North Carolina Department of Transportation

Traffic Management & Signal Systems Unit
DESIGN MANUAL

Introduction

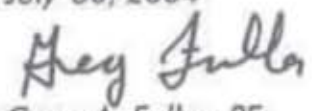
The North Carolina Department of Transportation's Traffic Management and Signal Systems Unit has prepared this Design Manual as a medium for the presentation of commonly used design practices. It also serves as a format to present new design standards and practices, and to ensure more uniformity in the design of traffic signal plans, electrical details, and communications cable routing plans prepared for the NCDOT.

The intention of this Manual is not to provide an explanation or solution to every design problem encountered. This Manual is not a substitute for sound engineering judgment, experience, or knowledge, nor does it prohibit the application of new ideas and innovations.

This Manual is based on established practices and is supplemented by recent research. This Manual will require adjustments, additions, and deletions to keep abreast of improved technology resulting from continuing research and experience.

I hope this Manual presents valuable information in an understandable format that will provide the designer with many years of practical use.

Approved for implementation (Signals & Geometrics Section)
On December 1, 1995
Revised (Signals & Geometrics Section)
October 1, 1999
Revised
July 30, 2004



Greg A. Fuller, PE
Traffic Management and Signal Systems Engineer

TRAFFIC MANAGEMENT & SIGNAL SYSTEMS UNIT
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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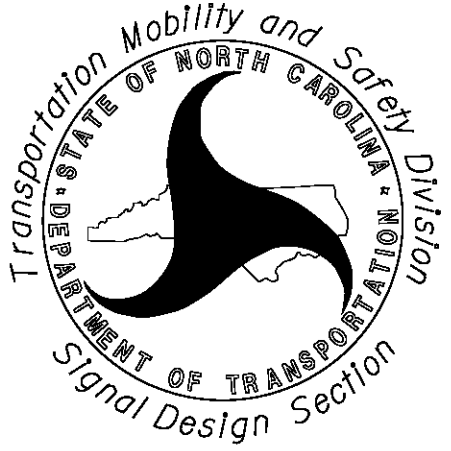
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Design Manual

Signal Design Section



Part 1

Table of Contents

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.

2070L Term	NEMA Equivalent	170 Equivalent
Call Detector	Place Call During Phase	Calling
Delay	Delay	Delay
Dual Entry	Dual Entry	Double Entry
Extension/Gap	Passage/Gap	Vehicle Extension
Full Time Delay	Inhibit Delay During Green?	Full Time Delay
Maximum Green	Maximum 1	Maximum Limit
Max Recall	Max Recall	Max Recall
Max Variable Initial	Maximum Initial	Maximum Initial
Minimum Gap	Minimum Gap	Minimum Gap
Min Green	Minimum Green	Minimum Initial
Min Recall	Min Recall	Vehicle Recall
Ped Recall	Ped Recall	Ped Recall
Red Clearance	Red Clearance	Red Clearance
Sec per Actuation	Sec per Actuation	Add per Vehicle
Soft Recall	Soft Recall	Soft Recall
Stop Bar Time	-	Type 3 Limit
Stretch	Extend	Carry
Time Before Reduction	Time Before Reduction	Reduce 0.1 Sec Every
Time to Reduce	Time to Reduce	
Vehicle Call Memory	Vehicle Call Memory	Vehicle Call Memory
Yellow Clearance	Yellow Change Interval	Yellow Change Interval
-	-	Alternate Extension
-	-	Count
-	-	Extension
-	-	Maximum Gap

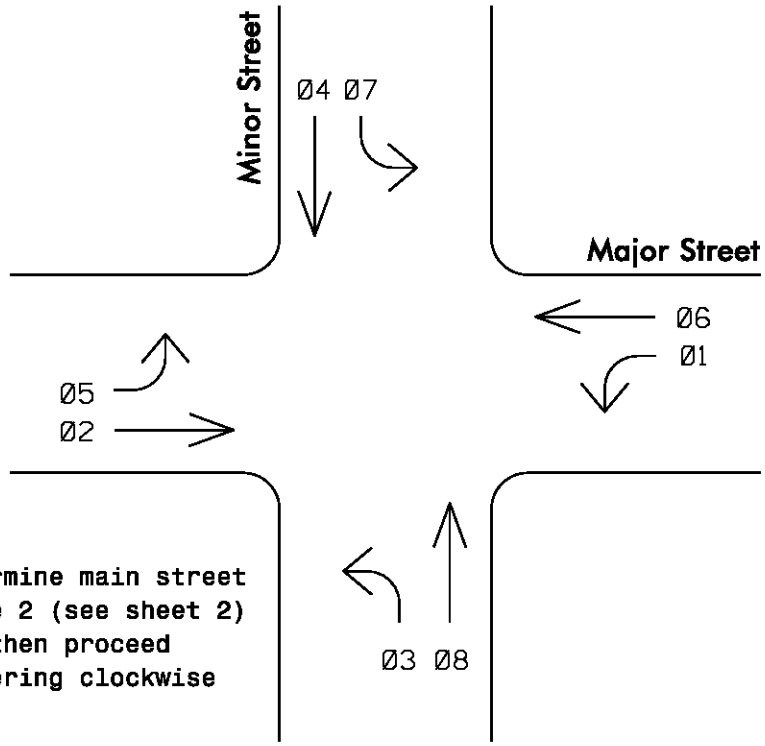
Controller Terms

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
1.0
SHEET 1 OF 1

Standard NEMA Orientation
Dual Ring Cabinet

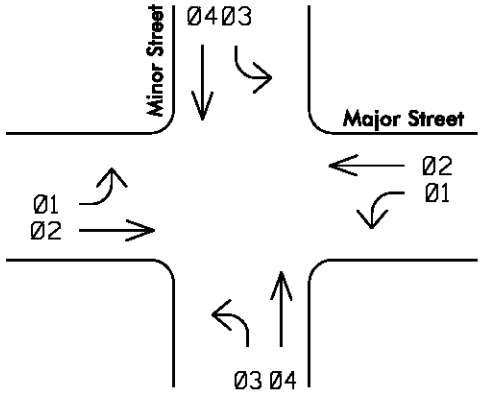


Determine main street phase 2 (see sheet 2) and then proceed numbering clockwise

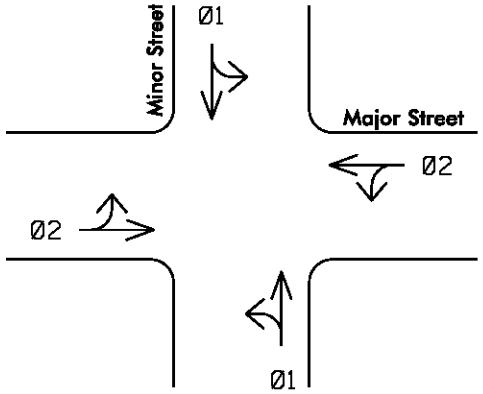
Sum of phases for each major street approach is 7.
(1+6=7 and 2+5=7)

Sum of phases for each minor street approach is 11.
(3+8=11 and 4+7=11)

Standard NEMA Orientation
Single Ring 4 Phase Cabinet



Standard NEMA Orientation
Single Ring 2 Phase Cabinet



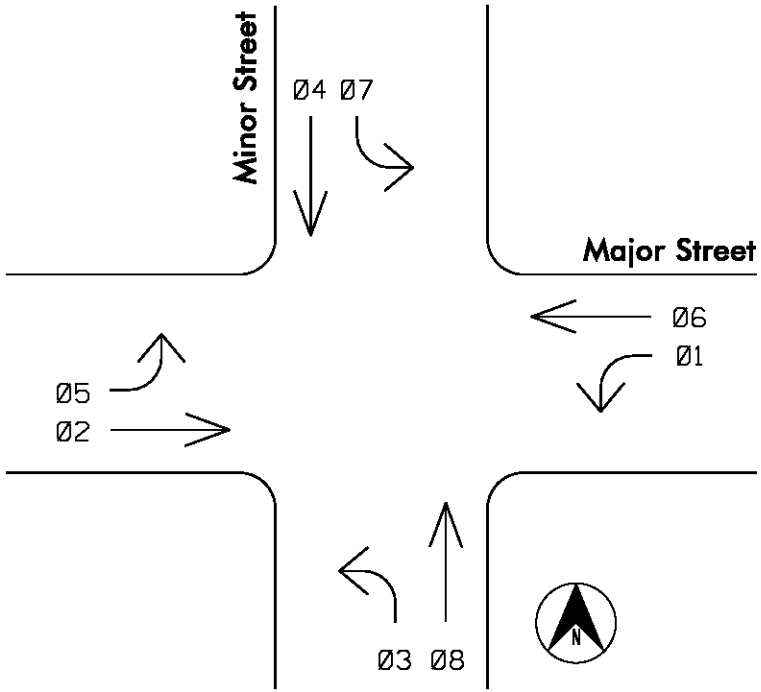
Numbering of NEMA Phases

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
2.0
SHEET 1 OF 4

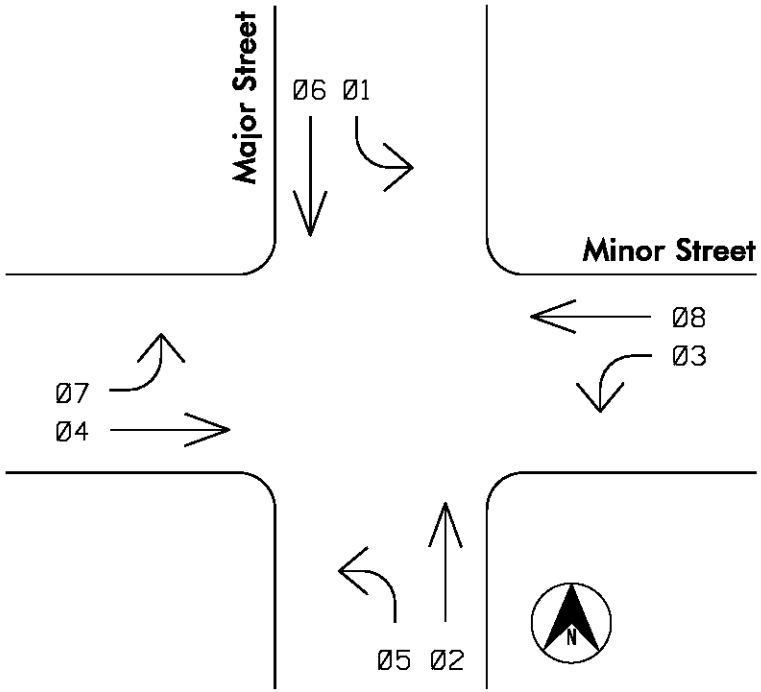
Standard NEMA Orientation
Dual Ring Cabinet
Major Street runs East–West



Phase Numbering

Phase 2 - Eastbound through movement
Phase 4 - Southbound through movement
Phase 6 - Westbound through movement
Phase 8 - Northbound through movement
Pair turning movements with the through movements if an exclusive left turn phase (protected or protected/permissive) is not used.
If location is being added to an existing system, match phase numbering to the system.

Standard NEMA Orientation
Dual Ring Cabinet
Major Street runs North–South



Phase Numbering

Phase 2 - Northbound through movement
Phase 4 - Eastbound through movement
Phase 6 - Southbound through movement
Phase 8 - Westbound through movement
Pair turning movements with the through movements if an exclusive left turn phase (protected or protected/permissive) is not used.
If location is being added to an existing system, match phase numbering to the system.

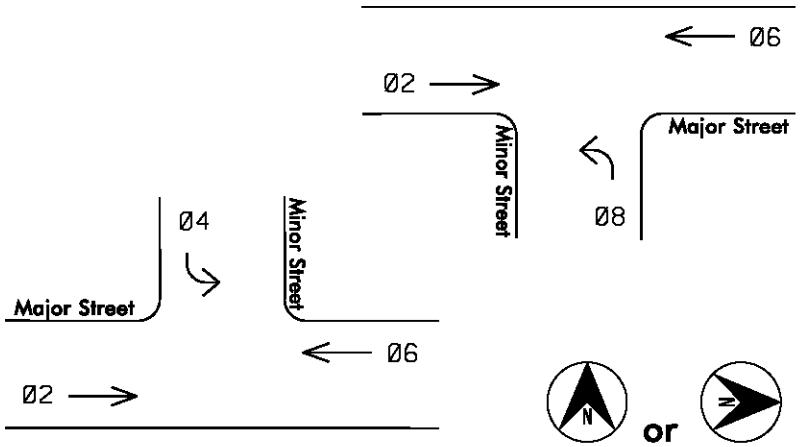
Numbering of NEMA Phases

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
2.0
SHEET 2 OF 4

Determining Movement Phase Numbers
Tee Intersections

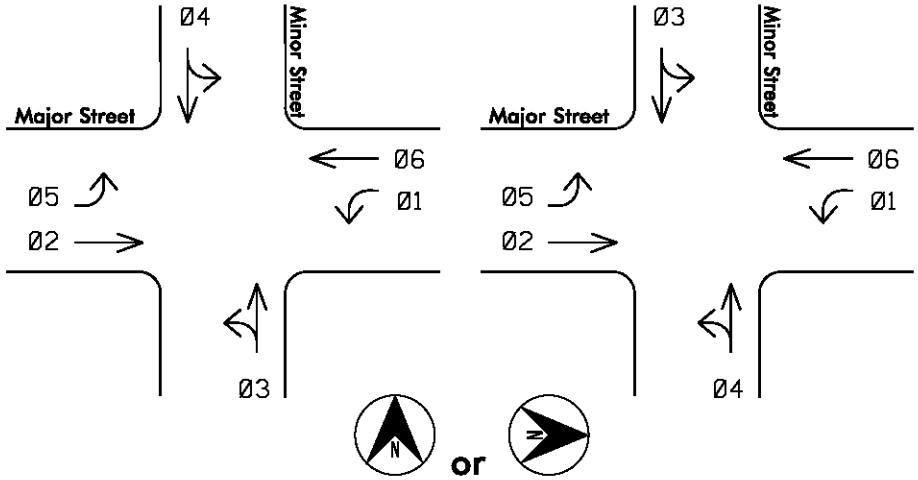


Phase Numbering

Movement numbering will conform to standard NEMA phasing shown on Sheet 1.
Phase 2 - Eastbound or Northbound through movement
Phase 4 - Southbound or Eastbound Stem of Tee movement
Phase 6 - Westbound or Southbound through movement
Phase 8 - Northbound or Westbound Stem of Tee movement

NOTE: For 2070 SE-PAC, there must be a phase in Ring 1 for phase 2 to operate. This means that there must be a phase 2 for phase 6 to operate and there must be a phase 4 if using phase 8. For Tee intersections on SE-PAC use phase 4 for the stem of the Tee.

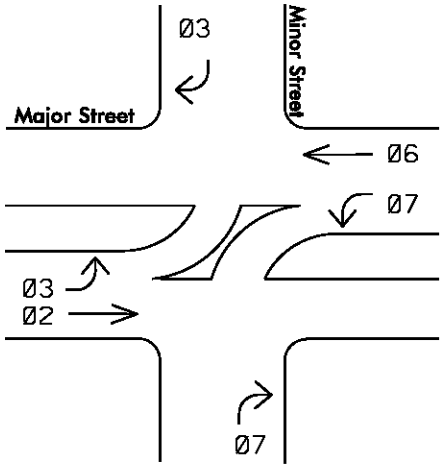
Determining Movement Phase Numbers
Split Side Streets



Phase Numbering

Main street movement numbering will conform to standard NEMA phasing shown on Sheet 1.
For side street movement numbering:
- If one approach is desired to be serviced first, label it phase 3 and the other approach phase 4.
- If there is no desire for either approach to be serviced first, label phase 4 for the eastbound or southbound movement and phase 3 for the westbound or northbound movement.

Determining Superstreet Phase Numbers
Cross Intersections w/"Leftovers"

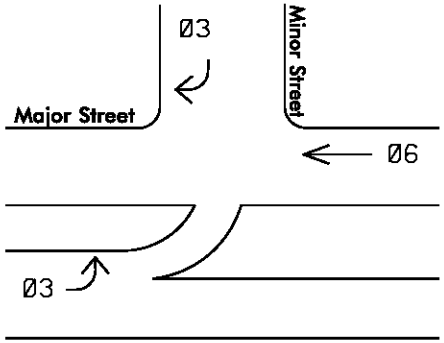


Phase Numbering

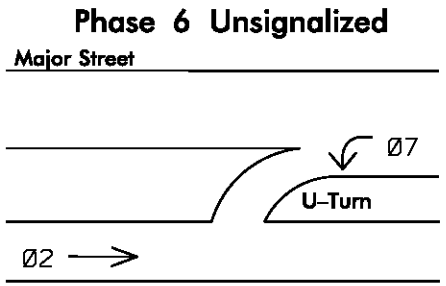
Main street through movement numbering will conform to standard NEMA phasing shown on Sheet 1.

For left turn and side street movement numbering:
- -Phase should be an odd number on the opposite side of NEMA barrier (3 or 7).
- -Sum of phases used at a superstreet signal should total 9 (2+7=9 or 3+6=9).
- -At a cross, each "pair" of movements should be controlled by separate controllers and cabinets to facilitate system coordination

Determining Superstreet Phase Numbers
U-Turn Only, Tee, or Unsignalized Right Turns



Phase 2 Unsignalized



Phase Numbering

Main street through movement numbering will conform to standard NEMA phasing shown on Sheet 1.

No signal heads needed for through movement adjacent to left turn movement if there is no signalized conflicting movment.

For left turn movement numbering:
- -Phase should be an odd number on the opposite side of NEMA barrier (3 or 7).
- -Sum of phases used at a superstreet signal should total 9 (2+7=9 or 3+6=9).
- -At a cross, each "pair" of movements should be controlled by separate controllers and cabinets to facilitate system coordination

Numbering of NEMA Phases

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
2.0
SHEET 4 OF 4

2–Phase
Dual–Ring Cabinet

PHASING DIAGRAM

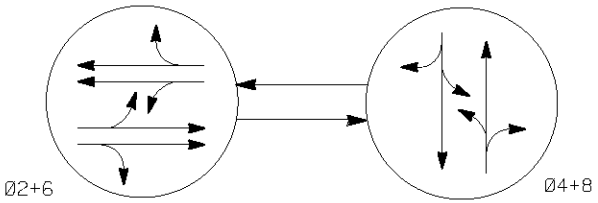


TABLE OF OPERATION			
SIGNAL FACE	PHASE		
	Ø 2 + 6	Ø 4 + 8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 2–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.1
SHEET 1 OF 1

3–Phase
Minimum Recall
Protected or Protected/Permissive
at Cross Intersection
Dual–Ring Cabinet

PHASING DIAGRAM

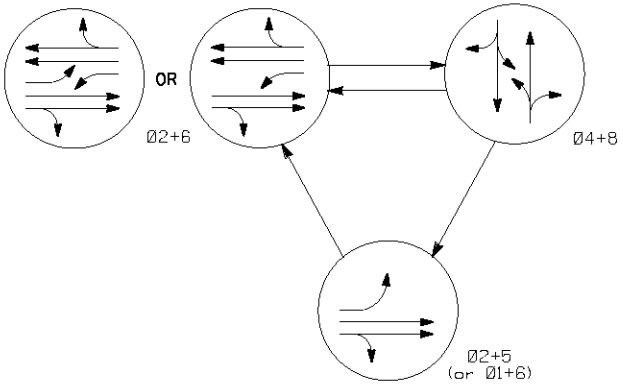


TABLE OF OPERATION				
SIGNAL FACE	PHASE Ø +	Ø 2 + 6	Ø 4 + 8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

3–Phase
Minimum Recall
Protected or Protected/Permissive
at Tee Intersection
Dual–Ring Cabinet

PHASING DIAGRAM

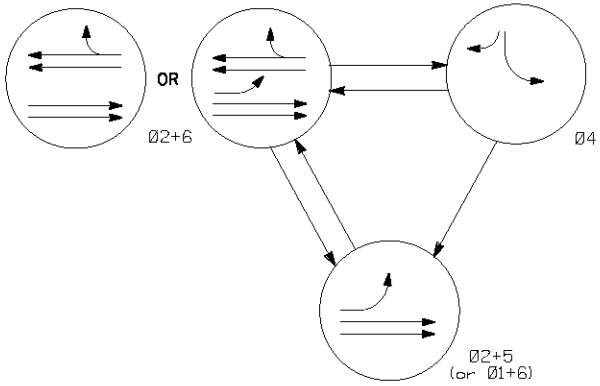


TABLE OF OPERATION				
SIGNAL FACE	PHASE Ø +	Ø 2 + 6	Ø 4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 3–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.2
SHEET 1 OF 2

3–Phase
Minimum Recall
Split–Side Street
Dual–Ring Cabinet

PHASING DIAGRAM

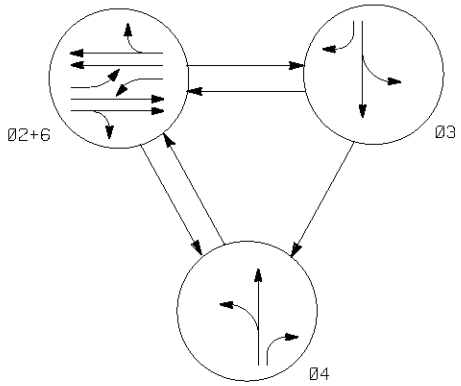


TABLE OF OPERATION				
SIGNAL FACE	PHASE			
	Ø2+6	Ø3	Ø4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

3–Phase
Minimum Recall
Lagging Left Operation
Protected or Protected/Permissive
at Tee Intersection
Dual–Ring Cabinet

PHASING DIAGRAM

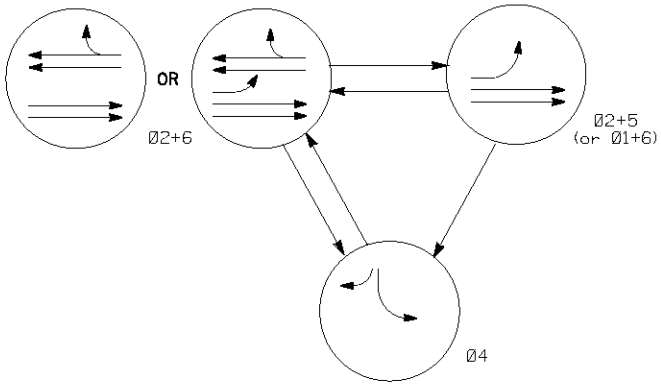


TABLE OF OPERATION				
SIGNAL FACE	PHASE			
	Ø2+6	Ø+	Ø4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 3–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.2
SHEET 2 OF 2

4–Phase
Minimum Recall
Protected/Permissive Main Street
Split–Side Street
Dual–Ring Cabinet

PHASING DIAGRAM

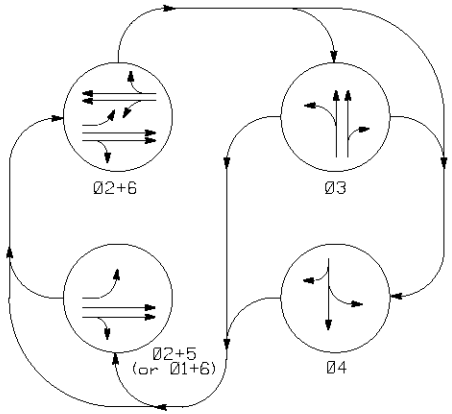


TABLE OF OPERATION

SIGNAL FACE	PHASE				
	Ø +	Ø 2 + 6	Ø 3	Ø 4	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

4–Phase
Minimum Recall
Protected/Permissive Main Street
Protected/Permissive Side Street
Dual–Ring Cabinet

PHASING DIAGRAM

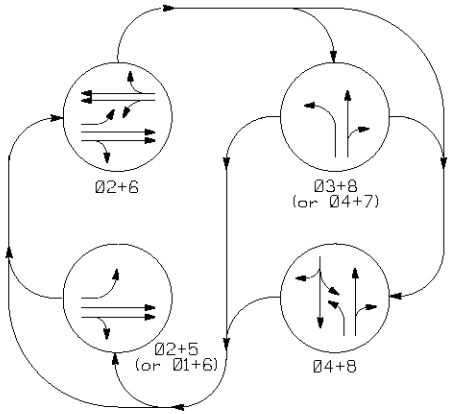


TABLE OF OPERATION

SIGNAL FACE	PHASE				
	*	Ø 2 + 6	**	Ø 4 + 8	FLASH

* Ø2+5 or Ø1+6 (Major Street Lefts)
** Ø3+8 or Ø4+7 (Minor Street Lefts)

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 4–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.3
SHEET 1 OF 3

4–Phase
Minimum Recall
Protected Main Street
Split–Side Street
Dual–Ring Cabinet

PHASING DIAGRAM

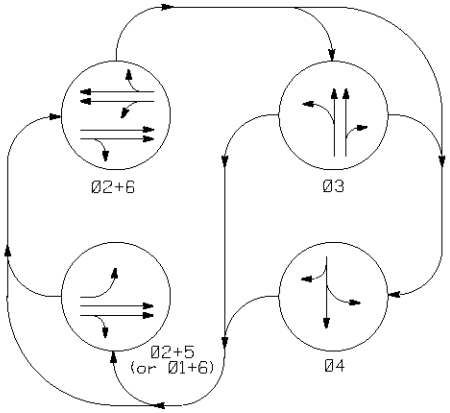


TABLE OF OPERATION					
SIGNAL FACE	PHASE				
	Ø +	Ø 2 + 6	Ø 3	Ø 4	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

4–Phase
Minimum Recall
Lead–Lag Operation
Dual–Ring Cabinet

PHASING DIAGRAM

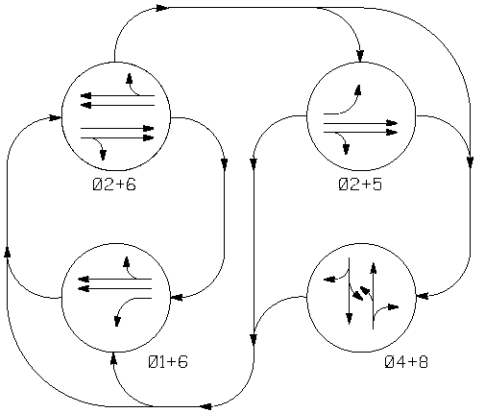


TABLE OF OPERATION					
SIGNAL FACE	PHASE				
	Ø 1 + 6	Ø 2 + 6	Ø 2 + 5	Ø 4 + 8	FLASH

With older controllers, the phase numbering may need to be modified

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 4–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.3
SHEET 2 OF 3

4–Phase
Soft Recall
Protected/Permissive Main Street
Split–Side Street
Dual–Ring Cabinet

PHASING DIAGRAM

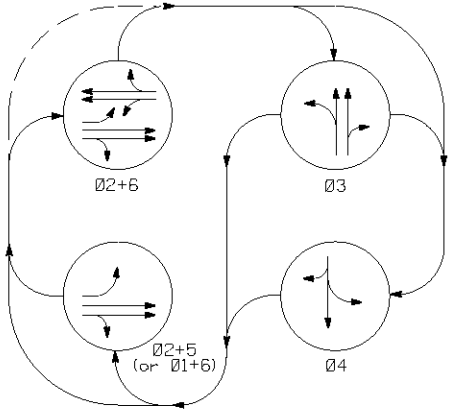


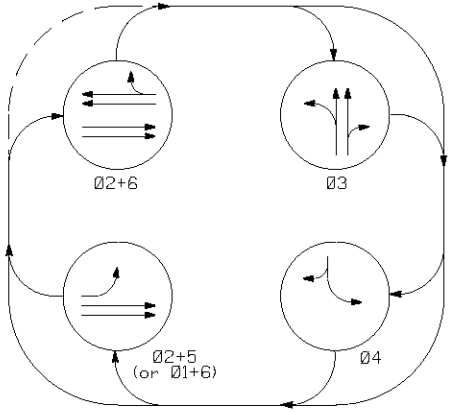
TABLE OF OPERATION					
SIGNAL FACE	PHASE				
	Ø +	Ø 2 + 6	Ø 3	Ø 4	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

4–Phase
Soft Recall
Protected Main Street
Split–Side Street
Dual–Ring Cabinet

PHASING DIAGRAM



Ø3 approach is one–way only

TABLE OF OPERATION					
SIGNAL FACE	PHASE				
	Ø +	Ø 2 + 6	Ø 3	Ø 4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 4–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.3
SHEET 3 OF 3

5–Phase
Minimum Recall
Protected/Permissive

PHASING DIAGRAM

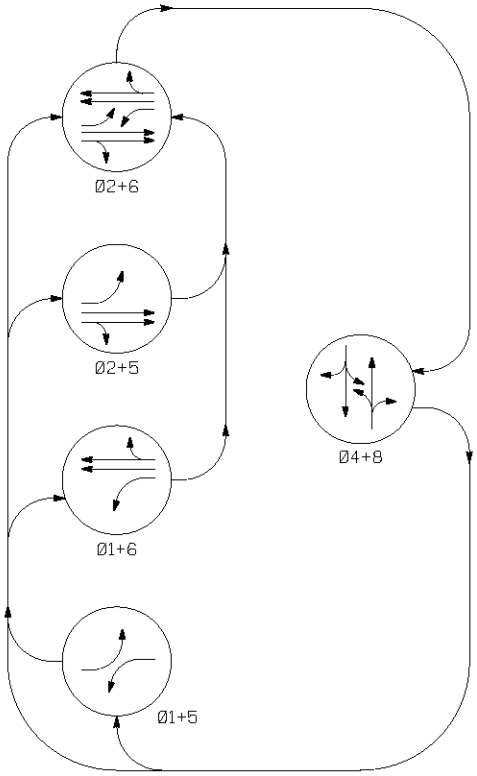


TABLE OF OPERATION						
SIGNAL FACE	PHASE					
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø4+8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

5–Phase
Minimum Recall
Protected

PHASING DIAGRAM

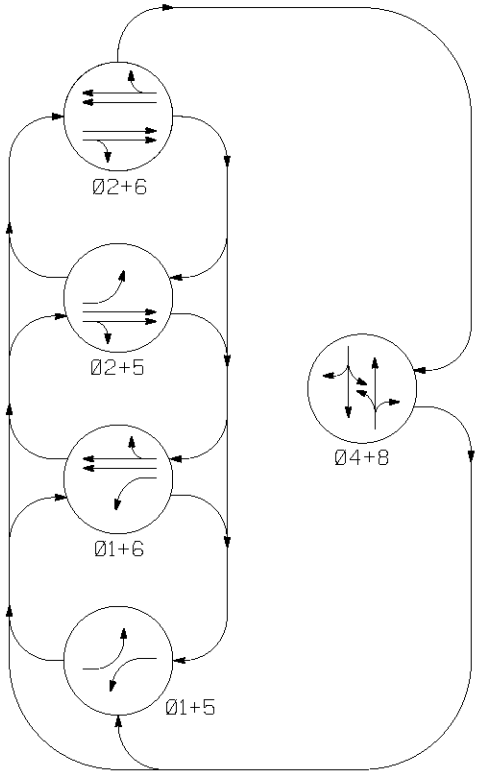


TABLE OF OPERATION						
SIGNAL FACE	PHASE					
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø4+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 5–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.4

5–Phase
Soft Recall
Protected

PHASING DIAGRAM

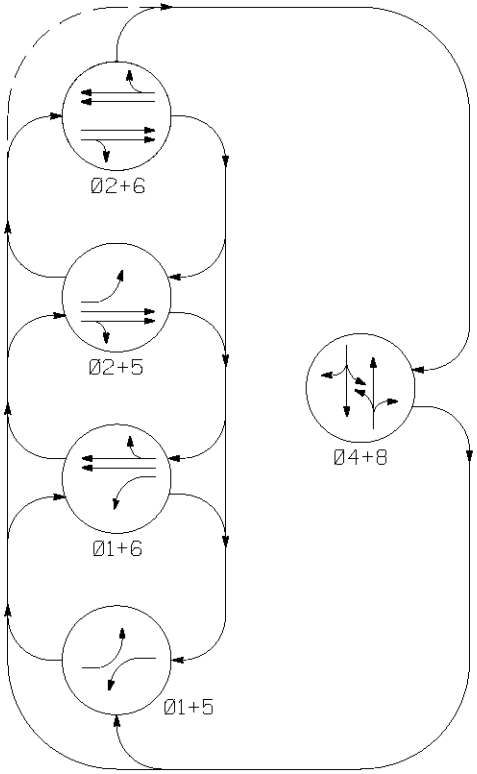


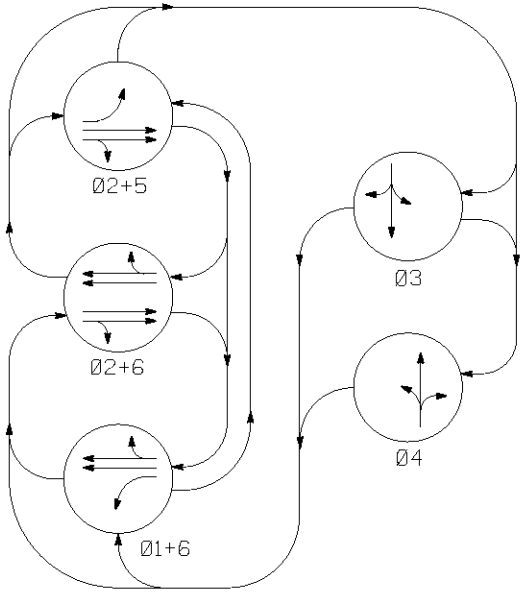
TABLE OF OPERATION

SIGNAL FACE	PHASE					
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø4+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

5–Phase
Minimum Recall
Lead–Lag Operation
Split Side Street

PHASING DIAGRAM



With older controllers, the phase numbering may need to be modified

TABLE OF OPERATION

SIGNAL FACE	PHASE					
	Ø1+6	Ø2+6	Ø2+5	Ø3	Ø4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 5–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.4
SHEET 2 OF 2

6–Phase
Minimum Recall
Protected/Permissive Main Street
Split Side Street

PHASING DIAGRAM

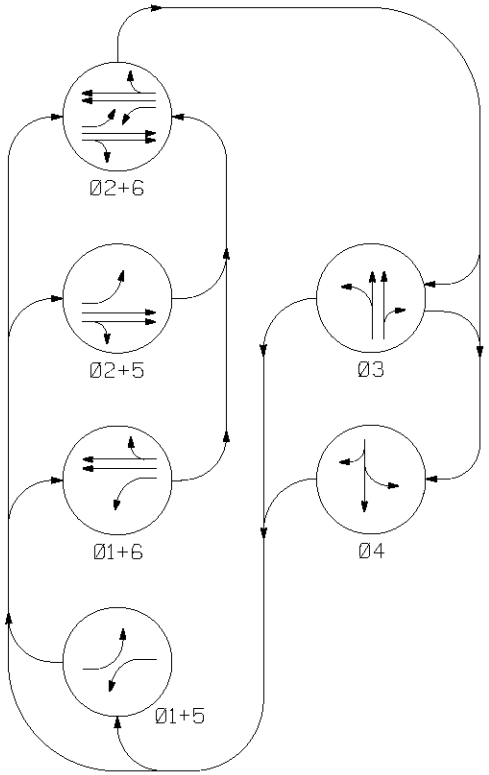


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3	Ø4	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

6–Phase
Minimum Recall
Protected/Permissive Main Street
Protected/Permissive Side Street

PHASING DIAGRAM

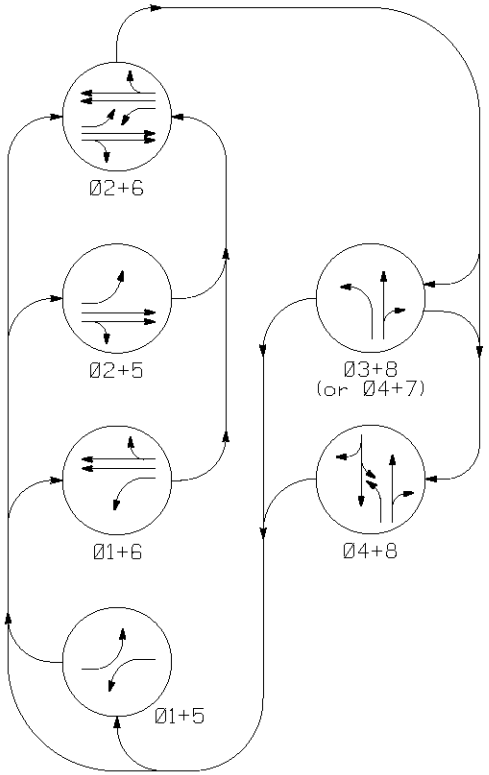


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø+	Ø4+8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 6–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.5
SHEET 1 OF 3

6–Phase
Minimum Recall
Protected Main Street
Split Side Street

PHASING DIAGRAM

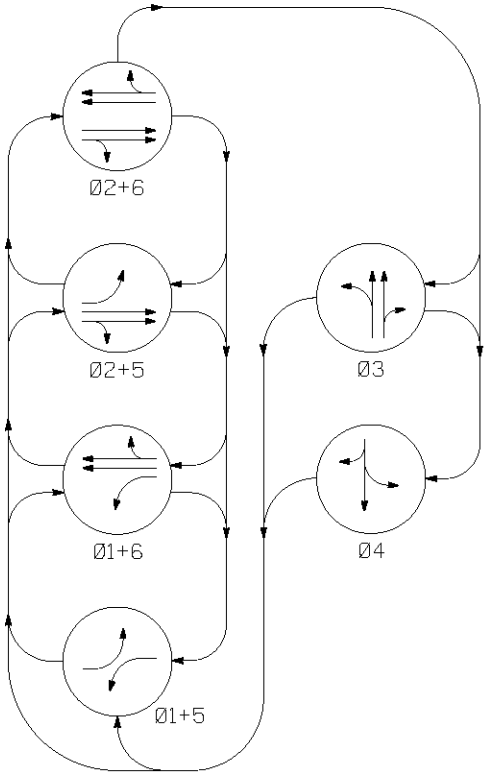


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3	Ø4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

6–Phase
Minimum Recall
Protected Main Street
Protected/Permissive Side Street

PHASING DIAGRAM

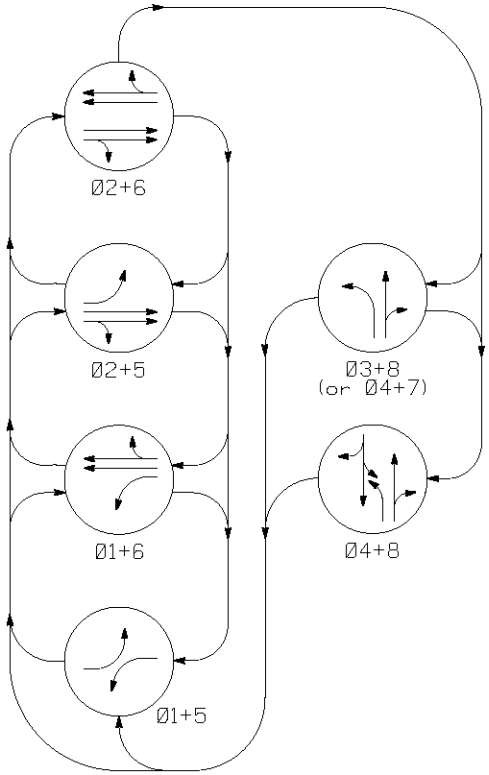


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø+	Ø4+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 6–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.5
SHEET 2 OF 3

6–Phase
Soft Recall
Protected Main Street
Split Side Street

PHASING DIAGRAM

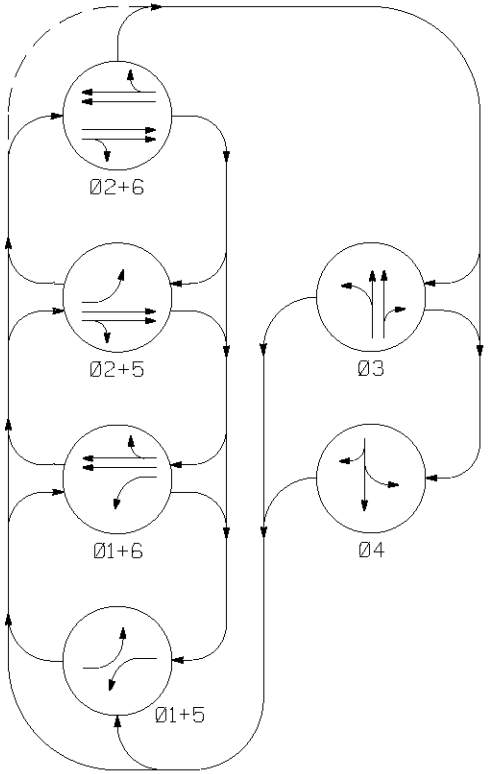


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3	Ø4	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

6–Phase
Soft Recall
Protected Main Street
Protected/Permissive Side Street

PHASING DIAGRAM

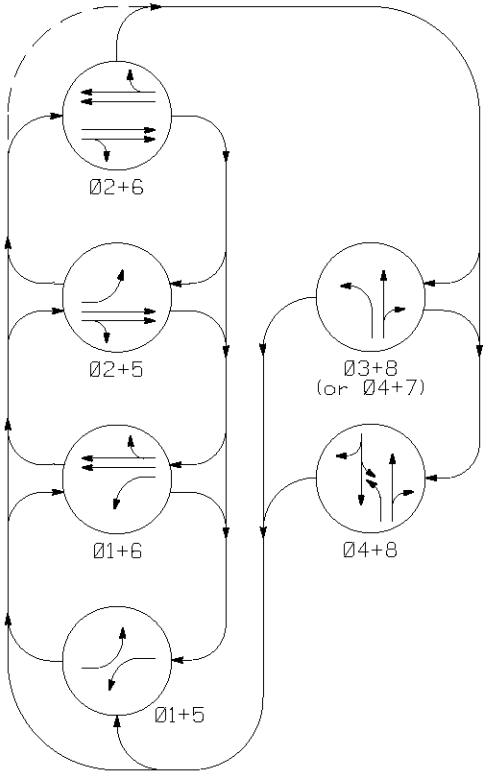


TABLE OF OPERATION

SIGNAL FACE	PHASE						
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø	Ø4+8	FLASH
					+		

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 6–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.5
SHEET 3 OF 3

7–Phase
Minimum Recall
Lead–Lag Main Street

PHASING DIAGRAM

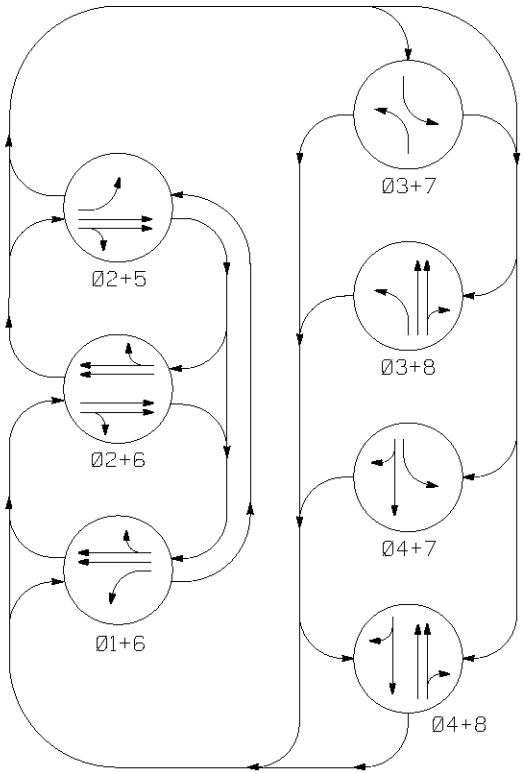


TABLE OF OPERATION								
SIGNAL FACE	PHASE							
	Ø1+6	Ø2+6	Ø2+5	Ø3+7	Ø3+8	Ø4+7	Ø4+8	FLASH

With older controllers, the phase numbering may need to be modified

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

7–Phase
Minimum Recall
Lead–Lag Side Street

PHASING DIAGRAM

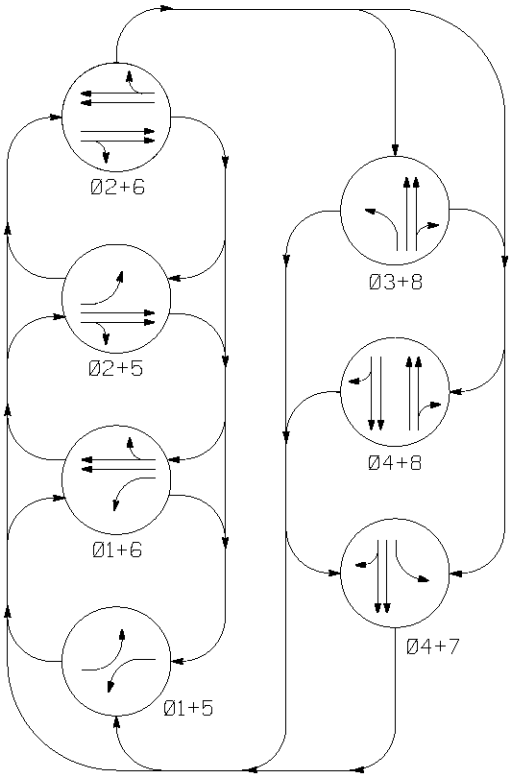


TABLE OF OPERATION								
SIGNAL FACE	PHASE							
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3+8	Ø4+8	Ø4+7	FLASH

With older controllers, the phase numbering may need to be modified

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 7–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.6
SHEET 1 OF 1

8–Phase
Minimum Recall
Protected/Permissive Main Street
Protected/Permissive Side Street

PHASING DIAGRAM

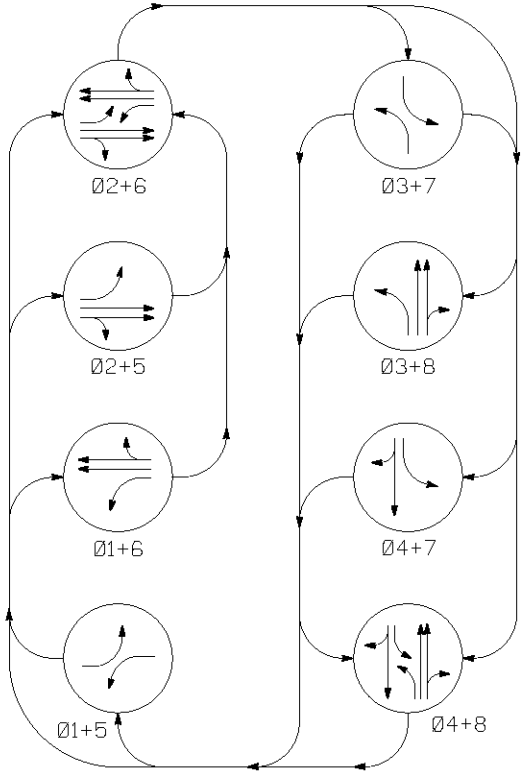


TABLE OF OPERATION

SIGNAL FACE	PHASE								
	01+5	01+6	02+5	02+6	03+7	03+8	04+7	04+8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

8–Phase
Minimum Recall
Protected/Permissive Main Street
Protected Side Street

PHASING DIAGRAM

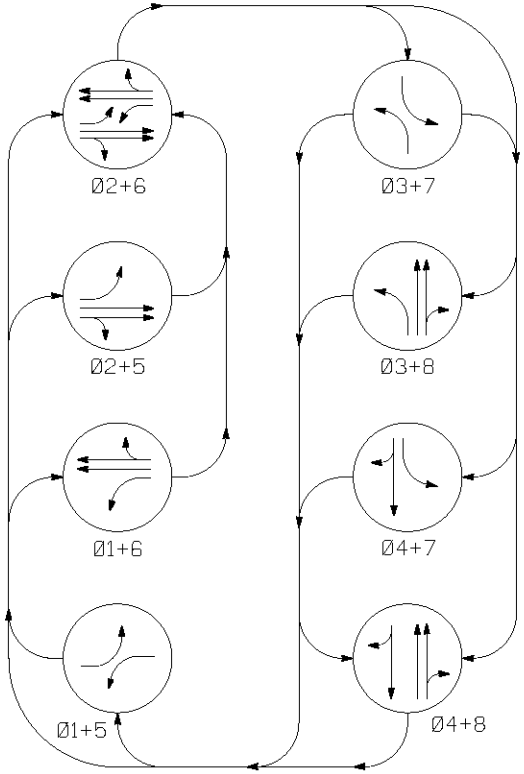


TABLE OF OPERATION

SIGNAL FACE	PHASE								
	01+5	01+6	02+5	02+6	03+7	03+8	04+7	04+8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 8–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.7
SHEET 1 OF 3

8–Phase
Minimum Recall
Protected Main Street
Protected/Permissive Side Street

PHASING DIAGRAM

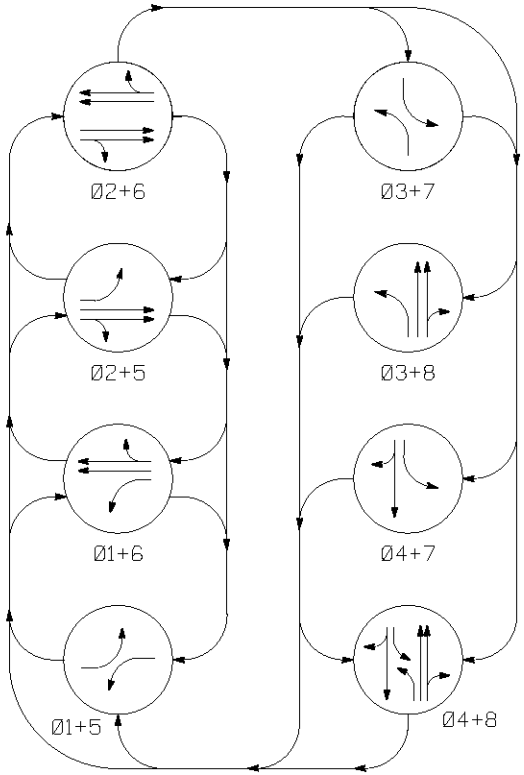


TABLE OF OPERATION									
SIGNAL FACE	PHASE								
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3+7	Ø3+8	Ø4+7	Ø4+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

8–Phase
Minimum Recall
Protected Main Street
Protected Side Street

PHASING DIAGRAM

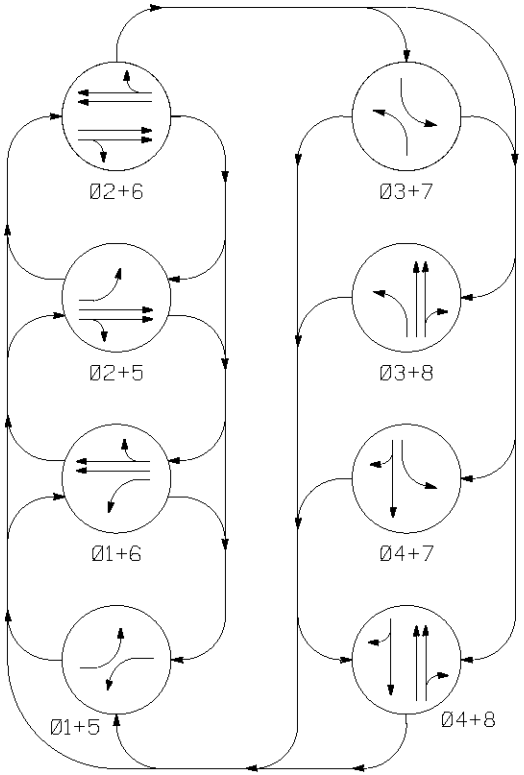


TABLE OF OPERATION									
SIGNAL FACE	PHASE								
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø3+7	Ø3+8	Ø4+7	Ø4+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 8–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.7
SHEET 2 OF 3

8–Phase
Minimum Recall
Protected and Protected/Permissive Main Street
Protected and Protected/Permissive Side Street

PHASING DIAGRAM

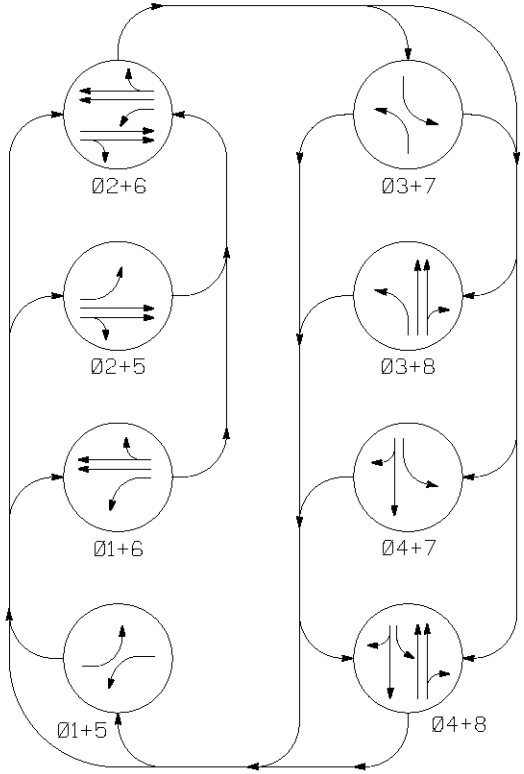


TABLE OF OPERATION									
SIGNAL FACE	PHASE								
	01+5	01+6	02+5	02+6	03+7	03+8	04+7	04+8	FLASH

Use appropriate omit note(s)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

8–Phase
Soft Recall
Protected Main Street
Protected Side Street

PHASING DIAGRAM

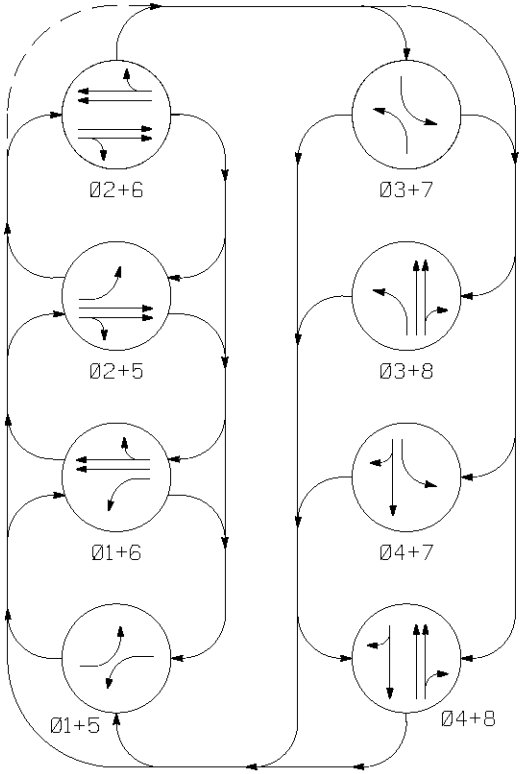


TABLE OF OPERATION									
SIGNAL FACE	PHASE								
	01+5	01+6	02+5	02+6	03+7	03+8	04+7	04+8	FLASH

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: 8–Phase Operation

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
2.1.7
SHEET 3 OF 3

The use of Dallas Phasing is prohibited
in the 2009 MUTCD.

This page has been removed from the Design Manual.

Red Revert Backup Protection

Yellow Trap and Dynamic Backup Control

A "yellow trap" occurs when a traffic signal cycles directly from concurrent through phases to a fully protected phase opposing a permitted phase (also known as "backing up"). This situation is avoided in a signal design whenever possible. Typically, phase omits or forcing the signal to cycle through the side street (even if there are no vehicle calls) to serve the protected phase have been used to protect against a "yellow trap."

Red Revert

Red revert is a feature in 2070 Oasis software that allows the signal to cycle from a permissive left turn phase on the major street to a protected phase and avoid a "yellow trap." Red revert simulates an all red "dummy" phase by clearing the through phase(s) to red for a brief interval before cycling to the adjacent protected left turn phase and then returning to green again; the opposing through phase will stay red for the duration of the protected turning phase.

The time that the adjacent through phase displays red before returning to green is a function of the red revert time. Typically the red revert time is programmed to (at least) 5 seconds to avoid the appearance of improper operation.

Conditions for Use

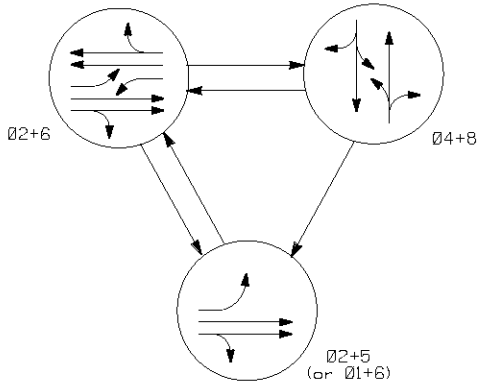
1. Used only with 2070 Oasis Software
2. Cannot be used with NEMA TS-1, TS-2, 170, or other 2070 software (such as SE-PAC, NAZTEC, or the Cary Signal System)
3. Used only on the major street (phases 2+6)
4. May be used when there is one or two protected/permissive phases (1 and/or 5) on the major street
5. Use in conjuncion with 5 section (doghouse) heads.
6. Use in place of phase omit and clearing through the side street.
7. Do NOT use with Railroad Preemption if the major street is the approach that crosses the tracks and is used in the Track Clearance Phase.

When Used On Plans:

-Typically set red revert time for phase 2 (and/or 6) to 5.0 seconds.
-Default red revert time for all other phases is 2.0 seconds.
-Use the following note on plans:
Enable backup protect for phase 2 (and/or 6) to allow the controller to clear from phase 2+6 to phase 2+5 (and/or 1+6) by progressing though an all red display.

3 Phase
Minimum Recall
Protected/Permissive Left One Direction
Permissive Only Left Other Direction

PHASING DIAGRAM

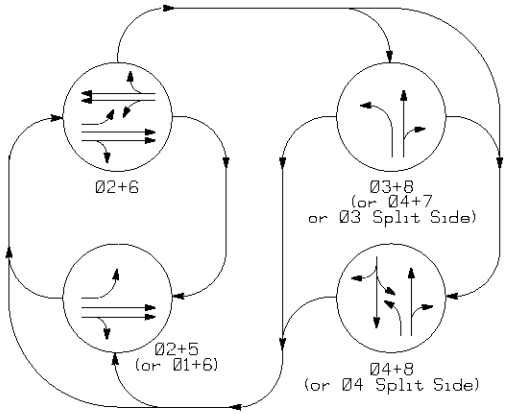


Use Red Revert for Phase 2 (6 if 1+6 is used)

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

4 Phase
Minimum Recall
Protected/Permissive Left One Direction of Major Street
Permissvie Left on Other Direction of Major Street
Protected/Permissive Side Street
OR Split Side Street

PHASING DIAGRAM



Use Red Revert for Phase 2 (6 if 1+6 is used)
Use appropriate omit note(s) for side street

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: Red Revert Operation

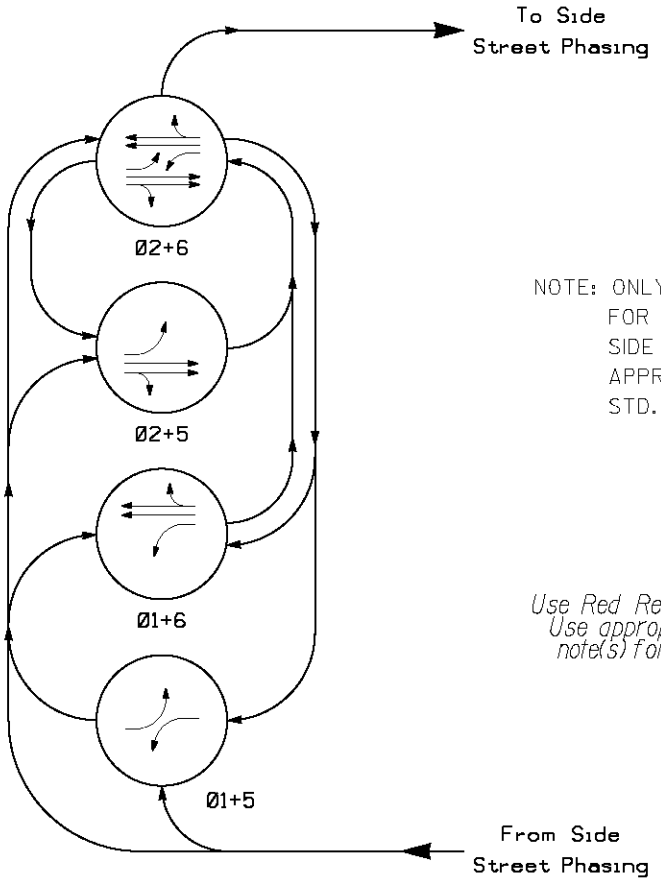
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
2.3
SHEET 2 OF 3

5–8 Phase
Minimum Recall
Protected/Permissive Main Street w/Red Revert

PHASING DIAGRAM



NOTE: ONLY PHASING DIAGRAM FOR MAJOR IS SHOWN. FOR SIDE STREET PHASING, SEE APPROPRIATE PHASING IN STD. 2.1.

Use Red Revert for Phases 2 and 6
Use appropriate omit or lead/lag note(s) for side street as needed

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: Red Revert Operation

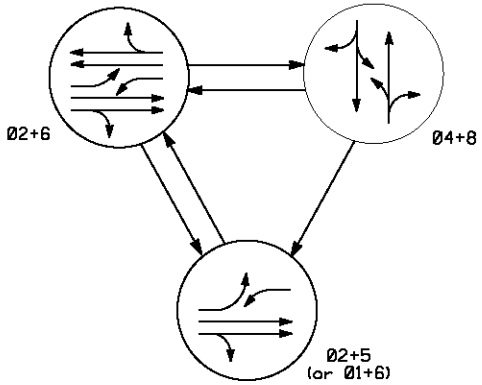
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
2.3
SHEET 3 OF 3

3 Phase
Minimum Recall
Protected/Permissive Left One Direction
Permissive Only Left Other Direction

PHASING DIAGRAM



Phase 5 may be lagged (Phase 1 if 1+6 is used)

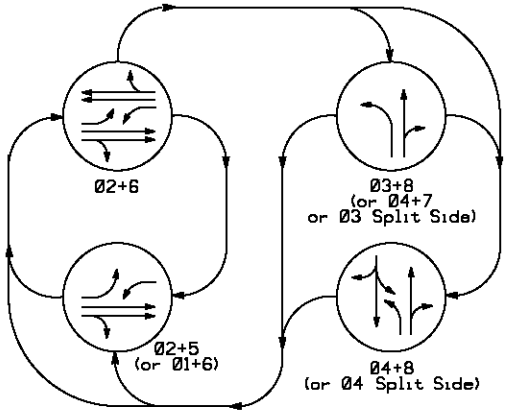
THIS ASSUMES A 4 SECTION FYA IS USED FOR THE LEFT TURN ON ONE APPROACH (PHASE 5) AND A 3 SECTION FYA IS USED FOR THE LEFT TURN ON THE OTHER APPROACH OF MAIN STREET

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

TABLE OF OPERATION				
SIGNAL FACE	PHASE			
	Ø2+5	Ø2+6	Ø4+8	FLASH
51	←	FY	~~R~~	~~Y~~
61	~~FY~~	FY	~~R~~	~~Y~~

4 Phase
Minimum Recall
Protected/Permissive Left One Direction of Main Street
Permissvie Left on Other Direction of Main Street
Protected/Permissive Side Street
OR Split Side Street

PHASING DIAGRAM



Phase 5 may be lagged (Phase 1 if 1+6 is used)

THIS ASSUMES A 4 SECTION FYA IS USED FOR THE LEFT TURN ON ONE APPROACH (PHASE 5) AND A 3 SECTION FYA IS USED FOR THE LEFT TURN ON THE OTHER APPROACH OF MAIN STREET

NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

TABLE OF OPERATION					
SIGNAL FACE	PHASE				
	Ø2+5	Ø2+6	Ø3+8	Ø4+8	FLASH
51	←	FY	~~R~~	~~R~~	~~Y~~
61	~~FY~~	FY	~~R~~	~~R~~	~~Y~~

Phasing Typicals: Flashing Yellow Arrow

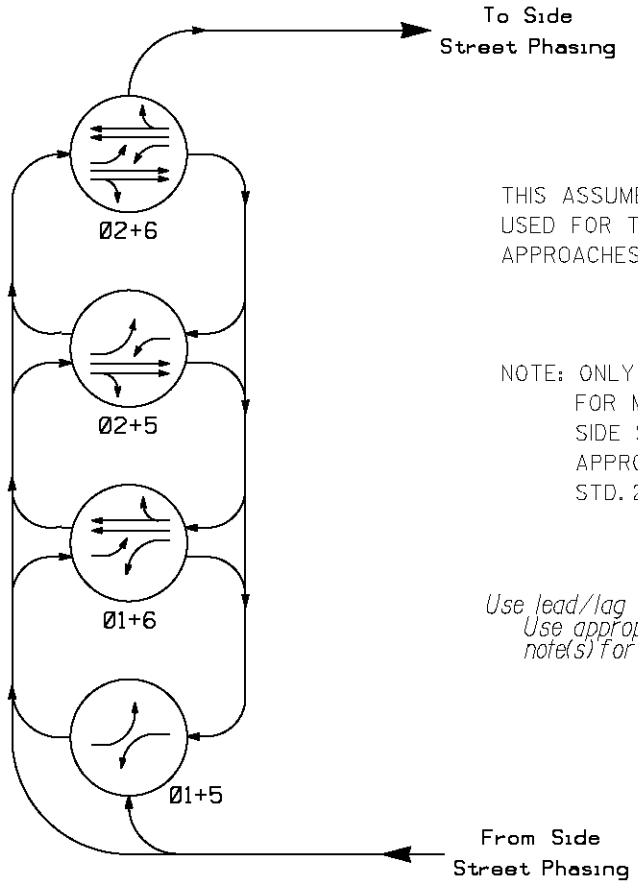
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
2.4
SHEET 1 OF 2

5–8 Phase
Minimum Recall
Protected/Permissive Main Street

PHASING DIAGRAM



THIS ASSUMES A 4 SECTION FYA IS USED FOR THE LEFT TURN ON BOTH APPROACHES OF THE MAIN STREET

NOTE: ONLY PHASING DIAGRAM FOR MAJOR IS SHOWN. FOR SIDE STREET PHASING, SEE APPROPRIATE PHASING IN STD. 2.1.

Use lead/lag notes for Phases 1 and 5
Use appropriate omit or lead/lag note(s) for side street as needed

TABLE OF OPERATION

SIGNAL FACE	PHASE					
	Ø1+5	Ø1+6	Ø2+5	Ø2+6	Ø4+8	FLASH
11	←	←	FY	FY	~~R~~	~~Y~~
51	←	FY	←	FY	~~R~~	~~Y~~

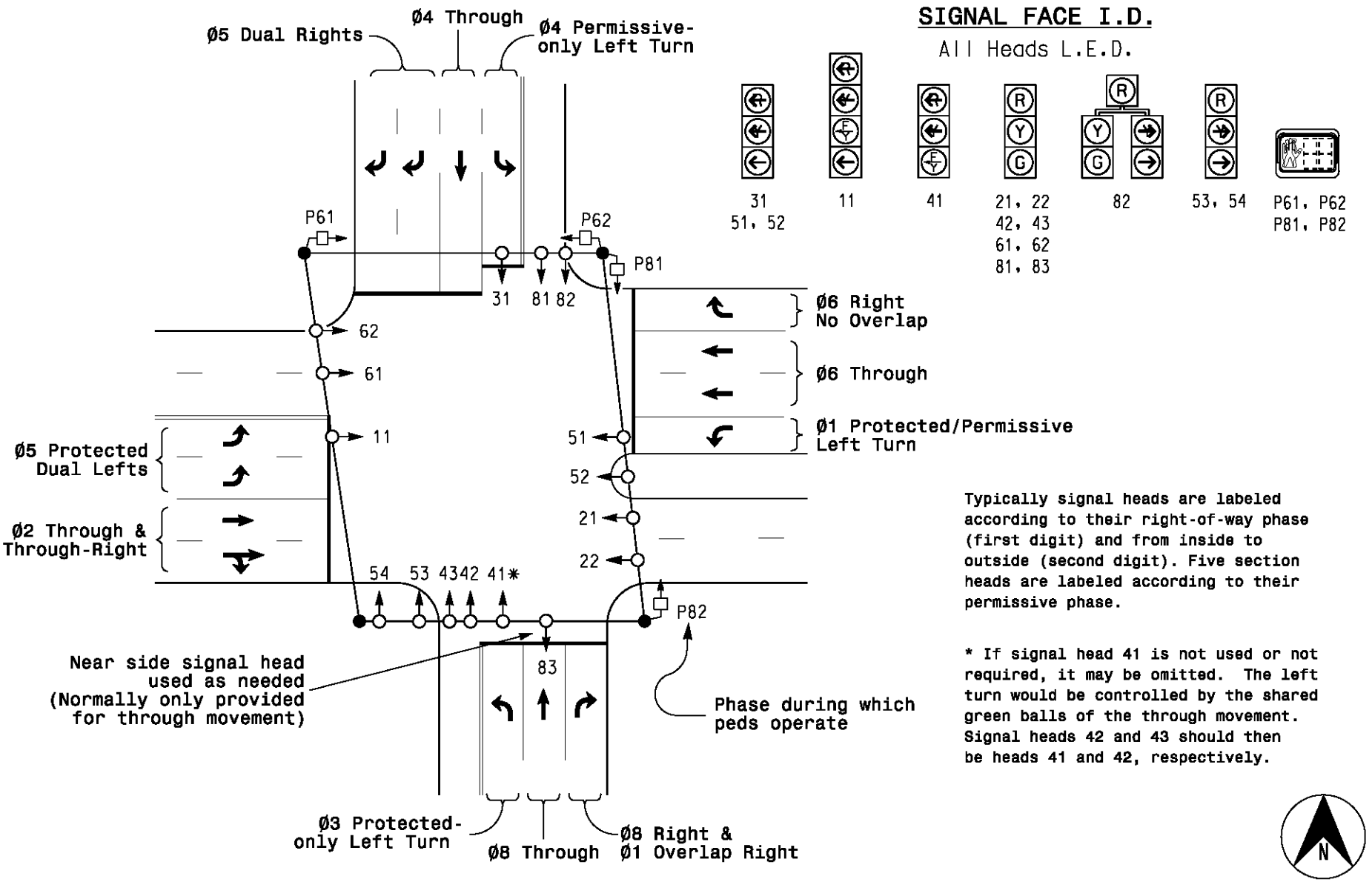
NOTE: TRAFFIC MOVEMENTS ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY

Phasing Typicals: Flashing Yellow Arrow

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO. 2.4



Typically signal heads are labeled according to their right-of-way phase (first digit) and from inside to outside (second digit). Five section heads are labeled according to their permissive phase.

* If signal head 41 is not used or not required, it may be omitted. The left turn would be controlled by the shared green balls of the through movement. Signal heads 42 and 43 should then be heads 41 and 42, respectively.

Typical Numbering of Signal Heads

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.0
SHEET 1 OF 6

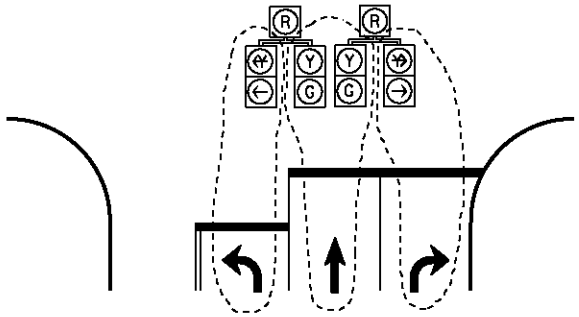
Signal Head Types

CONFIGURATION	3-Section	3-Section	3-Section	4-Section Vertical	4-Section	5-Section
USAGE	All situations where other signal heads are not recommended	Permitted Turn	Protected Turn	Split Side Street RR Clearance Phasing EV Preempt Phasing	Protected/ Permissive Turn	Protected/ Permissive Turn
PLACEMENT	Lane Line or Lane ℄	Lane ℄	Lane ℄	Lane Line or Lane ℄	Lane ℄	Lane Line

Number of Signal Faces

A minimum of two signal faces is required for the through movement. This total includes the through signal face belonging to the 5-section "shared" head that may control adjacent left or right turn lanes.

Clarification: A 5-section head is an assembly of 2 signal faces which share a common red ball indication. See example below.



This approach display has 2 signal heads each of which is comprised of 2 signal faces for a total of 4 signal faces. Two of the faces belong to the through move, and one each belongs to the left and right turns. Because the center two faces control the through (major) move, it is in conformance with the above requirement.

Per Section 4D.11 of the 2009 MUTCD, if the 85th percentile, posted, statutory, or design speed is 45 MPH or more, one signal head should be used per each through lane on the approach.

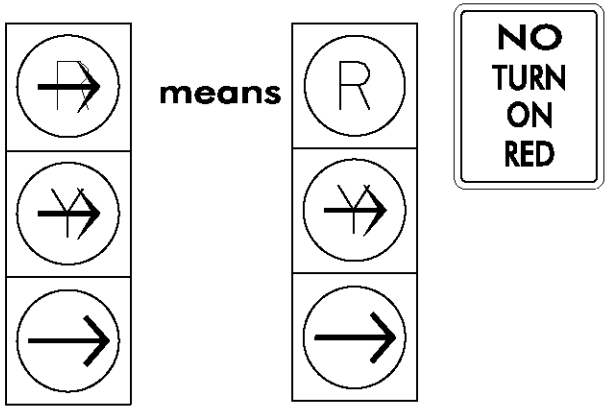
Use of CIRCULAR RED vs. RED ARROW

(Section 4D.04 of the 2009 MUTCD)

As stated in the MUTCD, and in accordance with NC General Statute 20-158, vehicles facing a steady CIRCULAR RED signal shall stop at the marked stop line and shall remain stopped until a signal indication to proceed is displayed unless the vehicle is turning right. A vehicle is permitted to make a right on CIRCULAR RED, subject to applicable traffic laws and yielding the right of way to other roadway users, unless a traffic control device, such as a sign, is in place prohibiting a turn on red.

As stated in the MUTCD, vehicles facing a steady RED ARROW signal shall stop at the marked stop line and shall remain stopped until a signal indication to proceed is displayed. A vehicle shall NOT make a right turn on a RED ARROW.

In North Carolina, vehicles are prohibited from making a left turn on red from a one way street onto another one way street at all times.



It shall be the NCDOT practice to display a CIRCULAR RED whenever possible and allow right turns on red. This may include the use of a CIRCULAR RED indication in a head otherwise containing GREEN and YELLOW ARROWs.

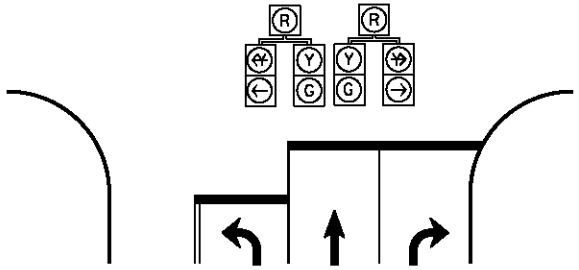
If it is intended to prohibit right turns on red at an intersection, one of the following shall be displayed:

- If the signal head contains CIRCULAR YELLOW and GREENs, a CIRCULAR RED shall be used in conjunction with a "NO TURN ON RED" sign (R10-16).
- If the signal head only has YELLOW and GREEN ARROWs, a RED ARROW shall be used. No sign is needed as a RED ARROW means no turn on red.

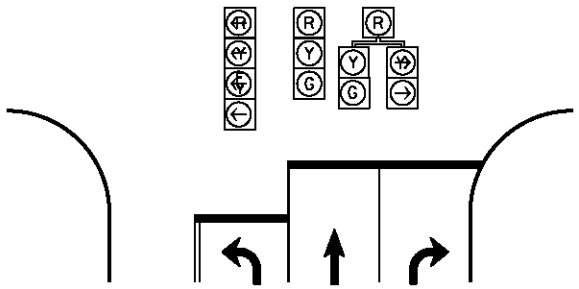
Use of 4 Section (Protected/Permissive) Flashing Yellow Arrow Signal Faces

Traditionally, a 5 section "doghouse" head has been used for protected/permissive turning movements. This head has a combination of CIRCULAR and ARROW displays, and is often used as "shared" head between the turning movement and the through movement, although the head could be used exclusively for the turning movement.

The new preferred display for protected/permissive left turns is the Flashing Yellow Arrow (FYA). This head is intended to be an exclusive head for the turn lane and displays only ARROW indications. A FYA is displayed for the permissive movement, instead of the traditional CIRCULAR GREEN. Vehicles may make the turn indicated by the FYA after yielding to pedestrians and conflicting movements. A solid GREEN ARROW is used to indicated a protected movement. The FYA head should be centered over the turn lane(s). Note that the FYA head is an exclusive for the left turn, and 2 signal heads containing CIRCULAR RED, YELLOW, and GREEN displays are still required for the through movement.



This approach display has 2 signal heads each of which is comprised of 2 signal faces for a total of 4 signal faces. Two of the faces belong to the through move, and one each belongs to the left and right turns. Because the center two faces control the through (major) move, it is in conformance with the requirement for 2 signal faces for the through movment. The 5 section head may still be used in limited situations.



FYAs for left turns should be used:

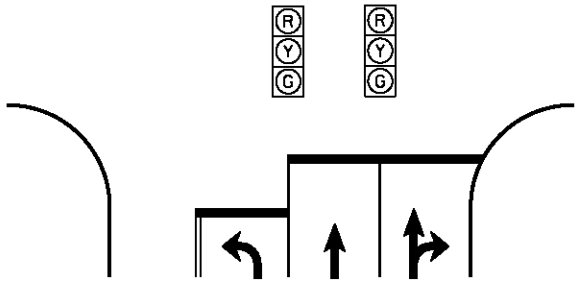
- When the turn lanes are offset (separated from the through lanes)
- When the opposing travel lanes use (3-section or 4-section) FYAs or fully protected (single or dual) lefts to avoid "yellow trap"
- Along corridors, where other FYA displays are used for left turns
- At Railroad preempt locations, which eliminate the need for blankout signs

When FYAs are used for left turns, the yellow and red clearance times should be the same for concurrent through phases (2+6 and/or 4+8).

NOTE: FYAs for right turns may be used on a limited basis as determined by Engineering judgment. When used, the FYA head should replace the 5 section shared "doghouse" head for the right turn. As a result, it may be necessary to add an addtional 3 section CIRCULAR head for the through movement.

Use of 3–Section (Permissive) Left Turn Flashing Yellow Arrow Signal Faces

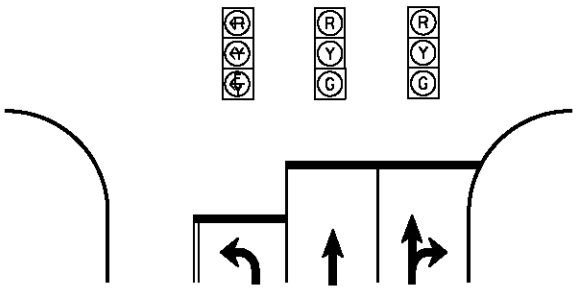
Traditionally, a CIRCULAR GREEN display has been used to indicate a permissive movement. Vehicles may turn right or left as allowed on a CIRCULAR GREEN after yielding to pedestrians and conflicting movements.



A CIRCULAR GREEN may be used as a shared display with the through movement. In the example shown, the signal heads are mounted over the lane lines (extended) and are classified as shared heads, because the head display is "shared" by vehicles in adjacent lanes (left and through or the through and through-right). The two "shared" heads meet the requirements for through signal displays. When an FYA is not used for the left turn display, the signal heads should be mounted over the lane line extended instead of as shown in Std. 3.2. IN NO CASE shall a CIRCULAR GREEN display be located directly over or in front of a left turn lane.

Optional Permissive Left Turn Signal Display

An optional display for permissive turns is the Flashing Yellow Arrow (FYA). Vehicles observing an FYA may make the turn indicated by the flashing yellow arrow after yielding to pedestrians and conflicting movements, the same as a CIRCULAR GREEN. The FYA head should be centered over the turn lane(s). Note that the FYA is an exclusive head for the left turn, and 2 signal heads containing CIRCULAR RED, YELLOW, and GREEN displays are still required for the through movement.



FYAs for left turns should be used:

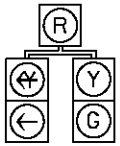
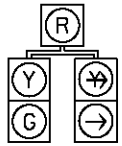
- When the turn lanes are offset (separated from the through lanes)
- When the opposing travel lanes use (3-section or 4-section) FYAs or fully protected (single or dual) lefts to avoid "yellow trap"
- Along corridors, where other FYA displays are used for left turns
- At Railroad preempt locations, which eliminate the need for blankout signs

When FYAs are used for left turns, the yellow and red clearance times should be the same for concurrent through phases (2+6 and/or 4+8).

FYAs for right turns may be used on a limited basis as determined by Engineering judgment.

Programming for Flashing Operation of Signal Heads

Signals typically may flash during certain types of malfunctions or equipment failures. For statewide consistency, traffic signal heads should be set to flash the displays shown in the event of flashing operation:

SIGNAL HEAD										
MAJOR STREET										
MINOR STREET										

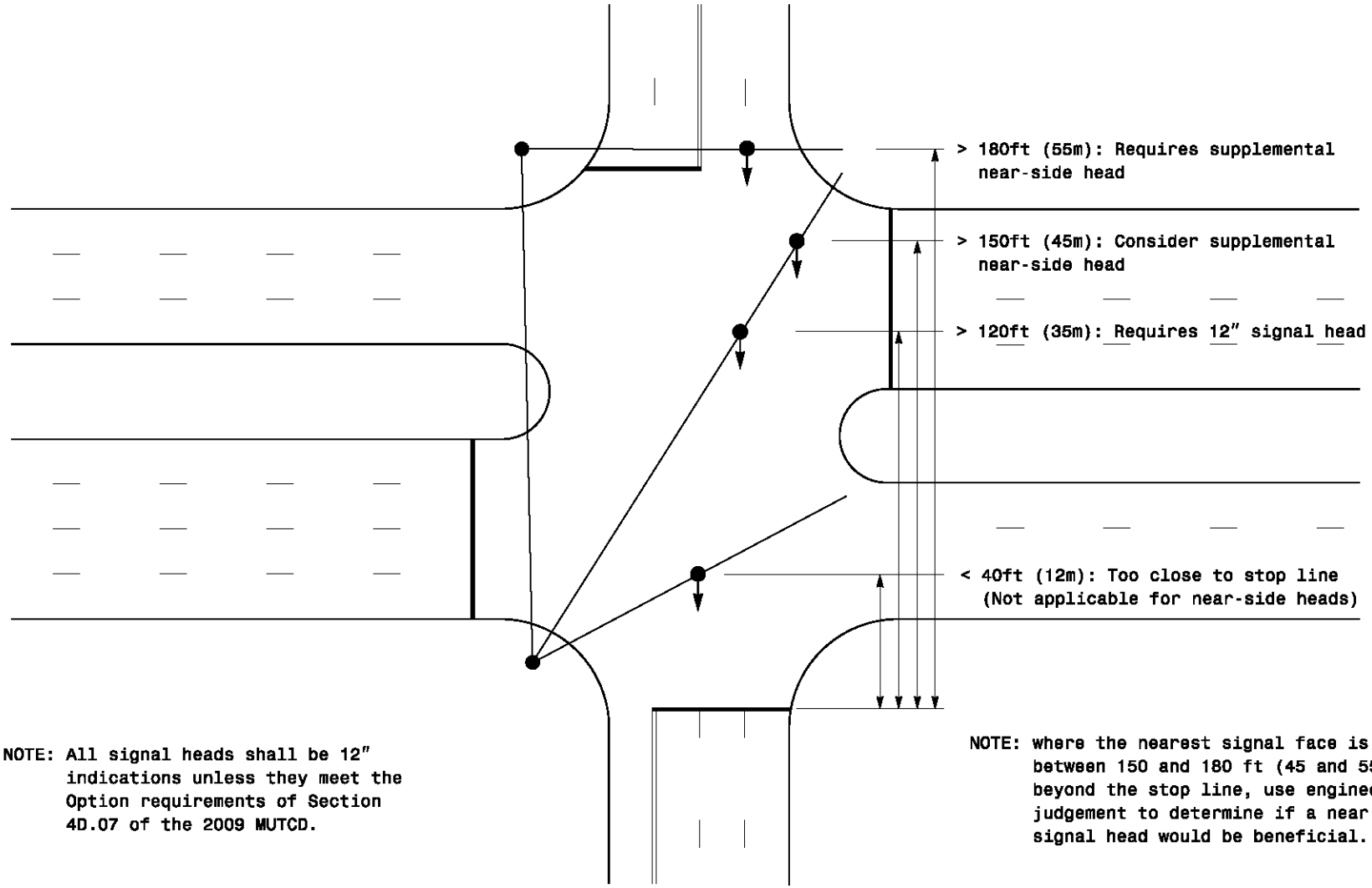
Flashing display does not change if a RED ARROW is used in place of a CIRCULAR RED for right turn displays.

At some intersections, such as those utilizing Railroad Preemption, engineering judgement may be used to modify or alter the flashing operation. This modification may include flashing the minor street through movements yellow and the main street red or using a red flash on all approaches (equivalent of an all way stop).

Program all signal heads on the same approach to flash concurrently.

Allowable Signal Head Distance from Stopbar

(Section 4D.14 of the 2009 MUTCD)



NOTE: All signal heads shall be 12" indications unless they meet the Option requirements of Section 4D.07 of the 2009 MUTCD.

NOTE: where the nearest signal face is located between 150 and 180 ft (45 and 55 m) beyond the stop line, use engineering judgement to determine if a near side signal head would be beneficial.

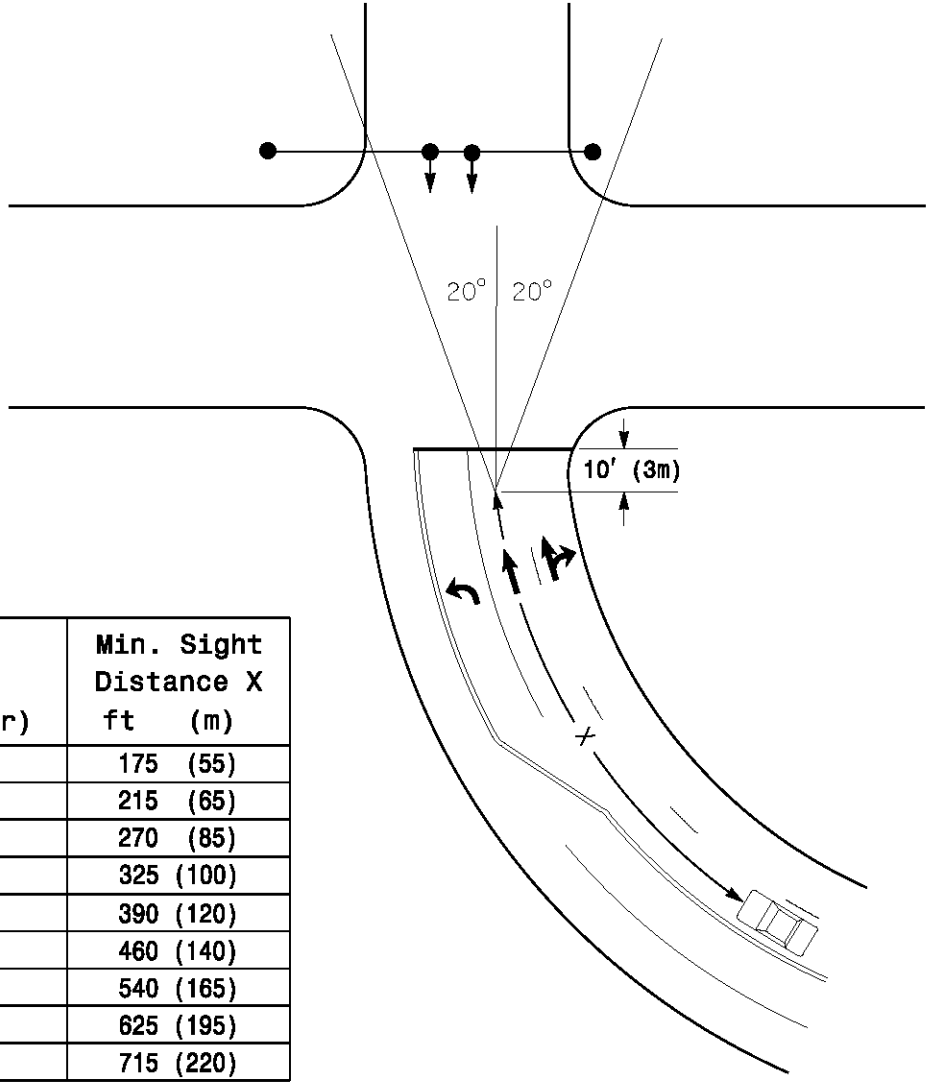
MUTCD Requirements for Signal Heads

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.1
SHEET 1 OF 2

Signal Face Visibility Parameters



Speed mph (km/hr)	Min. Sight Distance X ft (m)
20 (32)	175 (55)
25 (40)	215 (65)
30 (48)	270 (85)
35 (56)	325 (100)
40 (64)	390 (120)
45 (72)	460 (140)
50 (80)	540 (165)
55 (88)	625 (195)
60 (96)	715 (220)

To conform to section 4D.13 of the 2009 MUTCD, locate one, and preferably both, signal heads within a cone of vision extending 20 degrees to the left and right of the centerline of all the approach lanes in the direction of travel.

To conform to section 4D.12 of the 2009 MUTCD, the driver should be able to continuously view the signal face from the minimum sight distance for the 85th percentile speed.

Where this visibility requirement cannot be met, erect a suitable sign (such as a Signal Ahead Sign) to warn approaching traffic (Section 4D.12 of the 2009 MUTCD) or install a supplemental near side head.

MUTCD Requirements for Signal Heads

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
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12-10

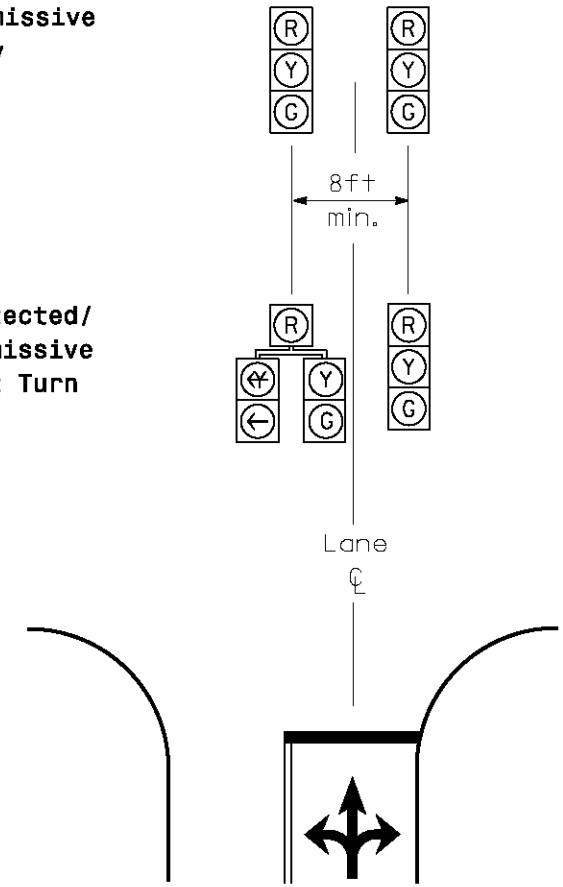
STD. NO.
3.1
SHEET 2 OF 2

CASE 1

Standard Main or Side Street
Signal Head Configuration

1A - Permissive Only

1B - Protected/ Permissive Left Turn



CASE 2

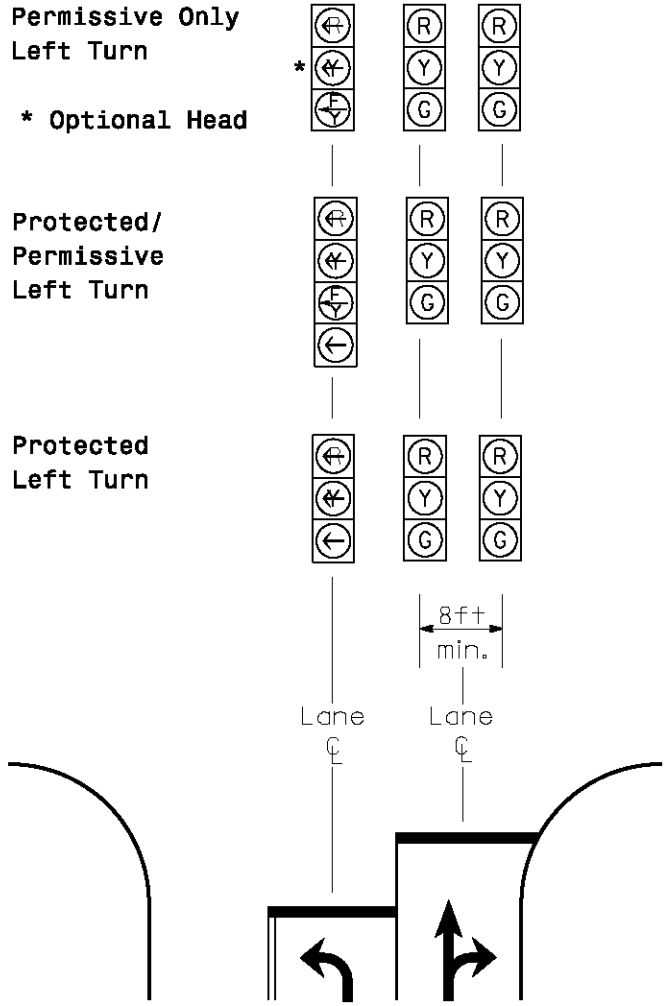
Standard Main or Side Street
Signal Head Configuration

2A - Permissive Only Left Turn

* Optional Head

2B - Protected/ Permissive Left Turn

2C - Protected Left Turn



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

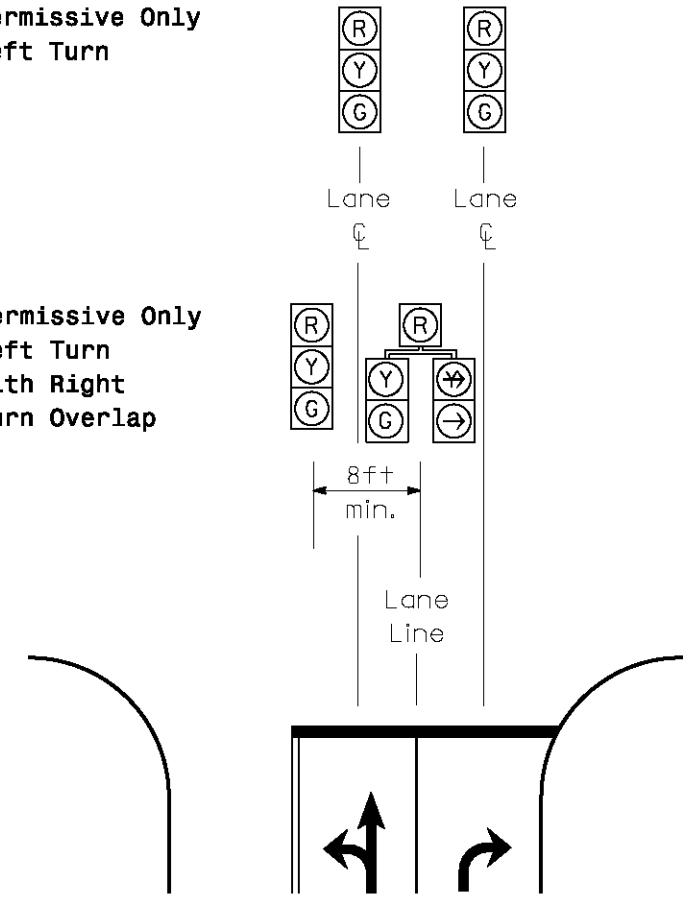
STD. NO.
3.2
SHEET 1 OF 24

CASE 3 (1 OF 2)

Standard Main or Side Street Signal Head Configuration

3A - Permissive Only Left Turn

3AR - Permissive Only Left Turn with Right Turn Overlap

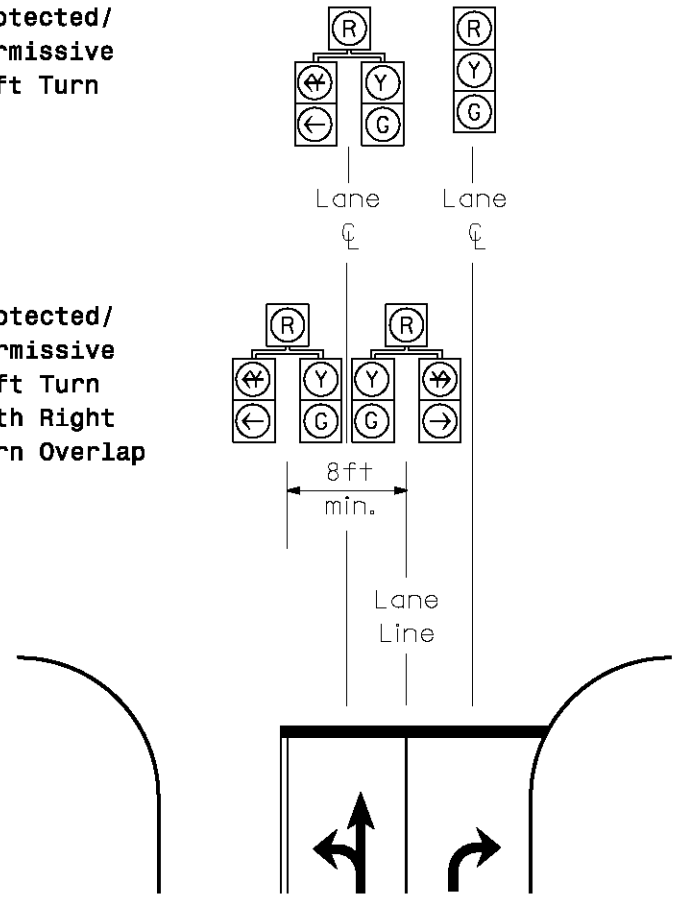


CASE 3 (2 OF 2)

Standard Main or Side Street Signal Head Configuration

3B - Protected/ Permissive Left Turn

3BR - Protected/ Permissive Left Turn with Right Turn Overlap



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

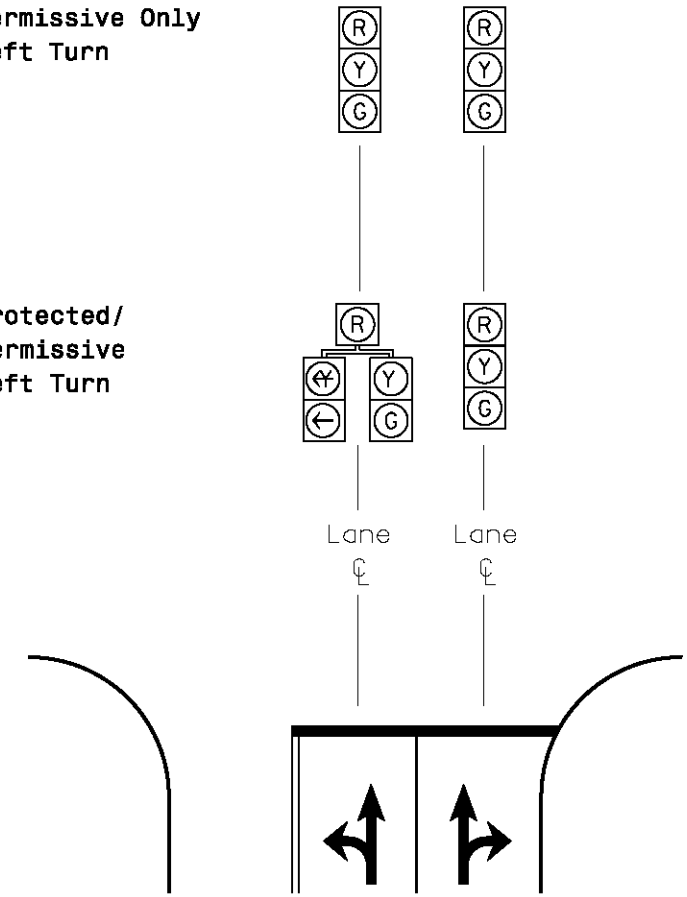
STD. NO.
3.2
SHEET 2 OF 24

CASE 4

Standard Main or Side Street Signal Head Configuration

4A - Permissive Only Left Turn

4B - Protected/ Permissive Left Turn



CASE 5 (1 OF 3)

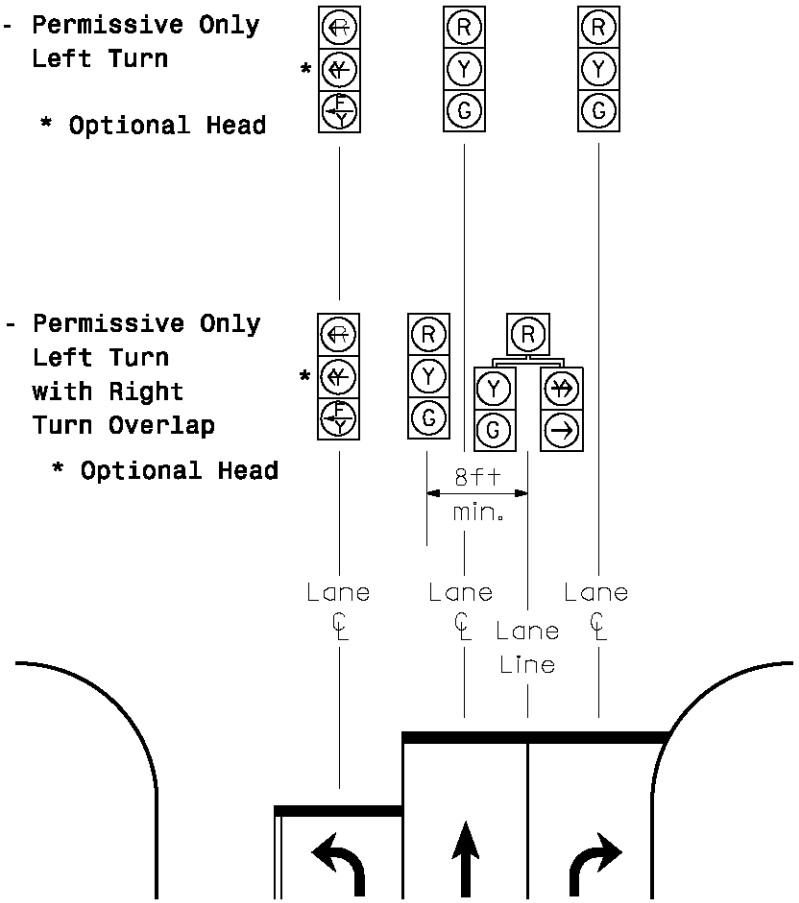
Standard Main or Side Street Signal Head Configuration

5A - Permissive Only Left Turn

* Optional Head

5AR - Permissive Only Left Turn with Right Turn Overlap

* Optional Head



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

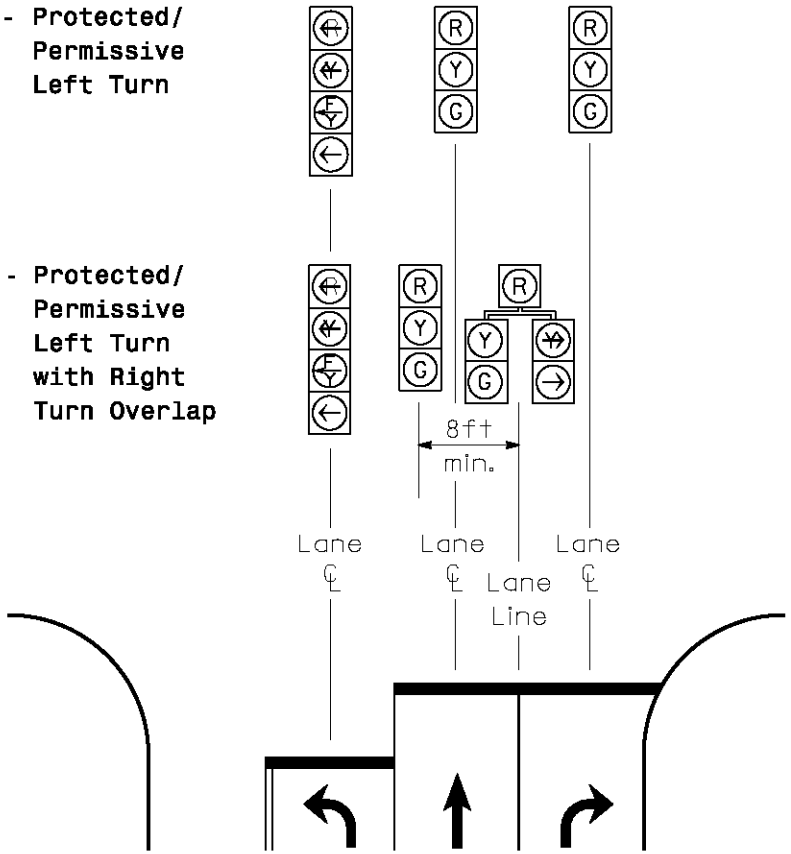
STD. NO.
3.2
SHEET 3 OF 24

CASE 5 (2 OF 3)

Standard Main or Side Street
Signal Head Configuration

5B - Protected/
Permissive
Left Turn

5BR - Protected/
Permissive
Left Turn
with Right
Turn Overlap

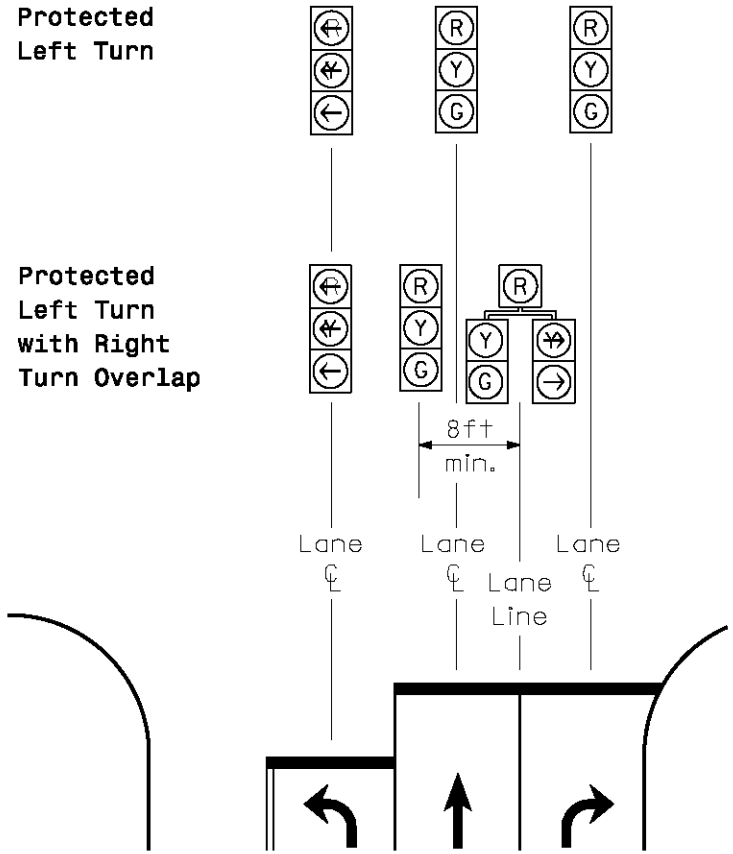


CASE 5 (3 OF 3)

Standard Main or Side Street
Signal Head Configuration

5C - Protected
Left Turn

5CR - Protected
Left Turn
with Right
Turn Overlap



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 4 OF 24

CASE 6

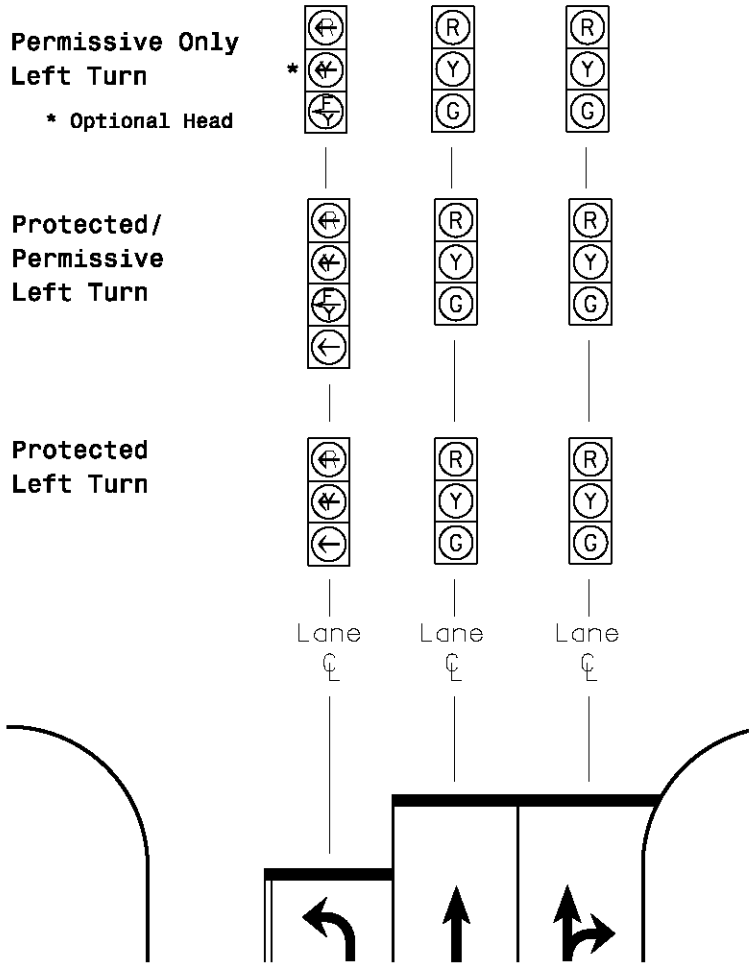
Standard Main or Side Street Signal Head Configuration

6A - Permissive Only Left Turn

* Optional Head

6B - Protected/ Permissive Left Turn

6C - Protected Left Turn



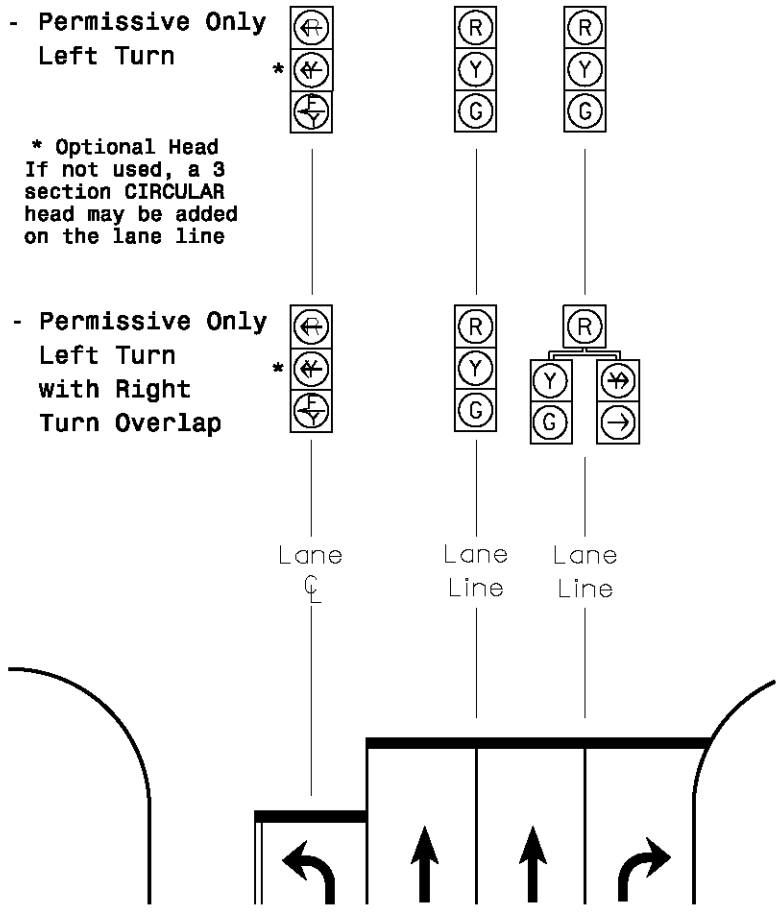
CASE 7 (1 OF 3)

Standard Main or Side Street Signal Head Configuration

7A - Permissive Only Left Turn

* Optional Head
If not used, a 3 section CIRCULAR head may be added on the lane line

7AR - Permissive Only Left Turn with Right Turn Overlap



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

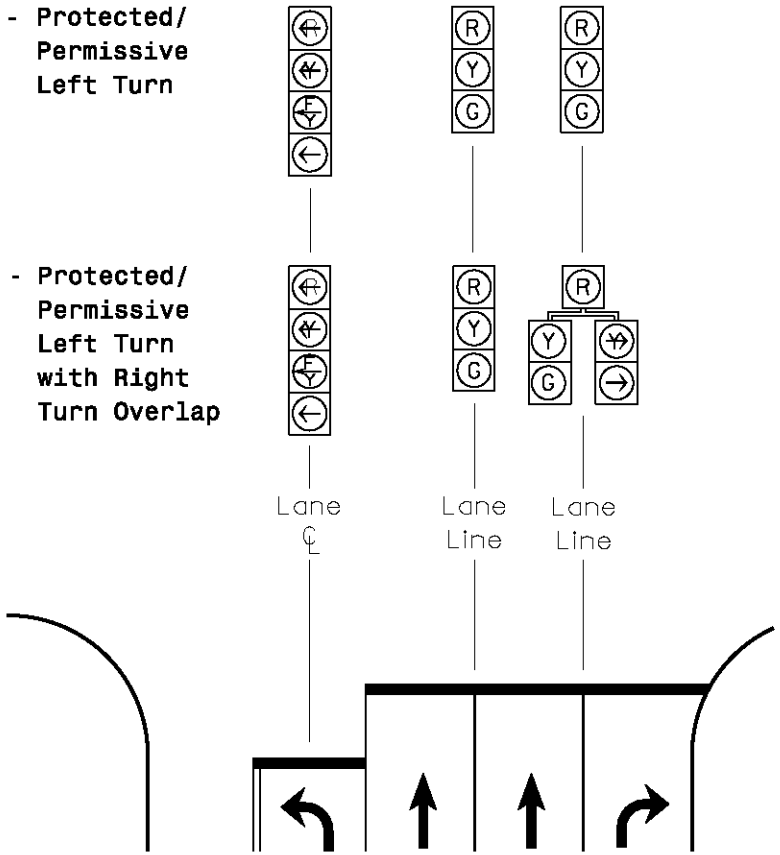
STD. NO.
3.2
SHEET 5 OF 24

CASE 7 (2 of 3)

Standard Main or Side Street
Signal Head Configuration

7B - Protected/
Permissive
Left Turn

7BR - Protected/
Permissive
Left Turn
with Right
Turn Overlap

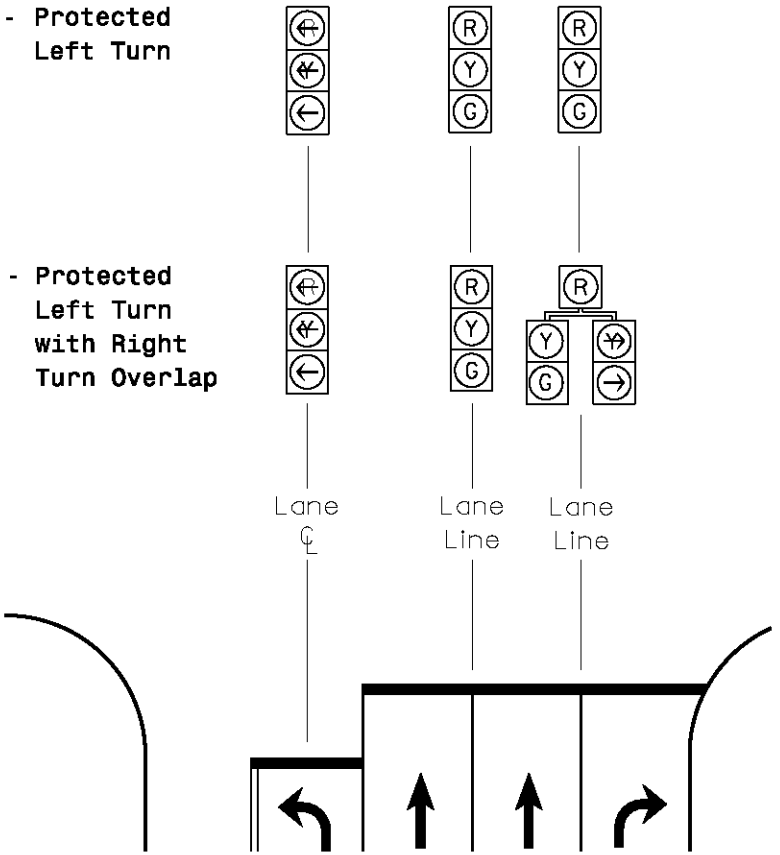


CASE 7 (3 OF 3)

Standard Main or Side Street
Signal Head Configuration

7C - Protected
Left Turn

7CR - Protected
Left Turn
with Right
Turn Overlap



Signal Head Approach Displays and Alignment

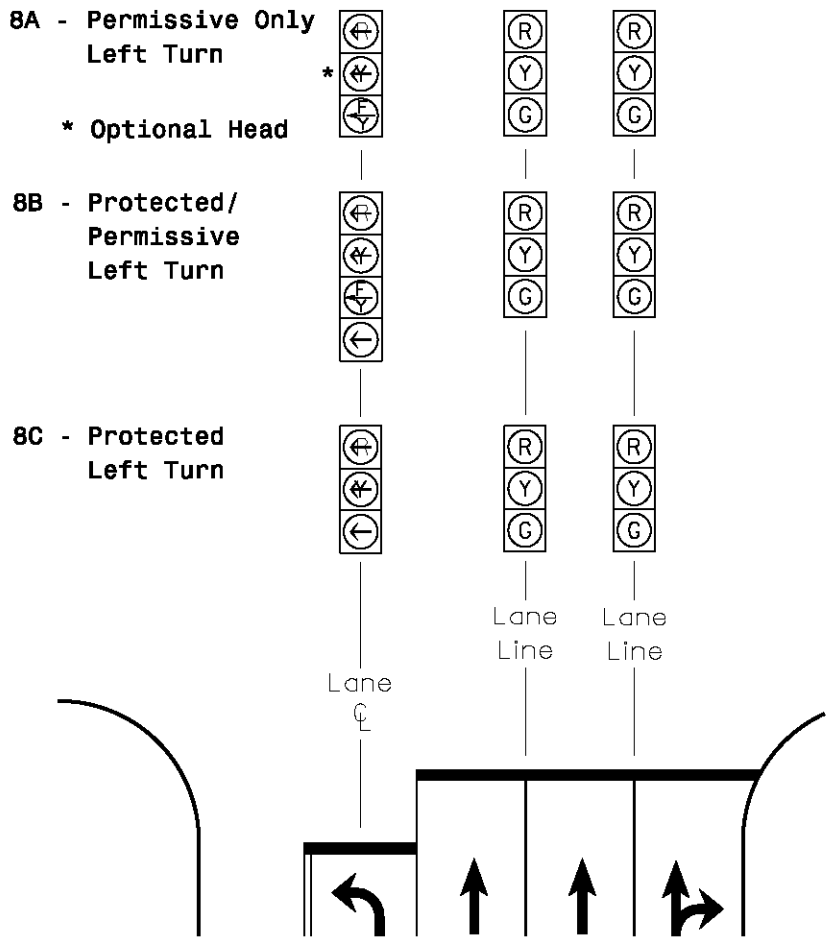
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 6 OF 24

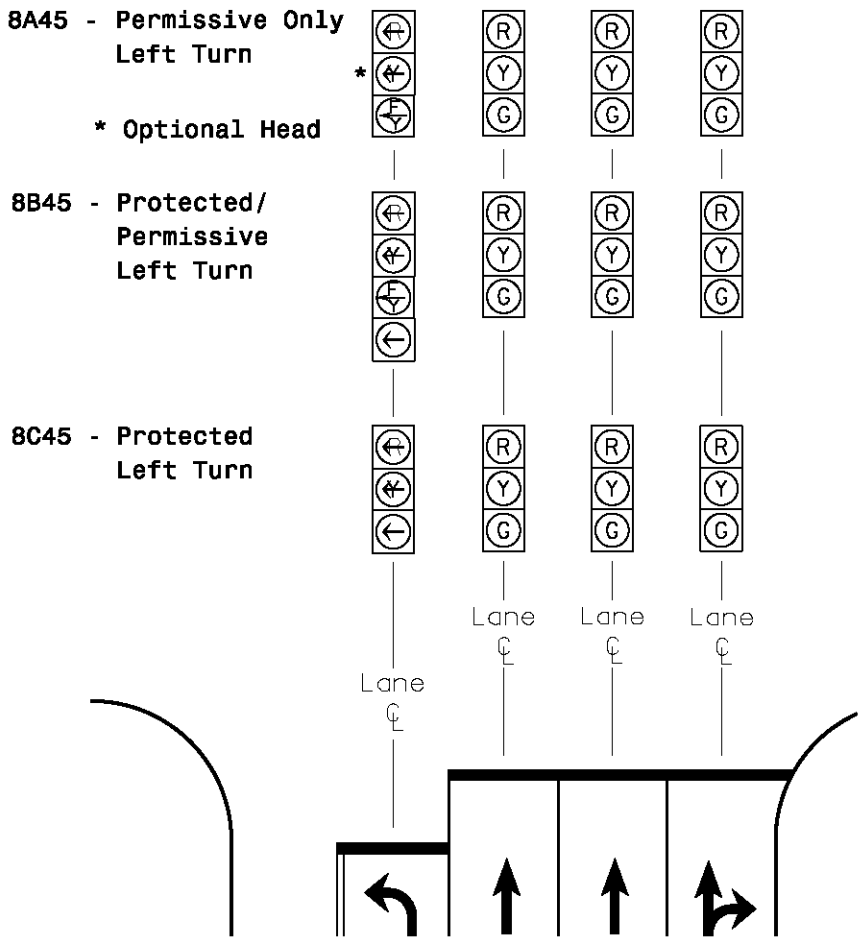
CASE 8 (1 OF 2)
(Speeds less than 45 MPH)

Standard Main or Side Street Signal Head Configuration



CASE 8 (2 OF 2)
(Speeds 45 MPH or above)

Standard Main or Side Street Signal Head Configuration



Signal Head Approach Displays and Alignment

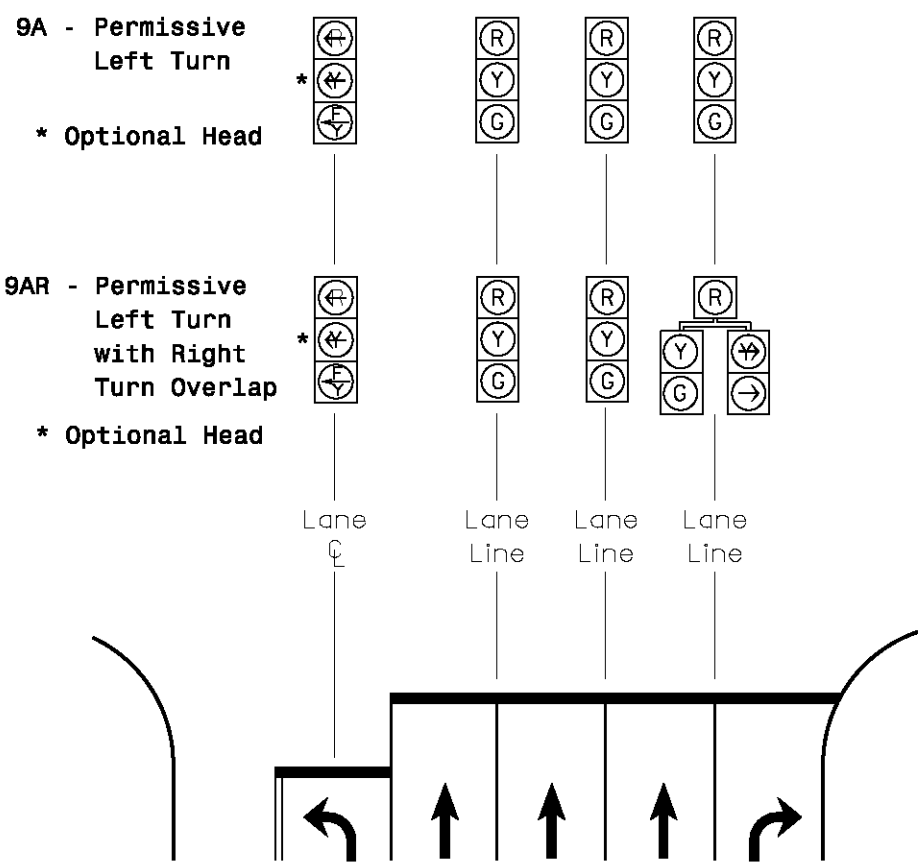
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 7 OF 24

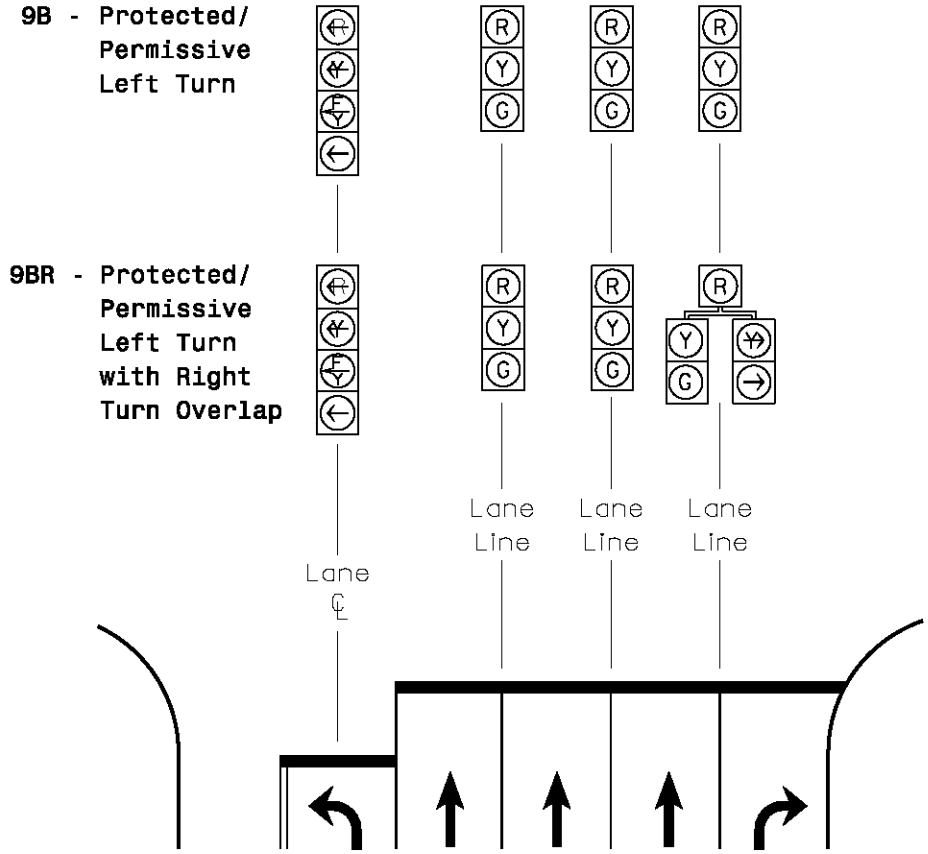
CASE 9 (1 OF 3)

Standard Main or Side Street
Signal Head Configuration



CASE 9 (2 OF 3)

Standard Main or Side Street
Signal Head Configuration



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

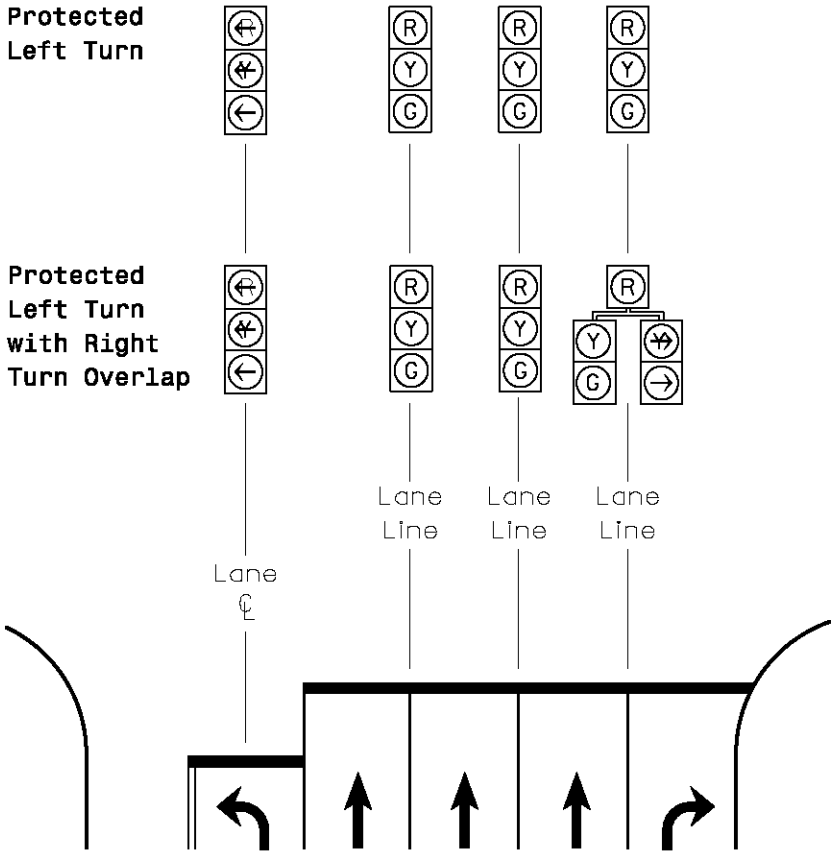
STD. NO.
3.2
SHEET 8 OF 24

CASE 9 (3 OF 3)

Standard Main or Side Street Signal Head Configuration

9C - Protected Left Turn

9CR - Protected Left Turn with Right Turn Overlap



CASE 10 (1 OF 2)

(Speeds less than 45 MPH)

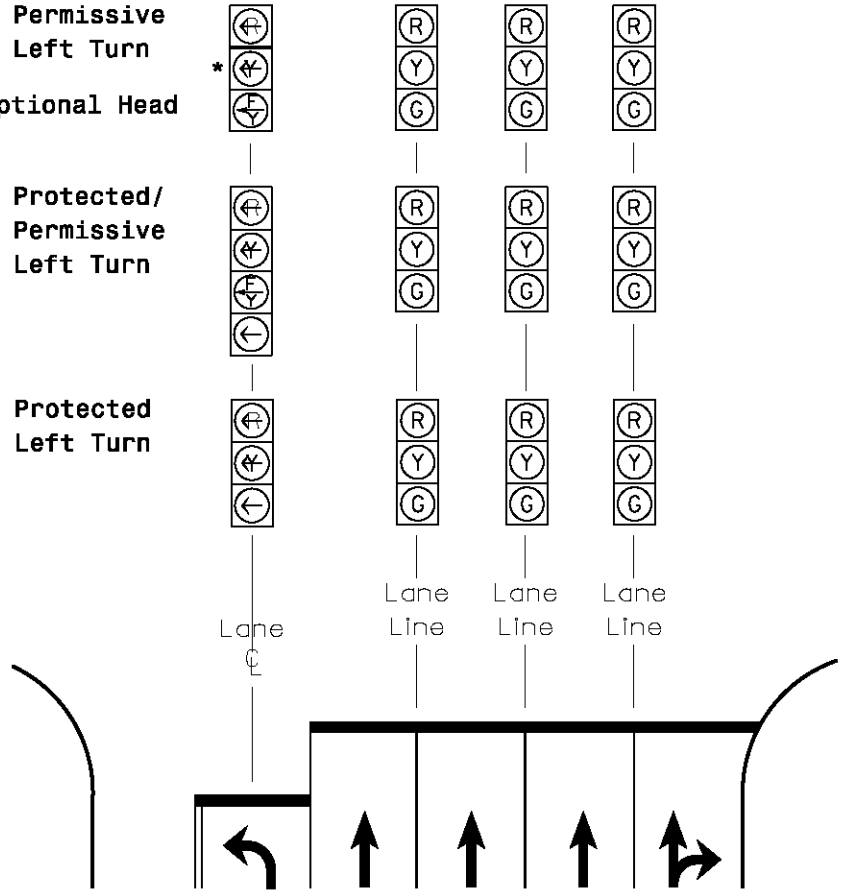
Standard Main or Side Street Signal Head Configuration

10A - Permissive Left Turn

* Optional Head

10B - Protected/ Permissive Left Turn

10C - Protected Left Turn



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 9 OF 24

CASE 10 (2 OF 2)

(Speeds 45 MPH or above)

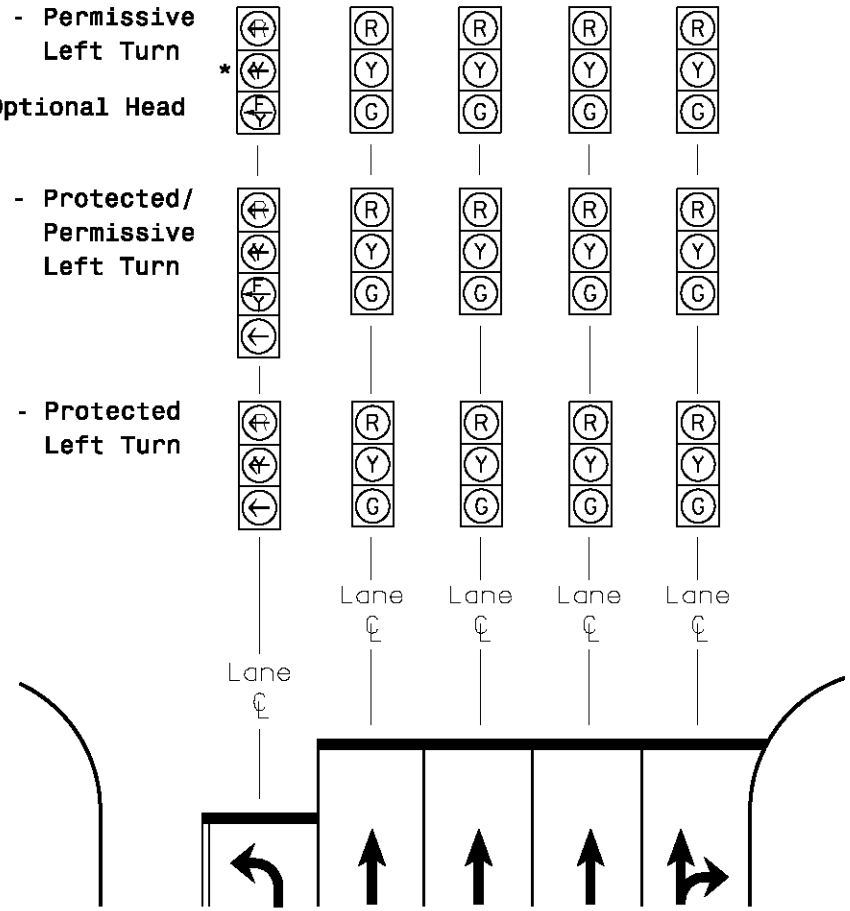
Standard Main or Side Street Signal Head Configuration

10A45 - Permissive Left Turn

* Optional Head

10B45 - Protected/ Permissive Left Turn

10C45 - Protected Left Turn

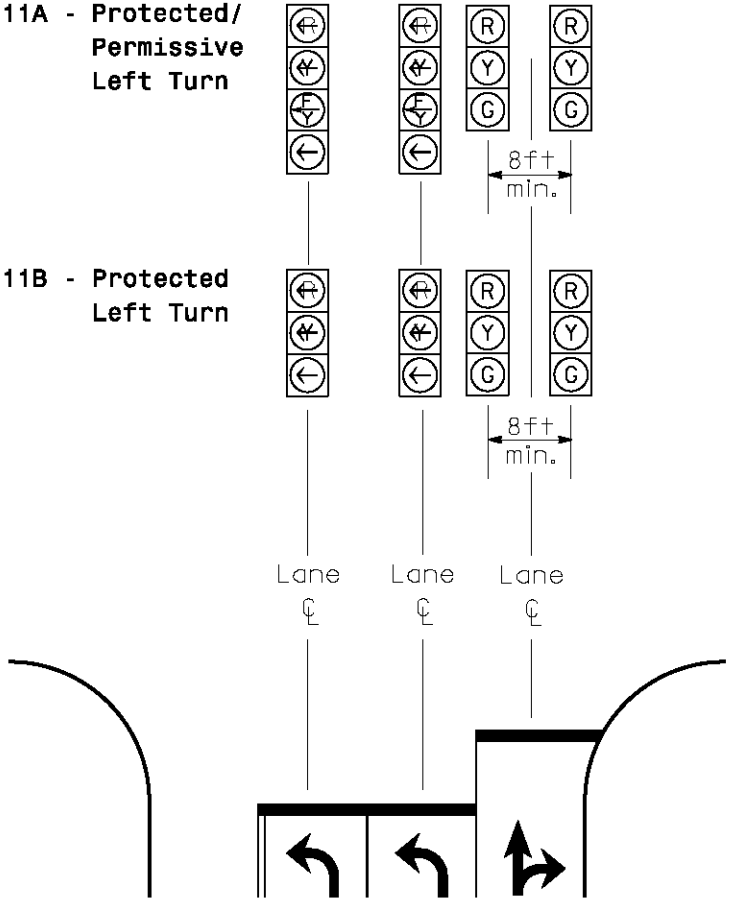


CASE 11

Main or Side Street Signal Head Configuration for Dual Left Turn Movements

11A - Protected/ Permissive Left Turn

11B - Protected Left Turn



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

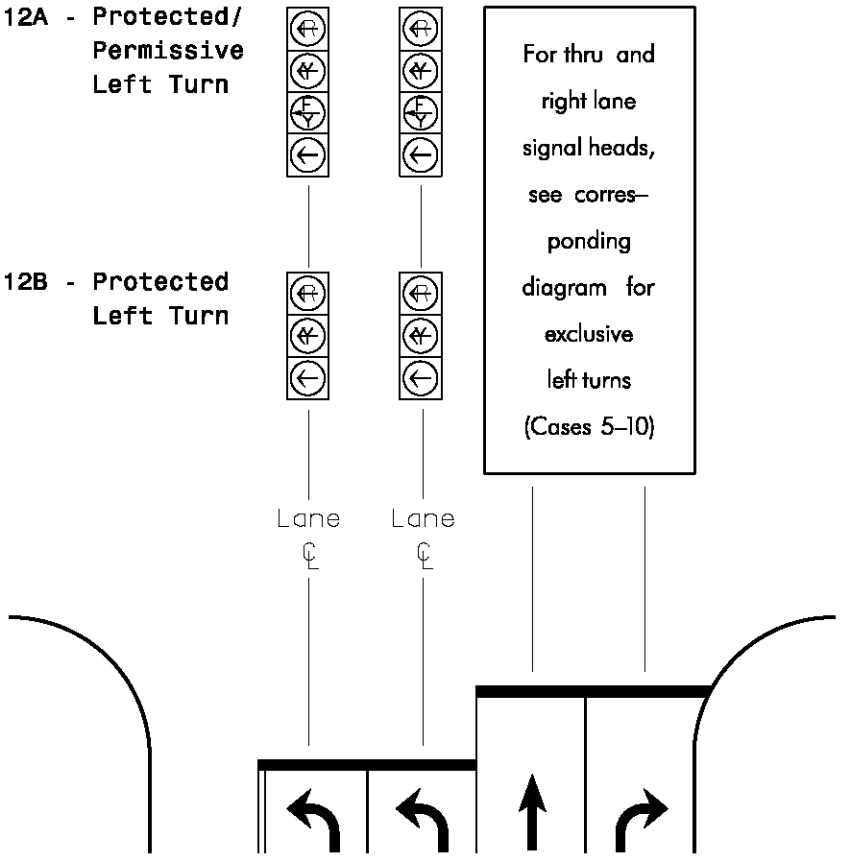
STD. NO. 3.2

CASE 12

Main or Side Street
Signal Head Configuration
for Dual Left Turn Movements

12A - Protected/ Permissive Left Turn

12B - Protected Left Turn

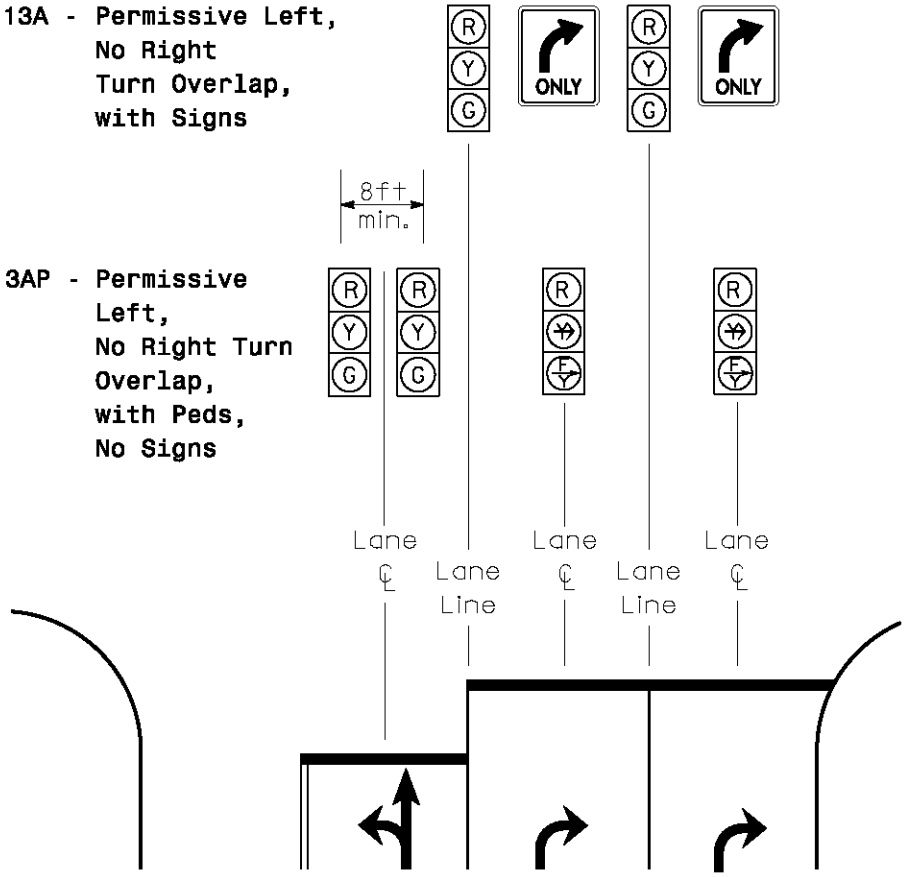


CASE 13 (1 OF 2)

Main or Side Street
Signal Head Configuration
for Dual Right Turn Movements

13A - Permissive Left, No Right Turn Overlap, with Signs

13AP - Permissive Left, No Right Turn Overlap, with Peds, No Signs



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

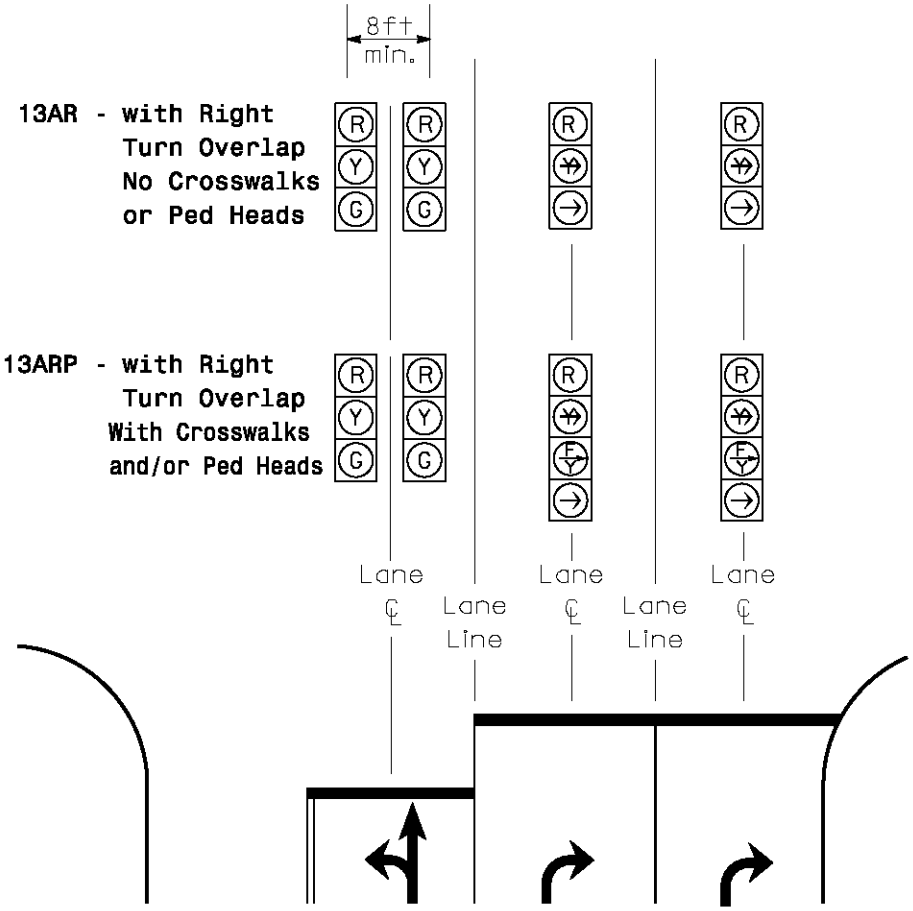
STD. NO.
3.2
SHEET 11 OF 24

CASE 13 (2 of 2)

Main or Side Street
Signal Head Configuration
for Dual Right Turn Movements

13AR - with Right Turn Overlap No Crosswalks or Ped Heads

13ARP - with Right Turn Overlap With Crosswalks and/or Ped Heads



CASE 14

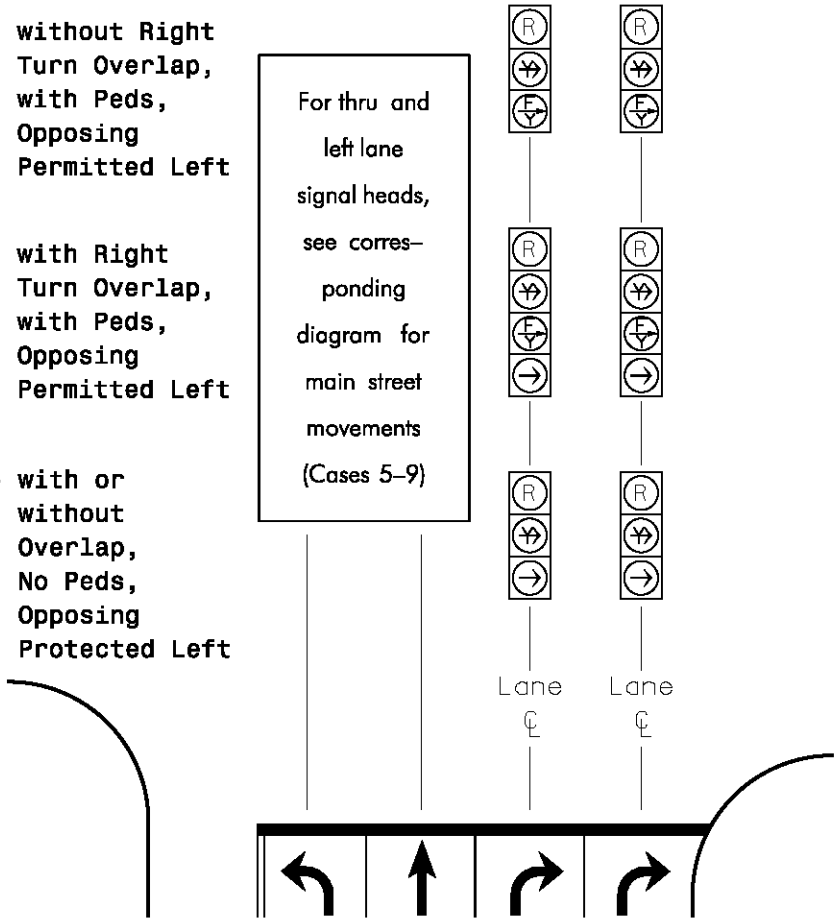
Main or Side Street
Signal Head Configuration
for Dual Right Turn Movements

14A - without Right Turn Overlap, with Peds, Opposing Permitted Left

14B - with Right Turn Overlap, with Peds, Opposing Permitted Left

14C - with or without Overlap, No Peds, Opposing Protected Left

For thru and left lane signal heads, see corres–ponding diagram for main street movements (Cases 5–9)



Signal Head Approach Displays and Alignment

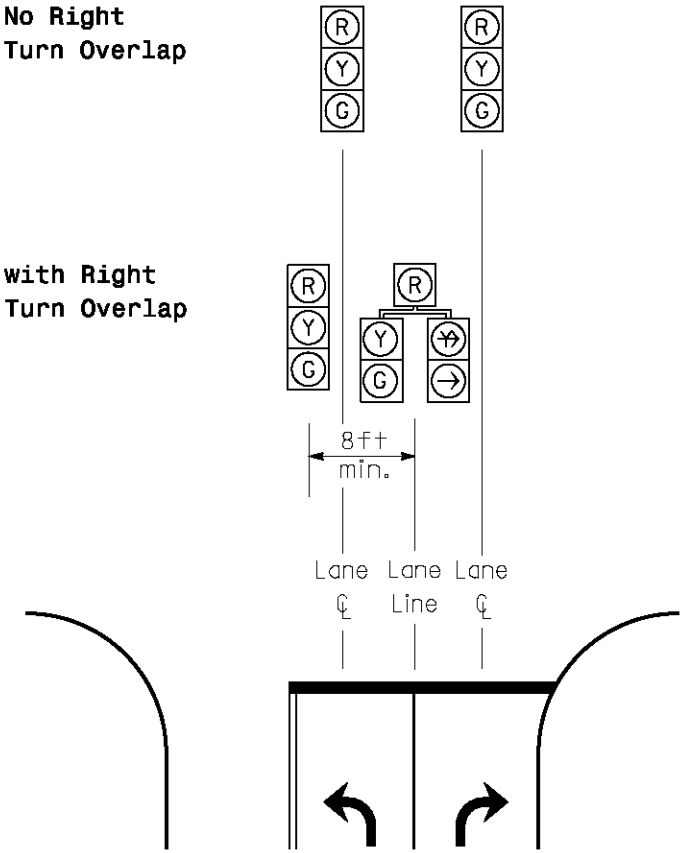
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

CASE 15

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration

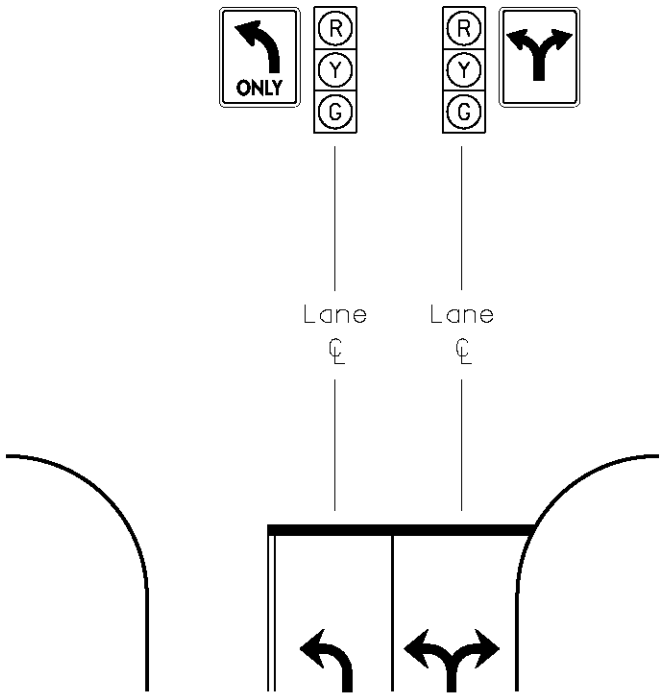
15A - No Right Turn Overlap

15AR - with Right Turn Overlap



CASE 16

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration



Signal Head Approach Displays and Alignment

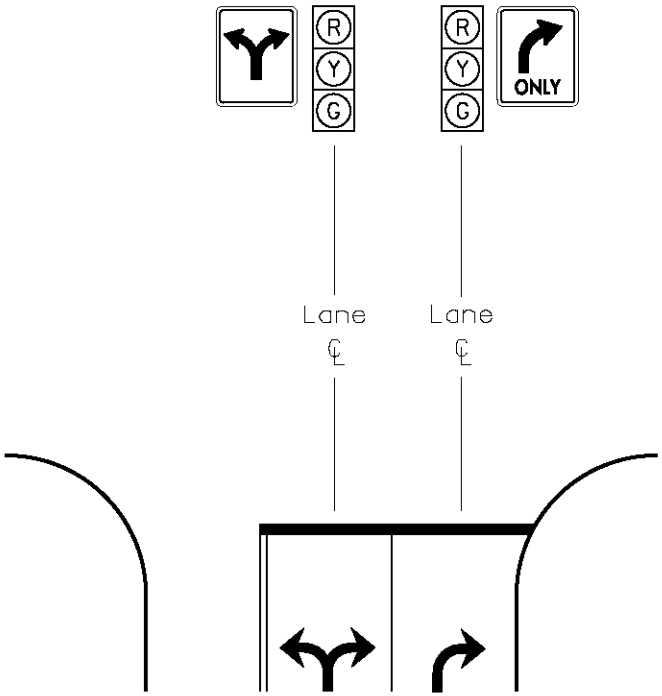
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 13 OF 24

CASE 17

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration



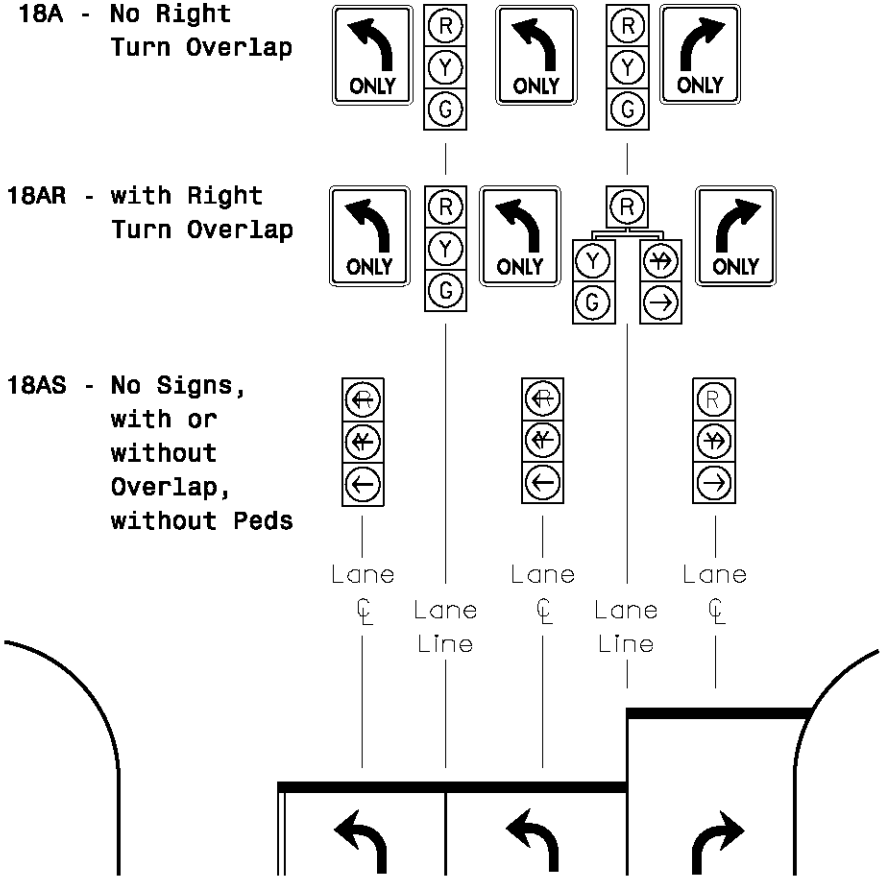
CASE 18

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration

18A - No Right Turn Overlap

18AR - with Right Turn Overlap

18AS - No Signs, with or without Overlap, without Peds



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 14 OF 24

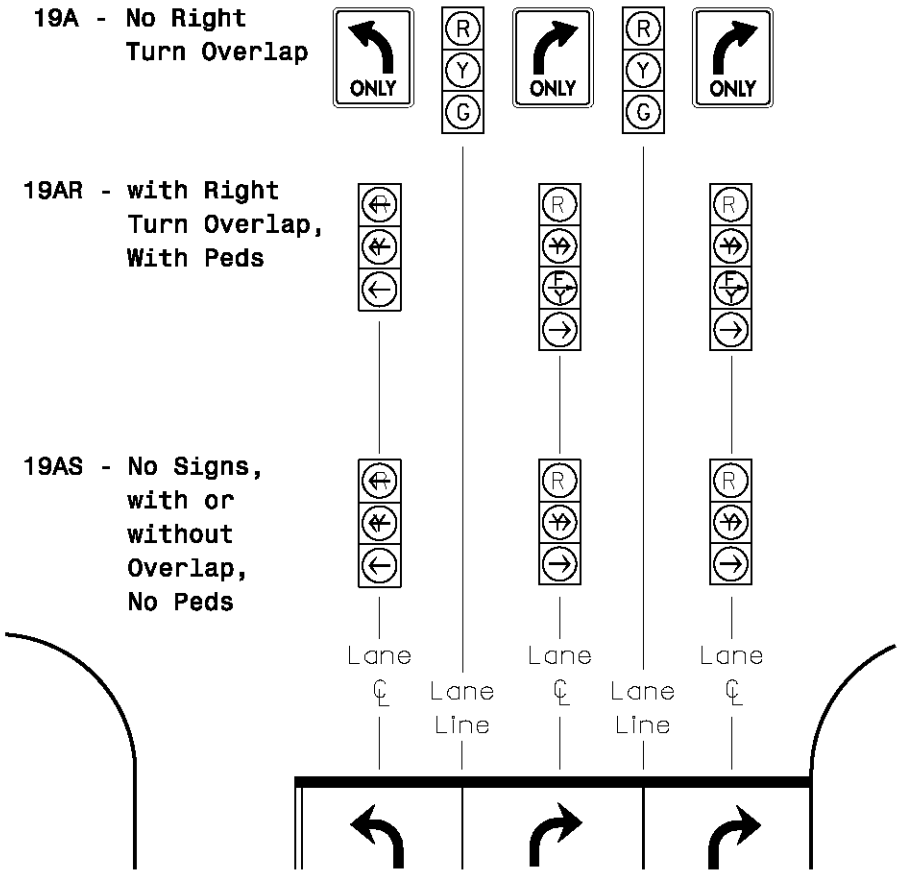
CASE 19

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration

19A - No Right Turn Overlap

19AR - with Right Turn Overlap, With Peds

19AS - No Signs, with or without Overlap, No Peds



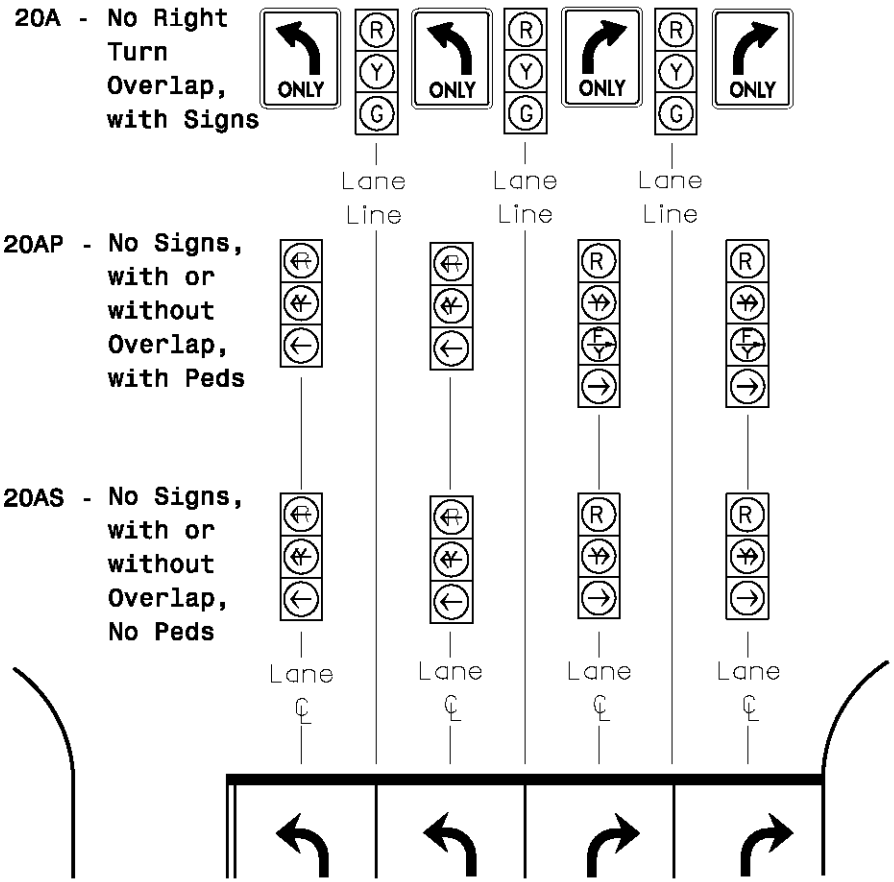
CASE 20

Stem of "Tee" Intersection or Ramp Terminal or One–Way Situation Signal Head Configuration

20A - No Right Turn Overlap, with Signs

20AP - No Signs, with or without Overlap, with Peds

20AS - No Signs, with or without Overlap, No Peds



Signal Head Approach Displays and Alignment

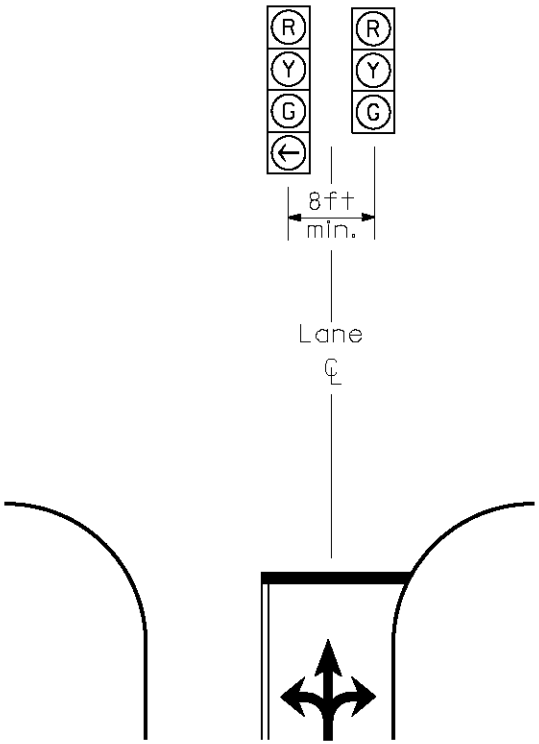
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 15 OF 24

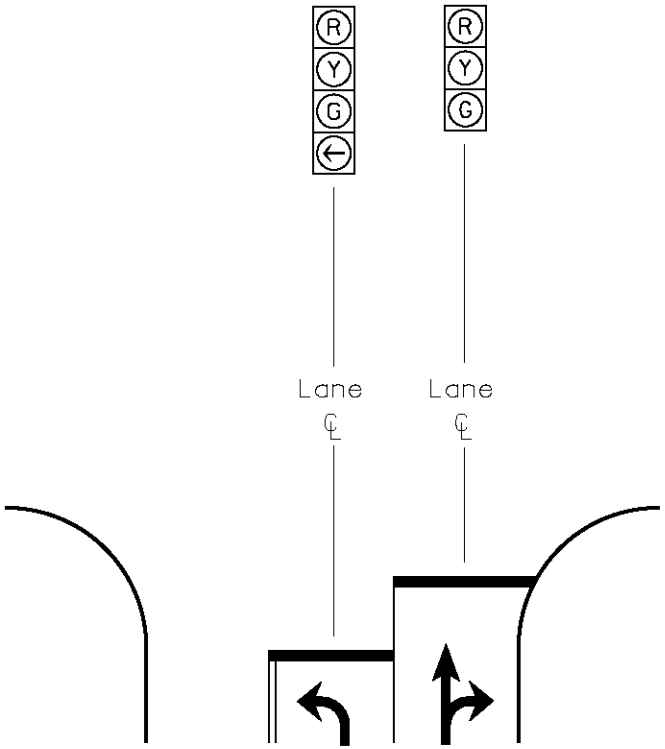
CASE 21

Split Phasing
Signal Head Configuration



CASE 22

Split Phasing
Signal Head Configuration



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

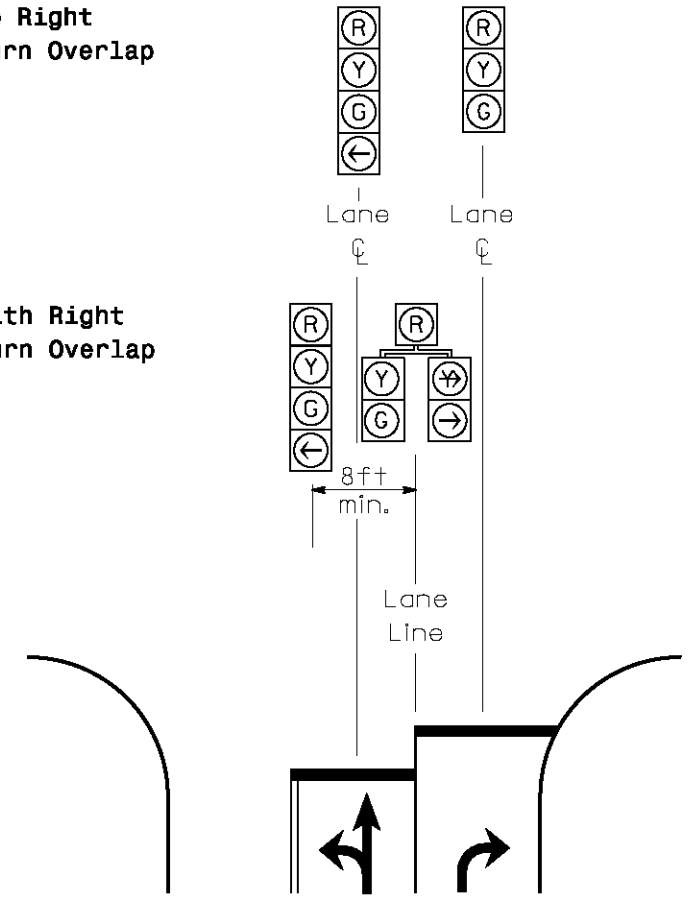
STD. NO.
3.2
SHEET 16 OF 24

CASE 23

Split Phasing
Signal Head Configuration

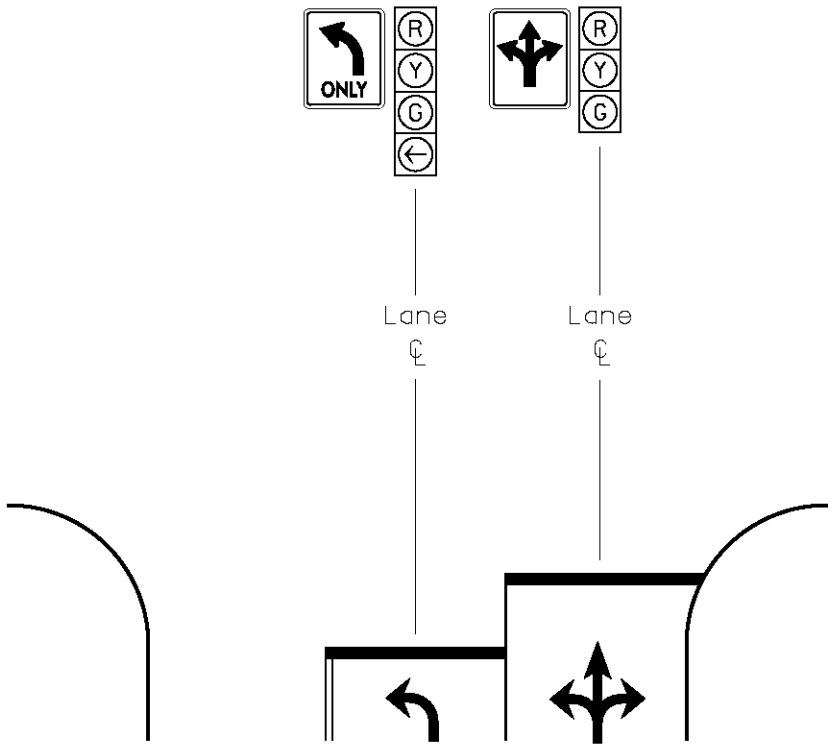
23C - No Right
Turn Overlap

23CR - with Right
Turn Overlap



CASE 24

Split Phasing
Signal Head Configuration



Signal Head Approach Displays and Alignment

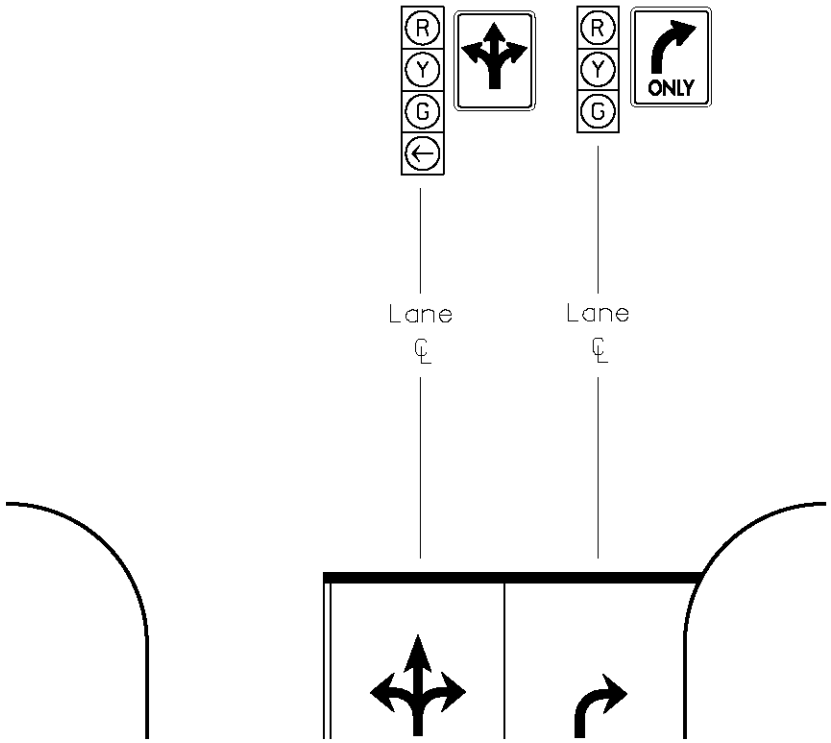
SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 17 OF 24

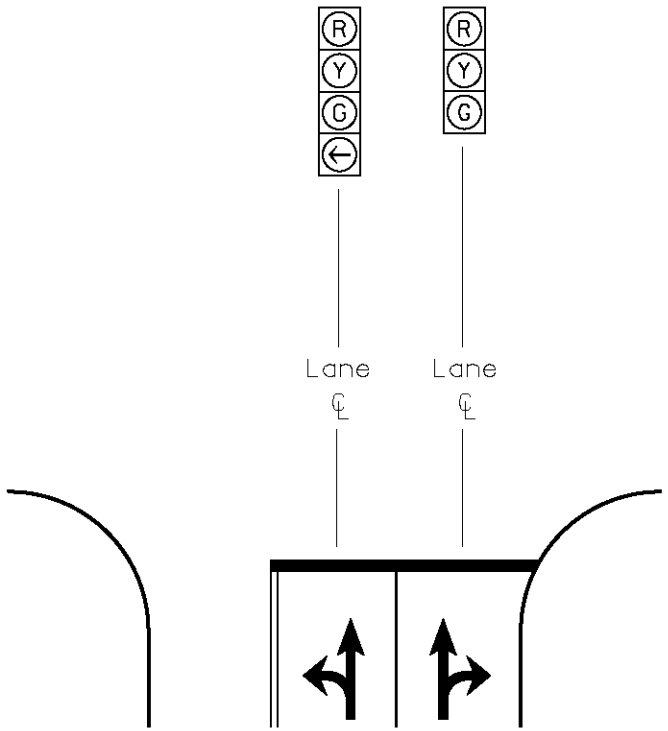
CASE 25

Split Phasing
Signal Head Configuration



CASE 26

Split Phasing
Signal Head Configuration



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

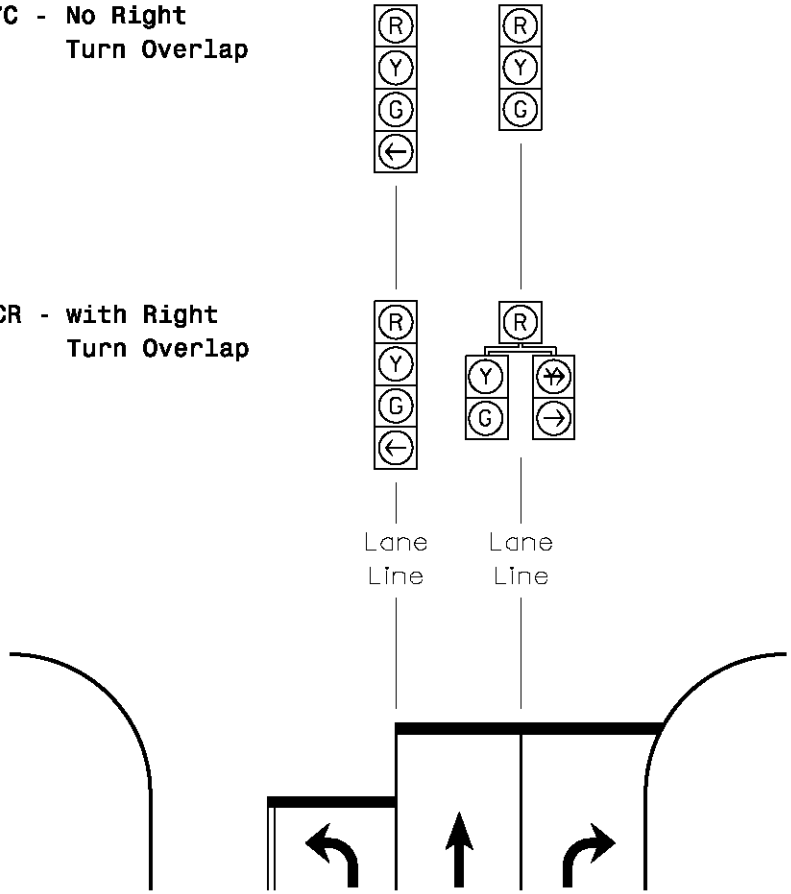
STD. NO.
3.2
SHEET 18 OF 24

CASE 27

Split Phasing
Signal Head Configuration

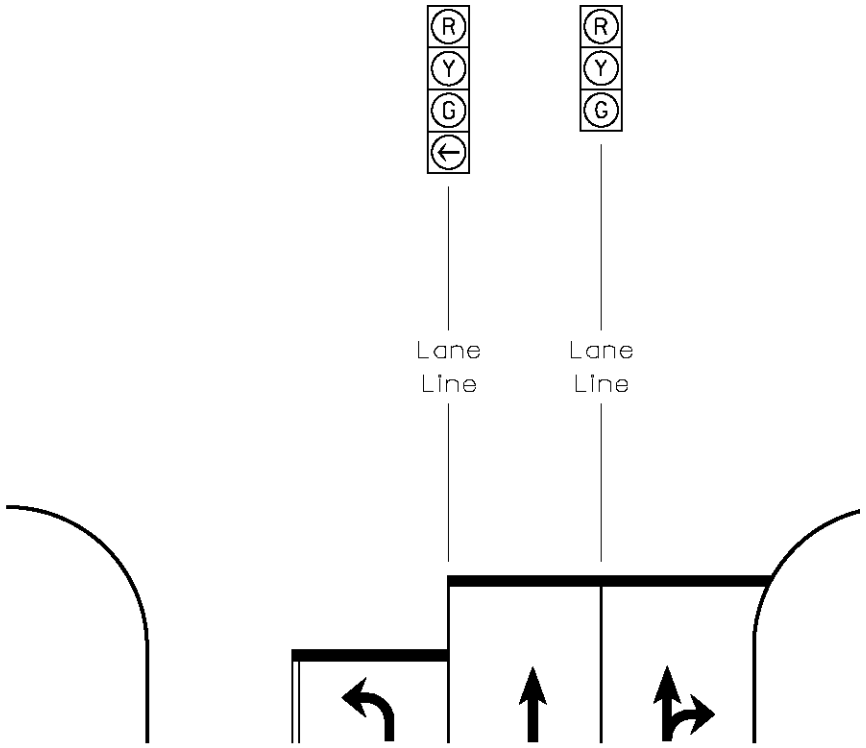
27C - No Right Turn Overlap

27CR - with Right Turn Overlap



CASE 28

Split Phasing
Signal Head Configuration



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

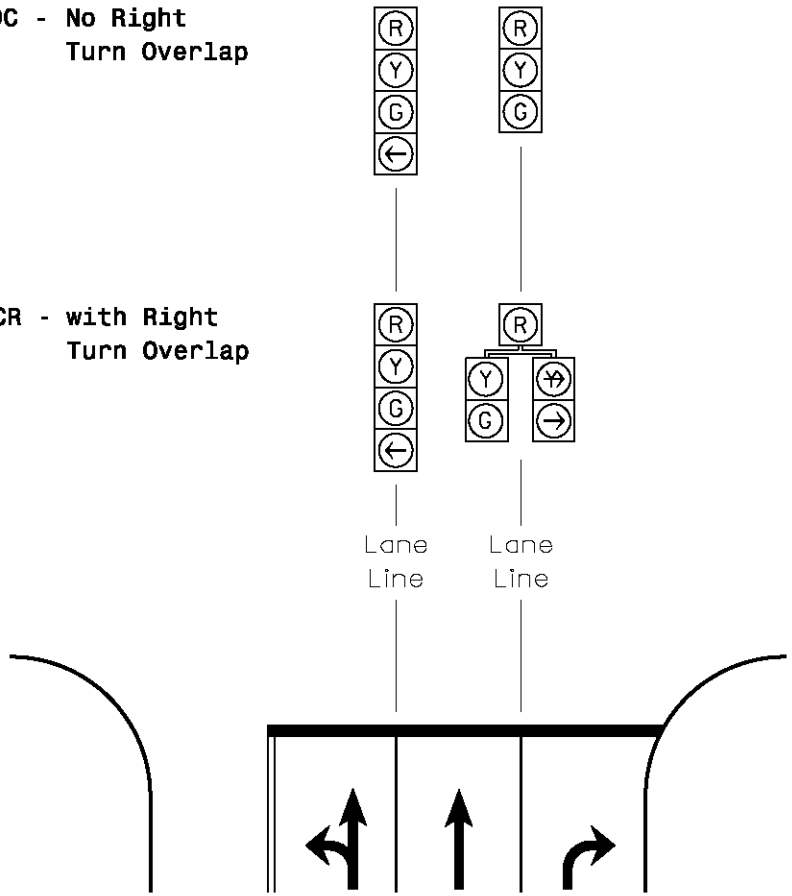
STD. NO.
3.2
SHEET 19 OF 24

CASE 29

Split Phasing
Signal Head Configuration

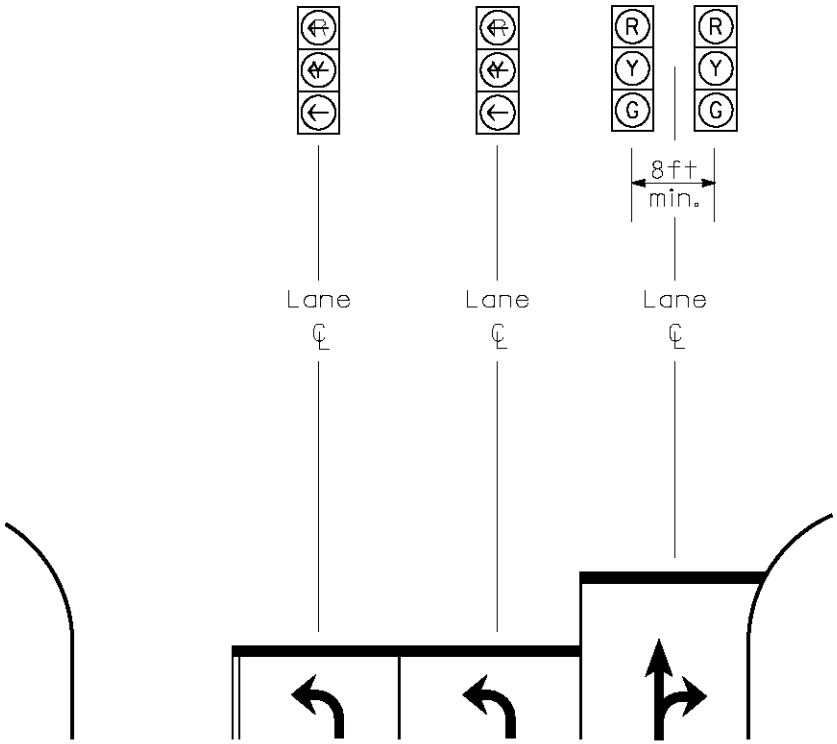
29C - No Right Turn Overlap

29CR - with Right Turn Overlap



CASE 30

Split Phasing
Signal Head Configuration



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

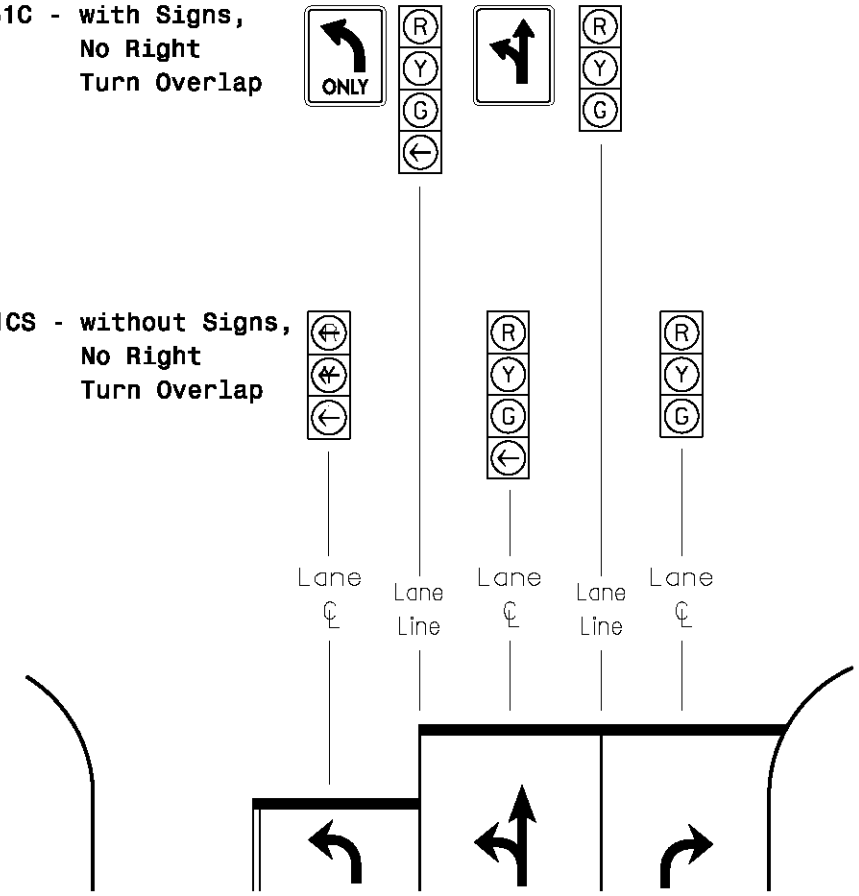
STD. NO.
3.2
SHEET 20 OF 24

CASE 31 (1 OF 2)

Split Phasing
Signal Head Configuration

31C - with Signs,
No Right
Turn Overlap

31CS - without Signs,
No Right
Turn Overlap

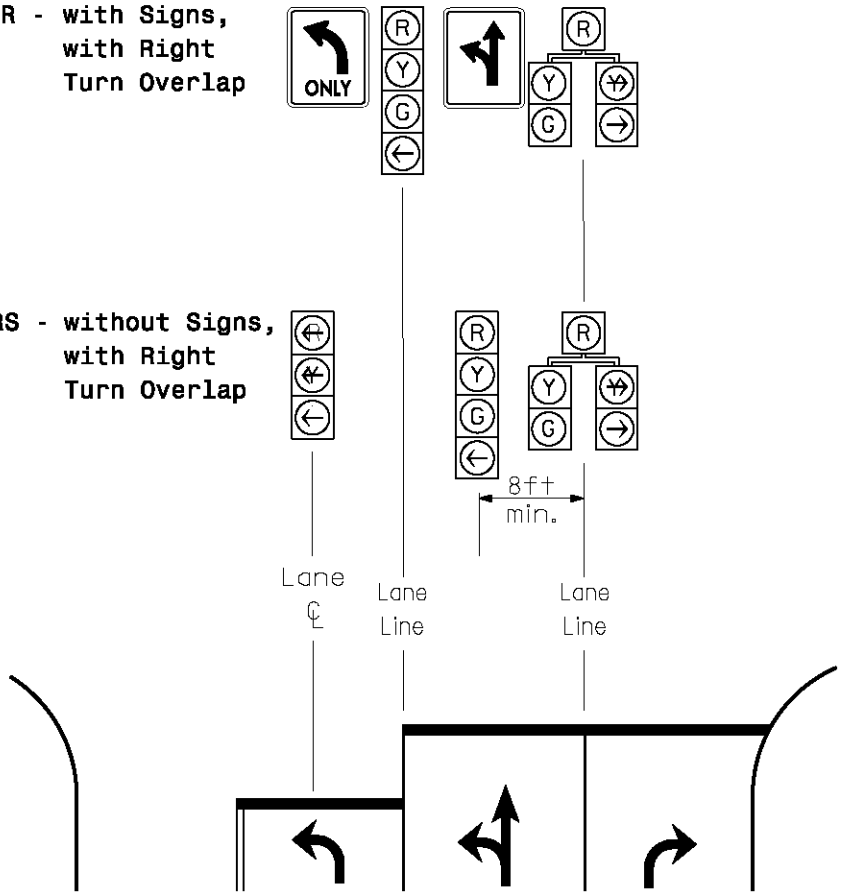


CASE 31 (2 OF 2)

Split Phasing
Signal Head Configuration

31CR - with Signs,
with Right
Turn Overlap

31CRS - without Signs,
with Right
Turn Overlap



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

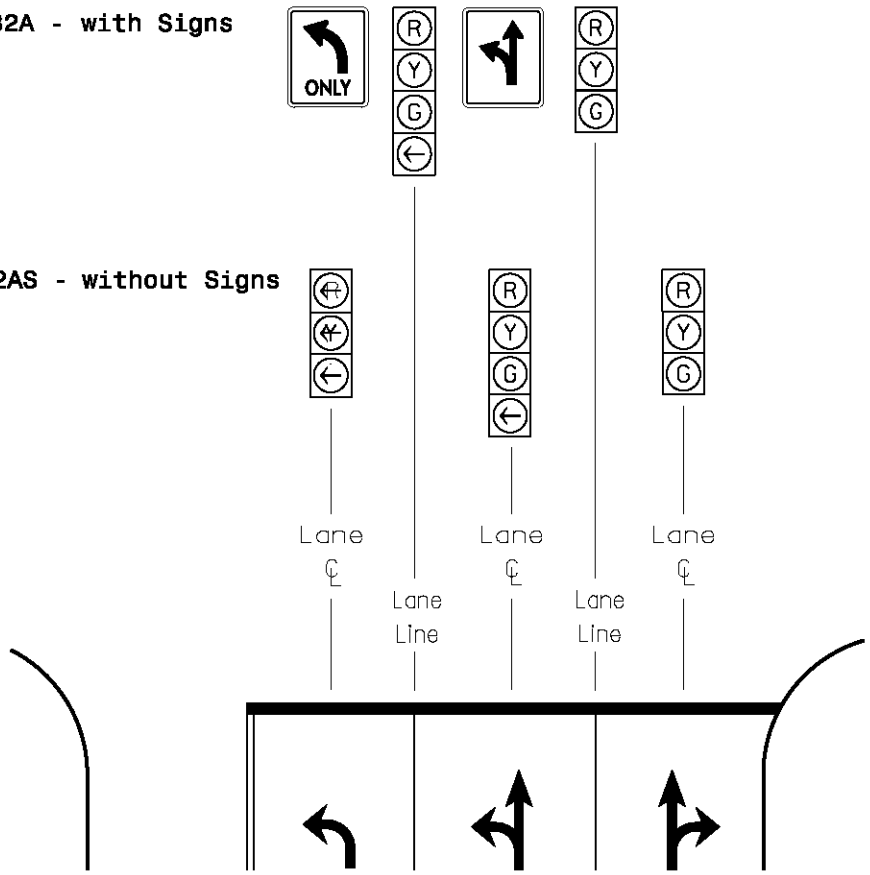
STD. NO.
3.2
SHEET 21 OF 24

CASE 32

Split Phasing
Signal Head Configuration

32A - with Signs

32AS - without Signs



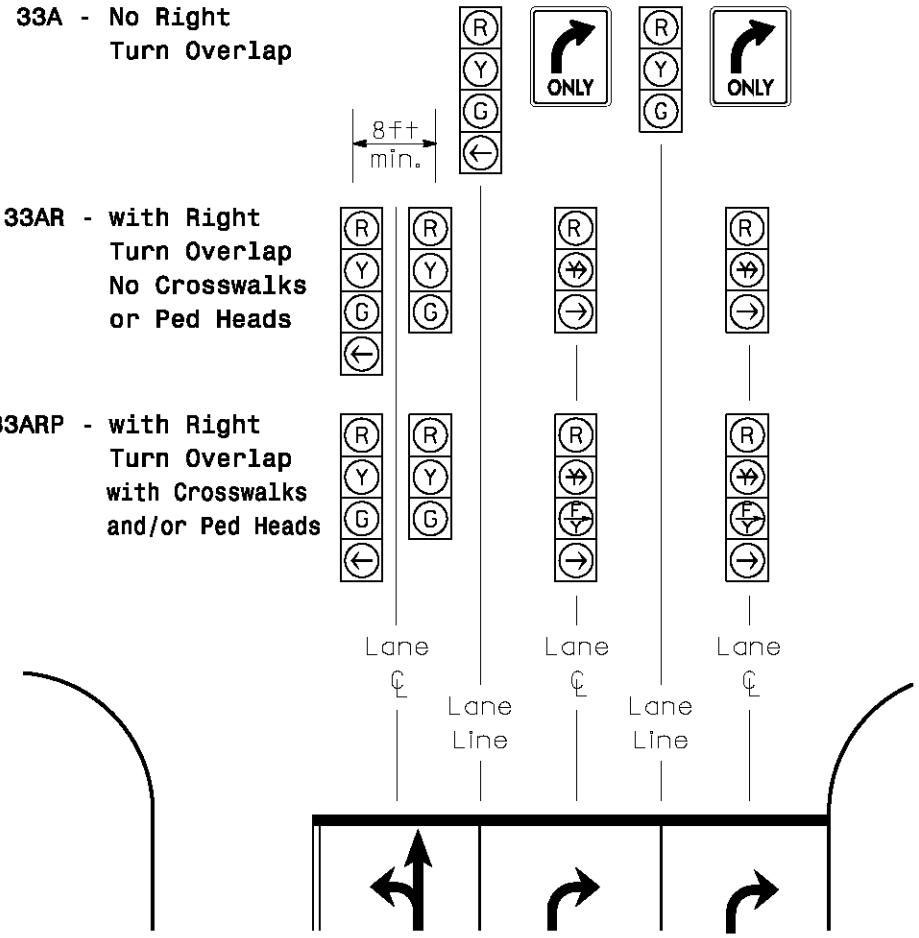
CASE 33

Split Phasing
Signal Head Configuration
for Dual Right Turn Movements

33A - No Right
Turn Overlap

33AR - with Right
Turn Overlap
No Crosswalks
or Ped Heads

33ARP - with Right
Turn Overlap
with Crosswalks
and/or Ped Heads



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

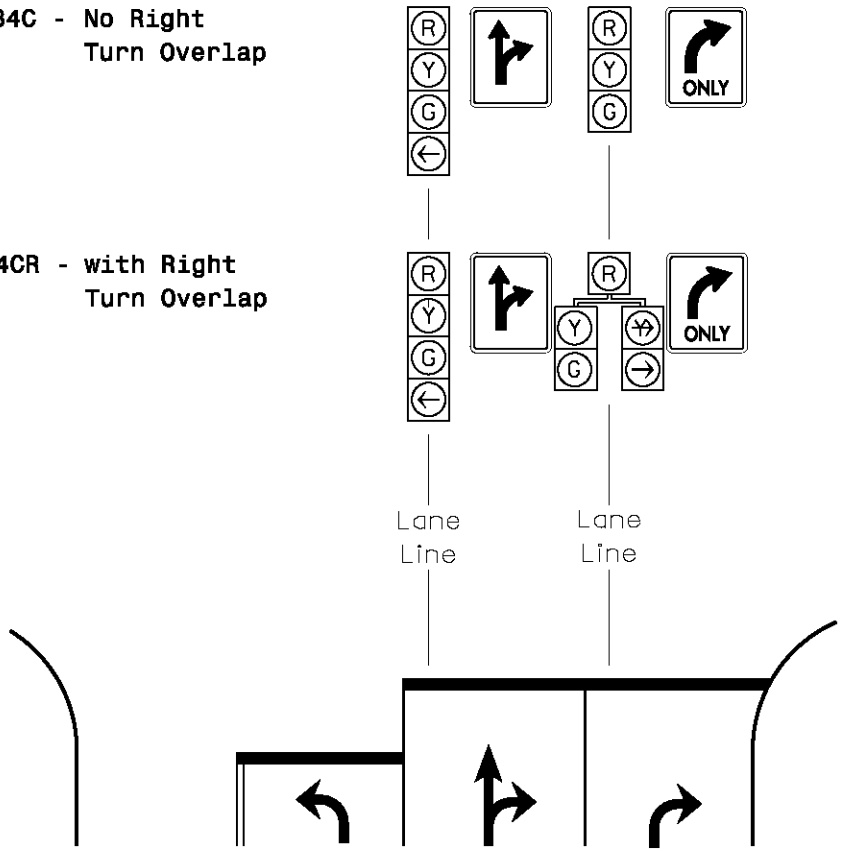
STD. NO.
3.2
SHEET 22 OF 24

CASE 34

Split Phasing
Signal Head Configuration

34C - No Right Turn Overlap

34CR - with Right Turn Overlap

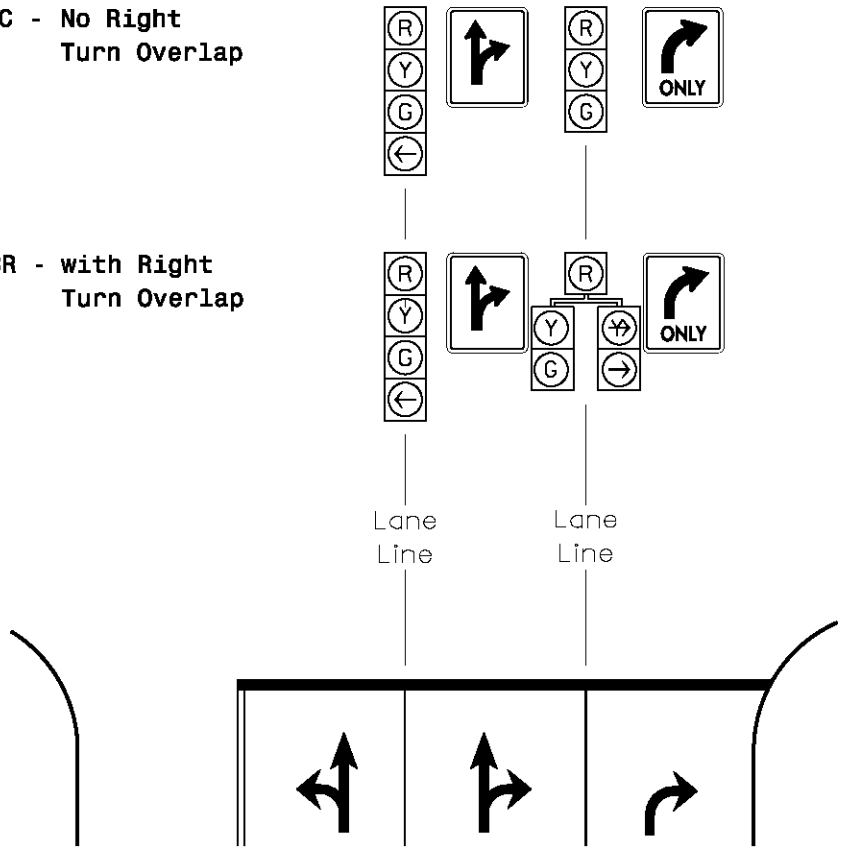


CASE 35

Split Phasing
Signal Head Configuration

35C - No Right Turn Overlap

35CR - with Right Turn Overlap



Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

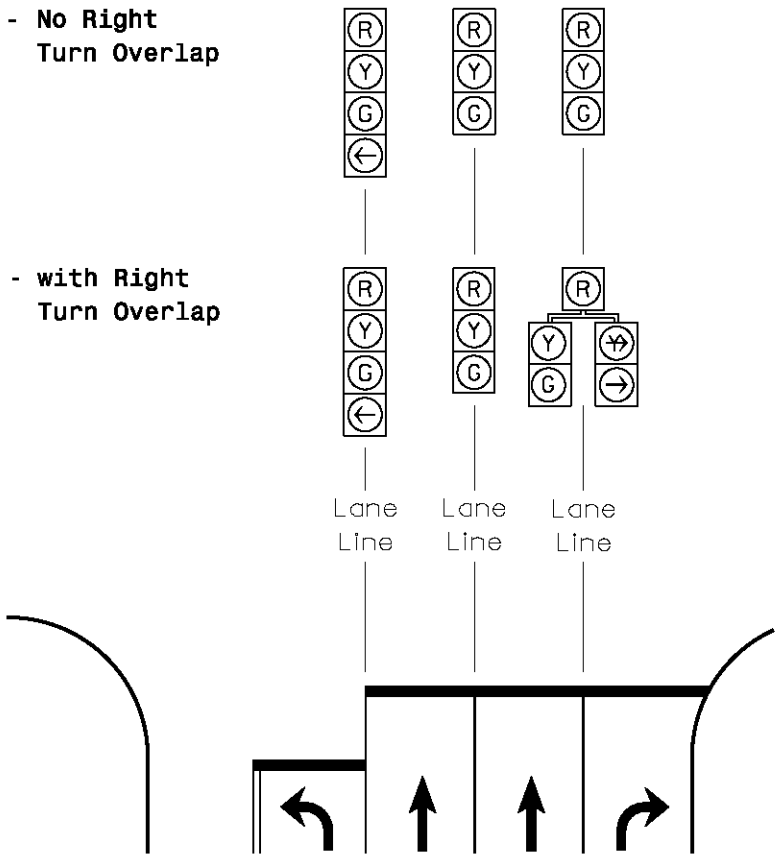
STD. NO.
3.2
SHEET 23 OF 24

CASE 36

Split Phasing
Signal Head Configuration

36C - No Right Turn Overlap

36CR - with Right Turn Overlap

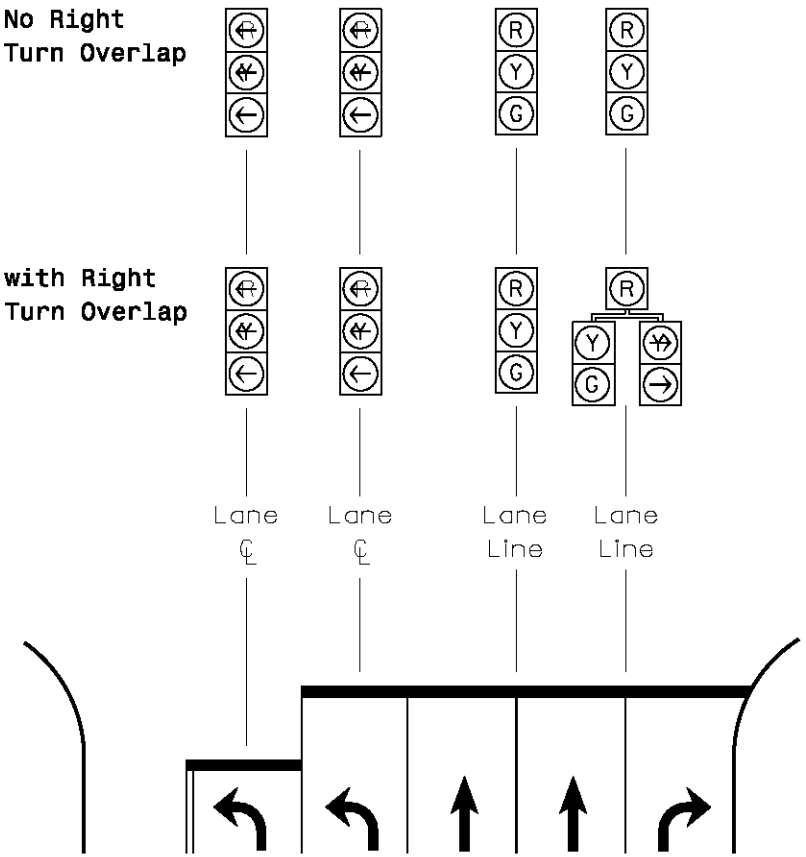


CASE 37

Split Phasing
Signal Head Configuration

37C - No Right Turn Overlap

37CR - with Right Turn Overlap



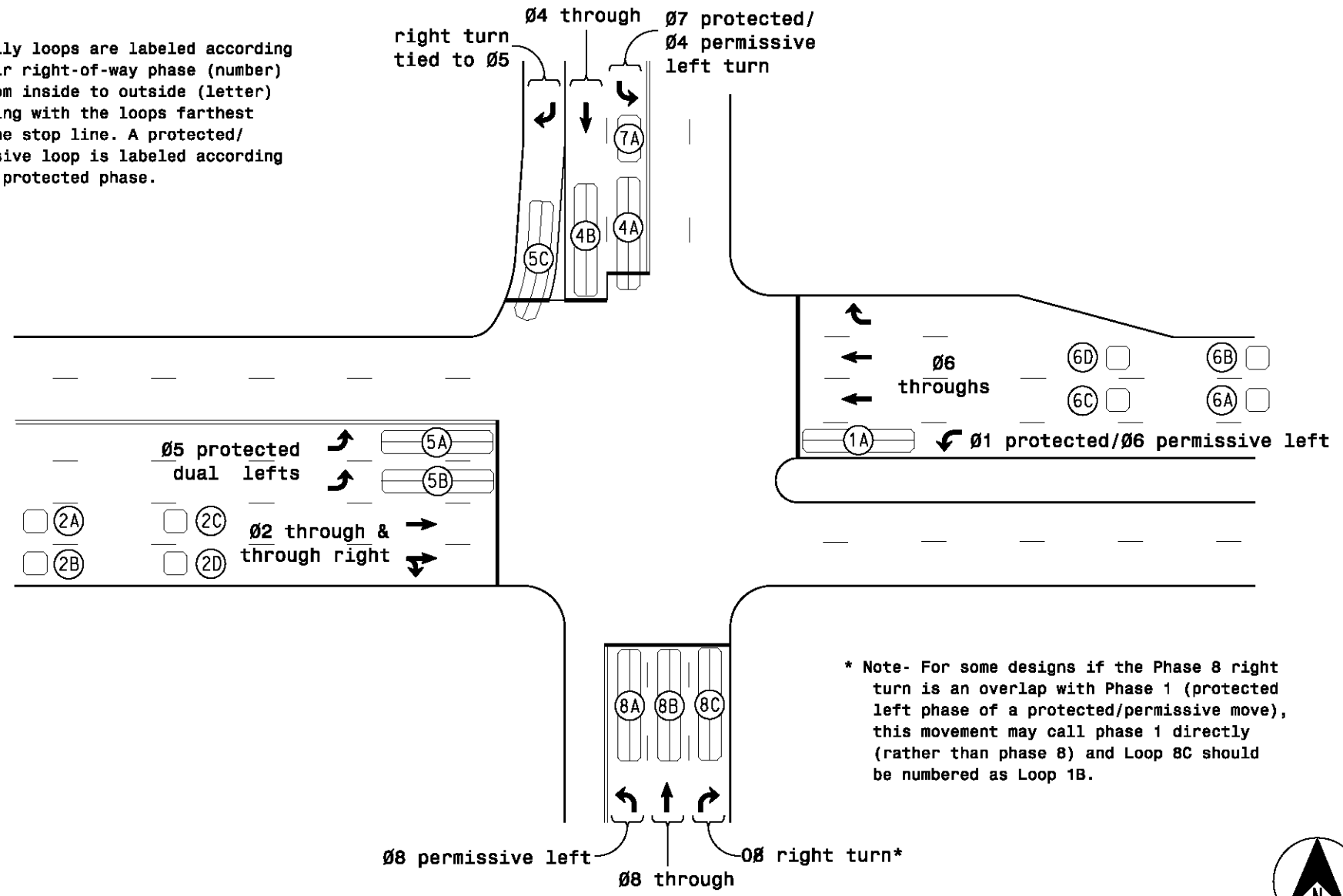
Signal Head Approach Displays and Alignment

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

12-10

STD. NO.
3.2
SHEET 24 OF 24

Typically loops are labeled according to their right-of-way phase (number) and from inside to outside (letter) beginning with the loops farthest from the stop line. A protected/ permissive loop is labeled according to its protected phase.



* Note- For some designs if the Phase 8 right turn is an overlap with Phase 1 (protected left phase of a protected/permissive move), this movement may call phase 1 directly (rather than phase 8) and Loop 8C should be numbered as Loop 1B.

N

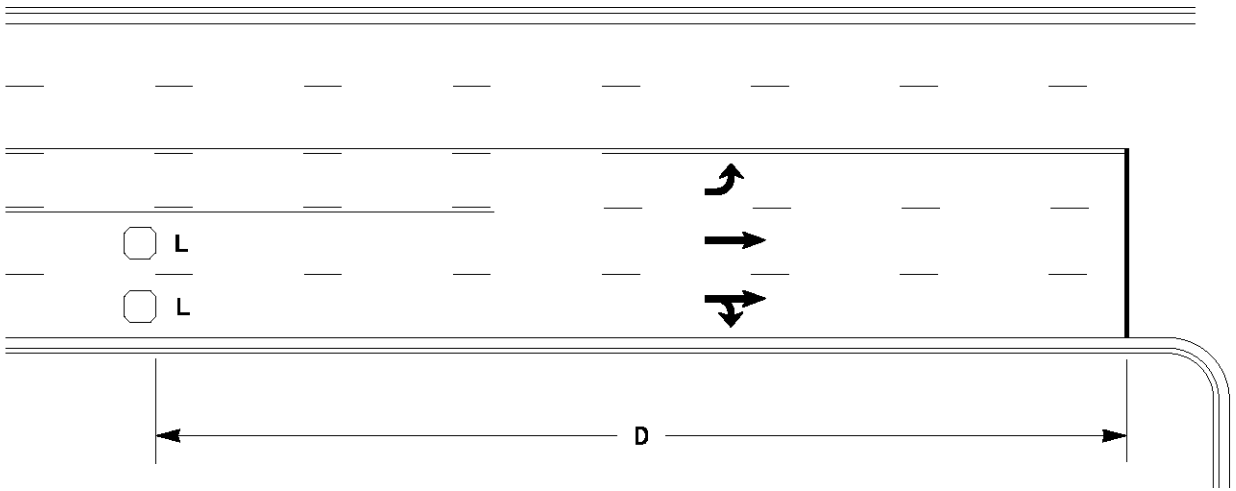
Typical Numbering of Loops/Detection Zones

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-09

STD. NO.
4.0
SHEET 1 OF 1

Volume Density Operation



Design Speed mph (km/hr)		D ft	(m)
40	(64)	250	(75)
45	(72)	300	(90)
50	(80)	355	(110)
55	(88)	420	(130)

L = 6ft X 6ft (1.8m X 1.8m)
Presence loop
Wired in series for TS1 Controllers
Wired to separate detectors/channels
for 170, TS2, and 2070 Controllers

Design Considerations:

-High speed [≥40 mph (64 km/hr)]
-Preferred option for cost and efficiency

Notes:

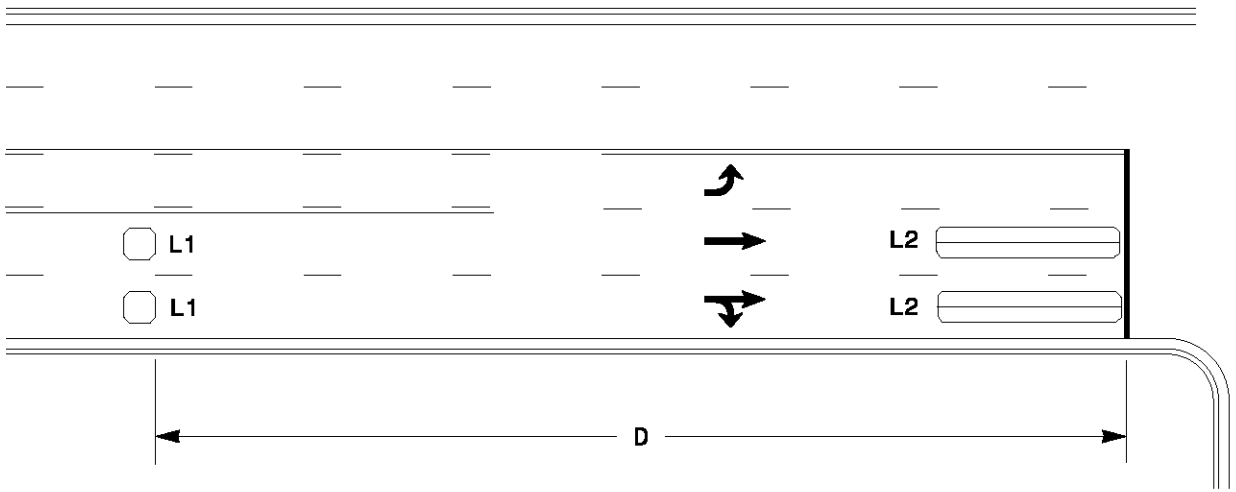
-Set vehicle call memory to "LOCK"
-Not appropriate for use with out-of-street detection
-Volume density loops can double as system detectors when wired separately.

Loop Placement for Main Street Through Movements

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Volume Density Operation with DC/EC

(Delayed Call/Extended Call)



L1 = 6ft X 6ft (1.8m X 1.8m)
Presence loop
Wired in series for TS1 Controllers
Wired to separate detectors/channels
for 170, TS2, and 2070 Controllers

L2 = 6ft X 40ft
(1.8m X 12.0m)
Quadrupole loop
Wired to separate
detectors/channels

Design Speed mph	(km/hr)	D ft	(m)	L2 Delay sec	L2 Extend sec
40	(64)	250	(75)	5.0	2.0
45	(72)	300	(90)	5.0	2.0
50	(80)	355	(110)	5.0	2.0
55	(88)	420	(130)	5.0	2.0

Design Considerations:

-High speed [≥40 mph (64 km/hr)]
-High volume driveways between L1 and L2
-Single lane approach with left turns
-High truck traffic with steep positive grades
-Out-of-street detection
-More efficient than standard "stretch"
detection, but costlier to install and maintain

Notes:

-Do not program "ACTUATIONS B4 ADD" (not applicable for 2070 controllers), "SEC. PER ACTUATION" and "MAX. INITIAL"
-Delay on loops L2 must be FULL TIME delay
-Do not program "Vehicle Call Memory" for phases 2 & 6
-Loops L1 can double as system detectors when wired separately

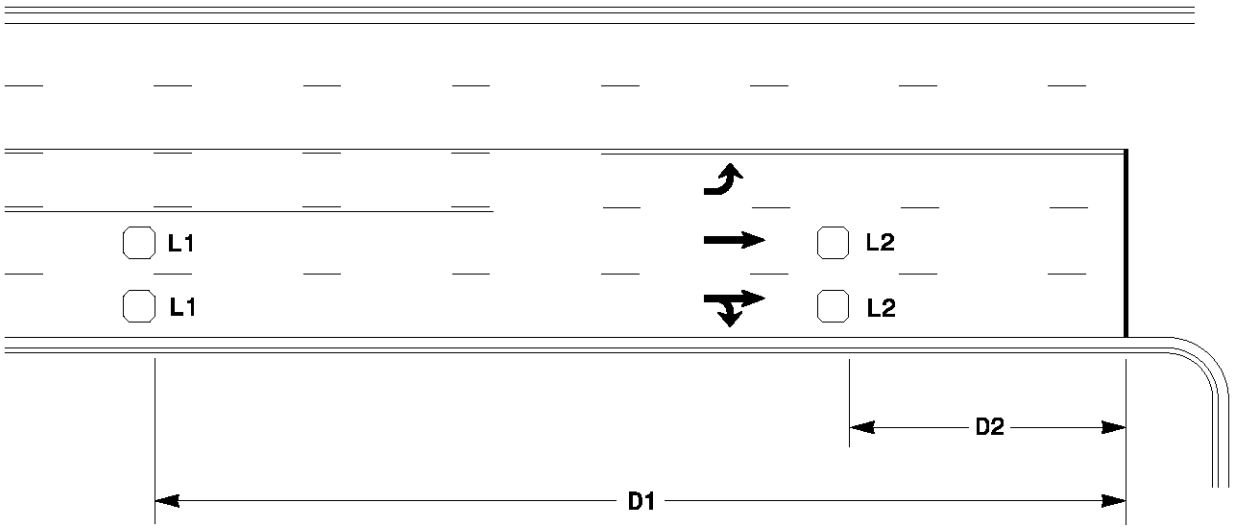
Loop Placement for Main Street Through Movements

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.1
SHEET 2 OF 4

Extend (Stretch) Detection



L1 = 6ft X 6ft
(1.8m X 1.8m)
Presence loop
Wired in series

L2 = 6ft X 6ft
(1.8m X 1.8m)
Presence loop
Wired in series

Design Speed mph (km/hr)	D1 ft (m)	D2 ft (m)	Extend sec
40 (64)	250 (75)	80 (25)	1.3
45 (72)	300 (90)	90 (27)	1.6
50 (80)	355 (110)	100 (30)	1.9
55 (88)	420 (130)	110 (35)	2.2

Design Considerations:

-High speed [≥40 mph (64 km/hr)]

-High volume driveways between L1 and L2

Notes:

-Appropriate for use with out-of-street detection

-Loops L1 can double as system detectors, IF wired to separate detectors/ channels

-Gap time typically 2.0 seconds

-For TS-1 controllers, round Extend time up to nearest 0.25 seconds

-Loop placement may be varied due to design constraints such as bridges or poor pavement, or non-standard placement of existing loops. In such cases, recalculate Extend times for L1.

$$\text{Extend time (sec)} = \left(\frac{\text{(D1-D2) feet}}{\text{(Design Speed -5) mph}} \times \frac{\text{3600 sec/hr}}{\text{5280 ft/mi}} \right) - \text{Gap time}$$

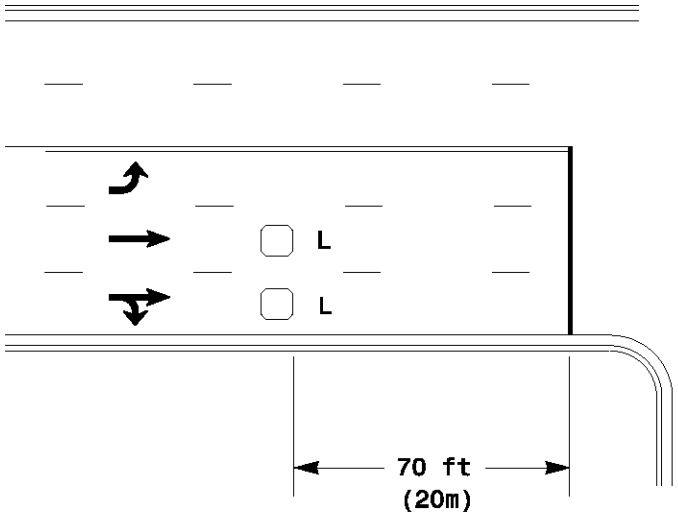
Loop Placement for Main Street Through Movements

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.1
SHEET 3 OF 4

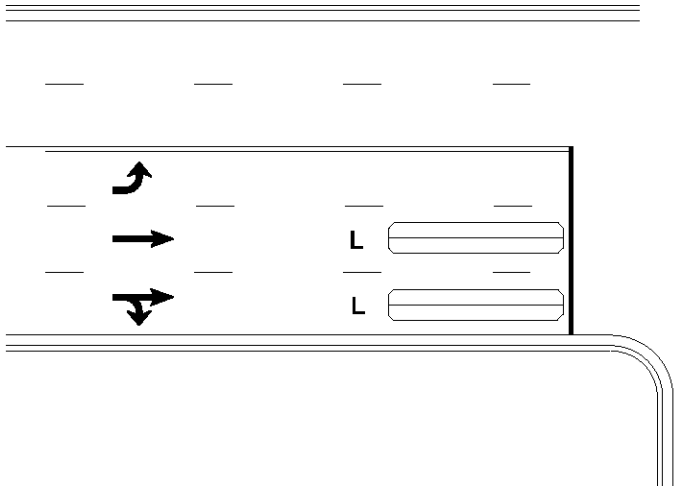
Low Speed Detection



L = 6ft X 6ft (1.8m X 1.8m)
Presence loop, wired in series

Design Considerations:

-Low speed [≤35 mph (56 km/hr)]
-Gap time typically 3.0 seconds
-Preferred option



L = 6ft X 40ft (1.8m X 12.0m)
Quadrupole loop, wired to
separate detectors/channels

Design Considerations:

-Low speed [≤35 mph (56 km/hr)]
-Gap time typically 0-2 seconds
-Appropriate for use with soft recall

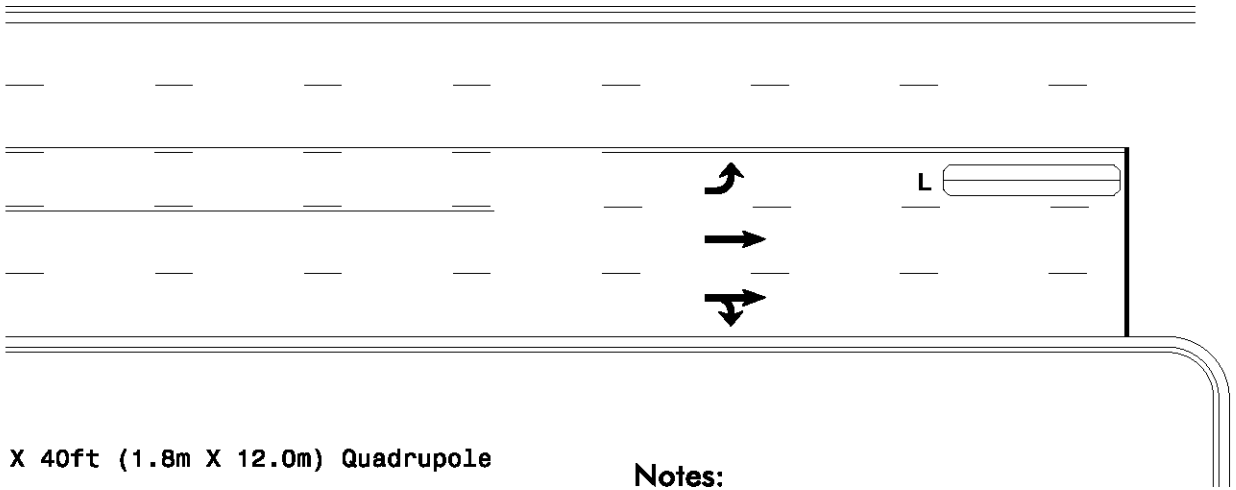
Loop Placement for Main Street Through Movements

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.1
SHEET 4 OF 4

Presence Detector



L = 6ft X 40ft (1.8m X 12.0m) Quadrupole

or, if longer detection area is needed:

6ft X 50ft (1.8m X 15.0m) Quadrupole

or

6ft X 60ft (1.8m X 18.0m) Quadrupole

Notes:

-Loops may not be required for all main street permissive turns

-Option to use 6ft X 6ft (1.8m X 1.8m) loop to wire in series with 70' through loops.

Loop Type	Delay time	Full Time Delay
Left Turn Loop on Main Street with Low Speed or Stretch Detection	0 sec	N/A
Left Turn Loop on Main Street with Volume Density Detection	3-5 sec	Yes
Left Turn Loop on Side Street	2-3 sec if "clipping" prevention is desired; 0 sec otherwise	No

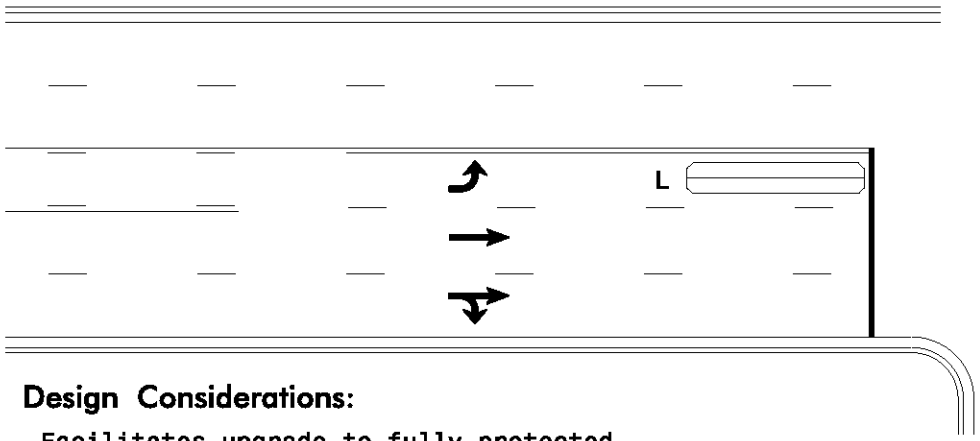
Loop Placement for Permissive Left Turns

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.2
SHEET 1 OF 1

Presence Loop with 2 Channel Detector



L = 6ft X 40ft (1.8m X 12.0m) Quadrupole loop

or, if longer detection area is needed:

6ft X 50ft (1.8m X 15.0m) Quadrupole loop

or

6ft X 60ft (1.8m X 18.0m) Quadrupole loop

Design Considerations:

- Facilitates upgrade to fully protected or downgrade from fully protected
- Calls up arrow when 1 or 2 cars waiting to turn
- Consider queue loop (Std. No. 4.1.3:2) for light left turn traffic or for light opposing through traffic

Note:

- Calling/extending the permissive phase may not be required for main street loops
- Gap time typically 1-3 seconds

Loop Type	Detector Channel	Phase	Delay Time	Full Time Delay
Left Turn Loop on Main Street with Low Speed or Stretch Detection	1	Protected Phase	10-30 sec	No
	2	Permissive Phase	0 sec	N/A
Left Turn Loop on Main Street with Volume Density Detection	1	Protected Phase	10-30 sec	No
	2	Permissive Phase	3-5 sec	Yes
Left Turn Loop on Side Street	1	Protected Phase	10-30 sec	No
	2	Permissive Phase	2-3 sec if "clipping" prevention is desired; 0 sec otherwise	No

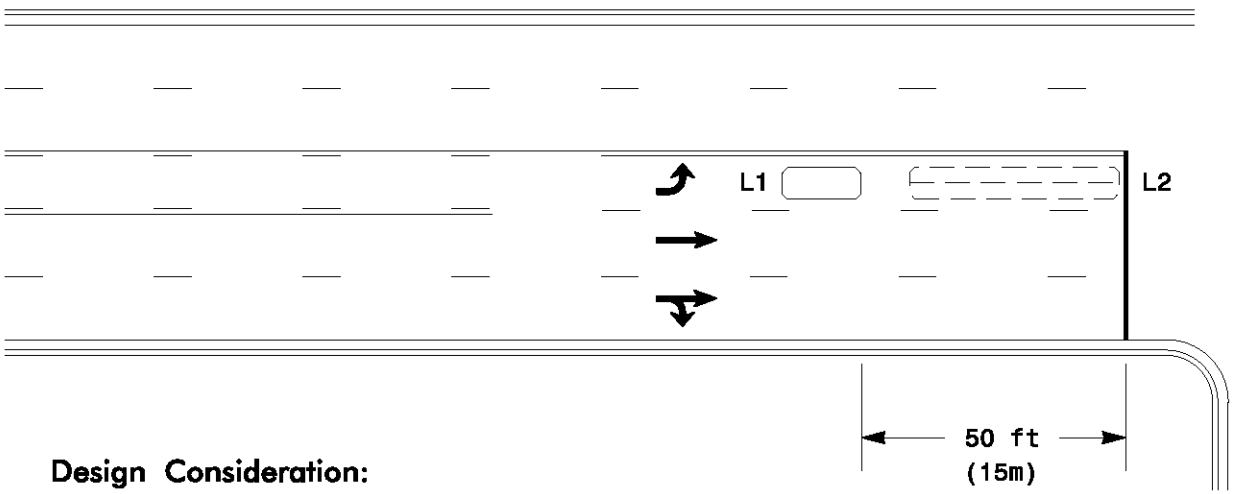
Loop Placement for Protected/Permissive Left Turns

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.3
SHEET 1 OF 2

Queue Detector Loop



L1 = 6ft X 15ft (1.8m X 4.5m)
Presence loop (Queue detector) with Call delay

L2 = 6ft X 40ft
(1.8m X 12.0m)
Quadrupole loop

Design Consideration:

-Calls up arrow when 3 or more cars waiting to turn
-Consider for side street left turns

Notes:

-L2 is optional when permitted phase has minimum recall
-L1 min green typically 8 seconds
-L1 gap time typically 2-4 seconds
-L2 gap time typically 1-3 seconds

Loop Type	Phase	Delay Time	Full Delay Time
L1: Queue Detector	Protected Phase	5-15 sec	No
L2: Left Turn Loop on Main Street with Low Speed or Stretch Detection	Permissive Phase	0 sec	N/A
L2: Left Turn Loop on Main Street with Volume Density Detection	Permissive Phase	3-5 sec	Yes
L2: Left Turn Loop on Side Street	Permissive Phase	2-3 sec if "clipping" prevention is desired; 0 sec otherwise	No

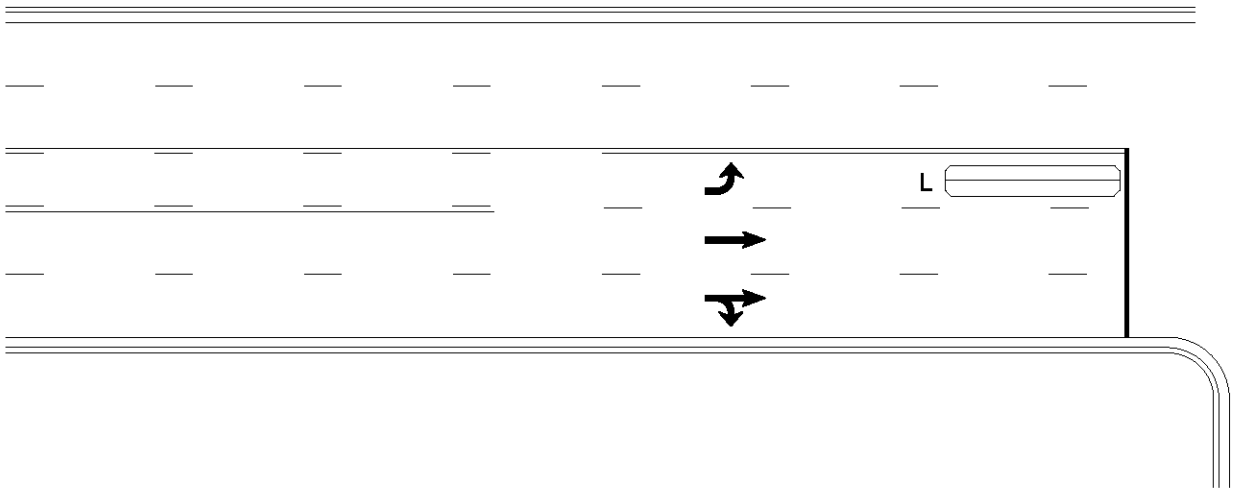
Loop Placement for Protected/Permissive Left Turns

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.3
SHEET 2 OF 2

Presence Detector



L = 6ft X 40ft (1.8m X 12.0m) Quadrupole

or, if longer detection area is needed:

6ft X 50ft (1.8m X 15.0m) Quadrupole

or

6ft X 60ft (1.8m X 18.0m) Quadrupole

Notes:

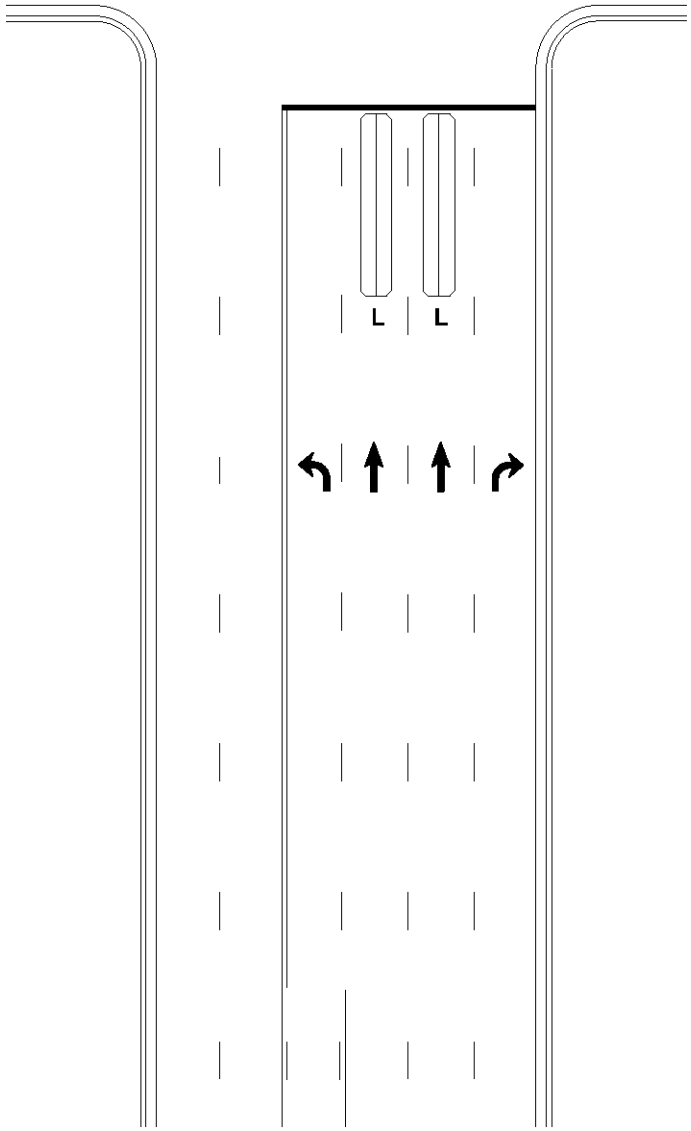
-Gap time typically 1-3 seconds
-A short (2 or 3 sec) call delay may be used if turning vehicles are able to "clip" loop L
-If call delay is used, do not program full time delay

Loop Placement for Protected Left Turns

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.4
SHEET 1 OF 1



Typical Presence Detection

L = 6ft X 40ft (1.8m X 12.0m)
Quadrupole loop
Wired to separate detectors/channels

or, if longer detection area is needed:

6ft X 50ft (1.8m X 15.0m) Quadrupole
or
6ft X 60ft (1.8m X 18.0m) Quadrupole

Notes:

- Consider delay (NOT full time) if through lane is shared with a right-turn move, except where right turn on red is prohibited
- Gap time typically 1-3 seconds
- Consider higher gap time or longer detection area under the following circumstances:
  - Steep positive approach grade
  - High truck volumes

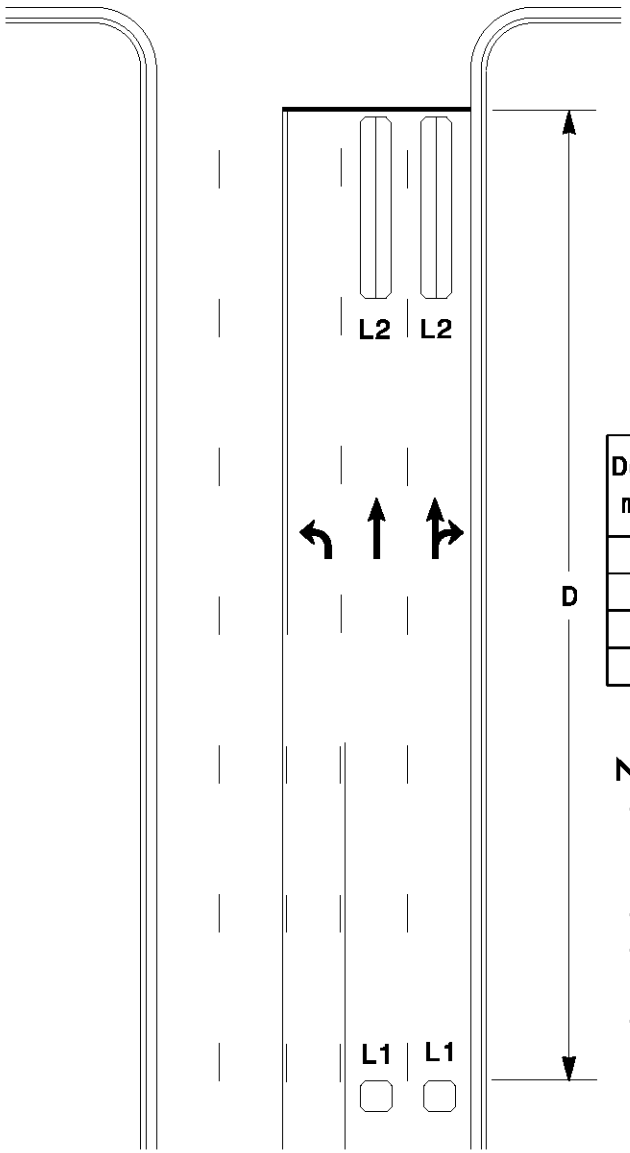
Loop Placement for Side Street Through Movements

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.5
SHEET 1 OF 3

Volume Density Operation with DC/EC
(Delayed Call/Extended Call



L1 = 6ft X 6ft (1.8m X 1.8m) Presence loop
Wired in series for TS1 Controllers
Wired to separate detectors/channels
for 170, TS2, and 2070 Controllers

L2 = 6ft X 40ft (1.8m X 12.0) Quadrupole loop
Wired to separate detectors/channels

Design Speed mph (km/hr)	D ft (m)	L2	
		Delay sec	Extend sec
40 (64)	250 (75)	5.0	2.0
45 (72)	300 (90)	5.0	2.0
50 (80)	355 (110)	5.0	2.0
55 (88)	420 (130)	5.0	2.0

Design Considerations:

-Cross intersection AND
-High speed [≥40 mph (64 km/hr)] AND
-Good horizontal and vertical alignment
-In some cases can provide better efficiency than "stretch" detection

Notes:

-Do not program "ACTUATIONS B4 ADD" (not applicable for 2070 controllers), "SEC. PER ACTUATION" and "MAX. INITIAL."
-Delay on loops L2 must be FULL TIME delay
-Do not program "Vehicle Call Memory" for phases 4 & 8.
-Loops L1 should be programmed for "EXTENSION" but NOT "CALLING."
-For TS2 controllers, loops L1 must be programmed with 100 second delay (INHIBIT DELAY DURING GREEN = YES) to ensure that the loop acts to extend the phase only.
-Loops L1 can double as system detectors if wired separately.

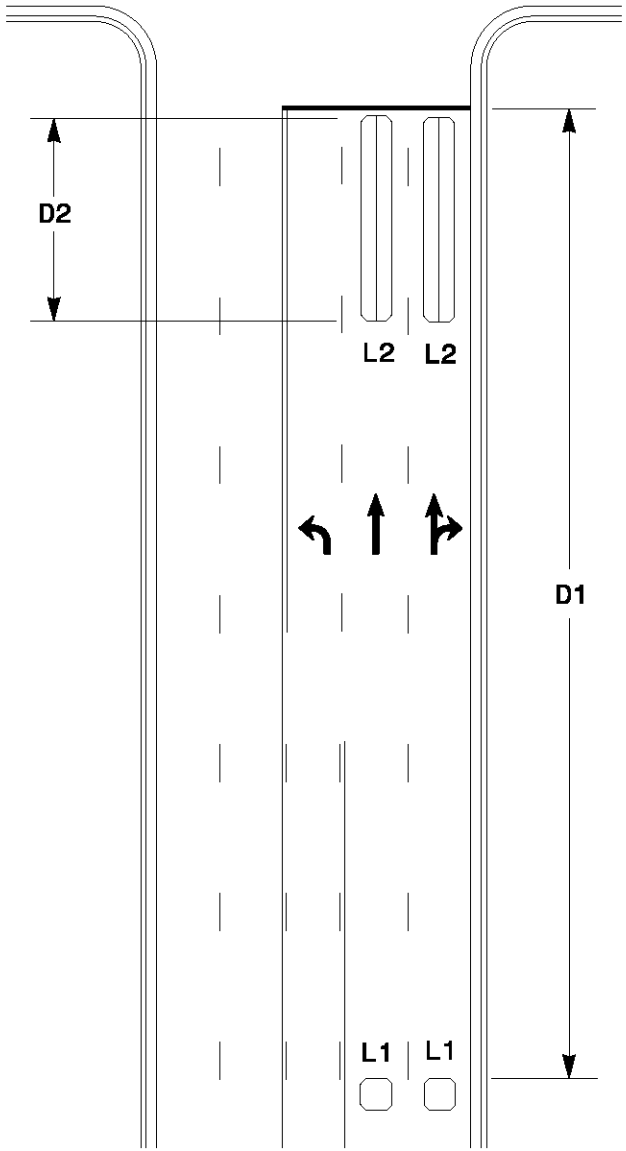
Loop Placement for Side Street Through Movements

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.5

Extend (Stretch) Detection



L1 = 6ft X 6ft (1.8m X 1.8m)
Presence loop, Wired in series

L2 = 6ft (1.8m) X D2 Quadrupole loop
Wired to separate detectors/channels

Design Speed mph (km/hr)	D1 ft (m)	D2 ft (m)	Gap Time sec	L1 Extend sec
40 (64)	250 (75)	40 (12)	2.0	2.1
		60 (18)	1.0	2.7
45 (72)	300 (90)	40 (12)	2.0	2.4
		60 (18)	1.0	3.1
50 (80)	355 (110)	40 (12)	2.0	2.8
		60 (18)	1.0	3.5
55 (88)	420 (130)	40 (12)	2.0	3.2
		60 (18)	1.0	3.9

Design Considerations:

-Cross intersection AND
-High speed [≥40 mph (64 km/hr)] AND
-Good horizontal and vertical alignment

Notes:

-Loops L1 should be programmed for "EXTENSION" but NOT "CALLING."
-For TS-1 controllers, round Extend time up to nearest 0.25 seconds.
-Loop placement may be varied due to design constraints such as bridges or poor pavement, or non-standard placement of existing loops. In such cases, recalculate Extend times for L1 (See Std. 4.1.1:3).
-For TS2 controllers, in addition to appropriate extend time, loops L1 must be programmed with 100 second delay (INHIBIT DELAY DURING GREEN = YES) to ensure that the loop acts to only extend the phase.
-Loops L1 can double as system detectors, if wired separately.

Loop Placement for Side Street Through Movements

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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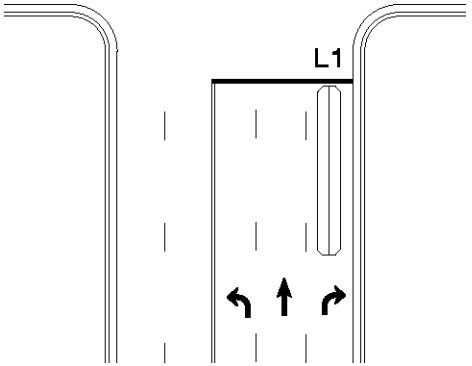
STD. NO.
4.1.5
SHEET 3 OF 3

Typical Detector Layouts

Standard Turn

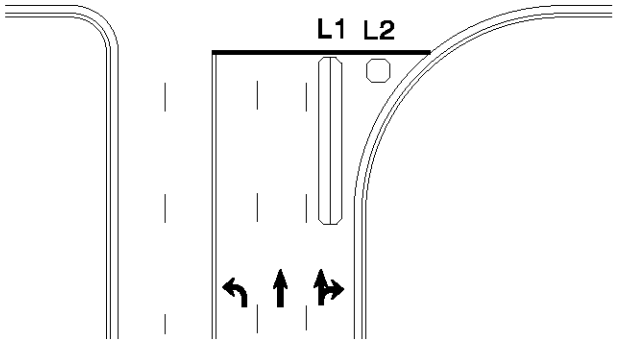


L1 = 6ft X 40ft (1.8m X 12.0m) Quadrupole loop
L2 = 6ft X 6ft (1.8m X 1.8m) [Minimum] Presence loop
Wired to separate detector/channel
L3 = 6ft X 30ft (1.8m X 9.0m) Quadrupole loop

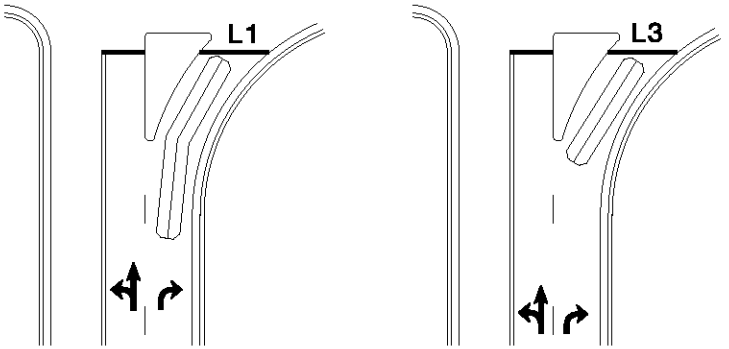
Notes:

-Call delay appropriate for right turn loops unless right turn on red is prohibited.
-Suggestions for delay:
-Exclusive right turn lane: 15 sec
-Right turn lane shared with through or through/ left movement: 10 sec or greater
-Do not program full time delay.

Wide Radius Turn



Channelized Turn



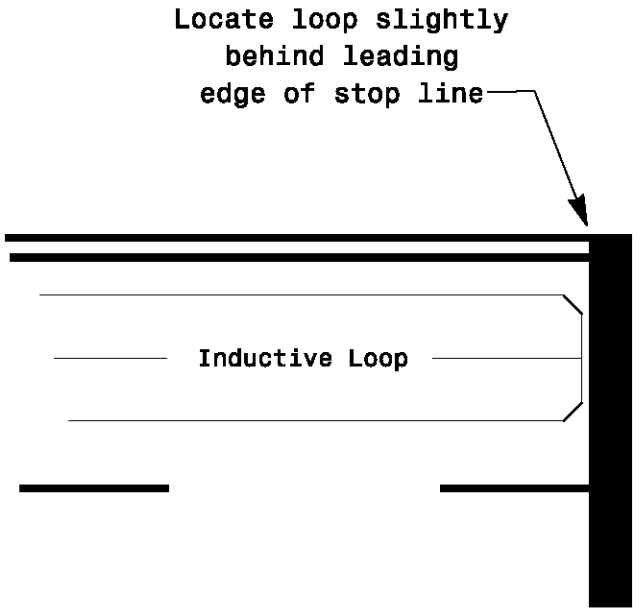
Delete detection for yield condition

Loop Placement for Side Street Right Turns

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.6
SHEET 1 OF 1



Note:

Loop may be located in advance of stop line when stop line is greater than 15′ (4.5m) from edge of intersecting roadway; or, when loop detects a permissive or protected/permissive left turn.

Placement of Presence Loops

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.1.7
SHEET 1 OF 1

Loop Dimension ft (m)	Turns	Inductance uh	Loop Wire ft (m)	Sealant gal * (liter)	Sawcut ft (m)
6 X 6 (1.8 X 1.8)	3	72	72 (22)	0.8 (3)	24 (7)
	4	120	96 (30)		
	5	180	120 (37)		
	6	252	144 (44)		
6 X 15 (1.8 X 4.5)	2	63	84 (26)	1.3 (5)	42 (13)
	3	126	126 (39)		
	4	210	168 (52)		
6 X 25 (1.8 X 7.5)	2-4-2	218	224 (69)	2.7 (10)	87 (27)
6 X 30 (1.8 X 9.0)	2-4-2	258	264 (81)	3.1 (12)	102 (31)
6 X 40 (1.8 X 12.0)	2-4-2	338	344 (105)	4.0 (16)	132 (41)
6 X 50 (1.8 X 15.0)	2-4-2	418	424 (130)	5.0 (19)	162 (50)
6 X 60 (1.8 X 18.0)	2-4-2	498	504 (154)	5.9 (23)	192 (59)

* Amount of sealant is rounded up to nearest tenth of a gallon or liter

Amount of Inductance, Loop Wire, Sealant and Sawcut for Inductive Loops

Calculate additional loop wire or sawcut for loop wire tail section by measuring length of tail section from loop to edge of pavement.

OR

ENGLISH $L\ (ft) = 6+(N-1)12$

METRIC $L\ (m) = 1.8+(N-1)3.6$

Where: L = Length of loop wire or sawcut
N = Number of lanes crossed by tail section

To calculate additional sealant for loop wire tail section:

ENGLISH $S\ (gal) = L\ (ft) / 33$

METRIC $S\ (liters) = L\ (m) / 2.6$

Where: S = Amount of sealant
L = Length of sawcut required for tail section

Loop Wire and Lead-In Calculations

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO. 4.2

Loop Inductance Notes

-Loop inductance should be equal to or greater than the lead-in inductance. A 2-to-1 ratio is preferable.

-Average lead-in cable inductance is .22μh/ft (.72μh/m)

-The minimum total inductance on a single digital detector (channel) is 50 uh, the maximum is 1000 μh.

-The maximum number of turns is 6.

-If the loop (excluding quadrupoles) will have more than 2″ (50mm) of cover, add 1 turn to the loop over the normal calculated number of turns.

-Loops connected in series

$L_{Total} = L_1 + L_2 + \ldots + L_N$

Where: N = Number of loops in series
L = Loop inductance (μh)

-Recommended number of turns for a single 6′ X 6′ (1.8m X 1.8m) loop:

Length of Lead-in ft (m)	Number of Turns
< 250 (75)	3
250-375 (75-115)	4
375-525 (115-160)	5
> 525 (160)	6

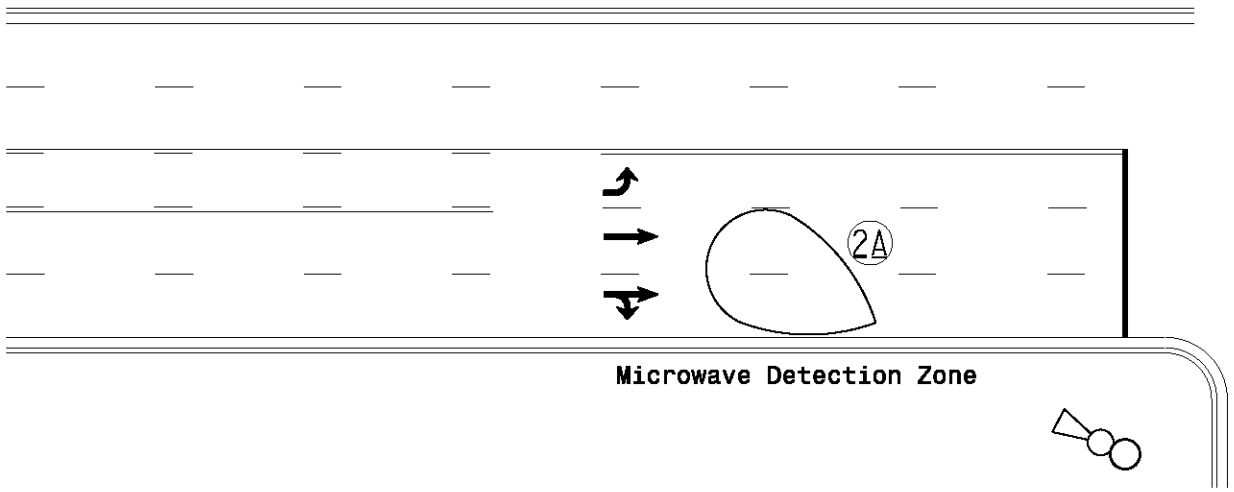
Loop Wire and Lead-In Calculations

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.2
SHEET 2 OF 2

Microwave Vehicle Detector



Design Consideration:

-Loops are not feasible due to bridges, poor pavement or anywhere loop lead-in can not be reasonably maintained such as constructions zones, etc.
-Typically used for only one to two detection areas, or one approach of an intersection.

Notes:

-Requires one microwave detector unit per detection zone.
-Microwave detector needs to face traffic.
-Some microwave detectors have specific detection zone size parameters based on mounting height and distance from zone.
-Cannot be used for system detection or vehicle counting.

2070L LOOP & DETECTOR INSTALLATION

INDUCTIVE LOOPS					DETECTOR PROGRAMMING							
LOOP	SIZE (FT)	TURNS	DISTANCE FROM STOPBAR (FT)	NEW LOOP	PHASE	CALLING	EXTENSION	FULL TIME DELAY	SYSTEM LOOP	STRETCH TIME	DELAY TIME	NEW CARD
2A	*	*	70	Y	2	Y	Y	-	-	-	- -	*

*Microwave Detection Zone

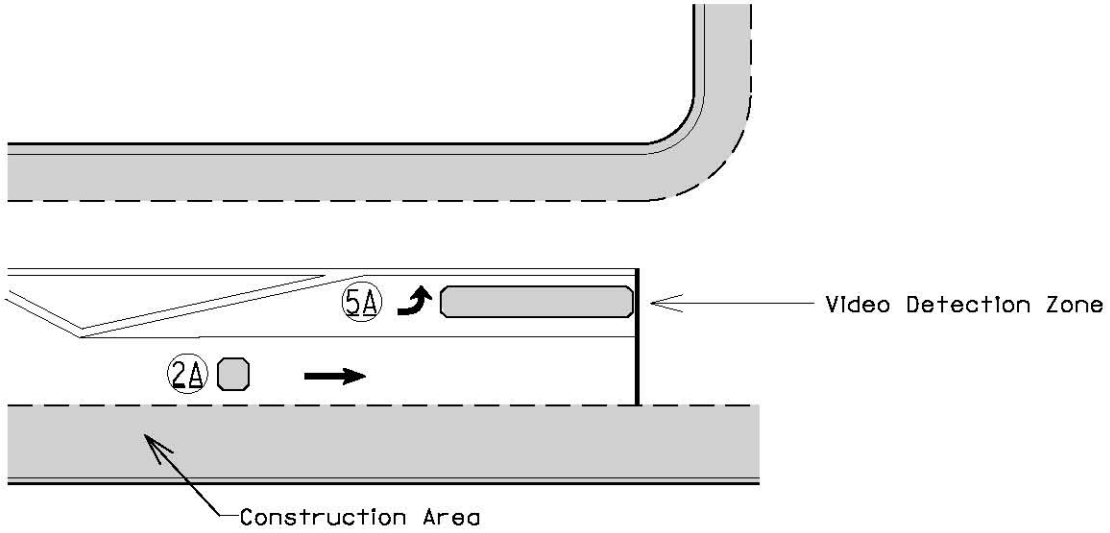
Out-of-Street Detection

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.3
SHEET 1 OF 2

Video Detection Systems
(Loop Emulator)



Design Consideration:

-Loops are not feasible due to bridges, poor pavement, or anywhere loop lead-in can not be reasonably maintained such as constructions zones, etc.
-Flexibility is desired in detection areas due to traffic shifts associated with constuction phasing
-All other detection options have been exhausted.

Notes:

-Cannot be used for vehicle counting.
-Cannot be used for system detection.

2070L LOOP & DETECTOR INSTALLATION

INDUCTIVE LOOPS					DETECTOR PROGRAMMING							
LOOP	SIZE (FT)	TURNS	DISTANCE FROM STOPBAR (FT)	NEW LOOP	PHASE	CALLING	EXTENSION	FULL TIME DELAY	SYSTEM LOOP	STRETCH TIME	DELAY TIME	NEW CARD
2A	6X6	*	70	*	2	Y	Y	-	-	-	- ·	*
5A	6X40	*	0	*	5	Y	Y	-	-	-	- ·	*

*Video Detection Zone

Out-of-Street Detection

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

5-05

STD. NO.
4.3
SHEET 2 OF 2

NOTES		WHEN TO USE	
L 01	Refer to "Roadway Standard Drawings NCDOT" dated July 2006 and "Standard Specifications for Roads and Structures" dated July 2006.	**H 01**	All Plans except Developer Plans
L 03	Refer to "Roadway Standard Drawings NCDOT" dated July 2006, "Standard Specifications for Roads and Structures" dated July 2006, and all applicable sections of the latest version of the generic Project Special Provisions. The PSP can be accessed at the following website: http://www.ncdot.org/doh/preconstruct/traffic/itss/	**H 03**	Developer Plans
L 04	Do not program signal for late night flashing operation unless otherwise directed by the Engineer.	**H 04**	For locations without railroad preemption
L 05	This location contains railroad preemption phasing. Do not program signal for late night flashing operation.	**H 05**	For locations with railroad preemption
L 10	Omit phase 1 during phase 2 on.	**H 10**	Phase omit note for TS1,TS2, and 2070 operation
L 11	Program phase 1 as protected/permissive.	**H 11**	Phase omit note for 170 operation
L 12	Omit phase 5 during phase 6 on.	**H 12**	Phase omit note for TS1,TS2, and 2070 operation
L 13	Program phase 5 as protected/permissive.	**H 13**	Phase omit note for 170 operation
L 14	Omit phase 3 during phase 4 on.	**H 14**	Phase omit note for TS1,TS2, and 2070 operation
L 15	Program phase 3 as protected/permissive.	**H 15**	Phase omit note for 170 operation
L 16	Omit phase 7 during phase 8 on.	**H 16**	Phase omit note for TS1,TS2, and 2070 operation
L 17	Program phase 7 as protected/permissive.	**H 17**	Phase omit note for 170 operation
L 18	Wire cabinet to allow the controller to clear from phase # to phase # by progressing through phase # (see Electrical Details for wiring).	**H 18**	Additional note for omit situations for TS1 operation
L 19	Program controller to clear from phase # to phase # by progressing through phase # (see Electrical Details).	**H 19**	Additional note for omit situations for TS2, 2070, and 170 operation
L 20	Enable Backup Protect for phase # to allow the controller to clear from phase # to phase # by progressing through an all red display.	**H 20**	Alternate to Phase Omits in 2070s. Used with Red Revert.
L 21	Disable Backup Protect for phase #.	**H 21**	Use for FYA plans with existing 2070 cabinets where backup protection is no longer needed.

NOTES		WHEN TO USE	
L 22	Phase 1 and/or phase 5 may be lagged.	**H 21**	Use for exclusive left turns and Flashing Yellow Arrows
L 23	Phase 3 and/or phase 7 may be lagged.	**H 22**	Use for exclusive left turns and Flashing Yellow Arrows
L 24	The order of phase 3 and phase 4 may be reversed.	**H 23**	Use for split side streets
L 25	Program phase 4 and phase 8 for dual entry.	**H 24**	For use with TS-1 or TS-2 equipment
L 30	Relocate existing signal heads numbered #.	**H 30**	Use when head is moved to new span
L 31	Reposition existing signal heads numbered #.	**H 31**	Use when head is "slid" on same span
L 32	Install backplates for signal heads numbered #.	**H 32**	As needed
L 33	Tether signal heads numbered #.	**H 33**	As needed
L 40	Run all lead-in cable overhead on existing utility poles where possible.	**H 40**	Urban projects with many driveways
L 41	Abandon existing loops #.	**H 41**	As needed, usually by contracts
L 42	Use controller input delay for phase #. Override channel # call delay during peak hours.	**H 42**	Add this note for variation on protected-permissive design.
L 43	Set all detector units to presence mode.	**H 43**	All Plans
L 44	In the event of loop replacement, refer to the current ITS and Signals Design Manual and submit a Plan of Record to the Signal Design Section.	**H 44**	Use when not replacing “old style” loops
L 50	Locate new cabinet so as not to obstruct sight distance of vehicles turning right on red.	**H 50**	All plans with new cabinets
L 51	The cabinet should be designed to include an Auxiliary Output File for future use.	**H 51**	Use on plans with new 2070 cabinets and no FYA
L 52	Program all timing information into phase banks 1, 2, and 3 unless otherwise noted.	**H 52**	Standard with 170 operation
L 53	Set phase bank 3 maximum limit to 250 seconds for phases used.	**H 52**	Signal system plans with 170s
L 60	Omit "WALK" and flashing "DON'T WALK" with no pedestrian calls.	**H 60**	Use for pedestrian-activated signals

NOTES		WHEN TO USE	
L 61	Program pedestrian heads to countdown the flashing "Don't Walk" time only.	**H 61**	Use with countdown peds
L 70	Flash beacon # continuously.	**H 70**	Actuated flasher plan
L 71	Flash beacons # when actuated by loop #.	**H 71**	Actuated flasher plan
L 80	Thirty days after implementation of the revised signal operation, signs # and/or orange flags may be removed at the discretion of the Regional Traffic Engineer.	**H 80**	Use on plans being revised from fully protected or split side street phasing to protected-permissive phasing
L 81	Remove existing "Left Turn Signal" sign(s)-(R10-10L) and/or existing "Right Turn Signal" sign(s)-(R10-10R).	**H 81**	As needed
L 82	Existing "Left Turn Yield on Green" ball sign(s)-(R10-12) may be removed at the discretion of the Regional Traffic Engineer.	**H 82**	As needed
L 90	Pavement markings are existing.	**H 90**	Signal upgrades
L 91	Repaint stopbars and/or crosswalks.	**H 91**	As needed
L 92	Install pavement markings to designate lane separations for **APPROACH**.	**H 92**	As needed
L 93	Revise pavement markings as shown. All pavement markings and raised reflective markings shown are a representation of actual placement criteria. Refer to NCDOT Roadway Standard Drawings actual placement.	**H 93**	Safety plan with proposed reflectorized markings
L 100	Install box span, if possible.	**H 100**	As needed
L 110	This is a proposed plan view only. Field adjust all drainage, superelevation, utility conflicts, and grade changes.	**H 110**	Geometric changes only.
L 120	Locate emergency vehicle preemption switch in **LOCATION**.	**H 120**	Emergency vehicle preemption (pushbutton actuated)
L 121	The Division Traffic Engineer will determine the Delay Time and Preempt Dwell Min Time for the emergency vehicle preemption timing.	**H 121**	Emergency vehicle preemption (pushbutton actuated)
L 122	This intersection features an optical preemption system. Shown locations of optical detectors are conceptual only.	**H 122**	Optical preemption

NOTES	WHEN TO USE
L 123 Program signal heads numbered # to clear to all red before going into preempt.	**H 123** Use in place of dummy phase for emergency vehicle preemption
L 124 Ensure flashing operation does not alter operation of blankout signs.	**H 124** Standard with RR preemption with blank-out signs
L 125 Clear signal heads numbered # from flashing 8" yellow to steady 12" yellow during interval 1 and steady red during interval 2.	**H 125** RR preemption plans with advance flashing heads (for non-standard clearance)
L 126 Program start vehicle call OFF for phase #.	**H 126** RR preemption plans with preempt phase that does not have corresponding regular phase (170 controller)
L 127 Program parent phases for Overlap "P" for all phases used in normal operation.	**H 127** Most signal plans with railroad preemption that have a Track Clearance phase.
L 128 Upon completion of Railroad (or Emergency Vehicle) Preemption, controller returns to normal operation based on vehicle demand.	**H 128** RR or EV Preemption plan when an exit phase (first normal phase served after preemption) is not or cannot be designated
L 129 The Division Traffic Engineer will determine the hours of use for each phasing plan.	**H 129** Flashing Yellow Arrow plans designed with multiple or time of day phasing options.
L 131 These loops serve as queue backup detectors. After # seconds of constant actuation, the detector unit places a call to the controller to preempt normal operation to clear out the storage lanes.	**H 131** Backup queue detectors
L 132 Existing Yellow Change Interval for phase # may be decreased by # seconds per week until the required value is reached.	**H 132** Major adjustments to clearance times
L 133 Maximum times shown in timing chart are for free-run operation only. Coordinated signal system timing values supersede these values.	**H 133** Standard with coordination
L 134 Closed loop system data: Intersection Number #, Local telemetry address number #, Channel number #.	**H 134** Closed loop signal system plans
L 135 Closed loop system data: Master Asset #, Controller Asset #.	**H 135** 2070 Closed loop signal system plans

OASIS 2070L LOOP & DETECTOR INSTALLATION CHART

	INDUCTIVE LOOPS					DETECTOR PROGRAMMING							
	LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	PHASE	CALLING	EXTENSION	FULL TIME DELAY	STRETCH TIME	DELAY TIME	SYSTEM LOOP	NEW CARD
Volume density loops combined w/system loops	2A/S1	6X6	420	5	Y	2	Y	Y	–	–	–	Y	Y
	2B/S2	6X6	420	5	Y	2	Y	Y	–	–	–	Y	Y
Queue Detector	3A	6X15	50	3	Y	3	Y	Y	–	–	15	–	Y
	8A	6X40	+5	2–4–2	Y	8	Y	Y	–	–	–	–	Y
Volume Density with DC/EC for sidestreet	4A	6X6	300	5	Y	4	–	Y	–	–	–	–	Y
	4B	6X40	0	2–4–2	Y	4	Y	Y	Y	2.0	5	–	Y
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X60	0	2–4–2	Y	5	Y	Y	–	–	15	–	Y
						2	Y	Y	Y	–	3	–	Y
Stretch loops	6A, 6B	6X6	300	EXISTING	–	6	Y	Y	–	1.6	–	–	Y
	6C, 6D	6X6	90	EXISTING	–	6	Y	Y	–	–	–	–	Y
System Loop	S3	6X6	+120	4	Y	–	–	–	–	–	–	Y	Y

Oasis 2070L Controller

Detector Programming Attributes

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Extension - Select to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Full Time Delay - Select to delay during red, yellow, and green. If not selected, controller will time delay during red and yellow only. Selecting this attribute is equivalent to selecting NO for NEMA's "Inhibit Delay During Green." (Usually not selected)

Stretch Time - Enter times in intervals of .1 second

Loop Chart Typicals

SIGNAL DESIGN SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SE-PAC 2070: Use with Burlington, Hickory and Raleigh Signal Systems

SE-PAC 2070 LOOP & DETECTOR UNIT INSTALLATION CHART

	INDUCTIVE LOOPS						DETECTOR PROGRAMMING																	
								TIMING		OPERATION MODE												STATUS	
										0	1	2	3	4	5	6	7						
	LOOP NO.	SIZE (ft)	TURNS	DIST. FROM STOPBAR (ft)	NEW	EXISTING	ASSIGNED PHASE	DELAY	EXTEND (STRETCH)	VEHICLE	PEDESTRIAN	1 CALL	STOP A	STOP B	PROT/PER LEFT	PROT/PER THROUGH	AND	SWITCH	SYSTEM LOOPS	NEW	EXISTING
VD loops combined w/system loops	2A/S1	6X6	5	300	X	–	2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
	2B/S2	6X6	5	300	X	–	2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Volume Density with DC/EC for sidestreet	4A	6X6	5	300	X	–	4	100 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
	4B	6X40	2–4–2	0	X	–	4	5 SEC.	2.0 SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Left turn loop calling 2 phases	5A	6X40	2–4–2	0	X	–	5	15 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
							2	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Stretch loops	6A, 6B	6X6	5	300	X	–	6	– SEC.	1.6 SEC.	X	–	–	–	–	–	–	–	–	X	X	–
	6C, 6D	6X6	5	90	X	–	6	– SEC.	– SEC.	X	–	–	–	–	–	–	–	–	X	X	–
Protected Left Turn Loop	7A	6X40	2–4–2	0	X	–	7	3 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
Sidestreet Loop	8A	6X40	2–4–2	0	X	–	8	10 SEC.	– SEC.	X	–	–	–	–	–	–	–	–	–	X	–
System Loop	S3	6X6	5	+125	X	–	–	– SEC.	– SEC.	–	–	–	–	–	–	–	–	–	X	X	–

Detector Programming Attributes

Vehicle- Vehicle detector operates as standard vehicle detector

Pedestrian - Vehicle detector operates as standard pedestrian detector (Not Used)

1 Call - Typically Not Used

Stop A - Typically Not Used

Stop B - Typically Not Used

Prot/Per Left - Typcially Not Used

Prot/Per Through - Typically Not Used

And - Typically Not Used

Switch - List an alternate phase that could be extended when green by loop detection while the assigned primary phase is red (Not Normally Used)

Extend (Stretch) - Enter times in intervals of .1 second

SE-PAC cannot be programmed for Full Time Delay

NAZTEC 2070: Use with Greensboro Signal System

LOOP & DETECTOR UNIT INSTALLATION CHART
NAZTEC APOGEE SOFTWARE 2070 CONTROLLER

	INDUCTIVE LOOPS					DETECTOR PROGRAMMING								
	LOOP	SIZE (FT)	DISTANCE FROM STOPBAR (FT)	TURNS	NEW LOOP	PHASE	SWITCH (PHASE)	DELAY TIME	STRETCH TIME	CALLING	EXTENSION	ADDED INIT.	SYSTEM LOOP	NEW CARD
P/P Left turn loop calling 2 phases	1A	6X40	0	2-4-2	X	1	6	15	–	X	X	–	–	X
VD loop combined w/system loop	2A/S1	6X6	300	5	X	2	–	–	–	X	X	X	X	X
	2B/S2	6X6	300	5	X	2	–	–	–	X	X	X	X	X
Stretch Detection for sidestreet	4A	6X6	300	5	X	4	–	–	3.4	–	X	–	–	X
	4B	6X40	0	2-4-2	X	4	–	10	–	X	X	–	–	X
P/P Left turn loop calling 2 phases	5A	6X40	0	2-4-2	X	5	2	15	–	X	X	–	–	X
Stretch loops	6A, 6B	6X6	300	5	X	6	–	–	1.6	X	X	–	–	X
	6C, 6D	6X6	90	4	X	6	–	–	–	X	X	–	–	X
Protected left turn phase loop	7A	6X40	0	2-4-2	X	7	–	3	–	X	X	–	–	X
Sidestreet loop	8A	6X40	0	2-4-2	X	8	–	10	–	X	X	–	–	X
System Loop	S3	6X6	+125	5	X	–	–	–	–	–	–	–	X	X

2070 Controller w/Naztec Apogee Software

Detector Programming Attributes

Switch (Phase) - Typically used for protected/permitted left turns to call and extend the (primary) protected phase after the side street is serviced and extend the (secondary) permitted time for the corresponding adjacent through phase.

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Extension - Select to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Added Init. - Volume-density feature that extends the Minimum Green timer. Use if loop operates using volume-density detection

Stretch Time - Enter in intervals of .1 second

Naztec Apogee cannot be programmed for Full Time Delay

NEMA LOOP & DETECTOR INSTALLATION CHART
with TS-1 CABINET

	INDUCTIVE LOOPS						DETECTOR UNITS								
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	UNIT NO.	NEW	EXISTING	CHANNEL	NEMA PHASE	TIMING		PLACE CALL DURING PHASE	INHIBIT DELAY DURING GREEN?
												FEATURE	TIME		
Volume density loop	2A	6X6	300	4	X		1		X	1	2	–	–	ALL	NO
Volume Density with DC/EC for sidestreet	4A	6X6	300	4	X		2		X	1	4	–	–	4	NO
	4B	6X40	0	2–4–2	X					2	4	DC/EC	5/2	ALL	NO
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X40	0	2–4–2	X		3	X		1	5	DELAY	15	ALL	YES
										2	2	DELAY	3	2	NO
Stretch Loops	6A, 6B	6X6	300	4	X		4		X	1	6	EXTEND	1.75	ALL	NO
	6C, 6D	6X6	90	4	X					2	6	–	–	ALL	NO
Sidestreet loop	8A	6X40	0	EXIST		X	1		X	2	8	–	–	ALL	NO
System Loop	SD1	6X6	+150	4	X		5	X		2	System Detector				

TS–1 Cabinet

Enter Stretch times in intervals of .25 second

Both of these charts are also used for Cary Signal System (2070N Equipment)

NEMA LOOP & DETECTOR INSTALLATION CHART
with TS-2 CABINET

	INDUCTIVE LOOPS						DETECTOR UNITS					
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	NEMA PHASE	NEW	EXISTING	TIMING		INHIBIT DELAY DURING GREEN?
										FEATURE	TIME	
Volume density loop combined w/ System Loop	2A/SD1	6X6	300	4	X		2	X		–	–	NO
							–	X		System Detector		
Volume Density with DC/EC for sidestreet	4A	6X6	300	4	X		4	X		DELAY	100	YES
	4B	6X40	0	2–4–2	X		4	X		DC/EC	5/2	NO
Left turn loop calling 2 phases (with volume density on phase 2)	5A	6X40	0	2–4–2	X		5	X		DELAY	15	YES
							2			DELAY	3	NO
Stretch loops	6A	6X6	300	4	X		6		X	EXTEND	1.6	NO
	6B	6X6	90	4	X		6			–	–	NO
Sidestreet loop	8A	6X40	0	EXIST		X	8	X		–	–	NO
System Loop	SD2	6X6	+150	4	X		–	X		System Detector		

TS–2 Cabinet

Enter Stretch times in intervals of .1 second

Loop Chart Typicals

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170 LOOP & DETECTOR INSTALLATION CHART

	INDUCTIVE LOOPS						DETECTOR PROGRAMMING															
								TIMING		ATTRIBUTES									STATUS			
										1	2	3	4	5	6	7						
	LOOP	SIZE (ft)	DIST. FROM STOPBAR (ft)	TURNS	NEW	EXISTING	NEMA PHASE	DELAY	CARRY (STRETCH)	FULL TIME DELAY	PEDESTRIAN CALL	RESERVED	COUNT	EXTENSION	TYPE 3	CALLING	SYSTEM LOOPS	NEW	EXISTING
Volume density loop	2A	6X6	300	4	X		2	– SEC.	– SEC.	–	–	–	X	X	–	X	–	–	X
Volume Density with DC/EC for sidestreet	4A	6X6	300	EXIST		X	4	– SEC.	– SEC.	–	–	–	–	X	–	–	–	–	X
	4B	6X40	0	2–4–2		X	4	5 SEC.	2.0 SEC.	X	–	–	–	X	–	X	–	–	X
Left turn loop calling 2 phases (with omit phase programmed)	5A	6X40	0	2–4–2	X		5	30 SEC.	– SEC.	–	–	–	–	X	–	X	–	X	–
							4	30 SEC.	– SEC.	–	–	–	–	–	–	X	–	X	–
							2	3 SEC.	– SEC.	X	–	–	–	X	–	X	–	X	–
Stretch loops	6A, 6B	6X6	300	4	X		6	– SEC.	1.6 SEC.	–	–	–	–	X	–	X	–	–	X
	6C, 6D	6X6	90	4	X		6	– SEC.	– SEC.	–	–	–	–	X	–	X	–	–	X
Sidestreet loop	8A	6X40	0	EXIST		X	8	– SEC.	– SEC.	–	–	–	–	X	–	X	–	–	X
Pedestrian pushbutton	P81, P82	N/A	N/A	N/A	X		8	– SEC.	– SEC.	–	X	–	–	–	–	–	–	–	–
System Loop	SD1	6X6	+150	3	X		–	– SEC.	– SEC.	–	–	–	–	–	–	–	X	X	–

170 Controller

(Use for Durham Signal System)

Detector Programming Attributes

Full Time Delay - Select to delay during green and red. If not selected, controller will time delay during red only. Selecting this attribute is equivalent to selecting NO for NEMA's "Inhibit Delay During Green." (Usually not selected)

Pedestrian Call - Select to assign as a pedestrian detector. Used with ped push-button.

Reserved - Currently not in use. (Not selected)

Count - Select to count vehicles. (Usually selected with volume density loops)

Extension - This allows the detector to extend the green time. Gap resets after each call. Must be selected whenever Vehicle Extension Time is entered in the timing chart. (Usually selected)

Type 3 - This attribute will place call during green until the call drops or the Type 3 Limit expires. Once the Type 3 detector drops off it will not be active until the next phase. This attribute is similar to NEMA's EC/DC operation except that the loop is disconnected after a set time instead of after a gap in traffic. (Usually not selected)

Calling - Select to place call during red. Selecting this attribute is similar to selecting ALL for NEMA's "Place Call During Phase." (Usually selected)

Carry (Stretch) - Enter times in intervals of .1 second

Loop Chart Typicals

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Oasis 2070L Timing Chart (Part 1)

For All Plans

- Main Street:
  55 mph (88 km/hr) - 14 sec
  50 mph (80 km/hr) - 14 sec
  45 mph (72 km/hr) - 12 sec
  40 mph (64 km/hr) - 12 sec
  ≤35 mph (56 km/hr) - 10 sec

  Side Streets, Lefts, and Main Street Stopbar Detection:
  Set to 4-8 sec, depending on size of detection area, grade, truck traffic, etc.
  Typically 7 sec.

- Main Street - Typically 2.0 sec for stretch detection, 3.0 sec for low speed detection. For volume density, amount of time required to get vehicle traveling 5 mph (8 kph) under the speed limit from upstream loop to stop line, generally 6.0 sec.
  Side Street - Typically 1.0-3.0 sec. Adjust for size of detection area, grade, truck traffic, etc.

- Maximum green times may be determined with the help of a software package. Alternately, a hand calculation may be suitable:

$$\text{Max Green} = 4 + 2\left(\frac{\text{Heaviest PHV per lane}}{\text{3600/est cycle length}}\right)$$

  PHV = Peak hour volume

- See STD. NO. 5.2.2
- A type of Backup Protection. Typically set to 5.0 for phase(s) used, otherwise default is 2.0 sec. (See Std. 2.3)
- Typically 4-7 seconds
- See STD. NO. 6.0
- None, Min Recall, Max Recall, Soft Recall, Ped Recall or Ped Soft Recall
- None, Red, or Yellow (See Definitions)
- On or not selected (see Definitions)
- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Extension 1 to 0.0 and Recall Position to Max Recall. Enter N/A for Vehicle Call Memory.

OASIS 2070L TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
• Min Green 1*	10	7	7
• Extension 1*	3.0	1.0	3.0
• Max Green 1*	45	20	25
• Yellow Clearance	3.6	3.7	3
• Red Clearance	1.9	2.1	
• Red Revert	5.0	2.0	
• Walk 1*	4	-	
• Don't Walk 1	12	-	
Seconds Per Actuation*	-	-	
Max Variable Initial*	-	-	
Time Before Reduction*	-	-	
Time To Reduce*	-	-	
Minimum Gap	-	-	
• Recall Mode	MIN RECALL	-	
• Vehicle Call Memory	YELLOW	-	
• Dual Entry	-	O	
• Simultaneous Gap	ON		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Oasis 2070L Timing Chart (Part 2)

For Volume Density Plans (See 5.2.3 Sheet 1)

Variable Initial Features (Time only during non-green portion of phase)

- Amount added to Variable Initial Time (starting at 0) for each actuation of detector loops. Typical values:
  2.5 secs for single through lane
  1.5-1.8 sec for two through lanes
  1.0-1.5 sec for three through lanes
  When traffic is more evenly distributed over multiple lanes, use lower number. Increase for high truck traffic.

- Time needed to service a queue reaching from detector loop to stop line. Calculated by:

$$\text{Maximum Variable Initial} = 4 + 2\left(\frac{\text{Distance to loop}}{\text{Std veh length} = 20' (6m)}\right)$$

Gap Reduction Features (Time only during green portion of phase)

- Time that expires before gap reduction begins. Prevents premature transfer of green. Typically 15-30 secs, but never less than the minimum green.
  For sidestreet Volume Density, may use 0 or 5 sec.
- Amount of time over which gap time will reduce from initial value (Extension 1) to minimum value (Minimum Gap). Typically 30-60 secs.
  For sidestreet Volume Density, may use 15 or 20 sec.
- Set equal to lowest gap time that allows vehicle to clear dilemma zone. Typically 3.0 sec - 4.0 sec., but no lower than 3.4 sec. for 55 MPH

Notes:
-The sum of the Time Before Reduction and the Time to Reduce should not exceed the Max Green 1 time.
-The Extension 1 resets to the initial value if the serviceable conflicting call is removed (eg. Turns right on red).

OASIS 2070L TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
Min Green 1*	12	7	7
Extension 1*	6.0	6.0	2.0
Max Green 1*	90	30	25
Yellow Clearance	4.3	3.6	3.1
Red Clearance	1.4	2.1	2
Red Revert	5.0	2.0	
Walk 1*	4	–	
Don't Walk 1	12	–	
• Seconds Per Actuation*	1.5	–	
• Max Variable Initial*	34	–	
• Time Before Reduction*	15	0	
• Time To Reduce*	30	15	
• Minimum Gap	3.0	3.0	
Recall Mode	MIN RECALL	–	
Vehicle Call Memory	YELLOW	–	
Dual Entry	–	O	
Simultaneous Gap	ON		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

SE–PAC 2070 Timing Chart
(Burlington, Hickory and Raleigh Signal Systems)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See Sheet 1, Max Green 1
- See STD. NO. 5.2.2
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial
- See Sheet 2, Time Before Reduction
- See Sheet 2, Time to Reduce
- See Sheet 2, Minimum Gap

For All Plans

- None, Min Recall, Max Recall, Soft Recall, or Ped Recall
- Lock or Non-Lock (See Definitions)
- On or not selected (see Definitions)
- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Extension 1 to 0.0 and Recall Position to Max Recall. Enter Non-Lock for Vehicle Call Memory.

Note: SE-PAC Software cannot use Red Revert for backup protection. Phase omits must be used.

SE-PAC 2070 TIMING CHART

FEATURE	2	4	5
Min Green *	10	7	7
Passage Gap *	3.0	2.0	2.0
Maximum Green *	45	25	15
Yellow Change	3.9	3.4	3.0
Red Clear	1.8	2.1	2.2
Walk *	–	–	–
Pedestrian Clear	–	–	–
Added Initial *	–	–	
Maximum Initial *	–	–	
Time Before Reduction *	–	–	
Time To Reduce *	–	–	
Minimum Gap	–	–	
Recall Mode	MIN RECALL	–	
Vehicle Call Memory	LOCK	NON–LOCK	
Dual Entry	–	ON	
Simultaneous Gap	ON	ON	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Naztec Apogee 2070 Timing Chart
(Greensboro Signal System)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See Sheet 1, Max Green 1
- See STD. NO. 5.2.2
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial
- See Sheet 2, Time Before Reduction
- See Sheet 2, Time to Reduce
- See Sheet 2, Minimum Gap

For All Plans

- None, Min Recall, Max Recall, Soft Recall, or Ped Recall
- Yes or No (See Definitions)
- On or not selected (see Definitions)
- On or not selected, usually selected (see Definitions)

Note: For Pre-Timed Signal, set Gap, Extension 1 to 0.0 and Recall Position to Max Recall. Enter No for Lock Calls.

Note: Naztec Apogee Software can not use Red Revert for backup protection. Phase omits must be used.

NAZTEC APOGEE 2070 TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 5
• Min Green *	12	7	7
• Gap, Extension *	6.0	2.0	2.0
• Maximum Green 1 *	90	30	20
• Maximum Green 2 *	110	25	25
• Yellow Clear	5.1	3.8	3.0
• Red Clear	1.2	1.9	2.1
• Walk *	4	–	–
• Pedestrian Clear	16	–	–
• Added Initial *	1.5	–	
• Maximum Initial *	34	–	
• Time Before Reduction *	15	–	
• Time To Reduce *	60	–	
• Minimum Gap	3.0	–	
• Recall Mode	MIN RECALL	–	
• Lock Calls	YES	NO	
• Dual Entry	–	ON	
• Simultaneous Gap	ON	ON	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

NEMA Timing Chart (Also for Cary 2070N Signal System)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See STD. NO. 5.2.2
- See Sheet 1, Max Green 1
- None, Min Recall, Max Recall, Soft Recall or Ped Recall
- Lock or Nonlock
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1

For Volume Density Plans (See 5.2.3 Sheet 1)

Variable Initial Features (Active only during non-green portion of phase)

- Number of vehicles that arrive that will not count toward Maximum Initial value. For most controllers, this value is zero. If needed (such as Traconex TMP 390 and Minnesota Microtronics 800 controllers), the Actuation B4 Add may be calculated:

  $$\text{Actuation B4 Add} = \frac{\text{Min green} - 4}{2}$$

- Amount added to Variable Initial Time (starting at 0) for each actuation of detector loops. Typical values:
  - 2.5 secs for single through lane
  - 1.5-1.8 sec for two through lanes
  - 1.0-1.5 sec for three through lanes

  When traffic is more evenly distributed over multiple lanes, use lower number. Increase for high truck traffic. For the Traconex and Minnesota Microtronics controllers:
  - 2.0 secs for single through lane
  - 1.3-1.5 sec for two through lanes
  - 1.0-1.3 sec for three through lanes
- See Sheet 2, Maximum Variable Initial

Gap Reduction Features (see Sheet 2)

Notes:
- The sum of the Time Before Reduction and the Time to Reduce should not exceed the Max Green 1 time.
- The Passage/Gap resets to the initial value if the serviceable conflicting call is removed (eg. Turns right on red).

NEMA TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 6
• Minimum Green*	12	7	12
• Passage/Gap*	6.0	1.0	6.0
• Yellow Change Int	4.3	3.6	4.
• Red Clearance	1.4	2.1	1
• Maximum 1*	90	20	
• Recall Position	MIN RECALL	NONE	
• Vehicle Call Memory	LOCK	NONLOCK	
• Walk *	4	-	
• Flashing Don't Walk	12	-	
Volume Density	ON	OFF	
• Actuation B4 Add*	0	-	
• Sec Per Actuation*	2.5	-	
• Maximum Initial*	34	-	
• Time B4 Reduction*	15	-	
• Time To Reduce*	30		
• Minimum Gap	3.0		

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Note: For Pre-Timed Signal, set Passage/Gap to 0.0 and Recall Position to Max Recall. Enter N/A for Vehicle Call Memory.

Note: NEMA Equipment cannot use Red Revert for backup protection. Phase omits must be used.

170 Timing Chart (Durham Signal System)

For All Plans

- See Sheet 1, Min Green 1
- See Sheet 1, Extension 1
- See STD. NO. 5.2.2
- See Sheet 1, Max Green 1
- None, Veh Recall, Ped Recall, Max Recall, Soft Recall
- None, Yellow Lock, Red Lock
  Yellow Lock begins locking call during yellow, Red Lock begins locking call during red. Typically None for stopbar detection and Yellow Lock for setback detection.
- On or Off
- See Sheet 1, Walk 1
- See Sheet 1, Don't Walk 1
- Used with Type 3 Limit Detector Attribute, See STD NO. 5.2:3

For Volume Density Plans (See 5.2.3 Sheet 2)

Variable Initial Features (Active only during non-green portion of phase)

- See Sheet 2, Seconds per Actuation
- See Sheet 2, Maximum Variable Initial

Gap Reduction Features (Time only during green portion of phase)

- The gap the controller starts reducing from. Unlike NEMA and 2070L controllers, the 170 starts reducing this gap immediately. Typically 6.8-8.0 secs. If Volume Density is not used, enter Vehicle Extension time, as a time must be entered.
- Maximum Gap reduces by 0.1 sec after this much time until it reduces to the Minimum Gap. Typically 1.0-2.4 secs.
- See Sheet 2, Minimum Gap. If Volume Density is not used, enter Vehicle Extension time, as a time must be entered.

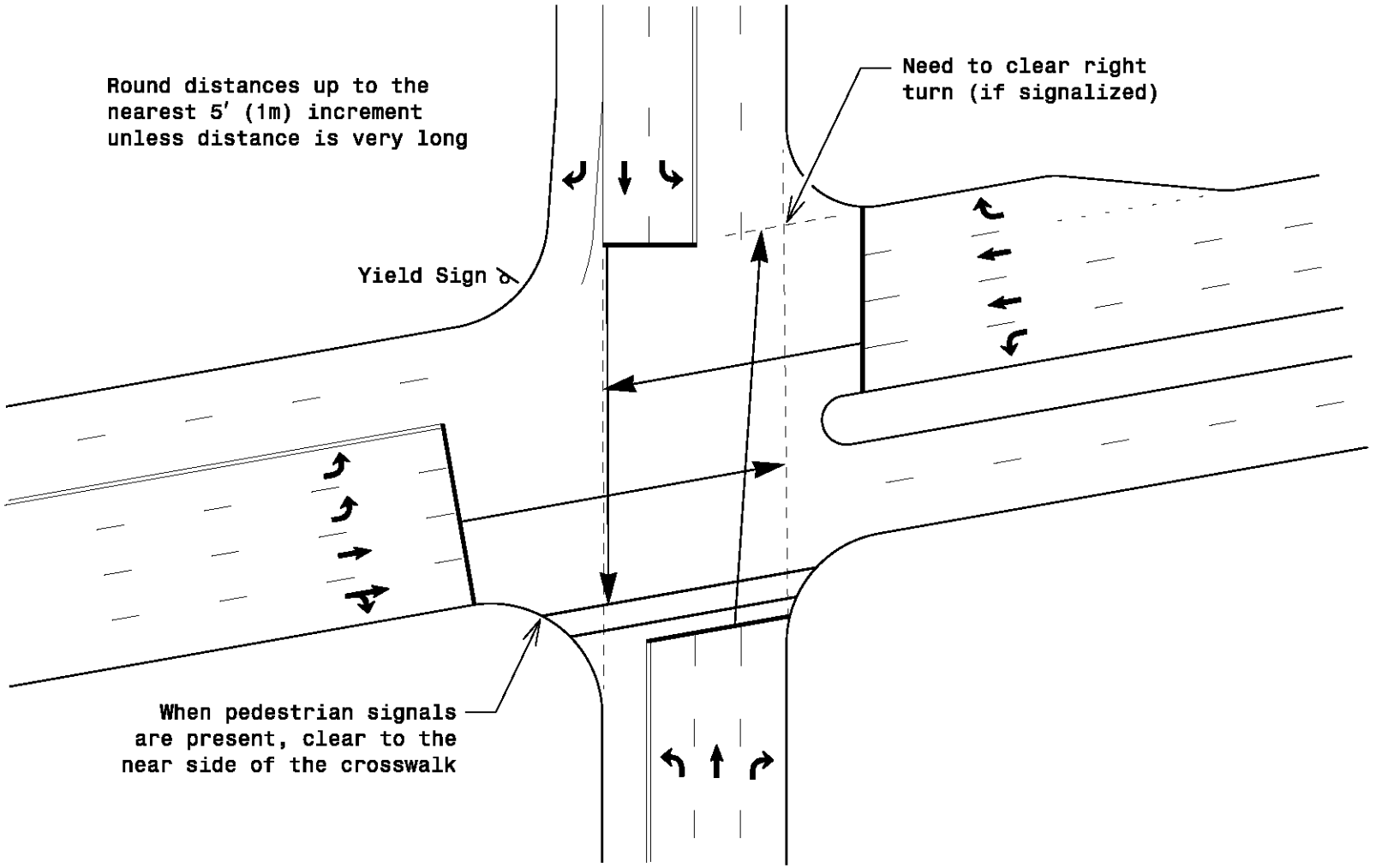
170 TIMING CHART

FEATURE	PHASE 2	PHASE 4	PHASE 6
• Minimum Initial*	12	7	12
• Vehicle Extension*	6.0	1.0	6.0
• Yellow Change Int	4.3	3.6	4.4
• Red Clearance	1.4	2.1	1.4
• Maximum Limit*	90	20	90
• Recall Position	VEH RECALL	NONE	VEH RE
• Vehicle Call Memory	YELLOW LOCK	NONE	YELLOW
• Double Entry	OFF	ON	O
• Walk*	4	-	
• Flashing Don't Walk	12	-	
• Type 3 Limit	–	-	
• Add Per Vehicle*	1.5	-	
• Maximum Initial*	34	-	
• Maximum Gap*	7.0	1.0	
• Reduce 0.1 Sec Every*	1.5	-	
• Minimum Gap	3.0	1.0	

* These values may be field adjusted. Do not adjust Min Green and Extension times for phases 2 and 6 lower than what is shown. Min Green for all other phases should not be lower than 4 seconds.

Notes:
-For non-volume density operation, set Maximum Gap and Minimum Gap equal to Vehicle Extension.
-For Pre-Timed Signal, set Vehicle Extension to 0.0 and Recall Position to Max Recall. Enter none for Vehicle Call Memory.

Through Movement Clearance Distances



Change and Clearance Intervals

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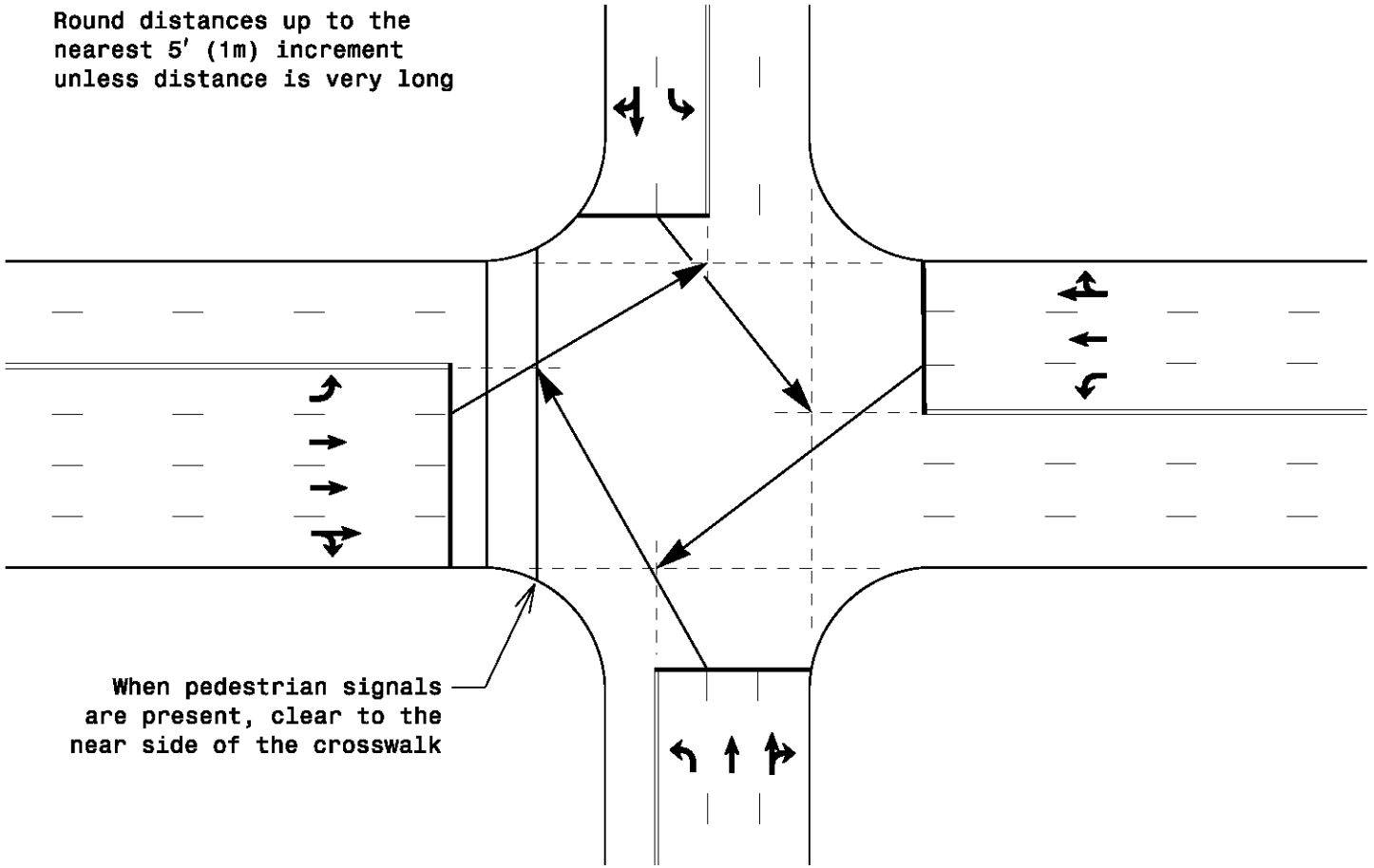
Standard Left Turn Movement Clearance Distances



Change and Clearance Intervals

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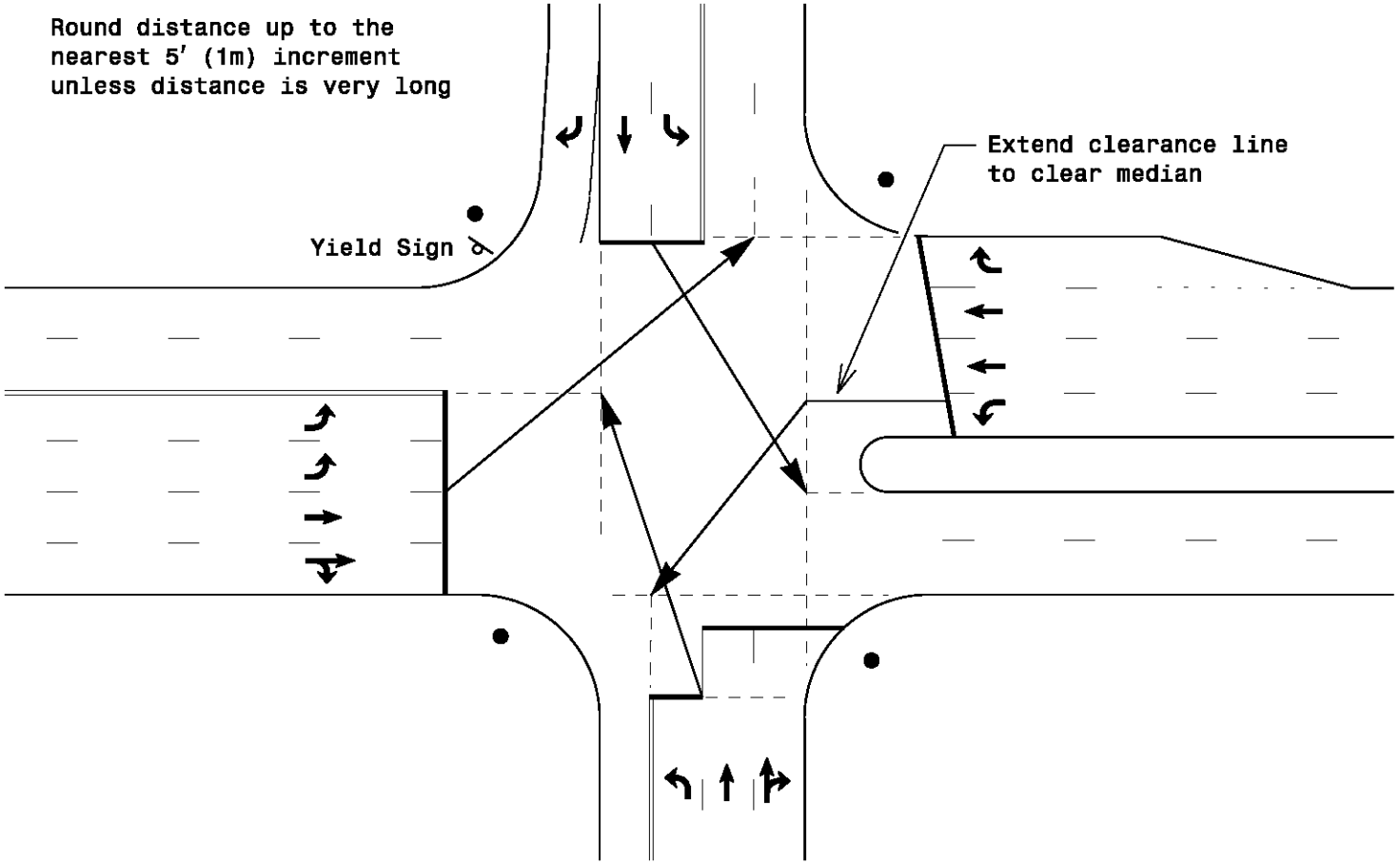
Other Left Turn Movement Clearance Distances
Median, Dual Left, Setback



Determination of Yellow Change and Red Clearance Intervals

Yellow Change Interval

$$\text{Yellow interval} = t + \frac{v}{2a + 64.4g}$$

t = perception reaction time, typically 1.5 seconds
v = design speed*, in ft/sec
a = deceleration rate, typically 11.2 ft/sec^2
g = grade

Round up to nearest 0.1 second.

Minimum yellow change interval is 3.0 seconds.

Hold stakeholder discussion** when calculated yellow change interval is longer than 6.0 seconds.

Red Clearance Interval

$$\text{Red interval} = \frac{w}{v}$$

w = width of intersection, in feet
v = design speed*, in ft/sec

If the initial calculation results in an all red time longer than 3.0 seconds, recalculate the red time as follows:

$$\text{Recalculated red interval} = \frac{1}{2}\left(\frac{w}{v} - 3\right) + 3$$

Round up to nearest 0.1 second.

Red clearance interval should be between 1.0 and 6.0 sec.

Hold stakeholder discussion** when recalculated red clearance interval is longer than 4.0 seconds.

Notes

* Design speed is the speed limit unless a speed study determines that the 85th percentile speed is faster or intersection geometrics compel vehicles to traverse the intersection slower.

** The purpose of a stakeholder discussion is to provide advance notification and involvement to stakeholders and provide an opportunity to consider possible countermeasures.

For most left turn lanes, assume a speed of 20 mph (32 kph) to 30 mph (48 kph). For locations with unusual conditions a higher or lower speed may be appropriate.

For separate left turn phases, calculate yellow and red intervals.

For left turns without a separate phase, calculate yellow and red times for both the through movement and the left turn movement. Use the highest yellow and enough red to equal the highest total time.

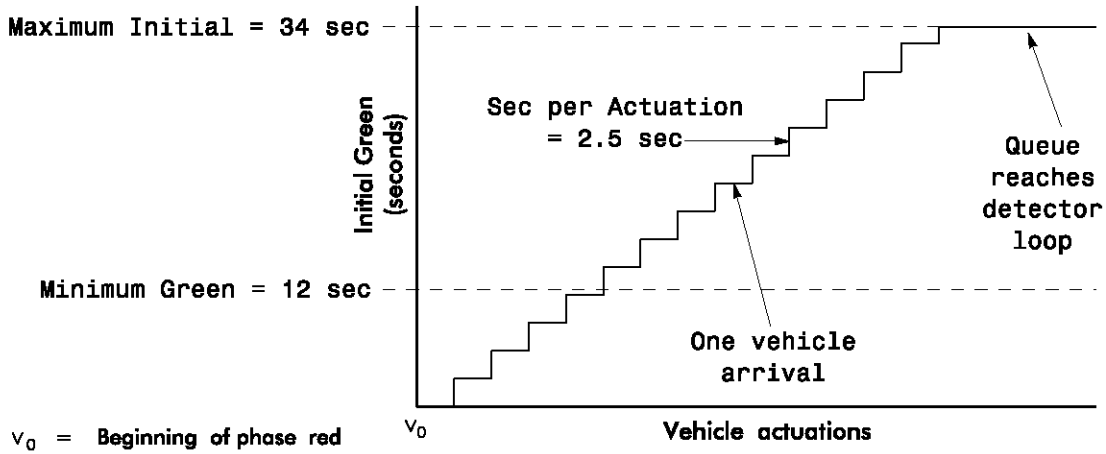
Where existing times are higher than calculated times, use the calculated values unless there is a documented history of the need for higher times. If approach is high speed and existing times are significantly higher than the calculated times, use the calculated values but consider adding a note to the plan to direct field forces to reduce the time incrementally. Include in the note how much and how often to reduce time until the final value is reached. (Ex. Existing Yellow Change Interval for phase 2 may be decreased by 0.2 seconds per week until the required value is reached.)

Where revising a location or adding a new signal along a corridor, consider comparing clearance times at adjacent intersections to new calculations to meet driver expectations.

Sources:
Traffic Engineering Handbook, Fifth Edition, Institute of Transportation Engineers, 1999.

A Policy on Geometric Design of Highways and Streets, Fourth Edition, American Association of State Highway and Transportation Officials, 2001.

Variable Initial Parameters



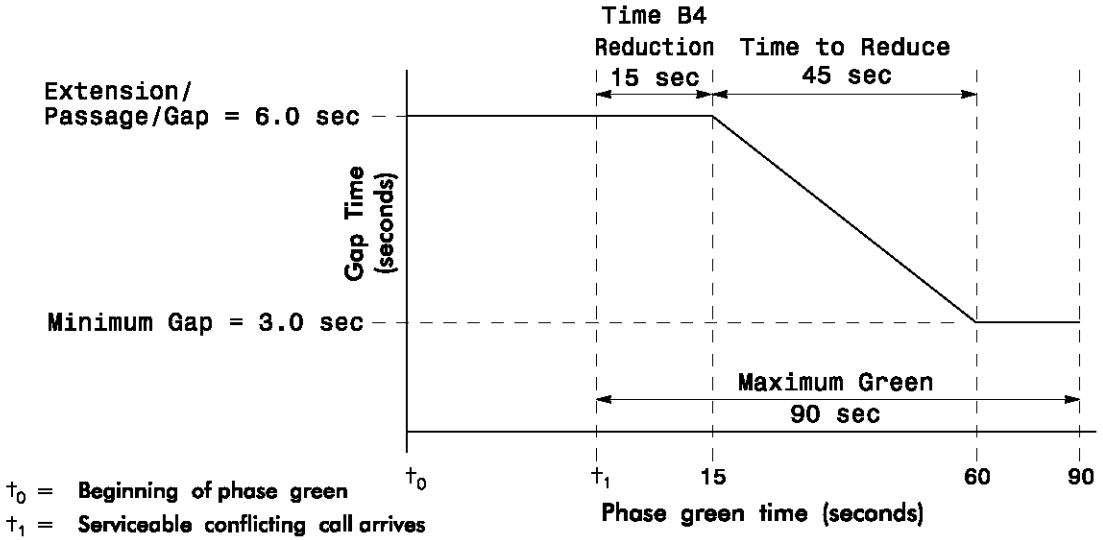
v_0 = Beginning of phase red with no vehicles waiting

Variable initial operation increases the MIN Green interval in a manner dependent upon the number of vehicle actuations placed on the phase while it is in the Yellow or Red interval. The variable initial interval is calculated as a function of the vehicle actuations and the MIN Green, Seconds Per Actuation, and MAX Variable Initial settings. The following relationship calculates the variable initial interval:

Initial Interval = (# of Vehicle Actuations) X (Seconds Per Actuation Setting)

If the calculated initial interval is less than the MIN Green setting, the MIN Green time will be used as the initial interval. If the calculated initial interval is greater than the MAX Variable initial setting, the MAX Variable initial will be used as the initial interval.

Gap Reduction Parameters



t_0 = Beginning of phase green

t_1 = Serviceable conflicting call arrives

Gap Reduction reduces the allowable gap between successive vehicle actuations by dynamically decreasing the extension time. The rate of reduction is based on the setting of the Extension, Minimum Gap, and Time to Reduce settings. Using this method, the gap will be reduced by the following relationship:

$$\text{Reduction} = \frac{\text{Extension} - \text{Minimum Gap}}{\text{TTR}} \times (\text{Current Green Interval Time} - \text{TBR})$$

This reduction begins when the Green interval has timed the Time Before Reduction (TBR) setting. Reduction of the allowable gap will continue until the gap reaches a value equal to or less than the Minimum Gap In the presence of continual vehicle actuations, the phase will not gap out, even if the gap has been reduced to zero.

Volume Density Timing Example 2070L and NEMA Controllers

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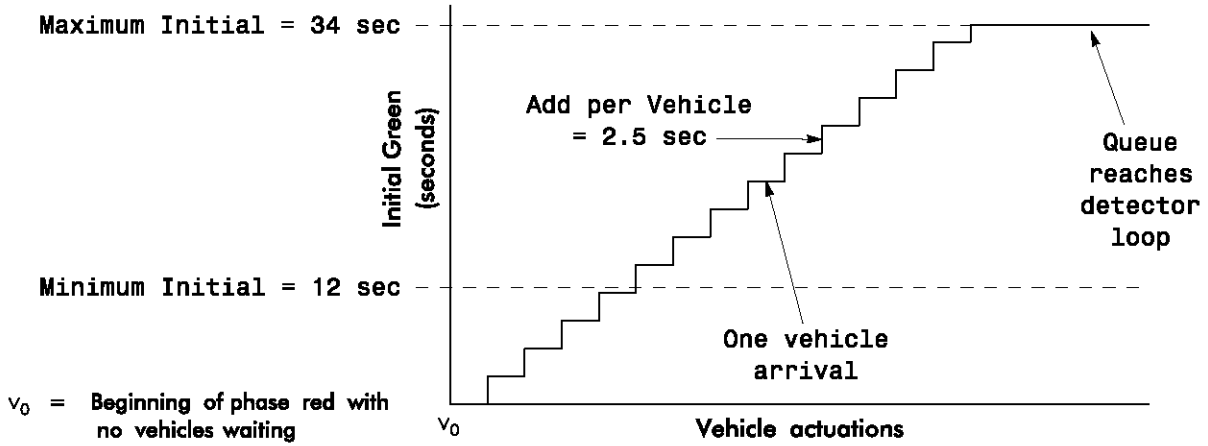
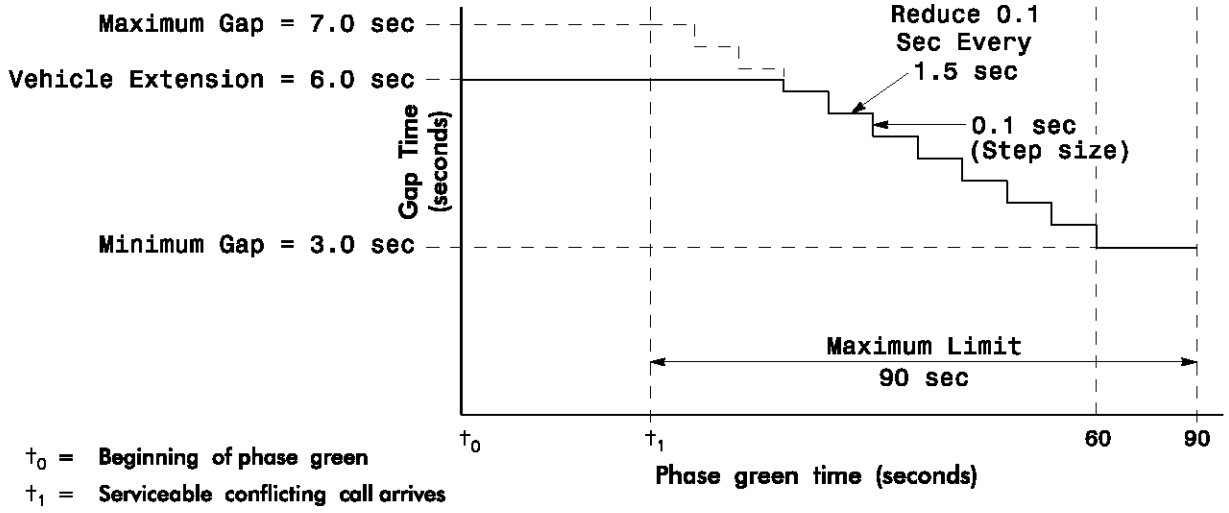


Variable Initial Parameters



Gap Reduction Parameters

Note: The controller begins timing the gap reduction from the Maximum Gap (7.0 sec) when it gets a conflicting call; however, the 'real' maximum gap is the Vehicle Extension (6.0 sec). The Vehicle Extension time will never go above 6.0 seconds. The time the controller takes to reach the Vehicle Extension from the Maximum Gap is the 170's version of Time B4 Reduction.

Volume Density Timing Example – 170 Controller

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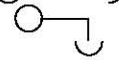
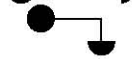
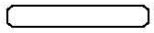
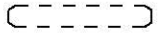
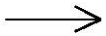
Standard Signal Plan Legend

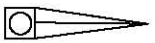
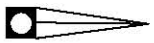
LEGEND

PROPOSED		EXISTING
	Traffic Signal Head	
	Modified Signal Head	N/A
	Sign	
	Pedestrian Signal Head With Push Button & Sign	
	Signal Pole with Guy	
	Signal Pole with Sidewalk Guy	
	Inductive Loop Detector	
	Controller & Cabinet	
	Junction Box	
	2-in Underground Conduit	
N/A	Right of Way	
	Directional Arrow	

Note:

Symbols for utilities, hydrology, property lines, etc. should mirror standards set by NCDOT's Roadway Design Unit.

Other Common Symbols

PROPOSED		EXISTING
	Modified Pedestrian Head	N/A
	Metal Strain Pole	
	Metal Pole with Mastarm	
	Signal Pedestal	
	Directional Drill	N/A
	Out of Pavement Detector	
	Video Detection Area	
	Out of Pavement Detection Area	
	Master Controller & Cabinet	
N/A	Railroad Cantilever	
N/A	Railroad Gate and Flasher	
N/A	Railroad Tracks	
	Construction Zone Drums	
	Construction Zone	
	New Pavement	N/A
N/A	Wheelchair Ramp	
N/A	Wheelchair Ramp	
	Sign I.D.	

Common Drawing Symbols

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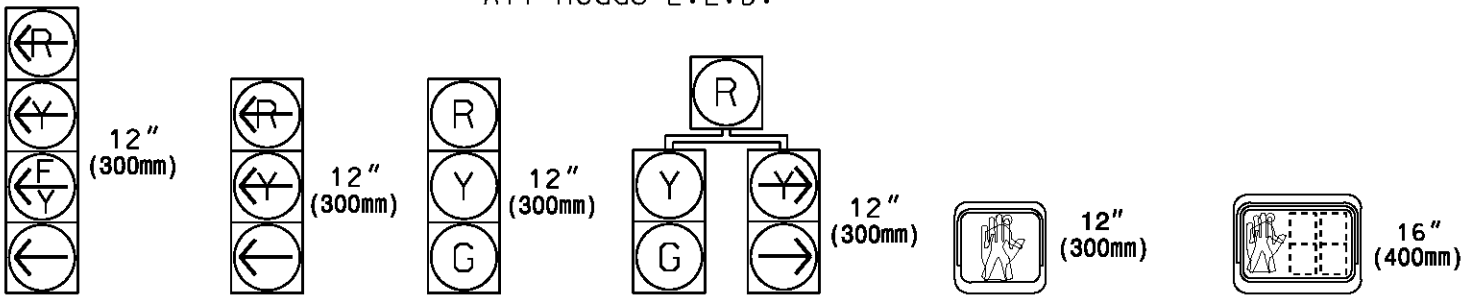
Typical Appearance of Signal Face I.D.

SIGNAL FACE I.D.

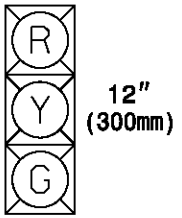
All Heads L.E.D.



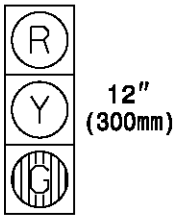
51 | 11, 12 | 21, 22, 42, 61, 62 | 42 | P21, P22 | P61, P62

Signal Faces/Heads with Special Characteristics

Optically Programmed Head



Section with Louver



Signal Face I.D. Details

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Project Type

Indicate whether 'New Installation,' 'Signal Upgrade,' or 'Temporary Signal.'

Graphic Scale

Include a graphic scale on all plans.

Plan Description

Description should include:

- # Phases
- Type of Actuation
- w/ Special Features (if any)
- Isolated or System (including type)

Text and Lettering

-Letter sizes should approximate the following:
Title block street names and title heads...3/16in (5mm)
All other lettering.....1/8in (3mm)

-List the routes in the title block using the word "at", not "and", as follows:

SR XXXX (Tree Avenue) at SR XXXX (Stump Drive)

-OR-

SR XXXX (Tree Avenue) at SR XXXX (Stump Drive)/NC 123 (Branch Street)

Metric Block

For metric plans, include the metric block in the upper righthand corner.

North Arrow

For Spot Safety projects, align the main street to run horizontally across the plan where possible. For Contract projects, align the plan in the same general direction as the roadway plans. For closed loop system projects, align signal plan sheets in the same general direction as the cable routing plans where possible.

Address

For plans developed in house, include the department logo with the Signals & Geometrics Section's address in the title block.

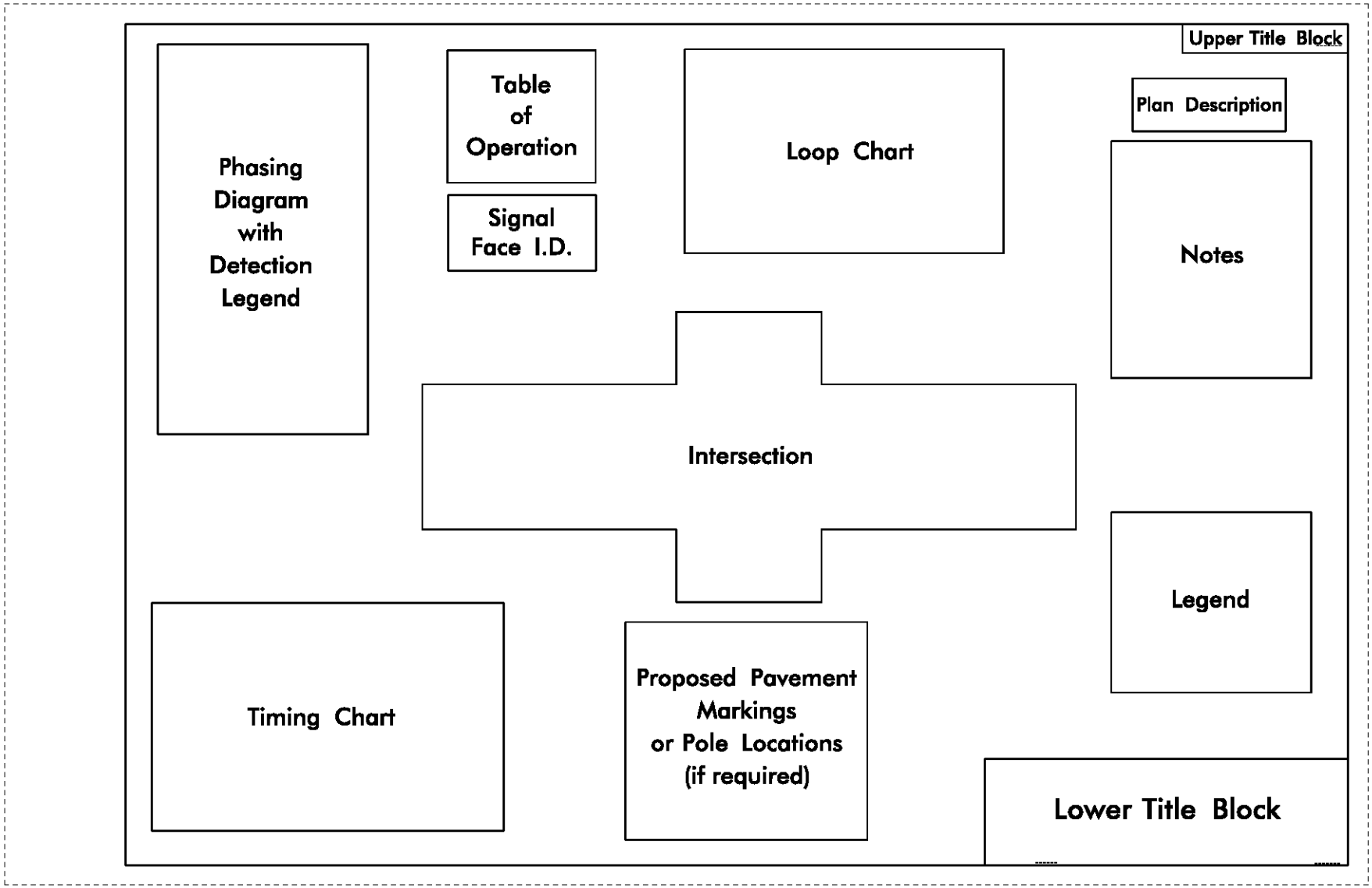
For plans developed by private engineering firms, include the department logo with the Signals & Geometrics Section's address in the title block and the firm's name with address on the plan sheet beside the title block.

For plans developed by municipalities, include the department logo with the Signals & Geometrics Section's address in the title block and the municipality's name with address on the plan sheet beside the title block.

For plans developed by private engineering firms for a municipality, include the department logo with the Signals & Geometrics Section's address in the title block and the firm's name with address on the plan sheet beside the title block.

Note: Private engineering firms and municipalities are responsible for placing their name with address on the plans. Company or municipal logos are permitted providing they do not detract from the plan.

Typical Signal Plan Layout



Miscellaneous Drawing Format Items

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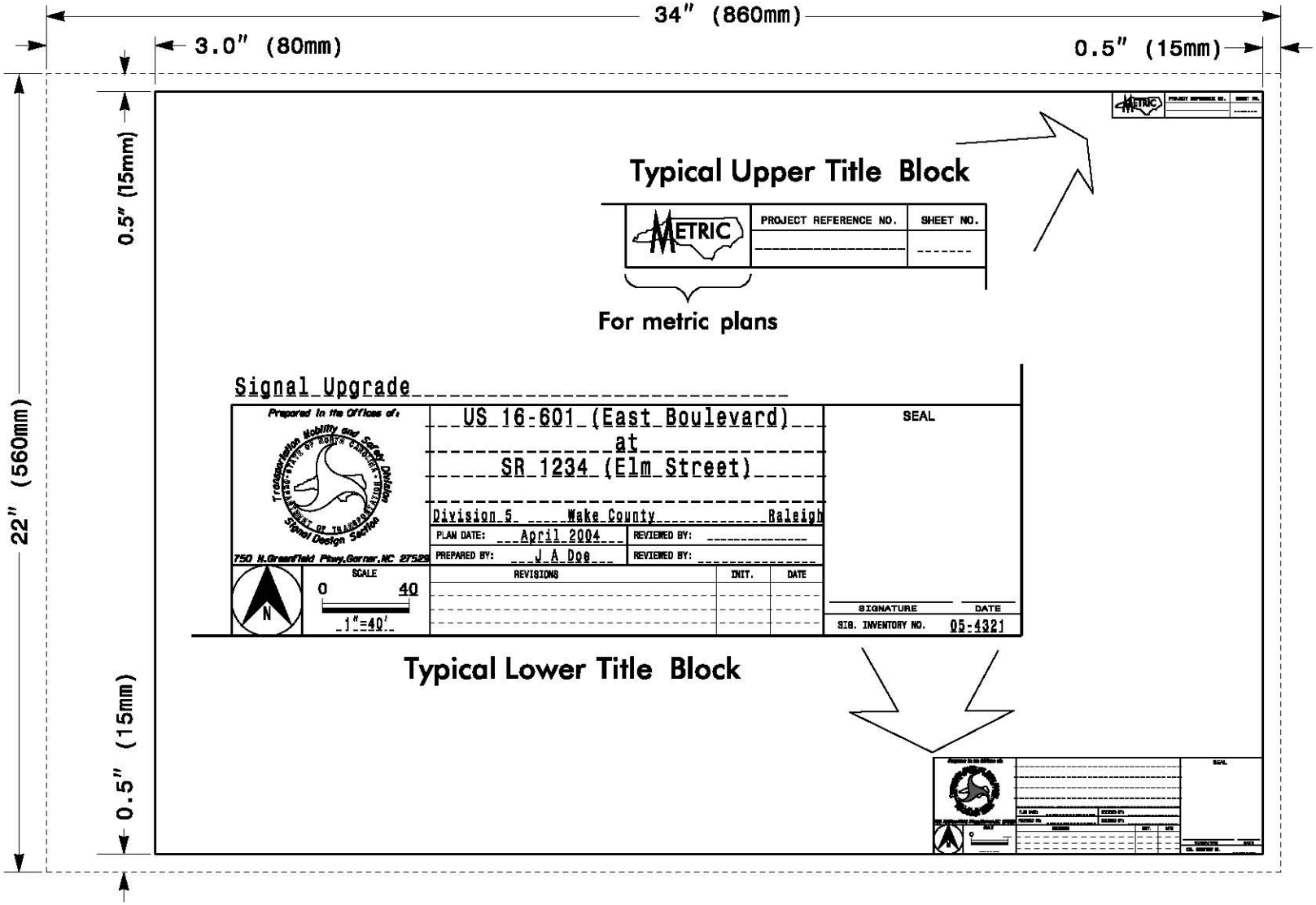
Typical Border Sheet with Dimensions



Miscellaneous Drawing Format Items

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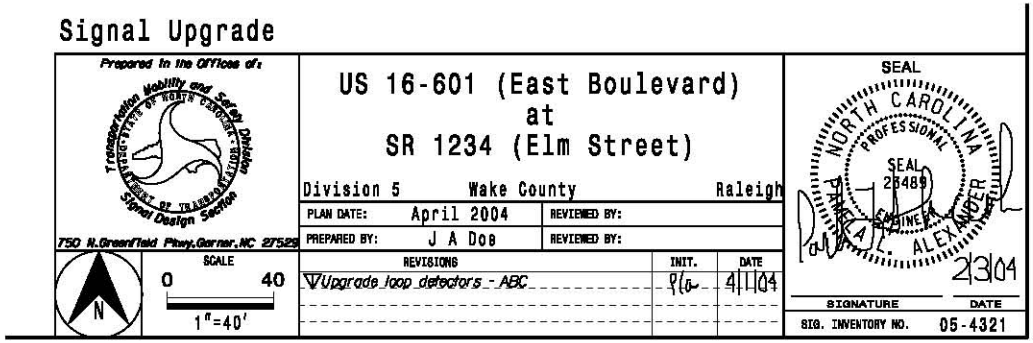
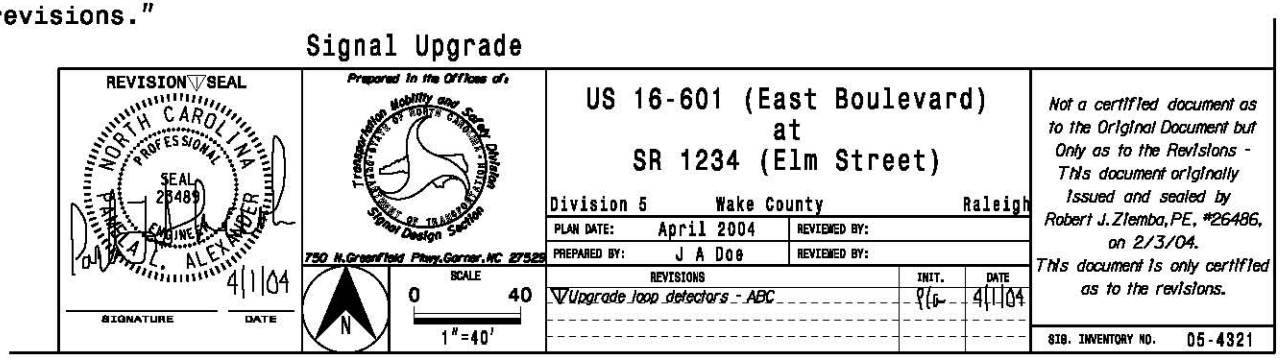
Revisions

When revising an existing traffic signal plan, include the revision number, date, and revision description. Additionally, enclose the revision number in a triangle and place the triangle on the plans near the affected area if needed for clarity.

When the PE making the revision is the same PE who sealed the original plan, the PE initials and dates the revision block and reseals the original plan with the original date.



When the PE making the revision is different than the PE who sealed the original plan, then a "Revision Seal" block needs to be added to the title block to the left (preferred) or just above the title block on the original plans. In addition, add the text "Not a certified document as to the Original Document but only as to the Revisions - This document originally issued and sealed by 'name,' 'PE number,' on 'date.' This document is only certified as to the revisions."



Signal Cable Calculations

Signal Cable

There is only one pay item for signal cable; combine measurements for 16-4 and 16-7 cable. Route cable to minimize the length of cable used. Add 3′ (1 m) extra in cabinets. Add 3′ (1 m) extra at each signal head. Assume 30′ (10 m) down poles. Note: Use 2 separate cable runs if there are more than 6 heads on a phase.

Example (See sheet 2)

Heads 61 & 62:
3′ (beside head) + 12′ + 3′ (beside head) + 270′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 331′

Head 11
3′ (beside head) + 256′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 302′

Heads 41 & 42:
3′ (beside head) + 15′ + 3′ (beside head) + 105′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 169′

Head 43:
3′ (beside head) + 220′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 266′

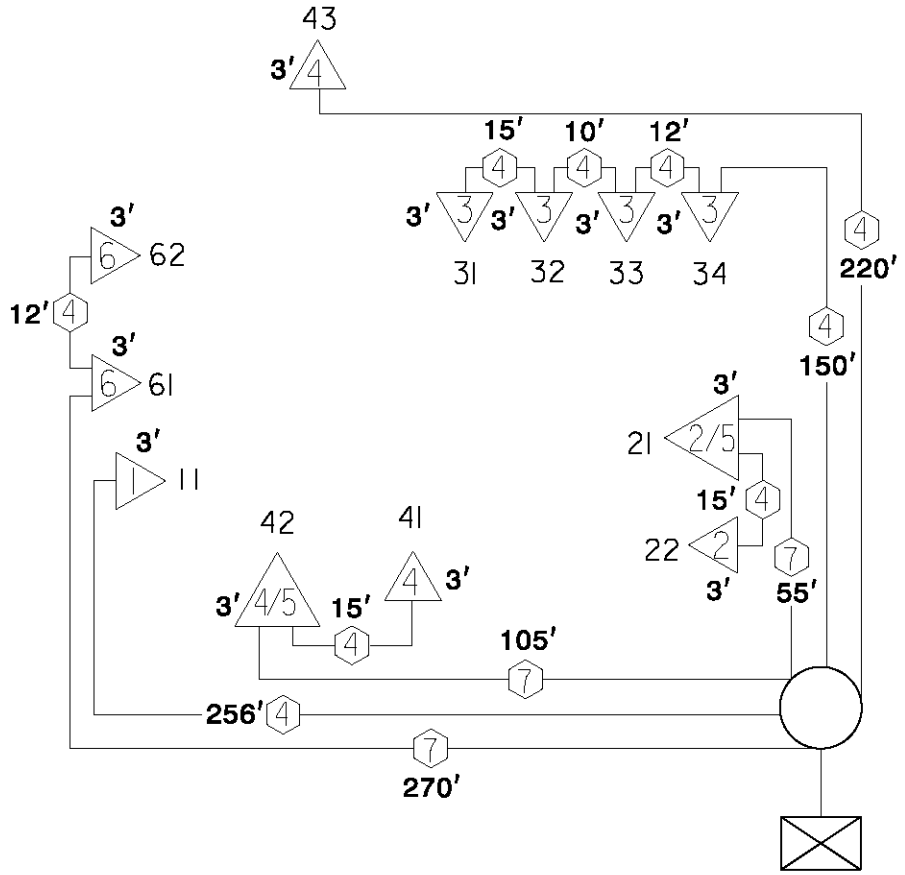
Heads 31, 32, 33 & 34:
3′ (beside head) + 15′ + 3′ (beside head) + 10′ + 3′ (beside head) + 12′ + 3′ (beside head) + 150′
+ 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 242′

Heads 21 & 22:
3′ (beside head) + 15′ + 3′ (beside head) + 55′ + 30′ (down pole) + 10′ (to cabinet) + 3′ (in cabinet) = 119′

Total: 331′ + 302′ + 169′ + 266′ + 242′ + 119′ = 1429′

Round up to nearest 10′ = 1430′

Signal Cable Example Diagram



Legend

- 4 — 16–4 Conductor
- 7 — 16–7 Conductor
- 4 — Phase/Overlap
- 22 — Signal Face I.D.
- 15' — Segment Distance

Plan Quantity Calculations

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STD. NO.
5.6
SHEET 2 OF 4

Messenger Cable & Loop Lead–In Calculations

Messenger Cable (Spanwire)

Example (See sheet 4)

Note: Do not add any length for guys as they are included as a pay item for guy assemblies.

145′ + 170′ + 110′ + 172′ = 597′

Round up to nearest 10′ = 600′

Loop Lead–In Cable

Each loop lead-in wire connects 1 loop to the cabinet if the is wired separately. Quadrupole and volume density (counting) loops need to be wired separately. If multiple loops are wired together, 1 lead-in connects the group to the cabinet. Low speed and extend (stretch) loops may be wired together. Include lead-in for pedestrian pushbuttons and microwave detectors. Assume 30′ (10 m) up or down poles.

Example (See sheet 4)

Loops 2A & 2B (together) and 5A (separate):
25′ + 30′ (up pole) + 172′ + 30′ (down pole) + 10′ (to cabinet)
= 267′ X 2 = 534′

Loop 6A and 6B (each separate):
250′ + 25′ + 30′ (up pole) + 110′ + 30′ (down pole) +10′ (to cabinet)
= 455′ X 2 = 910′

Loop 1A:
25′ + 30′ (up pole) + 110′ + 30′ (down pole) + 10′ (to cabinet)
= 205′

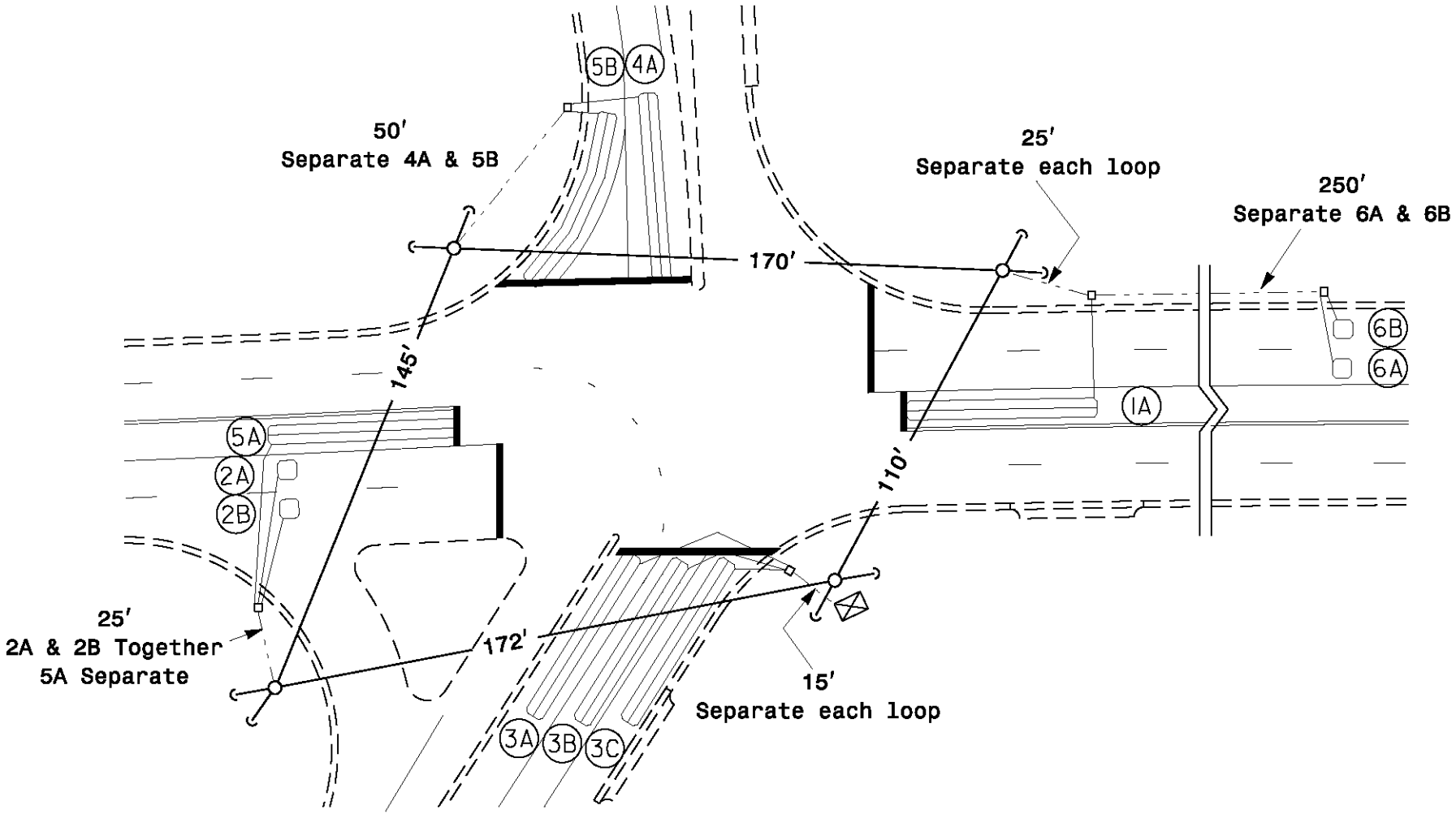
Loops 3A, 3B, and 3C (each separate): 15′
= 15′ X 3 = 45′

Loop 4A and 5B (each separate):
50′ + 30′ (up pole) + 170′ + 110′ + 30′ (down pole) +10′ (to cabinet)
= 400′ X 2 = 800′

Total: 534′ + 910′ + 205′ + 45′ + 800′ = 2494′

Round up to nearest 10′ = 2500′

Loop Lead-In & Messenger Cable Example Diagram



Plan Quantity Calculations

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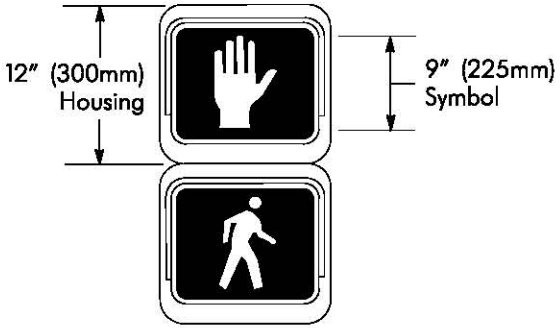
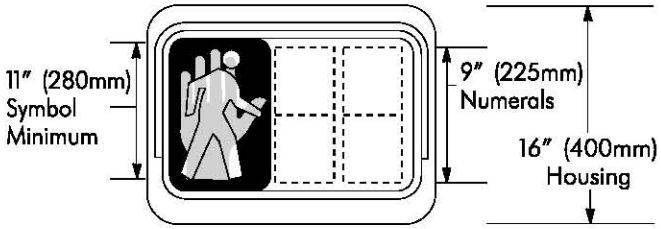
STD. NO.
5.6
SHEET 4 OF 4

Typical Pedestrian Heads

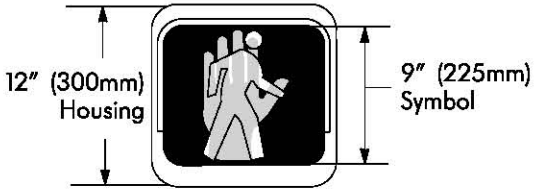
Retrofit Installation



Standard – Countdown Pedestrian Head



Alt/Preemption Pedestrian Head



Pedestrian Head Guidelines

-With pretimed operation, use "Ped Recall" when push buttons are not used.
-Also with pretimed operation, "Max Time" should not be less than the total of "Walk" and "Flashing Don't Walk" times.
-Typically, do not use countdown pedestrian heads with railroad preemption (unless pretimed operation).
-Countdown heads may not be compatible with some forms of EV or Fire Preemption.
-Existing 9" (225 mm) Housing, 2 section pedestrian heads are allowed when distance to head is less than 100 feet (30m).
-For head numbering refer to Std. No. 3.0:1.

Pedestrian Timing

-"Walk Time": Minimum 4 to 7 seconds, depending on pedestrian volume and characteristics.
-"Flashing Don't Walk Time" (FDW): Enough time to get from curb or shoulder to farside of the farthest traveled lane (D). Assume 4 feet (1.2m) per second (S), minus the concurrent yellow change interval (YC). Use slower travel speed where a high percentage of slower moving pedestrian traffic can be expected.

$$FDW = \frac{D}{S} - YC$$

Pedestrians Heads & Timing

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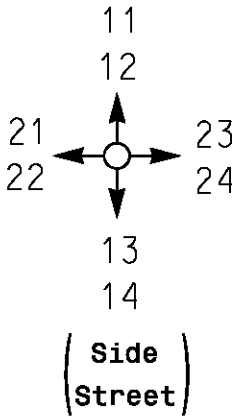
SHEET 1 OF 1

Typical Numbering for Flashers



SIGNAL FACE I.D.

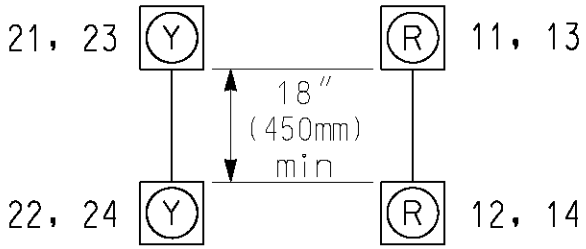


Table of Operation for Flashers

TABLE OF OPERATION		
SIGNAL FACE	INTERVAL 1	INTERVAL 2
	ON	OFF
	OFF	ON
	ON	OFF
	OFF	ON

Flashers

SIGNALS & GEOMETRICS SECTION
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7.0
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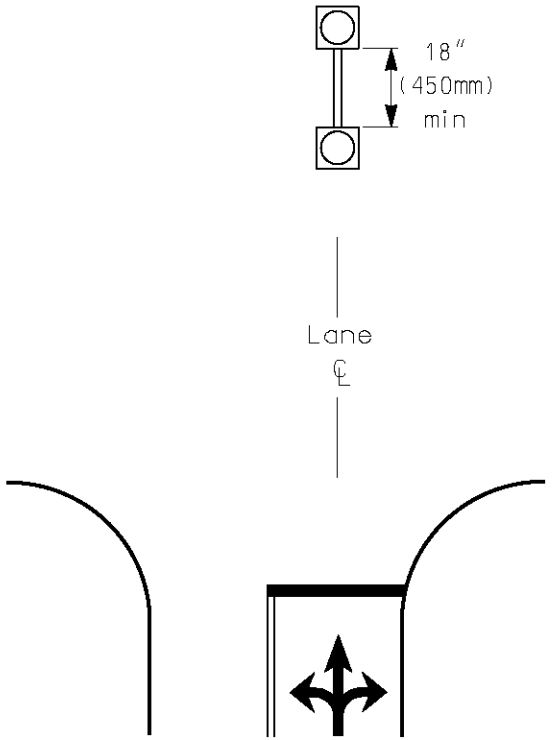
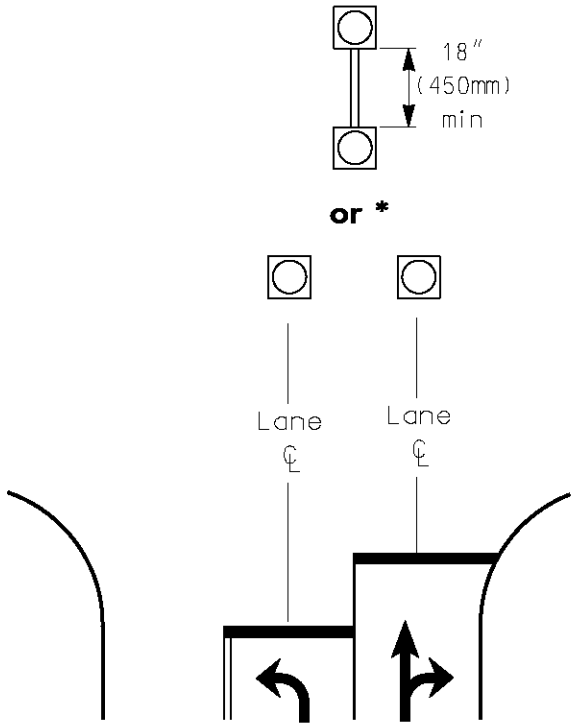
Signal Head Approach Display and Alignment

Single Lane Approach

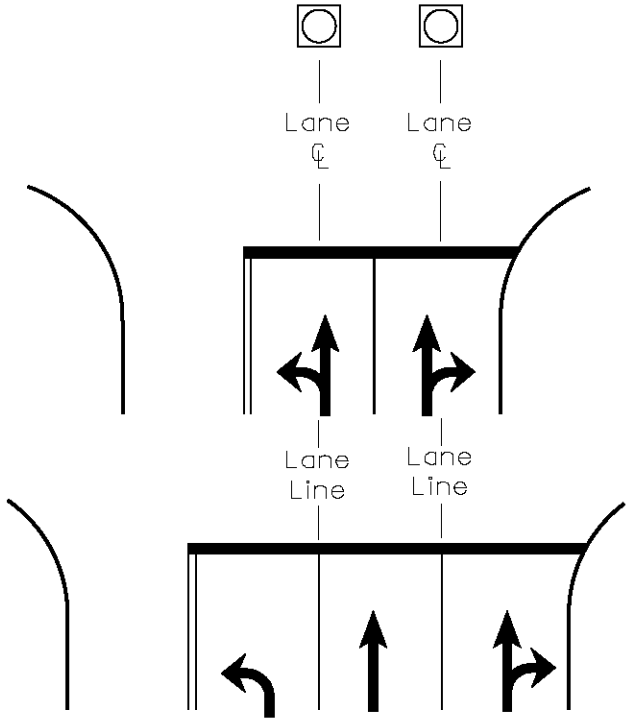


Single Lane Approach with Turning Bay



* Engineer to determine based on site specific characteristics

Multilane Approach



General Guidelines

- Flash vertically mounted heads alternatively
- Flash horizontally mounted heads concurrently

Flashers

SIGNALS & GEOMETRICS SECTION
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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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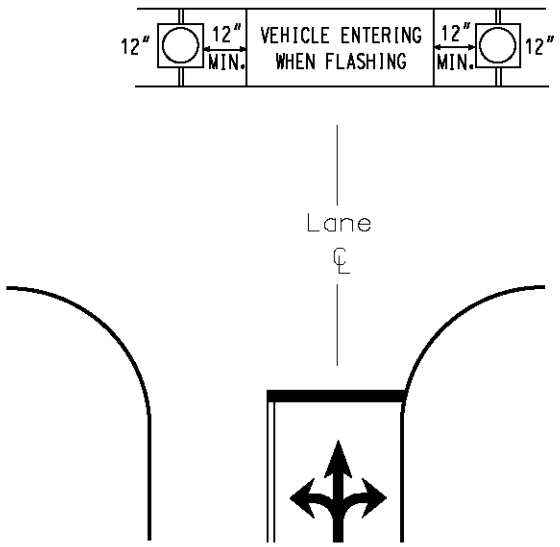
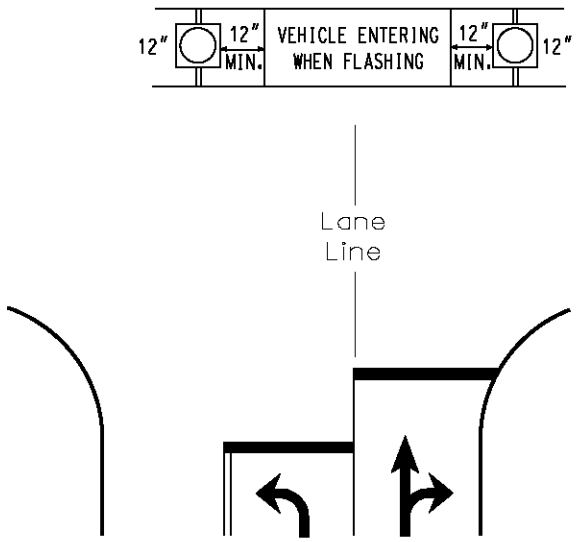
Actuated Flasher with Overhead Sign

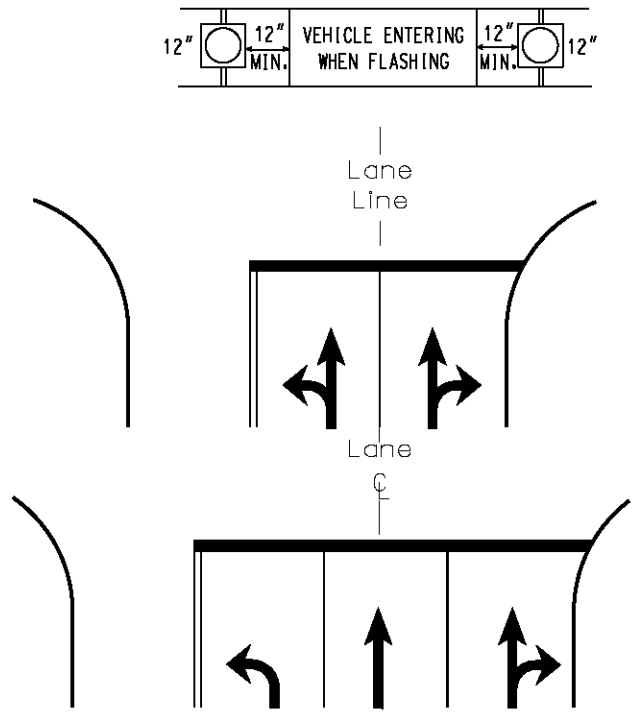
Single Lane Approach



Single Lane Approach with Turning Bay



Multilane Approaches



General Guidelines

–Sign may be installed at intersection or in advance of intersection, at engineer's discretion

–Typical sign size: 114"x36"

–Lettering size: 8"D

–See drawing notes (Std. No. 5.0) for notes specific to actuated flashers

Flashers

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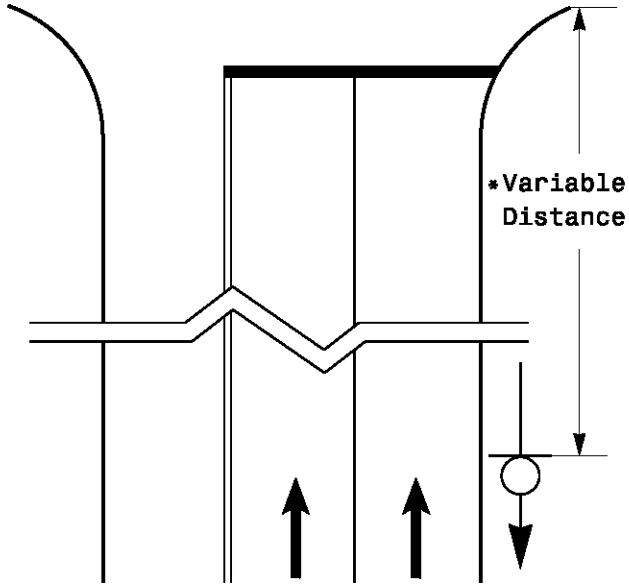
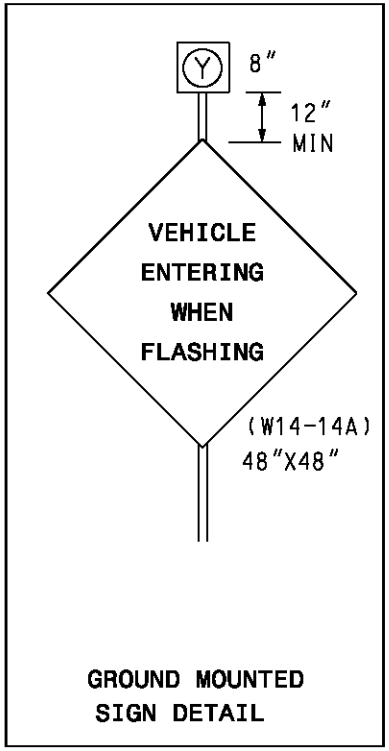
Actuated Flasher with Ground–Mounted Sign

Single or Multi Lane Approaches





General Guidelines

- For multilane divided roadways with medians dual ground mounted signs may be installed
- See drawing notes (Std. No. 5.0) for notes specific to actuated flashers
- * Refer to MUTCD Table 2C–4 for advance placement of signs

Flashers

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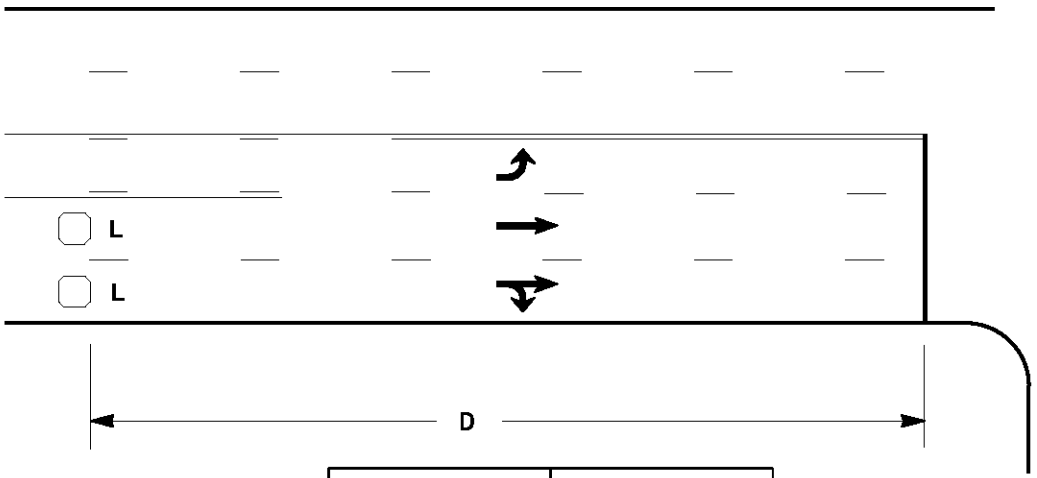
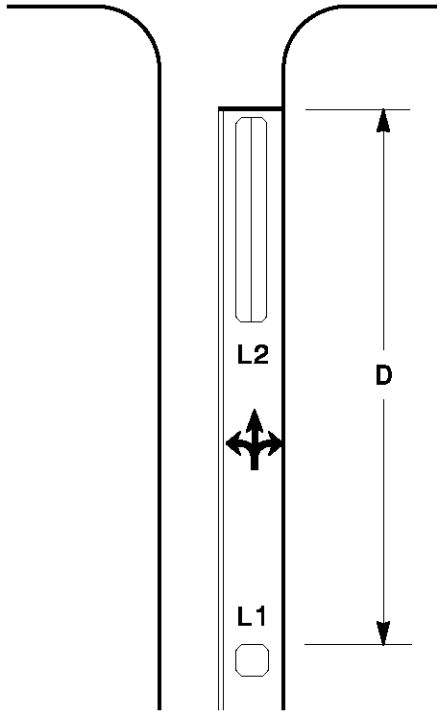
Loop Placement for Actuated Flashers

Main Street Loop Placement
(Single or Multilane)



Side Street Loop Placement



Design Speed mph (km/hr)	D ft (m)
40 (64)	250 (75)
45 (72)	300 (90)
50 (80)	355 (110)
55 (88)	420 (130)

L = 6ft X 6ft (1.8m X 1.8m), Presence loop

L1 = 6ft X 6ft (1.8m X 1.8m), Presence loop (Loop L1 is optional)

L2 = 6ft X 40ft To 60ft (1.8m X 12.0) Quadruple loop

Flashers

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Sign No.	Description	Graphic
R1-1	"STOP" Sign	
R1-2	"YIELD" Sign	
R3-1 R3-2	No Right Turn Sign No Left Turn Sign	
R3-3	"NO TURNS" Sign	
R3-4	No U Turn Sign	

Sign No.	Description	Graphic
R3-5a	Through Arrow "ONLY" Sign	
R3-5L R3-5R	Left Arrow "ONLY" Sign Right Arrow "ONLY" Sign	
R3-6L R3-6R	Combined Through and Left Arrow Sign Combined Through and Right Arrow Sign	
R3-18	No U-Turn/No Left Turn Sign	
R8-8	"DO NOT STOP ON TRACKS" Sign	

Commonly Used Signs

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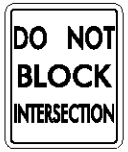
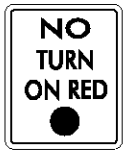
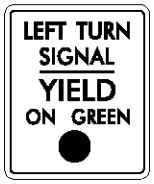
Sign No.	Description	Graphic
R10-6	"STOP HERE ON RED" Sign	
R10-7	"DO NOT BLOCK INTERSECTION" Sign	
R10-10L R10-10R	"LEFT TURN SIGNAL" Sign "RIGHT TURN SIGNAL" Sign	
R10-11 R10-11a	"NO TURN ON RED" ● Sign "NO TURN ON RED" Sign	
R10-12	"LEFT TURN YIELD ON GREEN" ● Sign	
R10-13	"EMERGENCY SIGNAL" Sign	

Sign No.	Description	Graphic
R10-15	"TURNING TRAFFIC MUST YIELD TO PEDESTRIANS" Sign	
R10-16	"U-TURN YIELD TO RIGHT TURN" Sign *For usage, see MUTCD Sect. 2B.45, Page 2B-43*	
R10-21	"LEFT TURN SIGNAL YIELD ON GREEN" ● Sign	
	Dual Turn Arrows Sign	
	Dual Turn and Through Arrows Sign	
W25-2	"ONCOMING TRAFIC MAY HAVE EXTENDED GREEN" Sign *For usage, see MUTCD Sect. 2C.39, Page 2C-20*	

Commonly Used Signs

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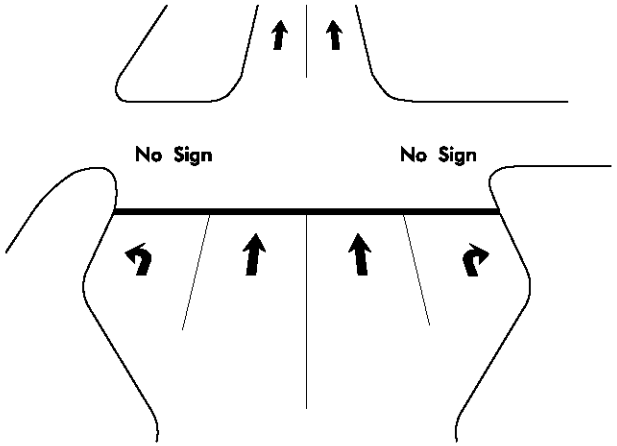
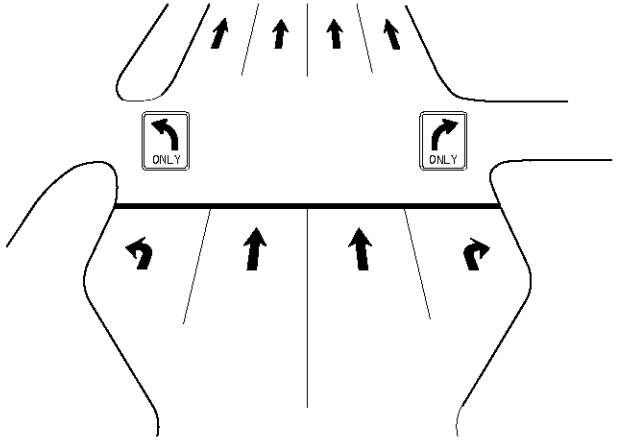
1) In general, lane-use control signs are not required when a vehicle must shift into a turning bay to make a turning movement (Example 1).

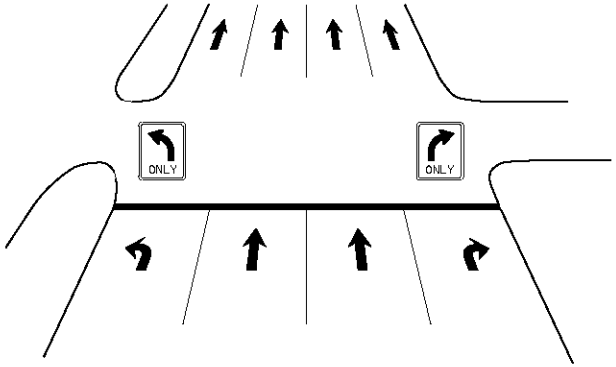
2) In general, lane-use control signs should be used when:
   A) Lane geometrics allow a through movement, but a mandatory turn is required (Examples 2 and 3).
   B) A lane without a turn bay ends abruptly (Example 4).



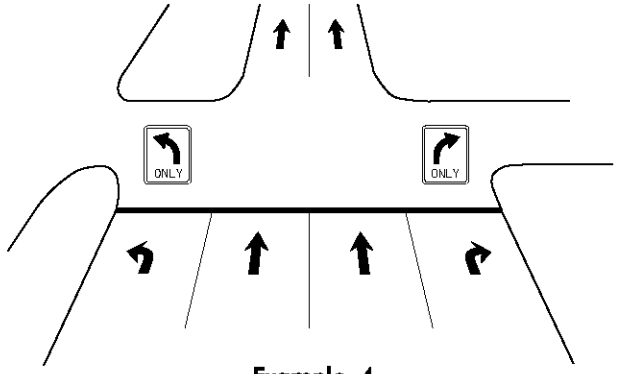
Example 1



Example 2



Example 3



Example 4

Application of Lane–Use Control Signs

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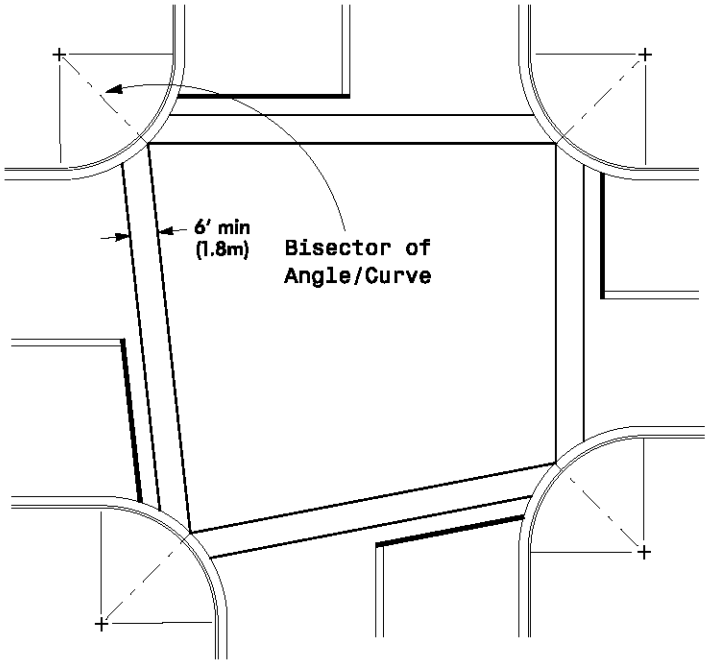
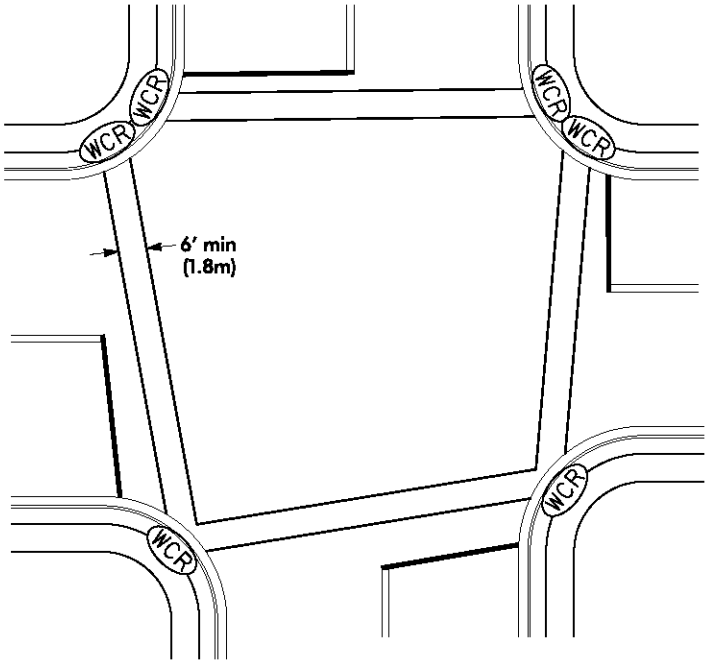
CASE 1

Locate Crosswalks from Center of Curve



CASE 2

Connect Wheelchair Ramps



Reference: Roadway Standard Drawing 1205.07

Crosswalks

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STD. NO.
9.0
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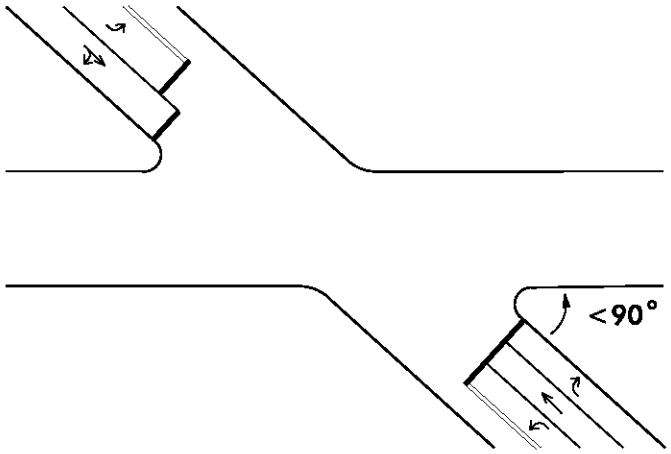
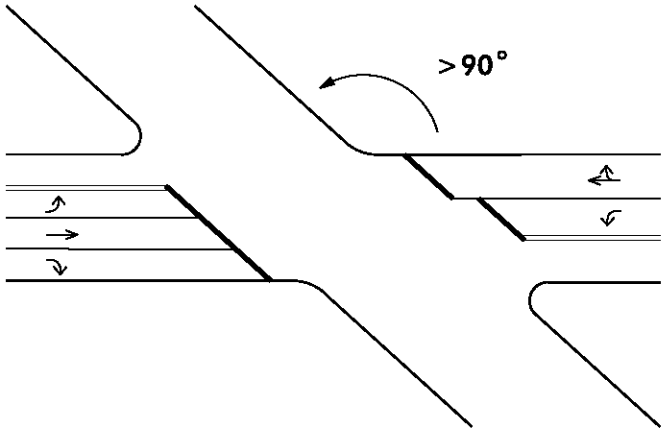
CASE 1



For approaches with intersection angles less than 90 degrees, place stop lines perpendicular to the centerline of the approach.

CASE 2



For approaches with intersection angles greater than 90 degrees, place stop lines parallel to the edge of the intersecting roadway.

Notes

-"Intersection angle" is defined as the angle between the approach in question and the intersection roadway to the right.
-Typically, place stop lines no more than 30 feet (9.1m) nor less than 4 feet (1.2m) from the nearest edge of the intersecting travel way.
-For stop line locations at crosswalks, locate stop line 4 feet (1.2m) behind and parallel to the nearest crosswalk line, but not within the area of a wheelchair ramp.

Reference: Roadway Standard Drawings 1205.04 and 1205.07

Stop Lines

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STD. NO.
9.1
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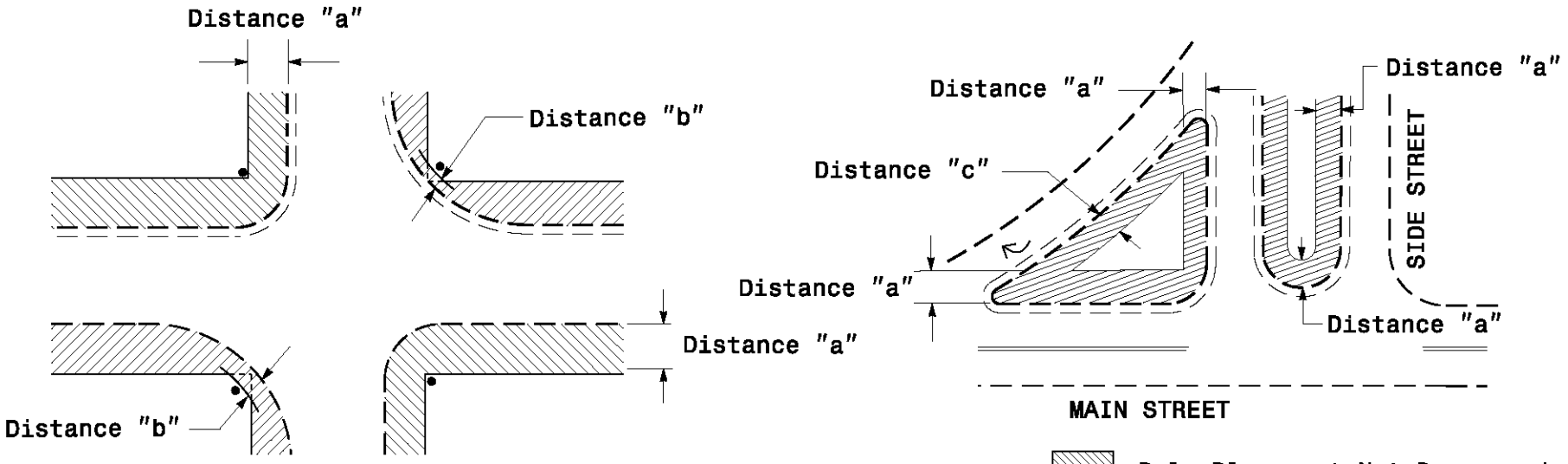
Clear Zone Distances for Pole Placement



Design Speed MPH (km/h)	Distance "a"		Distance "b"		Distance "c"		
	Distance from Face of Curb ft (m)	Distance from EOP ft (m)	Face of Curb ft (m)	EOP ft (m)	Side St. Speed MPH	Distance from Face of Curb ft (m)	Distance from EOP ft (m)
≤40 (64)	12 (3.5)	14 (4.0)	7 (2.0)	10 (3.0)	≤40	7 (2.0)	7 (2.0)
					45-50	7 (2.0)	7 (2.0)
					≥55	10 (3.0)	12 (3.0)
45-50 (72-80)	16 (5.0)	18 (5.5)			≤40	7 (2.0)	7 (2.0)
					45-50	10 (3.0)	12 (3.5)
					≥55	12 (4.5)	14 (4.5)
≥55 (88)	22 (6.5)	22 (6.5)			≤40	7 (2.0)	7 (2.0)
					45-50	10 (3.0)	12 (3.5)
					≥55	12 (3.5)	14 (4.5)

Note 1: When traffic signals are installed on high-speed facilities, the signal supports should be placed as far away from the roadway as practical.

Note 2: Painted islands should not be used for pole locations unless a method of protection is provided (such as a guardrail).

Distances are the desired minimum from the face of pole

Reference: "Roadside Design Guide" 2002 AASHTO

Standard Pole Placement

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10.0
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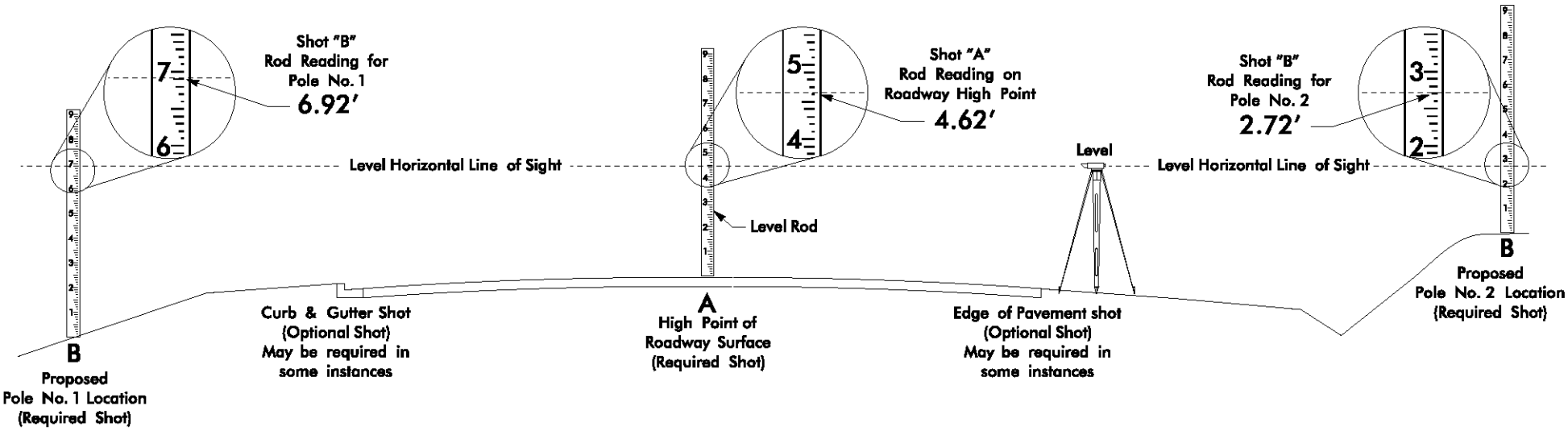
Survey Level With Rod Method

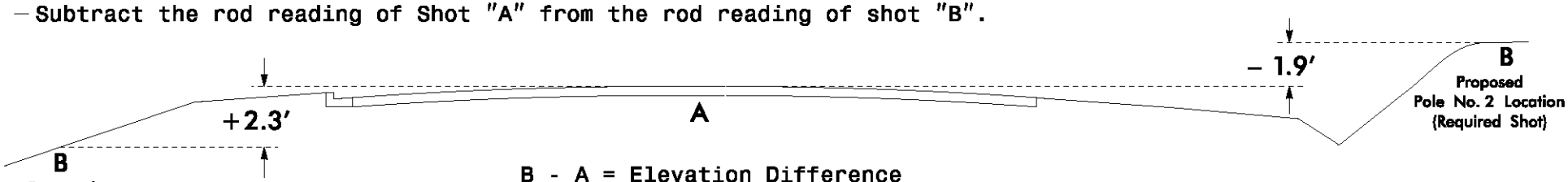
Step 1: Using a standard Survey Level and Level Rod:

– Take elevation shots on high point of roadway (shot "A") and at proposed pole foundation centerline (Shot "B").



Find the elevation difference between the proposed foundation and the high point of the roadway

– Subtract the rod reading of Shot "A" from the rod reading of shot "B".



B - A = Elevation Difference

(Do not round up)

Elevation difference for Pole No. 1: 6.92′-4.62′ = +2.3′
Elevation difference for Pole No. 2: 2.72′-4.62′ = -1.9′

Determining Elevation Difference for Metal Poles

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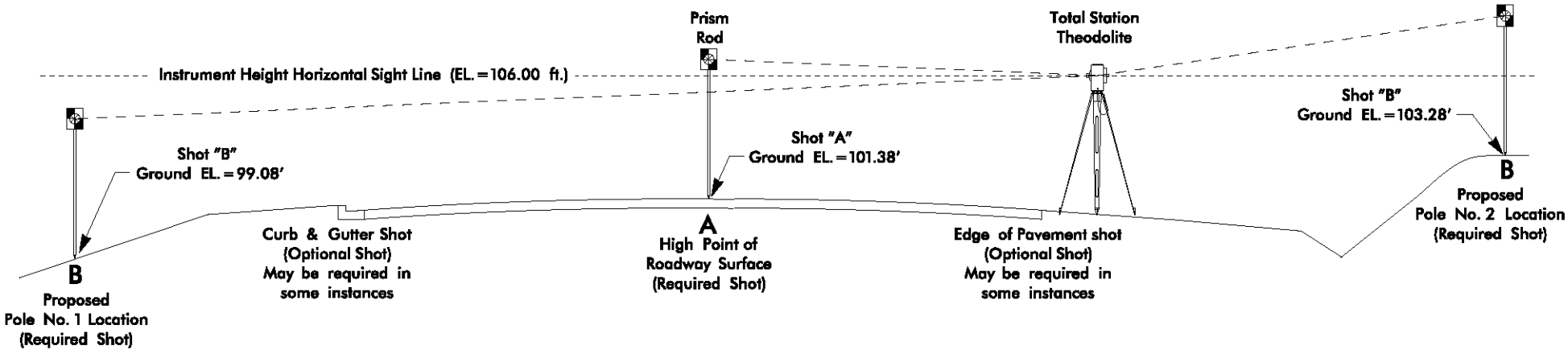
10.1.1
SHEET 1 OF 2

Total Station And Data Collector With Prism Rod Method

Step 1: Using a Total Station and Data collector with Prism Rod:

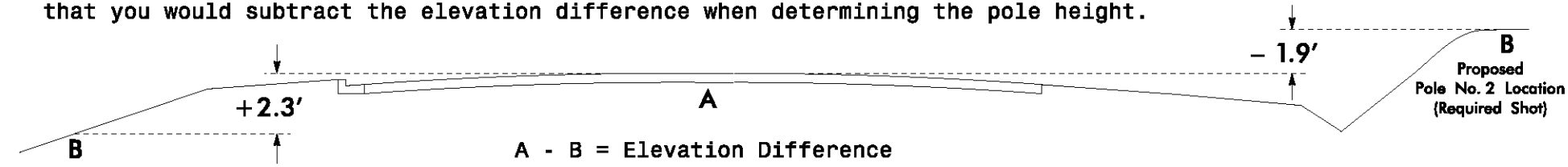
– Take elevation shots on high point of roadway (shot "A") and at proposed pole foundation centerline (Shot "B").



Step 2: Find the elevation difference between Shot "A" and Shot "B"

– Subtract the ground elevation of Shot "B" from the roadway elevation of shot "A".

Notice the difference in the equation when different survey methods are used. A positive number should reflect that you would add the elevation difference to the pole height, where a negative number would mean that you would subtract the elevation difference when determining the pole height.



A - B = Elevation Difference

(Do not round up)

{ Elevation difference for Pole No. 1: 101.38'-99.08' = +2.3'
{ Elevation difference for Pole No. 2: 101.38'-103.28' = -1.9'

Determining Elevation Difference for Metal Poles

SIGNALS & GEOMETRICS SECTION
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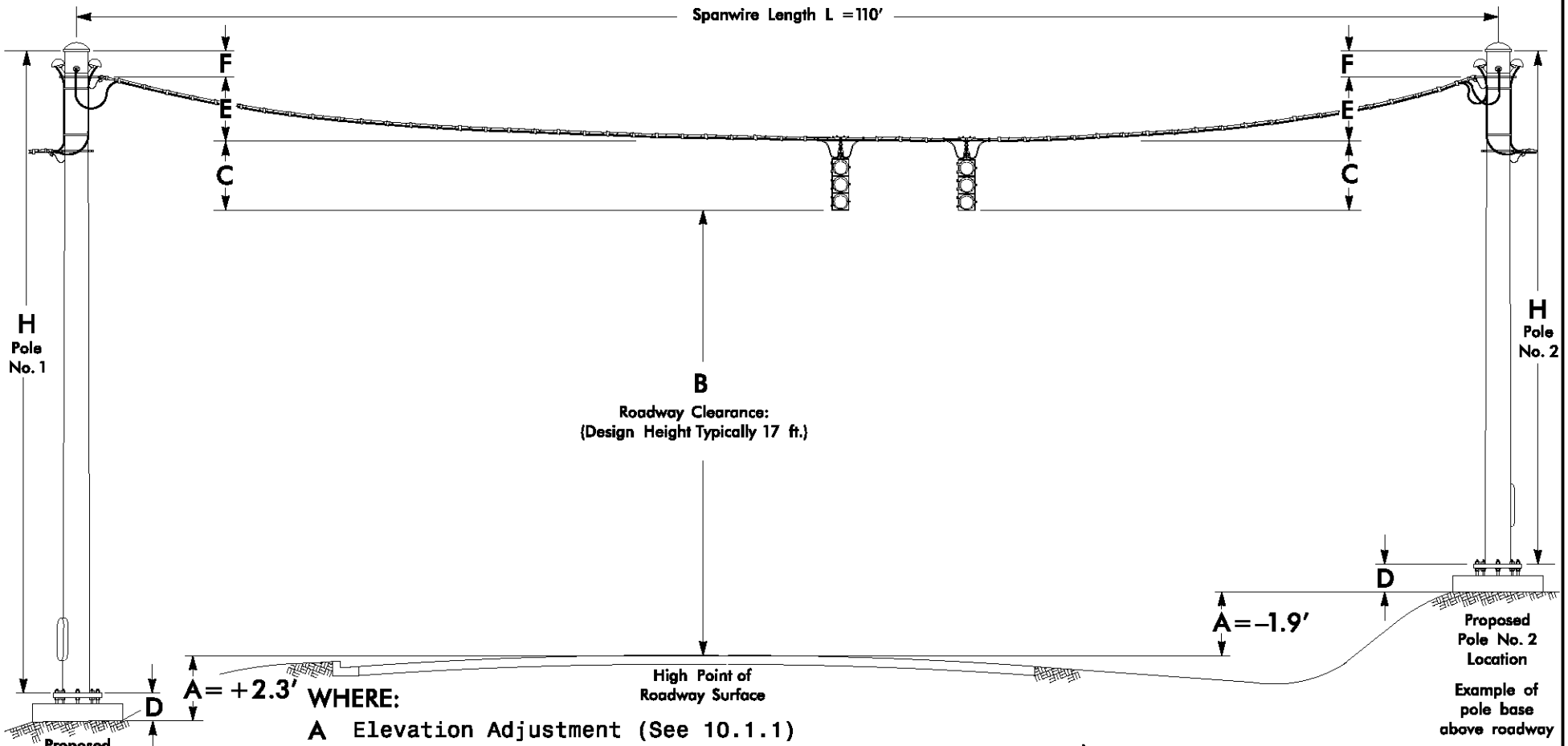
10.1.1
SHEET 2 OF 2

MINIMUM STRAIN POLE HEIGHT (H) = A + B + C − D + E + F



WHERE:

- **A** Elevation Adjustment (See 10.1.1)
- **B** Roadway Clearance Distance (Design Height typically 17′)
- **C** Signal Head Height for Spanwire Mounting (See 10.1.3)
- **D** Top of pole base above ground = 0.75′
- **E** Spanwire Sag = 4% of total Spanwire Length "L"
- **F** Spanwire Attachment Point (Minimum) = 1.5′ Below Top of Pole

Calculating H (Round up to .5 ft.)

Pole height for pole No. 1 (H): +2.3′+17′+4.25′-.75′+4.4′+1.5′ = 28.7′ => 29.0 ft.

Pole height for pole No. 2 (H): -1.9′+17′+4.25′-.75′+4.4′+1.5′ = 24.5′ => 24.5 ft.

Pole Height Determination – Strain Poles

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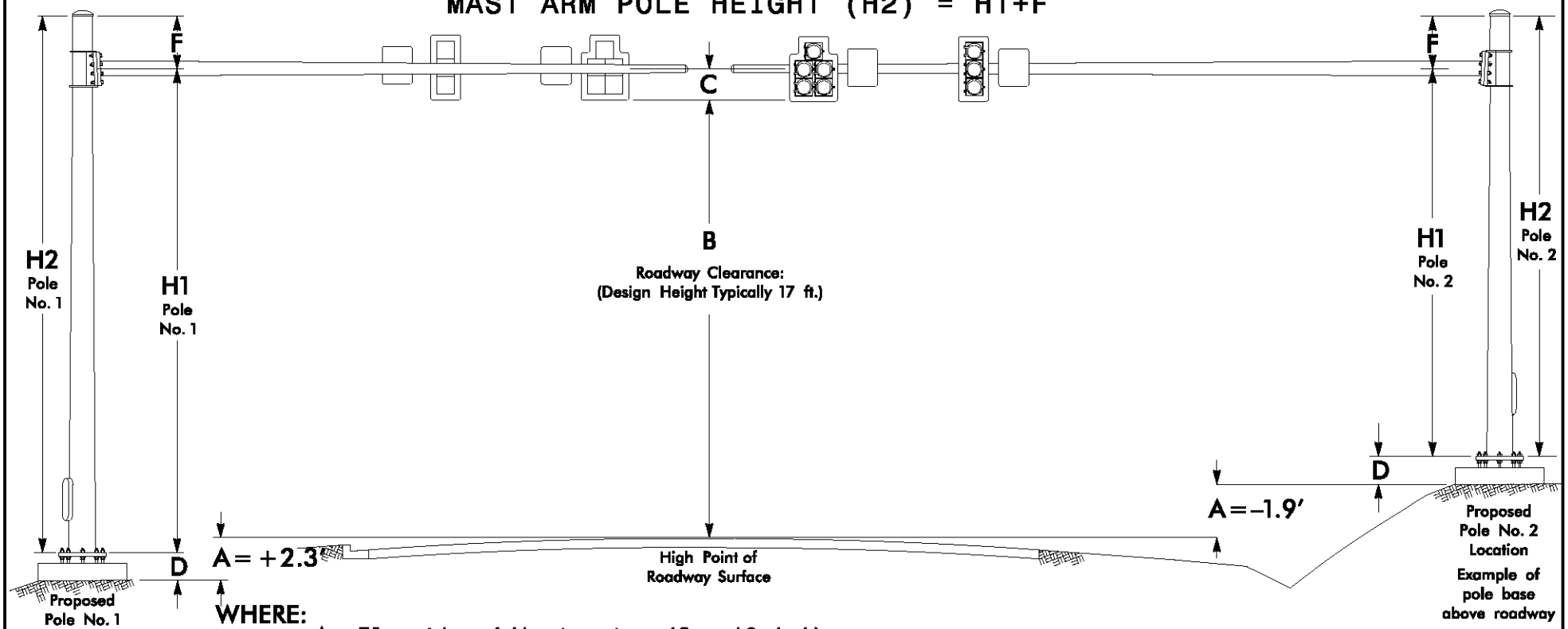
10.1.2
SHEET 1 OF 3

MAST ARM ATTACHMENT HEIGHT (H1) =A+B+C−D
MAST ARM POLE HEIGHT (H2) = H1+F



WHERE:

- **A** Elevation Adjustment - (See 10.1.1)
- **B** Roadway Clearance Distance (Design Height typically 17′)
- **C** ½ Signal Head Height for Mast Arm Mounting (See 10.1.3)
- **D** Top of Pole base above ground = 0.75′
- **F** ℄ Arm Attachment Point to Top of Pole = 2′

EXAMPLES:

Calculating H1 (Round up to .1 ft.)
- Mast Arm attachment height for pole No. 1 (H1): +2.3′+17′+(4.67′/2)-.75′ = 20.885′ => 20.9 ft.
- Mast Arm attachment height for pole No. 2 (H1): -1.9′+17′+(4.67′/2)-.75′ = 16.685′ => 16.7 ft.

Calculating H2 (Round up to .5 ft.)
- Pole height for pole No. 1 (H2): 20.9′+2′ = 22.9′ => 23.0 ft.
- Pole height for pole No. 2 (H2): 16.7′+2′ = 18.7′ => 19.0 ft.

Pole Height Determination – Straight Mast Arms

SIGNALS & GEOMETRICS SECTION
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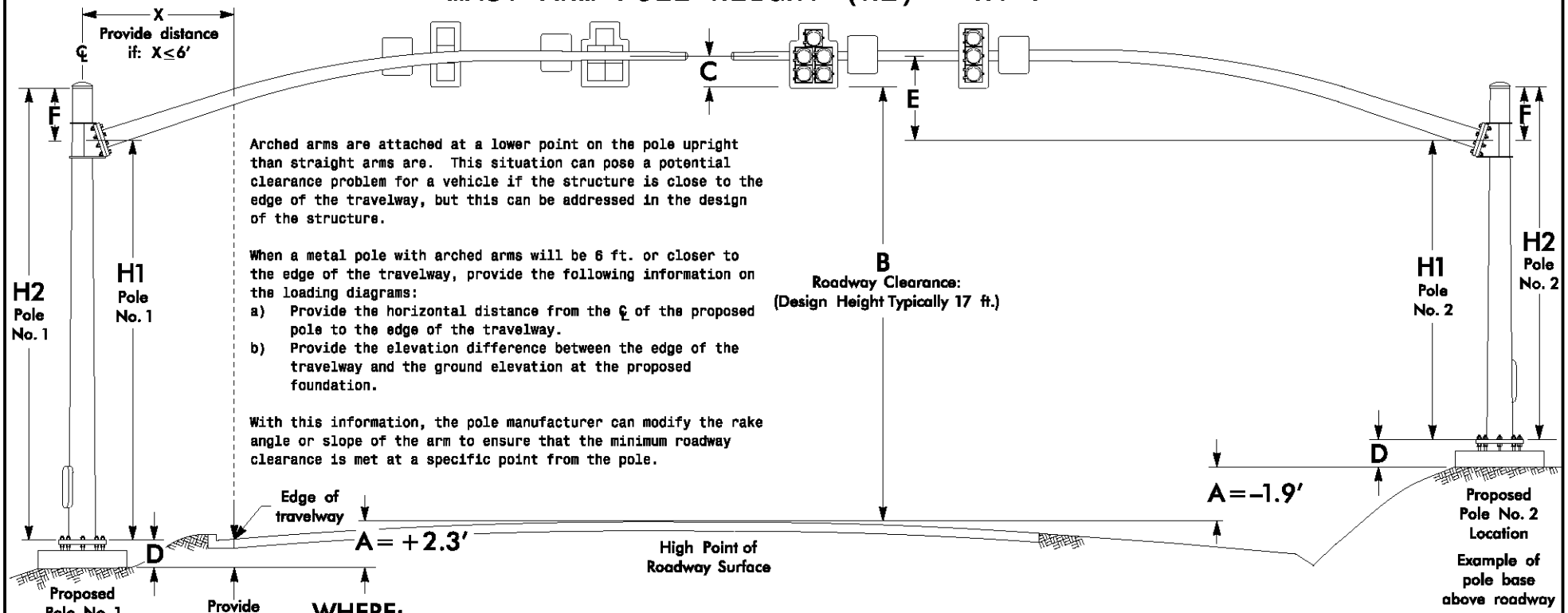
10.1.2
SHEET 2 OF 3

MAST ARM ATTACHMENT HEIGHT (H1) =A+B+C−D−E
MAST ARM POLE HEIGHT (H2) = H1+F



Arched arms are attached at a lower point on the pole upright than straight arms are. This situation can pose a potential clearance problem for a vehicle if the structure is close to the edge of the travelway, but this can be addressed in the design of the structure.

When a metal pole with arched arms will be 6 ft. or closer to the edge of the travelway, provide the following information on the loading diagrams:

a) Provide the horizontal distance from the ℄ of the proposed pole to the edge of the travelway.
b) Provide the elevation difference between the edge of the travelway and the ground elevation at the proposed foundation.

With this information, the pole manufacturer can modify the rake angle or slope of the arm to ensure that the minimum roadway clearance is met at a specific point from the pole.

WHERE:

- **A** Elevation Adjustment (See 10.1.1)
- **B** Roadway Clearance Distance (Design Height typically 17′)
- **C** ½ Signal Head Height for Mast Arm Mounting (See 10.1.3)
- **D** Top of pole base above ground = 0.75′
- **E** Nominal Rise in Mast Arm = 5′
- **F** ℄ Arm Attachment Point to Top of Pole = 2′

EXAMPLES:

Calculating H1 (Round up to .1 ft.)
- Mast Arm attachment height for pole No. 1 (H1): +2.3′+17′+(4.67′/2)-.75′-5.0′ = 15.885′ => 15.9 ft.
- Mast Arm attachment height for pole No. 2 (H1): -1.9′+17′+(4.67′/2)-.75′-5.0′ = 11.685′ => 11.7 ft.

Calculating H2 (Round up to .5 ft.)
- Pole height for pole No. 1 (H2): 15.9′+2′ = 17.9′ => 18.0 ft.
- Pole height for pole No. 2 (H2): 11.7′+2′ = 13.7′ => 14.0 ft.

Pole Height Determination – Curved /Arched Mast Arms

SIGNALS & GEOMETRICS SECTION
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STD. NO.
10.1.2
SHEET 3 OF 3

LOADING SCHEDULE FOR STRAIN POLES

DESCRIPTION	AREA	SIZE	WEIGHT
SIGNAL HEAD 12"-3 SECTION-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	9.2 S.F.	25.5" W x 52.0" L	56 LBS
SIGNAL HEAD 12"-4 SECTION (T-TYPE)-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	16.3 S.F.	42.0" W x 56.0" L	73 LBS
SIGNAL HEAD 12"-4 SECTION (VERTICAL)-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	11.6 S.F.	25.5" W x 65.5" L	69 LBS
SIGNAL HEAD 12"-5 SECTION-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	16.3 S.F.	42.0" W x 56.0" L	89 LBS
SIGNAL HEAD 8"-3 SECTION-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	6.3 S.F.	22.0" W x 41.5" L	41 LBS
SIGNAL HEAD 8"-4 SECTION (VERTICAL)-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	7.9 S.F.	22.0" W x 51.5" L	49 LBS
SIGNAL HEAD 8"-5 SECTION-WITH BACKPLATE, HANGER, AND BALANCE ADJUSTER	10.6 S.F.	35.0" W x 43.5" L	62 LBS
SIGN WITH HANGER	5.0 S.F.	24.0" W x 30.0" L	11 LBS
SIGN WITH HANGER	7.5 S.F.	30.0" W x 36.0" L	14 LBS
SIGN, LED BLANKOUT WITH HANGER	6.0 S.F.	24.0" W x 36.0" L	110 LBS

LOADING SCHEDULE FOR MAST ARM POLES

DESCRIPTION	AREA	SIZE	WEIGHT
SIGNAL HEAD 12"-3 SECTION-WITH BACKPLATE AND ASTRO-BRAC	9.3 S.F.	25.5" W x 52.5" L	60 LBS
SIGNAL HEAD 12"-4 SECTION (T-TYPE)-WITH BACKPLATE AND ASTRO-BRAC	16.3 S.F.	42.0" W x 56.0" L	90 LBS
SIGNAL HEAD 12"-4 SECTION (VERTICAL)-WITH BACKPLATE AND ASTRO-BRAC	11.7 S.F.	25.5" W x 66.0" L	74 LBS
SIGNAL HEAD 12"-5 SECTION-WITH BACKPLATE AND ASTRO-BRAC	16.3 S.F.	42.0" W x 56.0" L	103 LBS
SIGNAL HEAD 8"-3 SECTION-WITH BACKPLATE AND ASTRO-BRAC	6.4 S.F.	22.0" W x 42.0" L	43 LBS
SIGNAL HEAD 8"-4 SECTION (VERTICAL)-WITH BACKPLATE AND ASTRO-BRAC	7.9 S.F.	22.0" W x 52.0" L	53.5 LBS
SIGNAL HEAD 8"-5 SECTION-WITH BACKPLATE AND ASTRO-BRAC	10.6 S.F.	35.0" W x 43.5" L	75 LBS
SIGN RIGID MOUNTED WITH ASTRO-SIGN-BRAC	5.0 S.F.	24.0" W x 30.0" L	11 LBS
SIGN RIGID MOUNTED WITH ASTRO-SIGN-BRAC	7.5 S.F.	30.0" W x 36.0" L	14 LBS
SIGN, LED BLANKOUT WITH HANGER	6.0 S.F.	24.0" W x 36.0" L	110 LBS

Loading Schedules For Metal Poles

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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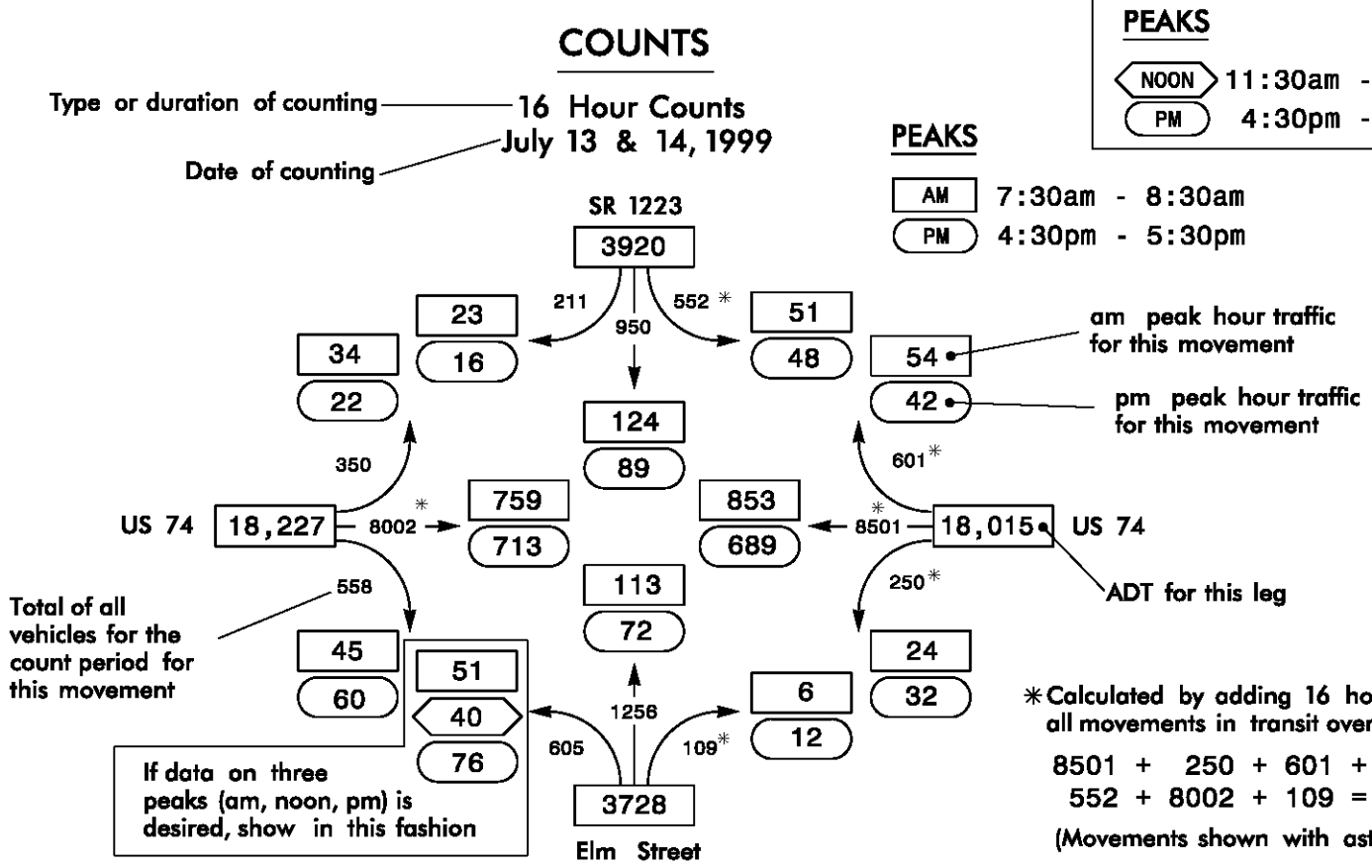
10.1.3
SHEET 1 OF 1

Typical Count Diagram
Complete Traffic Counts

If a "noon" (between 10:30am and 2:30pm) peak occurs, show in this fashion:

PEAKS

NOON 11:30am - 12:30pm
PM 4:30pm - 5:30pm



Traffic Counts

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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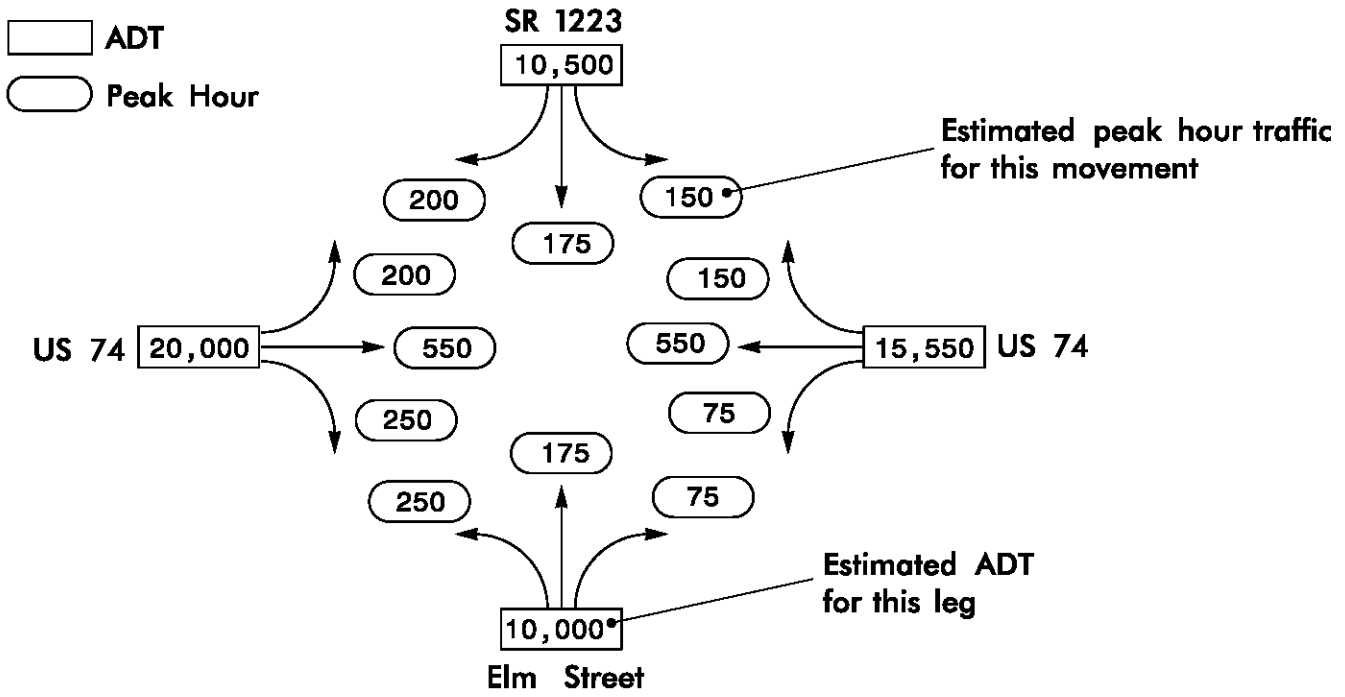
7-04

STD. NO.
11.0
SHEET 1 OF 3

Typical Count Diagram
Estimated Traffic Counts

Year 2020 Projected Volumes



Traffic Counts

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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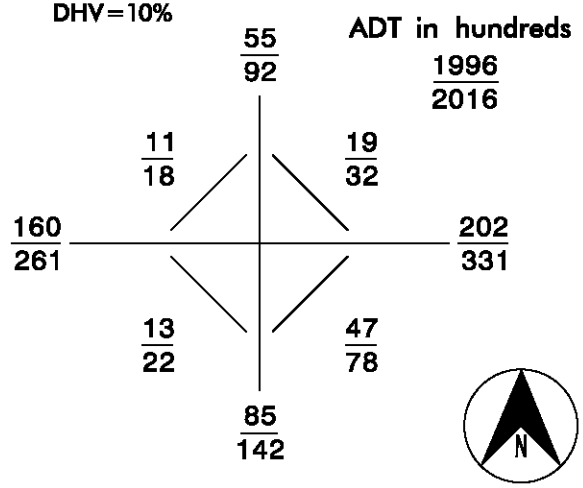
STD. NO.
11.0
SHEET 2 OF 3

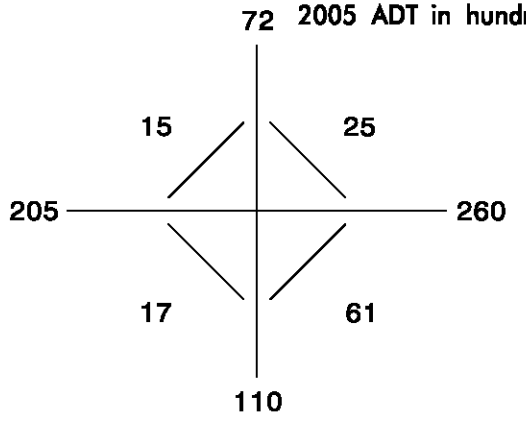
Conversion from Estimated ADT to Estimated DDHV – Example

GIVEN Project Letting Date = 2000
Design Year = Letting Date + 5 years = 2005
D = 60%
DHV = 10%



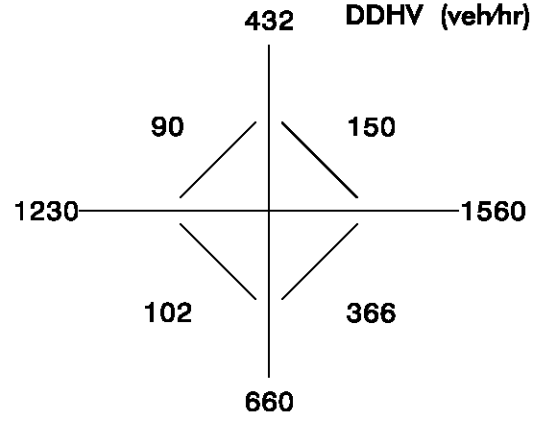
STEP 1 Interpolate to find 2005 ADT.

For the north leg, 55 + (92-55)(9/20) = 72



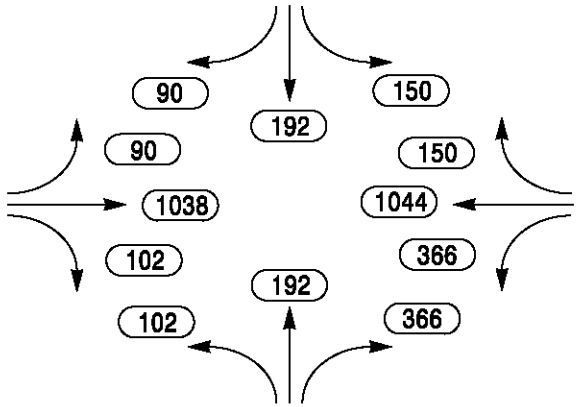
STEP 2 Convert to DDHV: (ADT)(DHV)(D) = DDHV.

For the north leg, (7200)(.10)(.60) = 432

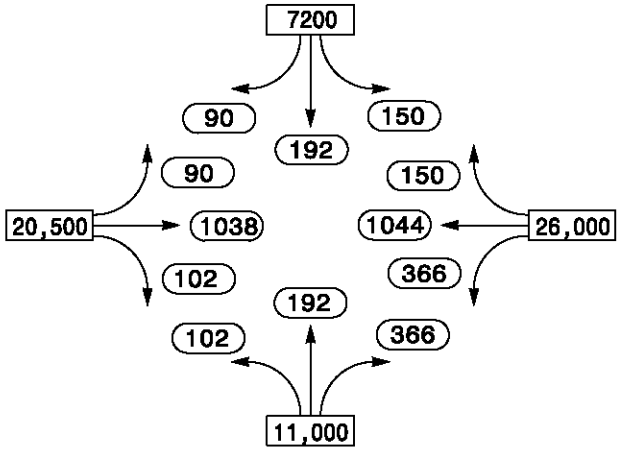


STEP 3 Determine through volumes by subtracting turning volume from total volume.

For the north leg, 432 - 90 - 150 = 192



STEP 4 Complete count diagram.



NOTES

-ADT = Average Daily Traffic

-DHV = Design Hour Volume

-DDHV = Directional Design Hour Volume

-D = Directional Split

-Use the highest directional split for each movement. Do not attempt to determine the direction of the peak flow for both the morning and afternoon peak hours.

-Because of the uncertainty of the data, a peak hour factor of 1.0 should be used when these peak hour volumes are used for analysis.

Traffic Counts

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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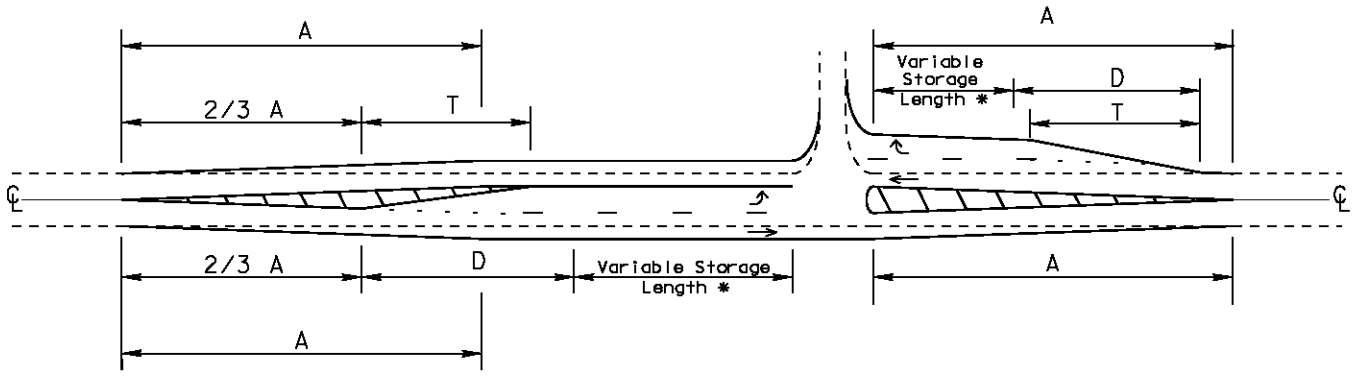
11.0
SHEET 3 OF 3

Recommended Treatment for Turn Lanes

Symmetrical Widening



Design Speed (mph)	Posted Speed (mph)	Minimum Deceleration Length (D)	Desirable Deceleration Length (D)	Bay Taper Length (T)	Approach / Departure Taper (A)
30	≤ 25	100′	150′	75′	$A = WS^2/60$ (IF $S \leq 40$ MPH) $A = WS$ (IF $S > 40$ MPH) S = Design Speed W = Width of Lateral Shift * Storage length for waiting vehicles should be calculated based on the latest version of the Highway Capacity Manual or Policy on Street and Driveway Access to North Carolina Highways.
35	30	100′	150′	75′	
40	35	150′	200′	100′	
45	40	150′	250′	100′	
50	45	150′	300′	100′	
55	50	200′	500′	150′	
60	55	250′	575′	200′	

From *Policy on Street and Driveway Access to North Carolina Highways*

Geometrics – Turn Lanes

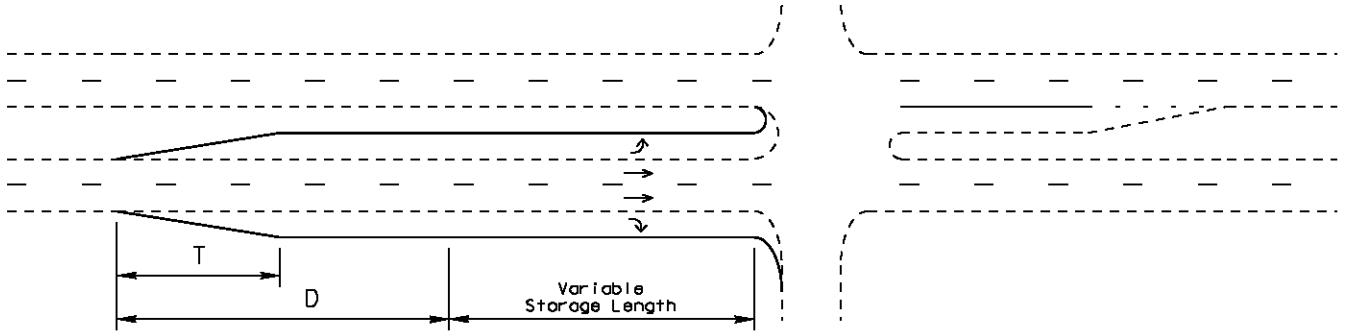
SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

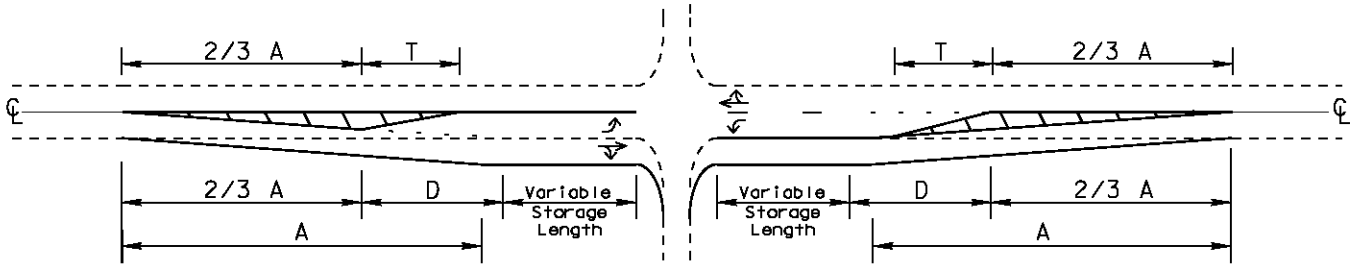
STD. NO.
12.0
SHEET 1 OF 2

Recommended Treatment for Turn Lanes

Pocket Lanes



Near Side Widening



All values to be determined using the table on the previous page.

From *Policy on Street and Driveway Access to North Carolina Highways*

Geometrics – Turn Lanes

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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7-04

STD. NO.
12.0
SHEET 2 OF 2

2070L Preemption Chart

Used to designate this interval as the preemption dwell interval. This interval will use Dwell Min. Time below. Selecting 255 sec. green indicates dwell (hold) phase.

Clearance times for dwell (hold) phase. Using 0.0 sec. for each will allow controller to use times set in normal operation.

Amount of time signal is in exit phase before preemption ends. Select 0 for controller to return to normal operation after preemption. Select 1 to designate an exit phase.

Clearance time not used when Interval 5 is exit interval.

Delay time after preempt call is received before going to preempt phase. Usually 0.0 sec. for Opticom systems; may need delay for pushbutton locations.

Minimum green time assured for current phase before transitioning into preempt phase. Usually 1 sec., so as to begin preemption sequence immediately (0 sec. will default to normal minimum green time).

Time provided to display Flashing "DON'T WALK" for pedestrians to clear intersection before beginning preemption sequence.

Clearance times provided to clear current phase before transitioning into preemption. Using 0.0 sec. for each will allow controller to use times set in normal operation.

Minimum time preemption dwell phase will run. Opticom systems typically use the same time as the phase in normal operation. Minimum time for pushbutton locations needs to be based on trial runs (typically by the Division).

Select yes to clear to all red before going into preemption to prevent yellow trap.

"Y" (for Yes) will time the "Ped Clear Before Pre" and "Yellow Clear Before Pre" simultaneously, thereby reducing overall clearance time needed before preemption. Select "N" to time "FDW" and then yellow clear and red clear before going into preeempt.

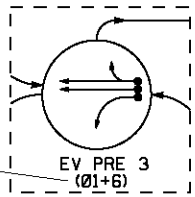
Time to extend preempt dwell phase after call is dropped (usually 2 sec.) Prevents the call from being dropped accidentally. Typically used for Opticom systems.

2070L EV PREEMPTION

FUNCTION	PRE 3	PRE 4	PRE 5	PRE 6
Interval 1 – Dwell Green	255	255	255	255
Interval 1 – Dwell Yellow	0.0*	0.0*	0.0*	0.0*
Interval 1 – Dwell Red	0.0*	0.0*	0.0*	0.0*
Interval 5 – Exit Green	1	1	1	1
Interval 5 – Yellow	0.0	0.0	0.0	0.0
Interval 5 – Red	0.0	0.0	0.0	0.0
Delay Time	0.0	0.0	0.0	0.0
Min Green Before Pre	1	1	1	1
Ped Clear Before Pre	0	0	0	0
Yellow Clear Before Pre	0.0*	0.0*	0.0*	0.0*
Red Clear Before Pre	0.0*	0.0*	0.0*	0.0*
Dwell Min Time	10	7	10	7
Enable Backup Protection	Y/N	Y/N	Y/N	Y/N
Ped Clear Through Yellow	Y/N	Y/N	Y/N	Y/N
Preempt Extend**	2	2	2	2

* Time defaults to time used for phase during normal operation
** Program Timing on Optical Detection Unit

Notes:
1) For pushbutton operation, use EV PRE 2.
2) For Opticom type operation:
   For 1 preempt, use EV PRE 3
   For 2 preempts, use EV PRE 3 and 5
   For 3 preempts, use EV PRE 3, 4, and 5
   For 4 preempts, use EV PRE 3, 4, 5, and 6
3) Include corresponding regular phases in phasing diagram



Emergency Vehicle Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-05

STD. NO.
13.0
SHEET 1 OF 2

NEMA Preemption Chart

Delay time after preempt call is received before going to preempt phase. Usually 0 sec. for Opticom systems. May need delay for pushbutton locations, typically Division will determine delay needed.

Time provided to display Flashing "DON'T WALK" for pedestrian to clear intersection before beginning preempt sequence. This time may be reduced if necessary.

Minimum green time assured for current phase before transitioning into preempt phase. Usually 1 sec., so as to begin preemption sequence immediately (0 sec. will default to normal minimum green time).

Highest yellow and highest red clear times needed to clear normal operation phases (may come from different phases).

Minimum time preemption dwell phase will run. Opticom systems typically use the same time as the phase in normal operation. Minimum time for pushbutton locations needs to be based on trial runs (typically by the Division).

Clearance times for dwell (hold) phase. Use clearance times from corresponding normal phase (See Std. 5.2.2, Sheet 4).

Some NEMA controllers allow Ped Clear time and Yellow Clear time Before Preempt to time simultaneously, while other brands do not. If in doubt about type of equipment being used, select "N."

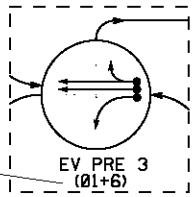
Time to extend preempt dwell phase after call is dropped (usually 2 sec.) Prevents the call from being dropped accidentally. Typically used for Opticom systems.

NEMA EV PREEMPTION

FUNCTION	PRE 3	PRE 4	PRE 5	PRE 6
Delay Before Preempt	0	0	0	0
Ped Clear Before Preempt	–	–	–	–
Min. Green Before Preempt	1	1	1	1
Yellow Clear Before Preempt	4.0	4.0	4.0	4.0
Red Clear Before Preempt	1.0	1.0	1.0	1.0
Preempt Dwell Min. Green	10	7	10	7
Yellow Clr After Preempt	4.0	4.0	4.0	4.0
Red Clear After Preempt	1.0	1.0	1.0	1.0
Ped Clear Through Yellow	Y/N	Y/N	Y/N	Y/N
Preempt Extend **	2.0	2.0	2.0	2.0

** Program Timing on Optical Detection Unit

Notes:
1) For pushbutton operation, use EV PRE 2.
2) For Opticom type operation:
   For 1 preempt, use EV PRE 3
   For 2 preempts, use EV PRE 3 and 5
   For 3 preempts, use EV PRE 3, 4, and 5
   For 4 preempts, use EV PRE 3, 4, 5, and 6
3) Include corresponding regular phases in phasing diagram



170 Preemption Chart

(See Above)

Time needed for pedestrians to clear intersection before going into preempt phase.

(See Above)

Preemption dwell phase minimum green (times after call is released).

(See Above)

170 EV PREEMPTION

FUNCTION	EVA	EVB	EVC	EVD
Delay Before Preempt	0	0	0	0
Ped. Clear Before Preempt	–	–	–	–
Min. Green Before Preempt	1.0	1.0	1.0	1.0
Clearance Time	7	7	7	7
Preempt Extend **	2.0	2.0	2.0	2.0

** Program Timing on Optical Detection Unit

Emergency Vehicle Preemption

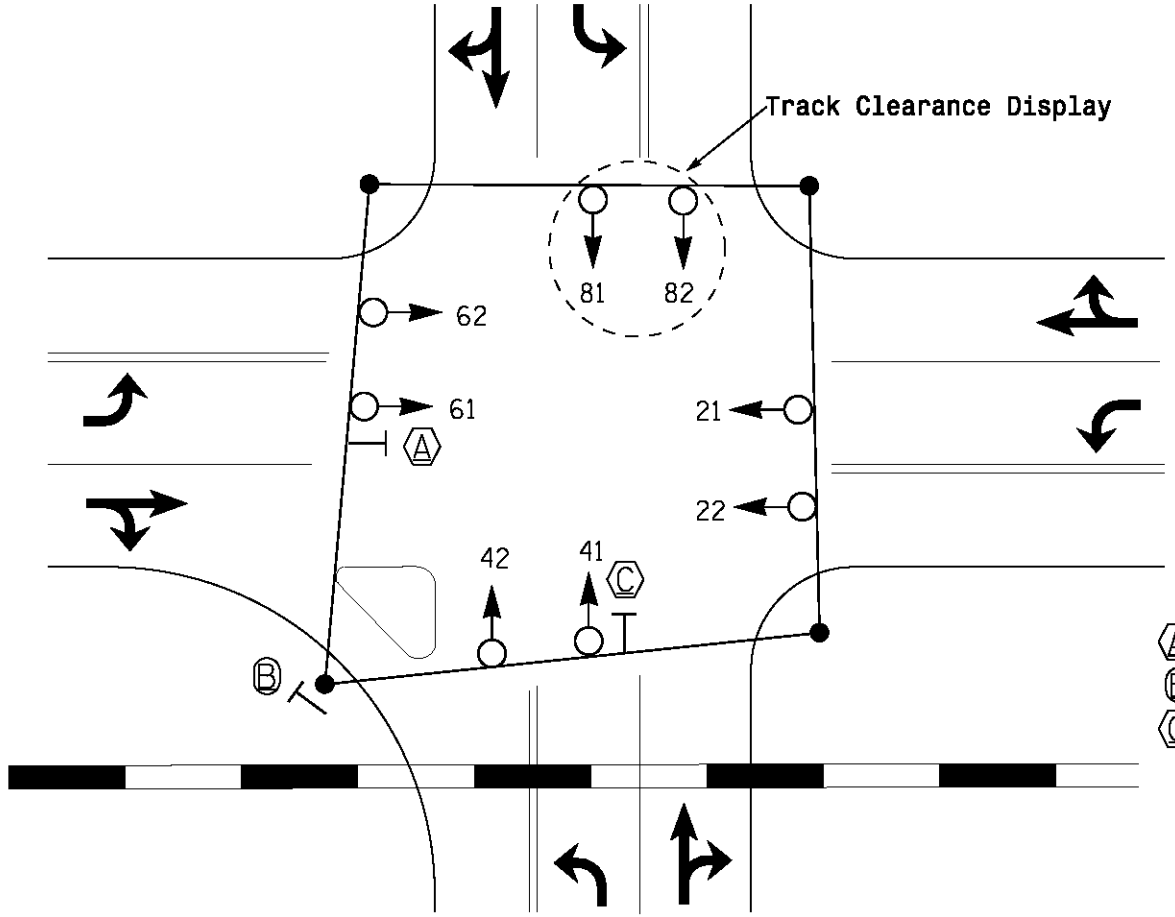
SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

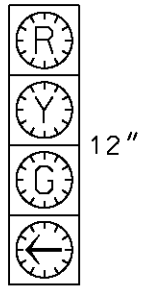
7-04

STD. NO.
13.0
SHEET 2 OF 2

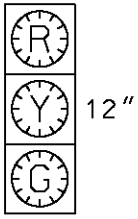
Use of Signal Heads and Blankout Signs
Permissive Only Displays

NOTE: BLANKOUT SIGNS ARE NOT USED IN CONJUNCTION WITH "YIELD" SIGN CONTROLLED MOVEMENTS





81



21, 22
41, 42
61, 62
82

Ⓐ No Left Turn Blankout Sign
Ⓑ Yield Sign (R1-2)
Ⓒ "ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN" Sign (W25-2)

Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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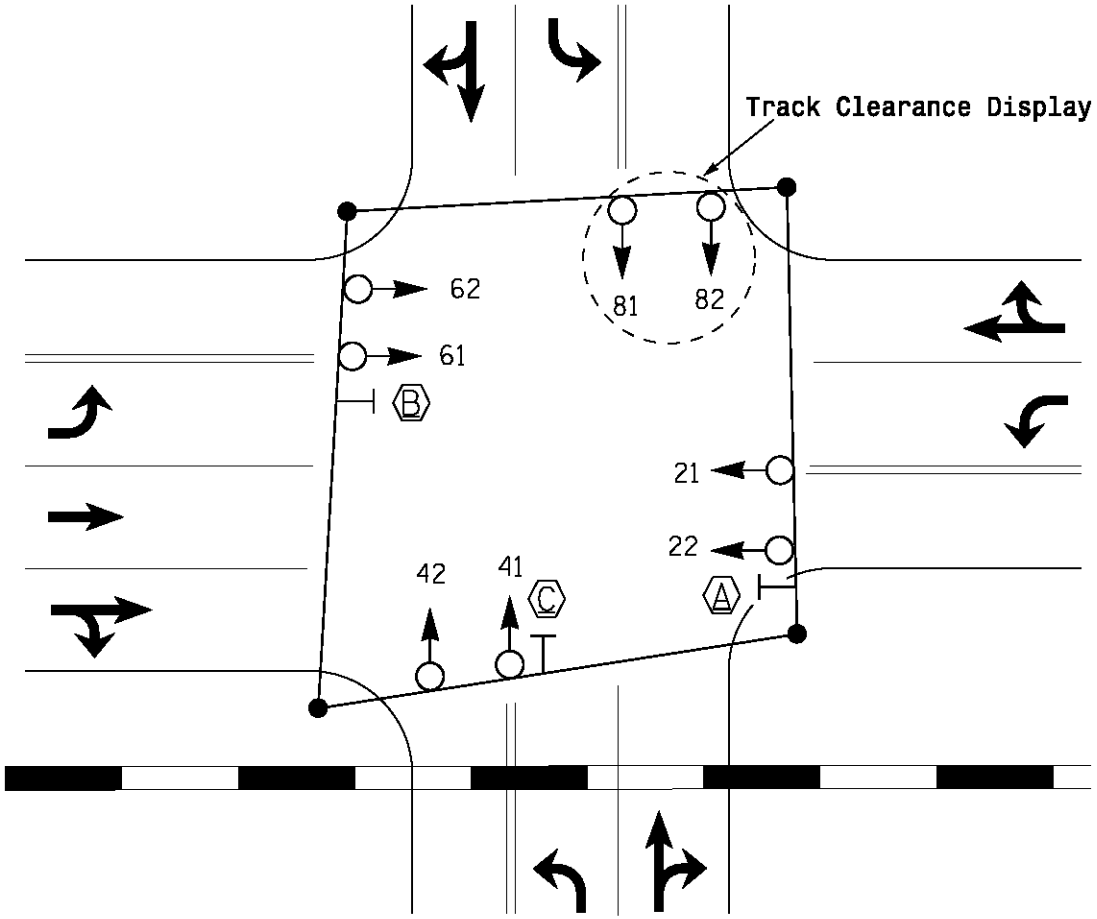
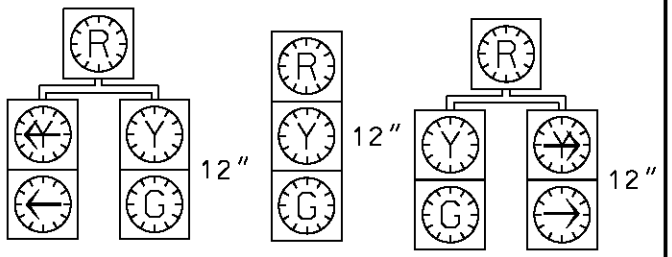
STD. NO.
13.1
SHEET 1 OF 10

Use of Signal Heads and Blankout Signs
Protected /Permissive Displays





21
41
61
81

42
62
82

22

Ⓐ No Right Turn Blankout Sign
Ⓑ No Left Turn Blankout Sign
Ⓒ "ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN" Sign (W25-2)

Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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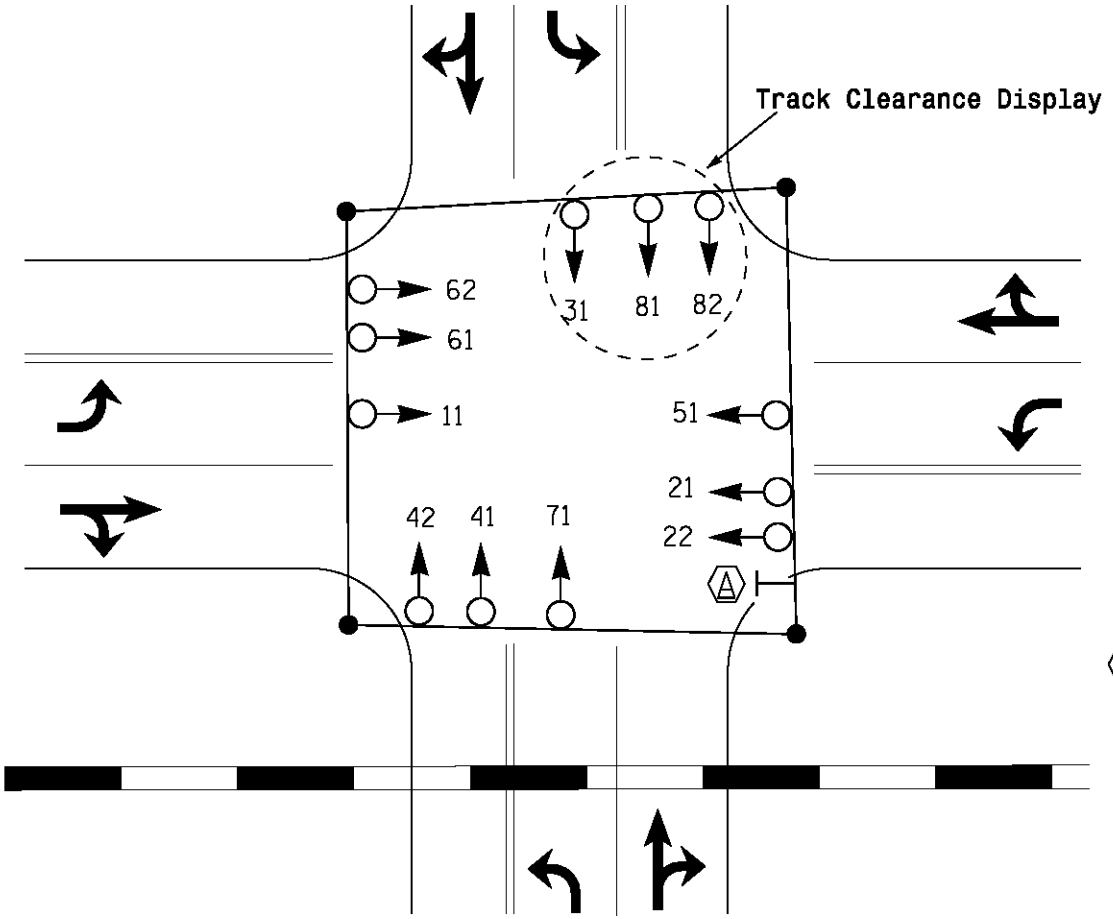
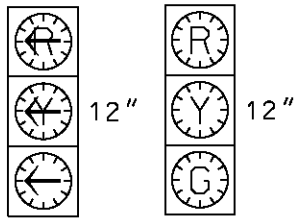
13.1
SHEET 2 OF10

Use of Signal Heads and Blankout Signs
Protected Only Displays

NOTE: BLANKOUT SIGNS ARE NOT USED IN CONJUNCTION WITH "RED ARROW" SIGNAL DISPLAYS





11	21, 22
31	41, 42
51	61, 62
71	81, 82

No Right Turn Blankout Sign

Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO.
13.1
SHEET 3 OF 10

Use of Signal Heads and Blankout Signs
Advance Signal Heads
(With Adequate Storage)

Design Consideration:

When active crossing warning devices consists only of flashers (no gates present) and there is room to store vehicles between the tracks and the intersection.

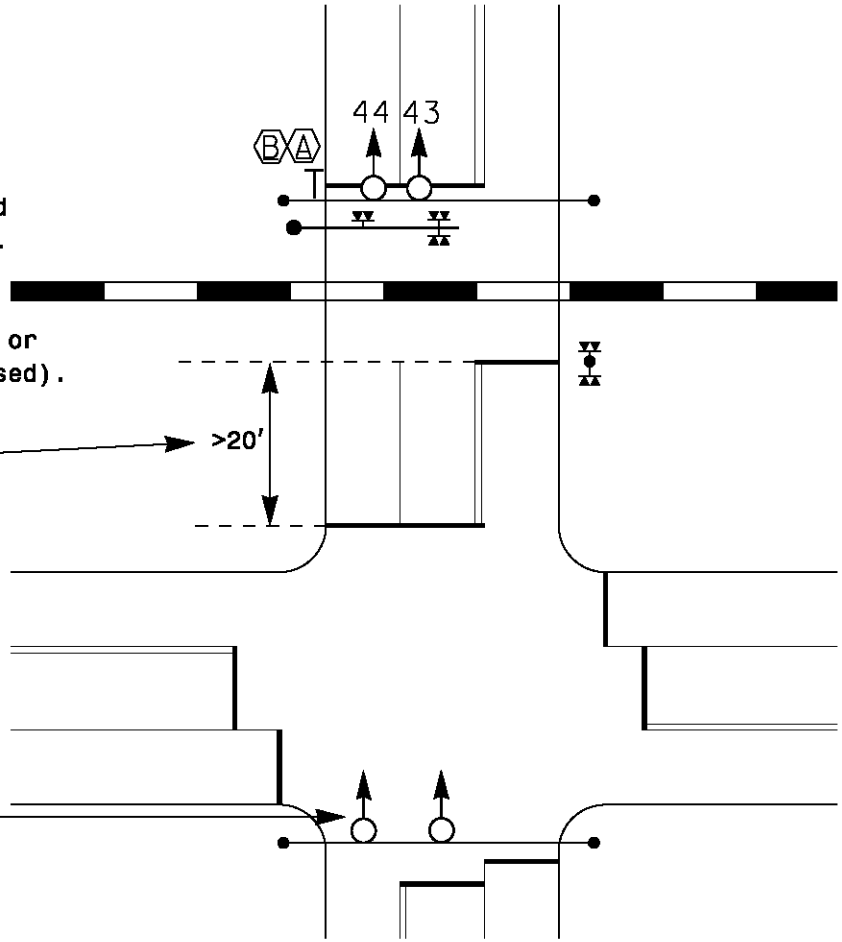
Advance signal faces should be located as near as practical to the stop line.

Advance signal heads should not block or obstruct flashers on cantilever (if used).

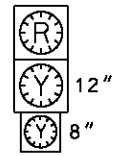
Adequate storage space to hold at least one design vehicle (typically assumed to be 20').

NOTE: Based on engineering judgement, advance signal heads may be placed downstream (across) of the railroad tracks.

NOTE: When advance heads are used, consider visibly limiting the signal heads for the approach from the railroad at the intersection.



SIGNAL FACE I.D.



43, 44

SIGN I.D.

Ⓐ "STOP HERE ON RED" Sign (R10-6)

Ⓑ "DO NOT STOP ON TRACKS" Sign (R8-8)

TABLE OF OPERATION

SIGNAL FACE	PHASE				
	Ø2+6	Ø4+8	RR CLR	RR PRE	FLASH
43, 44	FY	FY	R	R	R

FY = 8" Flashing Yellow

(See Note 125 in Section 5.0)

Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO.

13.1

Use of Signal Heads and Blankout Signs
Advance Signal Heads
(Without Adequate Storage)

Design Consideration:

When there is no room to store vehicles between the tracks and the intersection.

A Track Clearance Phase is generally not used in this situation.

A supplemental signal head should be used due to the potential for a train to block the signal heads.

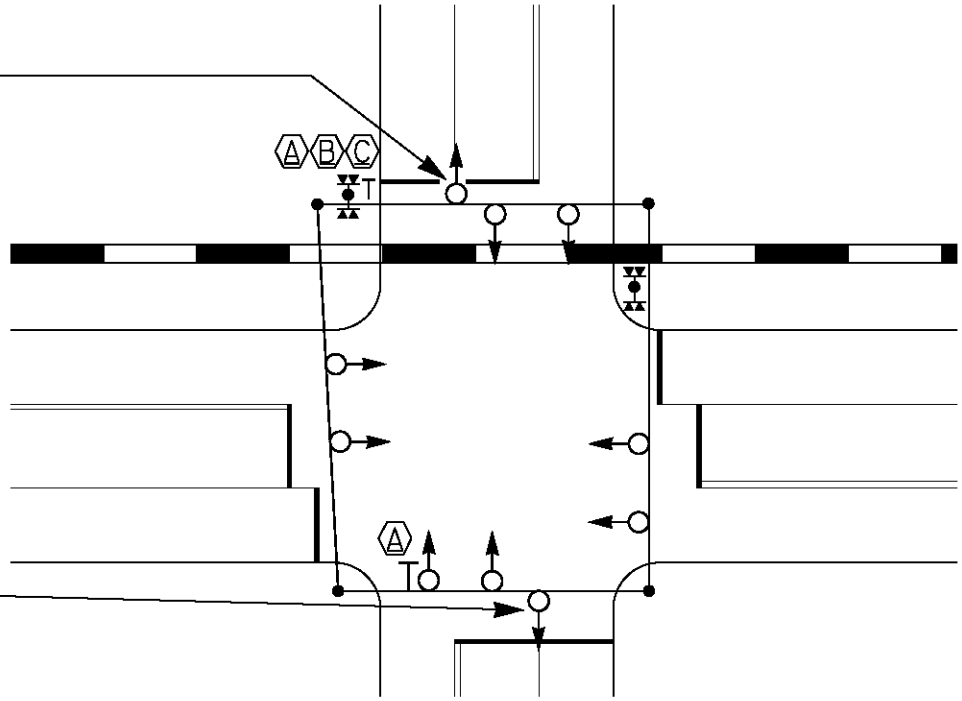
Traffic must stop at stopbar prior to railroad track for signal. A "NO TURN ON RED" sign should be used.

Advance signal heads should not block or obstruct flashers on cantilever (if used).

A supplemental signal head may be needed due to the potential for a train to block the signal heads.

SIGN I.D.

Ⓐ "NO TURN ON RED" Sign (R10-11)
Ⓑ "STOP HERE ON RED" Sign (R10-6)
Ⓒ "DO NOT STOP ON TRACKS" Sign (R8-8)



Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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7-04

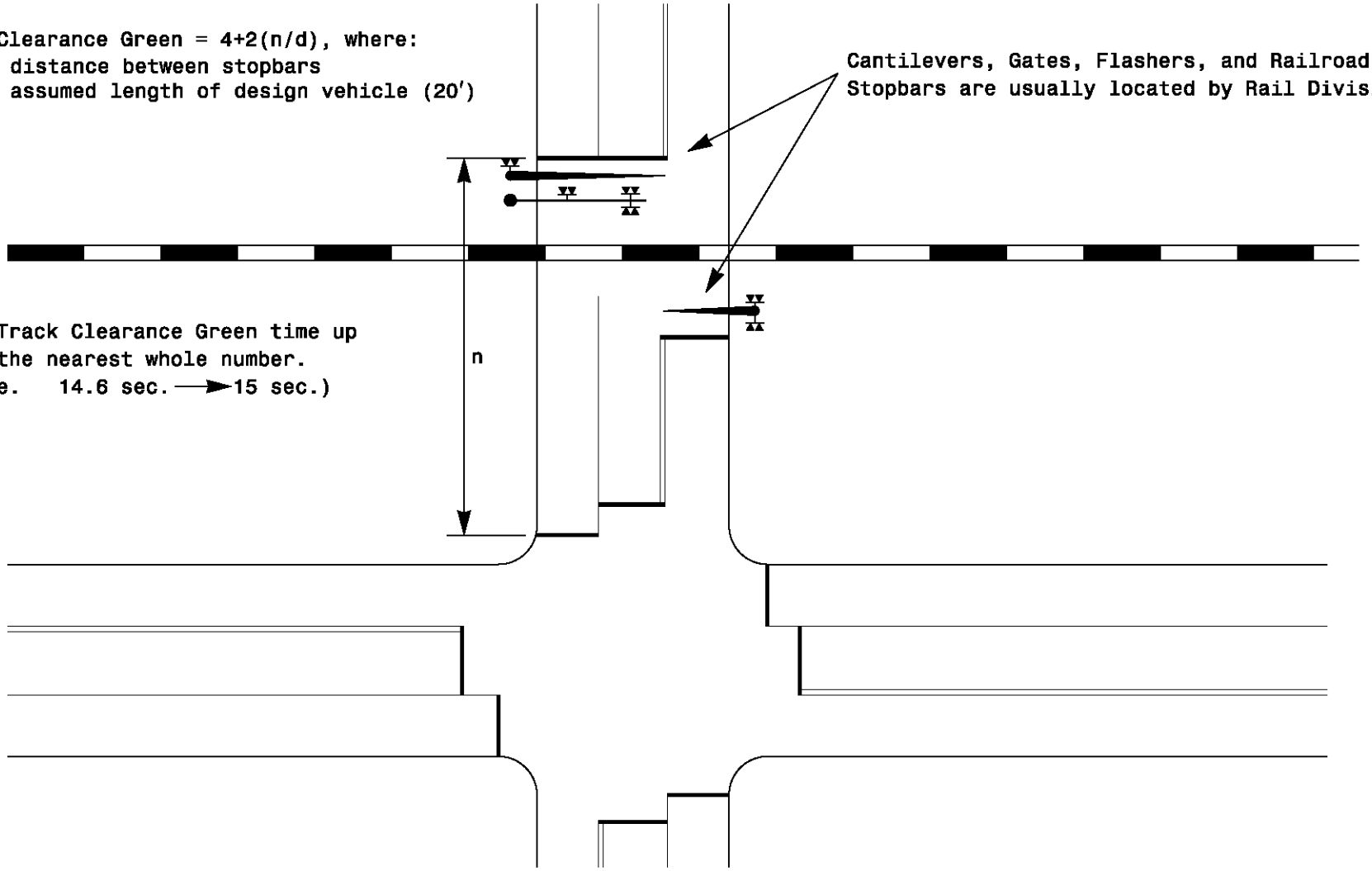
STD. NO.
13.1
SHEET 5 OF10

Track Clearance Phase Times

Greenshield's Formula:

Track Clearance Green = 4+2(n/d), where:
n = distance between stopbars
d = assumed length of design vehicle (20′)

Round Track Clearance Green time up
to the nearest whole number.
(i.e. 14.6 sec. ⟶ 15 sec.)



Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO.
13.1
SHEET 6 OF 10

2070L Preemption Chart

Based on Greenshield's Formula (see Sheet 6). Typically minimum is 10 seconds.

Times for track clearance phase. Should be the same times as if the phase were used in normal operation.

Used to designate this interval as the preemption dwell interval. This interval will use Dwell Min. Time below. Selecting 255 sec. green indicates dwell (hold) phase.

Clearance times for dwell (hold) phase. Using 0.0 sec. for each will allow controller to use times set in normal operation.

Amount of time signal is in exit phase before preemption ends. Select 0 for controller to return to normal operation after preemption. Select 1 to designate an exit phase.

Clearance time not used when Interval 5 is exit interval.

Delay time after preempt call is received before going to preemption sequence. Typically use 0 sec.

Minimum green time assured for current phase before transitioning into preempt phase. Usually 1 sec., so as to begin preemption sequence immediately (0 sec. will default to normal minimum green time).

Time provided to display Flashing "DON'T WALK" for pedestrians to clear intersection before beginning preemption sequence. This time may be reduced if necessary.

Clearance times provided to clear current phase before transitioning into preemption. Using 0.0 sec. for each will allow controller to use times set in normal operation.

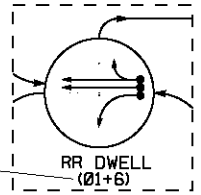
Minimum Green Time for Dwell (hold) phase. Typically, same as time used in normal operation.

"Y" (for Yes) will time the "Ped Clear Before Pre" and "Yellow Clear Before Pre" simultaneously, thereby reducing overall clearance time needed before preemption. Select "N" to time "FDW" and then yellow clear and red clear before going into preeempt.

2070L RR PREEMPTION 1	
Interval 1 – Track Clearance Green	12
Interval 1 – Track Clearance Yellow	3.7
Interval 1 – Track Clearance Red	1.8
Interval 2 – Dwell Green	255
Interval 2 – Dwell Yellow	0.0*
Interval 2 – Dwell Red	0.0*
Interval 5 – Exit Green	1
Interval 5 – Yellow	0.0
Interval 5 – Red	0.0
Delay Time	0
Min Green Before Pre	1
Ped Clear Before Pre	0
Yellow Clear Before Pre	0.0*
Red Clear Before Pre	0.0*
Dwell Min Time	7
Ped Clear Through Yellow	Y/N

* Time defaults to time used for phase during normal operation

Notes:
1) Use Preemption 1
2) Include corresponding regular phases in phasing diagram



Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-05

STD. NO.
13.1
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NEMA (TS–1 and TS–2) Preemption Chart

Delay time after preempt call is received before going into preempt sequence: Typically use 0 sec.

Time provided to display Flashing "DON'T WALK" for pedestrian to clear intersection before beginning preempt sequence. This time may be reduced if necessary.

Minimum green time assured for current phase before transitioning into preempt phase. Usually 1 sec., so as to begin preemption sequence immediately (0 sec. will default to normal minimum green time).

Highest yellow and highest red clearance times needed to clear normal operation phases (may come from different phases).

Based on Greenshield's Formula (see Sheet 6).

Times for Track Clearance phase. Should be the same times as if the phase were used in normal operation (See Std. 5.2.2, Sheet 4).

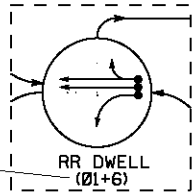
Min Green Time for Dwell (hold) phase. Typically same as time used in normal operation.

Yellow and Red Times of Dwell (hold) phase. Use highest yellow and red times if more than 1 Dwell phase is used.

Some NEMA controllers allow Ped Clear time and Yellow Clear time Before Preempt to time simultaneously, while other brands do not. If in doubt about type of equipment being used, select "N."

NEMA RR PREEMPTION 1	
Delay Before Preempt	0
Ped. Clear Before Preempt	–
Min. Green Before Preempt	1
Yellow Clear Before Preempt	–
Red Clear Before Preempt	–
Track Clearance Green	–
Track Clearance Yellow	–
Track Clearance Red	–
Preempt Dwell Min. Green	–
Yellow Clear After Preempt	–
Red Clear After Preempt	–
Ped Clear Through Yellow	Y/N

Notes:
1) Use Preemption 1
2) Include corresponding regular phases in phasing diagram



Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
13.1
SHEET 8 OF 10

170 Preemption Chart

Delay time after preempt call is received before going into preempt sequence: Typically use 0 sec.

Based on Greenshield's Formula (see Sheet 6).

170 RAILROAD PREEMPTION	
Delay Before Preempt	0
Track Clearance Green	–

NOTE: The Railroad preemption calls are immediate with 170 equipment. 170 Bi-Trans Software does not clear pedestrian times before entering Railroad Preemption. Ped displays go directly from a solid WALK to a solid DON'T WALK display and does not provide any clearance time (flashing DON'T WALK display).

Railroad Preemption

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Elements on a Signal Plan with Railroad Preemption

-AAR DOT Crossing Number on Plan.
-Name of Railroad(s) operating on tracks.
-Show all gates, flashers, and cantilevers on signal plan.
-Railroad Preemption Timing Chart.
-Be sure all phases (including any timed overlaps) lead directly to a Track Clearance phase.
-Railroad Preemption should have priority over Emergency Vehicle Preemption.
-"NO RIGHT (LEFT) TURN" Blankout signs as needed.
-Show blankout signs in Table of Operation. Illuminate blankout signs during track clearance and all preempt hold phases.
-Include blankout sign operation during flash mode in the Notes.
-When entering the preemption sequence, yellow traps are permitted if necessary to provide immediate and proper track clearance. Use an "ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN" sign (W25-2) on the approach(es) subjected to a yellow trap.
-Use a "DO NOT STOP ON TRACKS" sign (R8-8) on approach crossing tracks leading to signal (add any other time there is potential for traffic to queue across tracks).
-Use a "STOP HERE ON RED" sign (R10-6) if traffic is to stop prior to tracks and there is little or no storage room between tracks and the intersection.
-When possible, the street crossing the tracks should flash YELLOW in flashing operation, even if it is not the main phase (2+6). If the side street flashes yellow, then the main street flashes red. An all red flashing indication may also be used at some locations.
-2070 and most NEMA equipment can designate an exit phase upon leaving Railroad Preemption. Typically, exit to the primary phase that was unable to move due to the presence of a train.

Elements for Calculating Minimum Advance Warning Time

Delay Before Preempt
* Ped Clear Before Preempt
Min Green Before Preempt
* Yellow Clear Before Preempt
Red Clear Before Preempt
Track Clear Green
** Track Clear Yellow
** Track Clear Red
** Time for Exit Gates
Safety Equipment Reaction Time
(Usually 5 Seconds)

Add the above to find the Advance Warning Time needed to clear signal for preemption and request this time from Rail Division.

* These values may clear simultaneously with some types of signal equipment.

** If 4 quadrant (exit) gates are used, do not include Track Clear Yellow and Track Clear Red times in this equation. Instead add:
12 Seconds for exit gates to descend to horizontal position.
5 seconds (exit gates should be horizontal 5 seconds prior to train arrival).

Railroad Preemption

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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STD. NO.
13.1
SHEET 10 OF 10

Design Considerations

The purpose of system detectors is to provide volume and occupancy information for dynamic traffic control.

More advanced equipment allows for independent control of multiple zones in the same system, so each system must be evaluated to determine its logical segments. (a.k.a. zones)

Subject to the noted limits, enough system detectors should be included to provide redundant detection of main and side street traffic in each zone of the system:

- . Main street detection should be provided in each direction at multiple intersections in each zone.
- . Side street detection should be provided at critical intersections in each zone and at additional locations when combined loops are possible and system detector limits are not compromised.

Design Engineer should consult with system timing group to determine ultimate system detector locations.

System Detector Limits

- 2070 Systems:
  - . Each master controller is limited to 64 system detectors.
  - . Each local controller is limited to 16 system detectors.
- NEMA TS-1 and TS-2 Systems:
  - . Each master controller is limited to 32 system detectors.
  - . Each local controller is limited to 8 system detectors.
- Other Considerations:
  - . Pole-mounted cabinets frequently have limited rack space for detectors, which may limit the number of system detectors.
  - . Keep some system detectors in reserve for future signal addition and/or addition of system detectors based on field experience.

Closed Loop Signal Systems – General information

SIGNALS & GEOMETRICS SECTION
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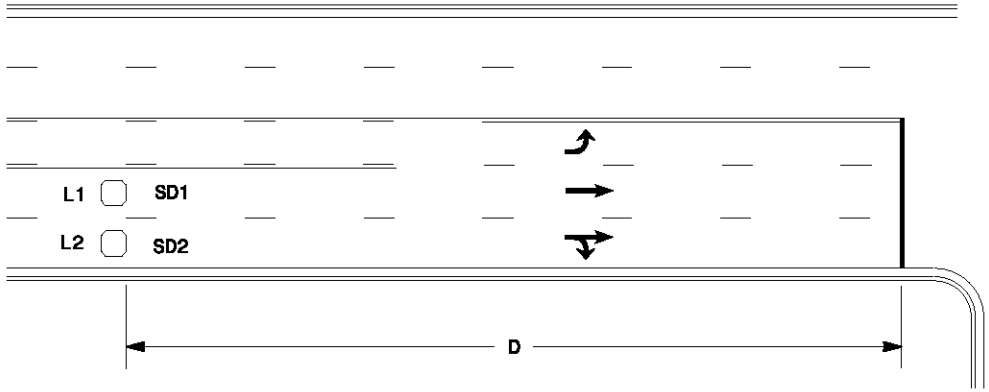
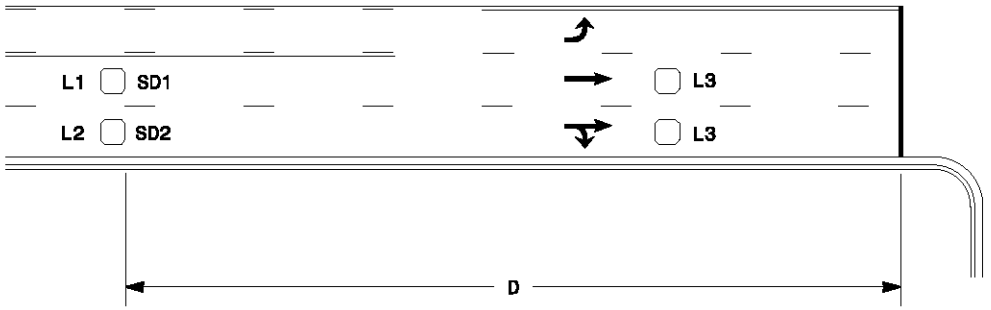
STD. NO.
14.0
SHEET 1 OF 1

Combined System and Main Street Detectors

System Detectors with Volume–Density Operation



System Detectors with Stretch Operation



Design Considerations:

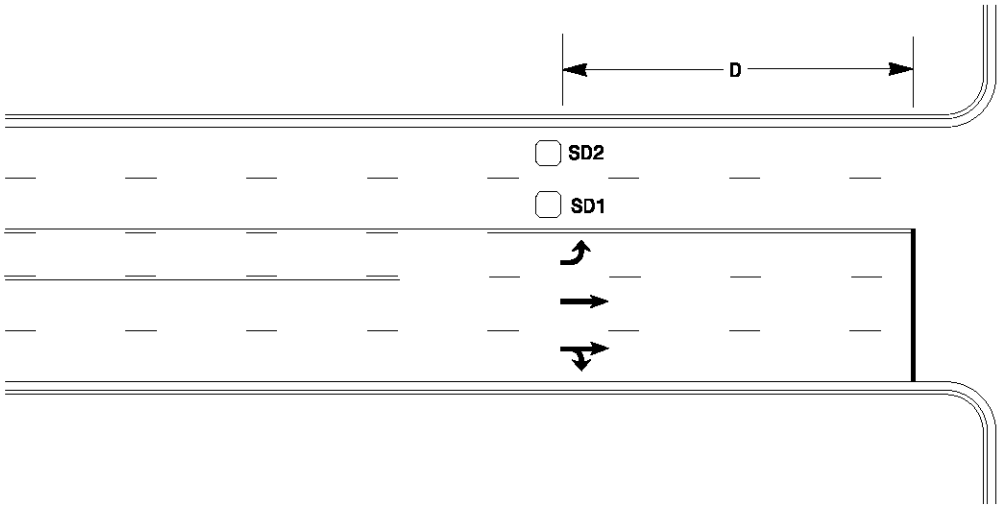
- Preferred treatment for new 2070 system installations.
- Typically for use with D>=300′ (90m).
- Loop size, turns, and location based on Main Street detection.
- Set detectors to presence mode.
- Any delay or stretch (carry) times must be programmed in the controller, not on the detector unit (may not be possible in older controllers, especially NEMA TS-1).
- Combined loops must be wired to separate detectors/channels.
- With Volume-Density operation, combined loops can be used with or without DC/EC.
- Not for use with low speed detection.

Closed Loop Signal Systems – Main Street Detection

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Downstream Main Street System Detectors

Downstream System Detector Placement



-SD = 6ft X 6ft,(1.8m X 1.8m)
Wired to separate channels

-D=50-250′ (15m-75m) beyond intersection

Design Considerations:

- -Preferred for consistency at signals in existing systems with downstream system detectors, especially older NEMA systems.
- -May also be appropriate in new systems at locations with heavy undetected turns from the side street to the main street (where side street system detectors are not appropriate).
- -Set detectors to presence mode.
- -Locate downstream system detectors past the point where traffic has selected a lane while also avoiding driveways.

Closed Loop Signal Systems – Main Street Detection

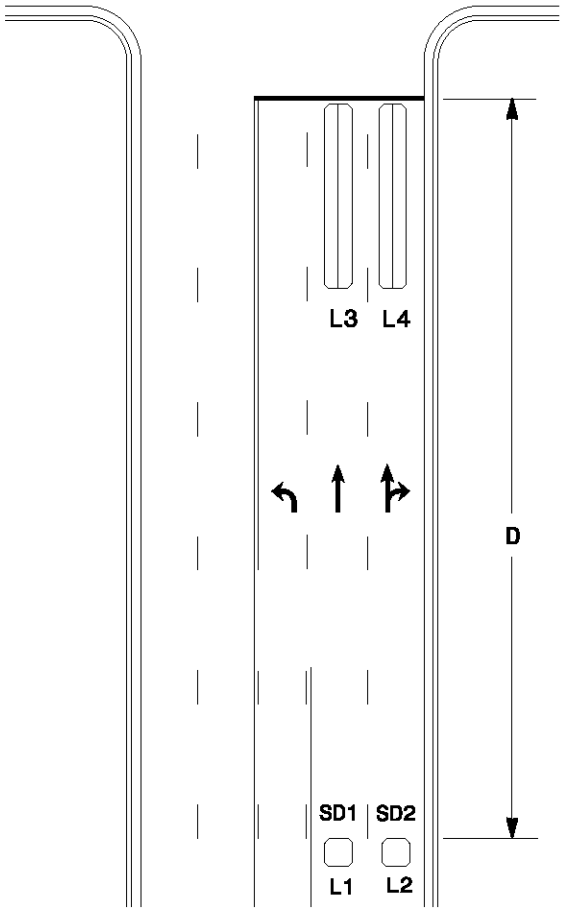
SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

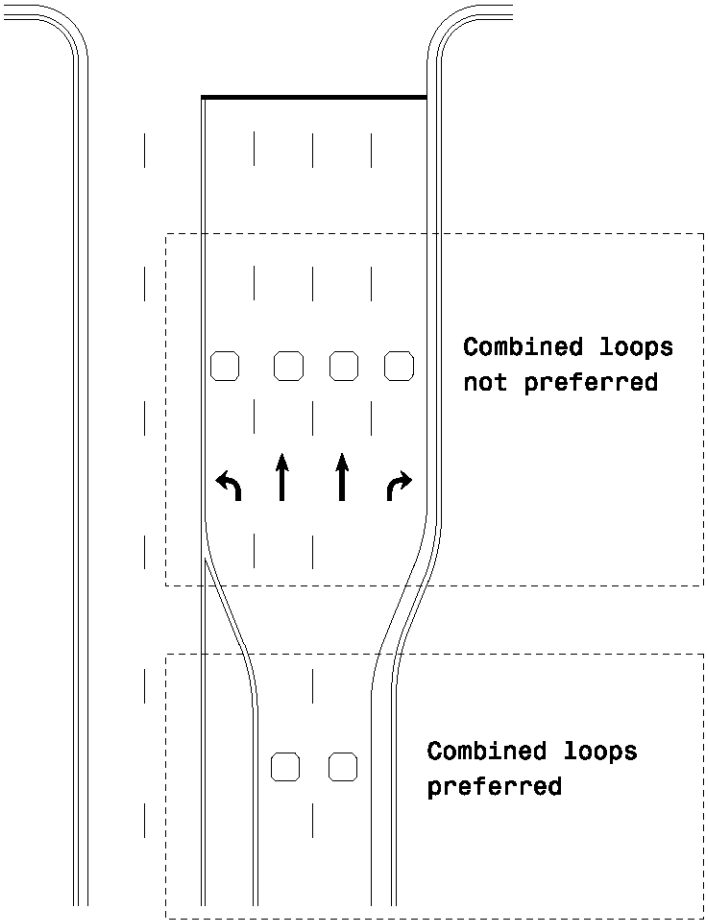
STD. NO.
14.1
SHEET 2 OF 2

Combined System and Side Street Detectors

SDs with Volume–Density or Stretch Operation



When to use combined loops



Design Considerations:

- Side street system detectors should be provided when combination loops are possible, provided system detector limits are not compromised.
- Combined system detectors are NOT preferred when loop placement is past the entrance to the left or right turn lane (when combined system detectors will miss traffic turning onto the main street -see figure).
- Typically for use with D>=300' (90m).
- Loop size, turns, and location based on side street detection.
- Set detection to presence mode.
- May not be possible in older controllers, especially NEMA TS-1.
- Combined loops must be wired to separate detectors/channels.

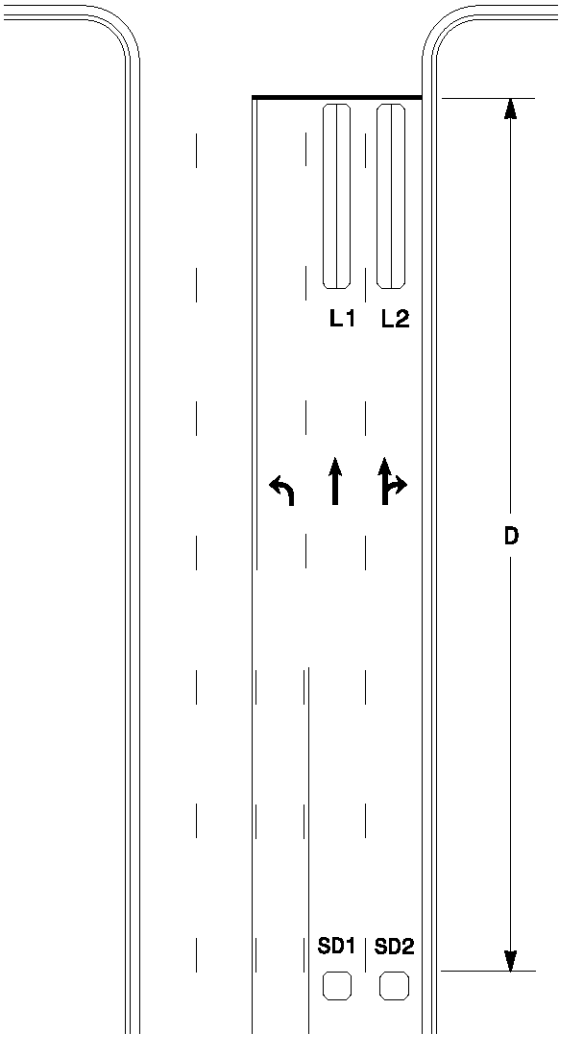
Closed Loop Signal Systems – Side Street Detection

SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
14.2
SHEET 1 OF 2

Upstream Side Street – System Detectors



-SD = 6ft X 6ft,(1.8m X 1.8m)
Wired to separate channels

-D = 300'-500', (90m-150m)

Design Considerations:

- When combination loops are not possible or not preferred, this treatment may be used at the critical intersection in each zone of new system installation.
- Set detectors to presence mode.
- D should be chosen to ensure all volume is counted before entering left or right turn lanes.
- If turn lane consideration makes D unreasonably large, consider placing a system detector in the turn lane (preferred) or using downstream main street system detectors at this location (less preferred)

Closed Loop Signal Systems – Side Street Detection

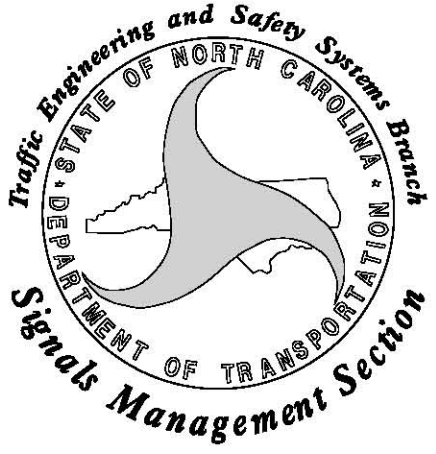
SIGNALS & GEOMETRICS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
14.2
SHEET 2 OF 2

Design Manual

Signals Management Section



Part 2

Table of Contents

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.

THIS ELECTRICAL DETAIL IS FOR
THE SIGNAL DESIGN: 11-1Ø1
DESIGNED: Ø7-2ØØ3
SEALED: Ø8-15-Ø3
REVISED: N/A

THIS ELECTRICAL DETAIL IS FOR
THE SIGNAL DESIGN: Ø2-1234T,
AND: Ø2-1234
DESIGNED: Ø3-2ØØØ
SEALED: Ø3-22-ØØ
REVISED: Ø9-Ø9-Ø3

1

Signal Plan I.D. Box

Every electrical detail must have a Signal Plan I.D. Box. The purpose of this box is to positively identify the signal plan that the electrical detail is designed to implement. The box has four data fields:

Signal Inventory Number - an inventory number is assigned to each signalized intersection. That number is found in the bottom right corner of the signal plan and should be entered in the first data field. Some plans have one or more temporary designs and a final design. If some or all of these designs can be combined on a single electrical detail, the different versions can be shown as on the lower example.

Design Date - this date is found on the signal plan in the area labeled 'Plan Date'. It should be duplicated in the second data field.

Seal Date - the third data field should contain the date that the signal plan was sealed on.

Revision Date - if a signal plan has been revised, the date of the revision is shown in the bottom data field. If a plan has been revised more than once, all revision dates should be shown. If the plan has no revisions, the data field should be designated as 'N/A'.

Signal Plan I.D. Box

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

2-12

STD. NO.
1.0
SHEET 1 OF 1

EQUIPMENT INFORMATION

CONTROLLER.....2070L
CABINET 336
SOFTWARE .....ECONOLITE OASIS
CABINET MOUNT.....POLE
OUTPUT FILE POSITIONS...12
LOAD SWITCHES USED.....S1,S2,S3,S4,S5,S8,S9
PHASES USED.....1,2,2PED,3,4,6,6PED
OVERLAPS.....NONE

EQUIPMENT INFORMATION

CONTROLLER.....2070L
CABINET .....332 W/ AUX
SOFTWARE .....ECONOLITE OASIS v3.02.77
(OR LATEST APPROVED VERSION)
CABINET MOUNT.....BASE
OUTPUT FILE POSITIONS...18 (12-STD, 6-AUX)
LOAD SWITCHES USED.....S1,S2,S4,S5,S7,S8,AUX S1,AUX S2
PHASES USED.....1,2,3,4,5,6
OVERLAP A.....1+4
OVERLAP B.....3+6
OVERLAP C.....NOT USED
OVERLAP D.....NOT USED

Equipment Information

Controller - gives the controller model.

Cabinet - gives the cabinet model (332 for a base mount cabinet, or 336 for a pole mount cabinet).

Software - gives the local software package to be used at a particular location. If the signal design includes railroad preemption, the specific version of the software will be listed.

Cabinet Mount - specifies whether the traffic signal cabinet is a base mount or pole mount design.

Output File Positions - lists the number of load switch sockets available in the output file. Also specifies, if applicable, the presence of an auxiliary output file.

Load Switches Used - indicates which load switches are to be used on the design.

Phases Used - lists the phases used by the controller, including any phases used for timing only that have no field display.

Overlaps - lists the parent phases for any overlaps being used.

SIGNAL HEAD HOOK-UP CHART

LOAD SWITCH NO.	S1		S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	
CMU CHANNEL NO.	1		2	13	3	4	14	5	6	15	7	8	16	Ⓑ
PHASE	1		2	2 PED	3	4	4 PED	5	6	6 PED	7	8	8 PED	Ⓒ
SIGNAL HEAD NO.	11	82	21,22 23	P21, P22	NU	41,42	NU	51	61,62 63	P61, P62	NU	81,82	NU	Ⓓ
RED			128			101			134			107		Ⓔ
YELLOW			129			102			135			108		Ⓔ
GREEN			130			103			136			109		Ⓔ
RED ARROW	125							131						Ⓕ
YELLOW ARROW	126	126						132						Ⓕ
GREEN ARROW	127	127						133						Ⓕ
✋				113						119				Ⓖ
🚶				115						121				Ⓖ

NU = NOT USED

Ⓗ

Ⓗ Extra column - if more than one type of signal head is attached to the same load switch, a second column is added to the chart as shown above. In this example, both a 3-section all left arrow head and the arrow portion of a 5-section head are to run on phase 1.

2070 Signal Head Hook-Up Chart

The chart shown at left appears on all 2070 electrical details. Its purpose is to provide a user-friendly reference on connecting the signal heads to the cabinet field terminals.

Features:

Ⓐ Load Switch No. - displays the load switch designation.

Ⓑ CMU Channel No. - displays the conflict monitor unit channel number for each corresponding load switch position.

Ⓒ Phase - lists the function of the load switch. The load switch function can be reassigned in the controller programming. The default settings are shown at left.

Ⓓ Signal Head No. - lists the signal heads that should have connections made to the field terminals for this load switch. Note that a 4- or 5- section head may appear in two different columns because the red, yellow, and green balls are controlled by one load switch while the arrow indications are controlled by another.

Ⓔ Red, Yellow, Green - lists the field terminal number to which the red, yellow, and green ball indications for the signal heads listed in the row above should be tied.

Ⓕ Red, Yellow, and Green arrows - red, yellow, and green arrow indications for the signal heads should be tied to the field terminals that appear in these rows.

Ⓖ Pedestrian Signal Indications - the 'Hand' and the 'Man' indications of the pedestrian signal heads should be connected to the field terminals indicated. If no pedestrian signals are used, these two rows may be removed from the drawing.

2070 Signal Head Hook-Up Chart

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

2-12

STD. NO. 3.0

SIGNAL HEAD HOOK-UP CHART

LOAD SWITCH NO.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	AUX S1	AUX S2	AUX S3	AUX S4	AUX S5	AUX S6
CMU CHANNEL NO.	1	2	13	3	4	14	5	6	15	7	8	16	9	10	17	11	12	18
PHASE	1	2	2 PED	3	4	4 PED	5	6	6 PED	7	8	8 PED	OLA	OLB	SPARE	OLC	OLD	SPARE
SIGNAL HEAD NO.	61	21,22	NU	NU	41,42	NU	21	61,62	NU	41	81,82	NU	23,24	63,64	NU	43,44	NU	NU
RED	✳	128			101		✳	134			107		A121	A124		A114		
YELLOW		129			102			135		✳	108		A122	A125		A115		
GREEN		130			103			136			109		A123	A126		A116		
RED ARROW																		
YELLOW ARROW	126						132											
GREEN ARROW	127						133			124								

NU = NOT USED

✳ Denotes install load resistor. See load resistor installation detail this page.

Ⓘ

Ⓙ

Features (cont.):

Ⓘ Load Resistor note - if there is not a field indication for each of the three outputs on a given load switch, a note referring to the load resistor installation detail should appear below the field hook-up chart. An asterisk is to be placed in the chart to show where a load resistor needs to be installed. If only the green and yellow indications of the load switch are used (common with 5-section heads on protected/permissive left turns), an asterisk referring to the note should be placed in the 'red' row. If only the green arrow indication is used, the asterisk should appear in the 'yellow' row. This scenario can occur when a 4-section head is used to display a left turn that is only used during a preemption. See STD. NO. 4.0 for more information.

Ⓙ Auxiliary Output file - if overlaps are used, an auxiliary output file is installed providing additional load switch capacity for up to six overlaps. The default load switch to function relationships for the auxiliary output file are as follows:

- AUX S1 ——— OVERLAP A
- AUX S2 ——— OVERLAP B
- AUX S3 ——— SPARE
- AUX S4 ——— OVERLAP C
- AUX S5 ——— OVERLAP D
- AUX S6 ——— SPARE

Spare load switches AUX S3 and AUX S6 can be used as overlaps (e.g. overlap E and overlap F). To do so, the controller outputs assigned to their slots must first be reprogrammed as overlaps.

2070 Signal Head Hook-Up Chart

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 3.0

SIGNAL HEAD HOOK-UP CHART FOR 4-SECTION FYA PPLT SIGNAL HEADS USED IN A 332 BASE MOUNTED CABINET

SIGNAL HEAD HOOK-UP CHART

LOAD SWITCH NO.	S1		S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	AUX S1	AUX S2	AUX S3	AUX S4	AUX S5	AUX S6
CMU CHANNEL NO.	1		2	13	3	4	14	5	6	15	7	8	16	9	10	17	11	12	18
PHASE	1		2	2 PED	3	4	4 PED	5	6	6 PED	7	8	8 PED	OLA	OLB	SPARE	OLC	OLD	SPARE
SIGNAL HEAD NO.	11 ★	82	21,22	NU	31 ★	41,42	NU	51 ★	61,62	NU	71 ★	81,82	NU	11 ★	31 ★	NU	51 ★	71 ★	NU
RED		✳	128			101			134			107							
YELLOW			129		✳	102		✳	135		✳	108							
GREEN			130			103			136			109							
RED ARROW														A121	A124		A114	A101	
YELLOW ARROW		126												A122	A125		A115	A102	
FLASHING YELLOW ARROW														A123	A126		A116	A103	
GREEN ARROW	127	127			118			133			124								

NU = NOT USED

✳ Denotes install load resistor. See load resistor installation detail this page.

★ See pictorial of head wiring in detail below.

Ⓒ

Ⓑ

Ⓐ

2070 Signal Head Hook-Up Chart

The chart shown at left appears on all 2070 electrical details. Its purpose is to provide a user-friendly reference on connecting the signal heads to the cabinet field terminals.

Features:

Ⓐ Auxiliary Output file - the cabinet must be wired such that for each Flashing Yellow Arrow (FYA) approach, the solid green protected arrow is driven by a load switch monitored on channels 1, 3, 5, and 7. The associated solid red arrow, solid yellow arrow, and flashing yellow arrow (overlap phase) must be driven by a load switch monitored on channels 9, 10, 11, and 12 respectively. The signal monitor makes the following associations when FYA monitoring is enabled for each approach:

Channel 1 with 9
Channel 3 with 10
Channel 5 with 11
Channel 7 with 12

Overlaps are used to drive the solid red arrow, solid yellow arrow, and flashing yellow arrow. The display sequence is further controlled by logic statements programmed in the controller.

Ⓑ Any load switch that only drives the solid green arrow on a 4-section FYA head will have a load resistor installed on its associated yellow field terminal on the output file. Additionally, the SSM switch for that channel will remain in the OFF position on the conflict monitor.

Ⓒ In addition to the hookup information shown in this chart, every electrical plan utilizing FYA heads will have a FYA signal wiring detail showing a pictorial relationship of the signal head to output file wiring.

2070 Signal Head Hook-Up Chart For FYA

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 3.1

SIGNAL HEAD HOOK-UP CHART FOR 4-SECTION FYA PPLT SIGNAL HEADS USED IN A 336 POLE MOUNTED CABINET

SIGNAL HEAD HOOK-UP CHART

LOAD SWITCH NO.	S1	S2	S3		S4	S5	S6	S7	S8	S9		S10	S11	S12	
CMU CHANNEL NO.	1	2	9	13	3	4	14	5	6	11	15	7	8	12	16
PHASE	OLA	2	1 GRN	2 PED	3	4	4 PED	OLC	6	5 GRN	6 PED	OLD	8	7 GRN	8 PED
SIGNAL HEAD NO.	11★	21,22	11★	NU	NU	41,42	NU	51★	61,62	51★	NU	71★	81,82	71★	NU
RED		128				101			134				107		
YELLOW		129				102			135				108		
GREEN		130				103			136				109		
RED ARROW	125							131				122			
YELLOW ARROW	126							132				123			
FLASHING YELLOW ARROW	127							133				124			
✋															
GREEN ARROW			114							120				111	
🚶				✳							✳				✳

Ⓓ Ⓔ Ⓕ

✳ Denotes install load resistor. See load resistor installation detail this sheet.

★ See pictorial of head wiring in detail below.

NOTE: Load switches S1, S3, S7, S9, S10, and S12 require output remapping. See sheets x through y for details.

Features:

Ⓓ Load switch outputs that drive the solid red arrow, solid yellow arrow, and flashing yellow arrow will have to be remapped to function as vehicle overlaps.

Unused ped yellow loadswitch outputs will have to be remapped to drive the left turn green arrows.

Ⓔ FYA operation when using a 336 pole mounted cabinet operates in compact mode. The FYA compact mode switch on the conflict monitor must be set to the ON position. Further details are found in STD. NO. 7.0. The cabinet must be wired such that the (unused) ped yellow load switch outputs are wired to the conflict monitor as follows:

2-PY to Channel 9 Green (CMU pin 13, logical Channel 9)
4-PY to Channel 9 Yellow (CMU pin 16, logical Channel 10)
6-PY to Channel 10 Green (CMU pin R, logical Channel 11)
8-PY to Channel 10 Yellow (CMU pin U, logical Channel 12)

For all cabinets, this is accomplished through a keyed plug connection found on the inside panel of the output file. Plug together the two connectors labeled as shown below:

1-2PY	1-CMU-13
2-4PY	2-CMU-16
3-6PY	3-CMU-R
4-8PY	4-CMU-U

Ⓕ Unused ped 'Walk' load switch outputs must be terminated with a load resistor.

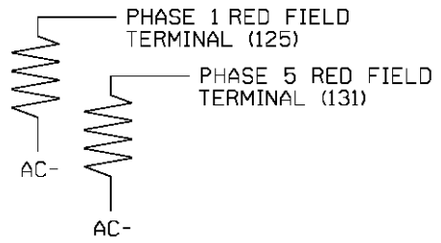
Load Resistor Installation Detail

LOAD RESISTOR INSTALLATION DETAIL

(install resistors as shown below)

ACCEPTABLE VALUES

VALUE (ohms)	WATTAGE
1.5K - 1.9K	25W (min)
2.0K - 3.0K	10W (min)



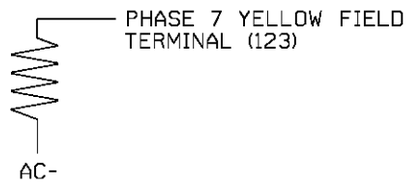
NOTE: The purpose of these resistors is to load the channel red monitor inputs in order for the Signal Sequence Monitor to use the full signal sequence monitoring capability on channels that do not use the red display in the field.

LOAD RESISTOR INSTALLATION DETAIL

(install resistor as shown below)

ACCEPTABLE VALUES

VALUE (ohms)	WATTAGE
1.5K - 1.9K	25W (min)
2.0K - 3.0K	10W (min)



In all traffic signal installations, the signal head displays are switched 'ON' and 'OFF' by solid state load switches. These load switches take a logic level input from the controller and switch AC power to the signal heads through a triac device. The triac is protected from transient voltages by a snubber circuit. In the 'OFF' condition there is a small leakage current through the snubber circuit. As long as there is a load across the circuit, such as a bulb or LED module, this leakage current goes unnoticed. If there is no load, however, the conflict monitor will see an 'OFF' condition as an active signal, resulting in either a false conflict or a dual indication fault.

If there is not a field indication for each of the three outputs on a given load switch, a load resistor needs to be installed. The load resistor takes the place of a bulb or LED indication and provides a load for the channel red or yellow monitor input, preventing the problems with unwarranted faults.

If only the green and yellow indications of the load switch are used (common with 5-section heads on protected/permissive left turns), a resistor needs to be installed on the red field terminal, as shown above left.

If only the green arrow indication is used, the resistor should be installed on the yellow field terminal as shown lower left. This situation can occur when a 4-section head is used to display a left turn that is only used during a preemption, or when a 4-section flashing yellow arrow head is used to display a protected left turn. In either case, no resistor is needed on the red terminal as the signal sequence monitoring capability is not used. See STDS. NO. 3.0 and 7.0 for more information.

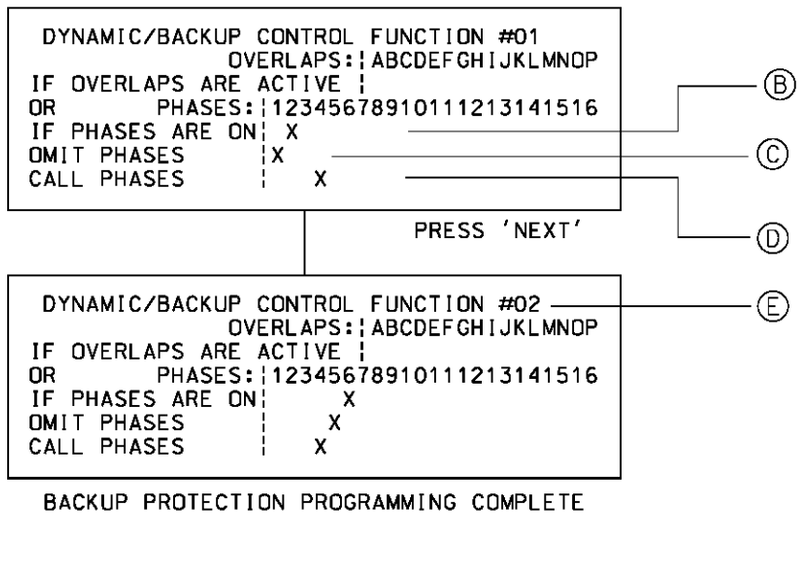
(OPTION #1)

DYNAMIC BACK-UP CONTROL PROGRAMMING

(program controller as shown below)

1. FROM MAIN MENU PRESS '2' (PHASE CONTROL), THEN '1' (PHASE CONTROL FUNCTIONS). SCROLL TO THE BOTTOM OF THE MENU AND ENABLE DYNAMIC/BACKUP CONTROL FUNCTIONS 1 AND 2. — Ⓐ

2. FROM PHASE CONTROL FUNCTIONS MENU PRESS '2' (DYNAMIC/BACKUP CONTROL FUNCTIONS).



BACKUP PROTECTION PROGRAMMING COMPLETE

(OPTION #2)

BACKUP PROTECTION NOTE

(program controller as shown below)

From Main Menu press '2' (Phase Control), then '1' (Phase Control Functions). Program phase 2 for 'Backup Protect'. Make sure the Red Revert times shown on the Signal Design Plans are programmed in the 'Phase Timing' menu.

Back-Up Protection Programming Detail

When a signal design requires the use of back-up protection to eliminate a yellow trap situation, two options are available.

Option #1 uses the Dynamic Back-Up function. The upper left image is an exact duplication of the dynamic back-up programming display found on a 2070 controller running Oasis control software.

The controller accomplishes "dynamic back-up protection" by omitting the left turn phase while the opposite through movement is "ON". Phase "ON" is a controller function that is active during the phase green, yellow change, and red clearance intervals.

Below is a brief explanation of dynamic back-up protection features and functionality:

Ⓐ Activation note - this note directs the installer to the phase control page of the controller programming. At the bottom of this page there is a parameter listed called "Dynamic/Backup". The installer is directed to flag the Dynamic/Backup functions that will be in use, otherwise the back-up programming will not function. See function number below in note Ⓔ.

Ⓑ Phase "ON" line - phases selected here determine when an "omit" is placed during the signal sequence.

Ⓒ Phase "Omit" line - phases selected here determine where an omit is placed during the selected phase "ON".

Ⓓ "Call" phases line - phases selected here determine the phase that the omitted phase detectors will call while that phase is omitted. The call placed is a special "dynamic call" that will be released when the selected phase switches to green. This dynamic call produces a minimum recall type operation (dynamic call will not max out a phase).

Ⓔ Function number - the controller is capable of up to sixteen dynamic functions. For normal back-up protection, one function should be used for each left turn that is being omitted. The example shown to the left shows phases 1 and 5 being omitted by phases 2 and 6 respectively. The phase calls will cycle the controller through the side street through movements before serving phases 1 and/or 5. Please note that each left turn omit is accomplished in a separate function.

Option #2 uses the Backup Protect function. This function puts the through phases in All Red before serving the left turns. This function is typically used in conjunction with increased Red Revert times on the concurrent through phase.

2070 OASIS Back–Up Protection Programming Detail

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO. 5.0

NOTES

1. To prevent "flash-conflict" problems, insert red flash program blocks for all unused vehicle load switches in the output file. The installer shall verify that signal heads flash in accordance with the signal plans. } Ⓐ
2. Program phases 4 and 8 for Dual Entry. } Ⓑ
3. Enable Simultaneous Gap-Out for all phases. } Ⓒ
4. Program phases 2 and 6 for Variable Initial and Gap Reduction } Ⓓ
5. Program phases 2 and 6 for Start Up In Green. } Ⓔ
6. Program phases 2, 4, 6 and 8 for 'STARTUP PED CALL'. } Ⓕ
7. Program phases 2 and 6 for Yellow Flash, and overlaps 1 and 2 as Wag Overlaps. } Ⓖ
8. The cabinet and controller are part of the (insert) System. } Ⓗ

Notes

All electrical details have a section of notes. A typical set for a 2070 design is shown above. Unneeded notes should be removed. Additionally, if there is a need to highlight an unusual setting or feature about the signal design that is not covered elsewhere on the electrical detail, a custom note can be added to this space.

Usage guidelines:

Ⓐ Flash setup note - the first sentence, concerning flash color setup on unused load switches, may be omitted if all load switches are used. The second sentence is always used.

Ⓑ Dual Entry note - directs that the indicated phases be programmed for Dual Entry. The '2070L Timing Chart' on the signal plan will specify which phases require this feature.

Ⓒ Simultaneous Gap-Out note - directs that all phases be programmed for Simultaneous Gap-Out. This note always appears and never requires modification.

Ⓓ Variable Initial and Gap Reduction note - directs that the indicated phases be programmed for these timing features. If the '2070L Timing Chart' on the signal plan has timing values for 'Seconds Per Actuation' and 'Max Variable Initial', that phase should be programmed for Variable Initial. If values are shown for 'Time Before Reduction', 'Time To Reduce', and 'Minimum Gap', the phase should be programmed for Gap Reduction.

Ⓔ Controller Start Up note - in general, the controller should be programmed to start up in the phase or phases that flash yellow. If no phases flash yellow, the controller needs to be programmed to start up in a red clearance interval. If this is the case, consult the signal plan designer to see if there is a preference about what phase(s) should be served first.

Ⓕ Startup Ped Call note - any ped phases that will be in use during normal operation should be listed here.

Ⓖ Yellow Flash note - this ensures phases 2 and 6 flash yellow during controller flash. Wag overlap programming flashes overlap 1 (OLA) and overlap 2 (OLB) concurrently with phases 1 and 6 (typically for FYA applications).

Ⓗ System note - if the signal is part of a closed loop or urban traffic control system, the system type and/or name (if available) is listed here.

Notes

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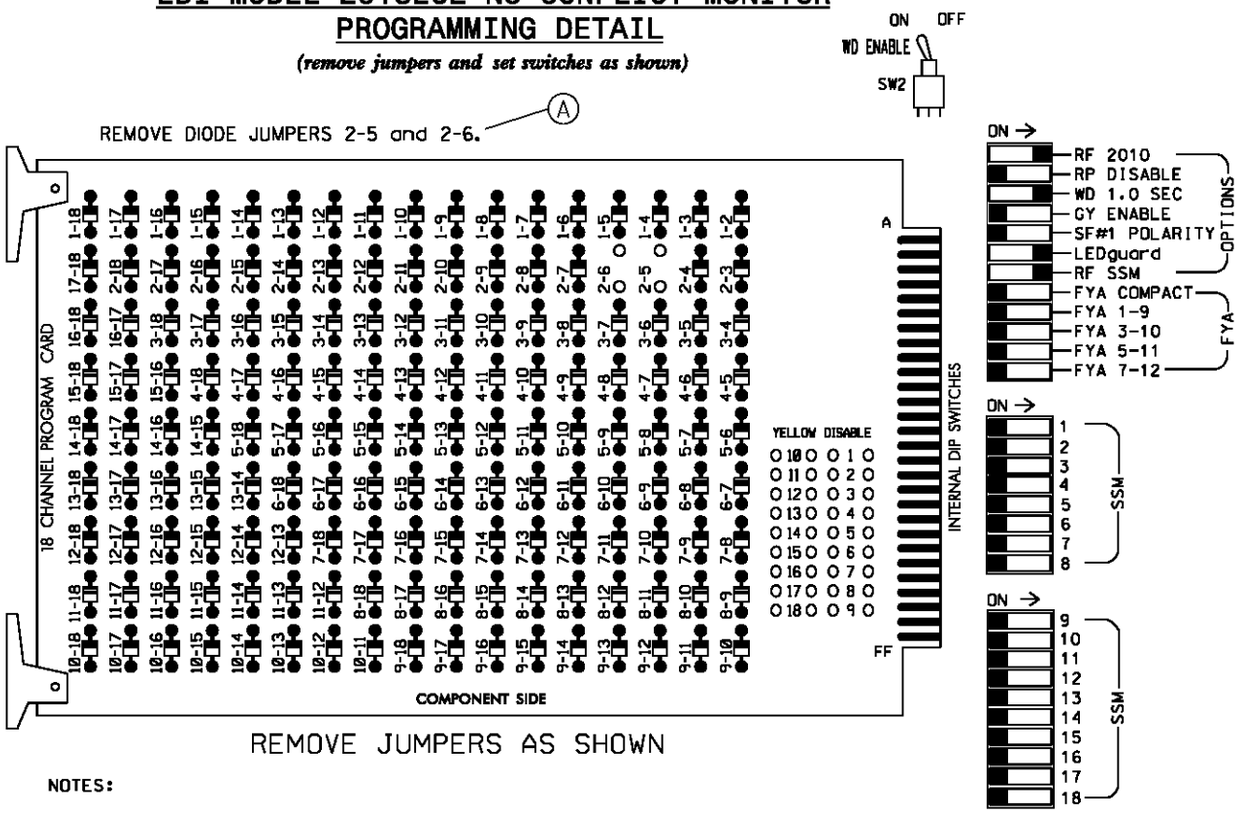
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.
6.0
SHEET 1 OF 1

EDI MODEL 2018ECL-NC CONFLICT MONITOR PROGRAMMING DETAIL

(remove jumpers and set switches as shown)



REMOVE JUMPERS AS SHOWN

■ = DENOTES POSITION OF SWITCH

NOTES:

1. Card is provided with all diode jumpers in place. Removal of any jumper allows its channels to run concurrently.
2. Ensure jumpers SEL2-SEL5 and SEL9 are present on the monitor board.
3. Ensure that Red Enable is active at all times during normal operation.
4. Connect serial cable from conflict monitor to comm. port 1 of 2070 controller. Ensure conflict monitor communicates with 2070.

2018 Conflict Monitor Programming

The conflict monitor typically used in all NCDOT 2070 installations is the EDI model 2018ECL-NC. The representation at the left is found in the top left corner on all the 2070 start drawings.

The 2018ECL-NC has 18 monitor channels. The default channel to load switch to function relationships are as follows:

Channel 1	S1	Phase 1
Channel 2	S2	Phase 2
Channel 3	S4	Phase 3
Channel 4	S5	Phase 4
Channel 5	S7	Phase 5
Channel 6	S8	Phase 6
Channel 7	S10	Phase 7
Channel 8	S11	Phase 8
Channel 9	AUX S1	Overlap A
Channel 10	AUX S2	Overlap B
Channel 11	AUX S4	Overlap C
Channel 12	AUX S5	Overlap D
Channel 13	S3	Phase 2 PED
Channel 14	S6	Phase 4 PED
Channel 15	S9	Phase 6 PED
Channel 16	S12	Phase 8 PED
Channel 17	AUX S3	Spare
Channel 18	AUX S6	Spare

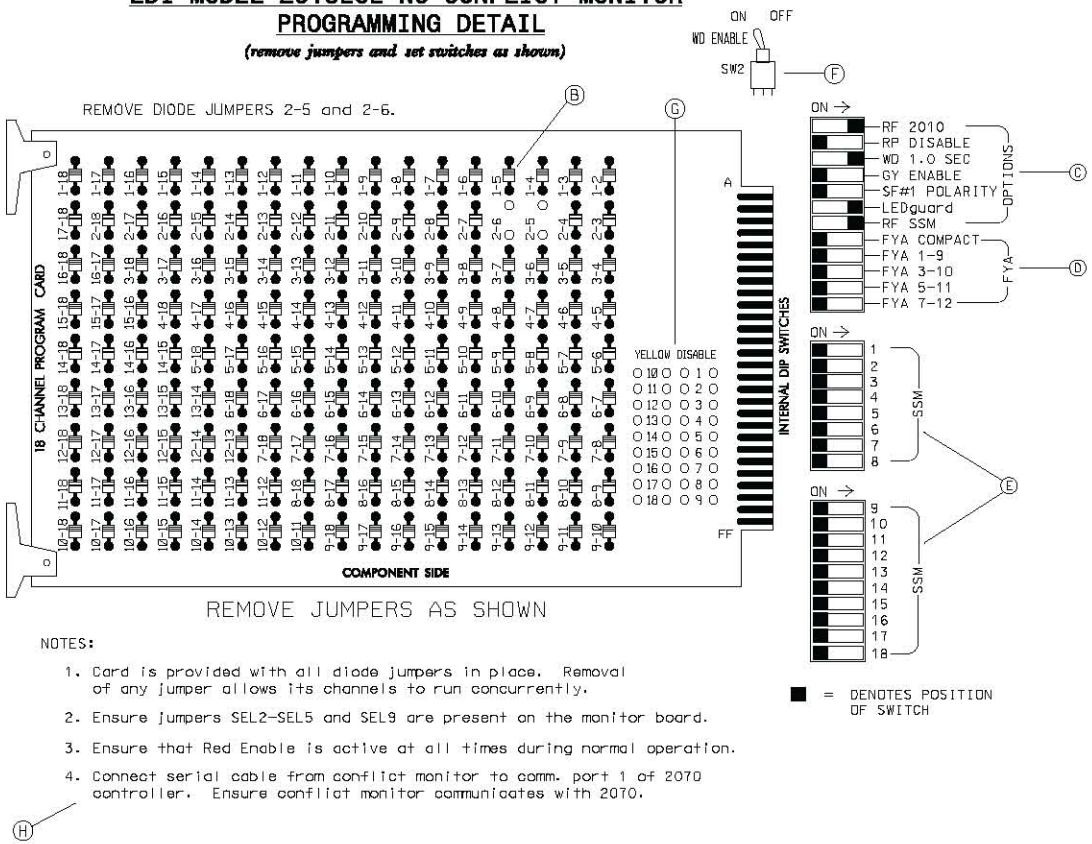
The channel to loadswitch relationship is fixed in the cabinet hardware. The loadswitch function can be changed in the controller software. Loadswitches AUX S1-AUX S6 are on the auxiliary output file.

Features:

Ⓐ Remove diode jumper note - for any two movements to be allowed to run concurrently, the corresponding diode jumper must be removed on the monitor card. This includes not only phases that can run concurrently, but also any ped or overlap that can run at the same time. Any permissible combination that does not have the corresponding jumper removed will result in an unwarranted conflict fault and place the intersection in flash. Conversely, removing a jumper representing a movement that should not be allowed creates a dangerous scenario where a true conflict can go undetected. This note lists the jumpers that should be removed on the monitor card.

EDI MODEL 2018ECL-NC CONFLICT MONITOR PROGRAMMING DETAIL

(remove jumpers and set switches as shown)



REMOVE JUMPERS AS SHOWN

NOTES:

1. Card is provided with all diode jumpers in place. Removal of any jumper allows its channels to run concurrently.
2. Ensure jumpers SEL2-SEL5 and SEL9 are present on the monitor board.
3. Ensure that Red Enable is active at all times during normal operation.
4. Connect serial cable from conflict monitor to comm. port 1 of 2070 controller. Ensure conflict monitor communicates with 2070.

H

■ = DENOTES POSITION OF SWITCH

Features (cont.):

Ⓑ Monitor card programming - the electrical detail provides a graphic representation of the monitor card after the appropriate diode jumpers have been removed as described above. This drawing should always match the remove diode jumper note directly above.

Ⓒ Option switches - these dip switches control a variety of optional settings for the 2018ECL-NC monitor. The settings shown at left should be used for all electrical details. For more information on these options, refer to the manufacturer's operations manual.

Ⓓ FYA switches - these switches are used to enable flashing yellow arrow monitoring using overlaps. Refer to the manufacturer's operations manual for more information on these switches.

Ⓔ SSM switches - these switches are used to enable dual indication, red fail, and minimum yellow clearance monitoring on individual monitor channels. In general, any channel that has both a green and a yellow indication in the field should have its SSM switch set to the 'ON' position. Channels used to monitor pedestrian movements, or the green arrow exclusively for a four-section head or four-section FYA head, should be set to the 'OFF' position.

Ⓕ Watchdog enable - enables the controller watchdog monitoring feature. If the monitor fails to sense the logic level signal being toggled by the controller, a 'WDT Error' fault will be triggered. Should always be shown in the 'ON' position.

Ⓖ Yellow disable jumpers - this feature allows the minimum yellow change monitoring to be disabled for a channel being used for a pedestrian movement. Since NCDOT also does not monitor dual indication for peds, the SSM switches for those channels should be set to 'OFF', making the use of the yellow disable jumpers unnecessary.

Ⓗ Notes - these four notes should appear with the conflict monitor programming detail on all 2070 electrical details. For more information on these options and conflict monitor functionality, refer to the manufacturer's operations manual.

INPUT FILE POSITION LAYOUT

(front view)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
FILE "I"	U	Ø 1 1A	Ø 2 2A	Ø 2 2C	Ø 2 2E	Ø 3 3A	Ø 4 4A	Ø 4 4C	Ø 4 4E	SYS. DET. S1	SLOT EMPTY	SLOT EMPTY	Ø2 PED DC ISOLATOR	Ø6 PED DC ISOLATOR	FS DC ISOLATOR
	L	NOT USED	Ø 2 2B	Ø 2 2D	NOT USED	NOT USED	Ø 4 4B	Ø 4 4D	NOT USED	SYS. DET. S2			Ø4 PED DC ISOLATOR	Ø8 PED DC ISOLATOR	ST DC ISOLATOR
FILE "J"	U	Ø 5 5A	Ø 6 6A	Ø 6 6C	Ø 6 6E	Ø 7 7A	Ø 8 8A	Ø 8 8C	Ø 8 8E	SYS. DET. S3	SLOT EMPTY	SLOT EMPTY	PRE3 DC ISOLATOR	PRE4 DC ISOLATOR	PRE1 AC ISOLATOR
	L	NOT USED	Ø 6 6B	Ø 6 6D	NOT USED	NOT USED	Ø 8 8B	Ø 8 8D	NOT USED	SYS. DET. S4			PRE5 DC ISOLATOR	PRE6 DC ISOLATOR	PRE2 AC ISOLATOR

EX.: 1A, 2A, ETC. = LOOP NO.'S

FS = FLASH SENSE
ST = STOP TIME
PRE = PREEMPT

INPUT FILE POSITION LAYOUT

(front view)

		1	2 Ⓐ	3	4	5	6	7	8	9	10	11	12	13	14
FILE "I"	U	Ø 1 1A	Ø 2 2A	Ø 2 2C	SLOT EMPTY	Ø 3 3A	Ø 4 4A	Ø 4 4C	SLOT EMPTY	SYS. DET. S1	SLOT EMPTY	SLOT EMPTY	Ø2 PED DC ISOLATOR	Ø6 PED DC ISOLATOR	FS DC ISOLATOR
	L	Ø 1 1B	Ø 2 2B	Ø 2 2D		NOT USED	Ø 4 4B	NOT USED		SYS. DET. S2			NOT USED	NOT USED	ST DC ISOLATOR
FILE "J"	U	Ø 5 5A	Ø 6 6A	Ø6/SYS 6C/S3	SLOT EMPTY	Ø 7 7A	Ø 8 8A	SLOT EMPTY	SLOT EMPTY	SLOT EMPTY	SLOT EMPTY	SLOT EMPTY	SLOT EMPTY	SLOT EMPTY	PRE1 AC ISOLATOR
	L	NOT USED	Ø 6 6B	Ø6/SYS 6D/S4		NOT USED	Ø 8 8B								NOT USED

EX.: 1A, 2A, ETC. = LOOP NO.'S

FS = FLASH SENSE
ST = STOP TIME
PRE = PREEMPT

2070 Input File Layout (332)

NCDOT uses 2070L controllers in type 170 cabinets. Each cabinet has one or two input files to accept inputs for traffic detection, pedestrian pushbuttons, preempt calls or other functions deemed necessary. The base mounted 332 cabinet has two input files, labeled 'I' and 'J'. The pole mounted 336 cabinet has only the 'I' file.

Each input file has 14 slots. Each slot can hold a 2-channel inductive loop detector, AC isolator or DC isolator. Each slot has two output terminals, but not every output terminal is independently connected to the controller. Slots 1, 4, 5 and 8 have the two output pins jumpered together and wired to a single controller harness pin. Neither of the output pins for slot 10 are connected to the controller.

Two examples of the input file layout for the base mounted 332 cabinet are shown left. The upper example shows how the rack is represented on the start drawings. The functions shown for slots 1-8 and 12-14 correspond to the default input assignments in the Econolite Oasis software. The controller detectors for slot 9 are assigned as local detectors by default, but NCDOT reserves them for system detectors instead. Slot 10 is not wired to the controller and is therefore unused. The upper and lower channels of Slot 11 in the I-File are assigned to Manual Advance and Manual Control Enable, respectively. Both channels of J11 are spares.

Features:

Ⓐ Inductive Loop Detectors - Input file slots 1-9 are set up for inductive loop detector cards. Each card has two channels. Each channel is represented on the electrical detail by a block in the layouts shown on the left. For each channel, the function of the loop is shown in the upper half of the block while the loop name is shown in the lower half. A channel can be assigned to a local detector, a system detector, or both. While the default phase settings should be followed as much as practical, controller detectors can be easily reassigned as needed.

2070 Input File Layout

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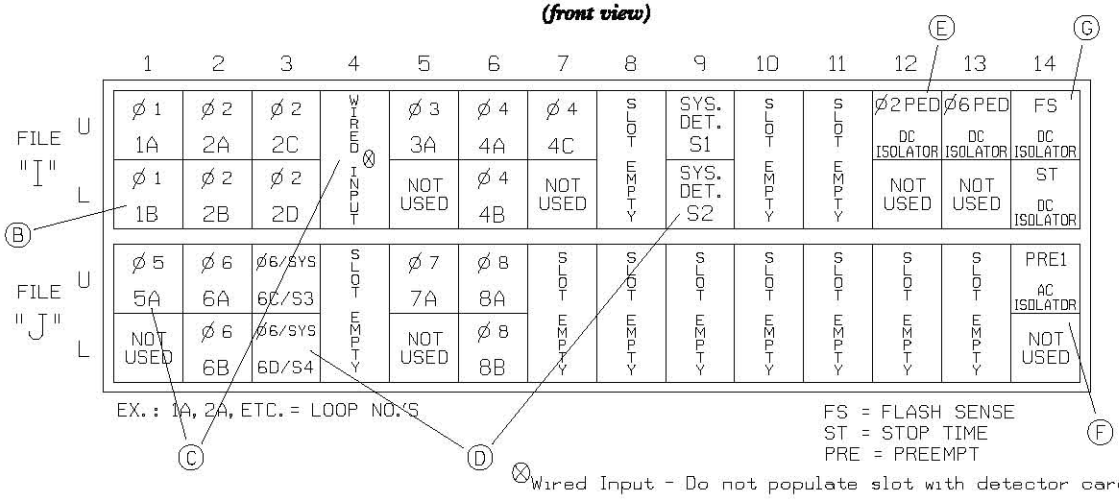
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

STD. NO.
8.0
SHEET 1 OF 3

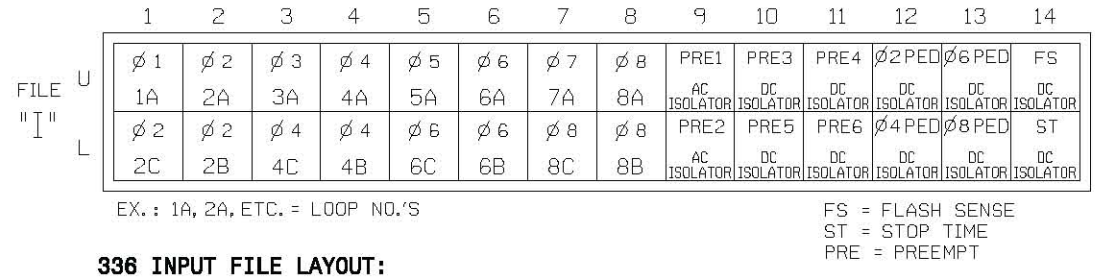
INPUT FILE POSITION LAYOUT

(front view)



INPUT FILE POSITION LAYOUT

(front view)



336 INPUT FILE LAYOUT:

The pole mounted 336 cabinet has only one input file. Both channels of all 14 slots are connected to the controller. The example shown above shows the default setup for the 336 input file. Slots 1-8 are set up for inductive loop detectors, slots 9-11 for preempts and slots 12 and 13 for pedestrian pushbuttons. Slot 14 is reserved for flash sense and stop time, just like on the 332 cabinet. Due to the space limitations, no slots are reserved for system detectors. System loops must be placed on unused local detector channels, with preference given to the lower channel (detector channel #2).

FEATURES (cont.):

Ⓑ Slots 1, 4, 5 and 8 have only one controller input pin. The lower channel is normally unused. However, the lower channel of these slots may be used if neither the loop on the upper channel nor the loop proposed for use on the lower channel have any associated delay timing and all other settings for both loops are identical. The controller will view the two loops as if they are one.

Ⓒ Loops That Call Two Phases - Sometimes a left turn loop will call both the left turn phase and the adjacent through movement with different timings or attributes for each. In this case, two detector channels are needed for the single loop. Utilize the default programmed detector settings. Populate the turn phase detector slot with a detector card. Then jumper the controller turn phase input pin to the through movement controller input pin that is associated with slot(s) 4 or 8. The through movement slot is not populated with a detector card as shown in the example at left.

Ⓓ System Detectors - Detector cards for system loops are normally placed in slots I9 and J9. If more than four dedicated system loops are needed, an unused channel from slots 1-8 may be used. A detector may also serve as both a local and a system detector, as shown in slot J3 in the example at left.

Ⓔ Ped Detectors - Pedestrian pushbuttons interface to the controller through DC isolator cards in slots I12 and I13.

Ⓕ Preempt Inputs - The default setup can accommodate six preempt inputs. Preempts 1 and 2 interface the controller through an AC isolator card in slot J14. Preempt 1 is normally reserved for railroad preemption, while preempt 2 can be used for a second railroad preempt or (more commonly) for pushbutton style emergency vehicle preemption. Preempts 3-6 are normally reserved for vehicle initiated EV preemptions and interface the controller through DC isolator cards. For more information on preemption, see STD. No. 9.0.

Ⓖ Slot I14 is reserved for flash sense and stop time. This DC isolator card is equipped from the factory, and this slot always appears on electrical details without modification.

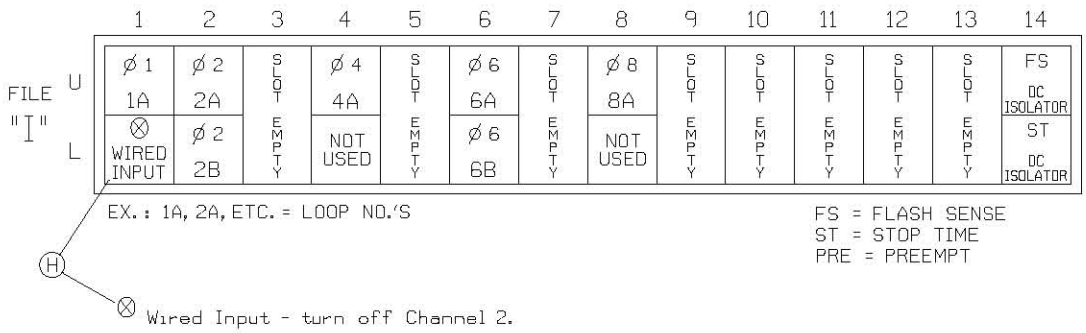
Using these slots for purposes other than those shown here may require reassignment of inputs in the controller software and/or modification of the surge protection on the cabinet input panel.

2070 Input File Layout

SIGNALS MANAGEMENT SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

INPUT FILE POSITION LAYOUT

(front view)



[1] ADD JUMPER FROM I1-F TO I1-W, ON REAR OF INPUT FILE. —— Ⓘ

FEATURES (cont.):

Ⓗ **Loops That Call Two Phases - Loops that call two phases in a 336 pole mounted cabinet require special wiring. A jumper must be added from the controller input pin of the first phase to the controller input pin of the second phase in the same slot that the loop detector is installed. Also, the second channel for the loop detector plugged into the slot must be turned OFF so that the detector can not inadvertantly place a call to the controller on the second channel.**

Ⓘ **Jumper Note - If a single loop requires two controller detector inputs, a note is placed below the Input File Connection & Programming Chart detailing which controller input pins should be jumpered together. Reference STD. NO. 8.1 sheet 1 for 332 and 336 cabinets.**

2070 Input File Layout

SIGNALS MANAGEMENT SECTION
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STD. NO.
8.0

INPUT FILE CONNECTION & PROGRAMMING CHART

LOOP NO.	LOOP TERMINAL	INPUT FILE POS.	PIN NO.	INPUT ASSIGNMENT NO.	DETECTOR NO.	NEMA PHASE	CALL	EXTEND	FULL TIME DELAY	STRETCH TIME	DELAY TIME
1A	TB2-1,2	I1U	56	18	1	1	Y	Y			
1B	TB2-3,4	I1L	56	18	1	1	Y	Y			
2A	TB2-5,6	I2U	39	1	2	2	Y	Y			
2B	TB2-7,8	I2L	43	5	12	2	Y	Y			
2C	TB2-9,10	I3U	63	25	32	2	Y	Y			
2D	TB2-11,12	I3L	76	38	42	2	Y	Y			
3A	TB4-5,6	I5U	58	20	3	3	Y	Y			3
4A	TB4-9,10	I6U	41	3	4	4		Y		2.8	
4B	TB4-11,12	I6L	45	7	14	4	Y	Y			15
4C	TB6-1,2	I7U	65	27	34	4	Y	Y			15
* S1	TB6-9,10	I9U	60	22	11	SYS					
* S2	TB6-11,12	I9L	62	24	13	SYS					
5A[1]	TB3-1,2	J1U	55	17	5	5	Y	Y			15
	-	I4U	47	9	22	2	Y	Y	Y		3
6A	TB3-5,6	J2U	40	2	6	6	Y	Y			
6B	TB3-7,8	J2L	44	6	16	6	Y	Y			
6C/S3	TB3-9,10	J3U	64	26	36	6/SYS	Y	Y			
6D/S4	TB3-11,12	J3L	77	39	46	6/SYS	Y	Y			
7A	TB5-5,6	J5U	57	19	7	7	Y	Y			3
8A	TB5-9,10	J6U	42	4	8	8	Y	Y			
8B	TB5-11,12	J6L	46	8	18	8	Y	Y			
PED PUSH BUTTONS											
P21,P22	TB8-4,6	I12U	67	29	PED 2	2 PED					
P61,P62	TB8-7,9	I13U	68	30	PED 6	6 PED					

NOTE:
INSTALL DC ISOLATORS IN INPUT FILE SLOTS I12 AND I13.

Ⓐ

[1] ADD JUMPER FROM J1-W TO I4-W, ON REAR OF INPUT FILE. ——— Ⓑ

* SYSTEM DETECTOR ONLY. REMOVE THE VEHICLE PHASE ASSIGNED TO THIS DETECTOR IN THE DEFAULT PROGRAMMING.

Ⓒ

INPUT FILE POSITION LEGEND: J2L
FILE J
SLOT 2
LOWER

336 Cabinet Chart:

The Input File Connection & Programming Chart for the 336 cabinet works the same as the chart for the 332 cabinet. The only differences are the loop terminal numbers and the relationship of the input file position with the controller pin number. The 336 cabinet start drawings have the correct values in their charts.

2070 Input File Connection & Programming Chart (332)

The purpose of the Input File Connection & Programming Chart is to provide the installer with a convenient reference for connecting inductive loops and pedestrian pushbuttons to the cabinet as well as for programming controller detectors. The example shown at left is set up to match the example shown in the 2070 Input File Layout section (STD. No. 8.0).

The key value to each row is the input file position (third column from the left). The first six values in the row should be considered attributes of the input file position. The relationship of the input file position with a specific inductive loop (first column) is decided during the preparation of the input file layout. Also, once the input file layout is established, all rows corresponding to unused input file positions can be deleted.

The relationship of the input file position with the loop terminal and pin numbers is fixed in the cabinet hardware. Changing these values entails rewiring the cabinet and should be avoided. The relationship of the input file position with the input assignment and controller detector numbers is set in the controller software. The values shown on the start drawings are the controller defaults. Changing them is only necessary if the detector is to be reassigned to another function.

The remaining (right-most) six columns contain attributes that apply to the specific loop associated with the input file position in question. These values can be found in the '2070L Loop Detector and Installation' chart on the signal plan and should be duplicated in this chart.

Additional Features:

Ⓐ Pedestrian Pushbuttons - If the design utilizes pedestrian pushbuttons, an extension is added to the Input File Connection & Programming Chart that contains the appropriate values for those detector channels. The values in the last five columns of the main chart do not apply to pedestrian detectors. The CADD cell containing the pedestrian detectors also includes a note reminding the installer to equip the appropriate slots with a DC isolator.

Ⓑ Jumper Note - If a single loop requires two controller detector inputs (see STD. NO. 8.0 sheets 2 and 3), a note is placed below the chart detailing which controller input pins should be jumpered together.

Ⓒ System Detector Note - If a detector channel is to serve as a system detector only, this note is included to remind the installer to remove the vehicle phase assigned to that detector in the default programming.

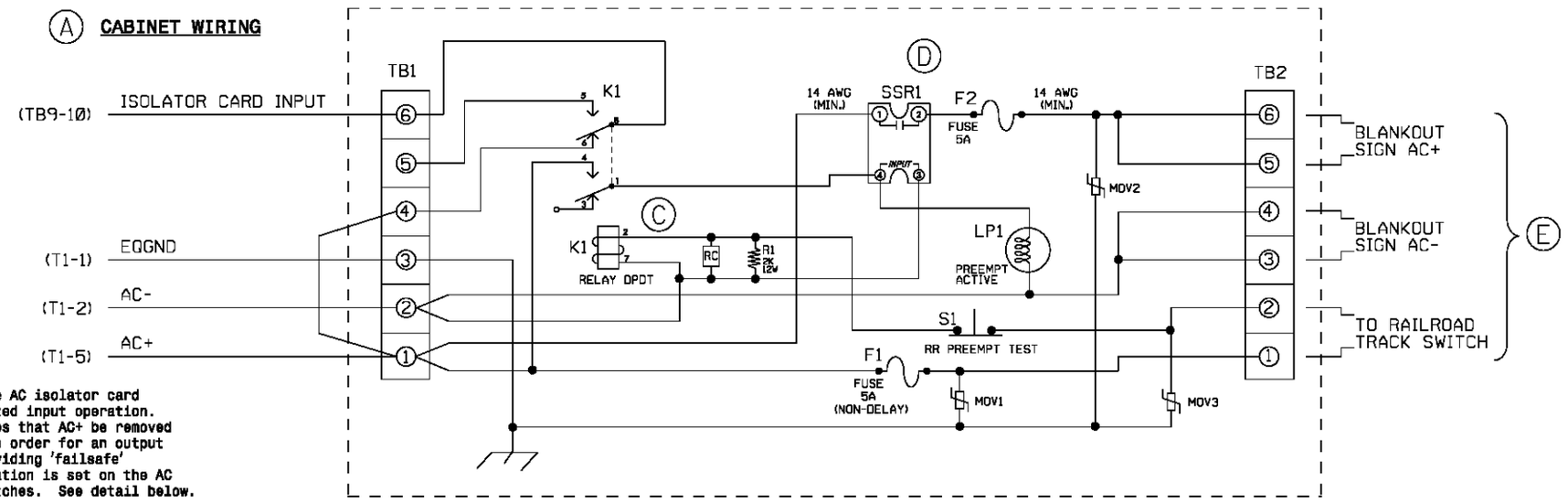
Ⓑ NOTES

1. Relay K1 is shown in the energized (Preempt not active) normal operation state.
2. Relay K1 is a DPDT with 120VAC coil with an octal base.
3. Relay SSR1 is a SPST (normally open) Solid State Relay with AC input and AC (25 amp) output.
4. AC Isolator Card shall activate preemption upon removal of AC+ from the input (as shown above). To accomplish this set invert dip switch on AC Isolator Card.

5. IMPORTANT!! A jumper must be added between input file terminals J14-E and J14-K if not already present. Also, terminal TB9-12 (on input panel) shall be connected to AC neutral (jumper may have to be added).

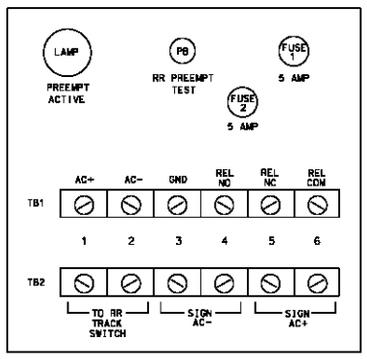
Ⓐ CABINET WIRING

PREEMPTION AND BLANKOUT SIGN CONTROL BOX



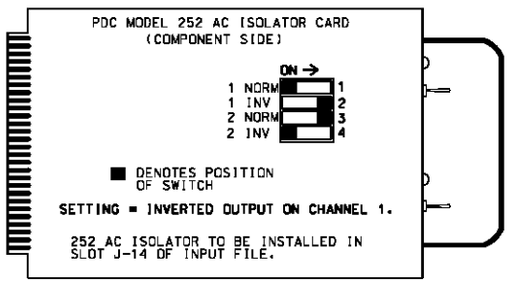
Note #4 indicates that the AC isolator card is to be set-up for inverted input operation. Inverted operation requires that AC+ be removed from the isolator input in order for an output to be generated, thus providing 'failsafe' operation. Inverted operation is set on the AC isolator card via dip switches. See detail below.

FRONT VIEW



PREEMPT 1 AC ISOLATOR (MODEL 252) OUTPUT PROGRAMMING DETAIL

(set DIP switches as shown below)



NOTE: IF ANOTHER MANUFACTURER TYPE OF AC ISOLATOR IS USED, OUTPUT PROGRAMMING IS LIKELY NOT TO EQUATE TO THAT SHOWN ABOVE.

2070 RR Preemption and Blankout Sign Control Box

The 2070 Preemption and Blankout Sign Control Assembly/Box provides the following functionality:

1. Provides the interface between the railroad crossing signal equipment and the traffic signal equipment, which includes, termination points for the interconnect cable, surge protection, and termination points for blankout signs.
2. Provides an output which directs the controller to begin the preemption sequence. A test switch is present to manually test this output.
3. Provides the control circuitry for the operation of any blankout signs required by the preemption sequence. This circuitry allows the blankout signs to operate normally, even when cabinet is in the flash mode.

Explanation of major components:

Ⓐ Cabinet wiring termination points - tells the installer where to make the connections in order to interface the box with the cabinet. These connections supply AC power to the box, as well as tie the preempt relay output to an AC isolator.

Ⓑ Notes section - describes the component types and part numbers used in the box. Any special wiring instructional notes are placed here.

Ⓒ Preempt relay - the coil of this relay (K1) is tied to the RR cabinet contacts which, when opened, indicate the presence of a train. When the RR contacts open, this relay de-energizes and removes AC+ from the isolator card, thus causing a preempt input to be placed on the controller. The other set of contacts on this relay cause AC+ to be applied to the input of SSR1 (which illuminates the blankout signs).

Ⓓ Blankout sign relay - this relay is a SPST, solid state relay which controls the illumination of the blankout signs. When this relay is activated by the preempt relay (K1), the signs will be switched "ON".

Ⓔ Field wiring termination points - tells the installer where the connections are made in order to interface the preempt box with the RR crossing signal equipment. Terminations for blankout sign AC+ and AC- are included here as well.

2070 RR Preemption and Blankout Sign Control Box

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PREEMPTION PROGRAMMING DETAIL

(program controller as shown below)

FROM MAIN MENU PRESS 'A' (PREEMPTION), THEN '1' (STANDARD PREEMPTION).

```
   PREEMPTION  #1  SETTINGS (NEXT:1-10)
 INTERVAL/TIMING  |  CLEAR/DWELL PHASES
   GRN YEL   RED  |12345678910111213141516
1   12  4.0  3.5 |X    X
2  255  0.0  0.0 |   X
3    0  0.0  0.0 |
4    0  0.0  0.0 |
5    1  0.0  0.0 | X   X
EXIT CALLS       |
              OPTIONS
PRIORITY (Y/N TO SELECT) .............HIGH
DELAY TIMER (0-255 SEC) ..............0
MIN GREEN BEFORE PRE (0= DEFAULT)....1
PED CLEAR BEFORE PRE (0= DEFAULT)....0
YELLOW CLEAR BEFORE PRE (0= DEFAULT).4.0
RED CLEAR BEFORE PRE (0= DEFAULT)....3.5
DWELL MIN TIMER (0-255 SEC) .........7
DWELL MAX TIMER (0=OFF,1-255MIN) ....0
DWELL HOLD-OVER TIMER (0-255) .......0
LATCH CALL? ..........................N
LINK TO NEXT PREEMPT? ................N
ENABLE BACKUP PROTECTION? ............N
HOLD CLEAR 1 PHASES DURING DELAY? ...N
FAST GREEN FLASH DWELL PHASES? .......N
PED CLEARANCE THROUGH YELLOW? ........N
INHIBIT OVERLAP GREEN EXTENSION? ....N
SERVICE DURING SOFTWARE FLASH? .......N
REST IN RED DURING DWELL INTERVAL? ..N
FLASH DWELL INTERVAL? ................N
ALLOW PEDS IN DWELL INTERVAL? ........N
RE-TIME DWELL INTERVAL? ..............N
OVERLAPS:                | ABCDEFGHIJKLMNOP
DWELL INT FLASH YELLOW   |
OMIT OVERLAPS:           |
```

(A) (B) (C) (D) (E)

Preemption Programming Detail

The image to the left is an exact duplication of the preempt programming display found on a 2070 controller running Oasis control software.

When a signal plan requires preemption, this detail is to be used on the electrical detail to instruct the installer on setting the different operational parameters required to operate the preempt sequence per the signal design plans.

Below is a brief description of the most commonly used features:

(A) Interval programming - this is the section in which interval phase selection and timing are programmed. Each interval consists of green, yellow clear, and red clear times. A section where phases are selected for each interval are positioned to the right of each set of timings. An interval time of 255 sec. is a special flag to the controller instructing it to use that interval as the "dwell" interval. The exit interval is designated when a 1 sec. green is selected following the dwell interval. Always use interval 5 as the exit interval.

Dwell interval - the dwell interval is the interval that the controller will rest in until the following two events occur:
1. The dwell minimum timer has expired, and
2. The preempt call is removed.

(B) Priority settings - there are four priority settings:
1. OFF - indicates the preemptor is not used.
2. LOW - use for low priority preempts such as transit vehicle preempts.
3. MED - use for emergency vehicle preempts.
4. HIGH - use for railroad preempts.

Railroad preempt should always be set to be the highest priority. If multiple preempts are set to the same priority, preempts will be served on a first come, first served basis.

(C) Dwell hold-over timer - this timer begins to time after the preempt call is removed. If this timer expires, the dwell interval will be released. If this timer does not expire before a second preempt call is received, the dwell interval will be retimed. Normally used with vehicle initiated EV preemption systems.

(D) Latch call - used in conjunction with the delay timer. The application for this feature is normally the fire house push button style of preempt. These types of preempts normally have a delay interval. This feature will allow the preempt call to latch and not release until the preempt is served.

(E) Hold clear 1 phases during delay - this feature is used in conjunction with the delay interval. If clear 1 phases are used in normal operation, and those phases just happen to be served during the delay interval, this feature will apply a hold on the clear 1 phases during the remainder of the delay interval.

(continued on next page)

PREEMPTION PROGRAMMING DETAIL

(program controller as shown below)

FROM MAIN MENU PRESS 'A' (PREEMPTION), THEN '1' (STANDARD PREEMPTION).

```
   PREEMPTION  #1  SETTINGS (NEXT:1-10)
INTERVAL/TIMING |  CLEAR/DWELL PHASES
  GRN YEL  RED  |12345678910111213141516
1  12  4.0  3.5 |X     X
2 255  0.0  0.0 |    X
3   0  0.0  0.0 |
4   0  0.0  0.0 |
5   1  0.0  0.0 | X   X
EXIT CALLS      |
            OPTIONS
PRIORITY (Y/N TO SELECT) .............HIGH
DELAY TIMER (0-255 SEC) ..............0
MIN GREEN BEFORE PRE (0= DEFAULT)....1
PED CLEAR BEFORE PRE (0= DEFAULT)....0
YELLOW CLEAR BEFORE PRE (0= DEFAULT).4.0
RED CLEAR BEFORE PRE (0= DEFAULT)....3.5
DWELL MIN TIMER (0-255 SEC) .........7
DWELL MAX TIMER (0=OFF,1-255MIN) ....0
DWELL HOLD-OVER TIMER (0-255) .......0
LATCH CALL? ..........................N
LINK TO NEXT PREEMPT? ................N
ENABLE BACKUP PROTECTION? ............N
HOLD CLEAR 1 PHASES DURING DELAY? ...N
FAST GREEN FLASH DWELL PHASES? ......N
PED CLEARANCE THROUGH YELLOW? .......N
INHIBIT OVERLAP GREEN EXTENSION? ....N  (F)
SERVICE DURING SOFTWARE FLASH? ......N  (G)
REST IN RED DURING DWELL INTERVAL? ..N  (H)
FLASH DWELL INTERVAL? ................N
ALLOW PEDS IN DWELL INTERVAL? .......N
RE-TIME DWELL INTERVAL? ..............N  (I)
OVERLAPS:               | ABCDEFGHIJKLMNOP
DWELL INT FLASH YELLOW  |
OMIT OVERLAPS:          |                (J)
                        |
```

Preemption Programming Detail (continued)

Ⓕ Inhibit overlap green extension - affects how green extension overlaps (a.k.a. timed overlaps) transition into preemption. If a green extension overlap will not be used in the preemption, this setting is typically "YES". This will inhibit the overlap green extension from timing and allow transition to preemption to be accomplished in the quickest possible time. This is most important in RR preemption applications. If the overlap is used in the first interval of the preempt, the setting should be programmed as "NO".

Ⓖ Service during software flash - this feature is normally used in conjunction with EV preemption. This allows the controller to come out of late night flash in order to serve the EV preempt.

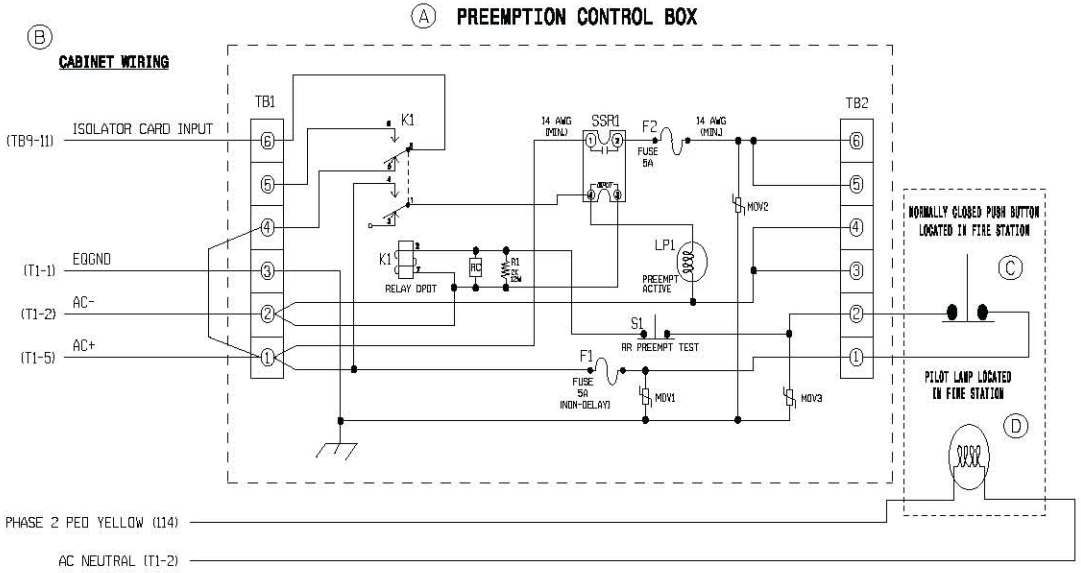
Ⓗ Rest in red during dwell interval - if the signal plan calls for the preempt dwell to be an all red rest state, this feature should be enabled. In addition, do not select any phases for the dwell interval.

Ⓘ Re-time dwell interval - used in conjunction with dwell hold-over timer. Allows the controller to re-time the dwell interval if a second preempt call is received before the hold-over timer times out. Normally used with EV preemption. Do not use this feature with railroad preemption unless there are special circumstances.

Ⓙ Omit overlaps - this feature allows overlaps to be omitted during preemption when the overlap parents are active during preempt, but the overlap is not desired. Overlaps will return during exit interval 5.

Note: description of features is not complete. This section is intended to address applicational use. Consult the Signal Design Section of this design manual and/or the Econolite Oasis manual for more details.

Emergency Vehicle Preemption Push Button And Indicator Lamp Wiring Detail



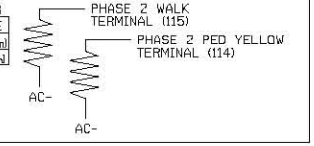
LAMP NOTES

If the ped movement associated with the loadswitch being used to operate the lamp is not used, a load resistor will have to be placed on the ped walk field terminal to drain off loadswitch leakage current. This resistor is shown in the load resistor installation detail.

1. If field terminal 114 has a conflict monitor wire attached, remove, tape, and label wire.
2. Make sure load resistors are in place as shown in the Load Resistor Installation Detail.
3. Install a loadswitch in Output File Slot S3.

LOAD RESISTOR INSTALLATION DETAIL

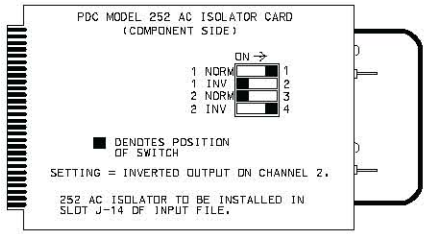
ACCEPTABLE VALUES	
VALUE (ohms)	WATTAGE
1.5K - 1.9K	25W (min)
2.0K - 3.0K	10W (min)



Ⓔ

PREEMPT 2 AC ISOLATOR (MODEL 252) OUTPUT PROGRAMMING DETAIL

(set DIP switches as shown below)



NOTE: IF ANOTHER MANUFACTURER TYPE OF AC ISOLATOR IS USED, OUTPUT PROGRAMMING IS LIKELY NOT TO EQUATE TO THAT SHOWN ABOVE.

This wiring detail gives the installer the information needed to interface the controller/cabinet assembly with a firehouse push button. The function of this button is to generate a controller input to initiate the EV preemption sequence.

Usually, there is also an indicator (pilot) lamp to be installed in the firehouse. The purpose of this lamp is to give the user positive feedback from the controller that the traffic signal has been preempted. The wiring for the indicator lamp is also shown on this detail.

Major components:

Ⓐ Preemption Control Box - this box essentially serves the same purpose in fire preemption applications as it does in railroad preemption applications. See STD. NO. 9.0 sheet 1 for a detailed description of the preempt control box.

Ⓑ Cabinet wiring termination points - tells the installer where to make the connections in order to interface the box with the cabinet. These connectons supply AC power to the box, as well as tie the preempt relay output to an AC isolator.

Ⓒ Firehouse Push Button - this is a momentary, normally closed, push button switch. The contacts of this switch are opened when the button is pressed, causing preempt to be activated.

Ⓓ Indicator Lamp - the function of this lamp is described above. This lamp is normally controlled by the yellow circuit of a pedestrian loadswitch. The function of the C1-pin associated with this ped yellow will have to be changed to operate this lamp correctly. A load resistor is normally tied in parallel with the lamp to drain off any induced voltage. Special programming notes are necessary to alert the installer of these changes. If delay before preempt interval is used, special logic processor programming is necessary for proper operation.

Ⓔ When the push button in the fire station is pressed, the preempt relay in the preempt control box de-energizes and removes AC+ from the AC isolator card. As such, the AC isolator card needs to have its switches set to the inverted position for channel 2.

Emergency Vehicle Preemption (Push Button Style) Wiring Detail

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Design Manual

Intelligent Transportation Systems (ITS) Section

Part 3

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TRANSPORTATION MOBILITY AND SAFETY DIVISION
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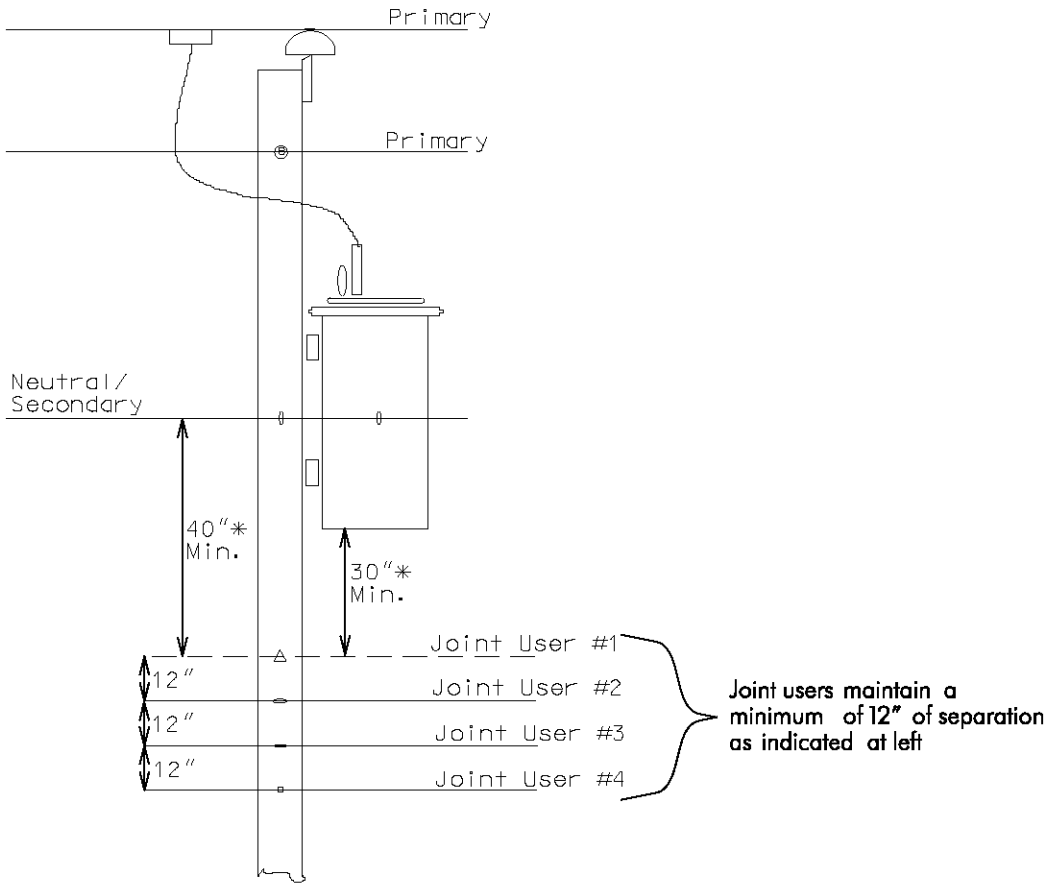
STD. NO.

Minimum Utility Clearance Requirements



NCDOT Minimum Attachment Clearances From Other Joint Users at the Pole

Clearance From	Min. Distance
Neutral / Secondary	40"
Power Service Drop	40"
Power Service Drip Loop[1]	40"
Top of Power Riser	40"
Bottom of Transformer	30"
Guy Attachment	12"

If the power service drip loop supplies power to an effectively grounded streetlight the minimum clearance requirement is reduced to 12"

Notes

The attachment point for joint user #1 must maintain a minimum of 40" below power and/or a minimum of 30" below bottom of transformer (whichever is greater)

"Joint User" refers to the power company CATV companies, NCDOT, phone company, cities, and others

NESC Clearance Requirements – Utilities

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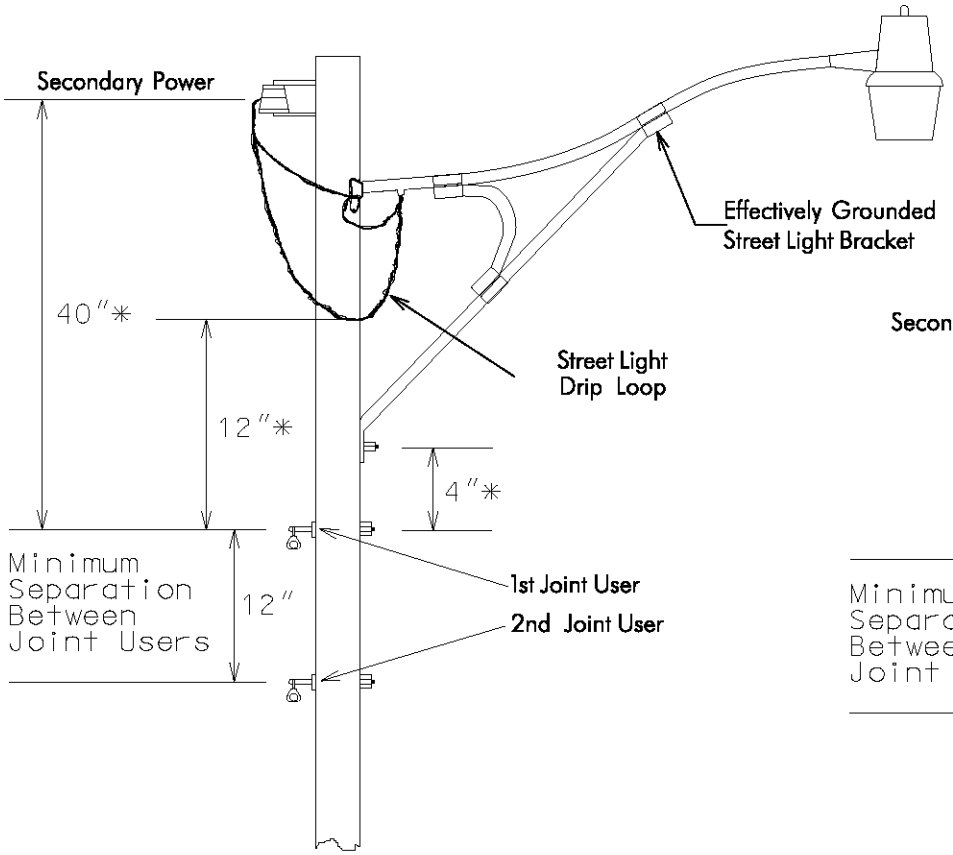
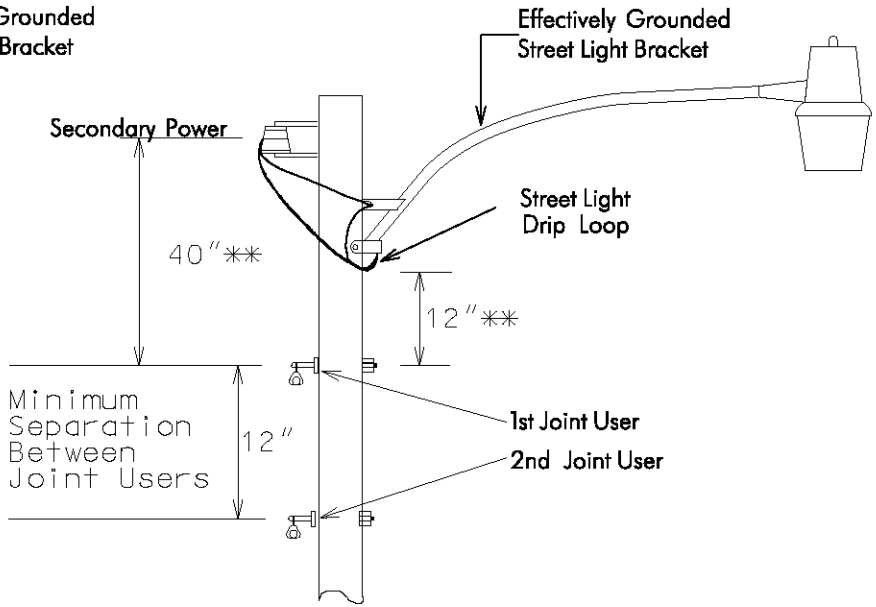
Street Light Clearances



* All three of these minimum clearance requirements for effectively grounded street lights must be met

"Joint User" refers to the power company CATV companies, NCDOT, phone company, cities, and others



**Both of these minimum clearance requirements for effectively grounded street lights must be met

IF THE STREET LIGHT /STREET LIGHT BRACKET IS NOT EFFECTIVELY GROUNDED, THEN THE MINIMUM CLEARANCE REQUIREMENT IS INCREASED TO 40" BELOW DRIP LOOP

NESC Clearance Requirements – Streetlights

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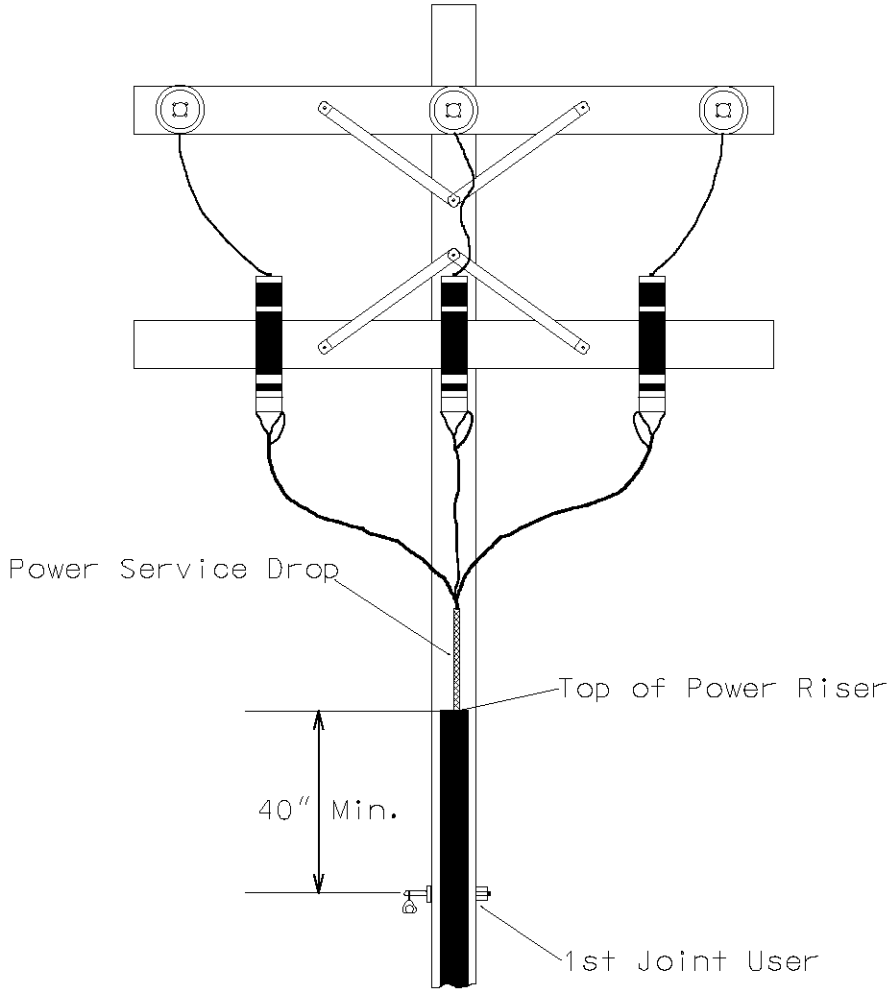

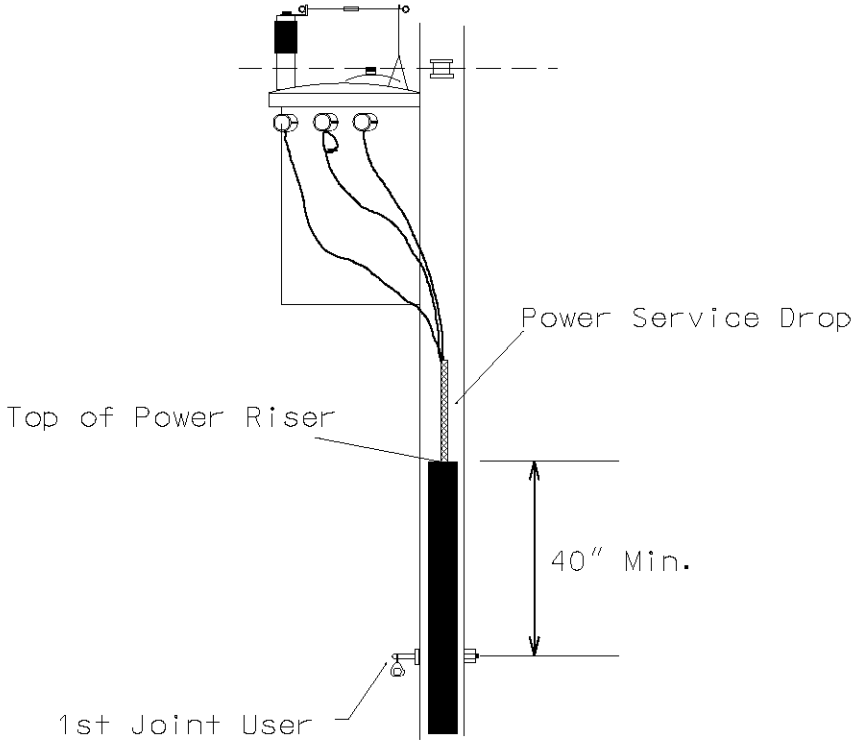

"Joint User" refers to the power company CATV companies, NCDOT, phone company, cities, and others

NESC Clearance Requirements – Power Risers

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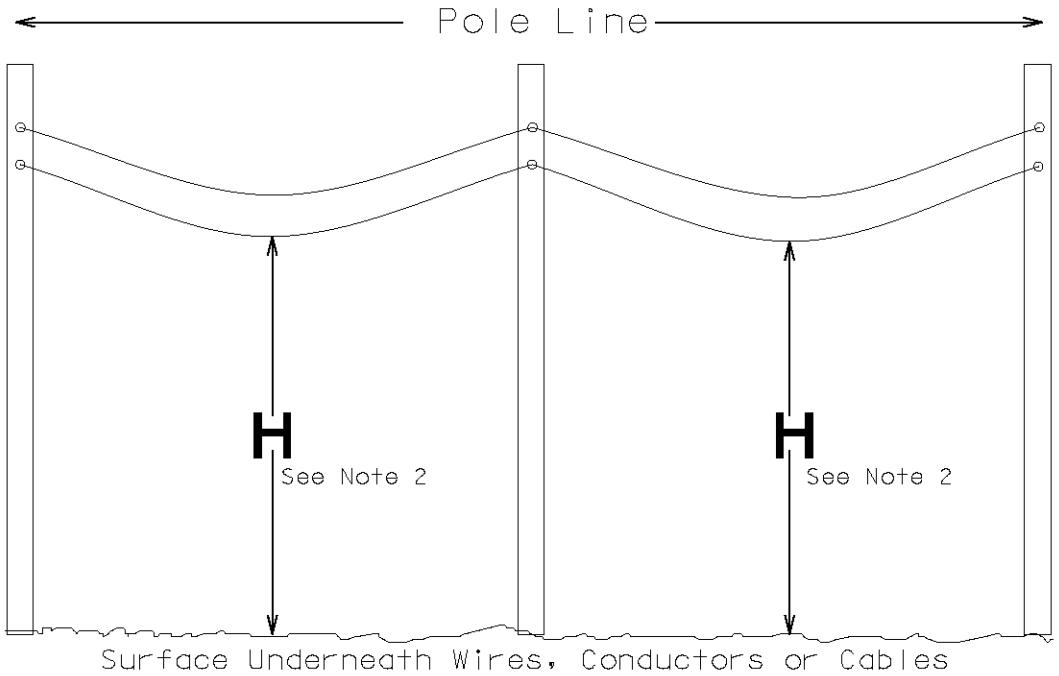

Table 1

Nature of Surface Underneath Wires Conductors or Cables	Minimum Clearance (H)*
1. Track rails of railroad except electrified railroads using overhead trolley conductors	30 FT
2. Roads, streets and other areas subject to truck traffic	18 FT
3. Driveways, parking lots, and alleys	18 FT
4. Other land traversed by vehicles such as cultivated, grazing, forest orchards, etc.	18 FT
5. Spaces and travel ways subject to pedestrian or restricted traffic only	15.5 FT

* These values have been adopted by NCDOT (as well as various utility companies) and exceed the specifications as set forth in the National Electrical Safety Code (NESC).

Notes:

1. See table 1 for acceptable minimum clearance values (H) over varying surfaces
2. "H" is defined as the vertical distance (Height) as measured from the lowest point (Typically Midspan) of the wires, conductors or cables to the surface below
3. Sag between poles should match the sag of existing utility lines

NESC Clearance Requirements – Height Over Grade

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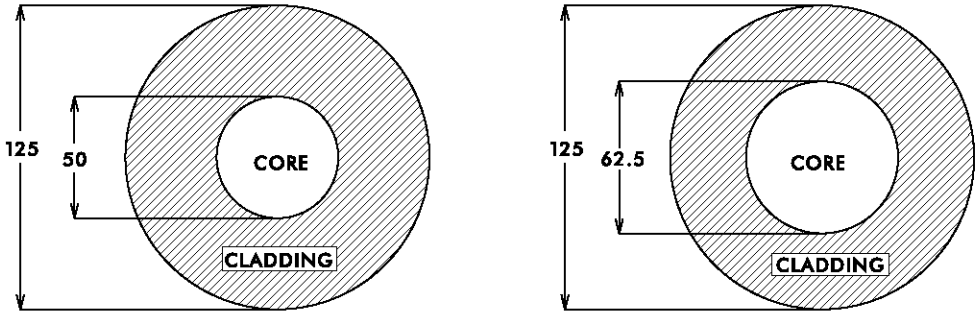
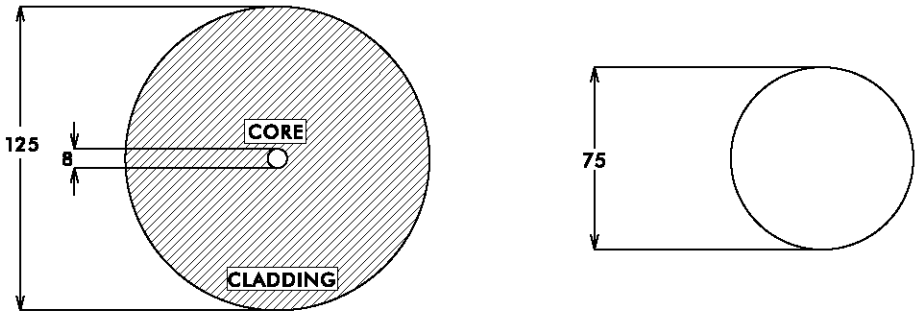
Fiber Optic Cross Section

All dimensions in micrometers (microns)

1,000,000 Microns = 1 Meter



Typical Dimension of Multimode Fiber



Typical Dimensions of Single Mode Fiber

Typical Dimension of Human Hair

Typical Signal Wavelengths

Fiber Type	Signal Wavelength	Typical Losses
Multimode	850 nm	3.5 dB /km
	1300 nm	1.5 dB /km
Single Mode	1310 nm	0.35 dB /km
	1550 nm	0.25 dB /km

Fiber Color Code

Number	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose
12	Aqua

	Number	Color
Blue Buffer Tube	1	Blue
	2	Orange
	3	Green
	4	Brown
	5	Slate
	6	White
Orange Buffer Tube	1	Blue
	2	Orange
	3	Green
	4	Brown
	5	Slate
	6	White

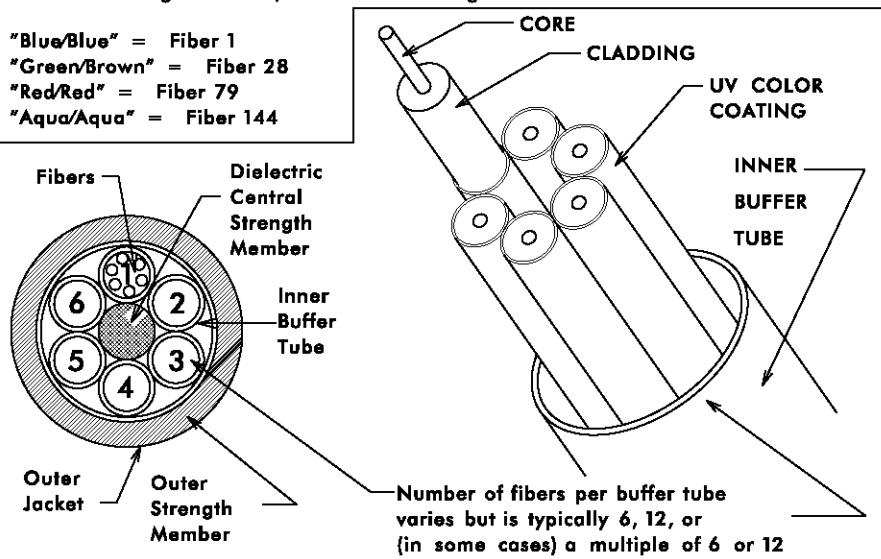
Individual fibers can be identified by number and by color

When specifying by color it is customary to refer to the buffer tube color followed by the fiber color

"Orange/Green" is the green fiber in the orange buffer tube

If a cable contained 144 fibers arranged with 12 buffer tubes each containing 12 fibers, then the following would be true

"Blue/Blue" = Fiber 1
"Green/Brown" = Fiber 28
"Red/Red" = Fiber 79
"Aqua/Aqua" = Fiber 144



FIBER OPTIC CABLE

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COMMON DRAWING SYMBOLS

●	EXISTING SIGNAL POLE	—→	NEW DOWN GUY
○	NEW SIGNAL POLE	↵	NEW SIDEWALK GUY
◘	EXISTING METAL POLE	⊏(((	NEW MICROWAVE VEHICLE DETECTION
⊙	NEW METAL POLE	■(((	EXISTING MICROWAVE VEHICLE DETECTION
◘—	EXISTING METAL POLE WITH MAST ARM	DMS	NEW DYNAMIC MESSAGE SIGN
⊙—	NEW METAL POLE WITH MAST ARM	DMS	EXISTING DYNAMIC MESSAGE SIGN
SP	SIGNAL POLE	—FO—	NEW FIBER OPTIC COMMUNICATIONS CABLE
□	NEW JUNCTION BOX	▪TWIST PR▪	NEW TWISTED PAIR COMMUNICATIONS CABLE
■	EXISTING JUNCTION BOX	—EXI—	EXISTING COMMUNICATIONS CABLE
▷□	NEW CCTV CAMERA	—REM—	EXISTING COMMUNICATIONS CABLE TO BE REMOVED
▶■	EXISTING CCTV CAMERA		NEW AERIAL GUY ASSEMBLY
∞	CABLE STORAGE RACK (SNOW SHOES)		NEW CONDUIT
			EXISTING CONDUIT
S	NEW SPLICE CABINET	—DD—	NEW DIRECTIONAL DRILLED CONDUIT
S	EXISTING SPLICE CABINET	—B&J—	NEW BORED AND JACKED CONDUIT
∞S	AERIAL SPLICE ENCLOSURE	⫴ ⫴	YAGI ANTENNA (DOUBLE) FOR REPEATER OPERATION
⤢	EXISTING SIGNAL CABINET	⫴	YAGI ANTENNA (SINGLE)
M	MASTER CONTROLLER CABINET	((•))	OMNI ATENNA
		XX-XXXX	SIGNAL INVENTORY NUMBER

NOTE:
DRAWING SYMBOLS SHOULD BE AT THE SAME SCALE AS THE PLAN SHEET
FOR INFORMATION ON SCALING LINE STYLES SEE "STANDARD SYMBOLOGY TABLES" SECTION 9.0

Drawing Format Items – Symbology

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
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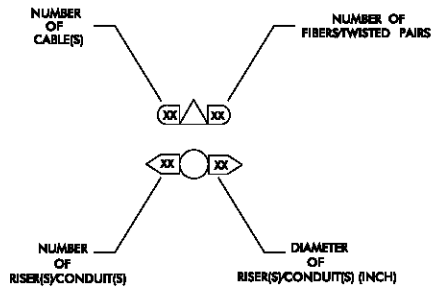
1. INSTALL REA, PE – 22, SHIELDED, TWISTED PAIR COMMUNICATIONS CABLE
2. INSTALL REA, PE – 38, (FIGURE 8) SHIELDED, TWISTED PAIR COMMUNICATIONS CABLE
3. INSTALL REA, PE – 39, (UNDERGROUND) SHIELDED, TWISTED PAIR COMMUNICATIONS CABLE
4. INSTALL SMFO CABLE
5. INSTALL MMFO CABLE
6. INSTALL FIBER OPTIC DROP CABLE
7. INSTALL TRACER WIRE
8. TRENCH OR PLOW
9. INSTALL PVC CONDUIT
10. INSTALL RIGID, GALVANIZED STEEL CONDUIT
11. INSTALL RIGID, GALVANIZED STEEL RISER WITH WEATHERHEAD
12. INSTALL RIGID, GALVANIZED STEEL RISER WITH HEAT SHRINK TUBING
13. INSTALL OUTER-DUCT POLYETHYLENE CONDUIT
14. INSTALL POLYETHYLENE CONDUIT
15. DIRECTIONAL DRILL CONDUIT
16. BORE AND JACK CONDUIT
17. INSTALL CABLE(S) IN EXISTING CONDUIT
18. INSTALL CABLE(S) IN NEW CONDUIT
19. INSTALL CABLE(S) IN EXISTING RISER
20. INSTALL CABLE(S) IN NEW RISER
21. INSTALL CABLE(S) IN EXISTING CONDUIT STUB-OUTS
22. INSTALL NEW CONDUIT INTO EXISTING CABINET BASE (USE EXISTING CONDUIT STUB-OUTS WHEN AVAILABLE)
23. INSTALL NEW RISER INTO EXISTING CABINET BASE (USE EXISTING CONDUIT STUB-OUTS WHEN AVAILABLE)
24. INSTALL NEW CONDUIT INTO EXISTING POLE MOUNTED CABINET
25. INSTALL NEW RISER INTO EXISTING POLE MOUNTED CABINET
26. TERMINATE COMMUNICATIONS CABLE ON EXISTING TELEMETRY INTERFACE PANEL IN TRAFFIC SIGNAL CONTROLLER CABINET
27. INSTALL NEW TELEMETRY INTERFACE PANEL IN TRAFFIC SIGNAL CONTROLLER CABINET
28. INSTALL INTERCONNECT CENTER, PATCH PANEL, JUMPERS AND FUSION SPLICE CABLE IN CABINET
29. INSTALL UNDERGROUND SPLICE ENCLOSURE
30. INSTALL AERIAL SPLICE ENCLOSURE
31. INSTALL POLE MOUNTED SPLICE CABINET
32. INSTALL BASE MOUNTED SPLICE CABINET
33. REMOVE EXISTING SPLICE CABINET
34. INSTALL CABINET FOUNDATION
35. REMOVE EXISTING CABINET FOUNDATION
36. INSTALL CCTV CAMERA ASSEMBLY
37. INSTALL CCTV CAMERA WOOD POLE
38. INSTALL CCTV CAMERA METAL POLE AND FOUNDATION
39. INSTALL JUNCTION BOX
40. INSTALL OVERSIZED JUNCTION BOX
41. REMOVE EXISTING JUNCTION BOX
42. INSTALL WOOD POLE
43. REMOVE EXISTING WOOD POLE
44. INSTALL AERIAL GUY ASSEMBLY
45. INSTALL STANDARD GUY ASSEMBLY
46. INSTALL SIDEWALK GUY ASSEMBLY
47. INSTALL MESSENGER CABLE
48. REMOVE EXISTING COMMUNICATIONS AND MESSENGER CABLE
49. REMOVE EXISTING MESSENGER CABLE
50. INSTALL TELEPHONE SERVICE
51. INSTALL CABLE STORAGE RACKS (SNOW SHOES) AND STORE 100 FEET OF CABLE
52. INSTALL DELINEATOR MARKER
53. STORE 20 FEET OF COMMUNICATIONS CABLE
54. LASH CABLE(S) TO EXISTING SIGNAL/COMMUNICATIONS CABLE
55. LASH CABLE(S) TO EXISTING MESSENGER CABLE
56. LASH CABLE(S) TO NEW MESSENGER CABLE
57. MODIFY EXISTING ELECTRICAL SERVICE
58. INSTALL NEW ELECTRICAL SERVICE

LEGEND

- FO — NEW FIBER OPTIC COMMUNICATIONS CABLE
- TWIST PR — NEW TWISTED PAIR COMMUNICATIONS CABLE
- EXI — EXISTING COMMUNICATIONS CABLE
- REM — EXISTING COMMUNICATIONS CABLE TO BE REMOVED
- NEW AERIAL GUY ASSEMBLY
- NEW CONDUIT
- EXISTING CONDUIT
- DD — NEW DIRECTIONAL DRILLED CONDUIT
- BAJ — NEW BORED AND JACKED CONDUIT
- NEW JUNCTION BOX
- EXISTING JUNCTION BOX
- NEW WOOD POLE
- EXISTING WOOD POLE
- 8 — AERIAL SPLICE ENCLOSURE
- NEW METAL POLE
- EXISTING METAL POLE
- NEW CCTV ASSEMBLY
- EXISTING CCTV ASSEMBLY
- DMS — NEW DYNAMIC MESSAGE SIGN
- DMS — EXISTING DYNAMIC MESSAGE SIGN
- NEW MICROWAVE VEHICLE DETECTION
- EXISTING MICROWAVE VEHICLE DETECTION
- NEW STANDARD GUY ASSEMBLY
- NEW SIDEWALK GUY ASSEMBLY
- NEW CABLE STORAGE RACKS (SNOW SHOES)
- EXISTING CONTROLLER AND CABINET
- S — EXISTING SPLICE CABINET
- S — NEW SPLICE CABINET
- SP — SIGNAL POLE
- XX-XXXX — SIGNAL INVENTORY NUMBER
- CCTV-XX — CCTV IDENTIFICATION NUMBER

CONSTRUCTION NOTE SYMBOLOGY KEY

- (XX) INDICATES NUMBER OF CABLES, LOOPS, ETC.
- (XX) INDICATES NUMBER OF FIBERS PER CABLE, TWISTED PAIRS PER CABLE, ETC.
- <XX> INDICATES NUMBER OF RISER(S)/CONDUIT(S)
- <XX> INDICATES DIAMETER OF RISER(S)/CONDUIT(S) (INCH)



Drawing Format Items – Construction Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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Understanding Construction Notes

Install one 12–fiber single mode fiber optic cable

Install two 6–fiber multi–mode fiber optic cables

Install one 2" diameter polyethylene conduit

Install one 1" diameter rigid, galvanized steel riser with weatherhead

Construction Note Conventions

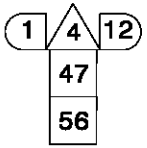
Place notes in numerical order

correct

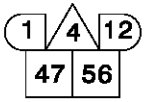
incorrect

Orient vertically

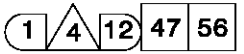
correct



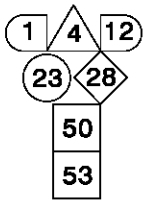
correct



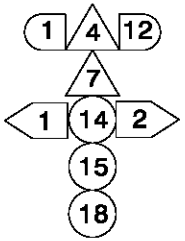
incorrect



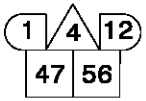
Some Common Construction Notes



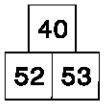
base mounted cabinet (master location)



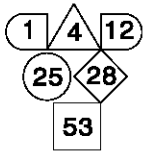
directional drilled conduit



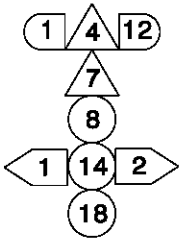
new fiber optic and messenger cable



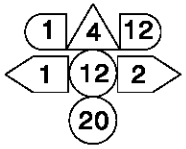
new oversized junction box



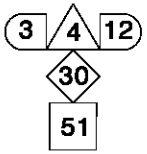
pole mounted cabinet



trenched or plowed conduit



new riser



aerial splice enclosure

For more information on construction notes, see sections 4–7 of this manual

Drawing Format Items – Construction Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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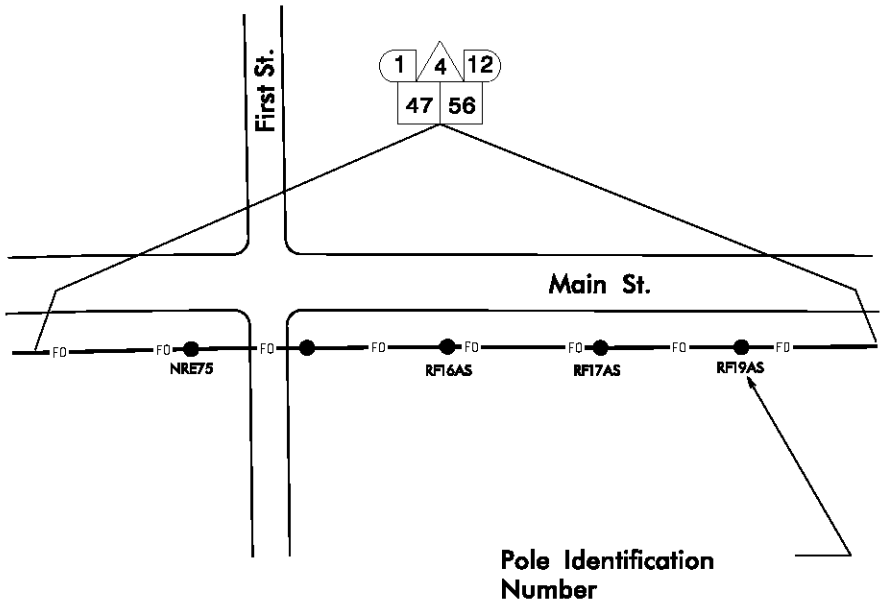
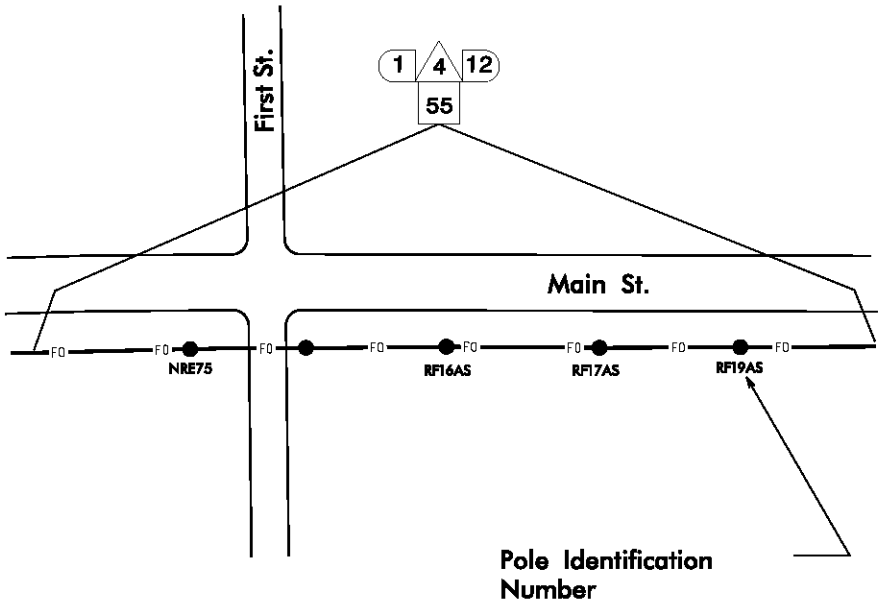
Case 1

New communications cable lashed to new messenger cable



Case 2

New communications cable lashed to existing messenger cable



Construction Notes for Aerial Cable Run

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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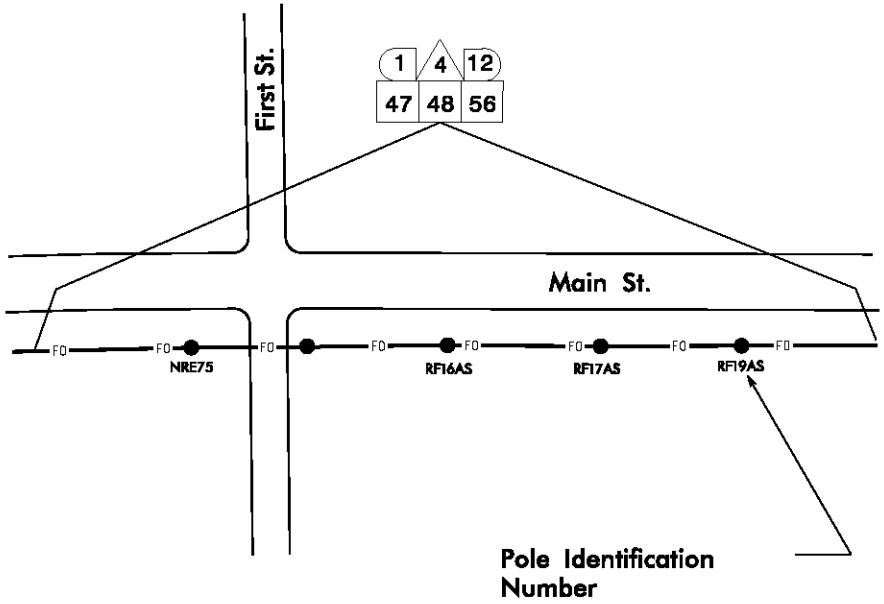
4.0
SHEET 1 OF 3

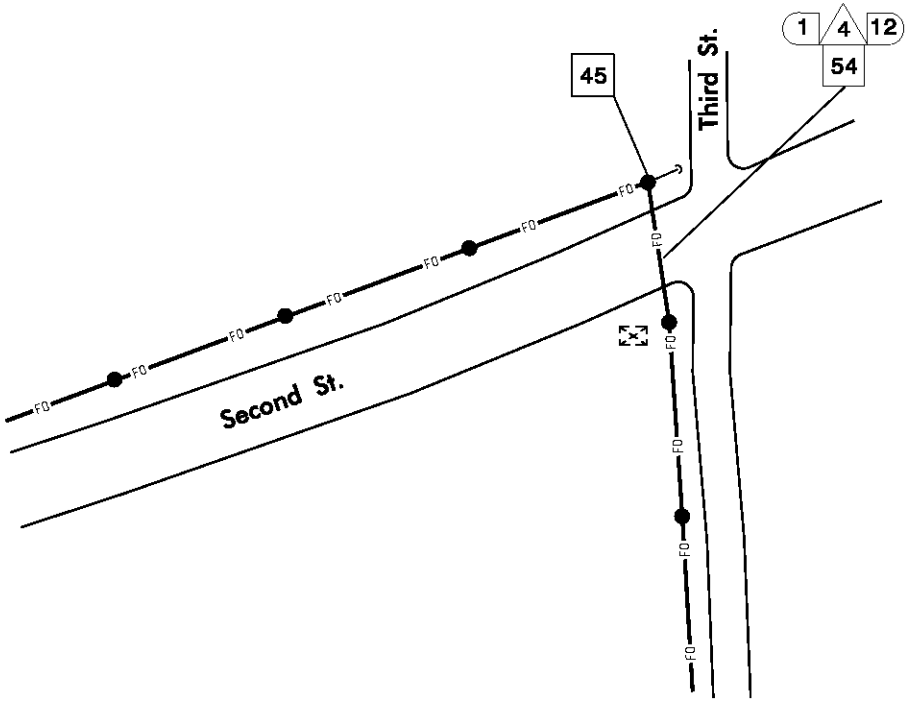
Case 3

Existing communications cable and messenger cable are to be removed new communications cable lashed to new messenger cable



Case 4

New communications cable lashed to existing signal/communications cable



Construction Notes for Aerial Cable Run

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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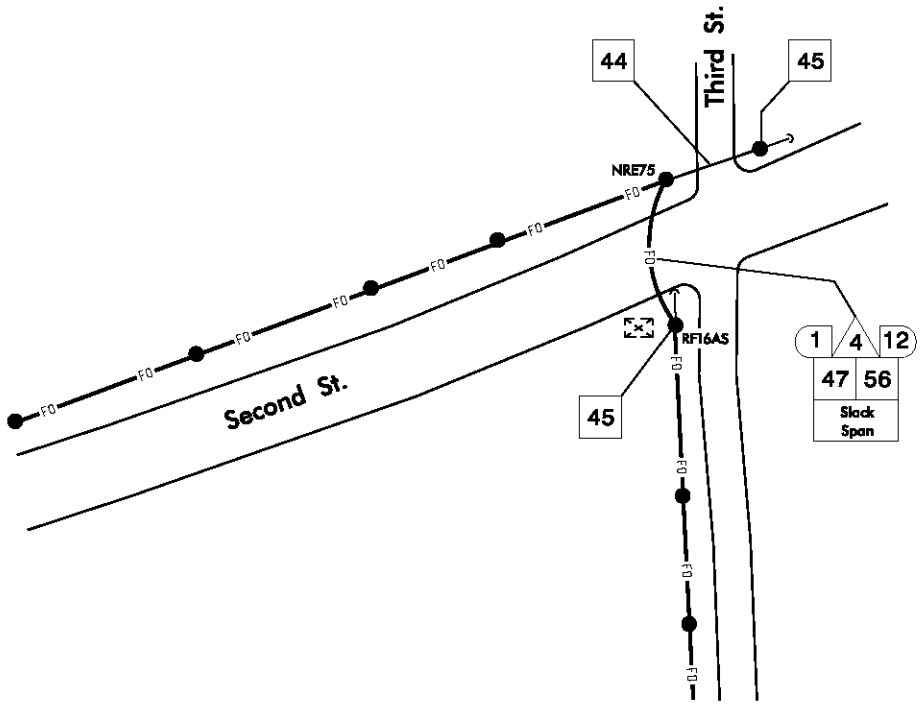
Case 5

New communications cable lashed to
new messenger cable and slack spanned



NOTE: Slack spanning should be used as a last resort.
In this case, a guy could not be placed on pole NRE75 to counteract the tension of the aerial installation along Third Street.
Therefore, slack span to pole RF16AS and place down guy at that pole.

Reserved for future use

Construction Notes for Aerial Cable Run

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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4.0
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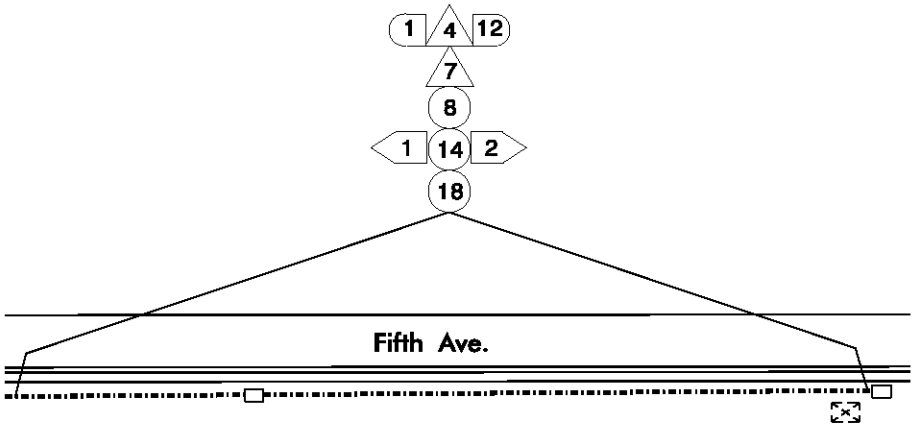
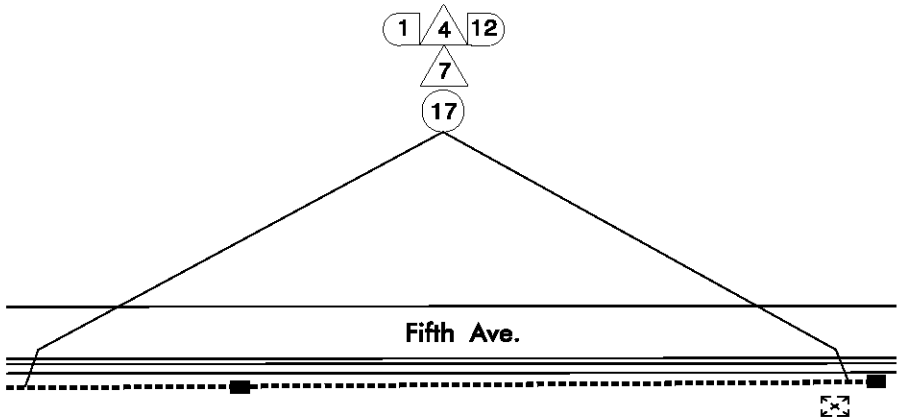
Case 1

Underground communications cable run
installed in new conduit trenched or plowed



Case 2

Underground communications cable run
installed in existing conduit



Construction Notes for Trenched or Plowed Conduit

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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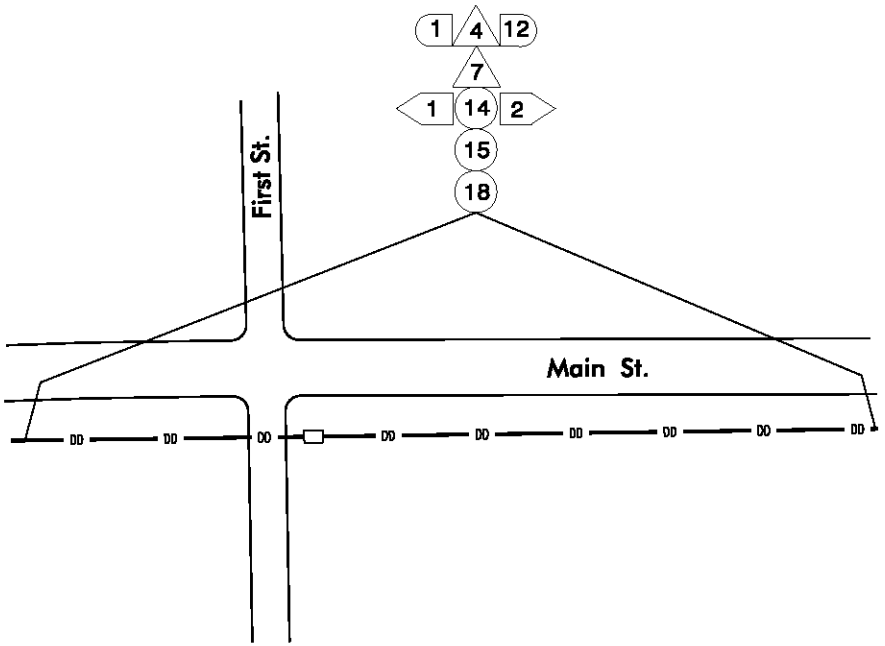
Case 3

Underground communications cable run
installed in new conduit directionally drilled



Case 4

Reserved for future use

Construction Notes for Directional Drilled Conduit

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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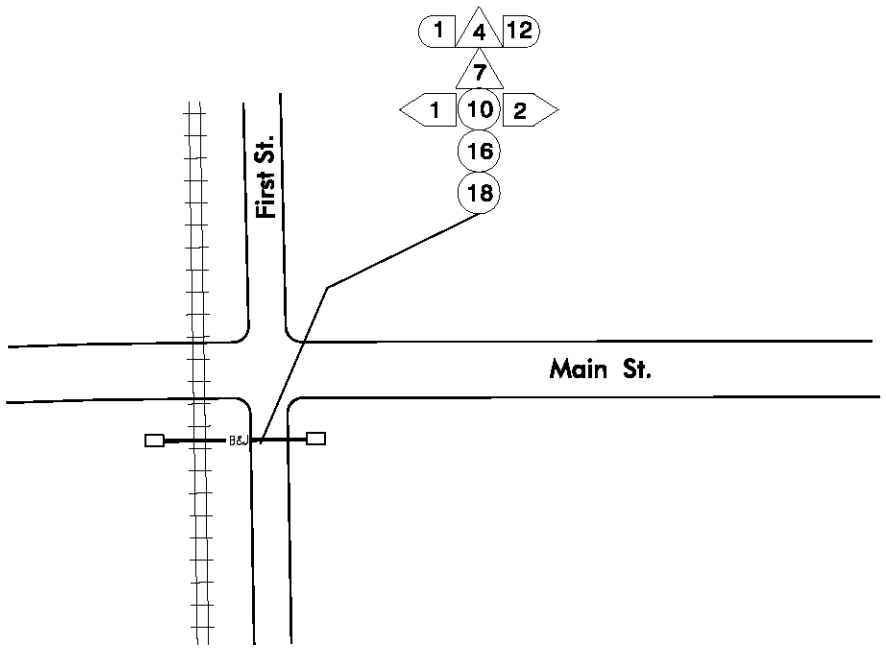
Case 5

Underground communications cable run
installed in new galvanized steel conduit



NOTE:This method is typically used for crossing under railroad tracks. However, it can be used for other applications requiring galvanized steel conduit.

Case 6

Reserved for future use

Construction Notes for Bored and Jacked Conduit

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
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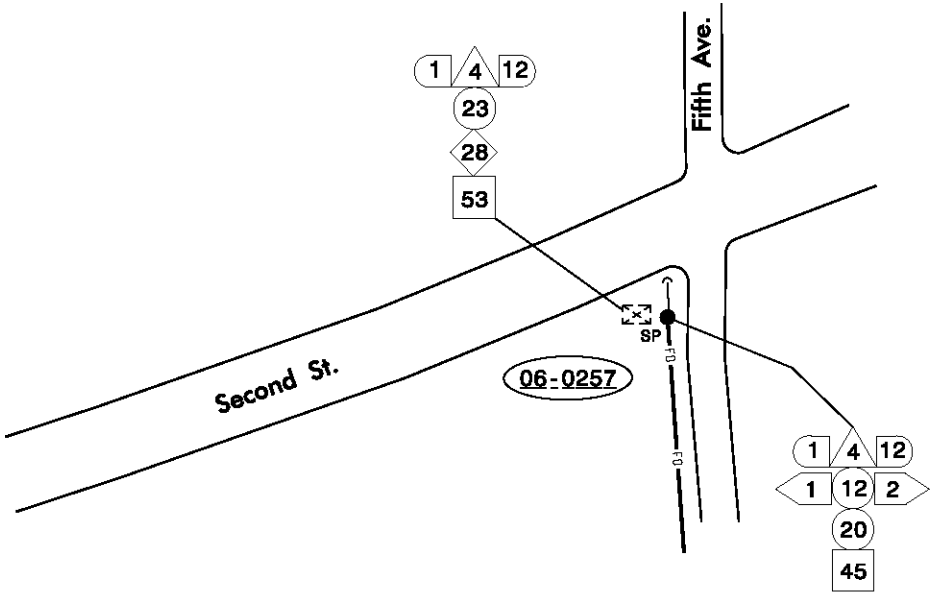
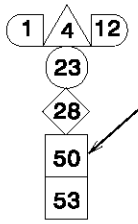
4.1
SHEET 3 OF 3

Case 1

Fiber routed from a pole riser to a base mounted signal cabinet at the end of a run with standard guy assembly

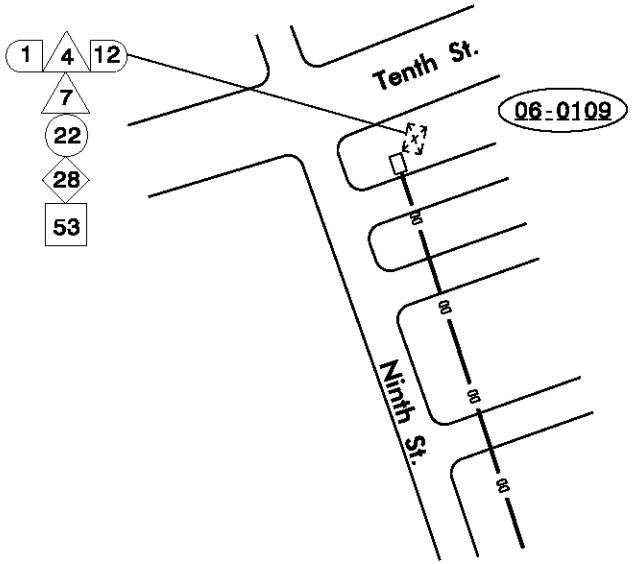


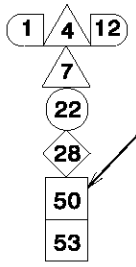


NOTE:If this is the master controller, add construction note #50.

Case 2

Fiber routed from a junction box to a base mounted signal cabinet at the end of a run (underground installation - no riser required)





NOTE:If this is the master controller, add construction note #50.

Construction Notes for Signal Cabinets and Risers

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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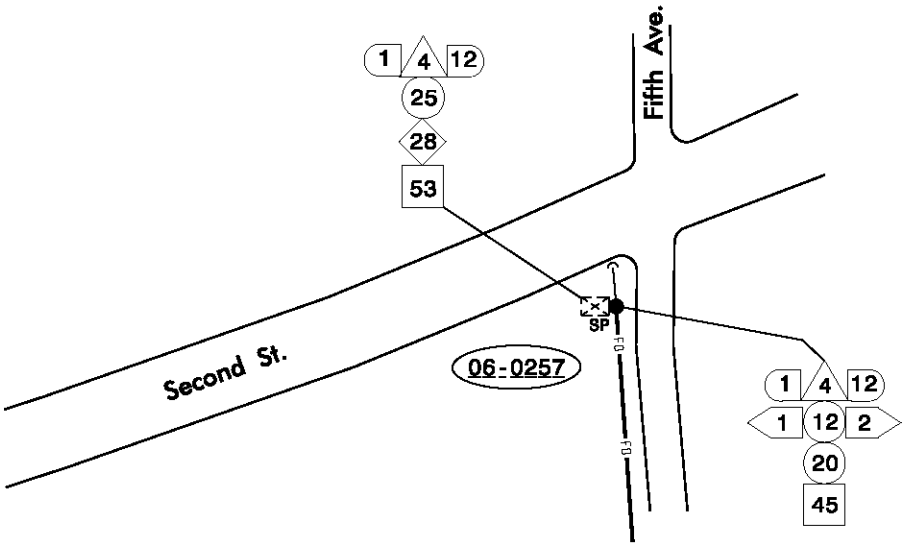
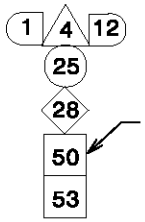
STD. NO.
4.2
SHEET 1 OF 4

Case 3

Fiber routed from a pole riser to a pole mounted signal cabinet at the end of a run with standard guy assembly

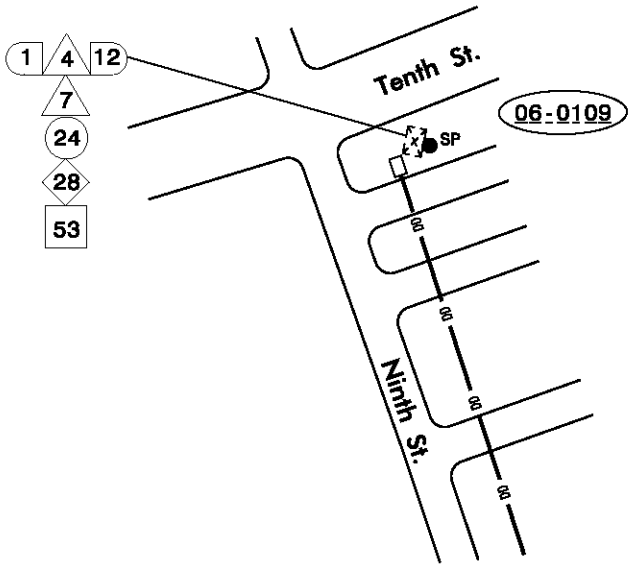


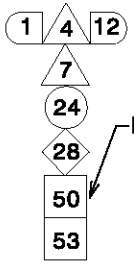


NOTE:If this is the master controller, add construction note #50.

Case 4

Fiber routed from a junction box to a pole mounted signal cabinet at the end of a run (underground installation - no riser required)





NOTE:If this is the master controller, add construction note #50.

Construction Notes for Signal Cabinets and Risers

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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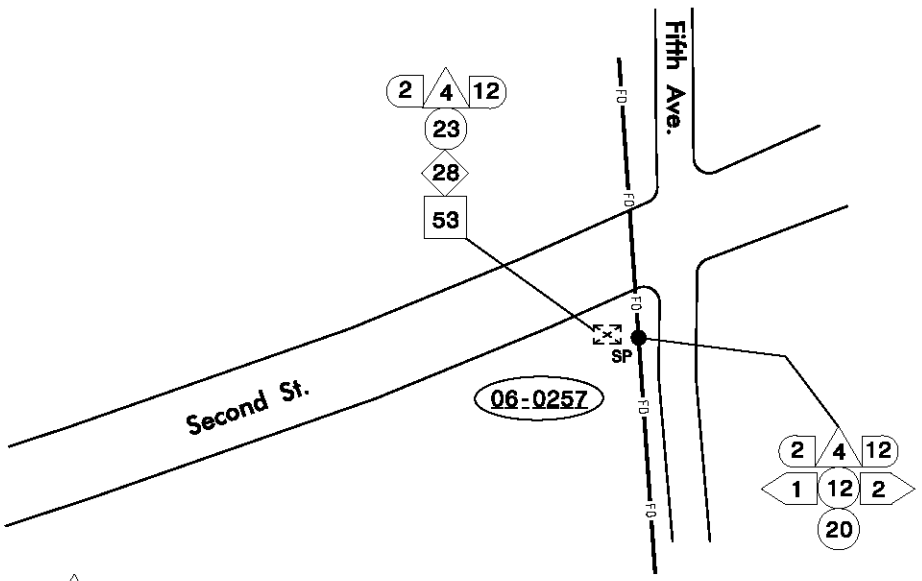
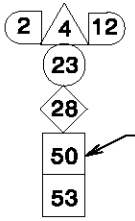
STD. NO.
4.2
SHEET 2 OF 4

Case 5

Fiber routed from a pole riser to a base mounted signal cabinet and back up through riser to continue to next location

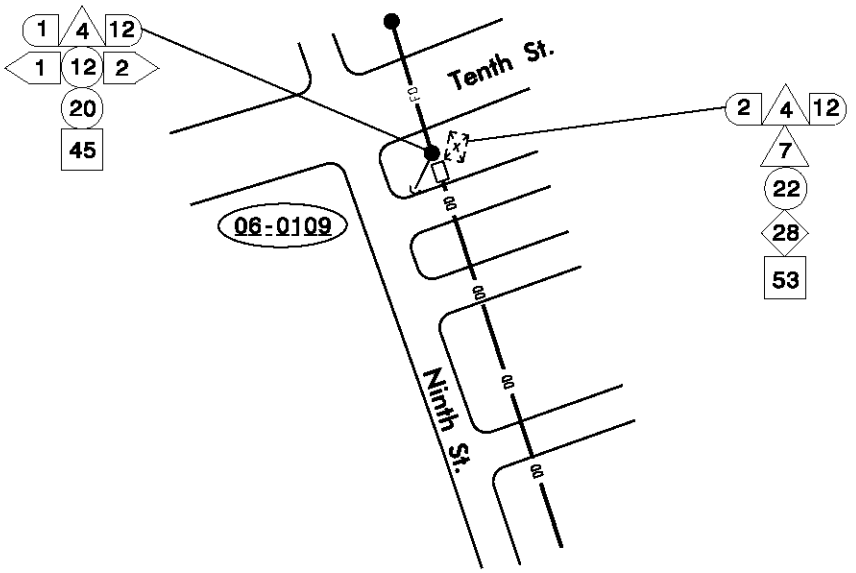


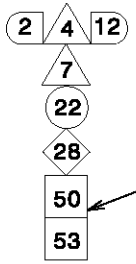


NOTE: If this is the master controller, add construction note #50.

CASE 6

Fiber routed from a junction box to a base mounted signal cabinet then up the pole riser to continue to next location (transition from underground to aerial - riser and guy required)





NOTE: If this is the master controller, add construction note #50.

Construction Notes for Signal Cabinets and Risers

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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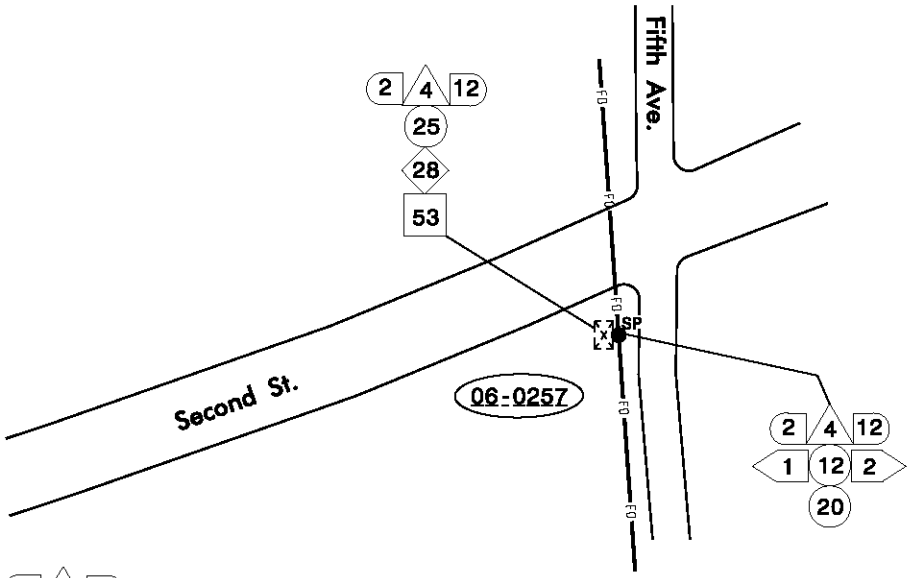
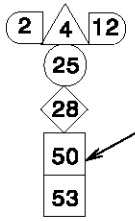
STD. NO.
4.2
SHEET 3 OF 4

Case 7

Fiber routed from a pole riser to a pole mounted signal cabinet and back up through riser to continue to next location

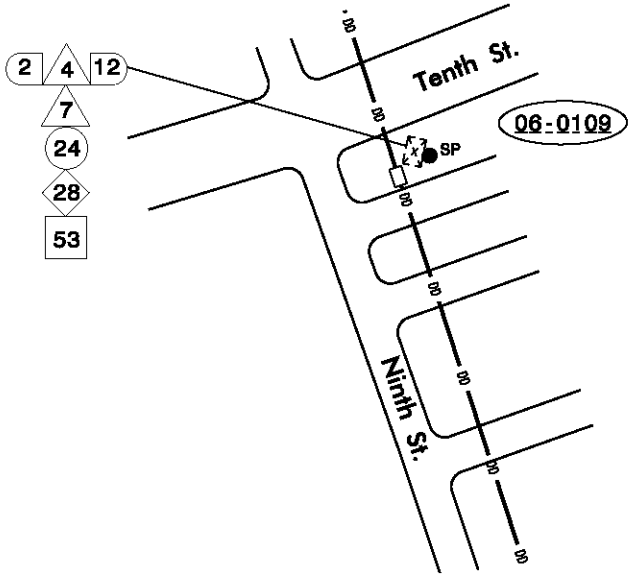


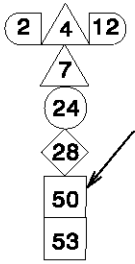


NOTE:If this is the master controller, add construction note #50.

Case 8

Fiber routed from a junction box to a base mounted signal cabinet and back to the junction to continue to next location (underground installation - no riser required)





NOTE:If this is the master controller, add construction note #50.

Construction Notes for Signal Cabinets

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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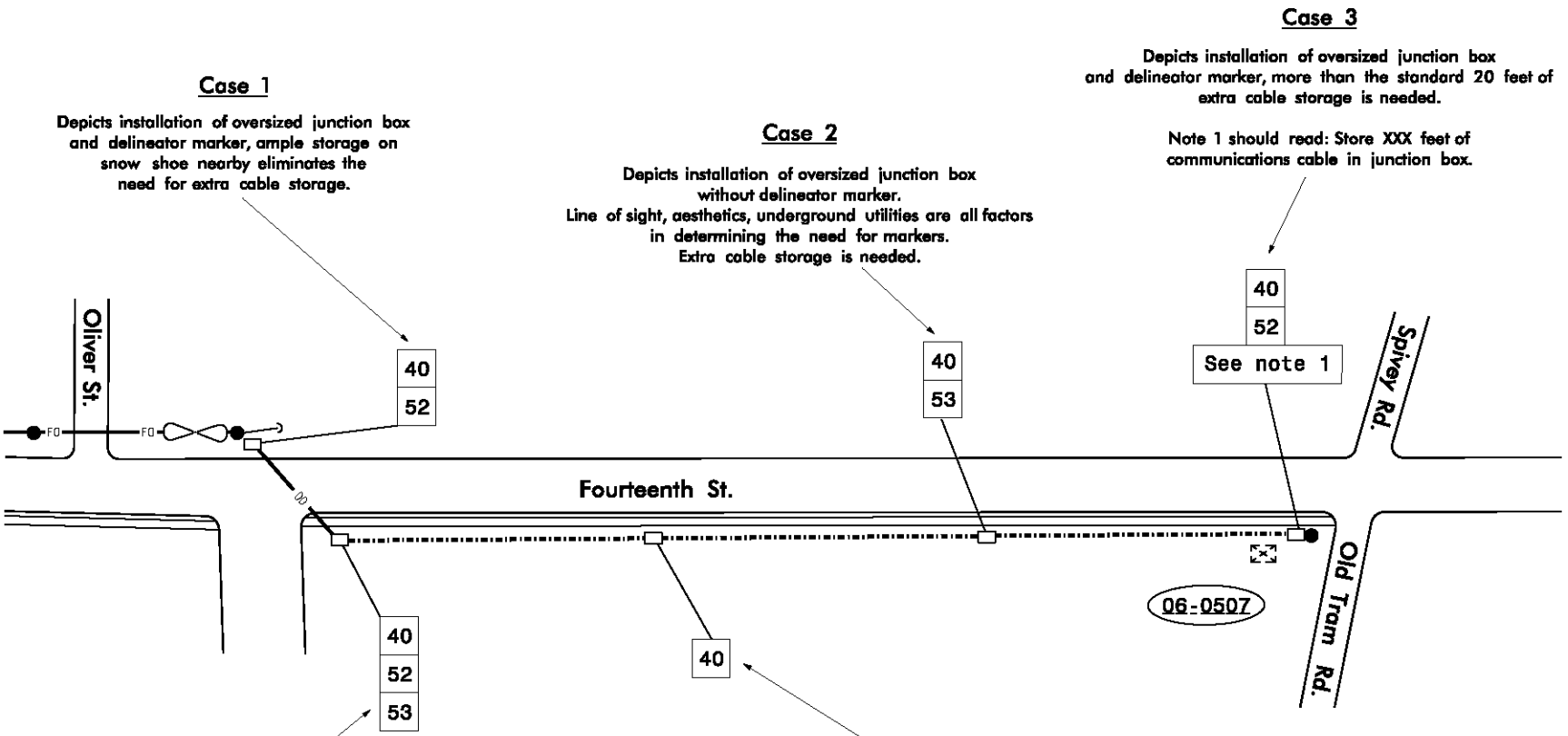

Note: Distance between junction boxes may vary.

Construction Notes for Oversized Junction Box

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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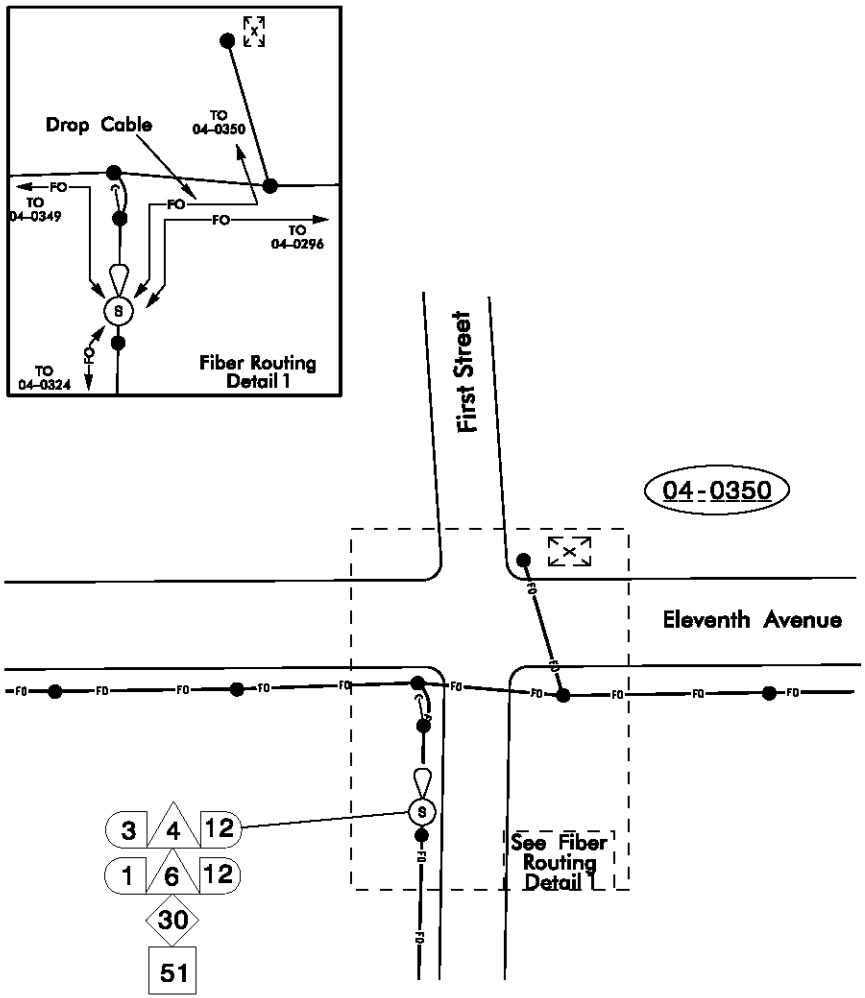
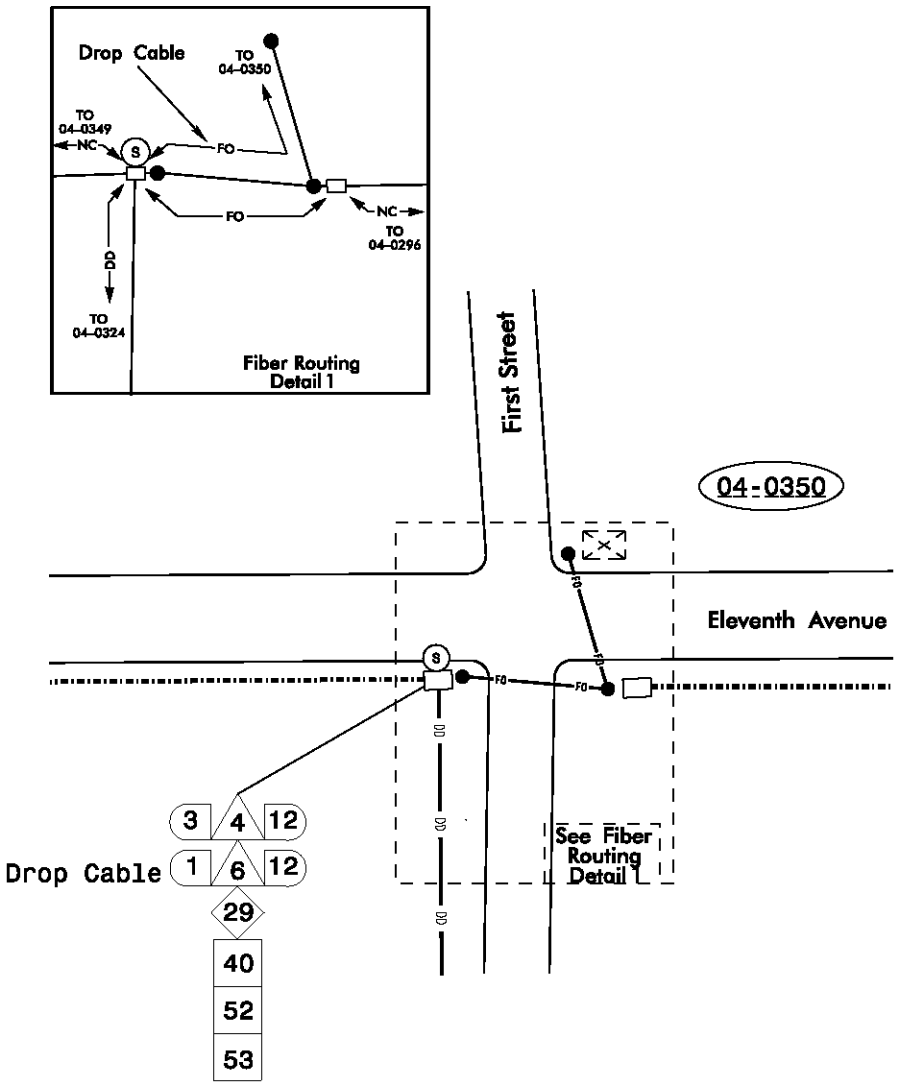
4.3
SHEET 1 OF 1





Fiber Routing Detail Drawing for Splice Enclosures

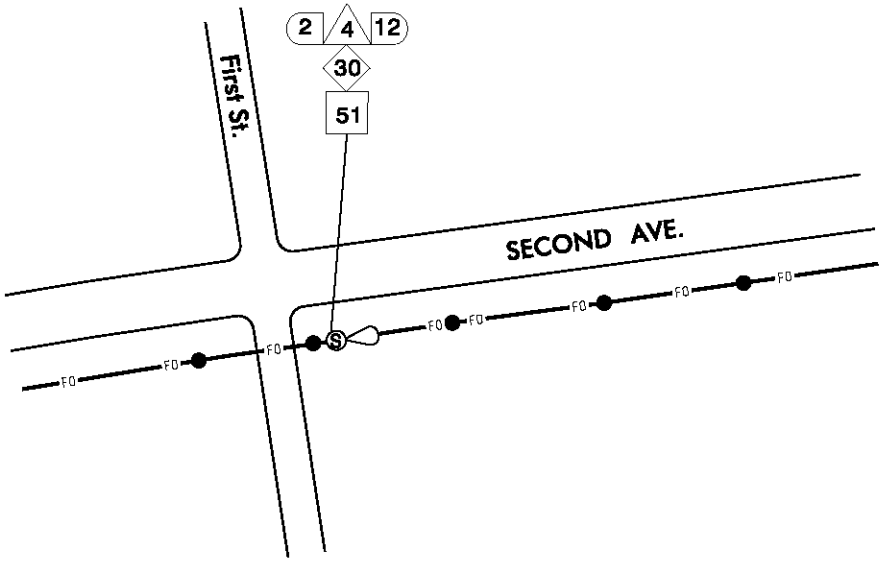
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.4
SHEET 1 OF 4

Case 1

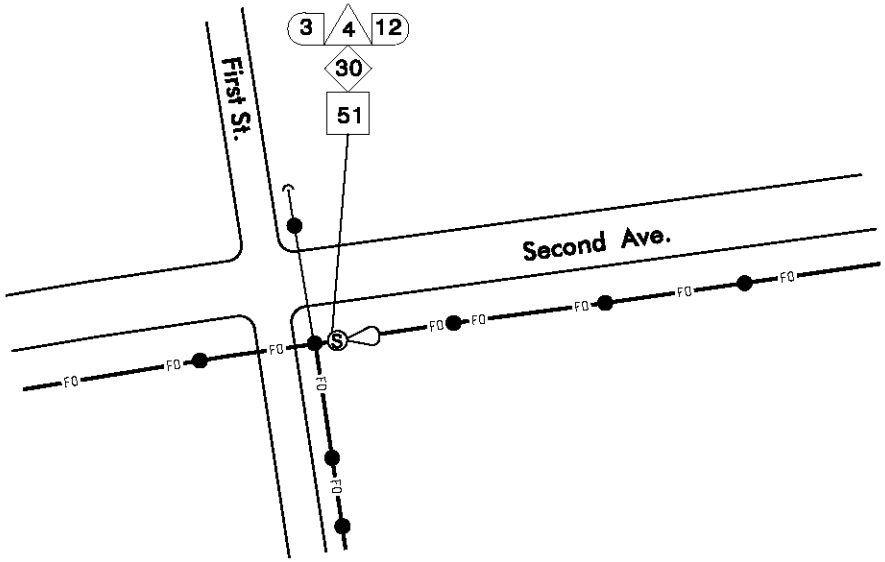
Cable routed to an aerial splice enclosure
with one cable in and one cable out



NOTE: In this case, the splice enclosure would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.

Case 2

Cable routed to an aerial splice enclosure
with one cable in and two cables out



Construction Notes for Splice Enclosures

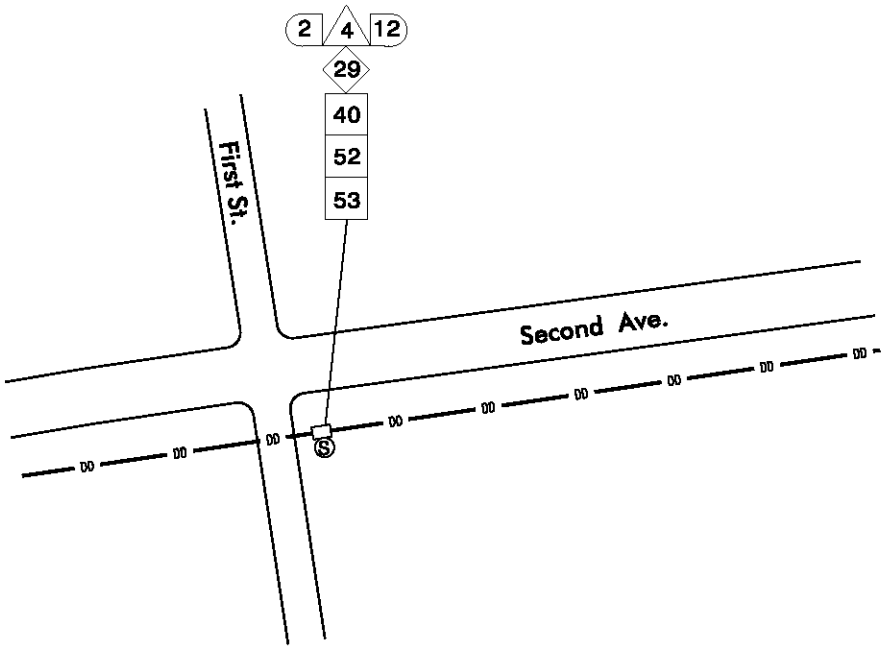
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.4
SHEET 2 OF 4

Case 3

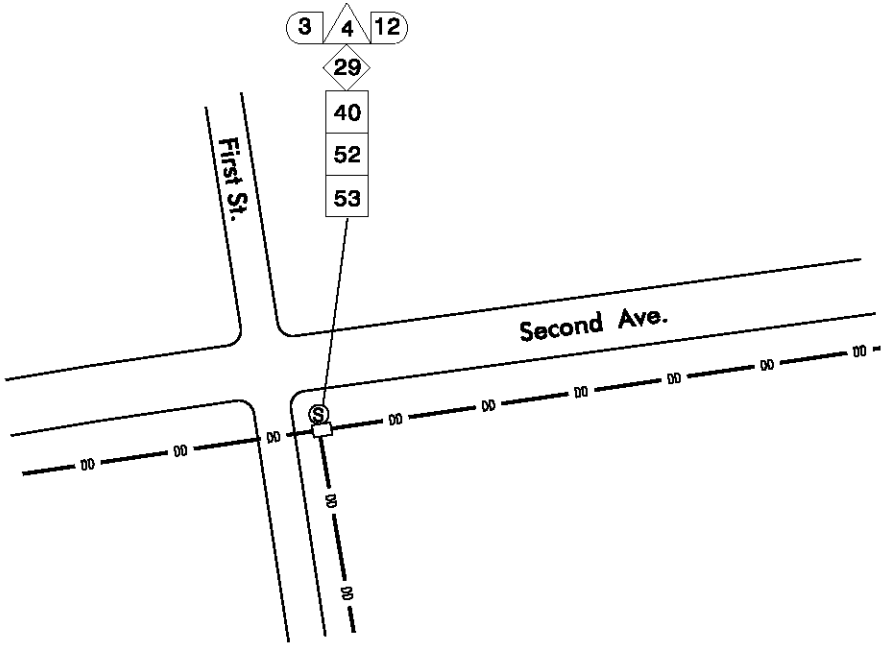
Cable routed to an underground splice enclosure
with one cable in and one cable out



NOTE: In this case, the splice enclosure would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the junction box.

Case 4

Cable routed to an underground splice enclosure
with one cable in and two cables out



Construction Notes for Splice Enclosures

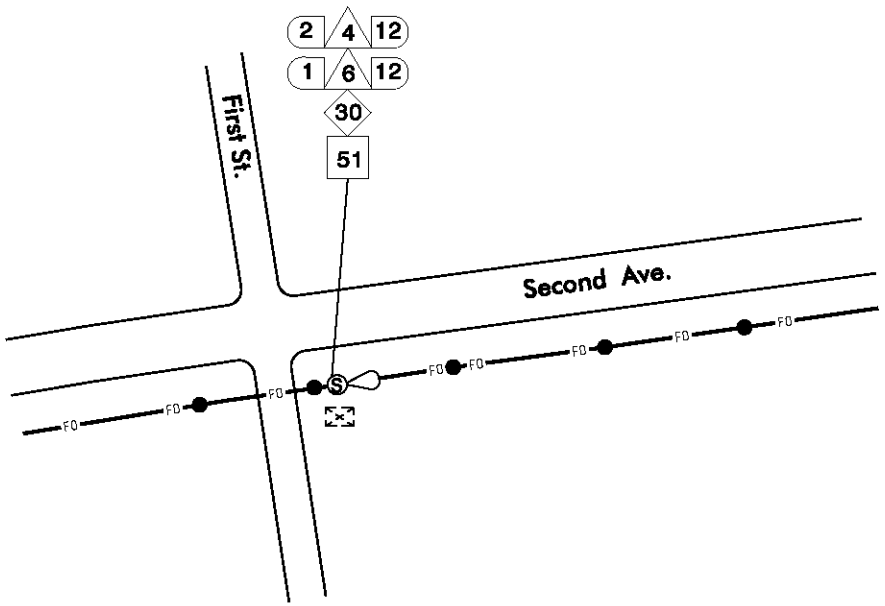
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.4
SHEET 3 OF 4

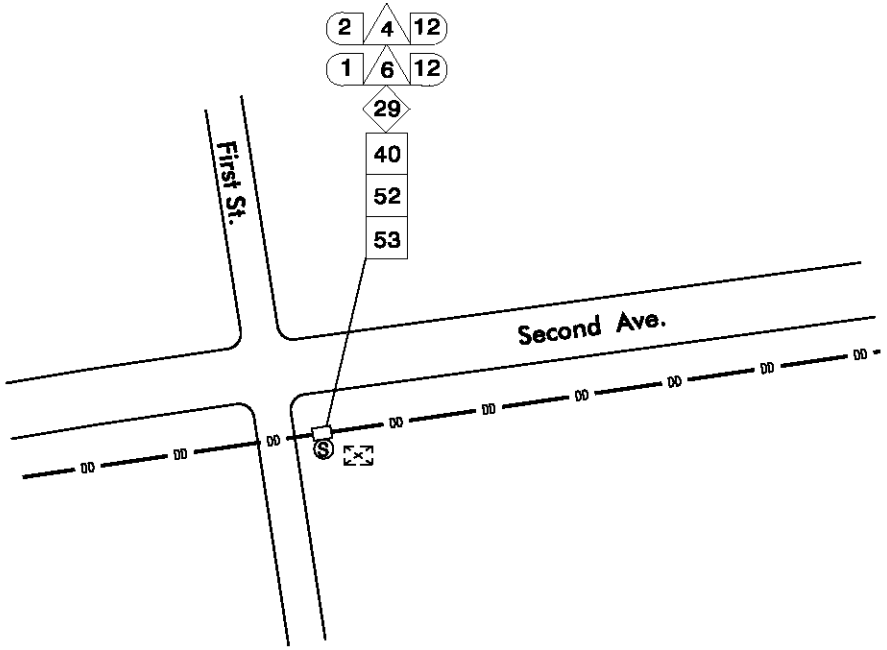
Case 5

Cable routed to an aerial splice enclosure
with one trunk cable in, one trunk cable out
and a drop cable routed to a cabinet



Case 6

Cable routed to an underground splice enclosure
with one trunk cable in, one trunk cable out
and a drop cable routed to a cabinet

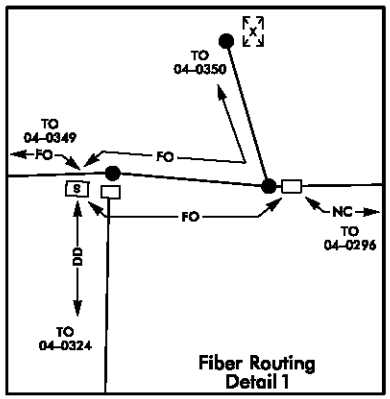


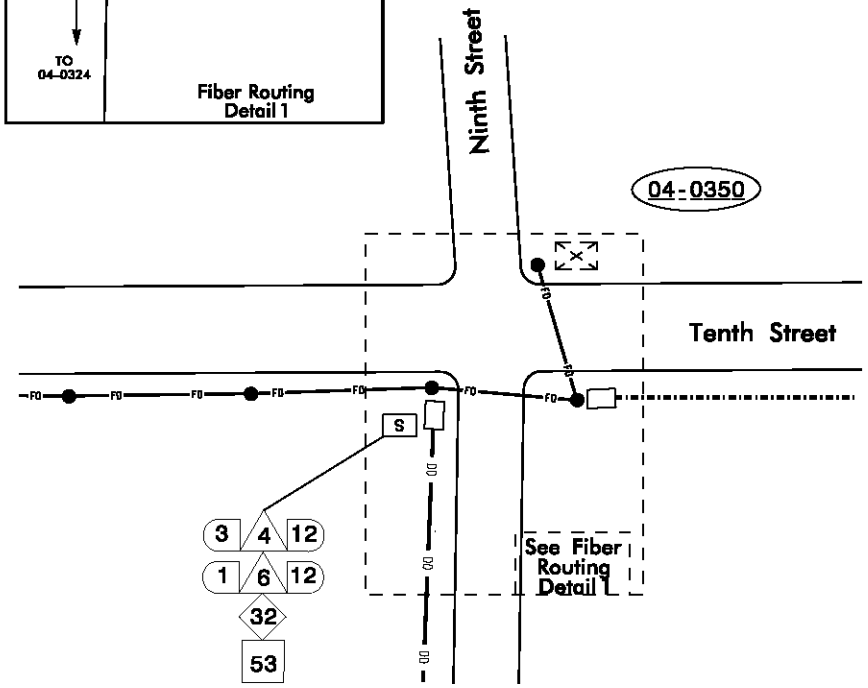
Construction Notes for Splice Enclosures

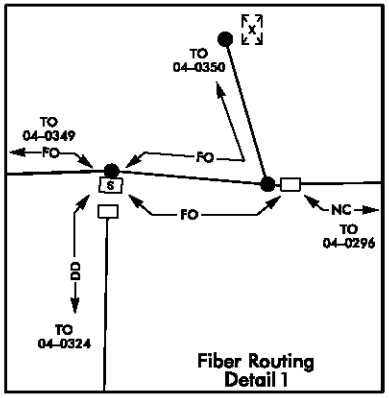
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

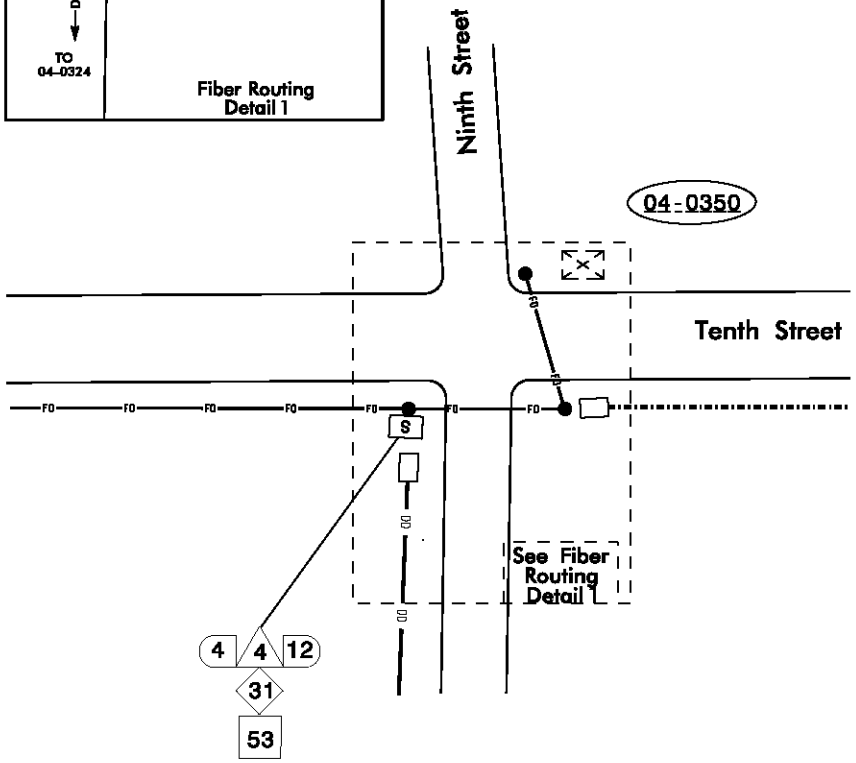
7-04

STD. NO.
4.4
SHEET 4 OF 4









Fiber Routing Detail Drawing for Splice Cabinets

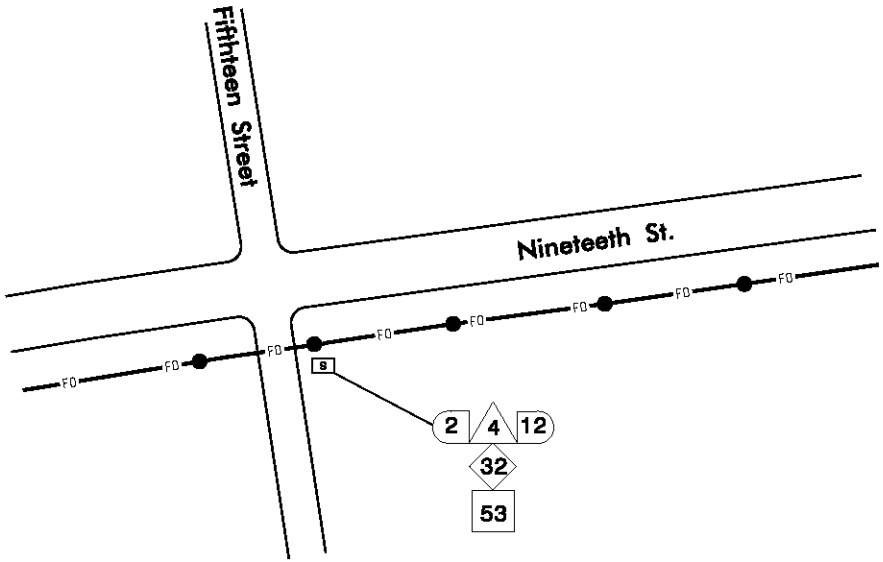
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.5
SHEET 1 OF 5

Case 1

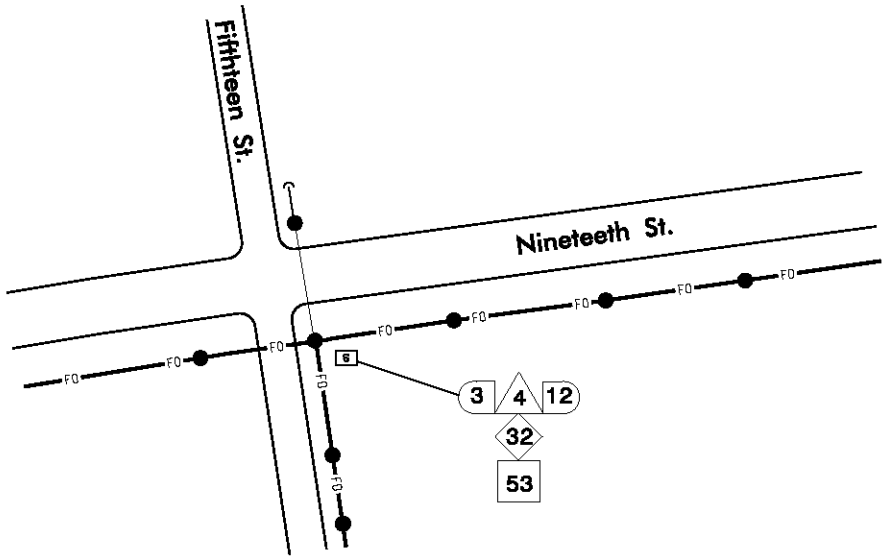
Aerial cable run routed through a riser
to a base mounted splice cabinet
with one in and one cable out



NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.

Case 2

Aerial cable run routed through a riser
to a base mounted splice cabinet
with one cable in and two cables out



Construction Notes for Splice Cabinets

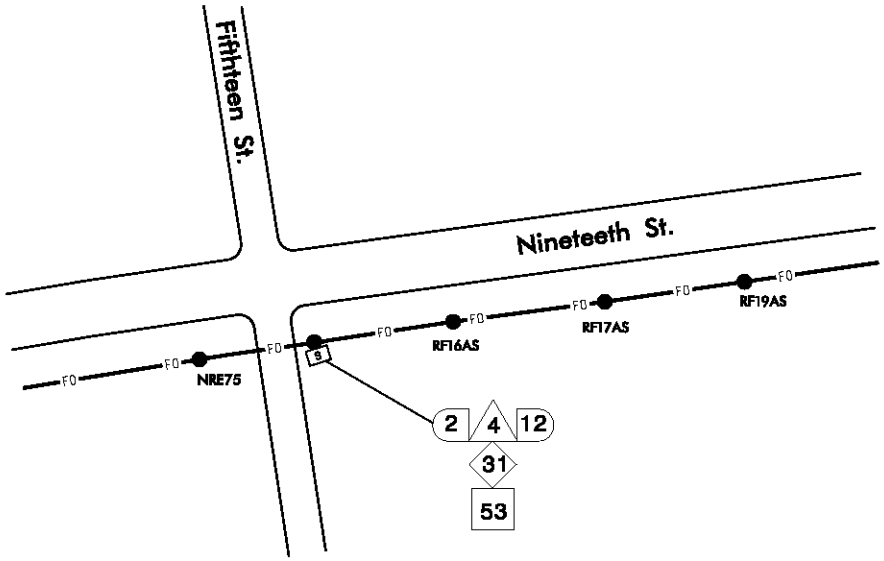
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.5
SHEET 2 OF 5

Case 3

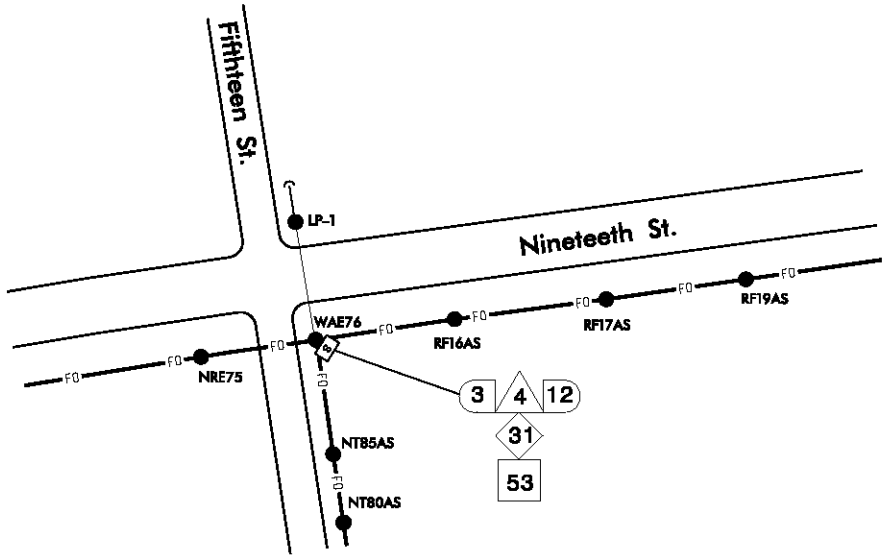
Aerial cable run routed through a riser
to a pole mounted splice cabinet
with one cable in and one cable out



NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the pole.

Case 4

AERIAL CABLE RUN ROUTED THROUGH A RISER
TO A POLE MOUNTED SPLICE CABINET
WITH ONE CABLE IN AND TWO CABLES OUT



Construction Notes for Splice Cabinets

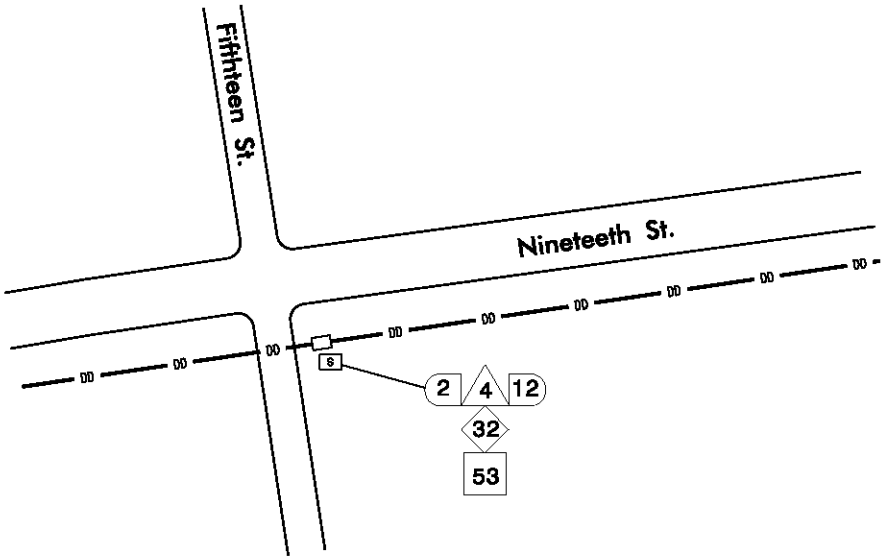
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.5
SHEET 3 OF 5

Case 5

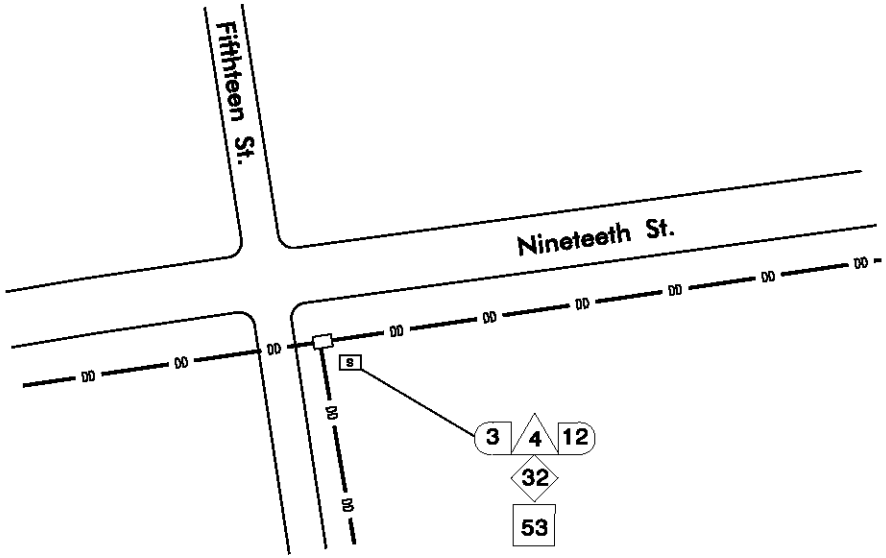
Underground cable run routed through a junction box
to a base mounted splice cabinet
with one cable in and one cable out



NOTE: In this case, the splice cabinet would be for a future traffic signal, camera, or dynamic message sign. This is also the method used for tying into an existing cable left terminated at the junction box.

Case 6

Underground cable run through a junction box
to a base mounted splice cabinet
with one cable in and two cables out



Construction Notes for Splice Cabinets

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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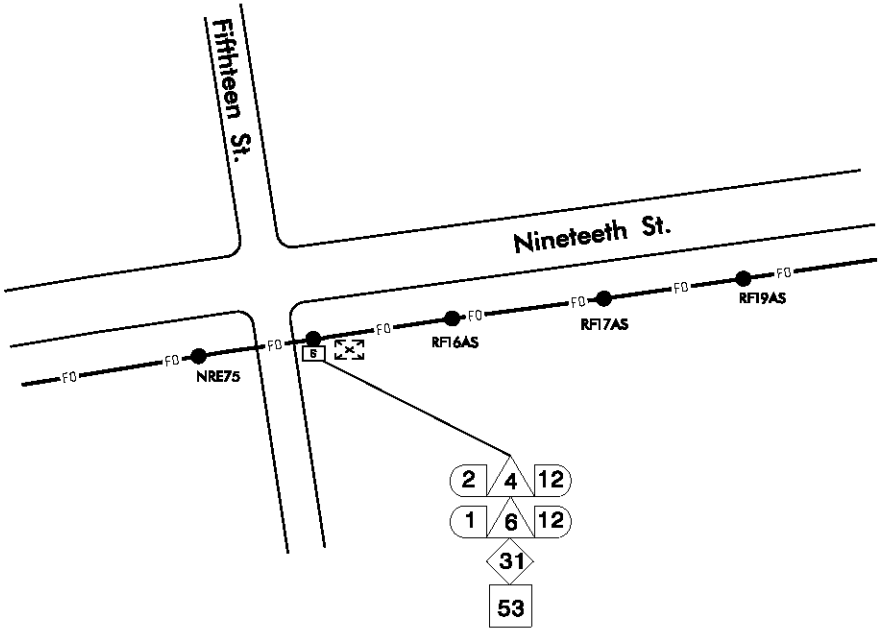
STD. NO.
4.5
SHEET 4 OF 5

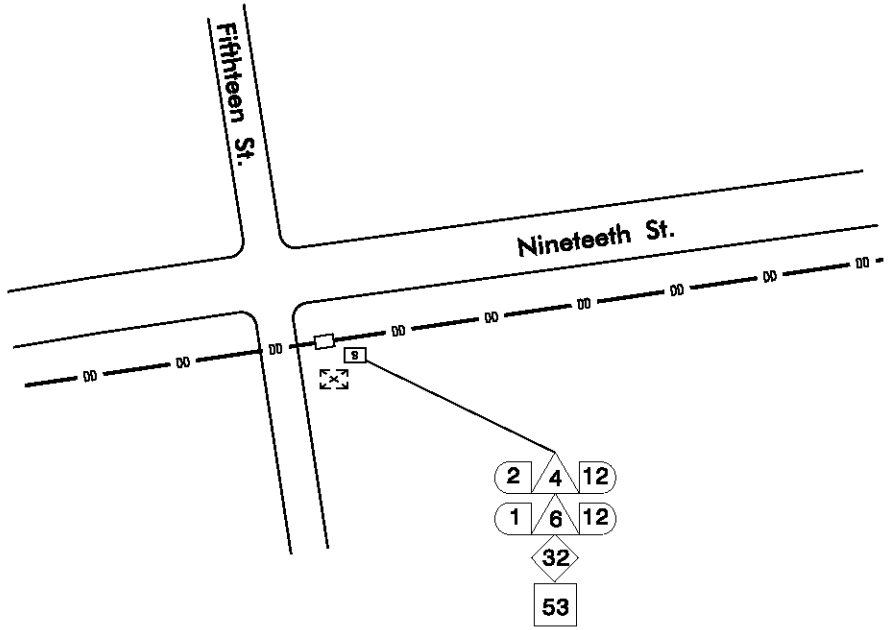
Case 7

Cable routed to a pole splice cabinet
with one trunk cable in, one trunk cable out
and a drop cable routed to a cabinet



Case 8

Cable routed to a base mounted splice cabinet
with one trunk cable in, one trunk cable out
and a drop cable routed to a cabinet



Construction Notes for Splice Cabinets

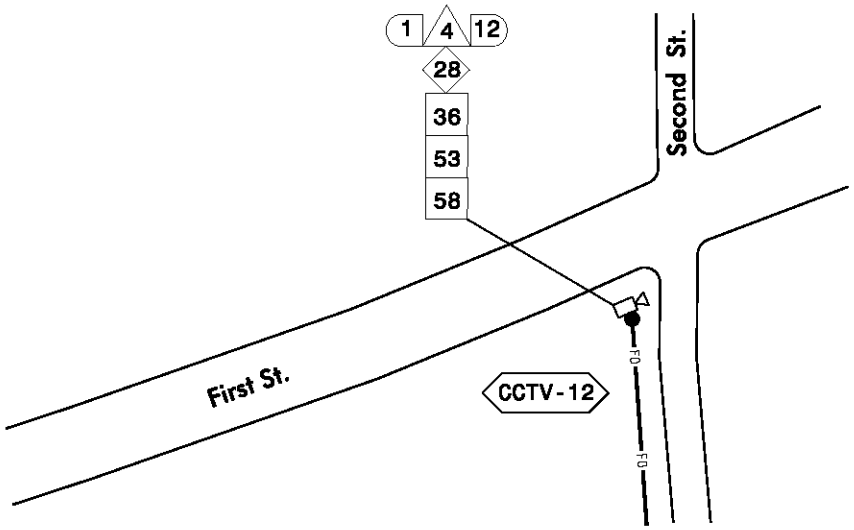
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
4.5
SHEET 5 OF 5

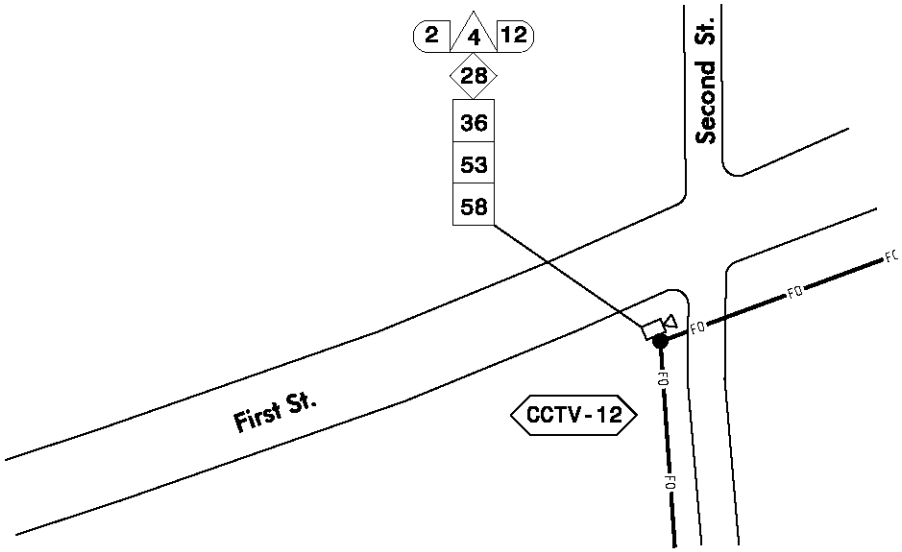
Case 1

CCTV assembly mounted on an existing pole
at the end of a run



Case 2

CCTV assembly on an existing pole
in the middle of a run



Construction Notes for CCTV Camera Assemblies

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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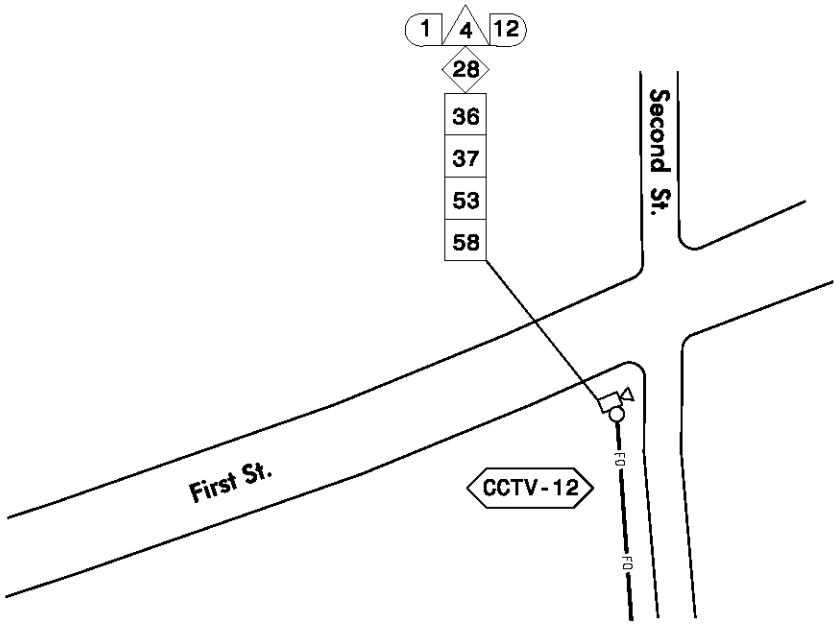
5.0
SHEET 1 OF 3

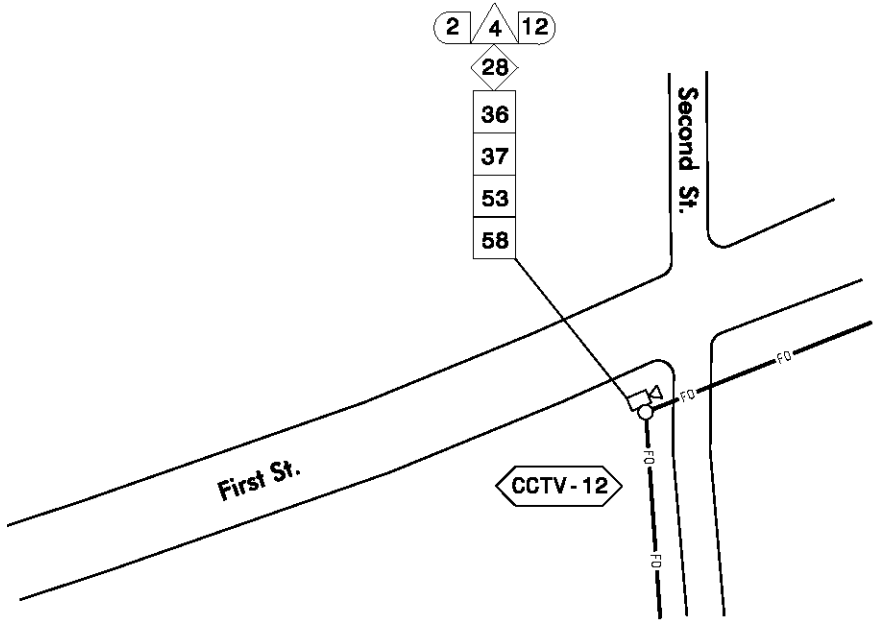
Case 3

CCTV assembly mounted on a new wood pole
at the end of a run



Case 4

CCTV assembly mounted on a new wood pole
in the middle of a run



Construction Notes for CCTV Camera Assemblies

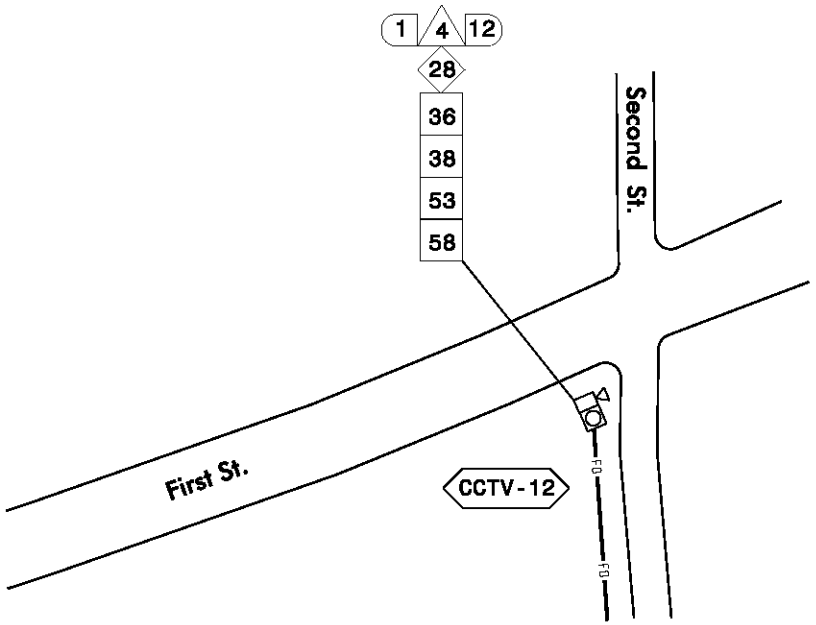
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
5.0

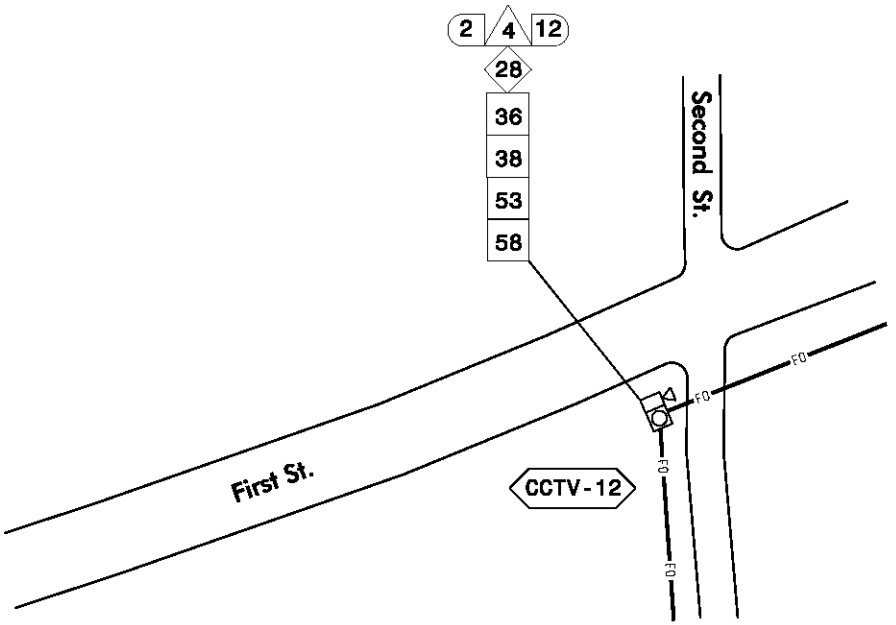
Case 5

CCTV assembly mounted on a new metal pole
at the end of a run



Case 6

CCTV assembly mounted on a new metal pole
in the middle of a run



Construction Notes for CCTV Camera Assemblies

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO.
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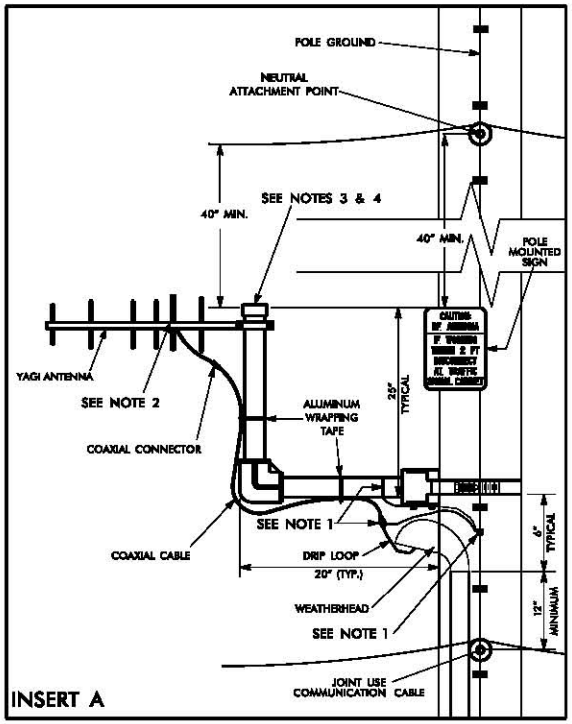
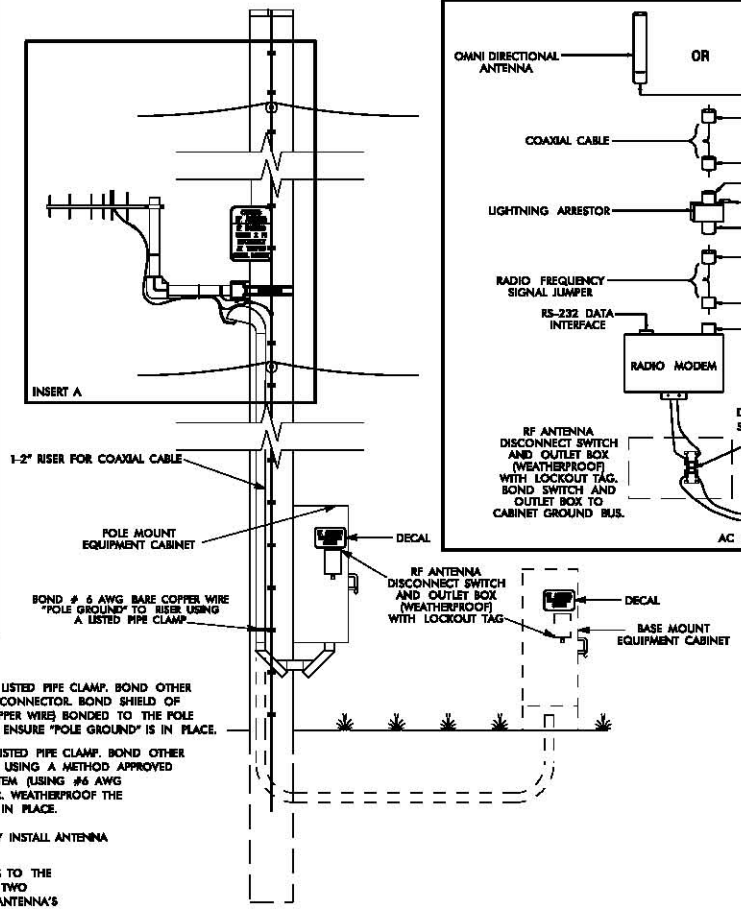
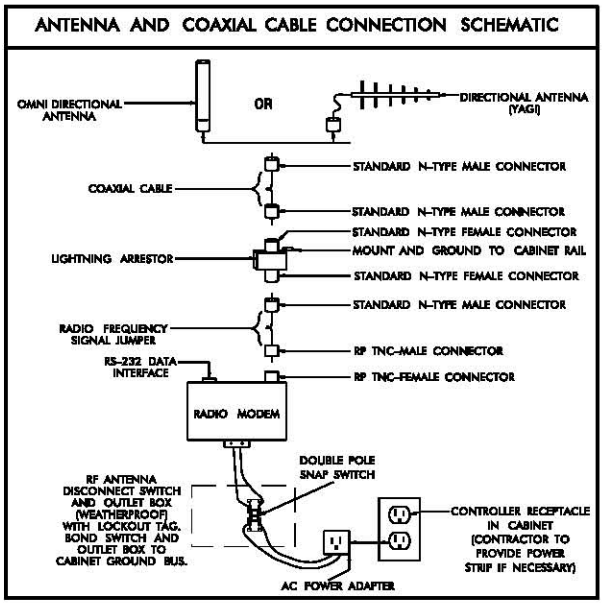
SHEET 3 OF 3







NOTES

1. WOOD POLE — BOND # 6 AWG SOLID BARE COPPER WIRE TO ANTENNA SUPPORT USING LISTED PIPE CLAMP. BOND OTHER END OF # 6 AWG SOLID BARE COPPER WIRE TO THE POLE GROUND USING A SPLIT BOLT CONNECTOR. BOND SHIELD OF COAXIAL CABLE WITH AN APPROVED GROUNDING SYSTEM (USING #6 AWG STRANDED COPPER WIRE) BONDED TO THE POLE GROUND. WEATHERPROOF THE CONNECTION ONCE THE GROUNDING SYSTEM IS INSTALLED. ENSURE "POLE GROUND" IS IN PLACE.

   METAL POLE — BOND # 6 AWG SOLID BARE COPPER WIRE TO ANTENNA SUPPORT USING LISTED PIPE CLAMP. BOND OTHER END OF # 6 AWG SOLID BARE COPPER WIRE TO THE POLE OR EXISTING SYSTEM GROUND USING A METHOD APPROVED BY THE ENGINEER. BOND SHIELD OF COAXIAL CABLE WITH AN APPROVED GROUNDING SYSTEM (USING #6 AWG STRANDED COPPER WIRE) BONDED TO THE POLE BY A METHOD APPROVED BY THE ENGINEER. WEATHERPROOF THE CONNECTION ONCE THE GROUNDING SYSTEM IS INSTALLED. ENSURE "SYSTEM GROUND" IS IN PLACE.

2. YAGI ANTENNA SHOWN IN VERTICAL POLARIZATION POSITION FOR CLARIFICATION. TYPICALLY INSTALL ANTENNA IN HORIZONTAL POLARIZATION POSITION.

3. TO CONSERVE VERTICAL SPACING ON THE POLE (JOINT-USE OR SIGNAL POLE) WITH REGARDS TO THE SURROUNDING UTILITIES, INSTALL THE ANTENNA MOUNTING HARDWARE USING ONE OF THE TWO METHODS LISTED BELOW: (ENSURE THAT THE MOUNTING METHOD DOES NOT DEGRADE THE ANTENNA'S SIGNAL INTEGRITY)
   A) ROTATE THE VERTICAL SUPPORT ARM 90 DEGREES SUCH THAT THE ANTENNA IS AT THE SAME HEIGHT AS THE HORIZONTAL SUPPORT ARM.
   B) ELIMINATE THE VERTICAL SUPPORT ARM AND MOUNT THE ANTENNA TO THE HORIZONTAL SUPPORT ARM.
   C) ANTENNA, ANTENNA SUPPORT ARM, AND SIGN TO MAINTAIN A 40" SEPARATION FROM NEUTRAL/POWER AND 12" FROM OTHER UTILITIES.

4. INSTALL AN END CAP TO SEAL THE EXPOSED END OF THE MOUNTING PIPE.

Wireless Communications – Typical Detail

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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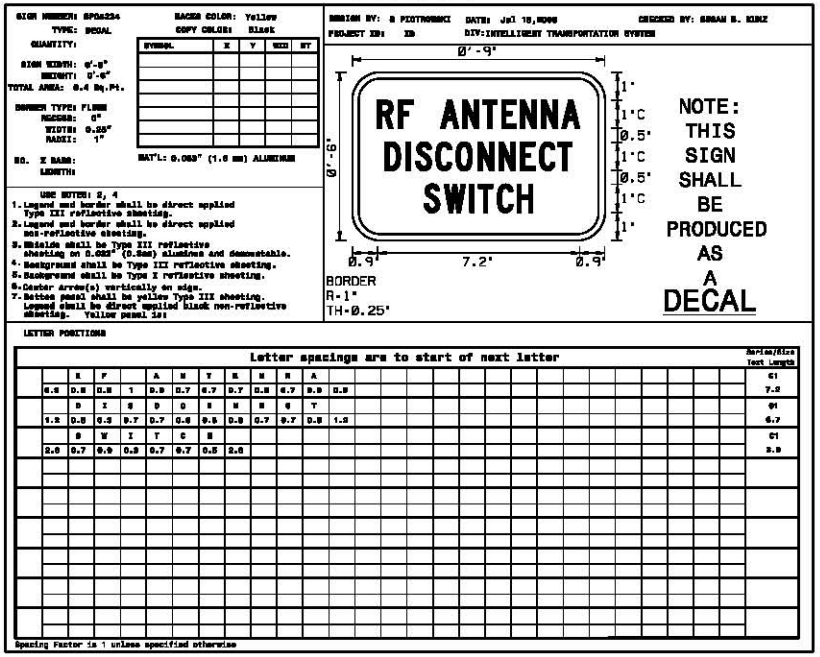
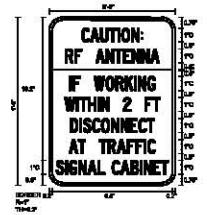
DECAL



POLE MOUNTED SIGN



0.60 SPACING FACTOR

Wireless Communications – Typical Detail

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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STD. NO.
6.0

LEGEND

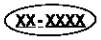

YAGI ANTENNA (DOUBLE) FOR REPEATER OPERATION


YAGI ANTENNA (SINGLE)

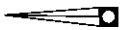

OMNI ANTENNA


EXISTING CONTROLLER AND CABINET


EXISTING MASTER CONTROLLER AND CABINET



SIGNAL INVENTORY NUMBER


EXISTING METAL POLE W/MAST ARM


EXISTING WOOD POLE


NEW METAL POLE

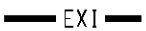
SP
SIGNAL POLE


EXISTING METAL POLE


NEW OVERSIZED JUNCTION BOX


EXISTING OVERSIZED JUNCTION BOX

EXISTING CONDUIT



EXISTING COMMUNICATIONS CABLE

NOTES FOR WIRELESS COMMUNICATIONS:

1. INSTALL COAXIAL CABLE:
   - A. ON WOOD POLES, REQUIRING A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   - B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM; FIELD DRILL A 1/2" HOLE UP THROUGH THE BOTTOM OF MAST ARM FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
   - C. ON METAL STRAIN POLES, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   - D. BETWEEN THE POINT OF EXITING THE RISER, METAL POLE OR MAST ARM AND THE ANTENNA, SECURE THE COAXIAL CABLE TO THE STRUCTURE USING 3/4" STAINLESS STEEL STRAPS EVERY 12".
2. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.
3. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN.
   (NOTE: RF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT–OWNED POLE.)
4. MAINTAIN PROPER CLEARANCE FROM ALL UTILITIES PER THE NATIONAL ELECTRICAL SAFETY CODE.
5. INSTALL WIRELESS SERIAL RADIO MODEM WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET.
   (NOTE: RF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT–OWNED POLE.)
6. REFERENCE "WIRELESS RADIO ANTENNA TYPICAL DETAILS."

Wireless Communications – Typical Plan Sheet Notes & Legend

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

8-12

STD. NO.
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WIRELESS – STANDARD CONSTRUCTION NOTES

YAGI VERTICALLY POLARIZED

INSTALL 8.5 DB GAIN YAGI ANTENNA VERTICALLY POLARIZED

INSTALL 13 DB GAIN YAGI ANTENNA VERTICALLY POLARIZED

YAGI HORIZONTALLY POLARIZED

INSTALL 8.5 DB GAIN YAGI ANTENNA HORIZONTALLY POLARIZED

INSTALL 13 DB GAIN YAGI ANTENNA HORIZONTALLY POLARIZED

OMNI VERTICALLY POLARIZED

INSTALL 3 DB GAIN OMNI ANTENNA VERTICALLY POLARIZED

INSTALL 6 DB GAIN OMNI ANTENNA VERTICALLY POLARIZED

ATTACHMENT NOTES

ATTACH ANTENNA 12" ABOVE SIGNAL CABLE

ATTACH ANTENNA 6" ABOVE SIGNAL CABLE

ATTACH ANTENNA 12" ABOVE SIGNAL CABLE WEATHERHEAD

ATTACH ANTENNA 6" ABOVE SIGNAL CABLE WEATHERHEAD

ATTACH ANTENNA 12" BELOW SIGNAL CABLE

ATTACH ANTENNA 6" BELOW SIGNAL CABLE

ATTACH ANTENNA 12" BELOW SIGNAL CABLE WEATHERHEAD

ATTACH ANTENNA 6" BELOW SIGNAL CABLE WEATHERHEAD

ATTACH ANTENNA 40" BELOW POWER

ATTACH ANTENNA ALONG MAST ARM A MINIMUM OF 6 FEET AWAY FROM THE VERTICAL SHAFT MEMBER

NOTE: ATTACHMENT NOTES FOR THE ANTENNA CAN ALSO BE CHANGED TO REFERENCE OTHER UTILITIES (I.E., PHONE, CABLE, ETC.)
NOTE: FOR UNDERGROUND CONDUIT INSTALLATIONS INCLUDE THE FOLLOWING NOTE — "PROVIDE COAXIAL CABLE SUITABLE FOR WET LOCATIONS"

OTHER COMMONLY USED NOTES

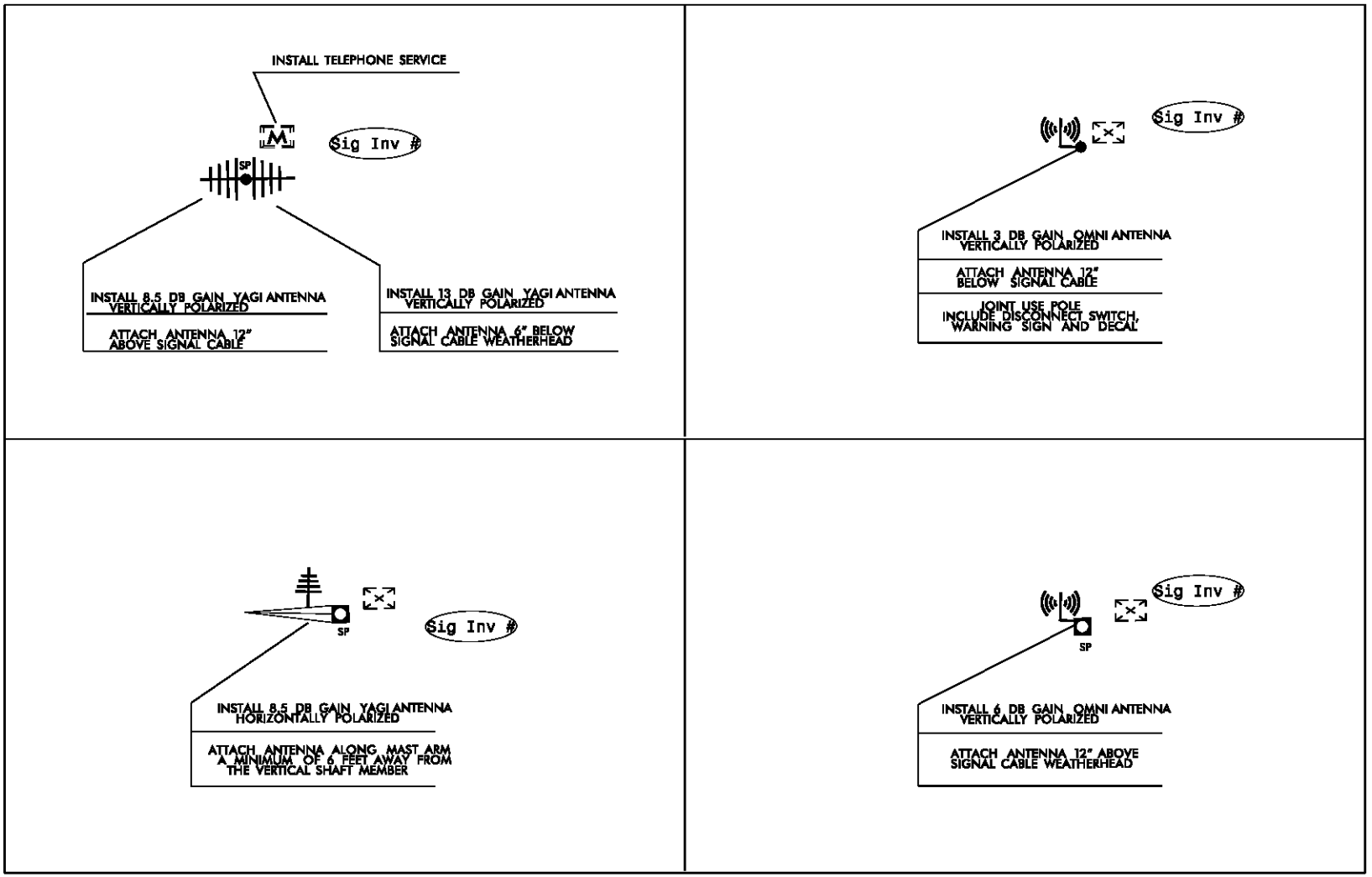
MASTER NOTE

INSTALL TELEPHONE SERVICE

JOINT USE POLE NOTE

JOINT USE POLE
INCLUDE DISCONNECT SWITCH, WARNING SIGN AND DECAL

SAMPLES



Wireless Communications – Sample Intersection with Wireless Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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ANTENNA DESIGN NOTES

OMNI ANTENNAS ARE ALWAYS INSTALLED VERTICALLY POLARIZED.

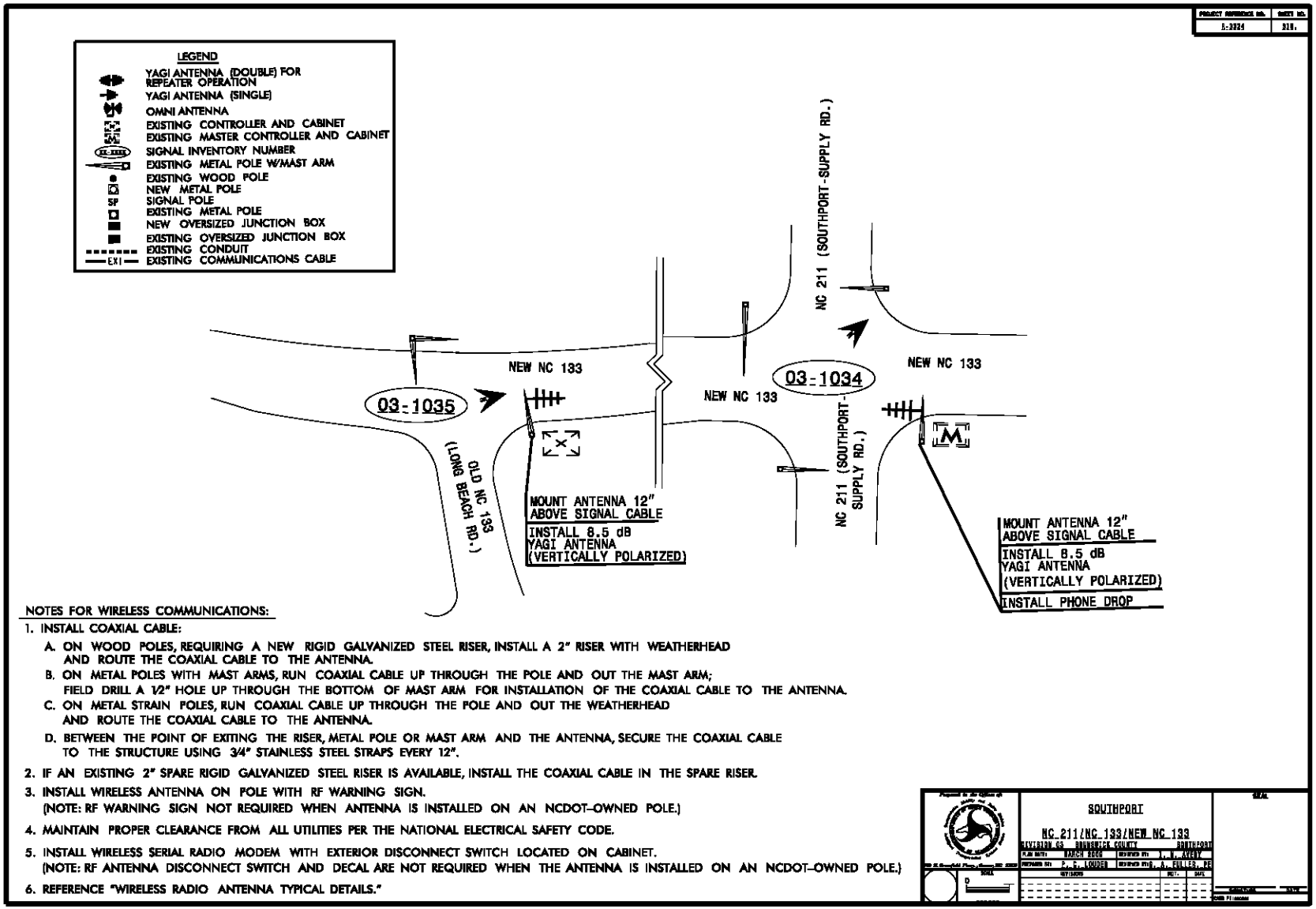
YAGI ANTENNAS CAN BE INSTALLED EITHER VERTICALLY POLARIZED OR HORIZONTALLY POLARIZED.

OMNI ANTENNAS CAN COMMUNICATE WITH BOTH OMNI ANTENNAS AND YAGI ANTENNAS. HOWEVER, IF COMMUNICATIONS IS DESIRED BETWEEN AN OMNI ANTENNA AND A YAGI ANTENNA, THEN THE YAGI ANTENNA MUST BE INSTALLED IN THE VERTICALLY POLARIZED POSITION.

YAGI ANTENNAS INSTALLED IN THE VERTICALLY POLARIZED POSITION CAN ONLY COMMUNICATE WITH OTHER YAGI ANTENNAS THAT ARE ALSO VERTICALLY POLARIZED.

YAGI ANTENNAS INSTALLED IN THE HORIZONTALLY POLARIZED POSITION CAN ONLY COMMUNICATE WITH OTHER YAGI ANTENNAS THAT ARE ALSO HORIZONTALLY POLARIZED.

WHEN DEALING WITH A DUAL ANTENNA DESIGN (REPEATING OPERATION) THE ANTENNAS CAN BOTH BE INSTALLED HORIZONTALLY POLARIZED OR VERTICALLY POLARIZED. ADDITIONALLY, ONE ANTENNA CAN BE INSTALLED HORIZONTALLY POLARIZED AND THE SECOND ANTENNA CAN BE INSTALLED VERTICALLY POLARIZED.



NOTES FOR WIRELESS COMMUNICATIONS:

1. INSTALL COAXIAL CABLE:
   - A. ON WOOD POLES, REQUIRING A NEW RIGID GALVANIZED STEEL RISER, INSTALL A 2" RISER WITH WEATHERHEAD AND ROUTE THE COAXIAL CABLE TO THE ANTENNA.
   - B. ON METAL POLES WITH MAST ARMS, RUN COAXIAL CABLE UP THROUGH THE POLE AND OUT THE MAST ARM; FIELD DRILL A 1/2" HOLE UP THROUGH THE BOTTOM OF MAST ARM FOR INSTALLATION OF THE COAXIAL CABLE TO THE ANTENNA.
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2. IF AN EXISTING 2" SPARE RIGID GALVANIZED STEEL RISER IS AVAILABLE, INSTALL THE COAXIAL CABLE IN THE SPARE RISER.
3. INSTALL WIRELESS ANTENNA ON POLE WITH RF WARNING SIGN. (NOTE: RF WARNING SIGN NOT REQUIRED WHEN ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)
4. MAINTAIN PROPER CLEARANCE FROM ALL UTILITIES PER THE NATIONAL ELECTRICAL SAFETY CODE.
5. INSTALL WIRELESS SERIAL RADIO MODEM WITH EXTERIOR DISCONNECT SWITCH LOCATED ON CABINET. (NOTE: RF ANTENNA DISCONNECT SWITCH AND DECAL ARE NOT REQUIRED WHEN THE ANTENNA IS INSTALLED ON AN NCDOT-OWNED POLE.)
6. REFERENCE "WIRELESS RADIO ANTENNA TYPICAL DETAILS."

SOUTHPORT
NC 211/NC 133/NEW NC 133
DIVISION 03 BRUNSWICK COUNTY SOUTHPORT

Wireless Communications – Sample Plan – Wireless Communications Plan (Stand Alone)

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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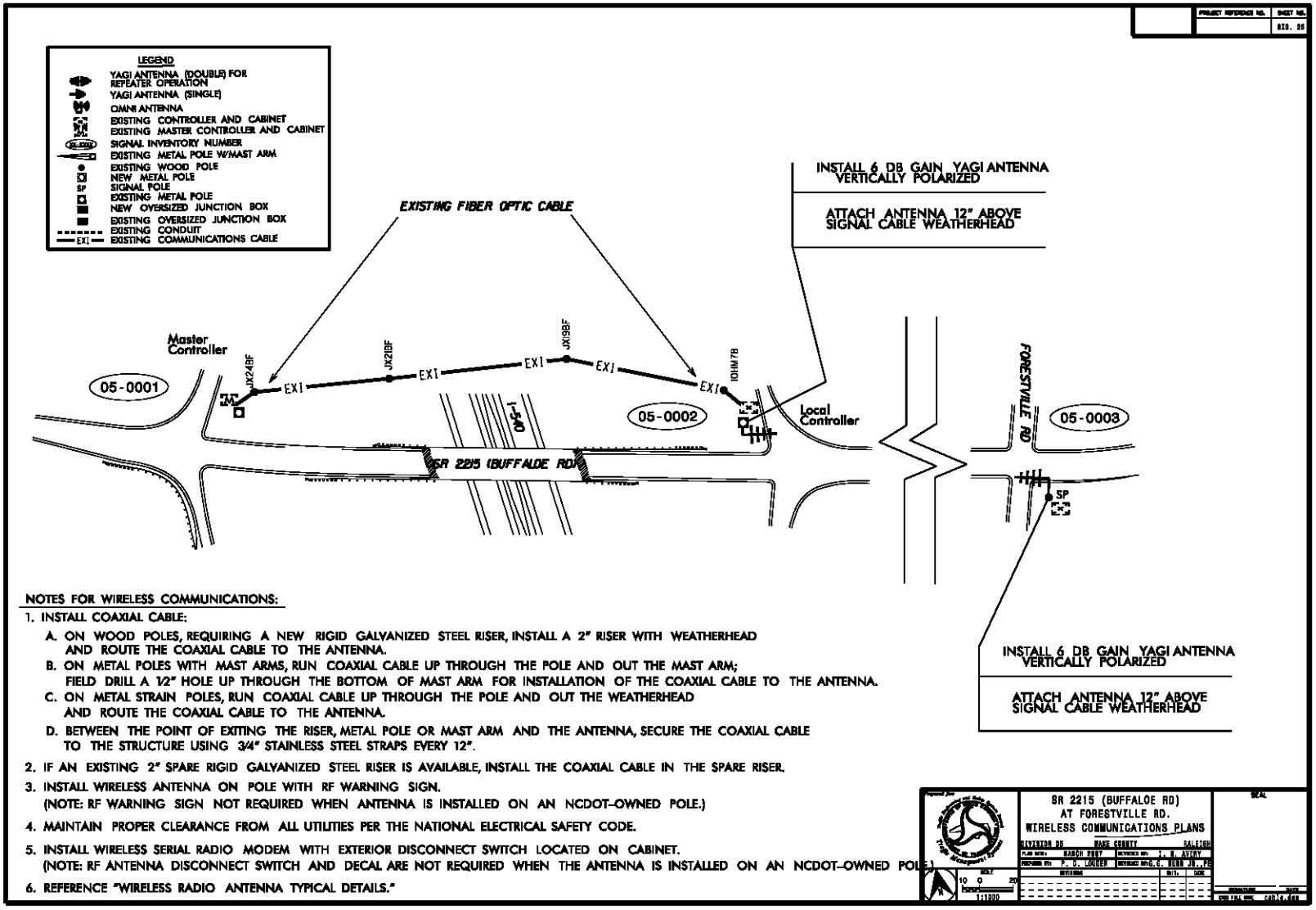

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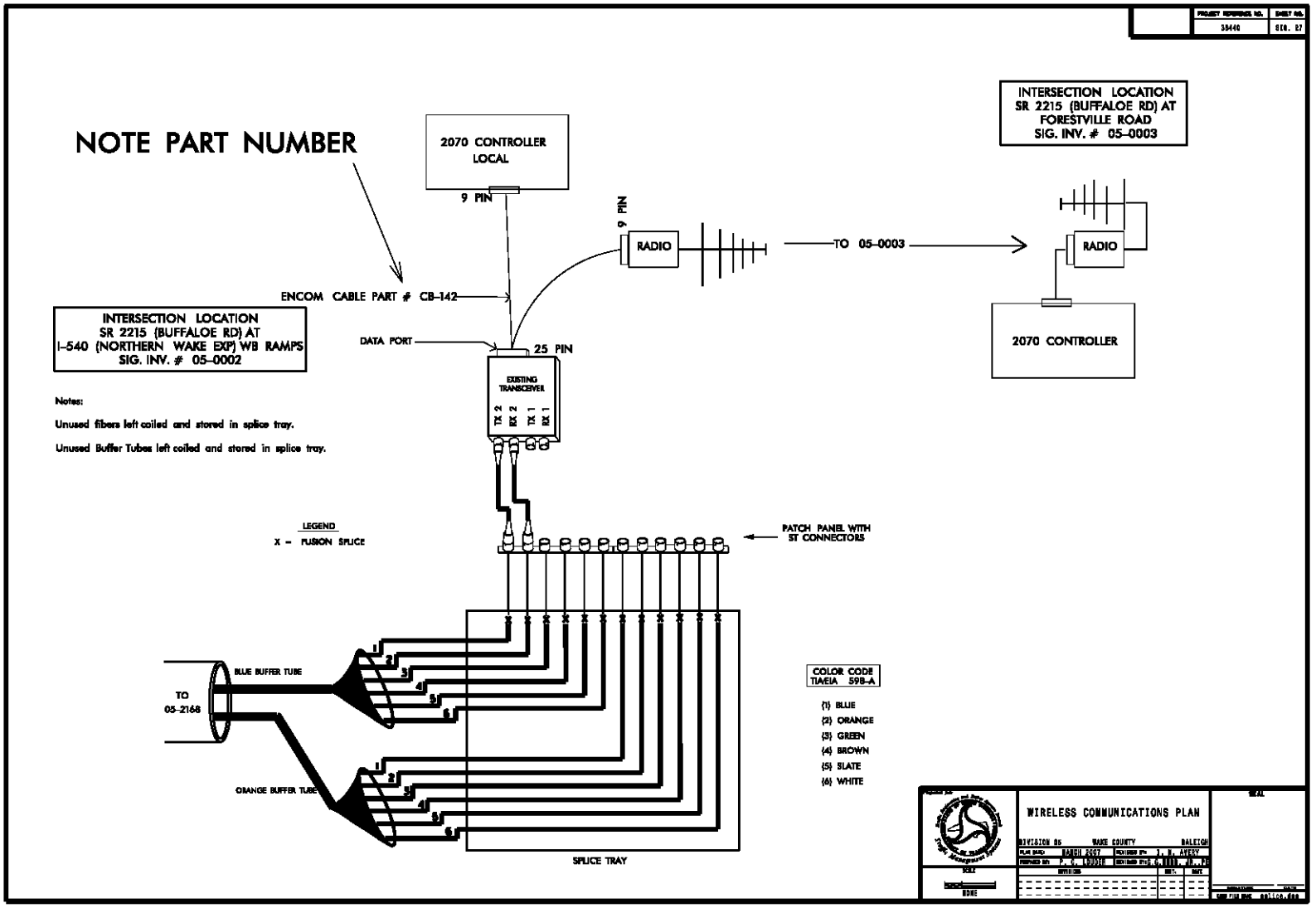
SR 2215 (BUFFALOE RD)
AT FORESTVILLE RD.
WIRELESS COMMUNICATIONS PLANS

Wireless Communications – Sample Plans – Fiber (Local Intersection) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

8-12

STD. NO. 6.5



Wireless Communications – Sample Plans – Fiber Splicing (Local Intersction) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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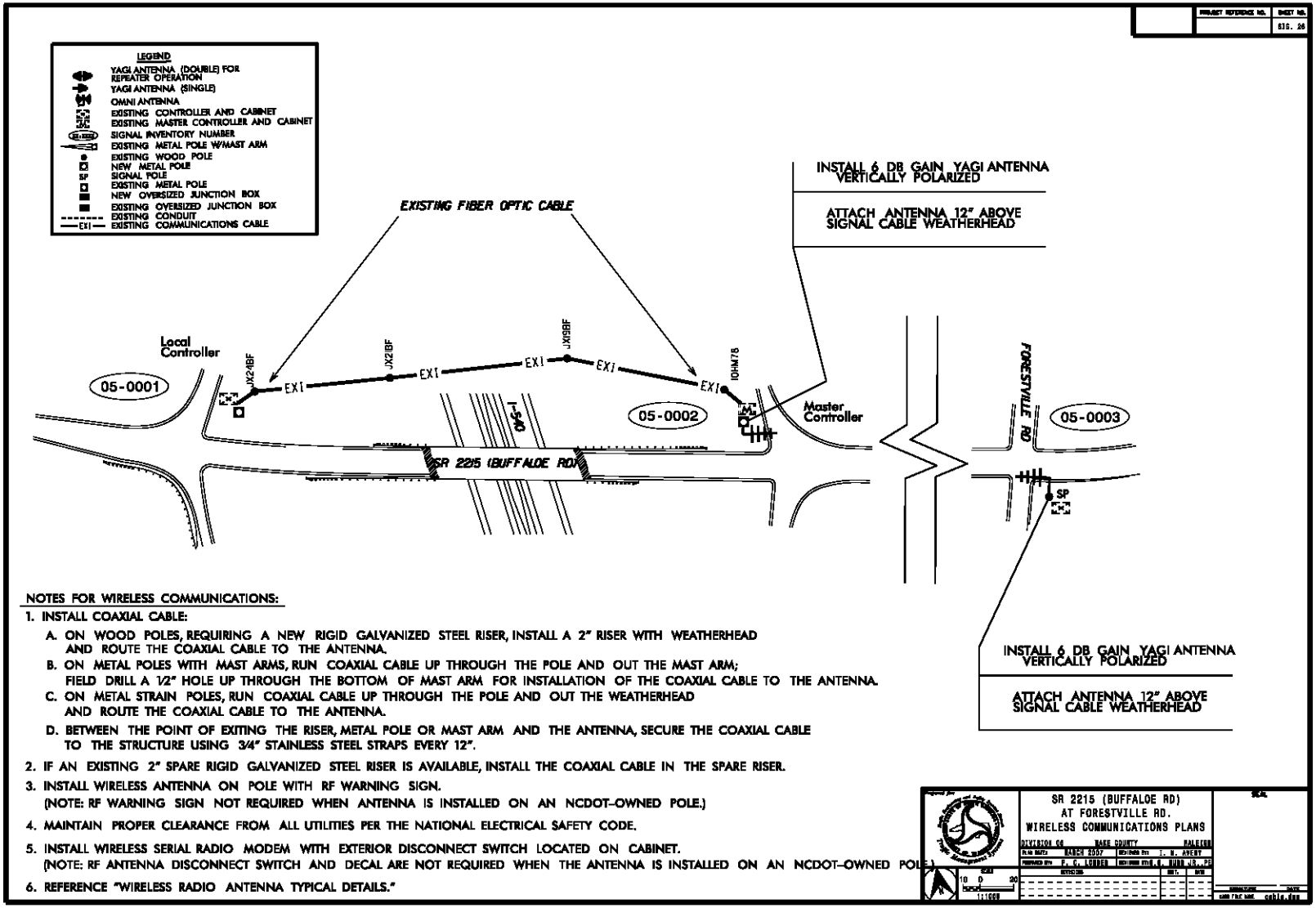

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SR 2215 (BUFFALOE RD)
AT FORESTVILLE RD.
WIRELESS COMMUNICATIONS PLANS

Wireless Communications – Sample Plans – Fiber (Local Intersection) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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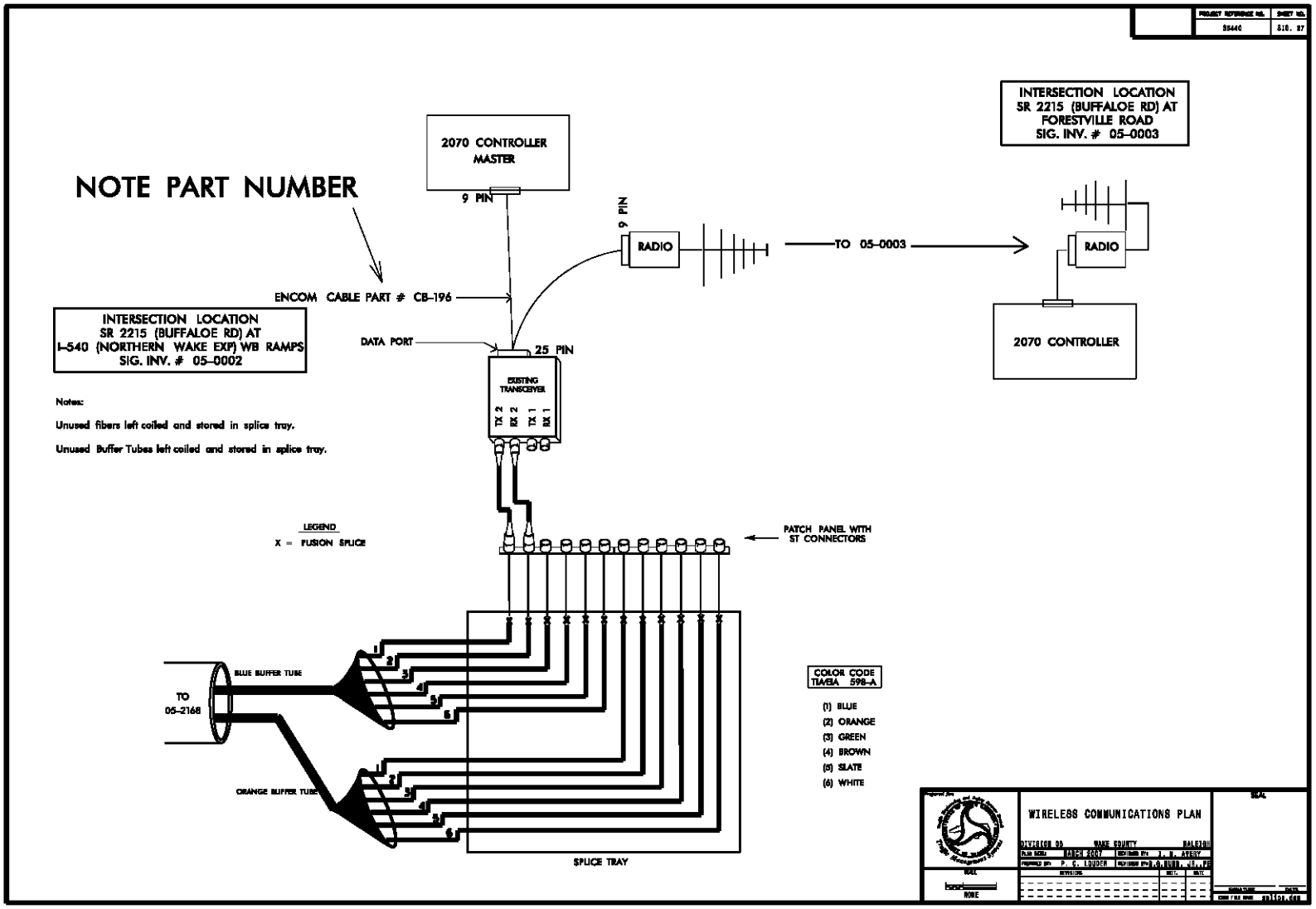

Wireless Communications – Sample Plans – Fiber Splicing (Master Intersction) to Wireless Intersection

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRANSPORTATION MOBILITY AND SAFETY DIVISION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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DMS Site Selection and Design Process

- Obtain recommended locations from Congestion Management Section
- Identify points of interest:
  - Alternate route(s)
  - Venues (Stadiums, Motor Speedways, Sports /Concert Arenas)
- Set up a field investigation event with the following people:
  - Division Incident Management Engineer
  - Regional ITS Engineer
  - Regional Traffic Engineer
  - Signing Project Design Engineer
- Select a location that meets the following criteria:
  - Select location that is 2–4 miles in advance of the point of interest
  - Insure that display has at least 1200′ of unobstructed sight distance
  - Avoid placement in curves
  - Select location where shoulder is widest to avoid future lane closure
  - Ensure an ideal location at least 50 feet in advance of the display can be selected for the controller cabinet
  - Consider phone and power service availability
  - For 1–2 lanes (each direction) consider pedestal type assembly
  - For 3 or more lanes (each direction) consider full span assembly
  - Ensure all parties agree on the selected location
- Confirm the location by sending emails to all parties involved
  - Reference the location from the nearest mile marker
  - If no mile marker exists, use bridge or intersection as reference
- Confirm availability of utilities by coordinating with Division personnel and Utility agents
- Develop Project Special Provisions
  - Determine if a particular brand is to be specified
    - Ensure integration section and pay item is included
    - Ensure that a bench test unit is not required
    - Determine if training is required
    - Determine if UPS, Modem, and Modem Reset devices are needed
  - Determine if desktop /laptop computers are needed
  - Determine if software upgrade is required
  - Determine if Fiber Optic Communication is to be used
    - Determine if dial–up backup system is not required
      - Ensure that dial up modems and related devices are not required
- Follow up with the Signing Section on the development of Structure line drawings, Traffic Control, and Roadway Plans
- If assembling the package for submission to Design Services, obtain plans from Traffic Control and Roadway and confirm quantities
- Ensure DMS Grounding Detail is inserted into the ITS Plans
- Ensure DMS Project Special Provisions are included with ITS Package

Dynamic Message Signs – Site Selection & Design Process

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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I. Cabinets

A. Note cabinet location

B. Note signal inventory number
(usually marked on cabinet)
Example: 01–0459

C. Note cabinet type
(base mount/pole mount)

D. Check inside cabinet for space conduit
(signal technician must be present before doing this)

II. Poles

A. Note pole type
(wood,metal,metal with mast arm)

B. Note pole number
(if applicable)
Use "SP" for signal pole

C. Determine NCDOT attachment height

D. Note any clearance problems or
adjustments required in order to
assume the desired attachment height

E. See section 1.0 for NESC clearance requirements

F. Record distances between poles
using laser range finder or measuring wheel

G. When evaluating adjustment options, be mindful
of 'height over grade' clearances

H. If adjustments are required on a pole,
record the attachment heights of all
existing utilities using the laser range finder

I. Determine vertical clearance over road as needed.
Use the laser range finder.
Measure from the roadway to the lowest
point on the span.

III. Roads and Structures

A. Record all road names and
state road (SR) numbers if applicable

B. Note any bridges (grade separations)

C. Record any landmarks, buildings, or
other structures for reference purposes
as needed

IV. Railroads

A. When the cable route crosses over
or under a railroad, special wire–line
agreements must be made.

B. The following information is needed
for wire line agreements:

1. Crossing number (if available)
usually found on cross arm mechanism
or crossing controller cabinet

2. Distance from center line of track to the
nearest pole on each side of the track
(for aerial installation)

3. Vertical clearance from the top of the rail
to the lowest existing overhead utility
(aerial installation)

4. Distance from crossing to the nearest
railway mile marker.
This information may be obtained through
NCDOT Railway Division, Railroad Company
Right of Way, or NCDOT Right of Way.

Utility Make Ready – Field Investigation Checklist

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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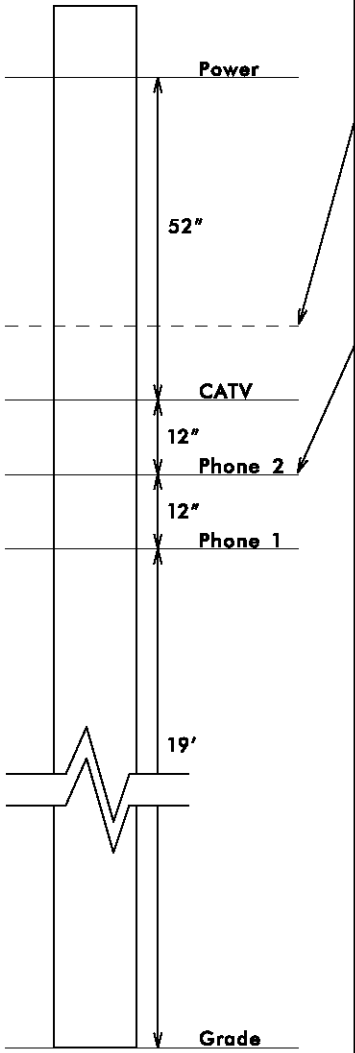
Case 1



A. If proposed NCDOT communications cable attachment height is 40" below power

Typical Adjustment Notes

no adjustment required

there is adequate clearance

B. If proposed NCDOT communications cable attachment height is 12" below CATV

Typical Adjustment Notes

CATV raise to 40" below power

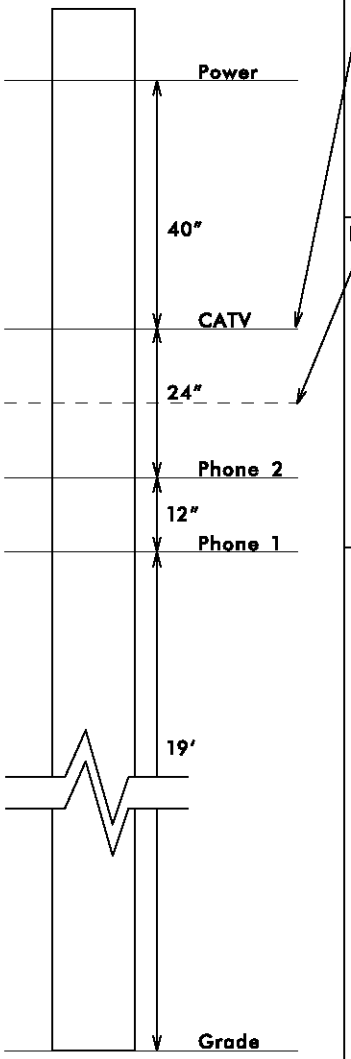
or

phone 2 lower to 24" below CATV
phone 1 lower to 12" below phone 2

Typical Utility Tree

25' -04"	Power	
21' -00"	CATV	52"
20' -00"	Phone 2	12"
19' -00"	Phone 1	12"

Case 2



A. If proposed NCDOT communications cable attachment height is 40" below power

Typical Adjustment Notes

CATV lower to 52" below power

B. If proposed NCDOT communications cable attachment height is 12" below CATV

Typical Adjustment Notes

no adjustment note required

there is adequate clearance

Typical Utility Tree

25' -04"	Power	
22' -00"	CATV	40"
20' -00"	Phone 2	24"
19' -00"	Phone 1	12"

Utility Make Ready – Common Adjustment Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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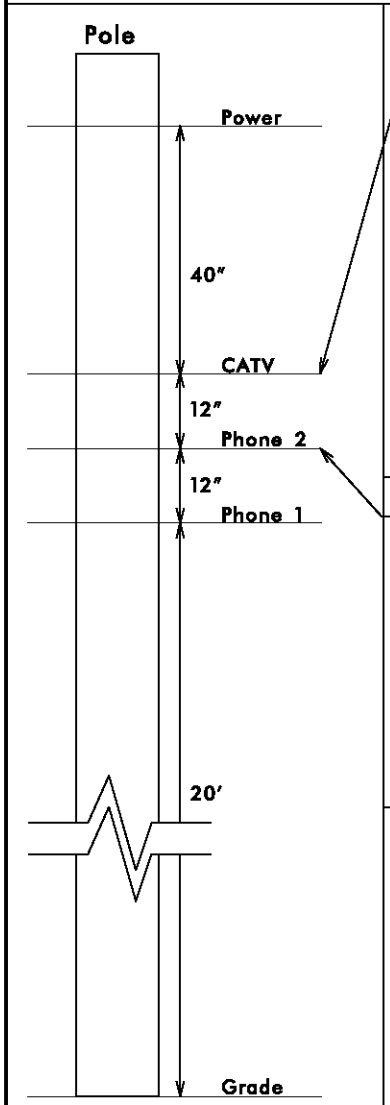
Case 3



A.

If proposed NCDOT communications cable attachment height is 40″ below power

Typical Adjustment Notes

All utilities to lower 12″

or

CATV lower to 52″ below power
Phone 2 lower to 64″ below power
Phone 1 lower to 76″ below power

or

CATV lower to 52″ below power
Phone 2 lower to 12″ below CATV
Phone 1 lower to 12″ below Phone 2

B.

If proposed NCDOT communications cable attachment height is 12″ below CATV

Typical Adjustment Notes

Phone 1 and Phone 2 lower 12″

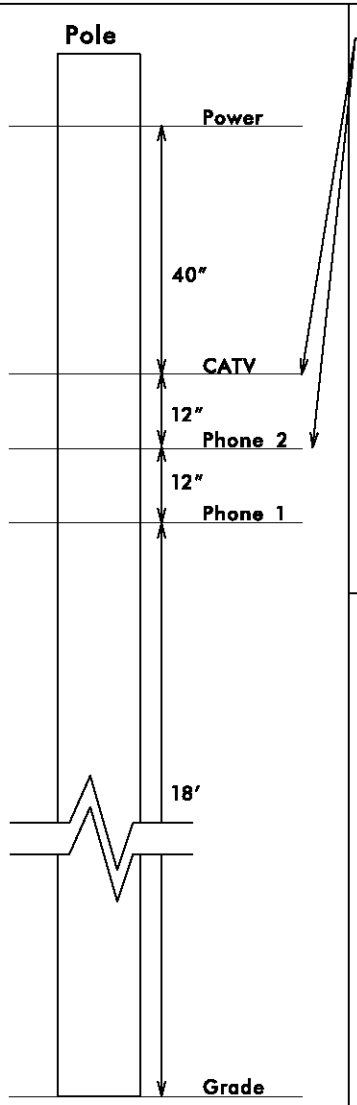
or

Phone 2 lower to 24″ below CATV
Phone 1 lower to 12″ below Phone 2

Typical Utility Tree

25′ -04"	Power	
22′ -00"	CATV	40"
21′ -00"	Phone 2	12"
20′ -00"	Phone 1	12"

Case 4



If proposed NCDOT communications cable attachment height is
40″ below power
or
12″ below CATV

Required adjustments would put lowest utility (phone 1) below 18′ above grade

Therefore the existing pole must be replaced with a taller pole

Typical Adjustment Notes

General

Change out pole

Specific

Replace existing power pole (pole #) with class 2 – 55′ wood pole

Typical Utility Tree

23′ -04"	Power	
20′ -00"	CATV	40"
19′ -00"	Phone 2	12"
18′ -00"	Phone 1	12"

Utility Make Ready – Common Adjustment Notes

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

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Standard Design Elements Feature Description	Level	Color	Line Wt.	Line Style
Existing Roads EOP	58150	4	4	0
Existing Roads Match Line	58151	3	4	0
Proposed Aerial Guy	58152	6	1	0
Existing Bridge	58153	6	3	0
Existing Sidewalk	58154	19	1	0
Proposed Construction Note Leader Line	58155	3	1	0
Proposed Attachment Note Leader Line	58156	3	1	0
Proposed Utility Adjustment Leader Line	58157	3	1	0

Text Feature Description	Level	Color	Line Wt.	Line Style	Font	Size (English) 30:1	40:1	50:1	60:1	70:1	80:1	90:1	100:1
Existing Road Text	58200	3	4	0	11	8	10	12	14	16	18	20	22
Existing Road Match Line Text	58201	13	4	0	11	8	10	12	14	16	18	20	22
Existing Sidewalk Text	58202	19	1	0	11	4	5	7	9	11	13	15	17
Proposed Slack Span Text	58203	3	1	0	11	4	5	7	9	11	13	15	17
Proposed Attachment Text	58204	3	1	0	11	6	8	10	12	14	16	18	20
Proposed Utility Adjustment Text	58205	3	1	0	11	8	10	12	14	16	18	20	22
Existing Railroad Text	58206	7	1	0	11	8	10	12	14	16	18	20	22
Existing Right of Way Text	58207	5	1	0	11	8	10	12	14	16	18	20	22
Existing Pole Text	58208	3	1	0	11	4	5	7	9	11	13	15	17
Proposed General Note Text	58209	3	1	0	11	8	10	12	14	16	18	20	22

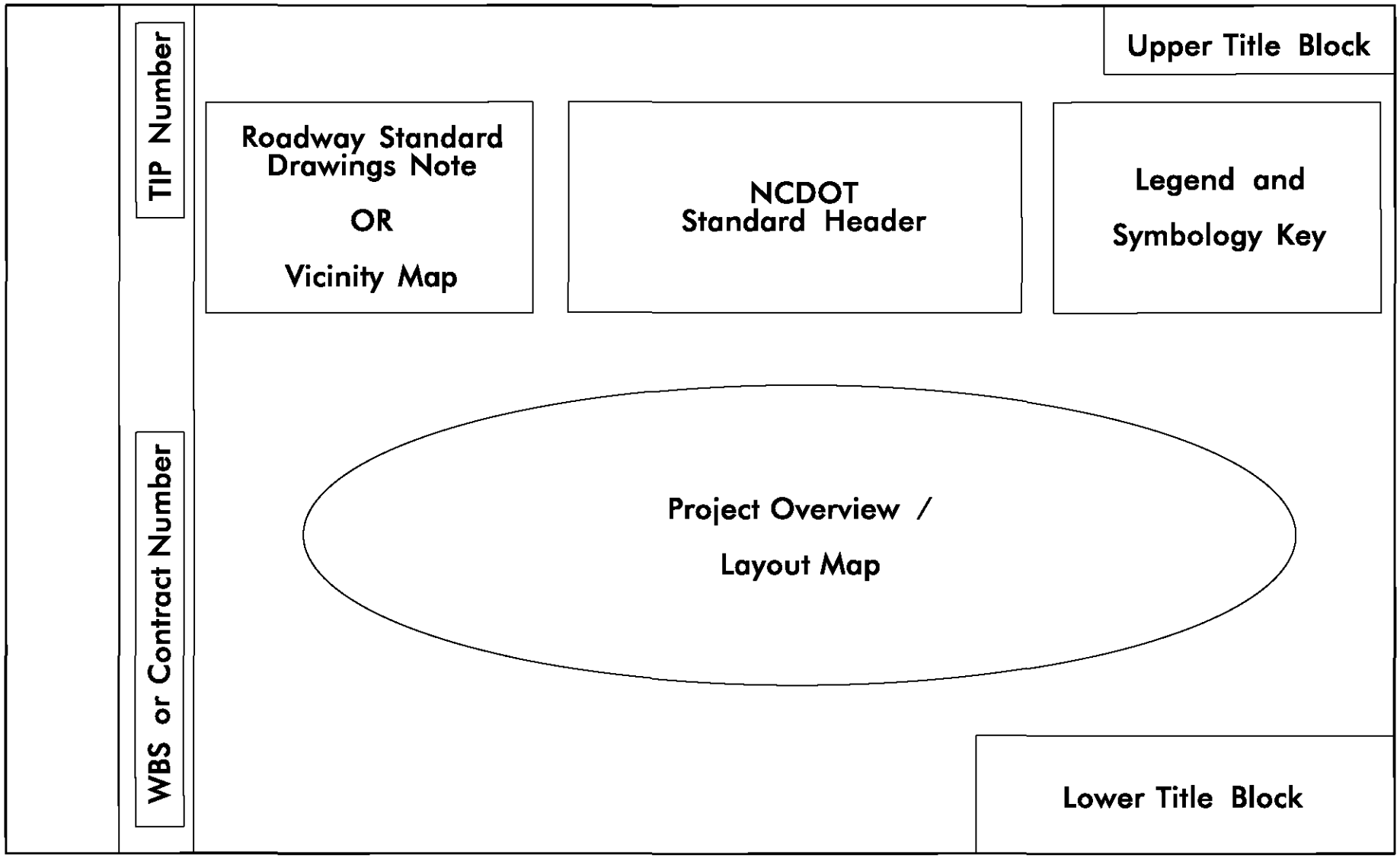
	Custom Line Styles Feature Description	Level	Color	Line Wt.	Line Style	Font	Scale 30:1	40:1	50:1	60:1	70:1	80:1	90:1	100:1
TMS Custom	Proposed Aerial Fiber Optic Cable	58000	3	0	Sig Com Cab FO		70	80	90	100	120	140	160	180
TMS Custom	Proposed Twisted Pair Cable	58001	4	0	Sig Com Cab Twi Pr Exi		70	80	90	100	120	140	160	180
TMS Custom	Existing Communications Cable	58002	1	0	Sig Com Cab Exi		70	80	90	100	120	140	160	180
TMS Custom	Remove Existing Communications Cable	58003	2	0	Sig Com Cab Rmv		70	80	90	100	120	140	160	180
TMS Custom	Proposed Conduit	58004	0	0	Sig Com Cab Nw Cond		70	80	90	100	120	140	160	180
TMS Custom	Existing Conduit	58005	6	0	Sig Com Cab Exi Cond		70	80	90	100	120	140	160	180
TMS Custom	Proposed Directional Drilled Conduit	58006	1	0	Sig Com Cab Dr Dri		70	80	90	100	120	140	160	180
TMS Custom	Proposed Jack and Bore Conduit	58007	120	0	Sig Com Cab Jac Bor		70	80	90	100	120	140	160	180
Other Custom	Existing Railroad Track	58008	7	2	(0) ncmap RR Gau Std		70	80	90	100	120	140	160	180
Other Custom	Existing Railroad Track (Title Sheet)	58009	0	1	(0) Sig Geo RR		1	1.5	2	2	2.5	2.5	3	3
Other Custom	Existing Railroad Gate	58010	3	1	(0) Sig Geo RR Gat		1	1.5	2	2	2.5	2.5	3	3
Other Custom	Existing Railroad Cantilever	58011	3	1	(0) Sig Geo RR Can		1	1.5	2	2	2.5	2.5	3	3
Other Custom	Existing Railroad Lights	58012	3	1	(0) Sig Geo RR Lit		1	1.5	2	2	2.5	2.5	3	3
Other Custom	Existing Right of Way	58013	5	1	(0) ncmap ROW Exi		30	40	50	60	70	80	90	100
Other Custom	Existing Guard Rail	58014	6	4	(0) Rdy GR Prop		30	40	50	60	70	80	90	100
Other Custom	Existing Fence Line	58015	0	1	(0) ncmap Fen		30	40	50	60	70	80	90	100
Other Custom	Existing Hedge Row	58016	153	1	(0) ncmap Hdg		30	40	50	60	70	80	90	100
Other Custom	Existing Woods	58017	153	1	(0) ncmap Wds		30	40	50	60	70	80	90	100
Other Custom	Existing Streams and Rivers	58018	99	1	2-5-2		1	1	1	1	1	1	1	1

Standard Sheet Layout – TMS Standard CADD Symbology

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.0
SHEET 1 OF 1



Standard Sheet Layout – UMR Title Sheet

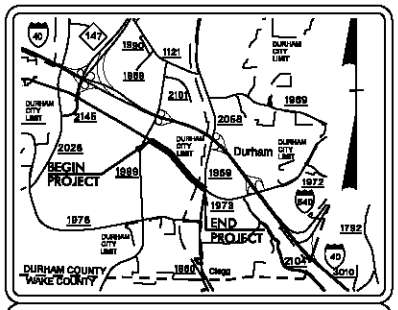
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.1
SHEET 1 OF 5

R-2904

WBS: 34512



VICINITY MAP

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

DURHAM COUNTY

LOCATION: NC 54 FROM SR 1999 (DAVIS DRIVE) TO SR 1959 (MIAMI BOULEVARD)

TYPE OF WORK: UTILITY MAKE READY

PROJECT REFERENCE NO.	SHEET NO.
R-2904	U/MR. 0

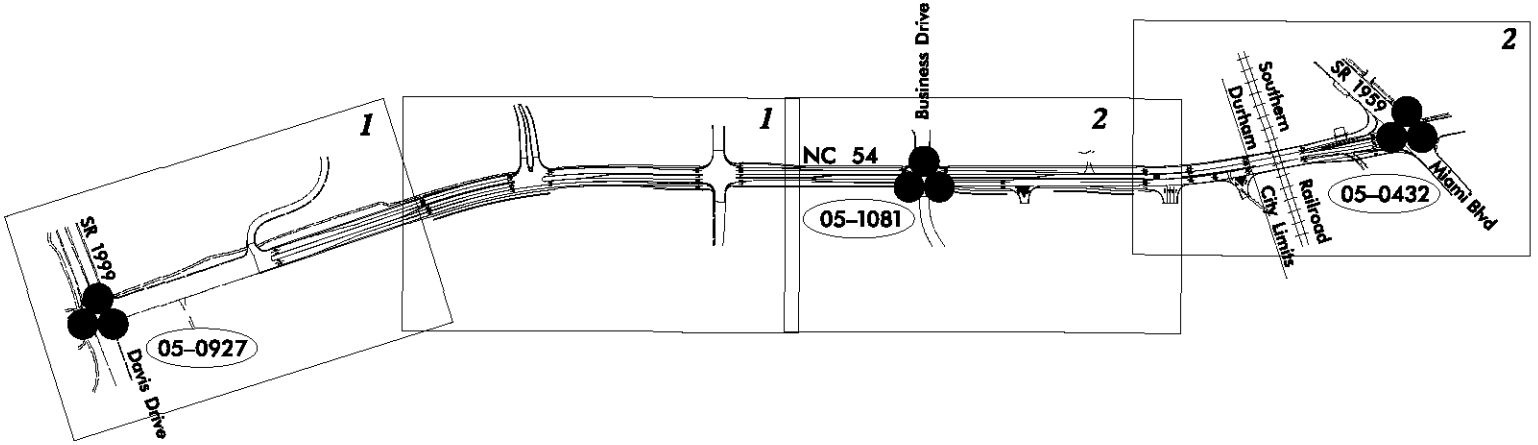
LEGEND

- FO — NEW FIBER OPTIC COMMUNICATIONS CABLE
- EX — EXISTING COMMUNICATIONS CABLE
- NEW CONDUIT
- EXISTING CONDUIT
- DD — NEW DIRECTIONAL DRILLED CONDUIT
- NEW JUNCTION BOX
- EXISTING JUNCTION BOX
- NEW WOOD POLE
- EXISTING WOOD POLE
- NEW METAL POLE
- EXISTING METAL POLE
- EXISTING CONTROLLER AND CABINET
- SP — SIGNAL POLE
- XX-XXXX — SIGNAL INVENTORY NUMBER
- SIGNALIZED INTERSECTION

POLE INVENTORY SYMBOLOGY

ATTACHMENT HEIGHT	EXISTING UTILITY
XX' - XX"	POWER
XX' - XX"	XXXXX
XX' - XX"	XXXXX
XX' - XX"	XXXXX
XX' - XX"	XXXXX
XX' - XX"	XXXXX
XX' - XX"	XXXXX

SEPARATION



Utility Make Ready Plans

REVISIONS 05 DURHAM COUNTY DURHAM

PLAN DATE: JANUARY 2004 REVIEWED BY: I. M. AVERY

PREPARED BY: J. HOOKER REVIEWED BY:

REVISIONS	INIT.	DATE

SEAL

SIGNATURE DATE

CADD FILENAME

Standard Sheet Layout – Sample UMR Title Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.1

Notes

Number UMR plan sheets in the upper title block

Utility Make Ready plans are not sealed by a professional engineer do not include seal in lower block

PROJECT REFERENCE NO.	SHEET NO.
R-2904	UMR 0

Typical Upper Title Block

Typical Lower Title Block

Prepared in the Offices of:

STATE OF NORTH CAROLINA · DEPARTMENT OF TRANSPORTATION · Traffic Engineering and Safety Systems Branch · Traffic Management Systems

122 N. McDowell St., Raleigh, NC 27603

SCALE 0

Utility Make Ready Plans

DIVISION 05 DURHAM COUNTY DURHAM

PLAN DATE: JANUARY 2004 REVIEWED BY: I. N. AVERY

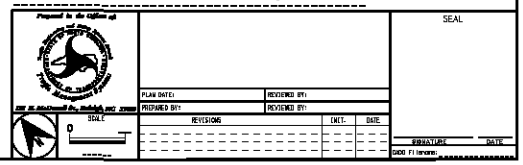
PREPARED BY: J. HOOKER REVIEWED BY:

REVISIONS	INIT.	DATE

SEAL

SIGNATURE DATE

CADD Filename:

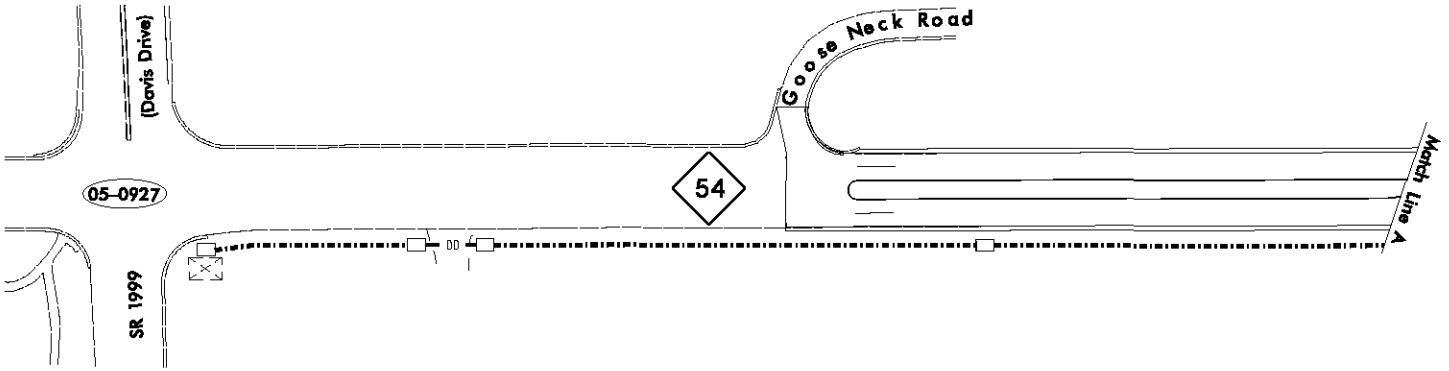


Standard Sheet Layout – Title Blocks – UMR

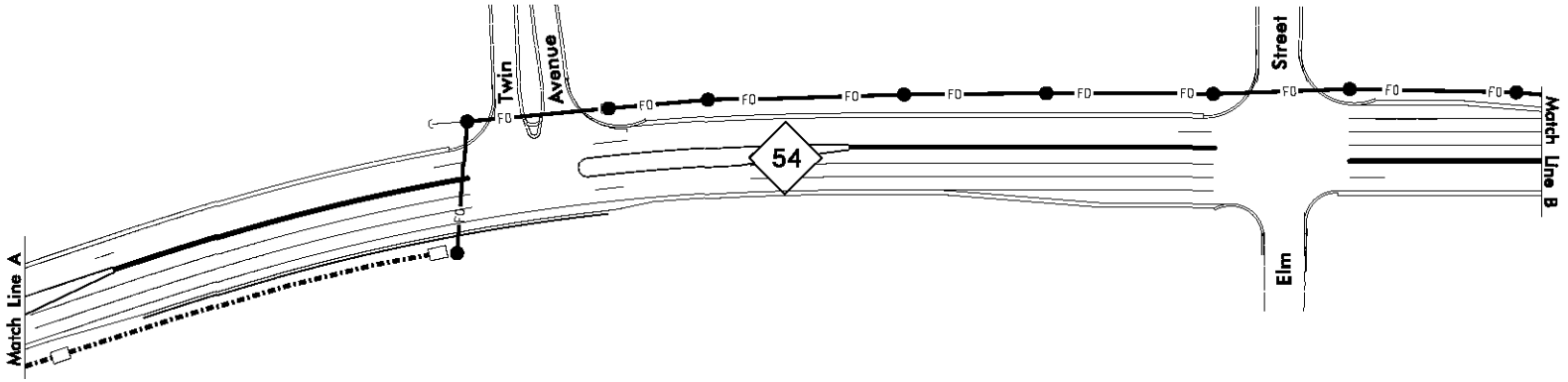
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO. 9.1



No Utility Make Ready Work Required This Sheet



Utility Make Ready Plans

DIVISION 05 DURHAM COUNTY DURHAM

PLAN DATE: JANUARY 2004 REVIEWED BY: I. N. AVERY

PREPARED BY: J. HOOKER REVIEWED BY:

REVISIONS | INIT. | DATE

SCALE: 0

SEAL

SIGNATURE DATE

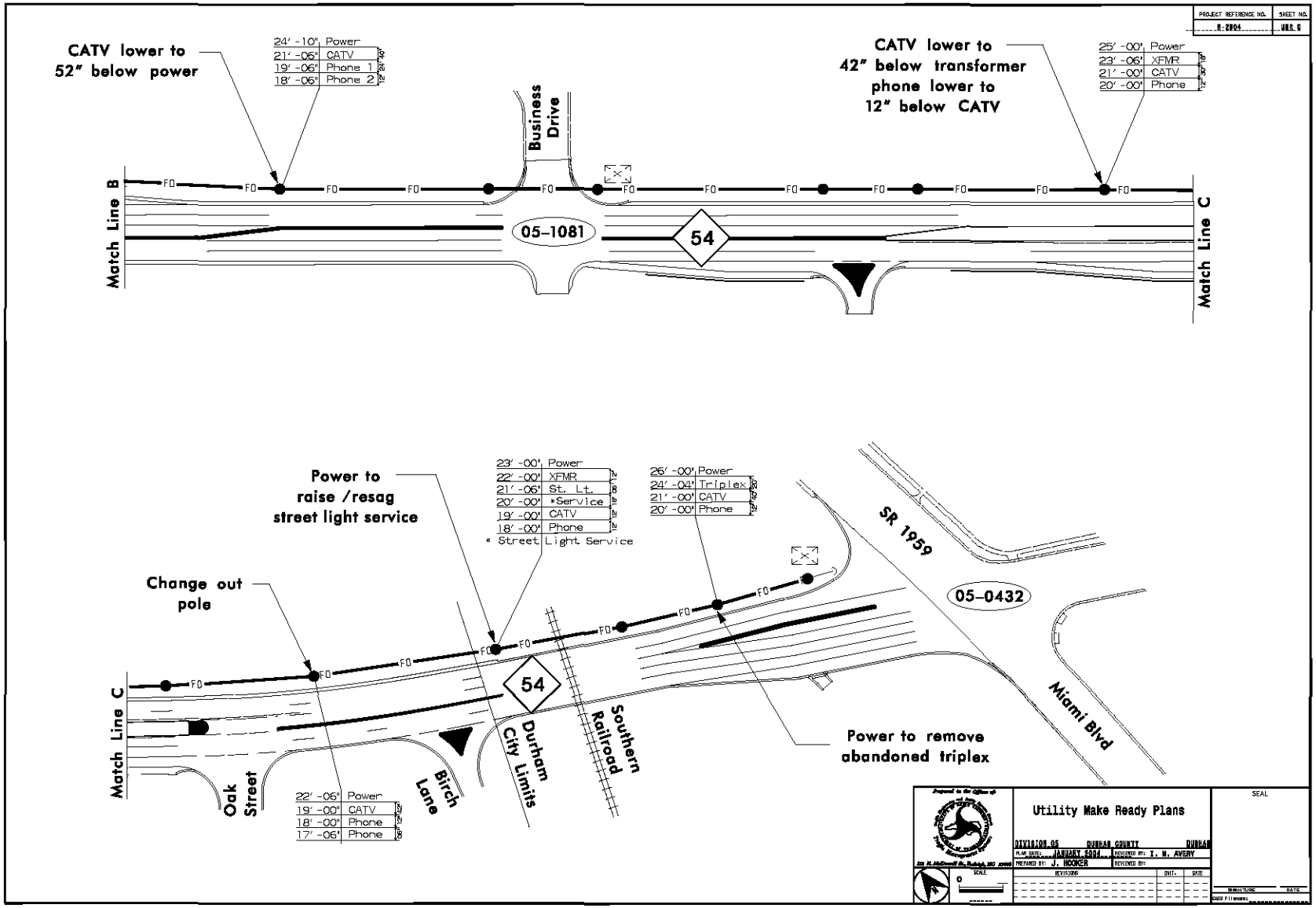
GOOD THROUGH

Standard Sheet Layout – Sample UMR Plan Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.1

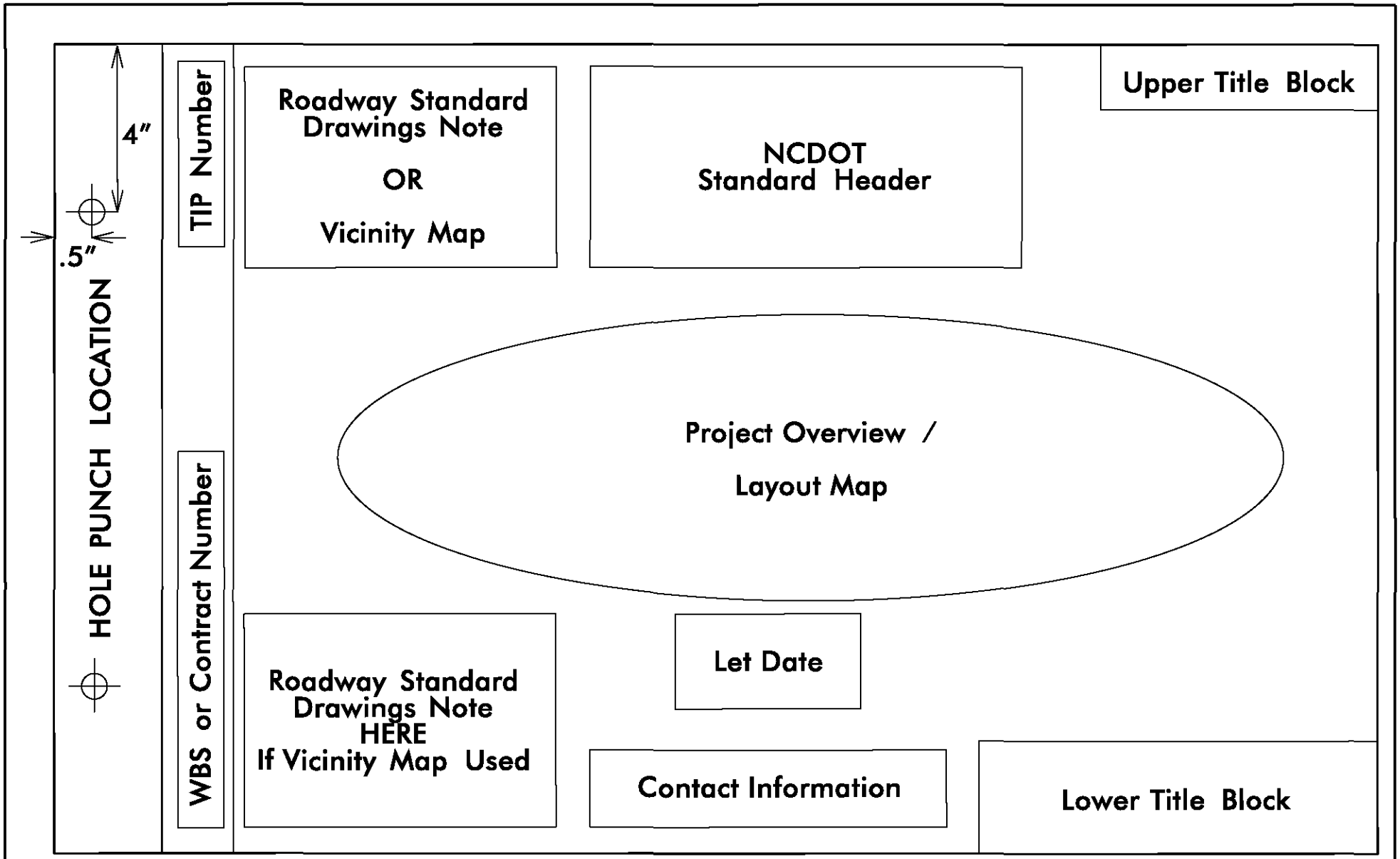


Standard Sheet Layout – Sample UMR Plan Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.1
SHEET 5 OF 5



Standard Sheet Layout – Cable Routing Title Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

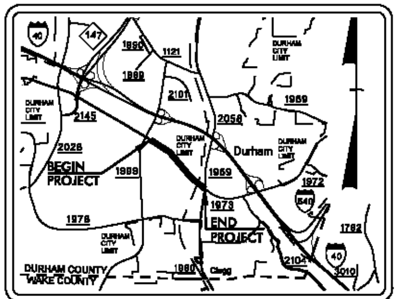
7-04

STD. NO.
9.2
SHEET 1 OF 5

PROJECT REFERENCE NO.	SHEET NO.
R-2904	TSS.1

R-2904

WBS: 34512



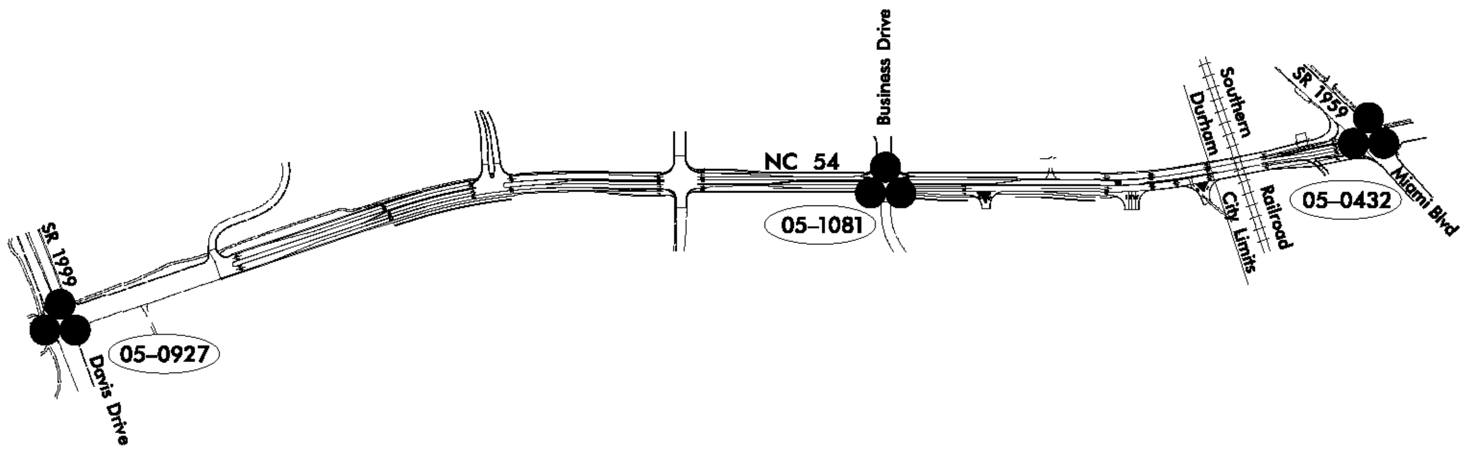
VICINITY MAP

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

DURHAM COUNTY

LOCATION: NC 54 FROM SR 1999 (DAVIS DRIVE) TO SR 1959 (MIAMI BOULEVARD)

TYPE OF WORK: COMMUNICATIONS CABLE AND CONDUIT ROUTING



ROADWAY STANDARD DRAWINGS

THE FOLLOWING ROADWAY STANDARDS AS APPEAR IN "ROADWAY STANDARD DRAWINGS", ROADWAY DESIGN UNIT – N.C. DEPARTMENT OF TRANSPORTATION – RALEIGH, N.C., DATED JANUARY 2002 ARE APPLICABLE TO THIS PROJECT AND BY REFERENCE HEREBY ARE CONSIDERED A PART OF THESE PLANS:

STD. NO.	TITLE
1715.01	UNDERGROUND CONDUIT
1716.01	JUNCTION BOXES
1720.01	WOOD POLES
1721.01	GUY ASSEMBLIES
1730.01	FIBER OPTIC CABLE – SPARE CABLE STORAGE
1730.02	FIBER OPTIC CABLE – CONDUIT INSTALLATION
1733.01	DELINEATOR MARKERS
1740.01	METAL POLES

Let Date: 12/14/04

NCDOT CONTACT:

TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
G.G. MURR, JR., PE – TRAFFIC MANAGEMENT SYSTEMS ENGINEER

Communications Cable and Conduit Routing Plans

DIVISION 05 DURHAM COUNTY DURHAM

PLAN DATE:	JANUARY 2004	REVIEWED BY:	I. M. AVERY
PREPARED BY:	J. HOOKER	REVIEWED BY:	J.Q. ENGINEER

REVISIONS	INIT.	DATE

SCALE 0

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 00000 ENGINEER JOHN Q. ENGINEER

SIGNATURE DATE

CADD Filename:

Standard Sheet Layout – Sample Cable Routing Title Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

Notes

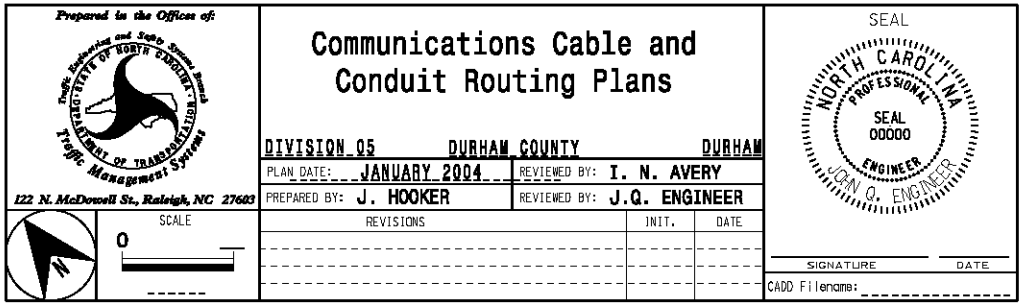
Number Cable Routing plan sheets in the upper title block

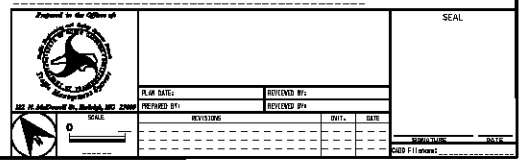
For Closed Loop System projects do not number the sheets. They are numbered later as part of a larger plan package.

PROJECT REFERENCE NO.	SHEET NO.
R-2904	TMS 1

Typical Upper Title Block

Typical Lower Title Block



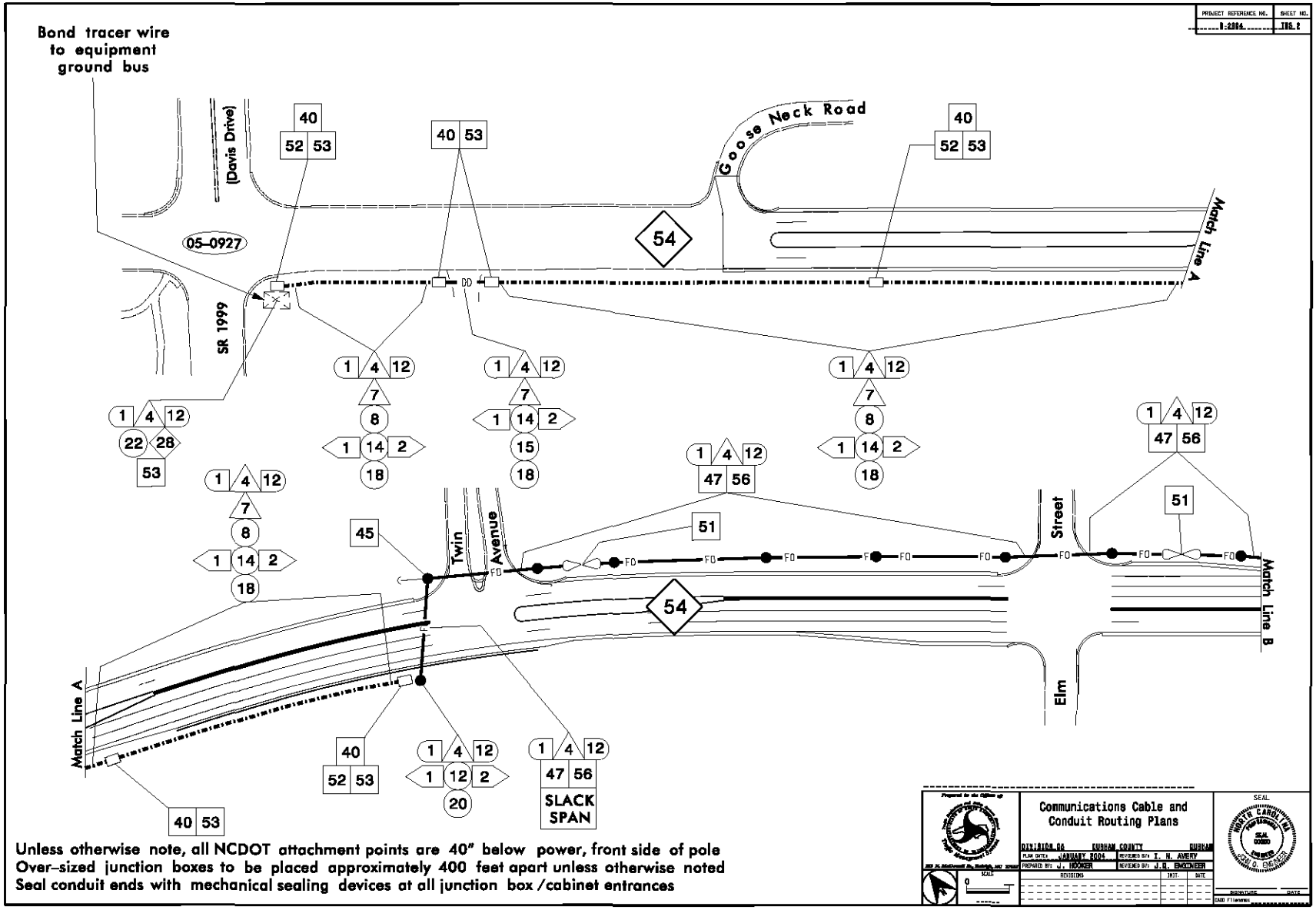


Standard Sheet Layout – Title Blocks – Cable Routing

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO. 9.2



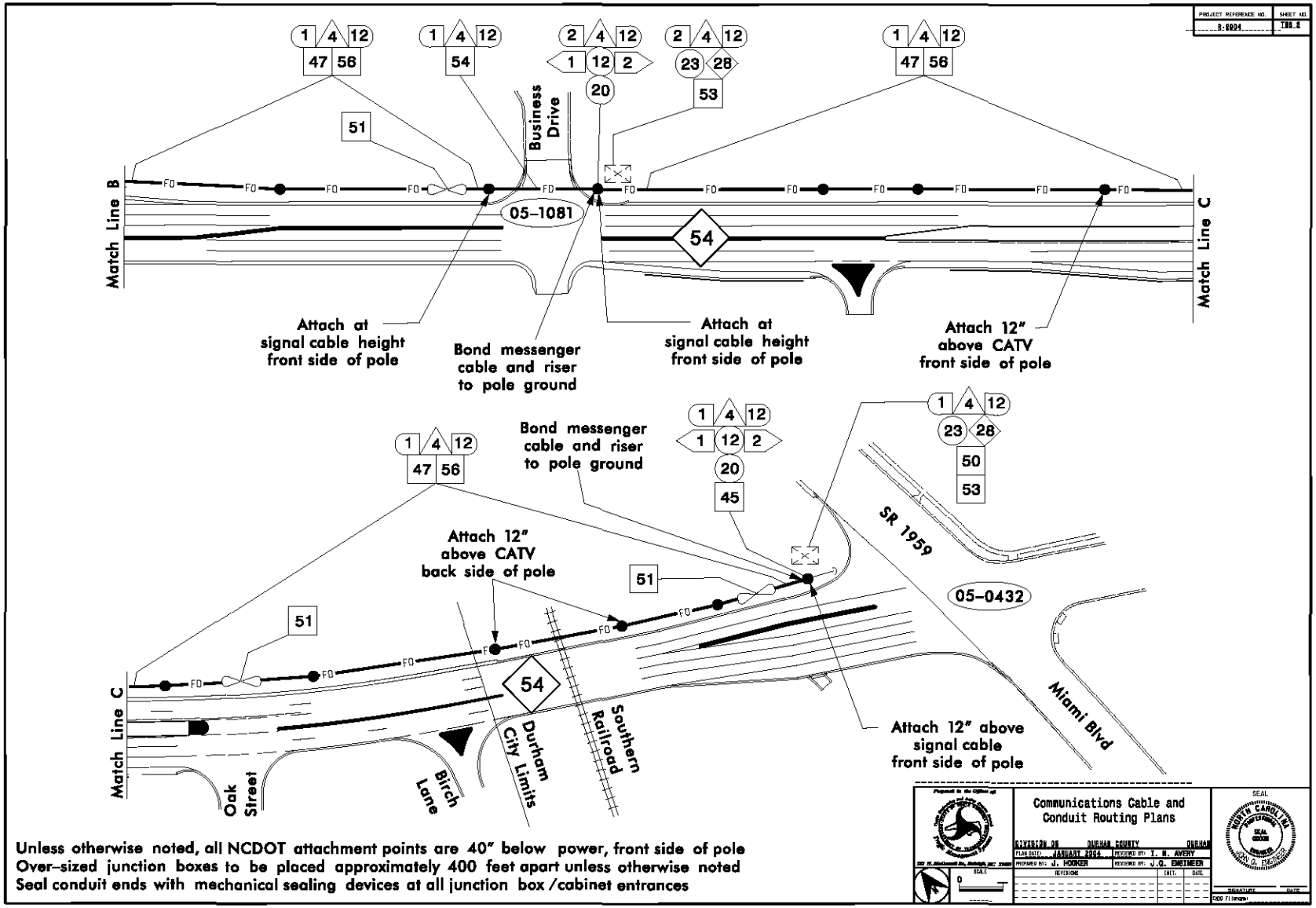
Unless otherwise note, all NCDOT attachment points are 40" below power, front side of pole
Over-sized junction boxes to be placed approximately 400 feet apart unless otherwise noted
Seal conduit ends with mechanical sealing devices at all junction box /cabinet entrances

Standard Sheet Layout – Sample Cable Routing Plan Sheet

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.2
SHEET 4 OF 5



Unless otherwise noted, all NCDOT attachment points are 40" below power, front side of pole
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Seal conduit ends with mechanical sealing devices at all junction box /cabinet entrances

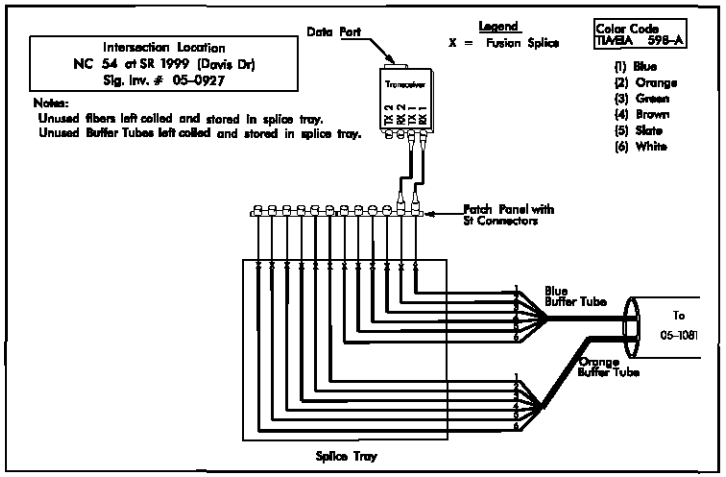
Standard Sheet Layout – Sample Cable Routing Plan Sheet

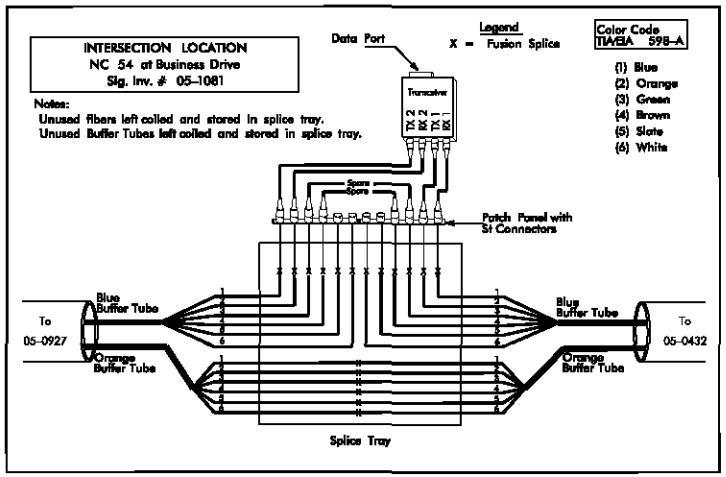
INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

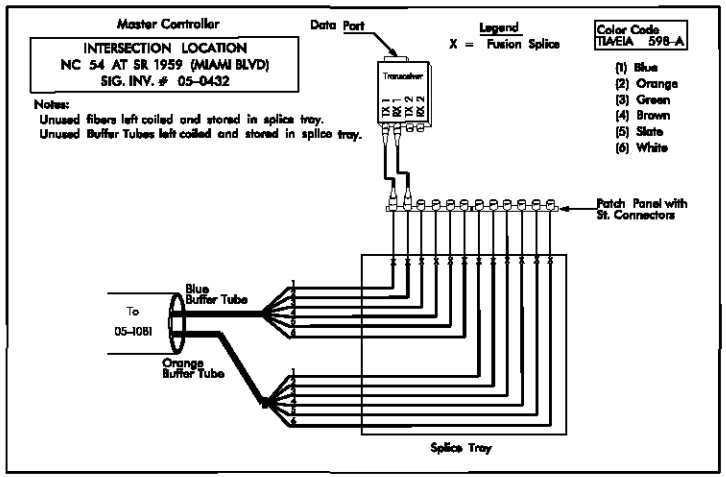
7-04

STD. NO.
9.2
SHEET 5 OF 5

Fiber Optic Cable







Transceiver termination configurations are generic. Contractor is responsible for determining \ ensuring proper terminations

PROJECT REFERENCE NO. B-2994 | SHEET NO. R18.

Splice Detail

DIVISION 06 DURHAM COUNTY DURHAM
PLAN DATE: JANUARY 2004 REVIEWED BY: I. N. AVERY
PREPARED BY: J. HOOKER REVIEWED BY: J.Q. ENGINEER
SCALE: 0
REVISIONS | INIT. | DATE

SEAL
NORTH CAROLINA
SEAL 00000
JOHN Q. ENGINEER

SIGNATURE DATE
CADD FILEname:

Standard Sheet Layout – Splice Plan

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.3
SHEET 1 OF 2

Fiber Optic Cable

PROJECT REFERENCE NO.	SHEET NO.
U-2904	STD.

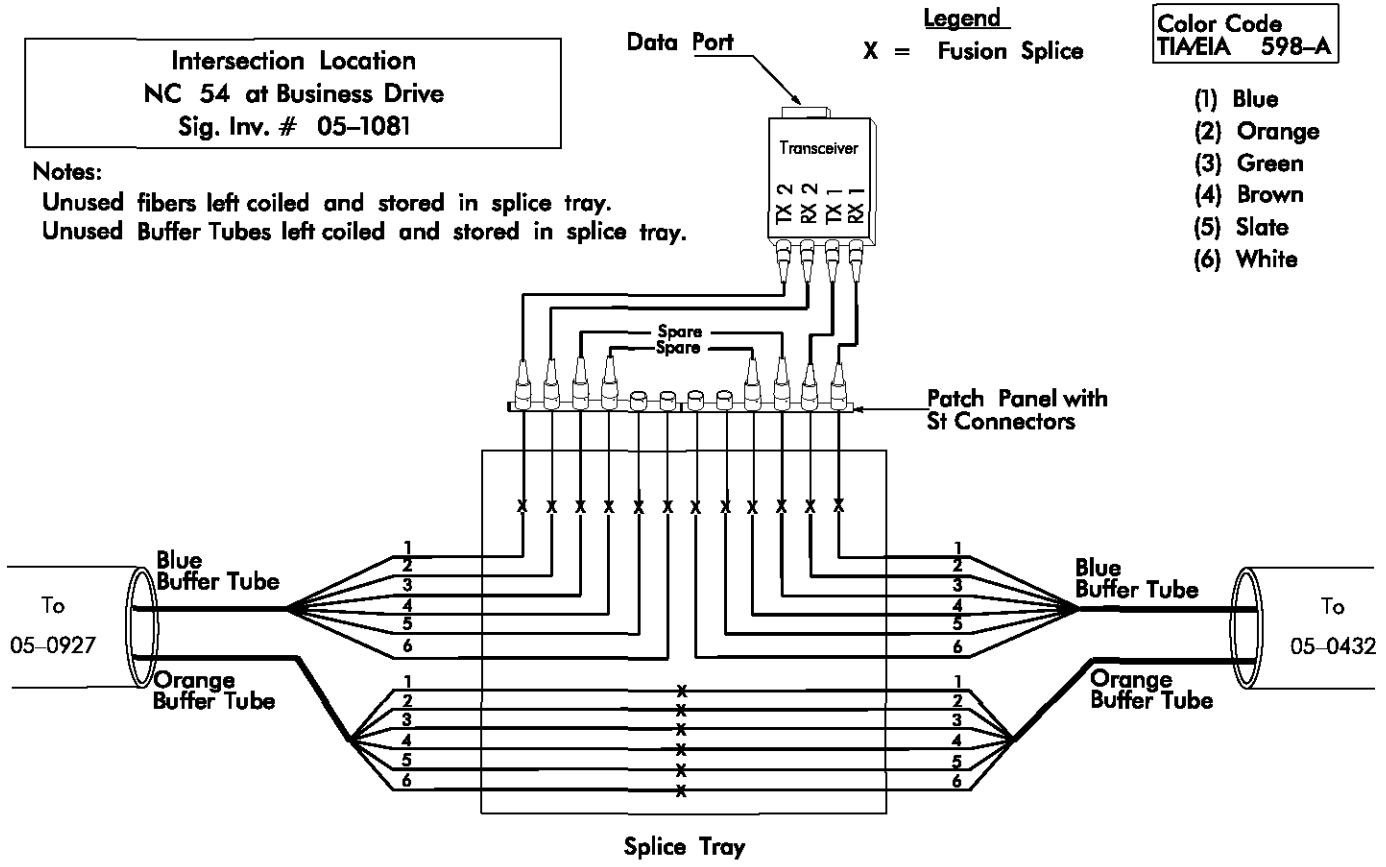
Intersection Location
NC 54 at Business Drive
Sig. Inv. # 05–1081

Notes:
Unused fibers left coiled and stored in splice tray.
Unused Buffer Tubes left coiled and stored in splice tray.

Legend
X = Fusion Splice

Color Code
TIA/EIA 598–A

(1) Blue
(2) Orange
(3) Green
(4) Brown
(5) Slate
(6) White



Transceiver termination configurations are generic. Contractor is responsible for determining \ ensuring proper terminations

Splice Detail

DIVISION 05 DURHAM COUNTY DURHAM
PLAN DATE: JANUARY 2004 REVISED BY: T. M. AVERY
PREPARED BY: J. HOOKER REVISED BY: J.D. ENGINEER

REVISIONS | INIT. | DATE

SEAL
NORTH CAROLINA
PROFESSIONAL ENGINEER
SEAL 00000
JOHN D. ENGINEER

SIGNATURE DATE

DGN File name:

Standard Sheet Layout – Splice Plan – Exploded View

INTELLIGENT TRANSPORTATION SYSTEMS SECTION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

7-04

STD. NO.
9.3
SHEET 2 OF 2

Design Manual

Definitions

Part 4

-A-

AASHTO - American Association of State Highway and Transportation Officials.

Actuated Operation - A traffic signal operation that responds to information from vehicle or pedestrian detectors and provides signal operation and phase timing accordingly.

Actuation - A registration of demand for right-of-way by traffic to the controller unit.

ANSI - American National Standards Institute

Average Daily Traffic (ADT) - The average two-way volume of traffic at a given location during a 24-hour day, measured over some period of time less than a year.

AWG - American Wire Gauge. Standard measurement of wire based upon the circular mil system. One mil equals 0.001 inch (or approximately 0.0254mm).

-B-

Back Panel - A panel that is mounted on the back of the inside of a cabinet and on which terminals are mounted. The back panel may also include the sidewalls of the cabinet.

Back Plate - A black metal plate attached to a signal head used to increase the target value of the signal face (used when signal face is not readily visible to motorist due to competing background lighting such as commercial signs and lights, sunlight, etc).

Barrier - A reference point in the designated sequence of a dual ring controller. The barrier interlocks the two rings, and assures that conflicting phases will not be selected and/or timed concurrently. Both rings cross the barrier simultaneously to select and time phases on the other side.

Blank-out Sign - A sign that is typically used to control turning movements by time-of-day operation or in a preemption sequence. Sign is blank until message is needed.

Bore & Jack - An installation method for underground conduit.

Buffer Tubes - Extruded cylindrical tubes used for protection and isolation encasing optical fibers.

-C-

Call - see Actuation

Call Delay - For a detector unit, the ability to delay its output to the controller for a predetermined length of time after a vehicle enters the detection zone. For a controller, the ability to disregard a call from a detector unit for a predetermined length of time.

Card-Rack Mounted Detectors - see Rack Mounted Detectors

Channel - A specified band for the transmission and reception of fiber optic data and/or images.

CIM - Cable Identification Marker

Cladding - The material surrounding the core of an optic fiber. The cladding keeps the light in the fiber core.

Clearance Interval - The time from the end of the right of way of one phase to the beginning of the right of way of a conflicting phase. See also Yellow Change Interval and Red Clearance Interval.

Closed Circuit Camera (CCTV) – A television transmission circuit with a limited number of reception stations and no broadcast facilities.

Closed Loop System (CLS) - A signal system in which signals are connected to a master controller. The master controller selects timing patterns for the system that may be traffic-responsive or time-of-day. The master is connected to a computer in a central office. The computer

can be used to monitor the system, make timing changes, and receive reports of signal malfunctions.

Communication Cable - Also called interconnect cable. The cable that is used to transmit and receive data between field devices and/or a central facility.

Communications Hub - Enclosure used to house a central computer network. It can be controlled from a remote location.

Conditional Re-service - A feature that allows reservice of an even phase (through phase) after an odd phase is conditionally serviced. Once the odd phase is allowed conditional service, the even phase (same ring) may begin timing again but times only minimum green.

Conditional Service - A feature that allows an odd phase to time again after normal service to that phase. Requirements for conditional service are: 1) A call is placed on odd phase while even phases are timing, 2) an even phase (same ring as odd phase) gaps or maxes out, and 3) vehicle clearance time of gapped/maxed out phase, plus conditional service minimum green time is less than or equal to the time remaining on the max timer of the even phase still timing.

Conduit - A polyethylene, PVC, or metal pipe used to protect wires or cables.

Conflict Monitor - A device located inside the cabinet (usually separate from controller) that continually checks for the presence of conflicting signal indications. Upon detection of conflicting indications, the conflict monitor will cause the signal to go into flash.

Controller (Signal Controller) - A device that determines the sequence and duration of indications displayed by traffic signals. See also Type 2070L Controller, NEMA Controller, and Type 170 Controller.

Controller Asset Number - A controller communication address number used in interconnected traffic signal systems. It is usually designated as the signal inventory number.

Coordination - A timing relationship between adjacent signals that allows traffic to progress smoothly along a corridor.

Cycle Length - The time period required for one complete sequence of signal indications. In an actuated traffic signal controller, a complete cycle is dependent on the presence of calls on all phases. In a pre-timed traffic signal, it is the complete sequence of signal indications.

-D-

Delineator Marker - A vertically anchored plastic dome post used to mark the path of underground conduit.

Design Hour Volume (DHV or K Factor) - The percentage of the 24-hour volume that occurs during the peak hour (usually on the Roadway Design Cover Sheet; if not, 10% is a good assumption).

Design Speed - The speed used for the design of the detection zone placement/controller timing.

Design Year - Usually five years after the project letting date.

Detection Zone - The area of the roadway where a vehicle will cause actuation.

Dielectric - A dielectric cable contains no metallic components and is, therefore, non-conductive. Glass fibers are dielectric.

Directional Drill - A method of installing underground conduit.

Digital Detector Unit (Detector) - A digital device used in a vehicle detection system which produces a signal when a vehicle passes through or remains within the detection zone of a sensing element.

Directional Split (D) - The highest percentage of the two-way traffic going in one direction at any time (usually on the Roadway Design Cover Sheet; if not, 60% is a good assumption).

Direction Design Hour Volumes (DDHV) - Estimated design year counts derived from ADT counts.

Drop Cable - A communications cable that is spliced into a trunk cable to service a traffic signal, CCTV, or DMS.

Dual Entry - An operating mode programmed on the controller that causes compatible phases on different rings to be served together even when only one of the phases has a call. Ex: For a location with phase 4 + 7 and 4 + 8 for side street phases, select dual entry for phase 4 so phase 4 comes on with phase 7 and phase 8.

Dual-Quad Phasing - Standard NEMA phasing sequence using two interlocking rings separated by a barrier.

Dual-Ring Controller - A controller unit containing two interlocking rings which are arranged to time in a preferred sequence and to allow concurrent timing of compatible phases in both rings, subject to the restraint of the barrier. Each of the compatible phase groups must cross the barrier simultaneously to select and time phases in the phase group on the other side.

Dummy Phase - A phase that times as a normal phase but for which there are no directly connected on-street signal indications. This is typically used as an all-red phase.

Dynamic Maximum Function - A 2070L feature that causes the maximum timing interval to be adjusted based on demand. Appropriate where demand is occasionally higher than normal max times (such as at a school).

Dynamic Message Sign (DMS) – A message board located over or near a road to alert travelers to possible traffic related problems. The message can be updated from a remote location. Formerly known as Changeable Message Sign and Variable Message Sign.

-E-

EIA - Electronic Industries Association

EIA-232 - A common interface standard for data communications equipment. It specifies signal voltages, signal timing, signal function, a protocol for information exchange, and mechanical connectors. Formerly known as RS-232.

Electrical Disconnect - Refers to the box where electrical connections are made. The box also houses the breaker controlling service to the cabinet.

Electrical Service - Includes the conduit, power meter, disconnect box, and triplex cable that provides power for any cabinet.

Emergency Vehicle Preemption - A type of preemption in which the normal signal sequence is interrupted, giving right of way to emergency vehicles.

Exclusive Mode – see Protected Mode

Exclusive Pedestrian Phase - A phase that serves only pedestrians. No vehicles are served.

Exclusive/ Permissive Mode – see Protected/Permissive Mode

Extend - For a detector unit, the ability of a detector to continue its output for a predetermined length of time following an actuation; i.e., after the vehicle leaves the detection zone. For a controller, the ability to hold a vehicle call for a predetermined length of time following an actuation (see also Stretch Detection).

-F-

Fiber - A thin filament of glass. An optical waveguide consisting of a core and a cladding that is capable of carrying information in the form of light.

Fiber Optic Jumper - Optical fiber cable that has connectors installed on both ends. Note: Industry standard utilizes a yellow jacket for SMFO jumper and an orange jacket for MMFO jumper.

Fiber Optic Pigtail - Optical fiber cable that has a connector installed on one end. Note: Industry standard utilizes a yellow jacket for SMFO pigtail and an orange jacket for MMFO pigtail.

Fiber Optic Receiver - An electronic device that converts optical signals to electrical signals.

Fiber Optic Splice - An interconnection method for joining the end of one bare fiber to another fiber.

Fiber Optic Splice Enclosure - An enclosure used to house a cable run splice point, and organize and protect splice trays.

Fiber Optic Splice Tray - A container used to secure, organize, and protect spliced fibers.

Fiber Optic Transceiver - An electronic device that converts optical signals to electrical signals and converts an electrical information-carrying signal to a corresponding optical signal for transmission by fiber. A transceiver is one device consisting of a transmitter and a receiver.

Fiber Optic Transmitter - An electronic device used to convert an electrical information-carrying signal to a corresponding optical signal for transmission by fiber. The transmitter is usually a Light Emitting Diode (LED).

Flashing Operation - A mode of operation in which traffic signal indications are turned on and off at a repetitive rate.

Free-Run Operation - A mode of operation for a traffic signal where the signal is not currently coordinated with adjacent traffic signals in the system.

Fully-Actuated Coordination - A traffic signal coordination feature in which at some point in the cycle, the coordinated phase loops become activated. This allows the coordinated phases the opportunity to gap out so that the traffic signal can service the minor phases without sacrificing system progression

Fully-Actuated Operation - A type of traffic signal operation in which all traffic movements are detected (actuated) and timing intervals vary with demand.

Fusion Splice - A permanent joint produced by the application of localized heat sufficient to fuse the ends of the optical fiber, forming a continuous light signal path.

-G-

Gap - Elapsed time between the end of one vehicle actuation and the beginning of the next actuation.

Gap-Out - Termination of a green interval due to an excessive time interval between the actuations of vehicles arriving on the green phase.

Gap Time - The time interval that extends the right of way portion of a phase. This interval is reset with each vehicle actuation. The phase is subject to the limit of the maximum green interval.

-H-

Heat Shrink Tubing - Used to seal the opening of a conduit or riser where fiber optic cable exits.

-I-

Inductive Loop - A loop of electrical wire placed in the roadway for vehicle detection.

Interconnect Cable - See Communications Cable

Interconnect Center - Refers to the housing compartment of the splice tray and patch panel.

Interval - Any of several divisions of the signal cycle during which signal indications do not change.

Isolated Signal - A signal which operates independently of any other signal.

-J-

Jumpers - See Fiber Optic Jumpers

Junction Box (Pull Box) - An enclosure usually placed underground with a removable top flush with ground level. It is used for splicing and storing cable. There are three types used for traffic purposes. 1) Regular sized junction boxes are used for loop lead-in or signal cable. 2) Oversized junction boxes are used primarily for communications cable. 3) Oversized heavy-duty junction boxes are used when the box may come in contact with vehicular traffic.

-L-

Lagging Left - A green arrow indication for a left turn that follows the green indication for the opposing through movement.

Lamp - The light bulb of a traffic signal section or an illuminated sign.

Lead-In Cable - The electrical cable that serves to connect the loop wire to the detector unit in the controller cabinet.

Leading Left - A green arrow indication for a left turn that precedes the green indication for the opposing through movement.

Lead/Lag Operation - A type of operation where a leading protected left is provided in one direction, followed by the through movements, and ending with a protected left in the opposite direction. Typically, the non-conflicting through movement is being served with the protected lefts.

Link - A telecommunications circuit between any two telecommunications devices.

Load Bay - The section of the back panel where load switches are installed.

Load Switch - An electrical device activated by the controller that turns power on or off for the traffic signal indications.

Locking Memory - A vehicle call for demand is remembered or held by the controller until the call has been satisfied by the appropriate green indication, even if the vehicle has left the detection zone.

Loop - see Inductive Loop

Loop Emulator Detection System - The system detects vehicles by processing images obtained through video cameras located at an intersection and providing outputs to the signal controller. The loop emulator detection system may be used when lead-in cable is difficult to maintain during lengthy time frames or when flexibility to move detection areas is needed such as for temporary signal configurations during numerous construction phases.

Loop Setback - The distance between the stop line and the loop.

Loop Wire - The electrical wire running from the lead-in cable to the inductive loop, forming the loop, and continuing back to the lead-in cable.

Louvers - A series of slats that are installed in a signal visor to limit a signal's visibility from an undesired direction.

-M-

Mast Arm - A structural support extending over the roadway from a pole, for the purpose of supporting traffic control devices.

Master Asset Number - A controller communication address number for the master controller that is used to communicate with the central computer.

Master Controller - A controller that supervises interconnected local controllers.

Maximum Green Interval - The maximum green time for a phase after an actuation by a conflicting phase.

Maximum Recall - An operating mode in which the right of way reverts to a particular phase. The controller serves this phase each cycle, regardless of vehicle demand.

Max-Out - Termination of a green phase resulting from the expiration of the maximum green interval.

Messenger Cable - see Span Wire

Microwave Vehicle Detector - A detector that uses a microwave beam to detect the motion of a vehicle. Microwave vehicle detectors are used where it may be impractical or cost prohibitive to use an inductive loop, such as on a bridge deck.

Minimum Green Interval (Initial Interval) - Minimum green indication time for a phase.

Minimum Recall - An operating mode in which the right of way reverts to a particular phase in the absence of conflicting vehicle calls. The controller serves this phase each time through the cycle for at least the minimum green interval, regardless of vehicle demand.

Modem - A device located in the master controller cabinet for transmitting digital data over telephone wires by modulating the data into an audio signal to send it and demodulating an audio signal into data to receive it.

Multi-Channel Detector - A detector unit that is capable of monitoring two or more detection zones.

MUTCD - Manual on Uniform Traffic Control Devices

-N-

National Electrical Safety Code (NESC) - Governs utility separations and clearances.

NEMA - National Electrical Manufacturer's Association

NEMA Controller - A type of controller in widespread use. The specifications for these controllers were developed by NEMA to provide compatibility and interchangeability. NEMA controllers are distinguished by standardized functions and input/output formats, and internal programming.

Nonlocking Memory - A controller feature in which a waiting call is dropped or forgotten by the controller after the vehicle leaves the detection zone.

-O-

OASIS - A traffic signal controller software developed by Econolite for implementation in an Advanced Transportation Controller (ATC) Type 2070 controller.

Occupancy - The proportion of time that a detection zone is occupied.

Offset - A time relationship, expressed in seconds or percent of cycle length, determined by the difference between the coordinated green phase and a system reference point.

Optically Programmed Head - A signal head containing optical units projecting an indication which is selectively masked so as to be visible only within desired viewing boundaries.

Option Zone - As a driver approaches a signal this is the area where, after seeing the signal head turn yellow, the driver is uncertain whether to decelerate and stop the vehicle, or continue and pass through the intersection.

Overlap - A green indication that allows traffic to move while a different phase is being timed.

-P-

Passage Time - see Gap Time

Patch Panel - A collection of connector panels in a common housing.

Peak Hour Factor (PHF) - The ratio of the total hourly flow to the maximum 15-minute rate of flow within the hour. A high PHF indicates uniform traffic throughout the hour and a low PHF indicates "spikes" of traffic within the hour.

Pedestrian Change Interval - The time that the flashing "Don't Walk" indication is displayed following the "Walk" interval.

Pedestrian Clearance Interval - The time interval that includes the pedestrian change interval, the yellow interval, and the all-red interval.

Pedestrian Push-button - A pedestrian detector that uses a pedestrian-operated button to place actuations.

Pedestrian Recall - An operating mode in which the controller serves a particular pedestrian phase for the walk time each time through the cycle, regardless of actuation.

Pedestrian Signal Head - Signal assembly advising pedestrians by word or symbols to "Walk" or "Don't Walk."

Pedestrian Soft Recall - An operating mode in which the controller serves a particular pedestrian phase for the walk time each time that the corresponding vehicle phase is served.

Permanent Call - A continuous call usually resulting from loop or detector unit malfunction.

Permissive Mode - A mode in which turning traffic is allowed to move but must yield to other traffic.

Phase - The right-of-way assignment of one or more traffic or pedestrian movements within the signal cycle.

Phase Omit - A feature that prohibits the controller from allowing a particular phase. Logic circuitry or controller programming may sometimes initiate the operation of this feature.

Phase Rotation - A programming option on some controllers that temporarily rearranges (rotates) the sequential order of phases to be served, depending on time-of-day or vehicle demand input. For example, a three-phase signal in which the left turn normally operates as a leading left, but operates as a lagging left during peak hours.

Phase Sequencing - A feature in which the traffic signal phases are sequenced differently than the NEMA standard dual ring configuration.

Pig Tail - See Fiber Optic Pigtail

Preemption - Transfer of the normal control of a signal to a special signal control due to a special situation such as passage of a train or granting of right of way to an emergency vehicle.

Presence Detection - The operating mode of a detector unit that sends a call to the controller as long as the vehicle remains within the detection zone.

Pretimed Operation - Traffic signal operation with predetermined fixed cycle length(s), fixed interval durations and interval sequence(s).

Protected Mode - A mode in which turning traffic is given right of way without having to yield to other traffic.

Protected/Permissive Mode - A mode in which turning traffic is given right of way during one portion of the cycle, but has to yield to other traffic during other portions of the cycle.

Pull Box - see Junction Box

Push-button - see Pedestrian Push-button

-Q-

Quadrupole Loop - An inductive loop design with a longitudinal saw slot along the center of a rectangular loop so that the loop wire can be installed in a figure-eight pattern. These loops are especially useful in the detection of small vehicles.

Queue Detector - A detector set back from the stop line so as not to place a call until a certain number of vehicles line up in the lane.

-R-

Rack-Mounted Detectors - Detector units that are not enclosed in a case and, therefore, must be inserted into a wired receptacle or "rack" in the cabinet.

Railroad Preemption - A type of preemption in which the normal signal sequence is interrupted when a train is approaching. Railroad tracks are cleared of vehicles and right of way is granted to vehicle movements that do not conflict with the train movement.

Recall, Maximum - see Maximum Recall

Recall, Minimum - see Minimum Recall

Recall, Pedestrian - see Pedestrian Recall

Recall, Soft - see Soft Recall

Red Clearance Interval - A clearance interval following the yellow change interval in which both the terminating phase and the next right of way phase display a red indication.

Red Detector Lock - A detector call is locked on a phase when that phase is in its red interval. The lock ensures service to the phase even if the detector input terminates prior to serving the phase.

Red Rest - An operating mode in which the signal will "rest" in red for all approaches, and will give a green indication to the first approach that is actuated.

Red Revert - Minimum red time before immediate phase reservice. Red revert times concurrently with the red clearance interval. This feature is typically used in lieu of a dummy phase.

Riser - A galvanized steel conduit that is used to protect wires and cables transitioning from underground to aerial.

RS-232 - See EIA-232

-S-

Sawcut - The groove cut into pavement to install inductive loops.

Sealant - The material used in the saw slot of an inductive loop to encapsulate the wire and environmentally seal the slot.

Self Healing Transceiver - A fiber optic transceiver that has the ability to transmit and receive a signal in a reverse direction should one of it's two channels become disabled or damaged.

Semi-Actuated Operation - A type of traffic signal operation in which some, but not all traffic movements are detected.

Sequential Phasing - Standard NEMA phasing sequence in which the cycle progresses through the individual phases in a predetermined order with no concurrent phases.

Shelf-Mounted Detectors - Detector units that are enclosed in a case and are placed on a shelf inside the cabinet.

Signal Face - That part of a signal head that controls one or more traffic movements in a single direction and contains one or more signal sections.

Signal Head - An assembly of one or more signal faces together with the associated signal housings.

Signal Section -The assembly of a housing, lens, and light source with necessary components and supporting hardware to be used for providing one signal indication.

Signal System - Two or more signal installations operating in coordination.

Simultaneous Gap-Out - An operating mode programmed on the controller in which two phases must concurrently satisfy their respective gap times in order to cross the barrier.

Single-Mode Fiber (SMFO) - A type of optical fiber in which the signal travels in one mode. The fiber has a small core diameter of approximately 8 microns. Used primarily for communications in transportation applications that may cover longer distances.

Snow Shoe - A cable storage rack used for storing extra cable on an aerial run.

Soft Recall - An operating mode in which the right of way reverts to a particular phase in the absence of conflicting vehicle calls. The controller is able to skip this phase in the cycle if there are no calls for it.

Span Wire (Messenger Cable) - A cable used to support traffic signal heads, signal cable, communications cable and/or signs.

Splice Cabinet - A cabinet used to provide a housing for cable splices.

Splice Enclosure - See Fiber Optic Splice Enclosure

Splice Tray - See Fiber Optic Splice Tray

Split - The portion of cycle length, in seconds or percent, allocated to green, yellow and all red for a particular signal phase.

Split Phasing - An operating mode in which two facing approaches are serviced with separate phases.

Standard Signal Face Clearances - A standard chart that shows how each signal clears from each phase.

Stop Line (Stopbar) - A pavement marking line indicating where vehicles should stop when directed by a traffic control device.

Strain Pole - Typically a metal pole that has sufficient strength to support a span wire without the use of guys.

Stretch Detection - A detection scheme which uses the extend feature of the detector unit and passage time on the controller to extend the green interval of a phase (see also Extend).

System Detectors - Detectors used to provide information to a master controller (or a central control computer). This information is used to select appropriate coordination patterns to meet the traffic demands.

-T-

Time Based System (TBS) - A system that changes timing plans on an internal time basis. This type of system does not require interconnection of the traffic signals.

Time-of-Day Patterns - Signal timing plans that are implemented according to the time of day.

Time-Space Diagram - A pictorial representation of the operation of a signal system.

Tracer Wire - A number 14 copper wire in a jacket that is pulled through non-metallic conduit along with fiber optic cable to provide a means for locating the conduit after it is installed.

Traffic-Actuated Controller - see Actuated Controller

Traffic-Adaptive System (TAS) - A system in which a master controller (or a central control computer) can adapt cycle length, splits and offsets based on vehicle demand.

Traffic-Responsive System (TRS) - A system in which a master controller (or a central control computer) specifies cycle, splits and offsets based on the real-time demands of traffic as sensed by vehicle detectors.

Traffic Signal - Any power-operated traffic control device that alternately assigns right of way.

Transceiver - See Fiber Optic Transceiver

Trenching - An excavation method to install a conduit system underground.

Triplex - An electrical service cable consisting of three twisted cables, two current carrying conductors, and one neutral. All three are housed in an outer jacket.

Trunk - A transmission link joining two points which is distinguished by its large information carrying capacity and that all signals go from point to point without branching off to any separate drops except at the end points.

Type 170 Controller - A type of controller in widespread use. In a Type 170 controller, processor hardware is standardized with the actual control being provided by specialized, externally-loaded software.

Type 2070L Controller - One of the three primary types of controllers in widespread use. In a Type 2070L controller, hardware is standardized at the module level to aid in compatibility between manufacturers' equipment. Currently, manufacturer specific drivers are embedded in the firmware to allow customer-supplied application programs, such as OASIS, to run in an OS-9 operating system.

-V-

Vehicle Call Memory – See Red Detector Lock and Yellow Detector Lock

Volume-Density - A type of signal control with a variable passage time and a variable minimum green time. It reduces the probability of vehicles being caught in the option zone.

-W-

Weatherhead - The entrance into the top of a riser used for electrical cables.

-Y-

Yellow Change Interval - The display of a yellow indication following the right of way interval which warns drivers of the termination of right of way.

Yellow Detector Lock - A detector call is locked on a phase whenever the phase is not in its green interval. The lock ensures service to the phase even if the detector input terminates prior to serving the phase.