Oregon Department of Transportation

Heavy Railroad Preemption Operations Guide

Traffic Engineering Section | Delivery & Operations Division

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Oregon Department of Transportation

Engineering & Technical Services Branch

555 13th Street NE
Salem, Oregon 97301

503-986-3568

Traffic Engineering Website

Contents

1 Preface

Oregon law ORS 824.200 to 824.256 authorizes ODOT to determine the character and type of traffic control devices used at **ALL** railroad-highway crossings in Oregon with the goal of achieving uniform and coordinated regulation. The ODOT Commerce and Compliance Division (CCD, formally rail division) has been delegated this authority via Chapter 741 of the Oregon Administrative Rules (OAR).

This document provides guidance on the preemption operation for all traffic signals interconnected to railroad-highway crossings in Oregon and establishes uniform methods and guidance. However, note that ODOT does not have jurisdiction over any traffic signal (e.g., normal operation and maintenance) located off the state highway system as per ORS 810.010, unless otherwise stated in an intergovernmental agreement. As such, this document may contain guidance that is not applicable or requires deviations when applied to a traffic signal located off the state highway system due to the potential for differences in traffic signal controller cabinet equipment/wiring, traffic signal software, and/or local agency traffic signal policies, guidelines, and practices.

This document supports and compliments the application of sound engineering judgement by transportation professionals. The intended audience of this document is transportation professionals involved in the design, operation, or maintenance of traffic signals in Oregon.

The state traffic operations engineer maintains this document, with concurrence from the ODOT CCD. Send comments or questions on this document to Chris.J.PRIMM@odot.oregon.gov, or

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1.1 Typical Railroad Relays

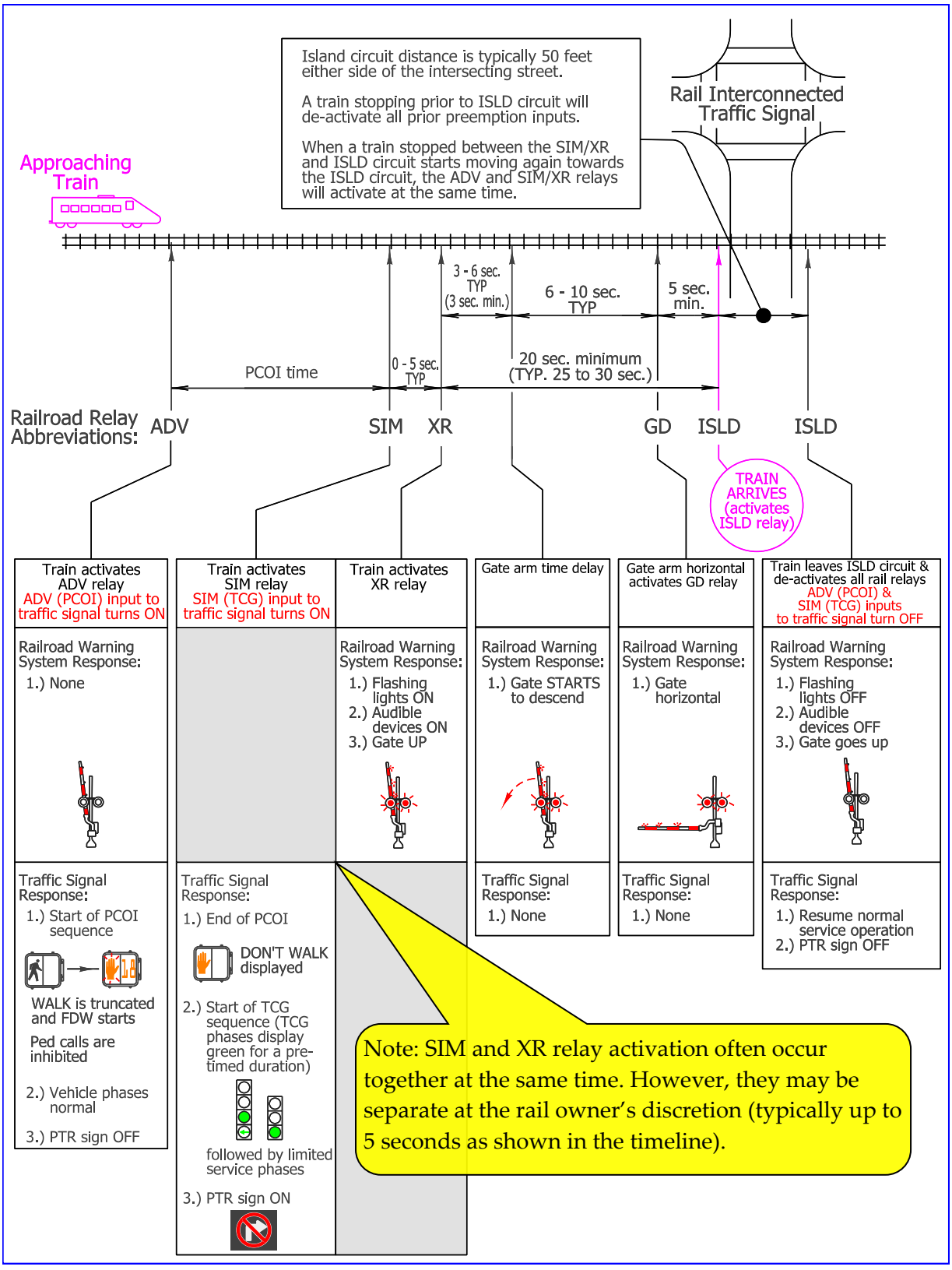
The railroad cabinet provides inputs to the traffic signal cabinet via relays. Each relay starts a specific action. Typical railroad relays with the responses of the traffic signal and railroad warning system (wig-wag flashing red indications, audible devices, and gate arm) are described in Table 1-1 below with the sequence shown in Figure 1-1. Note that only two relay inputs are used by the traffic signal controller in Oregon.

Additional railroad relay inputs used by the traffic signal controller may become standard in the future but will only be allowed in the new ATC serial cabinet. Retrofitting existing 332 and 332S cabinets will not be allowed.

Table 1-1 | Typical Railroad Relays Used for Preemption Operation

Acronym	Railroad Relay Name	Traffic Signal Response	Railroad Warning System Response	Input used in the Traffic Signal Cabinet
ADV	Advance Preemption Relay	Start of PCOI sequence: • Truncate any walk interval • Serve entire flashing don't walk interval • Pedestrian calls inhibited • Normal traffic signal phase rotation	No response	Yes: ADV(PCOI) input
SIM	Simultaneous Preemption Relay	Start of TCG sequence: • If present, PTR sign(s) turn on • Truncate any walk or flashing don't walk interval • If present, track clearance green (TCG) time served • Limited service phases served after TCG time	No response	Yes: SIM(TCG) input
XR	Crossing Active Relay	No Response	Railroad lights begin to flash and bells begin to ring	No
GD	Gate Down Relay	No response	Railroad gates are horizontal	No
ISLD	Island Relay	No response	Keeps the railroad warning system active until train leaves the island circuit	No

Figure 1-1 | Railroad Relay Activation with Traffic Signal and Railroad Warning System Response



1.2 General Traffic Signal Preemption Sequence Information

There are three basic preemption operation text templates that are used to describe BOTH the pedestrian clear out interval (PCOI) sequence (see section 1.2.1) AND the track clearance green (TCG) sequence (see section 1.2.2) that can be used based on which specific TCG sequence is required for the intersection:

1. Default standard track clearance green (TCG) sequence
2. Early track clearance green (TCG) sequence – Approval required (STE & CCD)
3. No track clearance green (TCG) sequence – Approval required (STE & CCD)

These text templates, described in detail in sections 1.2.1 and 1.2.2, are used when creating the preemption plan sheet (see section 1.2.3). The majority of intersections will use one of these three templates, modified only as per the instructions. However, unique operations may exist and will have custom text that is vetted by the diagnostic team and approved by ODOT CCD and the state traffic engineer as per OAR741-110-0070(3)(b). Additional information on unique operations may also be documented and kept in the signal timing files to inform the signal timer. Be sure to read and understand the preemption operation text of the site specific preemption plan sheet prior to programming the signal software.

OAR 741-110-0070 (3) – Operation of Active Devices:

(3) Advance Preemption or other appropriate methods shall be used to provide a pedestrian clear-out interval (PCOI) before the vehicle clear-out interval (VCOI).

(a) When a VCOI is required, the indication for the track clearance phases shall be GREEN.

(b) The road authority may submit an engineering study to the State Traffic Engineer to request a deviation from the standards. The State Traffic Engineer, together with the ODOT Rail and Public Transit Division, Crossing Safety Section Manager, may authorize a signalized intersection operation consistent with the findings of the study.

1.2.1 Pedestrian Clear Out Interval (PCOI) Sequence

The pedestrian clear out interval (PCOI) sequence happens prior to the start of the track clearance green (TCG) sequence to allow any pedestrian with an active pedestrian phase the opportunity to complete their crossing. It also inhibits any new pedestrian call from being served. The PCOI sequence is initiated when the ADV relay activates the ADV(PCOI) input. This sequence is described in all of the preemption text templates shown in Figure 1-2, Figure 1-4, and Figure 1-7. An illustration of this sequence is shown via example intersections in Figure 1-3, Figure 1-5, Figure 1-6, and Figure 1-8.

A PCOI sequence is required unless all crosswalks are closed. Note: there are rare cases where the PCOI sequence can be provided without using the ADV relay if there is no track clearance green phase required (e.g., Front Street at State Street in Salem), but to improve uniformity for all rail interconnected traffic signals it is desirable to always use the ADV relay and ADV(PCOI) input to initiate the PCOI sequence.

1.2.2 Track Clearance Green (TCG) Sequences

There are three basic options for the track clearance green (TCG) sequence that could be used based on the intersection's unique site specific features. Each option is discussed below in more detail.

1. Default standard track clearance green (TCG) sequence
2. Early track clearance green (TCG) sequence – Approval required (STE & CCD)
3. No track clearance green (TCG) sequence – Approval required (STE & CCD)

The track clearance green (TCG) sequences were previously called the vehicle clear out interval (VCOI). This terminology change was made to avoid confusion between the different definitions of VCOI used by the rail owner and the traffic engineers.

Default Standard Track Clearance Green (TCG) Sequence

The default standard track clearance green (TCG) sequence occurs after the PCOI sequence and allows vehicles that are inappropriately stopped on the railroad tracks to advance toward the signalized intersection and away from the railroad crossing via the pre-timed track clearance green (TCG) time. It can also allow the queue of vehicles between the signalized intersection and the railroad crossing to clear the intersection so they don't encounter a long delay, but there is no requirement to completely clear this queue. Following the TCG green time, limited service phases (i.e. phases with movements that don't conflict with the train) are served while the train occupies the crossing. When the train clears the crossing, the traffic signal returns to normal operation which may include alternate phasing to speed preempt exit, serve the longest held phases, return to coordination, or other strategies at the road authorities' discretion.

The default standard TCG sequence is initiated when the SIM relay activates the SIM(TCG) input. This sequence is described in the default standard preemption text template shown in Figure 1-2. An illustration of this sequence is shown via an example intersection in Figure 1-3.

The default standard preemption is used at the majority of intersections. When used, it is shown on the preemption plan sheet.

Early Track Clearance Green (TCG) Display Sequence

The early TCG display sequence can be used to enable the TCG phases to turn green prior to the SIM(TCG) input if there are no active pedestrian walk or flashing don't walk indications. The early TCG display is accomplished using the ADV(PCOI) input. The TCG indications can be programmed to display green at any time between the ADV(PCOI) input and SIM(TCG) inputs. **Note: The early TCG display sequence still includes the pre-timed TCG green time that is initiated with the SIM(TCG) input.** Following the TCG green time initiated by the SIM(TCG) input, limited service phases (i.e. phases with movements that don't conflict with the train) are served while the train occupies the crossing. When the train clears the crossing, the traffic signal returns to normal operation which may include alternate phasing to speed preempt exit, serve the longest held phases, return to coordination, or other strategies at the road authorities' discretion.

The early TCG display sequence may be beneficial when the any of following conditions exist:

- High volume of traffic on the TCG approach
- High volume of heavy trucks on TCG approach
- High train speed
- Long clear storage distance (e.g. over 100 feet)
- To eliminate pre-signals. See ODOT Traffic Signal Design Manual section 16.8.1.

Use of the early TCG display sequence should be carefully considered, as a long green time for the TCG phases may create excessive delays to the other phases and the traffic signal could appear to be "malfunctioning" since the railroad warning system will not be active at this time. Additionally, it is important to have a consistent time differential between the ADV(PCOI) input and the SIM(TCG) input to avoid unacceptably long TCG green times. Sites with large and irregular time differentials between the ADV(PCOI) input and SIM(TCG) input will not have cycling phases to prevent very long queueing on non-track clearance approaches.

This sequence is described in the early TCG display preemption text template shown in Figure 1-4. An illustration of this sequence is shown via an example intersection in Figure 1-5 (without a controller programmed delay) and in Figure 1-6 (with a controller programmed delay).

Use of the early TCG display sequence requires approval of ODOT CCD and the state traffic engineer. If approved, it is shown on the preemption plan sheet.

No Track Clearance Green (TCG) Sequence

The no TCG sequence occurs after the PCOI sequence and requires vehicles to stop or remain stopped at the railroad stop line by omitting the TCG green time and serving the limited service phases (i.e. phases with movements that don't conflict with the train) prior to the train's arrival. The limited service phases continue to be served while the train occupies the crossing. When the train clears the crossing, the traffic signal returns to normal operation which may include

alternate phasing to speed preempt exit, serve the longest held phases, return to coordination, or other strategies at the road authorities' discretion.

The no TCG sequence is initiated when the SIM relay activates the SIM(TCG) input. This sequence is described in the no TCG preemption text template shown in Figure 1-7. An illustration of this sequence is shown via an example intersection in Figure 1-8.

Use of the no TCG sequence requires approval of ODOT CCD and the state traffic engineer. If approved, it is shown on the preemption plan sheet.

Figure 1-2 | Default Standard Preemption Text Template

Designer Notes:
1. This is the default Standard Preemption operation
2. Fill out green locations with "__"
3. Follow and delete instructions in RED { }
4. Pink text may be deleted or re-labeled (according to instructions)
5. Black text should not be modified

TRAFFIC SIGNAL RAILROAD PREEMPTION USING TRACK CLEARANCE GREEN

Site Specific Constraints:

1. Track Clearance Green (TCG) phases: __ & __
2. Pedestrian Clear Out Interval (PCOI) time needed: ___ seconds
3. Limited Service vehicle phases: __,__,& __
4. Protected left-turn phase __ green arrow displayed only during the TCG sequence via a Type 7 signal head. {DELETE IF NOT APPLICABLE}
5. Frequent railroad switching within the control limits of the highway road crossing often abbreviates the PCOI time. {DELETE IF NOT APPLICABLE – VERIFY WITH ODOT RAIL DIVISION}

The Preemption Sequence is as Follows:

1. When the ADV relay activates the ADV (PCOI) input, the following PCOI sequence is initiated:
    a. No change to vehicle phase sequence
    b. All active pedestrian phase walk intervals immediately advance to and complete their flashing DON'T WALK interval
    c. All pedestrian phase calls are inhibited from being serviced
    d. Railroad Preemption PTR sign remains OFF. {DELETE IF NOT APPLICABLE}
2. When the SIM relay activates the SIM (TCG) input, the following TCG sequence is initiated:
    a. Railroad Preemption PTR sign turns ON. {DELETE IF NOT APPLICABLE AND RE-LABEL "b" TO "a" AND SO ON}
    b. All active pedestrian phase flashing DON'T WALK intervals immediately advance to solid DON'T WALK.
    c. Any active TCG phase displaying GREEN remains GREEN and all non-TCG phases displaying GREEN terminate by advancing through their YELLOW and RED clearance intervals.
    d. Once all TCG phases display GREEN simultaneously, the controller programmed TCG interval is timed followed by the TCG phases advancing through their YELLOW and RED clearance intervals
    e. All programmed Limited Service vehicle phases and their associated pedestrian phases are serviced in their normal sequence based on demand.
3. When the railroad relays deactivate the traffic signal inputs:
    a. Railroad Preemption PTR sign turns OFF {DELETE IF NOT APPLICABLE AND RE-LABEL "b" TO "a"
    b. Normal intersection operation and sequence resumes.

Figure 1-3 | Default Standard Preemption Example

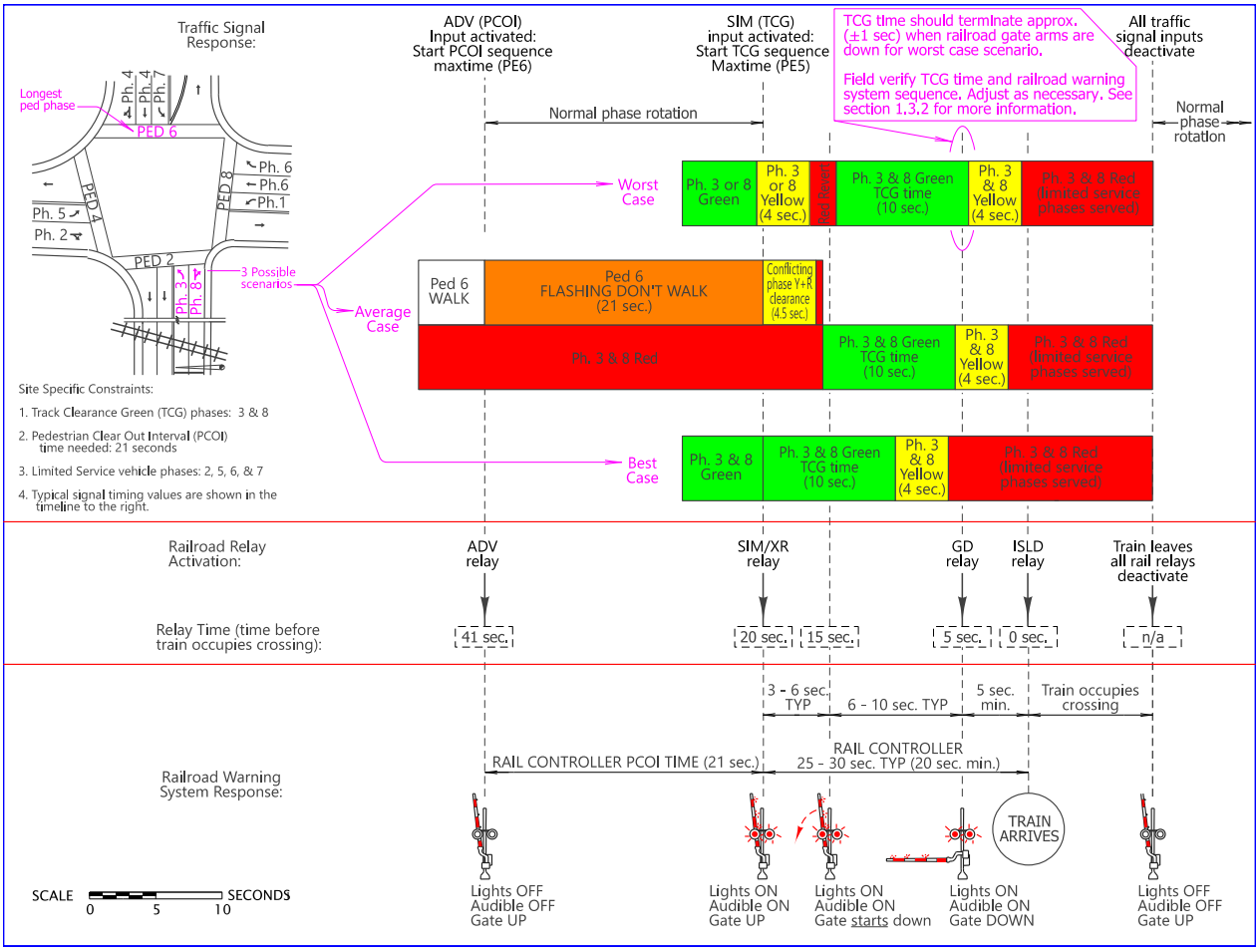


Figure 1-4 | Early TCG Display Preemption Text Template

Designer Notes:
1. This preemption operation requires approval of the ODOT CCD & state traffic engineer. Verify with the state traffic operations engineer 503-986-3568
2. Fill out green locations with "__"
3. Follow and delete instructions in RED { }
4. Pink text may be deleted or re-labeled (according to instructions)
5. Black text should not be modified

TRAFFIC SIGNAL RAILROAD PREEMPTION USING TRACK CLEARANCE GREEN WITH EARLY DISPLAY

Site Specific Constraints:

1. Track Clearance Green (TCG) phases: __ & __
2. Pedestrian Clear Out Interval (PCOI) time needed: ___ seconds
3. Limited Service vehicle phases: __,__,& __
4. Protected left-turn phase __ green arrow displayed only during the TCG sequence via a Type 7 signal head. {DELETE IF NOT APPLICABLE}
5. TCG phases may display GREEN early during the PCOI sequence as described in Section 1(b)(i)-1(b)(iii)
6. Frequent railroad switching within the control limits of the highway road crossing often abbreviates the PCOI time. {DELETE IF NOT APPLICABLE - VERIFY WITH ODOT RAIL DIVISION}

The Preemption Sequence is as Follows:

1. When the ADV relay activates the ADV (PCOI) input, the following PCOI sequence is initiated:
    a. All pedestrian phase calls are inhibited from being serviced.
    b. The following signal timing sequence begins:
        i. All active pedestrian phase WALK intervals immediately advance to and complete their flashing DON'T WALK interval. Skip to signal timing sequence 2(b)(i) if simultaneous preemption RR input is activated at this stage.
        ii. After a controller programmed delay, any active TCG Phase displaying GREEN remains GREEN and all non-TCG phases displaying GREEN terminate by advancing through their YELLOW and RED clearance intervals. Skip to signal timing 2(b)(iii) if simultaneous preemption RR input is activated at this stage.
        iii. Once all TCG phases display GREEN simultaneously, they remain GREEN. Skip to signal sequence 2(b)(iv).
    c. Railroad Preemption PTR sign remains OFF. {DELETE IF NOT APPLICABLE}
2. When the SIM relay actives the SIM (TCG) input, the following TCG sequence is initiated:
    a. Railroad Preemption PTR sign turns ON {DELETE IF NOT APPLICABLE}
    b. The following signal timing sequence begins: {IF "a" WAS DELETED ABOVE, RE-LABEL "b" TO "a"}
        i. All active pedestrian phase flashing DON'T WALK intervals immediately advance to solid DON'T WALK.
        ii. Any active TCG phase displaying GREEN remains GREEN and all non-TCG phases displaying GREEN terminate by advancing through their YELLOW and RED clearance intervals.
        iii. All TCG phases display GREEN simultaneously.
        iv. The controller programmed TCG interval is timed followed by the TCG phases advancing through their YELLOW and RED clearance intervals.
        v. All programmed Limited Service vehicle phases and their associated pedestrian phases are serviced in their normal sequence based on demand.
3. When the railroad relays deactivate the traffic signal inputs:
    a. Railroad Preemption PTR sign turns OFF {DELETE IF NOT APPLICABLE AND RE-LABEL "b" TO "a"
    b. Normal intersection operation and sequence resumes.

Figure 1-5 | Early TCG Display Preemption Example – Without Controller Programmed Delay

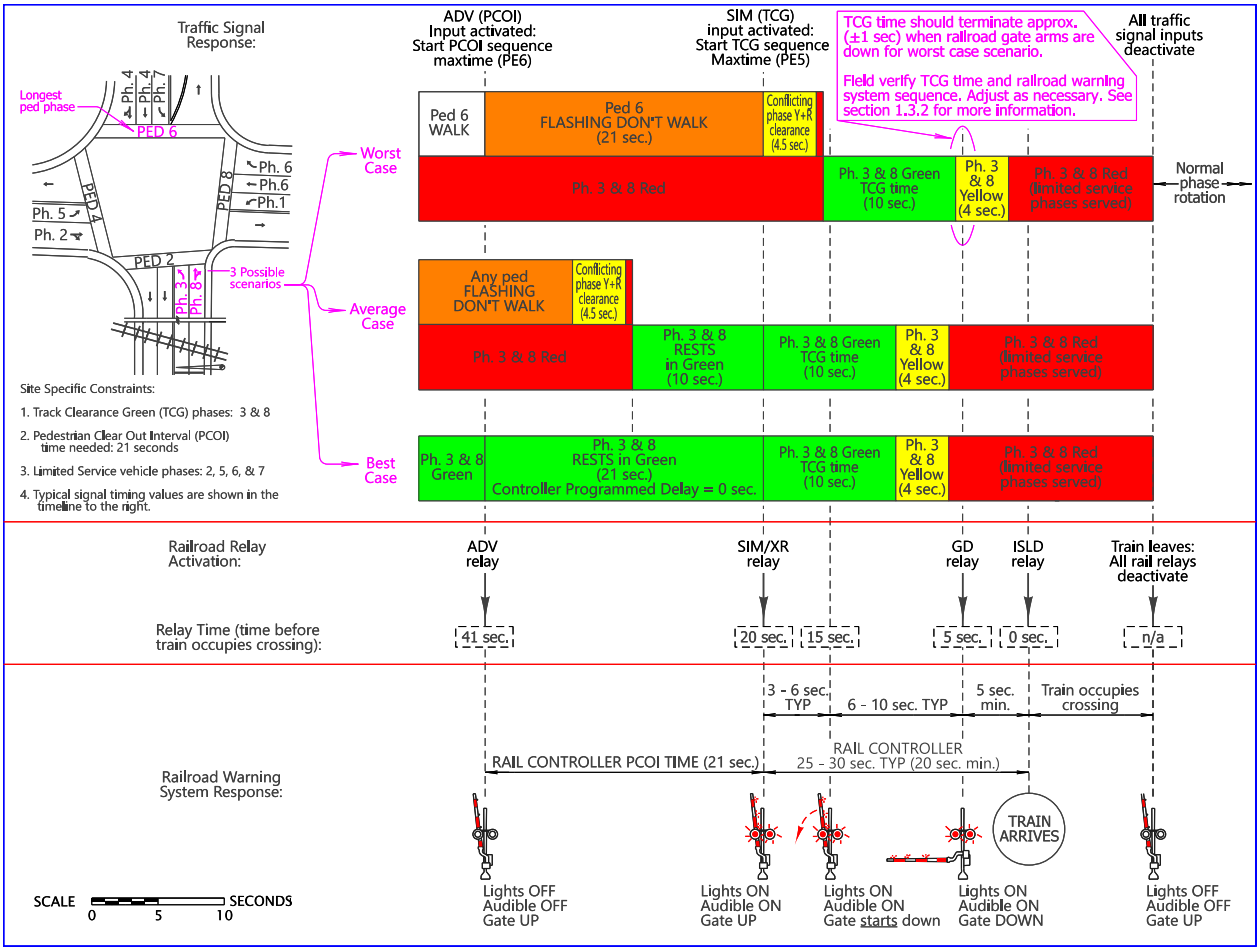


Figure 1-6 | Early TCG Display Preemption Example – With Controller Programmed Delay

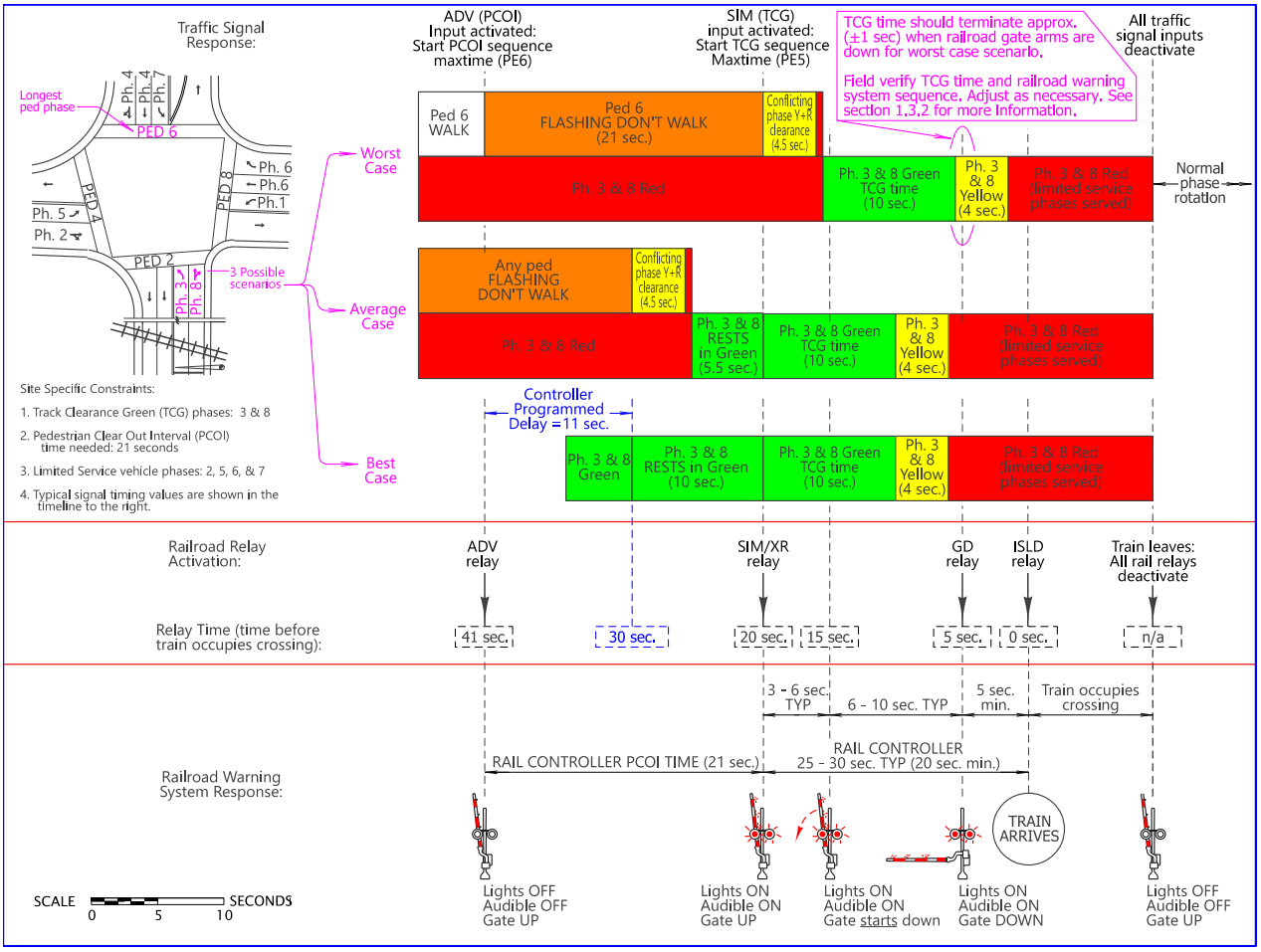


Figure 1-7 | No TCG Preemption Text Template

Designer Notes:
1. This preemption operation requires approval of the ODOT CCD & state traffic engineer. Verify with the state traffic operations engineer 503-986-3568
2. Fill out green locations with "__"
3. Follow and delete instructions in RED { }
4. Pink text may be deleted or re-labeled (according to instructions)
5. Black text should not be modified

TRAFFIC SIGNAL RAILROAD PREEMPTION USING NO TRACK CLEARANCE GREEN

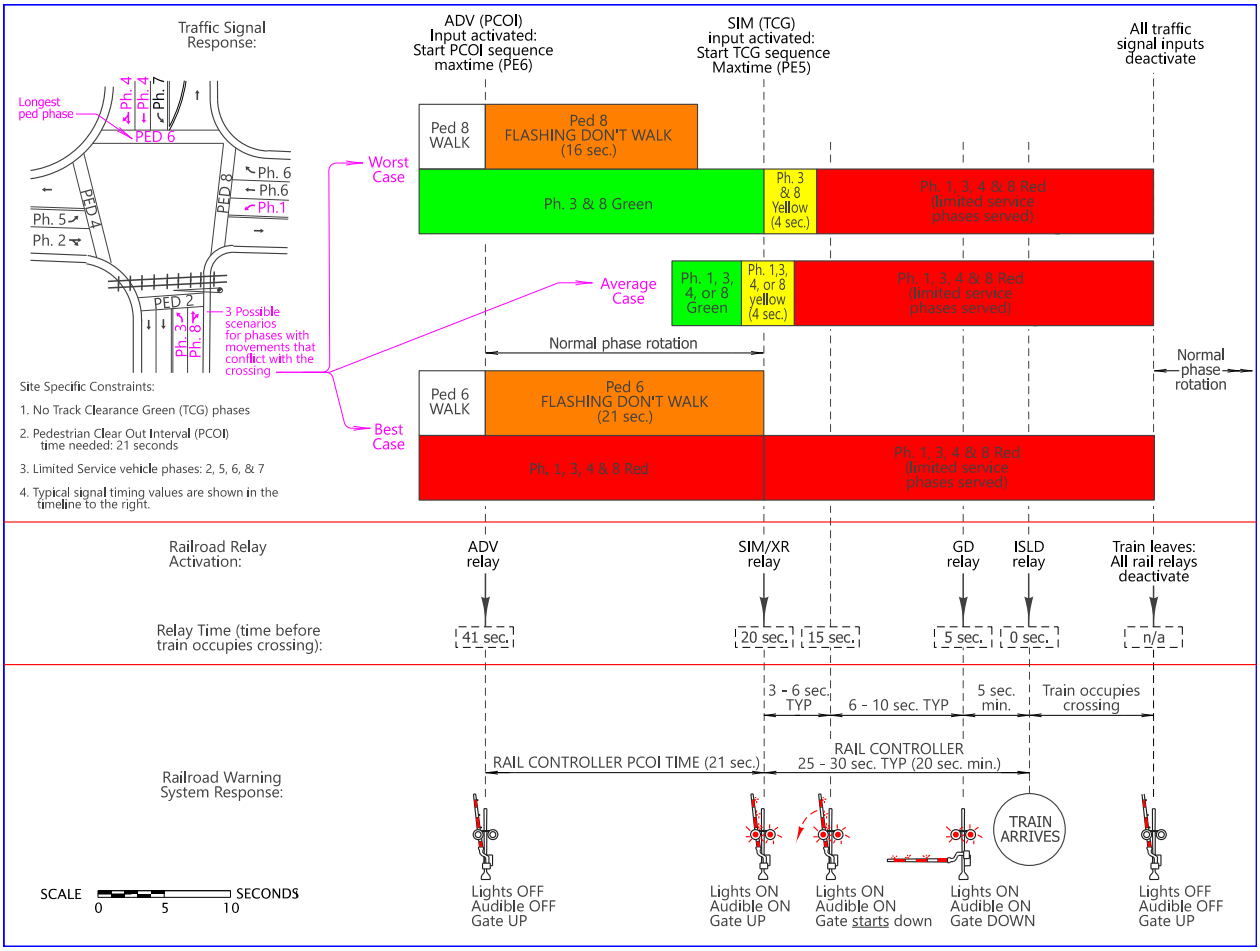
Site Specific Constraints:

1. No Track Clearance Green phases
2. Pedestrian Clear Out Interval (PCOI) time needed: ___ seconds
3. Limited Service vehicle phases: __,__,& __
4. Frequent railroad switching within the control limits of the highway road crossing often abbreviates the PCOI time. {DELETE IF NOT APPLICABLE – VERIFY WITH ODOT RAIL DIVISION}

The Preemption Sequence is as Follows:

1. When the ADV relay activates the ADV (PCOI) input, the following PCOI sequence is initiated:
    a. No change to vehicle phase sequence
    b. All active pedestrian phase walk intervals immediately advance to and complete their flashing DON'T WALK interval
    c. All pedestrian phase calls are inhibited from being serviced
    d. Railroad Preemption PTR sign remains OFF. {DELETE IF NOT APPLICABLE}
2. When the SIM relay activates the SIM (TCG) input, the following sequence is initiated:
    a. Railroad Preemption PTR sign turns ON. {DELETE IF NOT APPLICABLE AND RE-LABEL "b" TO "a" AND SO ON}
    b. All active pedestrian phase flashing DON'T WALK intervals immediately advance to solid DON'T WALK.
    c. All non-Limited Service vehicle phases displaying a GREEN terminate by advancing through their YELLOW and RED clearance intervals.
    d. All programmed Limited Service vehicle phases and their associated pedestrian phases are serviced in their normal sequence based on demand.
3. When the railroad relays deactivate the traffic signal inputs:
    a. Railroad Preemption PTR sign turns OFF {DELETE IF NOT APPLICABLE AND RE-LABEL "b" TO "a"}
    b. Normal intersection operation and sequence resumes.

Figure 1-8 | No TCG Preemption Example

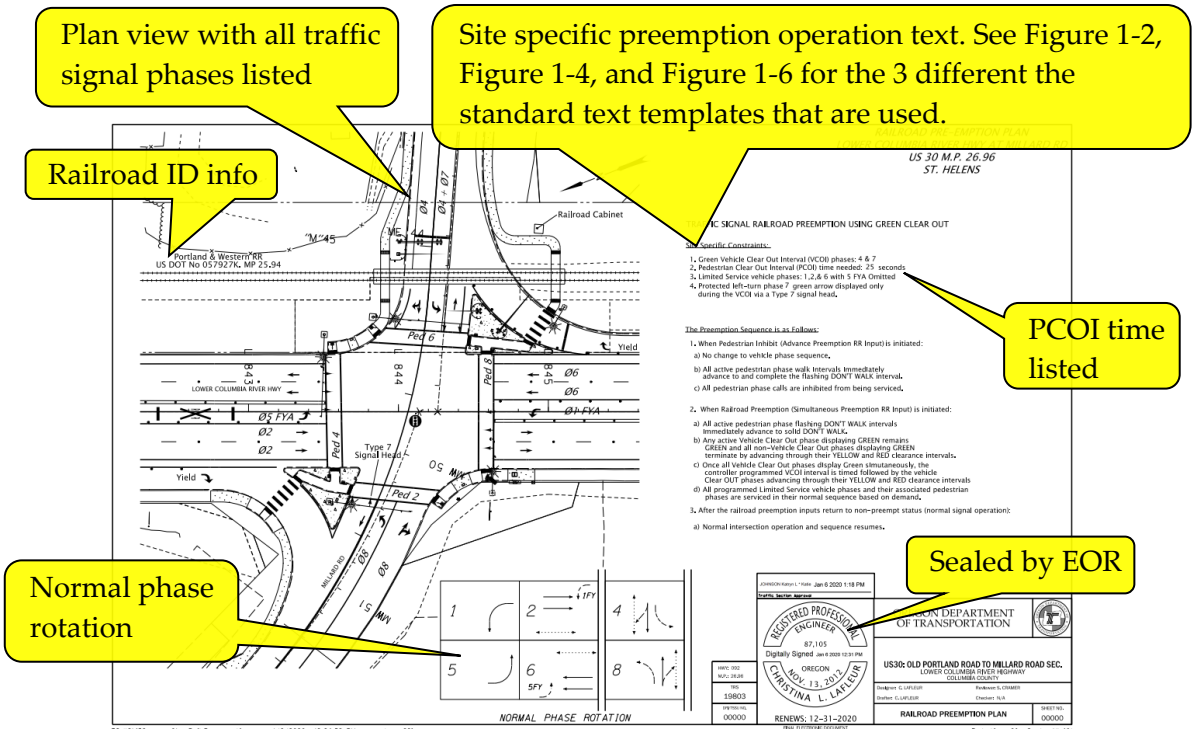


1.2.3 Preemption Plan Sheet

A preemption plan sheet is created for each rail interconnected traffic signal and details the high-level preemption operation parameters needed to program the traffic signal software. See Figure 1-9 for example of a preemption plan sheet.

The preemption plan sheet is part of the rail crossing order, reviewed and approved by all interested parties and must be followed. Existing rail crossing orders can be accessed via filenet for ODOT, filenet for external, or by contacting the ODOT CCD. For rail interconnected signals on the state highway system, preemption plan sheets are also now included in the traffic signal cabinet print (last page), as per the ODOT Traffic Signal Design Manual Chapter 20, and can be found in filenet (traffic signal drawing archive). Note that the filenet traffic signal drawing archive is able to store plan sheets for traffic signals not on the state highway if the local agency provides this information to the state traffic signal engineer. **If a cabinet print for a signal on the state highway does not have a preemption plan sheet or the preemption plan sheet is not accurate/current, contact the state traffic signal engineer to remedy the situation.**

Figure 1-9 | Preemption Plan Sheet Example



The signal timer shall operate the preemption sequences as stated in the preemption plan sheet.

Any changes to an existing preemption plan sheet require working thru the official rail crossing order process.

1.3 Calculations and Documentation of Calculations

This section contains the calculations for preemption operation and how they are documented.

1.3.1 Calculating the PCOI Time

The PCOI time is calculated by the road authority and placed in the railroad controller by the rail owner. The rail owner will design their track detection equipment and ADV relay time according to the PCOI value provided by the road authority.

NOTE: The PCOI time and the ADV relay time are not the same value! The railroad relay time is always stated as the estimated time of arrival of the train to the edge of pavement at the crossing when the relay is activated. The PCOI time is equal to the ADV relay time minus the SIM relay time (see Figure 1-3 and Figure 1-19 for illustrations and examples).

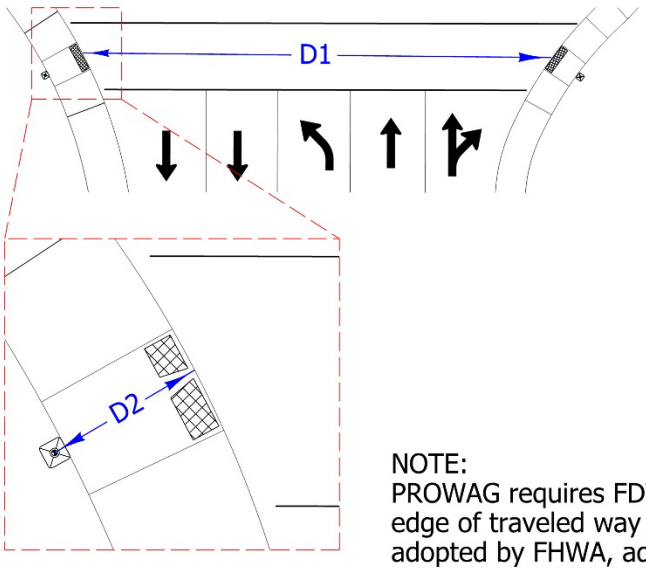
The PCOI time should equal the FLASHING DON'T WALK (FDW) time of the longest crosswalk at the intersection. This helps ensure that pedestrians using any crosswalk can finish their crossing prior to the TCG sequence and allows the countdown pedestrian indications to function as normally as possible. Table 1-2 shows the two calculations for FDW time that are used to determine the PCOI time and when to use them. See Figure 1-10 and Figure 1-11.

Table 1-2 | Flashing Don't Walk Calculations Used to Determine the PCOI time

FDW Calculation Used Determine PCOI Time	**Triggers for Calculating (Use PCOI & TCG**	**& Documenting PCOI Time Worksheet. See section** Error! Reference source not found.**)**
PROWAG FDW (PCOI time) See Figure 1-10	New Signal Installation or Existing Signal (No existing PCOI time)	• Need to establish a PCOI time
	Existing Signal (Existing PCOI time)	• Total signal rebuild
MUTCD FDW (PCOI time) See Figure 1-11	Existing Signal (Existing PCOI time)	• Partial signal rebuild • Adding a type 7 signal head • Changing permissive turns to protected turns for the TCG phases • Any work that impacts existing FDW timing (e.g., geometry/ramp changes, user requests, routine signal timing review, etc.)

Figure 1-10 | PROWAG FDW Calculation to Determine PCOI Time

$$\text{PROWAG FDW} = \text{PCOI time} = \left[\frac{D1 + D2}{3.5\ (\text{ft/sec})}\right] - 3\ (\text{sec})$$



Where:

FDW = Flashing Don't Walk time of longest crosswalk (in seconds)

D1 = Distance from curb to curb (in feet)

D2 = Longest distance from pushbutton to curb (in feet) - verify both pushbuttons for each crosswalk

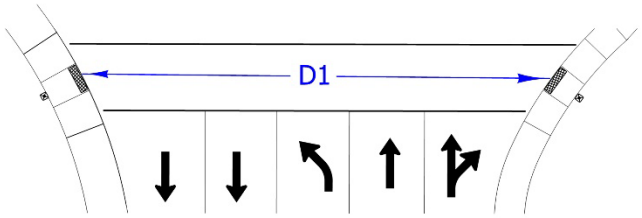
3.5 ft/sec = Default MUTCD recommended walking speed

3 sec = Default MUTCD recommended minimum yellow change interval

NOTE:
PROWAG requires FDW times to be calculated from pushbutton to edge of traveled way instead. While PROWAG has not yet been adopted by FHWA, adoption is likely in the near future.

Figure 1-11 | MUTCD FDW Calculation to Determine PCOI Time

$$\text{MUTCD FDW} = \text{PCOI time} = \left[\frac{D1}{3.5\ (\text{ft/sec})}\right] - 3\ (\text{sec})$$



Where:

FDW = Flashing Don't Walk time of longest crosswalk (in seconds)

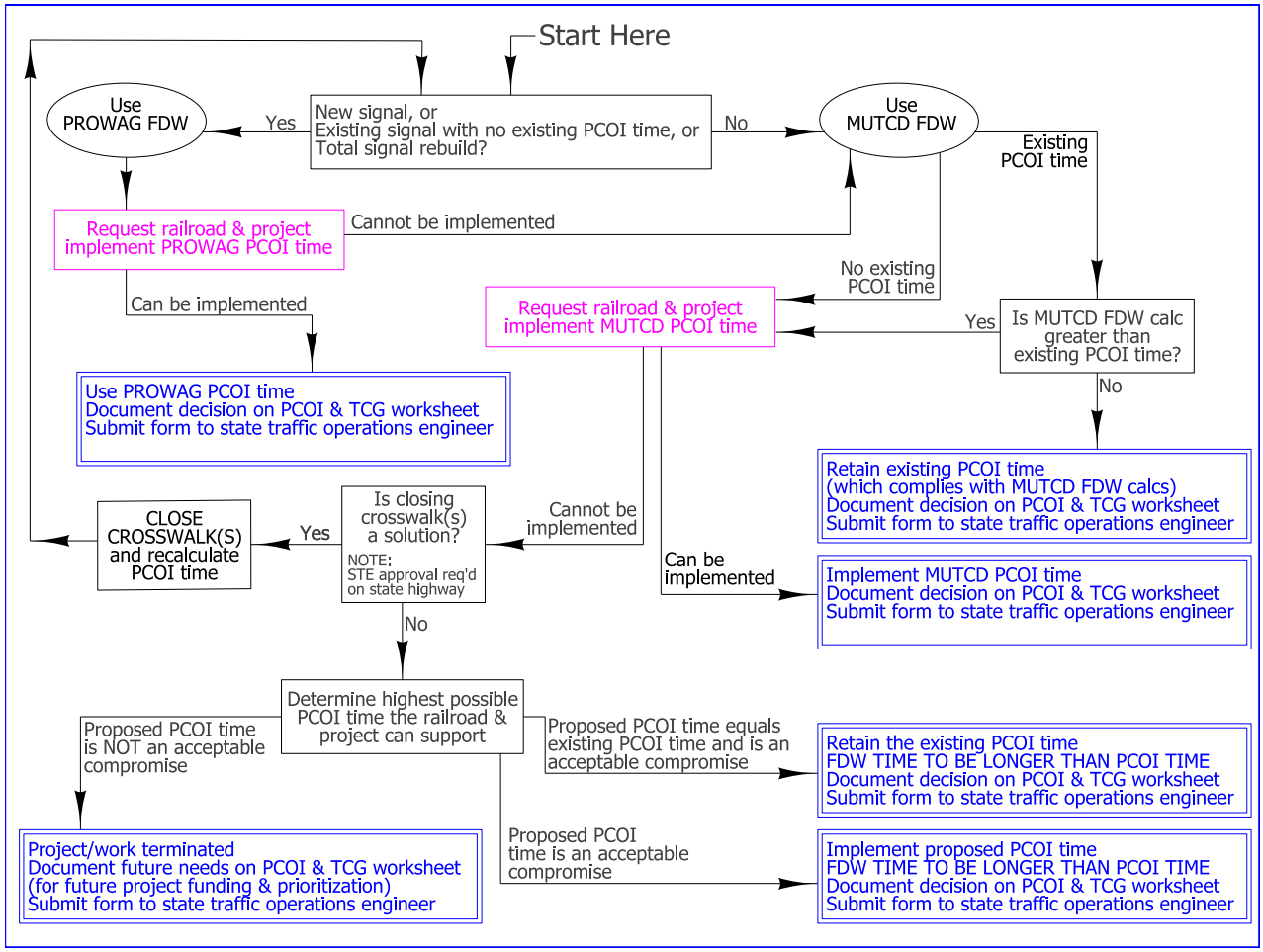
D1 = Distance from curb to curb (in feet)

3.5 ft/sec = Default MUTCD recommended walking speed

3 sec = Default MUTCD recommended minimum yellow change interval

When any proposed work triggers calculating the PCOI time, as listed in Table 1-2, use the following decision matrix to help document PCOI time decisions. See Figure 1-12. Documenting PCOI needs for future project planning and prioritization is also recommended using the PCOI & TCG worksheet.

Figure 1-12 | PCOI Time Project Decision Matrix



A few things should be verified and considered when making decisions on the PCOI time:

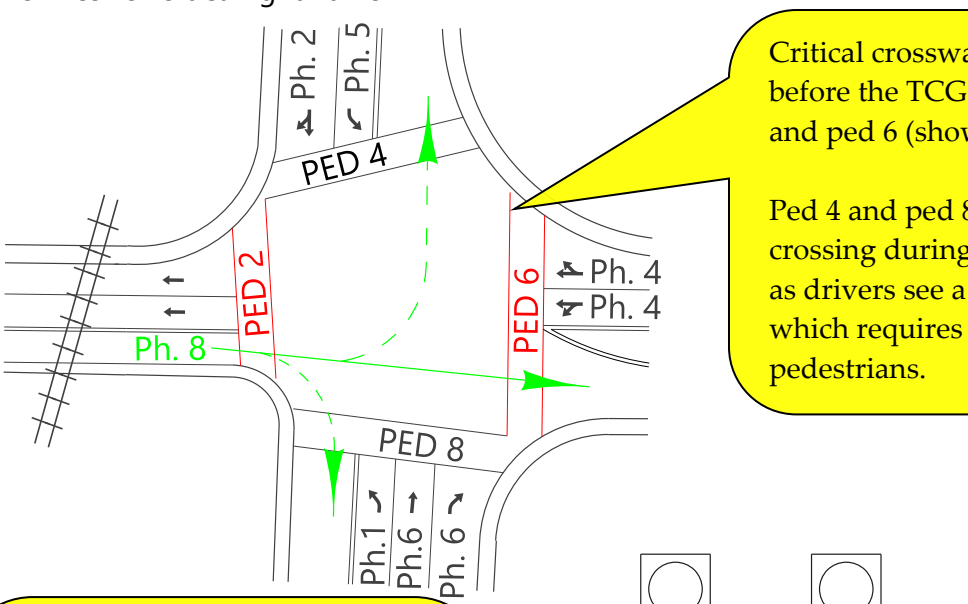
- **Existing PCOI time.** The existing PCOI time needs to be verified. To obtain the existing PCOI time, make a request to the ODOT CCD, who will field verify the value programmed in the rail controller (most accurate and preferred method). The rail crossing order and cabinet stickers can be used to verify the PCOI time, however there's a chance they do not reflect current existing conditions. Kinetics data can also be used to verify the PCOI time, but note times may vary depending on train operations (sometimes significantly). Therefore use kinetics data with caution.
- **Feasibility of implementing PROWAG or MUTCD PCOI times.** In certain cases this can be done relatively easily. In other cases it may be technically infeasible or may require new/modified railroad equipment which can be expensive and outside

of the project scope. If it is not feasible to implement a PCOI time equal to the calculated PROWAG or MUTCD PCOI time as per Figure 1-12 there are 3 alternative options discussed below. Available funding, project scope, technical feasibility, benefits/costs, risk assessment, and timelines should be considered when deciding which alternative option is the most appropriate. Documentation of the decision, using the PCOI & TCG worksheet (see section **Error! Reference source not found.**), shall be sent to the state traffic operations engineer so that PCOI time decisions can be tracked to allow for future project planning/funding prioritization to increase the PCOI time and to record any technical constraints.

- **Alternative option 1: Allow the FDW time to be longer than the PCOI time.** This option risks truncating the FDW time (which is permitted by the MUTCD) and negatively impacts the countdown feature. However, this may be an acceptable solution if the FDW time that is longer than the PCOI time is NOT a critical crosswalk to clear prior to the TCG sequence (e.g. the TCG turning movement is permissive so the pedestrian can finish their crossing during the TCG sequence and the drivers have a signal indication that requires them to yield to the pedestrian. See Figure 1-13, Figure 1-14, and Figure 1-15 for examples. This may also be a viable solution if pedestrian volume is low, the PCOI time is short by only a few seconds, the train frequency is low, and/or the train operates during hours when pedestrians are not likely to be using the intersection.
- **Alternative option 2: Close the crosswalk(s).** This option eliminates the risk of truncating the FDW time. However, the decision to close a crosswalk must consider many elements. See the ODOT Traffic Manual for the process, approvals, and elements to consider when proposing a crosswalk closure on the state highway system.
- **Alternative option 3: Terminate the proposed project/work.** The do-nothing option may be the only solution if option 1 or option 2 are not acceptable. In this case, a future project with increased scope and/or funding would be needed to address the PCOI time and complete the proposed work.

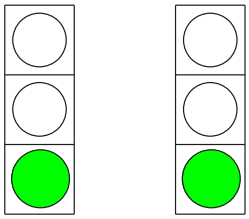
The preemption plan sheet and crossing order will state the PCOI time.

Figure 1-13 | Critical Crosswalks to Clear Prior to the Track Clearance Green Sequence: Permissive Left & Right Turns



Critical crosswalk phases to clear before the TCG sequence are ped 2 and ped 6 (shown in RED).

Ped 4 and ped 8 could continue crossing during the TCG sequence as drivers see a signal indication which requires them to yield to pedestrians.



TCG Indications: Ph. 8
(Permissive left & right turns)

NOTE: Per current guidance, a normally permissive only left turn movement requires a type 7 signal head (see section 1.5.3)

However, there may be existing legacy installations without a type 7 signal head where the left turn is still permissive during preemption as shown in this example.

Figure 1-14 | Critical Crosswalks to Clear Prior to the Track Clearance Green Sequence: Permissive Right Turns

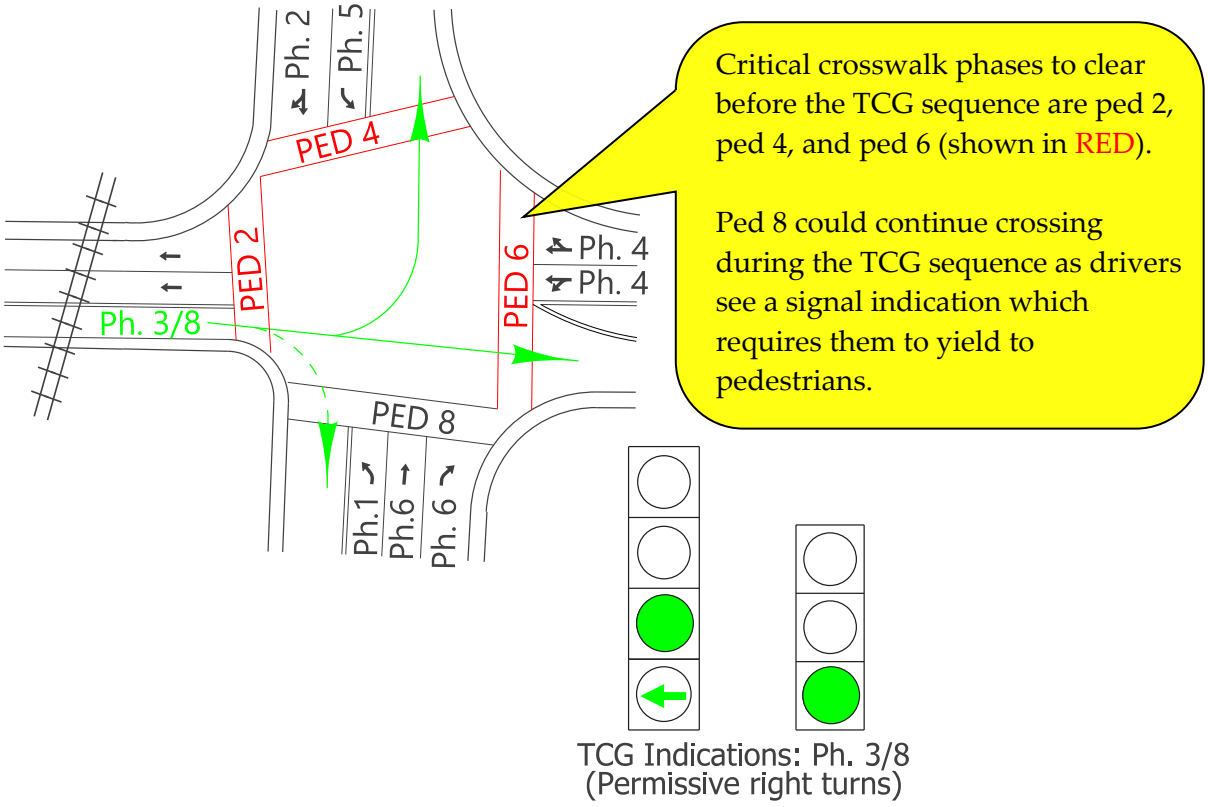
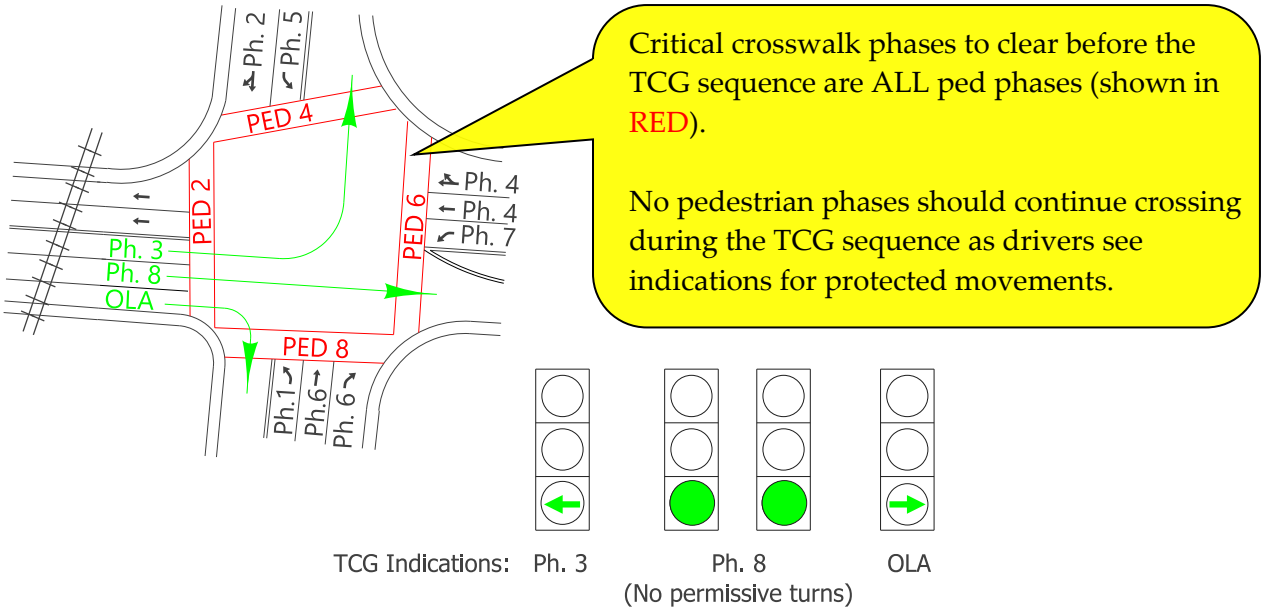


Figure 1-15 | Critical Crosswalks to Clear Prior to the Track Clearance Green Sequence: No Permissive Turns



1.3.2 Calculating the TCG Time

The TCG time is calculated by the road authority and placed in the traffic signal controller. The timing for the SIM/XR relays is calculated and placed in the railroad controller by the rail owner.

NOTE: The TCG time and the SIM/XR relay time are not the same value! The railroad relay time is always stated as the estimated time of arrival of the train to the edge of pavement at the crossing when the relay is activated. The TCG time should ALWAYS be shorter than the SIM/XR relay time (see Figure 1-3 and Figure 1-19 for illustrations and examples).

For each vehicle in the queue at the start of the TCG, approximately 1 to 1 ½ seconds of green time is required before a vehicle stopped on the tracks can begin moving. This is about half of the time required to completely clear the approach. As such, the TCG time is calculated according to Figure 1-16. This calculation is also contained on the PCOI & TCG worksheet (see section **Error! Reference source not found.**).

Figure 1-16 | Track Clearance Green (TCG) Time Calculation

$$TCG = \frac{D}{L} \times 2.0 \text{ seconds/vehicle}$$

Using the default L value, the equation above can be simplified to:

$$TCG = \frac{D}{10}$$

Where:

TCG = Track clearance green time in seconds

D = The distance in feet between the stop location of the highway traffic signal and the railroad tracks

L = The average vehicle length in feet (default value = 20 feet)

In general, the TCG time should not be less than 8 seconds or greater than 20 seconds as this timing fits well within the typical SIM/XR relay time calculated by the rail owner. The SIM/XR relay is typically timed to activate 25 to 30 seconds before the train arrives at the crossing (FRA requirement is 20 seconds minimum). **The TCG time must be field verified and it should correspond appropriately with the railroad warning system timing.** See Figure 1-3 and Figure 1-5 for a visual of the timing of the railroad warning system and the TCG time. A higher TCG time than calculated may be desirable based on site specific factors such as high percentage of heavy vehicles, steep roadway grades, etc.

For railroad crossings located at or over 200 ft from the traffic signal, a large portion of the TCG time could pass before an inappropriately stopped vehicle is provided an opportunity to move clear of the tracks. In these cases where the calculation results in a TCG time close to or greater than 20 seconds, additional detection time for the SIM/XR relay may be desirable. If a large TCG time is calculated or desired, coordinate with ODOT CCD, the traffic operations engineer, and the rail owner to determine an appropriate solution. Also see ODOT Traffic Signal Design Manual Section 16.1.2 for other options.

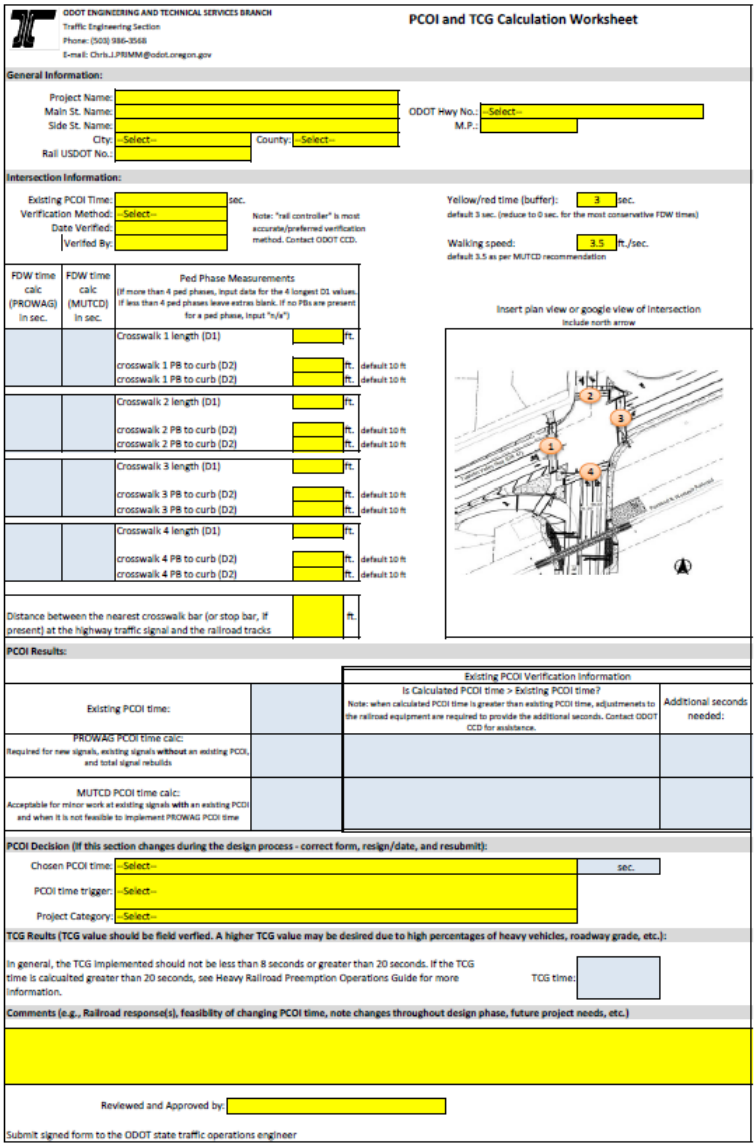
Once the TCG time is field verified, the TCG time is listed on the cabinet sticker as per section 1.7. It is NOT stated in the crossing order or in the preemption plan sheet.

1.3.3 PCOI & TCG Worksheet

The PCOI & TCG worksheet is used to calculate and document the PCOI time and TCG time. See Figure 1-17. It is located on the ODOT traffic signals website. It can also be obtained by contacting the state traffic operations engineer.

For rail interconnected signals on the state highway system, this worksheet should be completed by the region traffic section and submitted to the state traffic operations engineer. For rail interconnected signals off the state highway system, this worksheet should be completed by the road authority and submitted to the state traffic operations engineer.

Figure 1-17 | PCOI & TCG Worksheet Example



ODOT ENGINEERING AND TECHNICAL SERVICES BRANCH
Traffic Engineering Section
Phone: (503) 986-3568
E-mail: Chris.J.PRIMM@odot.oregon.gov

PCOI and TCG Calculation Worksheet

General Information:

Project Name:
Main St. Name:
Side St. Name:
City: --Select-- County: --Select--
Rail USDOT No.:
ODOT Hwy No.: --Select--
M.P.:

Intersection Information:

Existing PCOI Time: sec.
Verification Method: --Select--
Date Verified:
Verified By:
Note: "rail controller" is most accurate/preferred verification method. Contact ODOT CCD.

Yellow/red time (buffer): 3 sec.
default 3 sec. (reduce to 0 sec. for the most conservative FDW times)

Walking speed: 3.5 ft./sec.
default 3.5 as per MUTCD recommendation

FDW time calc (PROWAG) in sec.	FDW time calc (MUTCD) in sec.	Ped Phase Measurements (If more than 4 ped phases, input data for the 4 longest D1 values. If less than 4 ped phases leave extras blank. If no PBs are present for a ped phase, input "n/a")	
		Crosswalk 1 length (D1)	ft.
		crosswalk 1 PB to curb (D2)	ft. default 10 ft
		crosswalk 1 PB to curb (D2)	ft. default 10 ft
		Crosswalk 2 length (D1)	ft.
		crosswalk 2 PB to curb (D2)	ft. default 10 ft
		crosswalk 2 PB to curb (D2)	ft. default 10 ft
		Crosswalk 3 length (D1)	ft.
		crosswalk 3 PB to curb (D2)	ft. default 10 ft
		crosswalk 3 PB to curb (D2)	ft. default 10 ft
		Crosswalk 4 length (D1)	ft.
		crosswalk 4 PB to curb (D2)	ft. default 10 ft
		crosswalk 4 PB to curb (D2)	ft. default 10 ft

Distance between the nearest crosswalk bar (or stop bar, if present) at the highway traffic signal and the railroad tracks: ft.

Insert plan view or google view of intersection
include north arrow

PCOI Results:

		Existing PCOI Verification Information: Is Calculated PCOI time > Existing PCOI time? Note: when calculated PCOI time is greater than existing PCOI time, adjustmenets to the railroad equipment are required to provide the additional seconds. Contact ODOT CCD for assistance.	Additional seconds needed:
Existing PCOI time:			
PROWAG PCOI time calc: Required for new signals, existing signals **without** an existing PCOI, and total signal rebuilds			
MUTCD PCOI time calc: Acceptable for minor work at existing signals **with** an existing PCOI and when it is not feasible to implement PROWAG PCOI time			

PCOI Decision (If this section changes during the design process - correct form, resign/date, and resubmit):

Chosen PCOI time: --Select-- sec.
PCOI time trigger: --Select--
Project Category: --Select--

TCG Reults (TCG value should be field verfied. A higher TCG value may be desired due to high percentages of heavy vehicles, roadway grade, etc.):

In general, the TCG implemented should not be less than 8 seconds or greater than 20 seconds. If the TCG time is calcualted greater than 20 seconds, see Heavy Railroad Preemption Operations Guide for more information.

TCG time:

Comments (e.g., Railroad response(s), feasibility of changing PCOI time, note changes throughout design phase, future project needs, etc.)

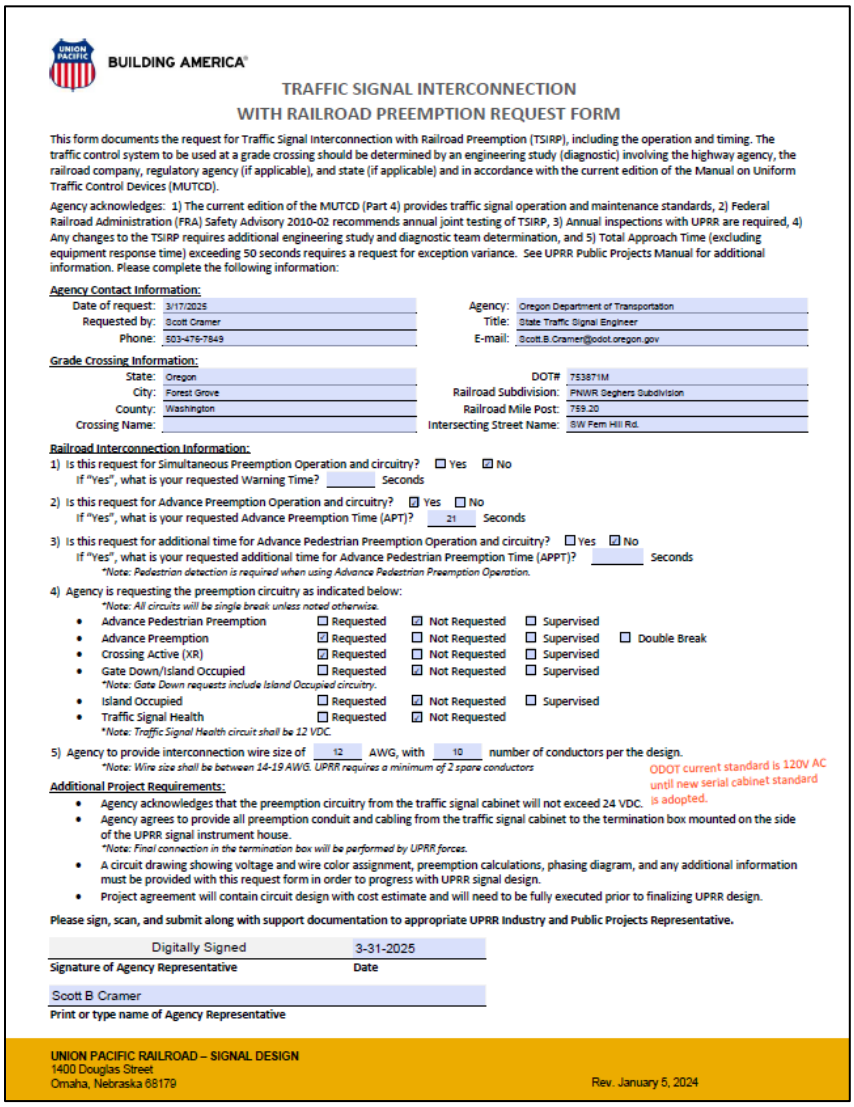
Reviewed and Approved by:

Submit signed form to the ODOT state traffic operations engineer

1.3.4 Railroad Owner Forms

When a project is proposed at a rail interconnected traffic signal, certain railroad owners may require filling out a form or providing documentation of project's interconnection/preemption operation and signal timing needs. For rail interconnected signals on the state highway system, the rail owner forms shall be filled out and signed by the Traffic Engineering Section. Upon request, the Traffic Engineering Section can provide a curtesy review of the form for other road authorities to help ensure statewide consistency and uniformity of responses. See Figure 1-18 for example.

Figure 1-18 | Railroad Owner Form (UPRR) Form (Filled Out Example)



BUILDING AMERICA®

TRAFFIC SIGNAL INTERCONNECTION
WITH RAILROAD PREEMPTION REQUEST FORM

This form documents the request for Traffic Signal Interconnection with Railroad Preemption (TSIRP), including the operation and timing. The traffic control system to be used at a grade crossing should be determined by an engineering study (diagnostic) involving the highway agency, the railroad company, regulatory agency (if applicable), and state (if applicable) and in accordance with the current edition of the Manual on Uniform Traffic Control Devices (MUTCD).

Agency acknowledges: 1) The current edition of the MUTCD (Part 4) provides traffic signal operation and maintenance standards, 2) Federal Railroad Administration (FRA) Safety Advisory 2010-02 recommends annual joint testing of TSIRP, 3) Annual inspections with UPRR are required, 4) Any changes to the TSIRP requires additional engineering study and diagnostic team determination, and 5) Total Approach Time (excluding equipment response time) exceeding 50 seconds requires a request for exception variance. See UPRR Public Projects Manual for additional information. Please complete the following information:

Agency Contact Information:

Date of request: 3/17/2025
Requested by: Scott Cramer
Phone: 503-476-7849
Agency: Oregon Department of Transportation
Title: State Traffic Signal Engineer
E-mail: Scott.B.Cramer@odot.oregon.gov

Grade Crossing Information:

State: Oregon
City: Forest Grove
County: Washington
Crossing Name:
DOT# 753871M
Railroad Subdivision: PNWR Gephers Subdivision
Railroad Mile Post: 759.20
Intersecting Street Name: SW Fern Hill Rd.

Railroad Interconnection Information:

1) Is this request for Simultaneous Preemption Operation and circuitry? ☐ Yes ☑ No
If "Yes", what is your requested Warning Time? ____ Seconds

2) Is this request for Advance Preemption Operation and circuitry? ☑ Yes ☐ No
If "Yes", what is your requested Advance Preemption Time (APT)? 21 Seconds

3) Is this request for additional time for Advance Pedestrian Preemption Operation and circuitry? ☐ Yes ☑ No
If "Yes", what is your requested additional time for Advance Pedestrian Preemption Time (APPT)? ____ Seconds
Note: Pedestrian detection is required when using Advance Pedestrian Preemption Operation.

4) Agency is requesting the preemption circuitry as indicated below:
Note: All circuits will be single break unless noted otherwise.

- Advance Pedestrian Preemption ☐ Requested ☑ Not Requested ☐ Supervised
- Advance Preemption ☑ Requested ☐ Not Requested ☐ Supervised ☐ Double Break
- Crossing Active (XR) ☑ Requested ☐ Not Requested ☐ Supervised
- Gate Down/Island Occupied ☐ Requested ☑ Not Requested ☐ Supervised
  Note: Gate Down requests include Island Occupied circuitry.
- Island Occupied ☐ Requested ☑ Not Requested ☐ Supervised
- Traffic Signal Health ☐ Requested ☑ Not Requested
  Note: Traffic Signal Health circuit shall be 12 VDC.

5) Agency to provide interconnection wire size of 12 AWG, with 10 number of conductors per the design.
Note: Wire size shall be between 14-19 AWG. UPRR requires a minimum of 2 spare conductors

ODOT current standard is 120V AC until new serial cabinet standard is adopted.

Additional Project Requirements:

- Agency acknowledges that the preemption circuitry from the traffic signal cabinet will not exceed 24 VDC.
- Agency agrees to provide all preemption conduit and cabling from the traffic signal cabinet to the termination box mounted on the side of the UPRR signal instrument house.
  Note: Final connection in the termination box will be performed by UPRR forces.
- A circuit drawing showing voltage and wire color assignment, preemption calculations, phasing diagram, and any additional information must be provided with this request form in order to progress with UPRR signal design.
- Project agreement will contain circuit design with cost estimate and will need to be fully executed prior to finalizing UPRR design.

Please sign, scan, and submit along with support documentation to appropriate UPRR Industry and Public Projects Representative.

Digitally Signed — 3-31-2025
Signature of Agency Representative — **Date**

Scott B Cramer
Print or type name of Agency Representative

UNION PACIFIC RAILROAD – SIGNAL DESIGN
1400 Douglas Street
Omaha, Nebraska 68179

Rev. January 5, 2024

Standard ODOT responses for 332 and 332S cabinets:

1.) "NO". This field only used if **ADDITIONAL** SIM relay time is desired due to a large TCG time. See section 1.3.2
2.) "YES" and filled in with the calculated PCOI time
3.) "NO" because the rail circuitry used for this relay is not the same as the ADV relay. The ADV relay is capable of activating the gate arms in the event of failed health circuit or traffic signal power outage.
4.) "REQUESTED" only for advance preemption (ADV relay) and crossing active (XR relay). All others are "NOT REQUESTED"
5.) As per standard wiring stated in the ODOT Traffic Signal Design Manual Chapter 16.
6.) Red note is added for railroad owner to provide an exception to the 24VDC requirement

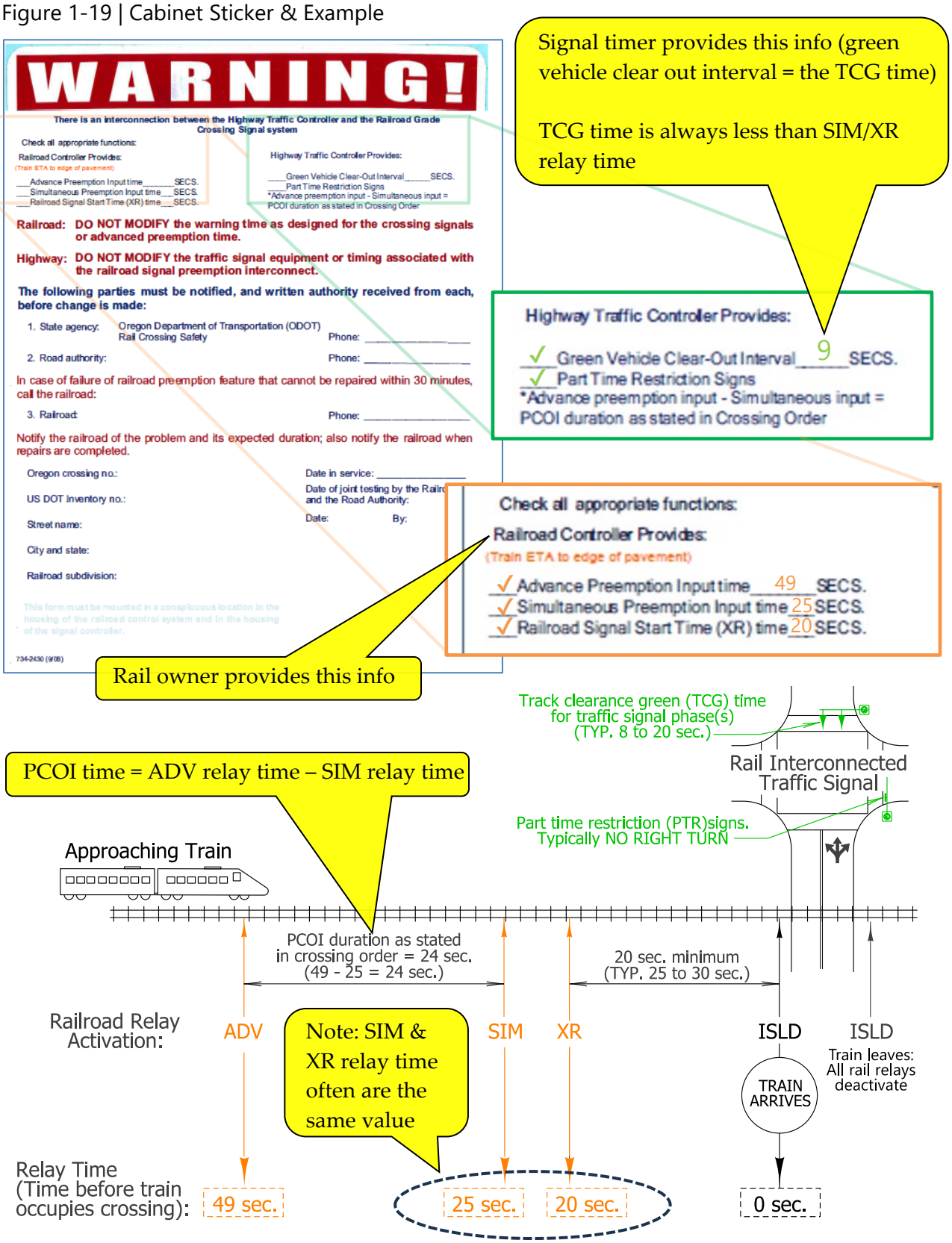
FYI: The future serial cabinet standard will have different requirements.

1.3.5 Cabinet Stickers

In both the rail controller cabinet and in the traffic signal controller cabinet, a sticker is required on the inside of the cabinet that lists the high-level interconnection parameters. It also states important information about making changes, contacts, and the dates of joint testing by the railroad and road authority. See Figure 1-19 for cabinet sticker example and explanation of fields.

The ODOT rail inspector is responsible for providing these stickers and ensuring they are filled out correctly and replacing them when necessary. If you see incorrect info or the sticker is getting worn out, contact the ODOT rail inspector to get a new sticker installed.

Figure 1-19 | Cabinet Sticker & Example



1.4 Cabinet Hardware and Inputs

The railroad cabinet and the traffic signal cabinet are hard wire interconnected using 3 wires:

- One 120VAC+ wire for a power input from the traffic signal cabinet to the rail cabinet (which then will return the two inputs described below back to the traffic signal cabinet)
- One wire for the ADV(PCOI) input from the rail cabinet relay to the traffic signal cabinet input file
- One wire for a SIM(TCG) input from the rail cabinet relay to the traffic signal cabinet input file

The non-preempted state of the railroad controller cabinet relays is closed (contact closure ON). A closed relay is always energized. When the relay is de-energized and opened (contact closure OFF due to an approaching train), an input is received by the traffic signal controller to initiate the preemption sequences. Any fault in the circuit (e.g., short or power outage) will also cause the relay to de-energize and open (contact closure OFF due to a failure), which will allow the traffic signal to initiate the preemption sequence and then rest in a safe mode of operation until the circuit failure can be fixed. The railroad warning system (flashing lights, audible devices, and gate arms) will also be activated in the event of a circuit fault. This is considered fail-safe operation. In contrast, if the non-preempted state of the relay is open (contact closure OFF), a short or power failure would just continue to leave the relay open (contact closure OFF) which would not be detectable.

In the traffic signal controller, the following C1-pins are reserved for railroad preemption operation:

- C1-51 pin for the ADV(PCOI) input (activated by the ADV relay from the railroad cabinet)
- C1-52 pin for the SIM(TCG) input (activated by the SIM relay from the railroad cabinet)

The 332S cabinet and 332 cabinet have different hardware and software configurations for rail preemption. See sections 1.4.1 and 1.4.2 for detailed information.

When comparing the hardware differences between the 332S and 332 cabinet, the following differences can be easy to overlook and cause confusion. Be sure to verify!

	332S	**332**
AC isolator type:	255 (inverting)	252 (non-inverting)
AC isolator location:	slot J12	slot J11
AC isolator light indications:	OFF=normal ON=preempted	OFF=preempted ON = normal
ADV(PCOI) input is wired to:	UPPER slot (J12U)	LOWER slot (J11L)
SIM(TCG) input is wired to:	LOWER slot (J12L)	UPPER slot (J11U)

1.4.1 332S Cabinet

The 332S cabinet is prewired by the manufacturer for the railroad circuity (e.g. wires to the input file, TB0, and fuse block are installed by the manufacturer).

The 332S cabinet uses a model 255 inverting AC isolator in the J12 slot to detect the railroad preemption inputs. See Figure 1-20 and Figure 1-21.

- J12U (C1-51 pin) for the ADV(PCOI) input
- J12L (C1-52 pin) for the SIM(TCG) input

Figure 1-20 | 332S Cabinet Print– Input File Configuration for Railroad Equipment

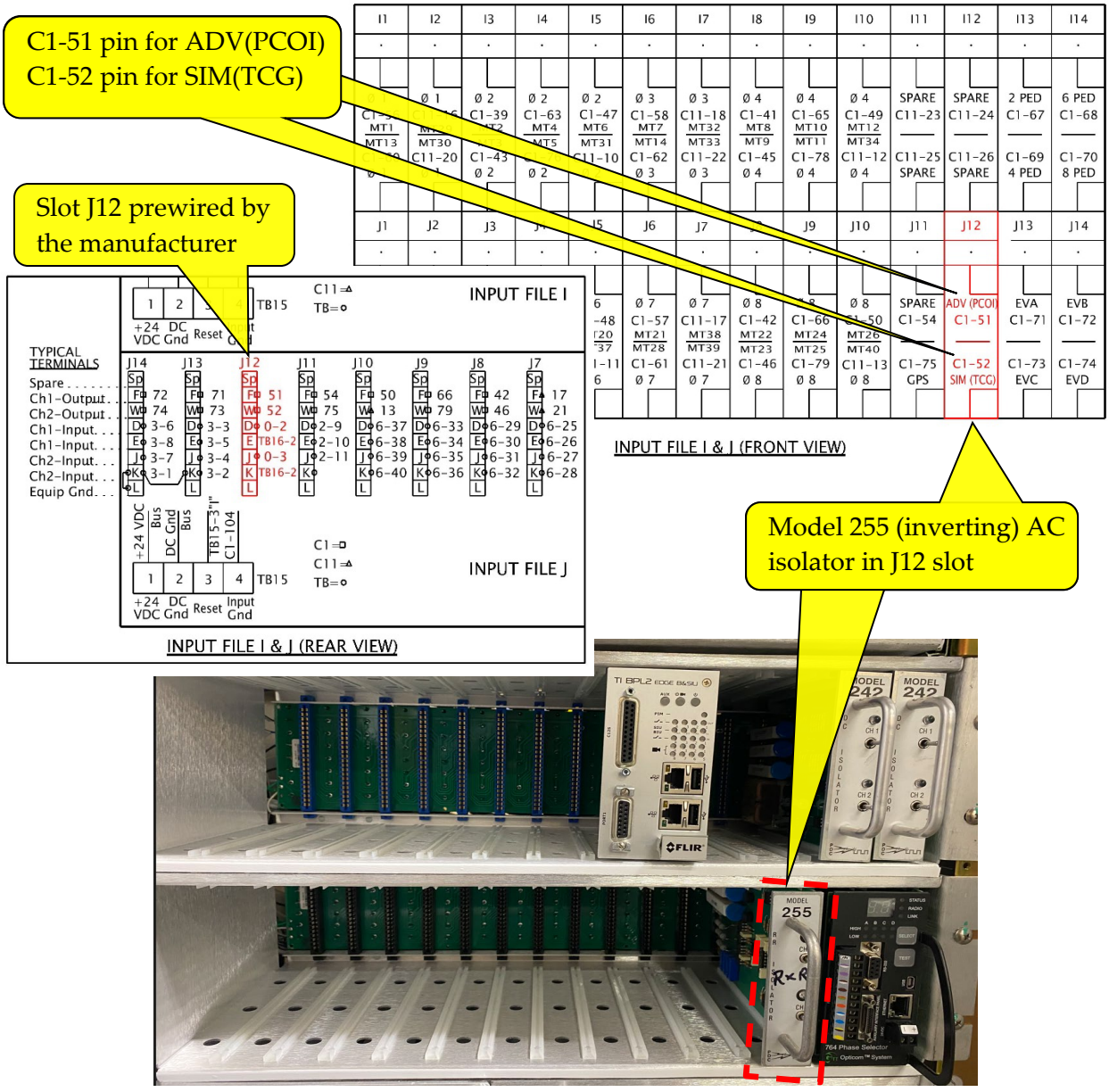
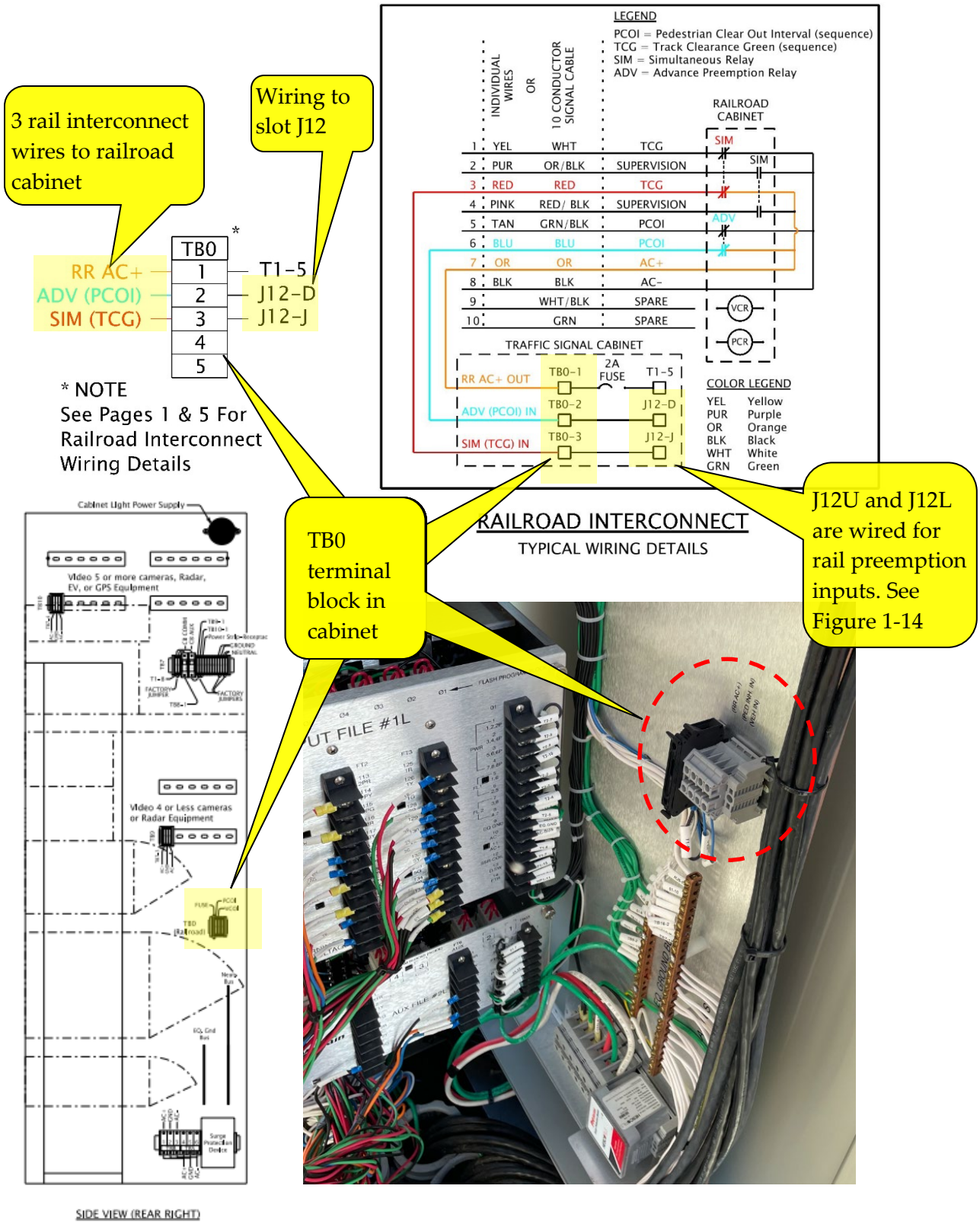
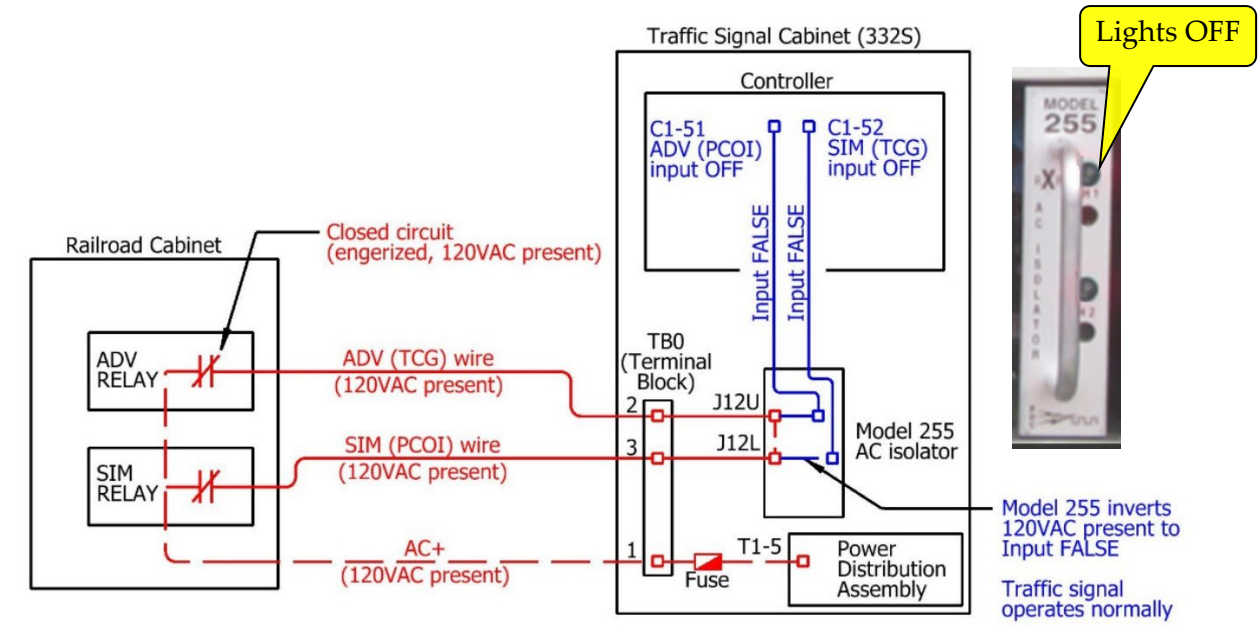


Figure 1-21 | 332S Cabinet Print Railroad Interconnect Wiring Details

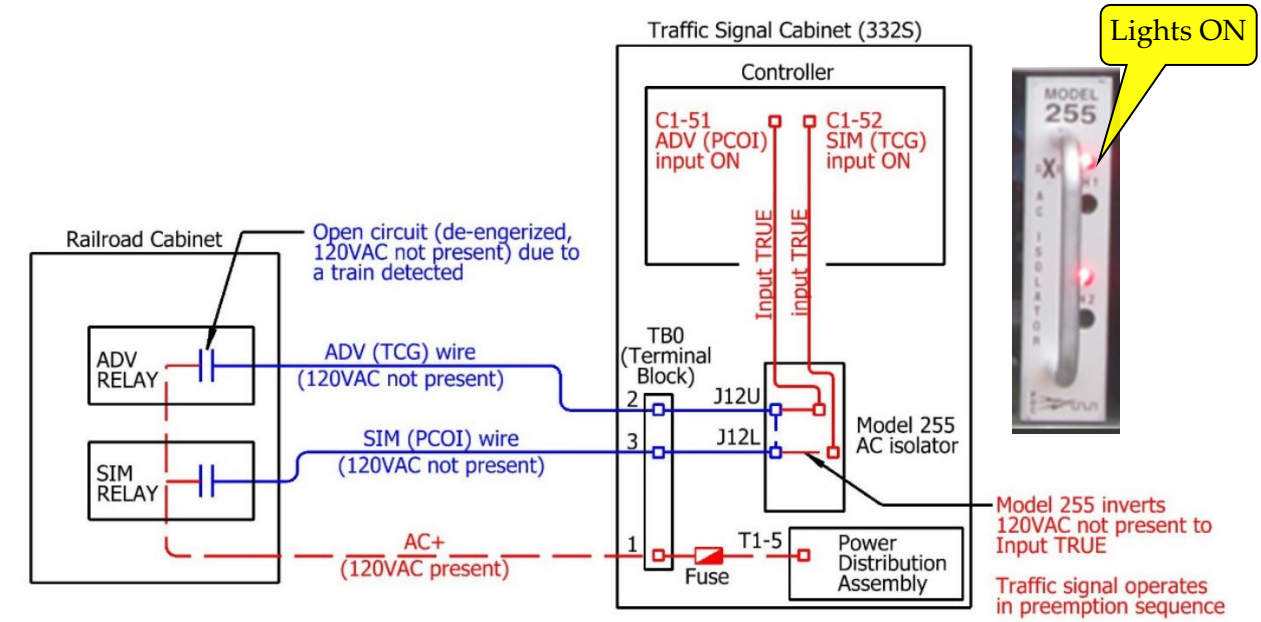


The standard wiring for the 332S cabinet input file includes the C1-51 and C1-52 pins, therefore these pins can be used directly from the input file to activate the appropriate rail preemption sequences. Directly using the C1-51 and C1-52 pins requires a model 255 AC isolator that can invert the 120VAC input received from the railroad cabinet to provide the correct input to the traffic signal controller. For example, if 120VAC is present, the isolator must report this to the traffic signal controller as a FALSE input rather than TRUE. For normal operation, the 255 AC isolator lights will be OFF and for preemption operation they will be ON. Note: if the 255 AC isolator is not plugged into to input file, the rail preemption PCOI and TCG sequences will never be served. See Figure 1-22.

Figure 1-22 | 332S Cabinet Hardware, Wiring, and Inputs



332S Cabinet - Normal Operation



332S Cabinet - Preemption Operation

1.4.2 332 Cabinet

The 332 cabinet is NOT prewired by the manufacturer for railroad circuity. TSSU or electricians responsible for maintaining the traffic signal will need to modify the 332 cabinet wiring to enable the railroad circuity as follows:

- Add a fuse from T1-5 to TB0-1
- Wire the back of the input file J11D &J to TB0-2 and TB0-3
- Add a neutral wire from the input file E&K to the neutral bus.

The 332 cabinet uses a model 252 AC non-inverting isolator in the J11 slot to detect the railroad preemption inputs. See Figure 1-23 and Figure 1-24.

- J11U (C1-54 pin) for the SIM(TCG) input, which is then connected to C1-52 pin via software logic
- J11L (C1-75 pin) for the ADV(PCOI) input, which is then connected to C1-51 pin via software logic

Figure 1-23 | 332 Cabinet Print– Input File Configuration for Railroad Equipment

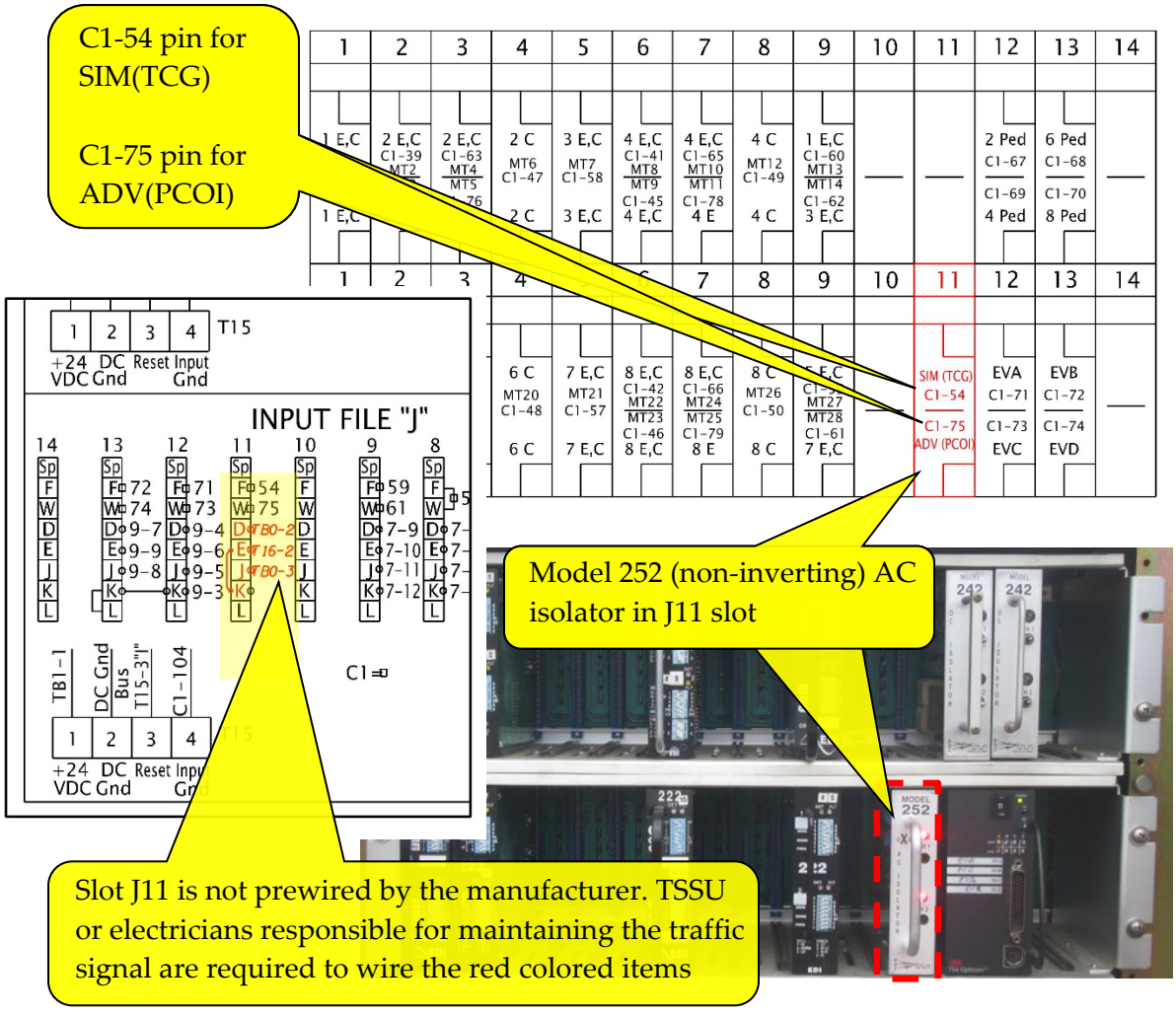
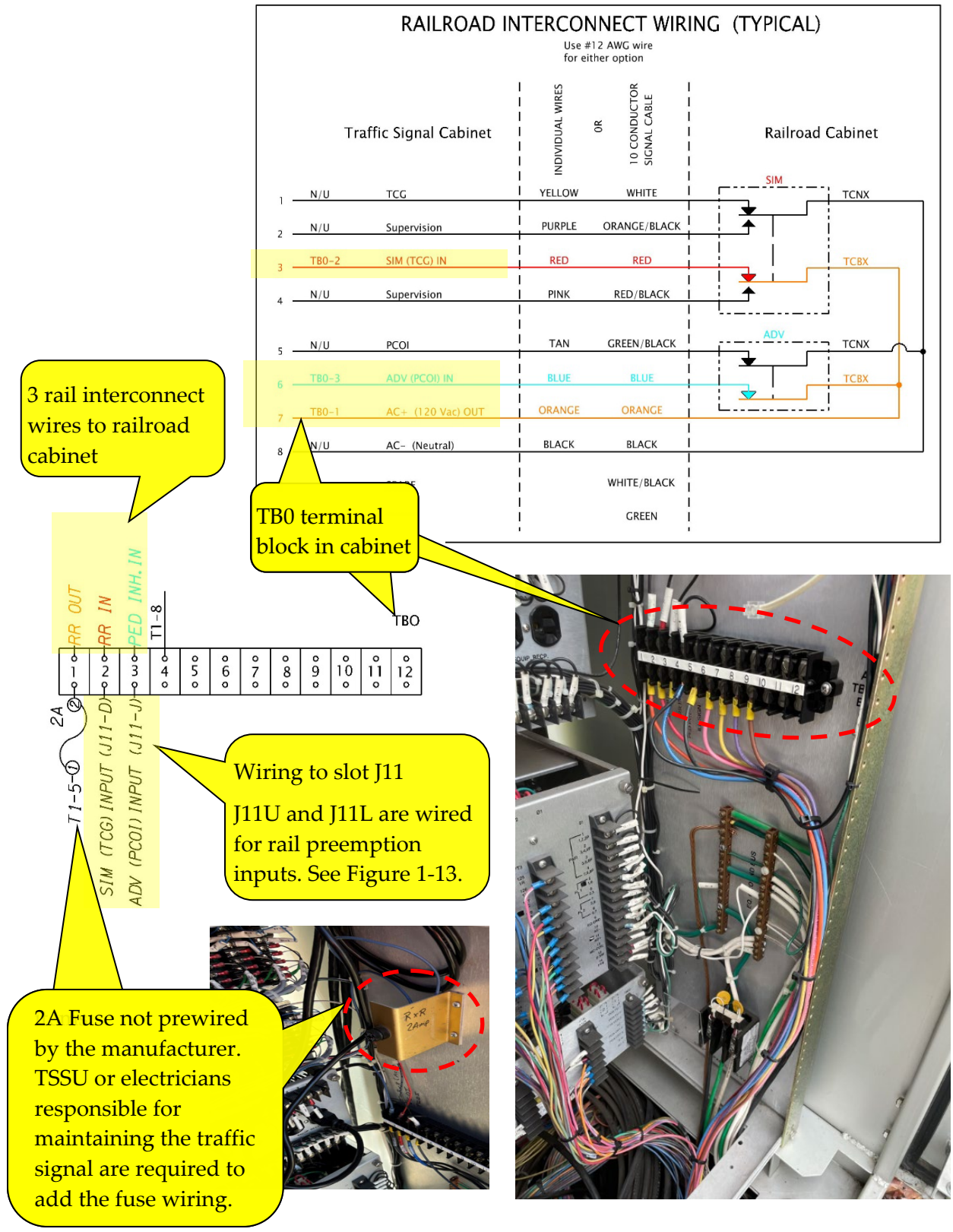


Figure 1-24 | 332 Cabinet Print Railroad Interconnect Wiring Details



Unlike the 332S cabinet, the standard wiring for the 332 cabinet input file does not include the C1-51 and C1-52 pins, therefore the unassigned spare C1-54 and C1-75 pins in the input file are used. The C1-54 and C1-75 pins are then programed to activate the appropriate C1-51 and C1-52 pins.

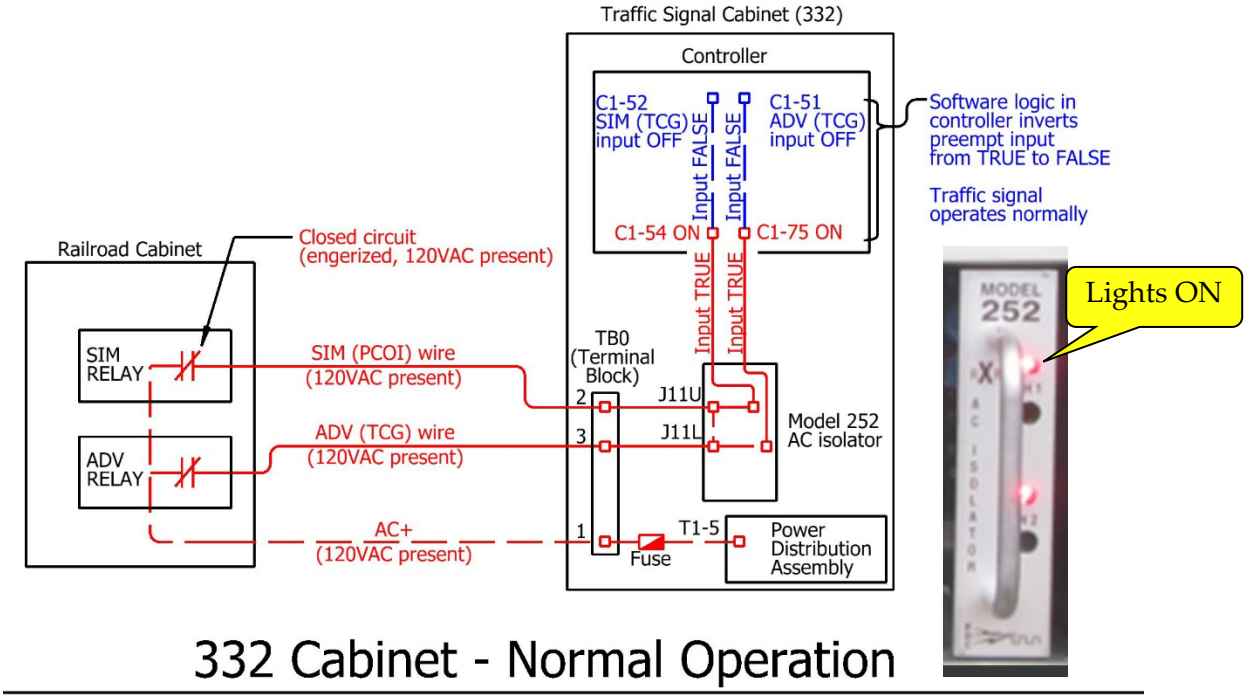
Unlike the model 255 AC isolator, the model 252 AC isolator does not invert the 120VAC input received from the railroad cabinet. For example, if 120VAC is present, the isolator will report this to the traffic signal controller as a TRUE input on the C1-54 or C1-75 pins. The traffic signal controller then requires a user program (logic) in the timing software to perform the inversion from TRUE to FALSE using the four C1-pins as follows:

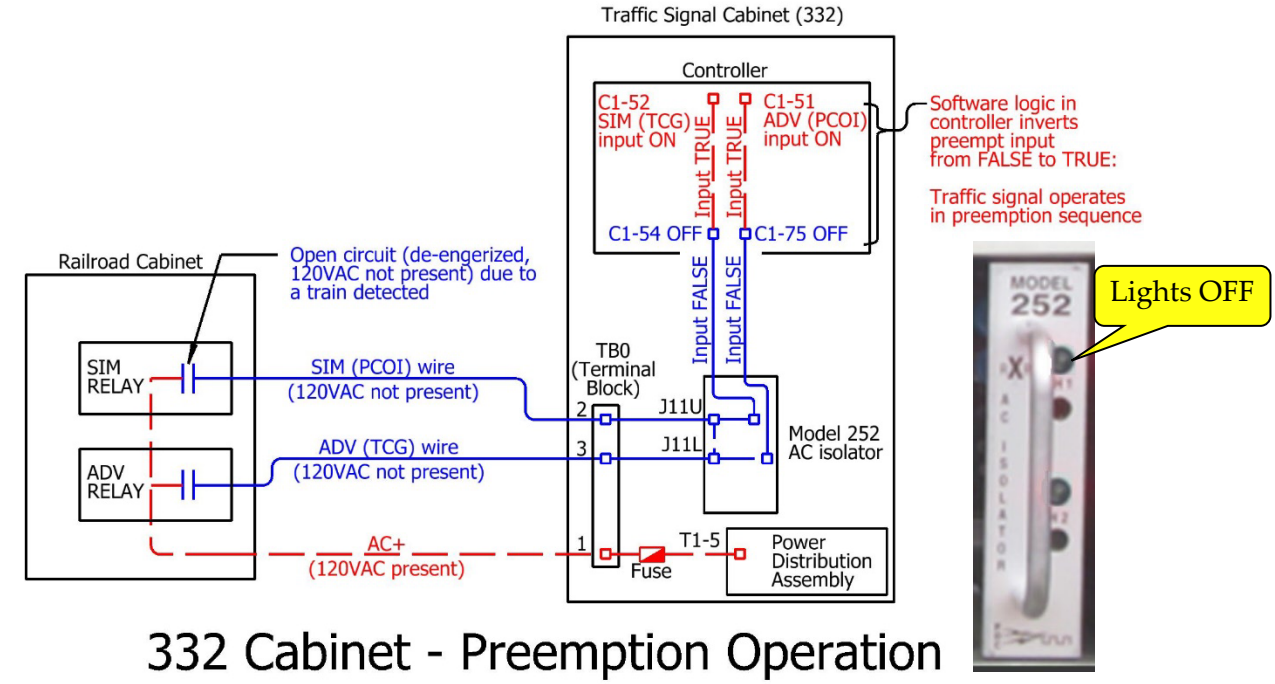
- When C1-54 is ON, turn OFF C1-52 (not preempted) and
  when C1-54 is OFF, turn ON C1-52 (preempted)
- When C1-75 is ON, turn OFF C1-51 (not preempted) and
  when C1-75 is OFF, turn ON C1-51 (preempted)

For normal operation, the 252 AC isolator lights will be ON and for preempted operation they will be OFF. Note: if the 252 AC isolator is not plugged into the input file, the rail preemption PCOI and TCG sequences will be served indefinitely. See Figure 1-25.

The 332 wiring, equipment, and programming is a legacy standard for rail preemption. It is no longer used for new installations.

Figure 1-25 | 332 Cabinet Hardware, Wiring, and Inputs





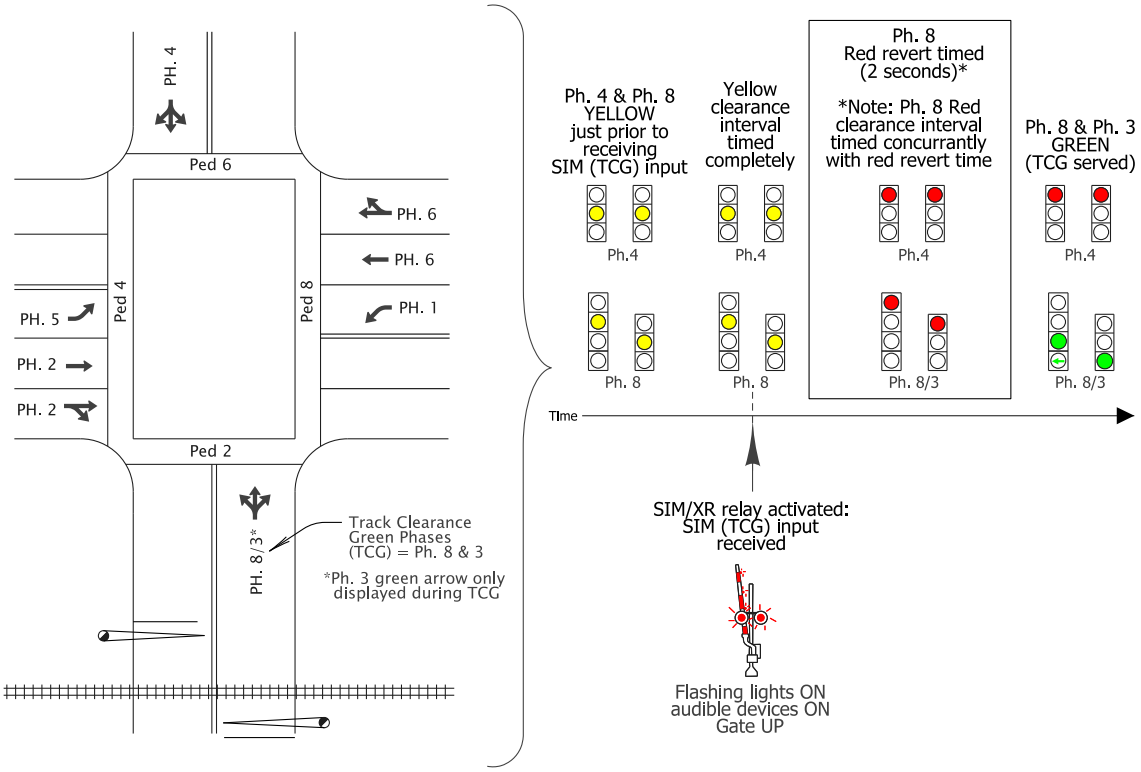
1.5 Rail Interconnected Traffic Signal Operations and Features

The following section provides general information on operations and features that are unique to rail interconnected traffic signals.

1.5.1 Red Revert

Red revert is a timing feature that can be programmed for each signal phase. This feature prohibits a green indication from immediately following a yellow indication which can occur during a preemption (rail or EV). A red indication (typically between 2 and 5 seconds) will follow the yellow clearance interval before serving the phase again. See Figure 1-26. This is done because many motorists divert their attention away from the traffic signal as they bring their vehicle to a stop. When the SIM(TCG) input is received during the yellow clearance interval of the TCG phases, the yellow clearance interval will be timed completely followed by a red interval equal to the amount of time specified by the red revert feature. Note: the red clearance interval is timed concurrently with the red revert time. All TCG phases should have a red revert value set at or near the 2 second minimum to allow a rapid return to the TCG phases. This includes the left turn phase assigned to the type 7 signal head green arrow, for consistency and uniformity. All other phases are typically set to 5 seconds.

Figure 1-26 | Red Revert Due to Preemption



1.5.2 PTR Signs

Part time restriction (PTR) sign(s) are typically installed at traffic signals with railroad interconnection. These sign(s) will state a turn restriction such as "NO LEFT TURN" or "NO RIGHT TURN" for any permissive turn movements of the limited service phases and are activated with the SIM(TCG) input.

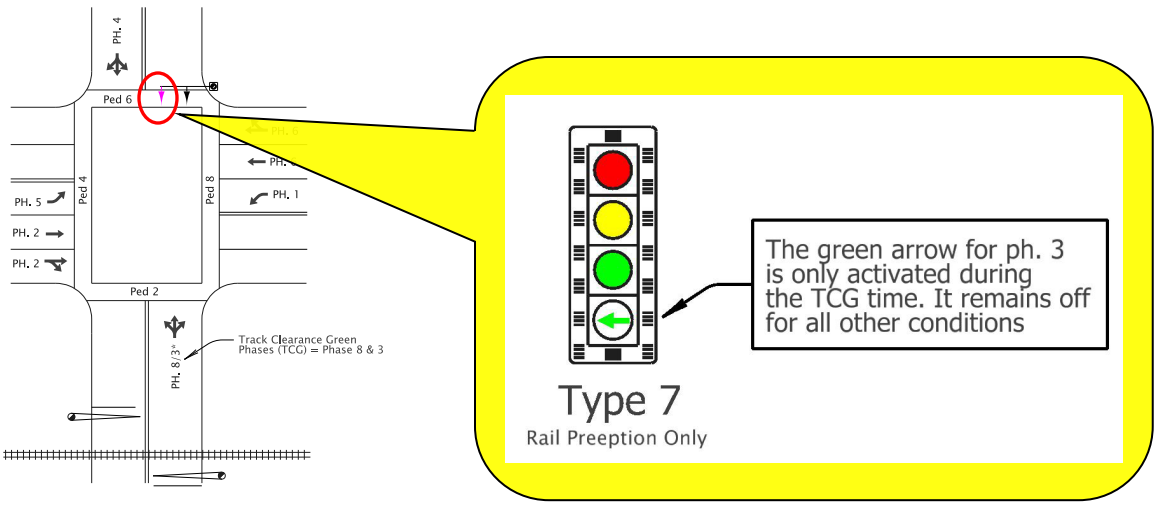
1.5.3 Type 7 Signal Head

The type 7 signal head is required when the TCG phase uses a green ball indication for a permissive only left turn movement for normal operations. This allows the use of a green arrow only during the TCG time so that drivers will know they have a protected left turn movement. In the past when green ball indications were used during the TCG time, motorists making a left turn would often hesitate during the TCG time as they weren't sure if/why the opposing through traffic was stopping. It is important to move vehicles as efficiently as possible during the TCG time so that any vehicle inappropriately stopped on the railroad tracks has minimal delay to move off the tracks.

The green arrow indication on the type 7 signal head is **only** activated during the TCG time. It is not activated under any other conditions, such as normal EV preemption. See Figure 1-27.
NOTE: For rail interconnected signals on the state highway system, the standard signal head for permissive only left turn phasing is now a type 3LCF signal head if a left turn only lane exists and there are no controller cabinet limitations. See section 1.5.5 and the ODOT Signal Design Manual for more information.

NOTE: For rail interconnected signals on the state highway system, the standard signal head for permissive only left turn phasing is now a type 3LCF signal head *if a left turn only lane exists and there are no controller cabinet limitations*. See section 1.5.5 and the ODOT Signal Design Manual for more information.

Figure 1-27 | Type 7 Signal Head



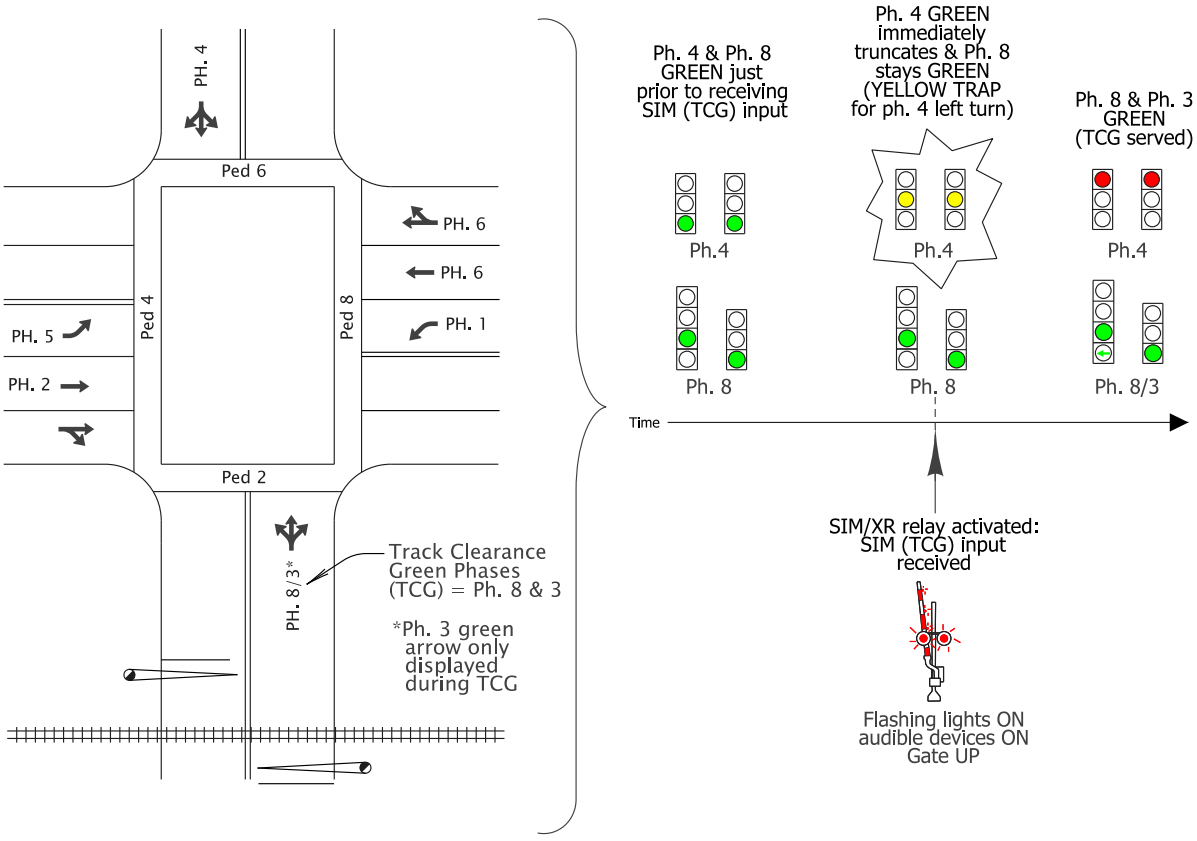
1.5.4 Rail Alarms

Rail alarms are used in the traffic signal controller software to provide notification of potential issues with the preemption inputs that may need attention. Selecting appropriate times to trip the alarms will depend on site specific conditions. The typical duration of preemptions, frequency of preemptions, and train switching activities should be taken into consideration to make sure the alarms are actually useful and not just a nuisance.

1.5.5 Yellow Trap

When railroad preemption is initiated at a traffic signal that has permissive only left turn movements from the roadway that crosses the railroad tracks, a yellow trap situation can occur for left turning vehicles opposing the TCG phases when green ball indications are used. See Figure 1-28.

Figure 1-28 | Left Turn Trap Due to Preemption

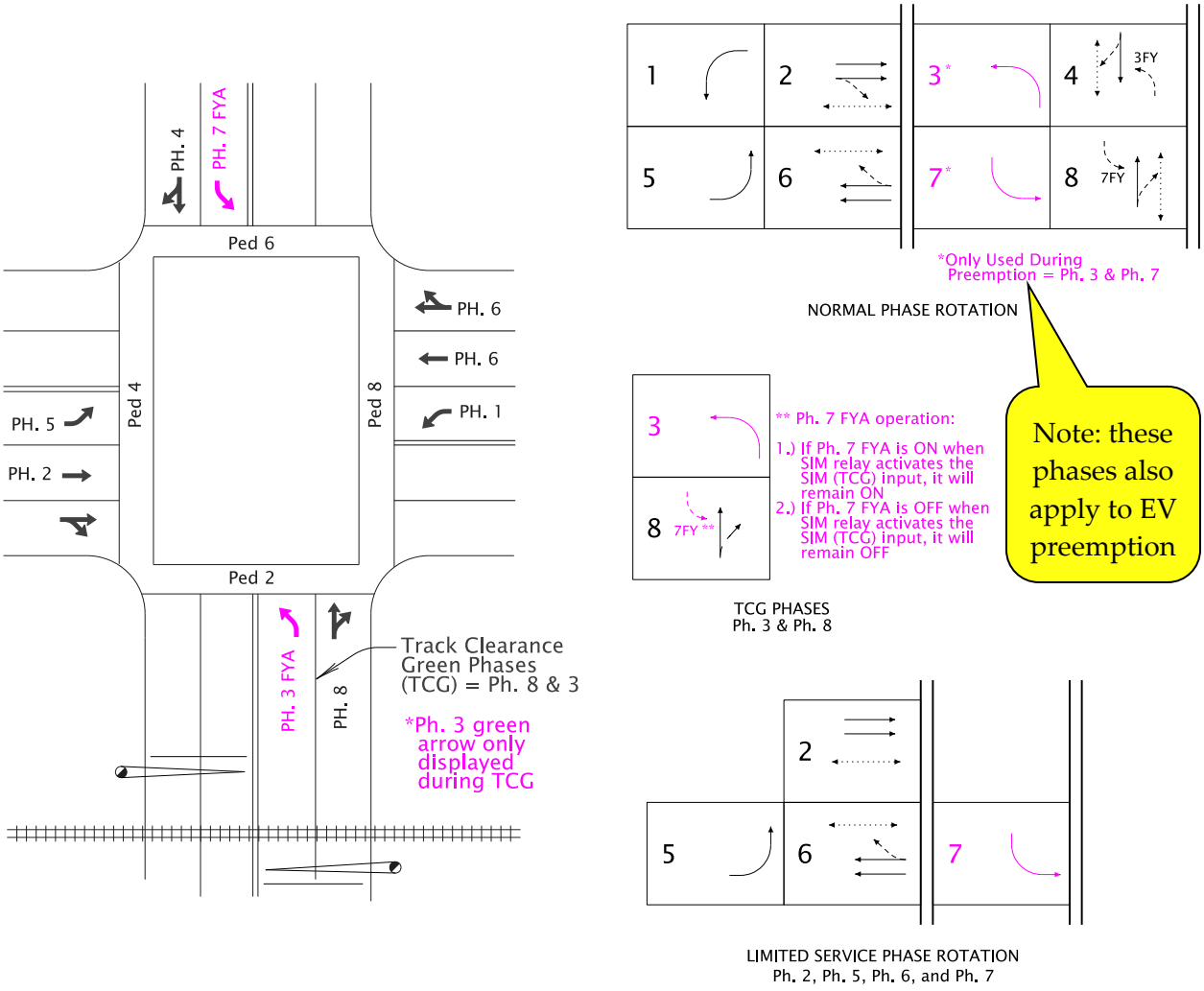


The use of protected only left turns, protected/permitted left turns using flashing yellow arrow, permissive only left turns using flashing yellow arrow, and split phasing will eliminate the yellow trap. However, these options may not be feasible or appropriate depending on the site-specific issues (lane geometry, traffic volumes, etc.). For rail interconnected signals on the state highway system, follow the left turn phasing guidance in the ODOT Traffic Signal Policy and

Guidelines to determine the appropriate left turn phasing at the intersection and the ODOT Signal Design Manual to determine the proper signal head type for left turn phasing.

If permissive only left turn phasing is deemed appropriate AND there is a left turn only lane for the left turn opposing the TCG phases AND no controller cabinet limitations, a flashing yellow arrow signal head (type 3LCF) should be used to eliminate yellow trap. See Figure 1-29.

Figure 1-29 | Permissive Only Left Turn Phasing Using Flashing Yellow Arrow (Type 3LCF Head)



If permissive only left turn phasing is deemed appropriate and there is not a left turn only lane for the left turn opposing the TCG phases or there are controller cabinet limitations, a standard type 2 signal head is the only option and yellow trap can occur as per Figure 1-28. However, yellow trap due to preemption only is deemed a low risk due to the other cues that accompany preemption that give drivers the ability to react appropriately to avoid a crash:

- For rail preemption, the railroad warning system is activated plus the train horn
- For EV preemption, an approaching emergency vehicle with lights and siren on

In addition, if a TCG phase is already green when the SIM(TCG) input is received, it is more important to keep it green vs. abruptly truncating it only to bring it rapidly back up just to prevent the yellow trap. Keeping the TCG phase green is the most efficient way to move a vehicle that may be inappropriately stopped on the tracks before the train arrives. Abruptly truncating the TCG phase green and bringing it rapidly back up violates driver expectancy and is likely to result in less efficient movement of vehicles during the TCG time. Also note that at any permissive left turn there is always a chance that an opposing thru vehicle will not stop for their yellow or red indication which creates an "artificial" yellow trap. As such, drivers making a permissive left turn must always be responsible for judging oncoming traffic regardless of the indication they are looking at.

As per the ODOT Traffic Signal Policy & Guidelines, sign W25-2 (oncoming traffic may have extended green) is not installed on state highways when the yellow trap results from a preemption.

1.6 Maxtime Software Standards

See the Heavy Rail Preemption Operations – Maxtime Software Version 2.14.0 Guide for the software specific standard default timing information for interconnected signals on the state highway system.

1.7 Preemption Operation Design Considerations

When a new railroad interconnected traffic signal is being designed/considered or when an existing railroad interconnected traffic signal is being modified, it is important to coordinate with the ODOT CCD and the signal designer during the design phase of the project to ensure that the appropriate preemption operation and traffic control devices are implemented. Each location is unique and all relevant site-specific information needs to be considered when determining the appropriate treatments. See the ODOT Traffic Signal Design Manual section 16.8 for specific design and operational information to consider during the diagnostic team meeting(s) and design phase.

A rail crossing order may be required prior to implementing operational changes in the field. Contact the ODOT CCD for requirements and see Section 1.10.

1.8 Joint Inspections

A joint inspection is the inspection of the preemption operation of the interconnected traffic signal and the railroad warning system devices with all parties present (rail maintainers, traffic signal maintainers, and ODOT CCD inspectors). The purpose of the inspection is to test all the interconnection equipment and ensure it is operating as designed and expected. An important additional benefit to verifying the preemption operation is establishing a good line of communication between agencies.

Joint inspections are required after certain changes to the system by either party (i.e., road authority or railroad) as per the authority of the ODOT CCD. See Section 1.9. Routine joint inspections are recommended on a yearly basis, as staffing and schedules permit.

A check list has been developed to assist ODOT signal timers and electricians when participating in a joint inspection. The check list contains software specific information and is therefore located in the Heavy Rail Preemption Operations – Maxtime Software Version 2.14.0. However local agencies using different software may still find the check list useful. Contact the state traffic operations engineer for access to the check list.

1.9 Signal Timing and Modifications at Existing Railroad Interconnected Traffic Signals

When making signal timing or signal equipment modifications at existing railroad interconnected traffic signals, certain actions will trigger different requirements. The four different levels of oversight/documentation/process requirements, from least to most restrictive, are shown in Figure 1-30 through Figure 1-33. **ALWAYS contact ODOT CCD (See Table 1-3) – they will send you e-mail documentation to officially state when a crossing order is NOT required for your records. ODOT CCD may also waive requirements at their discretion.**

Figure 1-30 | Requirements at Interconnected Traffic Signals, Level 1

	Action/Documentation/Process Requirements **(Bold Text = Requirement)**	Common Traffic Signal Modification Examples (not all inclusive)
Level 1	• No crossing order (e.g., rail owner input not necessary for decision making, no diagnostic team) • No PE/RA or C&M agreement • No update to the preemption plan sheet • No joint inspection in the field • **Region signal timers or maintaining electricians to give ODOT rail inspector an FYI notification after changes are made**	1. Min green/max green 2. Gap timing parameters 3. Recalling phases/yellow lock/red lock 4. Walk timing 5. FDW timing if it is equal to or less than the existing PCOI time 6. Adding/removing leading pedestrian intervals 7. Red/yellow timing as per ODOT policy 8. Coordination offsets/cycle length & time of day plans 9. Detection timing parameters 10. Updating detection (e.g. from loops to radar/video) 11. Adding/removing PTR signs or static signs for traffic movements that DO NOT CROSS the tracks 12. Adding/removing fire preemption, transit priority 13. Updating programmed signal heads to current standards (no phase changes) 14. Adding supplemental signal heads (no phase changes) 15. Replacing existing signal heads in-kind 16. Modification of controller cabinet equipment/wiring that are NOT for rail preemption operation

Figure 1-31 | Requirements at Interconnected Traffic Signals, Level 2

	Action/Documentation/Process Requirements **(Bold Text = Requirement)**	Common Traffic Signal Modification Examples (not all inclusive)
Level 2	• No crossing order (e.g., rail owner input not necessary for decision making, no diagnostic team) • No PE/RA or C&M agreement • No update to the preemption plan sheet • **Joint inspection in the field required**	1. Changing the TCG time between 8 seconds and 20 seconds 2. ATC controller swap outs 3. Controller firmware updates 4. Updating PTR signs to current standards 5. Changing input/output tables related to railroad preemption 6. Changes to user programs related to railroad preemption 7. Controller cabinet replacement (knock-downs) 8. Modifications of controller cabinet equipment/wiring that are for rail preemption operation 9. Rail interconnect wiring is affected (e.g., disconnected other than for testing)

Figure 1-32 | Requirements at Interconnected Traffic Signals, Level 3

	Action/Documentation/Process Requirements **(Bold Text = Requirement)**	Common Traffic Signal Modification Examples (not all inclusive)
Level 3	• No crossing order (e.g., rail owner input not necessary for decision making, no diagnostic team) • No PE/RA or C&M agreement • **Update to the preemption plan sheet required (see ODOT Traffic Signal Design Manual)** • **Joint inspection in the field required**	1. Activating the PTR for rail preemption in additional situations (e.g. also activating for pedestrians) 2. Adding/removing lanes that DO NOT CROSS the tracks 3. Changing existing lane use that DO NOT CROSS the tracks 4. Opening or closing crosswalks (with no change to existing PCOI time) 5. Adding/removing any vehicle/pedestrian/overlap phases 6. Changing existing left turn phasing (e.g., protected to PPLT) 7. Adding/removing split phasing 8. Adding/removing any limited service phases 9. Adding/removing a type 7 signal head

Figure 1-33 | Requirements at Interconnected Traffic Signals, Level 4

	Action/Documentation/Process Requirements **(Bold Text = Requirement)**	Common Traffic Signal Modification Examples (not all inclusive)
Level 4	• **Crossing order required (e.g., rail owner input required, diagnostic team required)** • **PE/RA and C&M agreement required** • **Update to the preemption plan sheet required (see ODOT Traffic Signal Design Manual)** • **Joint inspection in the field required**	1. Installing signal equipment that crosses over or under the railroad right-of-way (typically conduit work) 2. Adding/removing lanes that cross the tracks 3. Changing existing lane use of lanes that cross the tracks 4. Changing interconnection circuitry 5. Full signal rebuild 6. Partial signal rebuild (installing new foundations/traffic structures near rail right-of-way) 7. Decrease/increase needed to the existing PCOI time 8. Adding/removing the TCG phase 9. Changing the TCG time outside of 8 to 20 seconds 10. Adding/removing any signs used for or critical to railroad preemption or detailed in the existing crossing order (e.g., PTR signs, NO TURN ON RED signs, STOP HERE ON RED signs)

1.10 Rail Contacts

It is important for the road authority to communicate with ODOT CCD whenever doing any work at a railroad interconnected traffic signal, including traffic signal timing changes as per the previous section. See Table 1-3. For rail interconnected signals on the state highway system, additional information on ODOT CCD communication and processes are provided in the ODOT Traffic Manual.

Table 1-3 | ODOT CCD Contacts

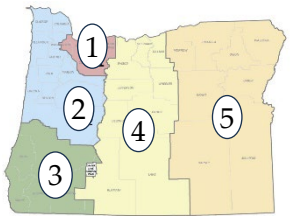
Job Description	Name (w/e-mail link)	Phone
Rail Signal Inspector	Bryon Alger	(541) 213-1624
Rail Safety Manager	Karla Tackett	(503) 476-6863
General ODOT CCD e-mail for interconnected traffic signal work inquires	CCD Rail Crossing	N/A

1.11 Road Authority Interconnected Traffic Signal Contacts

It is important for the ODOT CCD staff to communicate with the road authority knowledgeable in interconnected traffic signals when issues arise during rail inspections or construction projects. Table 1-4 lists the road authority contacts for ODOT (on the state highway or maintaining local agency traffic signals via IGA) and local agencies (off the state highway or maintaining state highway traffic signals via IGA). The ODOT dispatch number for each region is also listed, which can contact the appropriate on-call staff for intersections both on and off the state highway system.

Table 1-4 | Road Authority and Dispatch Contacts

Road Authority	Name (w/e-mail link)	Phone
ODOT Region 1	Michael Burkart	(503) 867-7561
ODOT Region 2	Nick Schlotthauer	(503) 779-7667
ODOT Region 3	William Fitzgerald	(541) 315-8997
ODOT Region 4	Jason Briedis	(541) 215-9517
ODOT Region 5	Tyson Tinnes	(541) 805-6167
PBOT	Stefan Bussey	(503) 823-5556
Washington County	Matt Dorado	(503) 846-7949
Clackamas County	Ioana Cosma	(503) 742-4691
City of Beaverton	Maggie Lin	(503) 713-9149
City of Salem	Eric Destival	(503) 302-7071
City of Corvallis	Ted Reese	(541) 766-6916
City of Eugene	Bret Jones	(541) 228-5722
City of Springfield	Scott Miller	(541) 726-3761
Lane County	Shashi Bajracharya	(541) 682-8510
City of Medford	Signal On-Call	(541) 200-9461

	Region 1 DISPATCH (Portland metro)	(503) 283-5859
	Region 2 DISPATCH (N. Valley & Coast)	(503) 362-0457
	Region 3 DISPATCH (S. Valley & Coast)	(541) 858-3103
	Region 4 DISPATCH (Central Oregon)	(541) 383-0121
	Region 5 DISPATCH (Eastern Oregon)	(541) 383-0121

1.12 History of Oregon's Standard Practices for Heavy Rail Preemption

The ODOT Traffic Signal Policy and Guidelines Section 8 states the basic standards for heavy rail preemption.

Oregon's preemption practice is different from that of most of the other states. Most of the other states typically use a single detection input to start the traffic signal preemption sequence and do not design for pedestrian crossing times. While the MUTCD Section 4D.27 allows the complete omission of the pedestrian walk interval and the pedestrian change interval, Oregon only allows this to occur for train switching operations, not for normal through trains traveling at speed. During train switching operations, the train operator performs additional safety requirements before occupying the railroad grade crossing.

Oregon's preemption practice of using two detection inputs and designing for the pedestrian crossing times been used successfully for a long time, with Oregon becoming even more committed to addressing the potential vehicle-pedestrian conflicts when the indications for the vehicle clear out phase began the change from flashing yellow to solid green in the 1980s. Recent data of highway-rail grade crossing incidents from the US Department of Transportation from 2021 to 2025 consistently shows Oregon having a small number in incidents in comparison to other states. In addition, highway-rail grade crossing incidents in Oregon are routinely analyzed by team of diverse stakeholders resulting in explicit guidance to improve safety which is then documented in the Oregon Highway-Railway Crossing Action Plan.

The key differences between Oregon's preemption practice and other jurisdictions are described below:

1. Oregon uses the ADV relay to clear any pedestrian conflicts prior to the track clearance green time, *with normal traffic signal phase rotation*. See section for description of this preemption operation. Most other jurisdictions use the ADV relay to start the TCG time for vehicles.

   Reasoning: *Clearing the pedestrian conflicts prior to the TCG time allows for a shorter TCG time, as vehicles will not have to negotiate with any pedestrians that may have been stranded in the crosswalk. Note: Oregon does have the option to display the TCG phases earlier than normal ONLY IN THE ABSENCE OF PEDESTRIAN CONFLICTS if approved by ODOT CCD and the state traffic engineer. See section 1.2.2 for description of the early display TCG sequence.*

2. Oregon TCG time is designed to clear only the vehicles located between the railroad stop line and the intersection stop line, to allow a vehicle stopped inappropriately on the tracks a chance to move off the tracks before train arrival. There is no requirement for the TCG time to clear the entire queue from the intersection. See section 1.3.2 for

more information. Most other jurisdiction's TCG time is designed to clear a design vehicle stopped at the railroad stop bar. See Figure 1-34.

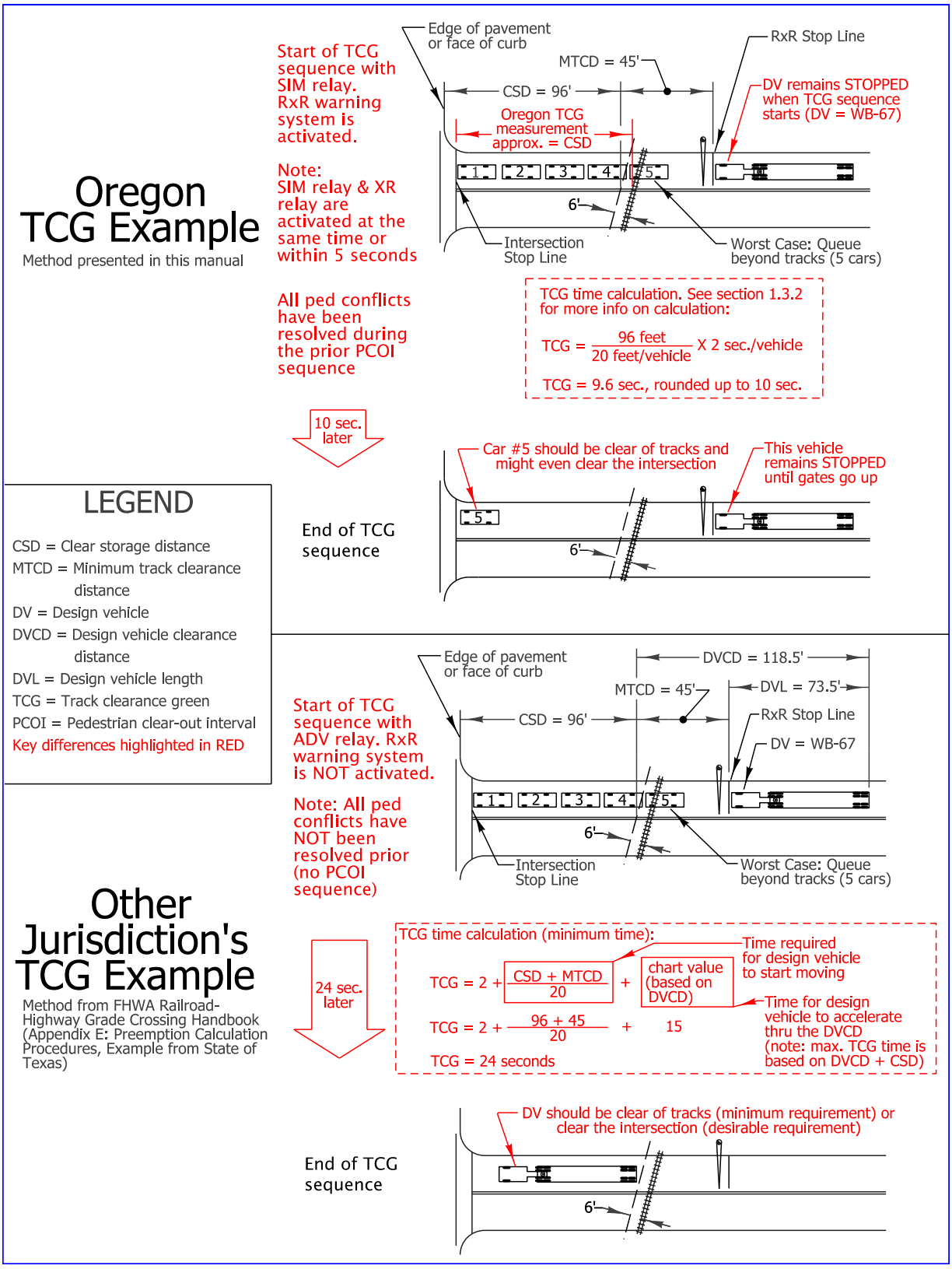
Reasoning: *The design vehicle located at the railroad stop bar is not in danger of collision with a train and therefore does not have to be moved during the TCG time if the railroad warning system is activated at the same time as the TCG sequence starts (see number 3 below). Oregon will have considerably shorter TCG times than other jurisdictions due to this difference in operation.*

3. Oregon uses the SIM relay to start the TCG sequence. The SIM relay and the XR relay (when the railroad warning system is active) often start at the exact same time or are offset only by 1 to 5 seconds. See Figure 1-1 for illustration. Most other jurisdictions start the TCG sequence via the ADV relay (when the railroad warning system is not active).

   Reasoning: *Oregon can start the TCG sequence via the SIM relay due to the shorter calculated TCG times (as discussed in number 1 and number 2 above). The shorter TCG times fit within the typical SIM/XR relay timing (FRA requires a minimum of 20 seconds before the train arrives at the crossing, with typical crossings designed at 25 to 30 seconds). Starting the TCG sequence with the SIM relay helps ensure that the vehicle at the railroad stop bar will stay stopped and not proceed forward during the TCG time as vehicles are required to stop for the railroad warning system per Oregon law 811.455(1)(a)(A) when a clearly visible electrical or mechanical signal is given by a device that warns of the immediate approach of a railroad train (i.e. railroad flashing lights and audible signal are activated), regardless of the traffic signal indications.*

   Starting the TCG sequence with the SIM relay consistently results in zero to minimal time of TCG time after the railroad gate arms are horizontal. See Figure 1-3 and Figure 1-5 for an illustration of TCG time with respect to the railroad warning system. Other jurisdictions that use the ADV relay to start the TCG sequence (and do not use a gate down input) can result in significant amounts of TCG time after the railroad gate arms are horizontal or early termination of TCG time (preempt trap) if the train is accelerating/decelerating, which is not desirable.

Figure 1-34 | Oregon TCG time vs. Other Jurisdictions TCG time

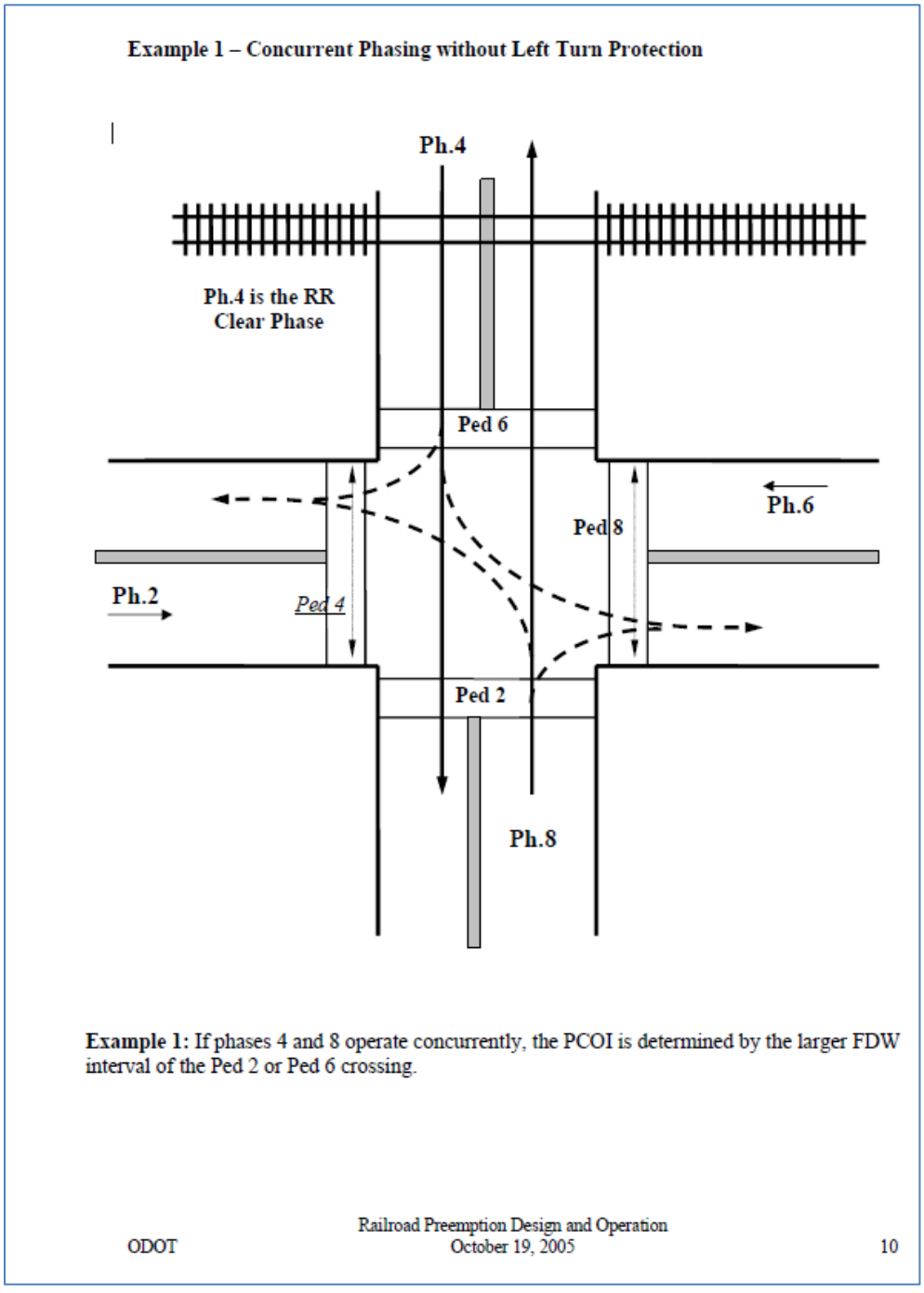


1.13 History Of PCOI Calculations

Railroad interconnected traffic signals that have an existing PCOI time that was calculated prior to approximately 2011 are likely to have a PCOI time that is too short according to the current standard described in this manual. This is due to a few changes to standards that have occurred in the past:

- The PCOI time was historically determined by the flashing don't walk interval (FDW) of the longest crosswalk that DOES NOT normally operate with the TCG phases. For intersections that had permissive left turn phasing for the TCG phases, this allowed the typically two longest crosswalks at the intersection (across the highway cross-section) to be omitted from the PCOI calculation as the pedestrian could finish a truncated ped phase during the following TCG sequence and turning vehicles would still have to yield to that pedestrian as per the GREEN circular ball indications displayed during the TCG sequence. See Figure 1-35.
- Truncating the pedestrian phases that DO NOT normally operate with the TCG phases as per the previous bullet point was more acceptable when the pedestrian signal heads were not countdown style. The countdown style was required by the 2009 MUTCD. Countdown style heads introduced the problem of presenting accurate and consistent FDW time information to the pedestrian at rail interconnected traffic signals when the PCOI time did cover the longest crosswalk at the intersection.
- The GREEN ARROW indication for the TCG phases (i.e. Type 7 signal head) became a standard in April 2007. Retrofitting existing signals with the type 7 signal head resulted in re-evaluating and updating the existing PCOI times as necessary (as one of the crosswalks omitted as per the first bullet point now had to be considered for the PCOI calc), but there was no formal documentation requirements for the PCOI calculations at that time. While many of the rail interconnected traffic signals have been updated with the type 7 signal head, a handful of traffic signals in 2025 still require a type 7 signal head update.
- Prior to the 2009 MUTCD, the walking speed of the pedestrian was 4 feet/second. In the 2009 MUTCD, the walking speed was changed to 3.5 feet/second. This had the biggest impact on existing PCOI times. Any PCOI time that was calculated and implemented prior to the adoption of the 2009 MUTCD (in approximately 2011) were now not long enough. While this was identified as an issue in 2011 and work was done to increase PCOI times as funding and staff time allowed, it was not a high priority for project work. Therefore, there is still likely a large number of intersections that require an increase to the existing PCOI time.

Figure 1-35 | Historical Determination of Longest Conflicting Crosswalk for PCOI Calculation



1.14 Definitions and Acronyms/Abbreviations Used in this Manual

ADV(PCOI) input = The input the traffic signal controller uses to initiate the PCOI.

ADV relay = The railroad controller cabinet relay that detects an approaching train and sends the ADV(PCOI) input to the traffic signal controller.

ADV relay time = The advance (ADV) relay time is the estimated time of arrival of the train to the edge of pavement at the crossing when the ADV relay is activated**.**

C&M agreement = Construction and Maintenance Agreement. An agreement issued by the ODOT ROW rail team. It is required for a project and included in the specifications. It is between ODOT, the road authority and the railroad to determine how the project will be constructed, how the project will be maintained, and any associated costs.

Crossing Order = A legal document issued by ODOT CCD regulating the traffic control devices used at the rail crossing. It specifies the requirements and responsibilities associated with constructing, relocating, altering or closing a rail crossing.

Diagnostic Team = A group of knowledgeable representative of the parties of interest in a grade crossing or group of grade crossings (see 23 CFR Part 646.204). Also see chapter 16 of the Traffic Signal Design Manual for additional information on diagnostic teams on ODOT projects.

GD relay = Gate down relay. The railroad controller cabinet relay that detects when the rail gate arm is fully horizontal.

ISLD relay = Island relay. The railroad controller cabinet relay that detects an approaching train and keeps the railroad relays and railroad warning system devices active until the train departs the rail crossing.

Joint Inspection = Inspection of the preemption operation of the interconnected traffic signal and the railroad warning system devices with all parties present (rail maintainers, traffic signal maintainers, and ODOT CCD inspectors).

Limited Service Phases = The traffic signal vehicle phases assigned to any vehicle movements that do not conflict with the rail crossing that are served after the TCG time while the train occupies the crossing.

ODOT CCD = ODOT Commerce and Compliance Division (formally known as Rail Division). Authority to control and regulate the construction, alteration, and protection of highway-rail and highway LRT grade crossings (in semi-exclusive alignments) is vested exclusively in the State through the Rail Division of the Department of Transportation in accordance with ORS 824.200 through ORS 824.256.

PE/RA = Preliminary Engineering/Review Agreement. An agreement that the railroad requires with the road authority to allow the railroad to review and be reimbursed for the cost to review

project plans during the design phase. ODOT CCD or ODOT ROW rail team will coordinate this process.

PCOI = Pedestrian Clear Out Interval. Part of the railroad preemption operation sequence that allows pedestrians to finish crossing during an active pedestrian phase AND prohibits pedestrians from starting a new active pedestrian phase before the TCG phases are served.

PCOI Time = The number of seconds between the ADV(PCOI) input and the SIM(TCG) input, used to allow any active pedestrian phases to finish their entire flashing don't walk time prior to the TCG sequence.

PCOI Sequence = Description of the sequence that is initiated with the ADV(PCOI) input.

Preemption Plan Sheet – A sealed plan sheet of the high-level preemption operation and parameters needed to program the traffic signal software as per the crossing order requirements.

PROWAG = Public Right-of-Way Accessibility Guidelines. Guidelines that contain scoping and technical requirements to ensure that pedestrian facilities located in the public right-of-way (including a public right-of-way that forms the boundary of a site or that lies within a site bounded by a property line), are readily accessible to and usable by pedestrians with disabilities. These guidelines apply to pedestrian facilities in public rights-of-way to the extent required by regulations issued by Federal agencies under the Americans with Disabilities Act of 1990, as amended (42 U.S.C. 12101 et seq.) (ADA).

Railroad Warning System Devices = The railroad wig-wag flashing red indications, audible devices, and gate arms.

SIM(TCG) input = The input the traffic signal controller uses to initiate the TCG sequence.

SIM relay = The railroad controller cabinet relay that detects an approaching train and sends the SIM(TCG) input to the traffic signal controller.

SIM relay time = The simultaneous (SIM) relay time is the estimated time of arrival of the train to the edge of pavement at the crossing when the SIM relay is activated**.**

TCG = Track Clearance Green. Part of the railroad preemption operation sequence that allows vehicles the opportunity to clear off the tracks via a green traffic signal indication before the train arrives. TCG was formally known as VCOI (Vehicle Clear Out Interval).

TCG Time = The number of seconds of GREEN time assigned to the TCG phases that is activated by the SIM(TCG) input.

TCG Phases = The traffic signal vehicle phases assigned to any vehicle movements that may queue between the intersection and rail crossing.

TCG Sequence = Description of the sequence that is initiated with the SIM(TCG) input.

- **Default Standard TCG Sequence** = The TCG time is provided followed by the limited service phases. Default standard used at the majority of intersections.

- **Early TCG Display Sequence** = The TCG phases will display GREEN indications during the PCOI in the absence of active pedestrian phases and rest in GREEN until the SIM(TCG) input initiates the TCG time followed by the limited service phases. Used where approved by ODOT CCD and the state traffic engineer.
- **No TCG Sequence** = The TCG time is not provided and only the limited service phases will be served. Used where approved by ODOT CCD and the state traffic engineer.

VCOI = Vehicle Clear Out Interval. This term is no longer used as it had multiple, slightly different means depending on how it was used (road authority vs. rail owner). It has been replaced by the term TCG (track clearance green).

XR relay = The railroad controller cabinet relay that detects an approaching train and activates the railroad warning system devices.

1.15 References

Manual on Uniform Traffic Control Devices (MUTCD), 11th Edition, U.S. Department of Transportation, Federal Highway Administration https://mutcd.fhwa.dot.gov/index.htm

Oregon Supplement to the Manual on Uniform Traffic Control Devices, 11th Edition, Oregon Department of Transportation https://www.oregon.gov/odot/Get-Involved/OTCDC/MUTCD11-OR-Supplement.pdf

Oregon Administrative Rules (OAR), Chapter 734, Oregon Department of Transportation, Highway Division https://sos.oregon.gov/archives/Pages/oregon_administrative_rules.aspx

Oregon Administrative Rules (OAR), Chapter 741, Oregon Department of Transportation, Rail Division https://sos.oregon.gov/archives/Pages/oregon_administrative_rules.aspx

Oregon Revised Statutes (ORS), chapter 811, Rules of the Road for Drivers https://www.oregonlegislature.gov/bills_laws/pages/ors.aspx

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Highway-Rail Crossing Handbook, Third Edition, Federal Highway Administration and Federal Railroad Administration https://railroads.dot.gov/sites/fra.dot.gov/files/2020-01/GXHandbook2019FRAFHWA.pdf

US Department of Transportation Highway-Rail Grade Crossing Incident Summary https://data.transportation.gov/stories/s/Highway-Rail-Grade-Crossing-Incident-Summary/vgvy-yf2j/

Oregon Highway-Railway Crossing Action Plan (2022-2027), Oregon Department of Transportation, Commerce and Compliance Division https://www.oregon.gov/odot/MCT/Rail_Safety/Oregon-Highway-Railroad-Crossing-Safety-Action-Plan.pdf