Oregon Department of Transportation

Traffic Signal Policy and Guidelines

March 2024

Oregon Department of Transportation

Engineering & Technical Services Branch

Traffic Roadway Section MS#5

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Traffic Section Website

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Preface

The Oregon Department of Transportation is responsible for installation, operation, and maintenance of traffic signals on the state highway system. The Oregon Transportation Commission has adopted as its policy, the Manual on Uniform Traffic Control Devices (MUTCD) and the Oregon Supplement to the Manual on Uniform Traffic Control Devices.

The Traffic Signal Policy and Guidelines are based on the MUTCD and the Oregon Supplement to the MUTCD and address only items not included in these publications or items that need further clarification. They reflect the Oregon Revised Statutes and Oregon Administrative Rules; ODOT practices; and agreements with the League of Oregon Cities (LOC) and the Association of Oregon Counties (AOC). The Traffic-Roadway Section publishes the Traffic Signal Policy and Guidelines under the authority delegated to the state traffic-roadway engineer under Delegation Order EB-06.

These guidelines are for the use of individuals involved in the design, operation, or maintenance of traffic signals on the state highway system in Oregon. Additional guidance is available in the references cited above and in the ODOT Traffic Manual. The purpose of this document is to encourage uniformity in the location, operation, and maintenance of traffic signals in Oregon. The use of the terms “shall,” “should,” and “may” in this document shall be identical to their meanings in the MUTCD.

This edition supersedes previous editions of the Traffic Signal Policy and Guidelines effective **March 15, 2024**. New content presented in this edition does not imply that existing ODOT signals are unsafe, nor does it mandate initiation of improvement projects or update to timing parameters unless otherwise specified.

Publication of the 11th edition of the MUTCD occurred during final review of this document. All interim approvals have been revoked and are incorporated, with some modifications, in the 11th edition of the MUTCD. While the entirety of the 11th edition of the MUTCD is not yet adopted, it does apply for these devices.

The state traffic operations engineer maintains the Traffic Signal Policy and Guidelines. Send comments or questions on this document to chris.j.primm@odot.oregon.gov or,

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1. Traffic Signal Approval Process

All traffic signal installations or removals and some traffic signal modifications require state traffic-roadway engineer approval. See ODOT Traffic Manual for process and approving authority.

All installations and modifications of traffic signals require two different approvals: operational and design. Operational approval is required before design approval can be granted and should be achieved before design work is started. Operational approval confirms the decision that the proposed installation, removal, or modification of the existing signal is the preferred method of traffic control for the intersection and covers how the intersection will operate. Design approval ensures the signal plans conform to ODOT standards and specifications. Appendix C shows the flowcharts for operational and design approval processes.

Operational approval for the installation or removal of a traffic signal requires an engineering study. The engineering study shall indicate the need for the traffic signal and demonstrate that the installation or removal of the traffic signal is expected to improve the overall safety and operation of the intersection. The following elements should be included in the engineering study, where applicable:

- Location (region, district, highway, milepoint, and side street name).
- Traffic volumes (am and pm volumes for base and future years).
- Traffic signal warrants analysis (per MUTCD and ODOT Analysis Procedures Manual).
- Signal progression analysis (refer to OAR 734-020-0480).
- Conceptual traffic signal design (if available).
- Vehicle turning template.
- Safety analysis (including crash history).
- Operational analysis.
- Documentation of Transportation System Plan consistency and/or other plans.
- Evidence of other agency support.
- Comparison of reasonable alternatives (e.g. stop control, roundabout, intersection relocation or reconfiguration, and/or grade separation) in an intersection control evaluation study. See ODOT Traffic Manual.

Modifications of existing traffic signals that require approval from the state traffic-roadway engineer shall also be supported by an engineering study. The study should include appropriate elements mentioned above.

The engineering study shall have region traffic engineer concurrence and be submitted to the office of the state traffic-roadway engineer (STRE) via STRE approval request form and include the above-mentioned elements. The cover letter shall also be accompanied with a signed Preliminary Signal Operations Design Form (Appendix D). The STRE approval letter and summary will include requirements regarding the approved lane configuration and phasing.

For all signal modifications only requiring region traffic engineer approval, documentation shall be sent to the Traffic-Roadway Section justifying and explaining the type of modification that is planned. This documentation is critical for the design review and approval process. Regions should retain a copy of documentation in their files. The following information should be included in the summary documentation:

- Location (region, district, highway, milepoint, and side street name).
- Existing intersection configuration and operation.
- Proposed intersection design configuration and operation.
- Traffic volumes (am and pm volumes for base and future years).
- Reason for the proposed modification.
- Any supporting information used in the region approval.

Some region traffic engineer approvals may be delegated further to reporting licensed professional engineers. See ODOT Traffic Manual for more information.

Design approval of a traffic signal requires traffic signal plans and specifications. The traffic signal plans and specifications shall follow the conditions of the operational approval. The requirements for design approval are covered in the ODOT Signal Design Manual.

1.1 Traffic Signal Warrants

For new signal installations, one or more of the traffic signal warrants, mentioned in Chapter 4C of the MUTCD, shall be met unless the traffic signals meet the criteria for special applications discussed in Section 1.2 below. An analysis of compliance with each applicable warrant should be included in the engineering study.

1.2 Special Applications

1.2.1 Projected Signal Warrants

MUTCD Warrant 1, Condition A or Condition B may be projected by using future year average daily traffic volumes to determine the future need for a traffic signal. The Transportation Planning and Analysis Unit (TPAU) has developed a procedure (refer to the Analysis

Procedures Manual) to project future traffic. Refer to OAR 734-020-0430 for limitations regarding projects using future volumes.

For new intersections where hourly traffic volumes are not available, average daily traffic (ADT) – based Preliminary Signal Warrant Analysis, as presented in the Analysis Procedures Manual, may be used instead of MUTCD Warrant 1 for warrant analysis.

1.2.2 Bicycle and Pedestrian Activated Warning Systems

Bicycle and pedestrian activated warning systems include flashing beacons and rectangular rapid flashing beacons. These devices can be useful at intersections or mid-block locations where there are potential conflicts between vehicles and pedestrians or bicyclists or both, or where there may be limited sight distance or lane width such as on narrow bridges or in tunnels.

Installation of these devices requires approval, see ODOT Traffic Manual section 310.3. Also, refer to Part 4 of the MUTCD, FHWA IA-21 and Section 5 of this document for guidance on these devices.

1.2.3 Pedestrian Signals and Pedestrian Hybrid Beacons (PHBs)

Pedestrian signals and pedestrian hybrid beacons (PHBs) include actuated pedestrian phases that assign right of way. These devices can be appropriate treatments at locations that meet criteria in the ODOT Traffic Manual Table 310.3-A, subject to related approval criteria. Note that on the state highway system pedestrian signals and pedestrian activated warning systems (see section 1.2.2) are strongly preferred over PHBs. See section 5.4.3, and the ODOT Traffic Manual for more information on STRE approval of PHB alternatives.

1.2.4 Emergency Traffic Signals

An emergency signal is a special traffic control signal that assigns the right of way to fire trucks and other vehicles providing emergency services. Refer to Chapter 4G of the MUTCD and Section 6.1 of this document for guidance on installation of emergency traffic signals.

1.2.5 Freeway Entrance Ramp Control Signals (Ramp Meters)

A ramp meter is a traffic signal on a freeway entrance ramp that controls the rate at which vehicles enter the freeway.

All ramp meter installations, modifications, and removals on state highways require approval from the region traffic engineer. The installation, modification, or removal of all ramp meters shall be supported by an engineering study that indicates the recommended action is expected to improve safety and/or operations. Additional guidance can be found in Chapter 4I of the MUTCD and Section 6.2 of this document.

1.2.6 Temporary and Portable Signals

A temporary traffic signal is typically used to control traffic in work zones. A portable signal is a temporary signal mounted on a trailer.

Installation of temporary and portable signals on state highways requires approval from the state traffic-roadway engineer. Refer to Chapter 4D of the MUTCD and Section 6.3 of this document for guidance on temporary and portable traffic signals. When considering the use of temporary or portable traffic signals, a site visit to observe field conditions should be conducted when investigating their possible use in work zones. Sight distance to the potential signal display locations shall be per MUTCD, Table 4D-2 "Minimum Sight Distance for Signal Visibility."

1.2.7 Flashing Beacons

Flashing beacons, including warning beacons and stop beacons, are supplemental devices installed in conjunction with warning or regulatory signs. Refer to Part 4 of the MUTCD, the ODOT Traffic Manual and the Traffic Signal Design Manual for guidance on the installation of these devices.

1.3 Approved Traffic Signals

If a traffic signal is not advanced to construction within five years of the approval from the STRE, the approval is rescinded per (OAR 734-020-0430).

The Traffic-Roadway Section maintains the traffic signal approval letters for traffic signal installations: before 12/18/2017 (FTP site, copy link and paste in windows explorer); post 12/18/2017.

1.4 Adaptive Signal Timing

Deployment of adaptive signal timing is under the respective region traffic engineer's authority. The approved software required for deployment is under STRE authority.

See section 2.6.3, Appendix F and the ODOT Signal Design Manual for deployment responsibilities and design guidance.

2. Design, Construction, Timing and Maintenance Responsibilities

2.1 Signal Design

The ODOT Signal Design Manual shall be the primary source for information related to traffic signal design. Refer to Part 4 of the MUTCD for additional design information.

2.2 Signal Construction

All necessary approvals, as discussed in the ODOT Traffic Manual, shall be obtained prior to advancing to construction and the construction shall be done according to the construction plans, ODOT Standard Specifications, Special Provisions and any applicable addenda or change orders.

Individual and unit responsibilities vary across regions. As part of the signal construction process, region signal timers, operations engineers, electricians, or vendor representatives are responsible for:

- Signal and appurtenance inspection.
- Detector layout when field adjustment is required.
- Detector calibration.
- Signal timing.
- Coordination with TSSU for equipment chamber testing, network installation and field testing.

Additional information on design and construction responsibilities can be found in the ODOT Signal Design Manual.

2.3 Signal Timing

The primary responsibility for timing of traffic signals on state highways belongs to the region traffic engineer/manager or designated representative under the authority of the STRE unless an interagency agreement dictates otherwise.

Copies of current signal timing and/or databases should be maintained and accessible by relevant maintenance staff, whether manually and/or programmatically. Physical and digital copies should be kept in the traffic signal controller cabinet if the traffic signal lacks communications that enable tracking signal timing remotely.

Traffic-Roadway Section staff is available for assistance with all aspects of signal timing.

2.4 Signal Maintenance

At the intersection of state highways, ODOT is typically responsible for the design, operation, inspection, and maintenance of all traffic signals. An intergovernmental agreement (IGA) with a local agency may define other traffic signal maintenance and operation arrangements.

At the intersection of state highways and county or city roads, ODOT is often responsible for design, operation, inspection, and maintenance of traffic signals. ODOT will typically develop an IGA with the local agency to clarify roles, arrange for maintenance, and allocate costs. ODOT, the Association of Oregon Counties (AOC), and the League of Oregon Cities (LOC) have established guidelines for the development of these agreements.

It is ODOT's intent to only allow traffic signals on state highways at intersections with public roads or roads identified in transportation system plans (TSP) or other local plans and will be public roads in the future.

When state or federal funds are used for the design or construction of a traffic signal not on a state highway, ODOT's responsibility is generally limited to design review and contract letting. However, ODOT may perform additional work as outlined in an IGA.

For specific information on maintenance activities refer to Activity 144, Traffic Signal Maintenance, in the ODOT Maintenance Guide.

ODOT is occasionally responsible for the operation, inspection, and maintenance of signals off system. An IGA should be developed with the local agency to clarify roles, arrange for maintenance, delineate any process to return duties to the local jurisdiction, allocate costs and reimbursements, and ensure the region has a design review role to ensure maintainable designs.

2.5 Signal Hardware and Software Standards

The office of the STRE will determine the specific type and character of the hardware and software used on the state highways.

Hardware includes, but is not limited to:

- Control system.
- Traffic structures.
- Any other components necessary to complete a traffic signal, except communication and intelligent transportation system components.

Software includes, but is not limited to:

- Controller software.
- Adaptive software.
- Any other devices utilized to run the traffic signal controller.

Central control software is selected by the Intelligent Transportation Systems unit in consultation with Traffic-Roadway Section.

2.6 Intelligent Transportation Systems (ITS)

There are several areas where intelligent transportation systems (ITS), traffic design and traffic operations interact. The ITS coordinator assigned to each region is the primary point of contact for communication and traffic monitoring (TripCheck) camera issues.

2.6.1 Communications

Signal interconnection and central communication is critical for coordinated, traffic responsive and adaptive signal timing. When programming or scoping a project, central and local communications paths will need to be determined. Contact the Traffic-Roadway Section to initiate this process, as directed by the ODOT Signal Design Manual.

2.6.2 Multi-Agency Operations

Where a corridor is operated by multiple agencies, considerable network and coordination work is likely to be required. Consider transferring operations and maintenance via IGA between agencies to avoid this situation. Where unavoidable, early coordination with the local agency and ODOT ITS is required. Regions may also consider monitoring and operating signals via the local jurisdiction's central software and VPN.

2.6.3 Adaptive Signal Timing

Adaptive signal timing is considered by FHWA to be an ITS technology and its use on federally funded projects requires an approved concept of operations (ConOps). Currently, a blanket ConOps for ODOT and local agencies within Oregon is in place. Procurement of licenses for internal ODOT use are streamlined through a contractual price agreement for Q-Free's MaxAdapt software. Other adaptive software can be installed only at signals maintained and operated by local jurisdictions and the choice to do so is not covered by ODOT's existing ConOps. A ConOps for these situations will be required by FHWA for deployment.

Typically, installation of non-preapproved software is requested by local agencies with a larger adaptive signal network which is linked to an ODOT signal. Regions should follow the flowchart in Appendix F to ensure appropriate parties are notified at the correct stage.

3. Yellow Change and Red Clearance Intervals

The purpose of the yellow change and red clearance intervals is to provide a safe transition between two conflicting signal phases. This section discusses ODOT's policy regarding the yellow change and red clearance intervals. The Institute of Transportation Engineers (ITE) and National Cooperative Highway Research Program (NCHRP) have published updates to their guidelines for change and clearance intervals and study is ongoing via pooled fund study as of the publication of this manual. ODOT will consider updates to these intervals when this study is finalized.

Due to Oregon law, ORS 811.260(4), motorists are expected to stop on yellow if they can do so safely. This is termed restrictive yellow. While this is not unique to Oregon, all adjacent states have permissive yellow laws. Motorist familiarity with Oregon law may impact their behavior.

3.1 Yellow Change Interval

The amount of time that the steady yellow signal is displayed is referred to as the yellow change interval. The duration of the yellow change interval is based on the driver's perception-reaction time, deceleration rate, the approach speed, and the approach grade.

Yellow change intervals in use at traffic signals on state highways shall meet or exceed ODOT's minimum yellow change intervals shown in Table 3-1. These yellow change intervals are based on Formula 1 from the Institute of Transportation Engineers (ITE) informational report, "Determining Vehicle Signal Change and Clearance Intervals," August 1994.

The ODOT minimum yellow change intervals shown in Table 3-1 are applicable for approaches where grades (downgrades) are 3% or less. For grades exceeding 3%, the ITE formula below should be used. Left turn velocities may be assumed to be 25 mph. ODOT's minimum yellow change interval is 3.5 seconds and maximum yellow is 5.0 seconds.

Figure 1: Yellow-change interval formula

$$y = t + \frac{v}{2a + 2Dg} \qquad (1)$$

Where:

- y = length of the yellow interval, to the nearest 0.1 second
- t = driver perception-reaction time, recommended as 1.0 second
- v = velocity of approaching vehicle, in ft/sec
- a = deceleration rate, recommended as 10 ft/sec^2

g = acceleration due to gravity, 32 ft/sec^2

G = grade of approach (3% downgrade would appear as -0.03)

3.2 Red Clearance Interval

Red clearance interval (also referred to as "all-red") provides additional time as a safety measure to any driver that may have entered the intersection during the yellow change interval to avoid conflict with traffic releasing from an opposing intersection approach. All traffic signals on state highways shall use ODOT's minimum red clearance interval shown in Table 3-1. These values may be increased as deemed necessary by engineering judgment. Some factors that may be considered for increasing red clearance interval include intersection width, vehicle and pedestrian conflict points, large percentage of trucks, late yellow or red actuation rate, and approach speed.

Table 3-1: ODOT Minimum Yellow Change and Red Clearance Intervals

Posted Speed (mph)	Minimum Yellow Change Intervals (1)(2) (sec)	Minimum Red Clearance (2) (sec)
25	3.5	0.5
30	3.5	0.5
35	4.0	0.5
40	4.3	0.5
45	4.7	0.7
50	5.0(3)	1.0
55	5.0(3)	1.0

(1) Applies to approaches with a downgrade of 3 percent or less.

(2) Some intersections may require more than the minimum times shown in the table.

(3) ODOT limits the yellow change interval to 5 seconds. The sum of the yellow change and red clearance intervals shall exceed the length of yellow interval calculated from Formula 1.

4. Turn Signals

Left and right turns at signalized intersections may be made in three operational modes, ordered most to least restrictive:

Protected Only: This mode allows vehicles to make turns without any conflicting vehicular, bicycle or pedestrian movements during the display of a steady green arrow.

Protected – Permissive: This mode is the combination of the protected and permissive modes. Turning vehicles have the right of way during the protected portion and they need to yield to the conflicting vehicular (including bicycles) and pedestrian movements during the permissive portion.

Permissive Only: This mode requires vehicles to yield to conflicting vehicular and pedestrian movements. Permissive left-turning vehicles yield to oncoming vehicles (including bicycles) and pedestrians. Permissive right-turning vehicles yield to conflicting bicycle and pedestrian movements.

4.1 Left-Turn Signals

This section discusses left-turn operation modes and phase sequences.

4.1.1 Left-Turn Signal Modes

The selection of the most appropriate mode of left-turn operation should be supported by an engineering study and should consider factors such as left-turn and opposing through volumes, posted speed, number of left-turn and opposing lanes (including turn lanes and bike lanes), sight distance, bicycle and pedestrian volumes, and crash history. Non-reactive safety assessments such as road safety audits and video analytics of near misses may be used to inform conclusions of the engineering study. The least restrictive form of left-turn mode that will accommodate all movements safely and efficiently should be used.

These guidelines are written in the suggested order in which an analyst might evaluate the best left-turn mode of operation (most to least restrictive: protected only, protected-permissive, and permissive only).

Opposing left-turn modes should be the same based on driver expectation. If one approach meets criteria for a more restrictive form of left-turn mode, the opposing left-turn mode should match the more restrictive mode. There may be unique circumstances where the use of mixed opposing left-turn modes may occur, for example, if one approach has a left-turn lane and the opposing approach has a shared through/left lane.

Variable left-turn modes of operation can be used based on time of day, presence of gaps in oncoming traffic, or the presence of conflicting pedestrians (refer to Section 4.1.1.2).

According to Section 4D.05 of the MUTCD, it is required to install a W25-2 sign (oncoming traffic may have extended green) if preemption is allowed for an approach from where drivers are allowed to make left-turn movements permissively. Historically, ODOT has not installed this sign on state highways. Empirical evidence indicates there are no safety or operational problems due to the absence of this sign. Informal surveys also indicate this sign doesn't provide clear message to the drivers. Based on these factors, this sign is not used on state highways.

4.1.1.1 Protected Only Left-Turn Mode

This mode provides the safest and most restrictive left-turn operation; however, overall intersection delay may increase.

Protected only left-turn mode shall be provided when:

- Multiple left-turn lanes are provided.
- An engineering study indicates that sight distance to the oncoming traffic is less than the distances shown in Table 4-1 below.

The below table is based on the AASHTO intersection sight distance for passenger cars. Different sight distance values should be used if there are more than two opposing through lanes or the left turning traffic has a high percentage of trucks. Refer to Tables 9-16 & 9-17 of "A Policy on Geometric Design of Highways and Streets" 2018, 7th Edition, AASHTO.

Table 4-1: Sight Distance Requirements (ft)

Posted Speed (mph)	One Opposing Through Lane	Two Opposing Through Lanes
20	165	180
25	205	225
30	245	270
35	285	310
40	325	355
45	365	400
50*	425	465
55*	495	540

Source: A policy on Geometric Design of Highways and Streets 2018, AASHTO – Table 9-17.

* For speeds higher than 45 mph, the stopping sight distance (higher value from Table 9-17) is used instead of intersection sight distance.

Protected only left-turn mode should be provided when:

- Crash history indicates five or more crashes involving left-turn movements (including crashes involving pedestrians) per approach in a consecutive 12-month period within the last three years.
- Left-turn volume routinely exceeds 300 vehicles per hour **or** the product of the opposing through and left-turn hourly volumes exceeds:
  - 150,000; if there is one opposing through lane, or
  - 300,000; if there are two opposing through lanes.

  Note: Where there is a significant lane imbalance, twice the highest single lane volume can be substituted for the total opposing hourly volume when making this calculation. If there is a dedicated right-turn lane the right-turn volumes may be added to the opposing through volumes.
- The posted speed of opposing traffic exceeds 45 mph.
- The left-turn movement crosses three or more lanes of opposing through motor-vehicle traffic.
- U-turns are permitted.
- There are high percentages of left-turning heavy vehicles.
- The opposing left-turn signal is protected only.
- Additional factors such as high bicycle and/or pedestrian volumes, traffic signal progression or coordination, intersection geometry, maneuverability of particular classes of vehicles, adequacy of gaps, or preemption-related operational requirements unique to preemption systems make it necessary to provide protected only left-turn mode.

4.1.1.2 Protected-Permissive Left-Turn (PPLT) Mode

Protected-permissive left-turn (PPLT) mode is very common and generally the most efficient mode of left-turn operation. It is typically used in situations where geometric conditions allow permissive left turns, but traffic volumes are high enough that a left-turn phase is required for capacity reasons.

For all state highway installations, the standard display for PPLT mode shall be the flashing yellow left-turn arrow (FYLTA) display. When PPLT mode is used, the determination of whether the protected portion is displayed before or after the permissive portion should be made based on operational requirements and efficiencies. Irrespective of the order, the FYLTA should only be displayed after a minimum delay period of 3.0 seconds following the green indication for the opposing through traffic.

Gap dependent FYLTA operation is when vehicle detection is used to delay onset of the FYLTA in the presence of conflicting vehicles and may be used to extend the delay time beyond the minimum. Using gap dependent FYLTA may replace the need for a minimum delay in rare cases, based on engineering judgment.

In addition to gap dependent FYLTA operation, FYLTAs may be used to provide variable left-turn mode of operation by time-of-day. For example, if traffic volumes during peak hours warrant protected only left-turn operation, then during those times, FYLTA signal head should be operated as protected only mode. During the off-peak hours when traffic volumes don't warrant protected only left-turn operation, FYLTA signal head can be operated as PPLT or as permissive only.

Flashing yellow left turn arrow signal heads should also be used to operate in "negative-ped" also known as "not-ped" mode. "Negative-ped" mode allows delaying or omitting the FYLTA when the complementary pedestrian phase is active, indicating a potential conflict.

Although not used for ODOT owned signals, there are some local jurisdictions whose signals ODOT maintains and operates with five section (doghouse) signal heads for PPLT operation. For these cases, the protected portion of the cycle should precede the permissive portion of the cycle to prevent the yellow trap (refer to Section 4.1.2). However, the permissive portion can precede the protected portion if there is no opposing left-turn movement.

If criteria discussed in Section 4.1.1.1 have not been met for protected only mode, PPLT should be provided when any one of the following criteria is satisfied:

- Left-turn volume routinely exceeds 200 vehicles per hour **or** the product of opposing through and left-turn hourly volumes exceeds:
    - 50,000; if there is one opposing through lane, or
    - 100,000; if there are two opposing through lanes.

      Note: Where there is a significant lane imbalance, twice the highest single lane volume can be substituted for the total opposing hourly volume when making this calculation. If there is a dedicated right-turn lane the right-turn volumes may be added to the opposing through volumes.
    - Projected volumes warrant PPLT mode within five years after the traffic signal is placed in service.
    - The opposing left turn approach has a PPLT turn signal or meets one or more of these criteria.

4.1.1.3 Permissive Only Left-Turn Mode

Permissive only mode is primarily used when traffic is light to moderate and when sight distance is adequate. This option provides the most efficient operation of the intersection; however, it can have adverse effect on safety in some situations. Permissive only mode may be used if none of the criteria discussed above is satisfied.

4.1.2 Left-Turn Signal Sequences

For protected only or protected-permissive left-turn mode of operation, it is important to determine the phase sequences. This section discusses the sequences of left-turn movements. The typical sequence options include:

- Leading or lead-lead phasing.
- Lagging or lag-lag phasing.
- Lead-lag phasing.
- Split left-turn phasing.

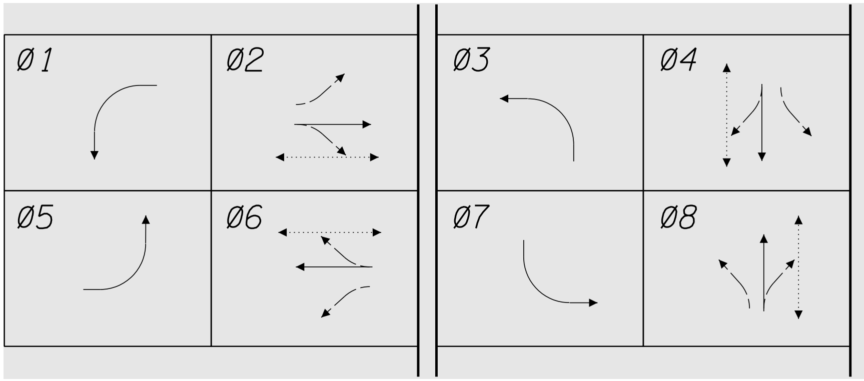
The terms leading or lagging indicate the order in which the left-turn phase is displayed, relative to the conflicting through movement.

Care should be taken in selecting appropriate sequence, as some sequences may result in an undesirable condition known as the “yellow trap,” especially if 5-section signal heads are used for PPLT operation. The “yellow trap” occurs when a driver, who has a permissive left-turn phase is waiting for a gap in the opposing through movement, sees a yellow indication for both through and left-turn movements, and mistakenly thinks that the signals for the opposing direction have become yellow simultaneously. It occurs when the permissive left-turn phase ends while the opposing through traffic continues to have a green signal indication, as in the case of lead-lag phasing using 5-section signal head. The “yellow trap” can be avoided by not using lead-lag phasing when 5-section signal heads are used for PPLT, or by using FYLTA for PPLT operation.

4.1.2.1 Leading or Lead-Lead Phasing

Lead-lead is a commonly used left-turn phase sequence in which both opposing left-turn phases start at the same time and precede the corresponding through movement. Lead-lead left-turn phasing is shown in Figure 4-1 for both major and minor roads. This operation is consistent with the driver expectation such that drivers react quickly to the leading green arrow indication. This operation also minimizes conflicts between left-turn and the through movements on the same approach when the left-turn volume exceeds its available storage length. This sequence typically yields more efficient operation when the left-turn volumes are lighter than their respective through volumes.

Figure 4-1: Lead-Lead Phasing for Both Major and Minor Roads



4.1.2.2 Lagging or Lag-Lag Phasing

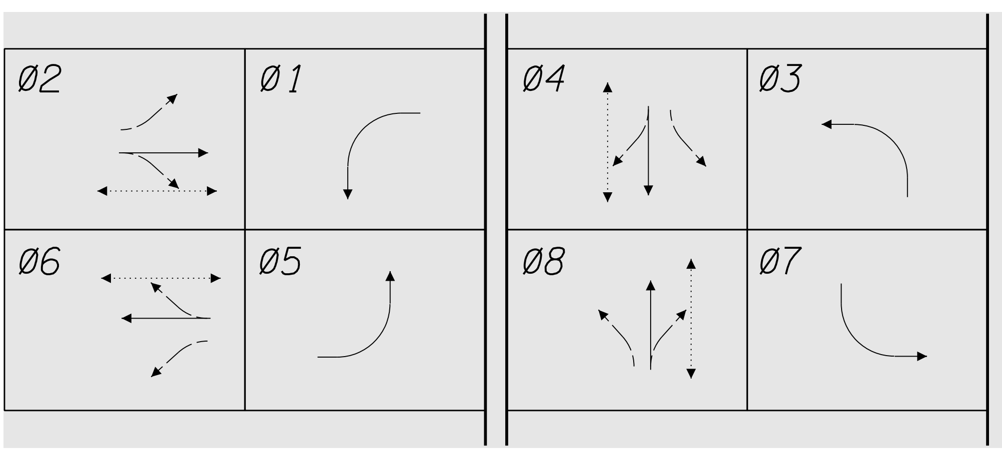
In lag-lag phasing sequence both opposing left-turn phases start following the through movements and end simultaneously. Figure 4-2 shows lag-lag phasing for both major and minor roads. This sequence is most used in coordinated systems with closely spaced signals, such as diamond interchanges. However, lag-lag phasing may offer operational benefits for the following situations:

- When left-turn volume is greater than the opposing through volume.
- When coordinated signal timing requires a specific phase order to progress traffic.

Lagging left-turn phases may offer operational benefits when a left-turn movement exists only on one approach, for example, at

- “T” intersections.
- The intersection of a two-way street and a one-way street.

Figure 4-2: Lag-Lag Phasing for Both Major and Minor Roads

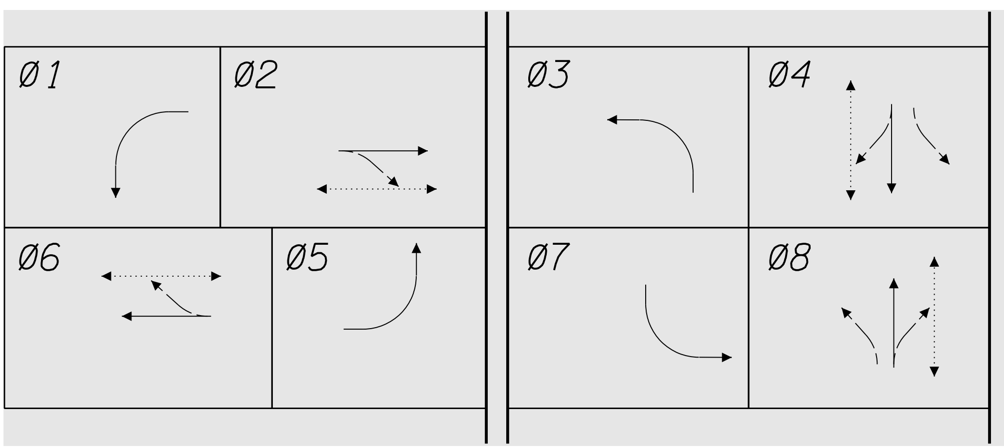


4.1.2.3 Lead-Lag Phasing

In lead-lag phasing sequence one of the opposing left-turn phases starts and operates concurrently with its corresponding through movement and the other left-turn phase starts following the opposing through movement and ends simultaneously with its concurrent through movement. Figure 4-3 shows lead-lag phasing for the major road. This phasing may offer operational benefits for the following situations:

- At intersections where the left-turn lanes are restricted from operating simultaneously due to geometric constraints.
- At intersections where the leading left-turn movement is not provided with an exclusive storage area, or the available left turn storage is relatively short.
- When coordinated signal timing requires a specific phase order to progress traffic.

Figure 4-3: Lead-Lag Phasing for Major Road and Lead-Lead Phasing for Minor Road



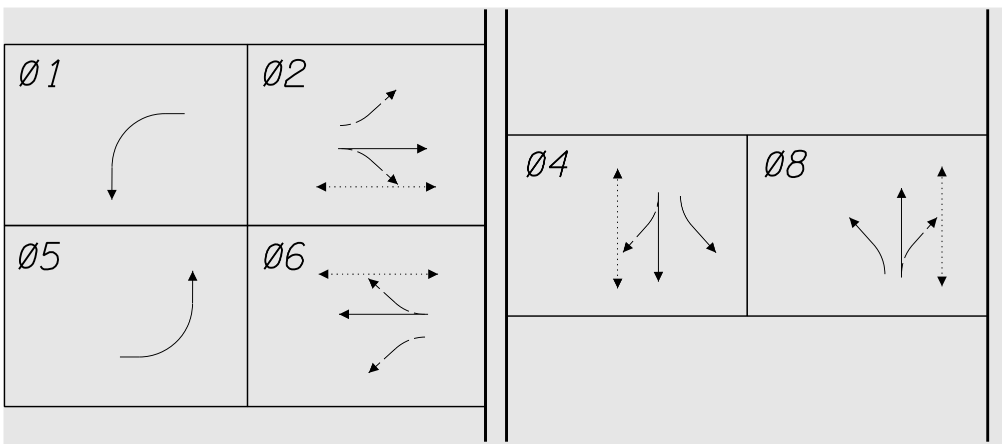
4.1.2.4 Split Phasing

In split phasing each approach on the same street is serviced exclusively. Use of split phasing on state highways requires approval from the STRE. Figure 4-4 shows split phasing for the minor road. Typically, it is the side street that is split phased. This option is generally less efficient than the other phasing options as it typically creates additional overall intersection delay. Split phasing should only be used in unusual situations as follows:

- Left-turn movements from opposing approaches can't be made concurrently due to a conflict of overlapping turning paths within the intersection. Restrictive phasing is another available option for this situation.
- The left-turn lane volumes on opposing approaches are approximately equal to the through traffic lane volumes and the total approach volumes are significantly different on two approaches.

- The width of the road is constrained such that an approach lane is a shared through and left-turn lane, yet left-turn volume is sufficient to justify an exclusive left-turn lane and phase, or sight distance is restricted.
- Drivers are permitted to turn left from more than one lane, but drivers are also permitted to use the rightmost left-turn lane as a through lane.
- Crash history suggests an unusually high number of side-swipe or head-on crashes in the middle of the intersection that involve left-turning vehicles.
- For actuated control one of the approaches has heavy volume, the other approach has minimal volume. In this situation, the phase associated with the low-volume approach would rarely be called and the intersection would function like a "T" intersection.

Figure 4-4: Split Phasing for Minor Road



4.1.3 Modifying Left-Turn Signals

The modification of left-turn mode from protected only mode to PPLT or permissive only mode shall be supported by an engineering study. The engineering study should consider each of the criteria given in Section 4.1.1.1 as well as the following:

- The crash history prior to the installation of the protected left-turn. If the signal was installed due to left-turn type crashes, protected only mode should be maintained unless the engineering study indicates a reduction in potential vehicle conflicts.
- The recent crash history to determine if there is evidence that a reduction in rear-end crashes may be achieved.
- An estimate of the expected reduction in delay per vehicle entering the intersection if the left-turn mode is changed.

4.2 Right-Turn Signals

Per ORS 811.360, right-turn movement by a vehicle facing a circular red or a red arrow indication is permitted after stopping unless a sign is posted to the contrary. Signalizing a right-turn lane on state highways requires approval from the region traffic engineer.

See ODOT Signal Design Manual or standard drawing TM460 for signal head arrangements.

4.2.1 Right-Turn Signal Modes

The right-turn signal installations and mode of operation shall be supported by an engineering study. Factors that improve capacity; and reduce congestion and related crashes shall be considered in the engineering study. These factors include presence of right-turn lane(s), right-turn volume, presence of a conflicting crosswalk, etc.

Right-turn movements controlled by a separate signal head which operates as an overlap with a complementary left-turn phase that also allows U-turn movements should not occur at the same signalized location.

4.2.1.1 Protected Only Right-Turn Mode

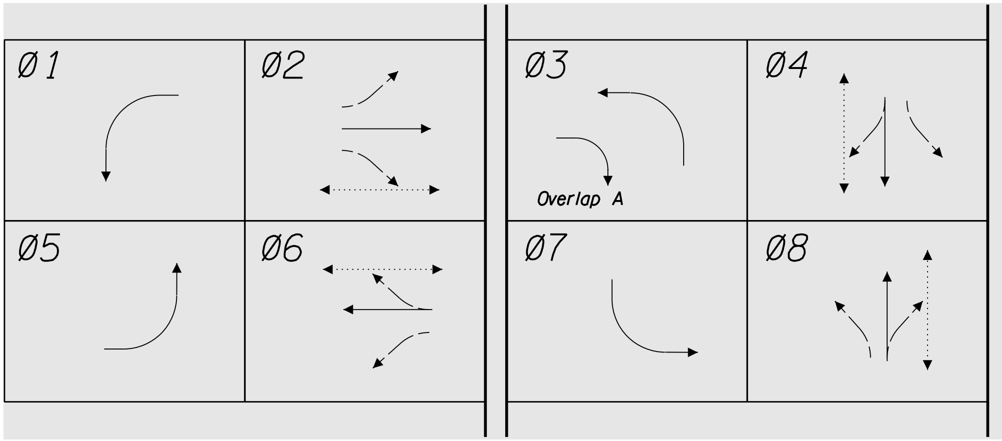
The protected only right-turn mode may be used concurrently with any other non-conflicting pedestrian or vehicular movements such as protected left-turn from a complementary left-turn lane. Generally, this mode is used for an exclusive right-turn lane. The standard practice for operating a protected right-turn signal at a location with a crosswalk adjacent to the right-turn lane is to assign the right-turn signal to an overlap phase that will not permit a green indication concurrently during the walk or flashing don't walk pedestrian intervals for the adjacent crosswalk. This is known as "negative-ped" overlap.

4.2.1.2 Protected-Permissive Right-Turn (PPRT) Mode

When the right-turn movement is protected during one part of the cycle and permissive during another part of the cycle, the mode is referred to as protected-permissive mode. As shown in Figure 4-5, the protected right-turn operation generally occurs during the complementary left-turn phase on the cross street. The permissive right-turn operation occurs during the adjacent through movement phase.

Although protected-permissive right-turn (PPRT) is typically not used on state highways, in some situations it may be beneficial to use this mode. For example, when there is heavy right-turn volume, use of this mode may provide operational benefits.

Figure 4-5: Protected-Permissive Right-Turn Mode



Where PPRT implementation is desired, draft guidance is available. Contact Traffic-Roadway Section to discuss implementation based on this guidance on a case-by-case basis.

4.2.1.3 Permissive Right-Turn Mode

This is the most used right-turn mode. No additional signal head is needed for this operation. Right-turn movements are served concurrently with the corresponding through movements, but right-turn movements must yield to the conflicting pedestrian movements. Right-turn on red is also permitted after stopping unless posted otherwise.

4.2.2 Modifying Right-Turn Signals

Engineering judgment should be exercised in the modification or removal of right-turn signals.

4.3 U-Turn

By Oregon law (ORS 810.130, ORS 810.200 and ORS 811.365), U-turn movements are not permitted at signalized intersections unless otherwise posted. As such, STRE approval is required for allowing U-turn movements at signalized intersections on state highways. An appropriate sign shall be used where U-turn movements are permitted. Refer to sign No. OR3-12 in the ODOT sign policy for ODOT policy regarding U-turn signs.

When U-turn movements are accommodated at an intersection, such movements shall be made from a left-turn lane. Refer to Section 2.6 and Section 308.5.6 and 504.6 of the ODOT Highway Design Manual for more information on accommodating U-turns. The following criteria should be used when considering whether to permit U-turn movements:

- The width of the receiving lanes of the intersection. The width should be sufficient to accommodate U-turn movements made by the design vehicle. U-Turns may be permitted for all vehicles at a signalized intersection if a 62-foot width (measured from the right edge of the left turn lane to the curb) for turning exists. U-Turns may be permitted for all vehicles except trucks if a 52 foot to 61.5-foot width (measured from the right edge of the left turn lane to curb) for turning exists.

- The design vehicle. Turning templates should be developed to demonstrate that the width is adequate to accommodate U-turn movements made by the design vehicle. Region traffic staff should coordinate with the roadway designer to determine the appropriate design vehicle. Vehicles other than trucks may be used as the design vehicle.
- Speed of the highway.
- Volume of traffic opposing and executing the U-turn.
- Adjacent roadside culture.
- Near-by locations where U-turn movements are permitted.
- Left-turn mode of operation for which U-turn is being considered. Protected only left-turn mode should be used for the approach.
- Impact of U-turn movements on the conflicting right-turn movement. U-turn movements should not be allowed where there are conflicting right-turn overlap movements.

5. Pedestrian Crossing and Signals

5.1 Pedestrian Crossing at Signalized Intersections

The design and operation of traffic signals shall take into consideration the needs of pedestrians to cross the roadway safely at all locations. It is desirable to keep all crosswalks open for pedestrians, but sometimes it may be necessary to close one or more crosswalks at a signalized intersection.

The STRE shall approve all crosswalk closures at signalized intersections on state highways, based on an engineering study. When supported by the study, generally only one crosswalk may be closed, which allows pedestrian access to all four quadrants of an intersection. The primary reason for closing a crosswalk is safety. Geometric and operational factors may also be considered.

The following points shall be considered regarding the design and operation of crosswalks at signalized intersections:

- Oregon statute (ORS 801.220) provides for crosswalks across all roadways at every intersection. Crosswalks shall be marked for all approaches of signalized intersections unless the crosswalk is closed by official action and signs are posted.
- Pedestrian signal heads shall be provided for all marked crosswalks at signalized intersections.
- Pedestrian detection (see ODOT Signal Design Manual) shall be provided where pedestrian signal heads are provided except when the pedestrian phase is recalled at all times, as is the case at signalized intersections in a central business district.

There are several options available in the controller software, which may provide safer and more efficient operations of pedestrian crossings including:

- Flashing yellow left-turn arrow "negative-ped" mode (refer to Section 4.1.1.2).
- Right turn overlap "negative-ped" mode (refer to Section 4.2.1.1).
- Push and hold for extended walk (allows for a longer walk time). Implementation of this option requires signage detailed in the ODOT Signal Design Manual.
- Leading pedestrian interval (LPI) provides advance service to a pedestrian before releasing adjacent vehicles. Studies indicate very low cost of implementation, relatively high efficacy, and low operational impact in most implementations. Regions may implement LPI using region signal operations engineer authority. Regions shall notify state traffic operations engineer's office of LPI deployments.
    - Factors to consider include:

- Conflict History: Motorists failing to yield to pedestrians through crash reporting or conflict analysis.
- Poor visibility: Pedestrian waiting areas cluttered, obscured, or outside motorist cone of vision.
- T intersections and one-way streets where left turning motorists have no opposing through vehicular traffic.
- Volumes of pedestrians and vehicles.
- Impacts to operations and delay for all modes, for example where side street volumes are low and the pedestrian phase service time is equal or greater than the vehicle service phase + LPI, no additional delay would be expected.
- Some research found lower efficacy in rural and suburban contexts compared with urban contexts.
- Illumination conditions: Lighting on sidewalks or adjacent to the roadway may not illuminate the pedestrian as well as lighting within crosswalks. LPI use may mitigate this scenario.
- Impacts of change in cycle length, if any.
- When choosing to utilize LPI with audible pedestrian signals, refer to Section 5.3. Community outreach should be considered. Some vision impaired users rely on audible cues from adjacent traffic to determine when to proceed.

- When regions determine LPI is an appropriate treatment keep these guidelines in mind:
  - LPIs are typically 3-7 seconds. Generally, the timing is selected to position the pedestrian in the middle of travel lane before releasing the complementary vehicle phase.
  - LPIs may be implemented by time of day, particularly when there are expected operational impacts.

5.2 Half Signals

A half-signal is a traffic control signal in which only two directions are controlled by the signal and the other two directions are typically controlled by stop signs.

In the past, these devices were installed on state highways to assist with pedestrian crossings at intersections. The potential for driver uncertainty exists when the mainline stops and the side street is facing a stop sign with conflicting pedestrians.

The MUTCD recommends that if a traffic signal is installed to accommodate pedestrian volumes, the minor street should be signalized. **Therefore, new half-signals shall not be installed on state highways.**

When a project involves modifications to a roadway where there is an existing half-signal, an engineering study shall be conducted to determine if the half-signal will remain in place.

See ODOT Signal Design Manual for more information.

5.3 Audible Pedestrian Signals

Audible pedestrian signals (APS) are an accessibility feature which may be included at signals or pedestrian activated warning systems. Section 5.3.1 is taken verbatim from appendix B of Association of Oregon Centers for Independent Living (AOCIL) v. ODOT Settlement Agreement.

Due to ODOT resource constraints and expected updates to national best practices, the process of APS deployment may be streamlined as discussed in section 5.3.2.

5.3.1 AOCIL v. ODOT Settlement Agreement language regarding APS

Audible pedestrian signals provide information in a non-visual format such as audible tones, speech messages, and/or vibrating and tactile surfaces. If a signalized intersection presents difficulties for pedestrians who have visual disabilities, an audible pedestrian signal may be provided to augment the standard pedestrian signal.

ODOT often receives requests to install audible pedestrian signals at signalized intersections from local jurisdictions and from individuals who need the non-visual format. When the local jurisdiction has a written policy to install audible pedestrian signals on traffic signals within their jurisdiction, work with the local jurisdiction to proceed with the audible signal installation.

If the local jurisdiction does not have a written policy to install audible pedestrian signals, or the request is from an individual who needs the non-visual format, the following process shall be used.

- Document the local jurisdiction or individual user request to install the audible signal. Send a copy of this documentation to ODOT's Office of Civil Rights (OCR), Attention Americans with Disabilities Act (ADA) Title II coordinator.
- Hold an on-site meeting with the requestor to understand the issues from the requestor's perspective. Discuss this location as well as alternate locations that may be investigated as more appropriate options. Include a discussion about the user's route and learn of any other barriers to accessibility along that route.

  - Document this on-site meeting and the issues discussed. Send a copy of this meeting documentation to ODOT's Office of Civil Rights, Attention ADA Title II coordinator.
  - Often the user's route includes local jurisdiction systems as well as the state highway. When this is the case, send a copy of the meeting documentation to the local jurisdiction. Follow-up with a phone call to the local jurisdiction to discuss the audible signal request, the on-site meeting, and any required coordination to address the audible signal and any identified barriers on the user's route.
- Following the on-site meeting, perform an engineering study in response to the request as discussed in Chapter 4E of the MUTCD. The engineering study includes the following:
  - Initial request.
  - Onsite meeting notes.
  - Requested intersection location(s.)
  - Intersection characteristics.
  - Signal phasing.
  - Traffic volumes.
  - Posted speeds.
  - Sight distance.
  - Crash history.
  - Neighborhood acceptance.
  - Evaluation of alternative routes.
  - Include alternate signalized crossing to determine if there are more desirable locations for the audible signal location.
- Consult with the local jurisdiction on the engineering study.
- When the engineering study discovers community opposition or conflicting format requests, contact Association of Oregon Centers for Independent Living (AOCIL) for input on methods to resolve this issue.
- The region traffic engineer will coordinate with the OCR ADA Title II coordinator to determine if installing the audible signal is the appropriate response to the request. Approval authority to install the audible signal, which is a traffic control device, is delegated to the region traffic engineer. However, in those circumstances that the region traffic engineer determines that based on the engineering study, the audible signal should not be installed, the region traffic engineer and the OCR ADA Title II coordinator will determine what other options will be used to address the request.

Region Traffic Engineer will contact the requester and discuss the ODOT determination on the audible signal request. If the audible signal has been determined to be inappropriate for this circumstance, the region traffic engineer will discuss the alternate option(s) ODOT will use to address the request. Discussion on timeframes for completion and ODOT commitments for ongoing communication by ODOT to the requestor need to be part of this discussion.

5.3.2. Streamlined APS Installations

When requested by an individual who needs the non-visual format, audible pedestrian signals should be provided. Coordinate and document the locations where audible pedestrian signals will be provided-through the CQCR process. Review Section 802 of the Highway Design Manual for more information about the CQCR process and procedures.

Hold an on-site meeting as described in section 5.3.1 to identify and document any other accessibility barriers for that individual**.**

If, following the onsite meeting with the requestor and initial engineering review, the region traffic engineer decides to install APS, documentation, filing and sharing of the described engineering study may be omitted.

The process in section 5.3.1 was intended to thoroughly consider and document decisions for APS deployments. Where APS are to be deployed, the requester's, AOCIL's and ODOT's desire for improved accessibility is met and the need for documentation is moot.

If an APS will not be installed in response to the request, the engineering study outlined in 5.3.1 shall be completed.

5.3.3 APS with Leading Pedestrian Intervals

Where leading pedestrian intervals are incorporated in the signal timing strategy, regions should install APS to provide a non-visual cue that a walk phase has begun.

5.4 Pedestrian Crossing Enhancements

Pedestrian crossings may be enhanced based on guidance in the ODOT Traffic Manual. The traffic manual provides guidance and approval criteria for available enhancements, as well as any required approvals. Refer to the ODOT Signal Design Manual for design guidance.

5.4.1 Pedestrian Activated Warning Beacons

Pedestrian activated warning beacons utilize wig-wag flashers actuated by pushbuttons to alert motorists of pedestrians desiring to or actively crossing a roadway. These beacons have typically been installed to supplement pedestrian and school warning signs at crossings across uncontrolled approaches. Operation and timing are similar to the rectangular rapid flashing beacon (RRFB), and in most cases new installations will choose an RRFB instead. New installations require STRE approval.

5.4.2 Rectangular Rapid Flashing Beacon (RRFB)

RRFBs are used similarly to pedestrian activated warning beacons. Instead of a wig wag pattern on a circular lamp, RRFBs utilize a specific flashing pattern on a pair of small rectangular strobes. These devices are allowed under IA-21: FHWA Interim Approval for Operational Use of Rectangular Flashing Beacons. Per IA-21, the flash duration should be based on the procedures provided in Section 4E.06 of the 2009 MUTCD for pedestrian clearance.

Note: As of December 2023, with the publication of the 11^{th} edition of the MUTCD, the guidance formerly provided through IA-21 is now provided by the updated MUTCD. For purposes of guidance around bicycle signals and other revoked IAs, see the 11^{th} edition of the MUTCD.

Per figure 4E-2 of the 2009 MUTCD, pedestrian clearance is the combination of time for a pedestrian to travel from curb or shoulder to median or far side of traveled way, curb or shoulder plus a buffer time. Buffer times at signalized locations are required to be at least three seconds (MUTCD) and are analogous to all-red clearance for motorists. At RRFBs, buffer times should account for perception-reaction as well as deceleration time for conflicting motorists.

Figure 5-1: Pedestrian Warning Device flash duration formula

$$F_d = \frac{d}{w} + t + \frac{v}{2a + 2Gg}$$

Where:

F_d = Flash duration (seconds)

d = distance, curb (shoulder) to curb (shoulder) or median refuge (feet)

w = walk speed (feet/second)

t = motorist perception-reaction time

v = motorist approach speed (feet/second)

a = motorist deceleration rate (feet/second^2)

g = acceleration due to gravity (32 feet/second^2)

G = grade of approach (3% downgrade would appear as -0.03)

Selection of appropriate variable values is left to engineering judgement within the following ranges:

w: 3.0-3.5 feet/second. Timing staff should consider the lower end of this range for crossings associated with schools or near elderly populations. See NCHRP 969 chapter 7.4 for more information.

t: 1.6-4.0 seconds. As RRFBs rest dark, motorists approaching who do not see a pedestrian they expect to cross may take longer to respond. Default value is 2.5

seconds. Where sight distance is compromised by geometry or common weather events, timing staff should consider longer perception reaction time. See NCHRP 600 for more information.

a: 10-12 feet/second^2. Default value of 10 feet/second^2 matching deceleration rate at signals. AASHTO Policy on Geometric Design of Highways and Streets (11.2 ft/s^2) and NCHRP 600 (12.1 ft/s^2) suggest higher deceleration rates may be expected.

When requested, audible pushbuttons may be used. According to IA-21, the message should state twice: “Yellow lights are flashing.” Additional guidance may be found in IA-21 and Section 4E.11 of the MUTCD.

5.4.3 Pedestrian Hybrid Beacon

Pedestrian hybrid beacons (PHBs) are also known as high-intensity activated crosswalk (HAWK) beacons. PHBs are generally no longer installed on Oregon state highways. RRFBs and pedestrian signals are preferred alternate devices. See ODOT Traffic Manual and ODOT Signal Design Manual for more information on selection and installation of new traffic control devices.

Chapter 4F of the MUTCD presents guidelines for operating PHBs.

6. Special Applications

6.1 Emergency Traffic Signals

An emergency traffic signal is a special traffic control signal that assigns the right of way to fire trucks and other vehicles providing emergency services. An emergency traffic signal is typically located at the access to a fire station.

Emergency traffic signals should no longer be installed. If an emergency signal or beacon is deemed necessary, regions should instead install a normal, actuated signal.

6.1.1 Basis for Installation

- An emergency traffic signal may be installed at a location that does not meet other traffic signal warrants.
- Generally, the fire station should be located either adjacent to the highway or no more than one block from the intersection.
- Either of the following criteria should be met:
    - The highway volumes should meet or exceed the minimum vehicular volume signal warrant as shown below in Table 6-1.
    - The sight distance from the normal stop position at the fire station exit should be less than that shown below in Table 6-2.

Table 6-1: Minimum ADT for Emergency Traffic Signal

Highway Lane	Standard Warrant	70% Warrant*
2-lane highway	8,850	6,200
4-lane highway	10,600	7,400

* May be used when posted speed exceeds 40 mph or within an isolated community with a population less than 10,000.

Table 6-2: Minimum Highway Sight Distance for Emergency Traffic Signal

Speed (mph)	Minimum Sight Distance (ft)
20	120
25	160
30	210
35	260

Speed (mph)	Minimum Sight Distance (ft)
40	320
45	380
50	450
55	520

6.1.2 Standard Practices

- Emergency vehicle hybrid beacon shall not be used as emergency traffic control signal.
- When the emergency traffic signal is at an intersection, a fully actuated signal operation shall be provided. Displays on all approaches should follow the standard design criteria.
- When the emergency traffic signal is located at a mid-block location, a circular green shall be displayed to the highway traffic when not in preemption.

6.2 Freeway Entrance Ramp Control Signals (Ramp Meters)

Ramp meters can improve safety, travel time, throughput, and environmental impacts on the freeway, freeway ramps, and adjacent arterials. Ramp meters can be effective for delaying or preventing breakdown of stable flow on the freeway.

Ramp meters are not intended to cause additional delay, divert or store traffic on local arterials but rather as a tool to balance the demand. Ramp meters are typically installed to increase vehicle headway by metering vehicles before the merge point of an entrance ramp and freeway. Ramp meters may also be used to break up platoons and reduce merging conflicts.

The installation of a ramp meter shall be based on an engineering study that indicates the ramp meter will improve safety and/or operation of the freeway ramp, freeway, or adjacent arterials. The engineering study should evaluate:

- Roadway geometry for ramp and freeway
- Freeway and ramp traffic volumes.
- Freeway and ramp crash history
- Freeway, ramp and adjacent arterial operating speeds.
- Freeway, ramp and adjacent arterial travel time and delay.

Ramp meters may include high occupancy vehicle (HOV) and/or transit bypass lanes. Such lanes should be metered in a way that would reduce the delay for the HOV and/or the transit vehicles. Metered bypass lanes may be provided for prioritizing trucks and transit vehicles.

Refer to the ODOT Signal Design Manual for the design of ramp meters.

6.3 Temporary and Portable Traffic Signals

Temporary and portable signals are generally used in work zones. Temporary traffic signals are typically described as signal displays supported by wood poles and span wires. Portable traffic signals are signal displays mounted on a trailer. Typical applications include but not limited to:

- One-lane two-way configuration.
- Installation of new traffic signals.
- Reconstruction of an intersection or interchange.

Temporary traffic signals are typically operated by region traffic or local jurisdictions through an IGA. Portable traffic signals are typically operated by contractors using timing parameters provided by region traffic.

STRE approval is required for installation of temporary and portable traffic signals on state highways. ODOT Traffic Control Plans (TCP) Design Manual lists several criteria for the applicability of temporary traffic signals. Temporary traffic signal designs and layout shall conform to the ODOT Traffic Signal Design Manual.

6.4 Bicycle Signals

Signalized intersections may be operated with phases specifically intended for bicyclists. These bicycle phases are used in combination with an intersection traffic control signal to control the movements of bicycles through an intersection. While less restrictive means of handling conflicts between bicyclists and motorists should be considered first, bicycle signal phases can be a useful tool to improve the safety or service of bicyclists through an intersection. Bicycle signal phases shall direct bicyclists to take specific actions and may be used to improve an identified safety or operational problem involving bicyclists.

A bicycle signal phase may be considered for use when an engineering study finds a significant number of bicycle/motor vehicle conflicts occur or may be expected to occur at the intersection and that other less restrictive measures would not be effective. Proximity to schools, parks, and popular bike routes should be considered. Additional delay to all roadway users should be considered. One of the following criteria below should be met:

- Two or more reported bicycle/vehicle collisions of types susceptible to correction by a bicycle signal have occurred over three years.
- Geometric factors are present that are best mitigated using a bicycle signal phase.
- An approach to a signalized intersection is intended for bicycles only and it is desirable to signalize that approach.

Examples of geometric configurations that might benefit from the use of a bicycle signal phase include:

- A bike lane to the right of a high volume right-turn lane.
- A multi-use path that comes into the intersection in such a way that motorists may not see or yield to bicyclists approaching the intersection.

In late 2013, FHWA issued Interim Approval 16 for the optional use of bicycle signals. All bicycle signals installed in Oregon shall meet the requirements set forth in the interim approval. For installation on state highways, regions should consult with the Traffic Roadway Section regarding the phasing and operational issues related to bicycle signals.

Note: As of December 2023, with the publication of the 11th edition of the MUTCD, the guidance formerly provided through IA-16 is now provided by the updated MUTCD. For purposes of guidance around bicycle signals and other revoked IAs, see the 11th edition of the MUTCD.

NCHRP report 969: Traffic Control Strategies for Pedestrians and Bicyclists is a good resource for timing and phasing considerations specific to bicycle signals.

7. Traffic Signal Removal

The STRE shall approve the removal of any permanent traffic signal on state highways per OAR 734-020-0500.

This section does not apply to:

- Relocations of the roadway.
- Removal of temporary traffic signals used for construction or maintenance activities.
- Signalized locations that are to be functionally replaced in the same location as a part of a highway reconstruction project.

7.1 Basis for Removal

A traffic signal should be removed if MUTCD traffic signal warrants are no longer met. This may be due to significant changes in geometry or traffic flow patterns that eliminate the need for the traffic signal.

7.2 Removal Request Process

The Region Traffic Engineer shall complete the following:

- Review traffic signal pre-installation warrants and original STRE approval letter. If the traffic signal was originally installed in response to Warrant 7 (Crash Experience), it should not be removed unless an engineering study indicates a reduction in potential vehicular conflicts.
- Determine the appropriate traffic control and any necessary mitigation to be used after the removal of the signal. Follow the procedure outlined for intersection control evaluation in the ODOT Traffic Manual.
- Contact all local agencies affected by the removal of the traffic signal, including the agency responsible for maintenance.
- Provide an inventory of current site conditions, which may include any of the following:
    - Summary of crash history at the intersection.
    - Posted speed.
    - Traffic volumes, including a summary of heavy turning movements, if appropriate.
    - Pedestrian volumes.

    - Proximity to other traffic signals.
    - Agency and road user cost.
    - Sight distance study.
- Prior to making the decision to request traffic signal removal, contact local business leaders, council persons, neighborhood associations, local and state police, and other emergency service providers and inform them of the intent. Address all concerns received.
- As discussed in Section 1, submit a cover letter and corresponding engineering study to the Traffic Roadway Section for review and approval by the STRE.

7.3 Public Notification

For any permanent traffic signal removal public notification shall be provided and may include any or all of the following:

- **News release** – A news release may be distributed to local newspapers, radio, and television stations.
- **Letter** – A letter may be sent directly to residents and commercial establishments within the immediate vicinity.
- **Public meeting** – If the proposed signal removal is a part of a highway reconstruction project, public notification may be provided during a public meeting or other methods available to the project team.

7.4 Removal of Traffic Signal Hardware

- Crashes and intersection operations should be monitored during a 90-day interim intersection control period prior to removing the remaining hardware (e.g., poles, mast arms, controller, cabinets, etc.). The remainder of the signal hardware may be removed if the engineering data confirms the signal is no longer needed.
- An existing signal being functionally replaced as part of a highway project by a new signalized location within close proximity, as determined by engineering judgment, may circumvent the interim intersection control period and be removed in its entirety immediately upon activation of the new signal.

8. Traffic Signal Preemption and Priority Systems

Traffic signal preemption and priority systems are traffic control devices. Use of preemption and priority systems to modify the operation of traffic signals is limited to:

- Trains.
- Moveable bridge operations.
- Emergency vehicles, bus, and traffic signal maintenance vehicles authorized by the traffic control signal owner.

Traffic signal preemption equipment may be used in either failsafe systems or signal preemption device systems.

Failsafe systems are used by heavy rail and moveable bridge operations. They have priority over emergency vehicle preemption and bus priority systems. Failsafe systems are hard wired to the traffic signal controller and operate independently of any other signal function. The default state of a failsafe system is preemption active.

Signal preemption device systems are used by emergency vehicles, buses, and traffic signal maintenance vehicles and are subject to the provisions of ORS 810.260, ORS 815.445, and OAR 734-020-0300, -0310, -0320, and -0330. These systems require the installation of hardware at the intersection that reacts to a device on or inside a vehicle. The default state of a signal preemption device system is normal traffic signal operation. The signal preemption device may respond to a single activation or may respond in recognition of priorities assigned to different users in a multi-priority system.

Both failsafe systems and signal preemption device systems may exist in a multi-priority system; however, only signal-preemption device systems respond to levels of priority.

8.1 Railroad Preemption (Heavy Rail)

Under Oregon law (ORS 824.200 to 824.256), ODOT is authorized to determine the character and type of traffic control devices used at all railroad-highway grade crossings (refer to OAR 741-110-0030). The ODOT Commerce and Compliance Division (CCD) has been delegated authority for this responsibility. Early engagement with ODOT CCD for signals with rail preemption is crucial to effect timely traffic signal operation changes, when those changes impact the rail crossing order.

Preemption is required when railroad tracks are located on a roadway within 215 feet of a signalized intersection. The distance is measured from the nearest rail at the crossing to the nearest stop location at the signalized intersection. Contact state traffic operations engineer's office for guidance on railroad preemption at railroad-highway grade crossings. MaxView Alarms 1-3 have been defined to utilize inputs 5 vehicle clear-out interval (VCOI) and 6 pedestrian clear-out interval (PCOI) to issue alarms for signals stuck in rail preempt. For this reason, inputs 5 and 6 shall not be reassigned nor utilized in signals without rail preemption. Selecting an appropriate time to trip the alarm will depend on site specific conditions. State traffic operations engineer's office recommends alarm thresholds of:

- Preempt 5 on alone for 120 seconds.
- Preempt 6 on alone for 15 minutes.
- Preempt 5 and 6 on together for 60 minutes.

Contact state traffic operations engineer's office for support in writing logic statements or refining values if nuisance alarms result from these suggested thresholds.

The following are the standard ODOT practices for railroad preemption:

- When a vehicle clear-out interval (VCOI) is required, the indication for the clearance phases shall be green. VCOI operation shall include a green left-turn arrow if a left turn movement exists, even if the left-turn movement operates permissively. Under normal operation, if the left-turn movement is permissive only, the display of the left-turn green arrow shall be used during rail preemption only. The use of green arrow is not allowed for use by emergency vehicle preemption and transit priority users.
    - Preempt 5/VCOI and shall not be reassigned.
- Advance railroad detection or other appropriate methods shall be used to provide a pedestrian clear-out interval (PCOI) prior to the vehicle clear-out interval (VCOI). This should be designed to minimize the occurrence of abbreviated pedestrian clearance intervals. In absence of pedestrians, a portion or the entire duration of the PCOI may be utilized to serve the clear-out phase(s), if mentioned in the crossing order.
    - Preempt 6/VCOI and shall not be reassigned.
- Part-time restriction sign(s) shall be posted to prohibit specific turning movement(s) toward the highway-rail grade crossing during preemption if called for in the crossing order. See ODOT Traffic Signal Design Manual for more information.

8.2 Railroad Preemption (Light Rail)

When light rail transit lines operate in a street running mode along with other traffic, they may be exempted from the preemption requirements. Contact state traffic operations engineer's office for more information. Refer to Chapter 8C of the MUTCD for additional guidance.

8.3 Moveable Bridge Preemption

Traffic signals on highways adjacent to moveable bridges should be interconnected with the moveable bridge control, if indicated by engineering considerations. Moveable bridge operations are under the jurisdiction of the local port authority and/or the U.S. Army Corps of Engineers. Chapter 4J of the MUTCD and the ODOT Traffic Signal Design Manual provides more guidance on moveable bridge preemption.

8.4 Emergency Preemption Systems

Emergency preemption systems provide emergency vehicles the capability to modify the green intervals or change the display sequence of a traffic signal.

- When multiple users of traffic control signal operating devices are authorized, the signal preemption device shall recognize and respond to the priority of each user as established in OAR 734-020-0330.
- Emergency service providers who want to use signal preemption devices on their emergency response vehicles for use on state highways shall make a written request for authorization. The form in Appendix E shall be completed, reviewed by the ODOT region traffic manager, and approved by the STRE. Traffic Roadway Section maintains a list of agencies that have been approved to use signal preemption devices on their emergency response vehicles on state highways.
- Some signal preemption devices can provide an encoded sequence, facilitating identification of authorized vehicles at a signalized intersection. Use of encoding can be helpful for troubleshooting, but use of encoding to reject preemption calls is strongly discouraged. Potential impacts to cross jurisdictional response and risks of equipment failing to be properly registered on the system generally outweigh the impact of unauthorized preemption.

8.5 Bus Priority Systems

Bus priority systems provide buses the capability to modify the length of green intervals but not the display sequence of a traffic signal.

- When multiple users of traffic control signal operating devices are authorized, the signal preemption device shall recognize and respond to the priority of each user as established in OAR 734-020-0300 and 734-020-0330.
- Agencies operating buses shall make a written request for authorization to use a traffic control signal operating device on a state highway. STRE requests shall be submitted by the region traffic engineer detailing the proposed bus priority system, its operations and its impacts.

- The transit authority and the road authority (region traffic) shall sign an intergovernmental agreement that covers cost, installation, operation, maintenance, and use.
- Signal preemption devices may include an identification system to recognize authorized vehicles at a signalized intersection.
- ODOT is currently working on its policies for next-generation (GPS-based) transit priority systems. Regions shall contact the state traffic operations engineer for current guidance when local transit agencies request installation of one of these systems.

9. Flashing Operation of Traffic Signals

Traffic signals can flash in two different modes: controller flash and cabinet flash.

Controller flash is a mode of traffic control operation that flashes the signal indications as dictated by the signal controller software using the standard output switchpacks. Controller flash is often referred to as “time of day” or “nighttime flash.”

In the past, this mode of operation was used to reduce energy consumption and motorist delay during off-peak hours. The potential for driver uncertainty exists when the motorist on the side street facing a flashing red indication assumes the mainline traffic also has a flashing red indication. Studies have shown that controller flash operation is associated with a higher crash rate. As a result, **this mode of operation should no longer be used on state highways**.

Removal of existing controller flash at traffic signals may require adding signal equipment upgrades such as vehicle and pedestrian detection systems. Projects to remove flashing operations should be prioritized and completed as budget allows or during highway reconstruction projects.

Cabinet flash is a mode of traffic control signal operation that flashes the signal indications using flasher relays provided in the signal control cabinet, independent of the operation of the traffic signal controller or its software. Cabinet flash is often referred to as “maintenance flash.” This mode of operation is only used when:

- Maintenance is performed on the traffic signal equipment.
- A conflict in the controller software exists.
- Equipment failure occurs.
- Power failure occurs.

If used, controller flash indications provided by the signal software should be the same as those provided by the cabinet flash. In general, the following criteria apply to both controller and cabinet flashing operation:

- Flashing red should be displayed to all approaches**.**
- Flashing operation of nearby traffic signals should be treated in a consistent manner.

Refer to MUTCD Chapter 4D for more discussion on flashing operation.

Appendix A: Definitions

MUTCD Section 1A.13, modified by 1A.13 of the Oregon Supplement to the MUTCD, ODOT Traffic Manual, and FHWA Signal Timing Manual define additional terms used in this manual not defined here.

Approach – [OAR 734-020-0420(1)**]** All lanes of traffic moving toward an intersection or mid-block location from one direction.

Bicycle signal – A bicycle signal provides indications for signal phases intended exclusively for controlling bicycle traffic.

Bus – [ORS 184.675 (6)**]** A motor vehicle designed for carrying 15 or more passengers, exclusive of the driver, and used for the transportation of persons.

Bus priority system – [OAR 734-020-0310(3)**]** A traffic control signal system that includes a traffic control signal operating device and signal preemption device designated to provide buses the capability to modify the green intervals but not the display sequence of a traffic control signal.

Cabinet flash – A mode of traffic control signal operation that flashes red or yellow indications using flasher relays provided in the signal control cabinet, independent of the operation of the traffic signal controller or its software. Cabinet flash is often referred to as "maintenance flash".

City street – A public road which is owned and operated by a city government intended for use of the general public for vehicles or vehicular traffic.

Controller flash – A mode of traffic control signal operation that flashes red or yellow indications as dictated by the signal controller software using the standard output switchpacks. Controller flash is often referred to as "nighttime flash".

County road – A public road which is owned and operated by a county government intended for use of the general public for vehicles or vehicular traffic.

Crossing order – A written authorization issued by the State of Oregon through the Commerce and Compliance Division of its Department of Transportation granting or denying applications from public road authorities or railroads seeking to alter, construct, change protective devices, or eliminate highway-rail or highway-LRT grade crossings (in semi-exclusive alignments.) It prescribes the time and manner of such alteration, change, installation and the terms and conditions thereof.

Crosswalk – A facility with design treatments for crossing pedestrians. See ODOT Traffic Manual.

Doghouse – A 5-section traffic control signal head used for control of protected-permissive operations of left and right turn lanes consisting of a single, circular red indication centered at the top with circular and arrow indications for yellow and for green, respectively, in the middle and lower portion of the display. Not allowed for new installations.

Emergency preemption system – [OAR 734-020-0310(4)] A traffic control signal system that includes a traffic control signal operating device and signal preemption device for the purpose of providing emergency vehicles the capability to modify the green intervals of a traffic control signal or change the display sequence.

Emergency vehicle – [ORS 801.260] A vehicle that is equipped with lights and sirens as required under ORS 820.350 and 820.370 and that is any of the following:

- Operated by public police, fire, or airport security agencies.
- Designated as an emergency vehicle by a federal agency.
- Designated as an emergency vehicle by the director of transportation.

Engineering study – [OAR 734-020-0420(8)] A documented comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, standards, guidance, and practices as contained in the MUTCD and other sources, for the purposes of deciding upon the applicability, design, operation, or installation of a traffic control device.

Flashing yellow left turn arrow (FYLTA) signal – A vertically stacked, all-arrow signal head. This is the standard display for PPLT. Various configurations are deployed:

- **Type 3LCF** A 3 section vertically stacked red arrow, yellow arrow, and green arrow from top to bottom respectively. The yellow arrow instructs yellow clearance with a steady indication and permissive turns with center flashing indication. This arrangement is preferred for new installations.
- **Type 3LBF:** A 3-section vertically stacked red arrow, yellow arrow, and bottom 'bimodal' green (protected) and flashing yellow arrow (permissive) signal head may be used but is not preferred.
- **Type 6L:** A 4 section vertically stacked red arrow, steady yellow arrow, flashing yellow arrow and green arrow from top to bottom, respectively.

See ODOT Traffic Signal Design Manual for more information.

Highway – [ORS 801.305(1)] Every public way, road, street, thoroughfare and place, including bridges, viaducts and other structures within the boundaries of this state, open, used or intended for use of the general public for vehicles or vehicular traffic as a matter of right.

Lag-lag phasing – A signal phase rotation in which both opposing left-turn movements start following the corresponding through movements and end simultaneously.

Lead-lag phasing – A signal phase rotation in which one of the opposing left-turn phases starts and operates concurrently with its corresponding through movement, and the other left-turn phase start following the opposing through movement and ends simultaneously with its concurrent through movement. The former left-turn phase is the "lead" phase, while the latter left-turn phase is the "lag" phase.

Lead-lead phasing – A signal phase rotation in which both opposing left-turn phases start at the same time and precede the corresponding through movements.

Maintenance flash – See cabinet flash.

Overlap – A traffic control signal display that provides a green indication concurrent with one or more compatible parent phases.

Part time restriction (PTR) sign – A sign designed to provide instructions only during operation when such sign is illuminated. Also known as a blank-out sign.

Pedestrian clear-out interval (PCOI) – The interval prior to the start of a railroad preemption sequence at a traffic control signal, during which active pedestrian "**walk**" intervals will be terminated and pedestrian clearance intervals will be provided.

Permissive left-turn – A left-turn mode during which left-turn movements may be made on the **circular green** or **flashing yellow arrow** indication after yielding to oncoming traffic and pedestrians.

Permissive right-turn – A right-turn mode during which right-turn movements may be made on the **circular green** indication after yielding to pedestrians. Unless otherwise posted, right-turn movements are also permitted on the **circular red** or **red arrow** indication after yielding to conflicting vehicles.

PPLT or PPRT – An abbreviation for traffic signal operation for protected-permissive left or right-turn movements.

Private approach – [OAR 734-020-0420(3)**] -** A private roadway or connection that is legally constructed and recognized by the Department under OAR 734-051.

Protected turn – A turn mode during which a turn may be made on a **green arrow** indication having right of way over any conflicting vehicular or pedestrian movement.

Public road – [OAR 734-020-0420(4)**]** A public roadway, or similar facility under the jurisdiction of a public entity and open to public travel.

Road authority – [ORS 801.445**]** The body authorized to exercise authority over a road, highway, street or alley under ORS 810.010.

Roadway – [ORS 801.450**]** The portion of a highway that is improved, designed or ordinarily used for vehicular travel, exclusive of the shoulder. In the event a highway includes two or more separate roadways the term "roadway" shall refer to any such roadway separately, but not to all such roadways collectively.

Sight distance – The unobstructed distance of roadway ahead visible to the driver. There are multiple types of sight distance that include stopping sight distance, passing sight distance, decision sight distance, and intersection sight distance.

Signal preemption device – [OAR 734-020-0310(7)] Traffic control signal equipment that reacts to a traffic control signal operating device and produces signal preemption and/or signal priority.

Signal preemption device system – An emergency preemption system or a bus priority system consisting of a signal preemption device installed at a signalized intersection and a traffic signal control operating device fixed to, or carried within, a vehicle.

Signalized intersection – The area within the identified stop locations of intersecting roadway approaches controlled by a traffic signal.

Split phasing – A signal phase rotation in which each approach on the same street is serviced exclusively with **green** signal indications.

State highway – A highway that is part of the state highway system as designated by the Oregon Transportation Commission, including the interstate system.

State highway system – [OAR 734-020-0420(6)] The group of roads and highways, so designated by law or by the Oregon Transportation Commission pursuant to ORS 366.220.

Street – A public road, generally within a city, town or a development center, but often used synonymously with the term highway or road.

Traffic control device – [ORS 801.540]

(1) Any sign, signal, marking or device placed, operated or erected by authority under ORS 810.210 for the purpose of guiding, directing, warning or regulating traffic.

(2) Any device that remotely controls by electrical, electronic, sound or light signal the operation of any device identified in subsection (1) of this section and installed or operated under authority of ORS 810.210.

(3) Any stop sign that complies with specifications adopted under ORS 810.200 that is held or erected by a member of a highway maintenance or construction crew working in the highway.

Traffic control signal – [OAR 734-020-0310(8)] A type of highway traffic signal by which traffic is alternately directed to stop and permitted to proceed.

Traffic control signal operating device – [OAR 734-020-0310(9)] Any active or passive device that is affixed to, or carried within, a vehicle that causes a change in the operation of a traffic control signal located at an intersection.

Traffic signal – See traffic control signal.

Variable left turn mode – The operating mode of left-turn signals changes among the protected only, PPLT, and permissive only mode during different periods of the day or as traffic conditions changes.

Vehicle clear-out interval (VCOI) – A traffic signal interval during which motor vehicles are permitted to advance through a highway intersection and away from a railroad grade crossing. The controllers for both the highway intersection and the railroad grade crossing are electrically interconnected. Generally, the VCOI follows a pedestrian clear-out interval (PCOI).

Appendix B: References

Analysis Procedures Manual, Version 2, Oregon Department of Transportation, Planning Section, Transportation Planning Analysis Unit, October 2022

Determining Vehicle Signal Change and Clearance Intervals, Institute of Transportation Engineers (ITE), August 1994

Guidelines for the Installation of Left-Turn Phasing. Research Report KTC-95-23, Kentucky Transportation Center, December 1995

Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections, NCHRP Report 731, Transportation Research Board, 2012

Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition, U.S. Department of Transportation, Federal Highway Administration (FHWA), May 2012

NCHRP Report 969 Traffic Control Strategies for Pedestrians and Bicyclists, TRB, 2022

NCHRP Report 600 Human Factors Guidelines for Road Systems, TRB, 2012

ODOT Highway Design Manual, Oregon Department of Transportation, Traffic-Roadway Section, Roadway Engineering Unit, 2023

ODOT's HSIP Countermeasures and Crash Reduction Factors, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Operations Unit,

ODOT Maintenance Guide, Oregon Department of Transportation, Maintenance Division, July 2011

ODOT Railroad Preemption Design and Operation, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Services Unit, December 2005

ODOT Sign Policy and Guidelines, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Standards Unit, 2022

ODOT Signal Design Manual, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Standards Unit, January 2023

Oregon Supplement to the Manual on Uniform Traffic Control Devices, 2009 Edition, Oregon Department of Transportation, November 2011

ODOT Traffic Controls Plan Design Manual, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Standards Unit, January 2022

ODOT Traffic Manual, 2023 Edition, Oregon Department of Transportation, Traffic-Roadway Section, Traffic Services Unit, January 2023

Oregon Administrative Rules (OAR), Chapter 734, Oregon Department of Transportation

Oregon Revised Statutes (ORS), 2021 Edition, Oregon State Legislature

Oregon Standard Specifications for Construction, Oregon Department of Transportation, Project Controls Office, Specifications Unit, 2021

Oregon Transportation Plan, Oregon Department of Transportation, Planning Section

A Policy on Geometric Design of Highways and Streets, 7th Edition, American Association of State Highways and Transportation Officials (AASHTO), 2018

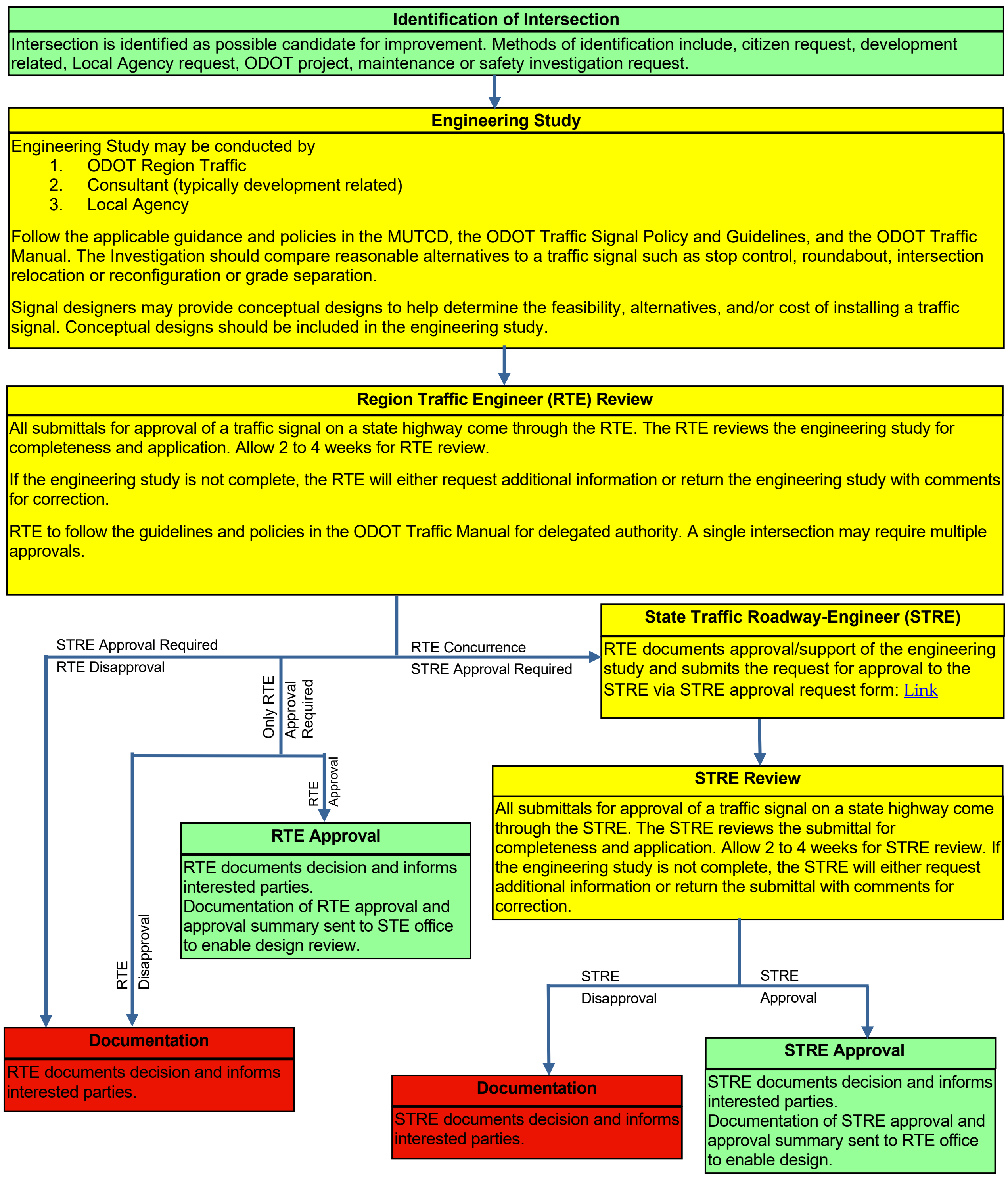
Signalized Intersections: Informational Guide, Second Edition. Report FHWA-SA-13-027. Federal Highway Administration (FHWA), July 2013

Traffic Control Devices Handbook, Second Edition. Institute of Transportation Engineers (ITE), 2013

Traffic Signal Timing Manual, Second Edition, NCHRP Report 812, 2015

Appendix C: Traffic Signal Approval Process

Traffic Signal Operational Approval



Traffic Signal Design Approval

Traffic Signal Design Begins

The signal designer shall have STRE operational approval prior to traffic signal design. STRE operational approval contains specific design requirements for the traffic signal.

Design Standards:

1. ODOT owned and maintained = full ODOT standards
2. ODOT owned, Local Agency maintained = partial ODOT standards (negotiated)
3. Local Agency owned, ODOT maintained = partial ODOT standards (negotiated)
4. Local Agency owned and maintained = full local standards

Pending Jurisdiction Transfers will not be considered when determining appropriate design standards.

Traffic Signal Design - Plans

1. Design Approval is required for all traffic signal plan sheets with a few exceptions listed in Chapter 2 of the ODOT Signal Design Manual

STRE design approval is not required for:

1. Portable Temporary Signals
2. Local agency owned and maintained signals. Federally funded projects may request a courtesy review for compliance with minimum Federal standards.

Cost Estimate

Prepared by the designer. No STRE office review required.

Specifications

Prepared by the designer. No STRE office review required unless changes are made to the specifications.

Traffic Signal Design Submitted to State Traffic-Roadway engineer (STRE) Office

The Traffic signal design shall be submitted to the Office of the STRE at all major project milestones, including DAP, Preliminary, Advance and Plans-in-Hand.

The traffic signal design should also be submitted for review to the region traffic engineer, region electricians and other interested parties.

The STRE Office is available to meet with designers to go over project details. This is recommended for complex projects and may reduce the STRE review time and/or comments.

Design Work

Signal designer addresses comments.

STRE Office Design Review

The STRE office reviews the traffic signal design. Allow a minimum of 2 weeks for review. Prior to final plans and after all comments have been resolved, the signal designer requests TRS Drawing Numbers from the STRE Office.

STRE Office Comments

Documentation

STRE Office provides a list of comments to be addressed.

All STRE Office Comments Resolved

STRE Office Design Approval

Signal designer to add digital signature field for STRE approval, digitally sign as Engineer of Record and submit to STRE Office for digitally signed approval by the STRE Office.

Appendix D: Traffic Signal Investigation Forms

Preliminary Signal Operations Design Form

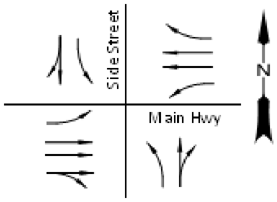
Preliminary Signal Operations Design

Traffic-Roadway Section
Traffic Engineering Unit
Phone: (503) 986-3568

Project: ____________ Key #: ________ Date: ________
Location: ____________ City: ________ County: ________
Highway: ____________ Hwy No: ________ Mile Point: ________

Existing Information

Lane Configuration



Crosswalks

- ☐ North Approach
- ☐ South Approach
- ☐ East Approach
- ☐ West Approach

Traffic Control

- ☐ 2-Way Stop
- ☐ All-Way Stop
- ☐ Signalized

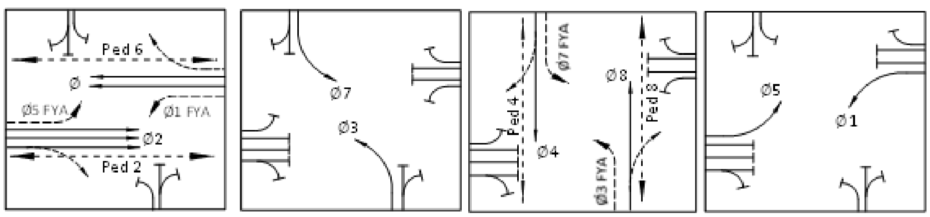
Bike Lanes

- ☐ North Approach
- ☐ South Approach
- ☐ East Approach
- ☐ West Approach

Posted Speed Limit

Highway: ______ mph
Side Street: ______ mph

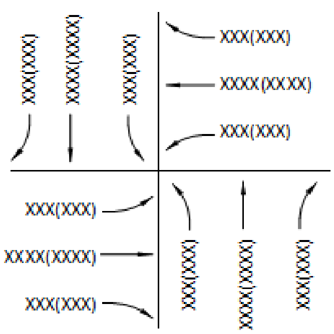
Existing Vehicle and Pedestrian Phasing (if Signalized)

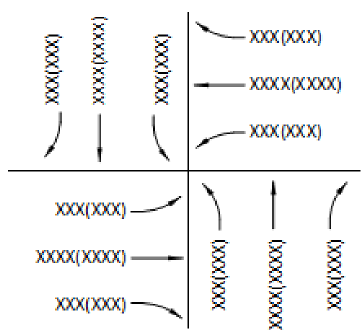


Ø2+Ø6 Ø3+Ø7 Ø4+Ø8 Ø1+Ø5

Traffic Volumes

Existing Year AM(PM) *Future Year*
20XX 20XX





Other Relevant Information

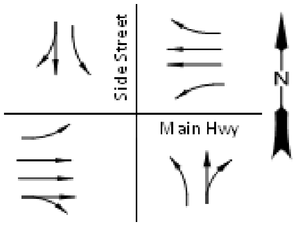
Page 1 of 2

Preliminary Signal Operations Design

Traffic-Roadway Section
Traffic Engineering Unit
Phone: (503) 986-3568

Recommended Signal Design

Lane Configuration



Crosswalks

- ☐ All crosswalks provided
- ☐ Following crosswalks closed
  - ☐ North Approach
  - ☐ South Approach
  - ☐ East Approach
  - ☐ West Approach

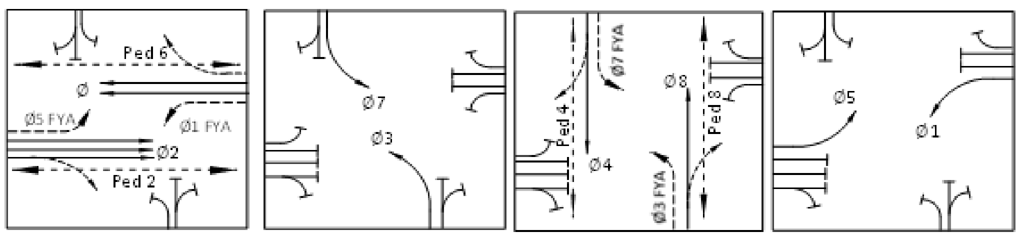
Bike Lanes

- ☐ North Approach
- ☐ South Approach
- ☐ East Approach
- ☐ West Approach

Other Required Features

- ☐ Signal interconnect to: ____________________
- ☐ Communication type: ____________________
- ☐ 2070 controller
- ☐ Illumination
- ☐ Audible/accessible pedestrian signals
- ☐ Railroad preemption
- ☐ Other: ____________________

Recommended Vehicle and Pedestrian Phasing



Ø2+Ø6 Ø3+Ø7 Ø4+Ø8 Ø1+Ø5

Notes regarding right-turn lane control

Primary considerations used to determine left-turn phasing

Considerations for mitigating bike-vehicle conflicts (if any)

Design Vehicle Information (to be confirmed with Roadway Designer)

- ☐ Design for
- ☐ Accommodate

Design Vehicle: [▾] If Bus or Other, specify: ____________

Recommended by: ______________________________________
Region Signal Operations Engineer

Page 2 of 2

Oregon Department of Transportation

Left Turn Signal Phasing Investigation

Traffic-Roadway Section
Traffic Engineering Unit
Phone: (503) 986-3568
Fax: (503) 986-4063

General Information

Project Name: ______________________ EA: ______________
Highway Name: ____________ Route No.: ______
Highway Number: ____________ Milepoint: ______ County: ______________
Minor Street: ______________________ City: ______________
District: ______________

Investigation Information

Investigator: ____________ Date: ______ Reviewed by ____________ Date: ______
Time: ______

1.) New signal: ☐ Existing signal: ☐
a.) Basis for Signal Approval: ____________
b.) Plans to improve/modify intersection: ☐ YES ☐ NO

2.) Existing phases[3]: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ Ped 2 ☐ Ped 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ Ped 6 ☐ Ped 8
Investigated phases: ☐ 1 ☐ 3 ☐ 5 ☐ 7

3.) Signal is located in a traffic signal system: ☐ YES ☐ NO
a.) If yes, lead/lag phasing existing: ☐ YES ☐ NO
If no, location of closest signals: ________
If no, location of signals proposed in TSP: ______
b.) Pending developments in area*: ☐ YES ☐ NO

4.) Traffic volumes meet minimum left-turn criteria[1]: ☐ YES ☐ NO
a.) If no, will traffic volumes meet minimum criteria within 5 years[1]: ☐ YES ☐ NO

6.) Crashes at intesection last three years[2]:

Year	Total crashes	Left turn crashes for investigated phase			
		Ø 1	Ø 3	Ø 5	Ø 7

a.) Nearby accesses/intersections with relevent left turn crash history*: ☐ YES ☐ NO
b.) Top 10% SPIS site: ☐ YES ☐ NO Year: ______

7.) Intersection geometry[3]:
☐ 4-leg intersection ☐ Interchange ramp
☐ T-intersection ☐ Other
a.) Geometry is appropriate for PPLT phasing: ☐ YES ☐ NO

8.) Number of opposing through lanes: ☐ 1 ☐ 2 ☐ 3+
9.) Multiple left turn lanes: ☐ YES ☐ NO
10.) U-turns permitted: ☐ YES ☐ NO
11.) Opposing left turn: ☐ YES ☐ NO
a.) Prohibited ☐ YES ☐ NO
b.) Exists ☐ YES ☐ NO
12.) Major street posted speed limit: _____ MPH
13.) Minor street posted speed limit: _____ MPH
14.) Sight distance to oncoming traffic (ft):
- Phase 1 _____
- Phase 3 _____
- Phase 5 _____
- Phase 7 _____

15.) Pedestrian concerns*: ☐ YES ☐ NO
16.) School Crossing: ☐ YES ☐ NO
17.) Railroad Preemption: ☐ YES ☐ NO

Comments: ______________________________________

[1]See attached volume analysis
[2]See attached accident analysis and PRC
[3]See attached T.M.S. DWG, V-file, sketch, or pictures
*If answer is yes, please provide details in comment area
Reference: ODOT Traffic Signal Policy and Guidelines, November 2013

Appendix E: EV Preemption Request Form

Request for Approval to Operate Traffic Signal Control Operating Devices on State Highways

ORS 810.260 and 815.445 and OAR 734-020-0300 to -0330 provide for the use of traffic control signal operating devices by emergency vehicles. Each emergency service provider seeking to use a traffic control signal operating device on a State Highway must make a formal request to the Oregon Department of Transportation.

To make a request, please provide the information requested below and submit it to the ODOT region where the emergency preemption system will operate. The region traffic manager will review the request and submit a recommendation to the state traffic-roadway engineer. The state traffic-roadway engineer has approval authority for all requests.

Contact the Traffic-Roadway section, Oregon Department of Transportation at 503-986-3568, if you have questions about completing this form.

Emergency Service Provider___________________________________Telephone_________________________

Address___________________________________ City_______________________ Zip Code _______________

Contact ______________________________ Title _____________________Email ________________________

Indicate whether your organization is a ____ Public agency or ___ Private emergency service provider.

Private emergency service providers should provide verification that the vehicles to be equipped with traffic control operating devices have been designated as emergency vehicles by ODOT's Transportation Safety Division per OAR 737-100-0030. (Contact Program Manager Michele O'Leary at 503-986-4198 for more information about this requirement.)

1. List the types of vehicles that you want to equip with traffic control signal operating devices.

Type of Vehicle	Gross Vehicle Weight	Purpose of Vehicle

2. Describe the geographical area where the emergency vehicles operate or provide a map.

3. Sign this request form and submit it to the ODOT Region Traffic Manager for review.

Signature of Applicant____ Date________________

ODOT Region Review

Review the Request Form, check the following, and submit to the state traffic-roadway engineer for approval.

____ Region is in substantial agreement with the information supplied by the applicant.

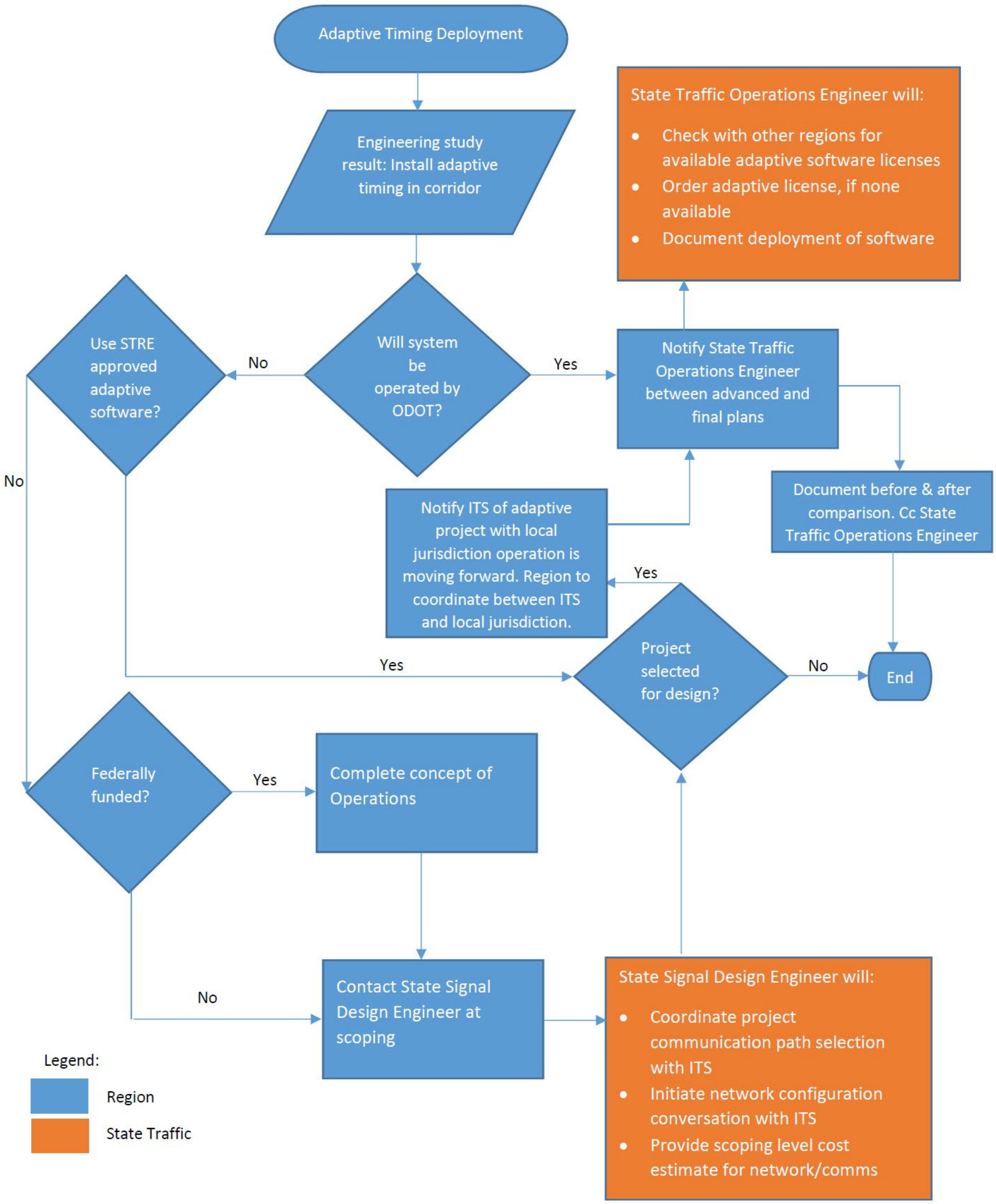
Region Traffic Manager______________________________________ Region_ Date____________

State Traffic-Roadway Engineer Review

________________________________ (name of emergency service provider) is authorized to operate traffic control signal operating devices on state highways in vehicles providing emergency services as provided for in ORS 810.260 and 815.445 and OAR 734-020-0300 to -0330.

State Traffic-Roadway Engineer____ Date_________________

Appendix F: Adaptive Signal Timing Process



Appendix G: Manual Revision History

This appendix summarizes the revisions made in this revision of the Traffic Signal Policy and Guidelines.

Date	Section	Notes
4/1/2022	General	Updated to accessible format, revised names, positions, titles, and links to current.
4/1/2022	Preface	Removed signatures, referenced delegation order, removed OCTDC concurrence.
4/1/2022	1.	Added Traffic Manual as primary reference for approval and delegation authority.
4/1/2022	1.2.3	Added section to differentiate from bicycle and pedestrian warning systems (1.2.2) and renumbered following sections.
4/1/2022	1.4	Added section to clarify authorities in adaptive timing deployment
4/1/2022	2.2	Added general responsibilities of operations staff
4/1/2022	2.6 and subsections	Added section to clarify roles and responsibilities where interfacing with ITS is required.
4/1/2022	3.	Clarified rationale for retaining existing change and clearance interval formulas.
4/1/2022	4.	Reorganized definitions.
4/1/2022	4.1.1.1	Updated reference to current edition of 'Green Book'. Differentiated conflicts between motorists and bicycles
4/1/2022	4.1.1.2	Revised direction related to doghouse or 5 section heads to reflect current hardware standards.
4/1/2022	4.2	Cited relevant ORS.
4/1/2022	5.1	Added guidance on leading pedestrian interval deployment and authority.

Date	Section	Notes
4/1/2022	5.3 and subsections	Reorganized to make settlement language a subsection, added language linking audible pushbuttons and leading pedestrian intervals.
4/1/2022	5.4.1	Removed design guidance provided elsewhere and updated to reflect currently preferred device selections.
4/1/2022	8.1	Added guidance to reserve alarms 1-3 for rail preemption related issues.
4/1/2022	8.3	Renamed section to 'Moveable bridge preemption.
4/1/2022	8.4	Clarified preferences regarding preemption device encoding.
4/1/2022	8.5	Clarified status on next-generation transit priority system options.
4/1/2022	9.	Removed option for flashing yellow when using controller flash.
4/1/2022	App. A	Added references for additional definitions.
4/1/2022	App. B	Updated references and links as needed.
4/1/2022	App F	Added appendix
4/1/2022	App G	Added change log
1/1/2023	5.4.2	Added RRFB Timing formula and supporting information
1/1/2023	Various	Typo correction
1/1/2023	Appendix B	Updated and added references and links
3/15/2024	General	Errata, typos, dates, hyperlinks and clarifying language. Removed reference to specific software packages.
3/15/2024	2.3	Revised language on timing database storage
3/15/2024	3	Added clarification on Oregon's restrictive yellow, and why that can be a factor in selecting a change interval

Date	Section	Notes
3/15/2024	4.1.1.2	Revised ordering phrasing and added exception to previously required delay before activating FYA.
3/15/2024	4.1.2.2	Removed statement on wasted time with Lag-Lag. With current head arrangements the lagging phases do not have to start at the same time.
3/15/2024	6.4	Added reference to NCHRP 969 for bicycle signal timing
3/15/2024	5; 5.3.2	Added streamlined process for APS deployment.
3/15/2024	8.5	Removed reference to deprecated transit priority form. Added instruction to submit STRE request.