Red Light Running Entrapment Against Commercial Truck Drivers – Florida

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It is all about the length of the yellow lights. The laws of physics require a yellow light to be at least a certain amount of time so that drivers can stop or go safely and legally. Human factors such as perception and reaction add to that time. Mechanical factors such as air-brake lag time also add to that time. The main problem is the federal standards themselves. When a city sets its yellows to the federal standards, the city already guarantees a large volume of drivers running red lights inadvertently. The federal standards violate the laws of physics[1]. The most time a yellow light offers is *half* the time it takes a driver to stop his vehicle. While most drivers believe that a yellow light means slow down, the yellow light forbids a driver to slow down. A driver must either stop or a driver must proceed to the intersection at full speed, even when proceeding means beating the light. Slowing down, on the other hand, requires up to twice the time a yellow light proffers. Drivers who slow down to turn or slow down for traffic near the intersection are entrapped by the yellow light. Had the yellow light been formulated to provide the time it takes a driver to stop, then drivers would have the option to slow down and always be safe and legal. Inadvertently running red lights would not exist. As it is though, drivers run red lights because drivers cannot break the indelible laws of physics.

Though it is problems of physics that are first and foremost causing drivers to run red lights, this paper is not about physics. This paper is rather about how the State of Florida exacerbates the problem for commercial truck drivers. The State of Florida sets its yellow light times shorter than Florida's requirements for commercial trucks.

The State of Florida entraps a much larger percentage of truck drivers than passenger car drivers. As is true for most States, Florida's traffic engineers only acknowledge the existence of passenger cars in its yellow timing standards. Engineers de-facto reduce the yellow light times to handle the majority of traffic--passenger cars, not to encompass all traffic which would include commercial trucks. Engineers willfully ignore unique vehicle streams like commercial trucks. Acknowledging them would mean longer yellow lights. Long yellow lights to traffic engineers are bad. Engineers presume that longer yellow lights significantly decrease traffic flow and decreasing traffic flow violates the traffic engineer's main goal of maximum flow. Safety is important but it comes in second.

(One should note that the safety of drivers does not automatically imply the legal motion of drivers. To increase safety but decrease legality, a traffic engineer can lengthen the all-red clearance interval and shorten the yellow light duration. The longer all-red interval reduces T-bone crashes and the shortened yellow increases drivers running red lights.)

The Florida's *CDL Handbook* demands the extra half second for commercial truck's air brakes[5]. The Florida *Traffic Engineering Manual* which tells traffic engineers how to time yellow lights ignores it. Most commercial trucks use air brakes and air brakes always require at least an extra 0.5 seconds to pressurize before providing the vehicle with a steady deceleration.

Commercial trucks have a normal deceleration of 8.0 ft/s^2, not the 10 ft/s^2 as used by Florida's traffic engineers[8,9]. Trucks are much heavier than passenger cars. They cannot slow down as quickly. A lower deceleration rate computes to a longer yellow light. Had Florida's traffic engineers recognized the existence of commercial trucks, then the slower deceleration rate of 8.0 ft/s^2 would translate to an additional 1.1 seconds of yellow time.

Most commercial truck drivers need more perception/reaction time too. Truck drivers responding to a light turning yellow not only must consider their own safety but also the safety of their passengers and of vehicles travelling around their truck. Depending on the weight of the truck, a passenger car's 10 ft/s^2 deceleration is too aggressive and can cause a truck to jackknife.

States' commercial driver's license handbooks include a section on perception/reaction time. Perception/reaction time is a topic unto itself. To put it briefly, CDL handbooks say a truck driver needs 2.5 seconds for perception/reaction time. But Florida sets its yellow light perception/reaction time to 1.0 second. A traffic engineer would argue that the CDL handbook states that the 2.5 seconds is within the context of *hazards* (which is true), and that 1.0 second is more than enough time for expected events such as intersections (which is true for the simplest intersections for passenger cars).

The problem with the traffic engineer's argument is the assumption that hazards never happen for drivers approaching intersections. That assumption is immediately proved false. Consider the situation of a light turning yellow and then a car pulling out from a business exit in front of a driver. Where business entrances are close to the intersection, the situation occurs frequently. Yet traffic engineers ignore this situation. The physics of the yellow light formula forbids a driver to slow down but the approaching driver must tap his brakes to avoid the collision. In many circumstances the driver will be forced to run a red light.

Perception/reaction times are the most subjective aspect of the yellow light formula. Adequate perception/reaction times vary from publication to publication. The most complete treatise on perception/reaction times comes from AASHTO. AASHTO, one of the foremost widely-used publications in traffic engineering, recognizes that drivers need at least 2.5 seconds at the minimum for all intersections[2]. AASHTO's figure comes without the existence of hazards.

Entrapment is illegal in the United States[3]. One only has to consider the requirements of air-brakes. Florida teaches its commercial truck drivers that they need a half second for air-brakes yet Florida does not give that half second in its yellow lights. The legal argument can be made that within its own documents, the State of Florida entraps commercial truck drivers.

Commercial Trucks

Commercial trucks are tractor-trailers, public buses and school buses. The cover illustration of *Florida Commercial Driver's License Handbook* illustrates this. For commercial truck drivers in Florida, the *Florida Commercial Driver's License Handbook* opposes the *Florida Traffic Engineering Manual* causing truckers to run red lights.

The *Florida Traffic Engineering Manual* sets the yellow light durations to 1 second[4]. The *Florida Commercial Driver's License Handbook* requires at least an additional 0.5 seconds for air brake lag time[5], additional time reflecting the difference between the commercial truck's deceleration rate (8.0 ft/s^2) and Florida's yellow time standard deceleration rate (10 ft/s^2), and possibly additional time for perception/reaction time.

Yellow Duration Does Not Accommodate Air Brake Lag Time

The *Florida Commercial Driver's License Handbook* states that trucks with air brakes require an additional 0.5 seconds to stop because it takes a minimum of 0.5 seconds for the air to flow through the lines to the brakes[5].

- The *Florida Traffic Engineering Manual* yellow light duration does not provide yellow time for air-brake lag time. Air brake lag time, while in the stopping distance formula in the Florida CDL Handbook, does not make an appearance in yellow light timing formula in the *Florida Traffic Engineering Manual.*

Deceleration Rates under *Emergency* Conditions

When computing the braking distance, it is first important to show that the *Florida Commercial Driver's License Handbook* uses the deceleration rate associated with emergency braking. Traffic engineers should not justify their practice of a short yellow light by using the braking distances in the CDL handbook. Under normal conditions a truck driver, just like a passenger car driver, does not slam on the brakes for a yellow light. Slamming on the brakes causes rear-end collisions for everyone and jackknifing for trucks.

To show that the handbook is using an emergency deceleration, I'll compute the handbook's implied deceleration rate. The handbook says that under ideal conditions, "At 55 mph on dry payment with good brakes, it can take about 216 feet"[6] to come to a stop. With this information, one can compute the deceleration rate:

The braking distance formula from the laws of physics is:

$$d = \frac{v^2}{2a}$$

where v is the initial speed of the vehicle and *a* is the deceleration rate. The handbook gives values for d and v. Solve for *a*:

$$a = \frac{v^2}{2d} = \frac{(55 * 1.47)^2}{2 * 216} = 15.1\ ft/s^2$$

15.1 ft/s^2 is the handbook's implied deceleration rate. One who is familiar with traffic engineering instantly recognizes this value as an emergency braking deceleration[7].

Deceleration Under *Normal* Braking Conditions

Under normal braking conditions, the deceleration of a commercial truck under the control of a best-performance driver, according to the National Cooperative Highway Research Program[8], is 0.25g, which is 0.25 x 32 = 8.0 ft/s^2. The State of Maryland[9] uses this rate in its yellow timing standard.

- The normal deceleration rate of a commercial truck is 8.0 ft/s^2.

- *The Florida Traffic Engineering Manual* sets the yellow time using a deceleration rate to 10.0 ft/s^2—that of a passenger car. 10.0 ft/s^2 is more aggressive than what a truck does normally.

I will compute the amount of additional yellow time necessitated by a truck's slower deceleration rate. Note the time component for braking within the yellow light formula is v / 2a. Therefore the additional yellow time, t, required for a commercial truck is the difference between a commercial truck's yellow time and a passenger car's yellow time:

$$t = \frac{v}{2a_t} - \frac{v}{2a_c} = \frac{v}{2\ x\ 8} - \frac{v}{2\ x\ 10}$$

For a 45 mph level road (45 mph = 66 ft/s), the additional yellow time for a truck = (66/16 – 66/20) = 4.125 – 3.3 = 1.125 seconds.

- Florida shorts the yellow light duration for a truck driver by about 1.6 seconds on a 45 mph level road. That is 1.125 seconds short by using the wrong deceleration rate plus 0.5 seconds short for not including air-brake lag time.

Different Perception-Reaction Times

The *Florida Commercial Driver License Handbook* states:

- That the "average perception time for an alert driver is 1.75 seconds."[11]

- That the "average driver has a reaction time of 0.75 seconds to 1 second."[11]

The handbook says that these values are for drivers when they see a hazard. The minimum Florida combined perception-reaction time for the *average* driver is 1.75 + 0.75 seconds = 2.5 seconds.

- Florida sets the perception-reaction time of yellow to 1.0 second[10]. Florida's traffic engineers ignore the possibility of hazards at intersections. They assume that cars never pull out into the road in front of drivers who are approaching the intersection, and that children never enter the crosswalk on the onset of yellow light. It is important to reiterate that traffic engineers consider only the majority of drivers and only the majority of events. They intentionally omit unique vehicle streams or relatively infrequent events regardless of how common those streams or events are.

- The American Association of State Traffic Highway Officials (AASHTO) recommends as minimum of 2.5 seconds perception-reaction time for all drivers in all scenarios[2].

Summary

The State of Florida does not allow commercial truckers their required air brake lag time. Florida needs to increase the yellow time by at least 0.5 seconds.

The State of Florida does not compensate for the heaviness of a commercial truck and instead sets the yellow to the decelerate rate of a passenger vehicle. For a 45 mph road, the State of Florida needs to increase the yellow time an additional 1.125 seconds.

The State of Florida does not allow any driver time to avoid hazards in the intersection. To avoid hazards in the intersection, the State of Florida has to increase the yellow light time by an additional 1.5 seconds.

References

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[4] Florida Department of Transportation, *Traffic Engineering Manual* , **3-6-2** (2010).

[5] Florida Department of Highway Safety and Motor Vehicles, *Florida CDL Handbook*, **61** (2013).

[6] Florida Department of Highway Safety and Motor Vehicles, *Florida CDL Handbook*, **23** (2013).

[7] Fawzi P. Bayan, et. al, *Brake Timing Measurements for a Tractor-Semitrailer Under Emergency Braking*, Publication 2009-01-2918, Scientific Expert Analysis Limited, **5** (2009).

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[9] Maryland Division of State Documents, Annotated Code of Maryland, Title 11 Department of Transportation, Subtitle 04 State Highway Administration, Chapter 14 Traffic Control Signal Monitoring Systems—Duration of Yellow Signal Indications, Section 02 (2012).

[10] Florida Department of Transportation, *Traffic Engineering Manual* , **3-6-2** (2010).

[11] Florida Department of Highway Safety and Motor Vehicles, *Florida CDL Handbook*, **23** (2013).