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Revision Type	Reference	Section Description (Red indicates Change of name from existing)	Description of Revision	New or Deletion	Primary POC
TEM	MANY	MANY	Go thru TEM and update MUTCD References throughout….		Fiant
TEM	100-1.2	INTRODUCTION - National Standards	Correct TEM reference		Fiant
TEM	100-1.3	INTRODUCTION - Uniformity in Traffic Control Standards - State Standards	Update this section to reflect Ohio Supplement and MUTCD becoming the OMUTCD as of 1/16/25. Other updates based upon new MUTCD.		Fiant
TEM	100-1.4	INTRODUCTION - Uniformity in Traffic Control Standards - Additional Specific Standards	Revise section so that it does NOT indicate that TEM and other Standard Documents supplement the OMUTCD as per feedback from FHWA. Otherwise ALL of those documents have to be part of the Ohio Supplement to MUTCD….		Fiant
TEM	100-2	INTRODUCTION - ODOT's Role/Responsibility	Delete mention of Office of Traffic Operations and include ITS under Office of TSMO		Beck
TEM	100-2.1	INTRODUCTION - District Traffic Engineer	Updated to clarify setting up timing for School Speed Limit Signs with flashing beacons part of DTE responsibilities		Beck
TEM	100-4	INTRODUCTION - Contacts	Remove references to Office of Traffic Operations		Beck
TEM	100-6.5	INTRODUCTION - Strain Pole Design (SWISS Software)	Update training course language related to this software		Young
TEM	101	OHIO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES	Update section to reflect release of Ohio Supplement and 11th Edition of Federal MUTCD and clarify that it will now be the OMUTCD		Fiant
TEM	102	TRAFFIC ENGINEERING MANUAL	Revise section so that it does NOT indicate that TEM supplements the OMUTCD as per feedback from FHWA. Otherwise TEM has to be part of the Ohio Supplement to MUTCD…. Also update to refer to TSMO rather than Traffic Operations		Fiant
TEM	103	STANDARD CONSTRUCTION DRAWINGS - Format	Update language to indicate that ODOT CADD Standards shall (instead of should) be used in all Microstation Drawings. Also, delete last two paragraphs of section 103-3. Revise Distribution language. Revise should to shall in first sentence and delete last sentence in 103-5.		Young
TEM	107	DEFINITIONS	Moving the existing content from Part 1501 to this new section.	New	Young
TEM	108	OTHER POLICIES AND STANDARD PROCEDURES	Moving the existing content from Part 1599 to this new section.	New	Young
TEM	150-2	CONSTRUCTION - Pre-Construction Conference	Add "Plans for Work Zone Traffic Incident Management" to list of Traffic Control items to be reviewed during pre construction conference		Young
TEM	180	RESEARCH	Update to reference new OMUTCD section		Fiant
TEM	195-1	TRAFFIC ENGINEERING REFERENCE RESOURCES - General	Delete reference to Office of Traffic Operations and Office of Roadway Engineering		Beck
TEM	195-6	TRAFFIC ENGINEERING REFERENCE RESOURCES - Temporary Traffic Control Manual (TTCM)	Delete to indicate TTCM is no longer an active manual.	Deletion	Willis
TEM	201-9	REGULATORY SIGNS - Truck Restrictions ~~- Weight Limits~~	Renamed Section. Renumber Section 201-9.1 to 201-9.1.1. Renumber Section 201-9.2 to 201-9.1.2. Renumber Section 201-9.3 to 201-9.1.3. Renumber to accommodate Hazmat and National Network signs		Soisson
TEM	201-9.2	REGULATORY SIGNS - Truck Restrictions - Hazardous Material Signs	New section describing why the R14-2 and R14-3 signs are not to be used in Ohio	New	Soisson
TEM	201-9.3	REGULATORY SIGNS - Truck Restrictions - National Network Signs	New section describing why the R14-4 and R14-5 signs are not to be used in Ohio and to use the R5-2 sign	New	Soisson
TEM	201-10	REGULATORY SIGNS - Lane-Use Control Signs	Reworded to refer users to SDMM for additional info on available signs and signcodes		Fiant

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TEM	201-15	REGULATORY SIGNS - KEEP RIGHT EXCEPT TO PASS Sign (R4-16)	Revised to incorporate updated ORC information to include removing reference to 3 lane roadways		Soisson
TEM	201-20	REGULATORY SIGNS - NO STOPPING ANY TIME Sign (R7-4a)	New section added to describe the proper sign to use along entrance and exit ramps	New	Soisson
TEM	204-2	ROUTE SIGNS - Ohio Byway Signing (~~M8-H4~~ M10-H3a series, M10-H3bP)	Updated to change sign code and placement responsibilities		Soisson
TEM	206-11	GENERAL INFORMATION SIGNS - Drinking Water Protection Area Signs (~~I-H15~~)	• Change to add surface water areas • Change sign code • Change color of sign		Soisson
TEM	209-4	FREEWAY & EXPRESSWAY DISTANCE & DESTINATION SIGNS - Weigh Station Signing for Freeways and Expressways	Show updated R13-H1 and R13-H2 signs		Soisson
TEM	211-2	SIGN DESIGNING - Standard Signs	Update to refer to Office of Roadway Engineering rather than Traffic Operations		Beck
TEM	211-4	SIGN DESIGNING - Sign Design Computer Program	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	220-8	MATERIALS AND HARDWARE - Production and Purchasing of Signs and Related Materials	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	221-3	SIGN SUPPORTS - Overhead Sign Support Inspection	Update to refer to Office of Roadway Engineering rather than Traffic Operations		Beck
TEM	242-2	PLAN NOTES - Power Supply for Sign Lighting	Delete existing note.		Young
TEM	242-3	PLAN NOTES - 630 Overhead Sign Support Modification, by Type, As Per Plan	Update note to make As Per Plan and provide more of a template based type note		Soisson
TEM	242-5	PLAN NOTES - 630 Modification of Barrier Wall Assembly	Delete, no longer needed	Deletion	Eberhardt
TEM	242-6	PLAN NOTES - Reserved	Delete placeholder		Young
TEM	242-7	PLAN NOTES - Reserved	Delete placeholder		Young
TEM	242-8	PLAN NOTES - 630 Signing Misc.: Solar-Powered Rectangular Rapid Flashing Beacon (RRFB) Sign Assembly	Delete with the implementation of SS 999	Deletion	Eberhardt
TEM	260-2	MAINTENANCE / OPERATIONS - Responsibilities	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	298-42 Figure	Example of Clearance Signs on a Low Clearance Structure	Added some additional figures for scenarios not already shown and added sign placement details for sign layouts		Eberhardt
TEM	301-22	PAVEMENT & CURB MARKINGS - Speed Reduction Markings	Added reference to new standard drawing TC-75.10 that addresses Speed Reduction Markings		Soisson / Eberhardt
TEM	342-2	PLAN NOTES - Handicap Symbol Marking	Delete Note. Needed information now found in SCD TC-71.10	Deletion	Eberhardt
TEM	342-3	PLAN NOTES - Raised Pavement Marker Removed	Delete Note	Deletion	Eberhardt
TEM	342-4	PLAN NOTES - Speed Measurement Markings	Delete Note. Needed information now found in SCD TC-88.10	Deletion	Eberhardt
TEM	342-6	PLAN NOTES - Speed Reduction Markings	Delete Note. Needed information now found in SCD TC-88.10	Deletion	Eberhardt

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TEM	350-8.3	CONSTRUCTION - Pavement Markings - Application of Pavement Marking Materials	Add mil thickness to Traffic Paint, Polyester and Epoxy		Soisson / Eberhardt
TEM	360-2.3	MAINTENANCE / OPERATIONS - Maintenance of Raised Pavement Markers (RPMs) - Inspection Guidelines for Existing RPM Installations	Added “loose” as a reason to be deemed “failed”		Soisson
TEM	397-3 Table	Speed Reduction Markings	New easy to read charts for determining spacing of Speed Reduction Markings	New	Soisson / Eberhardt
TEM	401-2	TRAFFIC CONTROL SIGNALS - GENERAL - Installation of Traffic Signals on State Highways	Updated reference to Office of TSMO		Beck
TEM	401-3	TRAFFIC CONTROL SIGNALS - GENERAL - Periodic Review of Signals	Updated OMUTCD Reference		Beck
TEM	401-9	TRAFFIC CONTROL SIGNALS - GENERAL - Americans with Disabilities Act (ADA) Requirements	Updated OMUTCD Reference		Beck
TEM	403-2	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Yellow Change and Red Clearance Intervals	Updated OMUTCD Reference		Beck
TEM	403-3	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Flashing Operation of Traffic Control Signals	Updated OMUTCD Reference		Beck
TEM	403-6	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Emergency-Vehicle Preemption Control Systems	Updated OMUTCD Reference and Updated reference to Office of TSMO		Beck
TEM	403-7	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Flashing Yellow Arrow (FYA) Operation	Updated OMUTCD Reference and removed references of FYA being an Interim Approval item since it is now in MUTCD & Ohio Supplement		Beck
TEM	403-10	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Railroad Preemption Control Systems	Updated OMUTCD Reference		Beck
TEM	403-15	TRAFFIC CONTROL SIGNAL FEATURES AND OPERATION - Left Turn Phase Operation Guidelines	Added some additional reference information on use of FYA and indicate that it "should" be used instead of "can" be used.		Beck
TEM	404-1	PEDESTRIAN CONTROL FEATURES - General	Updated OMUTCD Reference		Beck
TEM	404-2	PEDESTRIAN CONTROL FEATURES - Pushbuttons	Updated OMUTCD Reference		Beck
TEM	404-3	PEDESTRIAN CONTROL FEATURES - Accessible Pedestrian Signals and Locator Tones	Updated OMUTCD Reference		Beck

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TEM	404-5	PEDESTRIAN CONTROL FEATURES - Pedestrian Hybrid Beacons	Updated OMUTCD Reference		Beck
TEM	405-1	FLASHING BEACONS - General	Updated OMUTCD Reference and added language to standardize use of 12" size on ODOT maintained roadways		Beck
TEM	405-3	FLASHING BEACONS - Rectangular Rapid Flashing Beacon (RRFB)	Provide reference to OMUTCD and remove references to Interim Approval since these are now standard traffic Control Device in MUTCD.		Beck
TEM	406	SPECIAL PURPOSE TRAFFIC CONTROL SIGNALS	Updated OMUTCD References and revised general text to order special devices consistent with OMUTCD		Beck
TEM	408	IN-ROADWAY WARNING LIGHTS	Updated OMUTCD References and revised text to match MUTCD terminology. Also updated Title of 408-2.		Beck
TEM	420-4	MATERIALS AND SIGNAL HARDWARE - ~~Vehicular~~ Signal Heads	Updates throughout section to include updating OMUTCD references, introducing Bicycle Signal Faces, clarifying sizes of signal heads, clarifying colors of signal housings, reference to FYA signals, updates for T-intersection signal indications, clarifying clearance requirements, and revising the Dual-Arrow Signal Section to Bi-Modal Yellow-Green Arrow Signal Section.		Beck
TEM	421-2	SIGNAL SUPPORTS - Signal Support Inspections	Significant rewrite of this section to describe inspection procedure to be consistent with the "automated" Collector App process.		Duemmel / Beck
TEM	440-1.2	DESIGN INFORMATION - General - Overhead Utilities	New Section to emphasize potential overhead utility obstructions and providing required clearances from obstructions	New	Beck
TEM	440-7	DESIGN INFORMATION - Stage 2 and 3 Plan Submittals	Deleted reference to Form 496-2 since content is outdated and instead refers to Signal Design Reference Packet (SDRP).		Beck
TEM	440-11	DESIGN INFORMATION - Solar-Powered Electrical Devices	Revised to remove references to plan notes and instead refer to SCD TC-87.10 or Supp Spec 999		Beck
TEM	442-25	PLAN NOTES - 809 Preemption	Revised note to clarify that equipment needs to be furnished and installed rather than "supplied".		Beck
TEM	442-43	PLAN NOTES - 632 Auger-In Foundation, 8-inch Diameter by (Depth in Feet)	Revised note to call out new SCD TC-83.30 and that T-base should be specified		Beck
TEM	442-46	PLAN NOTES - 632 Signal Support, (By Type), As Per Plan	Update associated designer note to describe how to denote non-standard traffic signal supports when they are included by designers using an as-per-plan note		Duemmel
TEM	443	SPECIFICATIONS	Removing callout for Spread Spectrum Radio since it is outdated		Beck
TEM	460-2	MAINTENANCE / OPERATIONS - Responsibilities	Revised to callout School speed limit sign with flashing beacons rather than school flasher		Beck
TEM	460-3.3	MAINTENANCE / OPERATIONS - Preventive Maintenance - Other Electrical Traffic Control Devices	Revised to callout School speed limit sign with flashing beacons rather than school flasher and revised to indicate LED Lamps shall be used.		Beck
TEM	460-4	MAINTENANCE / OPERATIONS - As Required Maintenance	Revised to callout School speed limit sign with flashing beacons rather than school flasher		Beck
TEM	460-7	MAINTENANCE / OPERATIONS - Training	Revised to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	460-9 & 10	MAINTENANCE / OPERATIONS - Signal Databases	Deleted all content and replaced with reference to ODOT Collector Application	Deletion	Beck
TEM	460-10	MAINTENANCE / OPERATIONS - Dark Signals	Renumbered existing 460-11 to 460-10 with the deletion of current 460-10		Beck
TEM	470-1	OTHER CONSIDERATIONS - Alternative Intersection Design Guidance	Refer to Supp Spec 999 instead of TEM 242-8 plan note and add content to consider use of signal heads with green arrow for thru movements on a DDI.		Beck
TEM	496	Forms Index	Update index to show deletions and other formatting updates		Beck

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TEM	496-1	Signal Support Inspection Form	Delete Form	Deletion	Beck
TEM	496-2	Traffic Signal Stage 3 Check List	Delete Form	Deletion	Beck
TEM	496-7	Signal Inspection Form	Delete Form	Deletion	Beck
TEM	497	Tables Index	Update index to show correct OMUTCD references and other formatting updates		Beck
TEM	498	Figures Index	Formatting updates		Beck
TEM	500	Low Volume Roads	Removing all the content from this section. Leaving blank placeholder for future use to mirror MUTCD Part 5: TRAFFIC CONTROL DEVICE CONSIDERATIONS FOR AUTOMATED VEHICLES.	Deletion	Young
TEM	605-14.4	Temporary Guardrail	Update LD V1 reference to 603.1.2.1		Holloway
TEM	605-14.5	Portable Barrier (PB)	Need to add Fiberglass as a type of PB since section has recently been approved for use in Ohio		Holloway
TEM	605-14.5.2	Portable Barrier (PB) - End Treatment	Add the following at the end of the second paragraph: "See Roadway SCD RM-4.2 for design guidance for transitioning an F-Shape portable barrier run between anchored and unanchored portions."		Willis
TEM	608-1	INCIDENT MANAGEMENT - General	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	608-4	INCIDENT MANAGEMENT - Permitted Lane Closure Schedule (PLCS)	Revise to clarify reference to PLCS Website and clarify last sentence of section.		Willis
TEM	608-6	INCIDENT MANAGEMENT - Hazardous Materials (HazMat)	Deleted the following sentence: "However, a specific HazMat contract may be developed by the Office of Traffic Operations (OTO) to help facilitate this process in the future."		Beck
TEM	608-7.2.5	INCIDENT MANAGEMENT - Diesel Spills - For PLCS Mainline Segments - Documentation	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	620-3	MATERIALS AND HARDWARE - Retroreflective Sheeting	Remove option for the use of Reboundable sheeting		Soisson
TEM	630-4	PLANNING / PROGRAMMING - Permitted Lane Closure Schedule (PLCS)	Revised to indicate PLCS indicates min number of lanes to remain open during time interval rather than hours of day when lane closure permitted. Also revised transition language to past tense.		Willis
TEM	640-5.2	DESIGN INFORMATION - Use of Shoulders - Provisions for Use of Shoulders	Delete the last sentence of section that indicates, "Minimum clearance from existing obstructions may be reduced by 12 feet when traffic is shifted onto the shoulder."		Willis / Young
TEM	640-13.1	DESIGN INFORMATION - Capacity - General	Added (2010) reference to Highway Capacity Manual.		Willis
TEM	640-29.3	Work Zone Intelligent Transportation Systems - Work Zone CCTV	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	641-14	PLAN PREPARATION / PRODUCTION - Lane Closure at Entrance Ramp (MT-98.10 and 98.11)	Update Pay Item list to indicate that Work Zone Dotted Line is paid (by Width) and (by Type)		Willis
TEM	641-15	PLAN PREPARATION / PRODUCTION - Lane Closure at Exit Ramp (MT-98.20 and 98.21)	Update Pay Item list to indicate that Work Zone Dotted Line is paid (by Width) and (by Type)		Willis
TEM	641-16	PLAN PREPARATION / PRODUCTION - Lane Closure in Deceleration Lane (MT-98.22)	Update Pay Item list to indicate that Work Zone Dotted Line is paid (by Width) and (by Type)		Willis
TEM	641-17	PLAN PREPARATION / PRODUCTION - Typical Lane Closures for Ramps (MT-98.28 and 98.29)	Update Pay Item list to indicate that Work Zone Dotted Line is paid (by Width) and (by Type)		Willis

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TEM	641-32	PLAN PREPARATION / PRODUCTION - Typical Closures at Entrance Ramp and Turn Bay Closures (MT-98.30)	Update Pay Item list to indicate that Work Zone Dotted Line is paid (by Width) and (by Type)		Willis
TEM	642-18	PLAN NOTES - Permitted Lane Closure Schedule (PLCS)	Revised 1st paragraph to address when schedule not published. Revised last paragraph to refer to first paragraph. Updated designer note.		Willis
TEM	642-44	PLAN NOTES - Worksite Traffic Supervisor	Revise to remove reference to TTCM.		Willis
TEM	695-2	REFERENCE RESOURCES - Temporary Traffic Control Manual (reprint of OMUTCD Parts 1, 5 and 6)	Revise to indicate TTCM is no longer an active manual.		Willis
TEM	701	SCHOOL ROUTES AND ESTABLISHED SCHOOL CROSSINGS	Updated OMUTCD reference.		Beck
TEM	702-3	SCHOOL SIGNS - School Speed Limit Signs	Updated OMUTCD reference.		Beck
TEM	702-4	SCHOOL SIGNS - School Speed Limit Sign with Flashing Beacons	Updated OMUTCD reference. Update section to require use of rear-facing beacon.		Beck
TEM	702-5	SCHOOL SIGNS - SCHOOL ENTRANCE Sign (S3-H3)	Updated OMUTCD reference.		Beck
TEM	702-7	SCHOOL SIGNS - School Bus Stop Ahead Sign (S3-1); SCHOOL BUS TURN AHEAD Sign (S3-2)	Updated OMUTCD reference.		Beck
TEM	742-2	PLAN NOTES - 631 School Speed Limit Sign Assembly, Solar-Powered, As Per Plan	Deleting note. Moving applicable content to CMS 631.12.	Deletion	Beck
TEM	801-2.2	SIGNING - Application Process for STOP Sign Exemption	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	802-3	MARKINGS - Dynamic Envelope Marking with Cross-Hatching	Add information on how to pay for item and also removed reference to Florida DOT Standard Plans		Soisson
TEM	802-4	MARKINGS - Do Not Occupy Crossing Marking	Add information on how to pay for item		Soisson
TEM	804-4.4	Highway-Rail Grade Crossing Warning System Interconnection Design Guidelines - Traffic Signal Controller Unit	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	896-1 Form	Highway-Rail Grade Crossing and Timing	Updated to add columns for AP and APP, added footnotes and other minor edits for clarity		Duemmel
TEM	942-2	Plan Notes - 631 Crossing Sign Assembly with Warning Beacon, Solar Powered	Since RRFBs are now incorporated into the MUTCD, Plan Note 942-2 and its related sections in the TEM should be deleted. Will also delete 942-1 since no other notes in Part 9.	Deletion	Beck
TEM	1101	District SYSTEM LIGHTING PLAN (DSLP)	Minor updates to reference new section 1101-1		Duemmel
TEM	1101-1	District SYSTEM LIGHTING PLAN (DSLP) - Collector-Based Asset Management Databases and Required Inspection Intervals	Adding a new section related to Collector-Based Asset Management, especially as it relates to ODOT periodic inspection intervals.	New	Duemmel
TEM	1103-6.9.5	Underpasses and Tunnels - Need for Tunnel Traffic Control and ITS Devices	Update to refer to Office of TSMO rather than Traffic Operations		Beck

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TEM	1120-7	MATERIALS AND HARDWARE - Arc Flash Labeling Requirements	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1130	PLANNING / PROGRAMMING	Multiple updates throughout section to include: A list of non-roadway-illumination lighting applications, add information regarding turnkey remote-driver lighting products, just to make designers aware of their existence and potential application, and guidance on checking for obsolete 2-wire power service lighting installations.		Duemmel
TEM	1140-4.6.7.2	DESIGN INFORMATION - Luminaires and Sources - Specific Cases - Underpasses - Control Systems for Daylighting of Underpasses and Short Tunnels	Added clarifying language describing why these systems do not require 23 CFR 940 documentation.		Duemmel
TEM	1140-4.6.8.1	Tunnel Lighting Design Guidance	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1140-4.6.10	DESIGN INFORMATION - Luminaires and Sources - Specific Cases - Roundabouts	Updating design standards document reference from old DG-19-02 to RP-8-2022. This also results in minor rounding changes to the illuminance values in the Table.		Duemmel
TEM	1140-4.6.11	Mesh-Network Lighting Control Systems	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1140-5.4.4.3	Signalized Intersection Lighting Applications	Updated to indicate 5-conductor cable since that will already be in plans for signal heads		Beck
TEM	1140-7.4	Grounding - Fences and Guardrail	Revise Title and completely update content to refer to L&D Vol 1 and applicable Roadway SCDs		Holloway
TEM	1140-9	DESIGN INFORMATION - Pole Placement and protection	Revising to refer to high mast as Towers rather than poles and other minor clarifying edits		Duemmel
TEM	1142-22	Plan Notes - 625 Lighting, Misc.: FAA Type L-864 Obstruction, Medium-Intensity, Flashing ~~Lighting~~, LED	Misc updates to note to include Title change, indicating height required and referring to Office of TSMO rather than Traffic Operations.		Duemmel
TEM	1142-24	PLAN NOTES - 625 Decorative Post-Top Luminaire, Solid-State (LED), Lantern Style, 3000K, Black Finish	Revised Designer Note to refer to SS 813 Approved List and also limits luminaires to be specified to only two		Duemmel
TEM	1142-25	PLAN NOTES - 625, Decorative Post-Top Luminaire, Solid-State (LED), Acorn Style, Refractive Glass, 3000K, Black Finish	Revised Designer Note to refer to SS 813 Approved List and also limits luminaires to be specified to only two		Duemmel
TEM	1142-26	PLAN NOTES - 625, RGBW Aesthetic Lighting System	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1150-2.5	CONSTRUCTION - Project Inspection of Material	Delete Connector Kits and Splice Kits from list since these items are on QPL		Duemmel
TEM	1160-2	Lighting Maintenance Practice Process	Add reference to section 1101-1		Duemmel
TEM	1197-4 Table	Average Maintained Illuminance Design Values	Corrected 2nd Collector/Collector Row to say "Collector/Local"		Duemmel
TEM	1202	SCHOOL ZONES	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1203-2	SPEED ZONES - Procedures for Requesting and Authorizing Speed Zones	Update to refer to Office of TSMO rather than Traffic Operations		Beck

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TEM	1203-3	SPEED ZONES - Speed Zone Studies	Updated to remove reference to USLIMITS2 and instead just generically say USLIMITS since FHWA is working on release of USLIMITS3 in late 2025 or early 2026. Intent is for latest version of USLIMITS to be utilized for Speed Study		Yeray
TEM	1213-2.2	OTHER TRAFFIC ENGINEERING STUDIES - Determining Curve Advisory Speeds - Ball Bank Indicator	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1213-4.5	Systematic Signal Timing & Phasing Program (SSTPP) - Project Scope	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-1	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - General	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-3	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Requirements for All ITS Devices	- Update to refer to Office of TSMO rather than Traffic Operations - Reduced the standard design loading for ITS power services and added supporting information about multiple devices and conductor sizing - Added a requirement for designers to submit fusing recommendations when they submit voltage drop calcs		Beck
TEM	1303-4	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Closed Circuit Television (CCTV)	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-5	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Communication	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-6	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Dynamic Message Signs (DMSs)	Update to refer to Office of TSMO rather than Traffic Operations Included the new design loading from 1303-3 Added information about conductor sizing		Beck
TEM	1303-7	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Vehicle Detection or SFRD	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-8	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Highway Advisory Radio (HAR)	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-11	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Ramp Metering	Updated OMUTCD Reference and added information about conductor sizing		Beck
TEM	1303-14	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Variable Speed Limits	Update to refer to Office of TSMO rather than Traffic Operations		Beck

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TEM	1303-15	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Part-Time Travel on a Shoulder	Updated OMUTCD Reference and update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1303-16	DESIGN OF FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS. - Wrong Way Vehicle Detection Systems	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1342-2	PLAN NOTES - As-Built Construction Plans	New note describing requirements for providing as-built construction plans when ITS infrastructure installed on a project.	New	Beck
TEM	1342-3	PLAN NOTES - ITS Median Wall Raceway and Conduit System	New note describing median wall raceway and conduit system requirements	New	Beck
TEM	1342-11	PLAN NOTES - DMS & DDMS Support Structures	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1342-13	PLAN NOTES - Utilities	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1342-16	PLAN NOTES - CCTV Pole, __ Feet Tall	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1360-1	Maintenance/Operations - Inspections	Update to refer to Office of TSMO rather than Traffic Operations		Beck
TEM	1397-4 Table	CCTV Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1397-5a Table	Full-Size Walk-In Dynamic Message Sign (DMS) Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1397-5b Table	Front Access Dynamic Message Sign (DMS) Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1397-6 Table	Destination Dynamic Message Sign (DDMS) Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1397-7 Table	Vehicle Detection (SFRD) Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1397-9 Table	Ramp Metering Installations	Updates throughout table to provide current information and clarification		Beck
TEM	1415-3	RUMBLE STRIPS (INCLUDING STRIPES) IN THE ROADWAY - Rumble Stripes	• Reorganization of note • Separate edge line marking from rumble by 6” • Other various changes		Soisson
TEM	1500	Appendix	Eliminating this part of TEM. Moving applicable 1501 content to Part 1 (107) also updating definition of Pedestal and Pedestal Mount. Moving applicable 1599 content to Part 1 (108). Moving the 1505 content to a TEM FAQs page outside the individual parts and accessible from TEM homepage.	Deletion	Young

100-1.2 National Standards

To meet the need for nationwide uniformity of standards for signs, signals, markings and other devices on or adjacent to streets and highways, the **Federal Highway Administration (FHWA)** publishes the Manual on Uniform Traffic Control Devices (MUTCD) ***(see Section 193-17)*** and periodic revisions. Federal regulations **(23 CFR Part 655)**, as well as **Section 4511.09 of the Ohio Revised Code (ORC)**, require that the **Ohio Department of Transportation (ODOT)** adopt a **State** manual of uniform traffic control devices that correlates with, and so far as possible conforms to, "the system approved by the federal highway administration."

The national **MUTCD** is available on-line ***(also see*** Table 197-1***)***. Proposed changes to the national standards in the **MUTCD** are published by **FHWA** using the **Federal Register Docket** system.

100-1.3 State Standards

The Ohio Manual of Uniform Traffic Control Devices (OMUTCD) ***(see Chapter 101)*** is the **State** manual adopted by the **ODOT Director of Transportation** to establish standards for traffic control devices in **Ohio** in substantial conformance to the national manual. With the January 16, 2026 publication, the **OMUTCD** will consist of the Ohio Supplement to the MUTCD and the Federal MUTCD. To promote statewide uniformity in the design and application of traffic control devices, the **OMUTCD** standards apply to all public streets and highways, regardless of type or the level of governmental agency having jurisdiction, and site roadways open to public travel. The **OMUTCD** is available on-line.

100-1.3.1 Compliance with the OMUTCD

Any traffic control devices that are used for multimodal facilities must comply with the Ohio Manual of Uniform Traffic Control Devices (**OMUTCD**). The **OMUTCD** is incorporated and adopted in accordance with TEM 100-1.2 and 100-1.3 and is the state standard for traffic control devices installed on any street, highway, bikeway, or other multimodal facility open to public travel.

The jurisdiction implementing the multimodal facility must ensure that the project complies with the **OMUTCD.** Please note that interim approvals (IAs) have been issued by the **FHWA** for several traffic control items related to multimodal facilities. Status of all IAs is maintained on the Federal MUTCD Website. Agencies who desire to use traffic control devices with IAs must request specific approval from the **FHWA** using the procedure outlined in 1B of the **OMUTCD**. Other traffic control items not currently contained within the **OMUTCD** or that have been granted Interim Approval are still considered experimental. Agencies who desire to implement experimental traffic control devices must request approval from the **FHWA** using the procedure outlined in 1B of the **OMUTCD**.

100-1.4 Additional Specific Standards

ORC Sections 4511.10 and 4511.11 "address the responsibilities that **ODOT**, local highway authorities, and owners of site roadways open to public travel have to place and maintain traffic control devices on all highways within their respective jurisdictions in conformance with the **OMUTCD**."

For **ODOT**, the Traffic Engineering Manual (TEM), Traffic Standard Construction Drawings (Traffic SCDs), Traffic Plan Insert Sheets (Traffic PISs) and the Construction and Materials Specifications (C&MS) establish traffic control policies, standards, guidelines and specifications. These publications are discussed in detail in ***Chapters 102, 103, 104 and 105,*** respectively. See Table 197-3 for a list of available traffic engineering publications from the **ODOT** Office of Roadway Engineering (ORE) For Contact info see ***Section 100-4***.

100-2 ODOT's Role/Responsibility

As required by law **(ORC Section 4511.09)**, the **Ohio Department of Transportation (ODOT)** is responsible for adopting a manual which establishes traffic control standards that apply to all public streets and highways in **Ohio**, regardless of facility type or the level of governmental agency having jurisdiction.

The **Traffic Control Design Section** of the Office of Roadway Engineering (ORE) is responsible for developing and maintaining the **Ohio Manual of Uniform Traffic Control Devices (OMUTCD)**, and any additional **ODOT** traffic engineering design policies, guidelines, standards, etc.

The **ORE Traffic Control Design Section** is also responsible for coordinating **ODOT's** review of proposed changes to the national **MUTCD** ***(see Section 193-10)*** and preparing **ODOT's** response. Comments are solicited from related offices in **Central Office** and, time permitting, the **Districts** and others.

The procedures for revising the **OMUTCD**, **TEM**, **SCDs**, **PISs** and the **C&MS** are addressed in ***Sections 101-5, 102-5, 103-5, 104-4 and 105-3,*** respectively.

The Office of Transportation Systems Management & Operations (OTSMO) oversees many programs that collectively keep traffic moving safely and reliably on Ohio's major roads, such as the Statewide Traffic Management Center (TMC), the TSMO Funding program, Ohio's Traffic Incident Management (OTIM) program, Traffic Signal Operations, Intelligent Transportation Systems, and related data and applications.

100-2.1 District Traffic Engineer

Each district shall have a Traffic Engineers to fulfill the role as Engineer overseeing the districts traffic, signals, lighting, and sign duties. This person shall be a registered Professional Engineer in the State of Ohio with a working knowledge of traffic requirements. The duties and responsibilities of the District Traffic Engineer are as followed:

- Designs, standards, and specifications:
  - Signs, traffic signals, pavement markings, highway lighting, ITS
  - School zones, parking zones, air speed zones, work zones
- Traffic Studies
  - Curve, Speed Zone, Sight Distance, gap & capacity analysis
- Traffic Signal, multiway stop, and ramp meter warrant analysis
- Safety Studies
  - Formal, hot spot, congestion, roadway safety audit
- Traffic impact/interchange justification/interchange modification studies
- Traffic signal timing & phasing plans and modifications
- Ramp meter volume & occupancy activation thresholds

- Traffic signal maintenance agreements
- Timings for School Speed Limit Signs with Flashing Beacons
- OMUTCD & TEM interpretations
- Village signal permits & modification approvals
- Maintenance work orders
    - Signs, Traffic Signals, Pavement Markings, Lighting, ITS
- Oversight of Districtwide maintenance contracts
- Final inspection & acceptance of new traffic signals/signs/ITS/pavement marking/highway lighting
- Plan reviews
- New product approvals (QPL, APL, TAP)
- Development of policies and procedures
- Crash investigations
- Expert Witness
- Response to Attorney requests
- Sign Documents as a Registered Professional Engineer

100-4 Contacts

General traffic engineering inquiries should be directed to the **Ohio Department of Transportation,** Office of Roadway Engineering (ORE), see the contact information on the ORE Contacts page.

Comments, questions and proposed revisions of the **TEM** should be submitted to the **Office of Roadway Engineering Traffic Control Design Section** at that same address.

Comments or questions involving a specific area of concern handled by one of the **ORE or OTSMO** section supervisors or their staff may be referred directly to the appropriate area. For your convenience in addressing questions or concerns related to specific traffic engineering topics, a roster of contacts is provided below:

- ORE Contacts
- OTSMO Contacts

100-6.5 Strain Pole Design (SWISS Software)

The SWISS course provides training for consultants in the design of strain poles. It is also open to ODOT employees. The course objective is to provide assistance in the use of the computer program for the design of span wire signal supports. The SWISS software is available on-line.

To schedule a class or get additional information, please contact the **ORE Traffic Control Design Section**.

101 OHIO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES

101-1 Legal Authority

As noted in ***TEM Section 100-1.3***, the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) is the **State** manual adopted by the **ODOT Director of Transportation** to establish standards for traffic control devices in **Ohio** in substantial conformance to the national manual ***(see Section 193-10)***.

As noted in ***TEM Section 100-1.4***, **ORC Sections 4511.10 and 4511.11** make **ODOT** and local authorities within their respective jurisdictions, as well as owners of site roadways open to public travel responsible for placing and maintaining traffic control devices that conform to this manual. The **OMUTCD** and subsequent revisions apply to all traffic control devices erected in **Ohio** after the date of their adoption.

101-2 Organization

The organization of the OMUTCD is the same as the national manual. The Ohio Supplement to the MUTCD simply contains any sections, tables, or figures that contain Ohio Specific content in the Supplement Document. Currently, the **OMUTCD** is organized as follows:

- **Part 1** provides general information about the purpose of, and requirements for, traffic control devices, the legal authority of the manual, definitions and procedural information.
- **Part 2** provides information about signs, and includes barricades, gates and object markers.
- **Part 3** provides information about Markings, i.e., Pavement and Curb Markings, Delineators, Colored Pavements, and Channelizing Devices. Information about traffic control islands is also located in Part 3.
- **Part 4** provides information about highway traffic signals.
- **Part 5** provides information about traffic control device considerations for automated vehicles.
- **Part 6** provides information about temporary traffic control, including traffic incident management.
- **Part 7** provides information about traffic controls for school areas.
- **Part 8** provides information about traffic controls for highway-rail grade crossings and light rail transit grade crossings.
- **Part 9** provides information about traffic controls for bicycle facilities.
- **Appendix A** provides information about federal legislation related to the national **MUTCD**.

101-3 Format

See **Ohio Supplement to the MUTCD** Preface and Table of Contents for explanation of formatting of the Ohio Supplement document. See national **MUTCD**, Part 1 for the format of the national manual.

101-4 Distribution

The **OMUTCD** is only available electronically on-line. It can be accessed directly from the OMUTCD website or it can be accessed from the ODOT Office of Roadway Engineering (ORE) and ODOT Publications Gateway websites.

101-5 Revisions

For convenience in reviewing and updating the **OMUTCD**, the basic **ODOT** policy (since publication of **Revision 13 of the OMUTCD 1972 Edition**) has been to adopt the related text from the national manual **(MUTCD)** when preparing an **OMUTCD** revision, unless it is determined that there is a good reason to be different.

Maintaining/updating the **OMUTCD** is an ongoing function of the Office of Roadway Engineering. **OMUTCD Appendix A3** depicts the evolution of the **OMUTCD**, listing the various editions and revisions.

Comments and suggestions from users of the **OMUTCD** about the manual or proposed revisions of it are anticipated and welcome. **OMUTCD Section 1B** addresses the procedures for requesting interpretations, experimentations, changes and interim approvals. Design, application and placement of traffic control devices other than those adopted in the **OMUTCD** are prohibited unless the procedures outlined in **Section 1B** are followed. Requests for interpretations or changes in the **OMUTCD** shall be submitted to the ODOT Office of Roadway Engineering. As noted in ***Chapter 180,*** **OMUTCD Section 1B** requires that requests for permission to experiment or for interim approval of a device be submitted to the **Federal Highway Administration (FHWA).**

All proposed revisions to the **OMUTCD** will be reviewed according to the following process:

1. All proposed revisions should be submitted to the **ORE Administrator**. Preferably, a proposal for a revision of the text should include a marked-up copy of the related manual text.
2. The **ORE Traffic Control Design Section** will review the proposal and circulate it within **ODOT** for review and comment. For major revisions, a special task team or advisory committee, including representatives from the **ODOT Districts** as well as agencies and organizations outside **ODOT**, including **FHWA**, may be established to review the matter and provide comments. If a change is recommended, a draft revision will be prepared.
3. If approved by the **ORE Administrator**, the draft revision will be circulated among the **Districts**, related offices in **Central Office**, and other agencies and organizations as appropriate for review and comment.

4. The **Traffic Control Design Section** will coordinate review of comments received and preparation of revised text as needed. A final draft plus a list of any major technical difficulties, and proposed solutions, will be submitted to the **ORE Administrator** for approval.
5. If a revision of the **OMUTCD** is to be made, it will be prepared by the **Traffic Control Design Section** and a copy will be submitted to the local **FHWA** office for review and concurrence.
6. If the scope of the revision results in a complete new edition of the **OMUTCD**, it will be published to the website; otherwise, a copy of the revised **Ohio Supplement to the MUTCD** will be posted on the **OMUTCD** website. In either case, an e-mail announcement will also be sent to all those who have subscribed to the list service for the **OMUTCD.**

102 TRAFFIC ENGINEERING MANUAL

102-1 General

The purpose of the **Traffic Engineering Manual (TEM)** is to ensure, as much as possible, uniformity within **ODOT** regarding traffic engineering concerns by consolidating all this information into one manual. Some of this information can be critical in addressing the needs of our customers, and some may just be useful in simplifying or clarifying information published elsewhere. The **TEM** should be a useful tool in training personnel new to the subject, as well as providing a resource in addressing the wide range of inquiries from our customers, **ODOT** personnel, consultants, contractors, other government agencies and private citizens.

Except as noted in specific Sections, the policies, guidelines, procedures and standards established in this Manual are applicable only to **ODOT**-maintained highways and not local roads and streets. However, local jurisdictions are encouraged to use this publication and, as noted in ***Section 100-3***, may need to reference it at times, e.g., the **OMUTCD** references the **TEM** for some information.

102-2 Organization

The **TEM** has been arranged generally in the sequence of topics addressed in the **OMUTCD**. The Manual includes fifteen parts, arranged in the following sequence:

- **Part 1, General**, provides information about the organization and use of this and other publications, as well as general traffic-related materials, planning/programming, design, construction and maintenance/operations information.
- **Part 2, Signs**, provides information about traffic control signs.
- **Part 3, Markings**, provides information about markings and islands.

- **Part 4, Signals**, provides information about traffic signals.
- **Part 5,** has been reserved to provide traffic control device considerations for automated vehicles.
- **Part 6, Temporary Traffic Control**, provides information about temporary traffic control devices and applications, including traffic incident management.
- **Part 7, School Areas**, provides information about standards for traffic control in school areas, including school zone extensions.
- **Part 8, Railroad and Light Rail Transit Grade Crossings**, provides information about traffic controls at railroad-highway and light rail grade crossings.
- **Part 9, Bicycle Facilities**, provides information about traffic control devices related to Bicycle Facilities.
- **Part 10**, has been reserved for future use.
- **Part 11, Highway Lighting**, provides information about highway lighting.
- **Part 12, Zones and Traffic Engineering Studies**, provides information about traffic control zones and traffic engineering studies.
- **Part 13, Intelligent Transportation Systems (ITS)** provides information about various aspects of this subject, such as Systems Engineering Analysis (SEA) and Freeway Management Systems.
- **Part 14, Miscellaneous**, provides information about miscellaneous related devices, procedures, etc., such as rumble strips and driveway mirrors, that are not directly related to any single topic discussed in one of the other Parts of the **TEM**.

102-3 Format

102-3.1 General

Various format conventions have been adopted for this Manual. For convenience (and as a record and reminder for those developing text for the Manual), they have been consolidated in this Section.

A Table of Contents has been provided for each Part.

102-3.2 Numbering/Labeling Conventions

The following numbering conventions have been used in this Manual to provide a consistent organization for each Part. This is intended to help locate information and to simplify cross- references within the **TEM**:

1. Chapters and Sections within each Part are numbered based on the Part or Chapter number. For example, in Part 1 the Chapter and Section numbers start with 100. The Chapter headings in each Part are identified with a slightly larger font shown in bold and all capital letters.
2. Material within each Part in the **TEM** is generally arranged in a set pattern, for example (with "x" representing the Part number):
    a. Chapters x10 thru x29 – general standards and guidelines information presented.
    b. Chapter x30 – Planning/Programming information.

c. Chapter x40 – Design Information.

d. Chapter x41 – Plan Preparation/Production information.

e. Chapter x42 – **Plan Notes** and related designer information.

f. Chapter x43 – a listing of related **specification** items.

g. Chapter x50 – Construction-related material. This is generally intended to include information used in inspecting installation of traffic control devices on construction projects; however, this information may also be useful for ODOT force account installation of various devices.

h. Chapter x60 – Maintenance/Operations information. This generally addresses preventive maintenance and other operational issues.

i. Chapter x95 – has been reserved in each Part to incorporate discussion, as appropriate, about related, but separately published publications. For example, although the Sign Designs and Markings Manual (SDMM) is formally "incorporated" into the **TEM** as ***Section 295-2***, due to its size, and the fact that some people will not need both the **TEM** and the **SDMM**, the **SDMM** is published separately. To help avoid unnecessary reference to these other volumes, a brief description of each of these publications is included in the **TEM** text, with an indication of how it relates to the other information in this Manual ***(see Sections 295-2)***.

j. Chapter x96 – Forms referenced in the text, including a Forms Index with cross- references to related text Sections.

k. Chapter x997 – Tables referenced in the text, including a Tables Index with cross- references to related text Sections.

l. Chapter x98 – Figures referenced in the text, including a Figures Index with cross- references to related text Sections. Some figures may include charts.

3. Subdivisions of Chapters, Sections, have been labeled with a hyphenated number based on the Chapter number, e.g., ***Section 102-3***. The titles of these Sections are bold.

4. If further subdividing of information in a Section is needed, decimals are used with the number, e.g., ***Section 102-3.2*** and ***Section 205-2.3.1***. The titles of these subdivisions are bold and smaller size.

102-3.3 Text

Text format in the **TEM** generally follows that used in the **OMUTCD**; however, a few additional conventions have also been used.

1. References to Sections, forms, tables and figures within the **TEM** are highlighted using bold/italic text, e.g., ***Chapter 102***.
2. References to organizations, titles, documents, etc. are highlighted using bold text, e.g., **OMUTCD**.

102-3.4 Units of Measure

ODOT uses English units as the standard.

102-3.5 Definitions

As noted earlier ***(Section 102-2)***, in addition to **OMUTCD** Part 1, Chapter 107 of this Manual provides definitions of terms (including acronyms) used in this and related documents.

102-3.6 Artwork

Sign cuts for signs addressed in the **TEM** and not shown in the **OMUTCD** are included in the **TEM**.

Each form, table and figure is individually numbered. Editable copies of the forms and tables are available, as well as most of the figures.

102-4 Distribution

The **TEM** is only available electronically on-line. It can be accessed directly from the TEM webpage or from the ODOT Office of Roadway Engineering (ORE) and the ODOT Publications Gateway.

As needed, revisions of the **TEM** are posted to the web on a semi-annual basis. It is the responsibility of the individual receiving or downloading the Manual to ensure they are accessing the most recent publication version. A subscription service is available on the ODOT Publications Gateway website to allow interested individuals to receive e-mail notifications when updates and notices are posted.

102-5 Revisions

Maintaining/updating the **TEM** is an ongoing **ORE** function. The TEM Revision History page documents revisions of this Manual. Comments and suggestions from users of the Manual are anticipated and welcome.

All revisions to this Manual will be reviewed according to the following process:

1. All proposed revisions from outside **ORE** should be submitted to the **ORE Traffic Control Subject Matter Expert with the ORE Administrator and ORE Traffic Control Section Head copied**. Preferably, a revision proposal should include a marked-up copy of the related Manual text.
2. The proposal is circulated within **ORE** for review and comment. Depending on the subject and the scope of the proposed revision, the proposal should also be circulated to the **Districts** and related Offices in **Central Office** for review and comment. For major revisions, a special task team, including representatives from outside ORE, may be established to review the matter and provide comments. If a change is recommended, a draft revision will be prepared by the **Traffic Control Design Section**.
3. Per **Standard Procedure 122-004(SP)**, an approved **TEM** revision proposal is submitted to the **ODOT Standards and Specifications Committee** for review and approval; and then to the **Executive Committee** for final approval.

4. If approved, a **TEM** revision is finalized and posted to both the **TEM** website and the ODOT Publications Gateway. An e-mail announcement is sent to all those who have subscribed to the list service for the **TEM/SDMM** (on the Publications Gateway web page).

103 STANDARD CONSTRUCTION DRAWINGS

103-1 General

Numbered Standard Construction Drawings (SCDs) published by **ORE** have been established to standardize inclusion of certain traffic control information in **ODOT** contract plans. The drawings are developed and published by **ORE**. In addition to contract plans, they should also be used by **ODOT** operational forces as directed in this Manual and at other times when considered appropriate. **Designer Notes** have been developed to help define the intended use of **SCDs *(see Section 140-3)***.

Copies of the drawings are available on-line from the ORE Traffic SCD website.

103-2 Organization

The **Traffic Standard Construction Drawings (SCDs)** set is composed of individual standard drawings, grouped in four general categories, Highway Lighting (HL), Maintenance of Traffic (MT), Intelligent Transportation Systems (ITS) and other Traffic Control items (TC).

103-3 Format

To promote uniformity within **ODOT**, CADD standards have been established for published documents. Generally, these standards shall be used in all **MicroStation** drawings that are intended to be incorporated within the various publications. The CADD Engineering Standards Manual establishes specific CADD standards for use in developing plan sheets, including plan detail sheets developed for individual plans.

103-4 Distribution

Traffic SCDs, and the index for them, are available for downloading, as **MicroStation** or .pdf files, from both the Office of Roadway Engineering (ORE) SCD and the ODOT Publications Gateway websites.

As needed, revisions are posted on a semi-annual basis. It is the responsibility of the individual receiving or downloading the drawings to ensure they are accessing the most recent publication version. A subscription service is available on the Publications Gateway website to allow interested individuals to receive e-mail notifications when updates and notices are posted.

103-5 Revisions

Comments or questions about the drawings shall be directed to the **ORE Traffic Control Design Section**.

The Section maintains a log of work needed on the **Traffic SCDs**, assigns drawing numbers as needed, and generally coordinates development and approval of the drawings. The **ORE Traffic Control Design Section** reviews and develops new or revised, and when considered complete, submits the proposed new or revised drawing for review and approval by the Standards and Specifications, and Executive Committees. When approved, the official "revision date" is added to the drawing and it is scheduled for distribution in the next revision.

107 DEFINITIONS

107-1 General

Generally, for traffic control purposes, the definitions found in the **OMUTCD** will apply. Also, for design purposes, there are additional definitions provided in the three volumes of the **L&D Manual**. Additional definitions, including explanations of various acronyms, have been provided in this Chapter. For the convenience of the **TEM** users, some definitions found in the **L&D Manual** have also been included; however, definitions found in the **OMUTCD** have not been repeated unless there is a difference noted between how the term is used for traffic control purposes versus design purposes.

107-2 Acronyms and Abbreviations

Some of these acronyms and abbreviations may not be used in the **TEM** at this time; however, they are provided here as a convenience since they may appear in related references.

AAN – **American Association of Nurserymen**.

AASHTO – **American Association of State Highway and Transportation Officials**.

ACI – **American Concrete Institute**.

ADA – **Americans with Disabilities Act**.

ADAAG – **ADA Accessibility Guidelines**.

AISC – **American Institute of Steel Construction**.

AISI – **American Iron and Steel Institute**.

ANSI – **American National Standards Institute**.

AREA – **American Railway Engineering Association**.

ASCE – **American Society of Civil Engineers**.

ASM – **Application Standards Manual.** A manual previously published by the **Office of Traffic Engineering (OTE)** and was incorporated into the **TEM**.

ASME – **American Society of Mechanical Engineers**.

ASTM – **American Society of Testing and Materials.**

ATSSA – **American Traffic Safety Services Association.**

AWG – **American Wire Gauge.**

AWS – **American Welding Society.**

AWWA –**American Water Works Association.**

AWPA – **American Wood Preservers' Association.**

CGM – **Construction Guidelines Manual.** A manual which was previously published by OTE and was incorporated into the **TEM**.

DDD – **ODOT District Deputy Director.**

CADD – Computer-Aided Drafting and Design. See ***Section 1501-3*** for additional information.

C&MS – **Construction and Materials Specifications Book**. See ***Part 1*** for additional information.

EEI – **Edison Electric Institute**.

EMA – **Emergency Management Agency**.

EPA – **Environmental Protection Agency**.

FHWA – **Federal Highway Administration, Department of Transportation**.

FSP – Freeway Safety Patrol.

FSS – **Federal Specifications and Standards** from the **General Services Administration**.

GLCT – Great Lakes Circle Tour. See ***Part 2*** for additional information.

GSDM – **Guide Sign Design Manual (also known as the Design Manual for Directional Guide Signs)**. A manual previously published by **OTE**. The information is now located in Appendix C of the **Sign Designs and Markings Manual**, which is incorporated by reference into the **TEM**.

HazMat – Hazardous Material.

HCM – **Highway Capacity Manual**.

HMA – Highway Management Administrator.

HT – Highway Technician.

IC – Incident Commander.

ICS – Incident Command System.

IEEE – **Institute of Electrical and Electronic Engineers**.

IES – **Illuminating Engineering Society.**

IMSA – **International Municipal Signal Association.**

IPCEA – **Insulated Power Cable Engineers Association.**

ISSA – **International Slurry Seal Association.**

ITS America – **Intelligent Transportation Society of America**

ITE – **Institute of Transportation Engineers.**

OTIS – **Ohio Transportation Information System.**

L&D Manual – Location and Design Manual. A three-volume set of design manuals published by the **Office of Roadway Engineering Services** (Volume 1), the **Office of Hydraulic Engineering** (Volume 2) and the **Office of CADD and Mapping Services** (Volume 3).

LECT – Lake Erie Circle Tour. See ***Part 2*** for additional information.

LOS – **Level of Service**. See ***Section 1501-3*** and the L&D Manual Volume 1, for additional information.

L.C.L. – **Light Center Length**. See ***Section 1501-3*** for additional information.

LEO – **Law Enforcement Officer**.

LPA – **Local Public Agency**.

LTAP – Local Technical Assistance Program. See ***Section 1501-3*** for additional information.

MPO – Metropolitan Planning Organization. A federally designated collective for administering funding for projects within its jurisdiction, generally a group of local political entities in a geographical area.

MUTCD – **Manual on Uniform Traffic Control Devices**. This manual, published by **FHWA**, is described in ***Section 193-10***.

NCUTCD – **National Committee on Uniform Traffic Control Devices**. See ***Section 1501-3*** for additional information.

NEMA – **National Electrical Manufacturers Association**. See ***Section 1501-3*** for additional information.

NIMS – **National Incident Management System**.

OCA – **Office of Construction Administration**.

OHGO – A website that provides up-to-the-minute details on current traffic speeds, cameras, incidents, road conditions, and weather-related conditions.

ODNR – **Ohio Department of Natural Resources**.

ODOT – Ohio Department of Transportation.

OEPA – **Ohio Environmental Protection Agency**.

OMUTCD – **Ohio Manual of Uniform Traffic Control Devices**. See ***Section 101*** for additional information.

OPI – **Ohio Penal Industries**.

ORC – **Ohio Revised Code**.

ORDC – **Ohio Rail Development Commission**.

OSHA – **Occupational Safety and Health Administration**.

OTE – **Office of Traffic Engineering.** The traffic standards functions moved to the Office of Roadway Engineering in late 2012, and the remaining group was designated the Office of Traffic Operations (OTO).

O.L. – Overall Length. See ***Section 1501-3*** for additional information.

PDP – **Project Development Process**. **ODOT's** process for development of all projects bid or developed through **ODOT**.

PIS – Plan Insert Sheets. See ***Section 104*** for additional information.

PLCS – Permitted Lane Closure Schedule.

PS&E – Plans, Specifications & Estimates. See ***Section 1501-3*** for additional information.

RAM – Random Access Memory. See ***Section 1501-3*** for additional information.

REA – **Rural Electrification Administration**

ROM – Read Only Memory. See ***Section 1501-3*** for additional information.

RPM – Raised Pavement Marker. See ***Section 1501-3*** for additional information.

SCD – Standard Construction Drawing. See ***Section 1501-3*** for additional information.

SDMM – Sign Designs and Markings Manual. The **Standard Sign Design Manual** is described in ***Section 295-2***.

SHS – **Standard Highway Signs and Markings book**. This manual, published by **FHWA**, is described in ***Section 193-14***.

SOP – Standard Operating Procedure.

SSPC – **Steel Structures Painting Council**.

SLD – Straight Line Distance. See ***Section 1501-3*** for additional information.

TCD – Traffic Control Device.

TCDIM – **Traffic Control Design Information Manual**. A manual, previously published by **OTE**, which has been incorporated into the **TEM**.

TCP – Traffic Control Plan.

TEM – Traffic Engineering Manual.

TIMS – Transportation Information Mapping System. Web-based mapping tool; providing transportation employees and stakeholders, and the general public, a central access point for viewing, distributing, and analyzing **Ohio's** transportation data.

TIP – Transportation Improvement Plan. The method by which projects are accepted by the MPO.

TMA – Truck-Mounted Attenuator.

TMC – Traffic Management Center.

TODS – Tourist Oriented Directional Signs. See ***Section 1501-3*** and ***Part 2*** for additional information.

TRAC – Transportation Review Advisory Council.

TRPM – Temporary Raised Pavement Marker.

TTCD – Temporary Traffic Control Device.

UL – Underwriters' Laboratories, Inc.

107-3 Words and Phrases

The **OMUTCD** defines various terms used in that manual and herein. When the source of the definition is the **ORC** (usually **Section 4511.01**), the definition is shown in italics and the **ORC** section number is noted. The following list is intended to provide definitions of words and phrases not currently defined in the **OMUTCD**.

Some of the definitions in this Section will be incorporated into the **OMUTCD**; however, most of them are more detailed than needed for the **OMUTCD**. The source for most of these definitions was the **Construction Guidelines Manual**, previously published by **OTE** and now incorporated into the **TEM**. When definitions have been taken from other sources, such as the national **Manual on Uniform Traffic Control Devices (MUTCD)** and the **ODOT L&D Manuals**, they have been identified by a cross-reference.

Also, some of the terms noted herein may have different meanings depending on the context in which they are used. Clarification has been provided as needed.

Adaptation – The process by which the retina becomes accustomed to more or less light than it was exposed to during an immediately preceding period.

Adjustable Signal – A signal head having the signal faces mounted in the support hardware so that each face may be adjusted or "aimed," as required to present the indication to approaching traffic.

Alternate Bid – A bid process in which both a generic bid and a proprietary bid are taken for the same item of equipment or work. The maintaining agency may choose which bid to accept; however, if the agency chooses the proprietary bid and it is higher than the generic bid, it must use its own funds for 100 percent of the cost difference.

Amplifier – A device that is capable of intensifying the electrical energy produced by a sensor.

Analog Controller – A controller with a method of timing that measures continuous variables such as voltage or current.

Arterial Highway (or Street) – For traffic engineering purposes (**ORC 4511.01 and** OMUTCD), any U.S. or State numbered route, controlled-access highway, or other major radial or circumferential street or highway designated by local authorities within their respective jurisdictions as part of a major arterial system of streets or highways.

For design purposes, a functional classification for a facility primarily used for through traffic, usually on a continuous route (L&D Manual Volume 1).

Attenuator (Crash Cushion) – Protective device that prevents errant vehicles from impacting a fixed object by gradually decelerating or redirecting the vehicle (L&D Manual Volume 1).

Auto-Manual Switch – See Switch, Auto-Manual.

Auxiliary Equipment – Separate control devices used to add supplementary features to a signal controller.

Balance Adjuster – A device used to permit alignment of the point of suspension with respect to the center of gravity of the signal head so that the signal will hang vertically.

Ballast – An auxiliary device used with vapor lamps, on multiple circuits, to provide proper operating characteristics. It limits the current through the lamp, and may also transform voltage.

Ballast Mounting – Ballast shall be mounted within the luminaire housing (integral).

Bandwidth – The amount of green time available to a platoon of vehicles in a progressive signal system. This is also referred to as through band.

Barrier – A device which provides a physical limitation through which a vehicle would not normally pass. It is intended to contain or redirect a vehicle (L&D Manual Volume 1).

Barrier (Compatibility Line) – A reference point in the preferred sequence of a multi-ring controller unit at which all rings are interlocked. Barriers assure there will be no concurrent selection and timing of conflicting phases for traffic movement in different rings. All rings cross the barrier simultaneously to select and time phases on the other side **(NEMA)**.

Barrier Clearance – The distance required between the face of a barrier and the face of an obstacle to permit adequate shielding (L&D Manual Volume 1).

Barrier Curb – See Curb, Vertical.

Base Plates – In sign support breakaway connections, plates welded onto each beam half with skewed notches for torqued bolts so as to permit the plates to part under vehicle impact.

Bead Flotation – The ability of glass beads to assume a hemispheric secured position when dispensed onto the surface of the freshly applied pavement markings.

Beam Candlepower – The intensity of a beam forming light source expressed in candelas measured in a given direction.

Beam Spread – The angle between the two directions in the plane in which candlepower is equal to a stated percent (usually 10 percent) of maximum candlepower in the beam.

Beam-Type Support – See **Support, Beam-Type**.

Bearing Plate – A formed steel plate installed between a flatsheet sign and its mounting post so as to reinforce the sign.

Bid, Alternate – See **Alternate Bid**.

Bid, Generic – See **Generic Bid**.

Bid, Proprietary – See **Proprietary Bid**.

Binder – Resins and liquids used to combine dry ingredients into a formulation of pavement marking materials.

Bleeding – A condition where asphalt pavement surfaces soften to a point where released oils appear as stains in the marking.

Buffer - The space between the face of the curb and the sidewalk for the purpose of providing snow storage, a buffer between cars and pedestrians, a place for signs and to improve aesthetics (L&D Manual Volume 1).

In a **TEM**porary traffic control situation, "the buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle." **(OMUTCD Section 6C.06)**

Bracket Arm – A signal bracket, for bracket-mount applications, of tubular construction through which wiring can be passed to provide electrical connection of the signal faces.

Breakaway Beam-Type Support – See **Support, Breakaway Beam-Type**.

Burning position – Physical positioning of the lamp in the traffic signal. Normally, traffic signal lamps are used in horizontal burning position.

Cable – A group of separately insulated wires in a common jacket.

Cable Entrance Adapter – A device of tubular construction which is used between the span wire hanger and the traffic signal to provide for passing signal cable into the head.

CADD (Computer-Aided Drafting and Design) – The preferred method of preparing **ODOT** construction plans. **ODOT** has adopted **MicroStation** as its standard CADD software package and has developed various CADD standards to ensure plan uniformity.

Call – A registration of demand for right-of-way by traffic (vehicular or pedestrian) at a signal controller.

Calling Detector – A detector that is installed in a selected location to detect vehicles which may not otherwise be detected, and whose output may be modified by the controller unit.

Calling Relay – A detector relay which will allow a detector actuation to be transferred to the controller only when certain signal displays are occurring.

Camber – An upward curve in horizontal structural members so that when erected and under dead weight a horizontal position or slightly upward curve will result.

Camshaft – A device consisting of a stack of programmed cams operated by a drive motor for intermittent advancement in increments to cause contacts to open or close, thus causing the required signals to be energized.

Candela (cd) – The unit of luminous intensity; one candela is defined as the luminous intensity of 1/60th of one square centimeter of projected area of a blackbody radiator operating at the temperature of solidification of platinum.

Candlepower – Luminous intensity expressed in candelas.

Cantilever Support – See Support, Cantilever.

Carryover (Extended) Output – The ability of a detector to continue its output for a predetermined length of time following an actuation.

Catch Basin – A structure for intercepting flow from a gutter or ditch and discharging the water through a conduit (L&D Manual Volume 2).

Centerline of Construction – The reference line used for construction of a project. Normally located at the median centerline on a divided highway or at the normal crown point location on an undivided highway (L&D Manual Volume 3).

Centerline of Right-of-Way – The reference line used for the right-of-way of a project. Normally located at the center of a highway's existing right-of-way (L&D Manual Volume 3).

Center-Mount Support – See Support, Center-Mount.

Centralized Control Signal System – A system in which all control functions are controlled by a computer with direct communication to each local intersection controller without using the intermediate control and processing of a master controller.

Centrally Controlled – A system of peripheral devices which communicates with and which is manipulated via, a central control operator or software.

City – A municipal corporation having a population of 5,000 or more persons **(ORC Section 703.1)**.

Classification Detector – A detector that has the capability of differentiating among types of vehicles.

Clear Zone – The unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bike lanes, and auxiliary lanes, except those auxiliary lanes that function like through lanes. (L&D Manual Volume 1).

The total roadside border area, starting at the edge of the traveled way, that is wide enough to allow an errant driver to stop or regain control of a vehicle. This area might consist of a shoulder, a recoverable slope, and/or a non-recoverable, traversable slope with a clear run-out area at its toe (OMUTCD).

Coefficient of Utilization (CU) – Ratio of luminous flux (lumens) received on the work area to the rated lumens emitted by the lamp.

Cloverleaf Interchange – An interchange with loop ramps and outer ramps for directional movements. A full cloverleaf has ramps in every quadrant (L&D Manual Volume 1).

Collector – A functional classification for a facility in an intermediate functional category connecting smaller local road or street systems with larger arterial systems (L&D Manual Volume 1).

A term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways (OMUTCD).

Collector-Distributor (C-D) – A directional roadway adjacent to a freeway used to reduce the number of conflicts (merging, diverging and weaving) on the mainline facility (L&D Manual Volume 1).

Commercial Activity – For purposes of defining Tourist Oriented Activity for the TODS program, this is defined as "a farm market, winery, a bed and breakfast, lodging that is not a franchise or part of a national chain, antiques shop, craft store, or gift store."

Computed Initial Portion (Added Initial Portion, Variable Initial Portion) – An initial portion which is added to the minimum actuations on volume density timed controllers.

Computer – A device capable of accepting information, applying prescribed processes to the information and supplying results of these processes. It usually consists of input and output devices, storage, arithmetic and logic units, and a control unit.

Computer Program – A series of instruction or statements in a form acceptable to the computer which will achieve a certain result.

Concurrent timing – See Dual-ring Controller.

Conduit – A closed structure such as a pipe that has a span less than 10 feet as measured in a parallel direction to the roadway centerline (L&D Manual Volume 2).

Condulet – A fitting connected to solid or flexible electrical conduit to direct the routing path and containing a removable cover for wire pulling.

Conflicting Phases – Two or more signal phases which will cause interfering, or conflicting, traffic movements if operated concurrently.

Congestion Detection – A system of hardware and software designed and operated to provide data on the level of traffic congestion in the area being detected.

Contact, Signal Circuit – A device arranged to energize or de-energize signal light circuits during a specified interval.

Continuous Presence Mode – Detector outputs continue if any vehicle (first or last remaining) remains in the field of influence.

Controller (Controller Assembly) – A complete electrical or electronic device mounted in a cabinet for controlling the operation of a traffic signal (OMUTCD).

Controller, Local Intersection – See **Local Intersection Controller**.

Controller, Master – See **Master Controller**.

Controller, Traffic-Actuated – See **Traffic-Actuated Controller**.

Construction Limits – Lines shown on a plan view that outline the lateral extent of the work. Typically placed 4 feet outside the point where the backslope touches the existing ground unless additional room is required for construction activities (L&D Manual Volume 3).

Controlled-Access Highway – **(Partial Control of Access)** - Every highway, street or roadway in respect to which owners or occupants of abutting lands and other persons have no legal right of access to or from the same except at such points only and in such manner as may be determined by the public authority having jurisdiction over such highway, street or roadway **(ORC 4511.01 and** OMUTCD).

Highway right-of-way where preference is given to through traffic. In addition to access connections with selected public roads, there may be some private drive connections (L&D Manual Volume 1).

Converging Roadway – Separate and nearly parallel roadways or ramps which combine into a single continuous roadway or ramp having a greater number of lanes beyond the nose than the number of lanes on either approach roadways (L&D Manual Volume 1).

Coordinator (Coordination Unit) – A device used to interrelate the timing of one controller to others in a traffic signal system.

Coordination – See Signal Coordination.

Crash Cushion – See Attenuator.

Culvert – A structure which is typically designed hydraulically to take advantage of submergence at the inlet to increase hydraulic capacity. A structure used to convey surface runoff through embankments. A structure, as distinguished from a bridge, which is usually covered with embankment and is composed of structural material around the entire perimeter, although some are supported on spread footings with the streambed serving as the bottom of the culvert (L&D Manual Volume 2).

Curb, Sloping – Sloping curbs are designed so vehicles can cross them readily when the need arises. They are low with flat sloping faces. Total curb height should not exceed 6 inches. Formerly called Mountable Curb **(AASHTO)**.

Curb, Vertical – Vertical curbs may be either vertical or nearly vertical and are intended to discourage vehicles from leaving the roadway. The curb height ranges from 6 to 8 inches (150 to 200 millimeters). Formerly called Barrier Curb **(AASHTO)**.

Cycle – Any complete sequence of signal indications.

Cycle Selection Switch – A device which when operated discontinues automatic selection of cycle unit with associated split(s) and offset(s) and permits manual selection of another cycle unit.

Daylight Reflectance – The measure of daylight reflected from a pavement marking for the enhancement of visibility.

Decoder – A mechanism for translating a code into its various components.

Decision Sight Distance – The distance required for a driver to detect an unexpected or otherwise difficult-to-perceive information source or hazard in a roadway environment that may be visually cluttered, recognize the hazard or its threat potential, select an appropriate speed and path, and initiate and complete the required maneuver safely (L&D Manual Volume 1).

Dedicated Lines – Communication lines used solely to interconnect two or more intersections.

Delayed Output – The ability of a detector to delay its output for a predetermined length of time during an extended actuation.

Delay Relay – A detector relay which will provide an actuation only after the relay has been continuously energized for a set period of time.

Demand – The need for service, e.g., the number of vehicles desiring to use a given segment of roadway during a specified unit of time.

Demountable Copy – Sign copy made up of separate letters, digits, symbols, shields and border sections which are riveted or bolted to the sign panel and which may be readily removed.

Density – A measure of the number of vehicles per unit length of roadway; a measure of the concentration of vehicles usually stated as the number of vehicles per mile per lane.

Department – The **Ohio Department of Transportation**.

Design Exception – A document which explains the engineering and/or other reasons for allowing certain design criteria to be relaxed in extreme, unique, or unusual circumstances (L&D Manual Volume 1).

Design Hour – The 30th highest hourly volume of the design year (L&D Manual Volume 1).

Design Hourly Volume – The total volume of traffic in the design hour, usually a forecast of peak hour volume, measured in vehicles per hour (L&D Manual Volume 1).

Design Speed – A selected speed used to determine the various geometric design features of the roadway (L&D Manual Volume 1).

Destination Signs – Signs providing distance and/or directional information to a city, village or other objective.

Detections – The process used to identify the presence or passage of vehicles at a specific point or to identify the presence of one or more vehicles in a specific area.

Detector Modes – A term used to describe the duration of detector output when a detection occurs.

Diagnostic – (1) Pertaining to the detection, discovery and further isolation of a malfunction or mistake; (2) A program that facilitates computer maintenance by detection and isolation of malfunctions or mistakes.

Diamond Interchange – The simplest and most common type of interchange, formed when one-way diagonal ramps are provided in each quadrant and left turns are provided on the minor highway (L&D Manual Volume 1).

Diffuser – A device to redirect or scatter the light from a source, primarily by the process of diffuse transmission.

Digital Controller – A controller wherein timing is based upon a defined frequency source such as a 60-hertz alternating power source.

Digital Timing – See **Timing, Digital**.

Dilemma Zone – The range of distances from the Stop Line within which drivers are indecisive as to whether to stop or proceed through the intersection when the traffic signal indication changes from green to yellow. Distances are dependent upon travel speed.

Directional Interchange – An interchange, generally having more than one grade separation, with direct connections for all movements (L&D Manual Volume 1).

Direct Applied Copy – Sign copy cut from sheeting material and applied to the sign surface by a coated adhesive.

Direct Glare – Glare resulting from high brightness or insufficiently shielded light sources in the field of view or from reflecting areas of high brightness.

Direct Wire – A communications medium which uses hardware interconnect between the transmission and reception points.

Directional Detector (or Relay) – A detector that is capable of being actuated only by vehicles proceeding in one specified direction.

Directional Relay – A relay connected with detectors and designed to actuate only when traffic has crossed the detectors in a certain direction.

Disability Glare – Glare which reduces visual performance and visibility and which is often accompanied by discomfort.

Discomfort Glare – Glare which produces discomfort. It does not necessarily interfere with visual performance or visibility.

Disconnect Hanger – A mounting device for quick detachment or attachment of a signal head.

Distributed Control Signal System – A system in which all control functions are controlled by a master controller which is connected to all local intersections under its control. The master controller is typically located at an on-street location near the local intersection it controls. The master controller is connected to a computer to enable an operator to control, monitor and produce reports from each master controller database.

Divergence Angle – The angle at a reflective surface between a light ray striking the surface and an observer's line of sight.

Diverging Roadway – Where a single roadway branches or forks into two separate roadways without the use of a speed change lane (L&D Manual Volume 1).

Down Time – The time during which a device is unavailable for normal operation.

Drop-on Beads (Surface Applied Beads) – Glass beads dispensed concurrently with wet or molten marking material placement so that the beads are held on the surface to provide instantaneous retroreflectorization.

Dual Entry – See **Entry, Dual**.

Dual-ring Controller – A controller containing two interlocked rings which are arranged to time a preferred sequence and to allow concurrent timing of both rings, subject to the restraint in the Barrier (Compatibility Line).

Dummy Interval – A redundant interval in the cam switching mechanism incorporated so as to allow the total number of intervals in the cycle to correspond integrally with the total number of intervals provided on the cam switching mechanism.

Dwell – See **Rest**.

Edge of Traveled Way – The intersection of the mainline pavement with the treated or turf shoulder or the curb and gutter (L&D Manual Volume 1).

Electromechanical Controller – A controller which is characterized by electrical circuits using relays, step switches, motors, etc.

Electromechanical Electronic Controller – A controller combining electromechanical components and electronic timing circuits comprised of vacuum electronic tubes, resistors, capacitors and inductors, etc.

Emergency-Traffic Signal – A special adaptation of a traffic control signal to obtain the right-of-way for an authorized emergency vehicle.

Encoder – A device which converts data into a form for transmission over the communication link between two points in a system.

Entrance Ramp Approach Signs – Signs at a freeway or expressway interchange providing state route identification and directional information.

Entry, Dual – A mode of operation (in a dual-ring controller) in which one phase in each ring must be in service. If a call does not exist in a ring when it crosses the barrier, a phase is selected in that ring to be activated by the controller in a predetermined manner.

Entry, Single – A mode of operation (in a dual-ring controller) in which a phase in one ring can be selected and timed alone if there is no demand for service in a non-conflicting phase on a parallel ring.

Epoxy Markings – A mixture of epoxy resin and polymeric curing agent blended in a nozzle and spray applied to the pavement.

Expressway – As noted in OMUTCD Section 1A.13 **and ORC 4511.01(ZZ)**, for purposes of the traffic control standards, "a divided, arterial highway for through traffic with full or partial control of access with an excess of fifty percent of all crossroads separated in grade."

For design purposes (L&D Manual Volume 1), "a divided, arterial highway with full or partial control of access and generally with grade separations at major intersections."

Extendible Portion (Extensible Portion) – That portion of the green interval on an actuated phase following the initial portion which may be extended by traffic actuations.

Extension Detector – A detector that is arranged to register actuation at the controller only during the green interval for that approach so as to extend the green time of the actuating vehicles.

Extension Interval (Gap) – The timing interval during the extendible portion which is resettable by each detector actuation. The green right-of-way of the phase may terminate on expiration of the unit extension time.

Extension Limit – See **Limit, Extension**.

Extruded Markings – Pavement markings applied in a plastic state by means of a shaping die.

Extrusheet Sign – See **Sign, Extrusheet**.

Field Terminal Blocks - See **Terminal Blocks, Field.**

Filament – The electrical resistance element heated to incandescence by electric current.

Fill Slope – See **Foreslope**.

Filler – An ingredient adding bulk to the formulations of pavement marking materials.

Flash Control Switch – See **Switch, Flash Control**.

Flasher Controller – A complete electrical mechanism with cabinet for flashing a traffic signal or beacon.

Flatsheet Sign – See **Sign, Flatsheet.**

Footcandle (fc) – The unit of illumination when the foot is the unit of length; the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen. It equals one lumen per square foot.

Footlambert (fl) – The unit of brightness equal to the uniform brightness of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot. On a roadway, it equals the illumination in footcandles multiplied by the reflection factor of the surface.

Force Account – The direct performance of highway construction work by a highway agency, a railroad company or a public utility company by use of labor, equipment, materials and supplies furnished by them and used under their direct control.

For a construction project, force account is defined as a basis of payment for the direct performance of highway construction work with payment based on the actual cost of labor, equipment and materials furnished.

Force Off – A command to the controller that will force the termination of the current right-of-way interval during the extendible portion.

Force Skip – See **Omit, Phase**.

Foreslope – The slope from the edge of the graded shoulder to the bottom of the ditch. Also, called Fill Slope (L&D Manual Volume 1).

Freeway – As noted in **OMUTCD Section 1A.13 and ORC 4511.01(YY)**, for traffic control purposes, "a divided multi-lane highway for through traffic with all crossroads separated in grade and with full control of access."

For design purposes (L&D Manual Volume 1), "an expressway with full access control and no at-grade intersections."

Full-Actuated Controller – A type of actuated controller in which means are provided for traffic actuation on all approaches to the intersection.

Full-circle Tunnel Visor – A visor which encircles the entire lens.

Functional Classification – The grouping of highways by the character of service they provide (L&D Manual Volume 1).

Fuse Plate – See **Plate, Fuse**.

Gap, Maximum – The maximum time on volume-density timed controllers allotted for vehicles to proceed through the intersection. The interval portion is decreased to a fixed minimum in proportion to traffic demands.

Gap, Minimum – The lower limit to which the extendible portion of the extension time may be decreased on volume-density timed controllers.

Gap Reduction – A feature in volume-density controllers whereby the unit extension in the phase having the green is reduced in the extendible portion of the interval in proportion to the time vehicles have waited on the phase(s) having the red.

General Notes – A portion of a highway plan containing those plan notes required to clarify construction items not adequately covered by the specifications or plan details (L&D Manual Volume 3).

General Summary – A portion of a highway plan used to summarize the total estimated quantities with complete pay item descriptions, item numbers and funding splits (L&D Manual Volume 3).

Generic (or Generic Bid) – Specified by a generalized material or performance specification without reference to a manufacturer's brand name or registered trademark.

Generic Motorist Service Signing – Symbolic or word message signs in the OMUTCD which indicate the type of service, but not the specific name of the facility.

Glare – The sensation produced by brightnesses within the visual field that are sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility.

Glare Screen – A device used to shield a driver's eye from the headlights of an oncoming vehicle (L&D Manual Volume 1).

Glare Shield – A nonreflective vertical extension of a sign designed to mask the direct rays of sign lighting fixtures from the eyes of drivers approaching on the opposing roadway.

Glass Beads – Small spheres which, when exposed on a pavement marking surface, act as refracting and reflecting elements which return light back to its source.

Glint – The reflection of light from a specular surface.

Gradation – The classification of particle size distribution of dry material as determined by the passage or retention of portions of a specimen on standard sieves.

Graded Shoulder – The area located between the edge of the traveled way and the foreslope (L&D Manual Volume 1).

Green Interval (Right-of-way) – The operation of a controller in causing traffic signals to display indications permitting vehicles or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians.

Ground-Mounted Support – See **Support, Ground-Mounted**.

Headlight Sight Distance – The stopping sight distance required on an unlighted sag vertical curve (L&D Manual Volume 1).

Headwall – The structural appurtenance placed at the open end of a pipe to control an adjacent highway embankment and protect the pipe end from undercutting (L&D Manual Volume 2).

Hiding Power – The degree of opaqueness of a marking in masking underlying pavement shades.

Hinge Plate – See **Plate, Hinge**.

Hold – A command to the signal controller which causes it to retain the existing right-of-way interval.

Horizontal Sight Distance – The sight distance available in consideration of various horizontal alignment features, such as, degree of curvature and the horizontal distance to roadside obstructions (L&D Manual Volume 1).

Hybrid Control Signal System – Incorporates features of both the Centralized and Distributed Control Signal Systems.

Illumination (Illuminance) (E) – The density of luminous flux incident on a surface; the quotient of the flux divided by the area of the surface, when the flux is uniformly distributed.

Impact Resistance – The toughness of a material in resisting deformation and fracture due to a striking blow.

Incident – An unplanned occurrence which restricts traffic flow.

Incident Management – Practices used to help mitigate the effects of incidents.

Indicator Lights – Visual aids showing actuations and timing of intervals or phases on a controller for the purpose of programming inspection and maintenance.

Initial Portion – The first timed portion of the green interval in an actuated controller.

Inlaid Markings – Markings of preformed material pressed into the surface of newly placed asphalt concrete pavement.

In-mixed Beads (Premixed Beads) – Glass beads distributed uniformly through a pavement marking material to provide continuous retroreflectorization as the material wears away.

Interconnect – The traffic signal communication network connecting the system master with local intersection controllers.

Interconnected Controller – A controller which operates traffic signals under the supervision of a master controller.

Interface – A common boundary at which two separate systems or portions of each join or interact. An interface can be mechanical, as in adjoining hardware surfaces, or it can be electrical, as in signal level transformation points. Moreover, it can also refer to human and machine interface and the interaction between man and computer.

Interlock – A feature of electromechanical controllers which maintains the timing dial in step with the camshaft.

Intersection Sight Distance (ISD) – The sight distance required within the corners of intersections to safely allow a variety of vehicular maneuvers based on the type of traffic control at the intersection (L&D Manual Volume 1).

Interstate – Those roadways on the Federal System which have the highest design speeds and the most stringent design standards (L&D Manual Volume 1).

Interval Sequence – The order of appearance of signal indications during successive intervals of a cycle.

Interval Sequence Chart – A chart designating the order in which the phases of a cycle occur and the associated signal display for each interval.

Item Code – A nine-digit character used to catalogue pay item descriptions (L&D Manual Volume 3).

Item Master – A list of acceptable item codes and their corresponding pay item descriptions and units of measure (L&D Manual Volume 3).

Jack – A receptacle in a controller cabinet in which a plug-in device may be inserted.

Lamp – The part of the optical unit which, when energized electrically, provides the optical unit light source.

Lamp Lumen Depreciation Factor (LLD) – The multiplier to be used in illumination calculations to relate the initial rated output of light sources to the anticipated minimum rated output based on the relamping program to be used.

Lateral Clearance – The distance measured horizontally from the edge of traveled way to the face of an object (parapet, abutment, pier, wall, etc.) (L&D Manual Volume 1).

Lead-in Cable – The electric cable which serves to connect the sensor to the input of the detector unit.

Legal Speed – The legislated or agency authorized maximum speed limit of a section of roadway (L&D Manual Volume 1). Also see ORC 4511.21.

Level of Service (LOS) – A qualitative measure describing the operational flow of traffic (L&D Manual Volume 1).

Light – A form of radiant energy (such as emitted by the sun). For purpose of illuminating engineering, the energy is evaluated according to its capacity to produce visual sensations. Measurements are based upon a unit of luminous intensity equal to the light emitted by a Astandard candle@ in a horizontal direction.

Light Center Length (L.C.L.) – The dimension, in inches from the center of the filament to the top of the base (including solder on the base eyelet).

Light Sensitive Detector – A detector that uses a light-sensitive device for sensing the passage of an object interrupting a beam of light directed at the sensor.

Light Pole – A support provided with necessary internal attachments for wiring and external attachments for bracket and luminaire.

Limit, Extension – The maximum time of the extendible portion for which actuations on any traffic phase may retain the right-of-way after actuation on an opposing traffic phase.

Limit, Maximum – The maximum green time after an opposing actuation, which may start in the initial portion.

Limited Access (Full Control of Access) – Highway right-of-way where rights of access of properties abutting the highway are acquired, such that all access to and from the highway are prevented except at designated locations (L&D Manual Volume 1).

Limited Presence Mode – Detector output continues for a limited period of time if vehicles remain in field of influence.

Load Switch – A device used to switch power to the signal lamps.

Local Technical Assistance (LTAP) Program – **LTAP, or Technology Transfer (T2) Centers** have been established in each of the states to provide for the transfer of transportation technology and technical assistance to rural and local governments. The mission of the **Ohio LTAP Center** is to provide training, technical assistance, advice and other resources to **Ohio's** local governments, which include cities, counties, townships and villages. The **Ohio LTAP Center** is funded through the **FHWA** and **ODOT**.

Local Intersection Controller – The complete electrical mechanism mounted in a cabinet for controlling signal operation by selecting and timing the various signal head displays. The local intersection controller is located at the individual intersection site.

Local Road – A functional classification used for rural roadways whose primary function is to provide access to residences, businesses or other abutting properties (L&D Manual Volume 1).

Local Street – A functional classification used for urban roadways whose primary function is to provide access to residences, businesses or other abutting properties (L&D Manual Volume 1).

Logo Sign Panel – A retroreflectorized sign mounted on the Specific Service Sign showing the trademark logo, non-trademark logo, legend message or combination thereof for a motorist service available on a crossroad at or near an interchange.

Logo Program – The Ohio Logo Signing Program, also known as the Specific Service Sign Program, permits eligible businesses which provide gas, food, lodging, or camping services to drivers to have their logos placed on specific service (logo) signs. See Part 2 for additional information.

Longitudinal Joint – A pavement joint, in the direction of traffic flow, used to control longitudinal cracking on a rigid pavement or the joint formed between adjacent passes of a paver on a flexible pavement (Pavement Design & Rehabilitation Manual).

Loop Detector – A detector that senses a change of inductance of its inductive loop sensor caused by the passage or presence of a vehicle near the sensor.

Low-Volume Road - A low-volume road shall be a facility lying outside of built-up areas of Cities, towns, and communities, and it shall have a traffic volume of less than 400 AADT. A low-volume road shall not be a freeway, expressway, interchange ramp, freeway service road, or a road on a designated State highway system. In terms of highway classification, it shall be a variation of a conventional road or a special purpose road. A low-volume road shall be classified as either paved or unpaved.

Lumen (lm) – The unit of luminous flux; equal to the flux in a unit solid angle (one steradion) from a uniform point source of one candela. Traffic signal lamp output is rated in lumens.

Luminance (brightness) RATIO – The ratio between the luminances of any two areas in the visual field.

Luminaire – The complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Luminaire Dirt Depreciation Factor (LDD) – The multiplier to be used in illumination calculations to relate the initial illumination provided by clean new luminaries to the reduced illumination that they will provide due to direct collection on the luminaires at the time at which it is anticipated that cleaning procedures will be instituted.

Luminaire Efficiency – The ratio of the luminous flux leaving a luminaire to that emitted by the lamp or lamps used therein.

Luminaire Support – A bracket or mast arm attachment to a lighting pole from which a luminaire is suspended.

Magnetic Detector – A detector that senses changes in the earth's magnetic field caused by the movement of a vehicle near its sensor.

Magnetometer Detector – A detector that measures the difference in the level of the earth's magnetic forces caused by the passage or presence of a vehicle near its sensor.

Maintenance Factor (MF) – The product of the lamp lumen depreciation factor and the luminaire dirt depreciation factor (MF = LLD x LDD).

Manual Operation – The operation of a controller assembly by means of a hand-operated device(s) (manual pushbutton).

Manual Pushbutton – An auxiliary device for hand operation of a controller.

Mast Arm – A structural support over the roadway extending from a pole, for the purpose of supporting signal heads.

Mast Arm, Flexible Mount – A mast arm mount where the signal head is attached to the mast arm by a flexible joint and connector to permit "free swinging" between the signal and the mast arm.

Mast Arm, Rigid Mount – A mast arm mount where the signal head is rigidly affixed to the mast arm to prevent any relative movement between the signal and the arm.

Master Control – Centrally located equipment designed to supervise a number of intersections and used to select programs on secondary control equipment to best suit traffic needs.

Master Controller – An automatic device for supervising a system of secondary controllers, maintaining definite time interrelationship, selecting among alternate available modes of operations or accomplishing other supervisory functions.

Master Coordinator – A coordinator used to provide synchronization and selection of programs on secondary coordinators or pretimed controllers to maintain a traffic system.

Master-secondary Controller – A controller for operating a traffic signal and for providing supervision of other interconnected (secondary) controllers.

Maximum Green – The maximum time right-of-way can be extended by actuation on a phase provided an actuation has been registered on a conflicting phase.

Maximum Initial Portion – The limit of the computed initial portion on volume density timed controllers.

Maximum Limit – See **Limit, Maximum**.

Memory, Locking – The retention of an actuation for future utilization by the controller.

Memory, Nonlocking – A mode of actuated-controller operation which does not require detector memory.

Mercury Vapor Luminaire – A lighting unit containing a mercury vapor lamp mounted within a housing with a metal frame, glass lens and a reflector.

Microprocessor – A device which uses the flexibility of computer electronics on a limited scale. Microprocessors are basically microminiaturized CPUs (Central Processing Units).

Minimum Green – (1) The shortest time for which the right-of-way shall be given to a non-actuated phase; (2) The shortest time for which the right-of-way shall be given to an actuated phase provided an actuation has been registered for that phase.

Minimum "Initial" Lumens – A minimum value of initial light output below which no more than a specified percentage of individual lamps will be permitted.

Minimum Initial Portion (Fixed Initial Portion) – A fixed preset first interval portion of the right-of-way on volume-density controllers.

Minor Movement Controller – A device that can be used with a controller unit to provide subordinate phase timing.

Modular – Equipment which is designed such that functional sections are plug-in circuit boards and can be readily exchanged with similar units.

Modular Controller, by Function – Controllers constructed so that additional functional capabilities may be provided by the addition of hardware modules. A single module provides a function(s) for one or more phases in the controller.

Modular Controller, by Phase – A controller constructed so that each timing module is associated with only one independent phase. The addition or removal of modules associated with one phase will not affect the operation of the controller with respect to the other phases.

Motorist Services – Signing for the LOGO program (gas, food, lodging or camping), emergency hospitals, generic motorist services (gas, diesel, food, lodging, camping), tourist information centers, law enforcement agencies and motorist assistance.

Mountable Curb – see **Curb, Sloping**.

Mounting Height (MT. HT.) – The vertical distance in feet between the roadway surface and the center of the light source in the luminaire.

Movement – The travel direction and destination of a lane or lanes of vehicles at an intersection, i.e. left turn, through or right turn.

Multiplexing – A communications technique which allows more than one item of information to be transmitted or received at essentially the same time.

Municipal Corporation – A city or village.

National Committee on Uniform Traffic Control Devices (NCUTCD) – A private organization of 150 to 200 experts who are involved in the daily operation of highways or streets. The committee meets twice a year to discuss proposed changes to the national **MUTCD**, develop comments, and submit them to **FHWA** for consideration. Its current members are employees of State and local agencies directly involved with traffic engineering activities, or representatives of other organizations who have a major interest in traffic control issues.

National Electrical Manufacturers Association (NEMA) – A national association of signal equipment and electrical component manufacturers that has produced specification standards on traffic signal control equipment to promote compatibility and interchangeability of signal equipment among different manufacturers.

No-Tracking Condition – The degree of solidification of a newly applied marking at which no pickup by vehicle tires occurs.

Noise – Random variations of one or more characteristics of any entity such as voltage, current and data. Generally tending to interfere with the normal operation of a device or system.

Non-actuated Phase – A controller phase with no means for receiving actuations from vehicles and pedestrians.

Non-conflicting Phases – Two or more traffic phases which will not cause interfering traffic movements if operated concurrently.

Nonadjustable Signal (Fixed-faced Signal) – A signal having the faces mounted in a casting so that the indications are presented as a fixed angle.

Noninterconnected (Isolated) Controller – A controller for operating traffic signals not under master supervision.

Normal Design Criteria – The criteria used for the design of new or reconstructed projects (all projects that do not qualify as 3R) (L&D Manual Volume 1).

Object Marking – A marking intended for use on obstructions within or adjacent to the roadway.

Occupancy – The percentage of roadway occupied by vehicles at an instant in time. In general use it is a measurement based upon the ratio of vehicle presence time (as indicated by a presence detector) over a fixed period of total time.

ODOT-maintained Highways – All highways under **ODOT's** jurisdiction for which **ODOT** has responsibility for the maintenance.

Offset – The number of seconds or percent of the cycle length that a defined time-reference point (normally the start of major street green) at a traffic signal occurs after the time-reference point of a master controller or an adjacent traffic signal.

Offset Interrupter – A device which will distribute over two or more cycles the time required for large offset changes.

Offset Selection – Choosing one of several possible offsets manually or automatically either by time of day or in response to some directional characteristic of traffic flow.

Omit, Phase (Special Skip, Force Skip) – A command that causes omission of a phase due to lack of an actuation on that phase.

Open-bottom Tunnel Visor – A visor which encircles the entire lens except a segment equal to approximately 2 inches of circumference at the bottom of the lens.

Optical Unit – An assembly of lens, reflector, light source, and other components if required, with the necessary supporting parts to be used for providing a single indication.

Optically Programmed Signal – A signal head containing optical units projecting an indication which is selectively veiled as to be visible only within desired viewing boundaries.

Overall Length (O.L.) – The total distance from the tip of the bulb to the tip of the base, including solder on the base eyelet (does not apply to PAR type lamps).

Overlap – A right-of-way indication when the right-of-way is assigned to two or more traffic phases.

Overlay Sign – See **Sign, Overlay**.

Overpass Structure-Mounted Support – See **Support, Overpass Structure-Mounted**.

Panel – A board within the controller cabinet upon which are mounted field terminals, fuse receptacles or circuit breakers and other portions of the controller assembly not included in the controller unit or auxiliary devices.

Parking Control Zone – Part of a roadway in which parking is legally prohibited, restricted or regulated, as indicated by Regulatory Signs, pavement or curb markings.

Passage (Passage Time) – (1) The time allowed for a vehicle to travel at a given speed from the detector to the nearest point of conflicting traffic; (2) A term functionally equal to and often used interchangeably with **Unit Extension**.

Passage Detection – The ability of a vehicle detector to detect the passage of a vehicle moving through the detection zone and to ignore the presence of a vehicle stopped within the detection zone.

Passing Sight Distance - The visible length of highway required for a vehicle to execute a normal passing maneuver as related to design conditions and design speed (L&D Manual Volume 1).

Pattern – A unique set of traffic parameters (cycle, split and offset) associated with each signalized intersection within a predefined group of intersections (a section or subzone).

Pavement Edge (Edge of Pavement) – See **Edge of Traveled Way**.

Peak Hour – The maximum traffic volume hour of the day (L&D Manual Volume 1).

Pedestal – A vertical support on top of which the signal or controller cabinet is mounted.

Pedestal Mount – A signal head or controller cabinet mounted on top of a pedestal.

Pedestrian-Actuated Controller – A controller in which intervals such as pedestrian Walk and clearance intervals can be added to or included in the controller cycle by the actuation of a pedestrian detector (pushbutton).

Pedestrian Facilities – A general term denoting improvements and provisions made to accommodate or encourage walking.

Pedestrian Phase – A traffic phase allocated to pedestrian traffic which may provide a right-of-way pedestrian indication either concurrently with one or more vehicular phases or to the exclusion of all vehicular phases.

Pedestrian Recycle – Any start of pedestrian service after the start of the associated phase GREEN.

Phase – Those right-of-way and clearance intervals in a cycle assigned to any independent movement(s) of vehicle traffic or pedestrians.

Phase Diagram – A diagram illustrating the sequence of phases at an intersection with movement arrows indicated for each phase and showing overlaps, concurrent timing, etc.

Phase Omit – See **Omit, Phase**.

Phase Overlap – Refers to a phase which operates concurrently with one or more other phases.

Phase Sequence – (1) The order in which a controller cycles through all phases; (2) A predetermined order in which the phases of a cycle occur.

Photoelectric Control – An automatic switch controlled by ambient skylight intensity to turn sign or highway lighting on or off according to the changes of night or day.

Pigment – Fine solid insoluble particles which impart color and hiding power to the formulation of marking materials.

Plan Insert Sheet – See ***TEM Chapter 104***.

Plate, Fuse – In breakaway connections, a plate with notches for torqued bolts positioned over the point where the beam is sawed so that under vehicle impact the bolts will slip out of the notches to allow the beam to bend at the hinge plate on the opposite side.

Plate, Hinge – In breakaway connections, a plate positioned on the opposite side of the beam from the fuse plate and which bends under vehicle impact.

Play – A term used by **ODOT** to describe a preplanned detour route.

Playbook – A set of preplanned detour routes.

Point Detection – The detection of a vehicle as it passes a point or spot on a street or highway.

Polyester Markings – A mixture of polyester resin and catalyst applied by intermingling sprays to the pavement.

Post-Type Support – See **Support, Post-Type**.

Power Line Switch – See **Switch, Power Line**.

Preferred Sequence – The normal order of signal phase selection within a ring with calls on all phases.

Preemption Control – The transfer of the normal control of signals to a special control mode which may be required by railroad trains at crossings, emergency vehicles, mass transit equipment or other special needs.

Preemption Emitter – A device located on an approaching vehicle that emits a signal that, when detected by the preemption receiver, will change the normal operation of the traffic signals to provide a special sequence of signal displays for the approaching vehicle. The emitters have typically used optics, sound or radio as the signaling form.

Preemption Receiver – A device located at the signalized intersection that receives the preemption emitter signal from an approaching vehicle. In conjunction with a phase selector in the controller cabinet, the received signal causes the intersection controller to change to a predetermined signal display for the approaching vehicle.

Preformed Material – Flexible tape and sheet materials applied to the pavement by an adhesive.

Premarking – The procedure whereby the planned location of pavement marking is referenced or established by offset guide lines to assure correct placement.

Premixed Beads – See **In-Mixed Beads**.

Presence Detection – The ability of a vehicle detector to sense that a vehicle, whether moving or stopped, has appeared in its field.

Pressure Sensitive Detector – A detector that is capable of sensing the pressure of a vehicle passing over the surface of its sensor.

Pretimed Controller – A controller for the operation of traffic signals with predetermined and fixed cycle length(s), interval duration(s) and interval sequence(s).

Probe – The sensor form that is commonly used with a magnetometer-type detector.

Program Selection – The process of selecting the appropriate program for a given set of conditions. It can be accomplished manually or automatically either by time-of-day or in response to some characteristic or traffic flow.

Program Selection – The process of selecting the appropriate program for a given set of conditions. It can be accomplished manually or automatically either by time-of-day or in response to some characteristic or traffic flow.

Programmable Read Only Memory (PROM) – A device that stores data which cannot be altered by computer instructions. Data is stored ("burned") into this device externally by an electronic process. Some PROMs can be erased and programmed through special physical processes.

Proprietary Item (or Proprietary Bid) – Specified by reference to a single manufacturer's brand name or registered trademark.

PS&E (Plans, Specifications & Estimate) – A step between plan completion and construction in which **ODOT** obtains federal authorization to proceed to advertise for receipt of bids.

Publications Gateway - Library of key documents that support the department's programs and processes.

Pulse Mode – Detector produces a short output pulse when detection occurs.

QuickClear – An incident management program aimed at increasing safety for first responders, decreasing delay to the motoring public and minimizing the overall impact of incidents.

Radar Detector – A detector that is capable of sensing the passage of a vehicle through its field of emitted microwave energy.

Radio Interference Suppressor – A device inserted in the power line in the controller cabinet that minimizes the radio interference transmitted back into the power supply line, which interference may be generated by the controller unit or other mechanism in the cabinet.

Rake – The initial adjustment of a strain pole out of plumb so that it will be drawn to a vertical position under the span wire tensioning.

Random Access Memory (RAM) – A storage device with both read and write capabilities which will allow random access to stored data.

Rated "Initial" Lumens – The average amount of luminous flux (light) produced by a statistically acceptable sample of lamps on operation at rated voltage after having been seasoned to one-half to one percent of rated life.

Rated Life – The (arithmetic mean) average of burning hours for a sample number of lamps operated at rated volts and defined operating conditions.

Rated Voltage – The nominal or design operating voltage of the lamp; the voltage at which rated watts, lumens and life are determined.

Rated Watts – The average initial power (watts) consumed when the lamp is operated at rated volts.

Read Only Memory (ROM) – A storage device not alterable by computer instructions, e.g., magnetic core storage with a lockout feature or punched paper tape. ROM requires a masking operation during production to permanently record programs or data patterns in it. ROM is synonymous with nonerasable storage, permanent storage and read-only storage.

Recall – An operational mode for an actuated intersection controller whereby a phase, either vehicle or pedestrian, is displayed each cycle whether demand exists or not. This is usually a temporary or emergency situation.

Recall, Maximum Vehicle – With the control activation, right-of-way is returned to the phase for the maximum green limit once during each cycle without the necessity for an actuation.

Recall, Minimum Vehicle – With the control activation, right-of-way is returned to the phase once during each cycle without the necessity of an actuation. Timing is for at least an initial interval portion and may be extended by succeeding vehicles.

Recall, Pedestrian – With the control activation, pedestrian walk and clearance intervals for the phase are timed once during each cycle without the necessity of a pushbutton actuation.

Recall Switch - A manual switch which shall cause the automatic return of the right-of-way to a normally actuated phase regardless of the absence of actuation on that phase.

Reflector – A device used to redirect the luminous flux from a source by the process of reflection

Reflectorization – The enhancement of the night visibility of pavement markings by means of reflective glass beads.

Reflector Unit – A thin plastic unit with rear surface indented so as to redirect light by reflection.

Refraction – The process by which the direction of a ray of light changes as it passes obliquely from one medium to another in which its speed is different.

Refractor – A device used to redirect the luminous flux from a source or a reflector, primarily by the process of refraction

Responsive Mode – A system operation wherein the selection of signal timing programs is based on current traffic data as input by vehicle sensors within the network.

Rest – The interval portion of a phase when present timing requirements have been completed.

Resurfacing, Restoration and Rehabilitation (3R) – Improvements to existing roadways, which have as their main purpose the restoration of the physical features (pavement, curb, guardrail, etc.) without altering the original design elements (L&D Manual Volume 1).

Resurfacing, Restoration, Rehabilitation and Reconstruction (4R) – Much like 3R, except that 4R allows for the complete reconstruction of the roadway and alteration of certain design elements (i.e., lane widths, shoulder widths, Stopping Sight Distance, etc.) (L&D Manual Volume 1).

Reverse Screen – A silk screen with openings such that the sign background is deposited and the legend is not.

Rigid Overhead-Type Support – See **Support, Rigid Overhead-Type**.

Roadside – The area between the outside edge of the graded shoulder and the right-of-way limits (L&D Manual Volume 1).

Roadway – As noted in OMUTCD Section 1A.13 and **ORC 4511.01(EE)**, for traffic control purposes, "that portion of a highway improved, designed, or ordinarily used for vehicular travel, except the berm or shoulder. If a highway includes two or more separate roadways the term "roadway" means any such roadway separately but not all such roadways collectively."

For design purposes (L&D Manual Volume 1), "the portion of a highway, including shoulders, for vehicle use."

Route Markers – Signs which display a Township, County, State, U.S. or Interstate Route number or Bicycle Symbol, designed to be displayed alone or in an assembly, used to identify and mark numbered highway routes; includes various auxiliary markers used in junction assemblies, route turn assemblies and directional assemblies, etc.; also includes signs which incorporate cardinal direction and/or directional information in the body of the sign.

Route Shields – Signs which display a Township, County, State, U.S. or Interstate Route number, designed to be affixed to Guide Signs.

Sag – The amount of deflection at the lowest point of span wire used for the mounting of signal heads.

Sampling Detector – Any type of vehicle detector used to obtain representative traffic flow information.

Sealing Primer – A coating applied to surface areas prior to the placement of pavement markings to obtain proper adhesion.

Secondary Controller (Slave) – A controller which operates traffic signals under the supervision of a master controller.

Secondary Coordinator – A device used to supervise the cycle of an associated traffic actuated controller to permit synchronization and operation allowing passage of platoons of vehicles in a progressive traffic system.

Semi-Actuated Controller – A type of actuated controller in which means are provided for traffic actuation on one or more but not all approaches to the intersection.

Sensor – The sensing element of a detector.

Sequential Timing – See **Timing, Sequential**.

Serviceable Conflicting Call – A call which: (1) Occurs on a conflicting phase not having the right-of-way at the time the call is placed; (2) Occurs on a conflicting phase which is capable of responding to a call; or (3) When occurring on a conflicting phase operating in an occupancy mode, remains present until given its right-of-way.

Service Road – Sometimes referred to as a Frontage Road or Access Road, it is a roadway, generally running parallel to the mainline, which provides access to commercial, residential or farm areas (L&D Manual Volume 3).

Shared-Use Path – a bikeway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. A shared-use path also may be used by pedestrians, including skaters, joggers, users of manual and motorized wheelchairs, and other authorized motorized and non-motorized users (**ORC 4511.01(PPP)** and OMUTCD).

The L&D Manual Volume 1 also says that this is a facility physically separated from motor vehicle traffic by an open space or barrier, either within the highway right-of-way or within an independent right-of-way. Shared use paths may be used by a mix of non-motorized users such as bicyclists, walkers, runners, wheel chair users and skaters.

Sheeting – A flexible film of synthetic resin in various colors. The film of retroreflective sheeting encapsulates a layer of glass spheres or cube-corner prisms to redirect light by retroreflection. The film of nonretroreflective sheeting does not contain retroreflective elements.

Side Mount – A signal mounting arrangement where the signal head is mounted parallel to the vertical axis of a pole.

Sign, Extrusheet – A sign assembled of horizontal sections formed of aluminum sheet and spot welded extrusions, covered with sheeting and bearing a legend.

Sign, Flatsheet – A sign cut from a single sheet of material into the proper geometrical shape, covered with sheeting and bearing a legend.

Sign, Overlay – A sign which is fastened over an extrusheet sign and which consists of a sheet of material covered with sheeting and with or without copy.

Signal Circuit Contact – See **Contact, Signal Circuit**.

Signal Shut-Down Switch – See **Switch, Signal Shut-Down**.

Signal System, Centralized Control – See **Centralized Control Signal System**.

Signal System, Distributed Control – See **Distributed Control Signal System**.

Signal System, Hybrid Control – See **Hybrid Control Signal System**.

Single-ring Controller – A controller containing two or more sequentially timed and individually selected conflicting phases so arranged as to occur in an established order.

Skip Phasing – The ability of a controller to omit a phase from its cycle of operation in the absence of demand or as directed by a master control.

Silk Screened Copy – The copy deposited on the surface of a flatsheet sign by the transmission of paste through silk screen openings.

Silk Screen Paste, Opaque – A viscous paint used to form the legend on a flatsheet sign by the silk screen method.

Silk Screen Paste, Transparent – A fluid used to form a transparent colored background (or copy) on the reflective sheeting of a flatsheet sign by the silk screen method.

Single Entry – See **Entry, Dual**.

Skins – Undesirable fragments of solidified marking material.

Slipfitter – A mounting bracket which is used on the top of a pedestal.

Softening Point – The temperature at which a solid material exhibits a condition of plasticity while being heated.

Solid Spreader – See **Spreader, Solid**.

Solid State Device – a device characterized by electrical circuits, the active components of which are semiconductors to the exclusion of electromechanical devices or vacuum tubes.

Sonic Detector – A detector that is capable of sensing the presence of a vehicle through its field of emitted ultrasonic energy.

Span Support – See **Support, Span**.

Span Wire Hanger – A mounting bracket for supporting a signal head by clamping onto a span wire.

Span Wire Mount – A signal head suspended over the roadway on messenger wire.

Span Wire Support – See **Support, Span Wire**.

Special Skip – See **Omit, Phase**.

Specific Service Sign – A rectangular sign panel that includes: the words "GAS," "FOOD," "LODGING" or "CAMPING," directional information, and one or more logo sign panels.

Specific Service Sign Program (Logo Program) – The Ohio Logo Signing Program (see TEM Section 207-2 and OMUTCD Chapter 2J).

Speed, Legal – See **Legal Speed**.

Speed Zoning – The process of establishing reasonable and safe speed limits for sections of roadway where the statutory speed limits do not fit the road and traffic conditions. Speed Zones are intended to aid motorists in adjusting their speeds to those conditions. **See ORC 4511.21 and *TEM Part 12***.

Split – A division of the cycle length allocated to each of the various phases (normally expressed in percent).

Split Phase – That portion of a traffic phase that is separated from the primary movement to provide a special phase that is related to a parent phase and characterized by the inability to rest in a minor phase.

Split Selection Switch – A device on solid state controller units which when operated discontinues automatic selection of split changes which are independent of cycle length changes and permits hand selection of such split changes.

Spray Applied Markings – Pavement markings applied in the form of liquid droplets by means of a pressurized nozzle.

Spreader, Solid – A signal bracket having solid arms radiating from a hub through which wiring can be passed to provide electrical interconnection of the signal faces supported by the signal bracket.

Spreader, Tubular – A signal bracket having tubular arms radiating from a hub through which wiring can be passed to provide electrical interconnection of the signal faces supported by the signal bracket.

Staged Review Process – A series of review submissions at various stages in the design process (L&D Manual Volume 3).

Standard Construction Drawings – Detail drawings, identified by a specific number, published by **ODOT**, of items which are frequently used in plans and would otherwise require redrawing for each plan and have been pre-approved for general use (L&D Manual Volume 3). Also see ***TEM Chapter 102*** for further information.

Standard Pay Item – An item whose requirements are defined by the Standard Construction Drawings and the Construction and Materials Specifications or Supplemental Specifications (L&D Manual Volume 3).

Station – A point or position on a measured line using 100-foot increments as a base of reference (L&D Manual Volume 3).

Straight Line Distance (SLD) – Distance based on the centerline of the roadway as measured from the western or southern county line or other true beginning (L&D Manual Volume 3).

Stopping Sight Distance (SSD) – The cumulative distance traversed from the time a driver sees a hazard necessitating a stop, actually applies the brakes, and comes to a stop (L&D Manual Volume 1).

Strain Pole – A vertical support to which messenger wire and hardware are attached for supporting traffic signals.

Stop Timing – Provision within a controller to suspend timing operation upon assertion of an external command.

Superelevation – The cross-slope of the pavement used to compensate for the effect of centrifugal force on a horizontal curve (L&D Manual Volume 1).

Supplemental Specifications – Detailed specifications for items which are in the development stage or are used only occasionally. These specifications supplement or supersede the **Construction and Material Specifications** (L&D Manual Volume 3).

Support, Beam-Type – A ground-mounted support consisting of flanged steel beams embedded in concrete.

Support, Breakaway Beam-Type – A ground-mounted support consisting of flanged steel beams with a slip-plane joint near the ground line, with the lower stub embedded in concrete and the sign bearing portion containing a fuse and hinge plate near the lower edge of the sign.

Support, Cantilever – An overhead support consisting of a single vertical tubular member with attached arms at one side which may be single or dual.

Support, Center-Mount – A support which may be semi-overhead or of traffic clearing overhead height consisting of a single vertical tubular member with attached arms which may be symmetrical or eccentric to the vertical member.

Support, Ground-Mounted – Single or multiple posts or beams driven into the earth or embedded in concrete for the support of signs.

Support, Overpass Structure-Mounted – A skewed or flush-mounted support for attaching signs to an overpass structure, the type being determined by the overpass angle to the roadway.

Support, Post-Type – A ground-mounted support of steel single channels, channels bolted back to back, or square tubes, and normally driven into the earth.

Support, Rigid Overhead-Type – Support for a major sign or signs mounted on anchor bolt foundations and located off the berm or spanning the roadway.

Support, Span – A rigid overhead support spanning the roadway consisting of a box truss supported by single plane truss end frames.

Support, Span Wire – A support consisting of span wires connected to roadside strain poles mounted on anchor bolt foundations or embedded in concrete.

Switch, Auto-Manual – A device which, when operated, discontinues normal signal operation and permits manual operation.

Switch, Flash Control – A device which, when operated, discontinues normal signal operation and causes the flashing of any predetermined combination of signal indications.

Switch, Power Line – A manual switch for disconnecting power to the controller assembly and traffic signals.

Switch, Signal Shut-Down – A manual switch to discontinue the operation of traffic signals without affecting the power supply to other components in the controller cabinet.

Switch, Time – See **Time Switch**.

Synchronous-Motor Controller – A controller operated by a synchronous motor which maintains a constant speed determined by the frequency of the alternating current power supply.

System – A system is defined by the International Council of Systems Engineering (INCOSE) as "a combination of interacting elements organized to achieve one or more stated purposes."

Terminal Blocks, Field – Devices for connecting all wires entering the controller cabinet.

Thermoplastic Markings – Hot plastic markings applied to pavements by an extrusion or spraying process.

Time Switch – A device for the automatic selection of modes of operation of traffic signals in a manner prescribed by a predetermined time schedule.

Timer Gear – One of a set of different diameter gears determining the cycle time of a timer dial when inserted into the drive train.

Timing Analog – Pertaining to a method of timing that measures continuous variables such as voltage or current.

Timing Concurrent – A mode of controller operation whereby a traffic phase can be selected and timed independently and simultaneously with another traffic phase.

Timing Control – A calibrated device that provides a time setting for an interval or portion of an interval.

Timing Dial – That part of a controller which times one cycle length and its associated split(s) and offset(s).

Timing, Digital – pertaining to a method of timing that operates by counting discrete units usually based on the frequency of the power source.

Timing, Sequential – The arrangement of phases at multi-phase intersection into a sequence in which the phases will occur consecutively.

Tourist Information Center – A place where information of interest to tourists is provided as a free service to the public.

Tourist Oriented Directional Signs (TODS) – Signs used to identify Tourist Oriented Activities and conforming to the specifications contained in OMUTCD Chapter 2K, and **Rules 5501:2-8-01 to 5501:2-8-10 of the Ohio Administrative Code**. Also see ***TEM Section 207-3 and*** Table 297-16.

Tourist Oriented Activity – For purposes of the **TODS** program, any lawful cultural, historical, recreational, educational, or commercial activity, a major portion of whose income or visitors is derived during the normal business season from motorists not residing within 10 miles of the activity, and attendance at which is no less than two thousand in any consecutive twelve month period. See OMUTCD Section 2K.01.

Traffic-Actuated Controller – A controller for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors or pushbuttons.

Traffic Adjusted System – See **Traffic Responsive System**.

Traffic Control Plan – A portion of a highway plan dedicated to signing, signalization, pavement marking and other traffic control details (L&D Manual Volume 3).

Traffic Responsive Signal Control – The feature of a traffic signal control system that changes intersection signal timing based on information received from system roadway sensors.

Traffic Responsive System – A system in which a master controller (analog or digital) specifies cycle and offset based on the real-time demands of traffic as sensed by vehicle detectors.

Traffic Signal Preemption (Priority Control) – An interruption in the normal signal operation of a signalized intersection to provide predetermined signal displays to the various intersection approaches. Examples of traffic signal preemption are railroad activated, emergency preemption through direct wiring to a fire station, emergency vehicle activated, and transit vehicle activated.

Traffic Surveillance and Control System – An array of human, institutional, hardware and software components designed to monitor and control traffic, and to manage transportation on streets and highways and thereby improve transportation performance, safety, fuel efficiency and air quality.

Trailblazing Signs – Signs provided to indicate the preferred route to the Interstate or another state highway from non-state highways or streets within the city or village. Trailblazing signs are supplemental to entrance ramp approach signs.

Transmission – The process by which incident flux leaves a surface or medium on a side other than the incident side.

Transverse Joint – A pavement joint perpendicular to the centerline alignment of the pavement, designed to control cracking, provide for load transfer, and allow for the contraction and expansion of the pavement **(Pavement Design Manual)**.

Treated Shoulder – That portion of the graded shoulder which has some type of surface treatment (L&D Manual Volume 1).

Tree Lawn – See **Buffer**.

Trumpet Interchange – A Semi-directional T interchange (L&D Manual Volume 1).

Tubular Spreader – See **Spreader, Tubular**.

Uniformity – Illumination on roadways is usually expressed as a ration of average illumination to minimum illumination at any point on the roadway.

Unit Extension – See **Passage**.

Vertical Clearance – The distance, measured vertically, from the surface (pavement, shoulder, ground, etc.) to a fixed overhead object (bridge superstructure, sign, signal, etc.) (L&D Manual Volume 1).

Village – A municipal corporation having a population of less than 5,000 persons.

Visibility – The quality or state of being perceivable by the eye. In outdoor applications, visibility is defined in terms of the distance at which an object can be just perceived by the eye.

Visual Acuity – The ability to distinguish fine detail. Quantitatively, the reciprocal of the angular size in minutes of the critical detail which is just large enough to be seen.

Visual Angle – The angle which an object or detail subtends at the point of observation. It usually is measured in minutes of arc.

Visual Field – The locus of objects or points in space which can be perceived when the head and eyes are kept fixed. The field may be monocular or binocular.

Visual Surround – All portion of the visual field except the visual task.

Visual Task – Those details and objects which must be seen for the performance of a given activity, including the immediate background of the details or objects

Volume-Density Controller – A controller used with detectors located a sufficient distance in advance of the intersection which makes use of vehicle actuation quantities and time-of-waiting of the initial vehicle to vary green interval portions for increased capacity and minimized delays.

Weekly Programmer – A device used to determine the time of operation of programs on traffic control equipment according to a weekly schedule which may be preset to vary from day to day.

Work Limits – The extreme longitudinal limits of the contractor's responsibility, including all **TEM**porary and incidental construction (except **TEM**porary traffic control devices). Identified by the "Work Limit" station on the centerline of construction on the mainline and on the centerline of all side roads, cross roads, and

other construction generally running perpendicular to the project or separated from the project (L&D Manual Volume 3).

Work Zone Pavement Markings – Markings placed for a limited time to direct traffic movement during project construction.

Yield – The action of allowing a semi-actuated controller, or a full-actuated controller operating in the semi-actuated mode, to terminate the main street phase so as to begin satisfying existing cross street demand.

Yellow-Red Flash Terminals – Terminals which are wired to give the option of flashing either yellow or red on each traffic signal face by rearranging jumpers and/or field wires.

Zone of Detection – That area of the roadway within which a vehicle is detected by a vehicle detector system.

108 OTHER POLICIES AND STANDARD PROCEDURES

ODOT Policies and Standard Procedures have been established to address various aspects of **ODOT's** work. Some can be viewed on-line at **ODOT's** "Official Policies and Standard Procedures" web page. They are also available from the in-house intranet site Policies and Procedures page.

At times, there may be a need for the Offices of Roadway Engineering (ORE) and Traffic Operations (OTO) to issue (or help develop) numbered, formal **ODOT Policies**, **Guidelines or Standard Procedures (SOPs or SPs)**, separate from the **TEM and L&D Manual**. As noted above, these are available on-line; however, for the convenience of **TEM** users, copies of these documents have also been included in ***Chapter 1599***.

There are also other **ODOT** Policies, Guidelines, Standard Procedures, etc. issued by other **ODOT** offices that pertain to material discussed in the **TEM**. These too are listed in the index below, and for your convenience copies are available in this Chapter.

Policies

Number	Subject / Title	Responsible Office
16-004(P)	Development of Standards and Specifications Policy	Construction Management, Engineering, Planning
20-005(P)	Policy on Changes to the State Highway System and Use of the Director's Journal Entry	Division of Planning
21-003(P)	Curb Ramps Required in Resurfacing Plans	Roadway Engineering
21-008(P)	Traffic Management in Work Zones	Division of Engineering
27-014(P)	New Product Development	Construction Management

Standard Procedures

Number	**Subject / Title**	**Responsible Office**
122-004(SP)	Development of Standards and Specifications	Construction Management, Engineering, Planning
123-001(SP)	Traffic Management in Work Zones	Roadway Engineering
515-001(SP)	New Product Development	Division of Construction Management

150-2 Pre-Construction Conference

During the Pre-Construction Conference held for the project the following items relative to traffic control devices may be reviewed:

1. Inspection of signs, supports and other traffic control devices.
2. Traffic control devices for maintaining traffic.
3. Any work zone speed zones related to the project.
4. Certifications of sign and signal supports.
5. Approval requirements for catalog cuts of traffic control devices.
6. Delivery schedule of traffic control devices.
7. Storage and special care for traffic control devices.
8. Plans for maintenance of traffic.
9. Plans for Work Zone Traffic Incident Management
10. Staking of foundations for sign and signal supports and pull boxes.
11. Location of overhead utilities and underground facilities.
12. Coordination required with utilities for necessary relocations and attachments to their facilities.
13. Sequence of construction for traffic control devices.
14. Coordination required with local agencies for erection of new devices and removal or relocation of existing devices.
15. Work by other contractors and agencies.
16. Layout procedure for pavement markings.
17. Visibility inspection of traffic control devices.
18. Partial and final acceptance and opening to the road users.

180 RESEARCH

This Chapter in each **TEM** Part has been reserved to document pertinent research information.

OMUTCD Section 1B prohibits the design, application and placement of traffic control devices other than those adopted in the **OMUTCD** unless the provisions of **Section 1B** are followed. All such requests are sent to **FHWA**. For **ODOT**, the Office of Roadway Engineering (ORE) coordinates this process. Local authorities submit such requests to **FHWA** with a copy to the **ORE Administrator**.

195-1 General

Table 197-3 provides a consolidated list of **ODOT** traffic engineering publications. This Chapter provides brief descriptions of traffic engineering publications/reference resources that were not discussed in detail in the earlier Sections of ***TEM Part 1***.

195-6 Temporary Traffic Control Manual (TTCM)

See ***Section 695-2*** for further information.

201-9 Truck Restrictions

201-9.1 - Weight Limits

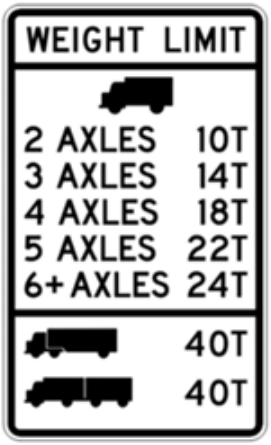
201-9.1.1 Weight Limit Target Compliance Dates

In accordance with the 11th Edition **MUTCD**, Table 1B-1 establishes a Target Compliance Date for Section 2B.64 covering Weight Limit Signs. Specifically, the **MUTCD** indicates the "requirement for additional Weight Limit sign with the advisory distance or directional legend in advance of applicable section of highway or structure" has been established with a **compliance deadline date of January 18, 2029**.

Due to changes in the new **MUTCD, ODOT** coordinated with **FHWA** to develop a new Ohio Specific Weight Limit Sign to replace the current sign and meet new **MUTCD** requirements. The table below shows the current sign and the new Ohio Specific Sign.

2012 OMUTCD

R12-H5 Sign



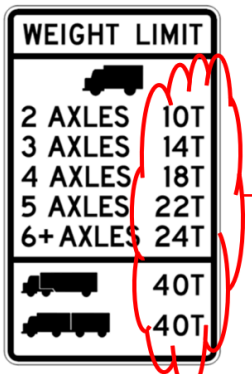
New Ohio Specific

R12-H6 Sign

New Sign Size Requirements
Conventional Road Single Lane: 30 X 48
Conventional Road Multi-Lane: 36 X 60
Expressway: 36 X 60
Freeway: 48 X 72

In order to meet the Target Compliance Requirements, the following will need to be completed before the **January 18, 2029 compliance deadline**:

1. Identify all structures that require posting based on load-carrying capacities.
2. Replace the existing R12-H5 sign(s) located on the roadway directly approaching the structure with the new R12-H6 sign.
3. Install the new R12-H6 sign with a supplemental warning plaque (W16-2aP, W16-3aP, or W16-9P) at the nearest intersecting roadway approaching the structure. The intent is for the sign to be placed on the structure side of the intersection so that it is visible by traffic approaching from sideroad as well as main road traffic approaching the intersection.
4. In addition, install the new R12-H6 sign with a supplemental warning plaque (W16-2aP, W16-3aP, or W16-9P), approximately 500 ft in advance of the nearest intersecting roadway approaching the structure. See below for the required sign advance assembly:



Sign values to be based upon Structure load carrying capacity

R12-H6

W16-2P

W16-2aP

W16-3aP

W16-9P

A warning plaque with the actual distance to the restricted structure is preferred (W16-2P, W16-2aP, or W16-3aP). The "AHEAD" WARNING plaque may be used when actual distance plaque is not practical.

See **Figure 298-3** for sign placement example.

201-9.1.2 Weight Limit Signing in Municipalities

A municipal corporation may restrict truck traffic on State or U.S. Routes through the municipal corporation only by regulating weight limits on the route, and only with the approval of the **Director of Transportation**.

A municipal corporation can regulate the use of its streets and can restrict the type of vehicles that travel over those streets pursuant to **ORC Section 4511.07**. However, **ORC Sections 4511.06 and 4513.33** restrict the use of that power for trucks traversing designated State or U.S. Routes. Thus, a municipal corporation may establish its own truck weight limits for streets and highways within its jurisdiction that differ from those established in **ORC Chapter 5577** and must post signs notifying the traveling public. However, when such weight limits involve State or U.S. Routes, **ORC 4513.33** requires the approval of the **Director** to alter them. Otherwise, the ordinance may conflict with **ORC Sections 4511.06 and 4513.33** and be found ineffective.

201-9.1.3 Emergency Vehicle Weight Limit Signing

A bridge posted with a Weight Limit sign (e.g., R12-H6~~5~~) shall not be signed simultaneously with the R12-7 ~~H7~~ sign. **MUTCD 2B.64** provides additional information on Emergency Vehicle Weight Limit signs.

R12-7

201-9.2 Hazardous Material Signs (R14-2 and R14-3)

To provide consistency and prevent confusion for road users, the R14-2 and R14-3 signs are generally not used along ODOT maintained routes.

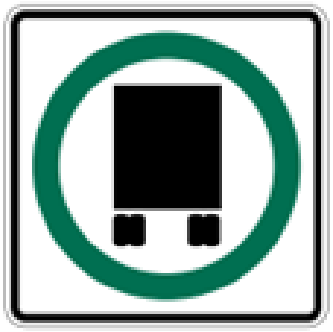
However, where a specific need is identified, the Hazardous Material Prohibition sign (R14-3) may be used to prohibit travel through a particular location that falls within federally restricted areas in accordance with 49 CFR 397 (e.g. tunnels, etc.). If the R14-3 sign is used, a corresponding alternative route should be identified using Hazardous Material Route (R14-2) signs.

R14-2

R14-3

201-9.3 National Network Signs (R14-4 and R14-5)

These signs are not used in Ohio. Use the R5-2 symbol sign when No Trucks signage is needed.



R14-4

R14-5

To reinforce an established regulation on no truck traffic, use the NO TRUCKS symbol (R5-2) sign.

R5-2

201-10 Lane-Use Control Signs

OMUTCD **Sections 2B.19 through 2B.22** address Lane-Use Control signs. For practicality, additional signs have been designed and assigned code numbers within the **SDMM**. For reference purposes, Table 297-1 provides a listing of them with their standard sizes and Figure 298-22 provides illustrations of them.

201-15 KEEP RIGHT EXCEPT TO PASS Sign (R4-16), SLOWER TRAFFIC KEEP RIGHT Sign (R4-3)

Effective June 30, 2025, the **ORC Section 4511.351** that required **ODOT** to erect the KEEP RIGHT EXCEPT TO PASS (R4-16) sign on Interstate highways with three or more lanes in the same direction was repealed. However, **ORC Section 4511.25** states, in part, that vehicles are to be driven in the right-hand lane on 2 lane routes except when passing….[. Consequently, the R4-16 may still be used in accordance with **OMUTCD** Section 2B.38 and with the guidance provided below.

For 3 or more lanes, use SLOWER TRAFFIC KEEP RIGHT (R4-3).

If a KEEP RIGHT EXCEPT TO PASS sign is installed, a STATE LAW (W16-H19P) plaque should also be installed above it.

The KEEP RIGHT EXCEPT TO PASS sign would be expected to have the greatest benefit in rural areas with a higher percentage of long distance traffic and greater spacing between interchanges. The message will be less relevant in urban areas with complex freeway designs and a higher percentage of relatively local traffic. For this reason, the sign is not recommended for installation within the outerbelt of major metropolitan areas, but may be installed on the outerbelt itself where, based on geometrics and other roadway characteristics, the message would be appropriate.

The recommended placement is on the left-hand (median) side of the roadway. Alternatively, the sign may be placed on the right-hand side of the roadway, or erected as a dual installation.

A sign should be placed where a rural Interstate highway transitions from three lanes to two lanes in the same direction. For long stretches of rural Interstate highways with two lanes, signs should be installed at a maximum interval of 10 miles.

The sign should not be installed in areas where, based on engineering judgment, it could have the potential to cause vehicle operators to make unnecessary or ill-advised lane changes. Factors to be considered for omitting the sign include closely spaced interchanges, dropped right lane at an interchange, left-hand exits, major freeway bifurcations, areas with lack of lane continuity, reduction in the number of through lanes at an interchange, horizontal curves, where the right lane ends requiring a merge into the adjacent lane, and in congested areas where THROUGH TRAFFIC KEEP LEFT or similar signs have been installed.

201-20 NO STOPPING ANY TIME Sign (R7-4a)

Pursuant to **ORC Section 4511.68(A)(14)**, NO STOPPING ANY TIME (R7-4a) signs may be placed along entrance and exit ramps to deter vehicles, including semi-trucks, from being parked there overnight. For this situation, the R7-4a signs should be used instead of NO PARKING (R8-3 series) signs.

ORC Section 4511.68(A) includes the act of parking into the prohibition on stopping and states "[n]o person shall stand or park a * * * vehicle * * * at any place where signs prohibit stopping * * * *."

Also, the 11th Ed. **MUTCD Section 2B-52** states "[t]he word 'stopping' when used on the R7 and R8 series signs refers to any vehicle, occupied by a driver or not, that stops other than to avoid conflict with other traffic or to comply with official direction."

204-2 Ohio Byway Signing (M10-H3a series, M10-H3bP)

As provided for in **OMUTCD Section 2D.58**, certain roads have been designated by **ODOT** as Ohio Byways based on their archeological, cultural, historic, natural, recreational, or scenic qualities. The Ohio Byway program is administered by the **Office of Local Programs**. A route must be approved by **ODOT** as an Ohio Byway before signs can be installed, and a route designated by **ODOT** as an Ohio Byway shall be signed.

Ohio Byways are not limited to **ODOT**-maintained highways, and may follow **County**, **Township** and municipal roads as well. **ODOT** is responsible for installing and maintaining Ohio Byway signs and auxiliary signs on **ODOT**-maintained highways. To ensure uniformity of appearance, **ODOT** will provide signs to the local authority for use on state route extensions within municipalities and on other local roads. The local authority is responsible for installing and maintaining the signs on local roads.

The Ohio Byway signs (M10-H3a series and M10-H3bP) are not considered route signs. For all the available specific M10-H3a designs, see the Ohio Sign Design and Markings Manual (**SDMM**).

The Ohio Byway sign assemblies should be installed in accordance with **OMUTCD Section 2D.58**.

The M8-H3 and the M8-H4 series versions of the Ohio Byway sign have been retired in July 2022 and July 2025 respectively and should no longer be used.

206-11 Drinking Water Protection Area Signs (I2-H15)

The **Ohio Environmental Protection Agency (Ohio EPA)** requested that signs be erected to designate those areas that have been scientifically determined to be contributing surface and ground water to public drinking water systems serving municipalities of populations of 500 or more persons. The I2-H15 sign is used for this purpose.

The signs are intended to increase public awareness, and alert emergency response teams that they are entering a **Drinking Water Protection Area**. The clean-up of spills is handled differently in these areas.

The I2-H15 sign includes a phone number. The statewide **Ohio EPA** emergency response phone number is 1-800-282-9378. The public drinking water provider will decide what phone number to include on the sign. This can be the statewide emergency response number or a local emergency response number (including 9-1-1).

It is not feasible to erect signs at every tributary that contributes to ground and surface water systems. As such, qualifying systems are permitted to have only one sign per direction for each ODOT-maintained highway that intersects either:

1. The Source Water Protection Area (five-year time of travel) for ground water systems, or
2. The main stem of the Corridor Management Zone or a Zone of Critical Concern for surface water systems.

Specific locations for the I2-H15 signs are initially proposed by the Source Water Area Protection (SWAP) Coordinator at the Ohio EPA in accordance with the guidelines above.

All requests to install I2-H15 signs on ODOT-maintained highways shall originate from the Ohio EPA SWAP Coordinator and be emailed to the responsible ODOT District via the Right-of-Way & Utility Permit District contact. The request should include a simple map showing the overlap of the protection area in question with the ODOT-maintained highway(s), showing the proposed locations of each sign with the GPS coordinates labeled, and the phone number to include on the sign.

Once the request is received, the District Permit contact will forward to the ODOT District Traffic Engineer to review the proposed sign locations to determine if there is sufficient space for the I2-H15, ensuring careful attention is given to minimizing sign clutter. Regulatory, warning and guide signs take precedence over the I2-H15 general information sign. ODOT cannot guarantee all requests for signs will be approved.

If the request is approved, ODOT will fabricate, erect and maintain the I2-H15 signs at the approved locations on ODOT-maintained highways.

ODOT will not fabricate, install and maintain signs for locations that fall within municipal corporation limits. Such locations should be coordinated through the municipality and they should provide, erect and maintain the I2-H15 signs.


DRINKING WATER
PROTECTION AREA
REPORT SPILLS
1-800-282-9378

I2-H15

209-4 Weigh Station Signing for Freeways and Expressways

209-4.1 General

Weigh Station Signing for freeways and expressways is addressed in OMUTCD **Sections 2D.49 and 2E.54, and Figure 2D-17**. On ODOT-maintained highways, the D8-H2, R13-H1 and R13-H2 signs shall be used (in addition to the D8-1 and D8-3).

The R13-H1 sign shall be located approximately 4,000 feet in advance of the gore. The R13-H2 sign shall be located approximately 3,200 feet in advance of the gore.

209-4.2 Exit Direction Sign (D8-H2)

As noted in OMUTCD **Section 2E.54**, on freeways and expressways this sign shall be erected at a minimum of 1500 feet in advance of the gore. The bottom line consists of a changeable message panel capable of displaying the words "OPEN" and "CLOSED." The legend "CLOSED" shall be displayed when the station is closed and the legend "OPEN" shall be displayed when the station is open and shall be controlled from the scale house.

614@id.ohio.gov) is signed in

R13-H1


HAZMAT
PLACARDED
VEHICLES
MUST ENTER
WEIGH STATION

R13-H2


WEIGH STATION
NEXT RIGHT
CLOSED

D8-H2

211-2 Standard Signs

Generally, the designs for standard Regulatory and Warning Signs, as well as various Guide Signs where the design is basically set, are prepared by **ORE** and published in the **SDMM**. ***Section 205-2*** provides some additional information on Conventional Road Destination Signs. The standard symbols used in these signs are provided in **SDMM Appendix A**, and design information is provided in **SDMM Appendices B and D**. The symbols, arrows, alphabet information and design standards used are based on those established by **FHWA**.

211-4 Sign Design Computer Program

A computerized sign design package (design and fabrication/production software) is currently in use in the **Office of TSMO, Office of Roadway Engineering (ORE)** and the **Districts**. Purchase and maintenance of the program, called **SignCAD**, is coordinated by the **Office of CADD and Mapping Services**.

The program includes a library of **ODOT** standard signs, maintained through a maintenance agreement **ODOT** has with the supplier.

ORE can assist the **Districts** in designing directional Guide Signs for construction projects or force account installation purposes, as well as special Regulatory and Warning Signs that may become necessary. The **Office of CADD and Mapping Services** can provide **SignCAD** training.

220-8 Production and Purchasing of Signs and Related Materials

220-8.1 General

The **Office of TSMO** operates a sign production facility and is responsible for the manufacture and coordination for procurement of all signs and related items required for use by **ODOT**. Actual sign production is accomplished by the Central Office Sign Shop located in Columbus.

Except for normal field maintenance of Guide Signs or in extreme emergencies, Districts should not fabricate, repaint or re-stencil any sign for use on ODOT-maintained highways.

Temporary non-standard signing, if used, should be replaced by standard signs as soon as possible.

220-8.2 Sign Shop Orders

All orders for signs, markers and any other materials or equipment to be supplied or manufactured by the **Sign Shop** shall be submitted to the **Sign Shop** through the automated Smart Sign Ordering System (SSOS). All necessary information shall be provided.

Orders for designable extrusheet signs should be accompanied by a **SignCAD** file so that the District can be assured that the **Sign Shop** will provide what they are expecting. If there are questions associated with this requirement, call the **Sign Shop** for assistance.

Excluding warehouse orders, standard sign orders shall be submitted in advance with as much lead time as possible, to afford the **Sign Shop** sufficient time to integrate fabrication into regular production schedules. "Rush" orders" shall be kept to a minimum.

In extreme situations, when circumstances dictate urgent need, orders may be made by telephone. The **Sign Shop** may be called directly when an emergency situation arises. However, a confirming Sign Shop Order via SSOS must be submitted following any telephone order.

220-8.3 Delivery

The **Sign Shop** will strive to complete, and have ready for pick-up or delivery, all orders for flatsheet signs within 30 days after receipt of order (ARO), and all extrusheet sign orders within 45 days ARO. The only exception to the preceding timeline is warehouse signs, which can be accessed on a daily basis. The primary delivery of flatsheet signs to the **Districts** will be the pony system. Each **District** should provide an adequately sized vehicle for the transporting of signs from the **Sign Shop** – full-sized vans or trucks ideally with bed covers to provide all weather transportation. The **Sign Shop** will deliver flatsheet signs when necessary and will routinely deliver all extrusheet signs.

220-8.4 Special Projects

The **Sign Shop** will accept special requests from various **ODOT** offices and other State agencies; however, all special requests must have prior approval from the **Sign Shop Administrator**. Regular highway sign production work will have priority in the scheduling of work through the **Sign Shop**.

220-8.5 Sign Costs

On July 1, 2000 the **Sign Shop's** operating budget was decentralized to the **Districts**. This funding measure now requires the **Districts** to designate a portion of their operating budget for the acquisition of traffic signs used in **District** sign maintenance activities. Billable sign costs that are passed on to the **Districts** are for materials only. Labor, benefits and overhead are excluded.

221-3 Overhead Sign Support Inspection

Inspection of overhead sign supports on construction projects is addressed in ***Sections 250-4 and 250-5***.

Bridge-mounted overhead sign supports and overhead sign supports with bridge-mounted foundations should be inspected annually, preferably at the time of, and included with, the annual bridge inspection. All other overhead sign supports should be inspected at a maximum five-year interval. New overhead sign supports should be inspected at the time of construction.

A statewide uniform practice for the periodic inspection of the structural components of existing **ODOT**-maintained overhead sign supports is also necessary to assure their structural integrity. All overhead sign supports, including but not limited to cantilever, butterfly, box truss, monotube, span wire, semi-overhead and bridge-mounted supports, should be periodically inspected. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked. The use of an inspection form is recommended. A sample form ***(***Form 296-4***)***, has been provided which may be used as is or modified by the **District** as desired.

Supports should be visually inspected from the ground. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means is not necessary on a routine basis, but may be used to more closely examine a defect that has been detected from the ground. Anchor bolts should be tested for structural integrity by sounding with a hammer. Non-destructive testing procedures, such as dye penetrant, ultrasonics and magnetic particle, are not necessary on a routine basis, but can be used to define the extent of a defect that has been detected by visual means. Written documentation of all inspections should be kept.

Items to be inspected should include, but not be limited to, foundation concrete, soil around the foundation, anchor bolts and nuts, structural members, structural connections, sign attachment assemblies and structural components of the sign lighting.

Deficiencies to be inspected for should include, but not be limited to, cracks in the concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, and corrosion.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Written documentation of corrective actions should be kept.

Overhead sign support inspection training is available from the **Office of Roadway Engineering**.

242-3 630 Overhead Sign Support Modification, by Type, As Per Plan

Overhead sign supports shall be modified as shown in the plans. The modification shall consist of (see examples below):

1. The insertion of a new box truss section of ___ feet.
2. The replacement of an existing arm with a new arm of ___ feet.
3. The replacement of an existing end frame with a new end frame.
4. The replacement of the existing pole with a new pole of ___ feet.
5. The relocation of an existing end frame.

Payment will be at the contract unit price for the modification of the overhead sign support, including all necessary material, parts, equipment and labor, using the designation: 630 Each - Overhead Sign Support Modifications, By Type, As Per Plan.

Designer Note: This note should be included on projects which require the modification of overhead sign supports. The note should be edited as required to specify the modification needed and to fill in the blank. When example 1 is used, it is typically used in combination with 3 or 5.

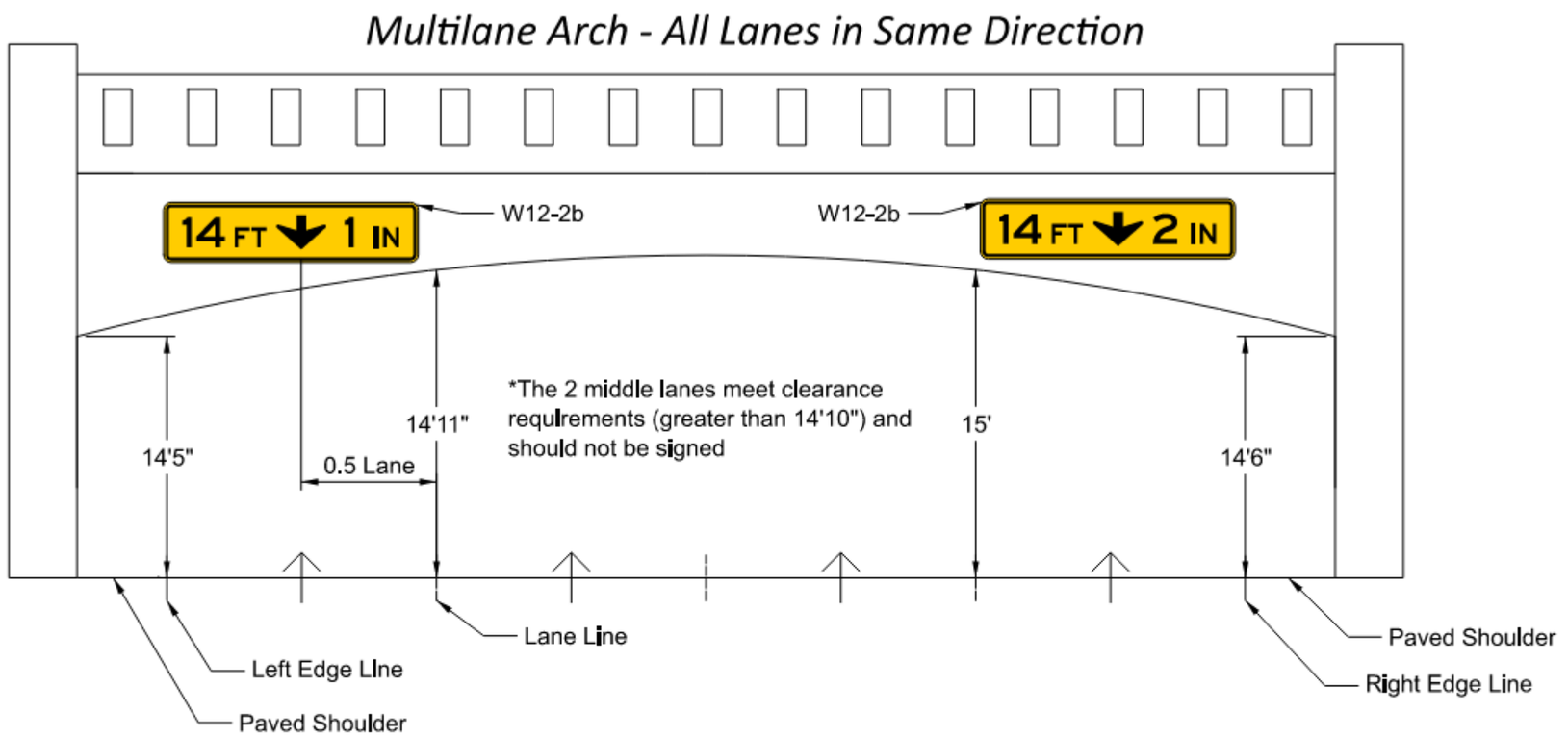
The following is a bid Item example: Overhead Sign Support Modification, Type TC-15.116, Design 6, New Box Truss Section ___ feet, As Per Plan.

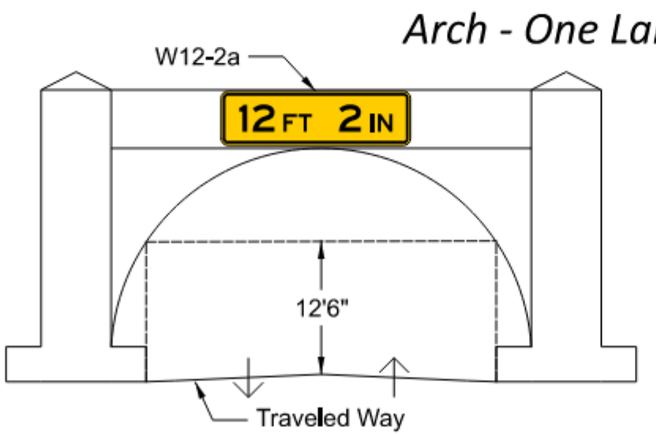
260-2 Responsibilities

In general, the **Districts** shall do the work necessary to maintain the signing on the state highway system and the **Office of TSMO** shall:

1. Staff and maintain a central **Sign Shop**.
2. Assist **Districts** in maintaining reasonable stock levels of materials and hardware required for new installations and maintenance through the management of annual term contracts.
3. Assist the **Districts**, through procedure manuals, training programs, inspections and other methods, in providing quality maintenance of traffic control features used on the state highway system.

Example of Clearance Signs on a Low Clearance Structure





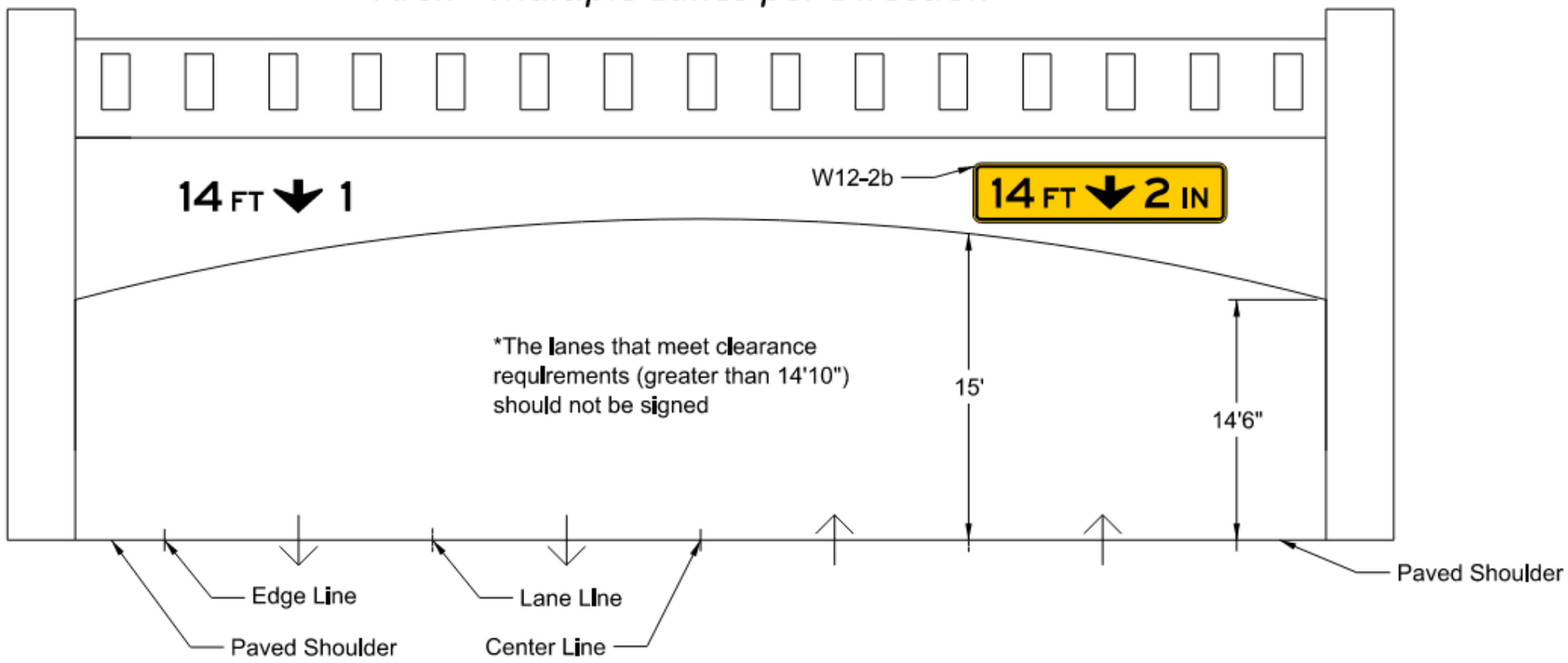
Legend:

↑ Driving Toward Bridge

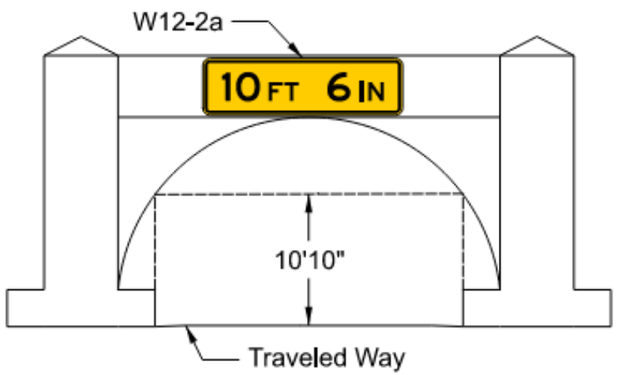
↓ Driving Away From Bridge

NOTE:
All Low Clearance Signs displayed on bridge use a 4" buffer from the actual low vertical clearance (Actual Height - 4")

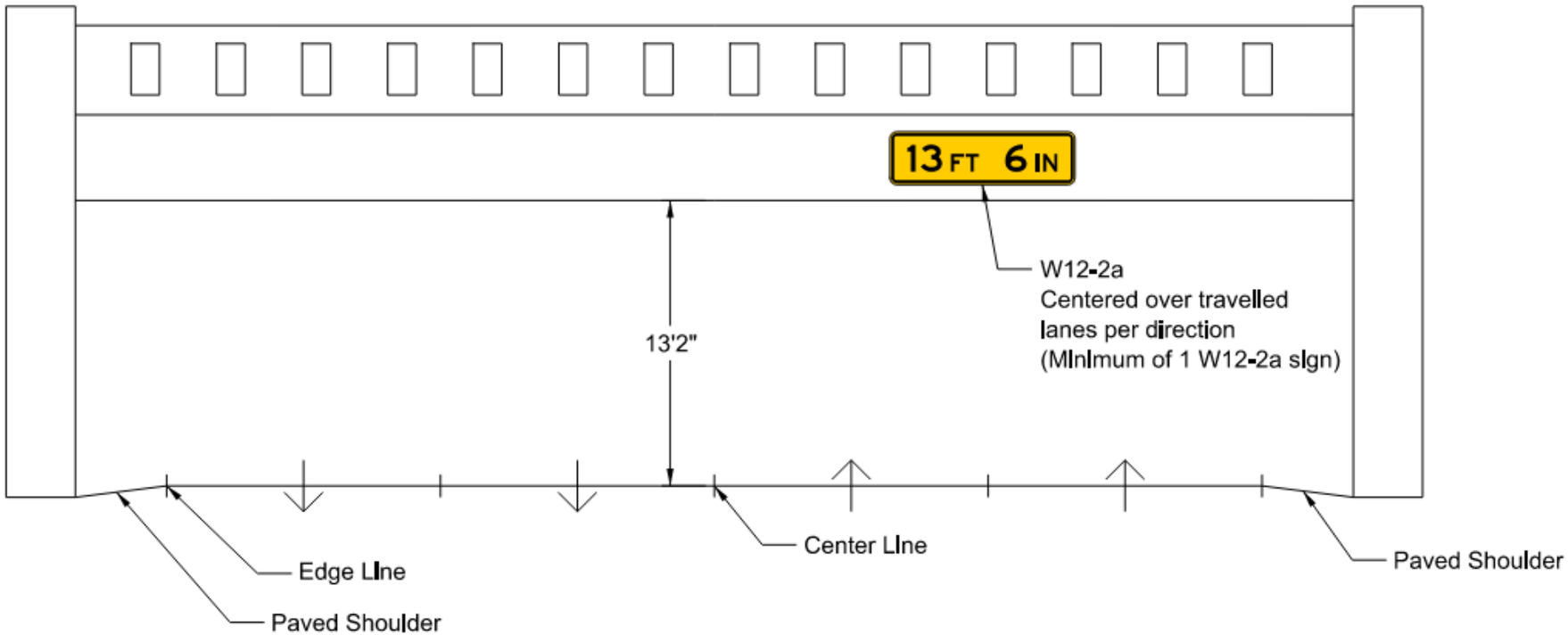
Arch - Multiple Lanes per Direction



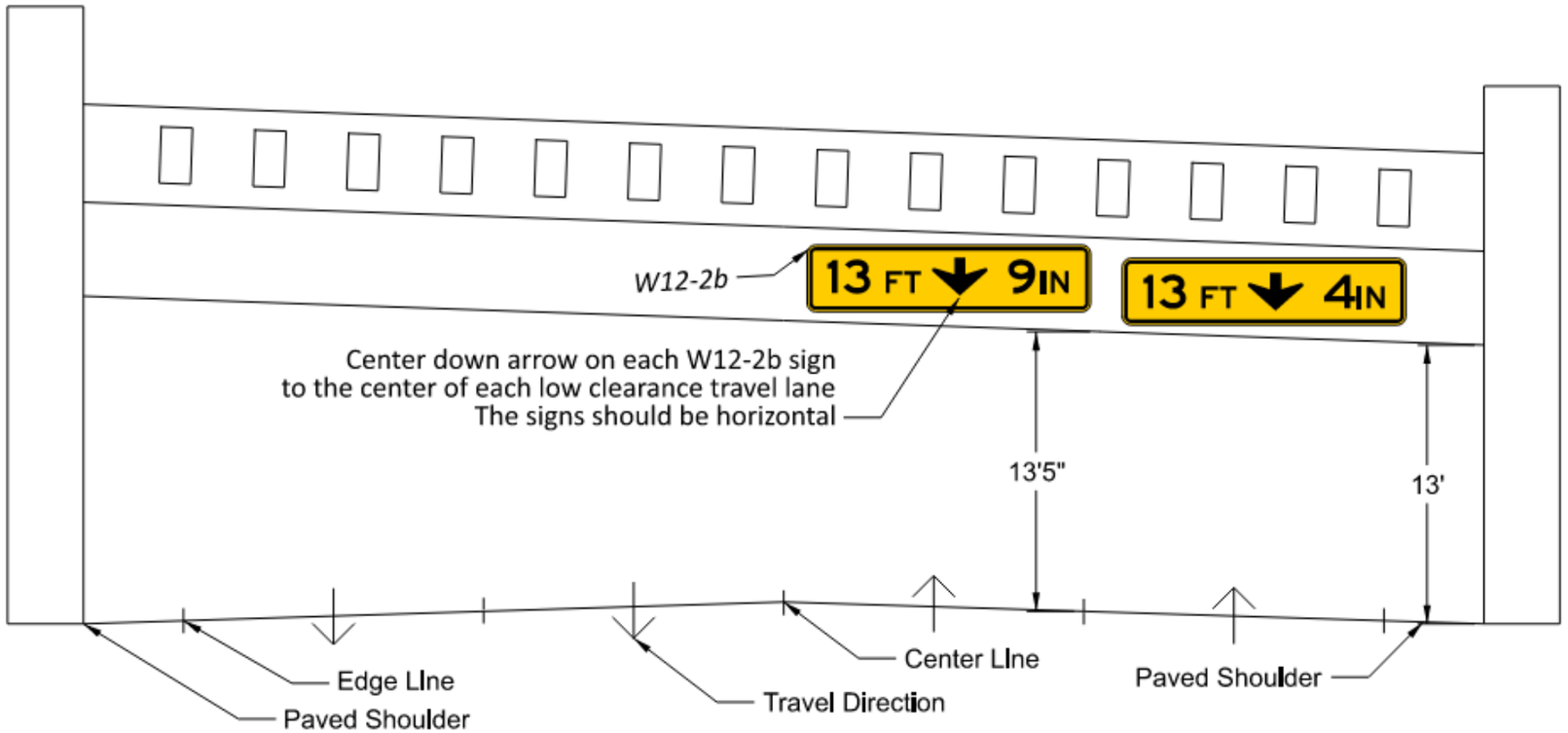
Arch - Single Lane



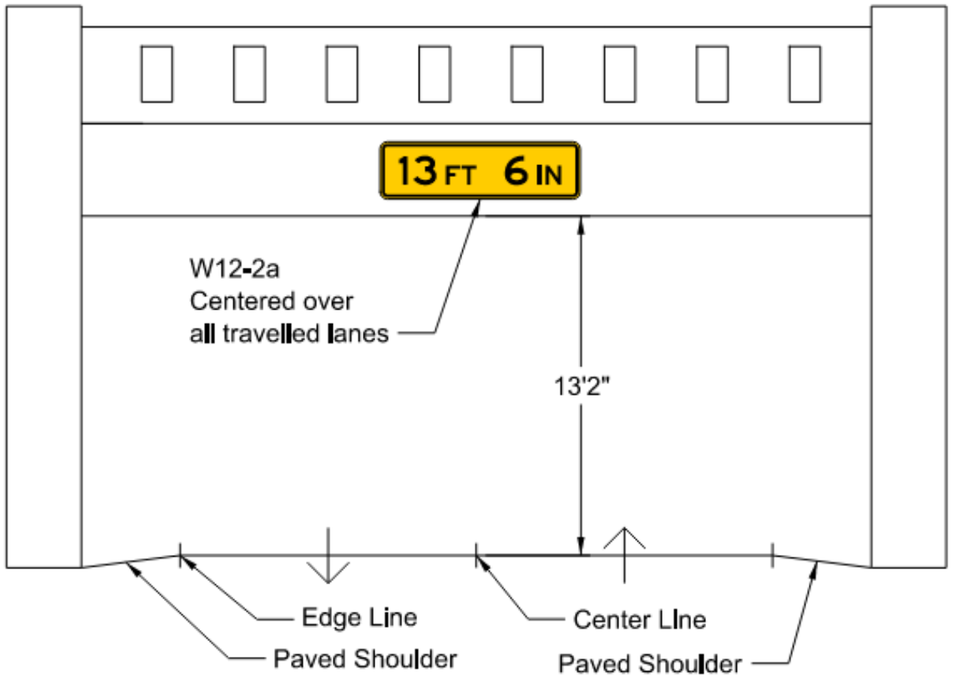
Standard Structure – Multiple Lanes per Direction



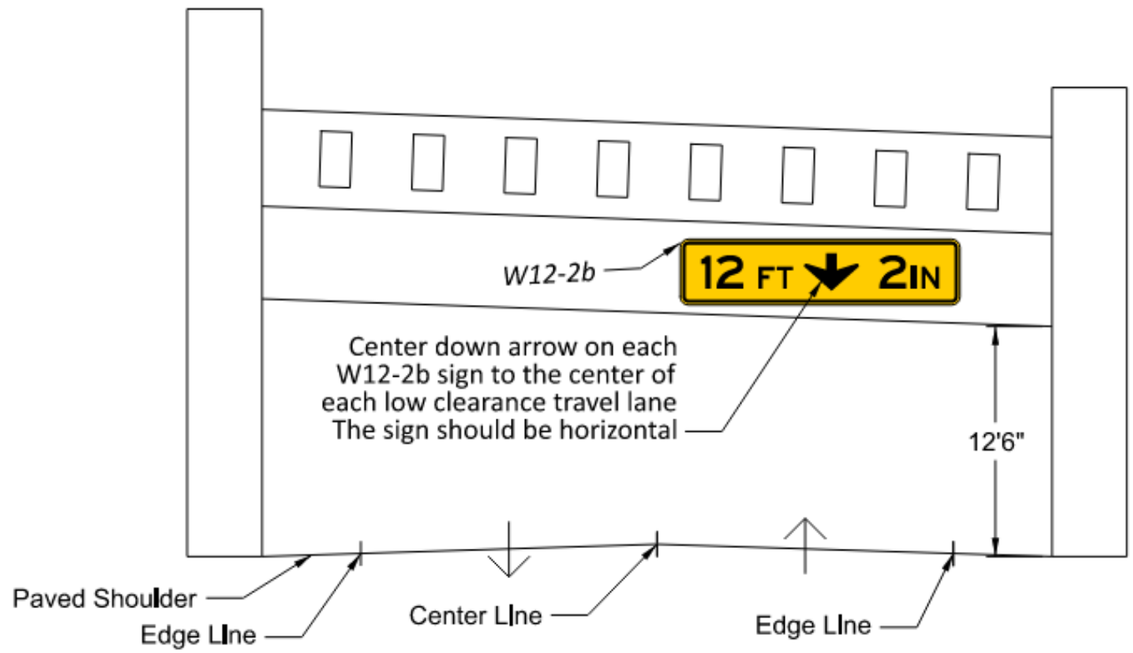
Standard Structure – Variable Clearance – Multiple Lanes per Direction

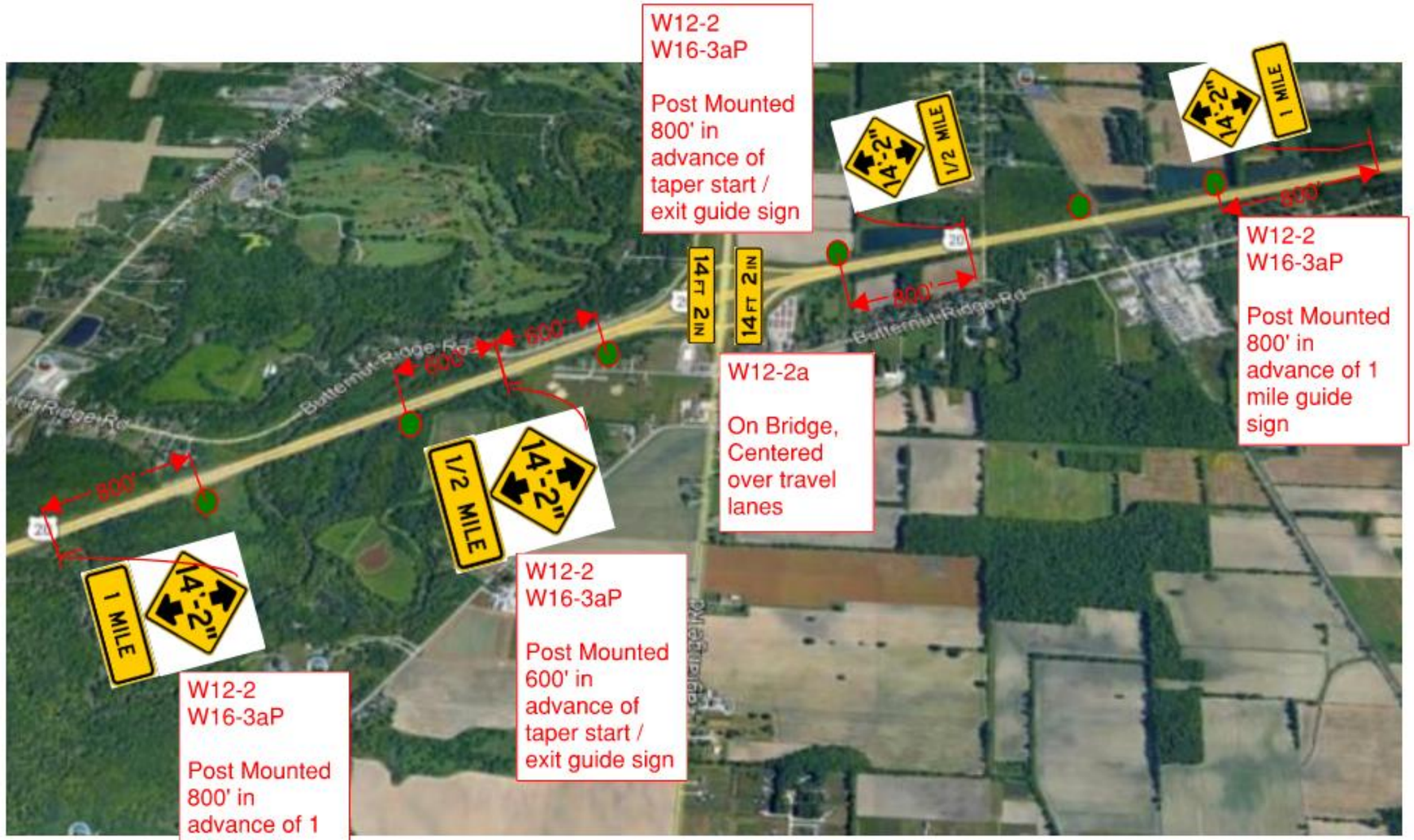


Standard Bridge - One Lane Per Direction



Standard Structure – Variable Clearance
One Lane per Direction




W12-2
W16-3aP
Post Mounted 800' in advance of taper start / exit guide sign
14FT 2IN
14FT 2IN
W12-2a
On Bridge, Centered over travel lanes
W12-2
W16-3aP
Post Mounted 800' in advance of 1 mile guide sign
W12-2
W16-3aP
Post Mounted 600' in advance of taper start / exit guide sign
W12-2
W16-3aP
Post Mounted 800' in advance of 1 mile guide sign
Freeway
W12-2 48x48
Existing Guide Sign
Buttermilk Ridge Rd
800'
600'
1/2 MILE
1 MILE
14'-2"


Conventional Route
W12-2 36x36
190
Rd U 20
Rd 23 0
1 MILE
14'-2"
W12-2
W16-3aP
1 MILE
14'-2"
W12-2
W16-3aP
14 FT 2 IN
14 FT 2 IN
1/4 MILE
14'-2"
W12-2
W16-3aP (1/4 MILE)
950 FT
14'-2"
W12-2
W16-2aP
W12-2a
On Bridge, Centered over travel lanes

301-22 Speed Reduction Markings

301-22.1 General

Speed Reduction Markings are transverse markings that are placed on the roadway within a lane (along both edges of the lane) in a pattern of progressively reduced spacing to give drivers the impression that their speed is increasing.

Speed Reduction Markings should be reserved for unexpected curves or other usages based on engineering judgment. They should not be used on long tangent sections of roadway or in areas frequented mainly by local or familiar drivers, such as school zones.

See **MUTCD Section 3B.28 and Figure 3B-25** for further guidance and details on the use of Speed Reduction Markings. See Traffic **SCD TC-75.10** for details on placement standards and guidance for Speed Reduction Markings. For example calculations on how to space the markings, see **TEM Table 397-03** Speed Reduction Markings Calculations for guidance.

301-22.2 Design

Speed Reduction Markings segments should be designed to achieve a 4-bar/sec spacing as a vehicle slows from the initial approach speed to the desired curve speed. The spacing between the transverse markings are progressively reduced from the upstream to the downstream end of the marked portion of the lane, to produce a gradual slowing from a vehicle's initial approach speed to the advisory curve speed. The goal is to achieve the slowing before the vehicle enters the curve.

For example, an applied layout designed to slow a vehicle from 55 mi/h (81 ft/sec) into a 35-mi/h (51 ft/sec) curve, the initial bar separation distance is 81÷4 or 20 ft, and the final separation distance is 51÷4 or 13 ft.

The total length of the Speed Reduction Markings segment depends upon the speed difference between the higher approach speed and the lower curve speed. Table 1 suggests approximate lengths, which may be used as guidelines. The basis for the numbers is to produce a comfortable speed reduction.

Table 1: Typical Guidelines for length (ft) of speed reduction markings segment in advance of curve

	Approach Speed (MPH)					
	45	**50**	**55**	**60**	**65**	**70**

Curve Speed (mph)	**15**	300	385	470	565	670	785
	20	275	350	440	535	640	755
	25	235	315	405	500	600	720
	30	---	270	360	450	560	670
	35	---	---	300	400	500	620
	40	---	---	---	335	440	555
	45	---	---	---	---	370	480
	50	---	---	---	---	---	405

301-22.3 Installation

Each Speed Reduction Marking shall consist of a pair of white transverse lines that are 12 inches in width (measured in the direction of travel) and extending 18 inches into the lane. One marking is placed on the left side of the lane and the second marking is placed on the right side of the lane, directly opposite the left side marking. Each marking is placed perpendicular to and abutted against the center line, edge line or lane line. Speed Reduction Markings shall only be used in lanes that have a longitudinal line on both sides of the lane.

The longitudinal spacing between the markings should be progressively reduced from the upstream to the downstream end of the marked portion of the lane.

350-8.3 Application of Pavement Marking Materials

Pavement marking materials shall be applied according to **C&MS Items 640 and 740** as follows:

1. Traffic paint, **C&MS Item 642**.
    a. Material Type, **Item 740.02**.
        i. Traffic paint Type 1, Fast dry, water-based paint, 20 mil thickness.
        ii. Traffic paint Type 1A, Fast dry, water-based paint, 15 mil thickness.
    b. Glass beads, **Item 740.09** Type A.
    c. Application of Traffic Paint, **Item 642**, Type 1 and 1A.
        i. Traffic paint Type 1 shall be applied when the pavement and air temperature are 50°F and above. Traffic paint Type 1A shall be applied when the pavement and air temperature are between 35°F and 50°F.
        ii. Glass beads Type A shall be applied at the rate of 10 pounds per 100 square feet of Type 1 traffic paint applied.
        iii. Glass beads Type A shall be applied at the rate of 8 pounds per 100 square feet of Type 1A traffic paint applied.
        iv. Type 1 traffic paint shall be applied at the rate of 22 gallons per mile of 4-inch solid line and/or at 1.25 gallons per 100 square feet .
        v. Type 1A traffic paint shall be applied at the rate of 16 gallons per mile of 4-inch solid line and/or at 0.94 gallon per 100 square feet.
        vi. Coning of the line is required because the pavement marking is not track free in 2 minutes or less.
2. Polyester Pavement Marking, **Item 643**.
    a. Material Type, **Item 740.03**.
    b. Glass beads, **Item 740.09** Type B.
    c. Application of Polyester, **Item 643**.
        i. Polyester shall be applied when the pavement and air temperature are 50°F and above.
        ii. Polyester shall be applied in two components (catalyst and resin) in proportions as recommended by the manufacturer.
        iii. Glass beads Type B shall be applied at the rate of 18 pounds per gallon (liter) of paint used.
        iv. Polyester shall be applied at the rate of 16 gallons per mile of 4-inch line and/or at 0.94 gallon per 100 square feet (15 mil thickness).
        v. Since dry time is 45 minutes and less:
            1. Coning is required to protect the line until track free.
            2. If tracking continues after 45 minutes cease marking operation until tracking problem is corrected.
3. Thermoplastic Pavement Marking, **C&MS Item 644**.

a. Material Type, **Item 740.04**.

b. Glass beads, **Item 740.09** Type C.

c. Application of Thermoplastic, **Item 644**.

i. For pavements less than six months old, thermoplastic shall be applied when the pavement surface and the ambient air temperature are 50^{o} F and rising. At the end of the construction season, if the surface temperature is 50^{o} F or less, apply Traffic Paint Type 1A.

ii. For pavements one year or older, thermoplastic shall be applied when the pavement surface and the ambient air temperature are 70^{o}F and rising.

iii. The temperature of thermoplastic at the point of application shall be at least 400^{o} F and not more than 440^{o}F .

iv. Glass beads, Type C shall be applied at the rate of 12 pounds per 100 square feet.

v. Thermoplastic material shall be applied at a thickness of 125 mils using an applicator that has a shoe that rides on the pavement and extrudes the thermoplastic (no ribbon application).

vi. Thermoplastic shall be applied at the rate of 2340 pounds per mile of 4-inch line and/or at 133 pounds per 100 square.

4. Preformed Pavement Marking, **C&MS Item 645**.

a. Material Types, Items **740.05 and 740.06**.

i. For Type A, permanent markings, Type A1, A2 or A3 material from **Item 740.05** shall be used -

1. Type A1 material, 0.090 inch thick shall be applied with pre-coated adhesive layer.
2. Type A2 material, 0.060 inch thick shall be applied with pre-coated adhesive layer.
3. Type A3 material, 0.020 inch thick shall be applied with pre-coated adhesive layer.

ii. For Type B work zone pavement markings, Type II (non-removable) material from **Item 740.06** shall be used. This material has a minimum thickness of 0.015 inch.

iii. For Type C work zone pavement markings, Type I (removable) material from **Item 740.06** shall be used. This material has a minimum thickness of 0.030 inch.

b. Glass beads - None.

c. Application of Preformed Pavement Marking, **Item 645**: Preformed pavement marking shall be applied according to the manufacturer's recommendations packed with material.

5. Epoxy Pavement Marking, **C&MS Item 646**.

a. Material Type, **Item 740.07**.

b. Glass beads, **Item 740.09** Type D.

c. Application of Epoxy Pavement Marking, **Item 646**.

i. Epoxy shall be applied at a surface temperature of 50^{o}F and above.

ii. Epoxy shall be applied in components, Part A and Part B, in the proportions recommended by the manufacturer.

iii. Cleaning and Surface Preparation shall be done according to Item 646.04 for different pavement types and manufacturer's recommendations.

iv. Glass beads Type D shall be apply at the rate of 31 pounds per 100 square feet. They shall be applied in a double-drop system with Size I, large gradation, first and Size II, regular graduation second in equal amounts by weight in the same pass.

v. Epoxy shall be applied at the rate of 22 gallons per mile of 4-inch line and/or at 1.25 gallon per 100 square feet (20 mil thickness).

6. Heat-Fused Preformed Thermoplastic Pavement Marking, **Item 647**.

a. Material Type, **Item 740.08**.

i. Type A90 is 90 mil thick.

ii. Type A125 is 125 mil thick.

iii. Type B90 is 90 mil thick.

iv. Type B125 is 125 mil thick.

b. Glass beads - Type A and B shall contain intermix beads throughout. Drop-on glass beads are not required unless using a non-surface beaded markings.

c. Application of Heat-Fused Preformed Thermoplastic Pavement Marking, **Item 647**.

i. Heat-Fused Preformed Thermoplastic Pavement Marking shall be applied only as auxiliary markings according to the manufacturer's recommendations.

ii. Apply primer sealer on Portland cement concrete pavements if recommended by the manufacturer.

7. Spray Thermoplastic Pavement Marking, **Item 648**.

a. Material Type, **Item 740.10**.

b. Glass Beads, **Item 740.09** Type G.

c. Application of Spray Thermoplastic, **Item 648**.

i. For pavements less than six months old, spray thermoplastic shall be applied when the pavement surface and the ambient air temperature are 50^{o}F and rising

ii. For pavements one year of older, spray thermoplastic shall be applied when the pavement surface and the ambient air temperature are 70^{o}F.

iii. The temperature of spray thermoplastic at the point of application shall be at least 400^{o}F and not more than 440^{o}F.

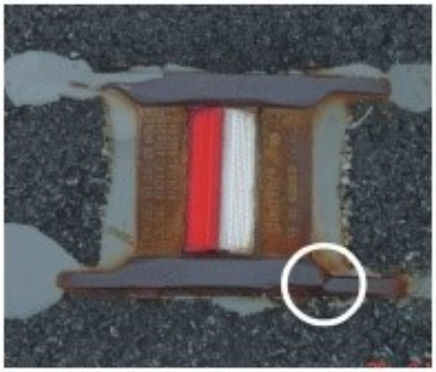
iv. Glass beads, Type C shall be applied at the rate of 10 pounds per 100 square feet.

v. Spray thermoplastic material shall be applied at a thickness of 45 mils.

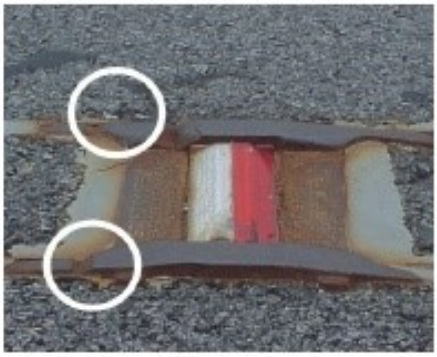
vi. Spray thermoplastic shall be applied at the rate of 762-886 pounds per mile of 4-inch line.

360-2.3 Inspection Guidelines for Existing RPM Installations

1. Casting Failure: An RPM casting has "failed" if it is broken, loose, cracked fully or partially, or if the casting is gouged. Broken leveling lugs/tabs or minor shaving or scratches on the casting do not constitute failure of the casting.



Keel is cracked.



Keels are gouged.

2. Poor Quality Installation: The following are considered poor quality installations:

a. Any of the four lugs/tabs are not resting on the pavement surface ***(see illustration 1, Section 350-5)***.

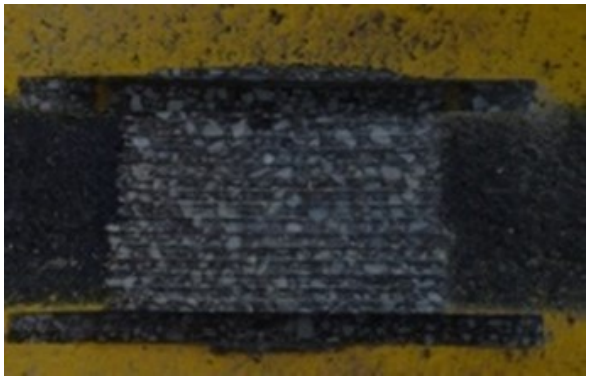
b. The epoxy adhesive does not fill all the voids around the casting ***(see illustration 2a, Section 350-5)***.

c. The epoxy adhesive is not all around the casting and level with the roadway surface. For example, **illustration 2b** in ***Section 350-5*** shows a casting with space between the casting and the pavement on one side and in contact with the pavement on the other side.

d. There is epoxy adhesive build-up on the casting lips in front of the reflector.

e. The epoxy is not hardened and/or not a uniform gray color ***(see illustration 7, Section 350-5)***.

f. The slot or cut for the RPM is intact and the casting is missing. This indicates that there was a poor bond between epoxy and pavement.



f. The leading casting rails are above the pavement so as to become a blunt edge which can become caught by a snowplow blade.

g. RPM installed on or close to a construction joint ***(see illustration 4, Section 350-5)***.

3. Pavement Failure: A missing casting with the surrounding pavement also missing is an indication of pavement failure. Typically, as shown in the illustration, the slot or cut made for the casting has lost its shape.

4. Adhesive Failure: Adhesive failure occurs when the bond between pavement surface and epoxy under the casting has failed. Usually surface of the under laying old pavement is visible and the casting is missing.

Speed Reduction Markings

See below for example of Spreadsheet and example output. Download the Spreadsheet to use on specific projects

DECELERATION RATE	6.7	FT/S^2

*CAN ALTER DECELERATION RATE TO PROJECT SPECIFIC NEEDS

***NCHRP 780 Design Guidance for Intersection Auxiliary Lanes (2014)**
***BASIS FOR 6.7 FT/S^2**

- The Green Book deceleration rate of 5.8 ft/s² prior to the end of the taper was within the range of average rates at the study sites, but 8 of the 12 sites had an average rate higher than 5.8 ft/s². The 50th percentile rate was approximately 6.1 ft/s² for low-speed sites and 6.7 ft/s² for high-speed sites. In addition, 85% of observed drivers at high-speed sites decelerated at a rate of 4.2 ft/s² or greater up to the end of the taper.

Table 6-16. Deceleration rates of left-turning vehicles prior to the end of the taper.

Site	Taper Rate[a]	Taper Length (ft)	Decel Length (ft)	Posted Speed Limit (mph)	Deceleration Rate Prior to End of Taper (ft/s²)				Number of Vehicles
					Avg	Std Dev	15th %ile	85th %ile	
AL-09	6.8	61	94	35	11.7	4.9	2.9	14.8	17
FL-10	7.9	71	216	45	5.5	4.0	0.6	8.0	28
FL-09	8.0	80	173	35	3.9	2.2	1.4	7.0	33
MS-03	8.9	93	186	45	6.9	2.4	4.0	9.2	24
FL-03	9.3	98	365	45	7.8	3.8	2.5	12.3	38
AL-08	10.2	115	230	35	4.2	1.8	2.1	6.0	17
MS-08	11.9	119	255	45	5.7	3.2	1.7	9.2	59
MS-05	11.4	125	80	35	11.5	3.9	8.0	15.2	20
TX-33	13.2	152	312	65	5.9	3.6	2.0	8.3	43
AL-03	16.9	186	180	50	6.4	1.9	4.3	7.9	44
TX-28	16.6	191	283	65	8.1	2.5	5.8	10.3	55
TX-21	17.7	204	115	50	6.3	1.6	4.2	8.0	32
All Sites					6.7	3.6	2.8	9.8	410
All Low-Speed Sites (35–45 mph)					6.7	4.1	2.2	10.8	236
All High-Speed Sites (50–65 mph)					6.8	2.7	4.2	9.0	174

[a] Taper rate is the amount of longitudinal distance for each unit of transverse distance (i.e., the length of taper for each unit of lane width added).

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
15		45			50			55			60			65			70		
		NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
		27			31			36			40			44			49		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	16.5	45.0	16.5	18.3	50.0	18.3	20.2	55.0	20.2	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	16.1	43.9	32.6	17.9	48.9	36.3	19.8	53.9	39.9	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	15.7	42.7	48.3	17.5	47.7	53.8	19.3	52.7	59.3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	15.2	41.6	63.5	17.1	46.6	70.8	18.9	51.6	78.3	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	14.8	40.4	78.3	16.7	45.4	87.5	18.5	50.4	96.7	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	14.4	39.3	92.7	16.2	44.3	103.7	18.1	49.3	114.7	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	14.0	38.1	106.7	15.8	43.1	119.6	17.7	48.1	132.4	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	13.6	37.0	120.3	15.4	42.0	135.0	17.2	47.0	149.6	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	13.2	35.9	133.5	15.0	40.9	150.0	16.8	45.9	166.5	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	12.7	34.7	146.2	14.6	39.7	164.5	16.4	44.7	182.9	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	12.3	33.6	158.5	14.2	38.6	178.7	16.0	43.6	198.9	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	11.9	32.4	170.4	13.7	37.4	192.4	15.6	42.4	214.4	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	11.5	31.3	181.8	13.3	36.3	205.7	15.1	41.3	229.6	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	11.1	30.2	192.9	12.9	35.2	218.6	14.7	40.2	244.3	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	10.6	29.0	203.6	12.5	34.0	231.1	14.3	39.0	258.6	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	10.2	27.9	213.8	12.1	32.9	243.2	13.9	37.9	272.5	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	9.8	26.7	223.6	11.6	31.7	254.8	13.5	36.7	286.0	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	9.4	25.6	233.0	11.2	30.6	266.0	13.1	35.6	299.0	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	9.0	24.4	242.0	10.8	29.4	276.8	12.6	34.4	311.6	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	8.5	23.3	250.5	10.4	28.3	287.2	12.2	33.3	323.9	14.0	38.3	360.5	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	8.1	22.2	258.6	10.0	27.2	297.2	11.8	32.2	335.7	13.6	37.2	374.2	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	7.7	21.0	266.4	9.5	26.0	306.7	11.4	31.0	347.0	13.2	36.0	387.4	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	7.3	19.9	273.8	9.1	24.9	315.8	11.0	29.9	358.0	12.8	34.9	400.2	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	6.9	18.7	280.5	8.7	23.7	324.5	10.5	28.7	368.5	12.4	33.7	412.5	14.2	38.7	456.6	16.0	43.7	500.6
24	X25	6.5	17.6	287.0	8.3	22.6	332.8	10.1	27.6	378.7	12.0	32.6	424.5	13.8	37.6	470.3	15.8	42.6	516.2
25	X26	6.0	16.5	293.0	7.9	21.5	340.7	9.7	26.5	388.4	11.5	31.5	436.0	13.4	36.5	483.7	15.2	41.5	531.4
26	X27	5.6	15.3	298.6	7.5	20.3	348.1	9.3	25.3	397.6	11.1	30.3	447.2	13.0	35.3	496.7	14.8	40.3	546.2
27	X28	5.2	14.2	303.8	7.0	19.2	355.2	8.9	24.2	406.5	10.7	29.2	457.9	12.5	34.2	509.2	14.4	39.2	560.5
28	X29	--	--	--	6.6	18.0	361.8	8.4	23.0	415.0	10.3	28.0	468.1	12.1	33.0	521.3	13.9	38.0	574.5
29	X30	--	--	--	6.2	16.9	368.0	8.0	21.9	423.0	9.9	26.9	478.0	11.7	31.9	533.0	13.5	36.9	588.0
30	X31	--	--	--	5.8	15.7	373.7	7.6	20.7	430.6	9.4	25.7	487.4	11.3	30.7	544.3	13.1	35.7	601.1
31	X32	--	--	--	5.4	14.6	379.1	7.2	19.6	437.8	9.0	24.6	496.5	10.9	29.6	555.1	12.7	34.6	613.8
32	X33	--	--	--	--	--	--	6.8	18.5	444.6	8.6	23.5	505.1	10.4	28.5	565.6	12.3	33.5	626.1
33	X34	--	--	--	--	--	--	6.4	17.3	450.9	8.2	22.3	513.3	10.0	27.3	575.6	11.9	32.3	637.9
34	X35	--	--	--	--	--	--	5.9	16.2	456.8	7.8	21.2	521.0	9.6	26.2	585.2	11.4	31.2	649.4
35	X36	--	--	--	--	--	--	5.5	15.0	462.4	7.3	20.0	528.4	9.2	25.0	594.4	11.0	30.0	660.4
36	X37	--	--	--	--	--	--	5.1	13.9	467.4	6.9	18.9	535.3	8.8	23.9	603.1	10.6	28.9	671.0
37	X38	--	--	--	--	--	--	--	--	--	6.5	17.8	541.8	8.3	22.8	611.5	10.2	27.8	681.2
38	X39	--	--	--	--	--	--	--	--	--	6.1	16.6	547.9	7.9	21.6	619.4	9.8	26.6	690.9
39	X40	--	--	--	--	--	--	--	--	--	5.7	15.5	553.6	7.5	20.5	626.9	9.3	25.5	700.3
40	X41	--	--	--	--	--	--	--	--	--	5.3	14.3	558.8	7.1	19.3	634.0	8.9	24.3	709.2
41	X42	--	--	--	--	--	--	--	--	--	--	--	--	6.7	18.2	640.7	8.5	23.2	717.7
42	X43	--	--	--	--	--	--	--	--	--	--	--	--	6.3	17.0	646.9	8.1	22.0	725.8
43	X44	--	--	--	--	--	--	--	--	--	--	--	--	5.8	15.9	652.6	7.7	20.9	733.5
44	X45	--	--	--	--	--	--	--	--	--	--	--	--	5.4	14.8	658.2	7.2	19.8	740.7
45	X46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	18.6	747.5
46	X47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	17.5	753.9
47	X48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0	16.3	759.9
48	X49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.6	15.2	765.5
49	X50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.2	14.1	770.7

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
15		45			50			55			60			65			70		
		NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
		27			31			36			40			44			49		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	16.5	45.0	16.5	18.3	50.0	18.3	20.2	55.0	20.2	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	16.1	43.9	32.6	17.9	48.9	36.3	19.8	53.9	39.9	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	15.7	42.7	48.3	17.5	47.7	53.8	19.3	52.7	59.3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	15.2	41.6	63.5	17.1	46.6	70.8	18.9	51.6	78.2	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	14.8	40.4	78.3	16.7	45.4	87.5	18.5	50.4	96.7	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	14.4	39.3	92.7	16.2	44.3	103.7	18.1	49.3	114.7	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	14.0	38.1	106.7	15.8	43.1	119.6	17.7	48.1	132.4	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	13.6	37.0	120.3	15.4	42.0	135.0	17.2	47.0	149.6	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	13.2	35.9	133.5	15.0	40.9	150.0	16.8	45.9	166.5	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	12.7	34.7	146.2	14.6	39.7	164.5	16.4	44.7	182.9	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	12.3	33.6	158.5	14.2	38.6	178.7	16.0	43.6	198.9	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	11.9	32.4	170.4	13.7	37.4	192.4	15.6	42.4	214.4	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	11.5	31.3	181.9	13.3	36.3	205.7	15.1	41.3	229.6	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	11.1	30.2	192.9	12.9	35.2	218.6	14.7	40.2	244.3	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	10.6	29.0	203.6	12.5	34.0	231.1	14.3	39.0	258.6	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	10.2	27.9	213.8	12.1	32.9	243.2	13.9	37.9	272.5	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	9.8	26.7	223.6	11.6	31.7	254.8	13.5	36.7	286.0	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	9.4	25.6	233.0	11.2	30.6	266.0	13.1	35.6	299.0	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	9.0	24.4	242.0	10.8	29.4	276.8	12.6	34.4	311.6	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	8.5	23.3	250.5	10.4	28.3	287.2	12.2	33.3	323.9	14.0	38.3	360.5	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	8.1	22.2	258.6	10.0	27.2	297.2	11.8	32.2	335.7	13.6	37.2	374.2	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	7.7	21.0	266.4	9.5	26.0	306.7	11.4	31.0	347.0	13.2	36.0	387.4	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	7.3	19.9	273.6	9.1	24.9	315.8	11.0	29.9	358.0	12.8	34.9	400.2	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	6.9	18.7	280.5	8.7	23.7	324.5	10.5	28.7	368.5	12.4	33.7	412.5	14.2	38.7	456.6	16.0	43.7	500.6
24	X25	6.5	17.6	287.0	8.3	22.6	332.8	10.1	27.6	378.7	12.0	32.6	424.5	13.8	37.6	470.3	15.6	42.6	516.2
25	X26	6.0	16.5	293.0	7.9	21.5	340.7	9.7	26.5	388.4	11.5	31.5	436.0	13.4	36.5	483.7	15.2	41.5	531.4
26	X27	5.6	15.3	298.6	7.5	20.3	348.1	9.3	25.3	397.6	11.1	30.3	447.2	13.0	35.3	496.7	14.8	40.3	546.2
27	X28	5.2	14.2	303.8	7.0	19.2	355.2	8.9	24.2	406.5	10.7	29.2	457.9	12.5	34.2	509.2	14.4	39.2	560.5
28	X29	--	--	--	6.6	18.0	361.8	8.4	23.0	415.0	10.3	28.0	468.1	12.1	33.0	521.3	13.9	38.0	574.5
29	X30	--	--	--	6.2	16.9	368.0	8.0	21.9	423.0	9.9	26.9	478.0	11.7	31.9	533.0	13.5	36.9	588.0
30	X31	--	--	--	5.8	15.7	373.7	7.6	20.7	430.6	9.4	25.7	487.4	11.3	30.7	544.3	13.1	35.7	601.1
31	X32	--	--	--	5.4	14.6	379.1	7.2	19.6	437.8	9.0	24.6	496.5	10.9	29.6	555.1	12.7	34.6	613.8
32	X33	--	--	--	--	--	--	6.8	18.5	444.6	8.6	23.5	505.1	10.4	28.5	565.6	12.3	33.5	626.1
33	X34	--	--	--	--	--	--	6.4	17.3	450.9	8.2	22.3	513.3	10.0	27.3	575.6	11.9	32.3	637.9
34	X35	--	--	--	--	--	--	5.9	16.2	456.8	7.8	21.2	521.0	9.6	26.2	585.2	11.4	31.2	649.4
35	X36	--	--	--	--	--	--	5.5	15.0	462.4	7.3	20.0	528.4	9.2	25.0	594.4	11.0	30.0	660.4
36	X37	--	--	--	--	--	--	5.1	13.9	467.4	6.9	18.9	535.3	8.8	23.9	603.1	10.6	28.9	671.0
37	X38	--	--	--	--	--	--	--	--	--	6.5	17.8	541.8	8.3	22.8	611.5	10.2	27.8	681.2
38	X39	--	--	--	--	--	--	--	--	--	6.1	16.6	547.9	7.9	21.6	619.4	9.8	26.6	690.9
39	X40	--	--	--	--	--	--	--	--	--	5.7	15.5	553.6	7.5	20.5	626.9	9.3	25.5	700.3
40	X41	--	--	--	--	--	--	--	--	--	5.3	14.3	558.8	7.1	19.3	634.0	8.9	24.3	709.2
41	X42	--	--	--	--	--	--	--	--	--	--	--	--	6.7	18.2	640.7	8.5	23.2	717.7
42	X43	--	--	--	--	--	--	--	--	--	--	--	--	6.3	17.0	646.9	8.1	22.0	725.8
43	X44	--	--	--	--	--	--	--	--	--	--	--	--	5.8	15.9	652.8	7.7	20.9	733.5
44	X45	--	--	--	--	--	--	--	--	--	--	--	--	5.4	14.8	658.2	7.2	19.8	740.7
45	X46	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.8	18.6	747.5
46	X47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.4	17.5	753.9
47	X48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0	16.3	759.9
48	X49	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.6	15.2	765.5
49	X50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.2	14.1	770.7

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
25		45			50			55			60			65			70		
		NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
		18			22			27			31			36			40		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	16.5	45.0	16.5	18.3	50.0	18.3	20.2	55.0	20.2	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	16.1	43.9	32.6	17.9	48.9	36.3	19.8	53.9	39.9	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	15.7	42.7	48.3	17.5	47.7	53.8	19.3	52.7	59.3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	15.2	41.6	63.5	17.1	46.6	70.8	18.9	51.6	78.2	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	14.8	40.4	78.3	16.7	45.4	87.5	18.5	50.4	96.7	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	14.4	39.3	92.7	16.2	44.3	103.7	18.1	49.3	114.7	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	14.0	38.1	106.7	15.8	43.1	119.6	17.7	48.1	132.4	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	13.6	37.0	120.3	15.4	42.0	135.0	17.2	47.0	149.6	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	13.2	35.9	133.5	15.0	40.9	150.0	16.8	45.9	166.5	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	12.7	34.7	146.2	14.6	39.7	164.5	16.4	44.7	182.9	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	12.3	33.6	158.5	14.2	38.6	178.7	16.0	43.6	198.9	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	11.9	32.4	170.4	13.7	37.4	192.4	15.6	42.4	214.4	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	11.5	31.3	181.9	13.3	36.3	205.7	15.1	41.3	229.6	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	11.1	30.2	192.9	12.9	35.2	218.6	14.7	40.2	244.3	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	10.6	29.0	203.6	12.5	34.0	231.1	14.3	39.0	258.6	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	10.2	27.9	213.8	12.1	32.9	243.2	13.9	37.9	272.5	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	9.8	26.7	223.6	11.6	31.7	254.8	13.5	36.7	286.0	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	9.4	25.6	233.0	11.2	30.6	266.0	13.1	35.6	299.0	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	9.0	24.4	242.0	10.8	29.4	276.8	12.6	34.4	311.6	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	--	--	--	10.4	28.3	287.2	12.2	33.3	323.9	14.0	38.3	360.5	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	--	--	--	10.0	27.2	297.2	11.8	32.2	335.7	13.6	37.2	374.2	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	--	--	--	9.5	26.0	306.7	11.4	31.0	347.0	13.2	36.0	387.4	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	--	--	--	9.1	24.9	315.8	11.0	29.9	358.0	12.8	34.9	400.2	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	--	--	--	--	--	--	10.5	28.7	368.5	12.4	33.7	412.5	14.2	38.7	456.6	16.0	43.7	500.6
24	X25	--	--	--	--	--	--	10.1	27.6	378.7	12.0	32.6	424.5	13.8	37.6	470.3	15.6	42.6	516.2
25	X26	--	--	--	--	--	--	9.7	26.5	388.4	11.5	31.5	436.0	13.4	36.5	483.7	15.2	41.5	531.4
26	X27	--	--	--	--	--	--	9.3	25.3	397.6	11.1	30.3	447.2	13.0	35.3	496.7	14.8	40.3	546.2
27	X28	--	--	--	--	--	--	8.9	24.2	406.5	10.7	29.2	457.9	12.5	34.2	509.2	14.4	39.2	560.5
28	X29	--	--	--	--	--	--	--	--	--	10.3	28.0	468.1	12.1	33.0	521.3	13.9	38.0	574.5
29	X30	--	--	--	--	--	--	--	--	--	9.9	26.9	478.0	11.7	31.9	533.0	13.5	36.9	588.0
30	X31	--	--	--	--	--	--	--	--	--	9.4	25.7	487.4	11.3	30.7	544.3	13.1	35.7	601.1
31	X32	--	--	--	--	--	--	--	--	--	9.0	24.6	496.5	10.9	29.6	555.1	12.7	34.6	613.8
32	X33	--	--	--	--	--	--	--	--	--	--	--	--	10.4	28.5	565.6	12.3	33.5	626.1
33	X34	--	--	--	--	--	--	--	--	--	--	--	--	10.0	27.3	575.6	11.9	32.3	637.9
34	X35	--	--	--	--	--	--	--	--	--	--	--	--	9.6	26.2	585.2	11.4	31.2	649.4
35	X36	--	--	--	--	--	--	--	--	--	--	--	--	9.2	25.0	594.4	11.0	30.0	660.4
36	X37	--	--	--	--	--	--	--	--	--	--	--	--	8.8	23.9	603.1	10.6	28.9	671.0
37	X38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.2	27.8	681.2
38	X39	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.8	26.6	690.9
39	X40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.3	25.5	700.3
40	X41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.9	24.3	709.2

Advisory Speed (MPH)	APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
30	50			55			60			65			70		
	NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
	18			22			27			31			36		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	18.3	50.0	18.3	20.2	55.0	20.2	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	17.9	48.9	36.3	19.8	53.9	39.9	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	17.5	47.7	53.8	19.3	52.7	59.3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	17.1	46.6	70.8	18.9	51.6	78.2	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	16.7	45.4	87.5	18.5	50.4	96.7	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	16.2	44.3	103.7	18.1	49.3	114.7	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	15.8	43.1	119.6	17.7	48.1	132.4	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	15.4	42.0	135.0	17.2	47.0	149.6	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	15.0	40.9	150.0	16.8	45.9	166.5	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	14.6	39.7	164.5	16.4	44.7	182.9	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	14.2	38.6	178.7	16.0	43.6	198.9	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	13.7	37.4	192.4	15.6	42.4	214.4	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	13.3	36.3	205.7	15.1	41.3	229.6	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	12.9	35.2	218.6	14.7	40.2	244.3	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	12.5	34.0	231.1	14.3	39.0	258.6	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	12.1	32.9	243.2	13.9	37.9	272.5	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	11.6	31.7	254.8	13.5	36.7	286.0	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	11.2	30.6	266.0	13.1	35.6	299.0	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	10.8	29.4	276.8	12.6	34.4	311.6	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	--	--	--	12.2	33.3	323.9	14.0	38.3	360.5	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	--	--	--	11.8	32.2	335.7	13.6	37.2	374.2	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	--	--	--	11.4	31.0	347.0	13.2	36.0	387.4	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	--	--	--	11.0	29.9	358.0	12.8	34.9	400.2	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	--	--	--	--	--	--	12.4	33.7	412.5	14.2	38.7	456.6	16.0	43.7	500.6
24	X25	--	--	--	--	--	--	12.0	32.6	424.5	13.8	37.6	470.3	15.6	42.6	516.2
25	X26	--	--	--	--	--	--	11.5	31.5	436.0	13.4	36.5	483.7	15.2	41.5	531.4
26	X27	--	--	--	--	--	--	11.1	30.3	447.2	13.0	35.3	496.7	14.8	40.3	546.2
27	X28	--	--	--	--	--	--	10.7	29.2	457.9	12.5	34.2	509.2	14.4	39.2	560.5
28	X29	--	--	--	--	--	--	--	--	--	12.1	33.0	521.3	13.9	38.0	574.5
29	X30	--	--	--	--	--	--	--	--	--	11.7	31.9	533.0	13.5	36.9	588.0
30	X31	--	--	--	--	--	--	--	--	--	11.3	30.7	544.3	13.1	35.7	601.1
31	X32	--	--	--	--	--	--	--	--	--	10.9	29.6	555.1	12.7	34.6	613.8
32	X33	--	--	--	--	--	--	--	--	--	--	--	--	12.3	33.5	626.1
33	X34	--	--	--	--	--	--	--	--	--	--	--	--	11.9	32.3	637.9
34	X35	--	--	--	--	--	--	--	--	--	--	--	--	11.4	31.2	649.4
35	X36	--	--	--	--	--	--	--	--	--	--	--	--	11.0	30.0	660.4
36	X37	--	--	--	--	--	--	--	--	--	--	--	--	10.6	28.9	671.0

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
35		55			60			65			70		
		NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
		18			22			27			31		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	20.2	55.0	20.2	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	19.8	53.9	39.9	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	19.3	52.7	59.3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	18.9	51.6	78.2	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	18.5	50.4	96.7	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	18.1	49.3	114.7	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	17.7	48.1	132.4	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	17.2	47.0	149.6	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	16.8	45.9	166.5	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	16.4	44.7	182.9	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	16.0	43.6	198.9	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	15.6	42.4	214.4	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	15.1	41.3	229.6	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	14.7	40.2	244.3	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	14.3	39.0	258.6	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	13.9	37.9	272.5	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	13.5	36.7	286.0	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	13.1	35.6	299.0	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	12.6	34.4	311.6	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	--	--	--	14.0	38.3	360.5	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	--	--	--	13.6	37.2	374.2	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	--	--	--	13.2	36.0	387.4	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	--	--	--	12.8	34.9	400.2	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	--	--	--	--	--	--	14.2	38.7	456.6	16.0	43.7	500.6
24	X25	--	--	--	--	--	--	13.8	37.6	470.3	15.6	42.6	516.2
25	X26	--	--	--	--	--	--	13.4	36.5	483.7	15.2	41.5	531.4
26	X27	--	--	--	--	--	--	13.0	35.3	496.7	14.8	40.3	546.2
27	X28	--	--	--	--	--	--	12.5	34.2	509.2	14.4	39.2	560.5
28	X29	--	--	--	--	--	--	--	--	--	13.9	38.0	574.5
29	X30	--	--	--	--	--	--	--	--	--	13.5	36.9	588.0
30	X31	--	--	--	--	--	--	--	--	--	13.1	35.7	601.1
31	X32	--	--	--	--	--	--	--	--	--	12.7	34.6	613.8

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
40		60			65			70		
		NUMBER OF BARS			NUMBER OF BARS			NUMBER OF BARS		
		18			22			27		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	22.0	60.0	22.0	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	21.6	58.9	43.6	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	21.2	57.7	64.8	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	20.7	56.6	85.5	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	20.3	55.4	105.8	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	19.9	54.3	125.7	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	19.5	53.1	145.2	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	19.1	52.0	164.3	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	18.7	50.9	183.0	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	18.2	49.7	201.2	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	17.8	48.6	219.0	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	17.4	47.4	236.4	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	17.0	46.3	253.4	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	16.6	45.2	270.0	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	16.1	44.0	286.1	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	15.7	42.9	301.8	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	15.3	41.7	317.1	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	14.9	40.6	332.0	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	14.5	39.4	346.5	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	--	--	--	15.9	43.3	397.2	17.7	48.3	433.9
20	X21	--	--	--	15.5	42.2	412.7	17.3	47.2	451.2
21	X22	--	--	--	15.0	41.0	427.7	16.9	46.0	468.1
22	X23	--	--	--	14.6	39.9	442.3	16.5	44.9	484.5
23	X24	--	--	--	--	--	--	16.0	43.7	500.6
24	X25	--	--	--	--	--	--	15.6	42.6	516.2
25	X26	--	--	--	--	--	--	15.2	41.5	531.4
26	X27	--	--	--	--	--	--	14.8	40.3	546.2
27	X28	--	--	--	--	--	--	14.4	39.2	560.5

Advisory Speed (MPH)		APPROACH SPEED (MPH)			APPROACH SPEED (MPH)		
45		65			70		
		NUMBER OF BARS			NUMBER OF BARS		
		18			22		
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	23.8	65.0	23.8	25.7	70.0	25.7
1	X2	23.4	63.9	47.3	25.3	68.9	50.9
2	X3	23.0	62.7	70.3	24.8	67.7	75.8
3	X4	22.6	61.6	92.8	24.4	66.6	100.2
4	X5	22.2	60.4	115.0	24.0	65.4	124.2
5	X6	21.7	59.3	136.8	23.6	64.3	147.8
6	X7	21.3	58.1	158.1	23.2	63.1	170.9
7	X8	20.9	57.0	179.0	22.7	62.0	193.7
8	X9	20.5	55.9	199.5	22.3	60.9	216.0
9	X10	20.1	54.7	219.5	21.9	59.7	237.9
10	X11	19.7	53.6	239.2	21.5	58.6	259.4
11	X12	19.2	52.4	258.4	21.1	57.4	280.4
12	X13	18.8	51.3	277.2	20.6	56.3	301.1
13	X14	18.4	50.2	295.6	20.2	55.2	321.3
14	X15	18.0	49.0	313.6	19.8	54.0	341.1
15	X16	17.6	47.9	331.2	19.4	52.9	360.5
16	X17	17.1	46.7	348.3	19.0	51.7	379.5
17	X18	16.7	45.6	365.0	18.6	50.6	398.0
18	X19	16.3	44.4	381.3	18.1	49.4	416.2
19	X20	--	--	--	17.7	48.3	433.9
20	X21	--	--	--	17.3	47.2	451.2
21	X22	--	--	--	16.9	46.0	468.1
22	X23	--	--	--	16.5	44.9	484.5

Advisory Speed (MPH)	APPROACH SPEED (MPH)			
50	70			
	NUMBER OF BARS			
	18			
BAR	SPACE ID (REVERSE IN PLAN)	SPACING (FEET)	SPEED (MPH)	CUMULATIVE DISTANCE (FT)
0	X1	25.7	70.0	25.7
1	X2	25.3	68.9	50.9
2	X3	24.8	67.7	75.8
3	X4	24.4	66.6	100.2
4	X5	24.0	65.4	124.2
5	X6	23.6	64.3	147.8
6	X7	23.2	63.1	170.9
7	X8	22.7	62.0	193.7
8	X9	22.3	60.9	216.0
9	X10	21.9	59.7	237.9
10	X11	21.5	58.6	259.4
11	X12	21.1	57.4	280.4
12	X13	20.6	56.3	301.1
13	X14	20.2	55.2	321.3
14	X15	19.8	54.0	341.1
15	X16	19.4	52.9	360.5
16	X17	19.0	51.7	379.5
17	X18	18.6	50.6	398.0
18	X19	18.1	49.4	416.2

401-2 Installation of Traffic Signals on State Highways

Policy 516-002(P) on this subject has been retired. If you have questions on this subject that are not otherwise addressed in this Manual, please contact the Office of Roadway Engineering Traffic Control Design Section or the Office of Transportation Systems Management & Operations (TSMO) Signals Section.

401-3 Periodic Review of Signals

As noted in OMUTCD **Section 4B.05**, changing traffic patterns may render an existing traffic signal either inefficient or no longer necessary. Therefore, the responsible agency should periodically conduct a traffic engineering study to evaluate the efficiency and necessity of traffic signals under its jurisdiction and determine if revisions may be needed. This traffic engineering study may lead to changing the signal timing, signal phasing, vehicle or pedestrian detection, roadway geometry, or the complete removal of the traffic signal.

Traffic signal installations that are not properly designed and maintained for current traffic conditions, or are no longer warranted, can result in the following conditions:

1. Excessive traffic delay.
2. Increased disobedience of the signal indications.
3. The use of less adequate routes in order to avoid such signals.
4. Increased crash frequency, especially rear-end crashes.

Some signalized intersections and/or signalized corridors may be eligible to apply for, and participate in, the Systematic Signal Timing & Phasing Program (SSTPP). See ***Section 1213-6*** for more information about this program.

401-9 Americans with Disabilities Act (ADA) Requirements

The **ADA** requirements are issued and regulated by the **US Justice Department**. Generally, there are four major **ADA** elements that affect traffic signal projects:

1. Curb Ramps
2. Truncated Domes (Tactile Bumps on the Curb Ramp)
3. ADA-Compliant Pushbuttons Located per **OMUTCD** 4I.05
4. Accessible/Audible Pedestrian Pushbuttons (Locator Tones)

See ***Sections 404-3 and 440-8*** for details on these requirements. Web addresses for **ADA Accessibility Guidelines** information are shown in Table 197-1. An additional resource to review is the **Office of Roadway Engineering's** ADA Design Resources.

403-2 Yellow Change and Red Clearance Intervals

The vehicle change interval (or phase change interval) described in OMUTCD **Section 4F** consists of the yellow change interval and the red clearance interval. A yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication. The function of the yellow change interval (Y) is to warn traffic of an impending change in the right-of-way assignment. For **ODOT**-maintained signals, the yellow change interval should be followed by a red clearance interval (R) of sufficient duration to permit traffic to clear the intersection before conflicting traffic movements are released. The durations of the yellow change interval and the red clearance interval shall be predetermined.

Make the yellow and red clearance intervals the same for all phases that may terminate concurrently to ensure the clearance intervals end at exactly the same time for both movements.

The length of the phase change interval can be determined using the following equations:

$$Y = t + \frac{1.47V_Y}{2a + 64.4g}$$

$$R = \frac{W + L}{1.47V_R} - 1$$

Y = yellow change interval (s)

R = red clearance interval (s)

t = perception/reaction time of driver (s) [typically 1s]

a = deceleration rate (ft/s2) [typically 10 ft/s2]

V_Y = approach speed (mph); yellow change interval (see tables below)

V_R = approach speed (mph), all red interval (see tables below)

g = approach grade

average of approaching 400 feet using 100 ft increments (percent of grade divided by 100; negative for downgrade)

W = width of intersection (ft)

measured from the approach movement stop-line to the far side of the intersection as defined by the extension of curb line, outside edge of the farthest travel lane, or the far side of the pedestrian cross-walk*

L = length of vehicle (ft) [typically 20 ft]

*A pedestrian crossing equipped with pedestrian signals on a receiving lane should not be considered unless the nearest crossing line is 40 feet or more from the extension of the farthest edge of the farthest conflicting traffic lane. If this condition exists, the intersection width should be measured from the back/upstream edge of the approaching movement stop line to the nearest pedestrian crossing lane.

Yellow change intervals should be between three and six seconds. Red clearance intervals should be between one and six seconds. Clearance intervals should be rounded to the nearest tenth of a second. See below for guidance if the maintaining agency has a rounding preference to the nearest whole or half second.

Yellow change interval approach speeds:

Movement	Speed study available	Speed study not available
Through	85th percentile speed	Posted speed limit + 7 mph
Left Turn	85th percentile speed	Posted speed limit – 5 mph

Red clearance interval approach speeds:

Movement	Speed study available	Speed study not available
Through	85th percentile speed	Posted speed limit + 7 mph
Left Turn	85th percentile speed of vehicles executing the left turn movement	25 mph

If engineering judgement determines that the approach speeds defined above are not representative of real-world conditions, alternate speeds may be used in the yellow change and red clearance interval equations.

For opposing approaches with differing speed limits or 85th percentile speeds, use the higher speed approach to evaluate clearance intervals. Make the yellow and all red clearance intervals the same for all phases that may terminate concurrently to ensure the clearance intervals end at exactly the same time for both movements.

Modern digital traffic controllers are capable of programming values to one-tenth of a second (0.1s) for any interval; therefore, the timings for the yellow change and red clearance intervals can be calculated in tenths of a second. Using the equations to calculate the yellow change and red clearance interval durations, the resulting

values should be rounded to the nearest 0.1 seconds. Values ending in 0.01 to 0.04 should be rounded down to the nearest tenth of a second whereas values ending in 0.05 to 0.09 should be rounded up to the nearest tenth of a second.

If an existing agency policy rounds these values to the nearest half-second (0.5s), then the following methodology is suggested:

- Values ending in 0.0 to 0.1 should be rounded down to the nearest whole number;
- Values ending in 0.2, 0.3, and 0.4 should be rounded up to the half-second;
- Values ending in 0.6 should be rounded down to the half-second; and
- Values ending in 0.7, 0.8, and 0.9 should be rounded up to the nearest whole number.

403-3 Flashing Operation of Traffic Control Signals

OMUTCD ***Sections 4G.01 through 4G.04*** list requirements for operating a traffic signal in flashing mode. When an **ODOT**-owned stop-and-go traffic signal is in flashing mode, red indications shall be used for all approaches. The Office of Transportation Systems Management & Operations (OTSMO) may approve special cases in which yellow indications can be used for major street approaches and red indications for all others.

ODOT-owned stop-and-go traffic signals shall not be placed in flashing mode during off-peak hours.

403-6 Emergency-Vehicle Preemption Control Systems

403-6.1 General

As noted in **OMUTCD Sections 4F.18 and 4F.19**, preemption systems are used to give certain vehicles control over traffic signals. In the most common preemption design, when an approach is under preemption control, it interrupts and overrides the normal traffic signal timing to give the approach a green indication while providing a red indication to the conflicting movements. Other preemption displays, such as whole-intersection steady-red or flashing red, are also possible. These systems use devices located on an approaching vehicle to preempt the normal operation of signalized intersections. This Section provides a consistent method for funding traffic control signal preemption systems if needed.

The intent of this Section is to cover preemption control which involves equipping the vehicle with a preemption emitter and equipping the signalized intersection with preemption receivers and processors (a.k.a., phase selectors). These systems tend to use proprietary equipment, and once a local governmental agency installs the equipment, the agency is often committed to the same brand and type of preemption equipment in order to have emitters and receivers work together.

Vehicle-activated systems can use light (optics), sound or radio signals (includes GPS systems) to activate a receiver at the intersection.

The decision to install and maintain a preemption control system shall be made by the maintaining agency. The cost for the installation and maintenance of a preemption control system at existing **ODOT** signals shall be assumed by the requesting agency.

For **ODOT** or Local intersections having preemption installed, pushbuttons shall be installed at all pedestrian crossings and pedestrian recall and recycle shall be removed.

403-6.2 Procedures

As per ORC 4511.031, the movement of equipment or unauthorized use by a Local agency to use other vehicles (i.e. snowplow trucks, non-emergency service vehicles) to receive preemption control is strictly prohibited. Violation of this requirement breaches ORC 4511.031 and may result in the disconnection or removal of the preemption equipment.

Before an Emergency Vehicle preemption control system can be installed at an **ODOT** signal, the requesting agency shall have a signed maintenance agreement with the District that places operations and maintenance responsibilities of the system to the Local agency, along with adhering to all requirements of the TEM, especially

preventing the Yellow Trap ***(see Section 403-9)*** and providing a proposed phasing diagram and controller settings. Additionally, during the initial installation or any regular maintenance, an approved Permit shall be acquired by the Local agency to perform work at the traffic signal.

The use of Federal/State funds will be considered for the expansion of an Agency's existing preemption system or the replacement of preemption equipment only at project intersections as further defined below:

For new preemption system equipment, at a new signalized intersection or at a signal rebuild and the existing equipment is over 15 years old **ODOT** will participate at the normal project participation rate in the acquisition and installation of a generic preemption system, that is approved on the Traffic Authorized Product List, as determined by the lowest contract bid price. In addition to obtaining generic bids, a local governmental agency may request alternate bids if they desire a specific brand of preemption equipment and agree to pay any extra cost above the generic bid price. Any proprietary or alternate bids for EmVPE that are not on ODOT's Traffic Authorized Product (**TAP**) List shall include timing to show activation prior to EmV reaching the intersection in accordance with 403-6.5. A Plan Note specifying at least two different preemption systems by manufacturer and model is equivalent to a generic bid item.

At a signal rebuild, if the existing equipment is less than 15 years old, it should be transferred to the new signal. The Local has the option to fund a replacement using Local funds.

When a municipality adds intersections to its existing preempt system, it can obtain the same type of equipment by either the use of alternate bids or, if justified, proprietary bids, as long as the equipment calculations show the device will activate prior to EmV reaching the intersection.

For proprietary bids to be considered justified, the existing preempt system must control an appreciable part of the municipality's intersections before it can be considered to represent the municipality's standard. As a measure of this standard, the existing system must constitute at least fifty percent of the signalized intersections of a municipality (see TEM 120-4). If this test is met, a proprietary bid requested by the municipality will be given consideration. Otherwise, alternate bids may be used to limit **State** and **Federal** participation to the generic system costs.

ITS project requirements are included in **Part 13** of the **TEM**, along with further explanation of the **Traffic Authorized Products** (TAP) list requirements. In terms of a Local Agency requesting funding of Emergency Vehicle Preemption products on a project that are not listed on the TAP, for consideration of approval by the **District** and the Office of TSMO, the following must be in place for the Local Agency for that product:

- Included in an ITS Architecture
- Part of a Regional or Local/MPO standardization policy for use
- Established (by publication or ordinance) technical specifications and/or standard drawings with performance requirements
- Field performance verification of noted specifications that are to be met

- Follow all applicable SEA requirements per Part 13, which may include a per project SEA or reference a preapproved blanket SEA for Regional or Local Agency/MPO

403-6.3 Preemption Emitters

The quantity of vehicle hardware provided with the system shall be as determined by the municipality, but should not exceed four emitters for each signalized intersection which will be equipped with preemption as a part of the project. Only fire, emergency medical, police and transit vehicles are eligible to be equipped. If alternate bids are used and the desired system utilizes vehicle-mounted emitters, the cost of this hardware shall be included in the alternate bid cost for comparison to the generic bids.

403-6.4 Local Maintaining Agency Policies

As a requirement for inclusion of vehicle preemption equipment in the contract, the local governmental agency shall have policies for the use of preemption. Written copies of the policies must be provided to the ODOT Project Manager during project development. For safety forces, the policies shall specify the types of emergency calls for which preemption may be employed and shall define any use of preemption when lights and sirens are not simultaneously employed. For transit vehicles, the policies shall define when and under what conditions the preemption may be employed.

When possible, municipalities are strongly encouraged to develop signal preemption policies which coordinate with surrounding **City**, **County** and **Township** forces. They should take into account mutual aid agreements, access to hospitals and transit where a vehicle operates outside of its normal jurisdiction.

403-6.5 Preemption Timing

Preemption timing shall not create a safety hazard for pedestrians legally using a signalized crosswalk. All Emergency-Vehicle Preemption timing shall include enough warning time for the Pedestrian Clearance Interval, Yellow, and All Red phases to run without being eliminated or truncated. When Preemption is being added to a plan, the selected Preemption device shall be shown to provide the above timing and activation prior to the Emergency Vehicle arriving at the intersection. For calculating the detection distance, the Emergency-Vehicle speed shall be posted speed limit plus 10 mph. Utilize TEM Form 496-20 to determine preemption detection time. An EmVPE detection distance worksheet Excel file is also provided on the Office of Roadway Engineering/Traffic Control web site.

403-7 Flashing Yellow Arrow (FYA) Operation

403-7.1 General

The OMUTCD **Sections 4F.04 and 4F.08** permit the use of a flashing yellow arrow (FYA) indication on applicable protected/permissive and permissive-only left-turn movements.

Operators of traffic signals should note that FYA operation complicates the wiring, programming and troubleshooting of a controller cabinet, as well as a different monitor testing procedure. Agencies must weigh the benefit of FYA operation against their ability to maintain traffic signal controllers. Agencies with limited resources or lacking skilled technicians devoted to traffic signal controller maintenance are cautioned against implementing FYA operation without due consideration of this complexity.

Since a traditional traffic signal display has only three load switch driver outputs per signal phase (red, yellow and green), the additional yellow arrow display used in FYA operation necessitates the distribution of four FYA Signal Output Group outputs per vehicle phase onto a pair of separate 3-output load switches inside the cabinet. In other words, FYA operation "uses up" additional outputs and complicates the conflict monitor input assignments and programming considerably.

For cabinets with many phases and/or overlaps, or cabinets that make use of "extra" load switch outputs (emergency preemption and/or railroad preemption confirmation light outputs and/or sign driver outputs, lane control signs, etc.), FYA implementation may be impossible. Only a close examination of the cabinet by **ODOT**, the traffic signal equipment vendor or other qualified person can determine this definitively.

The most easily implemented channel configurations use a "Protected Turn Channel" that includes the green arrow only, and a "Permissive Turn Channel" that includes the red arrow and both yellow arrows for each FYA phase, but this is not always possible depending upon the number of load switch bays available in the cabinet.

403-7.2 Design Considerations

The intersection(s) shall be monitored for crashes and compliance to continue its use, with the possibility of reverting back to previous operations.

The following characteristics from nationwide research should be used for guidelines when selecting appropriate locations:

a. Intersection Left Turn crashes for desired FYA movements is greater than 25% of total intersection crashes
b. Criteria meeting **Section 403-15 Left Turn Phase Operation Guidelines**
c. Corridor implementation over single intersection implementation, with the understanding that some intersections on the corridor may not meet the crash thresholds

d. Intersection already has updated clearance intervals, backplates on the signal heads, and functioning detection

e. Signal supports can accommodate the FYA signal head at the center of the left turn lane, proper vertical clearance, and the appropriate revised number of signal heads per approach for the adjacent movements

f. Cabinet wiring standardization using 16-Channel for **NEMA** and 18-Channel for Caltrans cabinets (see below for details)

403-7.3 Cabinet Requirements

To standardize FYA programming, maintenance, and operations, a new or existing cabinet with the below configurations shall be followed:

a. **NEMA** Cabinets (TS-2)

i. For **NEMA** equipment users, FYA operation should be implemented only on 16-channel cabinets for new construction

ii. FYA operation may be implemented on an existing 16-channel cabinet after a careful inspection of the existing cabinet construction and operation

iii. An MMU2 is required for FYA operation in a **NEMA TS2** cabinet

iv. **ODOT** does not support the use of FYA operation in **TS1** cabinets

v. Standardized channel configurations for FYA outputs are defined in the **NEMA** TS-2-2016 document Section 4 that describes the Malfunction Management Unit (MMU2), as well as monitor vendor EDI's monitor manual. These channel configurations are assigned letters A-F. These configurations assume the default 8-phase **NEMA** default ring-and-barrier structure. Phasing not following the standard ring-and-barrier structure may not be able to implement FYA operation. All **ODOT NEMA** cabinets shall follow Configuration B shown below.

vi. 16-bay **NEMA TS2** cabinets shall use LS13-LS16 for FYA implementation, and Configuration B shall be used for this purpose

vii. Generally, **ODOT**-spec **NEMA TS2** cabinets use LS9-LS12 load switch bays for pedestrian signals

FYA Channel Configurations (Remap = No)

Configuration	Protected Turn MMU2 Channels (Green Arrow only)	Green Arrow Load Switch Output	Permissive Turn MMU2 Channels (Red Arrow, Yellow Arrow, FYA)	Flashing Yellow Arrow Load Switch Output	Opposing Through Channels
B	1	1G	13	13G	2

Configuration	Protected Turn MMU2 Channels (Green Arrow only)	Green Arrow Load Switch Output	Permissive Turn MMU2 Channels (Red Arrow, Yellow Arrow, FYA)	Flashing Yellow Arrow Load Switch Output	Opposing Through Channels
	3	3G	14	14G	4
	5	5G	15	15G	6
	7	7G	16	16G	8

b. Caltrans Cabinets

i. For Caltrans equipment users, FYA operation should be implemented only on 332 cabinets that have 18-channels by use of auxiliary output file

ii. FYA operation may be implemented on an existing 18-channel 332 cabinet with auxiliary output file after a careful inspection of the existing cabinet construction and operation

iii. An 18-Channel Monitor (i.e.—2018ECLip or 2018KClip) is required for FYA operation in a 332 cabinet with auxiliary output file

iv. **ODOT** does not support the use of FYA operation in 12-channel or 336 cabinets

v. Standardized channel configuration for FYA outputs are shown below, which follows monitor vendor EDI's conflict monitor manual for FYA Mode/Regular Mode. All **ODOT** Caltrans cabinets shall follow the FYA Mode/Regular Mode Configuration shown below.

vi. Designers shall specify an auxiliary output file that adds 6 load bays for a total of 18.

vii. Generally, in **ODOT**-spec 332 cabinets, pedestrian load switches appear on monitor Channels 13-16

FYA Channel Configurations (Remap = No)

Configuration	Protected Turn CMU Channels (Green Arrow only)	Green Arrow Load Switch Output	Permissive Turn CMU Channels (Red Arrow, Yellow Arrow, FYA)	Flashing Yellow Arrow Load Switch Output (Aux. Output File)	Opposing Through Channels
FYA Mode	1	SWPK 1G	9	SWPK 9G *	2

Configuration	Protected Turn CMU Channels (Green Arrow only)	Green Arrow Load Switch Output	Permissive Turn CMU Channels (Red Arrow, Yellow Arrow, FYA)	Flashing Yellow Arrow Load Switch Output (Aux. Output File)	Opposing Through Channels
Regular Mode	3	SWPK 3G	10	SWPK 10G *	4
	5	SWPK 5G	11	SWPK 11G *	6
	7	SWPK 7G	12	SWPK 12G *	8

* Add wires to backpanel (and connect the proper 4-pin Molex combination if present) for these Green outputs, which are not normally wired to the monitor in a standard **ODOT** 332 cabinet.

ODOT suggests designers and operators contact their traffic signal equipment vendor and/or visit the websites of one of the conflict monitor equipment manufacturers. The manufacturers have a variety of useful training aids available that explain Flashing Yellow Arrow operation. Visit Eberle Design Inc. for further documentation and graphics.

For monitor testing assistance, a guide has been developed online.

403-7.4 Signing, Operations, and Public Information

As noted in **OMUTCD Section 4F.04**, the LEFT TURN YIELD ON FLASHING YELLOW ARROW (R10-12a) sign shall be used with the FYA for at least five years (see **OMUTCD Figure 4F-2**).

To operate uniformly across the state, on the FYA signal head, when the Protected Left Green movement does not lead and the through green movement occurs first in that direction, there should be a minimum three (3) second delay between the green ball through movement and the beginning of FYA. This Flashing Yellow Arrow delay should be programmed into the controller and is denoted in the Signal Timing Chart (Form 496-3).

Additionally, all possible conflicting pedestrian movements should be actuated, so the FYA will not display when the pedestrian walk is active. This should be denoted on the phasing diagram, and the controller settings describe this as "ped protect", which can be denoted in the FYA programming.

To further communicate the differences and functionality of the Flashing Yellow Arrow indication to an area, **ODOT** has developed a website to assist in public information, which includes videos, statistics, and a fact sheet.

During construction, it is recommended to have a PIO plan. Using Portable Changeable Message signs (PCMS) to alert to a new signal display along a corridor 2 weeks before and 4 weeks after activation, social media and news outlet stories, and Signal Operation Changed signs (See **Section 403-8**) are all proven methods for public outreach.

403-10 Railroad Preemption Control Systems

403-10.1 General

As noted in **OMUTCD Sections 4F.18 and 4F.19**, railroad preemption systems are used to give trains (both heavy and light rail) control over traffic signal operation. These systems use an interconnection between the railroad control system and the traffic signal controller to preempt the normal operation of signalized intersections. ***TEM Part 8*** provides detailed information regarding railroad preemption, standardized terminology and associated design requirements. This Section addresses minimum functional requirements for traffic signal control equipment to provide the proper operation required for railroad preemption.

Traditional railroad preemption interconnection relied on a single pair of wires which were normally closed through a relay in the railroad signal control equipment to provide a failsafe mode of operation. This normally closed circuit is required by **OMUTCD Section 8C.09**. If the connection between the wires was opened, the railroad preemption sequence in the traffic signal controller was initiated.

In recent years, much research has been conducted to further understand the operational needs transitioning into and during the railroad preemption sequence as well as the functioning of the interconnection circuit. The results of this research have led to significant changes in the **TEM** to implement new technology to further enhance safety at signalized intersections adjacent to railroad grade crossings.

ODOT has developed a required practice for the design and functionality of the railroad interconnection. This practice is contained in ***TEM Part 8***. It provides information on both the traffic signal controller interface and the railroad warning system interface (see ***Section 804-4***). There is also a requirement for an indicator panel to verify that the railroad circuitry is activating the interface at the traffic signal controller cabinet.

403-10.1.1 Coordinating with Railroad Companies During Traffic Signal Design Projects

Working with Railroads need not be difficult if the designer heeds these general comments:

1. Railroads are highly regulated by the **Federal Railroad Administration**.
2. Railroads tend to review documents slowly, so allow plenty of time for this process.
3. Railroads have their own design and construction preferences and standards that often differ somewhat from **ODOT**'s.
4. The large Class I Railroads have their own Engineering Department, including Communications and Signals, where most interaction with **ODOT** traffic signal projects will take place.
5. Smaller Railroads often contract out their Communications and Signals design, construction and maintenance work, including plan review.

6. For a designer working on an **ODOT** traffic signal project with Railroad involvement, the best way to establish a working relationship with the Railroad is to work through the Ohio Rail Development Commission. **ORDC** maintains close contact with the various Railroads' engineering and construction staff. **ORE** and **ORDC** can assist with railroad preemption design, plan reviews and timing calculations.
7. For a designer working on a **Local Public Agency** (LPA) traffic signal project with Railroad involvement **ORDC** can assist with preemption plan reviews and timing calculations.

Most of the detailed interaction between a railroad and a traffic signal designer will be in the design of Railroad Preemption Interface hardware, operation, and timing. Here are some more specific items the designer should keep in mind:

1. It is common that the traffic signal designer must ask the railroad for additional Advance Warning Time (AWT) not currently provided at most interconnected crossings. Providing additional warning time frequently involves difficult and costly changes to railroad track circuits and control equipment. There is often much back-and-forth between the railroad and the traffic signal designer on whether the requested AWT is achievable at a given location. Design compromises often must be made. Designers cannot put off AWT requests until late in the traffic signal design process.
2. Technological limitations of railroad crossing controllers tend to limit the amount of available warning time to no more than 50 seconds of Total Warning Time (TWT). This limit is also codified in the railroad industry's AREMA standards. Traffic signal designers should pursue every possible design tactic on the traffic signal end of the interconnected system to reduce the requested TWT to 50 seconds or less. When one considers that the usual simultaneous warning time of a gated crossing in **Ohio** is 25-30 seconds, the "50-second rule" leaves only 20-25 seconds of nominal advance warning time available to the traffic signal designer.
3. The **Office of Roadway Engineering** has developed a spreadsheet to assist with RRPE timing calculations. This completed spreadsheet showing the requested warning times, even if they are somewhat preliminary, should always be provided to the railroad as early as possible.
4. Data entry to the RRPE timing spreadsheet usually cannot be started before obtaining some basic existing crossing timing information from the railroad. This step takes time and effort, so designers must plan accordingly.
5. Crossing railroad right of way with traffic signal circuits can be difficult and requires coordination with the railroad. **ORDC** can provide advice on this designer-to-railroad coordination. Most times, jacking and boring is the preferred crossing method. Aerial crossings require high clearances that are often impractical. Pull boxes at each **ROW** line crossing are recommended.

403-10.2 Controller Functionality

In order to properly implement railroad preemption operation, additional requirements have been developed for the operation of railroad preemption in the controller unit. All new controller units which are to be interconnected with a railroad warning system must provide the following minimum operational features. The standard SCD TC-86.10 Processor Interface implements many of the following features itself, removing the need for special controller logic statements and I/O pin assignments, mapping much of the following functionality into the six minimum preempt inputs common to all **ODOT**-approved controllers. This is an important simplification in both design and construction, which is why the processor interface shall be used for all RRPE design.

1. A minimum of 10 preemption inputs and plans: Six independent railroad preemption plans in addition to four emergency vehicle preemption plans. See ***TEM Part 403-6*** for emergency vehicle preemption requirements.
2. Railroad preemption plan number 1 shall be the highest priority with each successive railroad plan following in reducing priority. Railroad preemption plans shall receive higher priority than emergency vehicle preemption plans. Railroad preemption plan 1 is reserved for railroad preemption fail-safe conditions and will transition to soft all-red flashing operation.
3. Each railroad preemption plan shall cause the controller unit to stop normal sequencing and advance, through proper change and clearance intervals, to a phase or phases known as the Preemption Clearance Phases. Programmable Dwell Phases and Exit Phases shall also be available for each Plan. Per unit or per phase setting for alternate minimum green interval during entry into any railroad preemption sequence.
4. Per unit or per phase setting for alternate pedestrian walk interval during entry into any railroad preemption sequence.
5. Per unit or per phase setting for alternate pedestrian change interval during entry into any railroad preemption sequence.
6. One phase or pair of phases will be provided per plan for Preemption Clearance. Each plan should be programmed for Yellow Trap Prevent, unless as directed by the District Traffic Engineer. Yellow Trap Prevent will force the transition through Yellow Change and Red Clearance for resolution of yellow trap if any phase opposing the Preemption Clearance phase(s) is active and displaying a green or flashing yellow arrow indication when the preemption plan is activated and the Preemption Clearance phase(s) are green.
7. Each controller railroad preemption plan should be capable of inhibiting Flashing Yellow Arrow operation during the Preemption Clearance interval. If a phase opposing the preemption clearance phases or phases is currently displaying flashing yellow arrow and Yellow Trap Prevent is not enabled, the flashing yellow arrow display shall continue through the preemption clearance phase(s) even though it would be inhibited had it not already been displaying a flashing yellow arrow.
8. Using the options in 4 – 8 above, when a railroad preemption plan is activated, the normal sequence shall terminate and transition to a programmed phase or phases for Preemption Clearance. The programmed values for any trailing overlap Green Extension preceding the Preemption Clearance (if used) should be timed, Yellow Change and Red Clearance shall be used during the transition. If no phases are programmed,

the normal sequence shall advance to All-Red or flashing red programmable by phase and overlap. Every overlap shall be capable of being forced to red, green, flashing yellow or flashing red during the Preemption Clearance interval subject to programmed ring and barrier sequence rules.

9. A timed interval (with a minimum range of 0 – 99 seconds) shall be provided for the minimum Preemption Clearance interval. This interval shall time in its entirety if a lower priority preemption plan is activated and the current preemption plan request is terminated before transitioning to the lower priority preemption plan. This interval shall immediately terminate if a higher priority preemption plan is activated, regardless of the activation request for the current plan.

10. A per-unit Advance Pedestrian Preempt (APP) input shall be provided in addition to the 6 railroad plans; generally, this is another preempt input (e.g., Preempt 11), but may also be implemented using a dedicated controller logic input. APP may be implemented through a preemption plan When activated, APP shall immediately terminate any active Pedestrian Walk movement currently being serviced and begin the normal Pedestrian Change interval for the phase(s). APP will also prevent (omit) any new pedestrian service from starting. Any pedestrian calls for service shall be stored, and processed APP is de-activated. Vehicle phases shall continue to time and sequence normally during APP.

11. Ability to inhibit pedestrian service per phase during each railroad preemption plan.

12. For **ODOT** or local intersections having preemption installed, pushbuttons shall be installed at all pedestrian crossings and pedestrian recall shall be removed.

13. In the event the controller unit is operating under manual control and any railroad preemption plan becomes active, the manual control shall be inhibited, and the railroad sequence shall govern. Once the railroad preemption is deactivated and the manual control input remains active, manual control operation shall be restored.

14. In the event the controller unit is operating in soft flash or off-duty flash and any railroad preemption plan becomes active, the flashing operation shall terminate normally and the sequence shall advance to the active railroad preemption plan.

15. Any controller unit proposed for use on an **ODOT**-maintained project where railroad preemption is required shall be furnished to the **ODOT** signal shop for testing prior to acceptance.

403-10.3 Cabinet Functionality

In order to properly implement railroad preemption operation, design specifications have been developed which describe both the traffic signal controller cabinet and railroad warning system interconnection ***(see Section 804-4)***.

403-15 Left Turn Phase Operation Guidelines

The different types of left turn phasing of protected, protected-permissive, and permissive are generally selected based on geometrics, volumes, crashes, and/or operations.

As a guideline, Table 497-10 was developed to choose the appropriate treatment. The Table was developed from collaboration of Local Partners, ITE, and FHWA guidelines.

Instances that refer to protected-permissive or permissive should be considered for Flashing Yellow Arrow installations with consideration of ***Section 403-7*** **Flashing Yellow Arrow (FYA) Operation**. Locations that have protected-only lefts can benefit from time-of-day use of FYAs (e.g. flashing yellow arrow operation at night).

404 PEDESTRIAN CONTROL FEATURES

404-1 General

Pedestrian signal indications **(see OMUTCD Figure 4I-1)** are special types of traffic signal indications intended for the exclusive purpose of controlling pedestrian traffic. Pedestrian signals are discussed in **OMUTCD Chapters 4L and 4K**. Construction mounting details are shown on Traffic SCD TC-85.10, and pedestrian signal equipment is specified in C&MS **Item 632** and C&MS **732**.

404-2 Pushbuttons

OMUTCD Section 4I.05 addresses pedestrian detection, usually accomplished using pushbuttons.

On actuated signal phases, if there is a reasonable expectation of pedestrian use, the phase shall be equipped with accessible pedestrian pushbuttons ***(see Section 404-3)*** to provide access to all corners of the intersection with sufficient time to safely cross the highway; and countdown pedestrian heads, marked crosswalks, applicable signs and ADA ramps shall be provided.

This is especially important on side-street phases where the signal green time is usually based on a short initial green interval with the green time extended by signal actuations. The initial green interval is usually not long enough to allow a pedestrian to cross the mainline. The accessible pedestrian pushbutton will initiate a guaranteed crossing time without input from vehicular traffic. The accessible pushbutton will also provide the pedestrian with a means to cross the mainline when there is no side-street traffic to initiate the signal phase for the pedestrian crossing.

See Curb Ramp requirements in **Section 440-8**. If accessible pushbuttons are provided, countdown pedestrian signal heads and marked crosswalks shall be required. Additionally, they shall be compliant with all **PROWAG** and **OMUTCD 4I and 4K** requirements including, but not limited to: curb cuts/ramps and slopes, crosswalk markings, countdown pedestrian signal heads, pushbutton access, and pushbutton installation locations. When accessible pushbuttons are provided, they should allow pedestrians to reach all corners of the intersection. Designers should be aware of this requirement and consider the possible future location of crosswalks when locating stop lines and stop line detectors at signals that do not presently include pedestrian facilities.

404-3 Accessible Pedestrian Signals and Locator Tones

As noted in ***Section 401-9***, use of accessible pedestrian signals and locator tones are major **ADA** elements that affect traffic signals. Accessible Pedestrian Signals supplement visual WALK indications and are designed to aid visually impaired pedestrians; and Locator Tones enable pedestrians who have visual disabilities to locate the pushbutton.

All requirements of **OMUTCD Section 4I.05** and **Chapter 4K** shall be met when installed.

The installation of Accessible Pedestrian Signals and/or Locator Tones shall be required at **ODOT**-maintained traffic signals when a new signalized intersection is being built or an existing traffic signal is being rebuilt, which work includes, but is not limited to, new supports, curb ramps, pedestals, or pedestrian equipment upgrades.

To retrofit an existing crossing with Accessible Pedestrian Accommodation, an engineering study which considers the factors specified in **OMUTCD Section 4I.05** and **Chapter 4K** shall be conducted and the following minimum conditions are met:

1. The proposed intersection must be signalized.
2. The audible devices should be retrofittable to the existing traffic signal hardware.
3. The signalized intersection should be equipped with pedestrian pushbuttons.
4. The selected crosswalk must be suitable for the installation of Accessible Pedestrian Signals and/or Locator Tones, in terms of surrounding land use and traffic patterns.
5. There must be a demonstrated need for the audible devices in the form of a request from an individual or a group that would use the audible signal.
6. The individual or group requesting the device should agree to train the visually impaired users in the use of the Accessible Pedestrian Signals and/or Locator Tones, as appropriate.

Additional guidance is available in **OMUTCD Part 4**.

404-5 Pedestrian Hybrid Beacons

OMUTCD Section 4J addresses the Pedestrian Hybrid Beacon (PHB), formerly known as a HAWK signal, for its application, design, and operations. Additionally, an 809 ATC controller shall be used to operate the system.

As noted in the **OMUTCD**, an engineering study, reviewed and approved by the ODOT District, shall be done to justify the PHB installation. As part of the study, it shall evaluate all aspects noted in Form 496-19 along with completing the form.

PHB installations shall use the STOP ON RED, YIELD ON FLASHING RED AFTER STOP (**R10-23a**) sign. See 201-16 for more details.

405-1 General

Flashing Beacons are addressed in **OMUTCD Chapter 4S**. Flashing beacons include Intersection Control Beacons, Warning Beacons, Speed Limit Sign Beacons and Stop Beacons. **OMUTCD 4S.01** allows 8-inch or 12-inch flashing beacons, but only 12-inch flashing beacons shall be used on ODOT-maintained roadways.

405-3 Rectangular Rapid Flashing Beacon (RRFB)

Rectangular Rapid Flashing Beacons are addressed in **OMUTCD Chapter 4L**. RRFBs had previously been addressed in Interim Approval 11 & 21.

See ***Section 240-9, Supplemental Specifications 997 and 999 and SCD TC-87.10*** for information on the use of these beacons on **ODOT**-maintained highways.

406-1 General

OMUTCD Chapters 4M through 4T present information on miscellaneous types of highway traffic signals including signals for emergency-vehicle traffic, one-lane two-way facilities, freeway entrance ramp control, movable bridges, toll plazas, flashing beacons and lane-use control.

408 IN-ROADWAY WARNING LIGHTS

408-1 General

In-Roadway Warning Lights are addressed in **OMUTCD Chapter 4U**. In-Roadway Warning Lights shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals, or pedestrian hybrid beacons.

408-2 Use of In-Roadway Warning Lights on State Highways

Because of the high speeds and volumes associated with state highways, an engineering study should be conducted to determine if other measures, such as increased signing and pavement marking, should be implemented before the use of in-roadway warning lights on **ODOT**-maintained highways. Any engineering study pertaining to the installation of in-roadway warning lights on state highways should be coordinated with the Offices of Roadway Engineering (ORE) and OTSMO.

The use of in-roadway warning lights at highway-rail grade crossings should also be coordinated with the Ohio Rail Development Commission (ORDC).

420-4 Signal Heads

420-4.1 General

Standards related to vehicular signal heads are addressed generally in **OMUTCD Chapters 4D and 4E**. Standards relating to bicycle signal heads are addressed in **OMUTCD Chapter 4H**.

For any project using **State** or **Federal** funds, louvered reflective backplates in accordance with C&MS **732.22** are required for all new signal heads (backplates are required for both mast-arm and span-wire installations). Backplates are not required for bicycle signal heads.

ODOT prefers mast arm installations per Traffic SCD TC-81.22 with rigid mounted polycarbonate signals to eliminate the potential for swinging heads, better lateral and vertical placement, and better aesthetics that help eliminate visual clutter. Additionally, as noted in **OMUTCD 4D.05**, locating primary signal faces on the far side of the intersection, as opposed to diagonally on spans, has been shown to provide safer operation.

If strain poles are used, the signal heads shall be polycarbonate plastic and be tethered per Traffic SCD TC-85.21 to minimize sway for span-wire type configurations. A signal support analysis should be performed on all existing strain poles to insure they are structurally adequate for the proposed changes. If span-wire supports are found deficient for backplates in all directions, then the intersection should be analyzed for mainline or East/West backplates only. Written documentation and calculations are required if the proposed additions/changes cannot be implemented.

420-4.1.1 Signal Head Components-- The ODOT QPL and TAP

In Construction Plans, the Designer calls out each signal head as a complete item, such as "632E05007 EACH, VEHICULAR SIGNAL HEAD, (LED), 3-SECTION, 12" LENS, 1-WAY, POLYCARBONATE, AS PER PLAN." This item includes multiple components: the signal head enclosure, attachment hardware, LED signal lamps, and backplate. However, the components that make up the signal head are approved by ODOT in several different ways.

1. The signal head enclosure and all attachment hardware are approved as an assembly and are QPL Items with material requirements in 732.02-732.05. Submittal procedures are listed on the Office of Materials Management web page. ODOT has some unique material requirements that manufacturers should carefully note and comply with (such as the visor mounting studs) or else the item will be rejected.
2. The backplate is also qualified as part of the signal head assembly above. In addition to the backplate material requirements in 732.22, the backplate coating must conform to Supplemental Specification 916.
3. The signal lamps (732.04) are listed on the Traffic Authorized Products (TAP) list, following the submittal procedure of Supplemental Specification 1097.

420-4.2 Signal Head Color

In **ODOT**-maintained traffic signal installations, the vehicular signal head housings and the outside of the visors shall be black. Bicycle signal head housings and the outside of the visors shall be highway yellow.

420-4.3 Signal Indications

420-4.3.1 Vehicular

Vehicular signal indications shall be 8 inches or 12 inches in diameter, depending on the provisions of **OMUTCD Section 4E.02**. For **ODOT**-maintained traffic signal installations, they shall be LED modules and they should be 12 inches in diameter. The 8-inch size is typically used only for low-speed, urban applications.

420-4.3.2 Bicycle

OMUTCD 4H.07 allows 4-inch, 8-inch and 12-inch bicycle signal heads. The 8-inch size shall not be used on **ODOT**-maintained roadways. The 4-inch size shall only be used for supplemental, post-mounted, near-side applications. The signal lamps shall be LED.

420-4.4 Number of Signal Faces on an Approach

420-4.4.1 Vehicular

In addition to meeting the minimum number of vehicular signal heads per approach set forth in **OMUTCD 4D.05**, there may be circumstances that lead to installing additional signal heads.

See guidelines for Supplemental or side-mounted traffic signal heads in ***Section 420-4.12***.

If side-mounted signal heads have been installed at an intersection and crash trends continue to increase, consideration may be given to installing one overhead traffic signal per lane.

In situations where a traffic signal is installed on an Interstate look-alike where the speed limit is 55 mph or greater, one overhead traffic signal per lane shall be installed.

See the Signal Design Reference Packet (SDRP) for typical signal head placements.

420-4.4.2 Bicycle

The number of required bicycle signal faces, including supplemental signal heads, is described in **OMUTCD 4H.08**.

420-4.5 Location of Five-Section Signal Heads for Protected/Permissive Turns

OMUTCD ***Sections*** ***4F.02, 4F.03, 4F.05 and 4F.07*** contain the requirements for signal head use for protected/permissive left turns. In protected/permissive signal phasing, the left (or right) turns can be made in both a protected (green arrow) and a permitted (circular green) signal phase.

The use of flashing yellow arrow signal heads should be considered over the use of "shared" five-section signal heads.

"Shared" five section signal face:

Because the circular signal indications in this five-section signal head apply to both the through and turning vehicles, the signal head should be located on an extension of the Channelizing Line that separates the through and turn lanes. The "shared" type of five section signal face is used extensively throughout **Ohio**.

Left-turn lanes on four-lane highways with wide medians are often separated from the through lanes by a large painted channelizing island in order to provide good alignment and sight distance for opposing left-turn vehicles. In this case, the five-section head should be located in front of the left-turn lane with an R10-12 sign, LEFT TURN YIELD ON GREEN, next to the signal head. Two additional three section signal heads should be provided for the through-traffic lanes. The maintaining agency should monitor crashes for this type of operation with the wide median. **ODOT**'s experience in some parts of the **State** showed that left-turning drivers were not yielding on the circular green and the phase operation had to be converted to "protected only."

See **Section 403-15 Left Turn Phase Operation Guidelines** for selecting left turn phase treatments.

420-4.6 Aluminum versus Polycarbonate

Signal heads are manufactured in either aluminum or polycarbonate plastic. The choice of which material to use will be made by the maintaining agency. Many urban jurisdictions prefer the use of polycarbonate, because they are much lighter and easier to handle. Because of the lighter weight, they are often used when adding left-turn signal heads to an existing signal support system. Polycarbonate signal heads are most often associated with rigid-mounted signal heads on mast arms where wind sway will not be a factor.

In **ODOT**-maintained traffic signal installations, polycarbonate signal heads should be used rigid mounted to mast arms or span-wire attached with tether.

420-4.7 Programmable Signal Heads

A programmable signal head utilizes a special optical lens that can be "programmed" to provide the signal display to only desired portions of the roadway. The programming is accomplished by steerable LED arrays behind the lens. Applications for the use of programmable heads may be severely skewed roadways where the signals may be visible from more than one approach and closely spaced intersections, or closely spaced intersections.

Because the lens is programmed to be visible from certain areas, the signal head should be rigid mounted or tethered. Programmable signal heads are much more expensive than a regular signal head and, if programmed incorrectly, can create an unsafe condition. Signal designers should give careful thought to their use and provide plan sheets clearly showing the desired visibility cutoffs.

See ***Section 450-10.5*** for additional details on optically programmable signal heads.

420-4.8 Vehicular Signal Indications on the Stem of a T-Intersection

Information about signal indications for approaches with no through movement can be found in **OMUTCD Section 4F.16**.

On the stem of a T intersection, where there is no through traffic, at least one of the turning movements shall be provided with dual indications, unless it is a single lane approach. In the case of a single lane approach, only two signal heads are required. The purpose of providing dual indications is to ensure that if one lamp fails, a second lamp will be provided to the predominant movement. Allowable combinations of signal indications are detailed in **OMUTCD Figure 4F-15**.

420-4.9 Signal Head Clearance

420-4.9.1 Vehicular

OMUTCD Section 4D.09 requires that the bottom of the signal housing and any related attachments to a vehicular signal face located over a roadway shall be at least 15 feet above the pavement. The top of the signal housing of a vehicular signal face located over a roadway shall not be more than 25.6 feet above the pavement. For new construction using mast arm overhead attachment, Traffic SCD TC- 85.20 requires a clearance of 17 to 19 feet above the pavement elevation at the center of the roadway. For new construction using span wire overhead attachment, Traffic SCD TC-85.22 requires a clearance of 17 to 19 feet (including tether attachment) above the pavement elevation at all points of the roadway. If the installation cannot be adjusted to the proper clearance, the engineer, in consultation with the maintaining agency, may direct the use of drop pipes or waive the maximum clearances requirement for each head.

420-4.9.2 Bicycle

OMUTCD Section 4H.09 outlines the requirements for the mounting height of bicycle signal heads.

420-4.10 Use of Balance Adjusters Prohibited

Balance adjusters shall not be used on signal installations with backplates. Experience has shown that balance adjusters allow enough twisting motion in the signal head to produce tether wire fatigue at the tether attachment point.

420-4.11 Bi-Modal Yellow-Green Arrow Signal Section

OMUTCD Section 4E.01 allows for the use of a dual-arrow alternative display, also referred to as a bi-modal display, of a GREEN ARROW and a YELLOW ARROW. However, these dual-arrow signal sections shall not be used on **ODOT**-maintained highways.

420-4.12 Supplemental Traffic Signal Heads

420-4.12.1 Vehicular

Approaches to traffic signals with high truck percentages (10% or greater) and/or high approach speeds (45 mph posted or greater) should include one or more supplemental signal heads. Typical placement is on the near-side right side signal support. Supplemental heads improve signal indication visibility for motorists approaching the signal when one or more high trucks (e.g., tractor-trailers) are stopped at or are approaching the intersection. Motorists following high trucks often have their view of overhead signal indications blocked by the truck.

A supplemental traffic signal head shall match the signal head it is supplementing. For example, a supplemental head on the right shall match the furthest right signal head on the mast arm/ span wire.

Installations with lower approach speeds and lower truck volumes should be considered on a case-by-case basis for supplemental heads, especially in situations with sight distance restrictions due to horizontal or vertical curves, or roadside or overhead obstructions.

420-4.12.2 Bicycle

Requirements for supplemental bicycle signal heads can be found throughout **OMUTCD Chapter 4H**.

421-2 Signal Support Inspections

A statewide uniform practice for the periodic inspection of the structural components of **ODOT**- maintained signal supports is necessary to assure their structural integrity. All strain pole, mast arm, and post-top supports should be periodically inspected. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked.

The use of the ODOT Collector App is required.

At a minimum, supports should be visually inspected from the ground. Items to be inspected should include, but not be limited to, foundation concrete, soil around foundation, anchor bolts and nuts, structural members and structural connections. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means to achieve arm-length visual inspection (VI) is recommended but not necessary on an annual basis. Arm-length VI may be used to more closely examine a defect that has been detected from the ground. There are many kinds of structural tests available, and Districts may contact the office of Roadway Engineering, Transportation Systems Management and Operations or Structural Engineering for assistance.

Anchor bolts should be tested for structural integrity visually (especially between the foundation and base plate) and by sounding with a hammer. Non-destructive testing procedures, such as ultrasonic thickness testing (UT), and crack detection by dye penetrant (DPT) and magnetic particle (MPT) are not necessary on a routine basis but can be used to define the extent of a defect that has been detected by visual means.

Deficiencies to be inspected should include, but not be limited to, cracks in concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, visible gaps between attachment plates, and corrosion. Corrosion of poles at the base of the tube is significantly enhanced by moisture and salt trapped by dirt, debris, and ice build-up under the base plate; the space between foundation and base plate shall be cleaned to allow for drainage and airflow. Varmint guards shall be removed to permit inspection of anchor bolts, leveling nuts, foundation and blocking by debris. When inspection reveals buried foundation tops, they must be exposed and the adjacent ground surface corrected by maintenance personnel.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Corrective actions should be entered into the Collector App.

All signal supports shall be inspected annually. New signal supports shall be inspected at the time of construction.

440-1.2 Overhead Utilities

Designers must also be aware of the possibility of overhead utility obstructions. OSHA and NESC outline minimum vertical clearance from overhead power lines. Other utilities (e.g. telecom) may have other clearance requirements. Poles, arms, signal heads and any other signal appurtenance must meet these minimum vertical clearance requirements. Utility wire must not rest on any portion of a signal support.

Overhead wires should not obstruct the view of a signal head.

Bagged signal heads shall not obstruct existing signal heads.

440-7 Stage 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage 2 and 3 plan submittals. The forms referred to in this Section are on-line in the Signal Design Reference Packet (see ***Section 495-2***), or on the OTSMO Forms web page.

1. Stage 2 Plan Requirements:
    a. Base plan drawn in accordance with L&D Volume 3 and the Signal Design Reference Packet at 1:20 scale, including roadway base lines.
    b. Traffic signal pole locations and skew angles, if required. Reference numbers for all poles.
    c. Signal head locations and direction; identify signal heads having turn arrows, louvers or special optically programmed features; signal head sizes; and reference numbers for all signal heads.
    d. Signal controller location and orientation.
    e. Detector locations, loop configurations and detection chart ***(***Form 496-4***)***.
    f. Underground conduit and pull boxes.
    g. Overhead sign locations, whether on signal spans, mast arms or located on separate supports.
    h. Legend for symbols used.
    i. Pavement marking pertinent to the signal operation.
    j. Signal phasing diagram, method of addressing yellow trap (where applicable), field hook-up chart and signal timing. See the Signal Design Reference Packet ***(Section 495-2)*** for typical signal timing charts, phasing diagrams and the field hook-up chart template.
    k. Handicap ramp locations.
    l. Right-of-Way lines.
    m. Corporation lines.
    n. Any existing features to be incorporated into the new signal. Any decision to reuse equipment must be based on a field check of the structural integrity and condition of the devices and agreement with the maintaining agency.
    o. Other physical features within the intersection and sidewalk area which may conflict with traffic flow, pedestrian flow or sight distance.
    p. **Synchro** files electronically.
    q. **SWISS** files electronically.
2. Stage 3 Plan Requirements:
    a. General Notes.
    b. Estimated quantities.
    c. Special details.
    d. Pole orientation chart.

e. Wiring diagram. It shall indicate the type of cable and number of conductors connecting each signal head, pedestrian head, detector, push button, etc. See SDRP for a sample diagram.

f. Coordination timing. All coordination timings shall be in seconds.

The Traffic Signal Stage 3 check list can be found in the Signal Design Reference Packet.

440-11 Solar-Powered Electrical Devices

Section 240-9**, **Supplemental Specification 999, and SCD TC-87.10 address installation of rectangular rapid flashing beacons (RRFBs) on **ODOT**-maintained highways.

Section 702-4 and ***SCD TC-87.20*** address the use of solar-powered School Speed Limit Signs with Flashing Beacons.

Section 442-50 provides a generic **Plan Note** for use with other permanent electrical or electronic devices used with **ODOT** signs, signals or ITS projects that are powered by batteries and recharged by solar panels.

442-25 809 Preemption

This item of work shall consist of furnishing and installing preemption equipment in the locations and local controllers as shown in the plans. The preemption shall conform to **ODOT** Supplemental Specification **809** and shall utilize communications to identify the presence of an emergency priority vehicle. It shall cause the traffic signal controller to select a pre-programmed preemption plan that will display and hold the desired signal phase for the direction of the emergency vehicle.

The communications medium shall employ either sound, light or radio detection techniques to determine and log the presence of the emergency vehicle. The system shall detect the presence of the vehicle through an emitting device located on the emergency vehicle. The system shall activate the preemption sequence by applying a signal to one of the controller's preempt discrete inputs. The system shall be completely compatible with the controller.

The equipment shall be shelf or rack mounted and easily removable and replaceable within the cabinet. Furnish and install equipment completely wired in the controller cabinet and tested. The system shall be capable of preempting and receiving priority for each approach to the intersection. It shall be possible to detect the emergency vehicle at least 2000 feet from the intersection in an 80dB-A noise environment.

All preemption plans should be programmed to prevent the Yellow Trap, unless as directed by the District Traffic Engineer. Yellow Trap Prevent will force the transition through Yellow Change and Red Clearance for resolution of Yellow Trap if any phase opposing the Preemption Clearance phase(s) is active and displaying a green or flashing yellow arrow indication when the preemption plan is activated and the Preemption Clearance phase(s) are green.

Furnish and install each intersection shown in the plans with the following components, each bid separately:

1. Preempt receiving unit.
2. Preempt detector cable.
3. Preempt phase selector assembly and interface wiring panel.
4. Preempt confirmation light.

If a **light-activated** system is specified, the Contractor shall use the Emergency Vehicle Preemption Agency Info table to determine compatibility with the proposed system. If existing emitters are found to be not compatible, then the City shall be supplied (at costs incidental to the system) with the emitters, transmitters, switches, wiring and all required vehicle equipment for the following emergency vehicles. The City shall be responsible for installing vehicle equipment.

If a **radio-activated** system is specified, the Contractor shall supply the above emergency vehicles with emitters at cost incidental to the system.

If a **sound-activated** system is specified, the Contractor shall use the Emergency Vehicle Preemption Agency Info table to determine compatibility of the sirens with the system. Each vehicle that is determined to be not compatible shall be supplied with new sirens at cost incidental to the system.

If a light, radio, or sound activated system is not specified, then Contractor shall furnish and install a radio activated system.

The City shall be supplied with software required to calibrate, log, and operate the system. Two (2) operating and instruction manuals shall be supplied with the software.

The Contractor shall thoroughly test the installed system. As a minimum, the Contractor shall verify that all connections are properly made to the controller cabinets. The Contractor shall check that the range setting is proper for each intersection. The Contractor shall determine that all phase selectors are selecting the proper phase and timing accurately. The Contractor shall verify that all vehicle emitters are being properly detected.

If the proposed preempt system is not compatible with the existing system, the Contractor shall provide training for up to fifteen (15) persons in the operation of the system. It shall be provided within 48 hours of the installation of the system. It shall consist of hands on instruction for a minimum of sixteen (16) hours. The Contractor shall provide training for up to four (4) persons in the installation and maintenance of the system. It shall consist of a minimum of eight (8) hours of instruction. Training shall be supplied within seven (7) days of the installation of the system. All training shall be held in a City supplied location. Training shall be conducted by someone who has performed this within the last year and does it on a regular basis. The cost of training, including course material, travel subsistence and related costs, shall be entirely borne by the Contractor and shall be incidental to the preemption equipment.

Emergency Vehicle Preemption Agency Info

Emergency Agency Contact Info (typ. Fire Dept.)		
	Existing	**Proposed**
Preemption Type (Radio, Light, or Sound)		
Preemption Make/ Model		
Number of intersections with EmVPE		
Number of vehicle emitters		

Refer to TEM 403-6 for all EmVPE requirements, which includes system and quantity limits

Payment for **Item 809 Preemption** shall be made at the contract unit price for each preemption in place and fully operational as shown in the plans, except for those items bid separately.

Designer Note: This note describes a generic bid item for preempt systems. The quantity in the plans should be one each for the system; not the number of intersections. However, it should be noted that a quantity for preempt receiving units, preempt detector cable, preempt phase selectors and preempt confirmation lights is required at each intersection.

See **Part 403-6** for more designer guidance.

See **Part 120-4** for more information on proprietary bid items by EmVPE.

The Designer shall coordinate with the Emergency Agency and fill-in the applicable information in the "Emergency Vehicle Preemption Agency Info" table above. Include the make and model of all existing emitters and receivers in use. If the existing system is sound-activated, include the siren pattern, frequency and period of all emergency vehicle sirens.

442-43 632 Auger-In Foundation, 8-inch Diameter by (Depth in Feet)

This item consists of supplying and installing a pole foundation in undisturbed soil by use of a power rotary drill rig ("Kelly drive"), at the location specified in the Plans. Provide an auger-in foundation of 8-inch minimum outside diameter and shaft length as specified in the item description. Integral cableway cutouts of 2-inch by 8-inch (minimum) shall be present on opposite sides of the shaft beginning at 30-inch depth. Provide a shaft and all hardware hot-dip galvanized finished per ASTM A153. Assure the base plate can accommodate 12-3/4-inch to 17-inch bolt circles as shown on **Standard Construction Drawings HL-10.13, TC-83.30, and TC-21.21**.

Install per manufacturer's instructions, with frequent checking and adjustment during auguring, to assure a plumb pole installation. Auger in the foundation until the top of the base plate is at the final grade elevation. Align the base plate side parallel to the roadway and align cableway cutouts with underground conduits shown in the Plans. If no conduits appear in the Plans, then install the cableway cutouts parallel to the roadway. Clean the inside of the installed foundation of soil and debris to the bottom of the cableway cutouts.

Dig conduit trench by hand using a trenching shovel within 2 feet of the installed foundation. If machine-trenching is performed within 2 feet of the foundation, re-install the auger-in foundation a short distance away, as directed by the Engineer, or replace with a cast-in-place concrete **632 Pedestal Foundation**. Foundation and conduit relocation and/or replacement foundations necessitated by machine-trenching too close to the original foundation are performed at the Contractor's expense.

Provide an auger-in foundation meeting these specifications and manufactured by AB Chance, Millerbernd, Pelco, or an approved equal.

Payment for this item is for each unit specified at the unit bid price, complete and in place.

Designer Note: Use this specification in place of **Item 632 Pedestal Foundation** only when necessary, such as for knockdown replacement and similar situations that require a quick installation. The concrete 632 Pedestal Foundation item is standard for new design, but the Auger-In Foundation is suitable for maintenance installations. The minimum specified length is five feet (60 inches) in urban areas and 6 feet (72 inches) in rural areas. For maintenance purposes, these two sizes are generic. The designer should specify a breakaway Transformer Base as part of the complete assembly. The designer shall perform basic 90mph design wind speed overturning moment calculations for all sign, signal, or light pole assemblies mounted on auger-in bases using the **AASHTO LRFDLTS-1**, with parameters per **TC-81.22**. Use this design overturning moment and local soils data to determine the required foundation dimensions using the Drilled Shaft Foundation Design Spreadsheet provided by the **Office of Roadway Engineering (ORE)**; the spreadsheet is available for download from the ORE website.

District approval is required before using this item in construction plans; provide copies of the spreadsheet and soils data to the District.

442-46 632 Signal Support, (By Type), As Per Plan

In addition to provisions of the **ODOT** C&MS, furnish and install signal poles as specified in the plans.

The signal support designer shall provide drawings of a signal support with structural aspects of the design and materials in compliance with the **AASHTO LRFDLTS-1**.

Submit, to the Engineer prior to incorporation: two copies of the signal support drawings and shop drawings, which identify and describe each manufactured signal support and signal support item which is being incorporated into the construction. The signal support drawings and shop drawings shall each be reviewed, stamped, and dated by a registered Professional Engineer.

Payment for **Item 632 "Signal Support, (By Type), As Per Plan"** shall be made at the contract unit price per each complete and in place, and shall include all signal support design, labor, materials, and equipment necessary to complete the work.

Designer Note: This note is required on all projects where non-standard signal supports are included in the plans.

Any feature such as fluted poles, clamp-on-arms, haunched arms, etc. that deviates from the support shown in the ODOT Standard Construction Drawings shall be accompanied by full design calculations by the Designer and/or Manufacturer using SABRE, StaadPRO, in-house Software, or equivalent software.

"Item 632 Signal Support, Non-Standard, Capacity Meets or Exceeds (By Type)", As Per Plan."

If the capacity of the proposed support does not meet or exceed that of a given ODOT Standard Type, then the Item shall be "632 MISC.."

443 SPECIFICATIONS

ODOT specifications for the furnishing and installation of traffic signal equipment are contained in the following C&MS sections, Supplemental Specifications and Supplements.

C&MS Sections:

625 and 725	Trench, conduit, ground rods and pull boxes
632 and 732	Traffic signal equipment
633 and 733	Traffic signal controllers

Supplemental Specifications:

804 and 904	Fiber Optic Cable and Components
805 and 903	GPS (Global Positioning System) Clock Assembly
809 and 909	Intelligent Transportation System (ITS) Devices and Components
810 and 910	Vital Inductive Loop Processor System
812	Precast Light Pole Foundations
813 and 913	Luminaire, Solid-State (LED)
816 and 907	Video Detection System
819 and 919	Railroad Preemption Interface
824	System Analysis
825	Arc Flash Hazard Calculations and Equipment Label
828 and 928	LED Blank Out Sign
898 and 998	Wireless Magnetometer Detection System
916	Coating Of Light Supports and Signal Supports Over Hot-Dip Galvanized Steel or Aluminum
961	Portable Traffic Signal

Supplements:

1048	Loop Detector Sealant Prequalification Procedure
1063	Signal Construction Personnel Requirements (631, 632, 633)
1076	Conflict Monitors for Use with Model 170E and 2070 Controllers/Cabinets
1094	Certification Procedure for Fabricators of Signal Supports and Strain Poles
1095	Model 242 DC Isolator Prequalification Procedure
1097	LED Lamp Prequalification Procedure (vehicular and pedestrian signal lamps)
1099	Video Detection System Prequalification Procedure

1104	Model 2070E Controller with 2070-1E CPU Prequalification Procedure

C&MS sections, the Supplemental Specifications and Supplements related to specific traffic signal items are referenced individually as they are discussed in this Manual.

The C&MS may be viewed on-line, as well as copies of the Supplemental Specifications and Supplements.

460-2 Responsibilities

The Office of TSMO (OTSMO) shall:

1. Staff and maintain a central repair facility for the purpose of repairing components of electrical traffic control devices.
2. Assist Districts in maintaining reasonable stock levels of all major electrical items, and their appurtenances, required for new installations and maintenance through the management of annual term contracts and spot purchase contracts.
3. Assist the Districts, through procedure manuals, training programs, inspections, and other methods, in providing quality maintenance.

The **Central Office Signal Shop** shall:

1. Repair, check and make serviceable for installation all signal controllers, signal relays, detectors, flashers, conflict monitors and other associated items.
2. Provide the loop detectors and other miscellaneous parts to custom wire as per plan new controller cabinets purchased by the **Districts** or rewire/refurbish existing controller cabinets.
3. Periodically provide the **Districts** with technical information concerning old and new equipment, such as: a list of outdated equipment that will not be repaired by the **Signal Shop**, changes, problems, software updates and etc. for any equipment owned by **ODOT**, and other tips or tricks that may help the **District** personnel.
4. Distribute to the **Districts**, at least once per calendar year, a list of all equipment, parts, and services available from the Signal Shop.

Each **District** shall:

1. Maintain a stock of traffic control equipment and other spare parts sufficient for normal preventive maintenance and emergency field repairs.
2. Have a plan to support the extraordinary (i.e., severe storm damage) traffic control equipment needs of the **District**.
3. Evaluate, authorize and maintain records of all changes in the location or operation of electrical traffic control devices.
4. Transport defective controllers, detector relays, detectors, conflict monitors, etc., to the **Central Office Signal Shop** (or approved contractor/vendor) for service, maintenance and repair, along with a **Signal Shop Order** and a tag indicating the exact type of malfunction. These units shall at all times be properly cushioned to prevent physical damage during shipping and handling.
5. Generate an "as built" drawing for each electrical traffic control device installation, including each new or upgraded intersection control beacon, school speed limit sign with flashing beacons or signal. The drawing

shall be per the CADD standards in **L&D Volume 3** and shall include the following, if appropriate:

a. Geometrics of the intersection.

b. Materials list.

c. Layout and location of the detectors, poles, pull boxes, cable runs, span wire, signal and pedestrian heads, controller, power service, phase diagram, detector operation, date of installation, revision block, and any other information which shows the intended operation.

d. Changes which affect the geometrics of the intersection and/or the operation of the signal shall be added to the drawing as revisions.

These electronic files shall be accessible to the **Central Office** in a read-only mode. Signal drawings which exist in a raster or single element format and cannot be modified shall be digitized or converted by other means when revisions become necessary.

6. Perform appropriate engineering studies, as needed, upon which revisions in signal operations, e.g., phasing may be based. When such revisions are required, an engineering report and necessary supporting data shall be submitted for approval to the appropriate **District** staff person.

Some signalized intersections and/or signalized corridors may be eligible to apply for, and participate in, the **Systematic Signal Timing & Phasing Program (SSTPP)**. See ***Section 1213-6*** for more information about this program.

460-3.3 Other Electrical Traffic Control Devices

For School Speed Limit Signs with Flashing Beacons, flashing and illuminated signs, and other electrical traffic control devices:

- LED lamps shall be used

460-4 As Required Maintenance

The following maintenance shall be conducted as required:

At signalized intersections, and for School Speed Limit Signs with Flashing Beacons and Intersection Control Beacons:

1. Replace premature failure of lamps. Clean all reflectors, lenses, tubes and/or lamps.
2. Repaint painted steel poles, controller housings and signal heads as necessary to maintain good appearance and protection.
3. If required by local conditions of smoke, smog, etc., clean all reflectors, tubes and/or lamps using a mild detergent.

At flashing signs, illuminated signs, and other electrical traffic control devices:

1. Replace premature failure of lamps. Clean all reflectors, lenses, tubes and/or lamps.
2. Maintain and replace all other items as required.

Maintain all signs and pavement markings directly associated with any of these devices.

460-7 Training

The **District** shall be responsible for training its personnel. The **Office of Training,** and the **Office of TSMO**, in cooperation with the **Districts**, will make the necessary classes and training available.

460-9 Signal Databases

Traffic signal inventory and inspection information is housed in the ODOT Collector App.

460-10 Dark Signals

ORC Section 4511.132 establishes a driver's duties upon encountering a dark signal (signal not operating due to a power outage).

When responding to notice of a dark signal, the **District** has the following options available:

1. No action.
2. Generators.
3. Temporary ALL-WAY STOP signs (erected in accordance with OMUTCD **Section 6F.03**) – If it cannot be ensured that the signal will come back in all-red flashing mode in conjunction with the temporary STOP signs, STOP signs shall not be placed at the intersection.
4. Law enforcement officer to flag traffic.

ODOT personnel to flag traffic.

The **District's** response to a dark signalized intersection may be based on the following factors:

1. Utility company time estimate for repairs.
    a. Short term.
    b. Long term.
2. Power outage being wide area or localized area.
3. Number of roadway lanes or type of roadway.
    a. 2 lane and 2 lane.
    b. 4 lane and 2 lane.
    c. 4 lane and 4 lane.
    d. Freeway ramp, urban.
    e. Freeway ramp, suburban or rural.
4. Prioritized listing of intersections constructed from such factors as volume, roadway types, location, etc.
5. Law enforcement request.

The following devices are also available for responding to a dark signal. Some of these devices need to be in place before the power outage.

1. Battery back-up.
2. Signal head backplate with reflective yellow tape outline.

3. SIGNAL AHEAD sign(s).

470-1 Alternative Intersection Design Guidance

For geometric requirements, see the Location & Design (L&D) Volume 1. For pedestrian routing and considerations, see the Multimodal Design Guide (MDG). The following are practical design guidance to consider for each unique site.

For all Alternative Designs listed, consider:

- Pavement Markings of Dotted Lines and/or Lane Control Arrows to enhance the lane assignments through transitions
- Turn Assignment/ Restriction Signs to enhance lane assignments
- Using Signal Head directional arrows instead of ball indications to further guide drivers
- Supplemental Signal Heads on Signal Supports or Pedestal Supports to enhance the indication, and in some cases, a continuous arrow indication
- Signalized Pedestrian Crossings at free flow ramps
    - Designers should consider pedestrian and bicycle crossings of free-flow ramps. RRFBs or dedicated controller phases can be used for these ramp crossings. Consider use of third and fourth-ring controller phases for free-flow-ramp crossings, either locked or unlocked to the Barrier. Careful consideration is required to determine where to locate ramp crossing phases in the controller Ring and Barrier structure. RRFBs are usually fully independent, but driver compliance can be an issue. See MDG 8.7.2 and Supplemental Specification 999 for information on RRFBs.

Additionally, design specific considerations for each interchange type includes but not limited to:

- Diverging Diamond Interchange (DDI)
    - Valuable resource: NCHRP Research Report 959, Diverging Diamond Interchange Informational Guide
    - Proximity of adjacent signalized intersections should be considered. Designers must examine both queue storage and signal coordination. Coordination timing is often controlled by adjacent major intersections and not by the alternative design intersection. Simple two-phase operation of alternative designs is cited as distinct advantage, but two-phase operation often results in much longer mainline green times. This green band discrepancy can result in long queues building up at adjacent intersections. Designers should include careful queue modeling when developing coordination timing, to prevent spillbacks.
    - District/CO discussion regarding Phasing Schemes:
        - Two-critical movement
        - Three-critical movement
        - Four-critical movement
    - Designers should note that DDI pedestrian routing is affected (and sometimes determined) by the physical dimensions and configuration of overpasses structures. See MDG 9.3.4 for pedestrian and

bicycle considerations at DDIs.

- Based on the chosen Phasing Scheme, determinations will then follow for:
  - Detection
  - Clearance Intervals
  - Pedestrian Timing
- Consider using signal heads with green arrows for through movements

- Superstreet/Signalized R-Cut
  - District/ CO discussions regarding 2 cabinets/ 2 controllers for the major movement intersection. The advantage of the two cabinet scenario is that it allows the ability to have different cycle lengths in each direction. Model the corridor in a traffic simulation software with both the one controller/ cabinet arrangement and the two controller/ cabinet arrangement at the main intersection. Compare these models to determine if two cycle lengths in each direction are needed. If so, the two controller/ cabinet alternative can be used.
  - In the two-cabinet setup, the following is needed:
    - Power: 18" pull boxes used to route conduit with 5/C No. 14 AWG Signal Cable between the two cabinets at the main intersection
    - Communications: 32" pull boxes used to route conduit (left empty for Fiber install – By Others) between the two cabinets at the main intersection for communications
    - Flash Interlock Relay panel at each cabinet, which ties the flash of the two cabinets together, so that if one cabinet goes into malfunction flash, it will trigger the other
  - See MDG 9.4.2 for pedestrian and bicycle considerations at RCUTs.
- Continuous Flow Interchange (CFI)
  - See MDG 9.4.3 for pedestrian and bicycle considerations at CFIs.
- Single Point Urban Interchange (SPUI)
  - See MDG 9.3.3 for pedestrian and bicycle considerations at SPUIs.

496 FORMS INDEX

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Form 496-1. Reserved for Future Use

Form 496-2. Reserved for Future Use

Form 496-3. Traffic Signal Controller Timing Chart

Form 496-3 is a sample Traffic Signal Controller Timing Chart, as noted in ***Section 440-7***. This form is shown in the Signal Design Reference Packet and on the OTSMO Forms web page.

Form 496-4. Traffic Signal/Radar Detection Chart

Form 496-4 is a sample Traffic Signal/Radar Detection Chart, as noted in ***Section 440-7***. This form is shown in the Signal Design Reference Packet and on the OTSMO Forms web page.

Form 496-5. Coordination Timing Chart

Form 496-5 is a sample Coordination Timing Chart, as noted in ***Section 440-7***. This form is shown in the Signal Design Reference Packet and on the OTSMO Forms web page.

Form 496-6. Report of Electrical Tests

Form 496-6 is used for reporting the results of the standard electrical tests, as noted in ***Sections 450-11.2, 450-11.3, 450-11.4, 50-11.5 and 50-11.6***.

Form 496-7. Reserved for Future Use

Form 496-8. Application to Install and Operate a Traffic Control Signal

Form 496-8 is used by village authorities to obtain permission to install and operate Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the OTSMO Forms web page.

Form 496-9. Request for Approval of a Traffic Control Signal Operation Plan

Form 496-9 is the operation plan for proposed village Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the OTSMO Forms web page.

Form 496-10. Permit for the Operation of a Traffic Control Signal on a State Highway

Form 496-10 is the Traffic Control Signal Permit as described in ***Section 401-6***, and is available on-line from the OTSMO Forms web page.

Form 496-11. Application to Modify Operation of a Traffic Control Signal

Form 496-11 is for proposed modifications to village Traffic Control Signals as described in ***Section 401-6***, and is available on-line from the OTSMO Forms web page.

Form 496-12. Reserved for Future Use

Form 496-13. Reserved for Future Use

Form 496-14. Application for a Permit to Have a Special or Off-Duty Law Enforcement Officer (LEO) Operate a Traffic Control Signal

Form 496-14 is the Application for a Permit described in ***Section 401-10***, and is available on-line from the OTSMO Forms web page.

Form 496-15. Permit for a Special or Off-Duty Law Enforcement Officer (LEO) to Operate a Traffic Control Signal

Form 496-15 is the Permit described in ***Section 401-10***, and is available on-line from the OTSMO Forms web page.

Form 496-16. Field Wiring Hook-Up Chart

Form 496-16 is the Field Wiring Hook-Up Chart described in ***Section 440-7***. This form is shown in the Signal Design Reference Packet and on the OTSMO Forms web page. Sample completed Field Wiring Hook-Up Charts are illustrated in ***Figure 498-2***.

Form 496-17. Reserved for Future Use

Form 496-18. Vehicular/Ped Volume Chart

Form 496-18 is an example of a Vehicular/Ped Volume Chart, as noted in ***Section 402-2***.

Form 496-19**. ODOT Pedestrian Hybrid Beacon (PHB) Evaluation Matrix**

See ***Section 404-4*** for additional information.

Form 496-20. Emergency Vehicle Preemption at Signalized Intersections

See ***Section 403-6*** for additional information.

497 TABLES INDEX

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Table 497-1. Cross Section Area of Conduit, Cable and Wire

Table 497-1 **is used as described in *Section 450-3.4* to size conduit based on the number and size of the conductors contained in the conduit.**

Table 497-2. Cable and Wire Identification

Table 497-2 **is referenced in *Section 450-10.3* and is a reproduction of** C&MS Table 632.05-1**.**

Table 497-3. Minimum Sight Distance

Table 497-3 **is referenced in *Section 450-10.4* and is a reproduction of *Table 4D-2* from OMUTCD, Section 4D.06.**

Table 497-4. Types of Overhead Signal Supports

Table 497-4 **depicts various types of overhead signal supports and is referenced in *Sections 440-3, 440-4 and 450-6.1*.**

Table 497-5. Areas for Signal Heads

Table 497-5 **presents areas used in *Sections 440-3 and 440-4* in designing overhead signal supports.**

Table 497-6. Height from Bottom of Signal Head to Messenger Wire or Mast Arm

Table 497-6 **presents the height (in feet) from the bottom of the signal head to the messenger wire or mast arm and is referenced in *Section 440-5*.**

Table 497-7. Minor Street Analysis Parameters – Minor Leg Lane Configurations and Right Turn Reductions

Table 497-7 **presents parameters used in the procedure described in *Section 402-5* for determining how many right-turning vehicles to remove from the minor street traffic in a signal warrant analysis.**

Table 497-8. Minor Street Analysis Parameters – Mainline Congestion Factors for Limiting Right Turn Reductions

Table 497-8 **presents mainline congestion factors used in the procedure described in *Section 402-5* for determining how many right-turning vehicles to remove from the minor street traffic in a signal warrant analysis.**

Table 497-9. Village Signal Permit Number Assignments

Table 497-9 **assigns numbers to be used by Districts for Village Signal Permits *(see Section 401-6)*.**

Table 497-10. Left Turn Phase Operation Guidelines

Table 497-10 **presents guidelines for left turn type selection *(see Section 403-15)*.**

498 FIGURES INDEX

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Figure 498-1. Emergency Traffic Signal Guidelines
Figure 498-1 **illustrates the cross-corner sight distance criteria suggested for use in reviewing requests for Emergency Traffic Signals, as described in *Section 406-3*.**

Figure 498-2. Sample Field Wiring Hook-Up Charts
As noted in *Section 440-7*, Figure 498-2 **shows sample Field Wiring Hook-Up Charts for 33X cabinet and NEMA cabinets.**

Figure 498-3. Suggested Loop Placement for Mainline vs. Large-Volume Side Street
Figure 498-3 **illustrates suggested loop detector placements as described in *Section 420-5* for an intersection with a large-volume side street.**

Figure 498-4. Suggested Loop Placement for Mainline vs. Ramp/T Intersection
Figure 498-4 **illustrates suggested loop detector placements as described in *Section 420-5* for an intersection with a ramp or T intersection.**

Figure 498-5. Suggested Loop Placement for Mainline vs. Low-Volume Side Street
Figure 498-5 **illustrates suggested loop detector placements as described in *Section 420-5* for an intersection with a low-volume side street.**

Figure 498-6. Reserved for Future Use

Figure 498-7. Reserved for Future Use

Figure 498-8. Exothermic Weld
Figure 498-8 **illustrates the equipment used for an exothermic weld as described in *Section 450 3.6*.**

Figure 498-9. Reserved for Future Use

Figure 498-10. Reserved for Future Use

Figure 498-11. Reserved for Future Use

Figure 498-12. Reserved for Future Use

Figure 498-13. Sag and Vertical Clearance Diagram
Figure 498-13 **illustrates sag and vertical clearance and is referenced in *Section 450-7*.**

Figure 498-14. Reserved for Future Use

Figure 498-15. Reserved for Future Use

Figure 498-16. Method of Measurement for Signal Cable

Figure 498-16 **illustrates the calculation method for the measurement of signal cables as described in *Sections 450-8.5 and 450-9*.**

Figure 498-17. Method of Measurement for Interconnect Cable

Figure 498-17 **illustrates the calculation method for the measurement of interconnect cable as described in *Sections 450-8.5, 450-8.8 and 450-9*.**

Figure 498-18. Method of Measurement for Detector Lead-In Cable

Figure 498-18 **illustrates the calculation method for the measurement of detector lead in cables as described in *Sections 450-8.5, 450-9 and 450-10.8*.**

Figure 498-19. Method of Measurement for Power Cable

Figure 498-19 **illustrates the calculation method for the measurement of power cable as described in *Sections 450-8.5 and 450-9*.**

Figure 498-20. Method of Measurement for Service Cable

Figure 498-20 **illustrates the calculation method for the measurement of service cable as described in *Sections 450-8.5 and 450-9*.**

Figure 498-21. Vehicular Signal Heads

Figure 498-21 **illustrates hardware and wiring for signal heads as described in *Section 450-10.4*.**

Figure 498-22. Reserved for Future Use

Figure 498-23. Reserved for Future Use

Figure 498-24. Reserved for Future Use

Figure 498-25. Reserved for Future Use

Figure 498-26. Reserved for Future Use

Figure 498-27. Vehicle Loop Test Targets

Figure 498-27 **illustrates the test targets described in *Sections 420-5 and 450-11.6*.**

Figure 498-28. Short-Circuit Test

Figure 498-28 **illustrates the connections for the short circuit test as described in *Section 450-11.3*.**

Figure 498-29. Circuit Continuity Test of Loop Wire

Figure 498-29 **illustrates the connections for the continuity circuit test on loop detector wire as described in *Section 450-11.4*.**

Figure 498-30. Reserved for Future Use

Figure 498-31. Reserved for Future Use

Figure 498-32. Reserved for Future Use

Figure 498-33. Cable Insulation Test

Figure 498-33 **illustrates the connections for the cable insulation test for loop detector wire as described in *Section 450-11.5*.**

Figure 498-34. Reserved for Future Use

Figure 498-35. Reserved for Future Use

Figure 498-36. Reserved for Future Use

Figure 498-37. Reserved for Future Use

Figure 498-38. Reserved for Future Use

Figure 498-39. Examples of Wire Size for Equipment Grounding Conductor

Figure 498-39 **presents examples of wire size for equipment grounding conductors as described in *Section 442-32*.**

Figure 498-40. Reserved for Future Use

Figure 498-41. Reserved for Future Use

Figure 498-42. Reserved for Future Use

Figure 498-43. Dilemma Zone Graph

Figure 498-43 **presents a graphical representation of the dilemma zone drivers face when approaching a signalized intersection.**

Figure 498-44. Span Support Guidelines

Figure 498-44 **presents a graphical representation of information in *Section 440-10* about the location of span-mounted traffic Signal supports *(see Subsection 440-10.6)*.**

Figure 498-45. Reserved for Future Use

Figure 498-46. Reserved for Future Use

5 - Traffic Control Device Considerations for Automated Vehicles

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Reserved for "Traffic Control Device Considerations for Automated Vehicles"

605-14.4 Temporary Guardrail

All guardrail used as a temporary barrier in maintenance of traffic applications shall conform to the same standards required for permanent guardrail in L&D Manual Volume 1, **Section 603.2.1**.

Guardrail should be as detailed in the current Roadway Standard Construction Drawings. Any variation from these standards shall be submitted for approval by the Office of Roadway Engineering (ORE) at the design stage, on a case-by-case basis.

Guardrail delineation shall be installed as described in ***Section 605-19*** and **Plan Note 5642-52** in ***Chapter 642***.

605-14.5 Portable Barrier (PB)

Portable Barrier (PB) includes portable concrete barrier (PCB), portable steel barrier, and portable fiberglass barrier. (It does not include portable water-filled barrier.)

605-14.5.2 End Treatment

The exposed end of the PB should be located at a distance from the edge of the traveled way equal to the clear zone distance for the facility as discussed in L&D Manual Volume 1, **Section 600.2**, plus a minimum of two full PB sections beyond. When this is not practical, impact attenuators shall be provided on the exposed ends of PB located within the clear zone. See **Section 641-23** and Traffic SCD **MT-101.75** for design guidance for impact attenuator placement.

Except as noted, exposed ends of PB shall be extended a minimum of two full sections outside the clear zone. The leading end of PB does not need to extend beyond the clear zone if shielded by another run of overlapping PB, permanent concrete barrier, or fully anchored guardrail (with anchor assembly). However, the PB shall extend/overlap at least 50' with 3' offset from another run of overlapping PB, permanent concrete barrier, or fully anchored guardrail (with anchor assembly). Connections or field transitions to guardrail are not crashworthy and are not permitted. Abutting or connecting PB to permanent concrete barrier or parapets is non-standard and requires special anchoring and design details. See Traffic SCD **MT-101.80** for design guidance for transitioning portable concrete barrier (does not pertain to portable steel barriers) to permanent concrete barrier. See Roadway SCD RM-4.2 for design guidance for transitioning an F-Shape portable barrier run between anchored and unanchored portions.

For acceptable flare rates for PB, see L&D Manual Volume 1, **Figure 602-1** and the SCDs.

See ***Section 620-2*** for information on Materials and Hardware Safety Criteria requirements.

608 INCIDENT MANAGEMENT

608-1 General

Traffic incidents are unpredictable, unique occurrences which restrict traffic flow. They are unplanned events such as emergencies and crashes, and each must be addressed individually. Effective incident management can help to increase safety at an incident scene, reduce costs associated with incidents and quickly restore traffic to its original flow.

OMUTCD **Chapter 6I** and ***TEM Chapter 608*** describe various incident management tools that can be effective in handling different types of incidents. Typically, each incident will require a unique approach and solution.

ORC Section 4511.21(H)(3) allows the **Director** to establish a Variable Speed Limit that is different from the established speed limit for traffic incidents that occur on all or portions of I-670, I-275 and I-90 (at the intersection with I-71 and continuing to the Ohio-Pennsylvania border). Contact the office of **TSMO** for additional information.

608-4 Permitted Lane Closure Schedule (PLCS)

The **Permitted Lane Closure Schedule (PLCS)** should be evaluated for every incident on Interstates, freeways/expressways, system ramps and other major multi-lane roadway segments. For more information on the **ODOT PLCS** see ***Section 630-4***. The **PLCS** is available on the **ODOT** website. Ideally, such schedules would be established for all highways to manage delays due to incidents and recurring congestion. Additional benefits of using **PLCS** requirements include reducing exposure of fire personnel, EMAs, law enforcement, and other responders to traffic hazards, and reducing the danger of secondary crashes to the public. Priority should be given to **PLCS** segments for all types of incidents, including crashes and diesel spills. It may not be possible to expedite the opening of **PLCS** segments for every incident (for example, some hazardous material (HazMat) incidents and unusual circumstances). However, all agencies should make every effort to follow the protocols and attempt to open lanes as soon as possible, particularly in order to adhere to **PLCS** closure restrictions.

608-6 Hazardous Materials (HazMat)

Currently, **ODOT** is developing procedures for HazMat spills. Although HazMat incidents constitute a small percentage of the incidents occurring on Ohio's roadways, they are responsible for a large portion of the delay. Several endeavors are underway to address these incidents. At this time, **ODOT** is to contact a contractor or HazMat Team to perform the cleanup.

608-7.2.5 Documentation

As noted in ***Section 608-3***, it is important to log traffic incidents. The **ODOT** HT or FSP staff who responds to a diesel spill incident shall document the incident. Some **Districts** may choose to use existing documentation for this and some may create a special diesel spill response form. For recommendations, contact the Office of **TSMO**. The information collected shall be as complete as possible for each spill addressed by **ODOT** and shall be maintained in a **District** file. The information listed below should be documented for each spill.

- Time/date.
- Location (Roadway, County, milepost location).
- Estimated amount of diesel on roadway.
- Weather conditions.
- Responders on site (ODOT, OEPA, etc.).
- Name of trucking company.
- License plate number.
- Driver's name.
- Fire/Police incident number.
- Time/Date on and off site.
- Information for cost recovery (material used) – type and amount.

Any reporting and documentation required by **OEPA** should also be followed. See the OEPA homepage for more information.

620-3 Retroreflective Sheeting

Faces of construction signs shall be Type IV, IX, or XI retroreflective sheeting complying with C&MS 614.03. Except for Warning Signs used in incident management areas, the background color of all construction Warning and Guide Signs shall be fluorescent orange as per C&MS 614.03. For information regarding retroreflective sheeting on other signs, see ***Section 220***.

For Warning Signs in incident management areas, the background color may be fluorescent pink.

Guidelines for retroreflective sheeting quality are provided in ODOT's Quality Guidelines for Temporary Traffic Control Devices ***(Section 695-4)***.

630-4 Permitted Lane Closure Schedule (PLCS)

Lane closures on Interstate and other freeways and expressways shall meet the minimum criteria presented in **Policy 21-008(P)** ***(see Section 601-2)***.

On the basis of this policy, **ODOT** developed a series of lane closure schedules. These schedules indicate the minimum number of lanes that shall remain open (MLO) during each half hour at a subject work zone location. Maintenance of Traffic (MOT) plans shall be in conformance with the permitted lane closure schedule (PLCS). However, as discussed in the policy, exceptions may be permitted, based on results of a queue length study or by exception request. ***(see Section 601-2)***.

If it is found that lane-closure requirements cannot be met at a reasonable cost for the subject work zone, the **District** has the option of applying for an exception or modification of the lane closure restrictions at the site. If such exception is not approved, the maintenance of traffic plans shall be revised to meet the requirements of the PLCS.

In February 2024, ODOT transitioned to a new PLCS system along with implementing a related new Plan Note. Plans **not yet** completed with Stage 2 (and design build scopes **not yet** filed with Central Office) by 3/1/2024 shall be revised to conform to the new PLCS system (and Plan Note). For plans that **have** completed Stage 2 (and design build scopes that **have** filed with Central Office) by 3/1/2024, Districts may (except as indicated below) use their discretion on choosing to revise the plans to comply with the new PLCS system (and Plan Note) from the former PLCS system based on the impacts and plan changes that would be required. However, any plan that has finished design and "shelved" but has not been filed with Central Office by 12/31/2024 shall be revised to conform to the new PLCS system (and Plan Note) before the project can be filed with Central Office. All other ODOT related operations (maintenance, etc) that occur on 3/1/2024 or later shall comply with the new PLCS system; Districts may use their discretion on deciding if an earlier districtwide transition date (after system roll out) is used for these operations.

The **PLCS** is available on the ODOT website.

See **Plan Note 642-18** in ***Chapter 642***. for further details, including when the **Plan Note** shall be added to plans.

640-5.2 Provisions for Use of Shoulders

When a shoulder is to be used as a traffic lane certain provisions shall be made:

1. Lane width, in accordance with ***Section 640-2***, shall be maintained. This may require widening the existing shoulder.
2. The designer shall evaluate the strength of the shoulder and consider strengthening it or replacing it with temporary pavement.
    a. Shoulders used for maintaining traffic, which are determined to be of insufficient strength, should be completely removed and replaced in accordance with the requirements of L&D Manual Volume 1, ***Section 301.2*** and the Pavement Design Manual ***(see TEM Section 194-9)***.
    b. Shoulders used for maintaining traffic, which are determined to be structurally sufficient, should also provide smooth travel. Provisions should be made to recondition shoulder surfaces that are rutted, raveled or otherwise insufficient.
3. The designer shall examine structures to ensure that sufficient width and height are maintained.
4. The designer should evaluate the roadside for obstacles which may require protection. Temporary protection may be required at obstructions that were not previously protected.

During any sequence of operations where traffic is to be maintained within 2 feet of the edge of the paved shoulder, the graded shoulder area adjacent to the paved shoulder should be strengthened. Item 411 aggregate placed a minimum of 6 inches deep, or a composition with similar structural characteristics, should be specified for 2 feet beyond the edge of the temporary traveled lane. This treatment should be placed in conjunction with final graded shoulder treatments when such shoulder use is required on final surface course pavements. This treatment may be left in place. When included, these items shall have separate notes and/or details as well as separate pay items.

Part-width use of shoulders may be required when either work or channelizing devices encroach upon the traveled lane adjacent to the shoulder.

640-13 Capacity

640-13.1 General

Capacity restrictions shall be evaluated for each project. The capacity criteria below have been developed to assist in identifying when traffic volumes may cause delays and/or backups during construction phases.

1. On two-lane highways where the ADT is greater than 6,000 (two-way) or where the peak hour traffic is greater than 600 vph (two-way).
2. On multi-lane non-freeway/non-expressways (more than two lanes, divided or undivided) where the directional ADT is greater than 14,000 per lane of traffic being maintained, or where the peak hour traffic is greater than 1,400 vph per lane of traffic being maintained.
3. On freeways and expressways, where lane closures do not meet the minimum criteria presented in the Permitted Lane Closure Schedule (PLCS), discussed in ***Sections 601-2 and 630-4***. Development of the **PLCS** is based on a simplified capacity calculation based on the Highway Capacity Manual (2010).

When the capacity criteria is exceeded, the Procedures set forth in **ODOT Policy 21-008(P)** shall be followed. Mitigation measures should also be considered in preparing Maintenance of Traffic Plans. These include re-sequencing construction to allow additional lanes to be used, use of shoulders as traffic lanes, temporary pavement, providing additional advance Warning Signs, use of alternate routes and corresponding signing, use of Portable Changeable Message signs or detours, Work Zone Intelligent Transportation Systems, and night work.

If there is a need to deviate from the **PLCS** provided for a specific location, the Lane Closure Queue Analysis Tool, discussed in ***Section 640-13.2***, shall be used.

640-29.3 Work Zone CCTV

When an MOT setup contains either narrowed lanes with limited shoulders, a contraflow configuration, limited access for Incident Management, or expectation for an increase in incidents, the project should consider adding temporary work zone cameras for incident monitoring. Coordination shall be done with both the Office of TSMO - ITS Section and the TMC. See Section 1303-4 for more information about CCTV cameras.

641-14 Lane Closure at Entrance Ramp (MT-98.10 and 98.11)

Traffic SCDs **MT-98.10** and **98.11** generally address lane closures in the vicinity of entrance ramps. **MT-98.10** applies primarily to major reconstruction work, where the work extends beyond the acceleration lane, upstream and downstream on the mainline and upstream on the ramp. **MT-98.11** applies to isolated work areas located primarily on the mainline, in the through lane adjacent to the acceleration lane of the entrance ramp.

Each of these **SCDs** includes separate details drawings. Work location determines which detail is used.

Traffic SCD **MT-95.30**, which pertains to lane closures on the mainline, shall be used as a companion drawing whenever **MT-98.10** or **98.11** is used.

The designer should exercise care when using **MT-95.30** in the area of an entrance ramp. The placement of signs for closing the right lane contained in **MT-95.30** may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition exists, the designer shall provide positive guidance for the road user. This may involve showing the exact placement of all signs and tapers noted in **MT-95.30** within both interchanges on a separate drawing, rather than relying on the **SCD**.

If the paved shoulder must be used to achieve minimum lane width, it may require that the shoulder be reconstructed or strengthened to accommodate the additional load. A separate sheet would be required in the plan detailing the shoulder work.

In order to work on an entire entrance ramp, it will be necessary to use both detail drawings from the applicable SCD. Traffic operation under the detail shown on the second page of each of these drawings may be significantly restricted, and poorer operation can be anticipated. Therefore, the design and project implementation should attempt to do as much of the work as possible using the detail shown on the first page of each of these SCDs. This should minimize the time and traffic restrictions involved when the work area is as shown in the detail on the second page of the drawing. Consideration should be given to providing temporary pavement to locate the merge/shift area in the first detail shown at a point downstream, which will then allow for adequate acceleration distance to be provided when the work area shifts and the second detail is used.

Adequate decision sight distance should be provided where possible. See ***Section 607-15*** and Table 697-8. If adequate decision sight distance cannot be provided, this should be documented, explaining the reason for non-compliance. Consideration should also be given to closing the ramp.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614 Class I markings** shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or

other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See OMUTCD **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Lane Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I, (By Width), (By Type)	Feet

641-15 Lane Closure at Exit Ramp (MT-98.20 and 98.21)

Traffic SCDs **MT-98.20 and 98.21** generally address lane closures in the vicinity of exit ramps. **MT-98.20** addresses lane closures using drums. **MT-98.21** addresses lane closures using portable barrier (PB). **MT-98.21** also addresses the use of impact attenuators in the exit gore. Otherwise, both drawings are basically the same.

Each of these SCDs includes separate details drawings. Work location determines which detail is used.

Where the impact attenuator is intended to apply to two **NCHRP 350** portable concrete barriers within the gore, one from the mainline and one from the ramp, the two **NCHRP 350** portable concrete barriers shall be joined to form one unit using a PCB "Y" connector segment. See the Roadway Plan Insert Sheet for details on this PCB "Y" connector segment. This insert sheet shall be provided in the plans. When using steel barrier or MASH portable concrete barrier, a double wide attenuator shall be used instead of a "Y" connector.

Traffic SCDs **MT-95.30** and **95.40**, which pertain to lane closures on the mainline, shall be used as companion drawings to **MT-98.20** or **98.21**, respectively.

The designer should exercise care when using Traffic SCD **MT-95.30** or **MT-95.40** in the area of an interchange immediately upstream of the work site. The placement of signs shown in **MT-95.30** or **MT-95.40** for closing the right lane may overlap an upstream ramp and confuse road users as to whether the ramp is open or closed. When this condition exists, the designer shall provide positive guidance for the exiting road user. This may include showing the exact placement of all signs and tapers noted in **MT-95.30** or **MT-95.40** within both interchanges on a separate drawing, rather than relying on the **SCD**.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. The designer should check the speed of any proposed Advisory Exit or Ramp Speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

The opening to the ramp shall have a minimum length of 200 feet. Within this space, the exiting vehicle must shift laterally to enter the exit ramp. Based on the **1985 Highway Capacity Manual**, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour. Consideration should be given to providing temporary pavement at the upstream end of the deceleration lane for use in the second detail of each of these **SCDs** if necessary in order to provide adequate ramp openings.

Traffic SCDs **MT-98.20** and **98.21** show an opening of 420 feet each, which is associated with a 70 miles per hour exiting speed. Openings longer than 420 feet should be used whenever conditions permit. When conditions will not allow a 420 foot opening, shorter values (but not less than 200 feet) may be used. When shorter openings (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (W13-1) shall be provided.

See OMUTCD **Section 6C.08** and ***Section 602-5*** for a discussion of taper rates.

If the paved shoulder must be used to achieve minimum lane width on the ramp, as noted in **MT-98.20 and 98.21**, it may be necessary to reconstruct or strengthen the shoulder to accommodate the additional load. A separate sheet would be required in the plan detailing this shoulder work.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all Item 614 Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See OMUTCD **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Channelizing Line, Class I, (By Width), (By Type)	Foot
Item 614,	Work Zone Dotted Line, Class I, (By Width), (By Type)	Foot

641-16 Lane Closure in Deceleration Lane (MT-98.22)

Traffic SCD **MT-98.22** addresses closure of the deceleration lane, with an opening located near the gore to provide access from the freeway/expressway to the ramp.

The opening to the ramp shall have a minimum length of 200 feet. Within this space, the exiting vehicle must shift laterally to enter the exit ramp. Based on the **1985 Highway Capacity Manual**, maximum capacity, regardless of design speed, occurs at a speed of 30 to 35 miles per hour. Below this speed, the freeway/expressway will experience unstable flow and capacity will decrease. Therefore, to avoid premature unstable flow and keep the facility at maximum capacity, all design elements on the freeway/expressway must meet or exceed an operating speed of 30 to 35 miles per hour.

Traffic SCD **MT-98.22** shows an opening of 420 feet each, which is associated with a 70 miles per hour exiting speed. Openings longer than 420 feet should be used whenever conditions permit. When conditions will not allow a 420 foot opening, shorter values (but not less than 200 feet) may be used. When shorter openings (associated with a speed at least 10 miles per hour less than the posted speed) are used, Advisory Speed signs (W13-1) shall be provided. See OMUTCD **Section 6C.08** and ***Section 602-5*** for a discussion of taper rates.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. The designer should check the speed of any proposed advisory Exit or Ramp Speed signs to avoid contradictory speed postings with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

Advance Warning Signs should be placed in locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use OMUTCD **Table 6C-1** to determine dimensions A, B and C.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I, (By Width), (By Type)	Foot

641-17 Typical Lane Closures for Ramps (MT-98.28 and 98.29)

Traffic SCD **MT-98.28** shall be used when work along an exit ramp leaves at least one lane open to ramp traffic.

The SCD includes two separate details drawings. Work location determines which detail is used. The first is intended for use when the work is in the inside portion of the ramp curve, with traffic to be routed along the outside portion of the curve. The second is intended for use when the work is in the outside portion of the ramp curve, with traffic to be routed along the inside portion of the curve.

Traffic SCD **MT-98.29** shall be used when work requires that the exit ramp be entirely closed.

Advisory Exit or Ramp Speed signs may exist at interchanges along the deceleration lanes or across from the exit gores. When the ramp will remain open, the designer should check the speed of any proposed advisory exit or ramp speed signs to avoid contradictory speed posting with existing signs. Where conflicts exist, the existing signs should be covered or removed. The proposed signs, when compared to the existing signs, should always provide a lower or equal advisory speed.

When **MT-98.29** is included in plans, treatment of the permanent Guide Signs in accordance with the guidelines for Advance Work Zone Information Signs shall be considered. The need for a detour and related signing must also be addressed.

Advance Warning Signs should be placed in such locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use OMUTCD **Table 6C-1** to determine dimensions A, B and C.

The following items would normally be included with the lump sum bid for **Item 614 Maintaining Traffic**: Signs, Cones, Drums and Warning Lights.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for three days or longer, all **Item 614** Class I markings shall be provided. If the markings are to remain for less than three days, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See **OMUTCD Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I, (By Width), (By Type)	Foot

641-32 Typical Closures at Entrance Ramp and Turn Bay Closures (MT-98.30)

Traffic SCD **MT-98.30** shall be used when work requires that the entrance ramp be entirely closed.

The SCD includes two separate details drawings. Lane configuration of the intersecting street determines which detail is used. The first is intended for use when the intersecting street has a dedicated turn lane to the entrance ramp. The second is intended for use when the intersecting street has a drop lane directly to the entrance ramp.

Treatment of the permanent Guide Signs and Lane Control Signs shall be considered. The need for a detour and related signing must also be addressed.

Advance Warning Signs should be placed in such locations that provide adequate sight distance for the existing vertical and horizontal roadway alignment. Use Table I to determine dimensions A, B and C.

Quantities for work zone pavement markings shall be provided in the plans. If the markings are to remain for more than three days, all Item 614 Class I markings shall be provided. If the markings are to remain for three days or less, consideration may be given to eliminating edge lines if the lines are represented by drums or other acceptable forms of channelization. Additional reduced marking at specific locations may also be appropriate. See OMUTCD **Section 6F.78** and ***TEM Subsection 605-11.11***.

The following items shall be shown as separate quantities in the plans, when required:

Item 614,	Work Zone Edge Line, Class I, (By Width), (By Type)	Mile
Item 614,	Work Zone Dotted Line, Class I, (By Width), (By Type)	Foot

642-18 Permitted Lane Closure Schedule (PLCS)

Lane closure(s) shall conform to the PLCS. Published **PLCS** information can be found on the **ODOT** website. Lane closure(s) shall not be permitted on the following highways when an applicable schedule is not published: Interstates (Functional Classification 1), other freeways and expressways (Functional Classification 2), multilane mainline ramps, and multilane system ramps.

The monthly published schedules required to be used, for each **PLCS** segment within the project area, are those that comprise the consecutive 12-month period beginning 15 months prior to the month and year of sale and ending 4 months prior to the month and year of sale. These same 12 months apply for the life of the project and shall be applied to each respective month of construction (month of lane closure(s) shall match month of **PLCS** used). Lane closure(s) in place for multiple months shall always comply with the current respective PLCS month.

(FOR EXAMPLE: If the sale date for the project was March of 2021, the monthly published schedules for each applicable **PLCS** segment would be December 2019 to November 2020. If this was a three-year project, year three would still be using the December 2019 to November 2020 monthly schedules. If the project desired to close two lanes in June 2021, reference would be made to the June 2020 schedule(s) for the respective **PLCS** segment(s). If the same two lanes were desired to be closed again in July 2021, reference would be made to the July 2020 schedule(s) for the respective **PLCS** segment(s).)

More restrictive changes to the allowable lane closure hours are at the discretion of the Engineer in order to comply with the Traffic Management in Work Zones Policy (21-008(P)) and Standard Procedure (123-001(SP)).

Less restrictive changes to the allowable lane closure hours are subject to the Traffic Management in Work Zones Policy (21-008(P)) and Standard Procedure (123-001(SP)) and shall not be implemented until, and unless, approved by the proper **ODOT** authority. [Existing MOT Exceptions that have already been approved in accordance to the Traffic Management
in Work Zones Policy and Standard Procedure are detailed in the Approved Maintenance of Traffic (MOT) Policy Exception(s) plan note.]

Except as directed in the first paragraph of this plan note, allowable lane closure hours for facilities and/or lane closure scenarios not covered by the PLCS, if any, shall be as specified elsewhere in the plans.

Designer Notes:

This **Plan Note** shall be included in the plans for all projects on an Interstate, other freeway or expressway, multilane mainline ramp or multilane system ramp. This **Plan Note** shall also be included in the plans for all projects on other highways with one or more roadway segments or ramps covered by the PLCS.

For projects that will have an advertisement period longer than 3 months, incrementally increase both the 15- and 4-month end points in the second paragraph by the number of additional months of advertisement.

The second to last sentence of the **Plan Note** (the bracketed information) shall be included when applicable. **Plan Note 642-32** shall also be included in the plans if there are existing MOT Exceptions that have already received approval in accordance to the Traffic Management in Work Zones Policy and Standard Procedure.

For projects on a facility that are typically covered by the PLCS that will be adding a new lane, or otherwise creating more available through lanes than the preconstruction condition, contact the District Work Zone Traffic Manager (DWZTM) for the specific allowable lane closure hours that will additionally need included in the plans to address the period of time when the additional lane(s) initially open to traffic until the end of the project.

Separately identify and specify any applicable allowable lane closure hours for facilities not covered by the PLCS.

642-44 Worksite Traffic Supervisor

Subject to approval of the Engineer, the Contractor shall employ and identify (someone other than the superintendent) a prequalified Worksite Traffic Supervisor (WTS) before starting work in the field. The WTS shall be trained in accordance with CMS 614.03, shall have successfully completed ODOT administered WTS testing (and re-testing when applicable) and be listed on the ODOT prequalified WTS roster. Prequalification expires every 5 years. Re-testing shall be successfully repeated every 5 years to remain prequalified.

The name of the prequalified WTS and related 24-hour contact information shall be provided to the Engineer at the preconstruction conference. If the designated WTS will not be available full time (24/7), the Contractor may designate an alternate (secondary) WTS to be available when the primary is off duty; however, the primary WTS shall remain the point of contact at all times. Any alternate (secondary) WTS is subject to the same training, prequalification and other requirements outlined within this plan note. At all times the Engineer, or Engineer's representatives, must be informed of who the primary WTS (and secondary WTS, if applicable) is at the current time.

The WTS position has the primary responsibility of implementing the Traffic Management Plan (TMP), monitoring the safety and mobility of the entire work zone, and correcting Temporary Traffic Control (TTC) deficiencies for the entire work zone. The WTS, and alternate WTS when on duty, shall have sufficient authority to effectively carry out the identified WTS responsibilities and duties. The duties of the WTS are as follows:

1. Be available on a 24-hour per day basis.
2. Be on site for all emergency TTC needs within one hour of notification by police or project staff, and effect corrective measures immediately on existing work zone TTC devices.
3. Attend preconstruction meeting and all project meetings where TTC management is discussed.
4. Be available on site for other meetings or discussions with the Engineer upon request.
5. Be aware of all existing and proposed TTC operations of the contractor, subcontractors and suppliers, and ensure coordination occurs between them to eliminate conflicting temporary and/or permanent traffic control.
6. Coordinate project activities with all Law Enforcement Officers (LEOs). The WTS shall also be the main contact person with the LEOs while LEOs are on the project.
7. Coordinate and facilitate meetings with ODOT personnel, LEOs and other applicable entities before each plan phase switch to discuss the work zone TTC for implementing the phase switch. Submit a written detail of MOT operations and schedule of events to implement the switch between phase plans to the Engineer 5 calendar days prior to this meeting.
8. Be present, on site for, and involved with, each TTC set up/take down and each phase change in accordance with CMS 614.03.

9. On a continual basis ensure that the TTC zone and all related devices are installed, maintained and removed in compliance with the contract documents.

10. On a continual basis facilitate corrective action(s) necessary to bring deficient TTC zones and all related devices into compliance with contract documents in the timeframe determined by the Engineer.

11. Inspect, evaluate, propose necessary modifications to, and document the effectiveness of, the TTC devices and traffic operations on a DAILY BASIS (7 days a week). In addition, perform one weekly night inspection of the work zone setup for daytime work operations; and one daytime inspection per week for nighttime projects. This shall include (but not be limited to) documentation on the following project events:

a. Initial TTC setup (day and night review).

b. Daily TTC setup and removal.

c. When construction staging causes a change in the TTC setup.

d. Crash occurrences within the construction area and within the influence area(s) approaching the work zone.

e. Removal of TTC devices at the end of a phase or project.

f. All other emergency TTC needs.

12. Complete the Department approved (CA-D-8) within GoFormz after each inspection as required in # 11 and submit it to the Engineer by the end of the workday in which the inspection occurred. The CA-D-8 includes a checklist of all TTC maintenance items to be reviewed. Contact GoFormz.Help@dot.ohio.gov to obtain a user account. Any deficiencies observed shall be noted on the CA-D-8, along with recommended or completed corrective actions and the dates by which such corrections were, or will be, completed. A copy of the current CA-D-8 document can be found on the Office of Construction Administration's Inspection Forms website.

13. Have copies of the contract documents available at all times on the project.

The Department will deduct:

A. The prorated daily amount of Item 614 Maintaining Traffic for any day in which the WTS fails to perform the duties set forth above. The prorated daily amount will be equal to the original bid amount for Item 614 Maintaining Traffic divided by the difference between the original completion date and the first day of work, in calendar days.

B. 1% of the original bid amount for Item 614 Maintaining Traffic for any day that a failure to perform WTS duties reoccurs or a TTC issue is identified in the field and is not corrected in the given timeframe per the Engineer. Deduction B shall not apply to situations covered by Deduction C.

C. 1% of the original bid amount for Item 614 Maintaining Traffic for any day that a lane or ramp is blocked (fully or partially) without TTC, as determined by the Engineer. This deduction shall be in addition to any other disincentives established for unauthorized lane use.

For days in which more than one deduction listed above occur, the highest deduction amount will apply.

If three or more total days result in issues described in Deduction B or C above, the primary WTS (and any alternate WTS, if applicable) shall be immediately removed from the work in accordance with C&MS 108.05. Upon removal the Engineer shall notify ODOT Central Office (WTSPrequalification@dot.ohio.gov) to register a removal at the project level against the statewide prequalification for the primary WTS (and alternate WTS, if applicable). Accumulation of three project level removals (from any projects statewide) shall cause statewide disqualification for any formerly Prequalified WTS. A WTS (and alternate WTS, if applicable) may be immediately and concurrently removed from the work at the project level in accordance with C&MS 108.05 and disqualified statewide from the ODOT prequalified WTS roster (regardless of the number of project level removals), as well as being subject to other potential consequences, in cases of falsified, dishonest or otherwise unethical activity or documentation.

Payment for the above requirements, responsibilities and duties shall be included in the lump sum price bid for Item 614, Maintaining Traffic.

Designer Note: The Worksite Traffic Supervisor note shall be used on Interstate and Interstate look-alike projects that include: contraflow, one-mile long crossover(s), multi-year work duration, or significant continuous impact to mainline traffic (e.g., reduced shoulder and/or lane widths, closed ramps, etc.). While not intended for use with resurfacing projects, this note may be considered for use when complex maintenance of traffic issues are anticipated.

695-2 Temporary Traffic Control Manual (reprint of OMUTCD Parts 1, 5 and 6)

Former OMUTCD **Parts 1, 5 and 6** (2012 version and earlier) had been compiled as a separate document to provide a convenient reference of this information. The book was titled the "Temporary Traffic Control Manual"; however, it was also known as the Construction Manual or the Orange book, since it historically had an orange cover.

This former publication has been superseded by the release of the updated OMUTCD (Federal MUTCD plus Ohio Supplement) in January 2026. The Temporary Traffic Control Manual (TTCM) publication has been discontinued.

Archived copies of this former manual are available for viewing or downloading electronically online from the TTCM website.

701 SCHOOL ROUTES AND ESTABLISHED SCHOOL CROSSINGS

As noted in **OMUTCD Section 7A.02**, it is important to have a uniform approach to school area traffic controls. A School Route Plan Map can be useful in identifying recommended walking routes to school. **OMUTCD Section 7A.02** and Figure 7A-1 also address school route plans.

Currently, the Safe Routes to School Program is coordinated by the **Office of Systems Planning & Program Management**, and information about this program, including the School Travel Plan guidelines, can be accessed on-line.

702-3 School Speed Limit Signs

A School Speed Limit sign is a regulatory traffic control device (see **OMUTCD** Section 7B.05). It may be a passive device (sign only) or an active one (sign with Speed Limit Sign Beacons). However, when used in conjunction with an active SCHOOL ENTRANCE sign assembly (***see Section 702-5***), an active School Speed Limit Sign with Flashing Beacons ***(see Section 702-4)*** should be used to help clarify when the 20 mile per hour requirement is in effect. New or replaced School Speed Limit Signs with Flashing Beacons should be solar powered to ease maintenance and utility requirements.

702-4 School Speed Limit Sign with Flashing Beacons

702-4.1 General

A School Speed Limit Sign with Flashing Beacons is an active device which consists of a School Speed Limit sign with Speed Limit Sign Beacons (a pair of alternately flashing yellow beacons), and may have an illuminated "20." Further details about the beacons are addressed in **OMUTCD Sections 7B.05, and 4S.04**.

Section 702-6 addresses the division of responsibilities and duties related to installation, operation and maintenance of these devices.

For more details, see SCD TC-87.20.

702-4.2 School Speed Limit Sign with Rear-Facing Beacon

A rear-facing beacon is a single yellow flashing beacon that must be installed on the back of a School Speed Limit sign equipped with forward-facing beacons. The rear-facing beacon notifies road users that the forward-facing beacons are operating (especially if there is an intersection or access point within the school zone) and reinforces the location of the end of the school zone.

The rear-facing beacon shall conform to **OMUTCD Section 4S.04**, and an END SCHOOL SPEED LIMIT (S5-3) sign (**OMUTCD Section 7B.05**) shall be mounted with it, supplementing the right-hand mounted END SCHOOL SPEED LIMIT sign.

The rear-facing beacon shall only operate when the forward-facing beacons are operating.

702-5 SCHOOL ENTRANCE Sign (S3-H3)

A SCHOOL ENTRANCE sign (S3-H3) may be used to help identify a school entrance and/or driveway where there is poor sight distance or a fairly large volume of traffic entering or exiting the driveway. It may be a passive device (sign only) or an active device (sign with flashing yellow warning beacon(s)). When the traffic is seasonal, the sign should be removed, folded or covered during the period the entrance is not in common use.

When supplemented with one or two flashing yellow warning beacons (**OMUTCD 4S.03**), this sign can be used to provide advance warning of the location and the related traffic at times when the School Zone speed limit is not in effect.

SCHOOL ENTRANCE signs may be either ground or overhead mounted. When supplemented with beacons, the sign is operated either manually, or by a timer, usually programmable, which is typically located in a cabinet on the highway right-of-way, or alternatively off the highway right-of-way in the school building.

Although this sign is not shown in the **OMUTCD**, it can be found in the **Sign Designs and Markings Manual (SDMM)**.

Section 702-6 addresses the division of responsibilities and duties related to installation, operation and maintenance of these devices.

702-7 School Bus Stop Ahead Sign (S3-1); SCHOOL BUS TURN AHEAD Sign (S3-2)

As noted in **OMUTCD Sections 7B.04**, these signs should be used in advance of locations where a school bus, when turning or stopped to pick up or discharge passengers, is not visible for an adequate distance in advance. **Ohio Administrative Code Section 3301-83-13 B(4)** states, "School bus stops shall be located at a distance from the crest of a hill or curve to allow motorists traveling at the posted speed to stop within the sight distance. If the line of sight is less than five hundred feet in either direction, an approved "School Bus Stop Ahead" sign shall be installed at least five hundred feet in advance of the school bus stop."

To avoid unnecessarily perpetuating these signs, a procedure should be established in each **District** whereby a record is kept when these signs are erected, documenting the location and date of the installation. This record should be checked regularly to assure that there is still a need for the sign. Form 796-3 depicts a sample letter used to have the schools annually reaffirm the need for these signs and/or to request signs for a new location.

801-2.2 Application Process for STOP Sign Exemption

Except as noted in ***Subsection 801-2.1*** for the interim statewide changeover program, if an LHA desires an exemption from the placement of STOP signs, the LHA shall submit a written request to the District. The **District** shall review the request and forward it with recommendations to the **Office of TSMO**. **OTSMO** shall review the STOP sign exemption request with the **District** and the **Ohio Rail Development Commission (ORDC)**. **OTSMO** will make recommendations to the **ODOT Director** and subsequently notify the LHA of the exemption status. When reviewing the exemption request the following should be considered:

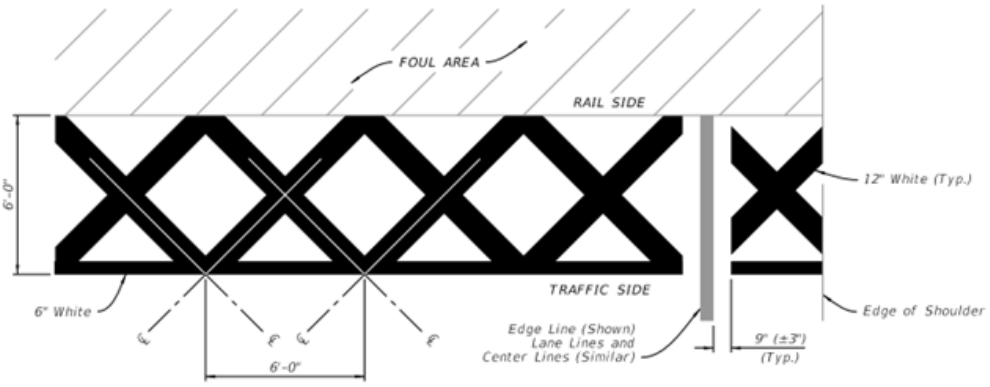
1. The existence and condition of traffic control devices near the crossing, and any potential conflicts and delays that may occur at nearby locations if a STOP sign is installed at the grade crossing, such as a queue of vehicles backing up into the intersection.
2. Cross-corner sight distances for both approaches to the crossing. Location and type of visual obstructions (check for permanent and seasonal obstructions). Can the driver adequately detect trains without coming to a stop?
3. Geometrics and approximate relative elevations.
4. Average daily traffic at the crossing (cars and trains). For example, without a compelling reason, STOP signs should not be used if there is less than one train per day. Also, STOP signs are generally impractical if the ADT is over 4,000 cars per day.

Highway-rail grade crossing locations on **ODOT**-maintained highways shall be evaluated using this same process and criteria.

802-3 Dynamic Envelope Marking with Cross-Hatching

When a **Diagnostic Team** determines that pavement markings are necessary to delineate the dynamic envelope at a highway-rail grade crossing, a dynamic envelope marking as shown in **MUTCD Figure 8C-3** should be used. Cross-hatching shall be included whenever a Dynamic Envelope marking is used to increase the visibility of the marking to approaching vehicles and to further indicate the need to keep the dynamic envelope clear.

The Dynamic Envelope Marking consists of a 6-inch white channelizing line as described in **C&MS 641.08** placed a minimum of 6-feet away and parallel to the nearest outside edge of rail at a highway-rail grade crossing. The Dynamic Envelope Marking also consists of 12-inch white diagonal markings arranged at 6-foot centers in a 6-foot by 6-foot "X" layout, as shown in Figure below. The Dynamic Envelope Marking is also illustrated in Traffic **SCD TC-71.10**.



Dynamic Envelope Marking with Cross Hatching

Unless otherwise noted in an Engineering Study conducted by a Diagnostic Team, the Dynamic Envelope Marking with Cross-Hatching should be accompanied by R8-8 "Do Not Stop on Tracks" signs installed per **MUTCD 8B.07**.

The quantity of Dynamic Envelope Crosshatch Markings will be measured by square footage and paid for by square foot.

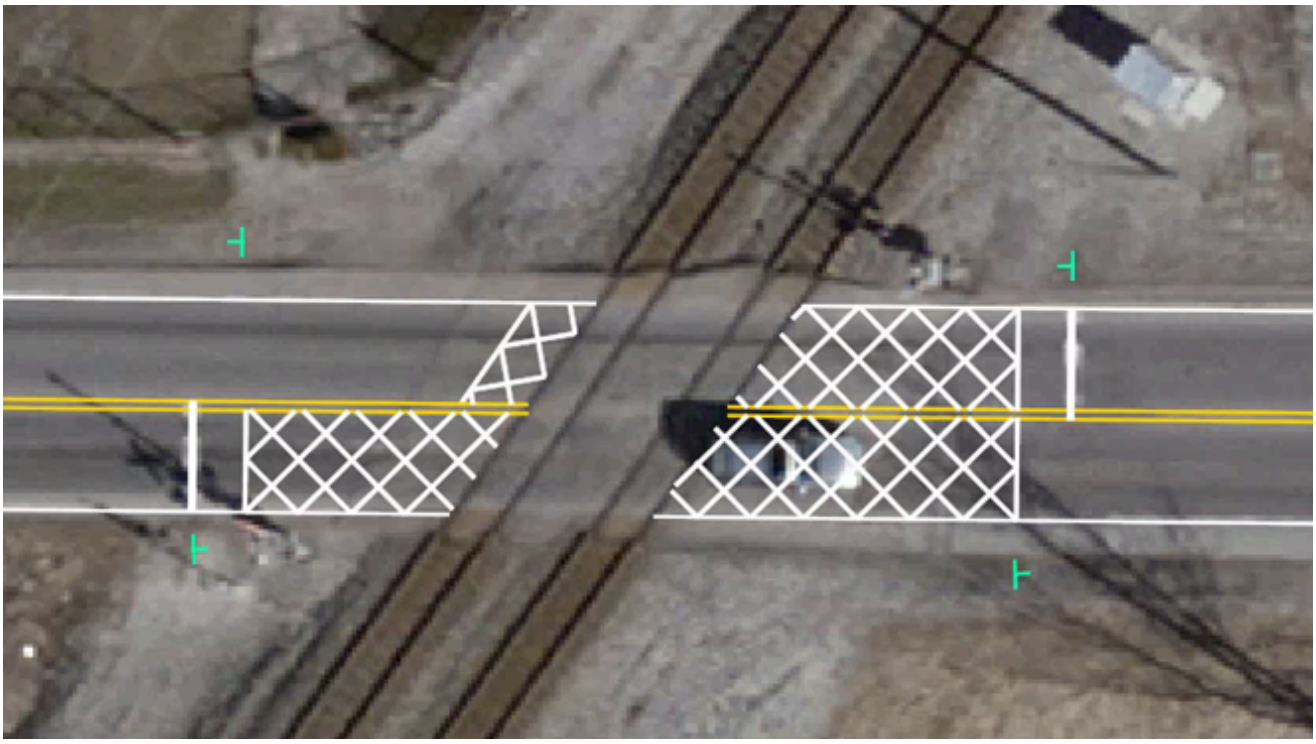
802-4 Do Not Occupy Crossing Marking

When a **Diagnostic Team** determines that pavement markings are necessary to delineate both the dynamic envelope at a highway-rail grade crossing and pavement that should be kept clear, a Do Not Occupy Crossing Marking should be used. The intent of the Do Not Occupy Crossing Marking is to identify pavement that vehicles are not permitted to occupy. The extent of the pavement subject to the Do Not Occupy Crossing Marking should be determined by the **Diagnostic Team** and documented in an **Engineering Study**.

At a minimum, the Do Not Occupy Crossing Marking consists of a 6-inch white channelizing line as described in **C&MS 641.08** placed parallel to and underneath the highway-rail grade crossing entrance gate (when in the active/down position) and downstream of the crossing and/or exit gate at a point determined by the **Diagnostic Team**.

Between the 6-inch channelizing marking and the nearest edge of rail, the Do Not Occupy Crossing Marking consists of 12-inch white diagonal markings arranged at 6-foot centers in a 6-foot by 6-foot "X" layout similar to that used for the Dynamic Envelope Marking with Cross-Hatching. Where there are no restrictions on pavement downstream of a highway-rail grade crossing, a Dynamic Envelope Marking with Cross-Hatching (see **802-3**) shall be used as the downstream marking.

The Figure below presents a typical example of the Do Not Occupy Crossing Marking.



Typical Application of Do Not Occupy Crossing Marking

White/Red Raised Pavement Markings (RPM's) shall be installed at 20 ft spacing along all edge lines, lane lines, and channelizing lines within the Do Not Occupy Crossing Marking and at least 100 ft upstream of the Do Not Occupy Crossing Marking unless otherwise determined by the **Diagnostic Team**.

Yellow/Red Raised Pavement Markings (RPM's) shall be installed at 20 ft spacing along center lines within the Do Not Occupy Crossing Marking and at least 100 ft upstream of the Do Not Occupy Crossing Marking unless otherwise determined by the **Diagnostic Team**.

When a Do Not Occupy Crossing Marking is used, the marking shall not overlap edge lines, lane lines, and center lines. Edge lines, lane lines, and center lines should be carried up to the outside edge of rail as shown in the Figure and per **MUTCD 8C.05**. The Do Not Occupy Crossing Marking layout is also illustrated in Traffic **SCD TC-71.10**.

Unless otherwise noted in an Engineering Study conducted by a Diagnostic Team, the Do Not Occupy Crossing Marking should be accompanied by R8-8 "Do Not Stop on Tracks" signs installed per **MUTCD 8B.07**.

The quantity of Do Not Occupy Crossing Markings will be measured by square footage and paid for by square foot.

804-4.4 Traffic Signal Controller Unit

The **Office of TSMO** shall maintain a list of approved traffic signal controllers for Railroad Preemption.

Refer to **TEM Part 4** for additional controller unit requirements.

Highway-Rail Grade Crossing Warning System Circuit Configuration and Timing Requirements

OHIO DEPARTMENT OF TRANSPORTATION
OHIO RAIL DEVELOPMENT COMMISSION

HIGHWAY-RAIL GRADE CROSSING WARNING SYSTEM INTERCONNECTION CIRCUIT CONFIGURATION AND TIMING REQUIREMENTS

Railroad(s): _____

DOT Crossing Number: _____ Date: _____

Crossing Name: _____

Issued By: _____ (Local Highway Authority)

This crossing warning system is proposed to be interconnected with an adjacent highway traffic control signal. In some cases, the warning system may be interconnected with two highway traffic control signals, usually one on each side of the grade crossing. The column for INTERCONNECT #2 circuits are only required if two railroads operate a single set of crossing gates.

The purpose of this document is to advise the railroad of the number of interconnection circuits required and the type and timing requirements of each circuit. This Form should be included as part of the Railroad Agreement for all projects. The railroad should refer to Chapter 804 of the ODOT Traffic Engineering Manual (TEM), Subsection 804-4 and standard drawing TC-86.10 for details concerning the requirements of the interface to be provided by the railroad.

TYPE OF INTERCONNECTION CIRCUIT AND TIMING REQUIRED	INTERCONNECT #1 RR: _____	INTERCONNECT #2 RR: _____
ADVANCE* (AP) (Note 1) (Y/N)		
SUPERVISED ADVANCE? (Note 1) (Y/N)		
SIMULTANEOUS (Note 1) (Y/N)		
GATE DOWN (Note 1) (Y/N)		
ISLAND (Note 1) (Y/N)		
GATE UP/APP** (Note 2) (Y/N)		
* Advance Preemption (AP) Time Per AREMA 3.3.10 (In Seconds) (Note 3)		
** Advance Pedestrian Preempt (APP) Time (In Seconds)		

Notes:

1. Typically Required per ODOT specs (see TC-86.10).
2. Typically Optional per ODOT specs.
3. Typically 50 seconds maximum Total Warning Time, per AREMA 3.3.10.

1101 District SYSTEM LIGHTING PLAN (DSLP)

Each **District** should develop and maintain a **District System Lighting Plan (DSLP)**. This is typically a GIS thematic map that uses a systematic approach to show both the **District's** existing and future highway lighting. The **DSLP** is a Planning tool and shall be maintained by each District even as **ODOT** develops Collector-Based Asset Management databases (see below). It is intended to provide for a uniform system and to improve maintenance efficiency with regard to factors such as partial, complete, conventional, high-mast and composite/hybrid designs. It allows the **District** to set priorities for the allocation of available funding for roadway lighting projects, and should be used as a guide in making Light B Don't Light decisions.

The **DSLP** is composed of county maps merged into a district-wide map. The twelve **DSLPs** make up a **Statewide System Lighting Plan (SSLP)**. Through the use of the **DSLP** and **SSLP** a consistent systematic treatment can be insured. Each **DSLP** database should be updated a maximum of every five years.

GIS requires a database made up of the existing physical inventory records. Suggested data and codes that should be used in the **DSLP** are shown in ***Tables*** 1197-1 ***and*** 1197-2, respectively.

There are a number of decisions to be made to create the **DSLP**. These decisions will involve not only the examination of each of the various intersections, interchanges and roadways in the highway system, with regard to the engineering merits of lighting that particular location, but they will also involve insuring equality of treatment of similar locations, prioritizing the planned changes, and forecasting the availability of resources.

1101-1 Collector-Based Asset Management Databases and Required Inspection Intervals

ODOT has implemented various "Collector Apps" to map and track field assets in a GIS database. Attributes and inspection/maintenance data are included, and in some cases, inspection and maintenance warnings and notifications are built into the app itself. Dashboards provide synoptic data presentations that are useful inputs to the DSLP.

At this time, the following lighting items have built-in required inspection intervals in the Lighting Collector App:

1. High Mast Towers- 8-year inspection interval.
2. Bridge-Mounted Light Supports- 8-year inspection interval. Bridge-mounted light supports are inspected annually by bridge inspectors as "Ancillary Structures," but the 8-year inspection should still be performed, especially for electrical items.
3. Median-Mounted Light Supports- 8-year inspection interval.

1103-6.9.5 Need for Tunnel Traffic Control and ITS Devices

NFPA 502 has requirements for traffic control devices to stop approaching traffic during certain events (e.g., a fire). This may include traffic control devices on the adjacent roadway network. Contact the **Office of Roadway Engineering** for assistance.

In addition, there is often a need for CCTV tunnel monitoring cameras and other devices requiring integration with **ODOT**'s ITS architecture, such as Dynamic Message Signs and Ramp Signals. Contact the **Office of TSMO - ITS Section** for assistance. Additional design information on traffic control and ITS devices is located in ***1140-4.6***.

1120-7 Arc Flash Labeling Requirements

The **National Electrical Code Article 110**, Requirements for Electrical Installations, requires that Arc Flash Hazard Warning markings be applied to many electrical enclosures. **ODOT Supplemental Specification 825** *ARC-FLASH HAZARD CALCULATIONS AND EQUIPMENT LABEL* is the construction item for such labeling. This item should be included for each lighting power service disconnect enclosure and all upstream enclosures on the customer end of the power service. Enclosures (including light towers) downstream from the main disconnect very rarely require arc-flash analysis.

It can be difficult for designers to decide which electrical enclosures will require **SS 825** during construction. The **ODOT District**, the **Office of Roadway Engineering**, and the **Office of TSMO** can provide assistance with this determination. The **Designer Notes of SS 825** also provide some useful guidance.

The arc flash label requirement of the NEC Art. 110 requires only a "generic" Warning marking, which does not need any site-specific electrical analysis. **ODOT SS 825** is intended to exceed this minimum NEC requirement by analyzing the subject enclosure and the electrical system feeding it. Based on this analysis, the **SS 825** label provides information to guide maintainers on the proper selection of PPE (Personal Protective Equipment) required for energized access to, or energized work within, that enclosure. **ODOT Standard Procedure 220-006(SP)** has additional Electrical Safety Procedure details, and the intent of SS 825 Arc Flash Labels is to satisfy this Procedure.

1130 PLANNING / PROGRAMMING

1130-1 General

The following sections are provided to assist planners and designers in developing standard uniform lighting systems. These sections discuss various aspects of lighting that shall be considered when planning new, or rehabilitating existing, lighting systems. The following are guidelines and are not meant to override a planner's engineering judgment.

1130-2 Programming of Projects

Before a lighting project is programmed, whether alone or in conjunction with a roadway project, a preliminary study should be completed. A preliminary study should include the following: Verifying that the project meets lighting warrants where available and is in conformance with the **DSLP** ***(Chapters 1101 and 1103)***; verifying what types of funding will be used ***(Section 1130-3)***; deciding what type of lighting is to be used ***(Chapter 1120)***; verifying who will maintain the system ***(Chapter 1102)***; and deciding what type of power supply is to be used ***(Section 1120-6)***. For temporary lighting see ***Part 6***.

1130-3 Funding Considerations

1130-3.1 General

The programming should specify all funding types used on the project. Federal funding for highway lighting is governed by **FHWA** policy (23 USC 120(C)). In general, highway lighting is eligible for Federal participation when warrants and criteria satisfy **AASHTO** and **ANSI** requirements ***(see Chapter 1106)*** and the project is on a Federal-aid highway system. There may also be occasional special programs involving Federal aid which require approval from offices other than the **Ohio Division Office of FHWA**. Under such circumstances, it is essential that requests for participation be initiated at the programming stage. State participation in lighting projects shall be as specified in ***Section 1130-4***.

1130-3.2 New Installation

If the proposed lighting system is in more than one funding jurisdiction, all agencies must agree in writing on their portion to be paid. For example, if an interchange that is to be lighted is within the boundaries of two incorporated areas, the funding would typically follow the corporation boundaries. If only a small portion of an

interchange is in an incorporated area, an attempt should be made in the design of the lighting to avoid placing any material or equipment within this area.

1130-3.3 Upgrade/Retro-fit

If the existing lighting system is in more than one maintenance jurisdiction, all agencies must agree in writing on their portion to be paid. Any changes in corporation limits from the original installation should be reflected in the funding split of the project and in the new maintenance agreement. It should also be remembered that lighting circuits do not necessarily stop at the project limits and therefore the project's lighting needs may be greater than expected if only the area inside the project limits is considered.

1130-3.4 Maintenance

If the existing lighting system is in more than one maintenance jurisdiction, each jurisdiction should have independent circuits that do not trespass into other jurisdictions. Each jurisdiction should have a separate control center. The maintenance agreements should be initiated in the planning stages.

1130-3.5 Project Lighting that is not used for Roadway Illumination

Examples of lighting construction items that are not used for roadway illumination but are often included in ODOT lighting plans are listed below. When any of these items are scoped or likely to be used in a project, contact the Office of Roadway Engineering for guidance during project planning, programming and design.

1. FAA Obstruction Lighting (see 1142)
2. USCG Navigation Lighting (see 1142)
3. Festoon Lighting (see HL-series SCDs)
4. Community Gateway Monuments (see ODOT Aesthetic Design Guidelines)
5. Landscape Lighting (see ODOT Aesthetic Design Guidelines)
6. Bridge Parapet and Abutment Slope Illumination (see ODOT Aesthetic Design Guidelines)
7. Major Bridge Aesthetic Lighting
8. Outdoor Power Pedestals for EV Charging Stations, Food Trucks, RVs, Boat Docks, etc. (Contact the Office of Roadway Engineering)

1130-4 State Participation

ODOT participation in highway lighting projects shall be as follows:

1. On limited-access highways and freeways, **ODOT** will participate in the cost of all lighting system items that are necessary to complete the lighting system. **ODOT** participation will be limited to the cost of a system to provide an average initial intensity in the range of 1.0 to 1.2 foot candles. If a system to provide

higher intensities is provided at the insistence of any political subdivision, the added cost of construction and maintenance resulting therefrom shall be borne by that political subdivision.

2. Existing lighting systems on crossroads and streets which cross limited-access highways and freeways without interchange facilities will be rearranged and/or replaced with similar styles and types of systems and equipment to provide a light intensity equal to that provided by the existing system. However, if the rearrangement of the existing road or street creates a need for a greater intensity for the safety of the traveling public, or requires changes in types and styles of system and equipment, modifications to the extent necessary to meet such need and requirements may be included subject to approval by the **Assistant Deputy Director of the Development Design Administration**.

3. On major improvements of existing highways within municipal corporations, existing lighting systems will be rearranged or replaced, if necessary, to restore light intensities to those previously existing, and in any event, to provide not less than the minimum average maintained intensity as recommended by **AASHTO** for expressways and highways, and for urban streets.

4. **ODOT** participation in the eligible costs of such construction, rearrangement, and replacement will be the same as **ODOT** participation in the other construction costs of the project.

5. **ODOT** will not participate in the cost of extensions and betterments to existing publicly-owned lighting systems included in the **ODOT** construction contract at the request of a municipality or other political subdivision.

1130-5 FAA Requirements

The programmer shall verify the location of the project in relation to all airports or heliports. If the project is within a 20,000 feet radius of a public-use or military airport or heliport, the programmer shall perform an Airway/Highway Clearance Analysis to determine if **FAA** notification is required **(see L&D Manual Volume 3, Section 1404.1)**.

1130-6 Aesthetic Lighting

Refer to the ODOT Aesthetic Design Manual.

Where a municipality desires to maintain aesthetic consistency for existing street lighting systems by using distinctive unit designs or by painting light poles, specific justification for such designs shall be submitted for **ODOT** approval before funds are authorized. In general, such justification must demonstrate that the municipality is not requesting funding for designs which exceed the official, published **City** standard, and that the distinctive design is used consistently through a reasonably large or historical area within the **City**.

1130-7 Maintenance Concerns

Prior to the programming of the lighting project, the programmer should verify that the **City** or **Village** will be able to maintain the lighting. Typically small **Cities** and **Villages** have lighting provided for and maintained by the local power company. Prior to the programming of a project to replace the existing utility-maintained lighting with **City** or **Village**-maintained lighting, **ODOT** should verify that the **City** or **Village** is capable of maintaining the proposed lighting or that they are willing to contract out the maintenance of the proposed lighting.

1130-7.1 Turnkey Lighting Design-Build-Maintain Model

Several companies (e.g., Musco and Acuity) offer various turnkey LED lighting design/build/maintain capabilities. These can be attractive for local agencies that are responsible for lighting ownership/maintenance and operation. Especially applicable to high mast lighting, the typical scenario often involves design, installation and a full-maintenance term (e.g, 10 years, extendable) that includes the photometric design, and the foundation, support, and luminaire installation (not the branch circuits). ODOT can participate in such projects, but the term maintenance portion of the contract cost must be paid by the local agency and does not count toward the LPA's construction cost split.

The chief engineering feature of these scenarios is the replacement of typical high mast luminaire and lowering device construction with a fixed crossarm type pre-aimed LED luminaire mount (i.e., lowering device is eliminated). The LED drive electronics, fuses, and surge-protective devices are all located at the base of the tower. Since nearly all LED luminaire maintenance tasks are associated with failures in these devices, there is no need for a lowering device, and any tasks requiring crane work at tower height are fully covered by the maintenance contract.

1130-8 Scope Preparation for Specific Projects

For each intersection, interchange and roadway affected by the project, the highway lighting should be described as it is to be upon the completion of the project. It should be stated whether the new lighting is to be part of the project or provided by others in conjunction with the project, including a statement that there is to no lighting at the particular intersection or interchange, or on the roadway section if that is the case.

1130-8.1 Always Check for Obsolete Power Service Voltage Configurations

ODOT and Local Agencies maintain some older lighting systems that were built with 480VAC, 2-wire, single-phase power service. This power service is considered obsolete by the National Electrical Safety Code (NESC) and will not be installed or updated by the Power Company. Therefore, all lighting projects that include power service with an existing 480VAC, 2-wire, single-phase service shall be scoped to include a change to the power service, usually to 240/480VAC 3-wire, single-phase service. Note that this reconfiguration of the power service usually requires additional work on the existing branch circuits and luminaires, such as pulling a new energized conductor through

all the lighting circuits. In addition, it often requires all luminaires to be replaced. This can create a large increase in construction cost compared to mistakenly specifying an in-kind replacement of the existing obsolete 480VAC, 2-wire, single-phase service.

Communicate this power service information to the Power Company and the District Utility Coordinator, because Power Companies often miss the presence of 480VAC, 2-wire, single-phase service during their plan review, and the resulting Change Orders during construction will cause significant delay and cost increases.

See 1120-6 and 1141-3.10 for information on power service and branch circuit voltage configurations.

Project Planners and Designers may contact the Office of Roadway Engineering for design assistance related to power service voltage configurations.

1140-4.6.7.2 Control Systems for Daylighting of Underpasses and Short Tunnels

Unless specified otherwise in the project scope, designers shall utilize a Photocell and Relay-Based Bank-Switching Control System. This system uses separate banks of luminaires for daylighting and night illumination, with relay switching between day and night circuits. The relays are controlled by a photocell. This is a simple, low-cost, and reliable control system that is easy to maintain. These photocell and relay-based systems are standalone (not interoperable) with no electronics, communications, or information processing, so they do not require 23 CFR 940 documentation to assure compatibility with an ITS Architecture (Ref. 23 CFR 940.3 Definitions).

More complicated control systems are available that use either bank switching or dimming of luminaires controlled by a Programmable Logic Controller (PLC) and light level sensors. These are usually commercial turnkey systems that are designed by the control system manufacturer and usually contain ITS elements such as remote communications that require 23 CFR 940 documentation for the project (see TEM Part 13 for 23 CFR 940 documentation requirements). The typical light level sensor of these more complicated systems is a luminance or illuminance sensor pointed at the entrance portal(s). Designers should not specify these systems and Contractors should not install them unless the project scope and Plans indicate their use. Owners should be aware that expensive and maintenance-intensive air conditioning must be provided for cooling the control enclosures of these systems. Such cooling is not required with Photocell and Relay Based Bank Switching Control Systems.

Daylighting control systems are operational during the day, so there is internal power dissipation within the electrical enclosure(s). Designers should carefully locate the control system enclosure(s) to keep them out of direct sunlight during daylight hours, to avoid overheating. Radiation shielding is required to reduce solar heating of the enclosure(s), as shown in SCD HL-40.20. Specify radiation shielding in the As Per Plan Note along with detail views or a reference to the methods shown in the SCD.

1140-4.6.8.1 Tunnel Lighting Design Guidance

Tunnel lighting design is done using luminance criteria (units of cd/m2) instead of the illuminance criteria (units of fc) typically used by **ODOT** for lighting design on open roadways. Designers should be aware that luminance-based tunnel design usually requires special software (e.g., AGi32™) not commonly used for open-roadway lighting design.

The following list includes specific design guidance for tunnel lighting design on **ODOT** projects. Contact the **Office of Roadway Engineering** for additional guidance.

A. An early step in tunnel lighting design is to obtain the required threshold luminance level (Lth). **RP-22** gives several methods for this in Part 6.4.

a. For short tunnels, the use of **RP-22** Part 6.4.1, which determines preliminary design Lseq and Lth values, will often be acceptable to **ODOT** as a final design value as well.

b. For long tunnels, the more involved **RP-22** Part 6.4.2 method of determining Lseq should be used. Essentially, the designer first calculates an equivalent veiling luminance (Lseq) for the general area seen by the driver approaching the tunnel under worst-case (bright sun) conditions. Next, Lth is obtained by multiplying Lseq by a ratio. The ratio value is determined by a subjective criterion known as the Safety Rating Number (SRN). Note that **ODOT** recommends the use of SRN = 5.

B. Long tunnels are rare in Ohio. However, if the tunnel is long, then following the threshold lighting zone will be one or more additional lighting zones of gradually decreasing design luminance values. **RP-22** Part 6.4.3 presents two methods for calculating the transition zone luminance values, either of which are acceptable to **ODOT**, but the Step-Down Method is preferred.

C. Choose the nighttime luminance levels per **RP-22** Part 6.4.5.

D. Some tunnels require switching steps that vary the internal luminance in response to the external luminance changes created by the weather and changes in the position of the sun. The following guidelines apply to **ODOT** projects:

a. Provide a PLC conforming to **ODOT** Supplemental Spec 818 for the control system.

b. Provide a control system enclosure conforming to **ODOT** Supplemental Spec 820. Locate the enclosure in an area that will not be in direct sunlight or provide a shelter, because the enclosure is passively cooled (unless active cooling is approved by **ODOT**). Provide all conduit entries with O-ring sealed hubs.

c. Obtain entrance portal measurements with one or more luminance meters compatible with the PLC inputs. An analog output is preferred, and this signal should be filtered and appropriately time-averaged at the PLC.

d. Dim tunnel luminaires using a 0-10VDC dimming signal obtained from the PLC. Buffer the signal as necessary. Provide a separate control signal for each zone.

E. Provide communications conforming to Supplemental Specification 809 for monitoring the tunnel conditions. The set of tunnel condition parameters that require remote monitoring will vary from project to project. Contact the **Office of TSMO - ITS Section**, for additional guidance.

a. The preferred method of monitoring tunnels that do not have fire alarm control panels is by CCTV. Unless the tunnel is short enough for the CCTV camera to see completely through, provide a CCTV camera at each entrance and exit portal.

b. For tunnels equipped with fire alarm control panels, coordinate with the **District** and any other authority having jurisdiction (**AHJ**) to determine communication requirements for the project. See also **NFPA 502**, **Part 4.5**.

F. If used, provide conduit bodies made of cast steel or malleable iron, with wedge-type malleable iron cover (not sheet steel), both triple-coated (electroplated or hot-dip zinc base coat, chromate intermediate coat, and epoxy finish coat), neoprene seal material, and all stainless steel hardware.

G. Provide metal conduit per **NFPA 502 Part 12.3.1**. If stainless steel conduit is not specified, provide Rigid Metallic Conduit per **ODOT CMS 725.04**. Exposed PVC conduit is not permitted in tunnels, per **NFPA 502 Part 12.3.2**.

H. Assure all electrical devices used in exposed areas are UL-Listed for Wet Locations.

I. Assure that all electrical and electronic devices in exposed locations operate over the following environmental conditions, within their respective enclosures:

a. Temperature: -30°F to +165°F.

b. Humidity: 0-100% RH.

J. Assure all circuit breakers are labeled for 100% load continuous use.

K. Do not locate luminaires or junction boxes directly under roof joints because the joints sometimes leak.

L. Provide LED tunnel lighting, emergency lighting and auxiliary lighting conforming to Supplemental Specification 813.

M. Assure that the lowest point of each conduit run is equipped with a conduit drain with a stainless steel screen, except drains located in areas subject to wash-down, which shall be rated NEMA 4X or IP66. Long horizontal conduit runs shall be equipped with such drains at a spacing not to exceed 50 feet and located on a short stub below the run.

N. Assure that each electrical pull box or manhole located above the tunnel level is equipped with a drain conduit routed to a suitable protected outlet location not subject to damage by mowers and other sources. Provide a varmint screen at the conduit drain outlet. Locate the outlet at least 1.5 feet above the bottom of a ditch, wall, slope or swale, or route to a suitable roadway drainage conduit. For conduit drain outlets in diches, slopes or swales, install a 12-inch square flat-panel marker sign on two U-channel posts that straddle the conduit at the outlet, to help locate and protect it. The sign message shall be "CONDUIT DRAIN" in 2-inch green letters on a white field using 730.18 Type I retroreflective

sheeting, with a 1-inch green stripe across the top, and facing the roadway. Mount the bottom of the sign panel at least 5 feet above grade.

1140-4.6.10 Roundabouts

All roundabouts shall be lighted. Roundabout lighting shall be designed according to **IES RP-8-2022**, published by the **Illuminating Engineering Society**. **ODOT**-maintained roundabouts shall have lighting design limits extending beyond the approach tapers. Typical installations shall have a minimum of eight pole locations: four illuminating the circulatory roadway and pedestrian areas and four illuminating the approach tapers. Design lighting levels and uniformity based on functional class of the intersecting roadways and pedestrian demand. The RP-8-2022 Table is reproduced below.

Design isolated (typically rural) roundabouts without adjacent existing or proposed lighting as a Local/Local installation.

Create As-Per-Plan notes to assure that no portion of a roundabout is opened prior to lighting being installed and tested, or operated, without lighting. The As-Per-Plan note should clearly define the required work and how the work is to be paid for. Also see **TEM 605-12.2 & 640-22.**

If ROW is sufficient and placement is practical (e.g., not in ditches, etc.), set back rural roundabout light poles per Clear Zone requirements in **L&D 600.2**. Set back urban roundabout light poles per L&D 600.2.2: a minimum of 6 feet behind curb and 12 feet for uncurbed roadways. The same offsets of 6 feet and 12 feet may be used in rural roundabout lighting design when Rural Clear Zone offsets are impractical using engineering judgment.

Illumination for Roundabouts				
Functional Classification	Maintained Average Horizontal Illuminance in Lux/fc on the Pavement Based on Pedestrian Area Classification			E_{avg} / E_{min}
	High	Medium	Low	
Major/Major	34.0/3.2	26.0/2.4	18.0/1.7	3:1
Major/Collector	29.0/2.7	22.0/2.0	15.0/1.4	3:1
Major/Local	26.0/2.4	20.0/1.9	13.0/1.2	3:1
Collector/Collector	24.0/2.2	18.0/1.7	12.0/1.1	4:1
Collector/Local	21.0/2.0	16.0/1.5	10.0/0.9	4:1
Local/Local	18.0/1.7	14.0/1.3	8.0/0.7	6:1

1140-4.6.11 Mesh-Network Lighting Control Systems

Most luminaire manufacturers offer lighting control systems that use 5-pin or 7-pin NEMA photocell sockets mounted on each luminaire to achieve several control and monitoring functions. Such systems are most suitable for streetlighting in urban environments for agencies whose standard luminaire includes the photocell socket. ODOT rarely specifies a photocell socket on individual luminaires. ODOT lighting systems use a single photocell in a control circuit that operates a magnetic contactor (see Standard Construction Drawing HL-60.31). Therefore, mesh-network lighting control systems are not used by ODOT. In addition, these systems are proprietary and not interoperable between brands.

For local public agencies that wish to use mesh-network lighting control systems, the project must be scoped to include this item, which generally adds significant hardware cost to the project. Also, ODOT recommends web-based subscription service rather than server-based application software. The nature of mesh-network control systems is such that they qualify as Intelligent Transportation Systems (ITS), and therefore their use in a project requires the designer to produce a Systems Engineering Analysis (SEA). See Part 13 for details on System Engineering Analysis.

NEMA 5-pin and 7-pin luminaire Control sockets also allow for the deployment of auxiliary sensors or network devices sometimes desired by local public agencies. These sensor systems are also proprietary and use the 5-pin or 7-pin socket as a source of readily available power and convenient, elevated placement. Some examples of these systems include network access points, gunshot detectors, detectors for CO2 and other chemical species, and CCTV cameras. ODOT generally does not participate in the deployment of such equipment as part of a lighting project.

Because they are proprietary, mesh-network control systems and auxiliary sensors require that, once scoped, the project designer, owner, and sponsor submit a Proprietary Product Request (see Section 1120-2). The Request will be reviewed by the Office of Roadway Engineering and The **Office of TSMO**.

1140-5.4.4.3 Signalized Intersection Lighting Applications

600V Distribution Cable (#10 AWG minimum) or 732.19 IMSA 5-conductor Traffic Signal Cable (#14 AWG minimum) may be specified. Green is used as the grounding conductor; red and orange are spares.

1140-7.4 Fences

See **L&D Volume 1 Section 603.1.2.1** and **SCD MGS-2.1** for guardrail grounding requirements and details.

See **L&D Volume 1 Section 606.3.3** and **SCD F-3.5** for fence grounding requirements and details.

1140-9 Pole Placement and protection

High mast towers and light poles not mounted on breakaway bases should not be placed in the following location:

1. Within the triangle created between the PC, PI, and PT points at highspeed ramp exit and entrance terminals defined by the outside edge of mainline and inside edge or ramp pavement. For light supports that have to be placed within this area they should be protected to prevent vehicles strikes even if outside clear zone.

1142-22 625 Lighting, Misc.: FAA Type L-864 Obstruction Lighting, Medium-Intensity, Flashing, LED

This item consists of installation and testing of FAA L-864-compliant obstruction lighting for marking of structures at least 151 feet AGL. Location and wiring shall be as shown in the Bridge Plans.

Each obstruction lamp shall utilize Light Emitting Diodes (LEDs). The obstruction lamp shall have a written minimum 5-year manufacturer warranty. The lamp shall be ETL verified to FAA Advisory Circular AC150/5345-43F, Type L-864 and shall be one of the following or approved equal:

1. International Tower Lighting Model IFH-1710
2. Point Lighting Model PFB-37001
3. Pharos Marine Automatic Power Model FA-250LED L-864.

Equip each obstruction lamp assembly with its own controller, housed in its own metal enclosure accessible by maintenance personnel standing at floor level. The controller shall operate at 120VAC or 240VAC, 60Hz as indicated in the Plans and have its own dedicated circuit breaker in a nearby panelboard as detailed in the Bridge Plans. The controller shall produce the appropriate FAA-required flashing rate, and the obstruction lamp shall operate continuously twenty-four (24) hours per day, with no intervening photocell control. The controller shall provide at least one unused alarm status output in the form of a dry-contact or solid-state relay closure that responds to defective or inoperative obstruction lamp conditions. At least one relay with complete contacts (Normally Open, Normally Closed, and Common) shall be provided. Alarm relay contact ratings shall be at least 500 mA resistive at 120VAC/30VDC. The controller shall provide at least one visible alarm status indicator for lamp failure indication. This indicator shall be in the form of a panel-mounted red dome-type LED visible from the outside of the enclosure.

The controller enclosure shall utilize a vertically hinged, swing-open door, and be rated NEMA 3R, minimum. Enclosure shall include at least one commercial grade NEMA 5-15 receptacle to accommodate wireless communication equipment to be installed later by **ODOT** for alarm status monitoring. An integral shelf shall be provided for this equipment inside the enclosure, and shall provide an open, accessible space for equipment measuring at least twelve (12) inches wide, eight (8) inches deep, and six (6) inches in height.

The Contractor shall fully test the system and arrange for acceptance inspection of the Obstruction Lighting installation by **ODOT** District signal maintenance personnel after the system is operational. During acceptance inspection, the Contractor shall demonstrate the proper operation of all lamps and alarms. Contractor shall provide a written manufacturer warranty and all operating manuals for obstruction lighting controller and lamp to **ODOT** District signal maintenance personnel at the time of inspection.

The Department shall measure LED FAA Type L-864 Obstruction Lighting by each individual obstruction light, complete and installed including any control devices and all wiring and conduits.

Designer Note: Although obstruction lighting is thought of as an incidental major bridge item, this note appears in the **TEM** as a 625 Item because bridge lighting maintenance typically falls to **District** signal and lighting electricians. **FAA** regulations require daily visual monitoring of obstruction lighting by the operator (**ODOT**) if they are not equipped with automatic monitoring. Very fast notification and response times are required for repair of malfunctioning obstruction lights. The use of LED lighting significantly reduces **ODOT's** maintenance operations and provides much better reliability by eliminating the frequent outages and routine lamp changes associated with obstruction lights using older incandescent lamp technology. The use of cellular modems for automatic monitoring is recommended and is coordinated through the **Office of Transportation System Maintenance and Operations (TSMO).** For structures 150 feet and lower, FAA L-810 low-intensity steady obstruction lights are used.

1142-24 625 Decorative Post-Top Luminaire, Solid-State (LED), Lantern Style, 3000K, Black Finish

This item consists of supplying and installing decorative post-top LED luminaires for street and/or sidewalk illumination.

A lantern style luminaire consists of a four discrete flat sloping sides, per HL-10.11, with or without glass or polymer panels, and a rounded or pointed top and a small cupola. Provide a luminaire with a B-U-G up-lighting rating of U2 or less.

The luminaire is intended for external on/off control and shall not include a photocell socket.

Assure the luminaire has a nominal power of 65-85 watts and a nominal color temperature of 3000K.

Provide a luminaire with factory-applied black finish.

Designer Note: Specify luminaires from the ODOT SS 813 Approved List. Use this text as a **Plan Note** template for streetscape and other decorative lighting applications. The goal of the note is to assist designers by listing several models of similar luminaires when no specific requirements are set forth in the project scope. Also, the note provides for a reasonable expenditure of public funds, serving as the Base Bid for which Alternate Bid Items may be included in the Plans. The note describes functional decorative LED luminaires in the most popular style category, without excessive decorative trim. The design veiling luminance ratio shall be per RP-8. Because this note only lists a few representative models, it must always include the "or approved equal" clause so that competing models that meet the specifications may be used. The poles used to support the luminaires are not specified in this note, but should be finished black per SS 916. Colored finishes other than black shall be Alternate Bid items. The designer must assure at least two luminaires are specified in the Plans, and shall provide illumination design documentation for each.

1142-25 625, Decorative Post-Top Luminaire, Solid-State (LED), Acorn Style, Refractive Glass, 3000K, Black Finish

This item consists of supplying and installing a decorative post-top LED luminaire for roadway and/or sidewalk illumination on posts of 16 feet nominal height.

HL-10.11 shows an acorn-style post-top luminaire schematically. This item consists of a base fitter, glass (not acrylic) globe and a rounded top with no decorative features such as finial, crown, band or ribs. Provide a luminaire with a B-U-G up-lighting rating of U4 or less.

Provide a luminaire compatible with the lighting branch circuit shown in the Plans. Assure the luminaire post-fitter has a hinged or captive door. Assure the luminaire can mount a photocell or wireless control that uses a NEMA standard photocell receptacle.

Provide a luminaire with 3G vibration rating. Protect each luminaire using a Surge Protective Device (SPD) conforming to **ODOT** Supplemental Spec 913.

Assure the luminaire has a nominal color temperature (CCT) of 3000K.

Provide a luminaire with factory-applied black finish meeting Supplemental Specification 916.

Designer Note: Specify luminaires from the ODOT SS 813 Approved List. Use this text as a **Plan Note** template for streetscape and other decorative lighting applications. The goal of the note is to assist designers by listing several models of similar luminaires when no specific requirements are set forth in the project scope. Also, the note provides for a reasonable expenditure of public funds, serving as the Base Bid for which Alternate Bid Items may be included in the Plans. The note describes functional decorative LED luminaires in the most popular style category, without excessive trim. This generic luminaire item is intended for external on/off control and should not include a photocell socket or control.

Designers should note the up-lighting and CCT restrictions intended to limit light pollution. There are options available for the refractive glass luminaires to limit up-lighting.

The poles used to support the luminaires are not specified in this note, but should follow HL-10.11 and be unfinished or finished black per SS 916. Colored finishes other than black shall be Alternate Bid items. The designer must specify at least two luminaires in the Plans, and shall provide illumination design documentation for each, with a specific emphasis on the Veiling Luminance Ratio.

For lighting low-speed roadways (35mph or less) it is acceptable to exceed the RP-8 maximum Veiling Luminance Ratio value of 0.3, up to a value of 0.8. Installations on roadways with posted of 85th-percentile speeds exceeding 35mph shall conform fully with RP-8 veiling luminance specifications.

ODOT's preferred post-top decorative luminaire is the Lantern Type because of its superior Veiling Luminance performance in comparison to the Acorn Type. **ODOT**-maintained installations shall use acorn-style luminaires with glass globes when acorn style is required. Occasionally, local jurisdictions prefer polymer globes (acrylic typically, but polycarbonate is available). If polymer globes are required, designers may change the title of the Note and specify from among the following luminaires:

1. NLS Savannah, _____lumens, photometric distribution: _____
2. Spring City Washington, _____ lumens, photometric distribution: _____
3. Holophane Washington Postlite, _____lumens, photometric distribution: _____
4. Sternberg A65LED Princeton, _____ lumens, photometric distribution: _____

1142-26 625, RGBW Aesthetic Lighting System

General:

This item consists of supplying, installing, testing, and providing training for an aesthetic lighting system, according to the details shown in the Plans.

Item 625 RGBW Aesthetic Lighting System is paid for by EACH instance (typically each separate structure to be lighted), and includes the following items: luminaires, controller, wiring, conduit and fittings, communication and wireless links (if required)

The luminaires for the system shall comprise arrays of four LED emitters to generate multiple colors and white light of various color temperatures and color-rendering indices (CRI).

The luminaire array is nominally composed of RGBW (Red, Green, Blue, White) emitters but may consist of emitters with different nominal colors.

Provide an aesthetic lighting system with a software or hardware limit to the white-light surface luminance of no more than 100 cd/m^2 in urban/suburban areas or 50 cd/m^2 in rural areas at any point of an illuminated surface over or directly adjacent to the roadway.

Provide an aesthetic lighting system with programmed transitions no shorter than 5 seconds between preset states whose minimum duration is 15 seconds.

Communications:

Assure the communications used for RGBW lighting control is DMX-512.

Web server access (when required) shall be secure HTTP (https) meeting all applicable **ODOT** network specifications for Intelligent Transportation Systems (ITS).

Luminaires:

Record the serial number and location of each luminaire installed for documentation and DMX programming.

The luminaire shall utilize either a single cable for power and control or two separate power and control cables.

Cables shall be integral to the luminaire and a minimum length of 9 feet.

Assure luminaire power/control cables are UL listed for outdoor application and sunlight resistance.

Assure the luminaire has ingress protection of IP66, minimum.

Assure the luminaire has a 3G vibration rating per NEMA C136.31.

Supply a luminaire that matches the beam angle specified in the plans to within +/- 5 degrees.

Assure the luminaire includes a surge protective device (SPD) meeting **ODOT** Supplemental Specification 913.

Maintain required separation of power and control circuits per NEC Article 800.

Assure the luminaire enclosures used are watertight and UL listed for wet locations.

The following luminaires are approved by **ODOT** for this item.

1. Philips Gen4 ColorBurst, ColorBlast, ColorReach, or ColorGraze. Philips luminaires shall include as incidental DataEnabler Pro devices, when required. Use 5-wire IMSA traffic signal cable (732.19) for power and control, with green as the equipment grounding conductor and white as neutral. Minimum acceptable IMSA wire gage is 14AWG, or larger if called for in the Plans.
2. Acuity Hydrel 8100. Use 4-wire IMSA traffic signal cable (732.19) for power, with green as the equipment grounding conductor and white as neutral and one spare. Minimum acceptable IMSA wire gage is 14ga AWG, or larger if called for in the Plans.
3. Lumenpulse brand Lumenbeam and Lumenfacade. Include all required Lumenpulse DC power control/splitter and cables. Use 4-wire IMSA traffic signal cable (732.19) for power, with green as the equipment grounding conductor and white as neutral and one spare.

Assure that in the absence of a control signal, a powered luminaire will remain in a dark state.

Central RGBW Lighting Programmable Controller:

Locate the controller in a climate-controlled building or 820 Instrumentation Enclosure as detailed in the Plans. The Central controller shall utilize the DMX-512 protocol.

The following programmable controllers are approved by **ODOT**:

1. Philips iColor Player
2. Pharos LPC-1

Central RGBW Lighting Preset Controller:

If specified, provide a surface-mounted panel with DMX output that has a minimum of 6 present lighting system configurations that are enabled by pushbutton actuation.

Assure there is a separate ON/OFF actuator on the present controller panel.

Include a programming application with the controller.

The following preset controllers are approved by **ODOT**:

1. Pharos BPS
2. Acuity Easyl Button Station

DMX cable:

Provide Belden 9841 or approved equal.

Wireless DMX Transceiver:

If called for in the Plans, install wireless DMX transceivers at each wireless link as shown.

Supply wireless transceiver power using a dedicated 120VAC branch circuit from the main lighting control center location, unless indicated otherwise in the plans.

Conduit, Fittings and Enclosures:

Install galvanized steel, aluminum, or stainless steel rigid metallic conduit and fittings as shown in the Plans.

If conduit material for this item is not specified elsewhere, then provide galvanized steel rigid metallic conduit and fittings.

Install vent drains in all electrical enclosures and boxes.

Install vent drains in all conduit runs exceeding 50 feet, at intervals not exceeding 50 feet between conduit system vent drains.

Install vent drains in a manner that maintains the NEMA ingress rating of the enclosure.

All conduits and fittings shall be UL listed for Wet Locations, constructed and installed in a manner to be watertight.

Make all conduit enclosure entries using watertight hubs; do not use threaded conduit ends and locknuts.

Make all wire and cable enclosure entries using watertight compression fittings.

Make wire connections (e.g., wire nuts) in boxes waterproof by wrapping with 3M Number 23 self-fusing rubber tape followed by a layer of 3M Super 88 heavy-duty vinyl electrical tape, or use approved equal tapes.

Install power wiring inside ¾-inch 725.04 galvanized conduit, unless indicated otherwise in the Plans.

Install all DMX control cables inside ½-inch 725.04 galvanized conduit, unless indicated otherwise in the Plans.

Support conduit at intervals of ten feet or less per NEC Article 344.

Coatings for conduits, enclosures and fittings, if required, shall meet the requirements of **ODOT** Supplemental Specification 916.

Provide enclosures conforming to **ODOT** Supplemental Specification 820.

Field Mock-Up:

Prior to purchasing luminaires and controls, the Contractor shall coordinate with the Engineer, the equipment vendor or manufacturer, and the project owner to conduct a test using a small number of temporary luminaires.

If a structure to be illuminated is not accessible for the mock-up, a substitute location may be used if approved by the Engineer.

The purpose of this test is to demonstrate to the Engineer and to the lighting system operating agency that the system proposed in the Plans meets the required engineering specifications and aesthetic qualities.

Testing:

1. Maximum Luminance Test:

Using a photometer measuring in units of cd/m^2, demonstrate to the Engineer during night testing that the programmed, operational lighting system meets the maximum surface luminance criteria stated elsewhere in this Note.

Set the system to its maximum output programmable configuration and measure the surface luminance using a spot or imaging photometer.

2. Burn-In Test:

Following the Maximum Luminance Test, operate the system for at least fourteen days without any maintenance intervention.

Demonstrate to the engineer during the night test a typical aesthetic display program. If the system is designed to provide dynamic display, then use a dynamic display program during the test period.

During this interval the system must not experience any operational or equipment failures, including luminaires, control system, or programming/software.

Any failures require a re-start of the testing interval.

For all aesthetic lighting installations on the Expanded National Highway System, notify the **ODOT** District and the administrators of the following **ODOT** offices at least four weeks in advance of the proposed test start and finish dates: the Office of Roadway Engineering, the Office of Structural Engineering, and the Office of TSMO. A representative from at least one of these **ODOT** offices must be present to approve each test.

Training:

The Contractor shall arrange a minimum one-day (4-7 contact hours) training session on the operation of the system. Complex systems may require more than one day.

Designer Notes: This draft **Plan Note** serves as a template for aesthetic lighting systems used for spot, wash (luminaires pointed down), or flood (luminaires pointed up) lighting of structures and other roadside features within and near the **ODOT** right-of-way.

Local ordinances may exist that affect design along non-ODOT right-of-way; the designer shall comply with all such ordinances.

The RGBW lighting system consists of LED luminaires using (nominally) red, green, and blue emitters that produce many different colors, including white.

This same note shall be used for single-color LED luminaires with slight modification.

Use an offline preset controller by default.

Programmable central control systems, when necessary, shall be deployed as follows on **ODOT**-operated facilities:

1. Philips iPlayer: Used for **ODOT** installations comprising 128 or fewer luminaires, which require four DMX addresses each. Standalone, non-networked control requiring on-site programming using a laptop computer (not included).
2. Pharos LPC: Used for **ODOT** installations requiring network access.

Submit lighting designs per **TEM** 1141-1. Use Visual™ or AGi32 design software.

Model surface reflectance using maximum foreseeable values and produce plan and elevation views as necessary to show all design luminance values at 100% for at least three representative colors and for white.

Design luminance levels exceeding the limits given below must be approved by **ODOT**'s Offices of Roadway Engineering, Structural Engineering, and Traffic Operations.

Aesthetic Lighting Systems are sometimes placed close to the roadway, in view of drivers, so a critical design goal is to achieve the limiting luminance criteria with the luminaires set to 100% output, thus limiting the possible luminance under controller or programming error conditions.

The designer is referred to CIE 150:2003 Guide On The Limitation Of The Effects Of Obtrusive Light From Outdoor Lighting Installations, for general design principles.

However, design values shall be those given by this **Plan Note** or other **ODOT** specifications.

Outdoor Advertising signs (message centers) outside of the right-of-way are not specifically addressed in this guidance for Aesthetic Lighting Systems.

Each system shall be characterized by its Environmental Lighting Zone as either Urban/Suburban or Rural, per Table 2.1 in CIE 150:2003.

Urban/Suburban Lighting Environment	Average Luminance (cd/m^2)	Maximum Luminance (cd/m^2)
Bridge parapets, piers, arches, spandrels and other structure elevation features over or near roadways	30	100
Bridge abutment slopes	40	160

Urban/Suburban Lighting Environment	Average Luminance (cd/m^2)	Maximum Luminance (cd/m^2)
Noise walls or other walls at least 50 feet from the traveled way	20	200
Externally-illuminated signs/plaques, statues, sculptures, trees, poles and other landscape items located at least 50 feet from the traveled way	50	150

Rural Lighting Environment	Average Luminance (cd/m^2)	Maximum Luminance (cd/m^2)
Bridge parapets, piers, arches, spandrels and other structure elevation features over or near roadways	15	50
Bridge abutment slopes	20	80
Noise walls or other walls at least 50 feet from the traveled way	10	100
Externally-illuminated signs/plaques, statues, sculptures, trees, poles and other landscape items located at least 50 feet from the traveled way	25	75

Tests show the albedo (broad visible-band light reflectance) of **ODOT** concrete mixes is around 0.35.

ODOT requires designers to use a fully diffuse (Lambertian) reflectance value (albedo) of no less than ρ=0.4 for new vertical structural concrete surfaces for converting illuminance, E (lux) to luminance, L (cd/m^2) using the following formula:

$L = E\rho/\pi$ (see RP-8-00 Annex A).

Note that 10.76 lux = 1 foot-candle.

Coated concrete surfaces or non-standard mixes may require the use of quasi-Lambertian or quasi-specular reflectance values during illumination design, though these may not be supported by typical lighting design software (e.g., Visual 3D).

Illumination design for aesthetic lighting may be done using Visual, AGi32, or equivalent software.

The Acuity™ Visual Floodlight Tool and Visual Wallwash Tool are also useful for initial (and sometimes final) design and ease of documentation.

The Acuity™ Visual Floodlight Tool and Visual Wallwash Tool will be used to document the design for review by **ODOT**; representative surfaces shall be documented separately using these online tools and results submitted to the **ODOT** Office of Roadway Engineering.

Designers should note that aesthetic luminaires aimed horizontally and parallel to bridge parapets and other surfaces often trespass directly into the view of drivers along the adjacent roadway and shall be designed to eliminate all such glare sources by baffles or similar means.

Horizontal surface illuminance onto streams, lakes, wetlands, wildlife crossings and other natural waters shall be limited to 0.1 fc (1.1 lux) unless specified otherwise.

Do not specify PVC or other non-metallic conduits. LFMC (Liquid-tight Flexible Metallic Conduit) may be specified as required for short flexible connections to the luminaires.

Locate the control enclosure(s) in a building or other sheltered location (e.g., under a bridge in a shaded area). See **ODOT** SS 820 Instrumentation Enclosure for additional enclosure requirements.

Do not use electrical and electronic control components (e.g., circuit breakers, hubs) not suitable for long-term installation in an outdoor, roadside environment.

All circuit breakers shall be 100% rated to accommodate continuous all-night operation of the lighting system.

Limit DMX cable runs to 800 feet between nodes.

Control (DMX) and power conductors must utilize separate conduits per NEC Article 800.

Designers should perform voltage drop calculations to determine the required power conductor size and submit the calculations to the Office of Roadway Engineering per **TEM** Part 11.

Item 625 Power Service is not included as part of this item.

Utilization voltage for RGBW luminaires should be 240VAC line-to-neutral, maximum, and luminaire drivers typically should be 120VAC-277 VAC auto-ranging.

Item 625 RGBW Aesthetic Lighting System is paid for by EACH instance (typically each separate structure to be lighted), and includes the following items: luminaires, controller, wiring, conduit and fittings, communication and wireless links (if required).

1150-2.5 Project Inspection of Material

The following materials are normally manufactured to standards that meet **ODOT** criteria and therefore do not have a **QPL**, do not normally have a **TE-24** and certified drawings are not normally required:

1. Exothermic Welds
2. Insulating Varnish
3. Split Bolt Connector
4. Expansion Fittings
5. Copper Crimps and Compression Connectors
6. Light Pole Decals
7. Circuit Identification Tags
8. Cable Grips
9. Wood Service Poles
10. Fuses for Control Center and Connector Kits
11. Photoelectric Cell and Bracket
12. Secondary Lightning Arrestor
13. Guy Anchors and Anchor Rods
14. Weather Heads
15. Watertight Hubs
16. Remote Ballast Enclosures and Mounting Brackets

Project inspection of material is used to verify that the material at hand is that listed on a **QPL**, or described on a **TE-24**, or for which certified drawings have been received, and that the material complies with the requirements of the contract documents. For material not on a **QPL** which does not have a **TE-24**, and for which certified drawings are not required, the project inspection of material is limited to comparing the material at hand with the requirements of the contract documents.

1160-2 Lighting Maintenance Practice Process

A contact point shall be established by each **District** for receiving notification from law enforcement personnel, emergency response and maintenance units, other governmental entities, utility companies, and the traveling public of damage to, and malfunction of, highway lighting. Periodic inspection of lighting installations shall also be made (see 1101-1).

The information obtained from these notifications and inspections shall be used to document the damage or failures, and the date of discovery. Based on the nature of the damage or failure, the **District Roadway Services Manager** will ensure that the appropriate responses are made, the incident tracked until repairs have been completed, and the date of completion of repairs documented.

Each **District** shall also see that preventive maintenance is performed to forestall failures, to facilitate repairs during responses to damage and failure, and to provide proper general housekeeping of the installations.

The use of “hot sticks” is not allowed.

Average Maintained Illuminance Design Values

Average Illuminance on the Pavement [1]			
Roadway and Walkway Classification [2]		**Foot-Candles**	**Uniformity (avg./min.)**
Freeway (including ramps)[3]		0.9	3:1
Expressway (including ramps)[3]	Commercial	1.4	3:1
	Intermediate	1.3	
	Residential	0.9	
Major[3]	Commercial	1.7	3:1
	Intermediate	1.3	
	Residential	0.9	
Collector[3]	Commercial	1.2	4:1
	Intermediate	0.9	
	Residential	0.6	
Local[3]	Commercial	0.9	6:1
	Intermediate	0.7	
	Residential	0.4	
Sidewalks	Commercial	1.4	3:1
	Intermediate	0.9	4:1
	Residential	0.4	6:1
Pedestrian Ways and Bicycle Paths[4]		2.0 (mixed ped, veh) 1.0 (ped only)	4:1

Full Intersection Lighting[5]	Major/Major	3.2 (H) 2.4 (M) 1.7 (L)	3.0
	Major/Collector	2.7 (H) 2.0 (M) 1.4 (L)	3.0
	Major/Local	2.4 (H) 1.9 (M) 1.2 (L)	3.0
	Collector/Collector	2.2 (H) 1.7 (M) 1.1 (L)	4.0
	Collector/Local	2.0 (H) 1.5 (M) 0.9 (L)	4.0
	Local/Local	1.7 (H) 1.3 (M) 0.7 (L)	6.0
Partial (Isolated) Intersection Lighting[5]	Major	0.8	3.0
	Collector	0.6	4.0
	Local	0.4	6.0

Notes:

1. Based upon R3 pavement classification, i.e. asphalt road surface, rough texture, Q_0 =0.07. ODOT generally does not separate Freeway into classes A and B as RP-8 does (Note 3).

2. The terms “commercial,” “intermediate” and “residential” are defined in ***Section 1103-4***. See **Chapter 1301** for definitions of the other terms.

3. Adapted from **American National Standard Practice for Roadway Lighting ANSI/ES RP-8, 200/2005: Illuminating Engineering Society of North America.** Used by permission.

4. This assumes a separate facility. Facilities adjacent to a vehicular roadway should use the illuminance levels for that roadway.

5. Based on RP-8 (2022). See that document for definitions of roadway classifications and High-Medium-Low (H-M-L above) pedestrian demand.

1202 SCHOOL ZONES

OMUTCD Section 7B.09 addresses School Zones and School Zone Extensions. ***Chapter 705*** of this Manual describes the procedures for requesting and withdrawing School Zone Extensions. The related forms are shown in ***Part 7*** of this Manual. Full-size copies of the forms are also available for downloading from the Forms page on the **Office of TSMO** website.

"Special Elementary Schools" (e.g., Amish), are eligible for school zone signing provided they meet the requirements in **Ohio Revised Code 4511,21(B)(1)(c)** and **4511.21(B)(1)(e), (i-v)**.

1203-2 Procedures for Requesting and Authorizing Speed Zones

1203-2.1 General

Requests for Speed Zones needing the approval of the **Director of Transportation (Director)** are submitted to the ODOT **District (District)** for review and approval using the procedures described in this Section.

The procedure and forms for speed zones in temporary traffic control zones (work zone speed zones) are addressed in **Subsection 1203-2.9** and utilize **Form 1296-17: Work Zone Speed Zone (WZSZ) Evaluation Sheet for High Speed (≥ 55mph) Multi-Lane Highways** which is available from the Forms page on the Office of TSMO website.

1203-2.2 State Highways within ODOT's Jurisdiction – General Procedure

All proposals for alterations of speed limits on **State** highways within **ODOT**'s jurisdiction shall be documented with the appropriate Speed Zone Study as outlined in ***Section 1203-3***. For temporary traffic control situations (WZSZs), see ***Subsection 1203-2.9***.

Once a determination has been made to alter a speed limit, the **District** may forward the proposed speed limit reduction to the appropriate **Ohio State Highway Patrol (OSHP) Post** for their consideration and comments.

Following resolution of any comments submitted by **OSHP**, the **District** shall prepare a description of the Speed Zone for the **Director's** approval using Form 1296-6a (Speed Limit Revision).

The revised speed limit is not in effect until the appropriate signs have been erected. Therefore, erection of the new Speed Limit signs, and their removal if/when the zone is withdrawn, must be documented to verify when the Speed Zone is in effect. See ***Section 1203-5*** for further details on the documentation process.

1203-2.3 Highways within Local Jurisdictions – General Procedure

As noted in ***Section 1203-1***, a **Board of Township Trustees** may, by resolution and based on "an engineering study," declare a prima-facie speed limit on unimproved highways and also on highways under their jurisdiction which are within residential and commercial subdivisions. The terms unimproved highway, and residential and commercial subdivision are defined in ORC Division 4511.21(K). It is recommended that the **Townships** document the reasons for these Speed Zones and when the Speed Limit signs are erected. Form 1296-15 is an example of a form that can be used for such documentation.

Except as provided in ***ORC 4511.21(K)*** for Township Roads, all requests for reduced speed limits on local roads (i.e., roads under the jurisdiction of a local authority other than **ODOT**) shall be submitted to the **District** for review and approval. The request shall be accompanied by a signed letter from the local agency requesting

the **Director** to declare the safe and reasonable speed limit as recommended by the accompanying Speed Zone Study. The appropriate Speed Zone Study, as outlined in ***Section 1203-3***, shall be included with all such requests. All requests shall be acknowledged, and the local authorities shall be notified whether additional data will be necessary to substantiate their request.

For temporary traffic control situations (WZSZs), see ***Subsection 1203-2.9***.

Based on the information received in the Speed Zone Study for review by the **District** and following a field review conducted by the **District,** if appropriate, approval of the submitted Speed Zone Study and its recommended reasonable and safe speed limit is granted by the **District**. If the recommendation of the Speed Zone Study is substantially different from that which was requested, the local authority may be asked to further substantiate their original request for review by the **District**.

Following resolution of any comments and upon acceptance of the results of the Speed Zone Study, the local agency shall submit to the **District** an appropriate resolution or ordinance requesting the **Director** to declare that safe and reasonable speed limit in accordance with the results of the Speed Study. Upon receipt of the appropriate resolution or ordinance from the local agency, the **District** shall prepare a description of the Speed Zone for the **Director's** approval using Form 1296-6a **(Speed Limit Revision)**.

The **District** shall notify the local authority of **ODOT**'s final action on the proposed Speed Zone request.

The revised speed limit is not in effect until the appropriate signs have been erected. Therefore, erection of the new Speed Limit signs, and their removal if the zone is withdrawn, must be documented to verify when the Speed Zone is in effect. See ***Section 1203-5*** for further details on the documentation process.

1203-2.4 Split Jurisdictions

ORC Division 4511.21(M)(1) addresses situations where the boundary of two local authorities rests on the centerline of a highway and both authorities have jurisdiction over the highway. Aside from **Division 4511.21(M)(1)** and the speed zoning process, there is currently no provision to address the inconsistency and confusion caused when responsibility for a section of highway is split between different jurisdictions. The speed limit may differ depending on which side of the roadway you are traveling. This can be confusing to motorists. When this occurs on State highways within **ODOT**'s jurisdiction, using the speed zoning process, the **District** should work with the local jurisdiction(s) to try to address the differences. This may involve:

1. Raising the lower speed limit to match the higher statutory speed.
2. Lowering the higher speed limit to match the lower statutory speed.
3. Determining an alternative speed limit on the basis of a Speed Zone Study in accordance with **Section 1203-3** that both jurisdictions can agree is appropriate.
4. Leaving the statutory speed limit on each highway section unchanged with no further action taken.

If a local jurisdiction is going to submit a speed zoning request for a roadway section that involves split jurisdictions, the jurisdiction initiating the request shall first contact the adjacent jurisdiction(s) to see if a compromise request can be developed. The speed zone request submitted to **ODOT** shall include letters of interest from the involved jurisdictions, and as appropriate, the related resolutions or ordinances from all jurisdictions involved prior to the **Director's** approval.

1203-2.5 Speed Zone Tracking Application

When the Speed Zone Study has been properly prepared the review process should take no more than 90 days from the date the **District** received the request to the date the **District** notifies the local jurisdiction of **ODOT**'s final determination on the proposed Speed Zone. The **District** will notify the local jurisdiction upon receipt of the Speed Zone Study. If the initial request is incomplete or if the **District** later in the review process requires additional information, this 90-day period begins again when the **District** receives the additional or revised information.

The **District** shall track the status of all Speed Zoning requests as they are processed by **ODOT** using the Traffic Regulation Database Management System **(TRDMS)**. Each **District** shall enter the required data as requests are received and shall update the records as each request is processed.

1203-2.6 Narrow and Low-Volume Rural Roads

As of July 19,2024, the previous **TEM** provision for an alternative Speed Zone Study method for "Narrow and Low-Volume Rural Roads" is rescinded. Any roadway with an approved Speed Zone Revision based on the previous Narrow and Low-Volume Rural Road" alternative Speed Zone Study will remain valid unless there is cause for withdrawal following **Section 1203-4** or a new Speed Zone Study is needed as detailed in **Section 1203-5**.

1203-2.7 Unimproved Highways and Residential and Commercial Subdivision Streets (Form 1296-15)

As noted in ***Section 1203-1 and Subsection 1203-2.3***, the **Ohio Revised Code 4511.21 (K) (5)** allows **Townships** (based on "an engineering study") to alter by Resolution the speed limit on unimproved highways and residential and commercial subdivision streets to less than 55 miles per hour, but not less than 25 miles per hour.

The Comments portion of the form can be used to document information from the study made to support the speed reduction.

As noted in ***Section 1203-2.3***, it is recommended that **Townships** document the reasons for the Speed Zones they establish on unimproved highways and residential and commercial subdivision streets, and when the Speed Limit signs are erected. Form 1296-15 is an example of a form that can be used for such documentation.

1203-2.8 Reserved for Future Use

Removed and reserved for future use.

1203-2.9 Speed Zones in Temporary Traffic Control Zones (Work Zone Speed Zones)

1203-2.9.1 General

Research has shown that motorists will only reduce their speed if they clearly perceive a need to do so. However, a speed limit reduction may be desirable in temporary traffic control zones that involve work on or near the traveled way, particularly on high-speed multi-lane highways. The Work Zone Speed Zone (WZSZ) process described herein applies to any work zone located on a multi-lane highway with a pre-construction speed limit of ≥ 55 mph and with a work zone condition at least 0.5 mile in length that reduces the existing functionality of the travel lanes or shoulders and has an expected work duration of at least three hours.

For purposes of the WZSZ process: the conditions that would "reduce existing functionality" of the travel lanes or shoulders are lane closures, lane shifts, crossovers, contraflow and/or shoulder closures; and the length of the work zone condition is measured from the beginning of the taper for the subject work zone condition impacting the travel lanes and/or shoulder to the end of the downstream taper, where drivers are returned to typical alignment.

The three-hour duration requirement is used to balance the additional exposure created by installing and removing WZSZ signing with the time needed to complete the construction or maintenance work.

Speed zones in construction work zones should be reviewed and approved as early as possible in the planning process. ***Sections 1203-2.9.2 through 1203-2.9.4*** address details of the process as applied to construction projects in the design phase and during construction, as well as Operations/Maintenance projects. ***Sections 1203-2.9.6 and 1203-2.9.7*** provide additional information used to navigate and complete the process.

At this time, Work Zone Speed Zones (WZSZs) on other streets and highways will be considered on a case-by-case basis, and must be submitted individually to the **District Work Zone Traffic Manager (DWZTM)** and **District Speed Zoning Coordinator (DSZC)** using the process described in ***Section 1203-3***. Before the **District** may approve such request, concurrence shall be obtained from the **Office of Roadway Engineering (ORE)**. If approved, the WZSZ must still be established and documented through a Speed Limit Revision Form, implemented in the field and tracked using principles consistent with the WZSZs on high-speed (≥ 55 mph) multi-lane highways, and withdrawn when completed.

A WZSZ is not in effect and enforceable unless all of the existing speed limit signs within 1 mile in advance of and inside the WZSZ are removed or covered and the WZSZ Speed Limit signs are in place with the appropriate legends displayed. Legends reflecting a speed limit in accordance with Table 1297-7 shall only be displayed when

the work zone condition in place reduces the existing functionality of the travel lanes or shoulders. At all other times (when the work zone condition no longer reduces the existing functionality of the travel lanes or shoulders) the original posted speed limit shall be displayed.

For further details about information that needs to be addressed regarding WZSZs, see ***Sections 605-3.4, 605-6.4, 640-18, 641-34 and 642-24***.

When the need for the WZSZ has ended, the WZSZ signage shall be removed and the original (pre-construction) speed limit signage restored. The related Work Zone Speed Limit Revision shall be withdrawn ***(see Section 1203-4)***.

See ***Section 1203-5*** for further information about documentation of WZSZs. This includes the required documentation of when and where the signs are erected, what speed limit is displayed, and when they are removed.

1203-2.9.2 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Construction Projects – During Design (Figure 1298-1a)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for construction projects during design, including design build projects, are described in Figure 1298-1a***, Work Zone Speed Zoning Process for Construction Projects – Design Phase***.

As noted above, Speed Zones in construction work zones should be reviewed and approved as early as possible.

1203-2.9.3 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Construction Projects – During Construction (Figure 1298-1b)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for construction projects during construction, are described inFigure 1298-1b***, Work Zone Speed Zoning Process for Construction Projects – During Construction***.

1203-2.9.4 WZSZs on High-Speed (≥55 mph) Multi-Lane Highways for Operations/ Maintenance Work (Figure 1298-1c)

In addition to the provisions of ***Section 1203-2.9.1***, details of the WZSZ process for operations and maintenance work on high-speed (≥55 mph) multi-lane highways are described in Figure 1298-1c***, Work Zone Speed Zoning Process for Operations/ Maintenance Work***.

1203-2.9.5 Reserved for Future Information

The new WZSZ process eliminated the need for the ***Work Zone Speed Zone Justification Report (***Form 1296-16***)***. Therefore, the form and related text has been deleted. This Section is reserved for future use.

1203-2.9.6 Warranted Work Zone Speed Limits for Work Zones on High-Speed (≥ 55 mph) Multi-Lane Highways (Table 1297-7)

Table 1297-7 is used to determine the warranted speed limit value(s) during qualifying work zone conditions (defined below and in ***Section 1203-2.9.1***) for multi-lane highways with a pre-construction speed limit of 55 mph or higher. All WZSZs are variable in nature, with the warranted work zone speed limit fluctuating with the conditions and factors in place at the time.

The table provides the warranted speed limit for each of the specific conditions given. Only one warranted speed limit applies at any one time; speed limit reductions are not cumulative. As conditions in the work zone change, the work zone speed limit shall adjust accordingly per Table 1297-7. WZSZ shall not be used for Moving/Mobile activities, as defined by the **OMUTCD**.

The following are definitions and additional information for use with Table 1297-7:

Work Zone Condition – A qualifying work zone condition is one that is at least 0.5 mile in length (as defined in ***Section 1203-2.9.1***), with an expected work duration of at least three hours, and reduces the existing functionality of the travel lanes or shoulders. As noted in ***section 1203-2.9.1***, the conditions that would "reduce existing functionality" of the travel lanes or shoulder are lane closure, lane shift, crossover, contraflow and/or shoulder closure.

Original Posted Speed Limit – The original, pre-construction, speed limit prior to any WZSZ. When determining a warranted work zone speed limit for a new or revised work zone condition in which there is a pre-existing work zone speed limit in place, always use the original (pre-construction) speed limit. Do not base a new work zone speed limit upon a prior work zone speed limit. Speed limit reductions are not cumulative.

Positive Protection - Positive protection is generally regarded as portable barrier or other rigid barrier in use along the work area within the subject qualifying work zone condition. A work zone Without Positive Protection is generally regarded as using drums, cones, shadow vehicle, etc., along the work area within the subject qualifying work zone condition. For work zones that are utilizing a combination of Temporary Traffic Control Devices (TTCDs), the designation of "with" or "without" positive protection should be based upon the type of devices used for the qualifying work zone condition being considered. If there is a combination of TTCD within the qualifying work zone condition being considered, engineering judgement should be used in determining the designation with consideration being given more towards the area in which workers will be located.

Worker Presence – Workers are considered as being present when on-site, working within the subject qualifying work zone condition.

The following are two examples demonstrating how to determine warranted work zone speed limit values from Table 1297-7:

Example 1

An Interstate with an original, pre-construction, posted speed limit of 70 mph will have a lane shift of 10-feet (>0.5 mile in length) in place 24/7 for several weeks using portable barrier. The work zone speed limit while the lane shift is in place when workers are present is 60 mph (65 when workers are not present, but the lane shift

remains in place). For one night there will also be a lane closure (> 0.5 mile in length) for six hours using drums; and the closed lane will be restored (reopened) before the end of the work shift, while the lane shift remains in place. The work zone speed limit during the lane closure is 55 mph and would only be applicable for the length of the lane closure. Once the closed lane was restored, the work zone speed limit in that area would go back to 60 mph while workers and the lane shift were still present.

Example 2
An Interstate with an original, pre-construction, posted speed limit of 65 mph will have a nighttime lane closure (>0.5 mile in length) in place for seven hours using drums, and the closure will be repeated nightly for three days. When workers are not present, all lane and shoulder functionality is restored. The work zone speed limit during times when the lane closure is in place and workers are present would be 50 mph. When workers are not present (and the condition impacting the existing functionality of the lane and shoulder is not present) the work zone speed limit would be the original, pre-construction, speed limit of 65 mph.

See ***Section 1203-2.9.7*** for information regarding an optional form for assistance in working with Table 1297-7.

1203-2.9.7 WZSZ Evaluation Sheet for High-Speed (≥55 mph) Multi-Lane Highways (Form 1296-17)

Form 1296-17 is an optional form available to assist in navigating the information in Table 1297-7. The form is used in the same way as Table 1297-7, to determine the warranted work zone speed limit values during qualifying work zone conditions on multi-lane highways with original (pre-construction) speed limits of 55 mph or higher. See ***Section 1203-2.9.6*** for definitions and additional information that applies to the use of Form 1296-17.

1203-2.10 Variable Speed Limits

ORC Section 4511.21(H)(3) allows the **Director** to establish a Variable Speed Limit that is different from the established speed limit for weather conditions, traffic incidents and congestion that occur on all or portions of I-670, I-275 and I-90 (at the intersection with I-71 and continuing to the Ohio-Pennsylvania border).

1203-3 Speed Zone Studies

1203-3.1 General

Generally, a Speed Zone Study used to support a request for alteration of a speed limit should include the following documents:

1. Form 1296-5 (Speed Check Form), or a summary sheet resulting from a mechanical speed check device as described in **Subsection 1203-3.3**
2. A scaled area map, sketch, or aerial view to identify the location of the proposed zone including locations of speed data collection sites
3. The recommended speed limit report from the most current FHWA version of **USLIMITS** with the determination narrative included

A crash history summary of the study segment including the total number of speed-related crashes and their severity shall only be considered when submitting a **USLIMITS** speed study in conjunction with a comprehensive safety study as outlined in **Subsection *1203-3.4.1.***

If conditions are not relatively consistent throughout the section under study, consideration should be given to splitting the study area into shorter sections.

FHWA's USLIMITS is a web-based tool used to conduct speed studies for setting appropriate speed limits. **USLMITS** is the required method for completing all speed zone studies as outlined in **Subsection 1203-3.4**.

1203-3.2 Field Review

A field review of the roadway section shall be made noting various physical conditions along and adjacent to the highway to aid in identifying and submitting inputs for **USLIMITS**.

The field review should identify the following:

1. Roadway segment start and end log points to be included in the study
2. New or existing route or roadway
3. Existing posted speed limit (mph)
4. Route/Facility type
5. 85th and 50th Percentile Speed (using Speed Checks as detailed in **Subsection 1203-3.3**)
6. Length of the study segment
7. Adverse alignment within the study segment
8. Statutory speed limit for the type of road

9. Study segment consists of a transition zone whereby the segment is transitioning to a non-limited access highway
10. Roadside rating category of the study segment as described in **USLIMITS**
11. Study segment classification as undivided, divided or having a two-way left turn lane
12. Total number of through lanes in both directions, excluding turn lanes

1203-3.3 Speed Check (Form 1296-5)

Except when using a summary sheet resulting from a mechanical speed check device and its associated software, a speed check using Form 1296-5 (Speed Check Form) shall be included in the study.

1. Speed checks may be taken with any device that will indicate vehicle speed with an accuracy of +10 percent, including mechanical speed check devices given its associated software prepares reports identifying the 50th Percentile and 85th Percentile speeds.
2. Record speeds of 100 vehicles for each direction of travel (observation need not exceed two hours even if less than 100 vehicles are recorded traveling in each direction over the entirety of the study area).
3. Speed checks should be taken at regular intervals using engineering judgment to adequately capture sample operating speeds throughout the study area.
4. Speed checks should be taken on weekday off-peak periods.
5. Speed checks should be taken to reflect only free-flowing vehicles.
    a. A vehicle is considered free flow if there is a minimum of five seconds gap (headway) from the other vehicle ahead of it, and it is not accelerating or decelerating for other reasons.
    b. If it is not possible to observe free-flow conditions, then the 85th-percentile speed of all vehicles should be increased 5 miles per hour to approximate the free-flow 85th-percentile speed.

1203-3.4 FHWA USLIMITS

USLIMITS is a web-based expert system tool designed to help practitioners with conducting an engineering study for setting reasonable, safe, and consistent speed limits for specific segments of roads.

USLIMITS was developed based on research through National Cooperative Highway Research Program (NCHRP). An expert panel, comprised of experienced traffic engineers and other subject matter experts, provided input to the development of the decision rules and logic flow employed within the tool. USLIMITS considers all major factors used by practitioners to make engineering judgment in determining an appropriate speed limit. This includes: operating speed (50th and 85th percentile), annual average daily traffic, roadway characteristics and geometric conditions, level of development in the area around the road, crash and injury rates, presence of on-street parking, and extent of ped/bike activity, as well as several others depending on the road type.

USLIMITS is applicable to all types of roads; however, it is not applicable to school zones, construction zones, or roads with variable speed limits that are raised or lowered based on weather, traffic conditions, or other factors. Engineering experience and knowledge should be used in collecting the required information and when

interpreting the results.

ODOT has adopted USLIMITS as its required method of setting reasonable, safe, and consistent speed limits within the State of Ohio in accordance with Ohio Revised Code 4511.21 as of July 19, 2024.

1203-3.4.1 Crash History Used in Completing USLIMITS

The following requirements and guidance concerning crash history data collection are specific to the engineering study process and utilization of **USLIMITS** for speed zoning in conjunction with a comprehensive safety study in Ohio under **ORC 4511.21**:

The crash history shall include the total number of speed related crashes and severity of those crashes that occurred within the study segment over the most recent 36 months where crash data is available.
Intersection crashes not on the approach to the section under study should not be included in the evaluation; and crashes at horizontal curves should be considered only after all appropriate Warning and Advisory Speed signs are in place.

Caution needs to be exercised in applying the crash experience if there is an over representation of crashes caused by situations essentially independent of the permanent speed limit. Therefore, in determining a permanent speed limit, crashes caused by animals, impaired drivers, vehicle defects, construction, traffic control devices, and environmental conditions, such as snow and ice, should not be included in the crash experience.

Documentation of the location and the type and severity of each crash shall be submitted with the request along with use of the Crash History Module in **USLIMITS**.

1203-3.5 Approved Speed Limit

The **District** will consider for approval the recommended speed limit from **USLIMITS**. If the requested speed limit is lower than the **USLIMITS** recommended speed limit, further study beyond the scope of a speed study will need to be conducted by the maintaining jurisdiction.

The approved speed limit shall not be less than the 50th percentile speed rounded to the closest 5 mph interval.

1213-2.2 Ball Bank Indicator

The ball bank indicator (BBI) should be mounted in a passenger car and carefully calibrated per the manufacturer's specifications. Several test runs are made in determining the speed to use. For each test run, the driver should:

1. Appraise the curve under observation to determine the approximate safe speed that may be maintained throughout the curve.
2. Conduct the first test at a speed 10 miles per hour below the appraised speed.
3. Make each succeeding test at a speed 5 miles per hour greater than the last one.
4. Attain the trial run speed on each test at a distance of at least one-quarter mile from the beginning of the curve.
5. Maintain a course throughout the curve precisely in the center of the lane and at uniform speed.

Form 1296-11 is a sample form for use in recording the results of this curve study and determining the recommended advisory speed. A full-size copy of the Curve Study Sheet is available from the Forms page on the Office of TSMO website.

1213-4.5 Project Scope

See the **Office of TSMO** website for the Traffic Signal Timing Scope.

1303-1 General

A primary goal of the Freeway Management System (FMS) is to provide reliable and timely travel information. This shall be achieved through the provision of route and segment-based travel times. Valid travel times are to be provided in real time, providing easily accessible information about delays.

Information dissemination will be accomplished using a variety of methods including:

- OHGO.com
- CCTV Cameras
- Dynamic Message Signs (DMS)
- Radio and television broadcasts (private sector leveraging FMS information)

It is the intended that **ODOT's** statewide FMS deployment will provide full coverage of six of the metropolitan areas with full instrumentation and communication to a central **Traffic Management Center (TMC)**, in accordance with the Regional Architecture prepared by the MPO in cooperation with **ODOT** and FHWA. The Regional Architectures are defined in the Detailed Project Plans, prepared under the direction of these same agencies.

See Chapter 1343 for information about the related C&MS sections and Supplemental Specifications.

The **ODOT** ITS infrastructure is maintained by the **Office of TSMO** - ITS Section.

The information provided herein is intended to provide designers all necessary details needed to develop a thorough plan for the ITS infrastructure.

1303-3 Requirements for All ITS Devices

When designing any ITS site which includes cabinets, devices, poles, structures, or other roadside obstacle, the designer shall take note of the layout of the surrounding area and make sure the location has the following attributes:

1. Prior to adding any ODOT-maintained ITS location, coordinate with the **Office of TSMO** – ITS Section to ensure the appropriate design layout is considered and performed.
2. ITS Devices should be located on relatively flat ground for ease of work pad installation and site maintenance. If flat ground is not accessible a work pad on sloped ground should be installed.
3. ITS Devices shall be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a safe and flat location to park maintenance vehicles (service trucks/bucket trucks) for at least 2 hours, along with a minimum of 250 feet of 12-foot wide paved shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and devices within 35 feet of maintenance vehicle accessible area. A safe parking location shall include a paved or aggregate 12-foot wide path to outside the clear zone, or a flat grassy area directly off the paved shoulder and protected/shielded from motorists by guardrail or concrete barrier. A break in the guardrail or barrier shall be provided to allow maintenance vehicles to backup into the protected area. The parking area and last 20ft of the access drive shall be 12:1 max. The remaining length of the access drive shall be no steeper than 6:1.
4. Device locations should be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.
5. Appropriate power services and grounding shall be designed. Power services shall be located near the power source from the power company (not near the device it is powering) in a clear and accessible area. This minimizes the need to have the power company add additional poles and service cable that would require special construction charges. Coordinate with the power company to determine the best location to install the power service and get the meter energized. From the power service, install underground conduit and pull boxes to the device location/cabinet (typically 2" conduit and 18" pull boxes per SCD ITS-14.10). For roadway crossings, 3" rigid conduit per 725.04 is preferred.

A single CCTV site requires a 120V power feed to the ITS Cabinet with a minimum of 20 amps design load. A higher design load will be needed for installs with multiple cabinets and/or devices. A single DMS install shall require a 120/240V AC power feed and a minimum of 50 amps design load. A higher design load will be needed for special DMS installations or installs with multiple DMS. For typical 120/240V single phase services (excluding DMS sites), install a minimum of 3 distribution cables (Hot, Neutral, Ground). DMS sites require 4 distribution cables (Hot, Hot, Neutral, Ground).

For locations where the cabinet/device is over 750 feet away from the power service/ meter, install a 240/480/V single phase service and a minimum of 4 distribution cables (Hot, Hot, Neutral, Ground), and install a 3 kVA Step-Down Transformer near the cabinet/ device per SCD ITS-50.11. A 7.5kVA Step-Down Transformer will be needed for DMS sites. Sites with multiple cabinets or devices will require larger Step-Down Transformers. Note that the practical limit of the dry-type encapsulated transformer specified in SS 809 is 25kVA. System grounding shall be installed per SCD ITS-50.10. See power service Standard Construction Drawings ITS-15.10 and ITS-15.11.

a. For instances where one power service is providing power to more than two dynamic message signs, item 809E65020, ITS Cabinet – Power Distribution Cabinet shall be utilized. This cabinet houses a load center with separate breakers for each cabinet, as well as separate lugs for multiple devices needing high amperage. When power cables are shared, design power conductors for the total load of all sites. After a 3-way splice, the conductor size may be reduced to carry the load of the individual site it is feeding.

Power services shall be designed with distribution cables based on appropriate voltage drop calculations. A maximum wire size of No. 1/0 AWG and a minimum of No. 6 AWG shall be used. Where No. 1/0 AWG wire is used, it must be spliced to No. 2 AWG wire in the pull box nearest the disconnect (disconnect entrances are typically too small to accommodate No. 1/0 AWG wires). The splice connections and smaller cable to the disconnect switch shall be incidental to the power service pay item per SCD ITS-15.10 or ITS-15.11. Voltage drop on a circuit shall not to exceed 5% nominal circuit voltage in steady state, since equipment can generally tolerate a voltage variance of 10%. The designer shall submit fusing recommendations to the ITS Engineer with the voltage drop calculations.

Only low voltage power for individual devices (PoE, <24 VAC, 57 VDC) is allowed through communication conduit and pull boxes. All other conductors shall be run through separate conduit with pull boxes labeled "Electric".

Follow the arc flash labeling requirements of Supplemental Specification 825. See TEM 1120-7 for more information. Provide this item for all ITS cabinets and disconnects/ safety switches.

6. SS 804 requires 150ft of fiber slack in each 32" pull box. To emphasize this requirement, designers should include slack callouts on plan sheets. When calculating fiber optic cable quantities, include the 150ft of slack in each pull box, any additional slack required, plus a 10% overage to account for any loss or unforeseen site conditions or elevation changes.

1303-4 Closed Circuit Television (CCTV)

CCTV cameras provide an opportunity for congestion and incident management verification. FMS areas function very efficiently with the use of CCTV cameras. They provide views of the highway system that can only be otherwise obtained by first hand viewers and provide a great amount of information to **Traffic Management Center (TMC)** operators. CCTV camera placement is expected to be at approximately 1-mile spacing to provide full coverage of the freeways. Cameras are usually located at interchanges which afford an opportunity to view not only the freeway mainline, but the ramps and cross routes as well. The viewing angle of the camera shall give preference to the freeway mainline with arterial coverage included to the extent possible. Each CCTV camera should be oriented so that minimal roadway is occluded. **Office of TSMO** - ITS Section prefers that a section in the middle of a ramp be chosen as the occluded area.

Most CCTV cameras installed for use in the FMS shall be of the pan-tilt-zoom type. CCTV cameras used in tunnels, trenches, or other areas where the cameras may have a high probability of being succumbed to moisture-spray from vehicles shall be tunnel/wall-mount cameras and/or thermal imaging cameras. Enhanced cameras with built-in analytics may be utilized in certain situations where the cameras can detect objects, queuing, or other events. Questions with regard to using enhanced cameras with analytics, should be asked to **Office of TSMO** - ITS Section. All of these cameras are referenced in the ODOT 809 Supplemental Specification.

The CCTV cameras are also in demand for use by local jurisdictions and other agencies, the media, and the public (via the internet). The central video control system is designed to accommodate external feeds of camera images. In cases where another agency wishes to access video feeds from the **TMC**, external users of the video will be required to sign a CCTV License Agreement. There shall be no fee for use of **ODOT** FMS video although the users must arrange for their own communication pathway to the **TMC** video server.

Information about operation of the CCTV cameras by **TMC** personnel, as well as remote access by authorized users, will be available from the O**ffice of TSMO**. This will include general rules for routine use of the cameras such as limitations on zoom functions during incidents and scenes involving solely private property. When CCTV cameras are being manipulated or are zoomed in to assist with an incident, the video signal from the server is generally blocked. It may be necessary to disable the video feed manually, or it may be an automatic software function, depending on the FMS software version. Generally, CCTV camera images will be recorded for a period of three days and then automatically overwritten.

When designing a CCTV site, the designer shall take note of the layout of the surrounding area and make sure that the camera location has the following attributes:

1. Prior to adding a camera to any **ODOT**-maintained location, coordinate with the **Office of TSMO** - ITS Section to ensure the appropriate design layout is considered and performed.

2. CCTV will have good view of all roadways. CCTVs placed at curvatures in the road should be placed on the outside of curves so that both directions can be seen.

3. CCTVs located in interchanges should be centrally located so that both on ramps can be viewed. This will provide monitoring for future ramp metering.

4. CCTVs should be located on relatively flat ground for ease of work pad installation and site maintenance. If flat ground is not accessible a work pad on sloped ground should be installed per ITS-50.12.

The designer shall utilize Table 1397-4 to design CCTV sites using the appropriate pay items, and including the appropriate Traffic Standard Construction Drawings (SCDs) and Supplemental Specifications on the plan cover sheet. The following is a more descriptive listing of the information provided in the table:

1. The appropriate CCTV Camera shall be chosen.
    a. Use a CCTV IP-Camera System, PTZ (809E60000) on straight sections of roadway where few directions need to be viewed at once.
    b. Use a CCTV IP-Camera System, Wall/Tunnel (809E60010) where the camera is to be located inside a tunnel and/or wall. This type of camera allows for dirt to be removed from the lens more easily and also tends to be less maintenance extensive in this type of installation.
    c. Use a CCTV IP-Camera System, Portable (809E60020) where there is need for a temporary CCTV to be setup, such as in a work zone. If needed, there are options to install other camera types in a temporary fashion as well. Contact the **Office of TSMO** – ITS Section for details.
    d. Use a CCTV IP-Camera System, Enhanced (809E60030) when specified by OTO. This is a PTZ camera with enhanced analytics capabilities.
    e. Use a CCTV IP-Camera System, Quad Multi-View Fixed with PTZ (809E60040) at interchanges and overpasses/ underpasses. The four fixed cameras can be aimed to view all four roadway directions at once, while the PTZ allows individual incidents to be viewed.
    f. Use a CCTV IP-Camera System, Multi-View (809E60050) when multiple fixed directions need to be viewed at once.
    g. Use a CCTV IP-Camera System, Fixed-View (809E60060) when one specific location needs to be viewed, such as underneath a large railroad bridge or up a ramp.
    h. Use a CCTV IP-Camera System, Wrong Way Detection (809E60070) as part of wrong way detection systems. The camera has software that can be configured to detect wrong way drivers.
2. The appropriate CCTV pole height shall be chosen.
    a. The standard installation requires the use of 70-foot poles, utilizing pay item **809E61020, CCTV Pole, 70' Tall.**
    b. The use of 50-foot poles is not allowed unless directed by the ITS Section. During the review process, ITS Section will review the plans and if necessary, may advise the designer to utilize item **809E61040, CCTV Pole, 50' Tall** in some locations.
    c. Design the camera pole foundation in accordance with the Geotechnical Design Manual (GDM) Section 1200.

3. The appropriate ITS cabinet type shall be chosen.

    a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted**.

    b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by the ITS Section.

4. Appropriate power services and grounding shall be designed. See section 1303-3 for requirements for All ITS Devices.

Also see **Plan Note 1342-2 and 1342-16** ***(TEM Section 1342)***.

1303-5 Communication

ITS communication systems are critical to successful operation. **ODOT** has determined that the most effective (high-level) system requirement for ITS communications is to build upon the core **ODOT** network with robust security standards/ protocols for devices connecting in from the field. Therefore, field device communications shall use Ethernet and other devices compatible with equipment routinely used by **ODOT**. The ITS network shall be separate from the **ODOT** network although there will be connectivity between the two systems. **ODOT** network interoperability is coordinated with the **Office of TSMO** ITS Field Operations and the Network Operations Center of the ODOT Division of Information Technology (DoIT).

Fiber optic cable is the medium of choice, although many "last-mile" and point-to-point applications require wireless or other forms of wire-line communications (e.g. Leased Telecom Lines, Wireless Radios, Cellular). Communications redundancy in the field is desired and shall be designed accordingly. Redundancy in some areas will be limited until additional funding is available or new techniques are developed. **TMC** operational redundancy shall be provided via backup Buckeye Traffic Servers.

To facilitate standardized communication protocols, NTCIP-compliant devices will be used when possible. Field device communication represents a significant cost in the design, deployment and operation of an FMS. **ODOT** systems will use a hybrid of Ethernet-based fiber optic and wireless communications to maximize bandwidth for the least cost to support the field infrastructure. Connectivity is desired for remote operations and "pushing" video and data to a number of external users/agencies. Wireless communication devices shall be supplied by the maintaining agency. Coordinate with the maintaining agency to determine communications requirements. See **Plan Note 1342-5 (TEM Section 1342)**. The central software system shall be designed to provide flexibility in the provision of access by others outside the **TMC** and the FMS/**ODOT** networks. An internet connection to the FMS network will be the most effective means of providing access to the system.

When designing plans that include fiber optic cable as a communication method, figures shall be included to show how the fiber optic cable is to be terminated/ spliced at each location. These figures include one figure per field cabinet ***(e.g.,*** Figure 1398-2***: Node Cabinet Assembly)***, one figure per splice enclosure ***(e.g.,*** Figure 1398-3***: Underground Splice Enclosure)***, one figure showing a high-level splicing scheme for the entire project ***(e.g.,*** Figure 1398-4***: Fiber Backbone Splice Chart)***, and a high-level device communication plan/ block-diagram for the entire project ***(e.g.,*** Figure 1398-5***: ITS Device Communication Diagram)***.
For **ODOT** projects with fiber interconnect, coordinate the termination diagrams with the **Office of TSMO** ITS Field Operations, and necessary diagrams or high-level diagrams can be provided.

When designing projects for current or future ITS deployments, the designer shall incorporate infrastructure containing conduit and fiber optic cable. While it may not always be possible or feasible to install fiber optic cable with projects, all effort should be made to include conduit infrastructure so that fiber optic cable can be installed

with minimal effort in the future. The following parameters shall be followed when installing communications infrastructure.

1. All median wall construction shall include one 2-inch multi-cell HDPE conduit. A micro-duct pathway, combination or empty 2-inch conduit raceway with micro-duct innerducts may alternatively be installed, as determined by the ITS Engineer during the design process. Median wall junction boxes shall be installed at a maximum of 1,000 feet apart for traditional multi-cell HDPE conduit, or a maximum of 2,000 feet apart for micro-duct pathway installations, and on each side of bridge structures. Refer to **Plan Note 1342-12** ***(TEM Section 1342-12)*** for median junction box notes. Contact the **Office of TSMO** - ITS Section for Typical Plan Drawings to be included in the plans.
2. Multiple Cell Conduits, Micro-Duct Pathways and Conduit Raceways placed within concrete barrier are incidental to the barrier per roadway standard drawings RM-4.3 through RM-4.8. Micro-duct innerducts, whether installed in new construction or retrofitting an old conduit system, should be itemized separately because this work is often completed by a subcontractor. Laterals from median wall to pull boxes, regardless of conduit type, should also be itemized separately for the same reason.
3. Installing conduit across an existing bridge will require a site-specific design due to varied bridge layouts. Consult OSE and district bridge engineers for guidance. The ITS Section can provide examples. Also provide an updated load rating analysis for the bridge.
4. Lateral crossings out of medians (barriers and grass) shall be installed at a maximum of every 4,500 feet and at all interchanges for future and existing device communications, as well as at slack storage locations. The lateral crossing shall include 2 conduits of the same type used in the median wall. A 32-inch pull box shall be installed in the shoulder of each lateral crossing. Contact the Office of Traffic Operations for Typical Plan Drawings to be included in the plans.
5. Conduit infrastructure buried in earth shall contain one 2-inch multi-cell HDPE conduit or a micro-duct pathway or combination, as determined by the ITS Engineer during the design process. Pull boxes shall be 32-inch typically but shall be 48-inch where splice enclosures will be installed. ITS pull boxes shall not be placed or buried in pavement. On steep slopes pull box lids can slide and cause difficulty for workers; therefore, call out a hinged pull box when a 32” or 48” pull box will be placed on a slope 4:1 or greater. Hinged pull boxes shall be installed so that the lid swings towards the bottom of the slope (i.e. hinge on the low side). The maximum spacing of pull boxes shall be 500 feet. If micro-duct pathways are installed, the maximum spacing shall be up to 2,000 feet, with continuous conduit pathways up to a maximum distance of 4,000 feet by continuing the conduit through the middle of every other pull box via the use of conduit couplers per manufacturer recommendations. (see Traffic SCDs ITS-14.10 and 14.11).
6. For multi-cell conduit refer to **Plan Note 1342-8** ***(TEM Section 1342-8)***.
7. For fiber optic installations in long haul installations, such as on interstates between metropolitan areas, a combination of air-blown fiber and micro-duct pathway shall be utilized. Refer to ODOT Supplemental Specification 804/904 for details regarding this method.

8. For fiber optic installations on signalized corridors, where there is not ample right-of-way to install fiber optic cable traditionally, as specified in 3. above, air-blown/pushable fiber optic cable shall be installed by saw cutting the pavement and installing a micro-duct pathway.

9. Underground warning/marking tape per CMS 725.22 shall be installed in all trenches containing underground communication conduit. Tape shall be terminated in communication cable markers. For underground warning/ marking tape specifications, refer to **Plan Note 1342-9** ***(TEM Section 1342-9)*** to be included in plans.

10. Communication cable markers shall be used and installed whenever ITS communication conduit is installed, even if the conduit is to remain empty until a future date. Refer to **Plan Note 1342-10** ***(TEM Section 1342-10)*** for specification to be included in plans.

11. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

12. Any conduit installed within 6 feet of guardrail shall be concrete-encased.

The following list outlines additional requirements:

1. For fiber optic design, the general rule of thumb is that any fiber cable shall be spliced in pull boxes closest to the cabinet locations and drop cable shall be utilized to connect to the cabinet. The general practice is to use drop cable to connect to one buffer tube in each direction of the trunk cable and terminate the drop cable into the cabinet.

Locations identified as Node sites by the **Office of TSMO** - ITS Section during review will generally have more than one buffer tube terminated at them. The designer will be directed by the ITS Section as to which fibers will terminate at which cabinets during review.

1303-6 Dynamic Message Signs (DMSs)

Dynamic Message Signs (DMSs) are a key component to an effective FMS. The installation of DMSs can help to reduce traffic congestion during incidents and will help to provide travelers with real time traffic information.

DMSs shall be installed at strategic locations on urban freeways to advise drivers of incidents and warn of congestion or stopped traffic. Generally, no alternate route will be specified, although the messages on the signs may suggest the use of alternate routes, and DMS locations should generally be in advance of major system interchanges where motorists can divert to alternate routes. When no particular incidents are worthy of mention, the default message, with travel time through key segments of the urbanized area, shall be displayed.

When considering DMS for non-urban areas, many factors shall be considered to make sure there is an appropriate benefit and need to the initial and ongoing costs. Data shall be presented to the **Office of TSMO** - ITS Section to show the purpose and need is warranted, including ADT, crash data, origin-destination data, bottle neck reports, good alternate routes, event traffic spikes, etc. The ITS Section will consider Input from the Traffic Management Center (TMC), the District, and other ODOT offices. The ODOT District shall send all outside agency requests while in the planning stages to the ITS Section for review and approval. District shall not approve of any outside requests without the approval of the ITS Section. The DMS location must be approved by the ITS Section before being designed and installed.

When designing a DMS site, the designer shall take note of the layout of the surrounding area and make sure that the DMS location has the following attributes:

1. DMS shall be located at points in the roadway that allow for motorists to view the sign at the greatest distance away. Most DMS have a viewing distance of approximately 1,100 feet. DMS should be located in an area that provides a straight roadway for that distance.
2. DMS cabinets should be located on relatively flat ground for ease of work pad installation and site maintenance. If site conditions present a condition where flat ground is not accessible, a sloped work pad should be installed. Details on the sloped work pad can be obtained from SCD's.
3. A single DMS requires a 120/240 VAC power service and a minimum of 50 amps design load. A higher design load will be needed for special DMS installations or installs with multiple DMS.

The designer shall utilize ***Table*** 1397-5a ***or*** 1397-5b to design DMS sites using the appropriate pay items, and including the appropriate standard drawings and Supplemental Specifications on the plan cover sheet. Table 1397-6 provides similar information for Destination DMS (DDMS) installations. The following list outlines additional requirements:

1. The appropriate DMS Type shall be chosen.
    a. For most installations along the freeway the **809E63000, DMS Full-Size Walk-In** shall be utilized.

b. For Queue Warning System installations, the standard installation requires a smaller sign than typically used for freeway DMS. The appropriate sign pay item is **809E63010, DYNAMIC MESSAGE SIGN (DMS), Front- Access**.

2. The appropriate mount type shall be chosen.

a. Truss Mount is typically chosen when the roadway is more than 3 lanes in the direction of the DMS and the placement of the DMS is needed over the inside lanes. This mount is also used when little to no shoulder is available for the placement of a pedestal mount sign. The truss will need to be sized accordingly for the location.

i. The related pay item for the catwalk is **630E70051, Catwalk, DMS Truss, As Per Plan** and **Plan Note 1342-10** ***(TEM Section 1342-10)***.

ii. The DMS Truss pay items are **630E70001, 630E70021, 630E70041** for the various lengths of trusses.

iii. Truss foundation pay items are **630E70070, Concrete Barrier Median Overhead Sign Support Foundation, DMS Truss and 630E70080, Overhead Sign Support Foundation, DMS Truss**.

b. Pedestal mounted signs are generally used more often and are usually less expensive and affect traffic less when installation is being performed. They are typically installed in areas with 3 lanes or less but may also be used in areas with more lanes as they are still effective.

i. The related pay item for the catwalk is **630E70061, Catwalk, DMS Pedestal, As Per Plan**.

ii. The DMS pedestal pay item is **630E70045, Overhead Sign Support, DMS Pedestal, As Per Plan**.

iii. The pay item for the foundation is **630E84511, Rigid Overhead Sign Support Foundation, As Per Plan**. Plans should also include **Plan Note 1342-10** ***(TEM Section 1342-10)***.

3. The appropriate ITS cabinet type shall be chosen.

a. The standard installation requires the use of special ground-mounted cabinets with power load centers, utilizing pay item **809E65000, ITS Cabinet – DMS**.

b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by the **Office of TSMO** – ITS Section.

4. Appropriate power services and grounding shall be designed. See Section 1303-3 for requirements for All ITS Devices. For typical 120/240V single phase services for DMS, install a minimum of 4 distribution cables (Hot, Hot, Neutral, Ground). For locations where the cabinet/device is over 750 feet away from the power service/meter, install a 480/240V single phase service and a minimum of 4 distribution cables (Hot, Hot, Neutral, Ground), and install a 7.5 kVA Step-Down Transformer near the cabinet/device per SCD ITS-50.11. Sites with multiple cabinets or devices will require larger Step-Down Transformers. Note that the practical limit of the dry type encapsulated transformer specified in SS 809 is 25kVA. System grounding shall be installed per SCD ITS-50.10. See power service Standard Construction Drawings ITS-15.10 and ITS-15.11.

a. For instances where one power service is providing power to more than two dynamic message signs, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet, as well as separate lugs for multiple devices needing high amperage. When a Power Distribution Cabinet is required, the adjacent Electric pull box shall be 24". When power cables are shared, design power conductors for the total load of all sites. After a 3-way splice, the conductor size can be reduced to carry the load of the individual site it is feeding.

Also see **Plan Note 1342-3** ***(TEM Section 1342-3)***.

1303-7 Vehicle Detection or SFRD

For an FMS, the conventional form of vehicle detection is side-fired radar detector (SFRD) with algorithms which manipulate the detector to develop speed, volume and occupancy or density. This data can be used for both the calculation of travel times and incident identification. In many states, the use of fixed-point detection for incident detection has proved to be costly and ineffective. Various types of detectors have been implemented with varying degrees of success. The current practice for obtaining travel-time information is using probe data, typically through cellular phone GPS, or mainline vehicle detection, typically through radar or loops.

Various technologies are available to provide travel times. The incidents are verified, and travel times can be corroborated using CCTV.

The main use of SFRD is for ramp metering. The detectors provide traffic data to both the local ramp meter and central software and allow for dynamic ramp metering along corridors and localized traffic-responsive ramp metering at spot locations.

For a ramp meter, when designing a SFRD site, the designer shall take note of the layout of the surrounding area and make sure that the SFRD location is designed per SCD ITS-76.10. If the radar placement cannot be made on the mast arm per the SCD due to site constraints, the radar can be placed typically 500 feet downstream of the merge point on the new ramp installations following PIS 207610

A standalone SFRD design shall have the following attributes:

1. SFRDs are typically located near existing or proposed ITS cabinets with network communications.
2. SFRDs should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet and SFRD within 35 feet of maintenance vehicle accessible area.
3. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

The designer shall use Table 1397-7 to design SFRD sites using the appropriate pay items, and including the appropriate standard drawings and Supplemental Specifications on the plan cover sheet. The following list outlines additional requirements:

1. The appropriate SFRD Type shall be included.
    a. For all installations, pay item **809E68900, Side-Fired Radar Detector** shall be included in the plans.
2. The appropriate mount type shall be chosen.

a. Typically, SFRD's are mounted to steel poles with break-away bases.

b. The proper pay items are **625E10491, Light Pole, Conventional, Each, As Per Plan and 625E14501, Light Pole Foundation, As Per Plan**.

3. The appropriate ITS cabinet type shall be chosen.

a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ground Mounted**.

b. The use of ITS Cabinet – Pole Mounted is not allowed unless directed by the **Office of TSMO** – ITS Section.

Also see **Plan Note 1342-4** ***(TEM Section 1342-4)***.

1303-8 Highway Advisory Radio (HAR)

Highway Advisory Radio (HAR) installations must be approved by the **Office of TSMO** – ITS Section. Due to newer and aging technology, HAR installations are being discontinued.

1303-11 Ramp Metering

Ramp Metering is another key FMS component (see OMUTCD Chapter 4P). Its basic function can help to greatly reduce traffic congestion in FMS areas and result in more efficient travel. There are several modes of ramp meter operation, including the following:

- Corridor-based Traffic-Responsive (using mainline and ramp traffic flow data from upstream and downstream stations).
- Local Traffic-Responsive (activated by mainline congestion or speeds at the ramp location).
- Pre-timed (Time-of-Day).
- Manual (locally through controller front display).
- Downloadable (from the **TMC**) ramp timing changes.

Properly timed and operating ramp meters help the mainline to maintain steady flow, resulting in less mainline rear-end crashes, while adding a few less severe crashes on ramps.

Ramp Metering is currently provided in the following metropolitan areas:

Columbus	**District 6** currently operational with new installations underway
Cincinnati	**District 8** currently operational with new installations underway

Ramp Metering may be provided in the following metropolitan areas as conditions warrant:

Toledo	**District 2**
Akron/Canton	**District 4**
Dayton	**District 7**
Cleveland	**District 12**

Special design considerations are needed for non-standard ramps or ramps with inadequate storage capacities or acceleration lengths. Nonstandard ramps will be metered on a case-by-case basis, although system-wide metering is the intent. Ramp Design Guidelines which provide law enforcement pads are included in **SCD ITS-76.10**. In all cases, it will be necessary to provide surveillance of the ramp meters through CCTV cameras or other means to ensure congestion is not aggravated by the metered condition.

When designing a Ramp Metering site, the designer shall take note of the layout of the surrounding area and make sure that the Ramp Meter location has the following attributes:

1. Ramp Meters are typically located along major corridors located in major metropolitan areas.
2. Ramp Meters should be located in areas that provide adequate access for ITS maintenance operations. These locations shall provide a minimum of 250 feet of 12-foot wide shoulder to be utilized for deceleration and acceleration. In addition, all efforts shall be made to locate the cabinet within 35 feet of a maintenance

vehicle accessible area. Ramp meter cabinets should also be located in areas where the ramp meter signal heads are clearly visible to verify the proper operation of the meter at the Stop Line.

3. Device locations shall be designed so that maintenance personnel do not have to cross ditches or streams, as these areas fill up with water during parts of the year and present a hindrance to ITS maintenance operations.

The designer shall use Table 1397-9 to design ramp metering installations using the appropriate pay items, and including the appropriate standard drawings and Supplemental Specifications on the plan cover sheet. The following list outlines additional requirements:

1. The appropriate Ramp Metering items shall be included.
    a. For all new ramp metering, itemize pay items similarly to Traffic Signal pay items (see Signal Design Reference Packet, SDRP, for details).
    b. If training is requested, pay item **809E67050, Ramp Metering Training** shall be included.
2. The appropriate ITS cabinet type shall be chosen.
    a. The standard installation requires the use of ground-mounted cabinets, utilizing pay item **809E65000, ITS Cabinet – Ramp Meter**.
    b. For instances where one power service is providing power to multiple cabinets or multiple devices, item **809E65020, ITS Cabinet – Power Distribution Cabinet** shall be utilized. This cabinet houses a load center with separate breakers for each cabinet and is also capable of housing smaller wall mount power transformers. When a Power Distribution Cabinet is required, the adjacent Electric pull box shall be 24". When power cables are shared, design power conductors for the total load of all sites. After a 3-way splice, the conductor size can be reduced to carry the load of the individual site it is feeding.

Also see **Plan Note 1342-6** ***(TEM Section 1342-6)***.

1303-14 Variable Speed Limits

ORC Section 4511.21(H)(3) allows the **Director** to establish a Variable Speed Limit that is different from the established speed limit for weather conditions, traffic incidents and congestion that occur on all or portions of I-670, I-275 and I-90 (at the intersection with I-71 and continuing to the Ohio-Pennsylvania border) and up to two additional locations. The Traffic Management Center (TMC) has standard operating procedures (SOP) for controlling variable speed limits.

Variable speed limit signs (VSLs) are standalone units that may be ground mounted, pole mounted or mounted to concrete barrier. Along managed lane corridors VSLs may also be displayed digitally within overhead dynamic message signs.

Work Zone Speed Zones (WZSZ) and accompanying Digital Speed Limit Signs (DSLs) are not applicable to this section. Information may be found in TEM 640-18.

Contact the **Office of TSMO** for additional information.

1303-15 Part-Time Travel on a Shoulder

Part-Time travel on a shoulder is also known in various places as managed lanes or hard shoulder running. It allows the shoulder, typically the left shoulder, to be used as an extra lane of travel during certain times to alleviate congestion and to aid in incident management.

The **MUTCD** (Chapter 4T) allows two general approaches for part-time travel on a shoulder: dynamic, requiring the use of electronic dynamic message signs; and fixed, requiring the use of flatsheet R3-51 signs. The dynamic approach provides more flexibility to respond to incidents and unexpected congestion than the fixed approach does.

Maintenance access should be evaluated when deciding the type of sign support to use.

During preliminary engineering, perform an alternatives analysis comparing the costs of opening the shoulder on a dynamic basis, opening the shoulder on a fixed time-of-day basis and building out an additional full-time lane. The cost of any additional ITS Maintenance personnel and TMC personnel should be considered in this analysis.

Additional information on part-time travel on a shoulder can be found in the statewide SEA and the ATDM study. Contact the **Office of TSMO** for more information.

1303-16 Wrong Way Vehicle Detection Systems

1303-16.1 Existing Conditions

Before a Wrong Way Vehicle Detection System will be installed, the following conditions shall be considered and rectified if applicable:

- Does the location have unique Geometry? (partial cloverleaf, etc.)
- Is there any crash history?
- Are all signs, pavement markings, channelizing devices and signals installed per the **OMUTCD** and **ODOT** Standards?
- Are supplemental signs provided on the approaching roadways and are the ramps per TC-73.20?
- Are all traffic control devices in good condition?
- Are all traffic control devices clearly visible during both daytime and nighttime conditions? (i.e. no obstructions, sign reflectivity, etc.)
- Are there traffic signal head alignment issues?
- Is Interchange lighting present to help nighttime motorists distinguish the ramp configuration?
- Is there any noticeable difference in traffic activity during nighttime conditions compared to daytime?
- Are there any other items that could cause motorist confusion?

The FHWA website provides further guidance that may be used when evaluating a potential Wrong Way Vehicle Detection System location.

1303-16.2 Functional Requirements

The following countermeasures to enhance the safety of ramp configuration should be considered only after all the traditional signing, lighting, pavement marking, delineation/channelization and traffic signal improvements etc. are found to be in accordance with the **OMUTCD** and **ODOT** standards:

1. Install a Wrong Way CCTV with analytics (ramp/ mainline as needed) per SS 909.03.H with an alert system for remote monitoring at subject locations where there is a potential for wrong way drivers. The location will then be monitored by the Statewide TMC to determine if additional countermeasures are needed.
2. If there are confirmed instances where motorists are driving the wrong way after the installation of CCTV with analytics or from an existing ITS camera, but such instances do not result in crashes and or freeway entrances (just turnarounds) consider installing LED enhanced Wrong Way/ Do Not Enter signs that flash 24/7.
    1. If it's desired to install LED enhanced Wrong Way/ Do Not Enter signs that flash only when there is the presence of a wrong way driver, the Wrong Way CCTV per SS 909.03.H shall be installed with the

addition of a controller with logics and cabling locally connected to activate the signs. The wrong way camera equipment and controller/wiring may be housed inside the traffic signal controller cabinet or shall have a separate ITS cabinet enclosure nearby. Coordinate with the **Office of TSMO** – ITS Section for the design and requirements of each location.

The **Office of TSMO** and **Office of Safety** must approve of the installations of such systems.

If there are no wrong way incidences for 3 years, the LED enhanced signs may be removed upon end of life or engineering judgement.

1342-2 As-Built Construction Plans

The Contractor shall provide As-Built Construction plans of the ITS infrastructure installed on the project with GPS Coordinate data, pictures, and information according to ODOT Supplemental Specification 809.

1342-3 ITS Median Wall Raceway and Conduit System

This is a field constructed multi-cell conduit system consisting of one 2-inch HDPE median wall raceway and two 2-inch HDPE laterals from the median wall junction boxes to 32" pull boxes in the shoulder with continuous micro-duct innerducts installed in the raceway and laterals.

One 2-inch HDPE conduit shall be installed in the median barrier wall per ODOT standard construction drawings ITS-14.50 and ITS-14.60. Two 2-inch HDPE conduits shall be installed for lateral crossings from the median wall junction boxes to 32" pull boxes in the shoulder.

2-inch HDPE conduits shall conform to Supplemental Specification 909.14.C.

Install 4-14mm/10mm (OD/ID) micro-ducts listed on the TAP conforming to ODOT Supplemental Specification 909.14.B in the median wall raceway and lateral crossings. Use the colors blue, orange, green, and brown to identify the micro-ducts. Install per ODOT standard construction drawings ITS-14.50 and ITS-14.60. The micro-ducts shall be continuous, unspliced/uncoupled segments from 32" pull box in the shoulder through the lateral crossings, median wall raceway, and median wall junction boxes to the next 32" pull box in the shoulder. Continuous micro-duct segments shall not exceed 4500'.

Micro-ducts shall be capped/plugged during installation to prevent liquid and debris from contaminating the micro-ducts and impeding fiber optic cable installation. Immediately after installation the micro-ducts shall be capped with manufacturer recommended push-on caps.

1342-11 DMS & DDMS Support Structures

The Contractor shall furnish and install this item according to ODOT Supplemental Specification 809, as well as any Standard Construction Drawings noted on the plans.

The Contractor shall furnish shop drawings to the Project Engineer for approval. The drawings shall be stamped by a Professional Engineer from the manufacturer. The item shall not be released for construction until approved by the **Office of TSMO** - ITS Section.

Designer Note: See Tables 1397-5a, 1397-5b and 1397-6 for additional information.

1342-13 Utilities

Designer Note: Note G102A is used on all plans where utilities presently exist within the construction limits of the project. Include the **Office of TSMO** – ITS Section as a utility owner when there will be work in the vicinity of ITS devices (fiber optic cable, CCTV, DMS, etc.).

ODOT Office of TSMO - ITS Section
1606 W Broad St
Columbus, OH 43223
614-387-4113
cen.its.lab@dot.ohio.gov

Include ODOT Office of Technical Services, Traffic Monitoring Section as a utility owner when there will be pavement milling or excavation in the vicinity of permanent vehicle count stations (also known as ATRs and WIMs).

ODOT Office of Technical Services
Traffic Monitoring Section
1980 W Broad St
Columbus, OH 43223

Field Operations	Vacant (Contact Anthony Stevens)	614-301-9461
District 2, 3, 12	Ronda Keller	614-965-4463
District 5, 6, 9, 10	Elizabeth Murphy	614-204-0291
District 4, 11	Darren Gerstenslager	614-273-4783
District 1, 7, 8	Colin Stone	614-852-7374

1342-16 CCTV Pole, __ Feet Tall

The Contractor shall furnish and install this item according to **ODOT** Supplemental Specification 809, as well as any standard construction drawings noted on the plans. The Contractor shall determine which type of pole to furnish and install (concrete or steel) when bidding on this item. The pole and foundation/embedment are incidental to this item regardless of material type. The Contractor shall also provide and install one complete lowering unit tool assembly per camera for lowering cameras per Supplemental Specification 809 (paid separately).

The Contractor shall furnish/install poles with the correct length/embedment and all couplings, handholes, etc., in the appropriate location above ground according to SCD ITS-12.10 or ITS-12.11.

For this site, located at _____, the pole height shall be __ ft above ground. The embedment depth for a concrete pole shall be __ ft. A special foundation design (is/ is not) required for a steel pole. (Include additional special foundation design and requirements here if needed.) (For projects with multiple camera poles, a table of all locations and embedment/foundation requirements can be provided here in this note in lieu of writing a paragraph for each location. If special foundation designs are required, those requirements likely need a separate paragraph for each location below the table.)

The Contractor may furnish/install longer overall length concrete poles at a deeper embedment depth if it is more beneficial for manufacturing, shipping, etc., as long as all above ground components maintain appropriate height level.

The Contractor shall submit all pole manufacturer fabrication drawing submittals, as well as installation procedures and backfill material, to the Engineer for acceptance before ordering.

Payment for each pole complete, installed, and accepted shall be made at the unit bid price for item 809, CCTV Pole, ____ Tall.

Designer Note: A contractor may choose to install either a concrete pole or a steel pole. It is essential to fill in the foundation information for both types of poles for accurate bidding.

Concrete poles are typically embedded in a foam foundation. Determine the embedment depth required for a concrete pole using Section 1200 of the ODOT Geotechnical Design Manual.

Steel poles use a concrete foundation. Use the standard foundation design provided in ITS-12.11, Note 4 unless the geotechnical exploration shows that the soil properties are not met. In that case, a special foundation design per Section 1200 of the ODOT Geotechnical Design Manual is required.

The foundation is included in the item regardless of material type. The designer should provide the design requirements for each type of foundation in the plans. The designer should contact the Office of TSMO – ITS Section and Office of Geotechnical Engineering as soon as possible with exact pole locations, also referencing any

available soils data, so the design requirements can be determined and coordinated for each location to include in this plan note.

An example table of multiple sites and the fields required is below.

Site #	Sheet #	Location Name	Latitude	Longitude	Expected Soil Conditions Description	Boring ID	Concrete Pole Embedment Depth (Feet)	Steel Pole Special Foundation Required (Y/N)

1360-1 Inspections

A statewide uniform practice for the periodic inspection of ODOT- maintained ramp meters, dynamic message signs, and CCTVs is necessary to assure their structural and operational integrity. Ramp meters should be inspected structurally and operationally annually. DMS supports should be inspected structurally on a five-year interval. CCTV and other devices should be inspected structurally and operationally every two years. The inspections should be conducted in a systematic and organized manner that will be efficient and minimize the possibility of any item being overlooked. The use of the ODOT ITS Collector App is required. The Collector App provides all of the required inspection fields.

At a minimum, supports should be visually inspected from the ground. Items to be inspected should include, but not be limited to, foundation concrete, soil around foundation, anchor bolts and nuts, structural members, and structural connections. Binoculars should be used as an aid for visual inspections. Use of a bucket truck or other means to achieve arm-length visual inspection (VI) is recommended but not necessary on an annual basis. Arm-length VI may be used to more closely examine a defect that has been detected from the ground. There are many kinds of structural tests available, and Districts may contact the office of Roadway Engineering, TSMO or Structural Engineering for assistance.

Anchor bolts should be tested for structural integrity visually (especially between the foundation and base plate) and by sounding with a hammer. Non-destructive testing procedures, such as ultrasonic thickness testing (UT), and crack detection by dye penetrant (DPT) and magnetic particle (MPT) are not necessary on a routine basis but can be used to define the extent of a defect that has been detected by visual means. Inspection records shall be kept adhering to **DAS** RIMS Retention policy.

Deficiencies to be inspected for should include, but not be limited to, cracks in concrete, soil erosion, non-bearing leveling nuts, loose anchor nuts, bent or distorted structural members, cracked welds, missing or loose hardware, visible gaps between attachment plates, and corrosion. Corrosion of poles at the base of the tube is significantly enhanced by moisture and salt trapped by dirt, debris, and ice build-up under the base plate; the space between foundation and base plate shall be cleaned to allow for drainage and airflow. Varmint guards shall be removed to permit inspection of anchor bolts, leveling nuts, foundation and blocking by debris. When inspection reveals buried foundation tops, they must be exposed, and the adjacent ground surface corrected by maintenance personnel.

Appropriate corrective action, in accordance with sound engineering practices, should be taken to correct detected deficiencies. Repairs should be made within a reasonable time frame, commensurate with the extent of the deficiencies found. Temporary remedial actions, up to and including complete removal of the structure, may be appropriate until permanent repairs can be accomplished. Written documentation of corrective actions should be kept.

CCTV Installations
(TEM 1303-4)

Task	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
Choose CCTV Camera		CCTV IP-Camera System, PTZ	809.05.B	809E60000	
	*	CCTV IP-Camera System, Wall/Tunnel	809.05.C	809E60010	
	*	CCTV IP-Camera System, Enhanced	809.05.E	809E60030	
	*	CCTV IP-Camera System, Quad Multi-View Fixed with PTZ	809.05.F	809E60040	
	*	CCTV IP-Camera System, Multi-View	809.05.G	809E60050	
	*	CCTV IP-Camera System, Fixed View	809.05.H	809E60060	
	*	CCTV IP-Camera System, Wrong Way Detection	809.05.I	809E60070	
Choose Pole	*	CCTV Pole, 50’ Tall	809.06	809E61040	**ITS-12.10** **ITS-12.11**
		CCTV Pole, 70’ Tall	809.06	809E6120	**ITS-12.10** **ITS-12.11**
Lowering Unit		CCTV Lowering Unit	809.07	809E61090	
Choose Cabinet Type	*	Pole Mounted	809.09.B	809E65010	**ITS-11.10**
		Ground Mounted	809.09.A	809E65000	**ITS-10.10**
Work Pad		Incidental			**ITS-10.11**

Grounding		Ground Rod		625E32000	**ITS-50.10**
Choose Power Service		Ground Mounted, 60 amp	809.03.C	809E51000 809E52000 809E52001	**ITS-15.10**
		Pole Mounted, 60 amp	809.03.C	809E55000 809E56000 809E56001	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet - Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from **Office of TSMO – ITS Section**					

Dynamic Message Sign (DMS), Full-Size Walk-In Installations(TEM 1303-6)

Task	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
DMS Type	*	Dynamic Message Sign (DMS), Full-Size Walk-In	809.08.A	809E63000	
Choose Mount Type		Overhead Sign Support, DMS Pedestal		630E70044	**ITS-30.13**
	*	Overhead Sign Support, DMS Truss, 80’		630E70000	**ITS-35.13**
	*	Overhead Sign Support, DMS Truss, 115’		630E70020	**ITS-35.13**
	*	Overhead Sign Support, DMS Truss, 150’		630E70040	**ITS-35.13**
Choose Foundation	*	Concrete Barrier Median Overhead Sign Support Foundation, DMS Truss		630E70070	**ITS-36.12**
		Overhead Sign Support Foundation, DMS Pedestal		630E70082	**ITS-30.12**
	*	Overhead Sign Support Foundation, DMS Truss		630E70080	**ITS-35.12**
Choose Catwalk	*	Catwalk, DMS Truss		630E70050	**ITS-35.11**
		Catwalk, DMS Pedestal		630E70060	**ITS-30.11**
Cabinet Type					
		ITS Cabinet - DMS	809.09.E	809E65040	
Work Pad		Incidental			**ITS-10.11**
Grounding		Ground Rod		625E32000	**ITS-50.10**

Choose Power Service		Ground Mounted, 100 amp	809.03.C	809E51100 809E52100 809E52101	**ITS-15.10**
		Pole Mounted, 100 amp	809.03.C	809E55100 809E56100 809E56101	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet - Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from the **Office of TSMO – ITS Section**					

Dynamic Message Sign (DMS), Front-Access Installations
(TEM 1303-6)

Task	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
Choose DMS Type	*	Dynamic Message Sign (DMS), Front-Access	809.08.B	809E63010	
Choose Beam Size		Ground Mounted Structural Beam Support, W-??x??			**TC-41.10**
Choose Beam Connection		Breakaway Structural Beam Connection		630E09000	**TC-41.10**
Foundation		Ground Mounted Structural Beam Support Foundation		630E84500	**TC-41.10**
Cabinet Type					
		ITS Cabinet - DMS	809.09.E	809E65040	
Work Pad		Incidental			**ITS-10.11**
Grounding		Ground Rod		625E32000	**ITS-50.10**
Choose Power Service		Ground Mounted, 100 amp	809.03.C	809E51100 809E52100 809E52101	**ITS-15.10**
		Pole Mounted, 100 amp	809.03.C	809E55100 809E56100 809E56101	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from **Office of TSMO – ITS Section**					

Destination Dynamic Message Sign (DDMS) Installations
(TEM 1303-6)

Task	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
Choose DDMS Type	*	DDMS, Freeway - Two-Line	809.08.C	809E63020	
	*	DDMS, Freeway - Three-Line		809E63030	
	*	DDMS, Arterial-Two-Line	809.08.D	809E63040	
	*	DDMS, Arterial - Three-Line		809E63050	
Define Sign Size		Sign, Ground Mounted Extrusheet, As Per Plan		630E80201	
Choose Beam		Ground Mounted Structural Beam Support, W-??x??			**TC-41.10**
Choose Beam Connection		Breakaway Structural Beam Connection		630E09000	**TC-41.10**
Foundation		Ground Mounted Structural Beam Support Foundation		630E84500	**TC-41.10**
Work Pad		Incidental			
Cabinet Type					
		Ground Mounted	809.09.A	809E65000	

Grounding		Ground Rod		625E32000	**ITS-50.10**
Choose Power Service		Ground Mounted, 60 amp	809.03.C	809E51000 809E52000 809E52001	**ITS-15.10**
		Pole Mounted, 60 amp	809.03.C	809E55000 809E56000 809E56001	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from **Office of TSMO – ITS Section**					

Vehicle Detection (SFRD) Installations
(TEM 1303-7)

Tasks	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
Vehicle Detection Type	*	Side-Fired Radar Detector	809.12.A	809E68900	**ITS-60.10**
Choose Pole (if needed)		Light Pole, Conventional, As Per Plan		625E10491	**HL-10.13**
Grounding		Ground Rod		625E32000	**ITS-50.10**
Choose Foundation		Light Pole Foundation		625E14500	**HL-20.11**
Choose Cabinet Type	*	Pole Mounted	809.09.B	809E65010	
		Ground Mounted	809.09.A	809E65000	
Choose Power Service		Ground Mounted, 60 amp	809.03.C	809E51000 809E52000 809E52001	**ITS-15.10**
		Pole Mounted, 60 amp	809.03.C	809E55000 809E56000 809E56001	**ITS-15.11**
Use if directed by ODOT	*	ITS Cabinet-Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from **Office of TSMO – ITS Section**					

Ramp Meter Installations
(TEM 1303-11)

Tasks	Approval Needed	Item Description	Supplemental Specification	Item Master	Traffic SCD No.
Choose Ramp Meter	*	Ramp Meter Items (various)	809.11		**ITS-76.10**
Choose Training	*	Ramp Meter Training	809.11.B	809E67050	
Cabinet Type	*	ITS Cabinet - Ramp Meter	809.09.D	809E65030	
Grounding		Ground Rod		625E32000	
Choose Power Service		Ground Mounted, 60 amp	809.03.C	809E51000 809E52000 809E52001	**ITS-15.10**
		Pole Mounted, 60 amp	809.03.C	809E55000 809E56000 809E56001	**ITS-15.11**
Use if directed by ODOT	*****	ITS Cabinet- Power Distribution Cabinet (PDC)	809.09.C	809E65020	
* Approval must be obtained from the **Office of TSMO – ITS Section**					

1415-3 Rumble Stripes

1415-3.1 General

Rumble stripes are milled longitudinal rumble strips supplemented by the related longitudinal pavement markings. Center line rumble stripes are applied in the same location as the center line marking such that the pavement marking material conforms to the grooved contours of the milled rumble strip. Edge line rumble stripes are offset by 6 inches to the outside of the edge line marking. Rumble stripes are used to reduce highway hypnosis and to alert sleepy, fatigued, impaired, or inattentive drivers that they are leaving the roadway (edge line) or crossing the center line. Rumble stripes offer a relatively low-cost, low-maintenance countermeasure to reduce head-on, side-swipe or run-off-the-road crashes. Rumble stripes define the roadway limits with the corresponding audio and vibratory impacts which result when a vehicle's tires pass over the rumble strips. Additional detail design information is available in **SCD TC-64.10, Rumble Stripes**. Lane line rumble stripes shall be not installed unless approved by the **Office of Roadway Engineering**.

1415-3.2 Candidate Locations

Installation of rumble stripes will be included in **ODOT** resurfacing, reconstruction or new alignment projects for all **ODOT** maintained 2 lane undivided roadways based upon the following:

1. Pavement width, including paved shoulders, is greater than 26 feet.
2. Posted speed limit greater than 45 mph.
3. Outside of built-up areas, including municipal corporation limits and urban area boundaries.
4. A minimum of 1" of new asphalt material is constructed. This includes double microsurfacing installations.

1415-3.3 Type Selection Criteria

With the exceptions noted in Section 1415-3.2, the determination to use edge line versus center line rumble stripes should consider the following pavement width (paved lanes and paved shoulders):

1. **Total Pavement Width 29' or Greater** – Install center line rumble stripes and, if other considerations listed below can be met, install. edge line rumble stripes.
2. **Total Pavement Width of 26' to 29'** – Install center line rumble stripes. If there is a need to address a noted crash pattern favoring the right side of the road, edge line rumble stripes may also be considered for installation along with the center line rumble stripes.
3. **Total Pavement Width Less than 26'** – No rumble stripes should be installed unless there is a documented crash experience where either edge line or center line rumble stripes could be an effective safety countermeasure. Install edge or center rumble stripes as required to address the specific noted crash pattern.

Where the total pavement width is sufficient for edge line rumble stripes, the following items shall be considered prior to their installation:

1. The paved shoulder width shall be at least 2 feet.
2. Unless an existing run-off-the-road crash problem exists, edge line rumble stripes should not be installed on any roadway or roadway section;
    a. with Amish vehicles, or
    b. with high driveway density, or
    c. which has been designated by ODOT as a bike route and has a paved shoulder width of less than 4 feet

Engineering judgment should be used in determining whether to place rumble stripes along roadway sections of variable width or relatively short multilane sections (such as through interchanges) with consideration given to the presence of rumble stripes on adjacent sections.

1415-3.4 Pavement Marking Materials

Due to installation and durability issues, thermoplastic pavement markings (**Item 644**), preformed pavement markings **(Item 645)** and heat-fused preformed thermoplastic **(Item 647)** shall not be used for center line rumble stripes.

1415-3.5 Installation

Except when interrupted as described below, center line rumble stripes shall be continuous and edge line rumble strips shall be installed in a 60-foot cycle (48' rumble stripe – 12' gap) to allow crossing of edge line by bicyclists. The milled portion of the rumble stripe shall be interrupted for raised pavement markers, intersecting roads or major driveways, and transverse markings (e.g., crosswalk lines, stop lines, yield lines, etc.) as detailed in **SCD TC-64-10, Rumble Stripes**.

Discontinue rumble stripe installation within built-up areas including a 650-foot buffer leading into and away from such areas.

Since rumble stripes extend through the pavement markings, the markings should be reapplied following cutting of the rumble strip.

Center line striping operations should move at no more than 8 miles per hour to ensure coating of both sides of the cut rumble profile.

1415-3.6 Use on Bridges

Rumble stripes should normally not be installed on bridges. Rumble stripes may be placed on a bridge if the alignment of the bridge or a specific crash pattern justify their use.

1415-3.7 Center Line Joint Requirements

Performance of longitudinal joints with center line rumble stripes have varied widely depending on the density achieved during construction. To ensure performance of cold longitudinal joints with center line rumble stripes surface courses (mill and fill or overlay) should be placed in accordance with Supplemental Specification 874 - Longitudinal Joint Preparation.