

Construction & Installation

General

The following topics in this section acquaints the inspector with a phase of construction or type of equipment used when installing a traffic signal. The topics are grouped by type of work for ease of use.

Each topic contains the following information and is intended to be used in conjunction with the appropriate section(s) of the standard specifications, special provisions, project specific plan sheets and/or standard drawings:

- Key Enforceable Items
- Tips and Tricks
- Inspector Action
- Typical Sources of Info
- Illustrations

Changes to the Plans and Specifications

Any changes made in the field are subject to the approval of the **ENGINEER OF RECORD (EOR)**. The Inspector should note the changes as they occur, as it will make processing the As-Constructed drawings easier and more accurate (see page 189).

Engineer of Record (EOR)

REGISTERED PROFESSIONAL ENGINEER
51322PE
Digitally Signed Aug 7 2018 9:12 AM
OREGON
JULY 9, 2007
TRENTON B. GLICK
RENEWS: 06-30-2019
FINAL ELECTRONIC DOCUMENT
AVAILABLE UPON REQUEST

REGISTERED PROFESSIONAL ENGINEER
51322PE
TRENTON B. GLICK
RENEWS: 06-30-2019

SIGNAL PLAN
1-5 (N.B.) RAMPS AT CENTRAL AVE.
1-5, M.P. 136.53
(SOUTHERLY)

LEGEND

- 1. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 2. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 3. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 4. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 5. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 6. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 7. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 8. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 9. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 10. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 11. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 12. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 13. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 14. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 15. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 16. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 17. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 18. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 19. Install new signal head (see Note 10) and install new signal head (see Note 10)
- 20. Install new signal head (see Note 10) and install new signal head (see Note 10)

FOREIGN DEPARTMENT OF TRANSPORTATION
SOUTHERN OREGON SIGNAL UPGRADE PROJECT
SIGNAL PLAN
Revision 07 Scale 1:200

This example shows a digital signature (current ODOT standard). An actual signature will be seen on older plans.

Construction

Coordination & Supplemental Inspection

Coordinate supplemental inspections as **required (No. 4, 5, 6, 7, 8 and 10)** or recommended (No. 1, 2, & 8) in the table below with the appropriate personnel:

- **ODOT Region Traffic*** is responsible for the signal timing and operation of the traffic signal.
- **ODOT Agency Electricians*** are responsible for the power cost and maintenance of the traffic signal.
- **ODOT Traffic Systems Services Unit (TSSU)*** is responsible for the initial chamber testing of the controller cabinet (and components) and installation of the components during signal turn-on.
- **Electrical Permitting Agencies (Building Codes Division, City, or County)** are responsible for permitting and inspecting electrical work.

***The Local Agency** (city or county) may provide these services via an inter-governmental agreement (IGA). Verify who is responsible for the maintenance and signal timing with the appropriate Region Traffic contact.

	Supplemental Inspection	When to request inspection	Contact	Advance Notice	More Info
1	Temporary Stage Adjustments	At anticipated stage change	Region Traffic	1 to 2 weeks	Pgs. 106 & 110
2	Pole & controller layout inspection	After radii are laid out and pole and controller locations are staked	Region Traffic & Agency Electricians	3 days	Pg. 116
3	Conduit in foundation inspection	After forms and conduits are in place, but before foundations are poured	Agency Electricians	3 to 5 days	Pg. 118
4	Conduit & backfill inspection TM471	During conduit installation, but before backfill	Agency Electricians	3 days	Pgs. 130 & 132
5	Power service inspection 00960.70	After service cabinet has been installed	Electrical Permitting Agency	As per the permit	Pg. 152
6	Loop layout inspection 00990.41(a)	After crosswalks and loops are laid out, but before sawcutting begins	Region Traffic	3 days	Pg. 170
7	Loop installation inspection 00990.41(a)	After sawcutting, but before loop wire is installed	Agency Electricians	3 to 5 days	Pg. 172
8	Field testing inspection 00990.70(g)	At anticipated signal completion date	Agency Electricians and TSSU	1 to 2 weeks	Pg. 188
9	Pre-signal turn-on inspection	At anticipated signal completion date	Region Traffic	1 to 2 weeks	Pg. 188
10	Final inspection 00150.90	After punch list items have been completed	Region Traffic & Agency Electricians	3 to 5 days	Pg. 189

General Sequence for Constructing a Traffic Signal

Prior To Construction	<ul style="list-style-type: none"> Attend pre-construction conference Obtain contractor's schedule Prepare field inspection forms for poles Review Blue and Green Sheet – obtain initial approval if write-in items are proposed Submit pole shop drawings for structural review (ordering poles typically requires 3 to 6 month lead time) Obtain labor certifications (electricians) Obtain Electrical Permit Request utility locates
Installation of Traffic Signal	<ul style="list-style-type: none"> Submit initially approved Green sheet items to TSSU for chamber testing (6 weeks minimum for testing) <p>2 Locate foundations (poles, pedestals, service and controller cabinet foundation)</p> <ul style="list-style-type: none"> Rough locate junction boxes and conduit trenches Excavate for foundations Install re-enforcing steel cage & anchor rod assembly (typically fabricated off-site) <p>3 Install conduits & ground rods that will be inside of the foundation</p> <ul style="list-style-type: none"> Pour concrete for foundations <p>4 Excavate conduit trenches, install conduit, & backfill conduit trenches</p>
	<ul style="list-style-type: none"> Install poles on foundations Install mast arm or messenger cable on pole: equipment on arm or span may already be installed off-site Install equipment on poles/mast arms/span wire & install tether cable Install service cabinet & controller cabinet <p>5 Electrical inspection/approval for power</p> <ul style="list-style-type: none"> Coordinate power hook-up with power company Install junction boxes, except JB's with loop wire entrances Install wiring in poles/pedestals/cabinets/junction boxes and conduits
	<p>6 Locate loop detection on pavement</p> <ul style="list-style-type: none"> Install loop wire entrance and junction box <p>7 Sawcut for loop detection</p> <ul style="list-style-type: none"> Install loop wire & test Seal loop wire & test Splice loop wire to loop feeder cable & test
	<p>8, 9 Coordinate with others for scheduling signal turn-on date</p> <ul style="list-style-type: none"> Agency Electricians perform Field Testing Inspection Address all punch list items from the Field Testing Inspection Signal Turn –on Approve & process QA/QC documents (Blue/Green sheets, FIR, etc.)
	<p>10 Final Inspection</p>

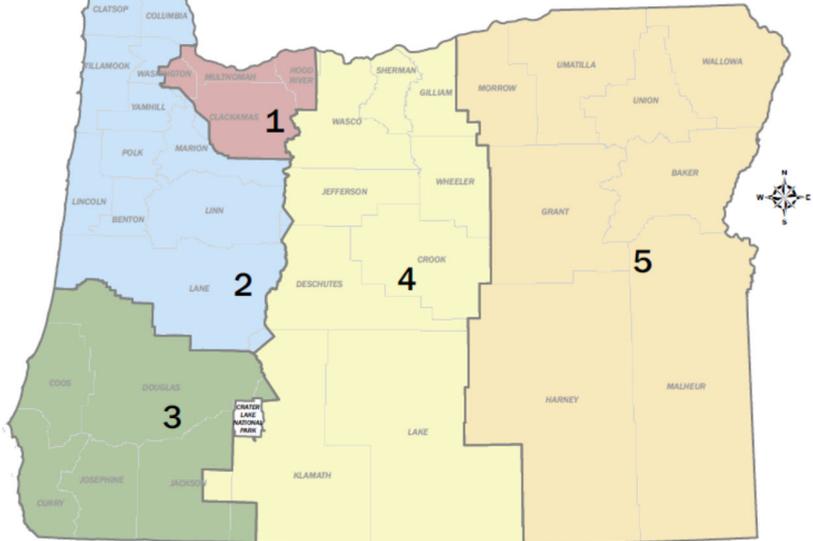
Note: chart shows a linear progression, but depending on contractor's schedule, some items may be constructed at the same time. Always refer the Contractor's Schedule.

Supplemental Inspection (See numbers 2 thru 10 in table on previous page)

Contacts

ODOT Statewide		
Discipline	Name	Phone
All	Kevin Haas, P.E. Traffic Standards Manager	(503) 986-3583
Traffic Signal Standards	Scott Cramer, P.E. State Traffic Signal Engineer	(503) 986-3596
	Joe Searcy, Electrician Traffic Signal Standards Specialist	(503) 986-3577
	Sarah McCrea, P.E. Traffic Control System Engineer	(503) 986-3251
	Katie Johnson, P.E. Traffic Signal QC Engineer	(503) 986-3595
Traffic Structures	Scott Jollo, P.E. Traffic Structures Engineer	(503) 986-3069
Illumination	Ernest Kim, P.E. Illumination Engineer	(503) 986-3587
Signal Timing	VACANT Traffic Signal Operations Engineer	(503) 986-3576
TSSU (electrical)	Barby Golden Lead Signal Tech	(503) 932-1483
	Sue Trummel Office Coordinator	(503) 378-2913
ITS Unit	Doug Spencer, P.E. ITS Standards Engineer	(541) 747-1276

OREGON DEPARTMENT OF TRANSPORTATION REGIONS



Construction

ODOT Region Traffic & Electrical Contacts

Region	Discipline	Name	Phone
1 Dispatch: (503) 283-5859	Agency Electricians	John Sapp - Manager	(971) 673-6240
		Lisa De Mers – Traffic Signals & Ramp Meters	(503) 969-1024
		Duc Phan - Illumination	(503) 969-1031
	Region Traffic	Ioana Cosmo – Signals East	(503) 793-0994
		Patrick Mahedy – Signals Central	(503) 731-8213
		Brian Sloane – Signals West	(503) 731-3125
		Phuong Nguyen – Ramp Meters	(503) 731-3004
2 Dispatch: (503) 362-0457	Agency Electricians	Rich Hinkle - Manager	(503) 986-2705
		David Dexheimer - Astoria	(503) 932-1479
		Scott Stinnett - Salem	(503) 932-1481
		Mike Dirks – Albany	(541) 921-0247
		Brian Parks - Eugene	(541) 953-6967
	Region Traffic	Darren Lawrence	(503) 986-2766
		Nick Schlotthauer	(503) 986-7214
3 Dispatch: (541) 858-3103	Agency Electricians	Lucas Schaufler – Manager	(541) 471-3802
		Brian Henry - Roseburg	(541) 580-8532
		Chris Emerson- Coos Bay	(541) 294-8031
		Curt Duncan- Grants Pass	(541) 621-2329
		Dave Smith- Central Point	(541) 890-7020
	Region Traffic	William Fitzgerald, P.E. – District 8	(541) 774-6359
		Aaron Brooks, P.E. – District 7	(541) 957-3517
4 Dispatch: (541) 383-0121	Agency Electricians	Brad Stevens	(541) 388-6077
	Region Traffic	Miranda Wells, P.E.	(541) 480-7812
5	Agency Electricians	Mark Herburger - North	(541) 969-6554
		Joe Gastanaga – South	(541) 889-4243
	Region Traffic	Don Fine	(541) 963-1594

Electrical Permits

Electrical permits are required for **ANY TYPE** of traffic signal work as per the Oregon Electrical Safety Law (ORS 479). The contractor is required to obtain all necessary permits to accomplish the work as per ODOT Standard Specification 00170.02. However, some exceptions may apply at the discretion of the Electrical Permitting Agency (a typical example is not requiring a permit for loop detector installation). If in doubt, contact the Agency Electricians who can help verify if electrical permits are required.

The Electrical Permitting Agency issues the permits and provides inspection as required by state law. Inspection is required before a new service cabinet can be energized. **Inspection protocol may vary based on the type of electrical work.**

The contractor will provide a copy of the permit(s) to the Agency prior to installation (00960.03). Pay close attention to the Electrical Permitting Agencies' requirements and timelines. Failure to comply with permits will add significant time and cost to the project.

Labor Requirements

Every person engaged in the installation of electrical equipment/wiring shall possess a valid Oregon electrical license or registration (00960.30):

- General Supervising License
- General Journeyman's License
- Electrical Apprentice Registration (must be working under the direct supervision of an individual with an electrical license)

Obtain a copy of the electrical license or apprentice registration at the pre-construction conference before any work is performed. OAR 918-030-0920 requires an individual's license to be visible when on the jobsite, unless it would create a safety issue. If a license or registration is not visible, it should always be immediately available upon request. You can also search/look up electrical licenses online.*

License Example:



**Check the
Expire Date**

*website link provided on Pg. 208

Work That Requires an Electrical License

These lists were developed in 1999 by the Oregon Building Codes Division as per Oregon Administrative Rule (OAR) 918-282-0120(1) due to a request for clarification of traffic signal work that requires an electrical license. Failure to follow these lists is a violation of Oregon Law and should be reported.

A license IS required to:

1. Install ground rods and grounding/bonding
2. Install conduit in a footing
3. Install luminaires on the pole
4. Install pedestrian pushbuttons
5. Install pedestrian signal heads
6. Install vehicle signal heads
7. Install interior illuminated signs on pole
8. Assemble and lay ALL conduit in a foundation or ditch
9. Assemble and handle conduit for boring operations
10. Install pull line in conduits
11. Pull wire and cable in ALL raceways (conduits, poles, arms)
12. Install ALL wire and making connections
13. Splice and solder loop wires to loop feeder cables
14. Install ALL cabinets (terminal, meter base, etc.)



A license is NOT required to:

1. Dig a hole for a footing in the ground
2. Tie rebar cages for the footings
3. Install anchor rods in a footing
4. Form the pole base
5. Unload the poles from a trailer
6. Unload the arms from the trailer
7. Unload light fixtures from trailer
8. Install arms on the poles
9. Install poles onto their bases
10. Uncrate pedestrian signal heads
11. Uncrate vehicle signal heads
12. Assemble ped heads into an assembly, on the ground
13. Assemble vehicle heads into an assembly, on the ground
14. Dig a ditch for conduit
15. Lay conduit alongside the ditch
16. Install poly warning tape in ditch above conduit
17. Backfill a ditch after conduit is assembled
18. Install gravel under junction boxes
19. Install concrete junction boxes
20. Install vehicle detector loops (saw, clean, place wire, seal)

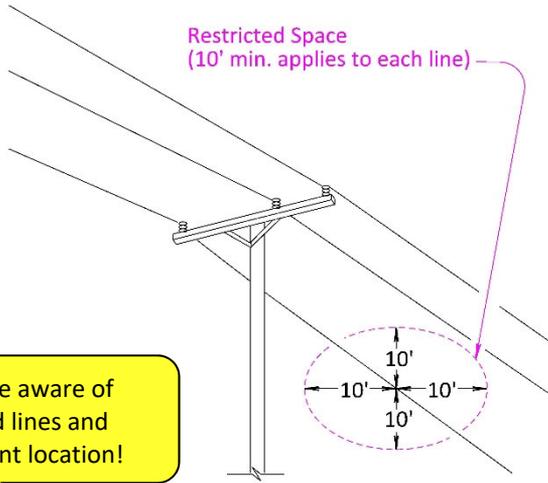
Working Near Overhead High Voltage Lines and Equipment

OAR 437-002-0047

- **Restricted space:**
 - For lines rated more than 600V to 50,000V, restricted space extends 10 feet in all directions from the surface of the line or equipment.
See illustration on next page.
 - For line rated more than 50,000V, restricted space extends 10 feet plus 0.4 inch for each 1000V over 50,000V, or twice the length of the insulator (but never less than 10 feet) in all directions from the surface of the line or equipment.
- **Proper notification:**
 - The persons responsible for the planned activity must notify the owner/operator of the line or equipment at least 2 business days prior to the beginning of work.
- **General Requirement:** Do not enter, perform any function or activity within the restricted space surrounding an overhead high voltage line or equipment unless:
 - Proper notification is provided; and
 - The line and/or equipment is de-energized and visibly grounded by the owner of the high voltage system or their authorized agent; OR
 - Accidental contact is effectively prevented by use of insulating barriers or guards.
- **The Insulating barrier or guard must:**
 - Be erected or installed by the owner or the high voltage system or their authorized agent; and
 - Not be attached to, or be part of the lines, equipment or machinery
 - Prevent all possible contact with the lines or equipment
 - Insulate against the system's maximum voltage
- Overhead line covers are only for visual reference, and their use does NOT allow entry into restricted space.
- This standard does NOT mandate that the owner of the lines or equipment must agree to de-energize, move, barricade, guard or insulate lines or equipment, or take other action to allow entry into restricted space.

**DO NOT ENTER RESTRICTED SPACE
(unless requirements of OAR "10 foot rule" are met)**

Restricted Space
(10' min. applies to each line)



Always be aware of overhead lines and equipment location!



Temporary Staging & Work Impacting Existing Traffic Signals

Key Enforceable Items

The existing signal cannot be removed until the temporary signal or new signal is operational.	00950.40
--	----------

Tips and Tricks

Become familiar with the stage construction plans and with the schedule of work so you can plan ahead and coordinate with others in a timely manner.
The signal may skip phases, or have green times that are either too short or too long, if the detection is not working properly. This can result in disobedience of the traffic signal, potential crashes, and excessive congestion.
Do not use signal head covers for vehicle or pedestrian signals that are active. The indication can still be seen with the cover on and has the potential to confuse users. Contact Agency Electricians or TSSU for assistance in disconnecting power to the indications. See illustration on this page.

Inspector Action

Contact Region Traffic in advance of any work that may impact the proper functioning of the traffic signal (See illustrations on next page): <ul style="list-style-type: none"> • Removal of existing loop detection (i.e. grind/inlay) • Temporary lane use changes or closures near the signalized intersection • Temporary lane reductions near the signalized intersection • Temporary closure of crosswalks • Push buttons that will be temporarily inaccessible 	
Observe the traffic flow once the change is made.	
Contact Region Traffic or Agency Electricians if you notice congestion or the signal not operating properly. Be as specific as you can in stating what you are observing.	
Coordinate a Supplemental Inspection (Recommended) prior to temporary staging changes.	Page 98



Signal indication should be OFF when signal head cover is installed.

Construction

Grinding near signal may impact detection



When work will affect signal timing, contact Region Traffic for temporary timing solutions!

Pushbutton
behind fence is
no longer
accessible



Construction

Flagging at Signalized Intersections: Using the Police Panel

Key Enforceable Items

Signals MUST be turned off during flagging operations.	Oregon Law: ORS 811.265
--	----------------------------

Tips and Tricks

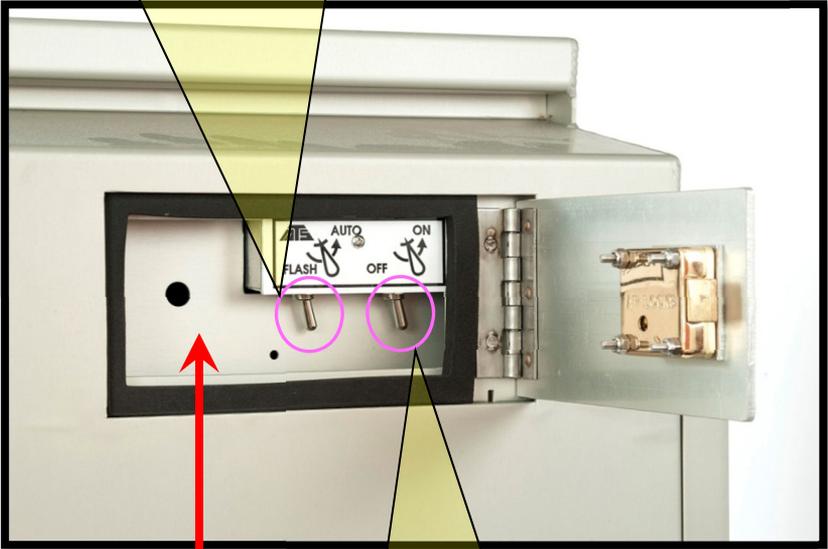
The signal is turned off through the “police panel” located on the side of the signal controller cabinet. See illustration on next page.
The police panel requires a key for access. Only trained personnel may be issued a key, as determined by TSSU.
DO NOT USE THE POLICE PANEL TO TURN OFF SIGNAL INDICATIONS IF YOU HAVE NOT BEEN PROPERLY TRAINED!!
ODOT Project Manager offices may already have internal procedures/agreements in place for who is allowed to access and use the “police panel” to turn off the signal.
Proper communication and understanding between the person using the police panel and flaggers is critical.

Inspector Action

Review and follow internal ODOT Project Manager Office procedures related to turning off the signal (if they exist).	Internal Procedure
Contact TSSU or Agency Electricians for permission to turn-off the signal if there is no procedure in place.	Internal Procedure
Contact TSSU or Agency Electricians for training in using the police panel and obtaining police panel keys.	Internal Procedure

This switch places the signal into flash

- "AUTO" is for the signal to run in normal operation
- "FLASH" places the signal into flash mode



This switch turns the signal indications on or off

- "ON" signal indications are on
- "OFF" signal indications are off

Police Panel



Temporary Signal (Standard)

Key Enforceable Items

The existing signal cannot be removed until the temporary signal or new signal is operational.	00950.40
Poles for temporary signals are non-standard wood poles. The contractor is responsible for providing design details to the agency for review and approval.	00225.10 & 00225.15
Region Traffic (or local agency) is responsible for signal timing.	00225.15(a)(5)
Do not use permanent signal equipment as part of the temporary installation.	00225.15(a)(1)
The contractor is responsible for maintenance (except inside the controller cabinet) and power costs of the temporary traffic signal. Agency Electricians may perform necessary maintenance at the contractor's expense.	00225.45(a)(2) & 00225.65(a)

Tips and Tricks

Become familiar with the stage construction plans. See illustration on next page.
Mast arms may need to be installed the day of permanent signal turn-on to avoid blocking temporary signal indications. Plan Sheets may indicate this. See illustration on next page.
If the stage construction requires changes to lane use or lane alignment, the signal head types/location and/or the signal phase may need to be adjusted. This may require assistance from the EOR, Region Traffic, TSSU, and Agency Electricians.

Inspector Action

Verify equipment used for temporary signals is new or like new.	00225.15(a)(1)
Verify (during each stage of construction) the pedestrian signals are visible and push buttons are accessible (ADA max reach of 10" to the push button with the correct sized clear space).	Pgs. 160, 162, & 164
Coordinate a Supplemental Inspection (Recommended) at each stage that requires moving or changing temporary signal equipment. See illustration on next page.	Page 98

Typical Sources of Info:

Specs: 00225.15, 00225.45, 00225.65, 00225.85, 00225.95

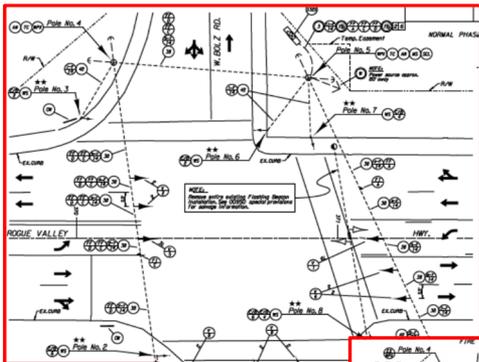
Std. Dwgs: TM452, TM455, TM870

Plan Sheets: YES

Blue Sheet/Green Sheet: Various



Mast arms may need to be installed the day of the signal turn-on to avoid blocking the working signal indications



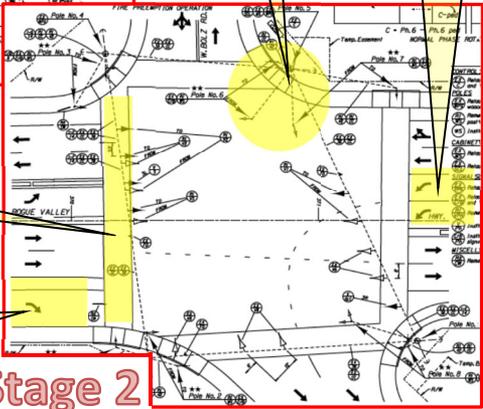
Stage 1

Radius change

New dual left turn

New crosswalk

New right turn lane



Stage 2

Become familiar with stage plans. Changes between stages as shown above require adjustment of the signal equipment & timing.

Temporary Wood Pole

Key Enforceable Items

Contractor to submit stamped working drawings, details and calculations for wood pole design to Engineer for review.	00225.15
ALL wiring on pole shall be in a conduit.	TM455
Bond all equipment within 10' of finish grade at each pole.	00225.45(a)(3)

Tips and Tricks

Wood poles are normally only used for temporary signal installations. They are ALWAYS non-standard poles and therefore require the contractor to submit calculations for review.
Rake pole away from the applied load.
Locate utilities before drilling holes.
As per the calculations, 1 or 2 guy anchors per pole may be required. See illustration on next page.

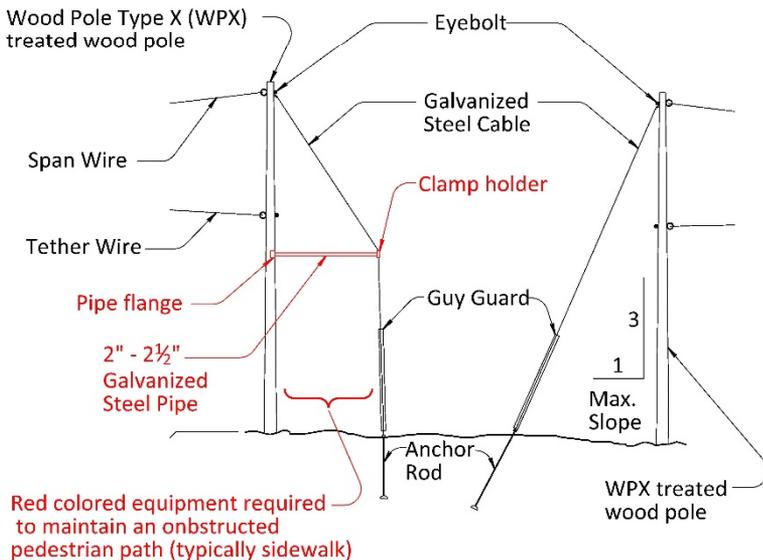
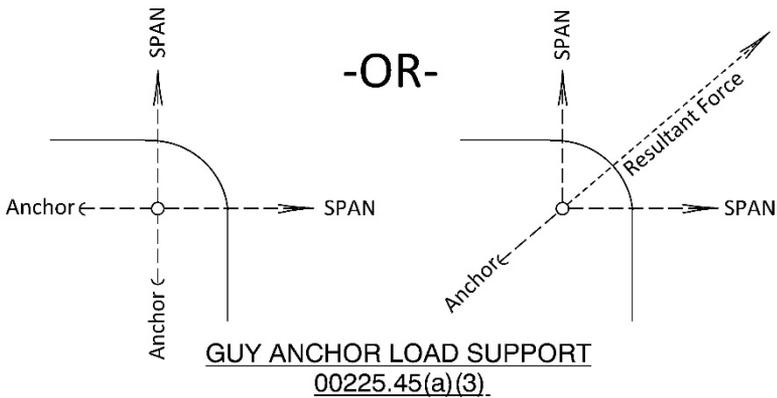
Inspector Action

Check poles for splits or in-transit damage.	00225.15(a)(3)
Verify setting depths.	Pole Submittal
Verify that minimum embankment requirements will be met during all applicable stages of construction. The permanent requirements may be applied to temporary poles.	TM653
Verify guy anchors are installed at 1:3 slope.	TM455
Verify guy anchors are not an obstruction to pedestrian walking paths. Use the galvanized steel pipe detail as needed to maintain a clear walking path. See illustration on next page.	TM455

Typical Sources of Info:

Specs: 00225.15 & 02120.10
Std. Dwg: TM455
Plan Sheets: YES
Blue Sheet/Green Sheet Info: NO





GUY ANCHOR
(TM455)

Construction

Portable Temporary Traffic Signal (PTTS)

Key Enforceable Items

PTTS are contained on the larger ODOT Qualified Products List, NOT the Green Sheets. They are NOT required to be chamber tested by TSSU. <i>See illustration on next page.</i>	00225.15(b)
Region Traffic is responsible for providing the contractor signal timing parameters. The contractor is responsible for installing and maintaining the signal timing.	00225.45(b)(3)
The devices are hard wire connected.	00225.45(b)(1)
Region Traffic, TSSU and/or Agency Electricians should be present during initial turn-on.	00225.45(b)(3)
The contractor is responsible for maintenance and power costs.	00225.46(c) & 00225.65(b)
Flaggers are to remain on stand-by for 2 hours after signal turn-on.	00225.45(b)(3)

Tips and Tricks

Typically only used for simple, short duration, two-way, one lane operation.
Become familiar with the stage construction plans.
The wiring connecting the devices should be protected from damage.

Inspector Action

Contact Region Traffic if the PTTS is NOT shown in contract plans (and contractor proposes to use one). Using a PTTS requires State Traffic Engineer Approval.	TM870
Coordinate with Region Traffic, Agency Electricians, TSSU and the Contractor to establish the signal turn-on date and time.	Internal Procedure & Page 188
Verify the signal heads line-up with the receiving lane.	00225.45(b)(1)
Verify appropriate temporary signing and striping is in place (stop lines, "Signal Ahead" signs, etc.).	Plan Sheets

Typical Sources of Info:

Specs: 00225.15(b), 00225.45(b), 00225.65(b), 00225.85(b), 00225.90

Std. Dwg: TM870

Plan Sheets: Typically YES (See Temporary Traffic Control Plan Sheets)

Blue Sheet/Green Sheet Info: Pg. 2 (from QPL)



Portable Temporary Traffic Signals are from the ODOT QPL List
(Not the Blue and Green sheets)
and do not require TSSU chamber testing

OREGON DEPARTMENT OF TRANSPORTATION
CONSTRUCTION SECTION

QUALIFIED PRODUCTS LIST

PUBLISHING DATE: JANUARY 2016



This list is published every six months and is available only from the Internet. Please notify the Product Evaluation Coordinator, in the Construction Section at the ODOT Materials Laboratory, of any changes in Standard Drawings, Special Provisions, or Specifications, etc., which would require additions to, deletions from, or changes to this listing.

Construction

Foundations (All): Location

Key Enforceable Items

Field Verification Forms are required for each pole prior to installation.	00962.02
Plan sheets will state the exact location of all signal poles, pedestals, and posts. See illustration on next page.	Plan Sheets
Plan sheets will show the general location of the controller cabinet and service cabinet: <ul style="list-style-type: none"> • If there is sidewalk, install flush against back of sidewalk. • If there is no sidewalk, install 3' walkway to cabinet. 	Plan Sheets & TM482
Service cabinet and controller cabinet must be at least 10 feet apart.	TM482

Tips and Tricks

All plans require a roadway plan sheet that establishes a survey alignment line for each intersection corner at the gutter line. Critical elevations/coordinates for the ramp & signal poles and pedestals will also be provided. See illustration on next page.
Changing a pole location may result in significant changes and re-design, such as a longer or shorter mast arm, a different type of pole, and/or a different foundation. See illustration on next page.
Ramp design and pole location are critical to meeting ADA requirements due to the tight tolerances. See pgs. 162 thru 165 for more info.

Inspector Action

Verify layout of curb, back of sidewalk, ADA ramps, raised island pedestrian cut-through paths, and/or other features near foundation.	Roadway Plan Sheets
Verify the location (station/offset) of the center of the pole using the Field Verification Forms & the Roadway Plan Sheets. Document updates to the Field Verification Form when changes occur.	00962.02 & Plan Sheets
Notify the EOR of any field conditions that may be in conflict with the foundation location (i.e. overhead/underground utilities, off right-of-way, etc.). The EOR is responsible for providing a new location.	Internal Procedure
Verify the location of the power source (commercial power). If it is different than as shown on the plans, notify the EOR.	TM485
Coordinate a Supplemental Inspection (Recommended).	Page 98
Verify foundation location does not present an obstruction to the pedestrian path (5' desirable, 4' minimum if approved).	RD720

Typical Sources of Info:

Specs: 00960.43 (Pedestals, Posts, & Cabinets), 00962.43 & 00963 (Poles)
 Std. Dwg: TM457, TM482, & TM653
 Plan Sheets: YES (Location)
 Blue Sheet/Green Sheet Info: NO

Foundation Installation (All): Conduit in Foundations

Key Enforceable Items

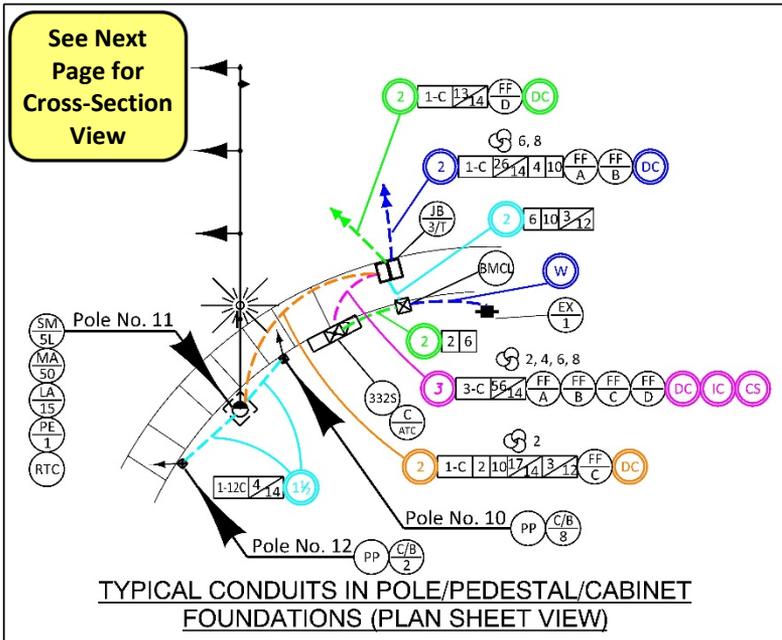
Conduits are not to be spliced/coupled at foundation edge. They must extend 10" to 12" beyond edge of the foundation.	TM471
Conduits to extend 2" minimum to 3" maximum above foundation and installed plumb.	TM471
Temporarily cap all conduit ends if no wire is installed.	TM471
All conduits in foundations must be FIBERGLASS.	TM471

Tips and Tricks

Put spacers between conduits when bundling to allow bushings to be installed later.

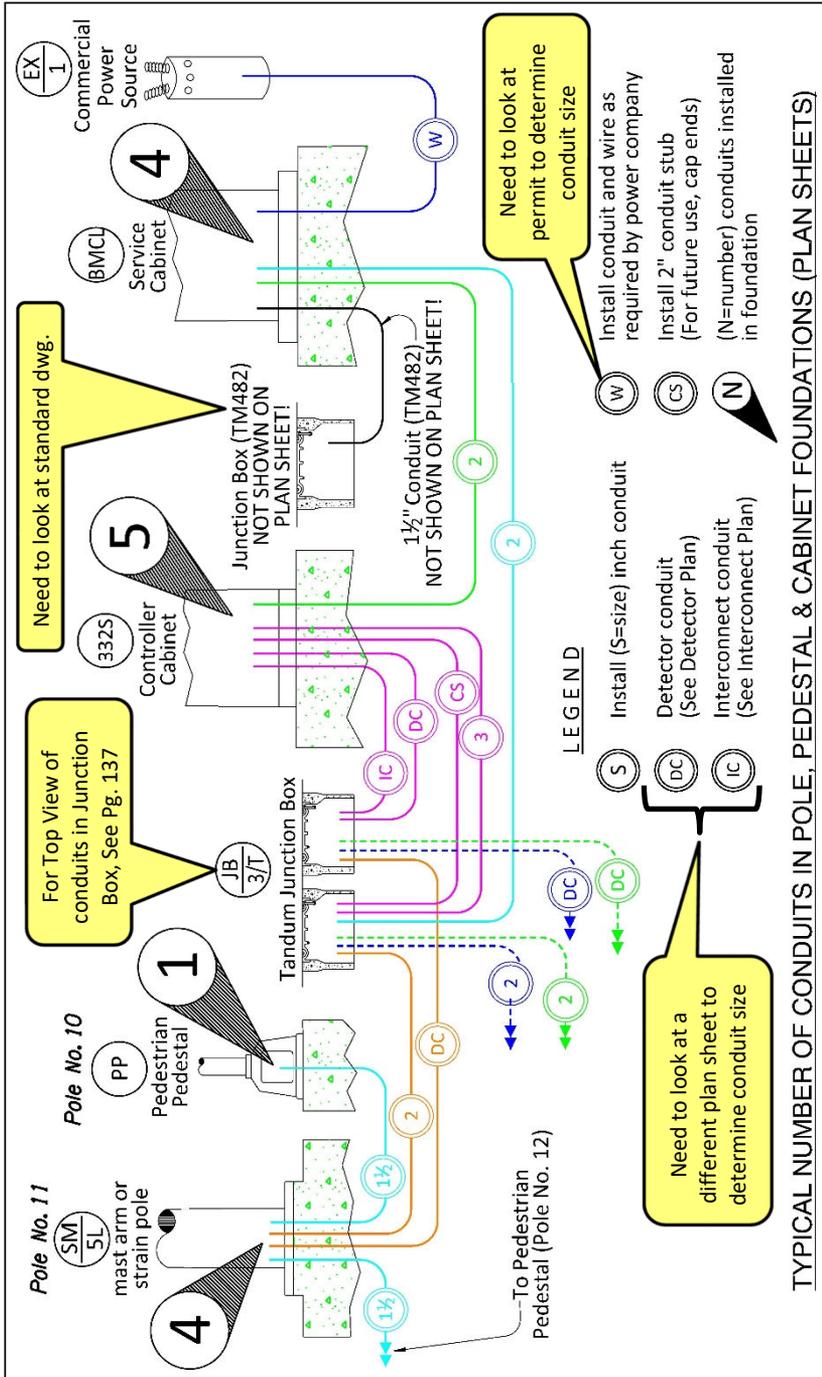
Inspector Action

Verify correct number & sizes of FIBERGLASS conduits are installed & grouped together at top. Note: Service Cabinet has a conduit only shown on TM482. See illustration on this page & next page.	Plan Sheets, TM471, & TM482
Verify conduits are in proper alignment.	TM471
Coordinate a Supplemental Inspection (recommended).	Page 98



Typical Sources of Info:

Specs: NO
 Std. Dwg: TM471 & TM482
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pg. 18



See Previous Page for Plan View

Construction

TYPICAL NUMBER OF CONDUITS IN POLE, PEDESTAL & CABINET FOUNDATIONS (PLAN SHEETS)

Foundations (Poles Only): Drilled Shaft Excavation

Key Enforceable Items

Before the pre-construction conference, contractor shall provide personnel qualification requirements for those performing the drilled shaft installation.	00963.30
At least 21 days before beginning drilled shaft construction, contractor shall submit a Drilled Shaft Installation Plan. DO NOT BEGIN WORK UNTIL ALL SUBMITTALS HAVE BEEN APPROVED. <i>See illustration on next page.</i>	00963.40(a)
Temporary casings used during construction must be removed.	00963.47(d)
Clean out the drilled shaft so that no more than 2" of loose or undisturbed material is at the bottom.	00963.43(f) to 00512.43(h)
The top foot of the foundation is always square.	TM653
Do not leave partially completed shaft excavations open overnight unless they are cased full depth and are covered at the surface to protect the public.	00963.43(a)

Tips and Tricks

NOTE: SM6L and SM7L mast arm poles have unique requirements - See TM655 thru TM658 and project plans for more info.

Inspector Action

Look up the foundation depth in the pole entrance chart.	Plan Sheets
Look up the foundation number (1 thru 9) and corresponding foundation diameter (36" or 42").	Plan Sheets & TM653
Verify pole location and finish grade before excavating using the Field Verification Form.	00962.02
Measure the final foundation depth and foundation diameter. <i>See illustration on next page.</i>	00963.43(f) to 00512.43(h) & TM653
Ensure the temporary casing is used according to the approved Drilled Shaft Installation Plan.	00963.43(c)
If caving or other unstable conditions occur during any construction procedure, stop further construction and notify the Engineer (Project Manager).	00963.43(a)

Typical Sources of Info:

Specs: 00512, 00962.41, & 00963

Std. Dwg: TM653

Plan Sheets: YES (Pole entrance chart for foundation number & depth)

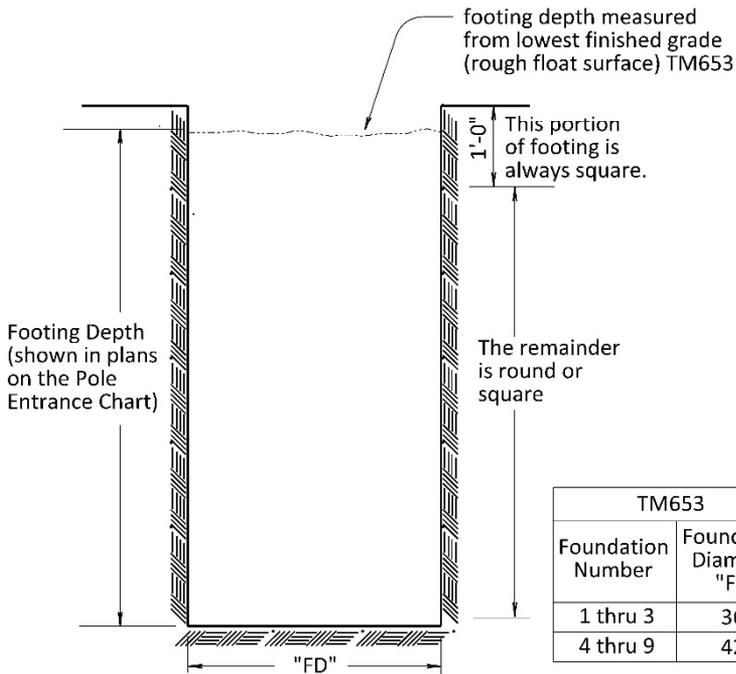
Blue Sheet/Green Sheet Info: NO

Contractor required to submit a plan at least 21 days in advance of drilled shaft construction for approval.

FOLLOW THE APPROVED PLAN.



DRILLED SHAFT INSTALLATION PLAN (00963.40(a))



TM653	
Foundation Number	Foundation Diameter "FD"
1 thru 3	36"
4 thru 9	42"

TYPICAL FOUNDATION EXCAVATION FOR SIGNAL POLES (TM653)

Foundation Installation (Poles Only): Reinforcing Steel

Key Enforceable Items

Anchor Rods (ASTM F 1554 Gr. 55) are NOT considered “high strength” and therefore DO NOT require lab check testing.	TM651, Note #7, 02560.30(a), & 02560.60(b)
Do not place reinforcing steel into the shaft excavation until Engineer has approved the elevation of the bottom of the shaft.	00963.45(a)
Place the cage such that it extends 3” above the bottom of the shaft. The cage may be supported on the bottom if approved.	00963.45(a)
Rigidly brace the cage to retain its shape for lifting. Bracing is shown on the shop drawings. Remove bracing during placement.	00963.45(b)
Maintain 3” cover (between cage and undisturbed soil) by placing spacers around the cage.	TM653 & 00963.45(c)
A steel template is used to hold the anchor rods plumb and in proper alignment. See illustration on next page.	00962.43
If concrete placement does not immediately follow cage placement, remove cage from the excavation and rectify the integrity of the excavation prior to reinstallation of the cage.	00963.45(a)

Tips and Tricks

If a temporary casing is used, the steel template holding the anchor rods and conduit(s) are installed AFTER the casing is completely removed, at the end of the concrete pour.
Rebar Size Number: Each number equals 1/8”. For example, a #5 bar is 5/8”. The QPL attachment A, shows examples of how to identify the rebar. Use AASHTO M31, Grade 60 (ASTM A615 or A706). TM653 note #16.
NOTE: SM6L and SM7L mast arm poles have unique requirements - See TM655 thru TM658 and project plans for more info.

Inspector Action

Verify the cage for the correct number, size, spacing & clearance of vertical rebar, ties, & hoops. See illustration on next page.	TM653
Verify anchor rod diameter, anchor plate diameter (out-to-out), and anchor rod alignment. See illustration on next page.	Plan Sheets & TM652
Verify top of anchor rods are at the elevation shown on the Field Verification Forms.	00962.02
Witness the lifting of the cage to ensure no distortion occurs.	00963.45(b)

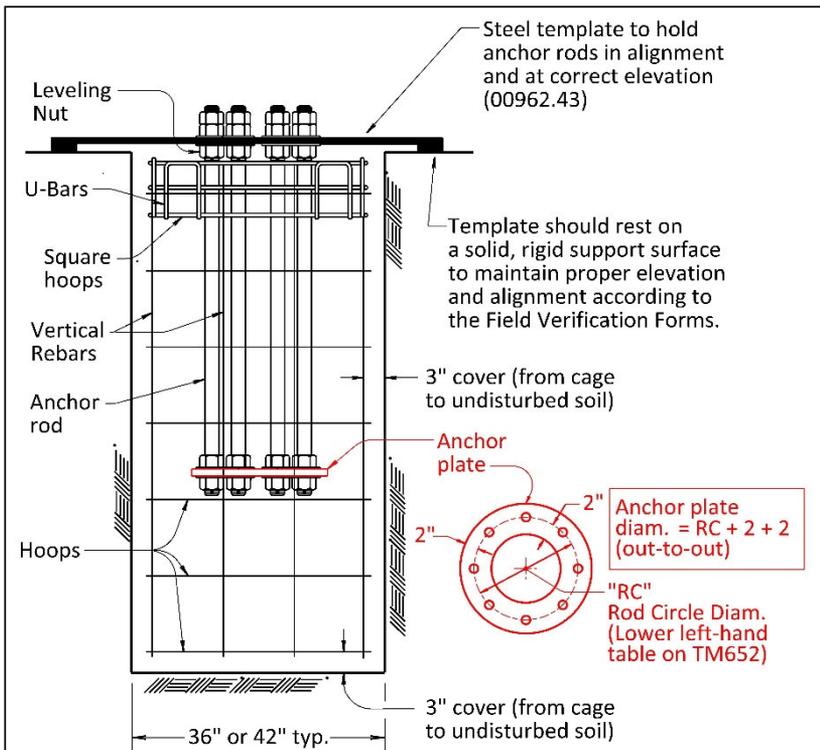
Typical Sources of Info:

Specs: 00962, 02560

Std. Dwg: TM651, TM652, & TM653

Plan Sheets: Typically NO (Non-standard foundations will be shown in plans)

Blue Sheet/Green Sheet Info: Pg. 2 (Reinforcing steel on the QPL)



**TYPICAL REINFORCING STEEL FOR SIGNAL POLES
(TM652 & TM653)**



Example of Steel template holding anchor rods

Foundation Installation (Poles Only): Concrete

Key Enforceable Items

Concrete according to 00440 except with an 8" slump ($\pm 1 \frac{1}{2}$ ").	00963.10
Foundations are constructed with one continuous concrete pour, except for 4" pad at top (measured from foundation control point). The top square hoop should be exposed. See illustration on next page.	00962.43 & TM653
Ground rods are located outside of foundation in the nearest junction box.	TM450 & TM452
Foundations are poured against undisturbed material. Some minor back-fill is allowed with well compacted materials.	TM653
Improper anchor rod alignment, adjustment of anchor rods after concrete has set, or incorrect conduit within the foundation may be cause for rejection of the foundation.	00962.43
Temporary casings used during construction must be removed.	00963.47(d)
Concrete foundation requires 7 days of cure AND must reach design strength (3000 psi) before it can be loaded. Break concrete test cylinders to verify.	00962.43, 00440, Table 00540-1, & TM651 Note #15

Tips and Tricks

Steel cage and template can be displaced by pour. Do not vibrate 8" slump.
The bottom two square hoops will be covered by the initial concrete pour (leaving 4" for closure pour). The top square hoop will be exposed and covered by the closure pour. See illustration on next page.
NOTE: SM6L and SM7L mast arm poles have unique requirements - See TM655 thru TM658 and project plans for more info.

Inspector Action

Verify that the shaft is clean.	00963.43(f)
Verify correct number and sizes of FIBERGLASS conduits are installed and grouped together at top before concrete is poured.	Page 118
Verify anchor rods are in proper alignment in the template.	TM652
Verify the top of anchor rods are at the correct elevation according to the Field Verification Forms prior to concrete pour.	00962.02
Witness concrete testing done by a certified QCT, and verify concrete meets contract requirements.	00962.10 to 00440.14(a)
Coordinate a Supplemental Inspection (recommended).	Page 98

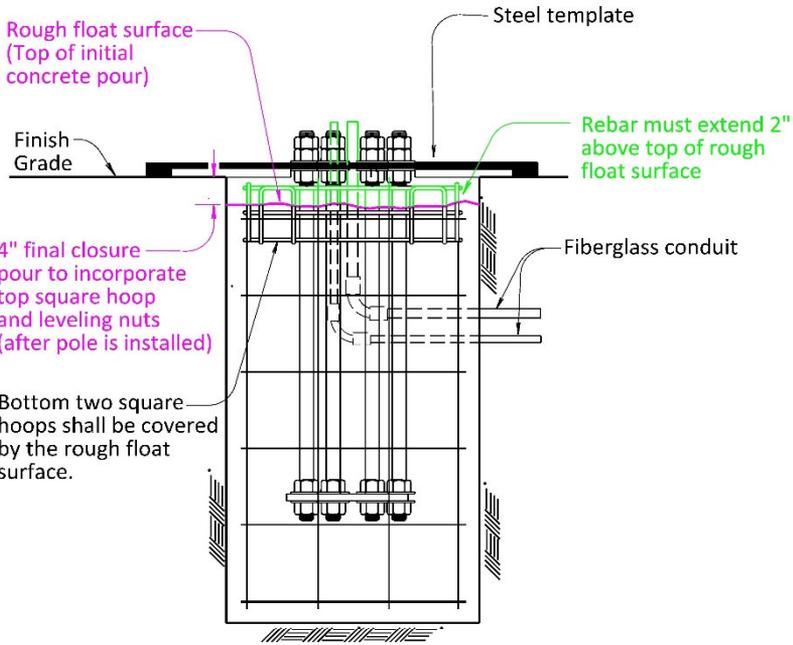
Typical Sources of Info:

Specs: 00962.10, 00962.43, 00963.10, & 00963.47

Std. Dwg: TM650 thru TM653

Plan Sheets: Typically NO (Non-standard foundations will be shown in plans)

Blue Sheet/Green Sheet Info: NO



**TYPICAL CONCRETE INSTALLATION FOR SIGNAL POLES
(TM652 & TM653)**

Top hoop exposed after initial concrete pour



Foundations (Pedestals, Posts, & Cabinets): Excavation & Concrete

Key Enforceable Items

Foundations are poured against undisturbed material. Some minor back-fill is allowed with well compacted materials.	00960.43
Foundations are constructed with one continuous concrete pour.	00960.43
Concrete foundation requires 7 days of cure AND must reach design strength (3000 psi) before it can be loaded. Break concrete test cylinders to verify.	00960.43 to Table 00540-1, & 00440
One ground rod is located inside of foundation. Note: the service cabinet also has a second ground rod located minimum 6 feet away in a separate junction box.	TM457 & TM482
Service cabinet foundation extends 2" on all sides.	TM482

Tips and Tricks

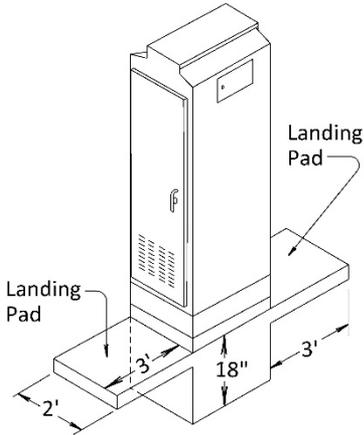
Type of Foundations (See illustration on next page):	Two types of cabinets: <ol style="list-style-type: none"> 1. Controller Cabinet 2. Service Cabinet 	Three types of pedestals: <ol style="list-style-type: none"> 1. Vehicle Pedestal 2. Pedestrian Pedestal 3. Pushbutton Post
Only vehicle pedestal foundations contain reinforcing steel. There is no reinforcing steel in the foundations for pedestrian pedestals, pushbutton posts, or cabinets.		
Typical RRFB foundations use a vehicle pedestal foundation with a pedestrian pedestal rod circle – details will be shown in the plan sheets.		
Rebar Size Number: Each number equals 1/8". For example, a #5 bar is 5/8".		

Inspector Action

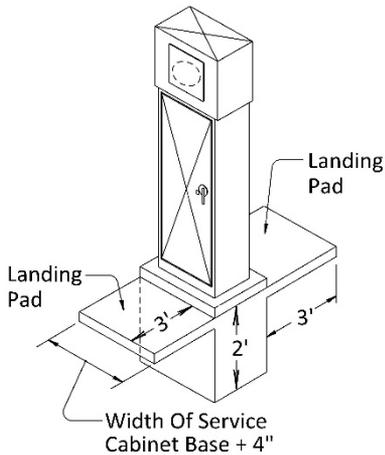
Verify location of foundation and finish grade before excavating.	Page 116
VEHICLE PEDESTALS ONLY - Verify cage for vertical bar size, ties, and clearance.	TM457
Verify correct number and sizes of FIBERGLASS conduit bends are installed and grouped together at top.	Page 118
Verify anchor rods diameter, length, rod circle diameter, and proper alignment in template.	TM457
Verify ground rod is installed in foundation.	TM457
Witness concrete testing done by a certified QCT and verify concrete meets contract requirements.	00960.43 to 00440.14(a)

Typical Sources of Info:

Specs: 00960.43, 00440, & 00540.48(a)
 Std. Dwg: TM457 & TM482
 Plan Sheets: NO
 Blue Sheet/Green Sheet Info: NO



#1: CONTROLLER CABINET

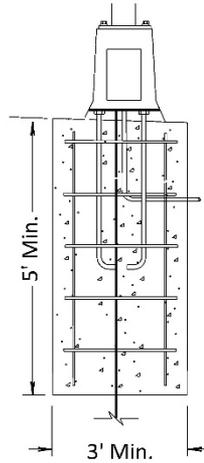


#2: SERVICE CABINET

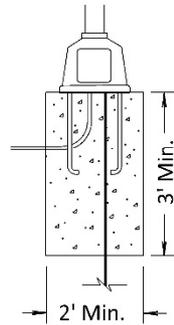
All Foundations Contain:

1. Anchor Rods
2. Fiberglass Conduit(s)
3. A Ground Rod
4. Building paper gasket between concrete & metal

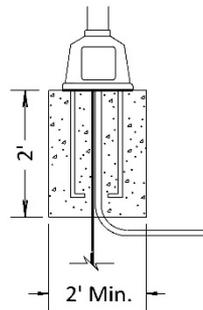
*Note: Vehicle pedestal also contains reinforcing steel



#1: VEHICLE PEDESTAL



#2: PEDESTRIAN PEDESTAL



#3: PUSHBUTTON POST

TYPES OF FOUNDATIONS (TM457 & TM482)

Conduit Trenching

Key Enforceable Items

Contractor may install conduit by either open trenching or horizontal directional drilling. Horizontal directional drilling (HDD) is required if shown on the plan sheets. <i>See illustration on next page.</i>	TM471 & Plan Sheets
Trenching for conduit shall be accomplished in the general pattern shown on the plans. Actual location of conduit runs may vary as necessary to avoid obstructions. Runs should be straight as possible. <i>See illustration on next page.</i>	TM471
Trench adequate depth to provide minimum cover for conduit.	TM471
Hold trench width to a practical minimum.	TM471
Saw-cut pavement before trenching with an approved pavement saw. An "earth saw", "conduit wheel", etc. are not approved.	TM471

Tips and Tricks

Utilities shown on plans are approximate. Un-located utilities are expensive and dangerous.
Plans sheets may specify horizontal directional drilling (HDD) in order to not disturb the existing roadway and traffic.
Most trenching will be done with a backhoe. It also may be done with a trencher, but care must be taken to provide proper backfill of a narrow trench.
'Hand-trenching' may be necessary in landscape, irrigated areas, under curb lines or for utility conflicts.

Inspector Action

Verify that utility locates have been completed prior to trenching.	00150.50(c)
Verify layout of all foundations (poles, pedestals, posts, & cabinets) and junction boxes, and service cabinet prior to trenching.	Plan Sheets
Check permit to ensure that greater trench depths aren't required by the permitting agency.	TM471
Measure the trench depth to verify the required minimum cover depth will be met.	TM471

Typical Sources of Info:

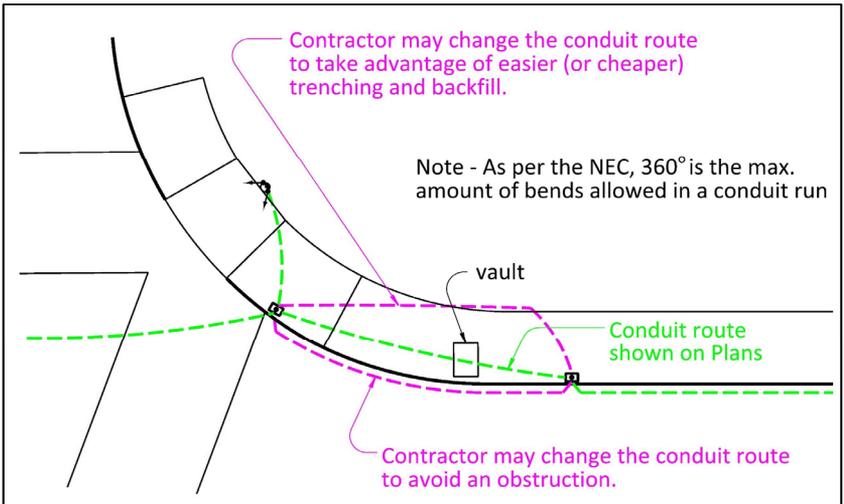
Specs: 00960.40 & 00960.41

Std. Dwg: TM471

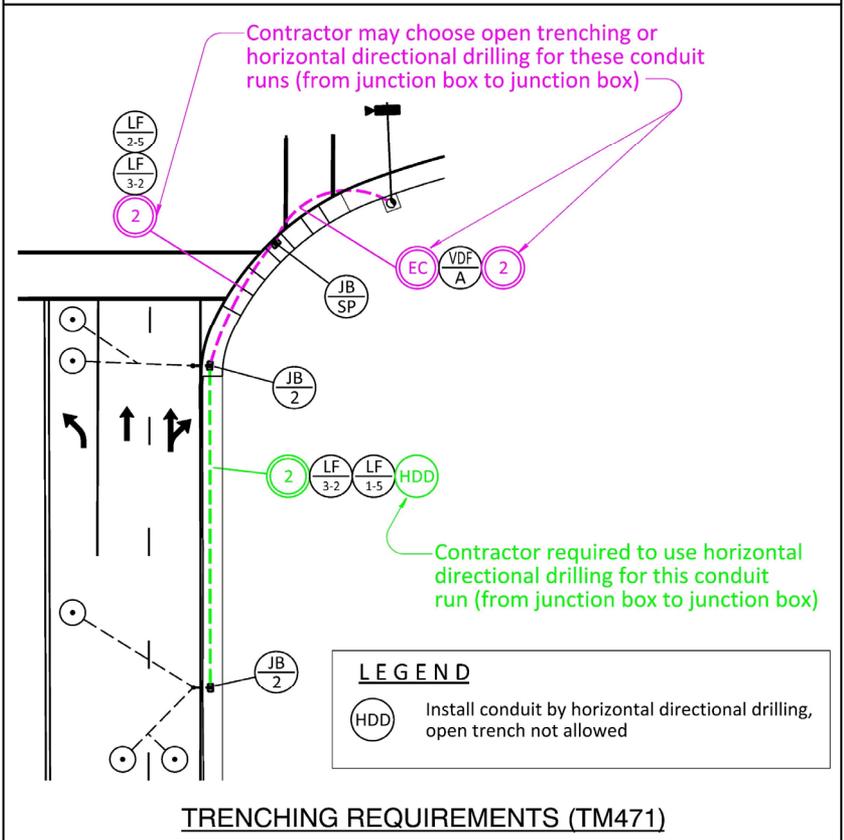
Plan Sheets: YES (for HDD requirements only)

Blue Sheet/Green Sheet Info: NO





CONDUIT ROUTING (TM471)



TRENCHING REQUIREMENTS (TM471)

Conduit Installation

Key Enforceable Items

The contractor has the option to use a larger size conduit than specified at no extra cost to Agency.	TM471
Conduit material requirements: <ul style="list-style-type: none"> • Conduit elbows must be FIBERGLASS • Conduit risers in junction boxes must be PVC • Conduit in foundations must be FIBERGLASS • Conduit installed underground may be any rigid non-metallic material (PVC, HDPE or Fiberglass) 	TM471
Conduit for future use shall be installed with a pull line and sealed (with a conduit plug).	TM471
Conduit installed under railroads requires a sleeve.	00960.42(e)
Conduit installed on structures requires expansion fittings at all structure expansion joints.	00962.42(f)
Must be installed by Licensed Electrician.	Oregon Law: Page 103
Conduit must be same size outlet-to-outlet (no reducers).	TM471

Tips and Tricks

Rigid metallic conduit installed underground is no longer used for new construction. However, small amounts of rigid metallic conduit are still used, such as hanging vehicle signals & signs on a span wire per TM463.
Contractor can choose to use any approved non-metallic conduit unless otherwise shown or specified. Most commonly used material is PVC.
If conduit is installed by horizontal directional drilling, HDPE material is common (eliminates joints in the conduit run).
Duct tape can be temporarily installed on the ends of conduit to keep debris out during the installation (before the wires are pulled).

Inspector Action

Coordinate a Supplemental Inspection by Agency Electricians (Required).	TM471 & Page 98
Verify size, material, and number of conduits in each trench. See illustration on next page.	Plan Sheets & TM471

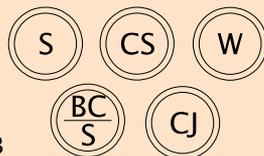
Typical Sources of Info:

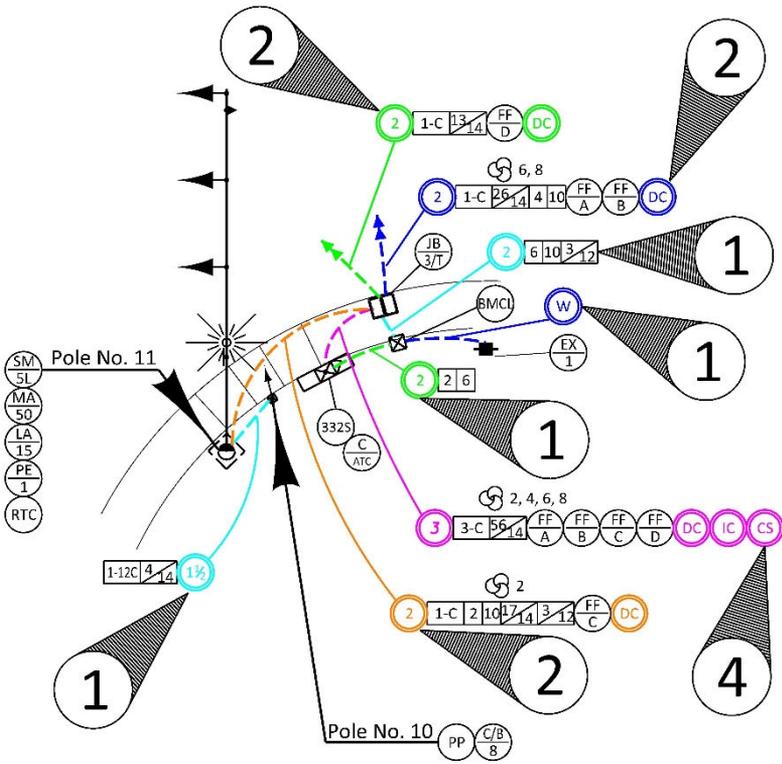
Specs: 00960.42

Std. Dwg: TM471

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 18, 19, 20, 22, & 23





LEGEND

- | | | | |
|------|--|------|---|
| (S) | Install (S=size) inch conduit | (W) | Install conduit and wire as required by power company |
| (DC) | Detector conduit (See Detector Plan) | (CS) | Install 2" conduit stub (For future use, cap ends) |
| (IC) | Interconnect conduit (See Interconnect Plan) | (N) | (N=number) conduits installed in trench |

NUMBER OF CONDUITS IN EACH TRENCH (PLAN SHEETS)

Trench Backfill

Key Enforceable Items

See illustration on next page	Sand Blanket	Non-metallic conduit installed in “Unsurfaced Areas” require a sand blanket.	TM471
		Non-metallic conduit installed under “Existing Paved Areas” do NOT require a sand blanket.	TM471
	Backfill Material	Trenches located under “Unsurfaced Areas” require selected granular backfill material in compacted in 6” layers.	TM471
		Trenches located under “Existing Paved Areas” require CLSM backfill.	TM471
	Plug all conduit ends during backfill operation, to keep debris from entering conduit. Keep plugged until wire is pulled.		TM471
	Place underground marking tape in all trenches NOT using CLSM for backfill.		TM471

Tips and Tricks

Contractor should be cautioned "Do not backfill until inspected".
Conduit can 'float up' when using CLSM backfill.
CLSM = Controlled Low Strength Material (See 00442)
Metallic conduit is no longer an option for underground conduit on traffic signal installations – must use rigid non-metallic conduit only as shown in TM471.

Inspector Action

Determine if a sand blanket is required (based on the location of the conduit trench). <i>See illustration on next page.</i>	TM471 & Plan Sheets
Determine the backfill material requirements (based on the location of conduit trench). <i>See illustration on next page.</i>	TM471 & Plan Sheets
Verify underground warning tape is installed for conduit installed in “Unsurfaced Areas”.	TM471
Coordinate a Supplemental Inspection by Agency Electrician (Required).	TM471 & Page 98

Typical Sources of Info:

Specs: 00442 (For CLSM requirements), 00960.10 (Backfill material)

Std. Dwg: TM471

Plan Sheets: NO

Blue Sheet/Green Sheet Info: NO

Junction Box Location

Key Enforceable Items

Junction box locations shown on plans are approximate; changes can be made to better fit site.	TM472
Junction boxes are to be no more than 300' apart; intermediate boxes may not be shown on plans, but 300' is the maximum, unless specified differently.	TM472
Apron type junction boxes must be installed in gravel shoulders where incidental traffic may occur. See illustration on next page.	TM472 & Plan Sheets

Tips and Tricks

Only cast iron is allowed in traffic areas. As such, cast iron boxes are rare. It is desirable to place junction boxes outside of the roadway surface for easier maintenance access. If used on a project, details for installation will be shown in the plan sheets (not a standard drawing).
Junction boxes in sidewalks may be subject to incidental traffic.

Inspector Action

Compare signal plans to roadway plans (or existing facilities) for conflicts.	Plan Sheets
Verify location of curb radius, concrete walk, crosswalks and curb ramps.	Plan Sheets
Verify edge of pavement and pedestrian landings in non-curbed sections.	Plan Sheets
Verify approximate location of detector loops.	Plan Sheets
Verify junction box type and material.	Plan Sheets
Verify junction boxes are NOT installed in the slope of ramps or driveways. See illustration on next page.	TM472

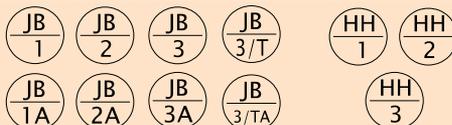
Typical Sources of Info:

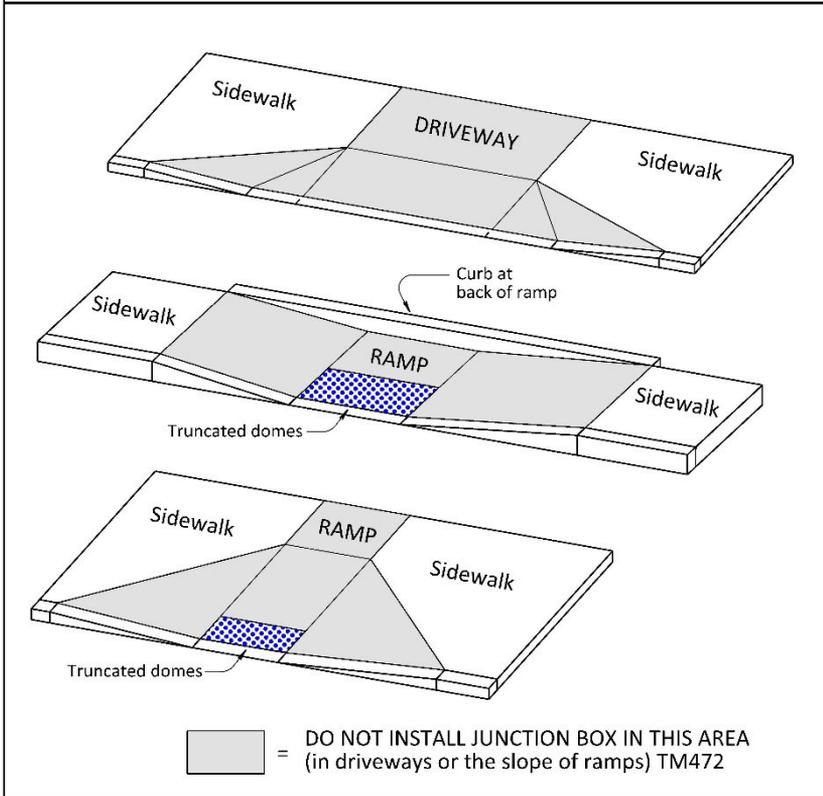
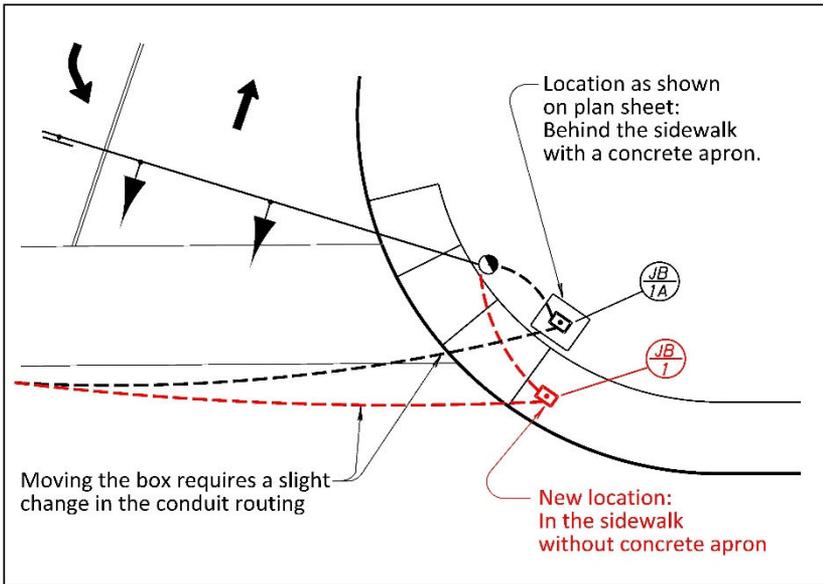
Specs: NO

Std. Dwg: TM472

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 25 & 26





Junction Box Installation

Key Enforceable Items

Conduit must enter box from underneath (exception: hand holes) and be near the end walls.	TM472
Do not install in traffic areas.	TM472
Locate box 12" from back of curb and 12" from back of sidewalk.	TM472
Do not install in gravel shoulders without apron.	TM472
Lids are held down with two stainless steel or brass hex head bolts.	TM472
Top of box shall be flush with surrounding grade or top of curb.	TM472
Tandem junction boxes are installed 4" apart.	TM472
Mark boxes with a type 1 delineator in unsurfaced areas.	TM472 & TM570
Lid shall be marked with appropriate label ("Signals", "Street Lighting", etc.).	TM472
Must be fitted with a recessed lid rated for incidental traffic.	Blue Sheets
Do not install in slopes of ramps or in driveways.	TM472

Tips and Tricks

Place box on bedding, backfill sides with well compacted material
Be sure junction box is not resting on conduits

Inspector Action

Verify finish grade for top of junction box.	Plan Sheets & Survey Info
Verify junction box size.	Plan sheets
Verify excavation for box is deep enough; box depth varies from 12" to 36" with an additional 12" (min.) depth needed for the ¾" – 0" gravel bedding.	TM472
Verify number, size and location of PVC conduit risers in box. <i>See illustration on next page.</i>	TM472

Typical Sources of Info:

Specs: NO

Std. Dwg: TM472

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 25 & 26

JB
1

JB
2

JB
3

JB
3/T

HH
1

HH
2

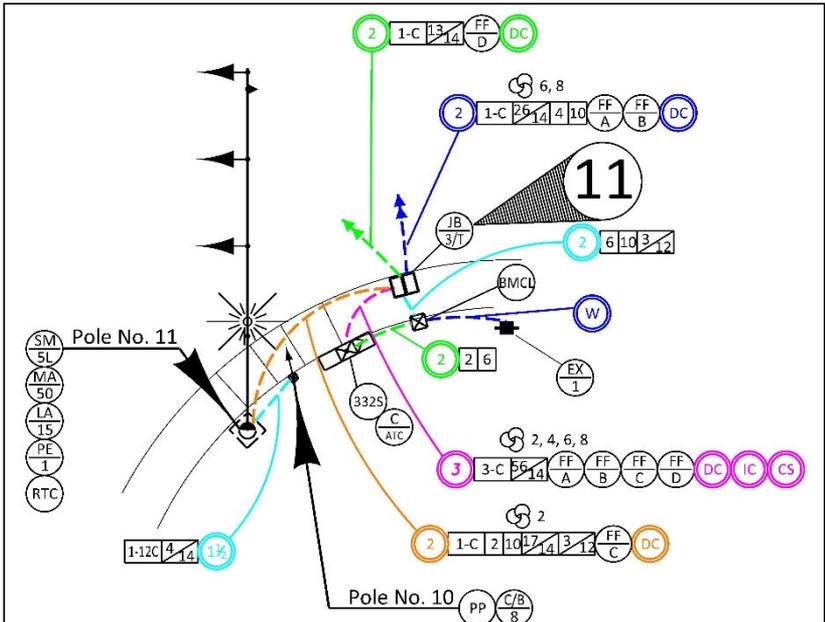
JB
1A

JB
2A

JB
3A

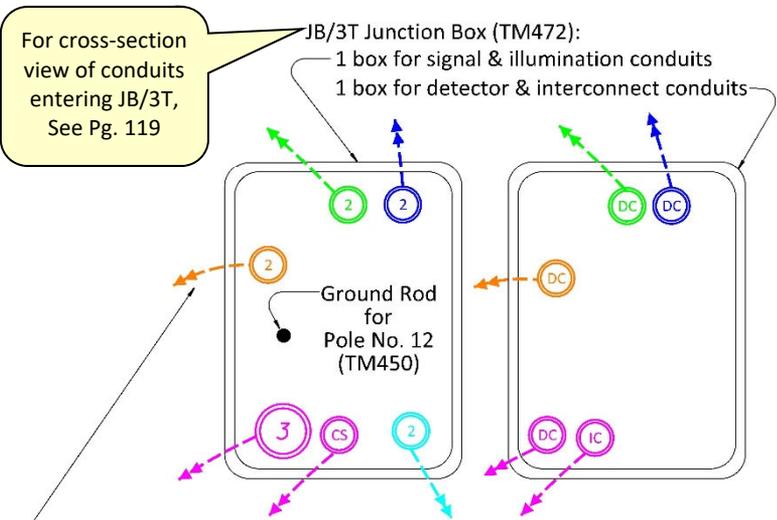
JB
3/TA

HH
3



LEGEND

N (N=number) conduits installed in junction box



Note: Conduits located within box near the appropriate edge so that direction of run can be easily determined (TM471)

EQUIPMENT INSIDE A JUNCTION BOX

Construction

Pedestal Installation

Key Enforceable Items

Vehicle pedestals use leveling nuts/washers and grout pad. Pedestrian pedestals/posts do not.	TM457
Concrete foundation requires 7 days of cure AND must reach design strength (3000 psi) before it can be loaded. Break concrete test cylinders to verify.	00960.43 to Table 00540-1, & 00440

Tips and Tricks

The entire assembly (pedestal base with compatible 4" diameter pipe, and metallic cap) is included in the blue sheet item for Pedestals.
Pedestals are designed to break-away if struck by a vehicle.
Reinstall handhole cover until wiring can be completed (to keep debris out).
The gasket between the concrete foundation and the cabinet is critical to keep the metal from corroding.

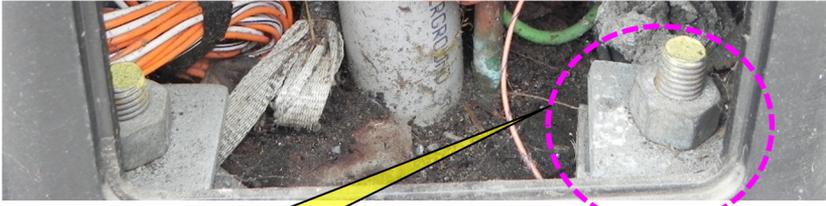
Inspector Action

Verify building paper gasket is installed between the concrete and the pedestal/post base.	TM457
Verify four 2" square washers are used at the top connection. <i>See illustration on next page.</i>	TM457
Verify pole cap is installed. <i>See illustration on next page.</i>	TM457

Typical Sources of Info:

Specs: 00960.43
 Std. Dwg: TM457
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 16 & 17



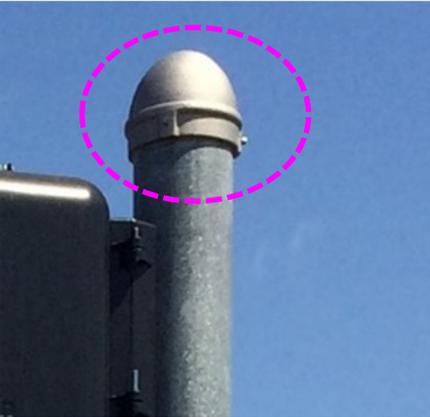


2" square washers

Small Round washers



Verify Correct Washers are Installed



Verify Pole Caps are Installed



Set screws too long

Mast Arm Pole Installation

Key Enforceable Items

Repair galvanizing damage from handling.	00962.46(j)(1)
Concrete foundation requires 7 days of cure AND must reach design strength (3000 psi) before it can be loaded. Break concrete test cylinders to verify.	00962.43, 00440, Table 00540-1, & TM651 Note #15
Lubricate anchor rods and nuts according to 02560.70.	00962.46(j)(2)
Install leveling nut & washer on anchor rods.	TM652 & 00962.46(j)(2)(a)
Install top washer & nut, rake pole to counteract load using leveling nuts.	00962.46(j)(2)(a)
Install final 4 inch concrete closure pour with ¾" pole drain (weep hole).	TM653
Tighten anchor rods and perform final tightening.	00962.46(j)
Poles and arms can be round or octagonal but two types shall not be mixed on project.	TM651, Note #5

Tips and Tricks

Reinstall handhole cover until wiring can be completed (to keep debris out).
NOTE: SM6L and SM7L mast arm poles have unique requirements - See TM655 thru TM658 and project plans for more info.

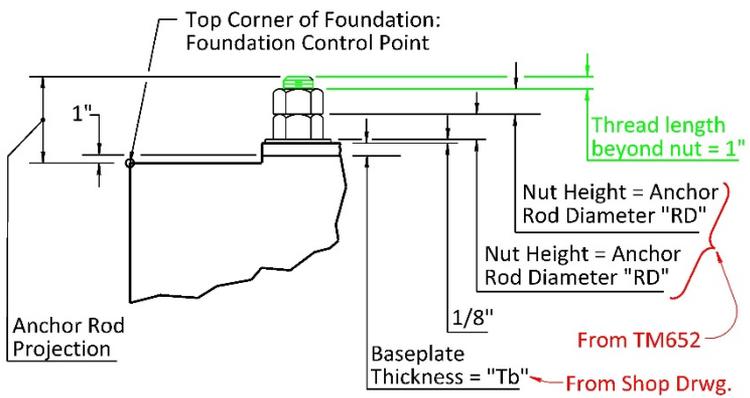
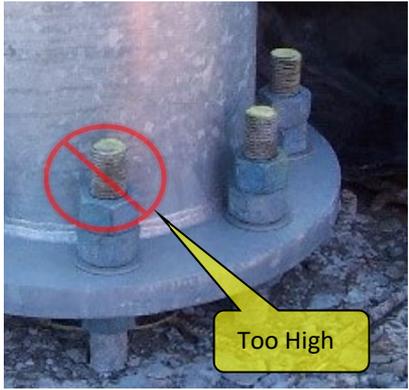
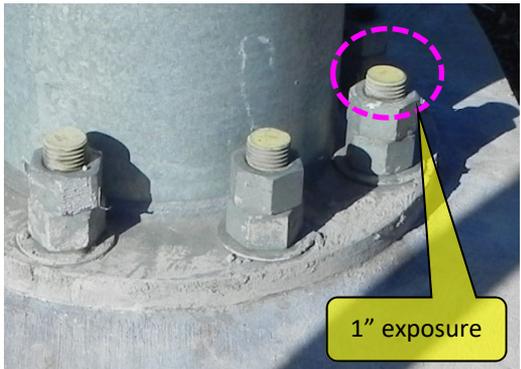
Inspector Action

Verify the pole tag is installed on pole.	00962.46(i)
Check pole for deviation from straightness.	00962.46(f)
Inspect factory welding (conduit hub).	TM652 & 00962.46(g)
Check for wire hanger hook ("J" hook) and grounding lug.	TM450, TM452, TM657 & 00962.50(a)
Check mast arm connection plate flatness.	00962.46(k)
Verify the anchor rod thread projection is 1" above the top nut. See illustration on next page.	TM653

Typical Sources of Info:

Specs: 00962.46(j)
 Std. Dwg: TM650 thru TM653
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: NO





Example:
 Anchor Rod Projection for SM5L Pole = $1" + 1\frac{3}{4}" + \frac{1}{8}" + 2" + 2" + 1" = 7\frac{7}{8}"$

ANCHOR ROD PROJECTION (TM653)

Mast Arm Connection

Key Enforceable Items

Rotational capacity tests for high strength fasteners (bolts used to connect the mast arm to the pole) is required to be performed by the manufacturer (not in the field). Provide 3 bolt assemblies per size per lot for check testing.	00962.10 to 02560.20 to 02560.60
4-bolt arm connections: Tighten bolts to a snug tight condition.	00962.46(j)(2)(c)
8-bolt arm connections: Tighten bolts using Direct Tension Indicator (DTI) washers. See illustration on next page. Note: for SM6L & SM7L poles: TM657 to TM656 note #24 to 00930.40(d)	TM652 to TM651 Note #22 to 00930.40(d)
Field rotational capacity testing is NOT required. All bolt inspections will be visual and no testing will be conducted.	00962.46(j)(3)

Tips and Tricks

Make sure mast arm won't block any active (temporary) signal indications. If the indications are blocked, the mast arm will need to be removed and reinstalled on the day of the signal turn-on. Plans sheets may also indicate that the mast arm must be installed on day of turn-on.

Inspector Action

Review DTI video and Spec Notes (March 2016) * *Website links provided on Pg. 208	Internal Procedure
Check pipe sleeve at mast arm mount for proper rounding.	TM652 or TM657
Determine the number of bolts required for each mast arm connection. Signal mast arm lengths of 15' to 35' require 4 bolts. Signal mast arm lengths of 40' to 75' require 8 bolts.	TM652 or TM657
Verify the mast arm connection bolt diameter, bolt circle, and bolt spacing requirements are met for each mast arm as per the table.	TM652 or TM657
Check for mast arm plate straightness and mast arm mounting plate fit/bolting (warped plates or bolts not seating).	00962.46(k)
Check the orientation of the DTI and check the gap on the DTI with a feeler gauge to verify the 0.005 inch feeler gauge is refused by ALL openings between profusions. Request feeler gauge from contractor (it is supplied with the DTIs) or from ODOT construction section. See illustration on next page.	00962.46(j)(2)(c) to 00930.40(d)(2)(a), and 00930.40(e)(2)

Typical Sources of Info:

Specs: 00962.46(j) & 02560

Std. Dwg: TM650 thru TM652, TM656 & TM657

Plan Sheets: YES

Blue Sheet/Green Sheet Info: NO



Check for proper rounding at inside of Pipe Sleeve to avoid damage to Control Cables (TM652)

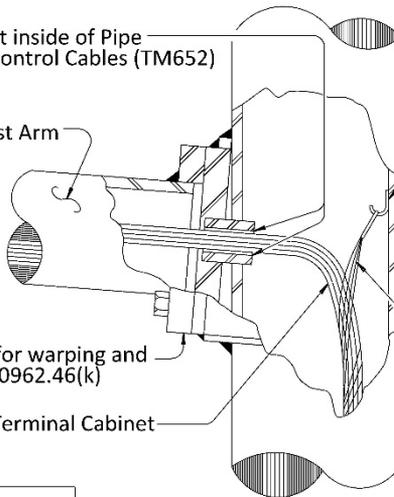
Mast Arm

"J" Hook

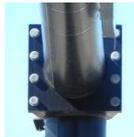
Check mounting plates for warping and mounting bolt seating 00962.46(k)

Strain Relief

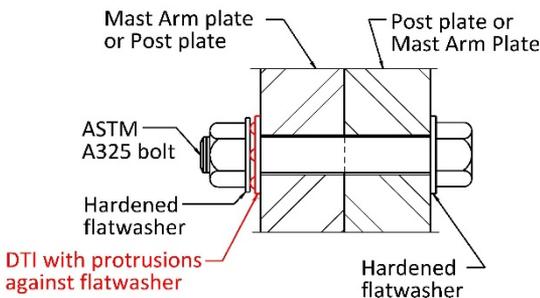
Control Cables from Terminal Cabinet



	Mast Arm Length (TM652)	Mast Arm Pole Type	
4 BOLT ARM CONNECTIONS	15'	SM1	NO DTI
		SM1L	
	20' or 25'	SM2	
		SM2L	
30' or 35'	SM3	DTI REQUIRED	
	SM3L		
8 BOLT ARM CONNECTIONS	40' or 45'	SM4	DTI REQUIRED
		SM4L	
	50' or 55'	SM5	
		SM5L	
	60' or 65'	SM6L	
70' or 75'	SM7L		



MAST ARM CONNECTION (TM450 & 652)



8-BOLT ARM CONNECTION DTI DETAIL (TM652)

Terminal Cabinet

Key Enforceable Items (Externally Mounted)

Terminal cabinets should have watertight compression fittings in bottom for control cable entrance. <i>See illustration on next page.</i>	TM488
Label all terminals with mechanically printed labels.	TM488
Required number of terminal blocks varies, but should be distributed equally amongst the three lines.	TM488
3 spare terminal blocks required in all terminal cabinets.	TM488
For span wire installations, do not bring bond wire into terminal cabinet. Bond messenger cable to pole.	TM452

Tips and Tricks

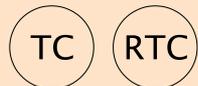
Terminal cabinets are mounted on poles. They are used as a splice point for the wiring from the signal controller cabinet and the wiring to the signal indications.
Most arm poles will specify <i>recessed</i> terminal cabinets. See plan sheets. Recessed terminal cabinets are contained within the pole on the pole shop drawing (they are not a blue sheet item).
Temporary wood poles will specify terminal cabinets (mounted externally on pole). <i>See illustration on next page.</i>

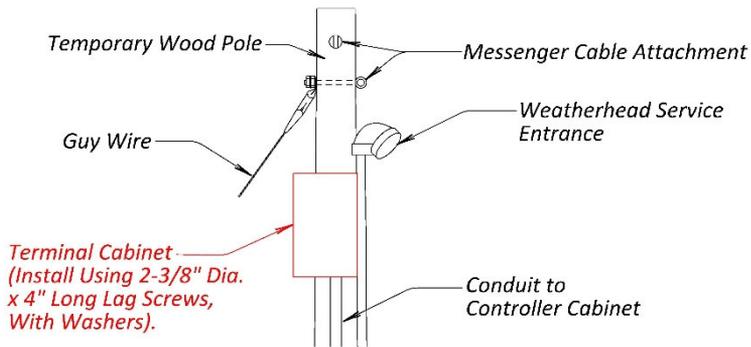
Inspector Action

Verify type of terminal cabinet: externally mounted (Blue sheet item) or recessed (part of pole submittal).	Plan Sheets
Externally mounted: verify 3 lines of mounting brackets for single sectional terminal blocks (quantity & size as needed).	TM488
Recessed: verify recessed terminal cabinet is installed at the proper orientation and meets pole submittal requirements.	Plan Sheets (Pole Entrance Chart)

Typical Sources of Info:

Specs: NO
 Std. Dwgs: TM488
 Plan Sheets: YES
 Blue Sheet/Green Sheet: Pg. 62





TERMINAL CABINETS FOR TEMP WOOD POLES
(TM455)



Compression fittings on bottom only (not on the side of the terminal cabinet)

Messenger Cable

Key Enforceable Items

Take up slack to minimum sag. Minimum sag is 5% of length of span (0.05 x length of span).	TM452
Only one messenger cable may be attached to an eye bolt. Multiple messenger cables attached to a single eyebolt is NOT allowed.	TM452
Multiple messenger cables attached to the same pole are 6 inches apart.	TM452
Messenger cable does not use "S" Hooks or turnbuckles.	TM452
Bond messenger cable to pole.	TM452

Tips and Tricks

Messenger cable is used to suspend equipment over the roadway in a span wire installation.
Eyebolts are designed to be in tension, not sheer; the force of the messenger cable should be in-line with the messenger cable. See illustration on next page.
Don't overlook workmanship details such as trimming off excess cable sticking out of the strandwise. See illustration on next page.

Inspector Action

Verify the messenger cable meets sag requirement of 5%.	TM452
Verify the messenger cable connection is properly installed.	TM452

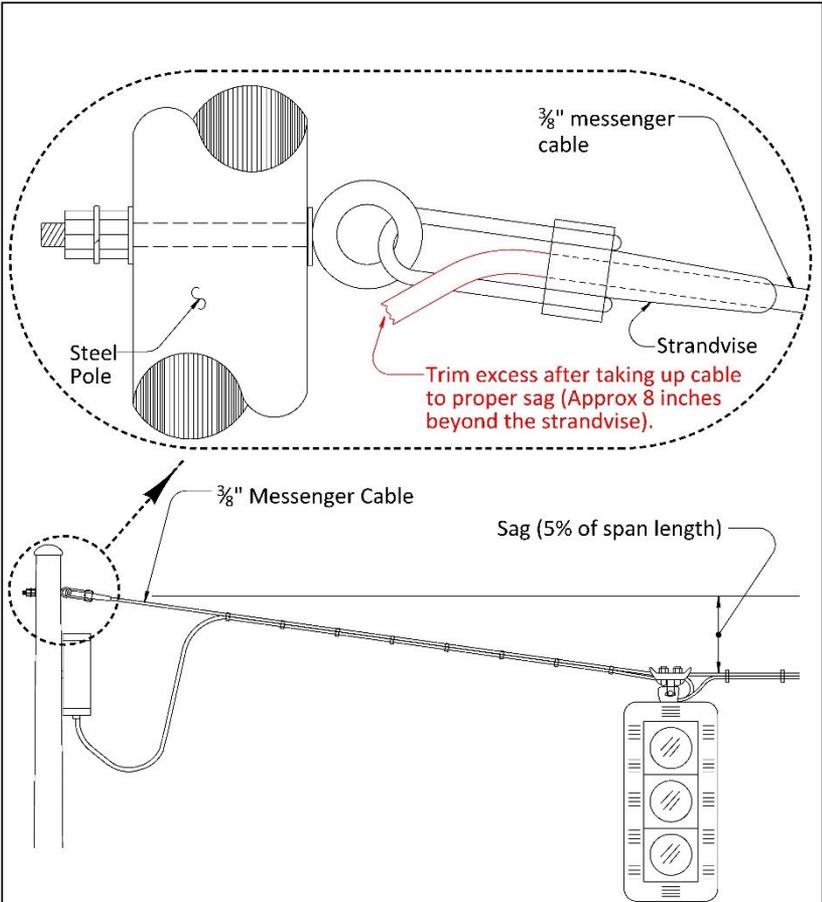
Typical Sources of Info:

Specs: NO
 Std. Dwg: TM452
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 29, 30, & 32

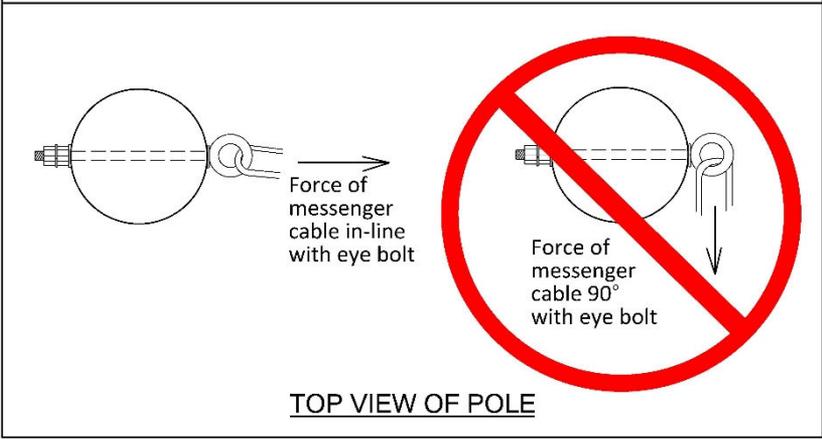
38

39

42



MESSENGER CABLE CONNECTION (TM452)



TOP VIEW OF POLE

Tether, Stabilizer Cable, and Tether Clamp

Key Enforceable Items

"S" hooks are State furnished by TSSU call 503-378-2956.	TM452
Close "S" hook on eyebolt side (pole side only).	TM452
Tether and stabilizer cable requires the use of "S" hooks and turnbuckles on both ends.	TM452

Tips and Tricks

Tether and stabilizer cable are used to prevent movement of equipment suspended from messenger cable.
The tether cable is inserted into the strandwise. The turnbuckle takes up the tension.
Stabilizer cable is typically only used in high wind areas. Stabilizer system will be shown in the signal plan sheets (not standard drawings).
Only one tether cable attached to an eye bolt. Multiple tether cables attached to a single eye bolt is not allowed. However, the stabilizer cable (if used) is typically attached to the same eyebolt as the tether cable.
See TM463 for tether clamp details (cable is installed below lock bolts and is wrapped in sheet lead).
Do not use high strength or larger cable. May not break when snagged.

Inspector Action

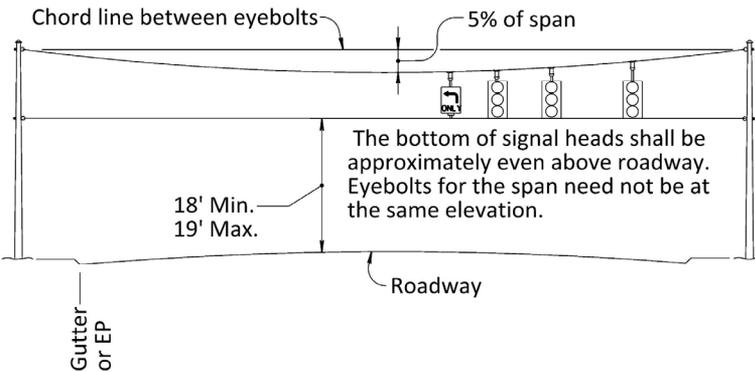
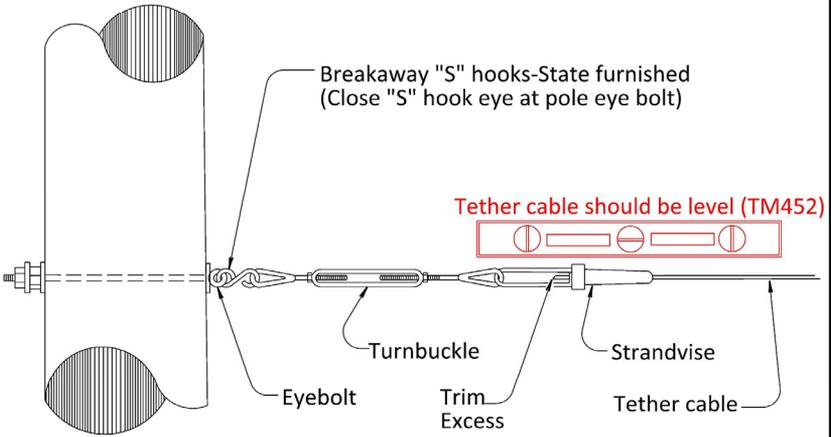
Verify the tether cable is 18 feet minimum to 19 feet maximum above the roadway. <i>See illustration on next page.</i>	TM452
Verify the "S" hook is closed on the eyebolt side only. <i>See illustration on next page.</i>	TM452
Verify "S" hooks and turnbuckles are used on both ends of the tether cable. <i>See illustration on next page.</i>	TM452
Verify the tether cable is level. <i>See illustration on next page.</i>	TM452

Typical Sources of Info:

Specs: NO
 Std. Dwg: TM452 & TM463
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 31, 32, & 34

38

41



TETHER CABLE CONNECTION (TM452)

Spanwire Hanger

Key Enforceable Items

Install hardware with anti-seize compound.	TM463
Extension shall be 1 ½ inch galvanized rigid conduit drilled and tapped to accept set-screw on hanger.	TM463
Mount signal head to tri-stud using lock-nuts (or lock washers and hex nuts), form control cable into drip loop, thread through hanger into signal head.	TM463
All set-screws go through wall of conduit. With conduit extending 5/8" beyond set screw.	TM463
Span wire hangers use 'U' bolts for attachment, not 'J' or 'L' bolts.	TM463
Always seal tri-stud adapters with silicon seal.	TM463

Tips and Tricks

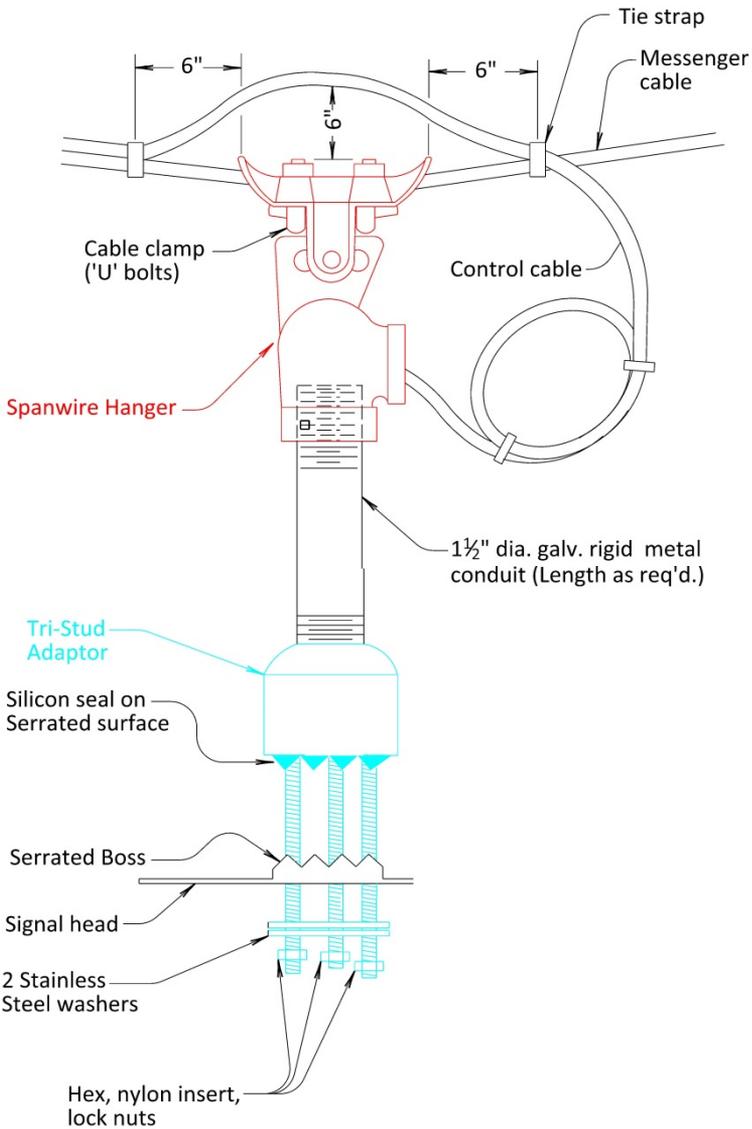
Spanwire hangers are used to suspend equipment from messenger cables. This includes the Type "A" mount for the Sign Bracket (see TM465). They also provide a cable entrance into the equipment.
Adjust length of conduit between spanwire hanger and tri-stud adaptor to achieve proper mounting height. See illustration on next page.
Bind control cable into a drip loop that is lower than the throat of the hanger.
Control cable must be arched over the span wire hangers to avoid damage.

Inspector Action

Check spacing of equipment mounted on mast arm.	Plan Sheets (Pole Entrance Chart)
Verify correct vertical clearance between the pavement and the bottom of the equipment on the span wire is met: 18 feet minimum to 19 feet maximum.	TM452

Typical Sources of Info:

Specs: NO
 Std. Dwg: TM463 & TM465
 Plan Sheets: NO
 Blue Sheet/Green Sheet Info: Pgs. 33, 35, & 65



MESSENGER CABLE ATTACHMENT & TRI-STUD ADAPTER (TM463)

Service Cabinet & Commercial Power Hook-up

Key Enforceable Items

Contractor obtains the required permits and arranges for utility to inspect the service cabinet and make the electrical hookup.	00960.03 & 00960.70
Install service cabinet and associated equipment early on to allow the utility ample time to schedule their work.	00960.70
Conduit and wiring between the commercial power source and service cabinet are specified in the electrical permit. See illustration on next page.	TM485, Plan Sheets, & Permit

Tips and Tricks

Wire from the service cabinet to the controller cabinet is installed in a separate conduit. Wire typically consists of 2 No. 6 AWG XHHW wires and a bond wire.
Do not route illumination circuit wiring through controller cabinet.
The meter base is inclusive to the service cabinet in permanent installations. A stand-alone meter base and stand-alone service cabinet mounted to a wood pole are used only for temporary signals.
The gasket between the concrete foundation and the cabinet is critical to keep the cabinet from corroding.
Utility companies should be notified at least two weeks in advance of the time power is needed at the site to allow them time to make adjustments or install equipment and wiring as necessary.
Utility will not provide power (energize) until AFTER the Electrical Permitting Agency has approved the service cabinet installation. The service cabinet must be energized prior to the field testing inspection by Agency Electricians.

Inspector Action

Verify location of power source and service cabinet.	Plan Sheets
Verify gasket between foundation and service cabinet is installed.	TM482
Verify there are 2 ground rods a minimum of 6' apart (one ground rod is located in the service cabinet foundation).	TM482 & Page 154
Coordinate a Supplemental Inspection by Permitting Electrical Agency (required) after the service is installed.	00960.70, Oregon Law & Page 98

Typical Sources of Info:

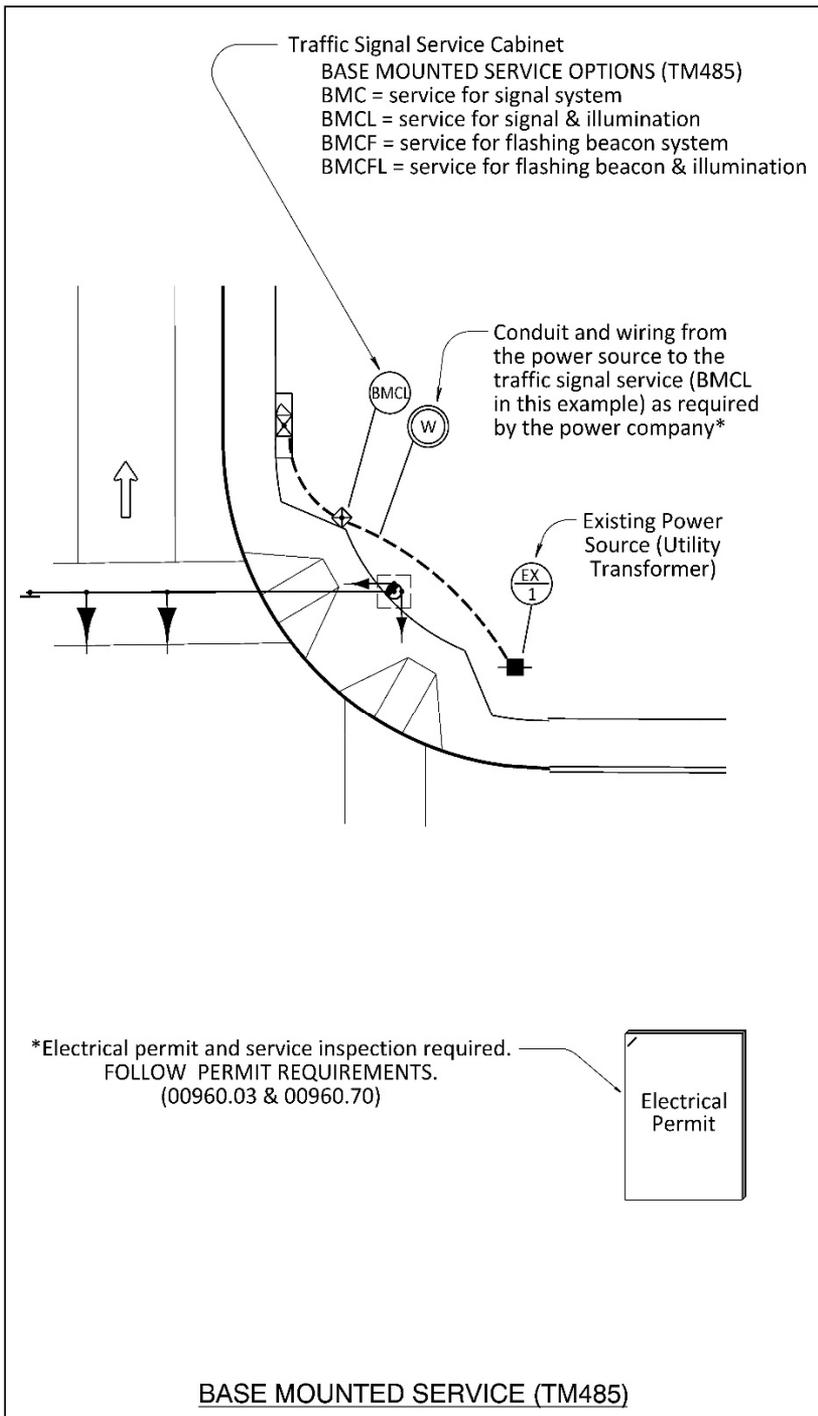
Specs: 00960.03, 00960.50, & 00960.70

Std. Dwg: TM482 & TM485

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 11, 12, & 61





Bonding & Grounding

Key Enforceable Items

Drive ground rods, attach appropriate size grounding electrode conductor and grounding lug.	00960.50
Ground rods for permanent structures must be installed in a junction box or a foundation as shown. The ground rod for temporary wood poles may be buried and is the only exception.	TM450, TM452, TM455, TM457, & TM482
All ground and bond wires must be stranded conductors.	00960.50(b)

Tips and Tricks

Bonding and Grounding can get rather complicated so this is one area where requesting assistance from Agency Electricians is STRONGLY suggested.
Bonding and grounding is typically necessary for all conduits with AC conductors and for all signal poles, pedestals, controller cabinet and service cabinet.
Bonding to the JB is not required in a non-metallic junction box with non-metallic lid.
Two ground rods are required at the service cabinet as per TM485 to eliminate the need to test resistance to ground. This requirement is more stringent than NEC code.
DC circuits are used for pedestrian push buttons, loop detection systems, and fire preemption systems. AC circuits are used for signal and pedestrian indications.

Inspector Action

Verify the ground rod is in the correct location for all poles, pedestals, controller cabinet, and service cabinet. See illustration on next page.	TM450, TM452, TM455, TM457, & TM482
Verify the ground rod extends above foundation or bottom of the junction box 2 to 3 inches to allow for properly attaching the clamp and wire.	00960.50(c)
Coordinate a supplemental inspection by Agency Electricians (recommended).	Page 98

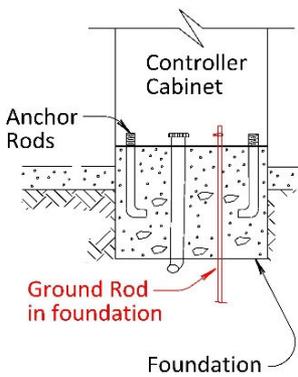
Typical Sources of Info:

Specs: 00960.50

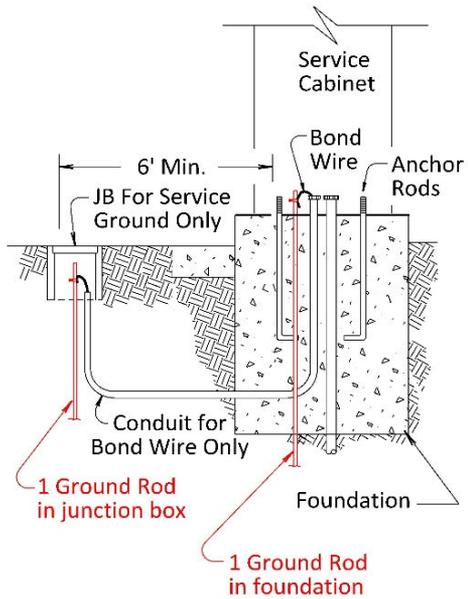
Std. Dwg: TM450, TM452, TM455, TM457, TM482, & TM485

Plan Sheets: NO

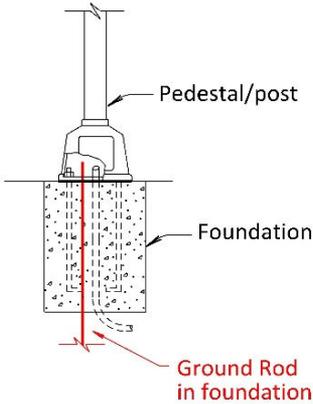
Blue Sheet/Green Sheet Info: Pgs. 36 & 37



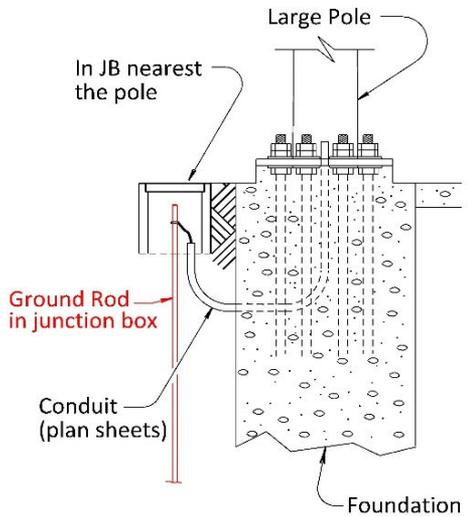
**CONTROLLER
CABINET (TM482)**



**BASE MOUNTED
SERVICE CABINET (TM482)**



PEDESTAL/POST (TM457)



POLE (TM450 & 452)

GROUND ROD LOCATIONS

Pulling Wires & Cables

Key Enforceable Items

Always pull wires and cables by hand in a straight line with the conduit opening, using a pulley device if necessary to achieve a straight line. <i>See illustration on next page.</i>	TM470		
Use approved lubricant to reduce pulling strain and prevent insulation damage.	TM470		
Wires and cables shall be continuous (No splicing) from terminal block to terminal block (Splicing loop wire to feeder cable in the junction box is the only exception). <i>See Page 180 for video/radar wiring and Page 182 for fire preemption wiring. See illustration on next page.</i>	TM470		
Do not tie or tape conductors or cables together inside conduit.	TM470		
<table border="0"> <tr> <td style="vertical-align: top;"> <p>2 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • Junction boxes (except first JB nearest controller cabinet) • Poles </td> <td style="vertical-align: top;"> <p>6 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • First junction box nearest the controller cabinet • Controller Cabinet • Service Cabinet </td> </tr> </table>	<p>2 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • Junction boxes (except first JB nearest controller cabinet) • Poles 	<p>6 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • First junction box nearest the controller cabinet • Controller Cabinet • Service Cabinet 	TM470
<p>2 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • Junction boxes (except first JB nearest controller cabinet) • Poles 	<p>6 feet of slack wire/cable in:</p> <ul style="list-style-type: none"> • First junction box nearest the controller cabinet • Controller Cabinet • Service Cabinet 		

Tips and Tricks

Typically requires one person pulling wire and one person feeding wire in the conduit.
Do not use any mechanical means to apply or multiply pulling force.

Inspector Action

Verify that all conduit bushings are installed before pulling wires. <i>See illustration on next page.</i>	TM471
Verify that bond wire (if required) is included in conduits.	00960.50
Verify that all wiring used meets the color code requirements.	TM470
Verify tracer wire is included in conduits.	TM470
Verify conduit is clean before pulling wires by witnessing the contractor use a mandrel and compressed air (existing conduit and new conduit).	00960.42(a) and (b)
Inspect pulled ends of conductors for insulation damage.	Workmanship
Verify conduit plug is installed in conduit after wires are pulled.	TM471
Verify pull line is installed in conduits shown for future use.	TM470 & Plan Sheets

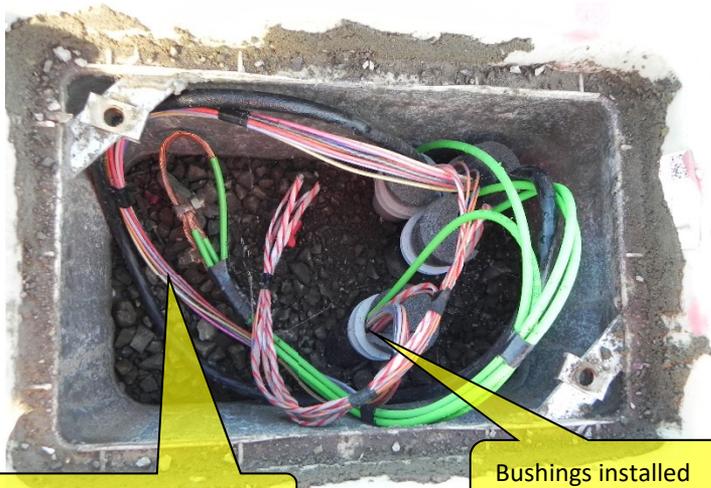
Typical Sources of Info:

Specs: NO

Std. Dwg: TM470

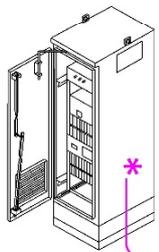
Plan Sheets: NO

Blue Sheet/Green Sheet Info: Pgs. 19, 20, 23, 36, 38, 39, 40, 41, & 54



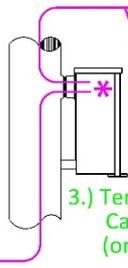
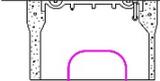
Slack wire in junction box

Bushings installed before wire is pulled



1.) Controller cabinet

2.) Junction Box**



3.) Terminal Cabinet (on pole)



4.) Signal Equipment

Continuous wire in conduit (no splice from controller cabinet to terminal cabinet on pole)

Continuous wire in mast arm or on span wire (no splice from terminal cabinet to signal equipment)

- * Wires land on terminal block
- **One Exception - loop wire to loop feeder cable is spliced in the junction box.



TRAFFIC SIGNAL WIRE SPLICING (TM470)

Wiring Poles, Mast Arms, and Spanwires

Key Enforceable Items

Use cable strain reliefs to support wiring at "J" hooks above mast arm connections.	TM450, TM652, & TM657
Wire mast arms with control cables (One 7 conductor wire cable per vehicle head).	TM470
Spanwire control cables exit bottom of terminal cabinet (using watertight compression fittings) and are attached to messenger cable with cable ties every 6 inches.	TM452
Tape off ends of extra (spare, unused) conductors.	TM470
No splices are allowed outside of the terminal cabinets (except for loop wire to loop feeder cable in the junction box).	TM470
Leave 2 feet of slack wire in the pole base.	TM470
Install 3 spare conductors as shown.	Plan Sheets
Do not terminate Fire Preemption or Illumination wiring in terminal cabinet.	TM465 & 00970.42

Tips and Tricks

Wiring poles consists of single conductors or control cable brought into pole terminal cabinets via underground conduit. Wiring the mast arm or span wire consists of control cable from the terminal cabinet to the various pieces of equipment.

[See illustration on next page.](#)

Signal conductors are normally THWN No. 14 AWG.

Illumination conductors are normally XHHW No. 10 AWG.

Become familiar with the color code and wiring shown on plans.

The details for wiring traffic signals can be hard to remember if you don't work with it all the time, so this is one area where requesting assistance from Agency Electricians is **STRONGLY** suggested.

Inspector Action

Verify "J" hooks above mast arm connection on mast poles.	TM450, TM652, & TM657
Verify the number of cables attached to each messenger cable.	Plan Sheets
Verify the color code requirements are met.	TM470

Typical Sources of Info:

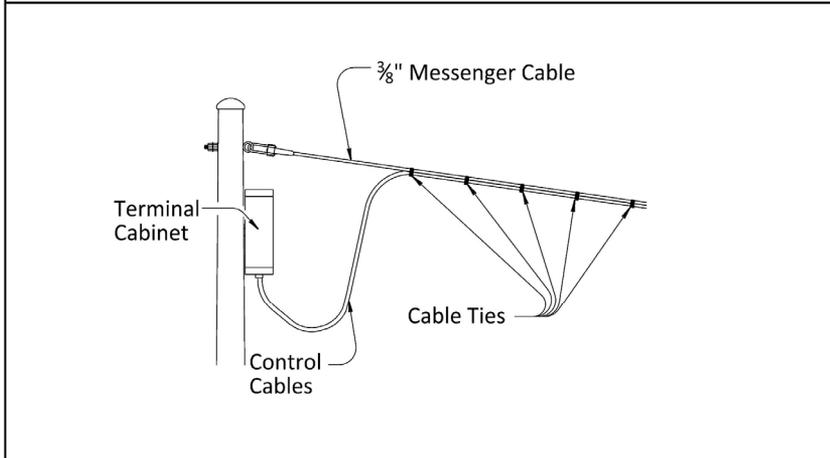
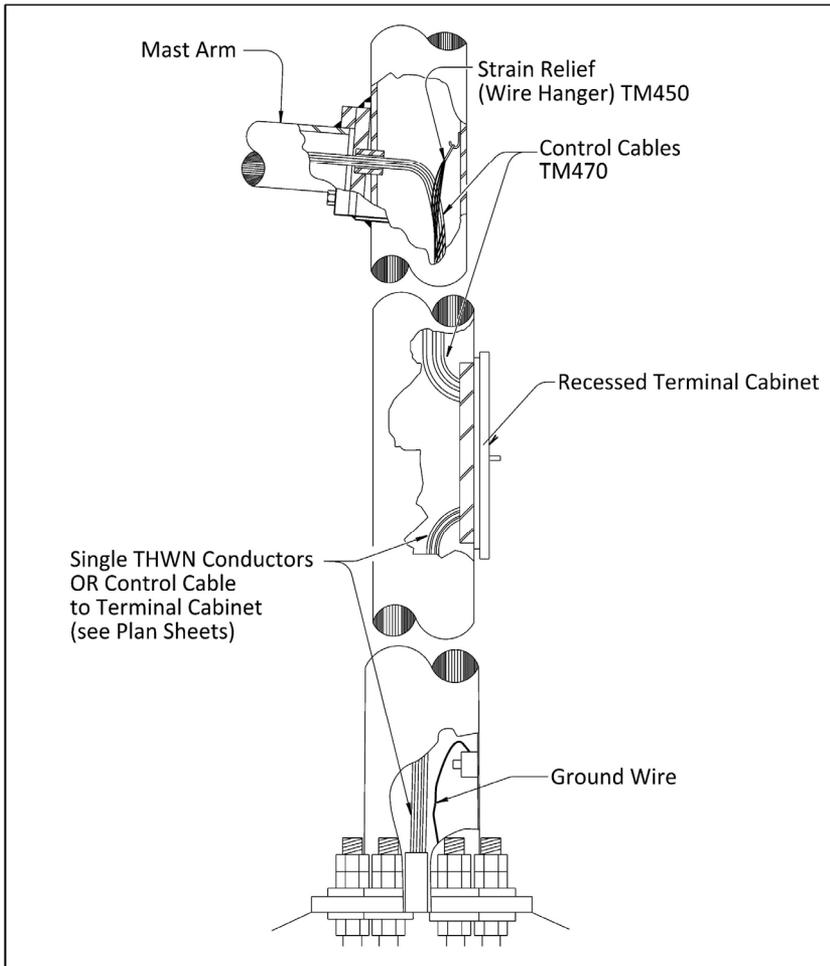
Specs: 00970.42

Std. Dwg: TM450, TM452, & TM470

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 36, 38, 41, 42, & 58





Pedestrian Signals

Key Enforceable Items

Housing, doors, and visors may be powder coated aluminum or polycarbonate.	Blue Sheets & Plan Sheets
Drill pole for clamshell mount (two ½ inch NF stainless steel allen head cap screws).	TM467

Tips and Tricks

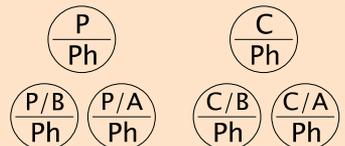
Hinged mounting brackets (clamshell mounts) are a two-piece, ready-to-use assembly into which the pedestrian signal is installed.
PLUMBING PIPE AND FITTINGS are not permitted.
Clamshells must be mounted with the hinge at the rear of the pedestrian signal housing but may need to be reversed to allow for the opening of the pedestrian signal.

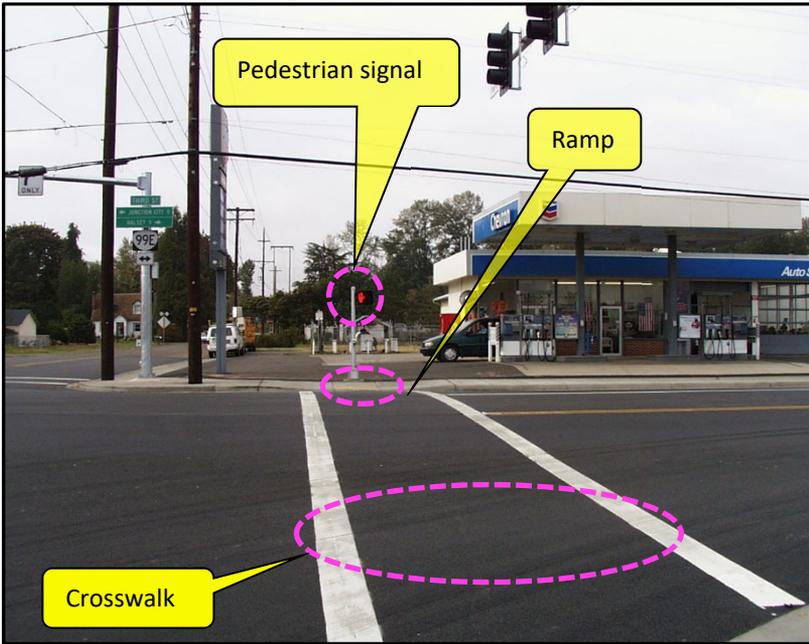
Inspector Action

Verify location of clamshell mount (pole has been drilled at proper location).	Plan Sheets (Pole Entrance Chart)
Verify angle of crosswalk before mounting head. In the field, check visibility and line-of-sight of pedestrian signal from far end of crosswalk, and adjust as necessary. <i>See illustration on next page.</i>	Plan Sheets
Verify that the pedestrian signal can be opened for maintenance.	TM467
Verify crosswalk and ramp placement with respect to the pedestrian signal. <i>See illustration on next page.</i>	Plan Sheets
Verify that signal head covers are installed over the pedestrian signals until the signal is turned-on.	00990.45
Verify the mounting height of the pedestrian signal is 7' to 7'6" above the paved surface near the pole (measured from the bottom of the pedestrian signal).	TM450, TM452, & TM457

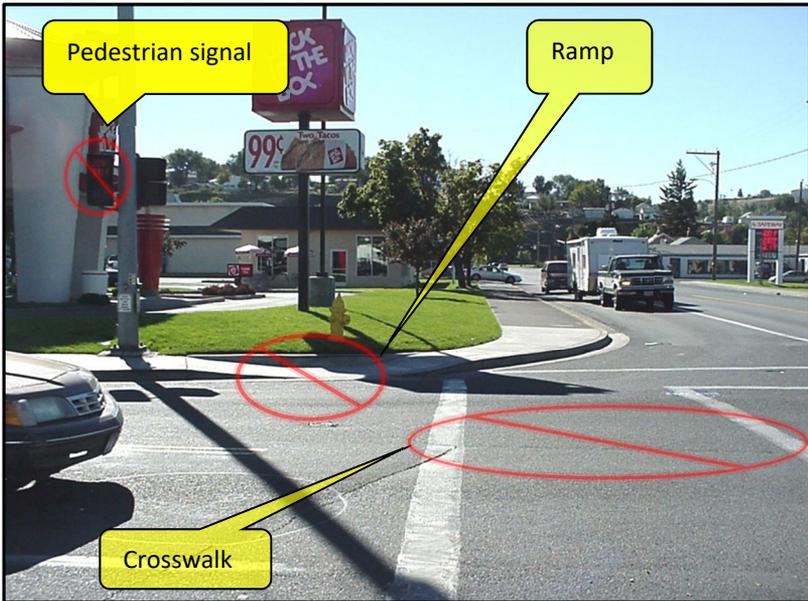
Typical Sources of Info:

Specs: 00990.45
 Std. Dwg: TM467
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 43, 44, & 45





Pedestrian signal, ramp access, & crosswalk should all line up, as shown in top picture. If you notice this is not the case, as shown in bottom picture, notify the EOR.



Pushbuttons: ADA Compliance Information

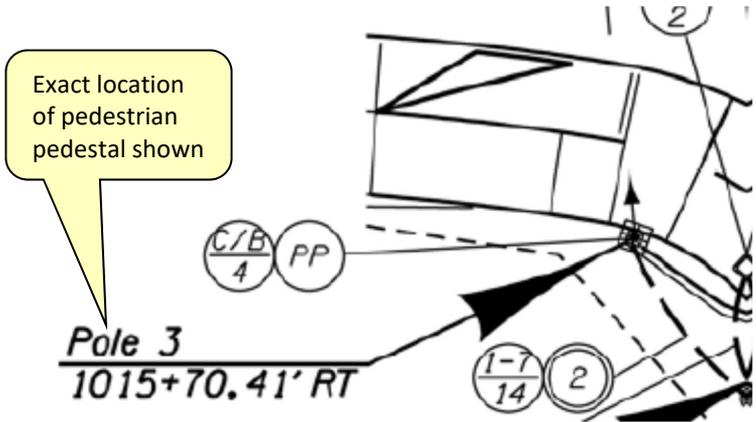
Tips and Tricks

Pedestals and poles with pushbuttons are precisely located by the EOR with station/offset/elevation in the roadway and signal plan sheets. This location should achieve compliance with ALL pushbutton placement requirements and ODOT documentation processes. **NOT FOLLOWING THE PLANS MAY RESULT IN PUSHBUTTONS THAT ARE NOT ADA COMPLIANT.** See example of signal plans on this page and example of roadway plans on next page.

If constructability issues arise and modifications to station/offset/elevations shown in the plan sheets appear necessary, NOTIFY THE EOR IMMEDIATELY. The EOR is responsible for re-design and verifying modifications meet all ADA and documentation requirements.

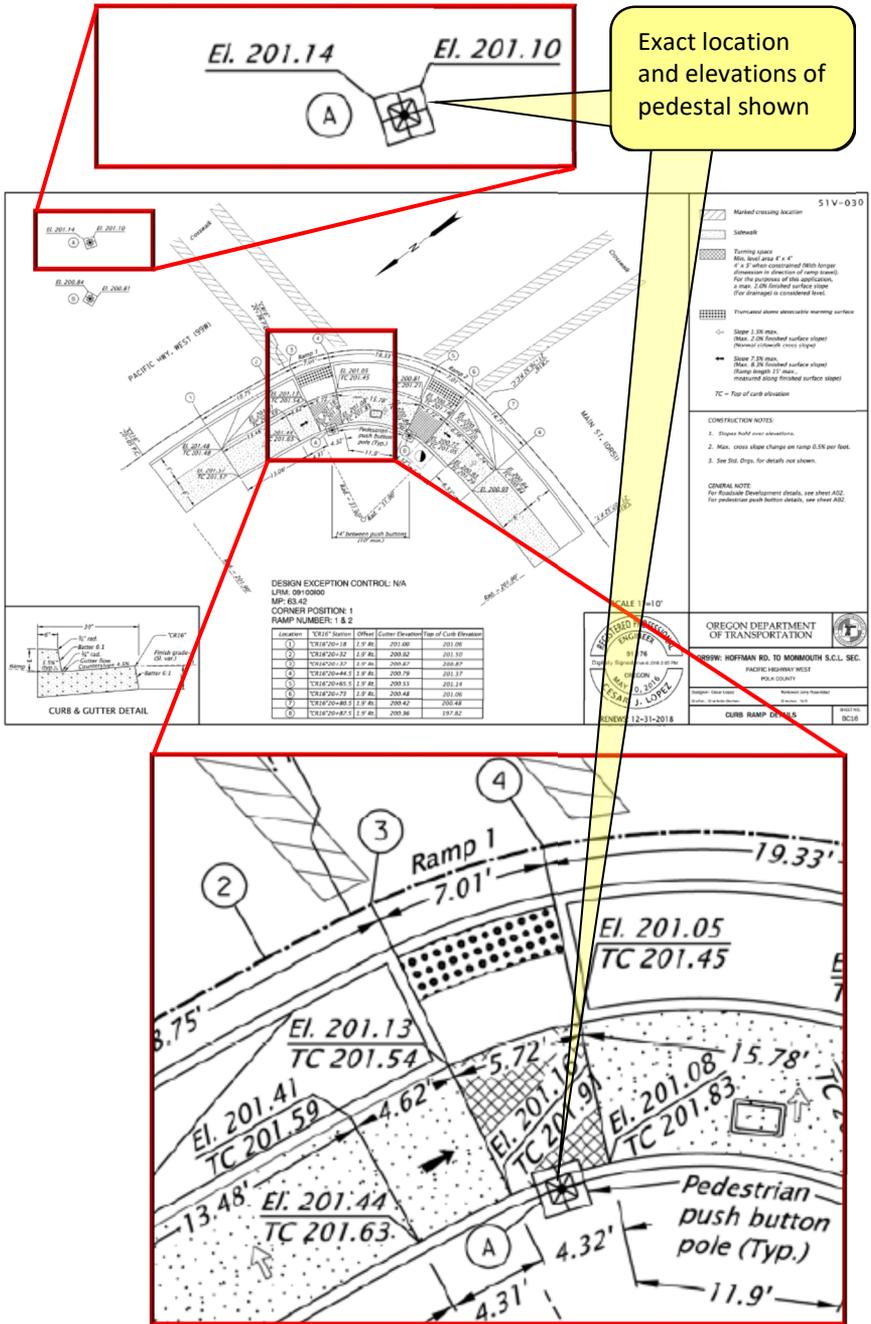
Plans will also show any unique details (e.g. incorporating curb into pedestal foundation).

Signal Plan Sheet Example



See TM650 thru TM653			EQUIPMENT ON POLE				
POLE NO.	DWG. NO.	TYPE	PED. SIGNAL/BUTTON DEG.	TERM. CABINET DEG.	SIGN DEG.	RADAR UNIT DEG	PHOTO ELECTRIC CELL
1	MB32	SM4L		180	270	235	
2	MB32	PP	90				
3	MB32	PP	355				
4	MB32	SM5L		180	270	235	180

Roadway Plan Sheet Example



Construction

Pushbuttons

Key Enforceable Items

Pushbuttons are installed in a one-piece assembly which includes the sign.	Blue Sheets
--	-------------

Tips and Tricks

H-frame pushbutton mounts are no longer used for new construction. The current standard is a 9"x12" mount.
Pushbuttons will typically be mounted on pedestrian pedestals only.
The 10" ADA Reach Distance cannot be met if the pushbutton is mounted on a pedestal or pole located behind a curb. Use of extension brackets is discouraged as a solution.

Inspector Action

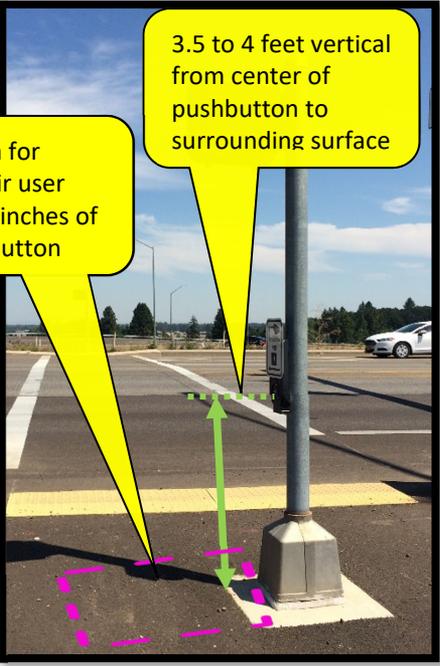
Verify angle of crosswalk before mounting pushbutton. The face of the pushbutton shall be mounted parallel to the crosswalk. See illustration on next page.	Plan Sheets & TM467
Verify that pole has been drilled at proper location to mount the pushbutton.	Plan Sheets (Pole Entrance Chart)
Verify the mounting height of pushbutton is 3.5 to 4 feet above the paved surface near the pole (measured from the center of the pushbutton). See illustration on next page.	TM450, TM452, & TM457
Verify that the ADA Reach Distance for the pushbutton is 10" or less (measured from obstruction to pushbutton). See illustration on next page.	TM467
Verify the grades in the vicinity of the pushbutton (sidewalk, ADA ramps, shoulder) match the grades shown in the plans	Roadway Plan Sheets
Fill out the roadway curb ramp inspection forms.	Internal Procedure
Verify that pushbutton covers are installed over the pedestrian pushbuttons until the signal is turned-on.	00990.46

Typical Sources of Info:

Specs: 00990.46
 Std. Dwg: TM467
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 46 & 84



Construction



Vehicle Signal Installation

Key Enforceable Items

Signals shall line up over lane lines as shown on the plans and according to the spacing detailed in the pole entrance chart. <i>See illustration on next page.</i>	Plan Sheets
--	-------------

Tips and Tricks

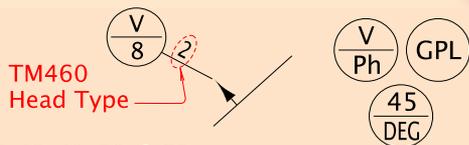
Vehicle signals are comprised of individual signal face sections configured to create any signal head type (modular construction). <i>See illustration on next page.</i>
Material may be polycarbonate (heavy duty) as per the plans or specifications.
Mounted to mast arms and poles with an adjustable bracket. <i>See Page 168.</i>
Suspended from messenger cable with a span wire hanger, conduit, and tri-stud adapter. <i>See Page 150.</i>
The plan sheets or special provisions will specify if louvers or non-standard visors are required.
Active signal heads shall not be covered with a vehicle signal cover – they can still be seen through the bag and can cause confusion.

Inspector Action

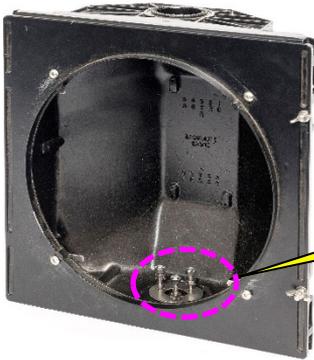
Verify the type of signal head to be installed.	Plan Sheets & TM460
Verify the indications are LED with clear lenses.	Blue Sheets
Verify the material (aluminum or polycarbonate).	Plan Sheets & Blue Sheets
Verify all hardware and fasteners are stainless steel.	TM460
Verify correct vertical clearance between the bottom of the equipment and the pavement is 18 feet minimum to 19 feet maximum.	TM450 & TM452
Verify self-tapping stainless steel pan head screws with flat washers (attached to screw) are used to install the backboard.	TM460
Verify that signal head covers are installed over the signal heads until the signal is turned-on.	00990.45

Typical Sources of Info:

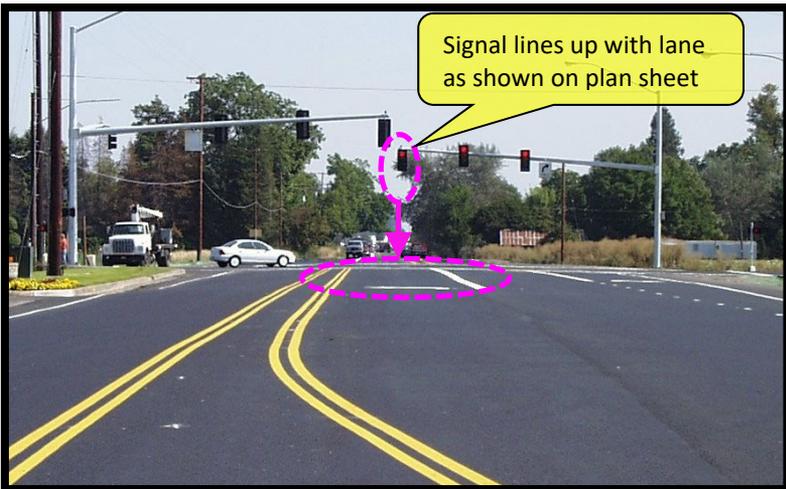
Specs: 00990.45
 Std. Dwg: TM460 & TM462
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 47, 48, 49, 50, & 52



Construction



Single signal head section.
Additional sections are
bolted together to create the
head types shown on TM460



Signal lines up with lane
as shown on plan sheet



Signal not in proper
location over lane line

Vehicle Signal Bracket

Key Enforceable Items

Adjustable brackets require a safety cable.	TM462
Trim excess portion of gusseted tube. See illustration on this page and next page.	TM462
Drill and tap pole and install chase nipple for wire entry into pole.	TM462

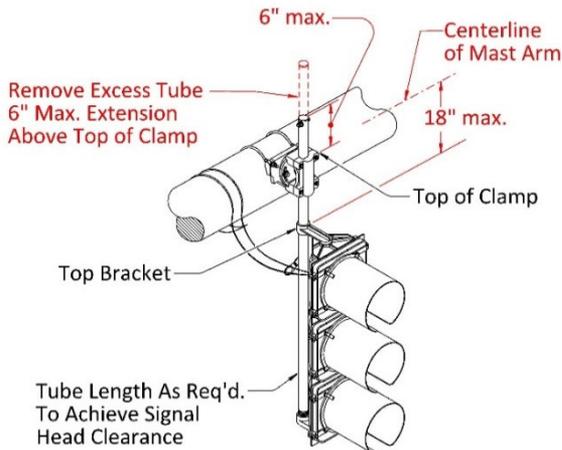
Tips and Tricks

Vehicle signal brackets are used to suspend equipment from mast arms and vertical poles. They also provide a cable entrance into the equipment. This includes the 4 inch side pole mount for mounting vehicle signals on pedestals.

Install hardware with anti-seize compound. Do not over tighten.

Inspector Action

Verify spacing of equipment mounted on mast arm.	Plan Sheets
Verify correct vertical clearance between the pavement and the bottom of the equipment on the mast arm is met, 18 feet minimum to 19 feet maximum.	TM450
Verify 18 inch maximum length of gusseted tube from centerline of mast arm to top of bracket. See illustration on this page.	TM462



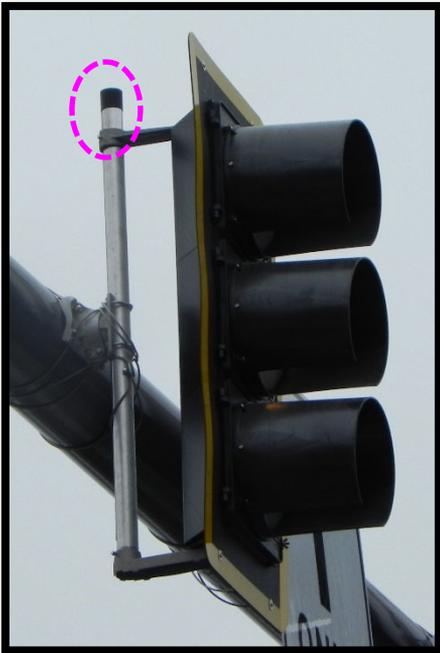
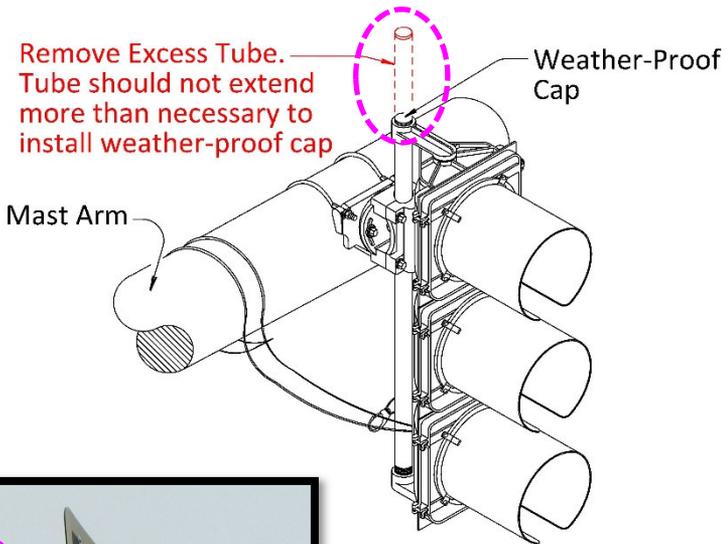
Typical Sources of Info:

Specs: NO

Std. Dwg: TM462

Plan Sheets: YES (pole entrance chart)

Blue Sheet/Green Sheet Info: Pg. 51



Sawcutting Detector Loops

Key Enforceable Items

Flush sawcut with high pressure water stream before cuttings dry. Blow out water and debris with high pressure/volume air, dry slot thoroughly with air or use a vacuum/extractor system.	00990.41(b)
---	-------------

Tips and Tricks

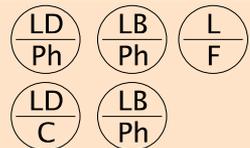
Sawcutting provides a slot into which the loop wires are installed to form the detector loop.
Loop wire returns cannot be routed through adjacent loops.
Detector loop installations are the most failure-prone portion of a signal. Careful construction according to TM475 and specifications greatly reduces this failure rate.
Plan sheets will show details for installing loops in existing or new open graded wearing surfaces.

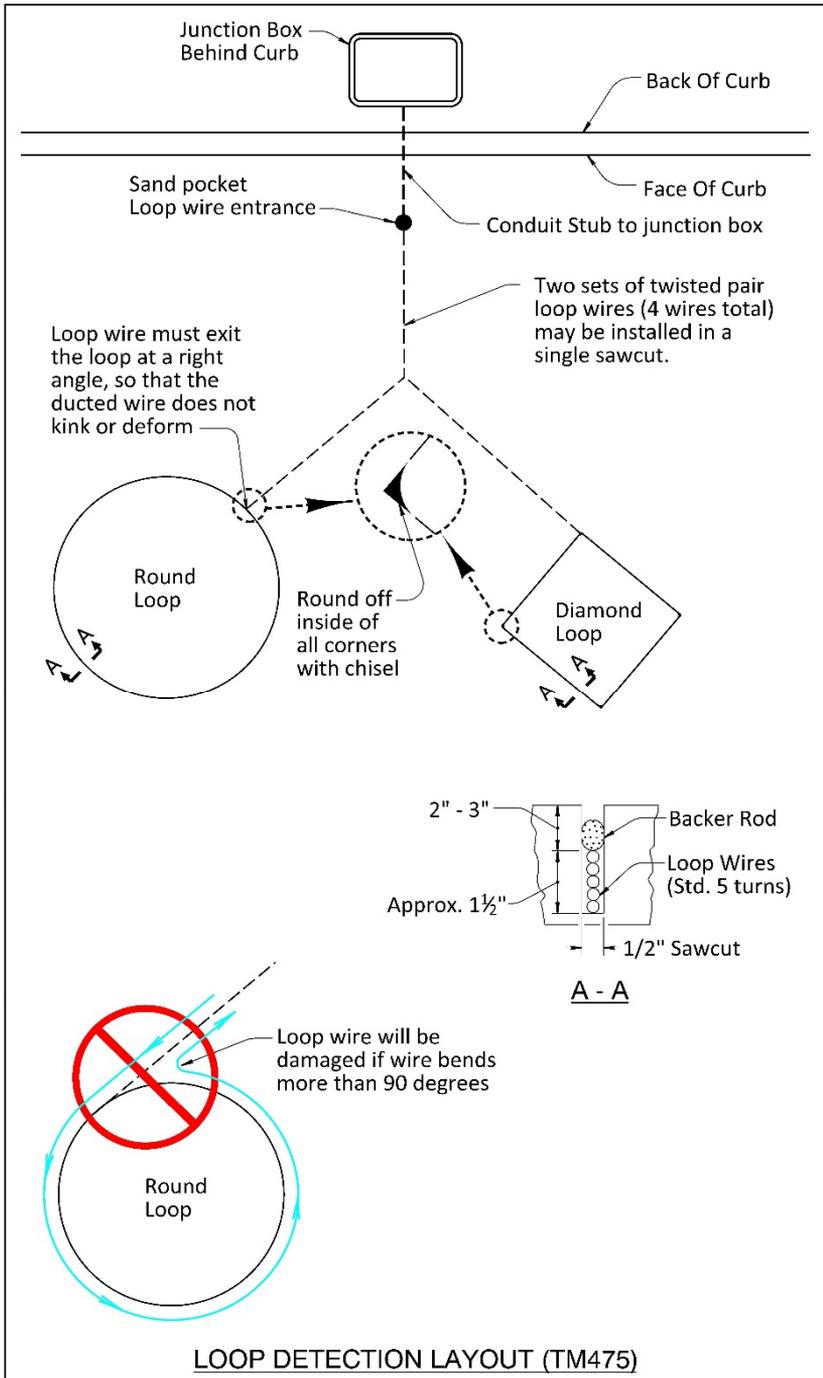
Inspector Action

Prior to sawcutting, verify the marked out loop locations (centered in lane line and proper distance from stop line) and loop wire returns.	TM475 & Plan Sheets
Verify sawcuts are at least ½ inch wide.	TM475
Verify sawcuts are deep enough to allow min. 2 inch cover over all wires placed in slot. See illustration on next page.	TM475
STOP construction if sawcut is deep enough to reach subbase/subgrade and contact EOR for options.	TM475
Verify all rocks and any other material in bottom of sawcut is removed.	00990.41(b)
Coordinate Supplemental Inspection by Agency Electrician (Required).	00990.41(a) & Page 98
Verify sawcut angles are no more than 90 degrees and all corners are rounded off (to prevent kinking and insulation damage of the loop wire). See illustration on next page.	TM475

Typical Sources of Info:

Specs: 00990.43(a) and (b)
 Std. Dwg: TM475
 Plan Sheets: YES (Location only)
 Blue Sheet/Green Sheet Info: NO





Loop Wire

Key Enforceable Items

If loops are to be installed in series, each pair of loop wires must return to the junction box before connecting the loops in series.	TM475
Wedge 1 inch lengths of backer rod into all sawcuts as loop wire hold-downs. Hold-downs should be placed no more than 12 inches apart and 6 inches from any corners.	TM475
Five turns of loop wire (to form the loop) is standard. See illustration on next page.	TM475
Loop wire returns are twisted 4-6 turns per foot from loop to the splice in the junction box. See illustration on next page.	TM475

Tips and Tricks

Installing detector loop wires requires good practices and great care to avoid damage which is not readily apparent. Loops may function initially and then fail later when moisture intrudes through minor damage to the wire insulation.
Loops located more than 500 feet from the controller cabinet may require more than 5 turns of wire. Plan sheets will state how many turns are required.
Twisted pairs in a too-narrow slot can hang up requiring excess force to properly seat in bottom of sawcut.
Avoid kinking, deforming, or stepping on the loop wire.

Inspector Action

Prior to installing loop wire: verify sawcut for adequate width & depth, absence of foreign debris, and ensure it is dry. See illustration on next page.	00990.41(b) & TM475
Witness installation of loop wire into sawcut using a blunt, non-metallic tool. The loop wire should slip effortlessly into a ½ inch wide slot. If it doesn't, STOP INSTALLATION and find out why.	00990.41(b)
Obtain report from contractor for testing of each loop during the following phases of installation 1.) Before splicing and sealing 2.) Before splicing after sealing and 3.) After splicing and sealing. Provide copies of report to TSSU.	00990.41(d)
Coordinate a Supplemental Inspection by Agency Electricians (Required).	00990.41(a) & Page 98

Typical Sources of Info:

Specs: 00990.41(a) and (b)

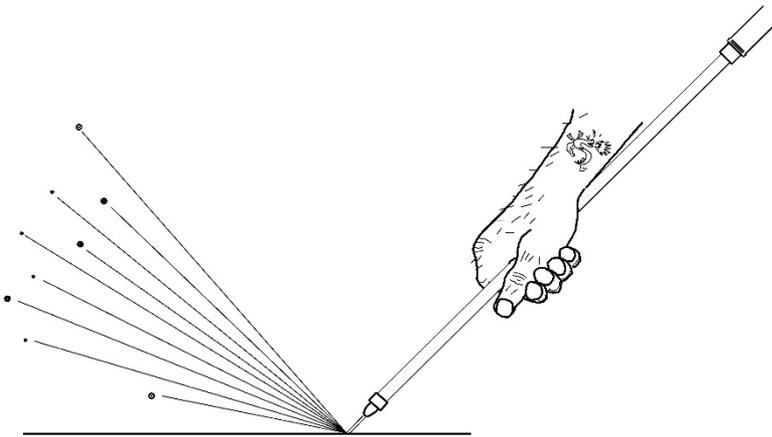
Std. Dwg: TM475

Plan Sheets: YES

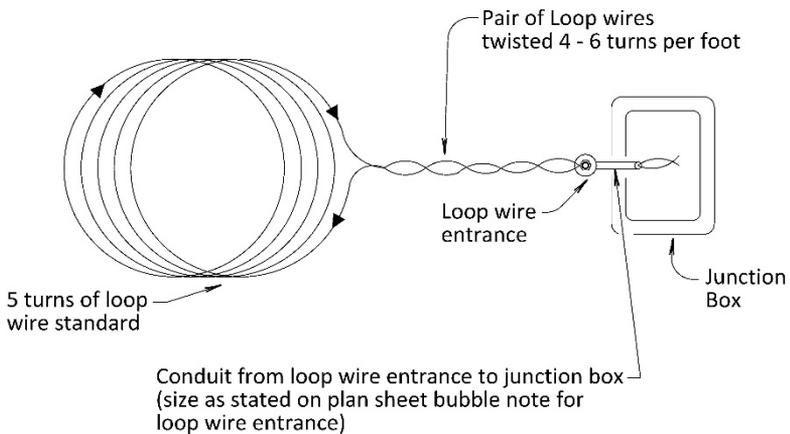
Blue Sheet/Green Sheet Info: Pg. 55



Flush sawcut with high pressure water before rock dust dries, then blow out water and debris with high pressure/volume air or use vacuum extractor system. Dry slot thoroughly. Check for sharp rock shards. 00990.41(b)



PREPARING THE SAWCUT BEFORE INSTALLING LOOP WIRE



LOOP WIRE INSTALLATION (TM475)

Loop Wire Entrance

Key Enforceable Items

4 inch minimum diameter core drill opening.	TM475
After installing wires, seal conduit with approved conduit plug and fill with sand.	TM475
Cap loop wire entrances with 3 inches of cold mix AC, not loop sealant. See illustration on next page.	TM475

Tips and Tricks

The Loop wire entrance provides loop wire access to junction box conduit stubs. In the event of a loop failure, the loop can be re-cut into these entrance points.

In the past, there were two types of loop wire entrances. Now there is only one type ([See illustration on next page](#)):

1. SAND POCKET – 4 inch opening cut into pavement, filled with sand and capped with AC cold mix.

Take care not to damage conduit stub.

Improperly sealed sawcut into sleeve or pocket may allow loop sealant migration into the conduit.

Inspector Action

Verify conduit stub is correct size (typically 2 inches).	Plan Sheets
Witness installation of at least one loop wire entrance and verify requirements shown on standard drawing TM475.	TM475

Typical Sources of Info:

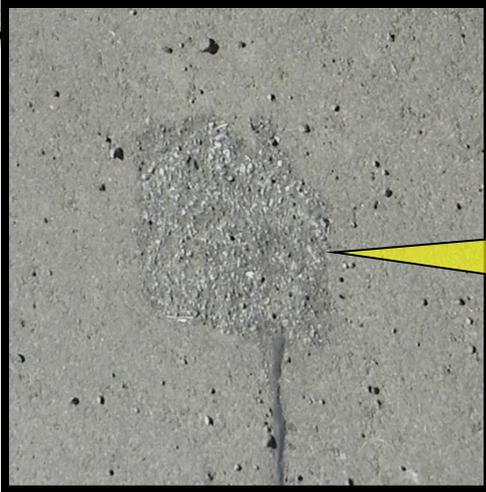
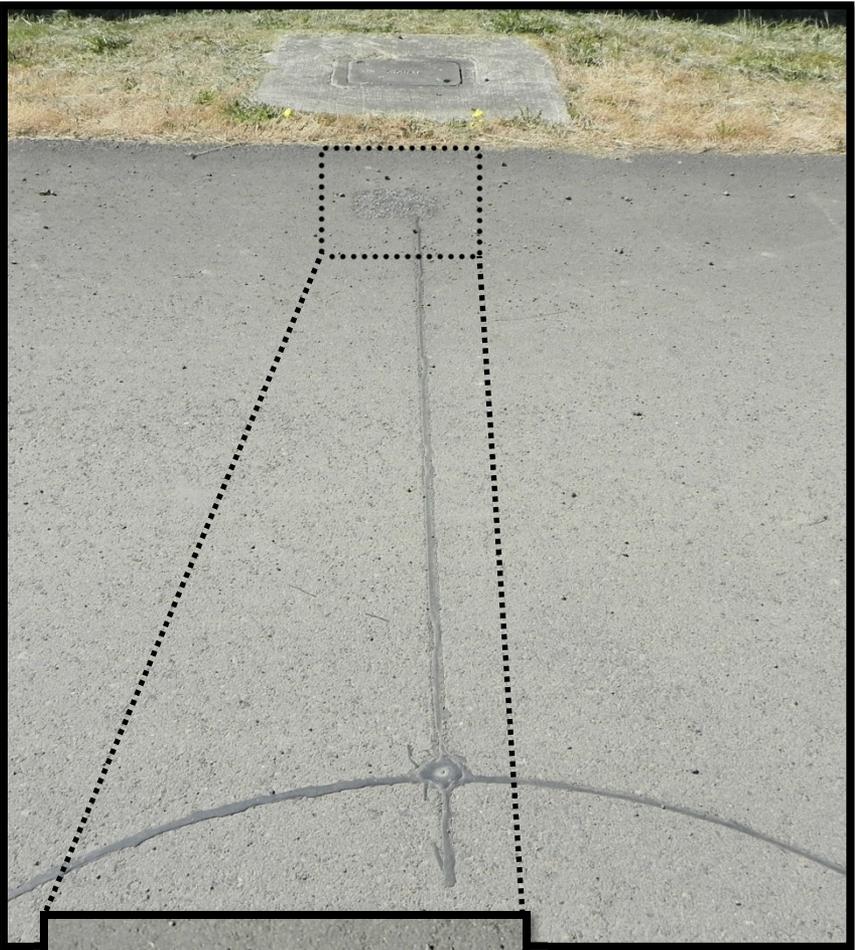
Specs: NO

Std. Dwg: TM475

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pg. 55





Loop wire entrance:
4 inch diameter cut
backfilled with 3
inches of A.C. cold mix

Sealing Detector Loops

Key Enforceable Items

Place sealant directly into sawcut, using manufacturer's recommendations.	00990.41(c)
High temperature sealants must be placed in lifts to avoid heat damage to insulation.	00990.41(c)
Surface of sealant should be within a 1/8 inch of the pavement surface without protruding. See illustration on next page.	TM475
Use only QPL listed sealants. Loop sealants shall be proportioned, mixed, and installed in accordance with manufacturer recommendations.	00990.10
DO NOT QUICK COOL SEALANT WITH WATER.	00990.41(c)

Tips and Tricks

Maintain clean and DRY sawcut before sealing.
DO NOT seal loops at temperatures below 40°F (as per manufacturer instructions).
If loops are installed on an existing open graded pavement surface, the plan sheets will show additional information for proper installation.
On sloped sections, duct tape can be used to contain sealant in sawcut. Remove tape after sealant is fully cured.
STOP construction if sealant runs or puddles on pavement surface until contractor corrects his placement method.

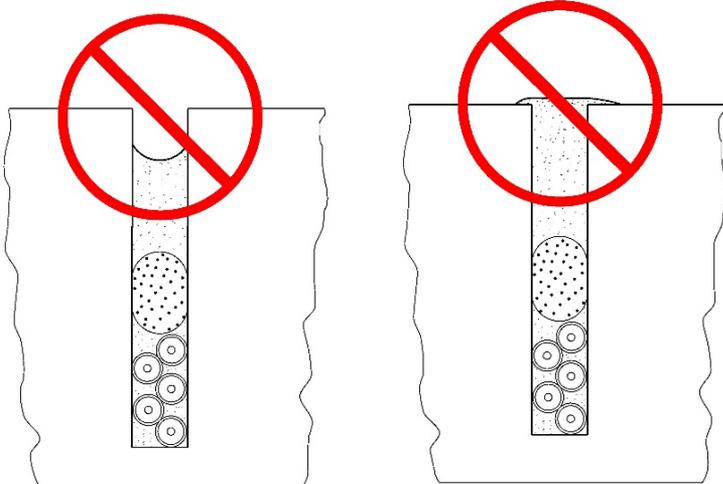
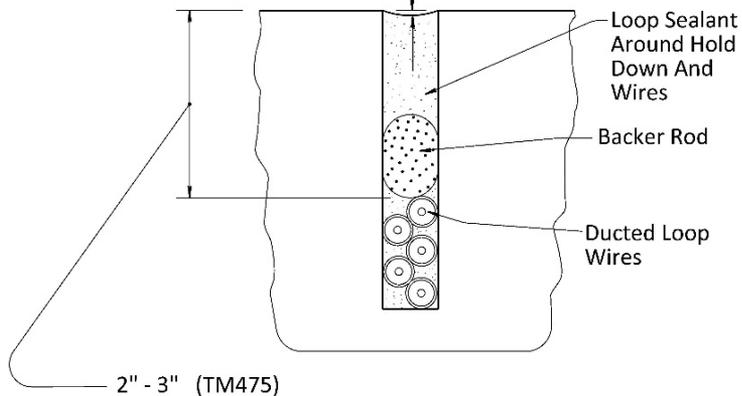
Inspector Action

Verify backer rods are in place.	TM475
Obtain report from contractor for testing of each loop during the following phases of installation: <ol style="list-style-type: none"> 1. Before splicing and sealing 2. Before splicing after sealing 3. After splicing and sealing Provide copies of report to TSSU.	00990.41(d)

Typical Sources of Info:

Specs: 00990.41(c) and (d)
 Std. Dwg: TM475
 Plan Sheets: NO
 Blue Sheet/Green Sheet Info: Pg. 2 (Backer Rod and Sealant from QPL)

Sealant 0" - 1/8" down from surface (TM475)



Detector Wiring Splice

Key Enforceable Items

Remove outer jacket of loop feeder cable, cut and remove drain wire and woven shield to approximately 4 inches back of intended splice.	TM475
Remove insulation from conductors, install screw on silicon grease filled wire connector, install black plastic self-locking straps, turn back wire connectors, insert into two piece plastic enclosure filled with silicon grease.	TM475
All splices for permanent installations must be made inside junction boxes (not in loop wire entrance). See illustration on next page.	TM475
Do not ground the shield or drain wire in junction box.	TM475

Tips and Tricks

Loop wire splices are made between pairs of loop wires (loops wired in series). They are also made between loop wires and loop feeder cable.
The plan sheets and special provisions may state that use of the Loop Splice (two-piece plastic enclosure on the blue sheets) is NOT required.

Inspector Action

Verify both ends of loop feeder cable and loop wires are labeled with the correct loop number.	TM475
Verify loops that are wired in series (two or more loops wired to a single loop feeder cable). See illustration on next page.	Plan Sheets
Obtain report from contractor for testing of each loop during the following phases of installation: <ul style="list-style-type: none"> 4. Before splicing and sealing 5. Before splicing after sealing 6. After splicing and sealing Provide copies of report to TSSU.	00990.41(d)

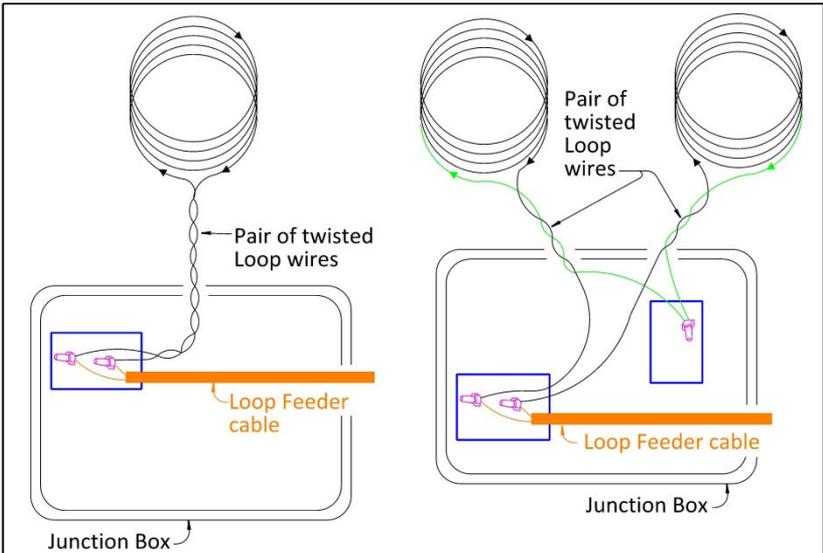
Typical Sources of Info:

Specs: 00990.41(d)

Std. Dwg: TM475

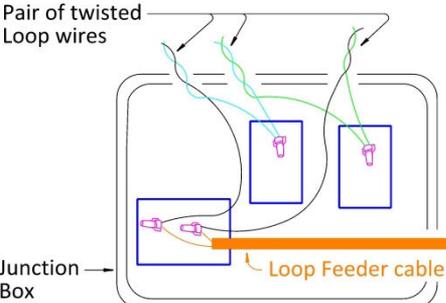
Plan Sheets: NO

Blue Sheet/Green Sheet Info: Pgs. 54, 55, & 56



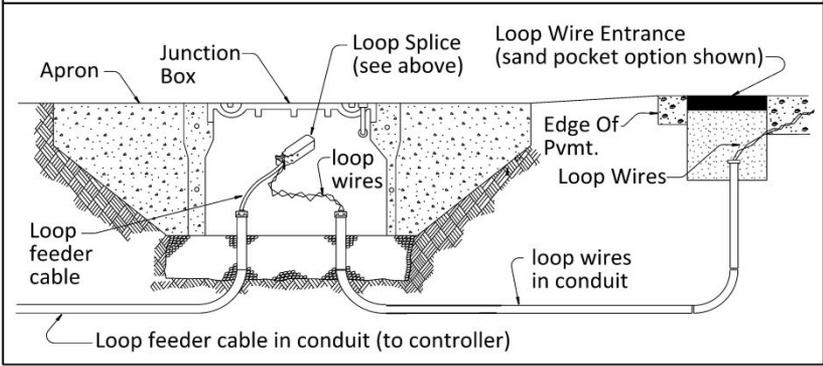
**Loop Splice:
Single Loop (TM475)**

**Loop Splice: 2 Loops Wired
in Series (TM475)**



LEGEND	
	= silicon wire connectors
	= two piece loop splice enclosure

Loop Splice: 3 Loops Wired in Series (TM475)



Construction

Video & Radar Detection

Key Enforceable Items

Video and Radar systems shall be from the Green Sheets only (no write-ins allowed).	Plan Sheets
Contractor is responsible for terminating video/radar detection wiring to the terminal blocks attached to the controller cabinet as shown in the cabinet print.	00990.42(a)
TSSU is responsible for installing and wiring the auxiliary devices not attached to the controller cabinet at the signal turn-on.	00990.70(f)
Connect the detector unit to the devices inside the controller cabinet with a single, unspliced length of cable. See illustration on next page.	Manufacturer's Instruction

Tips and Tricks

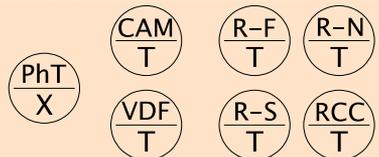
Due to the extended testing timeframe for approving a video/radar system, write-in products for a project are not allowed.
Region Traffic is responsible for configuring the detection zones as shown in the signal plan sheets during the signal turn-on. This may require the contractor or the manufacturer's representative to adjust the aim of the detection device. See illustration on next page.

Inspector Action

Verify the video/radar unit is installed at the appropriate location on the signal pole, mast arm, or luminaire arm.	Plan Sheets (Pole Entrance Chart)
Coordinate the manufacturer representative's on-site assistance to Agency electricians in setting up the devices prior to the signal turn-on date.	00990.30

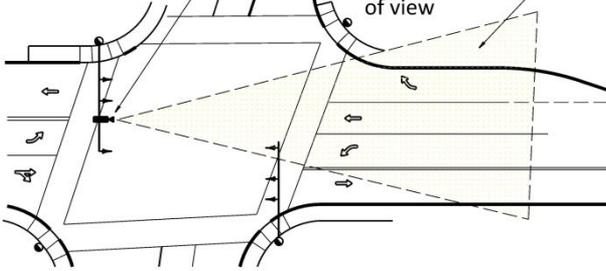
Typical Sources of Info:

Specs: 00990.30
 Std. Dwg: NO
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 83 & 88



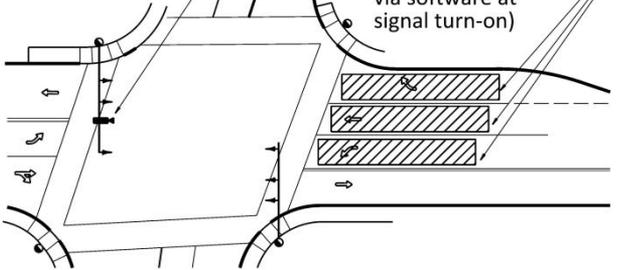
Video Detection Camera

camera field of view



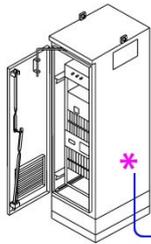
Video Detection Camera

Detection Zones (configured by Region Traffic via software at signal turn-on)



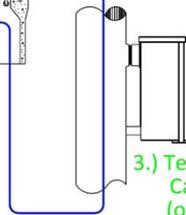
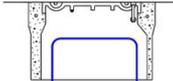
DETECTION ZONES (Plan Sheets)

Continuous wire: (no splice from controller cabinet to video/radar unit)

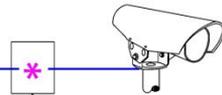


1.) Controller cabinet

2.) Junction Box



3.) Terminal Cabinet (on pole)



4.) video/radar Detector

Note: manufacturer may supply a terminal cabinet mounted near device



* Wires land on terminal block

VIDEO/RADAR DETECTOR WIRING

Fire Preemption System

Key Enforceable Items

Mount detector unit using appropriate method dependent upon placement (span wire or mast arm).	Plan Sheets & TM465
Connect the preemption detector (field) unit to the preemption interface inside the controller cabinet with a single, unspliced length of preemption feeder cable. See illustration on next page.	TM465
Knock out appropriate weep hole.	TM465

Tips and Tricks

One-channel detectors may have two barrels. Both barrels should be aimed towards the same approach (See manufacturer’s recommendations).
Two channel detectors require two barrels. Each barrel should be aimed at a different approach (See manufacturer’s recommendations).
If the preemption device is mounted to a vertical pole, the plan sheets will detail the installation information (i.e. mounting height, mounting details, and orientation on pole).

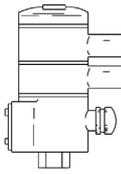
Inspector Action

Examine physical layout of intersection to ensure proper placement of detectors. Determine the channel and traffic movements assigned to each preemption detector (field) unit.	Plan Sheets
Verify the number of barrels for each preemption detector (field) unit (either 1 or 2). See illustration on next page.	Plan Sheets

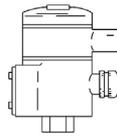
Typical Sources of Info:

Specs: NO
 Std. Dwg: TM465
 Plan Sheets: YES
 Blue Sheet/Green Sheet Info: Pgs. 80 & 81





Two Barrel Preemption Detector Unit (may be assigned to one or two channels)

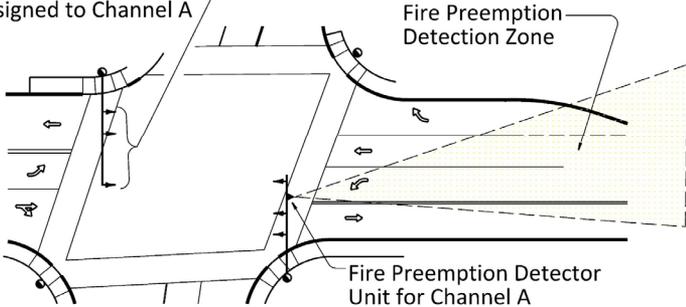
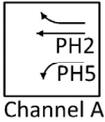


One Barrel Preemption Detector Unit (only assigned to one channel)

Plan sheets will state how many barrels and which channel(s) are assigned

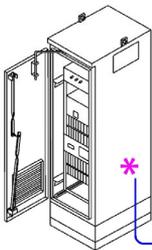
NUMBER OF BARRELS (Plan Sheets)

Signal phases for westbound approach assigned to Channel A

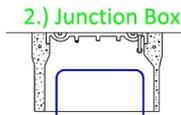


DETECTION ZONE & CHANNEL ASSIGNMENT (Plan Sheets)

Continuous wire: (no splice from controller cabinet to fire preemption detector) TM465



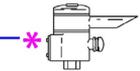
1.) Controller cabinet



2.) Junction Box



3.) Terminal Cabinet (on pole)



4.) Preemption Detector

* Wires land on terminal block

FIRE PREEMPTION WIRING

Luminaires (On Traffic Signal Pole)

Key Enforceable Items

Service cabinets for signals with illumination normally include a test switch.	TM485
Mount photoelectric cell 20 to 36 feet up pole.	00970.43
Luminaires must be installed level. If roadway profile grade is greater than 4 percent, rotate luminaire on arm so side-to-side position of leveling pad is parallel with roadway grade. <i>See illustration on next page.</i>	00970.44

Tips and Tricks

Support conductors with strain relief at top of pole.
Some local agencies use a photoelectric cell on each luminaire rather a system photoelectric cell.
In-line fuse holder used in the base of the pole, connecting the TC cable (going from the luminaire to the in-line fuse holder) and the XHHW wires (going from the in-line fuse holder to the Service Cabinet). <i>See illustration on next page.</i>
Wiring for illumination is not routed through the traffic signal controller cabinet.
If a pole location is changed, consult EOR. Luminaire or arm length may need to be changed.
Luminaires attached to signal poles are shown on the signal plans. Stand-alone luminaires are shown on the Illumination Plan Sheets.
NOTE: SM6L and SM7L mast arm poles have unique requirements - See TM655 thru TM658 and project plans for more info.

Inspector Action

Verify the luminaire arm length, luminaire type, and wattage.	Plan Sheets
Verify the lamp base is marked with month & year installed.	00970.44(b)
Verify the 7 day continuous and 7 day normal burn field test is conducted. Document any illumination that does not perform well during this time.	00970.70
Verify photoelectric cell is located in the correct position on the mast arm pole.	Plan Sheets & TM465

Typical Sources of Info:

Specs: 00970

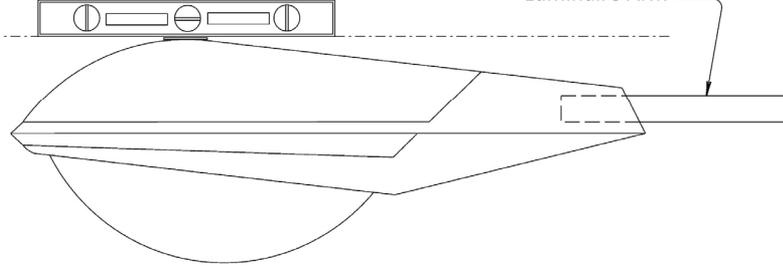
Std. Dwg: TM650, & TM465

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pgs. 57, 58, & 59

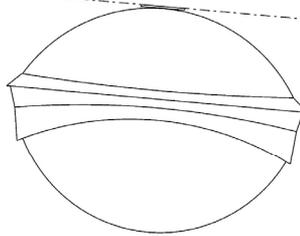


Front-to-back always level 00970.44

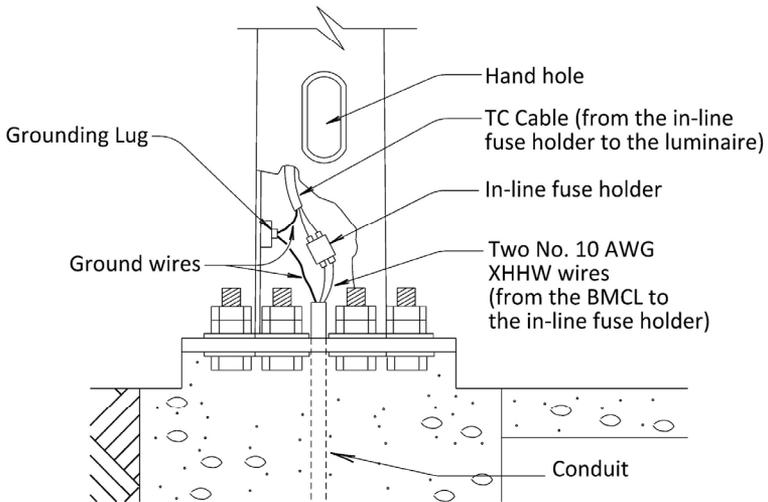


SIDE VIEW

Side-to-side parallel with roadway profile when grades exceed four percent
00970.44



FRONT VIEW



IN-LINE FUSE HOLDER & TC CABLE AT POLE BASE

Controller Cabinet

Key Enforceable Items

All traffic signal control equipment (items listed in the GREEN SHEETS) is submitted for physical, functional, and environmental testing. 6 week minimum for testing.	00990.70(a) & (b)
After testing, the controller cabinet (without internal components) will be released to the contractor for installation.	00990.70(e) & (f)
The TSSU will deliver and install all internal control equipment at day of turn-on.	00990.70(f)
Contractor is responsible for terminating all wires on the terminal blocks attached to the controller cabinet as shown in the cabinet print (input file, output file, fiber patch panel, etc.).	00990.42
Install building paper gasket between riser frame and foundation. Install non-hardening water-tight seal between riser frame and controller cabinet.	TM482

Tips and Tricks

Model 332s controller cabinets are specified for most signal installations (both temporary and permanent).
TEMPORARY SIGNAL: Maintain access to cabinet for all construction stages.
TEMPORARY SIGNAL: Installed on a temporary pre-cast foundation (see Plan Sheets).
The gasket between the concrete foundation and the cabinet is critical to keep the cabinet from corroding.

Inspector Action

Verify the controller cabinet is properly installed on the foundation (gasket is in place, riser is in place, non-hardening water tight sealant used, bolts and washers tight).	TM482
Verify walkway is provided to controller cabinet if it is not installed flush to back-of-sidewalk. See illustration on next page.	TM482
Verify louvered door on controller cabinet is installed in the orientation shown on the plan sheets.	Plan Sheets
Provide the contractor with the cabinet print. The cabinet print is provided by the EOR after the contract is let, to the project manager's office.	00990.70(a)

Typical Sources of Info:

Specs: 00990.70

Std. Dwg: TM482

Plan Sheets: YES

Blue Sheet/Green Sheet Info: Pg. 70 (+ other components listed Green Sheets)

332S



Louvered Door oriented according to plan sheet

Walkway



No walkway connecting controller cabinet to sidewalk



Installed flush to back of sidewalk

Field Testing Inspection & Signal Turn-On

Key Enforceable Items

Contractor is required to provide a video/radar manufacturer's rep. on-site within 1 week of anticipated signal completion date.	00990.30
Contractor is required to be present during the signal turn-on to un-bag signal heads and correct any errors.	00990.70(h)
TSSU will bring and install all of the components (that have been tested and approved) inside the controller cabinet.	00990.70(f)
Note the date and time of signal turn-on. After traffic signals are turned on and operating as designed, the agency responsible for maintenance assumes operation and maintenance of the signal.	0990.70(h)
Turn-on does not constitute final approval.	00990.70(h)
Note the required advance notice timeframes.	00990.70(b), (g), & (h)

Tips and Tricks

Flaggers should be on-site during the signal turn-on. Turning-on a new signal without flaggers may be possible, but turning-on a re-built signal always requires flaggers.
Region Traffic (or the maintaining local agency) provides the signal timing.
Signal turn-on's on a Friday or the day before a holiday are strongly discouraged.
Rule of thumb: Striping (crosswalks and stop lines) may be installed up to two weeks prior to scheduled signal turn-on date.

Inspector Action

Coordinate with Region Traffic, Agency Electricians, TSSU, and the Contractor to establish the signal turn-on date and time.	00990.70(h)
Coordinate a Supplemental Inspection by Agency Electricians (Required: "Field Testing Inspection").	00990.70(g) & Page 98
Verify the Contractor completes the "punch list" items from the Agency Electrician's Field Testing Inspection before the signal is turned on.	00990.70(h)
Verify striping and signing (temporary or permanent) is in place, such as stop bars, crosswalks, lane lines, lane use arrows, "Signal Ahead" and "New Traffic Pattern Ahead" signs, and lane use signs. Cover/remove any inappropriate signing ("Stop" & "Stop Ahead" signs) or striping.	Plan Sheets, 00225.41(e) & (f) and 00225.43(g)

Typical Sources of Info:

Specs: 00990.70

Std. Dwg: NO

Plan Sheets: NO

Blue Sheet/Green Sheet Info: NO

Final Clean-Up & Final Inspection

When the signals on the project have been successfully turned-on and all work (including punch list items) and clean-up has been satisfactorily completed, the project is ready for final inspection (see 00150.90). Supplemental Inspection is required for final inspection, see Page 98 for more info.

As-Constructed Drawings

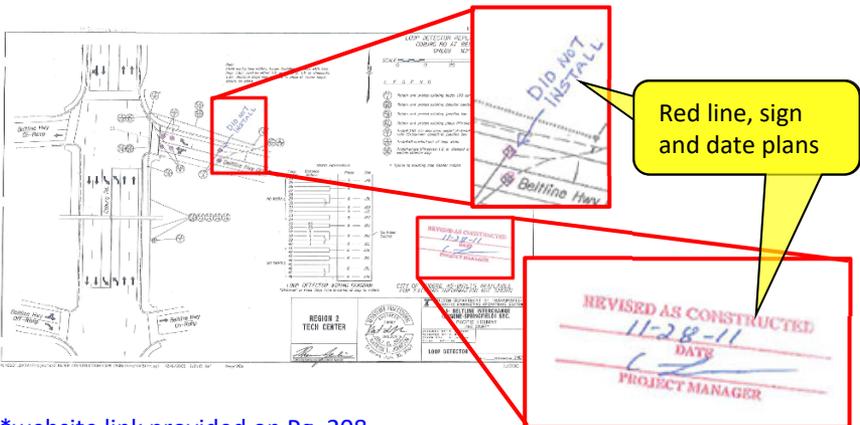
Once the signal installation has been accepted, as-constructed (red line, not modified CAD) drawings will need to be made by contractor and submitted (00960.71). The inspector will process the as-built according to the ODOT Construction Manual AND send a copy to the State Traffic Signal Engineer.

ANY part of the installation of the traffic signal that differs from the original design needs to be noted so that others will have accurate information as to how it was built. Especially important to note are changes in:

- location of junction boxes
- vehicle signal heads
- conduit runs
- wiring
- pole locations
- utilities

The changes noted on the drawings need to be detailed/complete enough to accurately amend the original plans. The as-constructed drawings you submit will be reviewed by the EOR and Traffic-Roadway Section.

Traffic-Roadway Section will archive the drawing on the Filenet website*. These drawings are important to Agency Electricians and designers; they rely on them to be accurate for maintenance and future design purposes.



*website link provided on Pg. 208

This page intentionally left blank

Other Signal Equipment

This manual explains typical traffic signal equipment and installation process.

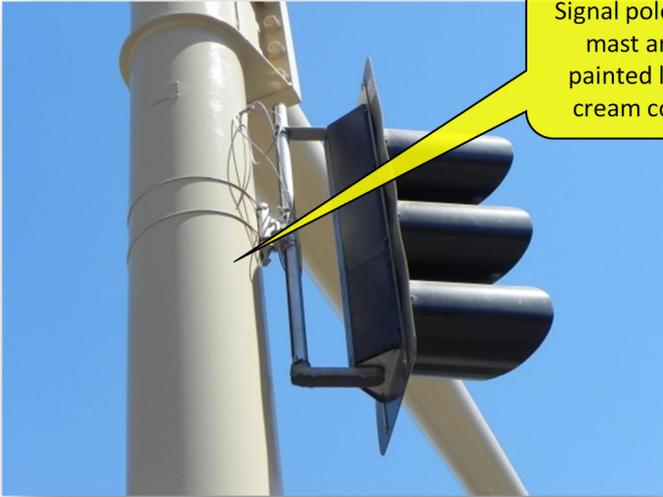
If your project contains a unique item or process, the EOR will include all information for materials and installation in the contract plan sheets and/or the special provisions.

Some types of signal equipment are only used in certain areas or for specific reasons. Several examples of signal equipment that are common, but used on an infrequent basis are listed below on the next few pages to give you some familiarity. If you have any questions on your project, contact the EOR for assistance.

1. **Ornamental Pole Treatments:** Decorative features on or around the poles and pedestals. Typically used in historic downtown districts for aesthetics.



2. **Paint or Powder coating of poles and other signal equipment:** Coloring of the signal equipment. Typically used in historic downtown districts for aesthetics.



Signal pole and mast arm painted light cream color

3. **Cast Iron Junction Boxes:** Boxes that are designed for substantial/continuous traffic loading (vs. incidental traffic). Typically used in the roadway or shoulder.



4. **Conduit Hub:** Typically used with cast iron junction boxes to provide a watertight connection for conduit entering the junction box.



5. **Preformed Loops:** Pre-made loop detector inside durable hose or PVC. Typically used on bridge decks or areas with poor pavement quality.

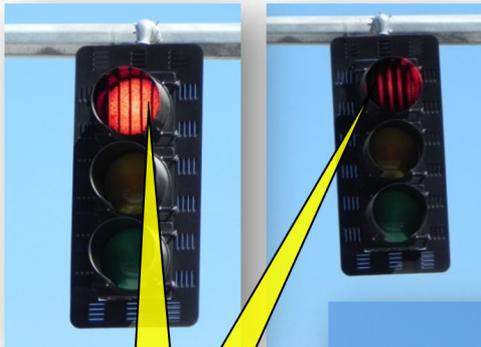


6. **336 Controller Cabinet:** Small pole mounted controller cabinet. Typically used for temporary traffic signals or locations where a standard base mounted 332s cabinet cannot be installed.



336
Controller
Cabinet
for temp
signal

7. **Louvers/Cut Off Visors (for signal heads):** Devices that selectively limit the visibility of the signal indications. Typically used when drivers may be confused by seeing indications that don't apply to them. Region Traffic will verify the proper visibility during the signal turn-on.



Louvers

Cut-off
visors

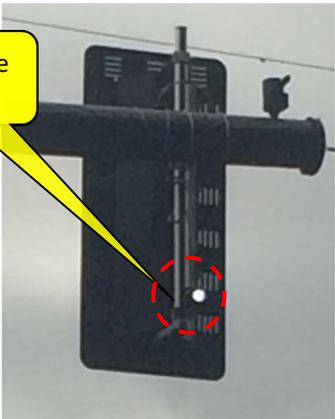
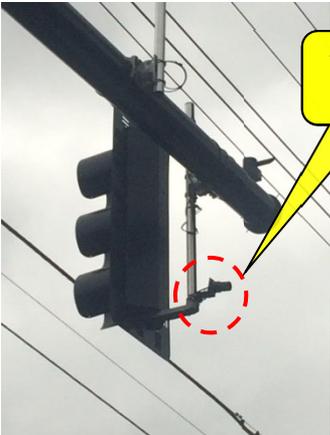


8. **Bike Signals:** Signal indications that have a red, yellow, and green bicycle symbol. Typically used in urban areas to facilitate safe and efficient movement of bike riders.



Bike Signal

9. **Tattletale lights:** Small white lights that are mounted on the backside of the vehicle signal to indicate when the signal is RED to aid law enforcement for red-light running violations. Used at the request of local law enforcement.



Tattletale light

Requesting Changes to Standard Drawings, Specifications or this Manual

If an error, omission, or need for clarification is discovered in the standard drawings, specifications, or this manual please let us know so we can address the issue in a future update. If you have a great idea, we want to hear it. Feedback from the field is EXTREMELY important for producing and maintaining quality documents.

We review the Project Manager's Narrative & all Contract Change Orders that are uploaded to the Construction Section server on a monthly basis. Please make detailed comments and notes in these documents – we use this information to improve our design standards, construction standards & specifications, and internal ODOT processes related to traffic signals.

We want to hear from you!

To request changes to standard drawings, specifications, or this Manual, contact the State Traffic Signal Engineer:

503-986-3596

E-mail: Scott.B.Cramer@ODOT.state.or.us