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Part 13 - INTELLIGENT TRANSPORTATION SYSTEMS

1300 GENERAL

This Part of the TEM addresses policies, guidelines, standard procedures, etc. related to Intelligent Transportation Systems (ITS), which in this context means electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

Submissions related to 23 CFR 940 approval shall be submitted to the Office of Roadway Engineering. Failure to obtain approval when required will result in the project being withheld from sale until the required approvals are given.

1301 23 CFR 940 Compliance

1301-1 General

1301-1.1 General

Federal Regulation 23 CFR 940 requires ITS projects and traditional projects with ITS components funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. The Ohio Procedures for Implementing ITS Regulations (23 CFR 940) documents the requirements to be used in Ohio for any ITS project utilizing Federal funds. These requirements apply to the ITS components.

The Ohio procedures incorporate guidance from several sources, including 23 CFR 940, the Programmatic Agreement for ITS Systems Engineering Analysis between the Federal Highway Administration’s (FHWA) Ohio Division Offices and ODOT and the Federal-Aid Highway Program Stewardship and Oversight Agreement. ODOT's interpretation of the Federal policy provides a streamlined process to address project definitions, ITS architecture modifications, and systems engineering. This approach will permit ODOT and FHWA to establish concurrence in the level of ITS assessment and documentation needed.

At its core, 23 CFR 940 defines what is considered an ITS project and then requires ITS projects to be in compliance with the governing ITS architecture and for the project to be developed using a Systems Engineering Analysis (SEA) process.

1301-1.2 ODOT PDP

Systems Engineering Analysis (SEA) is a planning document for both low-risk and high-risk ITS projects. The SEA should be completed and approved prior to stage 2 plans for projects that don’t have a feasibility study (typically path 2 and sometimes path 3 projects). For larger projects, the SEA should be performed at the same time as the feasibility study.

1301-1.3 General Criteria for ITS

In accordance with 23 CFR 940.3, an ITS project is “any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS user services as defined in the National ITS Architecture” and summarized in Table 1397-2, under the following categories:
In Ohio, a project would be considered to be an ITS project if it meets any of the following:

| Requires the integration of multiple separate systems. | Multi-Jurisdictional Technology Integration | Replaces existing or installs new central control software. | Expansion of Freeway Management System through additional phases |
**1301-2 Project Criteria**

ODOT uses a risk-based Systems Engineering Analysis approach to classify ITS projects into three categories: Exempt, Low-Risk or High-Risk ITS projects.

For examples of Exempt, Low-Risk and High-Risk projects see **Table 1397-1**. A differentiating factor in the determination of an ITS category, at the judgement of ODOT, can be the scale and complexity of the project. Projects with a very large scale or degree of complexity could be an overriding consideration to the project examples shown in **Table 1397-1**. For example, a project that would normally be considered Low-risk in **Table 1397-1** could be classified as a High-risk ITS project based on its complexity or scale. Consult with the Office of Roadway Engineering if unsure of the proper category for an ITS project.

**1301-2.1 Exempt Project**

Exempt projects are those that are typically comprised of commercially off-the-shelf (COTS) equipment with no integration of separate systems. Exempt projects usually involve the deployment of very proven technologies and don’t require the passing of information between separate ITS systems or between multiple stakeholders. More complex projects, that could normally considered low or high risk may also be categorized as being exempt if they are an expansion of an existing system and the expansion doesn’t add functionality to the system. It is simply additional items added to the existing system. Exempt projects require no documentation or specific approvals related to 23 CFR 940.

Enforcement systems and systems used primarily to gather and archive data not directly used for operational purposes are not generally considered to be ITS and can often be considered exempt.
The below table identifies activities that are typically considered exempt from 23 CFR 940 requirements:

<table>
<thead>
<tr>
<th>Exempt</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Changes and/or upgrades to an existing traffic signal system, including signal timing revisions, additional phases (vehicle or pedestrian) or detector installation.</td>
</tr>
<tr>
<td>• Routine maintenance and operation of an existing ITS system.</td>
</tr>
<tr>
<td>• Expansion of an existing traffic signal, ITS or freeway management system (FMS) that does not change or add to the original needs and requirements of the system. This type of project does not change any existing hardware, software or interfaces. It simply adds equipment (DMS, DDMS, CCTV, RWIS, etc.), software, locations or intersections to an existing system. The new equipment and software must be compatible with the existing.</td>
</tr>
<tr>
<td>• Installation of an isolated traffic signal. This is a single traffic signal, not connected to any type of external signal control, nor likely to be connected in the future due to its isolation.</td>
</tr>
<tr>
<td>• Installation of traffic signals which are part of a Time-Based Coordinated system.</td>
</tr>
<tr>
<td>• Installation of traffic signals which are part of a hardwired or wireless interconnected system that is locally controlled, i.e. where the timing patterns are controlled by the local controller and not by centrally controlled software.</td>
</tr>
<tr>
<td>• Installation of cameras that are not functionally integrated into other types of systems; for example, cameras solely for the purpose of traffic data collection or surveillance cameras.</td>
</tr>
</tbody>
</table>

1301-2.1.1 Exempt Project Requirements

CFR 940 Requirements for an Exempt project are as follows:

1. Ensure the project scope and specifications properly meet the definition of being Exempt; and

1301-2.2 Low-risk Projects

Low-risk projects involve COTS technology and devices that utilize existing and proven hardware and communication standards to ensure plug-and-play interoperability. No specific integration is required and there may be some passing of information from one system to another.

Low-risk projects require conformance with 23 CFR 940 including the requirement to follow a Systems Engineering Analysis (SEA) process in development. The SEA process has numerous requirements many of which can be addressed at the program level.

To accomplish this for low-risk projects, portions of the SEA process are incorporated into ODOT’s review and approval process for the Traffic Authorized Products (TAP) List. Project specific SEA requirements that cannot be covered by the TAP approval process are included in the SERF Form. The SERF form is a project specific documentation that, in conjunction with the TAP approval process, covers all of the SEA requirements. It is for this reason, that a project cannot be considered Low-risk nor can it utilize SERF documentation unless the products or systems that will be procured and installed by the project are on the TAP list. Products, systems or technologies not included in the TAP are considered High-risk and therefore require the full Systems Engineering Analysis requirements required by 23 CFR 940 (see High-Risk Project Requirements).
Typical low-risk ITS project elements that can utilize SERF documentation (in conjunction with products included on the TAP) are:

<table>
<thead>
<tr>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Closed loop arterial traffic signal system.</td>
</tr>
<tr>
<td>• Centrally controlled arterial traffic signal system.</td>
</tr>
<tr>
<td>• Highway Rail/Traffic Signal pre-emption.</td>
</tr>
<tr>
<td>• Traffic signal or signal system with Emergency Vehicle Pre-emption.</td>
</tr>
<tr>
<td>• Traffic signal system with Transit Priority.</td>
</tr>
<tr>
<td>• Ramp Meter system.</td>
</tr>
</tbody>
</table>

### 1301-2.2.1 Low-risk Project Requirements

CFR 940 Requirements for a Low-Risk project are as follows:

1. Ensure the project scope and specifications properly meet the definition of being Low Risk; and
2. Complete and submit for approval the appropriate SERF Documentation; and
3. Included with the SERF documentation is the applicable data flow diagrams from the governing architecture (either regional architecture if in an MPO area or if no regional exists utilize the Statewide ITS architecture). The Statewide architecture can be found at:

   http://ohioitsarch.transportation.ohio.gov/index.html

The SERF form for low-risk projects can be found on the “Forms” section of the Traffic Operations web page [OTO Forms](#).

### 1301-2.3 High-risk Projects

High-risk ITS projects come with various risk factors, such as cost overruns, not meeting agency needs and system failure. Due to these factors, High-risk ITS projects cannot utilize the SERF forms and they require detailed project specific Systems Engineering Analysis (SEA) documentation. The SEA is comprised of many separate parts and pieces that build on one another with the earliest steps being geared to identifying what are the functional requirements and concept of operations of the proposed ITS system. Later steps culminate in the validation and verification that the delivered system meet those functional requirements and full-fill the intended purpose of the system. The below “V” diagram depicts the Systems Engineering Analysis process that is applied to High-risk ITS project development.

Differentiators that make a project High-risk include:

1. Devices, technologies or systems provided in the project are not included on the TAP
2. Number of jurisdictions and/or modes involved.
3. New or unproven software creation.
4. Extent of new, unproven hardware and communication technology being used.
5. Number and level of complexity of new interfaces to other systems.
6. Level of detail needed in defining the functional requirements.
7. Requires integration of separate systems
8. Level of detail needed in defining the operations and management procedures.
9. Service life of the equipment and software technology.

Typical High-risk ITS projects or project elements are:

---

<table>
<thead>
<tr>
<th>High-Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>• New freeway management systems (FMS).</td>
</tr>
<tr>
<td>• Traffic signal systems that requires integration with other systems, e.g. FMS or RWIS.</td>
</tr>
<tr>
<td>• Ramp meter systems that require integration with adjacent traffic signal system(s).</td>
</tr>
<tr>
<td>• Regional traffic signal system (as opposed to an arterial traffic signal system) that has the potential to affect geographic areas outside of the maintaining agency.</td>
</tr>
<tr>
<td>• Regional transit systems.</td>
</tr>
<tr>
<td>• Any Low-Risk project that provides additional functionality than what is covered in the approved Functional Requirements document for that project category.</td>
</tr>
<tr>
<td>• Any project that requires new or unproven hardware, software or interfaces.</td>
</tr>
<tr>
<td>• Any project for which functional requirements and operations &amp; management procedures have not been documented.</td>
</tr>
<tr>
<td>• Adaptive Traffic Signal Control system.</td>
</tr>
<tr>
<td>• Any project that contains Autonomous or Connected Vehicle Technology</td>
</tr>
<tr>
<td>• Any project not considered Exempt or Low-Risk under the Programmatic Agreement.</td>
</tr>
</tbody>
</table>

1301-2.3.1 High-risk Project Requirements

CFR 940 Requirements for a High-risk project are as follows:

1. Ensure the project scope and specifications properly meet the definition of being High-risk; and
2. Complete and submit for approval the project specific Systems Engineering Analysis (SEA) documentation; and
3. Include the Standard Plan Note “Systems Engineering Analysis Requirements” in the project documents; and

1301-2.4 High-risk SEA Documentation Requirements

The general purpose of the High-risk ITS project SEA is to provide:

- A description of the scope of the ITS project (the general location, conceptual alternative, and logical termini or service area of the proposed project);
- A concept of operations that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS project;
- Functional requirements of the ITS project;
- Interface requirements and information exchanges between the ITS project and other planned and existing systems and subsystems; and
- Identification of applicable ITS standards.
The SEA Documentation should be organized and address as follows:
<table>
<thead>
<tr>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Description of the scope of the project</td>
</tr>
<tr>
<td>• General Location;</td>
</tr>
<tr>
<td>• Conceptual Alternative;</td>
</tr>
<tr>
<td>• Logical termini or service area;</td>
</tr>
<tr>
<td>• Interagency Coordination &amp; Possible Effects on neighboring communities;</td>
</tr>
<tr>
<td>• Include the PID, location, project description from ELLIS or other sources;</td>
</tr>
<tr>
<td>• Description of the ITS work;</td>
</tr>
<tr>
<td>• Project background (summary of purpose and need).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regional ITS Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identify portions of the Regional ITS Architecture being implemented</td>
</tr>
<tr>
<td>• Include identification of the ITS User Services which will apply to the project</td>
</tr>
<tr>
<td>• Include a graphic from the Regional ITS Architecture illustrating the data flows that will be incorporated</td>
</tr>
<tr>
<td>• The use of the FHWA software product TurboArchitecture is highly recommended. This software can be downloaded free of charge from the FHWA.</td>
</tr>
<tr>
<td>• If no Regional ITS Architecture exists for the project area, contact the ODOT Office of Roadway Engineering</td>
</tr>
<tr>
<td>• Provide documentation for revising the Regional ITS Architecture after project construction.</td>
</tr>
<tr>
<td>• Contact the appropriate MPO or ODOT Office of Roadway Engineering for preferred or required formats for submitting this information</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concept of Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Roles &amp; Responsibilities of participating agencies and stakeholders for operation and implementation</td>
</tr>
<tr>
<td>• Identification of Operation and Maintenance Responsibilities.</td>
</tr>
<tr>
<td>• Provide an Operational Concept - a high level description of the roles and responsibilities of the primary stakeholders and the systems they operate.</td>
</tr>
<tr>
<td>• Provide a Concept of Operations - including a more detailed description of how the system will be used. It should discuss what the project is to accomplish, including identifying stakeholder needs and resources that stakeholders can provide. It is non-technical and provides a bridge between the needs motivating the project and the specific technical requirements. The greater the expected impact on operations, the more detailed explanation will be required.</td>
</tr>
<tr>
<td>• For complex projects, operational scenarios may be necessary to illustrate the operations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Technical requirements for the technology being deployed and the requirements needed to achieve a successful project</td>
</tr>
<tr>
<td>• Explain how the project will be built and operated based upon the ITS Market Packages. High level functional requirements should be listed and can further be used to develop specific contract specifications language.</td>
</tr>
<tr>
<td>• Provide interface/communication requirements for all stakeholders in the project. This includes the existing systems already deployed in the region.</td>
</tr>
<tr>
<td>• Functional requirements are statements of the capabilities that a system must have (“functions”), geared to addressing the business needs that a system must satisfy. Business needs are the objectives for which the system is built. These functional requirements will be traced through the life of the project.</td>
</tr>
<tr>
<td>• A key aspect of the functional requirements is that they address what a system must do, but does not address how the system should accomplish the what. In other words, a functional requirement should not go into the details of how to implement the function.</td>
</tr>
<tr>
<td>• For more information on functional requirements, see the USDOT publication “Developing Functional Requirements for ITS Projects” which is available on the FHWA website.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative Systems &amp; Procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Describe the basis of the project scope and how it was developed</td>
</tr>
<tr>
<td>• Identify any proprietary items and explain the necessity and rationale for these items.</td>
</tr>
<tr>
<td>• Show the link between the system design concept and the operations and maintenance of the constructed project.</td>
</tr>
<tr>
<td>• Describe possible procurement methods for the design, construction, and operations/maintenance (as applicable) of the project.</td>
</tr>
<tr>
<td>• Explain why the preferred method was selected. In some cases, the procurement methods may be determined by State law.</td>
</tr>
</tbody>
</table>
Interfaces

- Identify all interface requirements and information exchanges between the project and any other planned or existing systems.

ITS Standards

- Identification of Applicable ITS Standards. (ODOT and National Standards are applicable)
- ITS Standards are available on-line from the FHWA website.
- List all ITS Standards which may be applicable to the project, indicate if the Standard is to be used in the project, and if not used, provide an explanation of why they are not being used.

Testing & Validation

- Identify the testing procedures to verify compliance with the standards as well as the requirement for interoperability.
- Explain the testing procedures and how they will verify the individual elements of the project comply with the project specifications. The specifications are based upon the high level functional requirements identified in SEA Item #4. For some projects, the testing procedures may be provided by a product vendor.
- Project submittal cut sheets, laboratory reports and precertification may be substituted for some field testing. Devices on a Qualified Providers List (QPL) do not need to be tested. Other devices or additional functionality will be included on the traceability matrix for field testing.

Traceability Matrix

- Provide a traceability matrix for documenting compliance of the testing procedures. The traceability matrix provides a mechanism for ensuring that each functional requirement is tested and that each item to be tested has been addressed in the specifications.
- A sample traceability matrix applicable to an emergency vehicle preemption project is shown as part of Form 1396-2 and is available on the OTO Forms web page http://www.dot.state.oh.us/Divisions/Operations/Traffic/Pages/Forms.aspx. The form may be modified as necessary.
- The traceability matrix will be included in the contract documents for use during construction.
- The completed traceability matrix will include the results of the test and any necessary work to address failures during the test and will be included in the project construction records.

Change Management

- Provide a description of the change management control.
- Describe what changes were made during project development, how changes were accommodated, and how change orders will be processed and managed during construction, including identifying necessary approvals.
- In many cases standard procedures used by the agency will incorporate many of these items.
- This item requires documentation of changes in design, construction, and operations.

Maintenance Plan

- Provide a Maintenance Plan and a funding analysis for the maintenance and operation of the system after completion. This includes an analysis of cost, personnel, software, utilities and anything further required to maintain and operate the system, typically on an annual basis. Examples of this item are available on the OTO website.
Intentionally blank.
1303  FREEWAY MANAGEMENT SYSTEMS ON ODOT-MAINTAINED HWYS.

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
- Dynamic Message Signs (DMS)
- Ohio 511 telephone number
- Radio and television broadcasts (private-sector leveraging FMS information)

It is 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 information provided herein is intended to provide designers all necessary details needed to develop a thorough plan for the ITS infrastructure.

1303-2  Traffic Management Center (TMC)

The ODOT's Statewide Traffic Management Center (TMC) operates traffic management and traveler information systems on Ohio's Interstates, other freeways, expressways, and state highways. The mission of the TMC is to increase transportation safety, reduce congestion, and increase efficiency on Ohio's state highways. Housed in ODOT's Central Office building, the TMC monitors traffic in each of the State's major metropolitan areas including Akron/Canton, Cincinnati, Cleveland, Columbus, Dayton/Springfield, and Toledo. TMC operators can control cameras and post traveler information messages to ODOT's Dynamic Message Signs, Highway Advisory Radios, and to the OHGO website. The TMC operators can also act as liaisons between the Freeways Service Patrol and various other public agencies that respond to the scenes of vehicle incidents.

1303-3  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. OTO 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. General area CCTV cameras shall be of the dome-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 OTO. 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 OTO. 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 OTO 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 site conditions present at 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 ITS-50.12.
5. CCTVs 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 CCTV within 35 feet of maintenance vehicle accessible area.
6. 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 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. For most installations along the freeway the 809E60000 CCTV IP-Camera System, Dome-Type shall be utilized.
   b. For installations where the camera is to be located inside a tunnel and/or wall-mounted the 809E60010, CCTV IP-Camera System, Type HD, Wall/Tunnel shall be utilized. 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. For installations where there is need for a temporary CCTV to be setup, such as at a work zone, the 809E60020, CCTV IP-Camera System, Portable shall be utilized.

2. The appropriate CCTV pole height shall be chosen.
   a. The standard installation requires the use of 70-foot concrete poles, utilizing pay item 809E61000, CCTV Concrete Pole with Lowering Unit, 70 FT.
   b. The use of 50 feet poles is not allowed unless directed by OTO. During the review process, OTO will review the plans and if necessary, may advise the designer to utilize item 809E61010, CCTV Concrete Pole with Lowering Unit, 50 FT in some locations.

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 OTO.

4. Appropriate grounding and power services shall be designed. Power services shall be designed with distribution cables based on appropriate voltage drop calculations. Voltage drop on circuit not to exceed 5% nominal circuit voltage in steady state since equipment can generally tolerate a voltage variance of 10%. All 60 Amp disconnects shall be fused at 30 Amps. See Standard Construction Drawings ITS-15.10 and ITS-15.11.
   a. For instances where one power service is providing power to multiple cabinets, 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.

Also see Plan Note 1342-2 (TEM Section 1342-2).

1303-4 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 OTO 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. 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), and 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 for the entire project (e.g., Figure 1398-5: ITS Device Communication Diagram). For ODOT projects with fiber interconnect, coordinate the termination diagrams with OTO ITS Field Operations, and 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 two 4-inch multi-cell Schedule 40 conduits. Median wall pull boxes shall be installed at a maximum of 1000 feet apart and on each side of bridge structures. Refer to Plan Note 1342-11 (TEM Section 1342-11) for median junction box notes. Contact the Office of Traffic Operations for Typical Plan Drawings to be included in the plans.

2. Lateral crossings out of medians (barriers and grass) shall be installed at a maximum of every 4500 feet and at all interchanges for future and existing device communications, as well as slack storage locations. The lateral crossing shall include two 4-inch multi-cell Schedule 80 conduits. 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.

3. Within metropolitan areas, conduit infrastructure buried in earth shall contain two 4-inch multi-cell conduits, and 32-inch pull boxes with maximum spacing of 500 to 750 feet (see Traffic SCDs ITS-14.10 and 14.11).

4. For multi-cell conduit refer to Plan Note 1342-7 (TEM Section 1342-7).

5. 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.

6. 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.

7. All newly installed buried conduit shall contain tracer wire. If conduit is for future fiber optic cable, 20 feet of slack in each direction should be left in each pull box. This will allow for tracer wire to be run inside of fiber optic cable markers to be installed when fiber is installed. For tracer wire specifications, refer to Plan Note 1342-8 (TEM Section 1342-8) to be included in plans.

8. Fiber optic cable markers shall be used whenever fiber optic cable is installed. Refer to Plan Note 1342-9 (TEM Section 1342-9) for specification to be included in plans.

9. 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.

10. 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 having 48 strands or less should be routed through the cabinets and all splicing shall be performed in the cabinets. No splicing on this cable shall be performed in splice enclosures.
2. All fiber optic cables having more than 48 strands 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 Traffic Operations (OTO) during review will generally have more than one buffer tube terminated at them. The designer will be directed by OTO as to which fibers will terminate at which cabinets during review.

1303-5 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. When no particular incidents are worthy of mention, the default message, with travel time through key segments of the urbanized area, shall be displayed. Messages for DMSs shall be chosen from a DMS message library unless a different message is truly needed. If a different message is needed it shall be created by the appropriate party. When resources limit full deployment of DMSs in accordance with Detailed Project Plans and FMS design guidelines, first priority will be given to sites on routes inbound to a central business district, deferring outbound DMSs to subsequent phases. The design plans must be in accordance with the Detailed Project Plan.

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. DMS 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 DMS within 35 feet of maintenance vehicle accessible area.

4. 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.

5. All DMS require 120/240 VAC power service and typically require up to 80 amps by the manufacturer.

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 809E63001, 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 630E70001, 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.
      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 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 OTO.

4. Appropriate grounding and power services shall be designed. Power services shall be designed with distribution cables based on appropriate voltage drop calculations. Voltage drop on circuit not to exceed 5% nominal circuit voltage in steady state since equipment can generally tolerate a voltage variance of 10%. All 100 Amp disconnects shall be fused at 80 Amps. See Standard Construction Drawing ITS-15.10 and ITS-15.11.
   a. For instances where one power service is providing power to multiple cabinets, 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.

Also see Plan Note 1342-3 (TEM Section 1342-3).

1303-6 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 OTO.
4. Appropriate grounding and power services shall be designed. Power services shall be designed with distribution cables based on appropriate voltage drop calculations. Voltage drop on circuit not to exceed 5% nominal circuit voltage in steady state since equipment can generally tolerate a voltage variance of 10%. All 60 Amp disconnects shall be fused at 30 Amps. See Standard Construction Drawing ITS-15.10 and ITS-15.11.
   a. For instances where one power service is providing power to multiple cabinets, 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.

Also see Plan Note 1342-4 (TEM Section 1342-4).

1303-7 Highway Advisory Radio (HAR)

Highway Advisory Radio (HAR) installations must be approved by the ODOT Office of Traffic Operations. Due to newer and aging technology, HAR installations are being discontinued.
1303-8  Travel Time

Travel times are calculated along segments of Ohio roadways using various sources of speed data. These travel times are then displayed on DMS, 511, and the OHGO website as a means of communicating to the public the expected travel time to and from select destinations. All travel time calculations are generated by the Office of Traffic Operations (OTO).

1303-9  Road Weather Information System (RWIS)

A Road Weather Information System (RWIS) is comprised of Environmental Sensor Stations (ESS) in the field, a communication system for data transfer, and central systems to collect field data from numerous ESS. These stations measure atmospheric, pavement and/or water level conditions for flood information. Central RWIS hardware and software are used to process observations from ESS to develop forecasts and display or disseminate road weather information in a format that can be easily interpreted. RWIS data are used by road operators and maintenance staff to support decision making.

There are three types of road weather information: atmospheric data, pavement data and floodwater level data. Atmospheric data include air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, cloud cover, tornado or waterspout occurrence, lightning, storm cell location and track, as well as air quality. Pavement data include pavement temperature, pavement freezing point, pavement condition (e.g., wet, icy, flooded), pavement chemical concentration, and subsurface conditions (e.g., soil temperature). Water level data include stream, river and lake levels near roads, as well as tide levels (i.e., hurricane storm surge).

Transportation managers utilize weather warning systems and websites to disseminate road weather information to travelers in order to influence their decisions. This information allows travelers to make choices about travel mode, departure time, route selection, vehicle type and equipment, and driving behavior. In Ohio, RWIS provides information on current conditions and assists with forecasting for snow, ice control and removal, flooding, etc. Information is available at the OHGO website. RWIS combined with forecasts provides District maintenance staff with the best information for snow and ice control. This information allows Districts to most efficiently allocate resources including snow plows, and salt and brine applications.

1303-10  Ramp Metering

Ramp Metering is another key FMS component (see OMUTCD Chapter 4H). 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:
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, pay item 809E67000, Ramp Metering System, or itemized 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, 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.

Also see Plan Note 1342-6 (TEM Section 1342-6).

1303-11 Ramp Meter Warrants

A ramp meter warrant analysis must be completed before the installation or design of a ramp meter on ODOT-maintained freeways (Interstate and non-Interstate). There will be two different types of ramp meter analyses, a retro-fit ramp meter analyses, with current volumes and data, used for determining if a ramp meter can be installed on an existing ramp, and a future ramp meter analysis, used for determining if a ramp meter is needed on a project in design. The following warrant criteria and flowcharts are to be used with both types of analysis.

Warrant 1 (Ramp Volume)

Is the ramp volume during the peak period greater than 240 vehicles per hour per lane (vphpl)?
240 vphpl is the practical lower limit for ramp metering.
Warrant 2 (Crashes)
*Has there been over 3 mainline merge related crashes in the past 3 years?*

Crashes can be pulled using ODOT’s Transportation Information Mapping System (TIMS). The area of the crash study shall be from the end of the entrance ramp gore area to 500 feet downstream.

Warrant 3 (Mainline Speed)
*Does the freeway operate at speeds 10 mph lower than the posted speed limit for duration of at least 30 minutes for 200 or more calendar days per year?*

INRIX or similar speed provider data can be used to gather historical speed data for the analysis. The study area shall include a half mile upstream and downstream of the ramps gore area in the ramp’s direction of travel.

Warrant 4 (Freeway Level of Service)
*Does the freeway operate at LOS D or worse during the peak period?*

The level of service analysis is to be done in HCS. If there are complicated weaving scenarios TransModeler can be used. The analysis is to be done from the end of the entrance ramp gore area to 500 feet downstream.

Warrant 5 (Mainline Volume)
*Does the total volume downstream of the gore during the peak period exceed the following?*
- Two mainline lanes in one direction – 2,650 vehicles per hour (vph)
- Three mainline lanes in one direction – 4,250 vph
- Four mainline lanes in one direction – 5,850 vph
- Five mainline lanes in one direction – 7,450 vph

Warrant 6 (Mainline Right Lane and Ramp Volumes)
*Is the ramp volume plus the mainline right lane volume downstream of the gore during the peak period greater than 2,100 vph?*

Warrant 7 (Signalized Intersection Platoon Warrant)
*Is the hourly volume entering from arterials, based on highest 30-second volume readings (during the critical peak period) projected to hourly values, greater than 1,100 vph?*

Warrant 8 (Acceleration Length)
*Is the available acceleration length after the stop line longer than the required acceleration length, or can geometric improvements be made to provide the required length?*

The available acceleration length is measured from the ramp meter stop line to the point where the right edge of the traveled way of the ramp is 12 feet from the right edge of the traveled way of the freeway.

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Available Acceleration Length
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For a single lane ramp meter, the required acceleration length value can be found in the AASHTO Green Book Exhibit 10-71 (shown below). The required acceleration value can be found using a design speed that is 10 mph below the posted speed limit and an initial speed of zero.
For a two-lane ramp meter, the required acceleration length can be found by adding merge distance with acceleration length. The merge distance for a high-speed entrance ramp is 600 ft per ODOT Location & Design Manual Volume 1, Figure 505-1a. The acceleration length can be found in the AASHTO Green Book Exhibit 10-71 (shown above) by using a design speed that is 10 mph below the posted speed limit and an initial speed of 25 mph. The initial speed of 25 mph assumes the traffic has already accelerated 600 ft and is not beginning from a stopped condition.

Warrant 9 (Ramp Storage Length)

Is the available or proposed ramp storage length greater than the required storage length on the ramp, or can geometric improvements be made to provide the required length?

The available storage length is measured from the ramp meter stop line to the nearest upstream intersection.

Required Storage length is calculated based on the hourly demand volume on the ramp, arrival rates, number of lanes on the ramp, discharge rate, and average vehicle length. The arrival and discharge rate are calculated based on a 140-second cycle length. Hourly discharge rate is 800 vph for a single-lane ramp meter and 1,600 vph for a dual or triple-lane ramp meter. These correspond to a “per 140-second cycle length” discharge rate of 31 and 62 vehicles. The basic premise of the methodology is that if the arrival rate is greater than the discharge rate, a queue
builds up. The following steps are used to calculate the required storage length at a candidate ramp meter location.

- **Step 1.** Obtain peak hour ramp demand volume.
- **Step 2.** Calculate 140-second arrival rates (rounded up to the next integer) using a peak hour factor of 0.80.
- **Step 3.** Determine the required number of lanes. If ramp peak hour volume is 240-800 vplph, then use a single lane ramp meter. If ramp peak hour volume is greater than 800 vplph use a two-lane ramp meter.
- **Step 4.** Calculate excess vehicles per 140-second cycle length by subtracting the discharge rate (i.e., 31 for single lane and 62 for dual lane) from the arrival rate.
- **Step 5.** Calculate additional queue length by multiplying the excess vehicles by a vehicle spacing of 30 feet. If there are no excess vehicles, the minimum queue length is to be used.
- **Step 6.** Calculate additional queue length per lane by dividing the calculated total queue length by the number of lanes.
- **Step 7.** Calculate the required storage length per lane by adding 420 feet to the additional queue length by lane. 420 ft is the minimum queue length needed per lane to account for vehicle platoons arriving at the ramp meter. The calculated storage length is to be rounded up to a multiple of 30. Additional storage must be provided if there are significant number of trucks, buses, or RVs using the ramp.

Below are some example calculations for required storage length.

**Example 1.** Calculate the required storage length for a ramp with projected peak hour volume of 1,790 vph.

Step 1: Peak hour demand volume is 1,790 vph.
Step 2: The 140-second arrival rate is 1,790 x 140/3600/0.8, which equals to 88 vehicles per cycle.
Step 3: The required number of lanes is two lanes because the demand volume exceeds the one lane capacity of 800 vph.
Step 4: Excess vehicles per 140-second cycle is 88 minus 62, which equals 26.
Step 5: The total queue length is 26 x 30, which equals 780 feet.
Step 6: The additional queue length per lane is 780/2, which equals 390 feet.
Step 7: Calculated required storage length per lane is 420 (minimum queue length to account for platoons) plus 390, which equals 810 feet.

**Example 2.** Calculate required storage length for a ramp with projected peak hour volume of 580 vph.
Step 1: Peak hour demand volume is 580 vph
Step 2: The 140-second arrival rate is \( 580 \times \frac{140}{3600}/0.8 \), which equals 29 vehicles per cycle.
Step 3: The required number of lanes is one lane because the demand volume is less than the one lane capacity of 800 vph.
Step 4: For one lane ramps, the 140-second discharge rate is 31 vehicles. Because the discharge rate is greater than arrival rate, a minimum of **420 feet** of storage length is required.

**Ramp Meter Retrofit Analysis**
The ramp meter retrofit warrant analysis is used to determine if an existing ramp can be metered with little to no modifications. The traffic count and speed data used in the analysis shall be a maximum of 3 years old to the date of the analysis.

**Future Ramp Meter Analysis**
The future ramp meter warrant analysis is used to determine if a ramp meter is needed on a project in design. The warrants are based on future certified traffic projections and traffic (July 17, 2020)
modeling. If the projected volumes show that a ramp meter is warranted for the project's Opening Year, that warrant is all that needs to be provided. If traffic volumes for Opening Year do not meet, further analysis will be done with two sets of traffic data. The first set will be projected traffic 5 years from the Opening Year and second set will be projected traffic 10 years from the Opening Year. They both are to be analyzed to see when the ramp meter meets warrants. When a ramp meter is warranted within 5 years, a full ramp meter built out is required with the project. When a ramp meter is warranted within 10 years, only the underground infrastructure and power service are to be installed with the project.

Warrant 8 (Required Acceleration Length) and Warrant 9 (Required Storage Length) are not included in the analysis because it is assumed that a project in design can provide the proper acceleration and storage lengths. The criteria for Warrant 8 and Warrant 9 are to be used to confirm the design ramp meets length requirements.

Warrant 1-Ramp Volume

Warrant 4-Freeway Level of Service

Warrant 5-Mainline Volume

1303-12 Traffic Incident Management

Traffic incident management is addressed in Chapter 608.

1303-13 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).

Contact ODOT Traffic Operations for additional information.

1303-14 Hard Shoulder Running

Contact ODOT Traffic Operations for information regarding Hard Shoulder Running.
1340  Design Information

1340-1  General

The L&D Manual Volumes 1 and 3 and Chapter 140 provide general background regarding design information for ODOT projects, including the three-stage review process typically used for traffic control plans. Additional design information has been provided in this Chapter, including checklists for Stage 2 and 3 submittals (see Section 1340-2). See Chapter 1303 for design information related to specific types of ITS projects; Plan Notes are addressed in Chapter 1342; Chapter 443 provides a listing of related C&MS Items; and Chapter 1395 provides information about the Traffic Authorized Product (TAP) List.

For information about traffic signal design requirements, see TEM Part 4. Designers working on signal design projects should also utilize the files and guidance provided in the Signal Design Reference Packet. See Chapter 495 for additional information regarding the reference packet.

1340-2  Stage 1, 2 and 3 Plan Submittals

The following information has been provided here as checklists for Stage 1, 2 and 3 plan submittals.

1. Stage 1 Plan Requirements:
   a. Base plan drawn to scale of 1:40 and it shall include roadway base lines in Traffic Surveillance Section.
   b. Existing ITS infrastructure identified and shown in plans. Existing plan sets can be obtained by either contacting the District Project Manager or by emailing Cen.ITS.Lab@dot.ohio.gov.
   c. Temporary plan for communications infrastructure during construction.
   d. Project overview map (similar to Figure 1398-5), excluding any field devices.

2. Stage 2 Plan Requirements:
   a. Proposed new locations for ITS devices
   b. Proposed location and path of new communication lines. Provide new service addresses if applicable.
   c. Power service locations with coordinated work order and / or service addresses.
   d. Underground conduit and pull boxes.
   e. Legend for symbols used.
   f. Fiber termination drawings, if applicable. See Figures 1398-2, 1398-3, 1398-5 and 1398-5, with proposed field devices, for sample diagrams.
   g. Right-of-Way lines.
   h. Standard Construction Drawings on cover sheet.
   i. Supplemental Specifications on cover sheet.

3. Stage 3 Plan Requirements:
   a. General Notes.
   b. Estimated quantities.
   c. Special details.
1342 PLAN NOTES

1342-1 General

Typical Plan Notes have been consolidated here for convenience in preparing plans. The number used for the Plan Note will be the same as the Section number. When a Plan Note revises the material or contractor requirements from that which is specified in the C&MS, both the note and the bid item will be “as per plan.” Where there are design instructions pertaining to a specific note, they are listed at the end of the note. These notes may be modified to further define the conditions of a project or maintaining agency.

In keeping with traditional format of Plan Notes, various format changes are used here that are not typical throughout the TEM, e.g., the terms Contractor and Engineer are capitalized.

1342-2 CCTV Installations

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.

Designer Note: See Table 1397-4 for additional information.

1342-3 Dynamic Message Sign Installations

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.

Designer Note: See Table 1397-5a, 1397-5b or 1397-6 for additional information.

1342-4 Vehicle Detection Installations

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.

Designer Note: See Table 1397-7 for additional information.

1342-5 RESERVED FOR FUTURE USE

1342-6 Ramp Metering Installations

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.

Designer Note: See Table 1397-9 for additional information.

1342-7 Items 625E25740 and 625E25750: Conduit 4" Multi-Cell Schedule 40 & Schedule 80, 725.20A

Description

This conduit is intended for the use in underground situations requiring more than one single conduit. This includes the main conduit raceway along the freeway, connection from pull boxes to the road side cabinets and for runs of conduit for multiple purposes, e.g., at ramp
meter installations, for loop lead-in cable, signals cable for ramp meter displays, signal cable for ramp meter signing flashers & illumination and power. The contractor shall plug all unused cells with conduit caps to assure air and water integrity of each individual innerduct.

**Materials**

The traffic surveillance raceway shall consist of a factory-assembled system of four (4) innerducts assembled within a protective outer duct. The innerducts shall be nominal 1.25 inch inside diameter, Type DB PVC per NEMA TC-8 with a bell insertion depth of 1.75 inches minimum. The outer duct shall be nominal 4 inch (inside diameter), Schedule 40 PVC. Carlon type Schedule 40 and 80 or approved equivalent.

The coupling shall be designed in a manner to permit easy field assembly. The coupling shall be marked or keyed in a manner to ensure the innerducts are properly aligned, any color codes are continued and the adjoining section is inserted to the proper depth in the bell. All keys and/or markings shall be visible after assembly to allow the inspection of each joint for proper assembly before burial. The sealing system shall be designed to assure air integrity of each individual innerduct and water integrity of the entire system.

Where innerduct(s) within a multi-cell duct are to remain empty, one ¼-inch nylon rope shall be installed in each of the open innerducts, the rope will remain to be used for a future cable installation. Also, each innerduct shall be plugged to maintain the air and water integrity. In addition, the outer duct shall be capped to maintain the air and water integrity of the entire system. For multi-cell duct installed in median walls, all ropes and plugs shall be installed prior to any concrete placement.

**Installed in trench**

Installation will be in 30-inch deep trench, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed outside of the roadway in trench shall be Schedule 40 unless directed by the ODOT engineer to use Schedule 80 for use in well-traveled vehicular areas.

**Installed under roadway**

Installation will be at least 30 inches deep jacked or drilled under pavement, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed under the roadway shall be Schedule 80.

**Installed within 6 feet of guardrail**

Installation will be at least 30 inches deep trench and encased in concrete.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed under the roadway shall be Schedule 80.

**Method of measurement**

The conduit will be measured by the amount of conduit in feet furnished and installed of each type Schedule 40 or 80 measured from center-to-center of pull boxes, foundation, etc., and will include all fittings and appurtenances, joints, bends, grounds and concrete encasement where specified.

The trench will be measured by the number of feet of trench completed as per C&MS 625.21.
Basis of payment

The payment for these items will be made for the accepted liner foot quantities at the contract bid price.

Item 625E25760: Conduit, 4", Multicell, 725.20B, HDPE
Item 625E25762: Conduit, Multicell, 4", 725.20B, HDPE, Jacked or Drilled

Description

This conduit is intended for the use in underground situations requiring more than one single conduit. This includes the main conduit raceway along the freeway, connection from pull boxes to the road side cabinets and for runs of conduit for multiple purposes, e.g., at ramp meter installations, for loop lead-in cable, signals cable for ramp meter displays, signal cable for ramp meter signing flashers & illumination and power. The contractor shall plug all unused cells with conduit caps to assure air and water integrity of each individual innerduct.

Materials

The traffic surveillance raceway shall consist of a factory-assembled system of (4) innerducts assembled within a protective outer duct. The innerducts shall be nominal 1 inch inside diameter, solid wall PE, SDR 13.5, coilable conduit. The outer duct shall be nominal 4 inch (inside diameter), solid wall PE, SIDR 11.5, coilable conduit. Blue Diamond 4N1 or approved equivalent.

The coupling shall be designed in a manner to permit easy field assembly. The coupling shall be marked or keyed in a manner to ensure the innerducts are properly aligned, any color codes are continued and the adjoining section is inserted to the proper depth in the bell. All keys and/or markings shall be visible after assembly, to allow the inspection of each joint for proper assembly before burial. The sealing system shall be designed to assure air integrity of each individual innerduct and water integrity of the entire system.

Where innerduct(s) within a multi-cell duct are to remain empty, one 1/4" nylon rope shall be installed in each of the open innerducts, the rope will remain to be used for a future cable installation. Also, each innerduct shall be plugged to maintain the air and water integrity. In addition, the outer duct shall be capped to maintain the air and water integrity of the entire system.

Installed in trench

Installation will be in 30" deep trench, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct.

Installed under roadway

Installation will be at least 30" deep jacked or drilled under pavement, except as noted on the plans.

All joints will be joined according to the manufacturer’s recommendations, in order to provide an air-tight enclosure of the interior ducts and a water-tight enclosure of the outer duct. All multi-cell conduit installed under the roadway shall be schedule 80.
Method of measurement

The conduit will be measured by the amount of conduit in feet furnished and installed, measured from center-to-center of pull boxes, foundation, etc., and will include all fitting and appurtenances, joints, bends, grounds, and concrete encasement where specified.

The trench will be measured by the number of feet of trench completed as per section 625.21.

Basis of payment

The payment for these items will be made for the accepted liner foot quantities at the contract bid price.

1342-9 Tracer Wire

The Contractor shall furnish and install this item according to ODOT Supplemental Specifications 804/904.

1342-10 Fiber Optic Cable Marker

The Contractor shall furnish and install this item according to ODOT Supplemental Specifications 804/904.

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 Traffic Operations.

Designer Note: See Table 1397-5 and Table 1397-6 for additional information.

1342-12 Item 625E29931 Median Junction Box, As Per Plan

The Contractor shall supply the median barrier junction pull boxes that meet the following specifications:

- Shall be of type polymer-concrete
- Size: 17 inches (height) x 30 inches (length)
- Minimum wall thickness: 0.5 inch
- Minimum lid thickness: 2 inches
- ANSI tier 22 rating with a minimum design load of 22,000 pounds
- Lid shall be marked “Traffic.”
- The median junction box shall be secured in the median barrier wall using dowels. (non-shrink grout may be used when necessary).

1342-13 Utilities

Designer Note: Include ODOT, Office of Technical Services, Traffic Monitoring section as a utility owner anytime there is pavement milling or any excavation work within the vicinity of our permanent count stations, also known as ATR’s and WIM’s. Please utilize Utility Note G102A1; below is our contact info:

Traffic Monitoring Section ODOT, 1980 West Broad Street, Columbus, Ohio 43223
1342-14  Protection of Traffic Monitoring Equipment

Prior to beginning any pavement activities or any excavation activities between [insert station or log points] and [insert station or log point] the contractor, the project engineer, and a representative from the owner will coordinate a time for the owner/maintaining agency to disconnect the equipment. Following the disconnection by the owner, the contractor will be allowed to perform their pavement activities, including pavement removal. The remove loops and sensors become the property of the contractor.

(Add the following portion for projects that also include excavation activities)

During the meeting, the owner/maintaining agency will identify equipment locations. Do not disturb pull boxes, controllers, cabinets, poles and conduits. Any damage will be the responsibility of the contractor and repairs must be accepted by the owner.

Designer Note: For use on resurfacing, minor rehabilitation, and bridge projects within 300 feet of a permanent traffic count station.

Projects of special concern – Those that involve a concrete median installation - either as part of a widening that converts the grass median to concrete or a project that replaces the existing concrete median. We need to include specific details for including a median pullbox, and occasionally conduits to allow us to reinstall loops and detectors following the construction of roadway and median work. In general, we handle reinstallation of our specialized equipment via a separate contract with certified material contractors including warranty clauses. Sometimes we request certain underground work be included with major pavement rehabs and median changes as part of a pavement project.

Early project coordination is key – please contact Sandra Mapel (614-644-0291, Sandra.Mapel@dot.ohio.gov) for site specific details and needs.

1342-15  Maintaining ITS During Construction

The Contractor shall maintain all preexisting or newly installed permanent ITS/Traffic devices and infrastructure during construction according to ODOT Supplemental Specification 809.

Designer Note: This lump sum pay item and note requires the contractor to maintain all permanent devices and communication which are existing or newly installed on the project, as well as setup any temporary communications needed, and perform utility locates for ITS/Traffic devices during construction. The plan note may be used without the pay item if the project involves little to no work for maintaining ITS/Traffic devices or infrastructure. The lump sum pay item may be used when the designer thinks it’s needed to compensate the contractor for their efforts, such as when a project has a reasonable amount of ITS/Traffic devices or infrastructure within its project limits which could potentially be impacted, or it’s known the contractor will have considerable work or effort in order to maintain ITS/Traffic devices or infrastructure.
1343 SPECIFICATIONS

ODOT specifications for the furnishing and installation of Intelligent Transportation System (ITS) equipment are contained in the following C&MS sections, Supplemental Specifications and Supplement. Also, see Chapter 443 for information about specifications related to traffic signal equipment.

631 and 731 Sign Lighting and Electrical Signs

Supplemental Specifications 804 and 904 address Fiber Optic Cable and Components. All construction projects where installation, relocation, and/or splicing of fiber optic cable is involved need to reference ODOT Supplemental Specifications 804 and 904.

Supplemental Specification 809 addresses Intelligent Transportation System (ITS) Devices and Components. All construction projects involving ITS or any item listed in Chapter 1303 needs to reference ODOT Supplemental Specification 809. The 809 Supplemental Specification has a section for each item and describes the work that needs to be performed for each item. The 809 specification also refers the contractors to the Traffic Authorized Product List.

Supplement 1077 covers the prequalification procedure for Dynamic Message Signs.

The C&MS, Supplemental Specifications and Supplements, may be viewed on-line.
1395  REFERENCE RESOURCES

1395-1  General

Various other reference resources that may be useful have been noted in *Chapters 193 and 194*.

1395-2  Traffic Authorized Product (TAP) List

The *Traffic Authorized Product (TAP) List* was developed due to technology changing at a rapid pace and the need to keep the ODOT ITS products up to date. The TAP was developed for the sole use of the contractors and its purpose is to remove any misinterpretation of specifications during the time of construction. References to the TAP should not be included in the plans.
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1396 FORMS INDEX

The following forms are available only on the Office of Traffic Operations (OTO) website.

1396-1 ITS Form

As noted in Subsection 1301-3.2, Form 1396-1 may be used and modified as necessary for completing the Systems Engineering Analysis.

1396-2 ITS Form for Emergency Vehicle Preemption (EVP)

As noted in Subsection 1301-3.2, Form 1396-2 is an abbreviated Minor ITS Form available for use in documenting the SEA for Emergency Vehicle Preemption projects.

1396-3 Systems Engineering Review Form (SERF)

As noted in Subsection 1301-3.1, Form 1396-3 may be used for a project to gain programmatic approval of meeting the requirements set forth under 23 CFR 940.
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TABLES INDEX

1397-1  Exempt, Low-Risk and High-Risk ITS Projects

As noted in Subsection 1301-1.2, Table 1397-1 presents examples of Exempt, Low-Risk or High-Risk ITS projects.

1397-2  ITS User Services

Table 1397-2 presents a list of all the ITS User Services available.

1397-3  Regional ITS Architecture in Ohio

As noted in Subsections 1301-2.2, 1301-2.4, and Table 1397-3 presents a list of the locations with MPO’s in Ohio, and the MPO websites.

1397-4  Closed Circuit Television (CCTV) Installations

As noted in Section 1303-3, Table 1397-4 provides a matrix outlining the process and references needed in designing CCTV pole installations.

1397-5  Dynamic Message Sign (DMS) Installations

As noted in Section 1303-5, Table 1397-5 provides a matrix of information needed in designing DMS installations.

1397-6  Destination Dynamic Message Sign (DDMS) Installations

As noted in Section 1303-5, Table 1397-6 provides a matrix of information needed in designing DDMS installations.

1397-7  Vehicle Detection Installations

As noted in Section 1303-6, Table 1397-7 provides a matrix of information needed in designing vehicle detection installations.

1397-8  RESERVED FOR FUTURE USE

1397-9  Ramp Metering Installations

As noted in Section 1303-10 Table 1397-9 provides a matrix of information needed in designing ramp metering installations.
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<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
</table>
| Exempt       | • Changes and/or upgrades to an existing traffic signal system, including signal timing revisions, additional phases (vehicle or pedestrian) or detector installation.  
              • Routine maintenance and operation of an existing ITS system.  
              • Expansion of an existing traffic signal, ITS or freeway management system (FMS) that does not change or add to the original needs and requirements of the system. This type of project does not change any existing hardware, software or interfaces. It simply adds equipment (DMS, DDMS, CCTV, RWIS, etc.), software, locations or intersections to an existing system. The new equipment and software must be compatible with the existing.  
              • Installation of an isolated traffic signal. This is a single traffic signal, not connected to any type of external signal control, nor likely to be connected in the future due to its isolation.  
              • Installation of traffic signals which are part of a Time-Based Coordinated system.  
              • Installation of traffic signals which are part of a hardwired or wireless interconnected system that is locally controlled, i.e. where the timing patterns are controlled by the local controller and not by centrally controlled software.  
              • Installation of cameras that are not functionally integrated into other types of systems; for example, cameras solely for the purpose of traffic data collection or surveillance cameras. |
| Low-Risk     | • Closed loop arterial traffic signal system.  
              • Centrally controlled arterial traffic signal system.  
              • Highway Rail/Traffic Signal pre-emption.  
              • Traffic signal system with Emergency Vehicle Pre-emption.  
              • Traffic signal system with Transit Priority.  
              • Ramp Meter system.  
              • Adaptive Traffic Signal Control system. |
| High-Risk    | • New freeway management systems (FMS).  
              • Traffic signal systems that requires integration with other systems, e.g. FMS or RWIS.  
              • Ramp meter systems that require integration with adjacent traffic signal system(s).  
              • Regional traffic signal system (as opposed to an arterial traffic signal system) that as the potential to affect geographic areas outside of the maintaining agency.  
              • Regional transit systems.  
              • Any Low-Risk project that provides additional functionality than what is covered in the approved Functional Requirements document for that project category.  
              • Any project that requires new or unproven hardware, software or interfaces.  
              • Any project for which functional requirements and operations & management procedures have not been documented.  
              • Any project not considered Exempt or Low-Risk under the Programmatic Agreement. |
Table 1397-2. ITS User Services

To find detailed information relating to each of the User Services below, visit [http://www.iteris.com/itsarch/](http://www.iteris.com/itsarch/) and select “User Services” from the navigation bar at the top of the screen.

### Travel and Traffic Management

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<td>En-route Driver Information</td>
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<td>1.3</td>
<td>Route Guidance</td>
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<td>1.4</td>
<td>Ride Matching And Reservation</td>
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<td>1.5</td>
<td>Traveler Services Information</td>
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<td>1.6</td>
<td>Traffic Control</td>
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<td>1.7</td>
<td>Incident Management</td>
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<td>1.8</td>
<td>Travel Demand Management</td>
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<td>1.9</td>
<td>Emissions Testing And Mitigation</td>
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<td>1.10</td>
<td>Highway Rail Intersection</td>
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</table>

### Public Transportation Management

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<td>2.2</td>
<td>En-route Transit Information</td>
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<td>2.3</td>
<td>Personalized Public Transit</td>
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<td>Public Travel Security</td>
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### Electronic Payment

| 3.1 | Electronic Payment Services     |

### Commercial Vehicle Operations

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<td>4.3</td>
<td>On-board Safety And Security Monitoring</td>
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<td>4.4</td>
<td>Commercial Vehicle Administrative Processes</td>
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<td>4.5</td>
<td>Hazardous Material Security And Incident Response</td>
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<td>4.6</td>
<td>Freight Mobility</td>
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</table>

### Emergency Management

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<th>Emergency Notification And Personal Security</th>
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<td>5.2</td>
<td>Emergency Vehicle Management</td>
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<td>5.3</td>
<td>Disaster Response And Evacuation</td>
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### Table 1397-2. ITS User Services (Continued)

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<th>Advanced Vehicle Safety Systems</th>
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<td>6.2 Lateral Collision Avoidance</td>
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<tr>
<td>6.3 Intersection Collision Avoidance</td>
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<tr>
<td>6.4 Vision Enhancement For Crash Avoidance</td>
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<tr>
<td>6.5 Safety Readiness</td>
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<td>6.6 Pre-crash Restraint Deployment</td>
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<td>6.7 Automated Vehicle Operation</td>
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<td>7.1 Archived Data</td>
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<tr>
<th>Maintenance and Construction Management</th>
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<tbody>
<tr>
<td>8.1 Maintenance And Construction Operations</td>
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</table>
### Table 1397-3. Regional ITS Architecture in Ohio
(Also see TEM Section 1301-2.)

<table>
<thead>
<tr>
<th>Region</th>
<th>Regional ITS Architecture</th>
<th>MPO: AMATS (Akron Metropolitan Area Transportation Study)</th>
<th>MPO Website: <a href="http://amatsplanning.org/">http://amatsplanning.org/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Akron/Canton</td>
<td>regionalitsarchitectureakron.htm/akronintro.htm</td>
<td>MPO: SCATS (Stark County Area Transportation Study)</td>
<td>MPO Website: <a href="https://www.starkcountyohio.gov/transportation">https://www.starkcountyohio.gov/transportation</a></td>
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<tr>
<td>Cincinnati/Northern Kentucky</td>
<td>regionalitsarchitectureoki.htm</td>
<td>MPO: OKI (Ohio-Kentucky-Indiana Regional Council of Governments)</td>
<td>MPO Website: <a href="http://www.oki.org">www.oki.org</a></td>
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<tr>
<td>Cleveland</td>
<td>regionalitsarchitecturenoaca.htm</td>
<td>MPO: NOACA (Northeast Ohio Areawide Coordinating Agency)</td>
<td>MPO Website: <a href="http://www.noaca.org">www.noaca.org</a></td>
</tr>
<tr>
<td>Columbus</td>
<td>regionalitsarchitecturemorpc.org</td>
<td>MPO: MORPC (Mid Ohio Regional Planning Commission)</td>
<td>MPO Website: <a href="http://www.morpc.org">www.morpc.org</a></td>
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<tr>
<td>Dayton/Springfield</td>
<td>regionalitsarchitecturemvrpc.org</td>
<td>MPO: MVRPC (Miami Valley Regional Planning Commission)</td>
<td>MPO Website: <a href="http://www.mvrpc.org">www.mvrpc.org</a></td>
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<tr>
<td></td>
<td></td>
<td>MPO: CCSTCC (Clark County-Springfield Transportation Coordinating Committee)</td>
<td>MPO Website: <a href="http://www.clarktcc.com">www.clarktcc.com</a></td>
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<tr>
<td>Toledo</td>
<td>regionalitsarchitecturetamacog.org</td>
<td>MPO: TMACOG (Toledo Metropolitan Area Council of Governments)</td>
<td>MPO Website: <a href="http://www.tmacog.org">www.tmacog.org</a></td>
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<tr>
<td>Youngstown</td>
<td>regionalitsarchitectureeastgate.htm</td>
<td>MPO: Eastgate (Eastgate Regional Council of Governments)</td>
<td>MPO Website: <a href="http://www.eastgatecog.org">www.eastgatecog.org</a></td>
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Table 1397-4. CCTV Installations  
(Also see TEM Section 1303-3.)

<table>
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<tr>
<th>Task</th>
<th>Prior Approval Needed</th>
<th>Item Description</th>
<th>Related Supplemental Specification</th>
<th>Item Master</th>
<th>Traffic SCD No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose CCTV Camera</td>
<td></td>
<td>CCTV IP-Camera System, Dome-Type</td>
<td>809.05.A</td>
<td>809E60000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*</td>
<td>CCTV IP-Camera System, Type HD, Wall/Tunnel</td>
<td>809.05.B</td>
<td>809E60010</td>
<td></td>
</tr>
</tbody>
</table>

If dome type camera is to be mounted on pole, choose pole height.

| Choose Pole Height           | *                     | CCTV Concrete Pole with Lowering Unit, 50 FT            | 809.06.A                           | 809E60100   | ITS-12.10       |
|                              |                       | CCTV Concrete Pole with Lowering Unit, 70 FT            | 809.06.A                           | 809E60100   | ITS-12.10       |

| Choose Cabinet Type          | *                     | *Pole Mount                                            | 809.09.B                           | 809E65010   | ITS-11.10       |
|                              |                       | Ground Mount                                           | 809.09.A                           | 809E65000   | ITS-10.10       |

| Choose Work Pad              |                       | Controller Work Pad, As Per Plan                       | 633E67200                          | ITS-10.10   | ITS-11.11       |

| Choose Grounding             |                       | Ground Rod, As Per Plan                                | 625E32001                          | ITS-50.10   |                 |

| Choose Power Service         |                       | Underground                                            | 809.05.A                           | 809E60000   |                 |
|                              |                       | Aerial                                                 | 809.05.B                           | 809E60010   |                 |

| Use if directed by ODOT      | *                     | ITS Cabinet-Power Distribution Cabinet (PDC)           | 809.09.A                           | 809E65020   |                 |

* Approval must be obtained from Office of Traffic Operations (OTO)
Table 1397-5a. Full-Size Walk-In Dynamic Message Sign (DMS) Installations
(Also see TEM Section 1303-5.)

<table>
<thead>
<tr>
<th>Task</th>
<th>Prior Approval Needed</th>
<th>Item Description</th>
<th>Related Supplemental Specification</th>
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<th>Traffic SCD No.</th>
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<tbody>
<tr>
<td>Choose DMS Type</td>
<td>*</td>
<td>DMS- Full-Size Walk-In</td>
<td>809.07.A</td>
<td>809E63000</td>
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<td>Choose Mount Type</td>
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<td>Overhead Sign Support, DMS Pedestal, As Per Plan</td>
<td>630E70045</td>
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<td>ITS-30.13</td>
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<tr>
<td></td>
<td>*</td>
<td>Overhead Sign Support, DMS Truss, 80', As Per Plan</td>
<td>630E70001</td>
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<td>ITS-35.13</td>
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<td>*</td>
<td>Overhead Sign Support, DMS Truss, 115', As Per Plan</td>
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<td>ITS-35.14</td>
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<tr>
<td></td>
<td>*</td>
<td>Overhead Sign Support, DMS Truss, 150', As Per Plan</td>
<td>630E70041</td>
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<td>ITS-35.14</td>
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<td>Choose Foundation</td>
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<td>Concrete Barrier Median Overhead Sign Support Foundation, DMS Truss</td>
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<td>Overhead Sign Support Foundation, DMS Pedestal</td>
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<td>ITS-30.12</td>
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<td>Overhead Sign Support Foundation, DMS Truss</td>
<td>630E70080</td>
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<td>ITS-35.12</td>
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<td>Choose Catwalk</td>
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<td>Catwalk, DMS Truss, As Per Plan</td>
<td>630E70051</td>
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<td>ITS-35.11</td>
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<td>Catwalk, DMS Pedestal, As Per Plan</td>
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<td>ITS-30.11</td>
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<tr>
<td>Choose Cabinet Type</td>
<td>*</td>
<td>*Pole Mount</td>
<td>809.09.B</td>
<td>809E65010</td>
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<td>809E65000</td>
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<tr>
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<td>Aerial</td>
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<tr>
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<td>ITS Cabinet-Power Distribution Cabinet (PDC)</td>
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</tbody>
</table>

* Approval must be obtained from Office of Traffic Operations (OTO)
Table 1397-5b. Front Access Dynamic Message Sign (DMS) Installations
(Also see TEM Section 1303-5.)

<table>
<thead>
<tr>
<th>Task</th>
<th>Prior Approval Needed</th>
<th>Item Description</th>
<th>Related Supplemental Specification</th>
<th>Item Master</th>
<th>Traffic SCD No.</th>
</tr>
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<tbody>
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<td>Choose DMS Type</td>
<td>*</td>
<td>DMS- Front-Access</td>
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<td>809E63001</td>
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<td>Choose Beam</td>
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<tr>
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<td></td>
<td>TC-41.10</td>
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<tr>
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<td>Ground Mounted Structural Beam Support Foundation</td>
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<td>TC-41.10</td>
</tr>
<tr>
<td>Choose Cabinet Type</td>
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<td>809.09.B</td>
<td>809E65010</td>
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</tr>
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<td></td>
<td></td>
<td>Ground Mount</td>
<td>809.09.A</td>
<td>809E65000</td>
<td></td>
</tr>
<tr>
<td>Choose Work Pad</td>
<td></td>
<td>Controller Work Pad, As Per Plan</td>
<td></td>
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<td>Contact OTO</td>
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<tr>
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<td>ITS-50.10</td>
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<tr>
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<td>809.02</td>
<td>625E34000</td>
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<td>Aerial</td>
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<td>625E34000</td>
<td>ITS-15.11</td>
</tr>
<tr>
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<td>ITS Cabinet-Power Distribution Cabinet (PDC)</td>
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</tbody>
</table>

* Approval must be obtained from Office of Traffic Operations (OTO)
### Table 1397-6. Destination Dynamic Message Sign (DDMS) Installations
(Also see TEM Section 1303-5.)

<table>
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<tr>
<th>Task</th>
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<th>Item Master</th>
<th>Traffic SCD No.</th>
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<tr>
<td><strong>Choose DDMS Type</strong></td>
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<tr>
<td>*</td>
<td>DDMS, Freeway-Two-Line</td>
<td>809E63020</td>
<td>ITS-40.10</td>
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<tr>
<td>*</td>
<td>DDMS, Freeway-Three-Line</td>
<td>809E63030</td>
<td>ITS-40.10</td>
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<tr>
<td>*</td>
<td>DDMS, Arterial-Two-Line</td>
<td>809E63040</td>
<td>ITS-40.10</td>
</tr>
<tr>
<td>*</td>
<td>DDMS Arterial-Three-Line</td>
<td>809E63050</td>
<td>ITS-40.10</td>
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<tr>
<td><strong>Define Sign Size</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sign, Ground Mounted Extrusheet, As Per Plan</td>
<td>630E80201</td>
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<tr>
<td><strong>Define Sign Mounting</strong></td>
<td></td>
<td></td>
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<td></td>
<td>Sign Erected, Extrusheet, As Per Plan</td>
<td>630E81201</td>
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<td><strong>Choose Beam</strong></td>
<td>Ground Mounted Structural Beam Support, W-??x??</td>
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<td>TC-41.10</td>
</tr>
<tr>
<td><strong>Choose Beam Connection</strong></td>
<td>Breakaway Structural Beam Connection</td>
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<td>TC-41.10</td>
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<tr>
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<td>Contact OTO</td>
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<tr>
<td><strong>Choose Cabinet Type</strong></td>
<td>*Pole Mount</td>
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<tr>
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<td>Ground Mount</td>
<td>809.09.A</td>
<td>809E65000</td>
</tr>
<tr>
<td><strong>Choose Grounding</strong></td>
<td>Ground Rod, As Per Plan</td>
<td>625E32001</td>
<td>ITS-50.10</td>
</tr>
<tr>
<td><strong>Choose Power Service</strong></td>
<td>Underground</td>
<td>809.02</td>
<td>625E34000 ITS-15.10 ITS-50.11</td>
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<td></td>
<td>Aerial</td>
<td>809.02</td>
<td>625E34000 ITS-15.11</td>
</tr>
<tr>
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<td>* ITS Cabinet-Power Distribution Cabinet (PDC)</td>
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* Approval must be obtained from Office of Traffic Operations (OTO)
Table 1397-7. Vehicle Detection (SFRD) Installations
(Also see TEM Section 1303-6.)

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<th>Tasks</th>
<th>Prior Approval Needed</th>
<th>Item Description</th>
<th>Related Supplemental Specification</th>
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<th>Traffic SCD No.</th>
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<td>Choose Vehicle Detection Type</td>
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<td>Side-Fired Radar Detector</td>
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<td>Choose Light Pole (if needed)</td>
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<td>Light Pole, Conventional, Each As Per Plan</td>
<td>625E10491</td>
<td>HL-10.13</td>
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<tr>
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<td></td>
<td>Ground Rod, As Per Plan</td>
<td>625E32001</td>
<td>ITS-50.10</td>
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<tr>
<td>Choose Foundation</td>
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<td>Light Pole Foundation, As Per Plan</td>
<td>625E14501</td>
<td>HL-20.11</td>
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<tr>
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<td>*Pole Mount</td>
<td>809E65010</td>
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<td></td>
<td></td>
<td>Ground Mount</td>
<td>809E65000</td>
<td>ITS-15.11</td>
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<tr>
<td>Choose Power Service</td>
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<td>Underground</td>
<td>625E34000</td>
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<td>Aerial</td>
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<tr>
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<td>ITS Cabinet-Power Distribution Cabinet (PDC)</td>
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</tbody>
</table>

* Approval must be obtained from Office of Traffic Operations (OTO)
Table 1397-8. Reserved for Future Use
### Table 1397-9. Ramp Metering Installations
(Also see TEM Section 1303-10.)

<table>
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<tr>
<th>Tasks</th>
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<th>Item Master</th>
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<td>Ramp Metering System #</td>
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<td>Choose Training</td>
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<td>Ramp Metering Training</td>
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<td>Choose Cabinet Type</td>
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<td>ITS Cabinet Ramp Meter</td>
<td>809.09.D</td>
<td>809E65030</td>
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<tr>
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<td>Ground Rod, As Per Plan</td>
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<tr>
<td>Choose Power Service</td>
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<td>Underground</td>
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<td>Aerial</td>
<td>809.02</td>
<td>625E34000</td>
<td>ITS-15.11</td>
</tr>
<tr>
<td>Use if directed by ODOT</td>
<td>*</td>
<td>ITS Cabinet-Power Distribution Cabinet (PDC)</td>
<td>809.09.C</td>
<td>809E65020</td>
<td></td>
</tr>
</tbody>
</table>

* Approval must be obtained from Office of Traffic Operations (OTO)

# Alternatively, typical Traffic Signal Pay items may be used.
1398 FIGURES INDEX

1398-1  Project Development Process (PDP)
As noted in Section 1301-3.1, Figure 1398-1 is a graphical representation of the Project Development Process (PDP).

1398-2  Fiber Optics Termination Diagram (Node Cabinet Assembly)
As noted in Section 1303-4, Figure 1398-2 is a sample representation of what shall be included in plan sets for all fiber optic design on ODOT projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-3  Fiber Optics Termination Diagram (Underground Splice Enclosure)
As noted in Section 1303-4, Figure 1398-3 is a sample representation of what shall be included in plan sets for all fiber optic design on ODOT projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-4  Fiber Optics Termination Diagram (Fiber Backbone Splice Chart)
As noted in Section 1303-4, Figure 1398-4 is a sample representation of what shall be included in plan sets for all fiber optic design on ODOT projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.

1398-5  ITS Device Communication Diagram
As noted in Section 1303-4, Figure 1398-5 is a sample representation of what shall be included in plan sets for all fiber optic design on ODOT projects dealing with Intelligent Transportation Systems (ITS) or Signal Systems.
Figure 1398-1. Project Development Process (PDP) – Phased Approach

**PDP Project Paths**

**Path 1**
Path 1 projects are defined as “simple” transportation improvements generated by traditional maintenance and preventative maintenance. They involve minor structure and roadway maintenance work with no ROW/utility impacts. These are typically NEPA exempt or CE Level 1 NEPA documents.

**Path 2**
Path 2 projects are also simple projects that may be similar in work type to Path 1 projects. They include minor structure and roadway work. Some examples may include: culvert and bridge replacement/reconstruction, resurfacing and addition of turn lanes/shoulders. These jobs can involve non-complex ROW acquisition (strip takes, temporary easements, and or channel easements). These jobs are typically CE Level 1 documents.

**Path 3**
Path 3 projects involve a higher level of complexity than projects in Path 1 or 2. They include work such as: moderate roadway and structure work including, intersection and minor interchange upgrades, minor realignments, reconstruction, median widenings, etc. They can involve utility and ROW acquisition including relocations. These projects are usually CE Level 2 or higher level NEPA documents.

**Path 4**
Path 4 projects involve complex roadway and structure work that may add capacity. Path 4 projects typically have multiple alternatives. Projects may include highway widening, new alignments in suburban or rural settings, reconstruction, access management, complex bridge replacement and/or multiple intersection/interchange alternatives. They may have substantial utility and/or ROW relocations/impacts. These are typically CE Level 3 or higher level NEPA documents.

**Path 5**
Path 5 projects have the highest complexity and typically add capacity. They involve projects like new capacity-adding alignments in complex urban centers, major highway widenings reconstructed interchange or new interchange. These projects will have substantial ROW relocations/impacts, complex utility issues, multiple alternatives and access management issues. These projects are typically higher level NEPA documents.
Figure 1398-2. Fiber Optics Termination Diagram  
(Node Cabinet Assembly)  
(Also see TEM Section 1303-4.)
Figure 1398-3. Fiber Optics Termination Diagram
(Underground Splice Enclosure)
(Also see TEM Section 1303-4.)

[Diagram of fiber optics termination showing color codes and connections between different cables and tubes.]
Figure 1398-4. Fiber Optics Termination Diagram
(Fiber Backbone Splice Chart)
(Also see TEM Section 1303-4.)
Figure 1398-5. ITS Device Communication Diagram
(Courtesy of HNTB, Ohio)
(Also see TEM Section 1303-4.)
Figure 1398-5. ITS Device Communication Diagram (continued)