in a format that can be easily interpreted. RWIS data are used by road operators and maintenance staff to support decision making.

There are three types of road weather information: atmospheric data, pavement data and floodwater level data. Atmospheric data include air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, cloud cover, tornado or waterspout occurrence, lightning, storm cell location and track, as well as air quality. Pavement data include pavement temperature, pavement freezing point, pavement condition (e.g., wet, icy, flooded), pavement chemical concentration, and subsurface conditions (e.g., soil temperature). Water level data include stream, river and lake levels near roads, as well as tide levels (i.e., hurricane storm surge).

Transportation managers utilize weather warning systems and websites to disseminate road weather information to travelers in order to influence their decisions. This information allows travelers to make choices about travel mode, departure time, route selection, vehicle type and equipment, and driving behavior. In **Ohio**, RWIS provides information on current conditions and assists with forecasting for snow, ice control and removal, flooding, etc. Information is available at the **OHGO** website. RWIS combined with forecasts provides **District** maintenance staff with the best information for snow and ice control. This information allows **Districts** to most efficiently allocate resources including snow plows, and salt and brine applications.

1303-10 Ramp Metering

Ramp Metering is another key FMS component (see **OMUTCD Chapter 4H)**. Its basic function can help to greatly reduce traffic congestion in FMS areas and result in more efficient travel. There are several modes of ramp meter operation, including the following:

- Corridor-based Traffic-Responsive (using mainline and ramp traffic flow data from upstream and downstream stations).
- Local Traffic-Responsive (activated by mainline congestion or speeds at the ramp location).
- Pre-timed (Time-of-Day).
- Manual (locally through controller front display).
- Downloadable (from the **TMC**) ramp timing changes.

Properly timed and operating ramp meters help the mainline to maintain steady flow, resulting in less mainline rear-end crashes, while adding a few less severe crashes on ramps.

Ramp Metering is currently provided in the following metropolitan areas:

Columbus	**District 6** currently operational with new installations underway
Cincinnati	**District 8** currently operational with new installations underway

Ramp Metering may be provided in the following metropolitan areas as conditions warrant:

Toledo	**District 2**
Akron/Canton	**District 4**
Dayton	**District 7**
Cleveland	**District 12**

Special design considerations are needed for non-standard ramps or ramps with inadequate storage capacities or acceleration lengths. Nonstandard ramps will be metered on a case-by-case basis, although system-wide metering is the intent. Ramp Design Guidelines which provide law enforcement pads are included in the **ODOT L&D Manual**. In all cases, it will be necessary to provide surveillance of the ramp meters through CCTV cameras or other means to ensure congestion is not aggravated by the metered condition.

When designing a Ramp Metering site, the designer shall take note of the layout of the surrounding area and make sure that the Ramp Meter location has the following attributes:

1. Ramp Meters are typically located along major corridors located in major metropolitan areas.
2. Ramp Meters should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet within 35 feet of a maintenance vehicle accessible area. Ramp meter cabinets should also be located in areas where the ramp meter signal heads are clearly visible to verify the proper operation of the meter at the Stop Line.
3. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

The designer shall use ***Table 1397-9*** to design ramp metering installations using the appropriate pay items, and including the appropriate standard drawings and **Supplemental Specifications** on the plan cover sheet. The following list outlines additional requirements:

1. The appropriate Ramp Metering items shall be included.
   a. For all new ramp metering, pay item **809E67000, Ramp Metering System.**
   b. If training is requested, pay item **809E67050, Ramp Metering Training** shall be included.
2. The appropriate ITS cabinet type shall be chosen.
   b. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ramp Meter.**
   c. For instances where one power service is providing power to multiple cabinets, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall mount power transformers.

Also see **Plan Note 1342-6** ***(TEM Section 1342-6)***.

1303-11 Traffic Incident Management

Traffic incident management is addressed in ***Chapter 608***.

1340 Design Information

1340-1 General

The **L&D Manual Volumes 1 and 3** and ***Chapter 140*** provide general background regarding design information for **ODOT** projects, including the three-stage review process typically used for traffic control plans. Additional design information has been provided in this Chapter, including checklists for Stage 2 and 3 submittals ***(see Section 1340-2)***. See ***Chapter 1303*** for design information related to specific types of ITS projects; **Plan Notes** are addressed in ***Chapter 1342; Chapter 443*** provides a listing of related **C&MS** Items; and ***Chapter 1395*** provides information about the **Traffic Operations Handbook** and the **Traffic Authorized Product (TAP) List**.

For information about traffic signal design requirements, see ***TEM Part 4***. Designers working on signal design projects should also utilize the files and guidance provided in the **Signal Design Reference Packet**. See ***Chapter 495*** for additional information regarding the reference packet.

1340-2 Stage 1, 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage1, 2 and 3 plan submittals.

1. Stage 1 Plan Requirements:
   a. Base plan drawn to scale of 1:40 and it shall include roadway base lines in Traffic Surveillance Section.
   b. Existing ITS infrastructure identified and shown in plans. Existing plan sets can be obtained by either contacting the **District Project Manager** or by emailing Cen.ITS.Lab@dot.ohio.gov.
   c. Temporary plan for communications infrastructure during construction.
   d. Project overview map (similar to ***Figure 1398-5***), excluding any field devices.
2. Stage 2 Plan Requirements:
   a. Proposed new locations for ITS devices
   b. Proposed location and path of new communication lines. Provide new service addresses if applicable.
   c. Power service locations with coordinated work order and / or service addresses.
   d. Underground conduit and pull boxes.
   e. Legend for symbols used.
   f. Fiber termination drawings, if applicable. ***See Figures 1398-2, 1398-3, 1398-5 and 1398-5***, with proposed field devices, for sample diagrams.
   g. Right-of-Way lines.
   h. **Standard Construction Drawings on cover sheet**.
   i. **Supplemental Specifications on cover sheet**.
3. Stage 3 Plan Requirements:
   a. General Notes.
   b. Estimated quantities.
   c. Special details.

Intentionally blank.

1342 PLAN NOTES

1342-1 General

Typical **Plan Notes** have been consolidated here for convenience in preparing plans. The number used for the **Plan Note** will be the same as the Section number. When a **Plan Note** revises the material or contractor requirements from that which is specified in the **C&MS**, both the note and the bid item will be "as per plan." Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of **Plan Notes**, various format changes are used here that are not typical throughout the **TEM**, e.g., the terms Contractor and Engineer are capitalized.

1342-2 CCTV Installations

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, as well as any Standard Construction Drawings noted on the plans.

Designer Note: See ***Table 1397-4*** for additional information.

1342-3 Dynamic Message Sign Installations

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, as well as any Standard Construction Drawings noted on the plans.

Designer Note: See ***Table 1397-5a, 1397-5b*** or ***1397-6*** for additional information.

1342-4 Vehicle Detection Installations

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, as well as any Standard Construction Drawings noted on the plans.

Designer Note: See ***Table 1397-7*** for additional information.

1342-5 Highway Advisory Radio Installations

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, and Traffic Standard Construction Drawings ITS-20.10.

Designer Note: See ***Table 1397-8*** for additional information.

1342-6 Ramp Metering Installations

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, as well as any Standard Construction Drawings noted on the plans.

Designer Note: See ***Table 1397-9*** for additional information.

1342-7 Items 625E25740 and 625E25750: Conduit 4" Multi-Cell Schedule 40 & Schedule 80, 725.20

Description

This conduit is intended for the use in underground situations requiring more than one single conduit. This includes the main conduit raceway along the freeway, connection from pull boxes to the road side cabinets and for runs of conduit for multiple purposes, e.g., at ramp meter installations, for loop lead-in cable, signals cable for ramp meter displays, signal cable for ramp meter signing flashers & illumination and power. The contractor shall plug all unused cells with conduit caps to assure air and water integrity of each individual innerduct.

Materials

The traffic surveillance raceway shall consist of a factory-assembled system of four (4) innerducts assembled within a protective outer duct. The innerducts shall be nominal 1.25 inch inside diameter, Type DB pvc per NEMA TC-8 with a bell insertion depth of 1.75 inches minimum. The outer duct shall be nominal 4 inch (inside diameter), Schedule 40 pvc. Carlon type Schedule 40 and 80 or approved equivalent.

The coupling shall be designed in a manner to permit easy field assembly. The coupling shall be marked or keyed in a manner to ensure the innerducts are properly aligned, any color codes are continued and the adjoining section is inserted to the proper depth in the bell. All keys and/or markings shall be visible after assembly to allow the inspection of each joint for proper assembly before burial. The sealing system shall be designed to assure air integrity of each individual innerduct and water integrity of the entire system.

Where innerduct(s) within a multi-cell duct are to remain empty, one ¼-inch nylon rope shall be installed in each of the open innerducts, the rope will remain to be used for a future cable installation. Also, each innerduct shall be plugged to maintain the air and water integrity. In addition, the outer duct shall be capped to maintain the air and water integrity of the entire system. For multi-cell duct installed in median walls, all ropes and plugs shall be installed prior to any concrete placement.

Installed in trench

Installation will be in 30-inch deep trench, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed outside of the roadway in trench shall be Schedule 40 unless directed by the ODOT engineer to use Schedule 80 for use in well-traveled vehicular areas.

Installed under roadway

Installation will be at least 30 inches deep jacked or drilled under pavement, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed under the roadway shall be Schedule 80.

Installed within 6 feet of guardrail

Installation will be at least 30 inches deep trench and encased in concrete.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed under the roadway shall be Schedule 80.

Method of measurement

The conduit will be measured by the amount of conduit in feet furnished and installed of each type Schedule 40 or 80 measured from center-to-center of pull boxes, foundation, etc., and will include all fittings and appurtenances, joints, bends, grounds and concrete encasement where specified.

The trench will be measured by the number of feet of trench completed as per C&MS 625.21.

Basis of payment

The payment for these items will be made for the accepted liner foot quantities at the contract bid price.

1342-8 <u>Tracer Wire</u>

Tracer wire shall be installed in one of the multi-cell innerducts in all conduit runs. Tracer wire shall be no smaller than #12 AWG wire. The wire shall be HDPE insulated, orange in color, and constructed of copper clad steel. Approximately 10 feet of slack of the tracer wire shall be left inside the adjacent pull boxes connecting the conduit runs. In situations where a Type fiber optic cable marker is to be installed in conjunction with the tracer wire, the tracer wire shall be run through the marker and connected to terminals at the top of the marker.

Payment for all tracer wire shall be included in the bid item for the fiber optic cable pay item.

1342-9 <u>Fiber Optic Cable Marker</u>

Fiber optic cable markers shall be installed as directed by the ODOT engineer and/or at every pull box containing fiber optic cable and shall be one of two types:

T**YPE 1 – COTTMARK 511, FRICK FLEXPOST, OR CARSONITE CURV-FLEX MARKER**

TYPE 2 – COTT BIGFINK, FRICK TESTPOST, OR RHINODOME TEST STATION

The fiber optic cable markers shall be 6 feet in length and shall be securely placed in the ground at a depth of 2 feet. Care shall be taken during installation not to damage any underground conduit in the vicinity. The Contractor shall use a Type 2 marker when the path of the fiber crosses underneath a roadway and when capable shall place a marker on both sides of the roadway at crossing. The Contractor shall connect tracer wire to terminal at top of Type 2 marker. Type 1 markers shall only be placed on straight fiber runs between pull boxes in the shoulder, and the Contractor shall be limited to the use of Type 1 markers so that a Type 2 marker shall be placed between any two Type 1 markers. Type 1 markers shall not be placed in succession down a fiber path. The markers shall be orange in color and shall have the following information located on the upper portion of the marker in a readable format:

WARNING
CONTACT OUPS 48 HRS BEFORE DIGGING
(NAME OF OWNING AGENCY**) FIBER OPTIC CABLE**
(OWNING AGENCY CONTACT #**)**

Payment for all fiber optic cable markers shall be included in the bid item for the fiber optic cable pay item,

1342-10 <u>DMS & DDMS Support Structures</u>

The Contractor shall furnish shop drawings to the Project Engineer for approval. The drawings shall be stamped by a Professional Engineer from the manufacturer. The item shall not be released for construction until approved by the Office of Traffic Operations.

Designer Note: See ***Table 1397-5*** and ***Table 1397-6*** for additional information.

1342-11 Item 625E29931 Median Junction Box, As Per Plan

The Contractor shall supply the median pull box that meets the following specifications:

Shall be of type polymer-concrete
Size: 17 inches (height) x 30 inches (length)
Minimum wall thickness: 0.5 inch
Minimum lid thickness: 2 inches
ANSI tier 22 rating with a minimum design load of 22,000 pounds
Lid shall be marked “Traffic.”

The median junction box shall be secured in the median barrier wall using dowels. (non-shrink grout may be used when necessary).

1342-12 Utilities

Designer Note: Include ODOT, Office of Technical Services, Traffic Monitoring section as a utility owner anytime there is pavement milling or any excavation work within the vicinity of our permanent count stations, also known as ATR's and WIM's. Please utilize Utility Note G102A1; below is our contact info:

Traffic Monitoring Section ODOT, 1980 West Broad Street, Columbus, Ohio 43223

Ed Newmeyer (District 2, 3, 12)	614-204-0914
Daren Dalton (District 5, 6, 9, 10)	614-204-0291 or 614-275-1382
Dan Diddle (District 4, 11)	614-560-9541
Bryan Stanifer (District 1, 7, 8)	614-204-0971
Sandra Mapel (Field Operations)	614-644-0391

Protection of Traffic Monitoring Equipment

Prior to beginning any pavement activities or any excavation activities between _[insert station or log points]_ and _[insert station or log point]_ the contractor, the project engineer, and a representative from the owner will coordinate a time for the owner/maintaining agency to disconnect the equipment. Following the disconnection by the owner, the contractor will be allowed to perform their pavement activities, including pavement removal. The remove loops and sensors become the property of the contractor.

(Add the following portion for projects that also include excavation activities)

During the meeting, the owner/maintaining agency will identify equipment locations. Do not disturb pull boxes, controllers, cabinets, poles and conduits. Any damage will be the responsibility of the contraction and repairs must be accepted by the owner.

Designer Note: For use on resurfacing, minor rehabilitation, and bridge projects within 300 feet of a permanent traffic count station.

Projects of special concern – Those that involve a concrete median installation - either as part of a widening that converts the grass median to concrete or a project that replaces the existing concrete median. We need to include specific details for including a median pullbox, and occasionally conduits to allow us to reinstall loops and detectors following the construction of roadway and median work. In general, we handle reinstallation of our specialized equipment via a separate contract with certified material contractors including warranty clauses. **Sometimes we request certain underground work be included with major pavement rehabs and median changes as part of a pavement project.**

Early project coordination is key – please contact Sandra Mapel (614-644-0291, Sandra.Mapel@dot.ohio.gov) for site specific details and needs.

1343 SPECIFICATIONS

ODOT specifications for the furnishing and installation of Intelligent Transportation System (ITS) equipment are contained in the following **C&MS** sections, **Supplemental Specifications** and **Supplement**. Also, see ***Chapter 443*** for information about specifications related to traffic signal equipment.

631 and 731 Sign Lighting and Electrical Signs

Supplemental Specifications 804 and 904 address Fiber Optic Cable and Components. All construction projects where installation, relocation, and/or splicing of fiber optic cable is involved need to reference **ODOT Supplemental Specifications 804 and 904**.

Supplemental Specification 809 addresses Intelligent Transportation System (ITS) Devices and Components. All construction projects involving ITS or any item listed in ***Chapter 1303*** needs to reference **ODOT Supplemental Specification 809**. The **809 Supplemental Specification** has a section for each item and describes the work that needs to be performed for each item. The **809** specification also refers the contractors to the Traffic Authorized Product List.

Supplement 1077 covers the prequalification procedure for Dynamic Message Signs.

The **C&MS**, **Supplemental Specifications** and **Supplements**, may be viewed on-line.

Intentionally blank.

1395 REFERENCE RESOURCES

1395-1 General

Various other reference resources that may be useful have been noted in ***Chapters 193 and 194***.

1395-2 Traffic Operations Handbook

The **Office of Traffic Operations (OTO)** has developed a set of material specifications located in the **Traffic Operations Handbook**. The intent of these specifications is to provide a standard set of specifications that are required for equipment and material manufacturers to meet for inclusion on the **Traffic Authorized Product (TAP) list**.

The specifications in the **Traffic Operations Handbook** are not intended to be used in construction plans and any specifications that are incorporated into construction plans will be deleted by comment during the plan review process. Any specifications that are not currently located in the **C&MS** or **Supplemental Specifications** will be provided by **ODOT** during the plan review process.

1395-3 Traffic Authorized Product (TAP) List

The **Traffic Authorized Product (TAP) List** was developed due to technology changing at a rapid pace and the need to keep the **ODOT** ITS products up to date. The **TAP** was developed for the sole use of the contractors and its purpose is to remove any misinterpretation of specifications during the time of construction. References to the **TAP** should not be included in the plans.

Intentionally blank.

1396 FORMS INDEX

The following forms are available only on the **Office of Traffic Operations (OTO)** website.

1396-1 ITS Form

As noted in ***Subsection 1301-3.2***, ***Form 1396-1*** may be used and modified as necessary for completing the Systems Engineering Analysis.

1396-2 ITS Form for Emergency Vehicle Preemption (EVP)

As noted in ***Subsection 1301-3.2***, ***Form 1396-2*** is an abbreviated Minor ITS Form available for use in documenting the SEA for Emergency Vehicle Preemption projects

1396-3 Systems Engineering Review Form (SERF)

As noted in ***Subsection 1301-3.1***, ***Form 1396-3*** may be used for a project to gain programmatic approval of meeting the requirements set forth under **23 CFR 940**.

Intentionally blank.

1397 TABLES INDEX

1397-1 Exempt, Low-Risk and High-Risk ITS Projects

As noted in ***Subsection 1301-1.2***, ***Table 1397-1*** presents examples of Exempt, Low-Risk or High-Risk ITS projects.

1397-2 ITS User Services

Table 1397-2 presents a list of all the ITS User Services available.

1397-3 Regional ITS Architecture in Ohio

As noted in ***Subsections 1301-2.2, 1301-2.4, and 1301-2.5***, ***Table 1397-3*** presents a list of the locations with **MPO's** in **Ohio**, and the **MPO** websites.

1397-4 Closed Circuit Television (CCTV) Installations

As noted in ***Section 1303-3***, ***Table 1397-4*** provides a matrix outlining the process and references needed in designing CCTV pole installations.

1397-5 Dynamic Message Sign (DMS) Installations

As noted in ***Section 1303-5***, ***Table 1397-5*** provides a matrix of information needed in designing DMS installations.

1397-6 Destination Dynamic Message Sign (DDMS) Installations

As noted in ***Section 1303-5***, ***Table 1397-6*** provides a matrix of information needed in designing DDMS installations.

1397-7 Vehicle Detection Installations

As noted in ***Section 1303-6***, ***Table 1397-7*** provides a matrix of information needed in designing vehicle detection installations.

1397-8 Highway Advisory Radio (HAR) Installations

As noted in ***Section 1303-7***, ***Table 1397-8*** provides a matrix of information needed in designing HAR installations.

1397-9 Ramp Metering Installations

As noted in ***Section 1303-10 Table 1397-9*** provides a matrix of information needed in designing ramp metering installations.

Intentionally blank.

Table 1397-1. Exempt, Low-Risk and High-Risk ITS Projects
(Also see *TEM Section 1301-1.2*.)

Exempt	• Changes and/or upgrades to an existing traffic signal system, including signal timing revisions, additional phases (vehicle or pedestrian) or detector installation. • Routine maintenance and operation of an existing ITS system. • Expansion of an existing traffic signal, ITS or freeway management system (FMS) that does not change or add to the original needs and requirements of the system. This type of project does not change any existing hardware, software or interfaces. It simply adds equipment (DMS, DDMS, HAR, CCTV, RWIS, etc.), software, locations or intersections to an existing system. The new equipment and software must be compatible with the existing. • Installation of an isolated traffic signal. This is a single traffic signal, not connected to any type of external signal control, nor likely to be connected in the future due to its isolation. • Installation of traffic signals which are part of a Time-Based Coordinated system. • Installation of traffic signals which are part of a hardwired or wireless interconnected system that is locally controlled, i.e. where the timing patterns are controlled by the local controller and not by centrally controlled software. • Installation of cameras that are not functionally integrated into other types of systems; for example, cameras solely for the purpose of traffic data collection or surveillance cameras.
Low-Risk	• Closed loop arterial traffic signal system. • Centrally controlled arterial traffic signal system. • Highway Rail/Traffic Signal pre-emption. • Traffic signal system with Emergency Vehicle Pre-emption. • Traffic signal system with Transit Priority. • Ramp Meter system. • Adaptive Traffic Signal Control system.
High-Risk	• New freeway management systems (FMS). • Traffic signal systems that requires integration with other systems, e.g. FMS or RWIS. • Ramp meter systems that require integration with adjacent traffic signal system(s). • Regional traffic signal system (as opposed to an arterial traffic signal system) that as the potential to affect geographic areas outside of the maintaining agency. • Regional transit systems. • Any Low-Risk project that provides additional functionality than what is covered in the approved Functional Requirements document for that project category. • Any project that requires new or unproven hardware, software or interfaces. • Any project for which functional requirements and operations & management procedures have not been documented. • Any project not considered Exempt or Low-Risk under the Programmatic Agreement.

Table 1397-2. ITS User Services

To find detailed information relating to each of the User Services below, visit http://www.iteris.com/itsarch/ and select “User Services” from the navigation bar at the top of the screen.

Travel and Traffic Management	
1.1	Pre-trip Travel Information
1.2	En-route Driver Information
1.3	Route Guidance
1.4	Ride Matching And Reservation
1.5	Traveler Services Information
1.6	Traffic Control
1.7	Incident Management
1.8	Travel Demand Management
1.9	Emissions Testing And Mitigation
1.10	Highway Rail Intersection

Public Transportation Management	
2.1	Public Transportation Management
2.2	En-route Transit Information
2.3	Personalized Public Transit
2.4	Public Travel Security

Electronic Payment	
3.1	Electronic Payment Services

Commercial Vehicle Operations	
4.1	Commercial Vehicle Electronic Clearance
4.2	Automated Roadside Safety Inspection
4.3	On-board Safety And Security Monitoring
4.4	Commercial Vehicle Administrative Processes
4.5	Hazardous Material Security And Incident Response
4.6	Freight Mobility

Emergency Management	
5.1	Emergency Notification And Personal Security
5.2	Emergency Vehicle Management
5.3	Disaster Response And Evacuation

Table 1397-2. ITS User Services (Continued)

Advanced Vehicle Safety Systems	
6.1	Longitudinal Collision Avoidance
6.2	Lateral Collision Avoidance
6.3	Intersection Collision Avoidance
6.4	Vision Enhancement For Crash Avoidance
6.5	Safety Readiness
6.6	Pre-crash Restraint Deployment
6.7	Automated Vehicle Operation

Information Management	
7.1	Archived Data

Maintenance and Construction Management	
8.1	Maintenance And Construction Operations

Table 1397-3. Regional ITS Architecture in Ohio
(Also see *TEM Section 1301-2*.)

Akron/Canton	
	Regional ITS Architecture: www.consystec.com/ohio/akron/akronintro.htm MPO: AMATS (Akron Metropolitan Area Transportation Study) MPO Website: www.ci.akron.oh.us/AMATS MPO: SCATS (Stark County Area Transportation Study) MPO Website: www.co.stark.oh.us/internet/HOME.DisplayPage?v_page=rpc
Cincinnati/Northern Kentucky	
	Regional ITS Architecture: http://www.consystec.com/oki/web/_regionhome.htm MPO: OKI (Ohio-Kentucky-Indiana Regional Council of Governments) MPO Website: www.oki.org
Cleveland	
	Regional ITS Architecture: http://www.consystec.com/ohio/noaca/web/index.htm MPO: NOACA (Northeast Ohio Areawide Coordinating Agency) MPO Website: www.noaca.org
Columbus	
	Regional ITS Architecture: http://www.morpc.org/transportation/highway/Architecture.asp MPO: MORPC (Mid Ohio Regional Planning Commission) MPO Website: www.morpc.org
Dayton/Springfield	
	Regional ITS Architecture: http://www.mvrpc.org/transportation/long-range/its/architecture/miami-valley-regional-its-architecture MPO: MVRPC (Miami Valley Regional Planning Commission) MPO Website: www.mvrpc.org MPO: CCSTCC (Clark County-Springfield Transportation Coordinating Committee) MPO Website: www.clarktcc.com
Toledo	
	Regional ITS Architecture: www.consystec.com/ohio/toledo/toledointro.htm MPO: TMACOG (Toledo Metropolitan Area Council of Governments) MPO Website: www.tmacog.org
Youngstown	
	Regional ITS Architecture: http://www.consystec.com/ohio/eastgate/index.htm MPO: Eastgate (Eastgate Regional Council of Governments) MPO Website: www.eastgatecog.org

Table 1397-4. CCTV Installations
(Also see *TEM Section 1303-3*.)

Task	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose CCTV Camera		CCTV IP-Camera System, Dome-Type	809.05.A	809E60000	
		CCTV IP-Camera System, Type HD, Wall/Tunnel	809.05.B	809E60010	
If dome type camera is to be mounted on pole, choose pole height.					
Choose Pole Height	*	CCTV Concrete Pole with Lowering Unit, 50 FT	809	809E61010	**ITS-12.10**
		CCTV Concrete Pole with Lowering Unit, 70 FT	809.06.A	809E61000	**ITS-12.10**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	**ITS-11.10** **ITS-11.11**
		Ground Mount	809.09.A	809E65000	**ITS-10.10** **ITS-10.11**
Choose Work Pad		Controller Work Pad, As Per Plan		633E67200	
Choose Grounding		Ground Rod, As Per Plan		625E32001	
Choose Power Service		Underground	809	625E34000	**ITS-15.10**
		Aerial	809	625E34000	**ITS-15.11**
Use if directed by ODOT		ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	
* Approval must be obtained from **Office of Traffic Operations (OTO)**					

Table 1397-5a. Full-Size Walk-In Dynamic Message Sign (DMS) Installations
(Also see *TEM Section 1303-5*.)

Task	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose DMS Type		DMS- Full-Size Walk-In	809.07.A	809E63000	
Choose Mount Type		Overhead Sign Support, DMS Pedestal, As Per Plan		630E70045	**ITS-30.13**
		Overhead Sign Support, DMS Truss, 80’, As Per Plan		630E70001	**ITS-35.13**
		Overhead Sign Support, DMS Truss, 115’, As Per Plan		630E70021	**ITS-35.14**
		Overhead Sign Support, DMS Truss, 150’, As Per Plan		630E70041	**ITS-35.14**
Choose Foundation		Concrete Barrier Median Overhead Sign Support Foundation, DMS Truss		630E70070	**ITS-36.12**
		Overhead Sign Support Foundation, DMS Pedestal		630E70082	**ITS-30.12**
		Overhead Sign Support Foundation, DMS Truss		630E70080	**ITS-35.12**
Choose Catwalk		Catwalk, DMS Truss, As Per Plan		630E70051	**ITS-35.11**
		Catwalk, DMS Pedestal, As Per Plan		630E70061	**ITS-30.11**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	
		Ground Mount	809.09.A	809E65000	
Choose Work Pad		Controller Work Pad, As Per Plan		633E67200	Contact **OTO**
Choose Grounding		Ground Rod, As Per Plan		625E32001	**ITS-50.10**
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	
* Approval must be obtained from **Office of Traffic Operations (OTO)**					

Table 1397-5b. Front Access Dynamic Message Sign (DMS) Installations
(Also see *TEM Section 1303-5*.)

Task	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose DMS Type	*	DMS- Front-Access	809.07.B	809E63001	
Choose Beam		Ground Mounted Structural Beam Support, W-??x??			**TC-41.10**
Choose Beam Connection		Breakaway Structural Beam Connection		630E09000	**TC-41.10**
Choose Foundation		Ground Mounted Structural Beam Support Foundation		630E84500	**TC-41.10**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	
		Ground Mount	809.09.A	809E65000	
Choose Work Pad		Controller Work Pad, As Per Plan		633E67200	Contact **OTO**
Choose Grounding		Ground Rod, As Per Plan		625E32001	**ITS-50.10**
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	

* Approval must be obtained from **Office of Traffic Operations (OTO)**

Table 1397-6. Destination Dynamic Message Sign (DDMS) Installations
(Also see *TEM Section 1303-5*.)

Task	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose DDMS Type		DDMS, Freeway-Two-Line		809E63020	**ITS-40.10**
		DDMS, Freeway-Three-Line		809E63030	**ITS-40.10**
		DDMS, Arterial-Two-Line		809E63040	**ITS-40.10**
		DDMS Arterial-Three-Line		809E63050	**ITS-40.10**
Define Sign Size		Sign, Ground Mounted Extrusheet, As Per Plan		630E80201	
Define Sign Mounting		Sign Erected, Extrusheet, As Per Plan		630E81201	
Choose Beam		Ground Mounted Structural Beam Support, W-??x??			**TC-41.10**
Choose Beam Connection		Breakaway Structural Beam Connection		630E09000	**TC-41.10**
Choose Foundation		Ground Mounted Structural Beam Support Foundation		630E84500	**TC-41.10**
Choose Work Pad		Controller Work Pad, As Per Plan		633E67200	Contact **OTO**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	
		Ground Mount	809.09.A	809E65000	
Choose Grounding		Ground Rod, As Per Plan		625E32001	**ITS-50.10**
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10** **ITS-50.11**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT		ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	
* Approval must be obtained from **Office of Traffic Operations (OTO)**					

Table 1397-7. Vehicle Detection (SFRD) Installations
(Also see *TEM Section 1303-6*.)

Tasks	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose Vehicle Detection Type		Side-Fired Radar Detector		809E68900	**ITS-60.10**
Choose Light Pole		Light Pole, Conventional, Each As Per Plan		625E10491	**HL-10.13**
Choose Grounding		Ground Rod, As Per Plan		625E32001	
Choose Foundation		Light Pole Foundation, As Per Plan		625E14501	**HL-20.11**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	
		Ground Mount	809.09.A	809E65000	
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	

* Approval must be obtained from **Office of Traffic Operations (OTO)**

Table 1397-8. Highway Advisory Radio (HAR) Installations
(Also see *TEM Section 1303-7*.)

Tasks	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose HAR Type		HAR Assembly	809.08.A	809E64000	**ITS-20.10**
		HAR Flashing Beacon System	809.08.B	809E64010	**ITS-20.10**
Choose Work Pad		Controller Work Pad, As Per Plan		633E67200	Contact **OTO**
Define Sign Size		Sign, Ground Mounted Extrusheet, As Per Plan		630E80201	
Define Sign Mounting		Sign Erected, Extrusheet, As Per Plan		630E81201	
Choose Beam		Ground Mounted Structural Beam Support, W-??x??			**TC-41.10**
Choose Beam Connection		Breakaway Structural Beam Connection		630E09000	**TC-41.10**
Choose Foundation		Ground Mounted Structural Beam Support Foundation		630E84500	**TC-41.10**
Choose Cabinet Type	*	*Pole Mount	809.09.B	809E65010	
		Ground Mount	809.09.A	809E65000	
Choose Grounding		Ground Rod, As Per Plan		625E32001	
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)		809E65020	

* Approval must be obtained from **Office of Traffic Operations (OTO)**

Table 1397-9. Ramp Metering Installations
(Also see *TEM Section 1303-10*.)

Tasks	Prior Approval Needed	Item Description	Related Supplemental Specification	Item Master	Traffic SCD No.
Choose Ramp Meter		Ramp Metering System	809.11.A	809E67000	**ITS-76.10**
Choose Training	*	Ramp Metering Training	809.11.B	809E67050	
Choose Cabinet Type	*	ITS Cabinet Ramp Meter	809.09.D	809E65030	
Choose Grounding		Ground Rod, As Per Plan		625E32001	
Choose Power Service		Underground	809.02	625E34000	**ITS-15.10**
		Aerial	809.02	625E34000	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from **Office of Traffic Operations (OTO)**					

1398 FIGURES INDEX

1398-1 Project Development Process (PDP)

As noted in ***Section 1301-3.1***, ***Figure 1398-1*** is a graphical representation of the Project Development Process (PDP).

1398-2 Fiber Optics Termination Diagram (Node Cabinet Assembly)

As noted in ***Section 1303-4, Figure 1398-2*** is a sample representation of what shall be included in plan sets for all fiber optic design on **ODOT** projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-3 Fiber Optics Termination Diagram (Underground Splice Enclosure)

As noted in ***Section 1303-4, Figure 1398-3*** is a sample representation of what shall be included in plan sets for all fiber optic design on **ODOT** projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-4 Fiber Optics Termination Diagram (Fiber Backbone Splice Chart)

As noted in ***Section 1303-4, Figure 1398-4*** is a sample representation of what shall be included in plan sets for all fiber optic design on **ODOT** projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-5 ITS Device Communication Diagram

As noted in ***Section 1303-4, Figure 1398-5*** is a sample representation of what shall be included in plan sets for all fiber optic design on **ODOT** projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

Figure 1398-1. Project Development Process (PDP)
(Also see *TEM Section 1301-3.1*.)

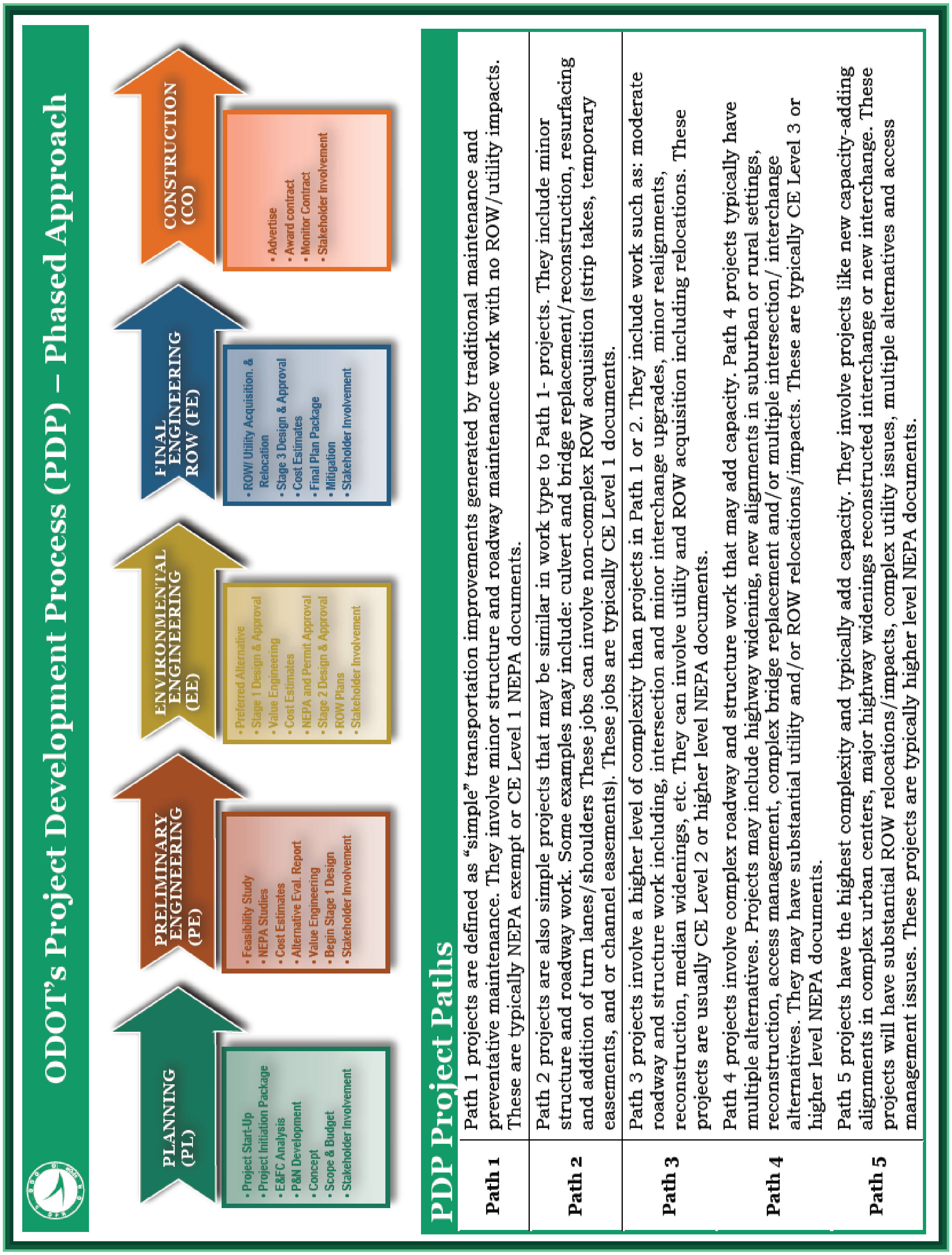


Figure 1398-2. Fiber Optics Termination Diagram
(Node Cabinet Assembly)
(Also see *TEM Section 1303-4*.)

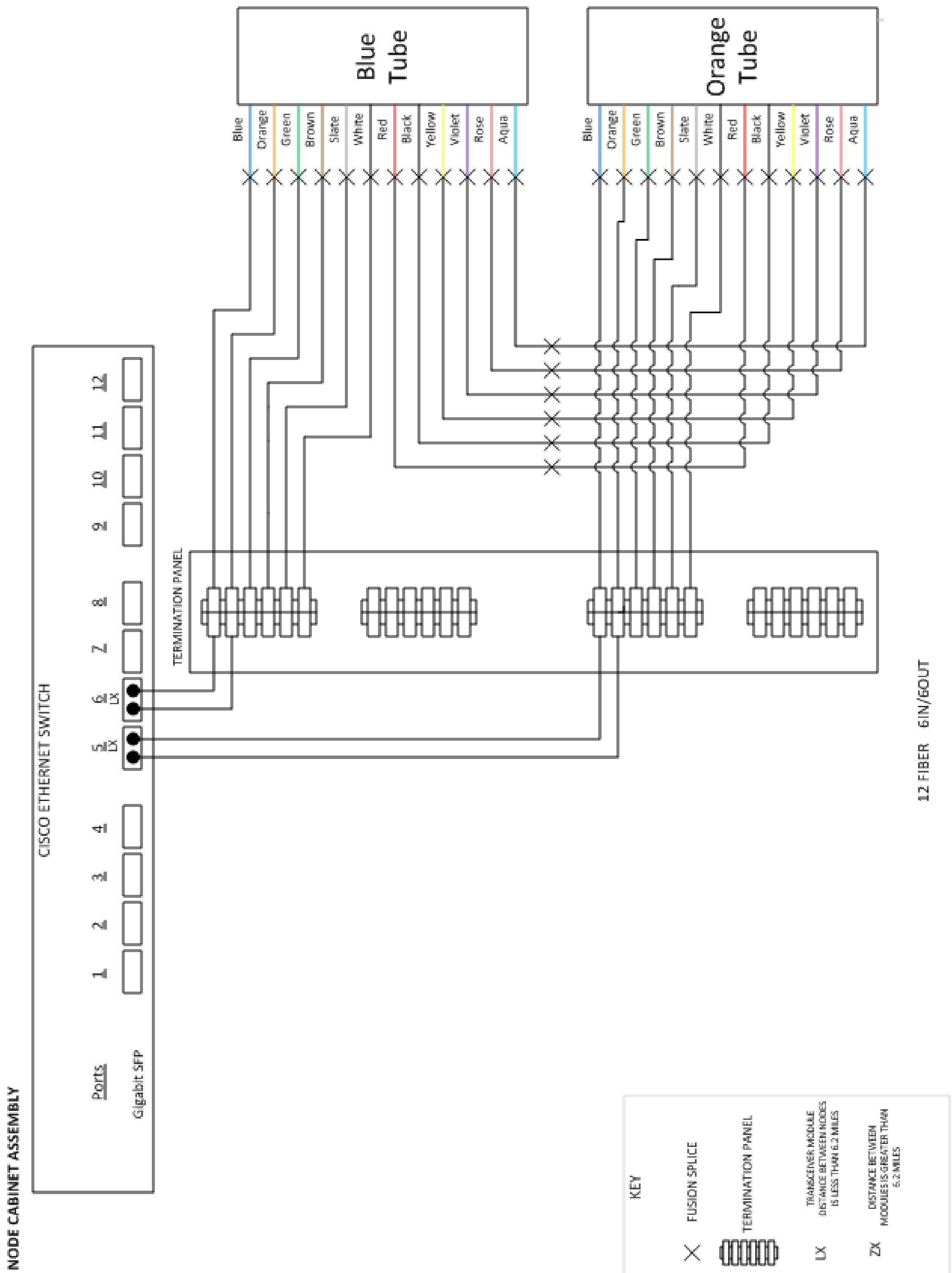


Figure 1398-3. Fiber Optics Termination Diagram (Underground Splice Enclosure)
(Also see *TEM Section 1303-4*.)

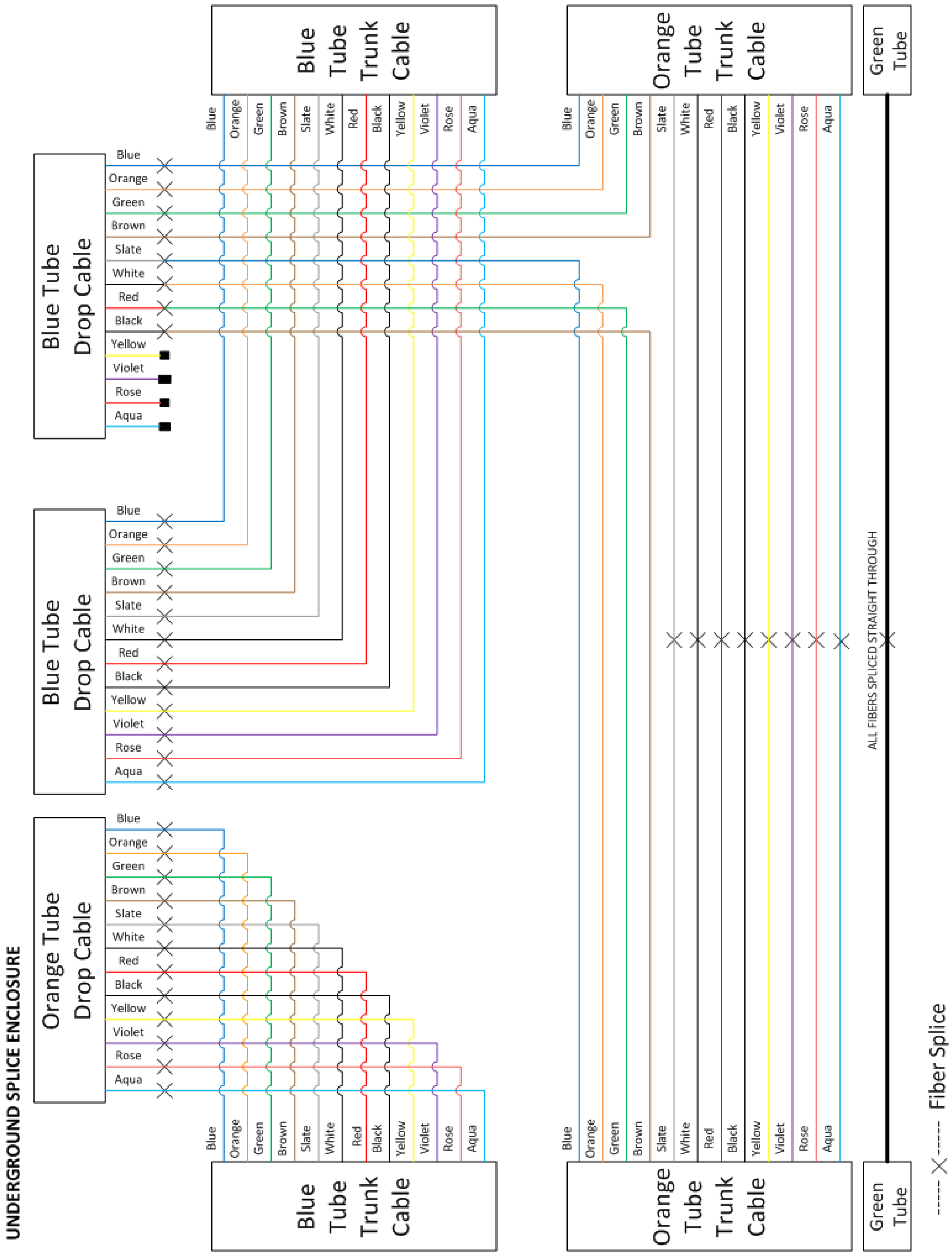


Figure 1398-4. Fiber Optics Termination Diagram (Fiber Backbone Splice Chart)

(Also see *TEM Section 1303-4*.)

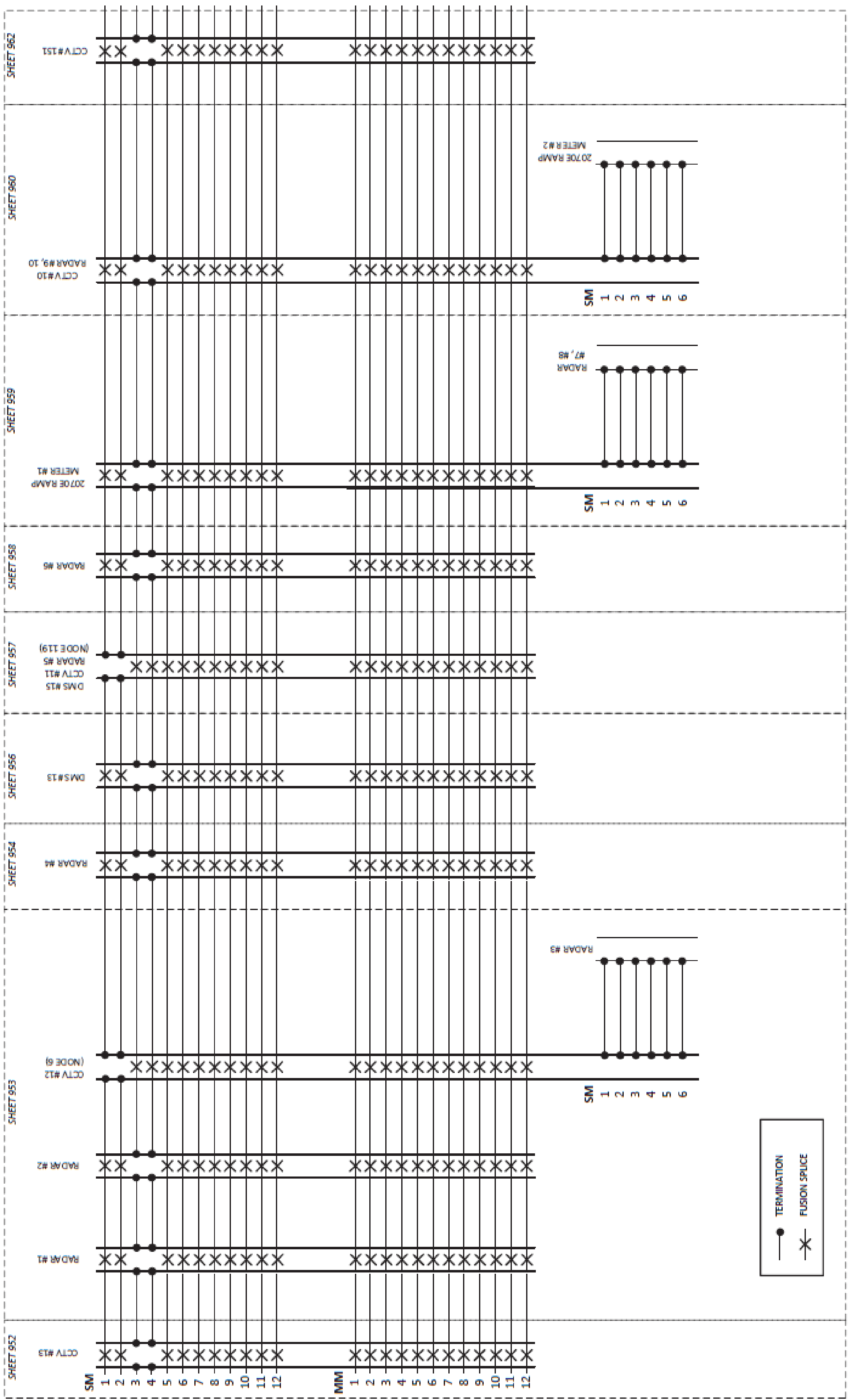


Figure 1398-5. ITS Device Communication Diagram (Courtesy of HNTB, Ohio)
(Also see *TEM Section 1303-4*.)

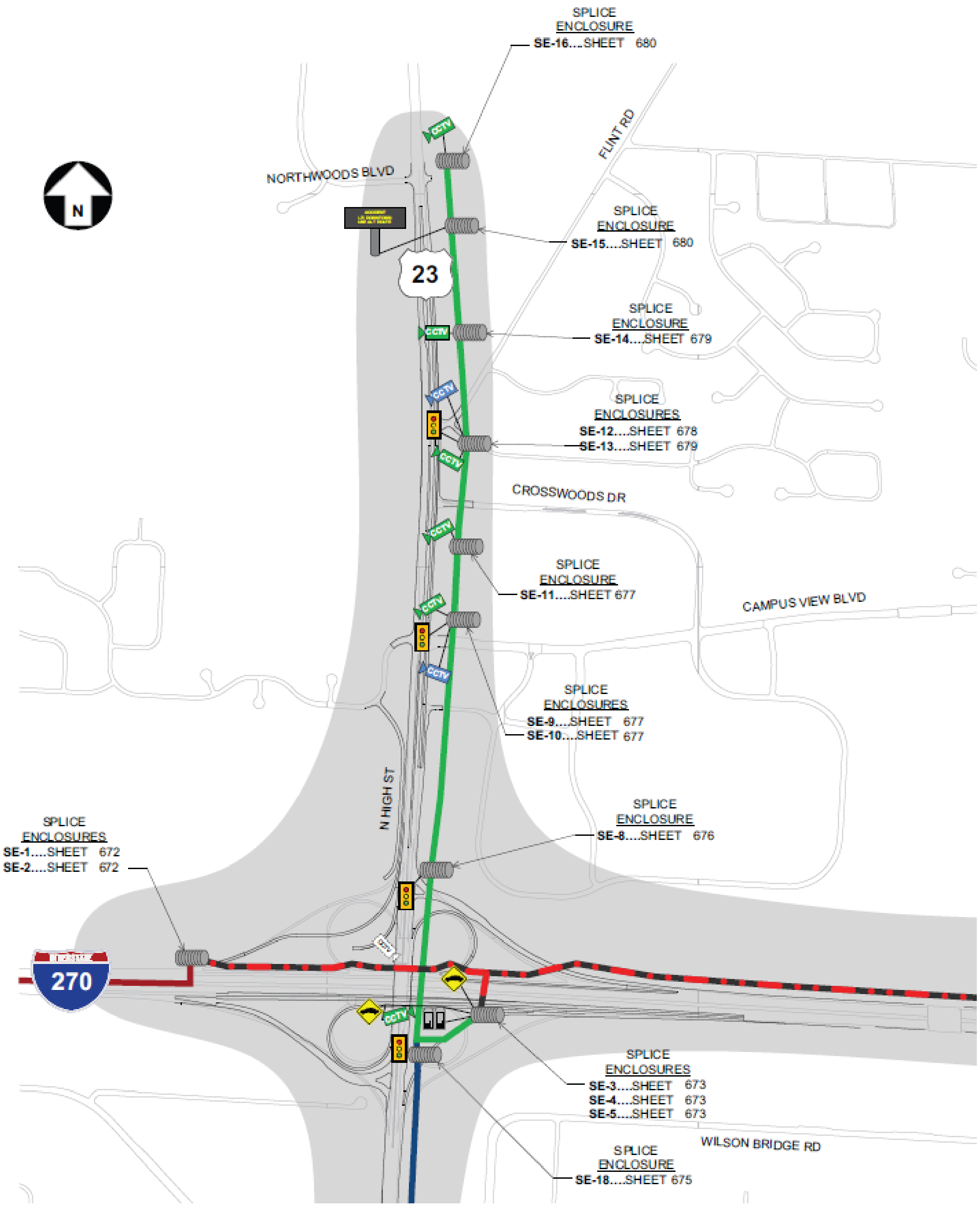


Figure 1398-5. ITS Device Communication Diagram (continued)

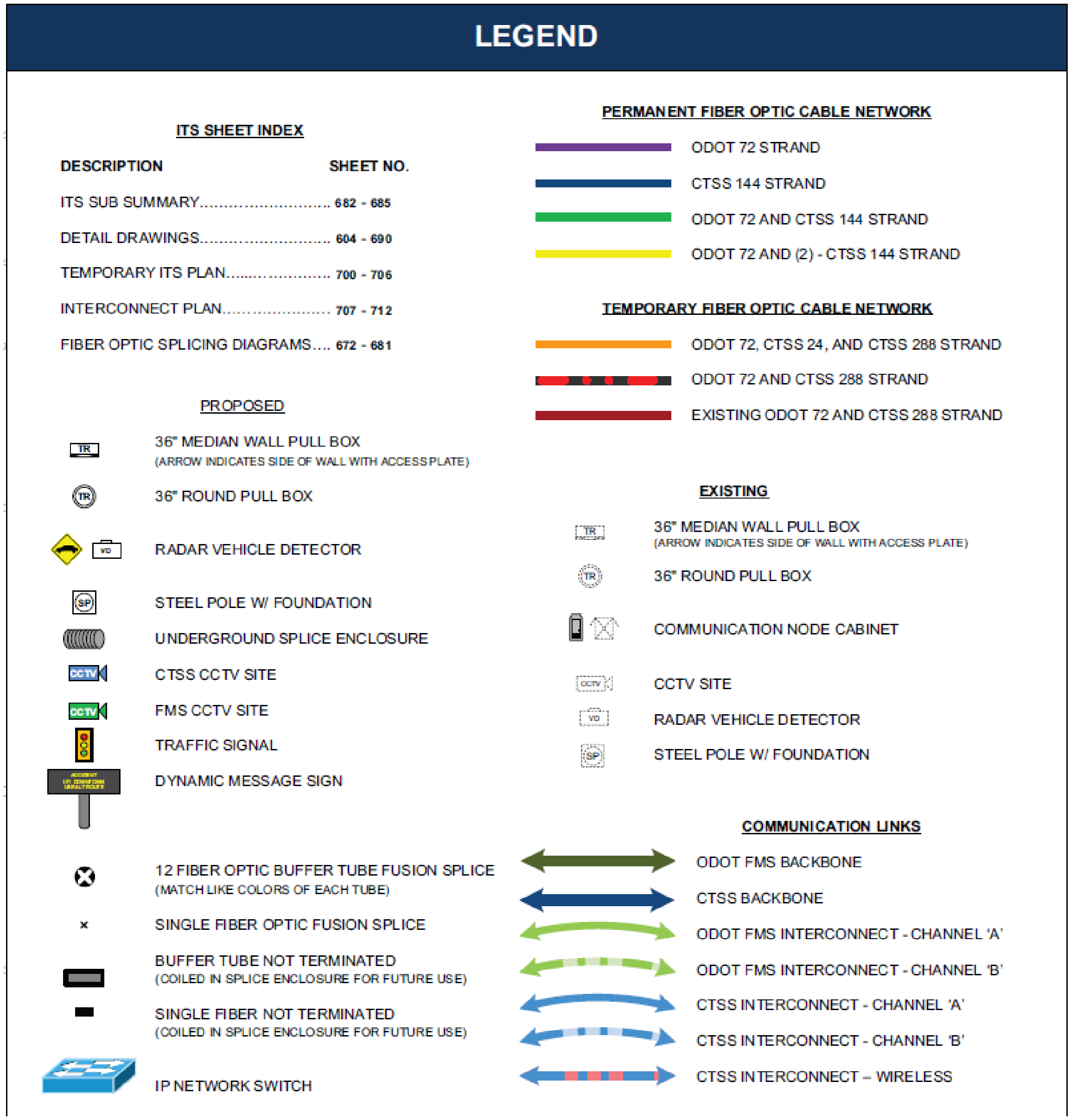


TABLE OF CONTENTS
Part 14 - MISCELLANEOUS

Intentionally blank.

Part 14 - MISCELLANEOUS

1400 GENERAL

This Part of the **TEM** serves as a collection of miscellaneous information not addressed in the other Chapters. For example, training provided by the **Office of Roadway Engineering (ORE) and the Office of Traffic Operations (OTO)** are addressed, as well as standards, policies and guidelines related to the use of rumble strips and other devices on **ODOT**-maintained highways.

TEM Part 1 addresses general information about specifications for traffic control devices and materials, and addresses various procedures addressing the review and approval of new products, and the purchase of traffic control related materials and equipment.

1401 TRAINING AVAILABLE

1401-1 General

There are various training opportunities available within **ODOT** in the traffic engineering field. In addition to the **ORE** Traffic Academy ***(see Section 1401-2)***, **ORE** and **OTO** provide additional courses related to various aspects of traffic control design and application. At this time, **OTO** offers courses in Traffic Signal Maintenance and in Overhead Sign Supports.

Also, the intranet web page for the **Office of Training: Employee Development & Enrichment** provides a link to the **ODOT** Training Course Catalog which contains courses for the Highway Technician (HT) Series. **ODOT** employees should consult their local **Training Coordinator** for additional information on these courses.

Courses presented by the **Ohio LTAP (Local Technical Assistance Program) Center** are also available for **ODOT** personnel sometimes, depending on space availability.

1401-2 Traffic Academy

The Traffic Academy provides training for consultants. It is also open to **ODOT** employees who wish to attend. Successful completion of the appropriate course is an **ODOT** requirement for consultant pre-qualification.

Detail information about the Traffic Academy and copies of some of the manuals used are available on-line at: www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficAcademy/.

1401-3 Overhead Sign Supports

Purpose: This course provides basic information regarding the inspection and repair of overhead sign supports.

- Designed For: Persons responsible for the inspection, maintenance and/or repair of overhead sign supports.
- Prerequisites: None
- Course Time: Varies
- Course Size: 4 Minimum, 12 Maximum
- Location: District or Central Office
- Program Manager: Jim Roth, Office of Traffic Operations (614) 752-0438

1401-4 NEMA Traffic Signal Maintenance

The **NEMA** Signal Maintenance Course is provided to the **Districts** upon request, on a first come first served basis by the **OTO Signals and ITS Section**. The course objectives are to help Signal Electricians, Project Engineers and Highway Technicians understand the operation, installation and maintenance of traffic signals.

This course is held only in Central Office at the Sign and Signal Shops, 1606 West Broad St. The class is restricted to six employees at a time because of limited classroom and equipment availability.

Course topics include:

- Understanding the terminology of traffic signals.
- Understanding traffic signal construction plans.
- Understanding **NEMA** traffic signal cabinet diagrams.
- Recognizing **NEMA** TS-1 and TS-2 traffic signal equipment.
- Basic programming of traffic signal equipment, including the use of laptops.
- Basic electrical safety and safe maintenance of traffic signals in the field.
- Trouble shooting malfunctioning traffic signals.

To schedule a class or get additional information, please contact the **OTO Signals and ITS Section**.

1401-5 2070 Traffic Signal Maintenance

The 2070 Signal Maintenance Course is provided to the **Districts** upon request, on a first come first served basis by the **OTO Signals and ITS Section**. The course objectives are to help Signal Electricians, Project Engineers and Highway Technicians understand the operation, installation and maintenance of 2070 traffic signal operation.

This course is held only in Central Office at the Sign and Signal Shops, 1606 West Broad St. The class is restricted to six employees at a time because on limited classroom and equipment availability.

Course topics include:

- Understanding the terminology of 2070 traffic signals.
- Understanding 2070 traffic signal cabinet diagrams.
- Recognizing 2070 traffic signal equipment.
- Basic programming of 2070 traffic signal equipment, including the use of laptops.
- Basic electrical safety and safe maintenance of traffic signals in the field.
- Trouble shooting malfunctioning traffic signals.

To schedule a class or get additional information, please contact the **OTO Signals and ITS Section**.

1401-6 Strain Pole Design (SWISS Software)

The SWISS course provides training for consultants in the design of strain poles. It is also open to **ODOT** employees. The course objective is to provide assistance in the use of the computer program for the design of span wire signal supports. The SWISS software is available on-line at: http://www.dot.state.oh.us/Divisions/Engineering/Roadway/TrafficControl/.

This course is held only in Central Office at the Sign and Signal Shops, 1606 West Broad Street. The class size is restricted to twelve people.

To schedule a class or get additional information, please contact the **ORE Traffic Control Design Section**.

1415 RUMBLE STRIPS (INCLUDING STRIPES) IN THE ROADWAY

1415-1 General

As defined in **OMUTCD Section 1A.13** a rumble strip is "a series of intermittent, narrow, transverse areas of rough-textured, slightly raised, or depressed road surface that extend across the travel lane to alert road users to unusual traffic conditions or are located along the shoulder, along the roadway center line or within islands formed by pavement markings to alert road users that they are leaving the travel lanes." Rumble strips within the roadway are addressed in this **TEM** Chapter.

ODOT standards, details and specifications for the use of longitudinal shoulder rumble strips are addressed in the **L & D Manual Volume 1, Section 605, Roadway SCD BP-9.1** and **C&MS Item 618**.

Permanent rumble strips shall be milled. They may be applied at any time to new or existing asphalt and concrete surfaces in good condition. However, they are not recommended for installation on bridge decks, crosswalks, within intersections, or within areas of abrupt vertical or horizontal alignment changes. The grooves for in-lane rumble strips should not extend to within 2 inches of a concrete pavement joint.

The decision to install rumble strips should include careful consideration of the effect of the noise produced by rumble strips on any nearby residents.

Although self-cleaning to a limited extent, rumble strips should be inspected periodically to determine if debris needs to be removed or if they need to be re-milled.

Rumble strips should not be installed without the recommendation of the **District Safety Review Team** and the approval of the **District Deputy Director**. They should be re-evaluated when conditions change, and paved over or removed when no longer needed.

The term "rumble stripes" refers to rumble strips that are in-line with longitudinal pavement markings (edge line or center line) ***(see Section 1415-3)***. Additional information on rumble strips and stripes in the roadway may be found in ***TEM Section 605-17 and Chapter 805,*** **Traffic SCD TC-64.10,** and **OMUTCD Section 6F.87**.

1415-2 Transverse Rumble Strips

1415-2.1 General

Transverse rumble strips are used to alert drivers in advance of the need to stop or slow down, or of unexpected abrupt geometric changes. They consist of parallel 4-inch grooves cut at 1-foot intervals.

Transverse rumble strips extend nearly across the full width of the lane of travel, normally starting 4 inches from the center line and stopping 18 inches short of the right edge line. They are not recommended when the pavement or pavement overlay is less than 1.75 inches in depth.

When shoulders are 2.5 feet or less in width, or non-existent, on roadways which are dedicated bicycle routes or have considerable bicycle traffic, consideration should be given to increasing the clear distance on the right side of the roadway to provide a total clear path for the bicyclists (including any existing shoulder) of 4 feet.

A transverse rumble strip installation is typically made up of three groups/pads of rumble strips with each group placed about 250 feet apart. Each group is typically composed of fifteen 4-inch strips/grooves. A sample drawing is available from the **Office of Roadway Engineering** upon request.

Transverse rumble strips should be preceded by a RUMBLE STRIPS sign (W8-H15a).

If the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the rumble strip shall be white.

1415-2.2 Intersections

Transverse rumble strips should be considered for use in advance of intersections where there is a documented problem involving angle and/or rear-end crashes related to red light or STOP sign violations only after all other countermeasures have been tried and proven ineffective.

Possible locations include isolated high-speed or expressway signalized intersections and intersections with inadequate stopping sight distance.

If used, rumble strips should be installed on the approach(es) with the crash problem. They are usually installed on a stop approach at a STOP sign controlled intersection, but may also be installed on the mainline, or on a signalized approach when the crash problem is related to that particular approach.

For highways with a speed limit less than 50 mph, the last rumble strip should be at least 200 feet from the Stop Line, or if none, from the point where the road user should stop. If the speed limit is 50 mph or greater, the last rumble strip should be at least 300 feet from the stopping point.

1415-2.3 Grade Crossings

As noted in ***Chapter 805***, rumble strips may be used at railroad grade crossings after other appropriate standard traffic control devices have been considered. The rumble strip installation is generally the same as for other intersections stop approaches; however, only two rumble strip pads, or groupings, are used. Contact the **Office of Roadway Engineering** for the detail drawing for this installation.

1415-2.4 Freeways and Expressways

Transverse rumble strips may be installed in the travel lanes in advance of toll booths both to alert drivers of the need to reduce speed before entering the toll booth area and to mitigate highway hypnosis.

They may be installed in the exit lane for loop ramps or other curved ramps where significant speed reductions are necessary when there is a documented problem involving run-off-the-road and/or rear-end crashes, but only after all other countermeasures have been tried and proven ineffective. They shall only be installed in the exit lane when the minimum braking distance for the necessary speed reduction exists beyond the final rumble strip.

Transverse rumble strips are not recommended inside lane-drop areas after the LANE ENDS sign. They may be installed to alert road users that the freeway or expressway is ending and that they must reduce speed when there is a documented problem involving crashes of the type susceptible to rumble strip treatment, but only after all other countermeasures have been tried and proven ineffective.

They shall only be installed with the recommendation of the **District Safety Review Team** and approval of the **District Deputy Director**.

1415-2.5 Other Applications

Transverse rumble strips may be considered for use in advance of locations where there is a documented problem involving crashes of the type susceptible to rumble strip treatment only after all other countermeasures have been tried and proven ineffective.

The use of rumble strip installations should be kept at a minimum, but may provide a solution to problems of excessive speed or of inattention resulting in crashes at narrow or one-lane bridges, at locations with abrupt changes in vertical or horizontal alignment, and at major commercial driveways with inadequate stopping distance because of horizontal or vertical alignment.

1415-3 Rumble Stripes

1415-3.1 General

Rumble stripes are longitudinal rumble strips supplemented by the related longitudinal pavement markings. They are used to reduce highway hypnosis and to alert sleepy, fatigued, impaired, or inattentive drivers that they are leaving the roadway (edge line) or crossing the center line. Rumble stripes provide increased wet/night visibility of the pavement markings, and better define the roadway limits with the corresponding audio and vibratory impacts which result when a vehicle's tires pass over the rumble strips. Additional detail design information is available in **Traffic SCD TC-64.10, Rumble Stripes.** Lane line rumble stripes shall be not installed unless approved by the **Office of Roadway Engineering**.

Except when interrupted as described below, center line rumble stripes shall be continuous and edge line rumble strips shall be installed in a 60-foot cycle (48' rumble stripe – 12' gap) to allow crossing of edge line by motorcyclists and bicyclists. The milled portion of the rumble stripe shall be interrupted for raised pavement markers, driveways, intersections, crosswalks and over structures as detailed in Traffic **SCD TC-64-10, Rumble Stripes.**

Rumble stripes shall be discontinued 650 feet in advance of built-up areas, including municipal corporation limits and urban area boundaries. Also, when leaving built-up areas leave a 650 foot gap before starting rumble stripes.

The rumble stripes may be preceded by a RUMBLE STRIPS sign (W8-H15a), and the sign may be supplemented with a plaque specifying CENTER LINE, EDGE LINE, or a combination. If the sign is used for a very long section of rumble stripes, it may be helpful to repeat the sign after major intersections, etc.

Since thicker pavement marking materials may reduce the effectiveness of rumble stripes, preformed pavement markings **(Item 645)** and heat-fused preformed thermoplastic **(Item 647)** shall not be used for rumble stripes, and thermoplastic **(Item 644)** should not be used with rumble stripes.

1415-3.2 Center Line Rumble Stripes

Center line rumble stripes are installed primarily to reduce head-on and side-swipe crashes on two-lane highways. Center line rumble stripes should be considered for use in roadway sections where there is a documented problem involving head-on or side-swipe crashes only after all other countermeasures have been tried and proven ineffective. Since they offer a relatively low-cost, low-maintenance countermeasure to prevent these types of crashes, they may also be installed in other roadway sections where there is a high potential for head-on or side-swipe crashes.

Since center line rumble stripes extend through the center line pavement marking, the pavement markings should be reapplied following installation. When using paint, it should be applied twice, once in each direction of travel.

Center line rumble stripes shall only be installed with the recommendation of the **District Safety Review Team** and the approval of the **District Deputy Director**.

1415-3.3 Edge Line Rumble Stripes

Edge line rumble stripes are installed primarily to reduce run-off-the-road crashes on two-lane highways with narrow shoulders. They should be installed on **ODOT**-maintained roadways meeting all of the following criteria:

1. Paved shoulder width of at least 2 feet and less than 4 feet.
2. The roadway surface including the shoulder is new.
3. 11-foot minimum lane width.
4. 2-lane routes outside built-up areas, such as business, residential or urban districts (defined in **ORC 4511.01**).
5. Speed limit greater than 45 miles per hour.

Discretion may be used for roadways where the following conditions or roadway users are encountered:

1. Areas of Amish buggy travel.
2. Areas of high driveway density outside built-up areas.

Any roadway or roadway section which has been designated by the **Office of Statewide Planning** or a **Metropolitan Planning Organization** as a bike route and has a paved shoulder width of less than 4 feet should not be considered for edge line rumble stripes unless an existing crash problem is exhibited.

1415-4 Rumble Strips in Temporary Traffic Control Zones

For information on the use of rumble strips for Temporary Traffic Control, see ***TEM Section 605-17*** and **Traffic SCD MT-97.20.**

1416 OTHER DEVICES

1416-1 Driveway Mirrors

Driveway mirrors (usually convex in shape) are sometimes used to help indicate to a driver the presence or absence of a moving or stationary vehicle and/or pedestrian. However, for the following reasons **ODOT** does not install these devices on **ODOT**-maintained highways:

- It takes some time for drivers to understand and interpret the information provided by these mirrors. A convex shaped mirror results in distortion of the image, speed and distance of any object. The degree of distortion depends on the radius of curvature and size of the convex mirror; the larger the radius of curvature the less distortion and vice versa. The image appears to be smaller, further away and traveling at a slower speed in a mirror with a smaller radius of curvature. A convex mirror with a small radius of curvature will also provide too much detail in a small area which will hamper the motorist's ability to discriminate detail.

- During low light levels, mirrors do not clearly distinguish cars with no lights on. In particular, dark colored vehicles may be difficult to detect in these mirrors in low light conditions such as dawn, dusk or overcast.

- These mirrors are fairly expensive, require routine cleaning and are subject to vandalism.

If property owners want to install and maintain one of these mirrors on their own, they should be advised of the concerns mentioned above, and if the mirror will be on the State right-of-way, they will need to get a permit.

Since the burden of responsibility for the location and subsequent safe use of residential driveways rests with the property owner, not **ODOT**, before installing one of these mirrors, the property owner should consider other alternatives, such as relocating the drive. However, in most instances, the property owner will decide that installing a mirror is the preferred alternative. Therefore, also consider advising a property owner considering installation of a driveway mirror that:

- Secure mounting is required to minimize misalignment from high winds, vibrations, etc.
- Fairly large (e.g., 3 x 2 foot), flat, rectangular mirrors produce realistic images.
- For a mirror to function properly, it may need to be mounted fairly high.
- The use of a Plexiglas or metal mirror can minimize damage from vandalism.
- More than one mirror may be needed for proper coverage.

TABLE OF CONTENTS
Part 15 - APPENDIX

Intentionally blank.

Part 15 - APPENDIX

1500 GENERAL

This Part will be used to provide additional or supplementary material that may be useful for those using this Manual. Copies of separate policies, guidelines and standard operating procedures referenced in other sections are included herein.

1501 DEFINITIONS

1501-1 General

Generally, for traffic control purposes, the definitions found in the **OMUTCD** will apply. Also, for design purposes, there are additional definitions provided in the three volumes of the **L&D Manual** ***(see Section 194-6 through 194-8)***. Additional definitions, including explanations of various acronyms, have been provided in this Chapter. For the convenience of the **TEM** users, some definitions found in the **L&D Manual** have also been included; however, definitions found in the **OMUTCD** have not been repeated unless there is a difference noted between how the term is used for traffic control purposes versus design purposes.

1501-2 Acronyms and Abbreviations

Some of these acronyms and abbreviations may not be used in the **TEM** at this time; however, they are provided here as a convenience since they may appear in related references.

AAN – **American Association of Nurserymen**.

AASHTO – **American Association of State Highway and Transportation Officials**.

ACI – **American Concrete Institute**.

ADA – **Americans with Disabilities Act**.

ADAAG – **ADA Accessibility Guidelines.**

AISC – **American Institute of Steel Construction**.

AISI – **American Iron and Steel Institute**.

ANSI – **American National Standards Institute**.

AREA – **American Railway Engineering Association**.

ASCE – **American Society of Civil Engineers**.

ASM – **Application Standards Manual**. A manual previously published by the **Office of Traffic Engineering (OTE)** and was incorporated into the **TEM**.

ASME – **American Society of Mechanical Engineers**.

ASTM – **American Society of Testing and Materials**.

ATSSA – **American Traffic Safety Services Association**.

AWG – **American Wire Gauge**.

AWS – **American Welding Society**.

AWWA –**American Water Works Association**.

AWPA – **American Wood Preservers' Association**.

CGM – **Construction Guidelines Manual**. A manual which was previously published by **OTE** and was incorporated into the **TEM**.

DDD – **ODOT District Deputy Director**.

CADD – Computer-Aided Drafting and Design. See ***Section 1501-3*** for additional information.

C&MS – **Construction and Materials Specifications Book**. See ***Part 1*** for additional information.

CRRC – Construction Reference Resource Center. Access to online construction references, including construction letting and award information, Specifications, Proposal Notes, etc.

DRRC – Design Reference Resource Center. A centralized source of electronically distributed design reference materials, including design manuals, Specifications, standard drawings, etc.

EEI – **Edison Electric Institute**.

EMA – **Emergency Management Agency.**

EPA – **Environmental Protection Agency**.

FHWA – **Federal Highway Administration, Department of Transportation**.

FSP – Freeway Service Patrol.

FSS – **Federal Specifications and Standards** from the **General Services Administration**.

GLCT – Great Lakes Circle Tour. See ***Part 2*** for additional information.

GSDM – **Guide Sign Design Manual (also known as the Design Manual for Directional Guide Signs)**. A manual previously published by **OTE**. The information is now located in Appendix C of the **Sign Designs and Markings Manual**, which is incorporated by reference into the **TEM**.

HazMat – Hazardous Material.

HCM – **Highway Capacity Manual**.

HMA – Highway Management Administrator.

HT – Highway Technician.

IC – Incident Commander.

ICS – Incident Command System.

IEEE – **Institute of Electrical and Electronic Engineers**.

IES – **Illuminating Engineering Society**.

IMSA – **International Municipal Signal Association**.

IPCEA – **Insulated Power Cable Engineers Association.**

ISSA – **International Slurry Seal Association.**

ITS America – **Intelligent Transportation Society of America**

ITE – **Institute of Transportation Engineers**.

OTIS – **Ohio Transportation Information System**.

L&D Manual – Location and Design Manual. A three-volume set of design manuals published by the **Office of Roadway Engineering Services** (Volume 1), the **Office of Hydraulic Engineering** (Volume 2) and the **Office of CADD and Mapping Services** (Volume 3).

LECT – Lake Erie Circle Tour. See ***Part 2*** for additional information.

LOS – **Level of Service**. See ***Section 1501-3*** and the **L&D Manual Volume 1**, for additional information.

L.C.L. – **Light Center Length**. See ***Section 1501-3*** for additional information.

LEO – **Law Enforcement Officer**.

LPA – **Local Public Agency**.

LTAP – Local Technical Assistance Program. See ***Section 1501-3*** for additional information.

MPO – Metropolitan Planning Organization. A federally designated collective for administering funding for projects within its jurisdiction, generally a group of local political entities in a geographical area.

MUTCD – **Manual on Uniform Traffic Control Devices**. This manual, published by **FHWA**, is described in ***Section 193-10***.

NCUTCD – **National Committee on Uniform Traffic Control Devices**. See ***Section 1501-3*** for additional information.

NEMA – **National Electrical Manufacturers Association**. See ***Section 1501-3*** for additional information.

NIMS – **National Incident Management System.**

OCA – **Office of Construction Administration**.

OHGO – A website that provides up-to-the-minute details on current traffic speeds, cameras, incidents, road conditions, and weather-related conditions.

ODNR – **Ohio Department of Natural Resources**.

ODOT – Ohio Department of Transportation.

OEPA – **Ohio Environmental Protection Agency**.

OMUTCD – Ohio Manual of Uniform Traffic Control Devices. See ***Section 101*** for additional information.

OPI – **Ohio Penal Industries**.

ORC – **Ohio Revised Code**.

ORDC – **Ohio Rail Development Commission**.

OSHA – **Occupational Safety and Health Administration**.

OTE – **Office of Traffic Engineering.** The traffic standards functions moved to the **Office of Roadway Engineering** in late 2012, and the remaining group was designated the **Office of Traffic Operations (OTO)**.

O.L. – Overall Length. See ***Section 1501-3*** for additional information.

PDP – **Project Development Process**. **ODOT's** process for development of all projects bid or developed through **ODOT**.

PIS – Plan Insert Sheets. See ***Section 104*** for additional information.

PLC – Permitted Lane Closure.

PLCM – Permitted Lane Closure Maps.

PS&E – Plans, Specifications & Estimates. See ***Section 1501-3*** for additional information.

RAM – Random Access Memory. See ***Section 1501-3*** for additional information.

REA – **Rural Electrification Administration**

ROM – Read Only Memory. See ***Section 1501-3*** for additional information.

RPM – Raised Pavement Marker. See ***Section 1501-3*** for additional information.

SCD – Standard Construction Drawing. See ***Section 1501-3*** for additional information.

SDMM – Sign Designs and Markings Manual. The **Standard Sign Design Manual** is described in ***Section 295-2***.

SHS – **Standard Highway Signs and Markings** book. This manual, published by **FHWA**, is described in ***Section 193-14***.

SOP – Standard Operating Procedure.

SSPC – **Steel Structures Painting Council**.

SLD – Straight Line Distance. See ***Section 1501-3*** for additional information.

TCD – Traffic Control Device.

TCDIM – **Traffic Control Design Information Manual**. A manual, previously published by **OTE,** which has been incorporated into the **TEM**.

TCP – Traffic Control Plan.

TEM – Traffic Engineering Manual.

TIMS – Transportation Information Mapping System. Web-based mapping tool; providing transportation employees and stakeholders, and the general public, a central access point for viewing, distributing, and analyzing **Ohio's** transportation data.

TIP – Transportation Improvement Plan. The method by which projects are accepted by the MPO.

TMA – Truck-Mounted Attenuator.

TMC – Traffic Management Center**.**

TODS – Tourist Oriented Directional Signs. See ***Section 1501-3*** and ***Part 2*** for additional information.

TRAC – Transportation Review Advisory Council.

TRPM – Temporary Raised Pavement Marker.

TTCD – Temporary Traffic Control Device.

UL – **Underwriters' Laboratories, Inc.**

1501-3 Words and Phrases

OMUTCD Section 1A.13 defines various terms used in that manual and herein. When the source of the definition is the **ORC** (usually **Section 4511.01**), the definition is shown in italics and the **ORC** section number is noted. The following list is intended to provide definitions of words and phrases not currently defined in the **OMUTCD**.

Some of the definitions in this Section will be incorporated into the **OMUTCD**; however, most of them are more detailed than needed for the **OMUTCD**. The source for most of these definitions was the **Construction Guidelines Manual**, previously published by **OTE** and now incorporated into the **TEM**. When definitions have been taken from other sources, such as the national **Manual on Uniform Traffic Control Devices (MUTCD)** and the **ODOT L&D Manuals**, they have been identified by a cross-reference.

Also, some of the terms noted herein may have different meanings depending on the context in which they are used. Clarification has been provided as needed.

Adaptation – The process by which the retina becomes accustomed to more or less light than it was exposed to during an immediately preceding period.

Adjustable Signal – A signal head having the signal faces mounted in the support hardware so that each face may be adjusted or "aimed," as required to present the indication to approaching traffic.

Alternate Bid – A bid process in which both a generic bid and a proprietary bid are taken for the same item of equipment or work. The maintaining agency may choose which bid to accept; however, if the agency chooses the proprietary bid and it is higher than the generic bid, it must use its own funds for 100 percent of the cost difference.

Amplifier – A device that is capable of intensifying the electrical energy produced by a sensor.

Analog Controller – A controller with a method of timing that measures continuous variables such as voltage or current.

Arterial Highway (or Street) – For traffic engineering purposes **(ORC 4511.01 and OMUTCD)**, any U.S. or State numbered route, controlled-access highway, or other major radial or circumferential street or highway designated by local authorities within their respective jurisdictions as part of a major arterial system of streets or highways.

For design purposes, a functional classification for a facility primarily used for through traffic, usually on a continuous route **(L&D Manual Volume 1).**

Attenuator (Crash Cushion) – Protective device that prevents errant vehicles from impacting a fixed object by gradually decelerating or redirecting the vehicle **(L&D Manual Volume 1)**.

Auto-Manual Switch – See **Switch, Auto-Manual**.

Auxiliary Equipment – Separate control devices used to add supplementary features to a signal controller.

Balance Adjuster – A device used to permit alignment of the point of suspension with respect to the center of gravity of the signal head so that the signal will hang vertically.

Ballast – An auxiliary device used with vapor lamps, on multiple circuits, to provide proper operating characteristics. It limits the current through the lamp, and may also transform voltage.

Ballast Mounting – Ballast shall be mounted within the luminaire housing (integral).

Bandwidth – The amount of green time available to a platoon of vehicles in a progressive signal system. This is also referred to as through band.

Barrier – A device which provides a physical limitation through which a vehicle would not normally pass. It is intended to contain or redirect a vehicle **(L&D Manual Volume 1).**

Barrier (Compatibility Line) – A reference point in the preferred sequence of a multi-ring controller unit at which all rings are interlocked. Barriers assure there will be no concurrent selection and timing of conflicting phases for traffic movement in different rings. All rings cross the barrier simultaneously to select and time phases on the other side **(NEMA)**.

Barrier Clearance – The distance required between the face of a barrier and the face of an obstacle to permit adequate shielding **(L&D Manual Volume 1).**

Barrier Curb – See Curb, Vertical.

Base Plates – In sign support breakaway connections, plates welded onto each beam half with skewed notches for torqued bolts so as to permit the plates to part under vehicle impact.

Bead Flotation – The ability of glass beads to assume a hemispheric secured position when dispensed onto the surface of the freshly applied pavement markings.

Beam Candlepower – The intensity of a beam forming light source expressed in candelas measured in a given direction.

Beam Spread – The angle between the two directions in the plane in which candlepower is equal to a stated percent (usually 10 percent) of maximum candlepower in the beam.

Beam-Type Support – See **Support, Beam-Type**.

Bearing Plate – A formed steel plate installed between a flatsheet sign and its mounting post so as to reinforce the sign.

Bid, Alternate – See **Alternate Bid**.

Bid, Generic – See **Generic Bid**.

Bid, Proprietary – See **Proprietary Bid**.

Binder – Resins and liquids used to combine dry ingredients into a formulation of pavement marking materials.

Bleeding – A condition where asphalt pavement surfaces soften to a point where released oils appear as stains in the marking.

Buffer - The space between the face of the curb and the sidewalk for the purpose of providing snow storage, a buffer between cars and pedestrians, a place for signs and to improve aesthetics **(L&D Manual Volume 1).**

In a temporary traffic control situation, "the buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle." **(OMUTCD Section 6C.06)**

Bracket Arm – A signal bracket, for bracket-mount applications, of tubular construction through which wiring can be passed to provide electrical connection of the signal faces.

Breakaway Beam-Type Support – See **Support, Breakaway Beam-Type**.

Burning position – Physical positioning of the lamp in the traffic signal. Normally, traffic signal lamps are used in horizontal burning position.

Cable – A group of separately insulated wires in a common jacket.

Cable Entrance Adapter – A device of tubular construction which is used between the span wire hanger and the traffic signal to provide for passing signal cable into the head.

CADD (Computer-Aided Drafting and Design) – The preferred method of preparing **ODOT** construction plans. **ODOT** has adopted MicroStation as its standard CADD software package and has developed various CADD standards to ensure plan uniformity.

Call – A registration of demand for right-of-way by traffic (vehicular or pedestrian) at a signal controller.

Calling Detector – A detector that is installed in a selected location to detect vehicles which may not otherwise be detected, and whose output may be modified by the controller unit.

Calling Relay – A detector relay which will allow a detector actuation to be transferred to the controller only when certain signal displays are occurring.

Camber – An upward curve in horizontal structural members so that when erected and under dead weight a horizontal position or slightly upward curve will result.

Camshaft – A device consisting of a stack of programmed cams operated by a drive motor for intermittent advancement in increments to cause contacts to open or close, thus causing the required signals to be energized.

Candela (cd) – The unit of luminous intensity; one candela is defined as the luminous intensity of 1/60th of one square centimeter of projected area of a blackbody radiator operating at the temperature of solidification of platinum.

Candlepower – Luminous intensity expressed in candelas.

Cantilever Support – See **Support, Cantilever**.

Carryover (Extended) Output – The ability of a detector to continue its output for a predetermined length of time following an actuation.

Catch Basin – A structure for intercepting flow from a gutter or ditch and discharging the water through a conduit **(L&D Manual Volume 2)**.

Centerline of Construction – The reference line used for construction of a project. Normally located at the median centerline on a divided highway or at the normal crown point location on an undivided highway **(L&D Manual Volume 3)**.

Centerline of Right-of-Way – The reference line used for the right-of-way of a project. Normally located at the center of a highway's existing right-of-way **(L&D Manual Volume 3)**.

Center-Mount Support – See **Support, Center-Mount**.

Centralized Control Signal System – A system in which all control functions are controlled by a computer with direct communication to each local intersection controller without using the intermediate control and processing of a master controller.

Centrally Controlled – A system of peripheral devices which communicates with and which is manipulated via, a central control operator or software.

City – A municipal corporation having a population of 5,000 or more persons **(ORC Section 703.1)**.

Classification Detector – A detector that has the capability of differentiating among types of vehicles.

Clear Zone – The unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bike lanes, and auxiliary lanes, except those auxiliary lanes that function like through lanes. **(L&D Manual Volume 1)**.

The total roadside border area, starting at the edge of the traveled way, that is wide enough to allow an errant driver to stop or regain control of a vehicle. This area might consist of a shoulder, a recoverable slope, and/or a non-recoverable, traversable slope with a clear run-out area at its toe **(OMUTCD)**.

Coefficient of Utilization (CU) – Ratio of luminous flux (lumens) received on the work area to the rated lumens emitted by the lamp.

Cloverleaf Interchange – An interchange with loop ramps and outer ramps for directional movements. A full cloverleaf has ramps in every quadrant **(L&D Manual Volume 1)**.

Collector – A functional classification for a facility in an intermediate functional category connecting smaller local road or street systems with larger arterial systems **(L&D Manual Volume 1)**.

A term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways (OMUTCD).

Collector-Distributor (C-D) – A directional roadway adjacent to a freeway used to reduce the number of conflicts (merging, diverging and weaving) on the mainline facility (L&D Manual Volume 1).

Commercial Activity – For purposes of defining Tourist Oriented Activity for the TODS program, this is defined as "a farm market, winery, a bed and breakfast, lodging that is not a franchise or part of a national chain, antiques shop, craft store, or gift store."

Computed Initial Portion (Added Initial Portion, Variable Initial Portion) – An initial portion which is added to the minimum actuations on volume density timed controllers.

Computer – A device capable of accepting information, applying prescribed processes to the information and supplying results of these processes. It usually consists of input and output devices, storage, arithmetic and logic units, and a control unit.

Computer Program – A series of instruction or statements in a form acceptable to the computer which will achieve a certain result.

Concurrent timing – See **Dual-ring Controller**.

Conduit – A closed structure such as a pipe that has a span less than 10 feet as measured in a parallel direction to the roadway centerline (L&D Manual Volume 2).

Condulet – A fitting connected to solid or flexible electrical conduit to direct the routing path and containing a removable cover for wire pulling.

Conflicting Phases – Two or more signal phases which will cause interfering, or conflicting, traffic movements if operated concurrently.

Congestion Detection – A system of hardware and software designed and operated to provide data on the level of traffic congestion in the area being detected.

Contact, Signal Circuit – A device arranged to energize or de-energize signal light circuits during a specified interval.

Continuous Presence Mode – Detector outputs continue if any vehicle (first or last remaining) remains in the field of influence.

Controller (Controller Assembly) – A complete electrical or electronic device mounted in a cabinet for controlling the operation of a traffic signal (OMUTCD).

Controller, Local Intersection – See **Local Intersection Controller**.

Controller, Master – See **Master Controller**.

Controller, Traffic-Actuated – See **Traffic-Actuated Controller**.

Construction Limits – Lines shown on a plan view that outline the lateral extent of the work. Typically placed 4 feet outside the point where the backslope touches the existing ground unless additional room is required for construction activities (L&D Manual Volume 3).

Controlled-Access Highway – (Partial Control of Access) - Every highway, street or roadway in respect to which owners or occupants of abutting lands and other persons have no legal right of access to or from the same except at such points only and in such manner as may be determined by the public authority having jurisdiction over such highway, street or roadway **(ORC 4511.01 and OMUTCD)**.

Highway right-of-way where preference is given to through traffic. In addition to access connections with selected public roads, there may be some private drive connections **(L&D Manual Volume 1)**.

Converging Roadway – Separate and nearly parallel roadways or ramps which combine into a single continuous roadway or ramp having a greater number of lanes beyond the nose than the number of lanes on either approach roadways **(L&D Manual Volume 1)**.

Coordinator (Coordination Unit) – A device used to interrelate the timing of one controller to others in a traffic signal system.

Coordination – See **Signal Coordination**.

Crash Cushion – See **Attenuator**.

Culvert – A structure which is typically designed hydraulically to take advantage of submergence at the inlet to increase hydraulic capacity. A structure used to convey surface runoff through embankments. A structure, as distinguished from a bridge, which is usually covered with embankment and is composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert **(L&D Manual Volume 2)**.

Curb, Sloping – Sloping curbs are designed so vehicles can cross them readily when the need arises. They are low with flat sloping faces. Total curb height should not exceed 6 inches. Formerly called Mountable Curb **(AASHTO)**.

Curb, Vertical – Vertical curbs may be either vertical or nearly vertical and are intended to discourage vehicles from leaving the roadway. The curb height ranges from 6 to 8 inches (150 to 200 millimeters). Formerly called Barrier Curb **(AASHTO)**.

Cycle – Any complete sequence of signal indications.

Cycle Selection Switch – A device which when operated discontinues automatic selection of cycle unit with associated split(s) and offset(s) and permits manual selection of another cycle unit.

Daylight Reflectance – The measure of daylight reflected from a pavement marking for the enhancement of visibility.

Decoder – A mechanism for translating a code into its various components.

Decision Sight Distance – The distance required for a driver to detect an unexpected or otherwise difficult-to-perceive information source or hazard in a roadway environment that may be visually cluttered, recognize the hazard or its threat potential, select an appropriate speed and path, and initiate and complete the required maneuver safely **(L&D Manual Volume 1)**.

Dedicated Lines – Communication lines used solely to interconnect two or more intersections.

Delayed Output – The ability of a detector to delay its output for a predetermined length of time during an extended actuation.

Delay Relay – A detector relay which will provide an actuation only after the relay has been continuously energized for a set period of time.

Demand – The need for service, e.g., the number of vehicles desiring to use a given segment of roadway during a specified unit of time.

Demountable Copy – Sign copy made up of separate letters, digits, symbols, shields and border sections which are riveted or bolted to the sign panel and which may be readily removed.

Density – A measure of the number of vehicles per unit length of roadway; a measure of the concentration of vehicles usually stated as the number of vehicles per mile per lane.

Department – The **Ohio Department of Transportation**.

Design Exception – A document which explains the engineering and/or other reasons for allowing certain design criteria to be relaxed in extreme, unique, or unusual circumstances **(L&D Manual Volume 1).**

Design Hour – The 30th highest hourly volume of the design year **(L&D Manual Volume 1).**

Design Hourly Volume – The total volume of traffic in the design hour, usually a forecast of peak hour volume, measured in vehicles per hour **(L&D Manual Volume 1).**

Design Speed – A selected speed used to determine the various geometric design features of the roadway **(L&D Manual Volume 1).**

Destination Signs – Signs providing distance and/or directional information to a city, village or other objective.

Detections – The process used to identify the presence or passage of vehicles at a specific point or to identify the presence of one or more vehicles in a specific area.

Detector Modes – A term used to describe the duration of detector output when a detection occurs.

Diagnostic – (1) Pertaining to the detection, discovery and further isolation of a malfunction or mistake; (2) A program that facilitates computer maintenance by detection and isolation of malfunctions or mistakes.

Diamond Interchange – The simplest and most common type of interchange, formed when one-way diagonal ramps are provided in each quadrant and left turns are provided on the minor highway **(L&D Manual Volume 1).**

Diffuser – A device to redirect or scatter the light from a source, primarily by the process of diffuse transmission.

Digital Controller – A controller wherein timing is based upon a defined frequency source such as a 60-hertz alternating power source.

Digital Timing – See **Timing, Digital**.

Dilemma Zone – The range of distances from the Stop Line within which drivers are indecisive as to whether to stop or proceed through the intersection when the traffic signal indication changes from green to yellow. Distances are dependent upon travel speed.

Directional Interchange – An interchange, generally having more than one grade separation, with direct connections for all movements **(L&D Manual Volume 1).**

Direct Applied Copy – Sign copy cut from sheeting material and applied to the sign surface by a coated adhesive.

Direct Glare – Glare resulting from high brightness or insufficiently shielded light sources in the field of view or from reflecting areas of high brightness.

Direct Wire – A communications medium which uses hardware interconnect between the transmission and reception points.

Directional Detector (or Relay) – A detector that is capable of being actuated only by vehicles proceeding in one specified direction.

Directional Relay – A relay connected with detectors and designed to actuate only when traffic has crossed the detectors in a certain direction.

Disability Glare – Glare which reduces visual performance and visibility and which is often accompanied by discomfort.

Discomfort Glare – Glare which produces discomfort. It does not necessarily interfere with visual performance or visibility.

Disconnect Hanger – A mounting device for quick detachment or attachment of a signal head.

Distributed Control Signal System – A system in which all control functions are controlled by a master controller which is connected to all local intersections under its control. The master controller is typically located at an on-street location near the local intersection it controls. The master controller is connected to a computer to enable an operator to control, monitor and produce reports from each master controller database.

Divergence Angle – The angle at a reflective surface between a light ray striking the surface and an observer's line of sight.

Diverging Roadway – Where a single roadway branches or forks into two separate roadways without the use of a speed change lane **(L&D Manual Volume 1)**.

Down Time – The time during which a device is unavailable for normal operation.

Drop-on Beads (Surface Applied Beads) – Glass beads dispensed concurrently with wet or molten marking material placement so that the beads are held on the surface to provide instantaneous retroreflectorization.

Dual Entry – See **Entry, Dual**.

Dual-ring Controller – A controller containing two interlocked rings which are arranged to time a preferred sequence and to allow concurrent timing of both rings, subject to the restraint in the Barrier (Compatibility Line).

Dummy Interval – A redundant interval in the cam switching mechanism incorporated so as to allow the total number of intervals in the cycle to correspond integrally with the total number of intervals provided on the cam switching mechanism.

Dwell – See **Rest**.

Edge of Traveled Way – The intersection of the mainline pavement with the treated or turf shoulder or the curb and gutter **(L&D Manual Volume 1)**.

Electromechanical Controller – A controller which is characterized by electrical circuits using relays, step switches, motors, etc.

Electromechanical Electronic Controller – A controller combining electromechanical components and electronic timing circuits comprised of vacuum electronic tubes, resistors, capacitors and inductors, etc.

Emergency-Traffic Signal – A special adaptation of a traffic control signal to obtain the right-of-way for an authorized emergency vehicle.

Encoder – A device which converts data into a form for transmission over the communication link between two points in a system.

Entrance Ramp Approach Signs – Signs at a freeway or expressway interchange providing state route identification and directional information.

Entry, Dual – A mode of operation (in a dual-ring controller) in which one phase in each ring must be in service. If a call does not exist in a ring when it crosses the barrier, a phase is selected in that ring to be activated by the controller in a predetermined manner.

Entry, Single – A mode of operation (in a dual-ring controller) in which a phase in one ring can be selected and timed alone if there is no demand for service in a non-conflicting phase on a parallel ring.

Epoxy Markings – A mixture of epoxy resin and polymeric curing agent blended in a nozzle and spray applied to the pavement.

Expressway – As noted in **OMUTCD Section 1A.13 and ORC 4511.01(ZZ)**, for purposes of the traffic control standards, “a divided, arterial highway for through traffic with full or partial control of access with an excess of fifty percent of all crossroads separated in grade.”

For design purposes **(L&D Manual Volume 1)**, “a divided, arterial highway with full or partial control of access and generally with grade separations at major intersections.”

Extendible Portion (Extensible Portion) – That portion of the green interval on an actuated phase following the initial portion which may be extended by traffic actuations.

Extension Detector – A detector that is arranged to register actuation at the controller only during the green interval for that approach so as to extend the green time of the actuating vehicles.

Extension Interval (Gap) – The timing interval during the extendible portion which is resettable by each detector actuation. The green right-of-way of the phase may terminate on expiration of the unit extension time.

Extension Limit – See **Limit, Extension**.

Extruded Markings – Pavement markings applied in a plastic state by means of a shaping die.

Extrusheet Sign – See **Sign, Extrusheet**.

Field Terminal Blocks - See **Terminal Blocks, Field**.

Filament – The electrical resistance element heated to incandescence by electric current.

Fill Slope – See **Foreslope**.

Filler – An ingredient adding bulk to the formulations of pavement marking materials.

Flash Control Switch – See **Switch, Flash Control**.

Flasher Controller – A complete electrical mechanism with cabinet for flashing a traffic signal or beacon.

Flatsheet Sign – See **Sign, Flatsheet**.

Footcandle (fc) – The unit of illumination when the foot is the unit of length; the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen. It equals one lumen per square foot.

Footlambert (fl) – The unit of brightness equal to the uniform brightness of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot. On a roadway, it equals the illumination in footcandles multiplied by the reflection factor of the surface.

Force Account – The direct performance of highway construction work by a highway agency, a railroad company or a public utility company by use of labor, equipment, materials and supplies furnished by them and used under their direct control.

For a construction project, force account is defined as a basis of payment for the direct performance of highway construction work with payment based on the actual cost of labor, equipment and materials furnished.

Force Off – A command to the controller that will force the termination of the current right-of-way interval during the extendible portion.

Force Skip – See **Omit, Phase**.

Foreslope – The slope from the edge of the graded shoulder to the bottom of the ditch. Also, called Fill Slope **(L&D Manual Volume 1).**

Freeway – As noted in **OMUTCD Section 1A.13 and ORC 4511.01(YY)**, for traffic control purposes, “a divided multi-lane highway for through traffic with all crossroads separated in grade and with full control of access.”

For design purposes **(L&D Manual Volume 1),** “an expressway with full access control and no at-grade intersections.”

Full-Actuated Controller – A type of actuated controller in which means are provided for traffic actuation on all approaches to the intersection.

Full-circle Tunnel Visor – A visor which encircles the entire lens.

Functional Classification – The grouping of highways by the character of service they provide **(L&D Manual Volume 1).**

Fuse Plate – See **Plate, Fuse**.

Gap, Maximum – The maximum time on volume-density timed controllers allotted for vehicles to proceed through the intersection. The interval portion is decreased to a fixed minimum in proportion to traffic demands.

Gap, Minimum – The lower limit to which the extendible portion of the extension time may be decreased on volume-density timed controllers.

Gap Reduction – A feature in volume-density controllers whereby the unit extension in the phase having the green is reduced in the extendible portion of the interval in proportion to the time vehicles have waited on the phase(s) having the red.

General Notes – A portion of a highway plan containing those plan notes required to clarify construction items not adequately covered by the specifications or plan details **(L&D Manual Volume 3)**.

General Summary – A portion of a highway plan used to summarize the total estimated quantities with complete pay item descriptions, item numbers and funding splits **(L&D Manual Volume 3)**.

Generic (or Generic Bid) – Specified by a generalized material or performance specification without reference to a manufacturer's brand name or registered trademark.

Generic Motorist Service Signing – Symbolic or word message signs in the **OMUTCD** which indicate the type of service, but not the specific name of the facility.

Glare – The sensation produced by brightnesses within the visual field that are sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility.

Glare Screen – A device used to shield a driver's eye from the headlights of an oncoming vehicle **(L&D Manual Volume 1)**.

Glare Shield – A nonreflective vertical extension of a sign designed to mask the direct rays of sign lighting fixtures from the eyes of drivers approaching on the opposing roadway.

Glass Beads – Small spheres which, when exposed on a pavement marking surface, act as refracting and reflecting elements which return light back to its source.

Glint – The reflection of light from a specular surface.

Gradation – The classification of particle size distribution of dry material as determined by the passage or retention of portions of a specimen on standard sieves.

Graded Shoulder – The area located between the edge of the traveled way and the foreslope **(L&D Manual Volume 1)**.

Green Interval (Right-of-way) – The operation of a controller in causing traffic signals to display indications permitting vehicles or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians.

Ground-Mounted Support – See **Support, Ground-Mounted**.

Headlight Sight Distance – The stopping sight distance required on an unlighted sag vertical curve **(L&D Manual Volume 1)**.

Headwall – The structural appurtenance placed at the open end of a pipe to control an adjacent highway embankment and protect the pipe end from undercutting **(L&D Manual Volume 2)**.

Hiding Power – The degree of opaqueness of a marking in masking underlying pavement shades.

Hinge Plate – See **Plate, Hinge**.

Hold – A command to the signal controller which causes it to retain the existing right-of-way interval.

Horizontal Sight Distance – The sight distance available in consideration of various horizontal alignment features, such as, degree of curvature and the horizontal distance to roadside obstructions **(L&D Manual Volume 1)**.

Hybrid Control Signal System – Incorporates features of both the Centralized and Distributed Control Signal Systems.

Illumination (Illuminance) (E) – The density of luminous flux incident on a surface; the quotient of the flux divided by the area of the surface, when the flux is uniformly distributed.

Impact Resistance – The toughness of a material in resisting deformation and fracture due to a striking blow.

Incident – An unplanned occurrence which restricts traffic flow.

Incident Management – Practices used to help mitigate the effects of incidents.

Indicator Lights – Visual aids showing actuations and timing of intervals or phases on a controller for the purpose of programming inspection and maintenance.

Initial Portion – The first timed portion of the green interval in an actuated controller.

Inlaid Markings – Markings of preformed material pressed into the surface of newly placed asphalt concrete pavement.

In-mixed Beads (Premixed Beads) – Glass beads distributed uniformly through a pavement marking material to provide continuous retroreflectorization as the material wears away.

Interconnect – The traffic signal communication network connecting the system master with local intersection controllers.

Interconnected Controller – A controller which operates traffic signals under the supervision of a master controller.

Interface – A common boundary at which two separate systems or portions of each join or interact. An interface can be mechanical, as in adjoining hardware surfaces, or it can be electrical, as in signal level transformation points. Moreover, it can also refer to human and machine interface and the interaction between man and computer.

Interlock – A feature of electromechanical controllers which maintains the timing dial in step with the camshaft.

Intersection Sight Distance (ISD) – The sight distance required within the corners of intersections to safely allow a variety of vehicular maneuvers based on the type of traffic control at the intersection **(L&D Manual Volume 1)**.

Interstate – Those roadways on the Federal System which have the highest design speeds and the most stringent design standards **(L&D Manual Volume 1)**.

Interval Sequence – The order of appearance of signal indications during successive intervals of a cycle.

Interval Sequence Chart – A chart designating the order in which the phases of a cycle occur and the associated signal display for each interval.

Item Code – A nine-digit character used to catalogue pay item descriptions **(L&D Manual Volume 3)**.

Item Master – A list of acceptable item codes and their corresponding pay item descriptions and units of measure **(L&D Manual Volume 3)**.

Jack – A receptacle in a controller cabinet in which a plug-in device may be inserted.

Lamp – The part of the optical unit which, when energized electrically, provides the optical unit light source.

Lamp Lumen Depreciation Factor (LLD) – The multiplier to be used in illumination calculations to relate the initial rated output of light sources to the anticipated minimum rated output based on the relamping program to be used.

Lateral Clearance – The distance measured horizontally from the edge of traveled way to the face of an object (parapet, abutment, pier, wall, etc.) **(L&D Manual Volume 1)**.

Lead-in Cable – The electric cable which serves to connect the sensor to the input of the detector unit.

Legal Speed – The legislated or agency authorized maximum speed limit of a section of roadway **(L&D Manual Volume 1)**. Also see **ORC 4511.21**.

Level of Service (LOS) – A qualitative measure describing the operational flow of traffic **(L&D Manual Volume 1)**.

Light – A form of radiant energy (such as emitted by the sun). For purpose of illuminating engineering, the energy is evaluated according to its capacity to produce visual sensations. Measurements are based upon a unit of luminous intensity equal to the light emitted by a Astandard candle@ in a horizontal direction.

Light Center Length (L.C.L.) – The dimension, in inches from the center of the filament to the top of the base (including solder on the base eyelet).

Light Sensitive Detector – A detector that uses a light-sensitive device for sensing the passage of an object interrupting a beam of light directed at the sensor.

Light Pole – A support provided with necessary internal attachments for wiring and external attachments for bracket and luminaire.

Limit, Extension – The maximum time of the extendible portion for which actuations on any traffic phase may retain the right-of-way after actuation on an opposing traffic phase.

Limit, Maximum – The maximum green time after an opposing actuation, which may start in the initial portion.

Limited Access (Full Control of Access) – Highway right-of-way where rights of access of properties abutting the highway are acquired, such that all access to and from the highway are prevented except at designated locations **(L&D Manual Volume 1)**.

Limited Presence Mode – Detector output continues for a limited period of time if vehicles remain in field of influence.

Load Switch – A device used to switch power to the signal lamps.

Local Technical Assistance (LTAP) Program – **LTAP, or Technology Transfer (T2) Centers** have been established in each of the states to provide for the transfer of transportation technology and technical assistance to rural and local governments. The mission of the **Ohio LTAP Center** is to provide training, technical assistance, advice and other resources to **Ohio's** local governments, which include cities, counties, townships and villages. The **Ohio LTAP Center** is funded through the **FHWA** and **ODOT**.

Local Intersection Controller – The complete electrical mechanism mounted in a cabinet for controlling signal operation by selecting and timing the various signal head displays. The local intersection controller is located at the individual intersection site.

Local Road – A functional classification used for rural roadways whose primary function is to provide access to residences, businesses or other abutting properties **(L&D Manual Volume 1)**.

Local Street – A functional classification used for urban roadways whose primary function is to provide access to residences, businesses or other abutting properties **(L&D Manual Volume 1)**.

Logo Sign Panel – A retroreflectorized sign mounted on the **Specific Service Sign** showing the trademark logo, non-trademark logo, legend message or combination thereof for a motorist service available on a crossroad at or near an interchange.

Logo Program – The Ohio Logo Signing Program, also known as the Specific Service Sign Program, permits eligible businesses which provide gas, food, lodging, or camping services to drivers to have their logos placed on specific service (logo) signs. See ***Part 2*** for additional information.

Longitudinal Joint – A pavement joint, in the direction of traffic flow, used to control longitudinal cracking on a rigid pavement or the joint formed between adjacent passes of a paver on a flexible pavement **(Pavement Design & Rehabilitation Manual)**.

Loop Detector – A detector that senses a change of inductance of its inductive loop sensor caused by the passage or presence of a vehicle near the sensor.

Lumen (lm) – The unit of luminous flux; equal to the flux in a unit solid angle (one steradion) from a uniform point source of one candela. Traffic signal lamp output is rated in lumens.

Luminance (brightness) RATIO – The ratio between the luminances of any two areas in the visual field.

Luminaire – The complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Luminaire Dirt Depreciation Factor (LDD) – The multiplier to be used in illumination calculations to relate the initial illumination provided by clean new luminaries to the reduced illumination that they will provide due to direct collection on the luminaires at the time at which it is anticipated that cleaning procedures will be instituted.

Luminaire Efficiency – The ratio of the luminous flux leaving a luminaire to that emitted by the lamp or lamps used therein.

Luminaire Support – A bracket or mast arm attachment to a lighting pole from which a luminaire is suspended.

Magnetic Detector – A detector that senses changes in the earth’s magnetic field caused by the movement of a vehicle near its sensor.

Magnetometer Detector – A detector that measures the difference in the level of the earth’s magnetic forces caused by the passage or presence of a vehicle near its sensor.

Maintenance Factor (MF) – The product of the lamp lumen depreciation factor and the luminaire dirt depreciation factor (MF = LLD x LDD).

Manual Operation – The operation of a controller assembly by means of a hand-operated device(s) (manual pushbutton).

Manual Pushbutton – An auxiliary device for hand operation of a controller.

Mast Arm – A structural support over the roadway extending from a pole, for the purpose of supporting signal heads.

Mast Arm, Flexible Mount – A mast arm mount where the signal head is attached to the mast arm by a flexible joint and connector to permit “free swinging” between the signal and the mast arm.

Mast Arm, Rigid Mount – A mast arm mount where the signal head is rigidly affixed to the mast arm to prevent any relative movement between the signal and the arm.

Master Control – Centrally located equipment designed to supervise a number of intersections and used to select programs on secondary control equipment to best suit traffic needs.

Master Controller – An automatic device for supervising a system of secondary controllers, maintaining definite time interrelationship, selecting among alternate available modes of operations or accomplishing other supervisory functions.

Master Coordinator – A coordinator used to provide synchronization and selection of programs on secondary coordinators or pretimed controllers to maintain a traffic system.

Master-secondary Controller – A controller for operating a traffic signal and for providing supervision of other interconnected (secondary) controllers.

Maximum Green – The maximum time right-of-way can be extended by actuation on a phase provided an actuation has been registered on a conflicting phase.

Maximum Initial Portion – The limit of the computed initial portion on volume density timed controllers.

Maximum Limit – See **Limit, Maximum**.

Memory, Locking – The retention of an actuation for future utilization by the controller.

Memory, Nonlocking – A mode of actuated-controller operation which does not require detector memory.

Mercury Vapor Luminaire – A lighting unit containing a mercury vapor lamp mounted within a housing with a metal frame, glass lens and a reflector.

Microprocessor – A device which uses the flexibility of computer electronics on a limited scale. Microprocessors are basically microminiaturized CPUs (Central Processing Units).

Minimum Green – (1) The shortest time for which the right-of-way shall be given to a non-actuated phase; (2) The shortest time for which the right-of-way shall be given to an actuated phase provided an actuation has been registered for that phase.

Minimum “Initial” Lumens – A minimum value of initial light output below which no more than a specified percentage of individual lamps will be permitted.

Minimum Initial Portion (Fixed Initial Portion) – A fixed preset first interval portion of the right-of-way on volume-density controllers.

Minor Movement Controller – A device that can be used with a controller unit to provide subordinate phase timing.

Modular – Equipment which is designed such that functional sections are plug-in circuit boards and can be readily exchanged with similar units.

Modular Controller, by Function – Controllers constructed so that additional functional capabilities may be provided by the addition of hardware modules. A single module provides a function(s) for one or more phases in the controller.

Modular Controller, by Phase – A controller constructed so that each timing module is associated with only one independent phase. The addition or removal of modules associated with one phase will not affect the operation of the controller with respect to the other phases.

Motorist Services – Signing for the LOGO program (gas, food, lodging or camping), emergency hospitals, generic motorist services (gas, diesel, food, lodging, camping), tourist information centers, law enforcement agencies and motorist assistance.

Mountable Curb – see **Curb, Sloping**.

Mounting Height (MT. HT.) – The vertical distance in feet between the roadway surface and the center of the light source in the luminaire.

Movement – The travel direction and destination of a lane or lanes of vehicles at an intersection, i.e. left turn, through or right turn.

Multiplexing – A communications technique which allows more than one item of information to be transmitted or received at essentially the same time.

Municipal Corporation – A city or village.

National Committee on Uniform Traffic Control Devices (NCUTCD) – A private organization of 150 to 200 experts who are involved in the daily operation of highways or streets. The committee meets twice a year to discuss proposed changes to the national **MUTCD**, develop comments, and submit them to **FHWA** for consideration. Its current members are employees of State and local agencies directly involved with traffic engineering activities, or representatives of other organizations who have a major interest in traffic control issues.

National Electrical Manufacturers Association (NEMA) – A national association of signal equipment and electrical component manufacturers that has produced specification standards on traffic signal control equipment to promote compatibility and interchangeability of signal equipment among different manufacturers.

No-Tracking Condition – The degree of solidification of a newly applied marking at which no pickup by vehicle tires occurs.

Noise – Random variations of one or more characteristics of any entity such as voltage, current and data. Generally tending to interfere with the normal operation of a device or system.

Non-actuated Phase – A controller phase with no means for receiving actuations from vehicles and pedestrians.

Non-conflicting Phases – Two or more traffic phases which will not cause interfering traffic movements if operated concurrently.

Nonadjustable Signal (Fixed-faced Signal) – A signal having the faces mounted in a casting so that the indications are presented as a fixed angle.

Noninterconnected (Isolated) Controller – A controller for operating traffic signals not under master supervision.

Normal Design Criteria – The criteria used for the design of new or reconstructed projects (all projects that do not qualify as 3R) **(L&D Manual Volume 1)**.

Object Marking – A marking intended for use on obstructions within or adjacent to the roadway.

Occupancy – The percentage of roadway occupied by vehicles at an instant in time. In general use it is a measurement based upon the ratio of vehicle presence time (as indicated by a presence detector) over a fixed period of total time.

ODOT-maintained Highways – All highways under **ODOT's** jurisdiction for which **ODOT** has responsibility for the maintenance.

Offset – The number of seconds or percent of the cycle length that a defined time-reference point (normally the start of major street green) at a traffic signal occurs after the time-reference point of a master controller or an adjacent traffic signal.

Offset Interrupter – A device which will distribute over two or more cycles the time required for large offset changes.

Offset Selection – Choosing one of several possible offsets manually or automatically either by time of day or in response to some directional characteristic of traffic flow.

Omit, Phase (Special Skip, Force Skip) – A command that causes omission of a phase due to lack of an actuation on that phase.

Open-bottom Tunnel Visor – A visor which encircles the entire lens except a segment equal to approximately 2 inches of circumference at the bottom of the lens.

Optical Unit – An assembly of lens, reflector, light source, and other components if required, with the necessary supporting parts to be used for providing a single indication.

Optically Programmed Signal – A signal head containing optical units projecting an indication which is selectively veiled as to be visible only within desired viewing boundaries.

Overall Length (O.L.) – The total distance from the tip of the bulb to the tip of the base, including solder on the base eyelet (does not apply to PAR type lamps).

Overlap – A right-of-way indication when the right-of-way is assigned to two or more traffic phases.

Overlay Sign – See **Sign, Overlay**.

Overpass Structure-Mounted Support – See **Support, Overpass Structure-Mounted**.

Panel – A board within the controller cabinet upon which are mounted field terminals, fuse receptacles or circuit breakers and other portions of the controller assembly not included in the controller unit or auxiliary devices.

Parking Control Zone – Part of a roadway in which parking is legally prohibited, restricted or regulated, as indicated by Regulatory Signs, pavement or curb markings.

Passage (Passage Time) – (1) The time allowed for a vehicle to travel at a given speed from the detector to the nearest point of conflicting traffic; (2) A term functionally equal to and often used interchangeably with **Unit Extension**.

Passage Detection – The ability of a vehicle detector to detect the passage of a vehicle moving through the detection zone and to ignore the presence of a vehicle stopped within the detection zone.

Passing Sight Distance - The visible length of highway required for a vehicle to execute a normal passing maneuver as related to design conditions and design speed **(L&D Manual Volume 1)**.

Pattern – A unique set of traffic parameters (cycle, split and offset) associated with each signalized intersection within a predefined group of intersections (a section or subzone).

Pavement Edge (Edge of Pavement) – See **Edge of Traveled Way**.

Peak Hour – The maximum traffic volume hour of the day **(L&D Manual Volume 1)**.

Pedestal – A vertical support on top of which the signal or controller cabinet is mounted.

Pedestal Mount – A signal head or controller cabinet mounted on top of a pedestal.

Pedestrian-Actuated Controller – A controller in which intervals such as pedestrian Walk and clearance intervals can be added to or included in the controller cycle by the actuation of a pedestrian detector (pushbutton).

Pedestrian Facilities – A general term denoting improvements and provisions made to accommodate or encourage walking.

Pedestrian Phase – A traffic phase allocated to pedestrian traffic which may provide a right-of-way pedestrian indication either concurrently with one or more vehicular phases or to the exclusion of all vehicular phases.

Pedestrian Recycle – Any start of pedestrian service after the start of the associated phase GREEN.

Phase – Those right-of-way and clearance intervals in a cycle assigned to any independent movement(s) of vehicle traffic or pedestrians.

Phase Diagram – A diagram illustrating the sequence of phases at an intersection with movement arrows indicated for each phase and showing overlaps, concurrent timing, etc.

Phase Omit – See **Omit, Phase**.

Phase Overlap – Refers to a phase which operates concurrently with one or more other phases.

Phase Sequence – (1) The order in which a controller cycles through all phases; (2) A predetermined order in which the phases of a cycle occur.

Photoelectric Control – An automatic switch controlled by ambient skylight intensity to turn sign or highway lighting on or off according to the changes of night or day.

Pigment – Fine solid insoluble particles which impart color and hiding power to the formulation of marking materials.

Plan Insert Sheet – See ***TEM Chapter 104***.

Plate, Fuse – In breakaway connections, a plate with notches for torqued bolts positioned over the point where the beam is sawed so that under vehicle impact the bolts will slip out of the notches to allow the beam to bend at the hinge plate on the opposite side.

Plate, Hinge – In breakaway connections, a plate positioned on the opposite side of the beam from the fuse plate and which bends under vehicle impact.

Play – A term used by **ODOT** to describe a preplanned detour route.

Playbook – A set of preplanned detour routes.

Point Detection – The detection of a vehicle as it passes a point or spot on a street or highway.

Polyester Markings – A mixture of polyester resin and catalyst applied by intermingling sprays to the pavement.

Post-Type Support – See **Support, Post-Type**.

Power Line Switch – See **Switch, Power Line**.

Preferred Sequence – The normal order of signal phase selection within a ring with calls on all phases.

Preemption Control – The transfer of the normal control of signals to a special control mode which may be required by railroad trains at crossings, emergency vehicles, mass transit equipment or other special needs.

Preemption Emitter – A device located on an approaching vehicle that emits a signal that, when detected by the preemption receiver, will change the normal operation of the traffic signals to provide a special sequence of signal displays for the approaching vehicle. The emitters have typically used optics, sound or radio as the signaling form.

Preemption Receiver – A device located at the signalized intersection that receives the preemption emitter signal from an approaching vehicle. In conjunction with a phase selector in the controller cabinet, the received signal causes the intersection controller to change to a predetermined signal display for the approaching vehicle.

Preformed Material – Flexible tape and sheet materials applied to the pavement by an adhesive.

Premarking – The procedure whereby the planned location of pavement marking is referenced or established by offset guide lines to assure correct placement.

Premixed Beads – See **In-Mixed Beads**.

Presence Detection – The ability of a vehicle detector to sense that a vehicle, whether moving or stopped, has appeared in its field.

Pressure Sensitive Detector – A detector that is capable of sensing the pressure of a vehicle passing over the surface of its sensor.

Pretimed Controller – A controller for the operation of traffic signals with predetermined and fixed cycle length(s), interval duration(s) and interval sequence(s).

Probe – The sensor form that is commonly used with a magnetometer-type detector.

Program Selection – The process of selecting the appropriate program for a given set of conditions. It can be accomplished manually or automatically either by time-of-day or in response to some characteristic or traffic flow.

Program Selection – The process of selecting the appropriate program for a given set of conditions. It can be accomplished manually or automatically either by time-of-day or in response to some characteristic or traffic flow.

Programmable Read Only Memory (PROM) – A device that stores data which cannot be altered by computer instructions. Data is stored ("burned") into this device externally by an electronic process. Some PROMs can be erased and programmed through special physical processes.

Proprietary Item (or Proprietary Bid) – Specified by reference to a single manufacturer's brand name or registered trademark.

PS&E (Plans, Specifications & Estimate) – A step between plan completion and construction in which **ODOT** obtains federal authorization to proceed to advertise for receipt of bids.

Pulse Mode – Detector produces a short output pulse when detection occurs.

QuickClear – An incident management program aimed at increasing safety for first responders, decreasing delay to the motoring public and minimizing the overall impact of incidents.

Radar Detector – A detector that is capable of sensing the passage of a vehicle through its field of emitted microwave energy.

Radio Interference Suppressor – A device inserted in the power line in the controller cabinet that minimizes the radio interference transmitted back into the power supply line, which interference may be generated by the controller unit or other mechanism in the cabinet.

Rake – The initial adjustment of a strain pole out of plumb so that it will be drawn to a vertical position under the span wire tensioning.

Random Access Memory (RAM) – A storage device with both read and write capabilities which will allow random access to stored data.

Rated "Initial" Lumens – The average amount of luminous flux (light) produced by a statistically acceptable sample of lamps on operation at rated voltage after having been seasoned to one-half to one percent of rated life.

Rated Life – The (arithmetic mean) average of burning hours for a sample number of lamps operated at rated volts and defined operating conditions.

Rated Voltage – The nominal or design operating voltage of the lamp; the voltage at which rated watts, lumens and life are determined.

Rated Watts – The average initial power (watts) consumed when the lamp is operated at rated volts.

Read Only Memory (ROM) – A storage device not alterable by computer instructions, e.g., magnetic core storage with a lockout feature or punched paper tape. ROM requires a masking operation during production to permanently record programs or data patterns in it. ROM is synonymous with nonerasable storage, permanent storage and read-only storage.

Recall – An operational mode for an actuated intersection controller whereby a phase, either vehicle or pedestrian, is displayed each cycle whether demand exists or not. This is usually a temporary or emergency situation.

Recall, Maximum Vehicle – With the control activation, right-of-way is returned to the phase for the maximum green limit once during each cycle without the necessity for an actuation.

Recall, Minimum Vehicle – With the control activation, right-of-way is returned to the phase once during each cycle without the necessity of an actuation. Timing is for at least an initial interval portion and may be extended by succeeding vehicles.

Recall, Pedestrian – With the control activation, pedestrian walk and clearance intervals for the phase are timed once during each cycle without the necessity of a pushbutton actuation.

Recall Switch - A manual switch which shall cause the automatic return of the right-of-way to a normally actuated phase regardless of the absence of actuation on that phase.

Reflector – A device used to redirect the luminous flux from a source by the process of reflection

Reflectorization – The enhancement of the night visibility of pavement markings by means of reflective glass beads.

Reflector Unit – A thin plastic unit with rear surface indented so as to redirect light by reflection.

Refraction – The process by which the direction of a ray of light changes as it passes obliquely from one medium to another in which its speed is different.

Refractor – A device used to redirect the luminous flux from a source or a reflector, primarily by the process of refraction

Responsive Mode – A system operation wherein the selection of signal timing programs is based on current traffic data as input by vehicle sensors within the network.

Rest – The interval portion of a phase when present timing requirements have been completed.

Resurfacing, Restoration and Rehabilitation (3R) – Improvements to existing roadways, which have as their main purpose the restoration of the physical features (pavement, curb, guardrail, etc.) without altering the original design elements **(L&D Manual Volume 1)**.

Resurfacing, Restoration, Rehabilitation and Reconstruction (4R) – Much like 3R, except that 4R allows for the complete reconstruction of the roadway and alteration of certain design elements (i.e., lane widths, shoulder widths, Stopping Sight Distance, etc.) **(L&D Manual Volume 1)**.

Reverse Screen – A silk screen with openings such that the sign background is deposited and the legend is not.

Rigid Overhead-Type Support – See **Support, Rigid Overhead-Type**.

Roadside – The area between the outside edge of the graded shoulder and the right-of-way limits **(L&D Manual Volume 1)**.

Roadway – As noted in **OMUTCD Section 1A.13 and ORC 4511.01(EE)**, for traffic control purposes, “that portion of a highway improved, designed, or ordinarily used for vehicular travel, except the berm or shoulder. If a highway includes two or more separate roadways the term “roadway” means any such roadway separately but not all such roadways collectively.”

For design purposes **(L&D Manual Volume 1)**, “the portion of a highway, including shoulders, for vehicle use.”

Route Markers – Signs which display a Township, County, State, U.S. or Interstate Route number or Bicycle Symbol, designed to be displayed alone or in an assembly, used to identify and mark numbered highway routes; includes various auxiliary markers used in junction assemblies, route turn assemblies and directional assemblies, etc.; also includes signs which incorporate cardinal direction and/or directional information in the body of the sign.

Route Shields – Signs which display a Township, County, State, U.S. or Interstate Route number, designed to be affixed to Guide Signs.

Sag – The amount of deflection at the lowest point of span wire used for the mounting of signal heads.

Sampling Detector – Any type of vehicle detector used to obtain representative traffic flow information.

Sealing Primer – A coating applied to surface areas prior to the placement of pavement markings to obtain proper adhesion.

Secondary Controller (Slave) – A controller which operates traffic signals under the supervision of a master controller.

Secondary Coordinator – A device used to supervise the cycle of an associated traffic actuated controller to permit synchronization and operation allowing passage of platoons of vehicles in a progressive traffic system.

Semi-Actuated Controller – A type of actuated controller in which means are provided for traffic actuation on one or more but not all approaches to the intersection.

Sensor – The sensing element of a detector.

Sequential Timing – See **Timing, Sequential**.

Serviceable Conflicting Call – A call which: (1) Occurs on a conflicting phase not having the right-of-way at the time the call is placed; (2) Occurs on a conflicting phase which is capable of responding to a call; or (3) When occurring on a conflicting phase operating in an occupancy mode, remains present until given its right-of-way.

Service Road – Sometimes referred to as a Frontage Road or Access Road, it is a roadway, generally running parallel to the mainline, which provides access to commercial, residential or farm areas **(L&D Manual Volume 3)**.

Shared-Use Path – a bikeway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. A shared-use path also may be used by pedestrians, including skaters, joggers, users of manual and motorized wheelchairs, and other authorized motorized and non-motorized users **(ORC 4511.01(PPP) and OMUTCD)**.

The **L&D Manual Volume 1** also says that this is a facility physically separated from motor vehicle traffic by an open space or barrier, either within the highway right-of-way or within an independent right-of-way. Shared use paths may be used by a mix of non-motorized users such as bicyclists, walkers, runners, wheel chair users and skaters.

Sheeting – A flexible film of synthetic resin in various colors. The film of retroreflective sheeting encapsulates a layer of glass spheres or cube-corner prisms to redirect light by retroreflection. The film of nonretroreflective sheeting does not contain retroreflective elements.

Side Mount – A signal mounting arrangement where the signal head is mounted parallel to the vertical axis of a pole.

Sign, Extrusheet – A sign assembled of horizontal sections formed of aluminum sheet and spot welded extrusions, covered with sheeting and bearing a legend.

Sign, Flatsheet – A sign cut from a single sheet of material into the proper geometrical shape, covered with sheeting and bearing a legend.

Sign, Overlay – A sign which is fastened over an extrusheet sign and which consists of a sheet of material covered with sheeting and with or without copy.

Signal Circuit Contact – See **Contact, Signal Circuit**.

Signal Shut-Down Switch – See **Switch, Signal Shut-Down**.

Signal System, Centralized Control – See **Centralized Control Signal System**.

Signal System, Distributed Control – See **Distributed Control Signal System**.

Signal System, Hybrid Control – See **Hybrid Control Signal System**.

Single-ring Controller – A controller containing two or more sequentially timed and individually selected conflicting phases so arranged as to occur in an established order.

Skip Phasing – The ability of a controller to omit a phase from its cycle of operation in the absence of demand or as directed by a master control.

Silk Screened Copy – The copy deposited on the surface of a flatsheet sign by the transmission of paste through silk screen openings.

Silk Screen Paste, Opaque – A viscous paint used to form the legend on a flatsheet sign by the silk screen method.

Silk Screen Paste, Transparent – A fluid used to form a transparent colored background (or copy) on the reflective sheeting of a flatsheet sign by the silk screen method.

Single Entry – See **Entry, Dual**.

Skins – Undesirable fragments of solidified marking material.

Slipfitter – A mounting bracket which is used on the top of a pedestal.

Softening Point – The temperature at which a solid material exhibits a condition of plasticity while being heated.

Solid Spreader – See **Spreader, Solid**.

Solid State Device – a device characterized by electrical circuits, the active components of which are semiconductors to the exclusion of electromechanical devices or vacuum tubes.

Sonic Detector – A detector that is capable of sensing the presence of a vehicle through its field of emitted ultrasonic energy.

Span Support – See **Support, Span**.

Span Wire Hanger – A mounting bracket for supporting a signal head by clamping onto a span wire.

Span Wire Mount – A signal head suspended over the roadway on messenger wire.

Span Wire Support – See **Support, Span Wire**.

Special Skip – See **Omit, Phase**.

Specific Service Sign – A rectangular sign panel that includes: the words “GAS,” “FOOD,” “LODGING” or “CAMPING,” directional information, and one or more logo sign panels.

Specific Service Sign Program (Logo Program) – The Ohio Logo Signing Program ***(see TEM Section 207-2* and OMUTCD Chapter 2J*)***.

Speed, Legal – See **Legal Speed**.

Speed Zoning – The process of establishing reasonable and safe speed limits for sections of roadway where the statutory speed limits do not fit the road and traffic conditions. Speed Zones are intended to aid motorists in adjusting their speeds to those conditions. **See ORC 4511.21 and *TEM Part 12*.**

Split – A division of the cycle length allocated to each of the various phases (normally expressed in percent).

Split Phase – That portion of a traffic phase that is separated from the primary movement to provide a special phase that is related to a parent phase and characterized by the inability to rest in a minor phase.

Split Selection Switch – A device on solid state controller units which when operated discontinues automatic selection of split changes which are independent of cycle length changes and permits hand selection of such split changes.

Spray Applied Markings – Pavement markings applied in the form of liquid droplets by means of a pressurized nozzle.

Spreader, Solid – A signal bracket having solid arms radiating from a hub through which wiring can be passed to provide electrical interconnection of the signal faces supported by the signal bracket.

Spreader, Tubular – A signal bracket having tubular arms radiating from a hub through which wiring can be passed to provide electrical interconnection of the signal faces supported by the signal bracket.

Staged Review Process – A series of review submissions at various stages in the design process **(L&D Manual Volume 3).**

Standard Construction Drawings – Detail drawings, identified by a specific number, published by **ODOT**, of items which are frequently used in plans and would otherwise require redrawing for each plan and have been pre-approved for general use **(L&D Manual Volume 3)**. Also see ***TEM Chapter 102*** for further information.

Standard Pay Item – An item whose requirements are defined by the Standard Construction Drawings and the Construction and Materials Specifications or Supplemental Specifications **(L&D Manual Volume 3).**

Station – A point or position on a measured line using 100-foot increments as a base of reference **(L&D Manual Volume 3)**.

Straight Line Distance (SLD) – Distance based on the centerline of the roadway as measured from the western or southern county line or other true beginning **(L&D Manual Volume 3)**.

Stopping Sight Distance (SSD) – The cumulative distance traversed from the time a driver sees a hazard necessitating a stop, actually applies the brakes, and comes to a stop **(L&D Manual Volume 1)**.

Strain Pole – A vertical support to which messenger wire and hardware are attached for supporting traffic signals.

Stop Timing – Provision within a controller to suspend timing operation upon assertion of an external command.

Superelevation – The cross-slope of the pavement used to compensate for the effect of centrifugal force on a horizontal curve **(L&D Manual Volume 1)**.

Supplemental Specifications – Detailed specifications for items which are in the development stage or are used only occasionally. These specifications supplement or supersede the **Construction and Material Specifications** **(L&D Manual Volume 3)**.

Support, Beam-Type – A ground-mounted support consisting of flanged steel beams embedded in concrete.

Support, Breakaway Beam-Type – A ground-mounted support consisting of flanged steel beams with a slip-plane joint near the ground line, with the lower stub embedded in concrete and the sign bearing portion containing a fuse and hinge plate near the lower edge of the sign.

Support, Cantilever – An overhead support consisting of a single vertical tubular member with attached arms at one side which may be single or dual.

Support, Center-Mount – A support which may be semi-overhead or of traffic clearing overhead height consisting of a single vertical tubular member with attached arms which may be symmetrical or eccentric to the vertical member.

Support, Ground-Mounted – Single or multiple posts or beams driven into the earth or embedded in concrete for the support of signs.

Support, Overpass Structure-Mounted – A skewed or flush-mounted support for attaching signs to an overpass structure, the type being determined by the overpass angle to the roadway.

Support, Post-Type – A ground-mounted support of steel single channels, channels bolted back to back, or square tubes, and normally driven into the earth.

Support, Rigid Overhead-Type – Support for a major sign or signs mounted on anchor bolt foundations and located off the berm or spanning the roadway.

Support, Span – A rigid overhead support spanning the roadway consisting of a box truss supported by single plane truss end frames.

Support, Span Wire – A support consisting of span wires connected to roadside strain poles mounted on anchor bolt foundations or embedded in concrete.

Switch, Auto-Manual – A device which, when operated, discontinues normal signal operation and permits manual operation.

Switch, Flash Control – A device which, when operated, discontinues normal signal operation and causes the flashing of any predetermined combination of signal indications.

Switch, Power Line – A manual switch for disconnecting power to the controller assembly and traffic signals.

Switch, Signal Shut-Down – A manual switch to discontinue the operation of traffic signals without affecting the power supply to other components in the controller cabinet.

Switch, Time – See **Time Switch**.

Synchronous-Motor Controller – A controller operated by a synchronous motor which maintains a constant speed determined by the frequency of the alternating current power supply.

System – A system is defined by the International Council of Systems Engineering (INCOSE) as "a combination of interacting elements organized to achieve one or more stated purposes."

Terminal Blocks, Field – Devices for connecting all wires entering the controller cabinet.

Thermoplastic Markings – Hot plastic markings applied to pavements by an extrusion or spraying process.

Time Switch – A device for the automatic selection of modes of operation of traffic signals in a manner prescribed by a predetermined time schedule.

Timer Gear – One of a set of different diameter gears determining the cycle time of a timer dial when inserted into the drive train.

Timing Analog – Pertaining to a method of timing that measures continuous variables such as voltage or current.

Timing Concurrent – A mode of controller operation whereby a traffic phase can be selected and timed independently and simultaneously with another traffic phase.

Timing Control – A calibrated device that provides a time setting for an interval or portion of an interval.

Timing Dial – That part of a controller which times one cycle length and its associated split(s) and offset(s).

Timing, Digital – pertaining to a method of timing that operates by counting discrete units usually based on the frequency of the power source.

Timing, Sequential – The arrangement of phases at multi-phase intersection into a sequence in which the phases will occur consecutively.

Tourist Information Center – A place where information of interest to tourists is provided as a free service to the public.

Tourist Oriented Directional Signs (TODS) – Signs used to identify Tourist Oriented Activities and conforming to the specifications contained in **OMUTCD Chapter 2K**, and **Rules 5501:2-8-01 to 5501:2-8-10 of the Ohio Administrative Code**. Also see ***TEM Section 207-***

3* and *Table 297-16.

Tourist Oriented Activity – For purposes of the **TODS** program, any lawful cultural, historical, recreational, educational, or commercial activity, a major portion of whose income or visitors is derived during the normal business season from motorists not residing within 10 miles of the activity, and attendance at which is no less than two thousand in any consecutive twelve month period. See **OMUTCD Section 2K.01**.

Traffic-Actuated Controller – A controller for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors or pushbuttons.

Traffic Adjusted System – See **Traffic Responsive System**.

Traffic Control Plan – A portion of a highway plan dedicated to signing, signalization, pavement marking and other traffic control details **(L&D Manual Volume 3)**.

Traffic Responsive Signal Control – The feature of a traffic signal control system that changes intersection signal timing based on information received from system roadway sensors.

Traffic Responsive System – A system in which a master controller (analog or digital) specifies cycle and offset based on the real-time demands of traffic as sensed by vehicle detectors.

Traffic Signal Preemption (Priority Control) – An interruption in the normal signal operation of a signalized intersection to provide predetermined signal displays to the various intersection approaches. Examples of traffic signal preemption are railroad activated, emergency preemption through direct wiring to a fire station, emergency vehicle activated, and transit vehicle activated.

Traffic Surveillance and Control System – An array of human, institutional, hardware and software components designed to monitor and control traffic, and to manage transportation on streets and highways and thereby improve transportation performance, safety, fuel efficiency and air quality.

Trailblazing Signs – Signs provided to indicate the preferred route to the Interstate or another state highway from non-state highways or streets within the city or village. Trailblazing signs are supplemental to entrance ramp approach signs.

Transmission – The process by which incident flux leaves a surface or medium on a side other than the incident side.

Transverse Joint – A pavement joint perpendicular to the centerline alignment of the pavement, designed to control cracking, provide for load transfer, and allow for the contraction and expansion of the pavement **(Pavement Design Manual)**.

Treated Shoulder – That portion of the graded shoulder which has some type of surface treatment **(L&D Manual Volume 1)**.

Tree Lawn – See **Buffer**.

Trumpet Interchange – A Semi-directional T interchange **(L&D Manual Volume 1).**

Tubular Spreader – See **Spreader, Tubular**.

Uniformity – Illumination on roadways is usually expressed as a ration of average illumination to minimum illumination at any point on the roadway.

Unit Extension – See **Passage.**

Vertical Clearance – The distance, measured vertically, from the surface (pavement, shoulder, ground, etc.) to a fixed overhead object (bridge superstructure, sign, signal, etc.) **(L&D Manual Volume 1)**.

Village – A municipal corporation having a population of less than 5,000 persons.

Visibility – The quality or state of being perceivable by the eye. In outdoor applications, visibility is defined in terms of the distance at which an object can be just perceived by the eye.

Visual Acuity – The ability to distinguish fine detail. Quantitatively, the reciprocal of the angular size in minutes of the critical detail which is just large enough to be seen.

Visual Angle – The angle which an object or detail subtends at the point of observation. It usually is measured in minutes of arc.

Visual Field – The locus of objects or points in space which can be perceived when the head and eyes are kept fixed. The field may be monocular or binocular.

Visual Surround – All portion of the visual field except the visual task.

Visual Task – Those details and objects which must be seen for the performance of a given activity, including the immediate background of the details or objects

Volume-Density Controller – A controller used with detectors located a sufficient distance in advance of the intersection which makes use of vehicle actuation quantities and time-of-waiting of the initial vehicle to vary green interval portions for increased capacity and minimized delays.

Weekly Programmer – A device used to determine the time of operation of programs on traffic control equipment according to a weekly schedule which may be preset to vary from day to day.

Work Limits – The extreme longitudinal limits of the contractor's responsibility, including all temporary and incidental construction (except temporary traffic control devices). Identified by the "Work Limit" station on the centerline of construction on the mainline and on the centerline of all side roads, cross roads, and other construction generally running perpendicular to the project or separated from the project **(L&D Manual Volume 3)**.

Work Zone Pavement Markings – Markings placed for a limited time to direct traffic movement during project construction.

Yield – The action of allowing a semi-actuated controller, or a full-actuated controller operating in the semi-actuated mode, to terminate the main street phase so as to begin satisfying existing cross street demand.

Yellow-Red Flash Terminals – Terminals which are wired to give the option of flashing either yellow or red on each traffic signal face by rearranging jumpers and/or field wires.

Zone of Detection – That area of the roadway within which a vehicle is detected by a vehicle detector system.

1505 FREQUENTLY ASKED QUESTIONS (FAQs)

1505-1 General

The ORE and OTO websites includes pages for frequently asked questions (FAQs) and their answers. Suggestions for items to be included should be forwarded to the ORE Traffic Control Design Section or the Office of Traffic Operations (OTO).

For reference, a couple of the most common traffic engineering-related items are noted below.

1505-2 What Are the Requirements for a Multi-way Stop Installation?

As noted in Section 2B.07 of the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), “Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.”

Generally, multi-way stop installations should be used sparingly because of the significant increases in delays and operating costs that can result from requiring all of the vehicles using the intersection to stop. Also, unnecessary stops, when the intersection is clear of conflicting movements, can lead to general disrespect for STOP signs.

Any decision to install multi-way stop control should be based on an engineering study. OMUTCD Section 2B.05 addresses restrictions on the use of STOP signs that also apply to multi-way stop applications. Section 2B.07 of the manual contains criteria that should be considered as part of the engineering study

1505-3 How Do I Get a Traffic Signal Installed?

Many people believe that traffic signals are the answer to all traffic problems at intersections. If this were true, no traffic engineer in his right mind would deny a request for a traffic signal. The need for traffic signals should be based on a competent engineering study.

A warranted traffic signal which is properly located and operated may provide for more orderly movement of traffic and may reduce the occurrence of certain types of accidents. On the other hand, an unwarranted traffic signal can result in increased delay, congestion and accidents.

Traffic signals should be installed when they will alleviate more problems than they will create. This must be determined on the basis of an engineering study.

The first step in getting a traffic signal installed is to determine the governmental agency that has jurisdiction for the intersection and contact that agency.

If the Ohio Department of Transportation (ODOT) has jurisdiction, then contact the Planning and Engineering Administrator in your local District Office with your request.

The District will then perform a warrant analysis. The warrants for a traffic signal are listed in the Ohio Manual of Uniform Traffic Control Devices, Chapter 4C. If the intersection meets any one of these warrants, then the next step is to use sound engineering judgment to determine if the signal should be installed. There are cases where, although a location meets the warrants, because of poor geometry, proximity to existing signals, etc. it is not signalized.

If a traffic signal can be installed without negatively impacting other intersections or the traveling public, then the traffic signal should be designed and constructed.

In accordance with the Ohio Revised Code, ODOT can only install and operate traffic signals at public streets. If a private development warrants a traffic signal, then the development must enter into an agreement with ODOT, pay for the installation of the traffic signal and pay a yearly maintenance/operating fee to ODOT.

1599 OTHER POLICIES AND STANDARD PROCEDURES

ODOT Policies and Standard Procedures have been established to address various aspects of **ODOT's** work. Some can be viewed on-line at **ODOT's** "Official Policies and Standard Procedures" web page. They are also available from the in-house intranet site Policies and Procedures page.

At times, there may be a need for the **Offices of Roadway Engineering (ORE) and Traffic Operations (OTO)** to issue (or help develop) numbered, formal **ODOT Policies**, **Guidelines** or **Standard Procedures (SOPs or SPs),** separate from the **TEM and L&D Manual**. As noted above, these are available on-line; however, for the convenience of **TEM** users, copies of these documents have also been included in ***Chapter 1599***.

There are also other **ODOT Policies**, **Guidelines**, **Standard Procedures**, etc. issued by other **ODOT** offices that pertain to material discussed in the **TEM**. These too are listed in the index below, and for your convenience copies are available in this Chapter.

Number	Subject / Title	Responsible Office
Policies		
16-004(P)	Development of Standards and Specifications Policy Effective: June 2, 2012	Construction Management, Engineering, Planning
20-005(P)	Policy on Changes to the State Highway System and Use of the Director's Journal Entry Effective: April 17, 2015	Division of Planning
21-003(P)	Curb Ramps Required in Resurfacing Plans Effective: April 17, 2015	Roadway Engineering
21-008(P)	Traffic Management in Work Zones Effective: April 17, 2015	Engineering
27-014(P)	New Product Development Effective: April 17, 2015	Construction Management
Standard Procedures		
122-004(SP)	Development of Standards and Specifications Effective: June 1, 2012	Construction Management, Engineering, Planning
123-001(SP)	Traffic Management in Work Zones Effective: November 2, 2015	Roadway Engineering
515-001(SP)	New Product Development Effective: September 12, 2005	Division of Construction Management

Intentionally blank.

Approved:

Jerry Wray
Director

Policy No. 16-004(P)
Effective: June 1, 2012
Responsible Division: Construction Management, Engineering, Planning
Supersedes Policy dated September 18, 2002

DEVELOPMENT OF STANDARDS AND SPECIFICATIONS

POLICY

POLICY STATEMENT:

This policy establishes the standard procedures for the development, approval, distribution, and implementation of all new and revised Standards and Specifications as listed under *Definitions*.

AUTHORITY:

Ohio Revised Code, Sections 5501.02, 5501.03 and 5501.31.

Code of Federal Regulations 23 CFR 625

REFERENCES:

Standard Procedure 122-004(SP)

SCOPE:

This Policy is applicable to the design industry, contracting industry, FHWA, and any affected department employee who may request revisions to Standards or Specifications.

BACKGROUND & PURPOSE:

The Department had a standard procedure for distribution of design standards and a standard procedure for development of construction specifications.

This standard procedure is the merger of two former standard procedures; 122-004(SP) dated September 18, 2002 and 510-005(SP) dated December 1, 2004, and the Administrative Ruling for Specification Committee Supplemental Instructions dated December 9, 2005. This document allows for more thorough and consistent development of new design standards and construction specifications. By having a construction perspective on design standards and a design perspective on construction specifications, it will ensure all perspectives are considered and eliminate potential conflicts when implemented.

DEFINITIONS

Construction and Material Specifications Book (C&MS): A published bound book that contains detailed provisions, together with the Plans and the Proposal, constitute the Contract for the performance of required work. It is an official legal and technical document by which the Department bids and constructs highway projects.

Design Manuals: A document that contains design criteria and describes plan content associated with various design specialty areas.

Proposal Notes: Published proposal notes contain a wide variety of legal and technical requirements necessary for the proper bidding and sale of an individual project. These notes override all other requirements in the Plans, C&MS, Supplemental Specifications, and Standard Construction Drawings

Publication Owner: The office that authors a Standard or Specification

Specifications: Contract documents used to issue instructions to contractors. For the purposes of this procedure, Specifications will include: the C&MS, Supplemental Specifications, Supplements, and Proposal Notes.

Standards and Specification Committees: Working committees, formed around specific materials or construction tasks, and composed of ODOT district and central office staff, representatives from the Federal Highway Administration and industry trade groups.

Standards: Documents related to design of an improvement. For the purposes of this procedure, Standards will include Design Manuals and Standard Drawings,

Standard Drawings: Detail drawings furnished by ODOT describing items which are frequently used in plans and would otherwise require a plan detail and require pre-approval for general use.

Supplemental Specifications: Individually numbered documents prepared in loose-leaf form describing the construction and material specifications for new items of Work.

Supplements: Individually numbered documents prepared in loose-leaf form describing necessary information such as laboratory methods of test, and certification or pre-qualification procedures for materials.

TRAINING

None required.

FISCAL ANALYSIS

Implementation of this standard procedure will provide cost savings to the Department. Construction personnel will have input in design standards and design personnel will have input in construction specifications. This allows for more thorough and consistent development of standards and specifications prior to their implementation and provides a feedback opportunity to incorporate lessons learned into contract documents through this continuous quality improvement process. Distribution of all standards and specifications are electronic in lieu of hard copy. Costs for paper, print, binders, and postage will be reduced considerably.

Intentionally blank

Approved:

Jerry Wray
Director

Policy 20-005(P)
Effective Date: 4/17/2015
Responsible Division: Planning

POLICY ON CHANGES TO THE STATE HIGHWAY SYSTEM AND USE OF THE DIRECTOR'S JOURNAL ENTRY

POLICY STATEMENT:

The Ohio Department of Transportation shall utilize a uniform system for developing, processing, and recording changes to the State Highway System through the use of an entry in the Director's Journal (JE). The goal is to clearly define those laws and procedures under which employees of the Department shall operate when planning or documenting changes to the State Highway System.

AUTHORITY:

Ohio Revised Code, Sections 5501.45, 5511.01, 5511.02, 5511.07, 5523.02, 5529.01, 5535.07, and 5553.041.

REFERENCES:

ODOT Project Development Process Manual
Real Estate Manual, Section 7400 - Property Disposal
Real Estate Manual, Section 8100 - Utilities
ODOT Public Involvement Guide

This Policy supersedes Director's Authorization (dated 10/3/97) and Standard Operating Procedure PH-P-406 (dated 06/04/93).

SCOPE:

The following offices, divisions, and district personnel are covered by this Policy:

Division of Planning, Office of Technical Services
Division of Planning, Office of Local Programs
Division of Planning, Office of Environmental Services
Division of Engineering, Office of Real Estate
All District Offices, Planning & Engineering and Highway Management Administrators

BACKGROUND AND PURPOSE:

Section 5501.31 of the Ohio Revised Code confers upon the Director the general duty to supervise all roads that comprise the State Highway System. The State Highway System consists of all highways designated as State Routes, U.S. Numbered Routes, and Interstate Routes. Chapter 5511 empowers the Director to make changes and additions to the State Highway System. The method used by the Director to record and archive such changes is to make an entry in the Director's Journal, otherwise known as a Journal Entry (JE). The issuance of a JE is a required procedural step in the Project Development Process (PDP) and is required by the Office of Technical Services before changes are made to the official Roadway Information data files and to the official map of the State of Ohio. When properly issued, a Director's JE relieves the Department of fiscal and legal responsibility for excess or unneeded highways, as well as associated property and structures. Further, it documents the required coordination between ODOT, local authorities, and the public.

This Policy and an accompanying Standard Procedure will ensure statewide consistency and uniformity in developing, processing, and recording of JE's.

TRAINING:

All affected Central Office and District employees will need to review the Policy and accompanying Standard Procedure. On-site instruction will be provided by the Office of Technical Services and the Office of Chief Legal Counsel upon request.

FISCAL ANALYSIS:

There should be minimal cost associated with the implementation of this Policy and its accompanying Standard Procedure since it is a clarification of existing requirements. To the extent that there is a backlog of needed Journal Entries, there may be a short-term personnel impact in the District Offices and in the Office of Technical Services.

Approved:

Jerry Wray
Director

Policy No.: 21-003(P)
Effective: 4/17/2015
Responsible Office: Roadway Engineering
Supersedes Policy 519-002(P) Dated 1/7/2011

CURB RAMPS REQUIRED IN RESURFACING PLANS

POLICY:

It is the policy of the Ohio Department of Transportation (ODOT) to comply with various civil rights laws and regulations, including Title II of the Americans with Disabilities Act (ADA). Title II of the ADA applies to all programs, services, and activities provided or made available by a public entity (e.g., state and local governments) or any of its instrumentalities or agencies. ODOT recognizes that pedestrian facilities (e.g., sidewalks) qualify as a program under the ADA.

PURPOSE OF THE POLICY:

The purpose of this policy is to establish the requirement of compliant curb ramps or curb cuts as part of ODOT-Let or Local-Let resurfacing projects. That is, this policy is one component of ODOT's commitment to ensure its programs, services, and activities are provided in a nondiscriminatory manner.

AUTHORITY:

Americans with Disabilities Act (ADA) (1990)
Civil Rights Restoration Act (1987)
Ohio Attorney General Opinion (1995)
Rehabilitation Act (1973) – Section 504

REFERENCES:

ADA Accessibility Guidelines (ADAAG)
FHWA "Designing Sidewalks and Trails for Access" (November 2001)
ODOT Location and Design Manual, Volume 1
ODOT Standard Construction Drawings or alternatives approved by the Standards Engineer
Public Right-of-Way Accessibility Guidelines (PROWAG)
42 USC Chapter 126, Subchapter II, Part A
28 CFR Part 36

SCOPE:

This policy is to be used by District Deputy Directors, Highway Management Administrators, Planning and Engineering Administrators, and other ODOT personnel responsible for implementing pavement resurfacing plans.

FISCAL IMPACT:

The costs associated with compliance or noncompliance with this policy would be dependent upon programmed resurfacing projects.

BACKGROUND:

The ADA requires public entities, when constructing or altering streets, roads, and highways, provide compliant curb ramps at intersections where curbs or other barriers exist between the street level and the pedestrian walkways.

The Federal Highway Administration (FHWA) encourages public agencies to use the standards set forth in the ADA Accessibility Guidelines (ADAAG) but notes that ADAAG standards were developed primarily for building and on-site facilities. Under ADAAG standards, an accessible design to a highway, street, or walkway includes accessible sidewalks and curb ramps with detectable warnings. 28 CFR § 35.151(c) and (e) (curb ramps); ADAAG 4.3-4.5 (accessible routes), 4.7 (curb ramps with detectable warnings), 4.29 (detectable warnings). Because ADAAG does not address the unique challenges to accessibility presented when dealing with sidewalks, street crossings, and other elements of the public rights-of-way, both FHWA and the Department of Justice, the entity responsible for enforcing ADA requirements, recommend using the Public Right-of-Way Accessibility Guidelines (PROWAG). Although PROWAG has not yet been formally adopted by USDOT and USDOJ, it is considered the best guidance available related to ADA requirements for public rights-of-way and should be used for sidewalks and street crossings as outlined in FHWA's 2006 guidance related to the topic.

Based on precedent-setting court cases and FHWA guidance, it is ODOT's policy that compliant curb ramps or curb cuts must be provided before the sale of or concurrently with the construction of any ODOT-Let or Local-Let resurfacing projects.

DEFINITIONS:

<u>Americans with Disabilities Act (ADA)</u>: Title II of the ADA is the federal civil rights law that prohibits discrimination by a state or local government against individuals with disabilities.

PROCEDURE:

I. Compliant curb ramps shall be constructed at intersections located within the resurfacing limits of all resurfacing projects (regardless of urban or rural location) whenever curbs and sidewalks are present or where existing curb ramps are not compliant with current standards.

a. Curb ramps should be constructed such that all quadrants of the intersection are accessible.

b. Compliant curb ramps should be constructed on a side street, even if no resurfacing work is being performed.

II. A break in the curb shall be constructed to provide access for individuals with disabilities at all intersection radiuses located within the resurfacing limits of all resurfacing projects (regardless of urban or rural location) whenever curbs are present and no sidewalk exists.

a. Existing curbs shall be cut flush with the pavement for a width of five feet with tapered sides at a rate of 3 to 1 or flatter.

b. New curbs shall be constructed flush with the pavement for a width of five feet with tapered sides at a rate of 3 to 1 or flatter.

c. This policy includes dropping the curb or cutting the curb on the side street, even if no resurfacing work is being performed.

III. Compliant curb ramps shall be constructed according to ODOT's Location and Design Manual and ODOT's Standard Construction Drawings or alternatives approved by the Standards Engineer.

IV. The cost of curb ramps outside of municipal corporations shall be funded as part of the project. The cost of curb ramps inside municipal corporations within the limits of resurfacing projects should be funded by the local agency.

V. After installation, ODOT shall inspect the curb ramps constructed under an ODOT-let contract for compliance and local authorities shall be responsible for the inspection of curb ramps under local-let project for compliance. If the curb ramp is not compliant with the current standards, the ramp must be brought into compliance before the project is completed or finalized by either ODOT or the local authority.

VI. After installation, the curb ramps shall be maintained by the agency (i.e., city, village, county, township, or ODOT) that has jurisdictional ownership of the main traveled way unless there is a maintenance agreement in place that specifically requires another agency to maintain the ramps. When obtaining consent legislation for the resurfacing project, the issue of maintenance of curb ramps shall be addressed in the legislation.

TRAINING:

The Office of Roadway Engineering will provide annual training as necessary to the District ADA Coordinators and/or District personnel responsible for reviewing and producing plans that contain right-of-way features.

ENFORCEMENT:

Each District Deputy Director, Highway Management Administrator, Transportation Planning Program Administrator, Production Administrator, and ODOT personnel responsible for implementing pavement resurfacing plans is responsible for ensuring that this policy is carried out in his or her respective program area.

The following procedure will be implemented on the effective date of this policy:

1. All tracings for resurfacing projects filed in Central Office on or after the effective date of this policy shall include provisions for curb ramps in accordance with this policy.

2. Compliant curb ramp details are shown on ODOT’s Standard Construction Drawings.

3. Resurfacing projects not in conformance with this policy will be rejected.

Reviews to ensure compliance will be conducted in accordance with ODOT Policy 220-001(P), Quality Assurance Review Policy.

Approved:

Jerry Wray
Director

Policy No.: 21-008(P)
Effective: 4/17/2015
Responsible Division: Engineering
Supersedes Policy: 516-003(P) Dated: 7/18/2000

TRAFFIC MANAGEMENT IN WORK ZONES

POLICY STATEMENT:

The Ohio Department of Transportation (ODOT) is committed to the easy conveyance of people and goods from place to place; including through our work zones. We will understand the impacts our work zones can have on mobility and mitigate potential delays to the extent practical.

AUTHORITY:

The Director of Transportation's authority to establish rules as conferred by 5501.02 of the Ohio Revised Code.

SCOPE:

This policy applies to work zones (contract construction, county maintenance or permit) on all ODOT maintained highways.

PROCEDURAL STATEMENT:

Projects on ODOT highways will be assessed to determine if impacts created by our work zones are acceptable as defined by the Standard Procedure. Where compliance with this Policy is deemed impractical or prohibitively expensive an exception to this Policy may be requested from the Maintenance of Traffic Exception Committee (MOTEC) or the Project Impact Advisory Council (PIAC) as appropriate per the Standard Procedure.

TRAINING:

The Office of Roadway Engineering will provide training to districts as necessary and to consultants via the ODOT Traffic Academy.

FISCAL ANALYSIS:

The cost associated with this Policy will be evaluated on a project by project basis. A determination will be made if the financial, constructability or schedule costs of Policy compliance is commensurate with the predicted work zone impacts to the motoring public.

Intentionally blank

Approved:

Jerry Wray
Director

Policy No. 27-014(P)
Effective: 4/17/2015
Responsible Division: Construction Management
Supersedes Policy: 27-014(P) Dated: 9/12/2005

NEW PRODUCT DEVELOPMENT

POLICY STATEMENT:

The Division of Construction Management is assigned the responsibility and authority to evaluate new product requests introduced to the Department. New products that have a determined need to the Department will follow a standardized procedure from initiation through potential specification development. All requests for new product evaluations will be initiated through the Office of Materials Management, New Products Engineer.

AUTHORITY:

Ohio Revised Code Statutes 5501.03

REFERENCES:

Standard Procedure 122-04(SP), Development of Standards and Specifications
Policy 27-005(P), Construction and Material Specification Development
Standard Procedure 510-005(SP), Construction and Material Specification Development

SCOPE:

New products introduced to the Department will be coordinated through the Office of Materials Management, New Products Engineer, and evaluated through established committees of appropriate ODOT, FHWA, and industry personnel. New products that meet or exceed established performance criteria may be developed into specifications through Standard Procedure 122-04(SP) Construction and Material Specification Development.

BACKGROUND AND PURPOSE:

The procedure for new product development was formerly under Standard Procedure 510002(SP) dated 3/1/03. This Standard Procedure was changed to 510-005(SP), effective 12/1/04, and no longer makes reference to new product development. This policy establishes a process for development of new products.

TRAINING:

None required

FISCAL ANALYSIS:

The operational fiscal impact of this policy is expected to be limited to committee members' time.

Approved:

Megan O'Callaghan, P.E.
Deputy Director of Construction Management

Jennifer Townley
Deputy Director of Planning

James Young, P.E
Deputy Director of Engineering

Standard Procedure - 122-004(SP)
Effective: June 1, 2012
Responsible Office: Construction Management, Engineering, Planning
Supersedes Standard Procedure 122-004(SP) dated September 18, 2002 and 510-005(SP) dated December 1, 2004

DEVELOPMENT OF STANDARDS AND SPECIFICATIONS

PROCEDURAL STATEMENT:

These standard procedures are for the development, approval, distribution and implementation of all new and revised Standards and Specifications as listed under *Definitions*.

AUTHORITY:

Ohio Revised Code, Sections 5501.02, 5501.03 and 5501.31.

Code of Federal Regulations 23 CFR 625

REFERENCES:

Development of Standards and Specifications (Policy No. 16-004(P))

SCOPE:

These standard procedures are applicable to the design industry, contracting industry, FHWA, and any affected department employee who may develop or request revisions to Standards or Specifications.

BACKGROUND & PURPOSE:

The Department had a standard procedure for distribution of design standards and a standard procedure for development of construction specifications.

This standard procedure is the merger of two former standard procedures; 122-004(SP) dated September 18, 2002 and 510-005(SP) dated December 1, 2004, and the Administrative Ruling for Specification Committee Supplemental Instructions dated December 9, 2005. This document allows for more thorough and consistent development of new design standards and construction specifications. By having a construction perspective on design standards and a design perspective on construction specifications, it will ensure all perspectives are considered and eliminate potential conflicts when implemented.

DEFINITIONS:

<u>Construction and Material Specifications Book (C&MS)</u>: A published bound book that contains detailed provisions, together with the Plans and the Proposal, constitute the Contract for the performance of required work. It is an official legal and technical document by which the Department bids and constructs highway projects.

<u>Design Manuals</u>: A document that contains design criteria and describes plan content associated with various design specialty areas.

<u>Proposal Notes</u>: Published proposal notes contain a wide variety of legal and technical requirements necessary for the proper bidding and sale of an individual project. These notes override all other requirements in the Plans, C&MS, Supplemental Specifications, and Standard Construction Drawings

<u>Publication Owner:</u> The office that authors a Standard or Specification

<u>Specifications</u>: Contract documents used to issue instructions to contractors. For the purposes of this procedure, Specifications will include: the C&MS, Supplemental Specifications, Supplements, and Proposal Notes.

<u>Standards and Specification Committee (Committee)</u>: Working committees, formed around specific design tasks, construction tasks or materials, and composed of ODOT district and central office staff, representatives from the Federal Highway Administration and industry trade

groups.

Standards and Specifications Committee Chairperson (Chairperson): The individual assigned by the Division of Construction Management Deputy Director with the responsibility to manage the standards and specification development process consistent with this standard procedure.

Specifications Coordinator: The individual assigned by the Division of Construction Management Deputy Director with the responsibility to perform the functions described in Section VII of this procedure.

Standards: Documents related to design of an improvement. For the purposes of this procedure, Standards will include Design Manuals and Standard Drawings.

Standard Drawings: Detail drawings furnished by ODOT describing items which are frequently used in plans and would otherwise require a plan detail. Standard Drawings require pre-approval for general use.

Supplemental Specifications: Individually numbered documents describing the construction and material specifications for new items of Work.

Supplements: Individually numbered documents describing necessary information such as laboratory methods of test, and certification or pre-qualification procedures for materials.

PROCEDURE STATEMENT

I. GENERAL:

A. All requests to add, revise or delete Standards and Specifications must be submitted in writing to the appropriate Publication Owner.

B. Contractors, producers, suppliers and consultants should submit their requests through their association.

C. FHWA may submit their request directly to the appropriate Publication Owner.

D. Department staff must submit their request through their Administrator.

E. All initial submissions for inclusion into the Standard or Specifications must include or reference the following topics:

1. Standards:

a. Description;

b. Manual or Drawing;
c. Design Considerations (i.e. applicability to various project types and conditions);
d. Method of calculation (if required);
e. Method of payment (if required);
f. Implementation procedure;
g. Review requirements for new/revised items; and
h. List of specifications or other standards that may be impacted by the revision.

2. Specifications:

a. Description;
b. Materials;
c. Construction requirements;
d. Method of measurement;
e. Basis of payment; and
f. Designer note to address conditions under which the Specification will be used on construction projects (if required).

II. COMMITTEES

A. The Administrators of Construction Administration, Roadway Engineering, Structural Engineering, Pavement Engineering, Traffic Engineering, Geotechnical Engineering, Environmental Services and Hydraulic Engineering will assign standards and specifications to the following committees:

1. Contract Administration Committee;

2. Geotechnical Committee;

3. Pavement Committee;

4. Structures Committee;

5. Hydraulics and Environmental Committee; and

6. Traffic and Roadway Committee.

B. See Attachment B for typical committee membership

III. PUBLICATION OWNER’S TASKS

A. Review requests to add, revise or delete existing Standards and Specifications, as needed;

B. Each Publication Owner is in responsible charge of their designated Standard or Specification (Attachment C) and shall:

1. Receive all proposed requests for inclusion into the publication;
2. Review the proposed request. If it has merit, prepare the initial draft and submit it to the appropriate Standards and Specifications Committee Chairperson;
3. In collaboration with Committee Chairperson, reconcile all comments received during reviews until recommended final draft is achieved
4. Submit the final draft Standard or Specification for quality control as described in this standard procedure;
5. Forward final draft Standard or Specification to Specification Coordinator for final review and formal review, respectively, and approval;
6. Reconcile all quality control comments received from FHWA or the Executive Committee. The Publication Owner will have ten days to resolve quality control comments and produce a final draft specification;
   a. Non-substantive Comments: At the discretion of the Publication Owner, reconciliation of the non-substantive quality control comments can be accomplished through written communication.
   b. Substantive Comments: Any substantive or content changes to the document recommended by either quality control reviewer will require that Publication Owner reconvene with the Committee to address the recommended changes.
   c. Quality Control Comment Reconciliation Validation: The Publication Owner will validate that the quality control comments have been satisfactorily addressed.

IV. COMMITTEE CHAIRPERSON'S TASKS

A. The Deputy Director of Construction shall assign one chairperson to each committee. The Chairperson acts as the liaison between the Department, FHWA and the industry.

B. The Chairperson will assemble approved committee members as designated in Attachment B.

C. The Chairperson shall:

1. Distribute the initial draft to committee members electronically for review and comment;
2. Allow committee members to review the initial draft and return written comments to the Chairperson within 21 days of receipt;
3. Schedule and conduct a committee meeting each quarter, if necessary. The purpose of this meeting is to thoroughly discuss the merits of the

initial draft Standard or Specification.

4. Return the initial draft and comments to the Publication Owner;
6. Collaborate with the Publication Owner and recommend a final draft Standard or Specification.

V. COMMITTEES' TASKS

A. General:

1. Attend committee meetings;
2. Review and update existing Standards and Specifications, as needed;
3. Remove obsolete Standards and Specifications
4. Review proposed Standards and Specifications;
5. Write all proposed Standards and Specifications to conform with the appropriate Quality Control Checklist (attachment D or E);
6. Circulate draft Standards and Specifications for review by non-committee members and other industry people as needed;
7. Assist the Committee Chairperson in providing documentation needed for the distribution of new and revised Standards and Specifications; and
8. Ensure compliance with the applicable state and federal regulations, policies and standard procedures.

VI. STANDARDS AND SPECIFICATIONS QUALITY CONTROL TASKS

A. Provide Standards quality control in accordance with Standards Quality Control Checklist (attachment E).

B. Provide Specifications quality control in accordance with Specification Quality Control Checklist (attachment D).

C. Collaborate with FHWA quality control review to ensure compliance with applicable laws, policies and standard procedures.

VII. SPECIFICATION COORDINATOR TASKS

A. These tasks will be performed by the Specification Coordinator (Division of Construction Management).

1. Log final draft Standards and Specifications recommended by the Committee;
2. Forward final draft Standards and Specifications to Executive Committee for final approval;
3. Return non-approved final draft Standards and Specifications and written comments received to the Publication Owner. Repeat steps 1 and 2 until Executive Committee final approval is obtained;

4. Log and forward the final draft Standards and Specifications approved by Executive Committee to FHWA.
5. Return non-approved final draft Standards and Specifications and written comments received to the Publication Owner. Repeat steps 2, 3, and 4 until formal approval is obtained;
6. Publish and distribute approved Standards and Specifications, designer notes, and other written guidance, to all interested parties including the FHWA and ODOT;
7. Notify Publication Owner of approval and publication of Standards and Specifications; and
8. Maintain a record of all Standards and Specifications and correspondence for tracking and historical purposes;

VIII. EXECUTIVE COMMITTEE

A. The Executive Committee is responsible for final approval of all Standards and Specifications on behalf of the Department.

B. Members of the Executive Committee are as follows:

1. Deputy Director Division of Engineering;
2. Deputy Director Division of Construction Management;
3. Deputy Director Division of Planning;
4. Deputy Director Division of Operations; and
5. District Deputy Directors (or designee)

C. In the event of a tie, the Assistant Director for Transportation Policy will make the final determination.

D. The Executive Committee will provide formal approval or non-approval in writing of all proposed Standard and Specifications with 14 days of receipt.

IX. FHWA

A. The FHWA will provide oversight of the Standards and Specification process and interact with the committees during Standard and Specification development.

B. FHWA defers development reviews to the Department for Standards and Specifications that are only editorial in nature.

C. The FHWA will provide formal approval in writing of all proposed Standard and Specifications with 14 days of receipt.

D. Formal FHWA approval is not required for Proposal Notes numbered below 100.

X. DISTRIBUTION

A. All new and revised Standards shall be published quarterly on the Design Reference Resource Center (DRRC) webpage (http://www.dot.state.oh.us/drrc/). All new and revised Specifications shall be published quarterly on the Construction Reference Resource Center (CRRC) webpage (http://www.dot.state.oh.us/crrc/).

B. The quarterly dates shall be the third (3rd) Friday of January, April, July, and October.

C. Exceptions to the quarterly release date will be considered provided the Deputy Director over the Publication Owner responsible for the revision demonstrates a safety or significant cost impact.

D. Each Division's webpage manager will maintain the DDRC webpage and CRRC webpage. Notification of changes shall be sent to the webpage manager two (2) weeks prior to the quarterly release date.

E. Notification of changes on the DRRC or CRRC webpage will be by email to a distribution list. Registration to the distribution list will be available to all internal and external customers.

F. All scope documents for LPA/Consultant Contracts shall require parties to incorporate revisions noted on the DRRC or CRRC webpage to Design Manuals, Proposal Notes, Standard Drawings, Construction and Material Specifications and Supplemental Specifications into Construction Plans.

G. All Standards and Specifications shall be available in Adobe Acrobat (.pdf) or TIF format.

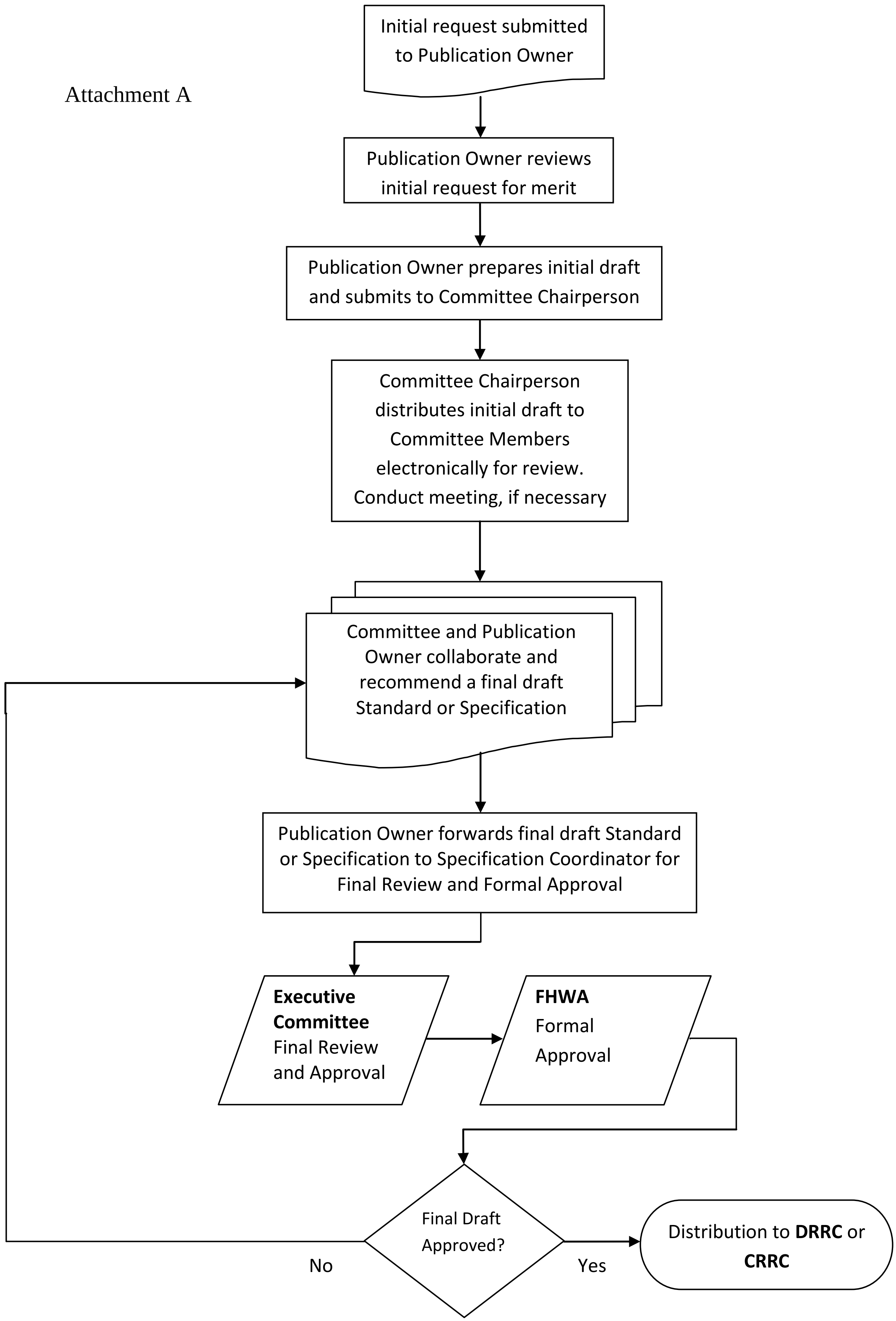
TRAINING

The Committee Chairperson must complete a course on writing Specifications in the Active Voice/Imperative Mood style.

FISCAL ANALYSIS

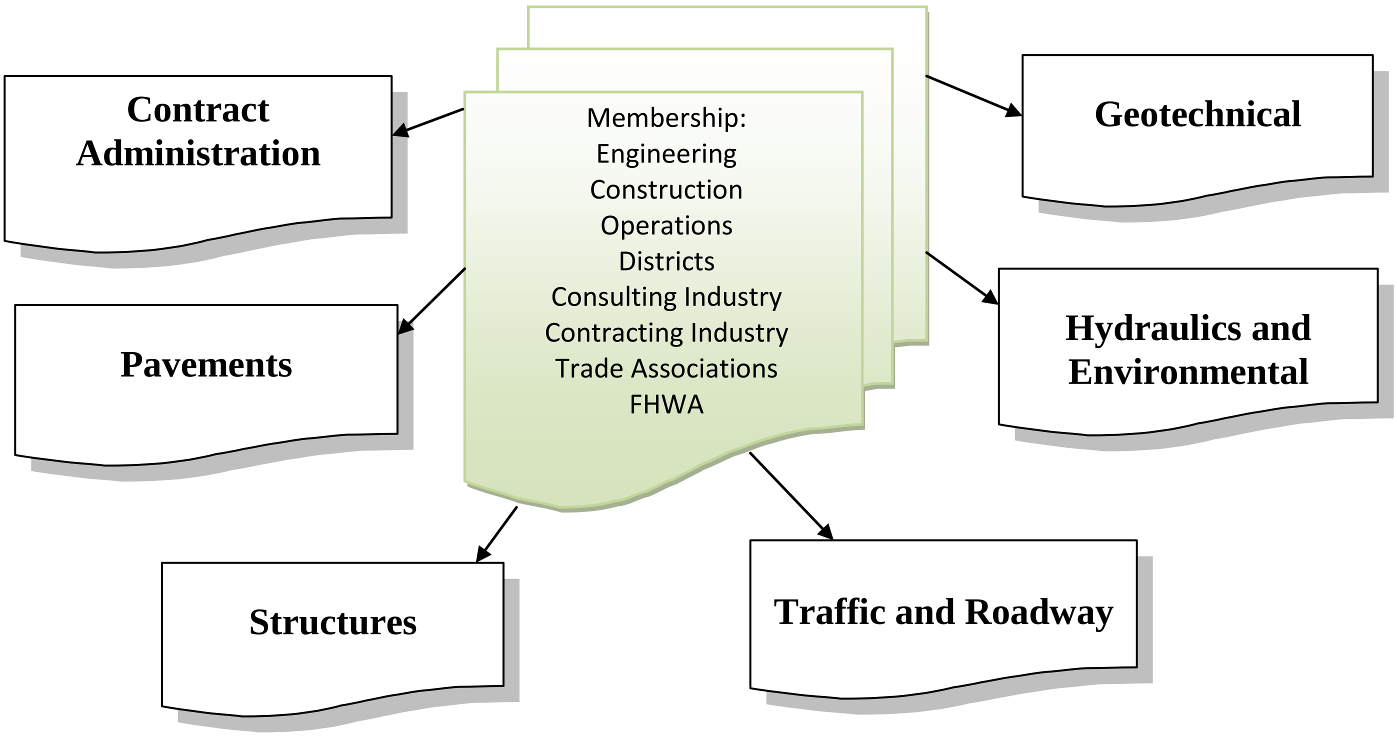
Implementation of this standard procedure will provide cost savings to the Department. Construction personnel will have input in design standards and design personnel will have input in construction specifications. This allows for more thorough and consistent development of standards and specifications prior to their implementation and provides a feedback opportunity to incorporate lessons learned into contract documents through this continuous quality improvement process. Distribution of all standards and specifications are electronic in lieu of hard copy. Costs for paper, print, binders, and postage will be reduced considerably.

Attachment A



Attachment B

Standards and Specifications Committees



CONTRACT ADMINISTRATION COMMITTEE
Committee Chairperson: from Construction Administration
Specification Sections: 100, 619, 624 Standards: Innovative Contracting Manual, CADD Engineering Standards Manual, Design Build Scope Manual, Real Estate Policies and Procedures Manual, Project Development Process Manual
Contract Sales Section
Office of Materials Management
Office of Construction Administration
Office of Real Estate
Office of Aerial Engineering
Office of Estimating (as needed)
Office of Environmental Services (as needed)
District Representatives (two for design and two for construction)
Federal Highway Administration
Ohio Contractors Association
Contractors (two chosen by Ohio Contractors Association)
American Council of Engineering Companies of Ohio (two member representatives)

GEOTECHNICAL COMMITTEE
Committee Chairperson: from Construction Administration
Specification Sections: 200, 304, 410, 411, 617, 651, 652, 653, 654 and pertinent 700 sections. Standards: Geotechnical Bulletins, Specifications for Geotechnical Explorations, Manual for Abandoned Underground Mines - Inventory and Risk Assessment, Survey and Mapping Specification
Office of Materials Management
Office of Construction Administration
Office of Pavement Engineering
Office of Geotechnical Engineering
Office of Aerial Engineering
Office of Environmental Services
District Representatives (two for design and two for construction)
Federal Highway Administration
Ohio Contractors Association
Contractors (two chosen by Ohio Contractors Association)
American Council of Engineering Companies of Ohio (two member representatives)
Ohio Aggregates & Industrial Minerals Association

PAVEMENT COMMITTEE	
Committee Chairperson: from Construction Administration	
Concrete sub-committee: Specification Sections: 255, 256, 257, 258, 305, 320, 321, 450, 608, 609, and pertinent 700 sections Standards: Sections of Location and Design Manual - Volume 3, Pavement Standard Drawings	**Asphalt** sub-committee: Specification Sections: 251, 252, 253, 254, 301, 302, 400 (except 410 and 411), 615, 618, and pertinent 700 sections Standards: Sections of Location and Design Manual - Volume 3, Pavement Standard Drawings
Office of Construction Administration	Office of Construction Administration
Office of Materials Management	Office of Materials Management
Office of Pavement Engineering	Office of Pavement Engineering
Office of Geotechnical Engineering	Office of Geotechnical Engineering
District Representatives (one for design and one for construction)	District Representatives (one for design and one for construction)
Federal Highway Administration	Federal Highway Administration
Ohio Contractors Association	Ohio Contractors Association
Contractor (chosen by Ohio Contractors Association)	Contractor (chosen by Ohio Contractors Association)
American Council of Engineering Companies of Ohio– member representative	American Council of Engineering Companies of Ohio – member representative
American Concrete Pavement Association	Flexible Pavements of Ohio
Ohio Aggregates & Industrial Minerals Association	Ohio Aggregates & Industrial Minerals Association
Ohio Ready Mix Concrete Association	

STRUCTURES COMMITTEE
Committee Chairperson: from Construction Administration
Specification Sections: 500, 610 and pertinent 700 sections Standards: Bridge Design Manual, Bridge Standard Drawings
Office of Construction Administration
Office of Materials Management
Office of Structural Engineering
Office of Geotechnical Engineering
District Representatives (two for design and two for construction)
Federal Highway Administration
Ohio Contractors Association
Contractors (two chosen by Ohio Contractors Association)
Ohio Ready Mix Concrete Association
American Council of Engineering Companies of Ohio (two member representatives)

HYDRAULICS and ENVIRONMENTAL COMMITTEE
Committee Chairperson: from Construction Administration
Specification Sections: 601, 602, 603, 604, 605, 613, 616, 638, 659, 660, 670, 671 and pertinent 700 sections. Standards: Location and Design Manual - Volume 2 - Drainage Design, Sections of Location and Design Manual - Volume 3, Hydraulic Standard Drawings, Waterway Permit Manual
Office of Construction Administration
Office of Materials Management
Office of Structural Engineering
Office of Hydraulic Engineering
Office of Roadway Engineering
Office of Environmental Services (as needed)
District Representatives (two for design and two for construction)
Federal Highway Administration
Ohio Contractors Association (if needed)
Contractors (two chosen by Ohio Contractors Association)
American Council of Engineering Companies of Ohio (two member representatives)
Ohio Aggregates & Industrial Minerals Association

TRAFFIC AND ROADWAY COMMITTEE
Committee Chairperson: from Construction Administration
Specification Sections: 606, 607, 614, 620- 622, 625-633, 640, 656, 657, 658, 661- 666 and pertinent 700 sections. Standards: Location and Design Manual - Volume 1 - Roadway Design, Traffic Engineering Manual, Roadway Standard Drawings, Traffic Standard Drawings
Office of Construction Administration
Office of Materials Management
Contract Sales Section
Office of Traffic Engineering
Office of Roadway Engineering
District Representatives (two for design and two for construction)
Federal Highway Administration
Ohio Contractors Association
Contractors (two chosen by Ohio Contractors Association)
Institute of Traffic Engineers (ITE) or
American Council of Engineering Companies of Ohio (member representative)

Attachment C

Publication Owners

Standards:

Bridge Design Manual	Office of Structural Engineering
CADD Engineering Standards Manual	Office of Aerial Engineering
Design Build Scope Manual	Office of Construction Administration
Geotechnical Bulletins	Office of Geotechnical Engineering
Innovative Contracting Manual	Office of Construction Administration
Location and Design Manual - Volume 1 - Roadway Design	Office of Roadway Engineering Services
Location and Design Manual - Volume 2 - Drainage Design	Office of Hydraulics
Location and Design Manual - Volume 3 - Highway Plans and associated Sample Plan Sheets	Office of Roadway Engineering
Manual for Abandoned Underground Mines - Inventory and Risk Assessment	Office of Geotechnical Engineering
Survey and Mapping Specification	Office of Aerial Engineering
Pavement Design and Rehabilitation Manual	Office of Pavement Engineering
Project Development Process Manual	Office of Environmental Services
Real Estate Policies and Procedures Manual	
Right of Way Plan Manual	Office of Real Estate
Utilities	Office of Real Estate
Railroad Coordination	Office of Real Estate
Specifications for Geotechnical Explorations	Office of Geotechnical Engineering
Traffic Engineering Manual	Office of Traffic Engineering
ODOT Standard Construction Drawings & Plan Insert Sheets	
Roadway	Office of Roadway Engineering Services
Bridges	Office of Structural Engineering
Traffic	Office of Traffic Engineering
Hydraulic	Office of Hydraulics
Pavement	Office of Pavement Engineering

Specifications:

Construction & Material Specifications	Office of Construction Administration
Supplemental Specifications	Office of Construction Administration
Supplements	Office of Materials Management or Office of Construction Administration
Proposal Notes	Office of Construction Administration

Attachment D

ODOT Specification Quality Control Checklist

Specification Number:	**Revision Date:**
Submitted By/Date:	**Reviewed By/Date:**

Check-off or Comment	**Quality Control Point:**
	Active Voice, Imperative Mood
	Spelling re-checked
	Cross references checked
	Designers note or usage instructions included
	Standard formatting followed: Times New Roman, 12 pt, as per C&MS
	Standard section numbering and bullets followed
	Computer file in MS Word, with revision tracking turned on, and edits shown from original document
	Punctuation re-checked
	English (Metric) units order checked
	Comments from committee members included as hidden comments in the MS Word file
	Specification concepts reviewed for conformance to applicable laws, regulations, policies, and procedures

This checklist is to be completed by the Specification Coordinator for each revised, or new Specification. The Specification Coordinator will send a completed copy to the Committee Chairperson and the FHWA when the QC check is completed.

Attachment E

ODOT Standards Quality Control Checklist

Standard:	**Revision Date:**
Submitted By/Date:	**Reviewed By/Date:**

Check-off or Comment	**Quality Control Point:**
	Description;
	Manual or Drawing;
	Design Considerations (i.e. applicability to various project types and conditions);
	Method of calculation (if required);
	Method of payment (if required);
	Implementation procedure;
	Review requirements for new/revised items;
	List of specifications or other standards that may be impacted by the revision
	Spelling re-checked
	Cross references checked
	Standard formatting followed
	Punctuation re-checked
	English (Metric) units order checked
	Comments from committee members
	Standards concepts reviewed for conformance to applicable laws, regulations, policies, and procedures

This checklist is to be completed by the Publication Owner for each revised, or new Standard. The Publication Owner will send a completed copy to the Committee Chairperson and the FHWA when the QC check is completed.

Attachment F

TITLE 23--HIGHWAYS

CHAPTER I--FEDERAL HIGHWAY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

PART 625_DESIGN STANDARDS FOR HIGHWAYS

Sec. 625.4 Standards, policies, and standard specifications.

The documents listed in this section are incorporated by reference with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and are on file at the Office of the Federal Register in Washington, DC. They are available as noted in paragraph (d) of this section. The other CFR references listed in this section are included for cross-reference purposes only.

(a) Roadway and appurtenances. (1) A Policy on Geometric Design of Highways and Streets, AASHTO 2001. [See Sec. 625.4(d)(1)]

(2) A Policy on Design Standards Interstate System, AASHTO, January 2005. [See Sec. 625.4(d)(1)]

(3) The geometric design standards for resurfacing, restoration, and rehabilitation (RRR) projects on NHS highways other than freeways shall be the procedures and the design or design criteria established for individual projects, groups of projects, or all nonfreeway RRR projects in a State, and as approved by the FHWA. The other geometric design standards in this section do not apply to RRR projects on NHS highways other than freeways, except as adopted on an individual State basis. The RRR design standards shall reflect the consideration of the traffic, safety, economic, physical, community, and environmental needs of the projects.

(4) Erosion and Sediment Control on Highway Construction Projects, refer to 23 CFR part 650, subpart B.

(5) Location and Hydraulic Design of Encroachments on Flood Plains, refer to 23 CFR part 650, subpart A.

(6) Procedures for Abatement of Highway Traffic Noise and Construction Noise, refer to 23 CFR part 772.

(7) Accommodation of Utilities, refer to 23 CFR part 645, subpart B.

(8) Pavement Design, refer to 23 CFR part 626.

(b) Bridges and structures. (1) Standard Specifications for Highway Bridges, Fifteenth Edition, AASHTO 1992. [See Sec. 625.4(d)(1)]

(2) Interim Specifications--Bridges, AASHTO 1993. [See Sec. 625.4(d)(1)]

(3) Interim Specifications--Bridges, AASHTO 1994. [See Sec. 625.4(d)(1)]

(4) Interim Specifications--Bridges, AASHTO 1995. [See Sec. 625.4(d)(1)]

(5) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO 1994 (U.S. Units). [See Sec. 625.4(d)(1)]

(6) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO

1994 (SI Units). [See Sec. 625.4(d)(1)]

(7) Standard Specifications for Movable Highway Bridges, AASHTO 1988. [See Sec. 625.4(d)(1)]

(8) Bridge Welding Code, ANSI/AASHTO/AWS D1.5-95, AASHTO. [See Sec. 625.4(d) (1) and (2)]

(9) Structural Welding Code--Reinforcing Steel, ANSI/AWS D1.4-92, 1992. [See Sec. 625.4(d)(2)]

(10) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, AASHTO 1994. [See Sec. 625.4(d)(1)]

(11) Navigational Clearances for Bridges, refer to 23 CFR part 650, subpart H.

(c) Materials. (1) General Materials Requirements, refer to 23 CFR part 635, subpart D.

(2) Standard Specifications for Transportation Materials and Methods of Sampling and Testing, parts I and II, AASHTO 1995. [See Sec. 625.4(d)(1)]

(3) Sampling and Testing of Materials and Construction, refer to 23 CFR part 637, subpart B.

(d) Availability of documents incorporated by reference. The documents listed in Sec. 625.4 are incorporated by reference and are on file and available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal--register/code--of--federal--regulations/ibr--locations.html. These documents may also be reviewed at the Department of Transportation Library, 400 Seventh Street, SW., Washington, DC, in Room 2200. These documents are also available for inspection and copying as provided in 49 CFR part 7, appendix D. Copies of these documents may be obtained from the following organizations:

(1) American Association of State Highway and Transportation Officials (AASHTO), Suite 249, 444 North Capitol Street, NW., Washington, DC 20001.

(2) American Welding Society (AWS), 2501 Northwest Seventh Street, Miami, FL 33125.

Intentionally blank

Approved:

David E. Slatzer
Deputy Director, Engineering

Standard Procedure No.: 123-001(SP)
Effective: November 2, 2015
Responsible Office: Roadway Engineering
Supersedes Policy: 516-003(P)
Dated: July 18, 2000

TRAFFIC MANAGEMENT IN WORK ZONES

PROCEDURAL STATEMENT:

Work zones have the potential to be a major source of delay to commerce and the motoring public. The Ohio Department of Transportation will systematically determine the impacts created by work zones and will eliminate, minimize or mitigate these impacts to the greatest extent practical. Ultimately this will enhance mobility and safety and maintain customer satisfaction while traveling through ODOT work zones.

AUTHORITY:

The Director of Transportation's authority to establish rules as conferred by 5501.02 of the Ohio Revised Code. This Standard Procedure is issued under the direction of Policy 21-008(P) dated April 17, 2015 and supersedes Policy 516-003(P).

REFERENCES:

Permitted Lane Closure Schedule (PLCS) website: http://plcm.dot.state.oh.us
Highway Capacity Manual (HCM)
Ohio Manual of Uniform Traffic Control Devices (OMUTCD)
23 CFR Part 630 Subpart J; Work Zone Safety and Mobility
23 CFR Part 630 Subpart K; Temporary Traffic Control Devices
ODOT Traffic Engineering Manual (TEM)
ODOT Project Development Process (PDP) Manual
ODOT Location and Design (L&D) Manual, Volume 3
ODOT Construction and Materials Specifications (C&MS)
ODOT Policy 21-008(P) "Traffic Management in Work Zones"

SCOPE:

This Standard Procedure applies to work zones (contract construction, county maintenance or permit) on all ODOT maintained highways.

DEFINITIONS:

Allowable Queue Length Threshold: Queue lengths on freeways and expressways shall not exceed the allowable queuing thresholds. The allowable queuing thresholds are as follows:

Predicted Queue Length	Maximum Duration
≤ 0.75 miles	Allowable for unlimited duration
> 0.75 miles	Not allowable

Where queues are normally present without lane closures, the threshold should compare existing queues to predicted queues caused by lane closure(s).

District Work Zone Traffic Manager (DWZTM): An individual appointed by the District Deputy Director responsible for implementation of this Standard Procedure.

Expressway: A divided arterial highway for through traffic with full or partial control of access with an excess of fifty percent of all crossroads separated in grade (ORC 4511.01(ZZ)).

Freeway: A divided multi-lane highway for through traffic with all crossroads separated in grade and with full control of access (ORC 4511.01(YY)).

Maintenance of Traffic Alternatives Analysis (MOTAA): The purpose of the MOTAA is twofold. First, it provides ODOT with information for use in determining if a part-width, crossover or contra-flow construction scenario is better for a given work zone. Second, it identifies potential problems, i.e., "constraints", with the various maintenance of traffic (MOT) scenarios and allows ODOT to make an informed decision on how to address these problems prior to detailed design of plans. See TEM Section 630-5 for more detailed information on how and when to prepare and submit MOTAAs.

Mainline Ramp: A ramp serving as a mainline continuation between sections of the same route numbered freeway (or expressway).

Maintenance of Traffic Exception Committee (MOTEC): The MOTEC is a sub-committee of the PIAC appointed by the Deputy Director of Engineering.

Maintenance of Traffic (MOT) Plan: Also known as Temporary Traffic Control (TTC) Plan. See the PDP, L&D Manual Volume 3, Section 1306 and the TEM Section 641 for additional information on preparing and submitting MOT plans.

Permitted Lane Closure Schedule (PLCS): The PLCS is a web based searchable data base tool that provides a quick and efficient method for identifying which hours of the day lane closures should not result in violations of the Allowable Queue Length Threshold.

Project Development Process (PDP): A project management and transportation decision-making tool that outlines project development from concept through completion. Depending on the size, complexity, and/or potential impact to the environment, ODOT transportation projects are categorized as following one of five paths (Path 1-5). All projects must advance through a series of sequential phases.

<u>Proper Coordination:</u> Communicating in advance and in a timely manner with others who may be impacted by the closure including but not limited to other ODOT offices (e.g., other Districts, Traffic Management Center, District Public Information Office, District Highway Maintenance, Central Office Hauling Permits, MOTEC/PIAC, etc.), other public agencies, emergency management services, local school districts, contractors, permit holders, business owners, special event coordinators and the like to ensure that the closure does not conflict with previously scheduled closures/events or that any impacts of such closures/events can be mitigated.

<u>Project Impact Advisory Council (PIAC):</u> The PIAC is a committee appointed by the ODOT Chief Engineer to consider policy exception requests that are anticipated to be longer in duration or more impactful than those considered by the MOTEC.

<u>Public Information (PI):</u> Specific effort to provide the public with information related to an impending or ongoing construction project. The level of PI should be commensurate with the anticipated work zone impacts to the public. Public relation campaign tools include, but are not limited to, consideration of stakeholders' needs during the decision-making process, public meetings, news releases, dedicated web sites, social media and media alerts.

<u>Service Ramp:</u> Interchange ramps between freeways (or expressways) and non-freeways (or non-expressways). These ramps provide access (connections) between freeways/expressways and other principal/minor arterials, collectors or local roads.

<u>Significant Project:</u> A project that is anticipated to cause sustained work zone impacts greater than the Allowable Queue Length Thresholds or a project that otherwise requires approval from the MOTEC or PIAC.

<u>System Ramp:</u> Interchange ramps (or connectors) between freeways (or expressways) and freeways (or expressways).

<u>Temporary Traffic Control (TTC) Plan:</u> See Maintenance of Traffic (MOT) Plan.

<u>Transportation Management Plan (TMP):</u> Overall strategy for accommodating traffic during maintenance, construction and force account projects. Elements of the TMP include Temporary Traffic Control (TTC) plans and addresses both Transportation Operations (TO) and Public Information (PI) component. For projects that are not considered Significant, the TMP may only include the TTC plan.

<u>Transportation Operations (TO):</u> The employment of various strategies to mitigate impacts of the work zone on the operation and management of the transportation system is required for Significant Projects. Strategies include, but are not limited to, incident management schemes, identification of alternate routes and work zone Intelligent Transportation Systems (ITS) or retiming of traffic signals affected by the work zone.

<u>Violation:</u> Queues in excess of the Allowable Queue Length Threshold.

PROCEDURES:

I. DISTRICT WORK ZONE TRAFFIC MANAGER (DWZTM)

Each District Deputy Director shall appoint a DWZTM within their district to be responsible for implementing this standard procedure. The DWZTM should possess a working knowledge of highway capacity theory; maintenance of traffic strategies and performance; ODOT manuals, standards and practices; and traffic flow modeling tools. Field experience on multi-lane construction projects is desirable. Information regarding the duties of the DWZTM can be found Section 601-3 of Traffic Engineering Manual (TEM).

II. MAINTENANCE OF TRAFFIC ALTERNATIVES ANALYSIS (MOTAA)

An MOTAA shall be performed as per the ODOT PDP and TEM section 630-5. The purpose of the MOTAA is to identify the most efficient alternative of maintaining traffic (part width, cross-over, contraflow) for a given project by identifying the benefits and constraints of each alternative.

Preferred alternatives identified by the MOTAA that violate Policy 21-008(P) “Traffic Management in Work Zones” will require an exception to be approved by the MOTEC or PIAC, as appropriate, prior to advancing to detailed design.

III. LANE CLOSURES

Capacity restrictions shall be evaluated as described below to assist in identifying when traffic volumes may cause delays and/or backups during lane closures.

A. For Freeways and Expressways Covered by the PLCS:

1. Road work that adheres to the PLCS may move forward without further analysis.

2. Road work that contemplates violating the PLCS shall be analyzed to determine the predicted resulting queues.

a. If the analysis predicts queues within the Allowable Queue Length Thresholds then the road work may move forward as contemplated;

b. Except as permitted in A.2.c, if the analysis predicts a Violation then the contemplated lane closures are not acceptable and shall be submitted to either MOTEC or PIAC as described in Section V and VI.

c. In order to facilitate unplanned and unforeseen lane closures, the Districts, at the discretion of the Deputy Director or Designee, may implement a TMP that violates the PLCS provided that the duration of the associated lane closure(s) is less than 24 consecutive hours in a 7 day period. Careful consideration shall be given to mitigating predicted queues and other traffic impacts along with Proper Coordination with the District PI team. Any unplanned and unforeseen lane closures expected to exceed the aforementioned time limit threshold shall be approved in advance by either the MOTEC or PIAC as required in Section V and VI.

See TEM Section 640-13.2 for additional information related to performing queue analysis.

B. For Other Major Roadways Not Covered by the PLCS:

TEM Section 640-13 provides traffic volume thresholds and guidance for two lane and multi-lane facilities where additional consideration of mitigating potential work zone impacts should be exercised. Mitigation efforts should be commensurate to the expected impacts. MOTEC or PIAC approval is not required for road work on these facilities, except as described in Section VI.B.

DWZTMs shall consult with the Office of Roadway Engineering if in doubt of the need for MOTEC or PIAC approval.

IV. RAMP CLOSURES

A. Service Ramps may be closed as necessary with Proper Coordination and PI;

B. System Ramp closures with a duration less than 24 consecutive hours may be implemented at the discretion of the Deputy Director or Designee after careful consideration and with Proper Coordination and PI. Closures during peak travel times should be avoided;

C. System Ramp closures with planned durations of 24-72 consecutive hours require approval of the MOTEC;

D. System Ramp closures with planned durations longer than 72 consecutive hours require approval of the PIAC;

E. Mainline Ramp closures shall be evaluated the same as the adjacent mainline sections (non-ramp) on the same facility.

V. MAINTENANCE OF TRAFFIC EXCEPTION COMMITTEE (MOTEC) REQUEST

The DWZTM shall petition the MOTEC for exceptions to the Allowable Queue Length Threshold in the following circumstances:

A. When the duration of predicted impacts of a Violation lasts up to and including one week; or

B. When the required queue analysis predicts a queue length greater than 0.75 miles and less than or equal to 5 miles; or

C. When System Ramp closures have a planned duration of 24-72 consecutive hours.

VI. PROJECT IMPACT ADVISORY COUNCIL (PIAC)

A. The DWZTM shall petition the PIAC for exceptions to the Allowable Queue Length Threshold in the following circumstances:

1. When the duration of predicted impacts of a Violation lasts longer than one week; or

2. When the required queue analysis predicts a queue length greater than 5 miles; or

3. When System Ramp closures have a planned duration in excess of 72 consecutive hours; or

4. When there are any planned full freeway or expressway closures (including Mainline Ramps) where traffic will be rerouted.

B. In addition to the exception requests as outlined above; the DWZTM shall consult the PIAC "as soon as practical" during project development, on any roadway type, when:

1. A project is planning on utilizing incentives/disincentives of $50,000 or more; or

2. A project is of regional significance or has the potential to be controversial, impactful or otherwise might be susceptible to negative public or political scrutiny; or

3. Where the financial, constructability or schedule costs of adhering to the Allowable Queue Length Thresholds that, in the opinion of the District, are excessive or impractical.

"As soon as practical" is the point in project development when sufficient information, based upon the topic, can be gathered and presented to the PIAC in order for the committee to make thoughtful considerations. It should not be so late in the project development process that plan changes required by the PIAC will adversely affect the project file date or sale date.

VII. SUPPLEMENTAL FUNDING FOR POLICY COMPLIANCE

For projects funded primarily by District Allocation, the DWZTM may request supplemental funding from the PIAC to assist with the cost of compliance with Policy 21-008(P) "Traffic Management in Work Zones". Typical costs can include:

A. Additional bridge widening necessary solely for the purposes of MOT.

B. Incentives designed to minimize MOT impacts.

C. Work zone ITS.

D. Innovations for minimizing MOT impacts.

VIII. TRANSPORTATION MANAGEMENT PLAN (TMP)

All projects shall incorporate the necessary component(s) of a TMP, as defined under Definitions, in accordance with the project's significance designation.

IX. NOTIFICATIONS

A. The DWZTM shall notify the Office of Roadway Engineering in writing a minimum of two calendar days (excluding weekends and holidays) in advance of implementation of all MOTEC or PIAC approved lane closures, full closures and/or System Ramp closures. The notification shall include:

1. Project ID number, if applicable.

2. County-Route-Section.

3. Date and time of approved closure(s).

B. The Office of Roadway Engineering shall notify the Ohio Division of Federal Highway Administration of MOTEC or PIAC approvals involving full closures on the interstate system (in accordance with FHWA Ohio Division Memorandum dated June 26, 2015) and upon implementation notification as required in IX.A.

TRAINING:

The Office of Roadway Engineering will provide training to districts as necessary and to consultants via the ODOT Traffic Academy.

FISCAL ANALYSIS:

The cost associated with this standard procedure will be evaluated on a project by project basis. A determination will be made if the financial, constructability or schedule costs of standard procedure compliance is commensurate with the predicted work zone impacts to the motoring public.

Approved:

<u>//s// William H. Lindenbaum</u>
William H. Lindenbaum, PE., PS.
Deputy Director
Division of Construction Management

Standard Procedure: 515-001(SP)
Effective: September 12, 2005
Responsible Division: Construction Management

NEW PRODUCT DEVELOPMENT

PROCEDURAL STATEMENT:

This standard procedure sets forth the process by which New Products, introduced to the Department, will be evaluated and approved/disapproved for use.

AUTHORITY:

Ohio Revised Code Statutes 5501.03
Code of Federal Regulations 23CFR635.411

REFERENCES:

Policy 27-014(P), New Product Development
Standard Procedure 510-005(SP), Construction and Material Specification Development

SCOPE:

This policy is applicable to Central Office Divisions and District Departments involved in planning, production, construction, and operation of our highway system.

DEFINITIONS:

<u>Construction and Material Specifications Book (C&MS):</u> A published bound book that contains detailed provisions, together with the plans and the proposal, constitute the contract for the performance of required work. It is the official legal and technical document by which the Department bids and constructs highway projects.

<u>New Product:</u> A product that does not meet an existing Department specification.

<u>New Product Engineer (NPE):</u> Engineer in charge of the evaluation and development of new product. This position is currently under the Office of Materials Management.

<u>Qualified Products List/Approved Product List (QPL/APL):</u> These are lists of products and their approval processes, conforming to items in the C&MS, maintained under the Office of Materials Management.

Proposal Note: Published proposal notes contain a wide variety of legal and technical requirements necessary for proper bidding and sale of an individual project. These notes override all other requirements in Plans, C&MS, Supplemental Specifications, and Standard Construction Drawings.

Specifications: Contract documents used to issue instructions to contractors. For the purposes of this procedure, Specifications will include: C&MS, Supplemental Specifications, Supplements, and Proposal Notes.

Specification Committees: Specification committees are working committees, formed around specific materials and construction tasks, and composed of ODOT district and central office staff, representatives from Federal Highway Administration (FHWA) and industry trade groups.

Supplemental Specifications: Individual numbered documents prepared in loose-leaf form describing the construction and material specifications for new items.

Supplements: Individual numbered documents prepared in loose-leaf form describing necessary information such as laboratory methods of test, and certification or pre-qualification procedures for materials.

Vendor: Manufacturer, company, distributor, marketing group, or individual, seeking ODOT approval of a new product.

PROCEDURE:

I. GENERAL:

A. All vendor initial contact with ODOT will be directed to the Office of Materials Management, New Product Engineer, (NPE).

B. In order to establish if a product falls under the definition of new product, all vendors will be required to determine if their product meets existing ODOT specification(s).

C. For each new product to be considered for review by the Department, the vendor will be required to submit a New Product Application. This application can found in Appendix 1.

1. For new products that deal with prefabricated erosion control devices, follow provisions of Appendix 2, Prefabricated Erosion Control Device – Product Evaluation Guidelines.

2. For new products that deal with fuel savings devices, additives or modifiers for fuels and lubricants, and other devices claimed to improve fleet efficiency, follow provisions of Appendix 3, Fuel Saving Devices, Additives, and Modifiers – Usage Guideline.

II. NEW PRODUCT INITIAL REVIEW

A. NPE will perform initial review of the new product. Review will include, but is not limited to, a literature search, verification of performance and application histories, cost comparison to current equivalent product(s), and a summation of findings.

B. The NPE will distribute new product application and initial review of findings to appropriate Office(s) within the Department, FHWA, and possibly industry for comments as to the need, practicality, potential application, concerns, and overall level of interest in the new product.

III. NEW PRODUCT INITIAL DECISION POINT

A. If comments received for the new product are negative, the Department will take no further action. NPE will provide vendor with a written response of the Department's decision.

B. If comments received for the new product are positive, NPE will form a committee to develop an evaluation plan for the new product. The committee will include key ODOT and FHWA personnel and may include industry representation.

IV. EVALUATION PLAN

A. An evaluation plan will be developed by committee and will document: how the new product will be evaluated, length of evaluation period, acceptance criteria the new product will be judged against, individual(s) responsible for monitoring the new product performance, and proposed site location and layout. New products may be subjected to lab testing, field testing or both. NPE will present new product and evaluation plan to appropriate Specification Committee for comment and approval.

B. If evaluation plan includes use of product as a demonstration on a project that requires federal oversight, an Experimental Construction Feature – Work Plan will also need to be developed. Follow instructions and forms found in Appendix 4.

V. EVALUATION PLAN EXECUTED

A. NPE will track new product evaluation and provide briefings to Specification Committee.

B. New product evaluations may be stopped at any time if performance does not meet expectation.

C. At termination of evaluation period, performance of the new product will be documented by NPE and reported to the Specification Committee. If the new product did not meet established performance criteria, the new product will be rejected from use by the Department. NPE will inform vendor of this decision in writing. If the new product met or exceeded performance criteria, Specification Committee will begin development of a specification. NPE will track use and performance of the new product under this supplemental specification. Modifications can be made to the specification as needed and will be approved by Specification Committee. NPE will work through the Specification Committee to either move new product to full specification status or reject from use. NPE will keep vendor informed of the status of their new product. NPE will also disseminate the results and status of the evaluation to those impacted within ODOT.

TRAINING:

None Required

FISCAL ANALYSIS:

The operational fiscal impact of this policy is expected to include Department resources to perform product evaluations and committee members' time.

Ohio DOT New Products Application Form

1. Date:

2. Product Name: 3. Brand/Trade Name:

4. Manufacturer: Phone:
Address: Web Address:
(Street, City, State, Zip Code)

5. Manufacturer Contact Person: Phone:
Address: Email:
(Street, City, State, Zip Code)

6. Vendor: Phone:
Address: Web Address:

7. Vendor Contact Person: Phone:
Address: Email:

8. Has the product been tried under another name? If so, please describe:

9. What date did the product come onto the market?

10. Is the product patented? Applied for date:

11. Is the product proprietary? If yes, what are the royalty costs and on what basis are they collected?

12. What is the primary use for the product?

13. List the outstanding features or benefits of the product:

14. List any alternate uses for the product:

15. This product is proposed as an alternate replacement or comparable to what existing ODOT construction or material specification? What product(s) would be direct competitor(s)?

16. List specific specifications that the product meets - AASHTO, ASTM, Federal, MUTCD, or Ohio DOT (certified test data must be submitted which support these claims):

17. Has the product been approved for use by another State DOT? If yes, please provide the following - State, contact name and number, if the product is used on a routine basis or experimentally, and copy of the DOT specification (if applicable):

18. Has the product been tried by the Ohio DOT before? If yes, please provide the following - Contact name and number, when and where the product was used, product performance, and reason(s) stating why the product should be tried again.

19. Has another Office or person in the Ohio DOT been contacted about this product?
If yes, please provide the details of that contact:

20. Has this product been evaluated, or is currently being evaluated by the National Transportation Evaluation Program? If yes, please provide the report or submittal number.

21. What is the generic product composition?

22. Describe any adverse effects associated with the use of your product. Examples would include – environmental, maintenance of traffic, safety concerns, or others?

23. Can a demonstration be provided?

24. If a demonstration is deemed necessary, will your product be supplied free of charge? Will labor and equipment be provided to install the product free of charge?

25. Is there a need for special equipment to install your product? If yes, what is the cost to buy/rent the equipment?

26. If this product is an alternate or replacement for an existing ODOT Construction and Specification item, please provide a cost comparison with this item.

27. What is the cost of the product per unit? Make assumptions on quantities if necessary.

28. What is the cost of the product per unit - installed?

29. Can these items be provided? If yes, please provide 2 copies of this information with the submission of the application.

Yes	No	
______	______	Specifications
______	______	MSDS data
______	______	Test data
______	______	Product literature
______	______	Pictures or drawings
______	______	Installation instructions

30. Can educational courses or videos be provided?
31. Is the product seasonal?
32. Are quantities limited?
33. Product can be delivered to the site after an order is placed in ____ days?
34. Does the product carry a warranty? If yes, please describe in detail the provisions of the warranty:

General Notes

1. A separate form will be required for each product submitted for evaluation.
2. Incomplete applications and/or erroneous information furnished as a part of this form will result in the product being rejected for evaluation.

In the event a field and or laboratory evaluation is deemed necessary, the following conditions will apply:

3. Product evaluation will be in accordance with applicable laboratory testing and field evaluation criteria established by the ODOT staff. The evaluation shall provide a true test of the products stated characteristics and application.
4. Acceptance of a product for evaluation by the ODOT is in no way a commitment to purchase, recommend, or specify the product investigated regardless of its performance.
5. When requested by the ODOT, the vendor or their representative will be present when the product is installed at the test site to lend assistance and provide expertise to those involved in the installation. The vendor shall also provide any special equipment necessary for the installation.
6. The ODOT will prepare a summary report upon completion of a suitable evaluation period to allow adequate exposure of the product to its functional environment. Data resulting from an evaluation of the submitted product is public information and will not be considered privileged. All information developed during this product evaluation will be released by the ODOT at its discretion.

The Ohio Department of Transportation will not consider any new product until this application is completed, signed by a responsible official of the manufacturer, and returned to the address shown below. All ODOT correspondence will be directed to the official of the manufacturer listed below.

Ohio Department of Transportation
Office of Materials Management
Attention: New Product Engineer
1600 West Broad Street, Columbus, OH 43223

Signature: ________________________________
(Official of manufacturer)

Name: ________________________________
(Please type or print)

Date: ________________________________

Title: ________________________________

Manufacturer: ________________________________

Address: ________________________________
(Street, City, State, Zip Code)

Prefabricated Erosion Control Devices
Product Evaluation Guideline

Office of Materials Management

June 25, 2014

The following references describe the Departments Construction Erosion Control Practices. These practices outline that the awarded project contractor will furnish all erosion control for the project. This will include installing all erosion and sediment control products, maintaining the products, and if required, a Stormwater Pollution Prevention Plan (SWPPP). The erosion and sediment control products will meet the requirements as outlined below.

1.	Standard Drawings:	DM-4.1 Erosion Control at Bridges DM-4.2 Erosion Control Mat Type A-I DM-4.3 Sediment and Erosion Controls DM-4.4 Construction Erosion Control
2.	Specifications:	Supplemental Specification 832
3.	Procedures:	Manual of Procedures, Item 832, Temporary Sediment and Erosion Controls

The contractor may propose a new erosion or sediment control product. A product notice, as outlined below, must be submitted to the Engineer and Department at the time of the SWPPP submittal. The product must have been submitted as a new product to the Office of Material Management for review prior to this evaluation or concurrent with this request. New erosion and sediment control products which involve filter fabric are required to meet ODOT 712.09 Type C, at a minimum.

The product notice shall include the following:

1. Sales brochure and test data describing the product.
2. New Product Application if not previously submitted (completed by the manufacturer). Contact New Product Engineer for a copy of this application: brad.young2@dot.state.oh.us
3. State the intended use of the product, and if applicable, the item the product will replace.
4. If the product is not a direct replacement for an existing approved product, describe how the product addresses the requirements of the National Pollutant Discharge Elimination System (NPDES) Permit (Supplemental Specification 832).
5. Any documentation of scientific testing from a reputable independent laboratory or university showing results based on controlled conditions.
6. Description of where the product is appropriate for use and specifying design limitations for each proposed application. (i.e. This product will be used on curb inlets with 1 acre or less of tributary area.)
7. The location and all necessary installation instructions or details shall be included in the

project's SWPPP.

8. Trial performance evaluation plan prepared by the contractor or their representative. State the project location(s) of the proposed trial performance evaluation(s). (At a minimum, evaluations will last three months and have weekly performance documentation.) Photo documentation of the product evaluation shall be provided on a monthly basis at a minimum.
9. List of any other projects the product has been used on. Supply a contact reference and phone number.

The Department will review the product notice. If the Department has reason that the product should not be used, the contractor will not be allowed to use the product. Otherwise, the Department will issue approval for the product to be installed in a trial performance evaluation(s).

Upon completion of each trial performance evaluation, a report will be submitted to the Department by the contractor or their representative. This report will provide the following information:

1. Weekly reports of the products performance, signed by project personnel concurring with the findings
2. Photo documentation
3. A summary of the results of the product, signed by project personnel concurring with the findings

The new erosion control product, installation, and maintenance can be paid for at an agreed upon price as described in SS832. If it is not replacing a current item, then payment is a part of the project as outlined in Supplemental Specification 832. Product proposals that do not directly replace existing approved products are required to provide a project cost breakdown and description of how the application specifically applies to the NPDES Permit (Supplemental Specification 832). Weekly performance evaluations and reporting will be at no cost to ODOT.

The contractor, without additional payment, will assume all responsibility for the removal, maintenance and replacement of the new erosion control product(s) in the event that those products do not provide the controls necessary to maintain NPDES compliance.

If the new erosion control product meets or exceeds the performance of the existing standards based on several trial performance evaluations, the product may become a standard erosion control product.

The Product Notice and Trial Performance Evaluation Report should be sent to:

Brad Young, New Products Engineer
Office of Materials Management.
1600 West Broad Street, Columbus, Ohio 43223
Email: brad.young2@dot.state.oh.us

Hans Gucker, Const. Hydraulics Engineer
Office of Construction Administration
1980 West Broad Street, Mail Stop 5190
Columbus, Ohio 43223
Email: hans.gucker@dot.state.oh.us

Fuel Saving Devices, Additives, and Modifiers – Usage Guideline

Office of Equipment and Support Services

July 26, 2005

This guideline establishes the requirements for vendors seeking ODOT approval of their fuel saving devices, additives and modifiers for fuels and lubricants and other add on devices claimed to improve fleet efficiency and save money.

The vendors will comply with the following conditions and requirements before any consideration will be given to the product:

1. ODOT is not interested in products that invalidate equipment warranties.

2. Many of these products are covered by the Department of Administrative Services purchasing contracts and they should be contacted.

3. Submission of sales brochures and data describing the product.

4. Material Safety Data Sheets (MSDS) for all chemicals.

5. Minimum cost savings will be at least 5% above the products cost per year.

6. Documentation of results from a major fleet operation (>100 vehicles).

7. Documentation of scientific testing from a reputable laboratory or university showing results based on controlled conditions. All tests will meet applicable ASTM and/or SAE standards.

Please submit documentation and product information to:

Ohio Department of Transportation
Office of Materials Management
Attn: New Products Engineer
1600 West Broad Street
Columbus, OH 43221

Construction Projects Incorporating Experimental Construction Features

1. What is the purpose or objective of the experimental features program?

a. The purpose of the experimental features program is to encourage highway agencies to evaluate new or innovative highway technology, or alternative standard technology, under actual construction and operating conditions by means of a program or experimental construction projects.
b. To provide a mechanism for the widespread dissemination and application of the results of these evaluations.

2. What are some key definitions of the program?

a. Control Section - a section or feature of a highway designed and constructed in a standard manner and as nearly as practicable under identical conditions so that comparisons can be made.
b. Experimental Feature - a material, process, method, equipment item, traffic operational device, or other feature that: (1) has not been sufficiently tested under actual service conditions to merit acceptance without reservation in normal highway construction, or (2) has been accepted but needs to be compared with alternative acceptable features for determining their relative merits and cost effectiveness.
c. Experimental Project - a Federal-aid highway construction project incorporating one or more experimental features.
d. Work Plan - a written program of action including a description of the experimental feature, experimental feature objectives, measurements to be made, characteristics to be evaluated, time schedules, reporting requirements, cost estimates, construction and post-construction inspection schedules, control sections, and evaluations to be conducted.

3. What are the general principles of the program

a. Experimental Project Designation. Any Federal-aid project incorporating experimental features should be designated an experimental project and treated accordingly.
b. Work plan. A work plan is required for each experimental feature.
c. Approvals
    1. For projects on the Interstate system that incorporate experimental features or on any National Highway System (NHS) route that incorporates proprietary products, the work plans must be approved by the Division Administrator prior to or with approval of Plans, Specifications, and Estimates (PS&E). Work plans for experimental projects utilizing State Planning and Research (SPR) funds need approval by the Division Administrator in accordance

with normal approval procedures for SPR funded studies. (For NHS projects with State approval authority and oversight, work plan approval is delegated to the State.)

2. Experimental features included in ongoing projects by change order also need approval by the Division Administrator.

d. Control Sections. Control sections or other alternatives should be provided for performance comparisons in all experimental projects unless the nature of the experiment is such that a control section or alternative would serve no purpose.
e. Cost Data. Cost data should be compiled for all experimental and control features.
f. Multiple Project Justification. Two or three construction projects should be adequate to conclusively evaluate a single feature. The justification for more than five construction projects should be carefully analyzed prior to initiation.

4. How should the results of the experimental features program be reported?

a. Reporting of results should be completed for all experimental features. All reporting (including form, content, and delivery) should follow the requirements set forth in the approved work plan. Final reports prepared utilizing SPR and non-SPR funds are to be submitted for review and approval to the FHWA Division Office in accordance with the established procedures for SPR funded Research Development and Testing (RD&T) studies. Two copies of the final report should be provided to the FHWA Division Administrator. The Division Office should forward one copy to the following address:

Mr. John McCracken, Director
FHWA Office of Research and Technology Services
Turner-Fairbank Highway Research Center, HRTS-1
6300 Georgetown Pike, Room F-204
McLean, VA 22101-2296

b. The FHWA supports the continued use of the AASHTO Product Evaluation List (APEL). Contracting agencies should provide the appropriate experimental feature evaluation report information to the APEL web site so that other agencies may benefit from their evaluations.

5. How are projects with experimental features terminated?

The Division Administrator may determine the project has been completed when the work plan goals either have been achieved or cannot be achieved.

6. How are projects with experimental features financed?

a. Total construction costs attributable to experimental features may be financed with the appropriate class of Federal-aid funds. SPR funds cannot be used for constructing experimental features.
b. Evaluation costs may be financed with the same class of funds used for construction of the experimental feature, SPR funds, or non-Federal funds. If SPR funds are used, the administrative requirements in 23 CFR Part 420 are applicable.

Ohio Department of Transportation
Office of Materials Management

Experimental Construction Feature - Work Plan

Feature to be evaluated:
Manufacturer:
Proposed location:
PID or Proj Number:_________ Expected Install Date:_________Estimated cost:__________
Other Information:
Is Federal approval required: Yes / No (If yes, FHWA signature required below)
Person responsible for reporting on the features performance:

To what extent has this feature been used in Ohio? Elsewhere?

What potential benefits can be derived from the installation of the feature?

How will the feature be installed? Describe the exact location and circumstances.

How will the features performance be judged? Describe any standards or control sections which the feature will be compared to.

Preparers Name:___________________	**Approved / Date:**
Office / District:___________________	**(Specification Committee Chair)**
Date:______________________________	**Approved / Date:**
	(FHWA, Ohio Division Administrator)

Intentionally blank