Measure Name: Traffic signal preemption

Definition: Transfer of normal operation of traffic signals to a special control mode that interrupts the normal sequence of traffic signal phases to accommodate train operation at or adjacent to the traffic signal-controlled intersection. [2]

Tags:

Type of Incident:

- ☐ Non-Motorized Users Only
- ☒ Motor Vehicles Only
- ☐ Both

Intervention Strategy:

- ☐ Data: application and planning
- ☐ Education: outreach and messaging
- ☐ Enforcement: policy development and rulemaking
- ☒ Engineering: technological and physical deterrents

Type of Problem:

- ☐ Non-Motorized Users Violating Warning Devices
- ☒ Motor Vehicles Violating Warning Devices
- ☒ Vehicle ROW Incursion
- ☒ Vehicle Congestion
- ☐ Blocked Crossing
- ☐ Vehicle Hang-up

Measure Category:

- ☐ Risk Assessment
- ☐ Policy and Enforcement
- ☐ Collaboration, Training, and Education
- ☐ Public Communication
- ☐ Physical Barriers
- ☒ Detection and Lighting
- ☒ Infrastructure Modification
- ☐ Post-Incident Management
- ☒ Warning Devices

Description

The Manual on Uniform Traffic Control Devices (MUTCD) defines preemption as "the transfer of normal operation of a traffic control signal or a hybrid beacon to a special control mode of operation" [1]. For crossings, traffic signal preemption is a special traffic signal timing sequence used at intersections at or adjacent to at-grade grade crossings [2]. A red-light signal at a downstream signalized intersection may force traffic to back up over the crossing; the primary function of preemption is to clear vehicles from the grade crossing when a train is detected to be approaching. Preemption will flash a green signal at the signalized intersection when the train is approaching to allow vehicles to clear from the tracks before train arrival.

There are two forms of preemption: simultaneous preemption and advance preemption. Simultaneous preemption occurs when the traffic signal controller is preempted at the same time the grade crossing active warning devices are activated, whereas advance preemption occurs when the traffic signal controller is preempted before the grade crossing active warning devices are activated [3]. Advanced preemption can allow additional time for the traffic signal to activate the track clearance phase and allow drivers to clear the minimum track clearance distance (MTCD) [4]. Simultaneous preemption can be effective at intersections where the timing plan for preemption is short, but advance preemption should be considered if the intersection requires a longer timing plan to clear the MTCD [4]. Advance preemption requires earlier detection, such as by installing longer "track circuits," more robust interconnection circuitry, and upgraded signaling systems [4].

According to the MUTCD and guidelines of other manuals, traffic signal preemption should be used where there is a signalized intersection within 200 feet of a grade crossing [1] [2] [3] [4]. However, preemption should also be considered at any site where traffic is observed to frequently back up over the tracks [3].

Additional search terms: *interconnection, intersection, congestion*

Advantages

- Improves safety by clearing vehicles from grade crossings [3].

Drawbacks

Include citations (use bracketed #s from research section)

- Preemption requires additional coordination between highway agencies and railroad companies to fully understand the operation of systems [2].
- Advance preemption requires additional infrastructure improvements and results in increased installation and maintenance costs. Additionally, these improvements are typically paid for by railroad companies and thus require additional coordination [2].
- Installation of preemption system can be expensive.

Notable Practices

- Preemption timing plans should consider the following: intersection geometry, highway-rail grade crossing geometry, approaches to the grade crossing, travel times to clear intersection/crossing, vehicle volumes, frequency of train movements, train stops within the approach to grade crossing, vehicle queue lengths, design vehicles, types of active warning devices, pedestrian activity [5].
- Clearance time is additional time provided to account for track features such as skewed grade crossings or other features that require additional time for vehicles to clear the crossing. This should be considered along with the number of large/slow vehicles that may typically utilize the crossing. The SCRRA manual recommends clearance time to be added to the minimum time at a rate of one second per 10 feet of MTCD exceeding 35 feet [5].
- Blank-out or Changeable Message Signs or other appropriate signal indications should be considered to prohibit left turns toward the grade crossing during preemption [2].
- "Preemption trap" is the condition where vehicles may be trapped within the MTCD due to improper timing of the preemption signal. Care should be taken to avoid this situation [5].
- Preemption may also be coordinated for other priorities such as emergency vehicles or transit vehicles. However, railroad preemption should always retain highest priority [3].

References

[1] Federal Highway Administration. (2023). Manual on Uniform Traffic Control Devices.

> Excerpt: The purpose of the MUTCD is to establish uniform national criteria for the use of traffic control devices that meet the needs and expectancy of road users on all streets, highways, pedestrian and bicycle facilities, and site roadways open to public travel.

[2] U.S. Department of Transportation. (2019). Highway-Rail Crossing Handbook – Third Edition.

> Abstract: The purpose of the *Highway-Rail Crossing Handbook, 3rd Edition* is an information resource developed to provide a unified reference document on prevalent and best practices as well as adopted standards relative to highway-rail grade crossings. The handbook provides general information on highway-rail crossings; characteristics of the crossing environment and users; and physical and operational changes that can be made at crossings to enhance the safety and operation of both highway and rail traffic over such intersections. The guidelines identified and potential alternative improvements presented in this handbook reflect current best practices nationwide.

[3] Texas Department of Transportation. (2015). Rail-Highway Operations Manual.

> Excerpt: The Texas Department of Transportation (TxDOT) Rail-Highway Operations Manual is intended to cover responsibilities and best practices on projects that impact both roadway and railroad rights-of-ways. The manual defines both District and Division TxDOT responsibilities on the various types of projects encountered and coordination efforts required between railroad companies and other entities.

[4] Cambridge Systematics. (2018). Rail Strategy Study – Grade Crossing Toolkit.

> Excerpt: The Grade Crossing Toolkit provides information and tools to identify candidate crossing improvements across a range of options. The Toolkit describes rail crossing treatments, such as grade

separations, closures, consolidation, passive treatments, active devices, quiet zones, and specialized treatments for pedestrian/bicycle issues.

[5] Southern California Regional Rail Authority. (2021). SCRRA Highway-Rail Grade Crossing Manual.

Excerpt: This Manual was developed in 2009 and issued as a Recommended Design Practices and Standards Manual.

Additional Resources

Institute of Transportation Engineers. (2019). Preemption of Traffic Signals Near Railroad Grade Crossings Recommended Practice, Second Edition.

Excerpt: Where a signalized intersection exists in close proximity to a railroad crossing—and either queues from the intersection impact the crossing, or queues from the crossing impact the inter- section—the railroad signal control equipment and the highway traffic signal control equipment should be interconnected. The normal operation of the traffic signals controlling the intersection should be preempted to operate in a special control mode when trains are approaching. While public agencies have practices or procedures on the preemption of traffic signals near railroad grade crossings, there have been significant advances in engineering and technology since the last edition in 2006. The goal of the recommended practice is to reflect the current state-of-the-practice and to provide the user with a broad overview of key considerations. The report is written primarily for engineers working for public agencies, railroads, and public transit agencies engaged in signal design and operational timing. ITE's intent for the recommended practice is to reflect a balance between sound engineering theory and practical application.

Related Measures

- Pre-signal
- Queue cutter

Images

- No image available