


Intelligent Transportation System (ITS)

Design Manual

Mississippi Department of Transportation
Traffic Engineering
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Document Revision History

Date	Version	Description
11/17/11	**Orig. Rel.**	Original/Initial Publication of Design Manual
1/31/19	**Ver. 2.0 Release**	Updated ITS Design Manual

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Acronyms

AASHTO	American Association of State Highway and Transportation Officials	**MM**	Multi-mode
AC	Alternating Current (Power)	**MOA**	Memorandum of Agreement
AHJ	Authority-Having-Jurisdiction	**MOU**	Memorandum of Understanding
ATMS	Advanced Traffic Management System	**MUTCD**	Manual on Uniform Traffic Control
AMR	Automatic Meter Reader	**NEC**	National Electrical Code
BDS	Bluetooth Detection System	**NEMA**	National Electrical Manufacturers Association
CADD	Computer Aided Design Development	**NFPA**	National Fire Protection Association
CATV	Cable Television	**NTB**	Notice to Bidders
CCTV	Closed Circuit Television	**NTCIP**	National Transportation
ConOps	Concept of Operations	**OSP**	Outside-Plant
DMS	Dynamic Message Sign	**OTN**	Open Transport Network
DSL	Digital Subscriber Line	**PB**	Pull Box
ECB	Electrical Communications Box	**PI**	Point of Intersection
ESS	Environmental Sensor Station	**POA**	Point of Attachment
FAA	Federal Aviation Administration	**PoE**	Power over Ethernet
FO	Fiber Optic	**PS&E**	Plan, Specification and Estimate
FDC	Fiber Distribution Center	**PTZ**	Pan-Tilt-Zoom
FHWA	Federal Highway Administration	**RDS**	Radar Detection System
GBIC	Gigabit Interface Converter	**RF**	Radio Frequency
GigE	Gigabit Ethernet	**RPU**	Remote Processor Unit
GUI	Graphical User Interface	**RTVM**	Requirements Traceability Verification
HAR	Highway Advisory Radio	**R/W**	Right of Way
HD	High Definition	**RWIS**	Road Weather Information System
IEEE	Institute of Electrical and Electronic Engineers	**SEA**	Systems Engineering Analysis
IP	Internet Protocol	**SEMP**	Systems Engineering Management Plan
ISP	Inside Plant	**SM**	Single Mode
ITE	Institute of Transportation Engineers	**SPD**	Surge Protection Device
ITS	Intelligent Transportation Systems	**TEL**	Telephone
LED	Light Emitting Diode	**TMC**	Transportation Management Center
LOS	Line of Sight	**UPS**	Uninterruptible Power Supply
MDOT	Mississippi Department of Transportation	**VDS**	Video Detection System

Backbone

A backbone is a part of the computer network infrastructure that interconnects different networks and provides a path for exchange of data between these networks

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1. Introduction

1.1 What is ITS?

Intelligent Transportation Systems (ITS) is the application of information collection and dissemination through communication mediums that aide in the planning, engineering, response, operations, and management of roadways. It's a tool that supports the movement of people, goods, and services throughout the state.

ITS aides in the reduction of the number of incidents, reduces congestion and delay, provides motorists with choices through information, improves transportation safety and mobility and enhances productivity through the use of advanced information and communications technologies.

ITS encompasses a broad range of advanced wireless and wire-line communications-based information and electronics technologies. When integrated into the Mississippi's transportation systems infrastructure, and in vehicles themselves, these technologies reduce congestion, improve safety and enhance Mississippi's productivity.

MDOT ITS Mission Statement

MDOT will use ITS technologies to improve the quality of life for State residents and visitors by providing more reliable, informative, safer, and flexible passenger and freight multi-modal transportation services.

1.2 Purpose of Manual

The primary purpose of the Mississippi Department of Transportation (MDOT) ITS Design Manual (hereafter referred to as "Manual") is to provide uniform guidelines and design criteria for ITS elements implemented on Mississippi's urban freeways, rural freeways, urban arterials and rural roadways. It is intended to guide users through the steps needed to develop a suitable design concept and complete a set of plans and specifications for Mississippi ITS projects. This includes projects executed by the MDOT or other jurisdictions in the State of Mississippi.

This MDOT ITS Design Manual is not intended to cover all ITS elements. The focus of this manual is on traffic related topics.

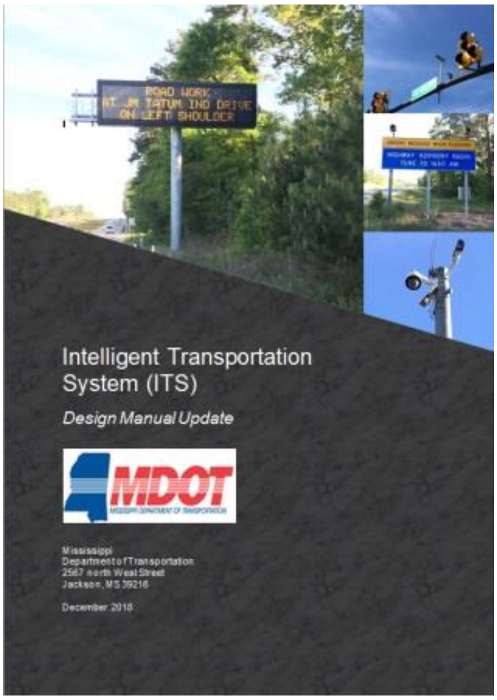
This Manual focuses on new ITS construction projects and projects that require upgrades of existing equipment and infrastructure. For contracts involving legacy equipment, the reader is referred to Section 2.5 Legacy Support.

The designer should also understand that:

1. The intent of this Manual is to produce consistent designs and is not intended to replace professional design analyses nor limit innovative design where equal performance in value, safety, and maintenance economy can be demonstrated.
2. Any conflict between the Manual and an applicable code, ordinance, statute, rule, regulation, and/or law shall be addressed with MDOT.
3. The use and inclusion of the Manual, standard specifications, special provisions, or model drawing details as part of the Contract Documents does not alleviate design professionals from their responsibilities or legal liability for any Contract Documents they create.
4. This manual is applicable for most designs. There may be instances where guidelines may not be appropriate. If the designer believes that a deviation from the Manual is warranted, such a deviation shall be submitted in writing.
5. It provides general guidance and design criteria but cannot address all project specific details that designers will encounter. Therefore, the designers shall confirm all assumptions and questions with the MDOT ITS Project Manager.

Given the rapidly changing ITS technologies, it is imperative that this Manual be considered a "living document." It will continue to be reviewed and updated periodically to reflect changes in technology, MDOT priorities and policies, and statewide and regional transportation needs.

All designers should routinely check the MDOT website (see Section 1.7) for future updates to this Manual.



1.3 Intended Audience

The Manual was prepared for design consultants, system integrators, and contractors involved in the design and deployment of ITS devices and systems in the State of Mississippi. It is assumed that users of this document have a solid understanding of the components and applications of ITS to develop a detailed MDOT ITS design and deployment consistent with this Manual.

1.4 Scope of Manual

The Manual is divided into six primary sections and appendices as shown below.

Section 1.0 – Introduction to manual, what is ITS, scope and purpose of manual, and general resources

Section 2.0 – General design guidance and resources to support the design

Section 3.0 – System design guidelines and considerations for ITS devices, communication hardware and TMC upgrades.

Section 4.0 – Power and grounding design guidelines and considerations

Section 5.0 – Communications design guidelines and considerations

Section 6.0 – PS&E Assembly for a complete PS&E package for MDOT ITS projects including example ITS plan sheets and model details, ITS Special Provisions (Specifications) and example ITS NTB.

Appendix A – Site review checklists for use during site reviews

Appendix B – Design checklists to provide guidelines for the design process

Appendix C – Plans checklists to provide guidelines for preparing the PS&E Packages

Appendix D – Typical label format examples

Appendix E – ITS NTB (examples)

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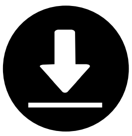
1.5 Icon Descriptions

To help guide the reader through this Manual, the following Icons are used to draw attention to various parts:


Checklist / Design Point or Recommendation


Focus Point


Available Resources


Link to Documentation on Internet

1.6 General Resources and References

Table 1 lists general resources and references for the designer that serve as ancillary resources to the Manual. The table is not an exhaustive list of supporting documentation, as other resources and references may be identified during the project development process.

It is also noted that all federal, state, and local requirements and specifications shall be taken into consideration.

Table 1: General Resource References and Links
FHWA Systems Engineering Guidebook for ITS **www.fhwa.dot.gov/cadiv/segb/index.htm**
FHWA Traffic Detector Handbook: Volumes I and II **https://www.fhwa.dot.gov/publications/research/operations/its/06108/06108.pdf** **https://www.fhwa.dot.gov/publications/research/operations/its/06139/06139.pdf**
FHWA Office of Operations – Traffic Control Systems Handbook **https://ops.fhwa.dot.gov/publications/fhwahop06006/index.htm**
The National Transportation Communications for ITS Protocol (NTCIP) Guide **https://www.ntcip.org/library/documents/pdf/guide.pdf**
Federal Highway Administration: Manual on Uniform Traffic Control Devices (MUTCD) **https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm**
AASHTO Roadside Design Guide **https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/policy_memo/aashto_rdg_120626/**
The National Transportation Communications for ITS Protocol (NTCIP) Guide **https://www.ntcip.org/library/documents/pdf/9001v0302b.pdf**
MDOT Roadway Design Manual **http://sp.mdot.ms.gov/RoadwayDesign/Pages/Roadway-Design-Manual.aspx**
MDOT CADD Manual **http://sp.mdot.ms.gov/Roadway%20Design/CADD/Forms/AllItems.aspx?RootFolder=%2FRoadway%20Design%2FCADD%2FMicrostation&FolderCTID=0x01200017B668FF6790EB4DAAE26B21E127E850&View={0F42333A-ECC9-47BF-8354-2A272F23BC2D}**

1.7 MDOT ITS Website

The MDOT ITS website includes various ITS information and resources for the state. The website portal can be visited by going to:

http://mdot.ms.gov/portal/its.aspx

For **Planning and Pre-Design documentation** click on the link "ITS Planning Resources" on the left sidebar to proceed to:

1. ITS Architectures
2. Master Plans
3. Systems Engineering documentation including the MDOT Systems Engineering Management Plan (SEMP) and Systems Engineering Analysis (SEA) Checklist.

For **Design documentation** click on the link "ITS Design Resources" on the left sidebar to proceed to:

1. MDOT ITS Standard Specifications
2. MDOT ITS Special Provisions
3. Example ITS Plan Sheets
4. Example ITS Details.

2. General Guidelines

The ITS project design begins with the high-level / conceptual design phase. It is assumed that designers will have access to aerial photography survey data and / or as-built plan sheets. In this phase, designers are to use this existing data along with site review data to determine the preliminary placement (or physical location) of ITS devices and communications infrastructure. Section 3 provides specific device location / placement and design guidelines.

2.1 Coordination with Other Disciplines

The designer shall provide all required or needed engineering services including; but not limited to, survey, geotechnical, electrical, permitting, utility coordination, structural, traffic, and railroad coordination to provide a complete ITS PS&E package

2.2 Systems Documentation Review and Needs Assessment

The guidelines provided in this Manual are intended to be part of a systems-engineering approach as illustrated in the graphic below that serves as the framework for the planning, design, development and deployment of ITS projects. Typical steps in the systems engineering process is shown in the following diagram. More information on systems engineering can be found at: **https://ops.fhwa.dot.gov/publications/seitsguide/index.htm**

A SEMP is one of a sequence of planning documents prepared and published by the MDOT under its Statewide ITS Integrator project and is available online as mentioned in Section 2.3.

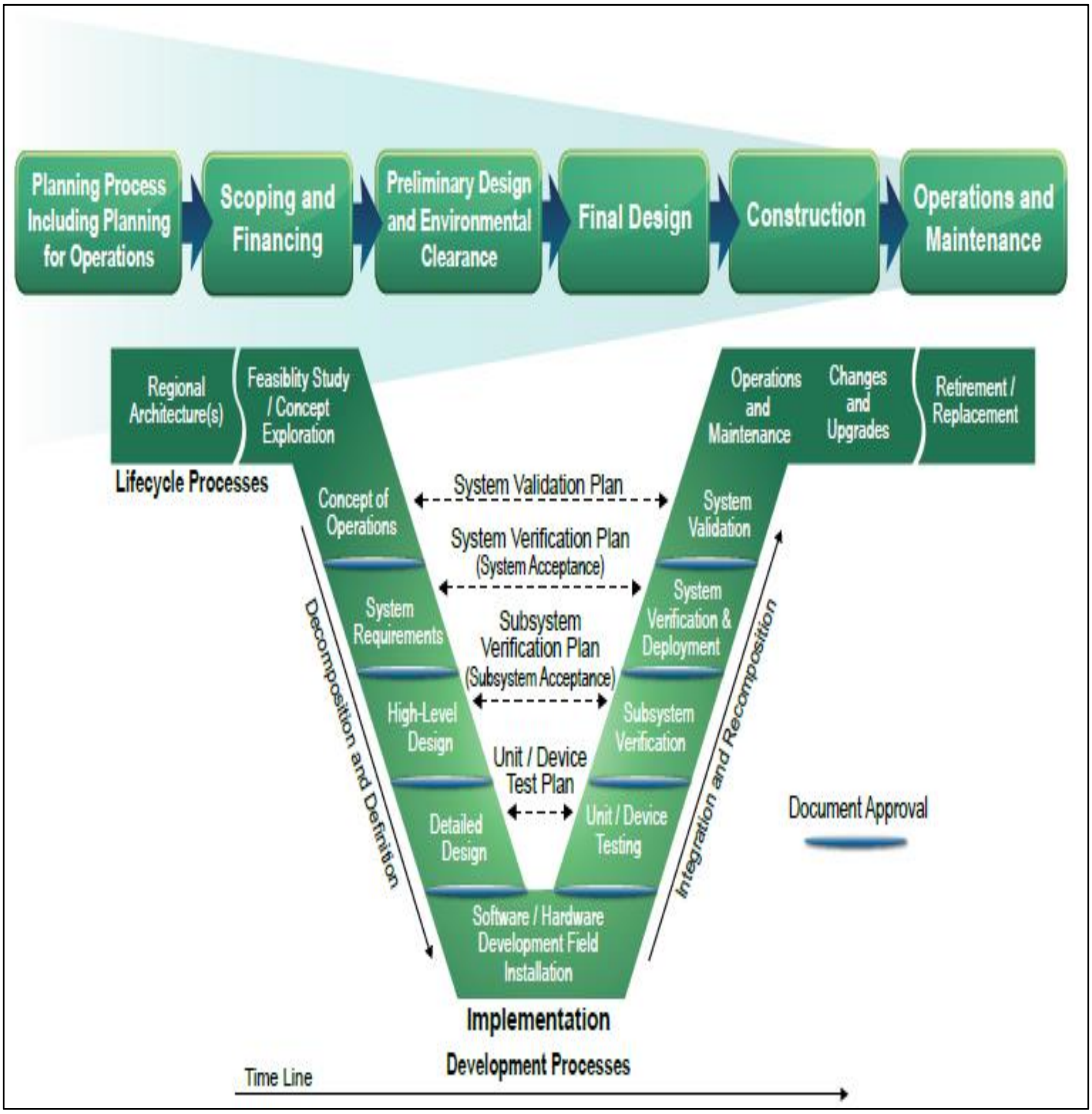
It is intended that this ITS Design Manual be consistent with the SEMP and facilitates the development of design concepts and details for a project once a project specific SEA has been completed (if required).

The designer shall review and/or provide the following systems documentation:

- ☐ Review existing MDOT SEMP, ITS Architecture, Concept/Feasibility Studies, and ConOps documentation as available and applicable and document project system requirements.
- ☐ Review corridor type (i.e., urban and rural freeways, urban and rural arterials), high congestion and bottleneck areas, incident/accident reports, high crash locations, TOC reports, traffic and roadway characteristics and conditions.
- ☐ Develop SEA report as required and applicable (see Section 2.3 for further details).

☐ Review as-built plans, aerials, or Google Earth and provide a preliminary layout of ITS device locations and power source locations.

Figure 1: Typical Steps in the Systems Engineering Process



2.3 Systems Engineering Analysis

The guidelines provided in this Manual are intended to be part of a systems-engineering analysis and approach that serves as the framework for the planning, design, development and deployment of ITS projects. The MDOT ITS Program is consistent with the U.S. DOT guidelines and rules.

MDOT has established a framework (Statewide Architecture) to guide regional ITS Planning, project development and implementation.

FHWA Rule 940 provides policies and procedures for implementing Section 5206(e) of the Transportation Equity Act of the 21st Century (TEA-21), Public Law 105-178, 112 Stat. 457, pertaining to the conformance with the National ITS Architecture and supporting standards. The rule states that all ITS projects, funded in whole or in part with funding from the Federal Highway Administration, shall be based on a SEA consisting of following required elements:

Table 2: Systems Engineering Analysis Requirements

Section of SEA	Description
1. Purpose	Stated purpose for performing the SEA
2. Description of the project	Overall description of the project (i.e., its geographic location, ITS elements to be installed, etc.)
3. Identification of sections of the SITSA/RITSA being implemented	Ensure that the project is consistent with the SITSA/RITSA
4. Requirements definitions	User services included in the National ITS Architecture should be used to develop a set of requirements before the project
5. Analysis of alternative system configurations	Alternative system configuration should be analysed to determine the best option to meet the requirements
6. Procurement options	The procurement type should be determined based on project scope
7. Identification of applicable ITS standards	The most recent ITS and testing standards should be identified
8. Operations and maintenance plan	Procedures and resources necessary for operation and maintenance should be identified

Source: MDOT SEMP, latest version

The project scope of work will clearly specify whether the development of a formal SEA report and/or other systems engineering tasks are required by the consultant for a particular ITS project. For more specific guidance on preparing an SEA, refer to Section 4.5 of the SEMP Version 2.0. The SEMP is available at the following link:

http://mdot.ms.gov/documents/its/Planning/Systems%20Engineering/

In addition, an SEA checklist is also available for use in SEA preparation in the same folder.

In all cases, the MDOT SEMP shall be referred to by the designer to ensure that their design follows a systematic systems-engineering approach and that test requirements are provided to provide verification of the ITS deployment.

2.4 Site Review

After the first conceptual design review meeting, designers shall conduct a site review and inspection to gain first-hand knowledge of the project location, field conditions, and will then propose device locations, conduit routing, and power source locations.

Detailed site review checklists are provided in **Appendix A**.

2.5 Legacy Support

This Manual focuses on ITS technologies for new ITS construction projects and project upgrades. New ITS construction projects are no longer using older / legacy technologies including; analog cameras, external video encoders and decoders, fiber optic modems / transceivers, video jet VJ10 transmitters, multi-mode channel video multiplexers and OTN nodes. The designer shall coordinate with the MDOT for legacy specifications and requirements as required and refer to Section 1.7 of this manual.

3. System Design Guidelines

The following subsections are intended to provide ITS designers and other users the design guidelines, criteria, and processes to develop and provide an ITS design that leads to a successful ITS deployment for MDOT.

The designer shall utilize the information in the following sections in concert with the Design Check-lists provided in ***Appendix B***

The criteria contained in this section are guidelines the designer shall follow for the design and deployment of new ITS devices(s) and subsystems. Deviation from these guidelines shall be discussed with and approved by the MDOT ITS Project Manager during the design process. ***Design checklists shall be used during the design process as guidance for the PS&E assembly.***

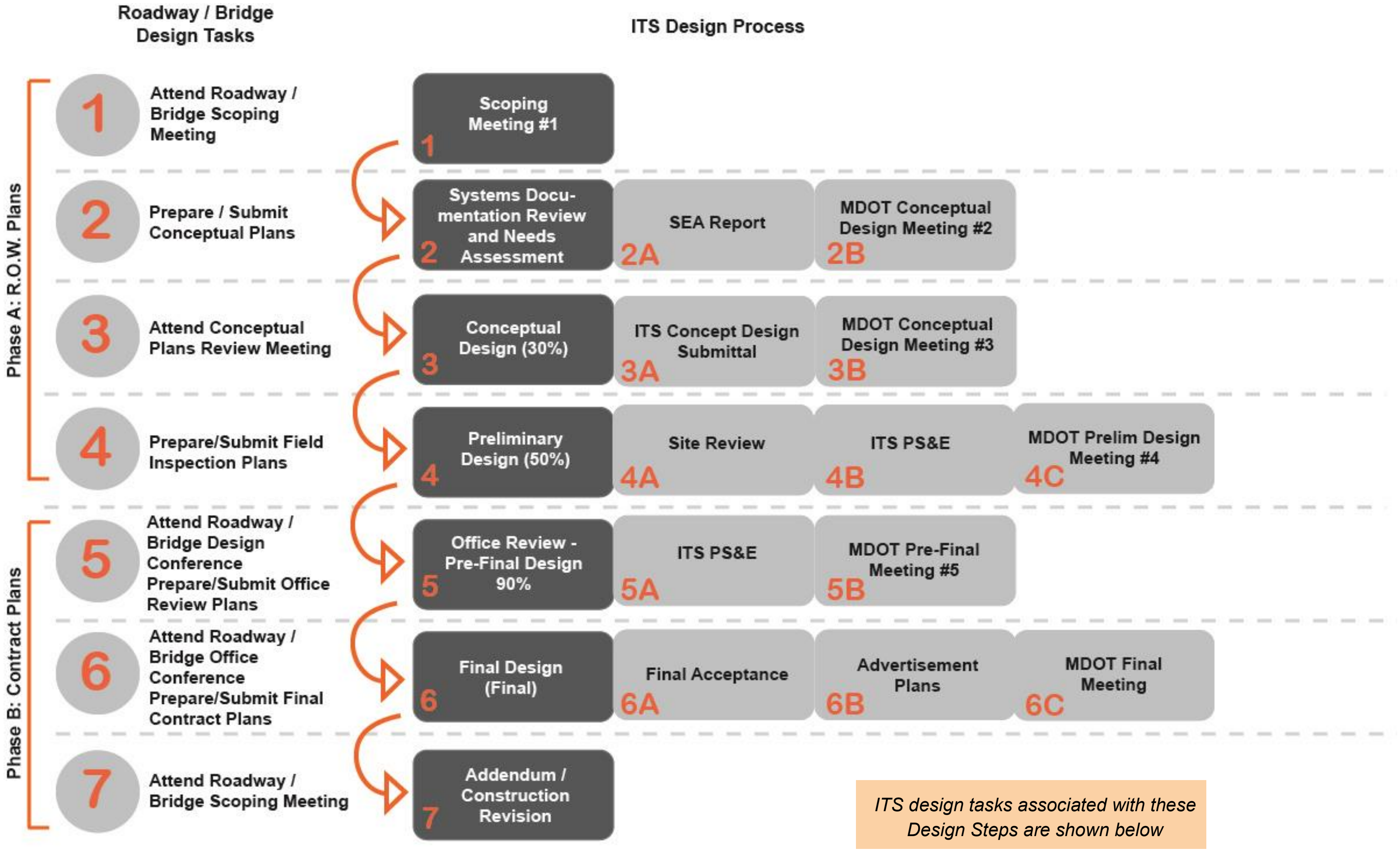
The overall goal of this Manual is to provide the designer with guidance to complete their design as well as providing the Department consistency with respect to ITS installations.

3.1 MDOT ITS Design Process

ITS designs are sometimes developed as an entirely standalone effort, but are more commonly incorporated into a larger set of documents for other infrastructure improvements (e.g., a road or bridge project).

Figure 2 shows the basic steps required to complete a MDOT ITS design, from the initial scoping meeting to the final PS&E Assembly. This typical workflow is applicable to standalone ITS projects, but also shows how ITS design tasks are integrated into the development of MDOT roadway/bridge projects.

Figre 2: MDOT ITS Design Process



The following checklists are typical tasks provided at each design step (items shown in italic indicate it is different from previous task):

1 Scoping Meeting

Meeting with the MDOT ITS Project Manager, District staff and local jurisdiction staff (if project is on non-MDOT R/W or sharing of resources is intended) to discuss the following:

- ☐ Review project goals and objectives, performance measures
- ☐ Review project ITS concepts and applications
- ☐ Review project roles and responsibilities
- ☐ Review project scope of services and limits
- ☐ Review project schedule

2 2A Systems Documentation Review & Needs Assessment

See Section 2.0 of this document for additional requirements

- ☐ Review existing SEMP, ITS Architecture Concept/Feasibility Studies, and ConOps documentation as applicable.
- ☐ Review corridor type (i.e., urban and rural freeways, urban and rural arterials), high congestion and bottleneck areas, incident/accident reports, high crash locations, traffic and roadway characteristics and conditions.
- ☐ Develop SEA report, as required and applicable.

3 Conceptual (High-Level) Design (30%)

See design checklists in **Appendix B** and 30% plans checklist in **Appendix C**

- ☐ Identify and document project system requirements
- ☐ Coordinate with other MDOT departments and outside agencies, as required or needed
- ☐ Identify other adjacent ITS and roadway projects that may impact this project and coordinate with the MDOT
- ☐ Provide a preliminary / general layout of ITS device locations and power source locations through the review of as-built plans, aerial maps, or Google Earth. Start coordination with local utilities early in this phase of the design process

- ☐ Determine potential communications routing or path, demarcation/interface points and linkage medium types (fiber optic, wireless, cellular service, etc.)

4 Preliminary Design (50%)

See design checklists in **Appendix B** and 50% plans checklist in **Appendix C**

- ☐ *Update and finalize* SEA report as applicable or needed
- ☐ Determine and document field device site locations
- ☐ *Provide preliminary design of and clearly identify proposed ITS elements, including but not limited to:*
    - *ITS device stations and offsets with GPS coordinates*
    - *Conduit routing / locations and types (sizes, lengths not required)*
    - *Information Systems Division (ISD) Computer Network Schematic*
    - *Communication cable types (lengths not required)*
    - *Electric cable types (sizes, lengths, # of conductors not required)*
    - *Pull boxes and types*
    - *Equipment pole or structure (including foundation) types and lengths*
    - *Field cabinet types and locations*
    - *Preliminary notes and details for any modifications to existing cabinets*
    - *Electric / power demarcation points (locations only)*
    - *Guard rail (new or existing) (preliminary locations, lengths only)*
- ☐ *Provide preliminary ITS device details including typical notes and details for ITS devices*
- ☐ *Provide power design for each ITS device location:*
    - *Provide preliminary electrical one-line diagrams, riser diagrams and details including typical notes and details for power service and supporting equipment*
    - *Provide step-up / step-down requirement calculations as required or needed*
    - *Determine power metering design as required*
    - *Provide UPS and power back-up design as required*
- ☐ *Provide near final (90%) communications design concepts and details including network equipment types.*
    - *If multiple communication options, provide pros / cons and recommendations for review and approval by MDOT*

- *Provide system communications block diagrams*
- *If fiber optic, then provide splice diagrams and a loss budget analysis with documentation*
- *If wireless, then provide a path analysis with documentation for each proposed link.*
- *If cellular, then determine required signal strength at site for required performance levels*

☐ *Provide a list of preliminary special provisions and NTBs as required or needed, if not included in the project scope*

☐ *Perform and document all design calculations including poles and / or other structures required. All geo-tech data required for structures shall be provided and documented*

☐ *Provide and address all necessary or required environmental impact studies, processes and concerns*

☐ Coordinate design with both internal/external disciplines

☐ *Identify, coordinate and develop all required permits and/or MOUs with other agencies*

☐ *Demonstrate proposed camera coverage and clear field of view at the proposed mounting heights to the satisfaction of the MDOT*

☐ *Develop an itemized cost estimate for the project taking into account estimated quantities, unit prices using the most recent bid data available, allowances, assumptions and contingencies. The estimate must also consider short-term trends on price volatile items based on the construction schedule and adjust the estimate accordingly.*

4A Site Review

See site review checklists in **Appendix A**

☐ Field locate and verify field ITS devices and field cabinet locations with stationing, offsets and GPS coordinates

☐ Refer to ITS device and field cabinet placement guidelines in this Manual when locating devices (see design checklists in **Appendix B**)

☐ Identify potential power points of service and start the coordination process with local utilities

☐ Identify potential power source within a reasonable distance to the ITS device site

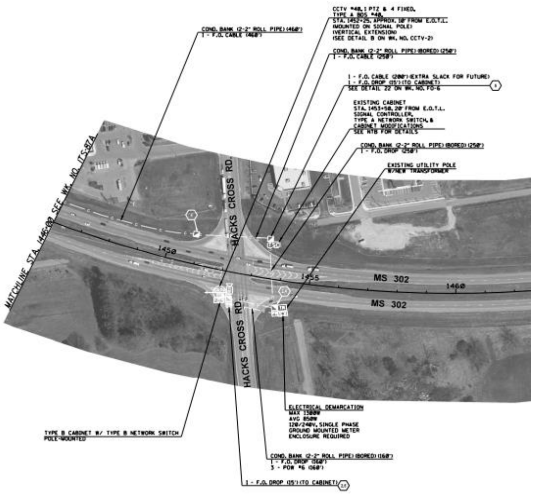
☐ Identify locations where devices are inside of the clear zone and will need guard-rail protection

- ☐ Identify potential conflicts including topography, access/maintainability, R/W restrictions, and power and communications considerations (make-ready work, coverage/signal strength, etc.). If aerial fiber, then determine owner of potential poles, height of existing user facilities on poles, potential make-ready work, and start the coordination process.

5 Office Review - Pre-Final Design (90%)

See design checklists in **Appendix B** and pre and final plans checklist in **Appendix C**

- ☐ Address 50% comments, include specifications and cost estimate
- ☐ *Finalize* design of ITS elements, including but not limited to:
  - ITS device *reference numbers***,** stations and offsets
  - Conduit *sizes, types and lengths*
  - Communication cable types and *lengths*
  - Electric cable types, *sizes, lengths and # of conductors*
  - Pull boxes and types
  - Equipment pole or structure types and lengths
  - Field cabinet types and locations
  - *Cabinet equipment and elevation details (e.g., networks switches, etc.), as required*
  - *Finalize* notes and details for any modifications to existing cabinets
  - Electric / power demarcation points *including required voltages, voltage drop calculations, and estimated power demand*
  - Proposed guard rail (new or existing) locations and *lengths*



- ☐ *Finalize* ITS device details, system communications block diagrams and splice diagrams for fiber optic installations
- ☐ *Finalize* electrical one-line diagrams, riser diagrams and details
- ☐ *Update* communications design concepts and details as needed
- ☐ *Finalize* special provisions and NTBs as required or needed
- ☐ *Update* design calculations including structures to reflect any design changes as needed
- ☐ *Finalize and obtain* all required permits and/or MOUs with other agencies
- ☐ *Finalize* design coordination with other internal/external disciplines
- ☐ *Provide erosion control plan if required by the project scope*

- ☐ *Provide traffic control plan if required by the project scope*
- ☐ *Finalize all other remaining and incomplete design tasks*
- ☐ Develop an *updated* itemized cost estimate for the project.

6 6A Final Design (100%)

See design checklists in **Appendix B** and pre and final plans checklist in **Appendix C**

- ☐ Address 90% comments and update cost estimate as needed
- ☐ Any other design revisions or updates shall be discussed with MDOT prior to making changes to the Plans.

6B Bid Ready Plans

- ☐ Address any further MDOT comments and prepare plans and specifications ready for advertisement

7 Addendum / Construction Revision

- ☐ Provide post design / bid services, such as assistance with RFI's and assist in the development of any addenda

3.2 ITS Design Compliance and Compatibility

The designer shall be responsible to review all relevant MDOT ITS Standard Specifications, ITS Special Provisions and ITS NTB documentation to confirm that the designer's ITS design complies with all established MDOT project requirements and expectations.

- ☐ Should the proposed ITS design not comply or not entirely comply with any of the requirements specified, but ultimately achieves the intent, the designer shall explain fully the extent, or lack thereof, of compliance, provide pros and cons along with a cost estimate of their proposed design for consideration by the Department.
- ☐ The design shall ensure that devices which share communication networks or provide related functions are compatible with each other and will not interfere with the operation of other devices or systems.
- ☐ The design shall incorporate features and functions that allow interoperability with other ITS deployments throughout the region and state including existing TMC hardware and software. Examples of general design characteristics that promote interoperability include: 1) open architecture and standards, 2) scalable and non-proprietary solutions and 3) compatibility with MDOT's software system.

3.3 Field Design

3.3.1 CCTV Camera Design

A. Overview / Description

A CCTV camera provides live streaming video surveillance of the Mississippi roadway network and enhances situational awareness. CCTV cameras enable MDOT Operations staff to perform a number of valuable monitoring, detection, verification, and response activities.

B. Operational Requirements

- ❖ Provide 100% freeway coverage
- ❖ Provide coverage of major intersections and selected traffic hot spots
- ❖ Stream video to MDOT traffic website
- ❖ Detecting incident and verifying location and type of incident
- ❖ Assist in determining appropriate responses to an unplanned event or incident
- ❖ Monitoring incident response and clearance
- ❖ Monitoring traffic conditions and congestion on mainlines and ramps
- ❖ Verify DMS message and readability (e.g., pixels out, etc.)
- ❖ Observing localized weather and other hazardous conditions along the roadway
- ❖ Monitoring assets (Homeland Security applications), as applicable

C. References – MDOT Specifications and Industry Standards

MDOT CCTV camera standard specifications, special provisions and industry standards documented in the table on the next page highlights some of the primary ones for each of the typical components used in a CCTV camera project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 3: CCTV Camera Specifications, Details and Standards	
Camera Component	**Applicable CCTV Specifications, Details and Industry Standards**
CCTV Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
CCTV System	MDOT Special Provisions Section 907-650 On-Street Video Equipment For CCTV Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	American Association of State Highway and Transportation Officials (AAHSTO) Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-634-A024 Traffic Signal and ITS Equipment Pole
Field Cabinet	National Electrical Manufacturers Association (NEMA) TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, Intelligent Transportation System (ITS) Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, National Electric Code (NEC) and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1205, Object Definitions for Closed Circuit Television (CCTV) Camera Control MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

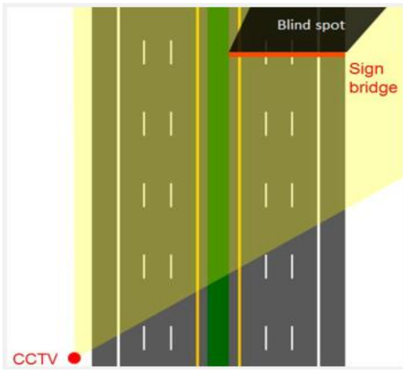
The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a CCTV camera design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of CCTV cameras and associated field cabinets.

General Placement Guidelines:

- ☐ Maximum coverage shall be obtained using the least number of cameras possible, although the following possible roadway conditions (horizontal and vertical curves and sags) may require additional cameras for mitigation:
  - Near the PI of horizontal curves that restrict visibility to less than ½-mile. Cameras should be located outside of horizontal curves to maximize viewing distance in each direction, where feasible.
  - At locations with recurring congestion and other high interest areas.
  - On the crests of vertical curves.
  - Freeway sections where vertical walls restrict visibility, especially around horizontal curves.
  - Sight lines obstructed by overhead guide signs, lighting and traffic signal poles.



- ☐ Designer shall coordinate with the agency responsible for traffic operations on the roadway.

- ☐ Future Overhead Obstructions -- Designer shall consider whether existing or future-planned overhead traffic / guide signs, gantries, bridges, median barrier walls, or other obstructions could limit the camera's coverage of the area

- ☐ Elevation – Higher elevations (on embankments) are preferable for both view distance and wireless communications (if utilized), however this must be balanced against ease of maintenance. Higher embankments will typically result in greater offsets requiring bucket trucks with greater reach (both horizontal and vertical) outriggers or possibly require maintenance from off of MDOT right-of-way.

Urban Freeways:

- The goal of CCTV camera placement is to achieve as near 100% unobstructed view as possible of all freeway mainline travel lanes, shoulders, and clear zones with overlap. Locate CCTV camera sites between interchanges as close to 1 mile spacing as practical, spaced evenly between the interchanges. Spacing between CCTV cameras may be increased slightly on tangent and level roadway sections or reduced where curves or visual obstructions are frequent.

- Locate camera(s) at all major interchanges of limited access roadways (interstate-to-interstate or interstate-to-major limited access) or at interchanges with highly travelled arterials, to provide 100% coverage as possible on all ramps and gores as well as coverage on secondary (arterial) major cross-roads.
    - The view should be optimized, if possible, for merging and weaving segments since there is a greater chance of collisions in these areas.

- Locate cameras within tunnels (if applicable and required) to provide full coverage in accordance with the requirements of NFPA 502.

- Place CCTV camera preferably all on the same side of the roadway as the fiber optic backbone.

Urban Arterials and Highways:

- Locate at, or near, major signalized intersections to provide coverage of both arterial and intersecting streets.

Rural Freeways and Rural Roadways:

- Coordinate with MDOT to verify the feasibility and operations of the devices before installation or making a final location decision

- Provide coverage at known locations of high accidents/incidents

- Provide full camera coverage, as directed by MDOT, on evacuation corridors or areas with known extreme weather or hazardous conditions.

Major Interchanges:

- Locate one (1) PTZ camera (MDOT Item No. 907-650 *On-Street Video Equipment, PTZ Type*) at each interchange. Proposed PTZ camera should be configured to default to one fixed travel direction.

- ☐ Locate one (1) fixed camera per travel direction not covered by the PTZ camera defaulted direction, including arterial. (MDOT Item No. 907-650, *On Street Video Equipment, Fixed Type*). In some rural and/or low volume locations, a camera may not be necessary for a view of the intersecting street. Discuss with the MDOT ITS project manager in these instances.

DMS Message Verification (along urban and rural freeways):

- ☐ Locate one (1) PTZ camera to provide a direct and clear front view of a DMS display that is capable of clearly seeing the display pixels under daylight and night-time conditions.
  - The PTZ camera shall be located a minimum of 300-feet in advance of all DMS sites.
  - The designer shall verify that the DMS verification camera is within the DMS cone of vision (i.e. viewing angles) of the sign display face to clearly view the pixels and adjust the distance as needed.
  - If in a signalized area, a PTZ camera may be placed at the preceding signal as long as there is line of sight.

Safety and Device Protection

- ☐ Medians are not the preferred location, but wide medians may be considered if suitable roadside locations are not available.
  - To reduce site erosion, reduce construction costs, and provide longer device structure life, avoid locating the structure on sections that have a fill slope of greater than one vertical to three horizontal.

Vegetation Obstruction

Poor Coverage

- ☐ CCTV coverage can be affected by the growth of vegetation along the roadway. Consider the time of year field review is conducted with type of plant and anticipated growth. Designer to coordinate with MDOT in regards to possible trimming. Any clearing that is necessary as part of construction shall be called out in the Plans.
- ☐ Cameras shall be placed where vegetation growth will not interfere with camera views.
- ☐ If it is impractical to relocate cameras or modify vegetation type to achieve full coverage, additional cameras shall be installed to ensure full coverage in urban areas.

Airport Flight Path:

- ☐ Consider implications of nearby airports when selecting pole locations. Restricted glide paths for approaching aircraft are sometimes distant from the airport itself. Consequently, pole locations and heights shall be approved by the FAA in projects passing near airports.
- ☐ The designer shall contact the FAA and complete Form 7460 along with providing all required documentation if the proposed camera location is within or close to established flight paths to determine any mitigation strategies.

External Lighting:

- ☐ Cameras shall be located so that the brightness of road lighting, including luminaire lighting, will not close the camera’s automatic iris and affect image quality and create blooming effects.
- ☐ In case where lack of light affects the view and it is needed for night-time monitoring, an alternate type of camera should be considered.

Future Construction:

- ☐ The designer shall find out if there is any planned construction (1-10 years) in the area where the proposed camera will be placed. It may be necessary to coordinate with the plan designer (engineer of record) or construction manager of these projects to ensure that the camera, or any of its components, will not need to be relocated or replaced during the construction process.

Field Cabinet

- ☐ When possible, the field cabinet for the CCTV camera shall be pole-mounted on the camera pole or existing structures to minimize cost.

- ☐ In locations where the pole is difficult to access, the field cabinet may be ground or pad-mounted at a more convenient location with easier access, such as adjacent to a frontage or access road.

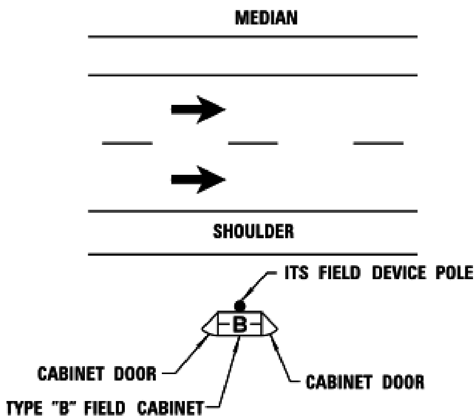
- ☐ Co-locate cameras where possible. In some cases, co-located different types of ITS devices may share the same field cabinet, which will influence field cabinet size requirements.

- ☐ CCTV equipment can be co-located within a traffic signal cabinet if required. The power for the CCTV equipment should be on a breaker separate from the signal breaker.

- ☐ Cable Run Distance: The total distance between the camera assembly and the field cabinet network switch shall not exceed 300 feet due Ethernet cable standards. Installations that require longer cable runs shall have approval from the MDOT. If a longer camera cable is approved, the distance between the camera field cabinet and camera pole shall not exceed 600 feet under any condition. The designer has the option of utilizing a PoE extender or media converter solution.

- ☐ Surface Grade Considerations: For ground (pad) mounted field cabinets, the slope of the terrain for field cabinet placement must be no steeper than 4:1. Grading provisions shall be provided as required.

- ☐ Maintenance Considerations for Locating Field Cabinet::
  - Mount away from traffic so that the maintenance person is facing traffic when looking at the field cabinet.
  - Locate at a level where the field technician will not need a stepladder to perform maintenance at the field cabinet location. The middle of the field cabinet should be at 30” from bottom of the ground surface.



- ☐ Accessibility: Provide sufficient clearance around the camera pole base to allow for:

  If field cabinet will be pole mounted, then

  - Installation of the pole-mount CCTV field cabinet (Type B).

- Access to both the front and back of the pole-mount CCTV field cabinet.
- Opening of the field cabinet doors to at least 90 degrees.
- Personnel to access the field cabinet exterior from either front or back.
- Safe location of a maintenance bucket truck (on shoulder or off pavement so as to not require a lane closure for maintenance).

If field cabinet will be base mounted, then

- Provide personnel easy and safe access to the field cabinet exterior.
- Place the field cabinet such that the exterior door(s) will open to at least 90 degrees.
- Provide a level concrete maintenance pad as provided in the Details and Special Provisions for all ground (pad) mounted field cabinets. A maintenance pad shall provide sufficient surface area for one maintenance person to stand with the field cabinet door open and a 3-foot clearance.
- Locate the field cabinet within the right of way.

2 Selection of CCTV Camera Components

The following checklist items provide the designer with guidelines to select CCTV camera components to complete the design for the project.

Camera Assembly Types and Requirements

Select Camera Type: Camera assembly types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 4: CCTV Camera System Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-650-A002	On Street Video Equipment, Fixed Type, Pressurized Barrel type, IP, HD, Color
2	907-650-A003	On Street Video Equipment, PTZ Type. Pressurized Dome type, IP, HD, Color

Camera Functional Requirements

In addition to the relevant specifications and standards listed in Table 3, the following requirements shall be accounted for during design:

- ☐ IP cameras that provide a minimum user-configurable image resolution of Full HD 1080P (1920 x 1080) to CIF 352 x 240 pixel array at 30fps
- ☐ Camera design that provides a minimum resolution (pixels per foot) of 20 at the subject
- ☐ Cameras with a sensitivity that has useable video at the following ambient low light conditions
  - Scene Illumination; F-stop set at wide open at 50% video (50 IRE)
  - 1.0 Lux (0.1 fc) at 1/30 shutter, color mode
  - 0.1 Lux (0.01 fc) at 1/30 shutter, monochromatic (black and white) mode
- ☐ Stabilization such that standard DOT placards with a size of 1 ft. by 1 ft. are continuously legible in conjunction with viewing specification and maximum zoom level at a distance of 750 ft.
- ☐ Pressurized camera casing/enclosure with a minimum impact rating of IK10 (within 30 miles of the coastline) and IK08 (for all other locations)
- ☐ Protection of viewing windows against degradation of materials and yellowing due to prolonged exposure to UV rays:
  - Optically correct material with infused inhibitors
  - Material that is scratch resistant
  - Acrylic or polycarbonate material for the viewing windows

Camera Mounting Types and Requirements

Select Camera Mounting Type: Camera mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 5: CCTV Camera Mounting Pay Item Numbers

No.	Pay Item Number	Type Description
New Poles		Note: Camera Lowering Device, as required or needed, to be included in cost of poles that are ≥ 60-feet tall
1	907-634-E001	Camera pole w/ foundation, 50-foot pole
2	907-634-E002	Camera pole w/ foundation, 60-foot pole
3	907-634-E003	Camera pole w/ foundation, 70-foot pole
4	907-634-E004	Camera pole w/ foundation, 80-foot pole
Existing Poles		

Table 5: CCTV Camera Mounting Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
5	907-634-B001	Traffic signal equipment pole shaft extension, 10-foot, video camera mount
6	907-634-B002	Traffic signal equipment pole lateral extension, 10-foot, video camera mount
7	907-634-G001	Traffic signal equipment pole mast arm extension

Camera Mounting Functional Requirements

In addition to the relevant specifications and standards listed in Table 3, the following requirements shall be accounted for during design:

- ☐ Existing Traffic Signal Poles: It is desirable to use an existing pole or traffic signal pole / mast arm (joint use) in urban areas to reduce overhead clutter if possible. Extensions may be used as approved by the MDOT as follows:
  - Traffic signal pole shaft vertical extension, 10-foot or as needed
  - Traffic signal pole horizontal (lateral) extension, various lengths
  - Mast arm extensions
- ☐ New Traffic Signal Poles: If a new signal installation, the signal pole height can sometimes be adjusted during the design process. Coordinate with the traffic signal engineer if this is needed.
- ☐ Existing Sign Structures: It is acceptable to install cameras on existing overhead sign structures (trusses) using an optional 30-foot vertical tubular extension to obtain sufficient height when power is available and standalone options are not available as approved by the MDOT.
  - Do not mount cameras on pedestal or post mount sign structures.
- ☐ New Camera Poles:
  - If existing poles are not available, locate new CCTV poles outside the clear zone, but within the right-of-way. If this is not possible, locate poles 6-feet behind guardrail per MDOT's standards.

- Locate poles to provide a minimum of 10-foot clearance (vertical and horizontal) off of power service lines and 75-feet from transmission lines.
- New signal pole heights can be adjusted in the design. Coordinate with a traffic signal engineer if a modification in height is needed.

☐ 50-Foot Camera Steel Strain Poles: Galvanized steel poles are the primary pole type used for most MDOT freeway CCTV camera applications. This height facilitates seeing the roadway for ½-mile or greater in any direction, and is typically high enough to be above most tree foliage

☐ 60- to 80-Foot Camera Steel Strain Poles: These pole heights may be warranted at some locations depending on terrain, land availability, obstructions, bridges, interchange geometry, etc. Also, new camera technology is allowing visual distance to be more than ½-mile in a direction (added distance can be from 1-3 miles in a direction) and having a taller pole may reduce the amount of camera pole sites needed for corridor camera coverage

- The designer shall verify that the MDOT has maintenance bucket trucks and equipment available to service the higher poles.
- If mounting on a bridge or sign structure, the designer shall determine whether a camera can sustain the vibration experienced on that structure and whether the image would be usable.
- The designer shall coordinate with MDOT Bridge Division if mounting on bridges. If at all possible, cameras should not be mounted on bridges.

☐ Camera Lowering System: A camera lowering system shall be used for poles taller than 50-feet or at a camera site that does not safely allow for a bucket truck to access a camera without closing a travel lane. This allows for maintenance of the camera without deploying a specialized bucket truck, and one person can perform the maintenance.

- External lowering systems can be applied to existing camera poles that are currently deployed and do not have an internal camera lowering system (any pole height), only if approved by the MDOT.
- A pole-mounted field cabinet shall not be on the same side as the hand hole for a camera lowering winch and shall not be under the camera to be lowered.
- Any device placed on the pole shall not affect the ability to utilize the lowering device.

- Use of lowering device shall not require an operator to stand directly beneath the equipment while it is being lowered.

Field Cabinet Types and Requirements

<u>Select Field Cabinet Type:</u> Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 6: CCTV Camera Field Cabinet Pay Item Numbers

No.	Pay Item Number	Type Description
1	660-A002	Equipment cabinet, Type A, pad or pole-mounted
2	660-A003	Equipment cabinet, Type B, pad or pole-mounted
3	660-B001	Cabinet modifications to existing cabinet

Field Cabinet Functional Requirements

Refer to Table 3 for a list of relevant specifications and standards

3.3.2 Dynamic Message Sign (DMS) System Design

A. Overview / Description

A DMS is a LED electronic sign which provides valuable traveller information to motorists along MDOT roadways and highways. The DMS disseminates timely, accurate and useful road condition and travel time information to travellers so that they can make informed decisions regarding their intended route and/or destination. The sign typically displays travel times to select interchange or destinations, and is used to inform motorists of delayed areas, accidents, severe weather and other alerts.

B. Operational Requirements

- ❖ Locate 1 to 3 miles in advance of major decision points along freeways
- ❖ Locate as directed by the MDOT along arterial roadways.
- ❖ Notify travellers of road closures
- ❖ Notify of incidents and lane closures
- ❖ Notify of weather / road conditions
- ❖ Notify of special events
- ❖ Display incident and travel time information
- ❖ Notify of future road construction work
- ❖ Display evacuation messages
- ❖ Display scheduled safety messages
- ❖ Display “amber” alert messages

C. Resources – MDOT Specification and Industry Standards

MDOT DMS standard specifications, special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a DMS project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 7: DMS Specifications, Details and Industry Standards	
DMS Component	**Applicable DMS Specifications, Details and Industry Standards[1]**
DMS Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
DMS System	MDOT Standard Specifications Section 656 and Special Provisions Section 907-656 Dynamic Message Sign NEMA TS-4 Hardware Standards for Dynamic Message Signs (DMS) with NTCIP Requirements For DMS Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-630 Traffic Signs and Delineators
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, ITS Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1205, Object Definitions for Closed Circuit Television (CCTV) Camera Control MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a DMS design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of DMSs and associated field cabinets.

General Placement Guidelines

- ☐ Site characteristics in the vicinity of planned DMS locations shall be taken into account including the following:
  - Provide the motorist sufficient time (approximately 11 seconds) to recognize the sign, read the message on the sign, determine their response to the message on the sign, and make adjustments (turn signals, lane changes) in response to the message on the sign.
  - Operating speed of the road (speed limit or prevailing speed)
  - Locate the DMS such that it is clearly visible and is not blocked by existing structures, vegetation, power lines, etc. If necessary, the designer may consider clearing and grubbing of existing vegetation if DMS visibility is affected.
  - Presence and characteristics of any vertical curves affecting sight distance
  - Presence of horizontal curves and obstructions such as trees or bridge abutments that constrain sight distance to the DMS
  - Location of the DMS relative to the position of the sun (for daytime conditions)
  - Presence and number of static guide signs in the vicinity and the information displayed on those signs
  - Presence and number of traffic signals in the vicinity
- ☐ DMS placement shall be clearly visible, unobstructed and maximize visibility of the DMS message and allow the driver sufficient time to read, process and react to the message

- ☐ DMS shall be located on straight sections of road if possible. If the DMS must be located on a curve, it shall be angled towards the road to verify that the cone of vision is at 1,000 feet and as approved by the MDOT

- ☐ Place DMS at a location where no conflict with underground or overhead utilities exist

- ☐ DMS shall not be located on a fill slope of greater than one vertical to three horizontal (1V:3H) to reduce site erosion, reduce construction costs and provide longer device structure life

Drivers need approximately one second per word to read and comprehend a message. For a 10-word message, drivers traveling at approximately 65 mph would require approximately 10 seconds to read and comprehend the message. The character height, cone of vision and lateral placement must all be considered when determining the placement of the sign to meet the sight distance requirements.

- ☐ DMS visibility requirements are dependent on speed and type of roadway as shown in Table 8. Distances represent normal daylight conditions.

Table 8: DMS Sight Distance Based on Speed Limit and Road Type

Legibility Distance Requirements	Urban Freeway	Urban Arterial or Highway	Rural Freeway and Rural Roadway
Less than 45 mph	N/A	600 feet	N/A
45 mph to 55 mph	800 feet	800 feet	800 feet
Greater than 55 mph	1000 feet or more	N/A	1000 feet of more

- ☐ DMS shall be located as close to existing communications and power as possible to simplified the design and minimize costs

- ☐ Designers shall coordinate the proposed location of a DMS with the local agency responsible for traffic operations on the roadway.

Urban Freeways

Locate DMSs along Urban Freeways taking into account the following:

- ☐ The standard spacing between successive DMS is generally 5 to 6 miles. As applicable, consider location of existing DMS and roadway geometrics when locating new DMS.

- ☐ DMS shall be located at a distance approximately ¼ to ½-mile in advance of any major interchange, merging/weaving sections, major decision points and potential diversion and evacuation routes.

- ☐ DMS shall be placed as to complement fixed route guidance signs already in use.

- ☐ DMS shall be spaced a minimum of 800 feet away (upstream or downstream) from existing or planned overhead static guide sign panels and other signs, per the MUTCD (or consider co-location). This does not include post-mounted guide signs and median mounted sequential guide signage

- ☐ DMS shall not be located near entrance and exit ramps

- ☐ Locate DMS in advance of high crash locations and traffic bottlenecks

Urban Arterials and Highways:

Locate DMSs along Urban Arterials and Highways taking into account the following:

- ☐ Use of DMS on urban arterial streets and highways is primarily limited to special events locations, diversion routes for hurricane evacuations and other state emergencies, or other special conditions as specified or directed by the MDOT.

- ☐ Typically a DMS will be placed on arterials prior to select major intersections and interchanges as directed by the MDOT

- ☐ DMS shall not be placed near a signalized intersection

- ☐ The requirements contained in the current version of the MUTCD shall be used as a guideline for sign placement.

- ☐ Locate a DMS with minimum interference from lighting, adjacent driveways, side streets, or commercial signage

Rural Freeways and Rural Roadways:

Locate DMSs along Rural Freeways and Rural Roadways taking into account the following:

- ☐ At this time, there are no MDOT specified criteria to determine the location for a rural DMS. However, in most cases, rural DMS would typically be used for special events or along hurricane evacuation routes as specified or directed by the MDOT

- ☐ The availability of electric power and communications are the controlling factors for installation of DMS in rural area

Vertical Placement

- ☐ DMS shall not be located within curves or excessive elevation/vertical changes
- ☐ The approaching segment of road shall be relatively flat (between 0% and 4 % vertical grade; 1% or less grade is preferred); avoid uphill approaches

Lateral Placement

- ☐ DMS structure shall be located far enough behind a barrier or outside of the road clear zone to comply with the minimum clearances.
- ☐ Lateral offset of the DMS shall be accounted for when considering the minimum legibility distance. Additional sight distance may be required for drivers to clearly view and react to the sign.

Sign Viewing Angle

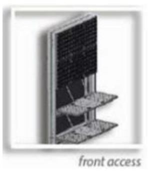
- ☐ The sign viewing angle shall be appropriate for the road alignment and the DMS structure as shown in Table 9. The Standard Specifications calls for 30-degrees and is typical and recommended for most conditions.

Table 9: DMS Placement Depending on Viewing Angle

Viewing Angle (from center axis of the LED)	Recommendation
30 degrees	Overhead placement and on straight road sections and slightly curved (horizontally and vertically) road sections
70 degrees	Wide freeways and highways and on curved road sections (if unavoidable) where a 30-degree viewing angle would not provide sufficient visibility distance

Maintenance / Sign Access

- ☐ Determine if there is any traffic, environmental or safety factors that would warrant a specific type of sign access (front, walk-in). Rear access is not an option in Mississippi. See Table 10 for DMS access type considerations.

Table 10: DMS Access Types			
Access Type	**Advantages**	**Disadvantages**	**Other Considerations**
Walk-In 	• Provides safe environment for worker over live traffic	• Highest in installed and recurring costs	• Catwalk or platform required to access the DMS
Front Access 	• Small and lighter sign allows for a smaller structure	• Sign mounted overhead might require a lane closure for maintenance	• A bucket truck is typically used to access the sign • Consider installing catwalk to avoid need for bucket truck and lane closures

- ☐ DMS shall be placed that accommodates access for service and maintenance
- ☐ Provide sufficient clearance around structural base to allow for safe location of a maintenance bucket truck (on a lane closure for maintenance) and for entry into the DMS housing such that a technician can safely park a bucket truck and access the platform and sign housing access door at a location not over the lanes of travel.

Field Cabinet

Field cabinet shall be located taking into account the following:

- ☐ A field cabinet shall be located within the right of way approximately 100 feet or more from the DMS in a flat, protected area where the DMS display (face) can be viewed.
    - If no suitable location is available for the cabinet to be ground-mounted, it may be pole/structure-mounted on the DMS (or other existing structure) to minimize cost or eliminate R/W takins. All pole-mounted options shall be approved by the MDOT.
- ☐ Location and orientation shall provide adequate protection for the field cabinet
- ☐ A level maintenance's concrete pad shall be provided at the field cabinet's main door
- ☐ Place the field cabinet such that the door(s) shall open to at least 90 degrees
- ☐ The maintenance shall be able to safely park a vehicle and safely access the field cabinet

- ☐ The field cabinet and critical electrical/electronic components shall be above the flood elevation

- ☐ Proximity of the DMS field cabinet to retaining walls or other intervening obstacles between the DMS and the AC power source should be considered

2 Selection of DMS System Components

The following checklist items provide the designer with guidelines to select DMS components to complete the design for the project.

DMS Types and Requirements

Select DMS Type: DMS types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 11: DMS System Pay Item Numbers

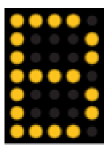
No.	Pay Item Number	Type Description
1	656-A001	**DMS Type 1:** Full color matrix, 3 lines by 21 characters, 18-in character height, 20mm resolution, walk-in enclosure
2	656-A002	**DMS Type 2:** Same as Type 1 except walk-in or front access enclosure (typically a walk-in enclosure)
3	656-A003	**DMS Type 3:** Full color matrix, 2 lines by 9 characters, 12-in character height, 20mm resolution, front access enclosure

DMS Type Functional Requirements

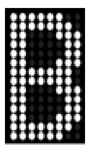
In addition to the relevant specifications and standards listed in Table 7, the following requirements shall be accounted for during design:

- ☐ Provide a DMS that is designed and tested to comply with the current version of NEMA TS 4 standards.

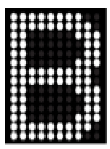
- ☐ Provide a typeface and fonts (i.e., MUTCD Series D 2000, NEMA TS-4, etc.) for DMS messaging as directed by the Department. Contact the Department for the font type.



NEMA A Series Font



MUTCD D Series Font



MUTCD E Series Font

☐ Provide nominal character and inter-line pixel spacing as shown in Table 12. A variation of up to ±1 pixel is acceptable.

Table 12: Typical Display Characteristic Requirements			
Requirement	**Type 1**	**Type 2**	**Type 3**
Usage (Pixels)	Text and/or Graphics	Text and/or Graphics	Text and/or Graphics
Inter-line Vertical Spacing	12	12	8
Character Horizontal Spacing	4	4	3
Rows, nominal	96	96	64
Columns, nominal	400	352	208
Default Text Character Font	24 x 15	24 x 15	16 x 11

DMS Mounting Structure Types and Requirements

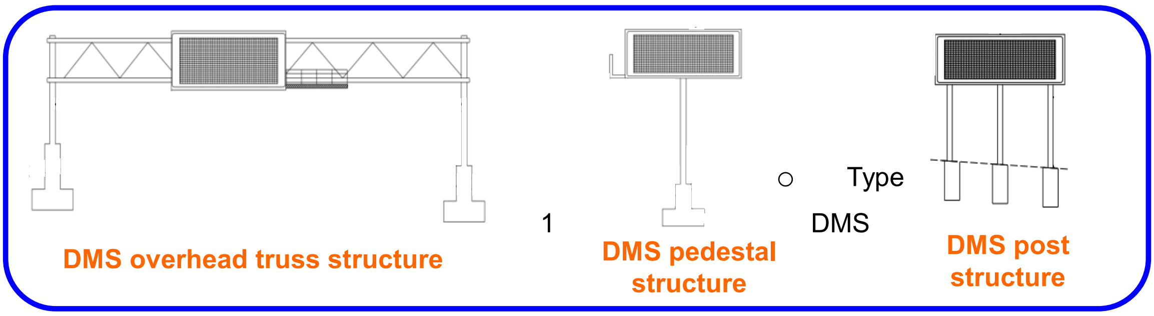
<u>Select DMS Mounting Structure Type</u>: DMS mounting structure types available for use on new MDOT ITS construction projects are as follows:

Table 13: DMS Mounting Structure Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	907-630-I0XY	Metal Overhead Truss Sign Support Assembly
2	907-630-J0XY	Metal Overhead Truss Sign Support Assembly on Bridge
3	907-630-M0XY	Pedestal Sign Support Assembly
4	907-630-Q0XY	Post Sign Support Assembly

DMS Mounting Structure Functional Requirements

In addition to the relevant specifications and standards listed in Table 7, the following requirements shall be accounted for during design:

☐ Select DMS Type Based on Location: DMS type is driven by location and lane configuration as described following the graphic below:



mounted on an overhead truss type structure shall be used for freeway (urban and rural) roadways with 3 or more lanes in each direction.

  - Type 2 DMS mounted on pedestal or post type structure shall only be used for roadways with 2 lanes in each direction and no immediate plans for widening.
  - Type 3 shall only be used for arterial roadways (urban and rural)

- ☐ Design shall be in accordance with latest AASHTO standards and Section 907-630. Design wind speed shall be 140 mph

- ☐ Design calculations shall include the following:
  - Sign weight, dimensions and appurtenances
  - Any non-standard loadings
  - Fatigue importance category
  - Design wind speed
  - Foundation design - One test boring should be completed at each DMS foundation location. Where exceptions are granted and no borings are completed, use worst-case soil conditions found on MDOT Standard Drawings.

- ☐ Additional calculations may be required if the design criteria specified in the MDOT standard specifications are not met. The following list of items that may need calculations is not all-inclusive, and may vary by structure type and details:
  - Post/Base plate connection and design
  - Anchor bolt design
  - Chord splices
  - Bolted connections
  - Ladder connections
  - Miscellaneous weld checks
  - Catwalk loading and connections

- ☐ Design Plans should include the following:
  - “General Notes” sheet
  - Signed and sealed certification letter from the manufacturer regarding DMS cabinet and connection
  - Drawing sheets showing, at a minimum, the applicable views and details shown on the ITS standard drawings
  - Panel connection details
  - Complete connection details with weld symbols

- ☐ A standalone drawing package is required for each DMS structure. Multiple structures shall not be presented without detail sheets.

- ☐ Guardrail shall be included and installed as dictated by MDOT installation standards and the Roadside Design Manual

- ☐ Develop DMS Detail Sheets to include sign placement over the travel lanes and clearance above the roadway (as applicable)

- ☐ Coordinate with the MDOT Bridge Division to review all DMS structures for structural sufficiency

- ☐ Coordinate with the MDOT Bridge Division to inspect any existing structures that are to be reused to evaluate their condition

Field Cabinet Types and Requirements

Select Field Cabinet Type: Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 14: DMS Field Cabinet Pay Item Numbers

No.	Pay Item Number	Type Description
1	660-A004	Equipment cabinet, Type C, pad-mounted

Field Cabinet Functional Requirements

Refer to Table 7 for a list of relevant specifications and standards

3.3.3 Radar Detection System (RDS) Design

A. Overview / Description

A RDS consists of an all-weather detector that is referred to as true-presence microwave detector. Its ranging capability is achieved by frequency-modulated continuous-wave operation capable of detecting vehicle presence and measuring other traffic parameters in multiple zones / lanes. To obtain speed, the distance between two range bins is divided by the time that the detected vehicle travels that distance. These devices are insensitive to weather and provide day and night operation.

The device is typically placed in a side-fire mount off the shoulder perpendicular to the roadway, capable of recording vehicle count, speed (including stationary vehicles), presence, and classification (vehicle lengths) data.

B. Operational Requirements

- ❖ Provide real-time data to support traffic and incident detection and management
- ❖ Support a traveller information system
- ❖ Provide data to support road capacity analysis
- ❖ Support multi-lane intersection control
- ❖ Support ramp metering
- ❖ Provide data to support performance measures
- ❖ Support queue detection systems
- ❖ Provide data to support planning and historical analysis

C. Resources – MDOT Specifications and Industry Standards

MDOT RDS standard specifications, special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a RDS project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 15: RDS Specifications, Details and Industry Standards	
RDS Component	**Applicable RDS Specifications, Details and Industry Standards[1]**
RDS Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
RDS System	MDOT Standard Specifications Section 641 Radar Detection System For RDS Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-630 Traffic Signal and ITS Equipment Poles
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, ITS Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1209, Object Definitions for Transportation Sensor Systems (TSS) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

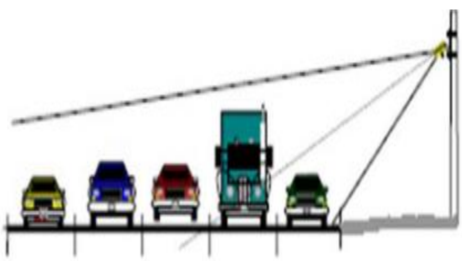
Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a RDS design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

1 Location and Placement Guidelines

Certain types of detectors are not appropriate for all facilities. For instance, loop detectors should not be used on a bridge or road span to avoid invading the deck structure, and while typically installed in pavement, lower depth magnetometers may be better suited in an under deck configuration so as to not compromise the deck. RDS sensors in tunnels may be subject to spurious returns from wave reflections.



The design a detection location, the following should be considered:

1. Detector purpose and spacing requirements derived from the overall system goals and objectives as directed by MDOT
5. Selection of technology based on several factors including; detection data type required, required accuracy, detection area, availability of mounting locations, pavement type/condition, accessibility requirements and weather/environmental conditions
6. Deployment criteria such as structure type and orientation of the sensor (detector). Minimize new structures and co-locate devices where possible.

The following checklist items provide the designer with guidelines to facilitate the locating of RDSs and associated field cabinets.

General Placement Guidelines

- ☐ The side-fire position is the preferred position because one unit can detect up to 20+ lanes, over a 200-foot distance, where a forward-looking position only covers one lane. However, the RDS can also be mounted on a bridge or sign truss directly over the lane in forward-looking position if highly precise speed data is required.

- ☐ If accuracy requirements can be fully achieved, one RDS unit may be used for multiple lanes and both directions of travel, if the roadway is not bifurcated. However, separate RDSs may be required for each direction of travel, but they may be installed on the same side of the roadway if conditions allow.

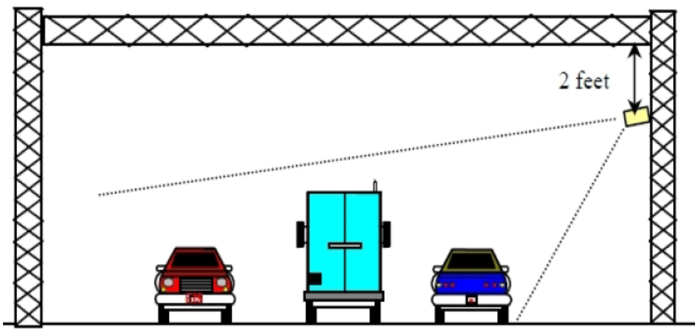
- ☐ To reduce cost, designers should try to mount a RDS on existing lighting poles (designer must coordinate with pole owners and the local agencies), or on CCTV camera poles.

- ☐ Additional precaution should be taken when specifying RDS subsystems within a continuous structure. Multiple overhead RDSs may be necessary in areas where reflections may cause multipath issues.

- ☐ Likely locations for RDSs are mid-way between traffic signals or within the bounds of an interchange, such as between a ramp, the freeway lanes, and a cross street. Such locations often provide reasonably free-flowing traffic, good proximity to both AC power and communication service if required, and protection from uncontrolled land disturbance activities which could damage the installation.

- ☐ A sign truss may be used for a side fire RDS, but accommodation must be made for the interference of the structure.

- ☐ If it is determined that the sign structure must be used for a RDS, follow manufacturer recommendations for angle, setback, and mounting height.



- ☐ When mounting a standalone RDS, the designer's first choice should be a breakaway pole, the pole length will be determined in accordance with grades and the manufacturer's recommendations.

- ☐ When locating the RDSs, designers must avoid metal signs and tree leaves within the detection zone, and shall place the poles outside of the clear zone whenever possible.

- ☐ RDSs shall be mounted without any signs and other flat surface mounted directly behind it. This will reduce multiple reflection paths form a single object or a vehicle

Urban Freeways

- ☐ If RDS is used for incident detection the designer shall coordinate with the MDOT for required spacing (typical spacing is approximately ⅓ to ½ miles apart).

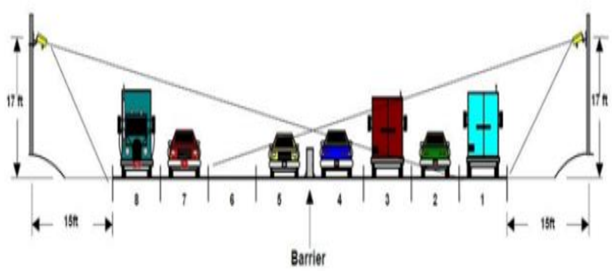
- ☐ Locate at least one RDS between all interchanges.

- ☐ RDS shall not be used to count entrance and exit ramps

- ☐ Where sight distances are not obscured, one RDS unit may be used to cover all lanes of traffic as per the manufacturer's recommended practices. Two RDSs on the same pole or on separate poles may be required to meet accuracy requirements and to provide better coverage for wide medians.

- ☐ If obstructions are unavoidable, the designer shall consider using multiple RDSs to avoid the conflict. For example, if a road is separated by a Jersey-barrier median, one RDS on either side of the road may be needed to capture all travel lanes.

- ☐ Provide two RDSs on same side of freeway if short median barrier and < 200 feet to the farthest E.O.T.L.



- ☐ RDSs shall be co-located with CCTV cameras using the same pole and field cabinet wherever possible

Urban Arterials and Highways

- ☐ Typical spacing for RDS on urban arterials and highways is approximately 1-mile or as required based on the application or directed by the MDOT

- ☐ Arterial ITS systems where speed detection is used are not used frequently in Mississippi at the time of the writing of this manual.

- ☐ If speed detection is needed for special applications on arterials and other surface streets, the preferred location for radar detection is where free-flowing traffic is common and where traffic flow stops are less likely from existing traffic signals.

- ☐ Typical spacing for RDS installations will vary along urban arterials depending on the application. Designers shall coordinate with the local agency (typically the County/ City DOT) responsible for traffic operations on the roadway.

- ☐ If only through movement detection is required, position the radar sensor to avoid detection of turn-only lanes

Rural Freeways and Rural Roadways

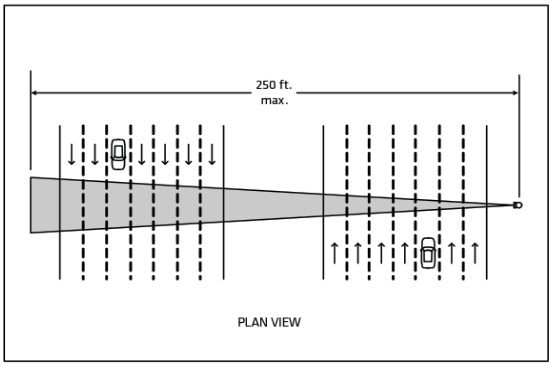
- ☐ Spacing for RDS installations depends on the application, but in general will be along critical routes for traffic monitoring and at or near the interchange areas. It is not uncommon for longer sections of rural roadways with lower traffic volumes to have detection only in the vicinity of interchanges or critical intersections

- ☐ The preferred location for RDS is where free-flowing traffic is less likely to be affected by a stop condition or traffic signal.

RDS Quantity Guidelines

- ☐ RDSs have a range of approximately 200 feet from the detector structure to the farthest detection point. Where necessary, multiple RDS can be used to get complete roadway coverage.

- ☐ At locations where the detection zone exceeds 200 feet, multiple RDSs must be used. This typically occurs at locations where two directions of travel must be captured.



- ☐ When the zone exceeds the detection capabilities of a RDS, provide one RDS on either side of the road to capture all travel lanes.

RDS Set-Back and Mounting Height Guidelines

- ☐ RDS setback is the distance from the edge of the nearest travel lane (EOTL) in the detection area to the RDS itself. This setback is required so that the RDS's radar beam can expand to cover the detection area.

- ☐ Table 16 is an example of the mounting height requirements as a function of the set-back distance. This will vary depending on the actual equipment used and setback from the first travel lane, so manufacturer's recommendations must always be considered during the site design.

- ☐ For typical detection scenarios, the recommended set-back should be between 25 to 35 feet or a minimum of 4 feet behind guardrail. Refer to manufacturer's recommended placement guidelines for site specific recommendations.

- ☐ Note that if the RDS structure is located on an embankment or hill, the mounting height may be more or less than the recommended mounting height from the base of the structure, depending on the structure elevation.

Table 16: RDS Recommended Mounting Height Guidelines (Verify with manufacturer requirements)

Set-Back from first detection lane (ft.)	Recommended Mounting Height (ft.)	Minimum Mounting Height (ft.)	Maximum Mounting Height (ft.)
10	16	9	22
15	20	12	26
20	23	15	30
25	26	17	33
30	29	19	37
35	30	20	40
40	33	22	43

Field Cabinet

Provide sufficient clearance around the pole base to allow for:

- ☐ Installation of a side-mounted RDS field cabinet

- ☐ Access to both the front and back of the side-mount radar field cabinet

- ☐ Opening of the field cabinet doors to at least 90 degrees

- ☐ Safe location of a maintenance bucket truck if the device mounting height requires bucket truck access (on shoulder or off pavement so as to not require a lane closure for maintenance)

- ☐ Type A cabinets are typically used for standalone RDS system installations. In the event that a RDS is to be mounted on the vertical support for an overhead sign, the RDS field cabinet can be mounted on the sign structural support. Co-location of RDSs with CCTV camera sites is desired with Type B field cabinets shared.

- ☐ Cable Run Distance: The maximum length of RDS communication cable from the RDS unit and the field cabinet is 4,000 feet (including slack coils and vertical distances).

2 Selection of RDS Components

The following checklist items provide the designer with guidelines to select RDS components to complete the design for the project.

RDS Types and Requirements

Select RDS Type: RDS types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 17: RDS System Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-641-C001	Type 1: ITS Radar Detection Sensor, true presence detector and also measure volume, occupancy, average speed and travel direction in the lane

RDS Functional Requirements

In addition to the relevant specifications and standards listed in Table 15, the following requirements shall be accounted for during design:

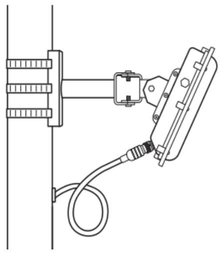
- ☐ Detection range from 10 to 200 feet

- ☐ Meet the following minimum performance metrics:
    - Average 5 minute volumes for all lanes combined with better than 95 percent accuracy compared to vehicles observed in video images for the same period.
    - Average 30 second volumes in every lane with better than 90 percent accuracy compared to vehicles observed in video images for the same period.

- Average 30 second speed for all lanes combined with better than 95 percent accuracy when compared to radar speed gun readings for the same period.
- Average 5 minute occupancy for all lanes combined with better than 85 percent accuracy when compared to dual inductive loop detection performance.
- Report greater than 95 percent occupancy accuracy compared to vehicles observed in video images for the same period whenever lanes are congested and vehicles are stationery for up to 15 minutes.

- ☐ NEMA 250 compliant – watertight, hose down, 4X corrosion protection, external icing

RDS Mounting Types and Requirements



Select RDS Mounting Type: RDS mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows. Mounting on existing structures (bridges, overhead trusses, sign structures, CCTV poles, DMS structures, etc.) is acceptable as approved by MDOT.

Table 18: RDS Mounting Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-634-F001	Detector pole w/ foundation, 20 ft. pole
2	907-634-F002	Detector pole w/ foundation, 35 ft. pole
3	907-634-F003	Detector pole w/ foundation, 50 ft. pole
4	907-634-F004	Detector pole w/ foundation, 25 ft. pole
5	907-634-G001	Traffic Signal Equipment Pole Mast Arm Extension
6	907-634-G002	Traffic Signal Equipment Pole Mast Arm Extension, 6 foot

RDS Mounting Type Functional Requirements

Refer to Table 15 for a list of relevant specifications and standards

Field Cabinet Types and Requirements

Select Field Cabinet Type: Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 19: RDS Field Cabinet Pay Item Numbers

No.	Pay Item Number	Type Description
1	660-A002	Equipment cabinet, Type A, pole-mounted
2	660-A003	Equipment cabinet, Type B, pole or pad-mounted

Field Cabinet Functional Requirements

Refer to Table 15 for a list of relevant specifications and standards

3.3.4 Bluetooth Detection System (BDS) Design

A. Overview / Description

A BDS provides an option for collecting original-destination information. A vehicle containing a detectable Bluetooth enabled device (i.e., mobile phone, iPad, tablet, etc.) is read at two consecutive Bluetooth reader stations or access points (called a matched detection). An electrical identifier called a MAC address and the time of detection is logged at each access point. This information along with the distance between the two consecutive readers is used to obtain a sample travel time between the two points. All vehicles are not detected at consecutive access points; however, as long as a certain sample of total vehicles, are successfully read an accurate travel time calculation is achievable.

B. Operational Requirements

- ❖ Provide real-time, true, spatial travel time data
- ❖ Support origin & destination (O&D) studies
- ❖ Provide real-time corridor monitoring
- ❖ Provide data to support performance measures
- ❖ Support planning and design purposes
- ❖ Provide data to support historical analysis
- ❖ Future V2I, V2V and V2X application support
- ❖ Provide distribution of traffic at intersection

C. Resources – MDOT Specifications and Industry Standards

MDOT BDS special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a BDS project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 20: BDS Specifications, Details and Industry Standards	
BDS Component	**Applicable BDS Specifications and Industry Standards**[1]
BDS Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
BDS System	MDOT Special Provisions Sections 907-666 Bluetooth Detection System For BDS Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-630 Traffic Signs and Delineators
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, ITS Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1205, Object Definitions for Closed Circuit Television (CCTV) Camera Control MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

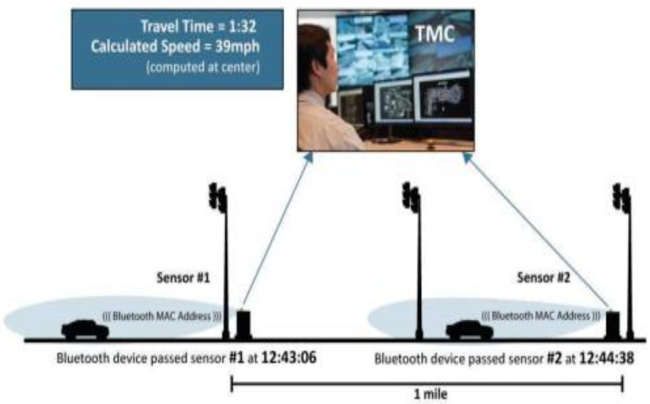
Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a BDS design. This discussion assumes that the preliminary engineering, agreements and additional preparatory work has been performed

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of BDSs and associated field cabinets.



General Placement Guidelines

- ☐ BDSs shall be installed at approximately 10 feet above the surface or as approved by MDOT
- ☐ BDS station spacing shall be based on the how the data collected will be used as well as the complexity of the roadway where the logical breaks in facilities where one would expect the potential for differing traffic conditions, such as at an interchange or major at-grade intersection. The following are average spacing depending on the type of roadway:
  - Freeways – 4 to 5 miles apart
  - Arterial Roadway (Without Traffic Signals) – 2 to 2.5 miles apart
  - Arterial Roadway (With Traffic Signals) – 1 to 1.5 miles apart
  - Dense Urban roadways – Every 1 mile

2 Selection of BDS Components

The following checklist items provide the designer with guidelines to select BDS components to complete the design for the project.

BDS Types and Requirements

Select BDS Type: BDS types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 21: BDS System Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-666-A001	Type A Bluetooth Detection System (without DSRC functionality), pole mounted self-enclosed unit capable of detecting Bluetooth enabled devices.
2	907-666-A002	Type B Bluetooth Detection System (with DSRC functionality), this type of detector shall be a unit that is mounted inside a typical ITS or Traffic Signal equipment cabinet.
3	907-666-B001	Bluetooth Detection System Server
4	907-666-C001	Bluetooth Detection System Server Licensing

BDS Type Functional Requirements

Refer to Table 20 for a list of relevant specifications and standards

BDS Mounting Types and Requirements

Select BDS Mounting Type: BDS mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 22: BDS Mounting Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
New Poles		
1	907-634-F001	Detector pole w/ foundation, 20 foot pole
2	907-634-F004	Detector pole w/ foundation, 25 foot pole
Existing Poles		
3	N/A	Traffic signal equipment pole w/ manufacturer recommended mounting hardware brackets

BDS Mounting Type Functional Requirements

Refer to Table 20 for a list of relevant specifications and standards

Field Cabinet Types and Requirements

Select Field Cabinet Type: Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 23: BDS Field Cabinet Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	660-A002	Equipment cabinet, Type A, pole-mounted
2	660-B001	Cabinet modifications to existing cabinet

Field Cabinet Functional Requirements

Refer to Table 20 for a list of relevant specifications and standards

3.3.5 Road Weather Information System (RWIS) Design

A. Overview / Description

A RWIS collects weather data via a combination of sensors that gather and transmit pavement and sub-surface pavement temperature, wind speed and direction, air temperature, visibility, precipitation, and humidity data. These sensors are controlled by a field controller, called a RPU, which then sends the sensor data to the TMC.

The information can be used to inform drivers of adverse conditions or to determine when to conduct road maintenance operations in a safe and effective manner. RWIS data should be used with an information dissemination source, such as DMS or mobile smart phone, to reach motorists to aid in reducing weather-related traffic collisions.

B. Operational Requirements

- Provide real-time weather related data
- Support weather advisories and warnings
- Support hurricane evacuations
- Measure air and surface temperature
- Measure humidity and visibility
- Measure precipitation and surface water level

C. Resources – MDOT Specifications and Industry Standards

RWIS standard specifications, special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a RWIS project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 24: RWIS Specifications, Details and Industry Standards	
RWIS Component	**Applicable RWIS Specifications, Details and Industry Standards[1]**
RWIS Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
RWIS System	MDOT Standard Specifications Section 907-670 Roadway Weather Information System For RWIS Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-639 Traffic Signal and ITS Equipment Poles
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, ITS Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1209, Object Definitions for Transportation Sensor Systems (TSS) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

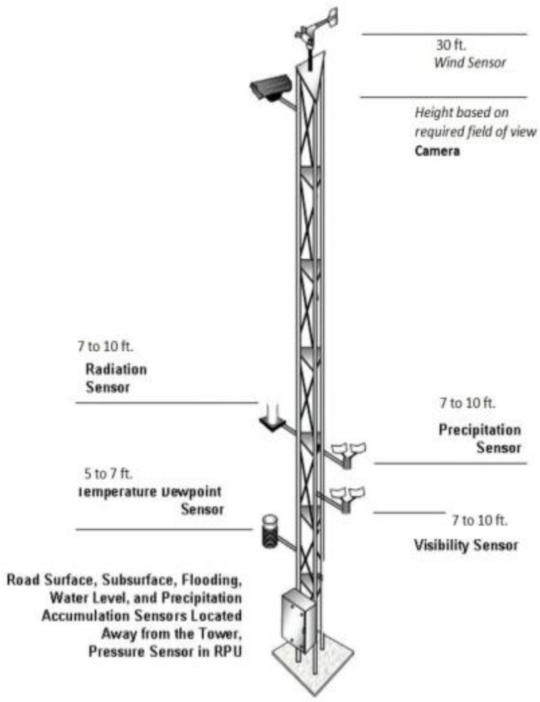
Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a RWIS design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

The typical RWIS site consists of a tower or pole, field cabinet, field processor or RPU, power distribution unit, and several outstations. The RWIS outstations may include some or all of the following:

1. Road sensors in travel lanes to measure surface temperature, sub-surface temperature and surface condition.



Drawing Credit: FHWA

2. Atmospheric sensors adjacent to the road to measure air temperature, relative humidity, wind speed and direction, visibility and precipitation.
3. A power source supplemented by an electric connection.
4. A data logger, connected to all the sensors, to translate and record the signals received from the sensors.
5. A communications device, such as a modem, to allow remote collection and transfer of data.

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of RWISs and associated field cabinets.

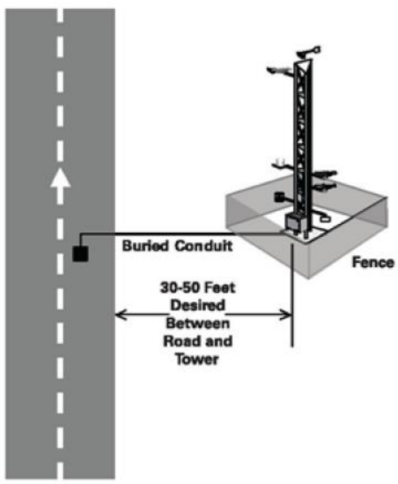
General Placement Guidelines

- ☐ Refer to FHWA *RWIS Guidelines (FHWA-HOP-05-0226)* for detailed siting location and installation information.

- ☐ Before locating RWIS sites, designer should consider the known weather issues that affect the transportation network. This may include areas prone to bridge deck icing, fog, standing water after heavy rains or areas impacted by inclement weather coupled with road conditions such as around sharp curves.
    - Are sensor types appropriate for the desired location and purpose including; wind speed and direction, air temperature and humidity, pavement and sub-surface sensors, visibility and precipitation?
    - Is the mounting height appropriate?
    - Is the equipment sufficiently hardened to withstand major storms?

- ☐ A poorly chosen site can result in incorrect readings, service difficulties or even damage from passing traffic. The site shall not be sheltered in such a way that sensor readings give a false indication of conditions closer to the road.

- ☐ The RWIS sensor support pole or tower shall be placed between 30 and 50 feet from the edge of the roadway to avoid the effects of passing traffic (e.g., heat, wind, and splash), yet still be able to detect the weather conditions affecting motorists.



Drawing Credit: FHWA

- Avoid standing water or locations where billboards, surrounding trees or other vegetation would affect the weather measurements.

- The height of sensors above the ground and their orientation can also affect readings, and need to be taken into account when selecting locations and installing equipment.

- The number and spacing of sites in the network is dependent upon a variety of factors, including topography, soil type, land use, microclimate zones, proximity to utilities and road classification.

- Generally, the greater the variability in these factors, the more sites will be required in the network.

- RWIS deployments should focus on roads where visibility issues or road icing are prevalent. The observation points and pavement sensors should be installed at critical points along the roads.

- Variations in sensor or structure siting may be unavoidable due to many circumstances, such as limited road right-of way, access for maintenance, geography and security concerns.

RWIS Tower Placement Guidelines

- The tower base shall be attached to a fenced concrete pad and, if within the clear zone, a barrier or guardrail shall be used. The fence shall be at least 15 feet from any face of the tower. If a fold over tower is probable, the fenced space shall accommodate the tower in the folded state without interference of the fence.

- Median placement on a divided highway is generally not feasible unless the median is 100 feet or wider.

- Access to the site for maintenance shall be provided that accommodate vehicles and personnel

- Electrical and communication services shall be reasonably available and accessible.

- The tower shall be placed in a clear area that minimizes the turbulence effect of wind passing over trees or other obstructions.

- The tower shall be placed in an area when surrounding terrain is low or native soil at least 50 feet from the tower.

- ☐ The tower shall be sited on relatively flat terrain and avoid slopes within 300 feet that could impact wind measurements.

- ☐ The tower base shall be at the same elevation as the surface of the road.

- ☐ The tower height shall be about 33 feet to accommodate a wind speed and direction sensor.

- ☐ Avoid swampy areas and steep cut sections.

A poorly chosen site can result in incorrect readings, service difficulties or even damage from passing traffic. The site should not be sheltered in such a way that sensor readings give a false indication of conditions closer to the road.

- ☐ Anti-climb panels shall be installed to restrict use of the open lattice of the tower to climb the tower.

- ☐ Avoid standing water (runoff that ponds) areas.

- ☐ RWIS station should be easily accessible by a bucket truck.

Field Cabinet

Design criteria for a suitable field cabinet location include the following:

- ☐ If possible, the RPU and other field cabinet components should be co-located within another MDOT field cabinet. If not, the field cabinet for the RPU shall be mounted on a new structure/pole-mounted or an existing structure to minimize cost.

- ☐ In locations where the structure/pole is difficult to access, the field cabinet may be ground-mounted at a more convenient location with easier access, such as adjacent to a frontage or access road.

- ☐ Placement of the field cabinet shall be accessible and shall not interfere with the accuracy of any sensor.

- ☐ Place the field cabinet at the safest possible location, generally along the right shoulder.

- ☐ Orient the field cabinet so that the Engineer or Technician is facing the road while performing maintenance at the cabinet location.

- ☐ The field cabinet should be at a level where the maintainer does not need a stepladder to perform maintenance at the field cabinet location.

- ☐ A level concrete pad should be provided at the front of the field cabinet for the maintenance worker to stand on while accessing the enclosure.

- ☐ Where possible, there should be adequate and safe parking in the vicinity of the field cabinet for a maintenance vehicle. Where this is not possible, locate the field cabinet where it is accessible by on-foot maintenance personnel.
- ☐ See MDOT and manufacturer specifications to determine the maximum distance between the field cabinet and the field device it services.
- ☐ Consider elevating the critical electronic components above the flood elevation.
- ☐ Use standard NEMA cabinets wherever possible. Specific equipment manufacturers may have different interior space requirements. In some cases, co-located ITS devices may share the same field cabinet, which will further influence field cabinet size requirements.

2 Selection of RWIS Components

The following checklist items provide the designer with guidelines to select RWIS components to complete the design for the project.

RWIS Types and Requirements

Select RWIS Type: RWIS types available for use on new MDOT ITS construction projects and system upgrade projects are as follows

Table 25: RWIS System Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-664-A002	Roadway Weather Information System (RWIS)

RWIS Type Functional Requirements

Refer to Table 24 for a list of relevant specifications and standards

RWIS Mounting Structure Types

Select RWIS Mounting Type: RWIS mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 26: RWIS Mounting Structure Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	907-634-F001	Detector pole w/ foundation, 20 ft. pole
2	907-634-F002	Detector pole w/ foundation, 35 ft. pole

RWIS Mounting Structure Type Functional Requirements

In addition to the relevant specifications and standards listed in Table 24, the following requirements shall be accounted for during design:

- ☐ The RWIS structure can be a tower, pole, or ITS Gantry. The RWIS structure must have a concrete foundation to provide a sturdy platform.
- ☐ Determine appropriate sensor types including; wind speed and direction, air temperature and humidity, pavement and sub-surface sensors, visibility and precipitation.
- ☐ Given the MDOT varying soil conditions, the foundation size must be designed for the specific site conditions, and in accordance with the manufacturer's minimum specifications.
- ☐ The structure should be sturdy and meet manufacturer's requirements for deflection to reduce contamination of sensor data by turbulence and wind flow around the structure.
- ☐ The structure height should be sufficient to accommodate the sensor/sensors. If installing wind sensors, tower should be at least 30 feet high. Towers are most frequently installed within a range of 35 to 50 feet from the edge of the paved surface and, if possible, at the same elevation as the surface of the road.

Field Cabinet Types

Select RWIS Mounting Type: RWIS mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 27: RWIS Field Cabinet Pay Item Numbers

No.	Pay Item Number	Type Description
1	660-A002	Equipment cabinet, Type A, pole-mounted
2	660-A003	Equipment cabinet, Type B, pole or pad-mounted

RWIS Mounting Type Functional Requirements

Refer to Table 24 for a list of relevant specifications and standards

3.3.6 Highway Advisory Radio (HAR) Design

A. Overview / Description

A HAR station provides information to the traveling public using AM radio. The nature of this information is varied, but the goal is to disseminate traffic and safety related information to travellers so that they can make informed decisions regarding their intended route and/or destination. In addition, a network of HAR stations can be incorporated into evacuation scenarios.

B. Operational Requirements

- ❖ Provide support for incident and road/lane closures
- ❖ Provide advisories on adverse conditions
- ❖ Support construction and maintenance operations
- ❖ Support Amber Alerts
- ❖ Provide evacuation-related messages
- ❖ Provide special event conditions

C. Resources – MDOT Specifications and Industry Standards

HAR standard specifications, special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a HAR project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 28: HAR Specifications, Details and Industry Standards

HAR Component	Applicable HAR Specifications, Details and Industry Standards[1]
HAR Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
HAR System	MDOT Standard Specifications Section 907-655 Highway Advisory Radio For HAR Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Standard Specifications Special Provisions Section 907-639 Traffic Signal and ITS Equipment Poles
Sign	Manual on Uniform Traffic Devices (MUTCD) Section 2I.09, Radio Informational Signing.
Beacon	Manual on Uniform Traffic Devices (MUTCD), Chapter 4L (Flashing Beacon Signs)
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation

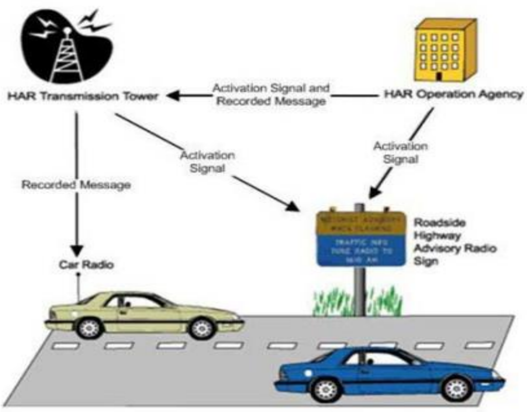
Table 28: HAR Specifications, Details and Industry Standards	
HAR Component	**Applicable HAR Specifications, Details and Industry Standards[1]**
	Section 4.0 Power Design Guidelines of this Manual
Communications	MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a HAR design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

A HAR system design must include all the equipment necessary for the operator to record verbal messages from onsite or remote locations, and to continually broadcast live, pre-recorded, or synthesized messages from roadside transmission sites. HAR designs must also include highway signs with remotely operated flashing beacons to notify motorists of HAR broadcasts.



The following are the primary design steps for developing a HAR system:

1. **System Purpose:** Design must satisfy the system purpose established in the operational requirements; for example, components of the design will differ if HAR is deployed to serve one interchange or if it is deployed along a corridor.

2. **System Coordination:** If there are existing HAR systems (MDOT or other agency) in the deployment area, the designer shall coordinate design and deployment of the new HAR stations with these other systems.

3. **Frequency Search:** Develop a list of AM frequencies that are available. Consider what frequencies the MDOT is currently using, as well as frequencies used by any neighbouring agencies along the same route. To maintain consistency for motorists, determine if these frequencies can be used for the proposed transmitter. This should be written into the contract for the contractor to verify the available AM frequencies using site survey equipment.

4. **Survey Onsite Listening**: Survey the road where it is intended for motorists to tune into the HAR broadcast when so instructed, using an automobile digital AM radio tuned to the candidate frequencies from Step 3. Monitor all of the candidate frequencies throughout the listening area at least once during daylight hours and at least once during the night. Again, this should be written into the contract so that the contractor is responsible for obtaining the correct frequency. The contractor should provide the MDOT a list of available frequencies at the site location, and the MDOT can direct the contractor to obtain a license for a particular frequency.

5. **Determine General Location For Coverage:** Find the approximate geographic center of the desired listening area for each transmitter. The HAR signal should propagate to a minimum radius of 4 miles from this point in all directions (highly dependent on the terrain and topography). If this coverage does not encompass the road that requires coverage, consider the possibility of adding repeater stations. Consider where HAR signs will be placed to announce to motorists entering the area that the signal is available.

6. **NOAA All-Hazards Alert System:** Verify reception of a National Weather Service channel (162.400-162.500 MHz) at the desired location. See coverage areas online at this NOAA link: **http://www.nws.noaa.gov/nwr/Maps/**

7. **Choose a Location:** See site specific location and placement guidelines below.

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of HAR transmitters, antennas, beacon signs and associated field cabinets.

General Placement Guidelines

- ☐ HAR systems shall be located at key decision points along the transportation system to provide the ability to transmit a meaningful message that can be received by motorists traveling through the broadcast zone.

- ☐ Locate in prior to interchanges that offer alternate routes and in advance of high crash locations and traffic bottlenecks.

- ☐ Locate along key commuter or evacuation corridors.

- ☐ Locate along the outside of the right-of-way wherever possible for ease of maintenance and to provide power service more directly.

- ☐ Locate within an interchange interior (inside the ramps) if feasible.

- ☐ If co-located with, or if located near, a communications HUT, provide sufficient distance away from the HUB and other structures to accommodate the ground plane antenna.

- ☐ Consideration should also be taken for providing phone line service in addition to fiber optic communications to permanent HAR installations.

Transmitter / Antenna Placement Guidelines

- ☐ Locate the transmitter/antenna site free from significant vertical (25 feet or higher) obstructions including; buildings, tall trees, terrain features, lighting, power/communications poles and towers, overpasses and overhead highway signs. Ideally there should a 25-foot radius clear zone around the antenna from obstructions.

- ☐ Locate the site where there is sufficient open ground for the cabinet and antenna installation.

- ☐ Locate the transmitter on the highest ground possible to aid in reception of the transmission.

HAR Sign / Beacon Placement Guidelines

- ☐ If possible, co-locate the sign/beacon with an existing CCTV camera for the purpose of visual verification.

- ☐ Locate flashing beacon signs within the HAR coverage area prior to exit signs or DMS associated with an interchange.

- ☐ Make sure that MUTCD sign standards have been followed for HAR beacon signs

- ☐ Locate HAR signs so they are visible and un-obstructed

- ☐ Locate HAR signs so that the sign permits the traveller to safely tune and then react to the HAR message

- ☐ Preliminary design or investigation of proposed sign sites must include a signal strength test if wireless communication is being used

- ☐ Signs should be placed on straight sections of road where possible

- ☐ Signs should be placed at least 800 feet from other static or dynamic signs or other visual obstructions.

- Signs should be located just inside the outer edge of the broadcast range of the HAR transmitter.

- Signs should be located far enough from an alternate route to give the motorist time to locate the radio channel (15-20 seconds), listen to the message twice (approximately 120 seconds), and divert to the alternate route.

- Motorists should not have to divert their attention from a complex road segment (sharp curves, merges, etc.) to tune their radio to the HAR frequency.

Field Cabinet

Design criteria for a suitable field cabinet location include the following:

- The field cabinet should be placed on the HAR ground mounted pole or sign structure.

- In locations where the HAR structure/pole is difficult to access, the field cabinet may be ground-mounted at a more convenient location (preferable less than 150 feet away) with easier access, such as adjacent to a frontage or access road.

- Place the field cabinet at the safest possible location, generally along the right shoulder.

- Orient the field cabinet so that the maintainer is facing the road while performing maintenance at the cabinet location.

- The field cabinet should be at a level where the maintainer does not need a stepladder to perform maintenance at the field cabinet location.

- A level concrete pad should be provided at the front of the field cabinet for the maintenance worker to stand on while accessing the enclosure.

- Where possible, there should be adequate and safe parking in the vicinity of the field cabinet for a maintenance vehicle. Where this is not possible, locate the field cabinet where it is accessible by on-foot maintenance personnel.

- See MDOT and manufacturer specifications to determine the maximum distance between the field cabinet and the field device it services.

2 Selection of HAR Components

The following checklist items provide the designer with guidelines to select HAR components to complete the design for the project.

HAR Types and Requirements

Select HAR Type: HAR types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 29: HAR System Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	907-655-A001	HAR System
2	907-655-C001	HAR System Software and Servers

HAR System Functional Requirements

In addition to the relevant specifications and standards listed in Table 32, the following requirements shall be accounted for during design:

- ☐ **Message Synchronization:** If there are adjacent HAR transmitters, make sure message synchronization has been taken into account in the design.

- ☐ **Licensing and Permits:** A FCC RF license is required for each HAR application, including additions based on RF bands used with any existing HAR systems. Traditionally, the choice of a HAR RF band has been left to the supplier because HAR system suppliers are typically more familiar with the process of FCC RF license acquisition. However, the designer shall note the following considerations:

    1. FCC licenses for RF bands at or near the bottom and top ends of the AM radio band are usually easier to obtain, as these are commercially least desirable. However, avoid accepting an RF band outside of the standard AM frequency range (520 KHz to 1610 KHz) because not all AM radios used in vehicles have the “extended” AM range (below 520 KHz, and between 1610 KHz to 1710 KHz).

    2. Where an existing HAR system is deployed along a corridor, give preference to the same RF band used in the existing system so that related HAR signs along the same road are uniform, if possible.

    3. FCC licensing is typically completed by the contractor during construction, as the FCC will only issue a permanent license once the HAR transmitter is fully

constructed. The FCC may issue a temporary license for a 3-month period before issuing a permanent license.

HAR Mounting Types and Requirements

<u>Select HAR Mounting Type</u>: HAR mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 30: HAR Mounting Pay Items Numbers		
No.	**Pay Item Number**	**Type Description**
1	907-655-B001	HAR Sign w/ Flashing Beacons
2	634-I	Wood Pole, Class, 30 to 35 foot

HAR Mounting Type Functional Requirements

In addition to the relevant specifications and standards listed in Table 32, the following requirements shall be accounted for during design:

- ☐ **Type of Pole:** The combined height between the pole support and the tip of the antenna element shall not exceed 49.2 feet in height from ground level in order to comply with FCC regulations. A standard 30 to 35 foot treated wooden or fiberglass utility pole may be used.

Field Cabinet Types and Requirements

<u>Select Field Cabinet Type</u>: Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 31: HAR Field Cabinet Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	660-A003	Equipment Cabinet, Type B, pole or pad-mounted
2	660-A004	Equipment Cabinet, Type C, pad-mounted

Field Cabinet Functional Requirements

Refer to Table 28 for a list of relevant specifications and standards

3.3.7 Video Detection System (VDS) Design

A. Overview / Description

A VDS consists of a video camera mounted above or along the road, angled towards the travel lanes. The system is configured using software to collect data only from predetermined "zones" within the travel lanes. Video images are processed by software to detect vehicle presence, speed, volume, occupancy and classification in each zone.

VDSs are used for freeway detection when justified by special conditions or requirements in MDOT ITS applications. Since video detection is general more expensive for ITS on freeways, due to the requirements for mounting height and mounting rigidity they are typically used on arterials, primarily at signalized intersections or on approaches to a signalized intersection. Designer should coordinate with MDOT before using VDS at any intersection.

B. Operational Requirements

- Support traffic and incident management
- Provide monitoring of multiple lanes
- Support queue detection systems
- Support wrong-way detection systems
- Support multi-lane intersection control
- Provide detection of turning patterns
- Detection of lane changes
- Provide vehicle classification

C. Resources – MDOT Specifications and Industry Standards

MDOT VDS standard specifications, special provisions and industry standards documented in the table below highlights some of the primary ones for each of the typical components used in a VDS project. This is not an all-inclusive list and the designer is responsible to provide a complete design.

Table 32: VDS Specifications, Details and Industry Standards	
VDS Component	**Applicable VDS Specifications, Details and Industry Standards**[1]
VDS Design Process	Refer to Section 3.1 MDOT ITS Design Process, **Appendix A** Site Review Checklists, **Appendix B** Design Checklists and **Appendix C** Plans Checklists
VDS System	MDOT Standard Specifications Section 907-643 Video Vehicle Detection System For VDS Details and Example Plan Sheets see MDOT ITS website (see Section 1.7)
Pole / Structure	AAHSTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals MDOT Special Provisions Section 907-639 Traffic Signal and ITS Equipment Poles
Field Cabinet	NEMA TS-2 Traffic Controller Assemblies Joint AASHTO/ITE/NEMA Committee on the ATC, ITS Standard Specification for Roadside Cabinets MDOT Standard Specifications Section 660 ITS Equipment Cabinets
Power	NFPA 70, NEC and all state/local codes (as applicable) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 4.0 Power Design Guidelines of this Manual
Communications	National Transportation Communications for ITS Protocol (NTCIP) 1209, Object Definitions for Transportation Sensor Systems (TSS) MDOT Specifications Section 722 Materials for Traffic Signal Installation Section 5.0 Communications Network Design Guidelines of this Manual
Operations	MDOT Special Provisions Section 907-659 TMC Modifications

Note: All MDOT specifications, details and industry standards referenced assume the latest version or edition

D. Design Considerations

The following subsections provide high-level guidance and checklists to assist ITS consultants through the MDOT ITS design criteria, requirements, and processes associated with a VDS design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

Criteria to justify using VDS instead of RDS include the following:

1. Need for shared video at the site
2. Need for improved volume accuracy by lane
3. Need for improved accuracy of speed by lane

1 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of VDSs and associated field cabinets.

General Placement Guidelines

- ☐ Refer to RDS placement guidelines as VDS is similar to RDS, however there are a few specific design requirements that pertain to VDS documented in this section.

- ☐ The designer shall consider the mounting height of the camera(s) as it is critical to the accuracy of the device. Generally, higher is better, facing on-coming traffic is better and facing west/north is better than facing east (rising sun)/south.

- ☐ VDS may be used in a side-fire configuration, directly in line with lane directions, or may be placed at any angle in-between.
  - For most freeway applications, an angle orientation provides enhanced accuracy. An angled orientation seems to reduce vehicle occlusion and allows multiple detection zone configurations.

- ☐ It is highly recommended that VDSs be co-located on existing structures meeting vertical clearance requirements and guidelines, such as bridges, truss structures, mast arms, poles, etc. as approved by MDOT.

- ☐ If installing VDS at a ramp location, two cameras will be needed; one for the ramp and one for the mainline.

- ☐ Detector Vertical Coverage. VDS can detect vehicles on as many lanes as are present in the video image. At a height of 30 feet, VDS can detect up to three lanes simultaneously. At a height of 20 feet, VDS can detect up to two lanes simultaneously. At heights less than 20 feet, only one lane can be detected per VDS camera.
  - Vertical tubular extensions shall be used to provide the vertical height for optimal performance of the VDS.

Urban Freeways

- ☐ If the detectors are part of a corridor data collection system, they should be spaced approximately 1-mile apart unless otherwise directed by the MDOT.

Urban Arterials and Highways

- ☐ An average spacing of 1-mile is recommended for detection in urban arterial areas
- ☐ For urban areas, traffic signal mast arms are the preferred structure for mounting VDS cameras. If mast arms are used, they must meet the vertical clearance guidelines shown on the standard drawings. If co-location is not possible because of spacing or other system needs, new overhead structures must be constructed. Any above-lane structure must comply with AASHTO standards for minimum clearance.

Rural Freeways and Rural Roadways

- ☐ VDSs are generally placed as directed on a case-by-case basis on rural freeways

Traffic Signal Applications

- ☐ Type 2 VDSs used for traffic signal controller input shall be located as recommended by the manufacturer and approved by the MDOT.

2 Selection of VDS Components

The following checklist items provide the designer with guidelines to select VDS components to complete the design for the project.

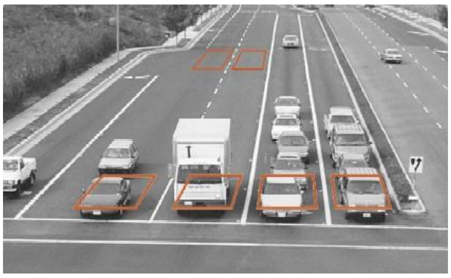
VDS Types and Requirements

Select VDS Type: VDS types available for use on new MDOT ITS construction projects and traffic signal system projects are as follows:

Table 33: VDS System Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-643-A001	Type 1 Video Vehicle Detection Sensor, 1 Sensor, Roadway Monitoring Capabilities
2	907-643-A002	Type 2 Video Vehicle Detection Sensor, 1 Sensor, Presence or Pulse Detection for Traffic Signal Controller inputs
3	907-643-A003	Type 3 Video Vehicle Detection Sensor, 1 Sensor, Presence or Pulse Detection of vehicle and bicycles for Traffic Signal Controller inputs
4	907-643-E001	Multi-Sensor Vehicle Detection Sensor (MSDS), 1 Sensor, Use both Video detection and radar sensing technology for multi-purpose

VDS Functional Requirements



In addition to the relevant specifications and standards listed in Table 20, the following requirements shall be accounted for during design:

- ☐ The design shall take into account the opportunity to possibly set-up multiple zones of detection using one camera. Thus in freeway ITS there is generally more accuracy for volume, speed and vehicle length (classification) by lane using only one device.

- ☐ The designer shall consider the possible performance impact from inclement weather such as fog, rain, and snow; vehicle shadows; vehicle projection into adjacent lanes; occlusion; day-to-night transition; vehicle/road contrast; and water, salt grime, icicles, and cobwebs on camera lens.

- ☐ The designer shall take into account that reliable night-time signal actuation requires street lighting.

- ☐ The designer shall consider that a 30 to 50 foot (typical) camera mounting height (in a side-mounting configuration) is general required for optimum presence detection and speed measurement.

- ☐ The design shall take into account that some VDS models are susceptible to camera motion caused by strong winds or vibration of camera mounting structure.

- ☐ Each VDS detection zone shall be defined such that only vehicles within the detected lane cross the zone. This will ensure that each detection zone gathers lane-specific data, and that vehicles are not counted more than once.

- ☐ Rigid mounting is necessary (cannot be mounted on span wire).

- ☐ The VDS system shall allow for detection zone calibration for accommodating perspective variations due to varying camera height and angles

- ☐ The VDS shall provide for both day and night operations

- ☐ Focal lengths shall be capable of adjustment such that the approach widths, as measured at stop line, equates to 100 percent of horizontal width of the view

VDS Mounting Types and Requirements

Select VDS Mounting Type: VDS mounting types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 34: VDS Mounting Pay Item Numbers

No.	Pay Item Number	Type Description
New Poles		
1	907-634-E001	Camera pole w/ foundation, 50-foot pole
2	907-634-E002	Camera pole w/ foundation, 60-foot pole
3	907-634-F003	Detector pole w/ foundation, 50-foot pole
Existing Poles		
4	907-634-B001	Traffic signal equipment pole shaft extension, 10-foot, video camera mount
5	907-634-G001	Traffic signal equipment pole mast arm extension

VDS Mounting Type Functional Requirements

Refer to Table 32 for a list of relevant specifications and standards

Field Cabinet Types and Requirements

Select Field Cabinet Type: Field cabinet types available for use on new MDOT ITS construction projects and system upgrade projects are as follows:

Table 35: VDS Field Cabinet Pay Item Numbers

No.	Pay Item Number	Type Description
1	660-A002	Equipment cabinet, Type A, pole-mounted
2	660-A003	Equipment cabinet, Type B, pole or pad-mounted
3	660-B001	Cabinet modifications to existing cabinet

Field Cabinet Functional Requirements

Refer to Table 32 for a list of relevant specifications and standards

3.3.8 Communications Hut Design

A. Overview / Description

A Communication Hut is a small environmental controlled prefabricated building used to house a collection of communications and network equipment, racks, power systems, and LAN and WAN interfaces to ITS devices in the field and to TMC systems and computers over fiber, wireless, and/or leased line communication systems.

B. Design Considerations

The following subsections provide high-level guidance and checklists to assist designers through the MDOT ITS design criteria, requirements, and processes associated with a Communications Hut design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

1 **Building Design Considerations**

The following checklist items provide the designer with general building design considerations.

- ☐ A fully operational Communications HUT as specified in MDOT Special Provisions Section 907-660 includes equipment racks, communications components, network and other equipment, HVAC, power distribution, lighting, security, cable runways, etc.

- ☐ HUTS shall serve as:
  - A communications node in the overall ITS wide-area network
  - Communications aggregation point to collect and route field device communications traffic.
  - Place to house equipment racks for fiber distribution units, a network layer-3 switch, and supporting equipment.

- ☐ Provide Plan, detail sheets and/or NTBs detailing the HUT design including the following:
  - Site and building layout including; the shelter dimensions, site preparation work, fencing, landscape, conduit and pull box installation.
  - Electrical, lighting, grounding, alarm, and HVAC systems details as necessary to accommodate the types and quantity of equipment the shelter will house.

- Equipment layout details showing inside of the building, including positioning of overhead cable trays, the quantity and placement of standard EIA/TIA 19-inch racks, demarcation and patch panels, and the equipment placement within each rack.
- Other details including back-up power systems such as UPS, generator, fuel tank, security cameras, security alarms, and other security features.

☐ A 8-foot to 10-foot to 10-foot x 12-foot HUT are typical sizes used by MDOT and should be considered standard unless otherwise directed by the MDOT.

2 Location and Placement Guidelines

The following checklist items provide the designer with guidelines to facilitate the locating of Communications HUTs.

General Placement Guidelines

☐ Locate HUTs where there is reasonable electrical service access, fiber trunk line connectivity, and accessibility by installation and maintenance personnel, including space for parking for maintenance vehicles.

☐ It is important to also consider site geography when locating HUTs as the nature of the equipment inside is costly and not environmental hardened; for example, avoid locating near water features or areas susceptible to flooding.

☐ HUTs typically are located at major junctions of two limited access facilities or at the interchange between a limited access facility and a major arterial.

☐ Before establishing a location as a HUT site, it is important to research to determine if the site is proposed for any roadway expansion or reconstruction.

☐ If this is the case, the HUT location must be chosen to avoid the anticipated construction. If the construction work is not fully conceptualized, a shift of the HUT away from the preferred interchange may be required.

☐ For long distance fiber optic trunk cable runs, a HUT will be installed every 20 to 25 miles or as approved by MDOT.

☐ Locate security camera(s) outside the building located and aimed for maximum viewing of the entrance and service vehicle parking areas.

3

3. Selection of Communications Hut Equipment

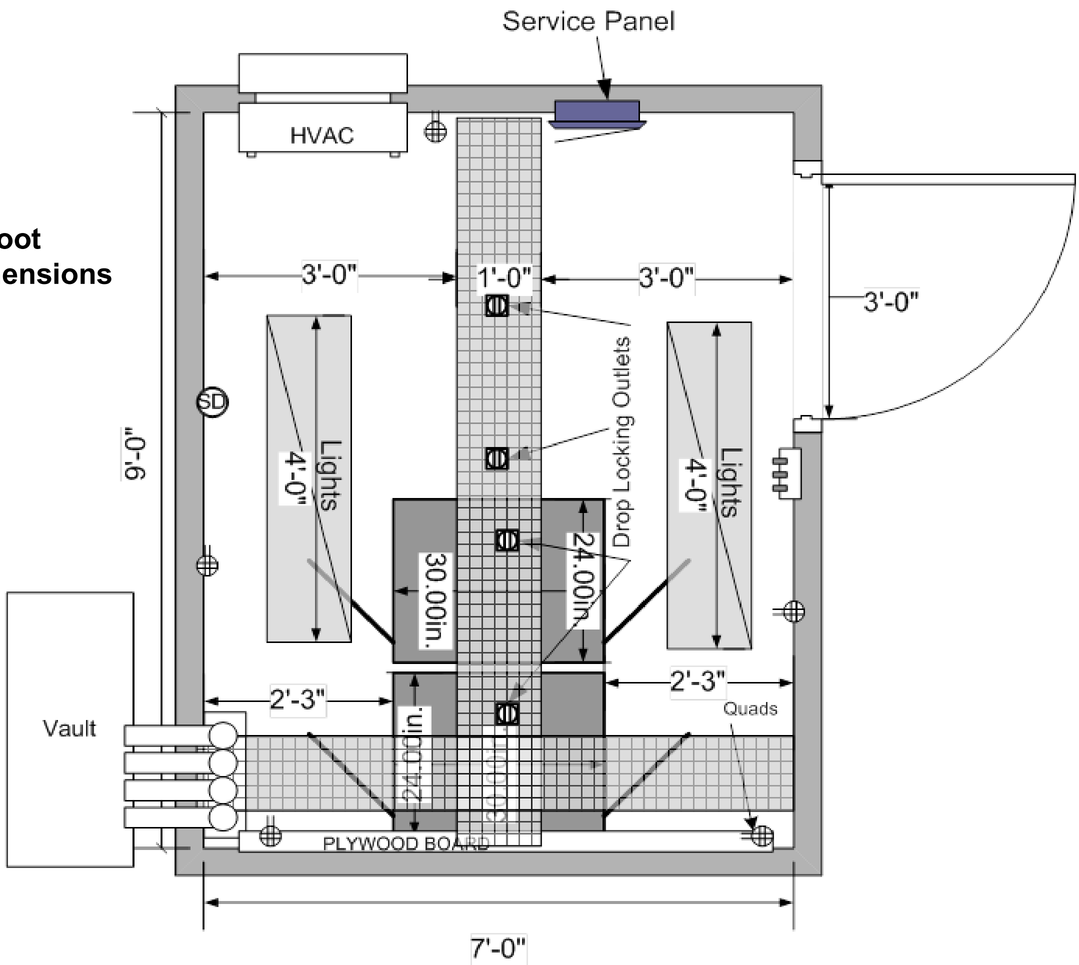
The following checklist items provide the designer with guidelines to select Communications HUT components to complete the design for the project.

Table 36: Communications HUT Pay Item Numbers		
No.	**Pay Item Number**	**Type Description**
1	907-664-B001	Communications Node HUT
2	907-664-C001	Communications Equipment Installation & Configuration

Equipment and Furnishings Options

- ☐ Hut equipment is specified in the Special Provision 907-660 and the NTBs. Typical diagram of a smaller Communications HUT is as follows:

8-foot x 10-foot Outside Dimensions



- ☐ Huts aggregate field device communications and serve as backbone nodes in the ITS network. New installation field devices communicate via Ethernet network to HUTs, which will contain a network layer-3 switch to route the communications through the ITS network.

- ☐ Preferred hut-to-hut communications schemes, organized from most to least advantageous for network capacity and redundancy are:
    - The HUT network layer-3 switch communicates directly to multiple network layer-3 switches forming a network backbone while using two separate fiber optic cables in separate physical routes.
    - The HUT network layer-3 switch communicates directly to a single network layer-3 switch forming a network backbone while using two separate fiber optic cables in separate physical routes.
    - The HUT network layer-3 switch communicates directly to a single network layer-3 switch forming a backbone using the same fiber optic cable.

- ☐ Several elements of the design task must be complete prior to the design of the HUT network electronics. All field devices (DMS, CCTV, RDS, BDS, RWIS, HAR) must be designed, including the station, and device ID. The fiber (device) allocation effort must be complete.

- ☐ In the HUT, all the equipment used to manage, aggregate, and process data is mounted in 19-inch wide equipment racks that are lined up in rows. The number of racks installed in the initial HUT installation will depend on the amount of HUT equipment required from the network electronics design. If the racks required do not completely fill the row, then reserve those rack spaces for when the space is actually needed, in the future.

- ☐ The fiber trunk cables, upon entering a HUT, are terminated in FDCs.
    - FDCs are passive, box-like, rack mounted devices which simply provide an enclosed space for termination of the individual trunk fibers and interface to fiber optic jumpers which connect to other network electronics equipment.
    - On the rear of the FDC is space for the individual trunk cable fibers to be spliced and then to be connected to the termination panel (ports) in the FDC.
    - On the front side of the FDC there is a panel of connectors to which fiber optic jumpers are attached.

- Splice trays will be used for proper storage of splices from fiber optic trunk cable to pigtails for FDC fiber ports. The splice trays are located in rack space directly adjacent to the FDC served.

- ☐ Trunk fibers are never attached directly to devices other than a FDC for several reasons:
  - The FDC allows for transition from outside plant to inside plant cable suitable for indoor environments in the TMC building or HUT building.
  - The individual fibers coming out of the trunk cable are fragile; breakage is possible, and the trunk cable needs to be protected.
  - Fiber optic Jumper cables can be replaced easily and cheaply, and are better protected than individual trunk fibers.
  - If changes are made, fiber optic jumpers can simply be reconnected to different devices; if different lengths are needed, fiber optic jumpers corresponding to those lengths can be purchased.
  - Fiber optic jumpers help organize FO connections by differentiating between fiber modes, yellow jacket for single-mode fiber and orange jacket for multi-mode fiber (legacy).

- ☐ The fiber optic jumpers are used for connection to the terminated fibers (in the FDCs). Either simplex or duplex fiber optic jumpers are used. A simplex fiber optic jumper allows for a single fiber connection, while a duplex fiber optic jumper connects a fiber pair.

- ☐ A system block diagram and associated tables should be prepared to logically show the interconnections between the various network electronics.
  - This should show the different types of equipment, and their interconnection, the FDCs, cable IDs, the quantities of the equipment (including fiber optic jumpers), and the equipment configuration list.

New HUT Equipment Designs

- ☐ As a general guide for determining types and quantities equipment for a typical size HUT, see Table 37 below.

Table 37: Equipment and Component List		
No.	**Equipment**	**Description**
1	FDC and Splices	1 FDC port per trunk fiber entering the Hut. FDCs are available in 24, 48, 72 and 96-port configuration (typ.). Fusion splices (equal to the # of FDC ports installed)
2	Equipment Racks	Between 2 to 5 equipment racks
3	Duplex Fiber Optic Jumper	1 per Gig-E switch backbone communications channel + 1 per field device daisy chain channel. Simplex fiber optic jumpers are rarely used.
4	Network Data Patch Cords	As required per design
5	Type C/E Network Switch	Typically 1 Gig-E switch per Hut (limited number of ports)
6	Hut UPS	1 UPS system per Hut

- ☐ The number of equipment racks will depend on the size of the HUT and overall purpose of the new HUT installation. The designer shall coordinate with MDOT on exact configuration required and develop appropriate Hut details include rack elevations,

Rack 1: Top of Rack: Network equipment
Bottom of Rack: HUT UPS
Rack 2: FDCs and Splice Trays
Rack 3: Spare FDCs and Splice Trays
Rack 4: Spare DOT/Agency equipment
Rack 5: Spare DOT/Agency equipment

Existing HUT Equipment Designs

- ☐ For projects that will install equipment in an existing HUT, the designer should inventory the HUT equipment and assess whether additional capacity is required for any network electronics equipment to support the new project.

- ☐ Additionally, the designer must coordinate with the MDOT ITS Project Manager to determine if there are other new projects placing equipment in the same HUT.

3.4 TMC System Design Upgrades

A. Overview / Description

TMCs as defined within the MDOT System are manned facilities that provide regional monitoring and control of traffic management devices. TMCs are either, owned and operated by MDOT, or by a local agency.

A TMC can range in size from a small office in an existing building to a totally new building specifically built to house a TMC. At a minimum, MDOT TMCs consist of an *operations area* and an *equipment room*.

- **Operations Area:** The operations area provides a work area where personnel through the use consoles, workstation computers and software view surveillance cameras, monitor traffic measurement devices, control field devices, and disseminate traveller information.
- **Equipment Room:** The equipment room houses the equipment racks and cabinets. Depending on the facility, communications terminations such as Ethernet switches and telephone circuits, may reside in the equipment room in addition to servers and video display system and other network (LAN and WAN) equipment.

B. Design Considerations

The following subsections provide high-level guidance and checklists to assist designers through the MDOT ITS design criteria, requirements, and processes associated with providing design upgrades to a TMC. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

Depending on scope of the ITS project, the number and types of ITS devices and subsystems to be designed and deployed, may require design upgrades to an existing TMC to support and accommodate the following:

1. Addition or expansion of ITS and/or network devices and capabilities.

2. Upgrade to the field communications (i.e., wireless to fiber, etc.) or device technology.

Consider any potential limitations introduced or imposed by existing facility construction on any design upgrades.

1

TMC System Design Considerations

The following checklist items provide the designer with TMC system design considerations.

Potential Operations Room Design Upgrades

- ☐ Addition of operator console furniture and associated components to accommodate additional operators.
- ☐ Addition or upgrade of operator workstation computers and monitors including re-arrangement of existing layout to accommodate the expansion.
- ☐ Addition or upgrade of video wall monitors and/or video display system.

Potential Equipment Room Design Upgrades

- ☐ Addition of equipment racks and supporting infrastructure.
- ☐ Addition or upgrade of network equipment to provide additional network ports, security, and/or performance.
- ☐ Addition or upgrade of communications equipment (passive and/or active) to support upgrades or expansion of fiber, wireless/radio, telephone and/or cellular communications.
- ☐ Addition or upgrade of system and/or database servers to support additional field devices.

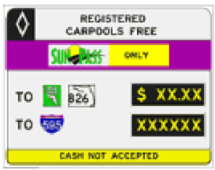
Potential Building / Room Support Systems Design Upgrades

- ☐ Upgrade of HVAC system to support additional equipment and/or personnel.
- ☐ Addition or upgrade to electrical and environmental infrastructure within the TMC area including building generator and/or UPS backup power subsystems (circuits and capacity).
- ☐ Upgrade or expansion of existing HVAC or lighting systems (type and placement).
- ☐ Upgrade to structured cabling and supporting infrastructure.
- ☐ Addition of integrated building or room control interface as required.

Potential TMC Upgrades as Result of Future Technology and Systems

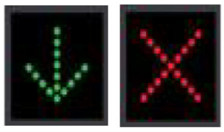
TMC upgrades and/or expansion including more operators, additional back-end equipment, upgraded communications and revised operational plans) may be required as a result of future trends in technology and operations as follows:

1. **TMC Co-location** combining operations between agencies (i.e., transportation/traffic and emergency management, etc.).



2. **Managed lanes** including; new types of dynamic signage, tolling technology, violation enforcement systems, and back-end operations.

3. **Integrated Corridor Management** including; real-time decision support systems, traffic/incident management, managed lanes, light rail transit, responsive signal operations, coordinated network management and joint O&M plan.

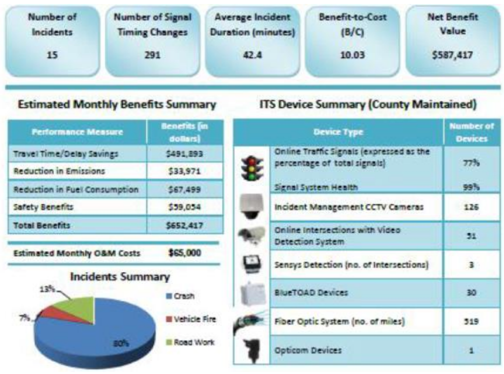


4. **Active Traffic Management** including; hard shoulder running, variable speed limits, lane control signs, queue warning, in-pavement lighting, dynamic messaging, etc.

5. **Connected Vehicle** corridors providing interoperable networked wireless communications among vehicles, the infrastructure, and motorist's personal communication devices.

6. **Public-Private Partnerships** including; control room operations, traveller information, incident management and maintenance.

7. **Proactive Operations** including real-time performance management using performance dashboards with predictive models and decision support systems to optimize operations in near real-time.



8. **Smart City Deployments** are urban areas that include data collected from citizens, devices, and assets that is processed and analyzed to monitor and manage traffic and transportation systems, power plants, water supply networks, waste management, law enforcement, information systems, schools, libraries, hospitals, and other community services.

9. **New software or any upgrades** to existing software or hardware required to provide cloud based capabilities (e.g., AWS Web Services)

2 Selection of TMC System Design Components

The following checklist items provide the designer with guidelines to select TMC System Design components to complete the design for the project.

TMC Design Upgrade Pay Item Numbers

Due to the broad nature of the TMC upgrade, designer should provide a description of the work being done. TMC design upgrade pay item numbers for use on new MDOT ITS projects and system upgrade projects are as follows:

Table 38: TMC Design Upgrades Pay Item Numbers

No.	Pay Item Number	Type Description
1	907-659-A00X	TMC Modifications
2	907-659-B00X	TMC Modifications – Monitor Systems

C. Construction Coordination

- ☐ Designers involved in the design upgrade or expansion of a TMC should be involved in the supervision of construction and implementation.

- ☐ Depending on the nature of a TMC design upgrades or expansion, there tend to be areas that most electrical contractors are not familiar with. The best way to prevent the Contractor from deviating from the plans or improperly interpreting the specifications is through close supervision of construction and implementation.

- ☐ The designer must maintain a constant dialog with the MDOT or AHJ and the Contractor to ensure the project meets their needs and expectations, and for modifications to existing TMCs, the project imposes minimal interruption to operations.

- ☐ Active management of both the MDOT or AHJ and the Contractor through all the phases of the project is the best way to ensure the project is completed as designed and to the satisfaction of the MDOT or AHJ.

- ☐ Hosting of information and data as part of ITS projects will be coordinated with MDOT IT in regards to desired solution including either 1) hosting on MDOT ITS servers or 2) via a cloud/web-based server.

4. Power and Grounding Guidelines

Power service availability is an essential element to ITS projects and needs to be properly addressed by the designer. This section briefly describes electrical power considerations that the designer needs to account for throughout the design process. This process should start early in the project because of the many layers of coordination that must take place.

4.1 Power Design and Grounding Requirements

4.1.1 MDOT ITS Power Design Process

Several steps are typically taken to provide an electric power design for ITS device deployment:

See overall system design process in Section 3.3.1, design checklists in ***Appendix B*** *and Example ITS Details on the MDOT ITS website (refer to Section 1.7)*

- ☐ Determine and document the total site power requirements (power load schedule)

- ☐ Coordinate with the electric utility provider to determine and select a suitable power service location (demarcation point) based on availability. Coordinate with the local electric utility provider as follows:

  Coordinate with power companies / utilities in the early stages of the project

  - The coordination of power service locations should start early in the design process so, if necessary, device locations can be repositioned to get the needed power service.
  - The designer is responsible for locating power service locations where the electric utility provider interfaces with the ITS project. This is achieved through first utility submission to the power companies with a request for power service location. At this stage, the plans should show all proposed ITS devices and their locations.
  - Following the plan submittal, the electric utility provider will either return a set of mark ups showing their transformer locations or request a field visit with the designer to discuss each location and power conduit path.
  - Once this information is provided, the designer should show power service locations and power conduit paths on the plans and send back for approval from the electric utility provider.

- ☐ Coordinate with the electric utility provider for required service voltage and type

- ☐ Provide an electrical power design in accordance with the latest NEC and local codes
- ☐ Provide design calculations for the proposed power design including voltage drop calculations and short-circuit analysis.
- ☐ Determine step-up/step-down transformer requirements with calculations, where applicable. The need for transformers will be based on voltage drop calculations.
- ☐ Determine metering solutions and options. Where possible, arrange a flat rate fee with the electric utility provider as approved by MDOT.
- ☐ Verify that all electrical/electronic component locations are above flood elevation.
- ☐ Develop riser diagrams showing aerial / underground demarcation points, overall layout of the proposed electrical systems
- ☐ Develop one-line diagrams showing overall main service and branch service layout including ratings and types of overcurrent protection devices and type of cables for the circuits.
- ☐ Develop step-down transformer, meter cabinet demarcation and other needed details.
- ☐ Develop field cabinet electrical distribution details.

4.1.2 Power Load Schedule

The total power (load schedule) requirement for an ITS site deployment is the sum of the power drawn by the following components:

- ☐ ITS device(s) (e.g. vehicle detectors, CCTV cameras, RWIS, DMS, etc.)
- ☐ Field cabinet components (i.e., cabinet lighting, fans, heaters, etc.). Refer to ITS Equipment Cabinets specification in MDOT Special Provisions Section 907-660
- ☐ Convenience outlet(s) inside the field cabinet or Hut building

Table 39: Typical Power Requirements (ITS device only, no field cabinet)		
No.	**ITS Device Type**	**Estimated Power**
CCTV Cameras		Typical
1	CCTV camera	30 watts
2	CCTV camera with heater	90 watts
DMS		Maximum / Typical
3	DMS, Type 1 & 2	2200 / 700 watts
4	DMS Type 3	4800 / 1000 watts
Vehicle Detectors		Typical
5	RDS	5 watts
6	VDS	25 watts
7	BDS	5 watts

4.1.3 Power Service Location and Type

Most ITS systems operate at 120/240VAC (single phase, 3-wire) with a power drop from the electric utility provider. Occasionally, a higher voltage/ampere service is required when the point of service is located a significant distance from the ITS device.

Other typical types of power systems that may be provided by the local utility service include: 120VAC (single phase, 2-wire), 120/208VAC (3-phase, 4-wire), 120/240VAC (3-phase, 4-wire), 277/480VAC (3-phase, 4-wire) and 240 or 480VAC (3-phase, 3-wire). Because power is the product of volts and amps, a higher voltage means you can deliver the same total power while using fewer amps.

- ☐ A means to disconnect power (safety switch) must be made available within a convenient distance from the powered field device / cabinet.
  - Type 1 SPD is usually provided in accordance with IEEE 1449 and the NEC.
  - Refer to ITS Model Details *on the MDOT ITS website (refer to Section 1.7)* for aerial and underground demarcation riser model details
- ☐ For power service locations greater than ¼-mile from the site, special designs requiring the use of step up/step down transformers may be necessary to mitigate power loss/voltage drop issues.
- ☐ Locate electric demarcation point within 100 feet (typical) of the electric utility provider's utility pole.
  - Final location of any new poles, guying and bracing (if needed) shall be approved by the electric utility provider

- ☐ Locate step-up transformer (as needed) within 15 feet of meter service and locate step-down transformer (as needed) within 15 feet of ITS field cabinet.
- ☐ Designers are responsible for showing power service locations and power service cable routing, from the power service location to the field cabinet and the ITS devices, on the Plans.
- ☐ Preliminary plans submittal should show all proposed devices and their locations.
- ☐ Following the plan submittal, the electric utility provider will either return a set of mark ups showing their transformer locations or request a field visit with the designer to discuss each location and power conduit path.
- ☐ Once this information is provided, the designer should show power service locations and power conduit paths on the plans and send back for approval from the power company.
- ☐ Designers shall callout the station for proposed power service locations on the Plans.

A. Power Service Location and Placement Guidelines

Locate electric demarcation point for use by the project taking into consideration the following:

- ☐ ITS devices in urban areas typically have power service locations nearby so device locations should only need to be adjusted slightly or not at all. Along rural facilities, it is often difficult to locate a device near a power service location and still meet all operational requirements. Solar power is a possible solution for certain devices (see Section 4.4 for more information).
- ☐ In rural locations, however, power service locations often control the location of the proposed ITS device. Hence, in rural locations, coordination with the power company as early as possible in the concept phase is recommended.
- ☐ Take note of the presence of retaining walls, guardrails, or other intervening obstacles between the proposed ITS devices and the power service locations, as this may affect the locations for proposed ITS devices, the choice of power service locations, or the routing for the power service conductors.
- ☐ The designer should consider the placement of power conduit based upon environmentally sensitive areas, as, R/W, drainage structures, and railroads; all should be avoided.

- If conduit must be placed under, over, or within the railroad property, the designer needs to coordinate closely with the MDOT and railroad company.

B. Power Service Type and Distribution

Power service is brought to the field cabinet to support local ITS devices and associated electrical components and subsystems.

- ☐ **Type A and B Field Cabinet:** Typical power service feeding these cabinets consist of120/240VAC, single phase (3-wire plus ground conductor), using THHN/THWN conductors sized accordingly within underground conduit. A 30A/2-pole main circuit breaker is typically provided along with a Type 2 SPD in accordance with UL 1449 and the NEC or as required by the Plans or directed by the MDOT.
- ☐ **Type C Field Cabinet:** Same as Type A/B field cabinets, except a 60A/2-pole main circuit breaker is typically provided or as required by the Plans or directed by the MDOT.
- ☐ **Communications Hut:** Same as the above, except a 100A/2-pole main circuit breaker is typically provided or as required by the Plans or directed by the MDOT.

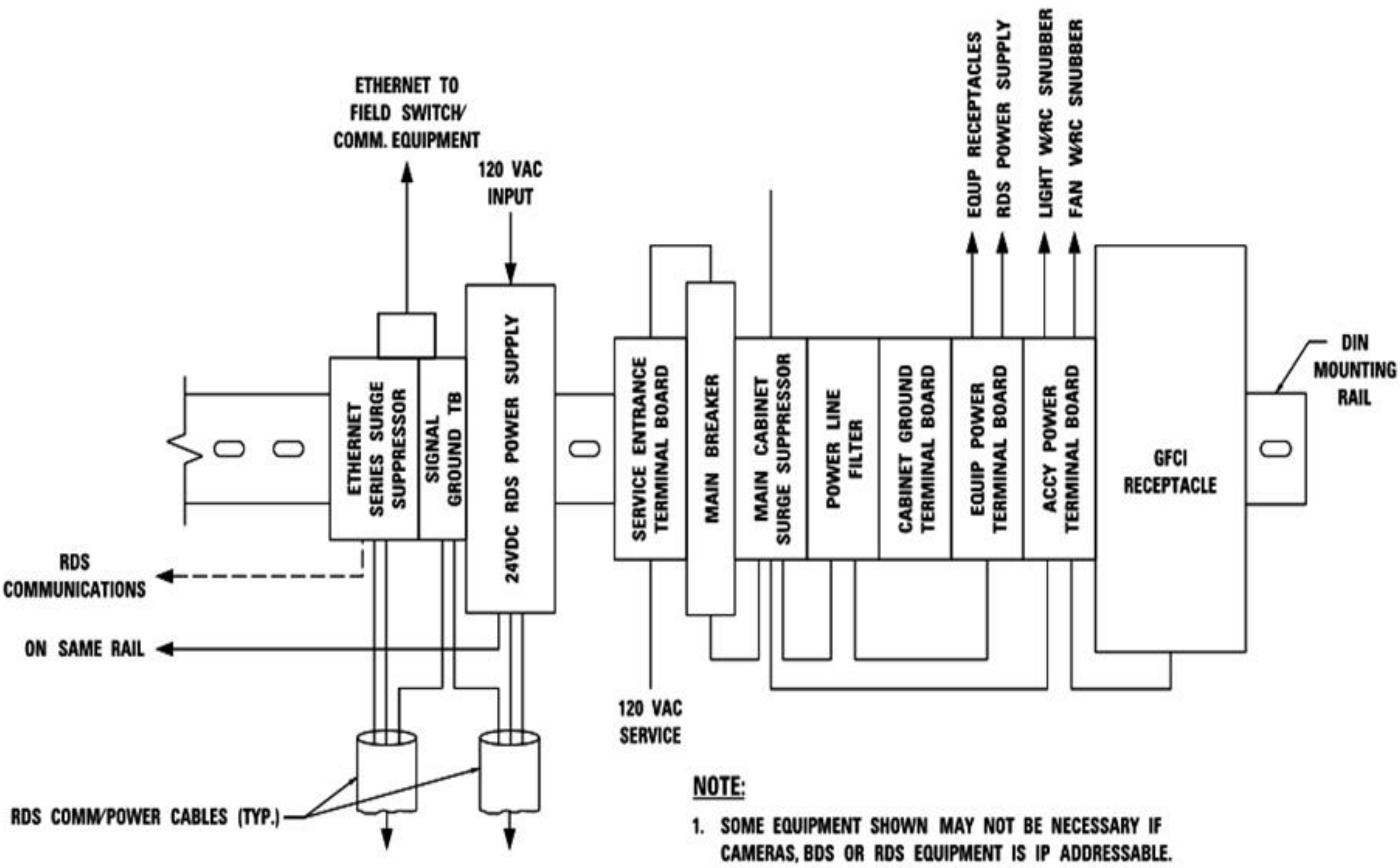
Once power service is made available in the ITS field cabinet, the electric power must be converted to the voltage and type (AC or DC) as appropriate for the electronic devices and equipment at the site as indicated below and showing in the typical drawing that follows.

- ☐ **DMS:** Most DMS displays typically operate on 120/240VAC, single-phase power (3-wires plus ground). The power is fed from an electrical panel / load center within a nearby DMS field cabinet. A power-disconnect (safety) switch is usually installed outside the DMS field cabinet. An additional power disconnect switch is also located at the base of the DMS support structure depending on distance from the field cabinet.
- ☐ **CCTV Camera:** Most CCTV systems typically operate on low-voltage (24VAC) power using low-voltage conductors sized to account for voltage-drop or PoE using outdoor-rated Cat-6 cabling. Power over Ethernet shall comply with IEEE 802.3at (PoE+ 30W, typ) or IEEE 802.3bt (PoE++ 60W for Type 3 and High-power PoE 90W for Type 4, typ.) depending on camera requirements. Appropriate power supplies or PoE power injectors shall be provided. Solar power can be used as discussed in Section 4.4
- ☐ **Detectors (RDS, VDS, BDS):** Most of the current detector systems typically operate on low-voltage power (12 to 24VDC) using low-voltage conductors sized to account for voltage-drop. Appropriate power supplies shall be provided. Solar power can be used as discussed in Section 4.4.
- ☐ **RWIS:** Most RWIS systems typically operate on 120VAC, single-phase power, as well as low-voltage power (12VDC) using low-voltage conductors. Appropriate power

supplies shall be provided. Solar power can be used as discussed in Section 4.4 or from a standard vehicle DC connector outlet.

- ☐ **Wireless Ethernet Radios:** Most modern Ethernet wireless radios typically operate using PoE IEEE 802.3af (15W) or PoE+ IEEE 802.3at (30W) using outdoor-rated Cat-6 cabling, as required by the wireless equipment.

Figure 3: Typical Electrical Distribution and RDS Communications Wiring Module



C. Conductors and Circuit Breakers

Conductor and breaker sizes should be selected based on the “worst-case” scenario in which all connected electrical components are operating at full capacity.

- ☐ All conductor and circuit breaker sizing shall be determined by the designer according to national and local electrical codes for the anticipated loads that will be experienced by equipment and all other electrical components.

- ☐ Where two devices for ancillary services perform opposing services and are not expected to operate simultaneously (e.g. heater and air conditioner), only the device that draws more power is factored into the calculations.

- ☐ For the preliminary sizing calculation, the expected load drawn from the convenience outlet is assumed to be 12 amperes at 120 volts. The designer is responsible for final sizing of all electrical components and conductors.

- ☐ Conductor size shall be selected to keep voltage drop over long lengths to less than a prescribed threshold as specified in Section 4.1.3 (C).

- ☐ See Section 4.1.2, Table 39, for typical power (load) requirements for commonly used ITS devices. Listed power loads are for estimation purposes only; actual power loads should be obtained from the related manufacturer(s) of the equipment being specified or provided.

D. Electrical Design Calculations and Analysis

Special consideration shall be taken by the designer to verify that voltage drop is within the specific tolerances of the electrical and electronic devices for the desired ITS system.

- ☐ Voltage drop for MDOT ITS projects shall be limited to 5% or less. Voltage drop becomes an important consideration for ITS deployment sites at long distances from the intended power source.

- ☐ Given a fixed distance between an ITS deployment site and related power service location, the designer needs to decide which method will be used to keep the related voltage drop within the design limits.

- ☐ The two most common methods are either to use larger power conductors or to transmit the electric power over the power cable at a higher voltage.
    - Transmission at a higher voltage commonly involves using a step-up transformer near the power service location and a step-down transformer at

the related ITS deployment site. This choice is often dominated by cost considerations.

- ☐ Provide a short-circuit analysis of the proposed electrical system to determine the magnitude of short circuit current the system is capable of producing. Compare that magnitude with the interrupting rating of the overcurrent protective devices. This will also ensure that existing and new equipment ratings are adequate to withstand the available short circuit energy available at each point in the electrical system.

> A short circuit analysis will help to ensure that personnel and equipment are protected by establishing proper interrupting ratings of protective devices (circuit breaker and fuses).

E. Metering

Metering for power consumption (draw) shall be provided at each ITS site from a power service location.

In locations that do not use AMR systems, safe and convenient meter reader access for utility personnel is an important consideration in selecting the deployment location.

- ☐ Roads with small or no shoulders should be avoided for meter location. One way to circumvent this limitation is to arrange for non-metered (flat-rate) electric service through the electric utility.

- ☐ Some AMR systems use short range RF communication systems, which allow drive-by meter data collection using mobile RF units.

- ☐ Some AMR systems use cellular data service, which allows utility offices to poll the meters from greater distances.

- ☐ Coordination with the power utility should be undertaken early in the design process to determine metering options.

- ☐ The following power metering options may be considered:
    - Metered, with safe and convenient personnel access.
    - Non-metered, flat usage rate.
    - Metered with AMR, using a drive-by RF data reader.
    - Metered with AMR, using a cellular data service.

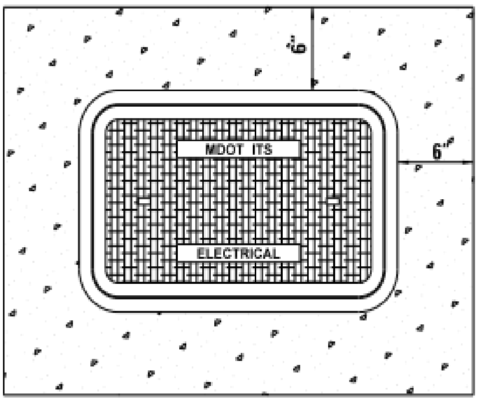
F. Electrical Design Pay Item Numbers

Electrical design pay item numbers for use on new MDOT ITS projects and system upgrade projects are as follows:

Table 40: MDOT Electrical Design Pay Item Numbers, Specifications and Industry Standards		
No.	**Pay Item Number**	**Type Description**
Electrical Components		MDOT Standard Specifications Section 636 Electric Cable MDOT Standard Specifications Section 722 Materials for Traffic Signal Installation
1	907-632-J001	Power Service Pedestal
2	907-633-A001	Uninterruptable Power Supply
3	907-636-A00X	Electric Cable, Direct Burial, IMSA 20-1, Gauge, No. Conductors
4	907-636-B001-B033	Electric Cable, Underground in Conduit, IMSA 20-1, Gauge, No. Conductors
5	907-636-B034-B055	Electric Cable, Underground in Conduit, THHN, Gauge, No. Conductors
6	907-636-C0XY	Electric Cable, Aerial Supported, IMSA 20-1, Gauge, No. Conductors
7	907-636-D0XY	Electric Cable, Aerial Supported in Conduit, IMSA 20-1, Gauge, No. Conductors
8	907-636-E001	Electric Cable, Underground in Conduit, Tracer Cable
9	907-636-I001	Ground Mounted Meter Enclosure
10	907-636-I002	Ground Mounted Transformer Enclosure
11	907-643-C001	Video Vehicle Detection Power Cable
12	907-643-G001	Multi-Sensor Vehicle Detection Power Cable

4.2 Cabling and Infrastructure

Power cabling and infrastructure shall be provided meeting the following requirements:



PLAN VIEW

- ☐ Power cable(s) should be routed in conduit and pull boxes separate from those used for communications cables.
- ☐ Type 2 pull boxes shall be used for electrical and should be located such that the conduit centerline is aligned with the centerline of the pull box to facilitate cable pulling.
- ☐ Pull boxes used for electrical are typically installed at a typical spacing of 250 feet with a maximum spacing of 650 feet to avoid damaging the power cable from excessive pulling tension.
- ☐ Pull boxes should not be installed in roads, driveways providing access to properties, drainage ponds or bottoms of drainage ditches.
- ☐ The covers of the pull boxes shall be provided with “MDOT ITS Electrical” legend unless otherwise directed by the MDOT.
- ☐ All electrical pull boxes should be grounded in accordance with the applicable codes and MDOT specifications.
- ☐ In urban areas, pull boxes should be flush with sidewalks or surface level to avoid the potential for pedestrians tripping.
- ☐ Concrete aprons should be provided for all junction boxes not installed in a sidewalk. In addition, the concrete apron should be sloped away from the pull box to reduce water intrusion.
- ☐ Conduit fill ratios should be in accordance with the NEC.

4.3 Grounding and Surge Protection

Lightning spikes, transients and line noise can destroy or will degrade electronic devices over time. Proper grounding, surge protection and power conditioning provides protection from these conditions. It regulates against sags (brownouts) and surges, thus reducing premature failure, improving equipment performance and maintaining uninterruptible operation of key equipment.

4.3.1 Grounding and Surge Protection

To protect the related ITS deployment, appropriate surge protection measures must be provided for ITS devices. These measures include:

- ☐ Plans involving ITS devices must also include provisions for grounding, bonding, and surge suppression to protect equipment and to ensure human safety.
- ☐ When developing plans consider existing geological and other physical characteristics (e.g., rock formations, underground utilities, gravel deposits, soil types and resistivity, groundwater) at proposed installation locations that may affect the design or layout of grounding systems.
- ☐ Placement and layout of grounding arrays should be planned in such a way that grounding paths from the down cable to the primary electrode are as straight as possible.
- ☐ Grounding and SPD placement and overall system design should be determined by project-specific needs, as well as the following general design criteria:
  - Follow best practices defined in the NFPA 780 Standard for the Installation of Lightning Protection Systems and NFPA 70, National Electric Code.
  - SPD equipment shall be provided in each field cabinet and Hut building to provide protection from energy (electric) surges by diverting and draining the excess (surge) energy to surrounding soil.
  - All copper cables brought into a field cabinet or communications Hut shall be provided by a surge protection device.
  - Place SPD equipment so that grounding connections are as short and straight as possible.
  - Conductor routing must avoid bending and provide physical separation between low-voltage and high-voltage signal paths.
  - Avoid routing unprotected wires or grounding wires parallel or adjacent to protected wiring.
- ☐ Grounding system shall consist of one or more ground rod electrodes to achieve a minimum ground resistance of 10 ohms or less unless otherwise approved by the MDOT.

- A proper grounding arrangement must be provided at the support structure and at the field cabinet for the system.
  - Where the field cabinet is installed at or close to the base of the support structure, both the support structure and the cabinet may be bonded to the same single-point grounding system.

- Large-diameter grounding conductors or flat-surface copper bands that are as straight (without turns or bends) as possible shall be provided to discharge or disperse the electric charge from a lightning strike quickly to the surrounding ground.

- The designer shall assess the site environmental conditions to determine if the grounding system is sufficient for the device location. Some devices require more robust grounding requirements (additional ground rods bonded together, etc.)

4.3.2 Power Back-up and Conditioning

Brief power interruptions can result in ITS controller and network equipment reboot requirements. This can render the device unavailable for several minutes upon a loss of power that lasts a fraction of a second.

- A UPS shall be provided as required by the project or directed by the MDOT. Frequent shutdowns and restarts of electronic devices generally cause the electronic device to fail prematurely. Most commercial UPS products also include other desired features such as power conditioning, which helps to filter out unwanted fluctuations in power quality and delivers “clean” power to the connected loads.

- Although it may not be feasible to maintain a large DMS display under UPS power, the DMS controller can be protected from brief outages that could result in loss of the effectiveness of the ITS resource for several minutes.

- The designer shall provide a UPS including batteries that are designed for extreme environmental conditions including exposure to moisture, dust, temperature swings and extremes, and high humidity.

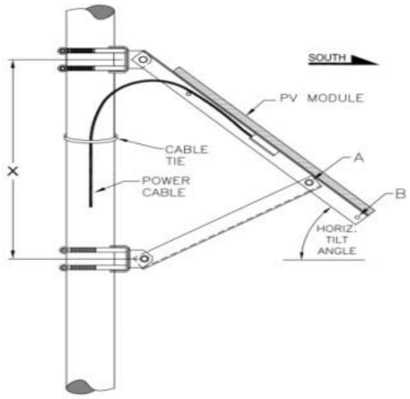
- UPS design should be capable of being remotely monitored.

- UPS design should include batteries that typically need to be replaced between three and six years.

- UPS shall be sized to provide a minimum 15 minutes (under full load) of run-time for all ITS field controllers, field network switches and field communications huts unless otherwise required or directed by the MDOT.

4.4 Alternative Power Considerations

4.4.1 Solar Power



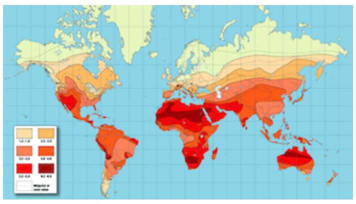
In locations where providing electrical service is not feasible or extremely expensive, the use of alternate power solutions should be considered such as solar power. The designer should ensure that all other installation options have been pursued with the placement of the device(s). Solar power should only be used as a last resort.

Solar power may be an option for some low-power ITS applications, depending on factors including:

- The amount of power the system needs
- The percentage of time that the system is operating (for example, beacons that only flash during certain infrequent events)
- The amount of time that the system must operate in the absence of sunlight
- The geographic location, which affects the amount of sunlight received

A solar power system is typically comprised of solar panels, a battery bank, cabling, and a charge controller (power regulator) that converts power generated from the solar panel to battery storage, manages the charging process of the batteries and then furnishes this battery power to the connected operating loads. If equipment requires AC voltage a power inverter would be used to convert from DC to AC.

A solar power system may only be used in areas where sufficient sunlight is generally available, which is defined as at least three 8-hour sunlit periods per week in typical conditions.



- Related average solar insulation data can be acquired, using the latitude and longitude of the deployment site, from the NASA Surface Meteorology and Solar Energy (SSE) division through its web site at **http://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?uid=1**.
- To receive the maximum amount of sunlight each day and throughout the year, solar panels must be oriented to face south. The inclination of the solar panel(s) should roughly correspond to the latitude of related deployment site. As an example, solar panels used near Jackson (approximate latitude 32.3° N) should be mounted at approximately 32.3 degrees from the azimuth, facing south.

- ☐ The battery bank and the solar panel assembly of a solar power system must be of sufficient sizes to support full operation of the connected loads for a minimum of 24 hours for applications where daily maintenance service is performed, and for a minimum of 7-days for other conditions or as otherwise stated or directed by the MDOT.

- ☐ Due to these sizing requirements, the use of a solar power system is generally limited to devices requiring 100 watts or less to operate. Devices requiring higher wattage for only brief periods may also be considered.

- ☐ The following devices may be candidates for solar power:
  - CCTV cameras (typically portable) that do not include a heater
  - Detectors
  - HAR transmitters and beacons
  - Portable devices (HAR, Detectors, DMS)

- ☐ Typical battery voltage used in ITS deployments is 12 volts per unit; if higher voltages are needed, the simplest way to achieve it is by connecting batteries in series. Where feasible, the main operating voltage of the device enclosure should be a whole multiple of 12 volts (e.g. 12V, 24V, 36V, 48V, etc.).
  - Energy delivery performance of the batteries diminishes at extreme high and low temperatures and as a result of rapid temperature swings.
  - Explicit mechanical measures must be provided to isolate the batteries from extreme ambient temperatures.

- ☐ In all cases, credible solar panel and battery sizing calculations must be obtained from the designer for all related loads, at all expected usage patterns, prior to acceptance of the related design.

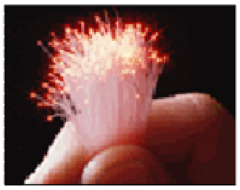
4.4.2 Back-Up Power Generator

The designer should consider adding a provision for an ITS deployment to include the means of accepting power from a mobile generator as an alternate, temporary power source. This provision usually includes the following:

- A twist-lock power receptacle behind a lockable window to accept the power cord from this alternate power source.
- A selector switch behind the lockable window that allows the choice between regular and alternate power sources.
- A notch at the lower edge of the lockable window to allow passage of the extension cord with the window closed and locked.

5. Communications Design Guidelines

5.1 Overview / Description



There are currently several communications options available to designers, including fiber optic cable, leased data lines, wireless, and broadband for transporting field video, data and/or voice network traffic to/from a TMC.

Designers should select the appropriate communications media and/or service that is best suited to each ITS project. In some circumstances, more than one communications method may be combined to meet the specific needs and conditions of a project.

5.2 Design Considerations and Requirements

The following subsections provide high-level guidance and checklists to assist designers through the MDOT ITS design criteria, requirements, and processes associated with a communications systems and network design. This discussion assumes that the preliminary engineering, agreements and preparatory work has been performed.

- ☐ The designer shall take into account key design considerations as follows for a C2F communication system design to support an ITS deployment:
  - Determine the required communication characteristics, mainly the required bandwidth (in Kbps, Mbps or Gbps).
  - Investigate what telecommunication options are available at/near the planned deployment site(s).
  - Coordinate with MDOT to ensure that their requirements are being met.
  - If using public infrastructure, confirm with telecommunication service providers that the required communication service is available at the deployment location.
  - Compare the related costs, benefits, security aspects of different communication options. Select a suitable communication means based on the options available at the deployment site.
  - Incorporate the chosen communication means into the overall communications design.

- ○ Communications routed through the public internet are acceptable only on a case-by-case basis. Any connection using public internet must be accepted by the MDOT for security reasons.

- ○ Verify that communication systems and critical electronic components are located above flood elevation.

- ☐ The MDOT ITS staff in the Traffic Engineering Division and IS staff in Jackson will provide information about existing ITS devices, communications and network technology already in use if requested by the designer. However, it is the responsibility of the designer to identify the device and provide the location information.

5.2.1 ITS Device Characteristics and Requirements

Each ITS system brings with it particular communication needs. The communication pattern and bandwidth requirement are the two principal factors in evaluating what the system or device needs to operate effectively.

- ☐ The designer shall consider typical bandwidth requirements for proposed ITS devices in the selection of communication medium and overall design.

Table 41: Typical ITS Communications Requirements

No.	System Type	Typical Usage Pattern	Minimum Bandwidth
1	CCTV PTZ camera	Continuous	512 Kbps to 3 Mbps
2	CCTV Fixed camera	Continuous	256 Kbps to 3 Mbps
3	DMS	Periodic, intermittent, short bursts	128 Kbps
4	RWIS Station	"	"
5	HAR Station	"	"
6	Vehicle Detector	Intermittent, short bursts	256 Kbps
7	Traffic Signal Controller	Periodic, intermittent, short bursts	≥ 128 Kbps

- ✓ With the exception of CCTV cameras, a typical network session between an ITS device and the TMC usually involves a small amount of data. Such communication sessions may take place only when specific needs arise or may be scheduled on a periodic basis, typically every ten minutes or longer.

- ✓ A network session with a small amount of transmission content and with an intermittent usage pattern can usually be supported by low-bandwidth communications with a bandwidth of 56 to 115 Kbps. Due to the long pauses between network sessions, the communication connection does not need to be engaged all the time (always on); an as-needed or on-demand communications arrangement may suffice.

- ✓ CCTV cameras, unless strictly used to transmit still images, require an always-on, continuous network session. The continuous transmission of the streaming video image and transmission of pan/tilt/zoom commands back to the camera requires a relatively large communication bandwidth. Typical 3Mbps or higher service is typically used for video transmission to the TMC although even lower bandwidths could be used for video streams with lower frame rate (frames-per-second) or lower resolution.

- ✓ The MDOT has a traffic signal management system, used to operate, control and maintain all of the MDOT and other agency traffic signals. All traffic signals should be integrated into the traffic signal management system. The designer shall coordinate with operating traffic signal agency as required for incorporating the traffic signals into the overall communications system design.

5.2.2 ITS Communications Options

Potential C2F communication arrangements or operations appropriate for MDOT ITS systems include:

- ☐ Designer shall review and select the most appropriate communications options as shown below and in Table 42 and coordinate with MDOT IS and MDOT ITS in regard to the final selected communications option(s) and overall communications network design.

1. **Fiber optic cable:** MDOT owned. Preferred option by MDOT. Possible leasing opportunities (shared resources, dark-fiber) if directed or approved by MDOT.
2. **Wireless/Radio:** Radio system involving P2P, P2MP, Mesh (licensed and unlicensed) Radio-Frequency (RF) technologies. This is regularly used by MDOT throughout the state.
3. **Leased Broadband Services:** Including MPLS, Dedicated/Carrier Ethernet and Broadband Cellular/Internet (4G/LTE, future 5G) services. These services are regularly used by MDOT.
4. **Leased Traditional Telephone Services:** Dial-up, voice-grade, lane-line telephone service. Seen more as a legacy solution for TMC to field communications and only used as required if directed by MDOT.

☐ Unless otherwise specifically stated, the designer should assume that single-mode fiber optic cable will be used for all communications infrastructure. Leased broadband radio and services may be used for portable traffic signal and ITS sites and possible remote TMCs, network aggregation points such as Communication Huts and Radio Tower Sites, and ITS device sites (i.e., CCTV cameras, DMSs, RWISs, and HARs) installations.

Table 42: Typical ITS Communications Options

No.	Communications Option	Typical Available Bandwidth / Capacity	Summary
1	Fiber Optic Cable	Up to 100 Gbps per wavelength depending on optical end equipment	DOT owned, Higher capital costs (if owned), leased monthly costs (by number of fiber strands, mileage and service agreement if leased)
2	Wireless / Radio	Up to 2 Gbps or higher depending on the band, distance and configuration	DOT owned, Except for short-range paths, wireless path and loss budget evaluation study is needed to ensure performance, lower infrastructure costs than fiber, wireless security measures
3	Leased Broadband Services	MPLS/Ethernet: Up to 150Mbps and higher depending on type of service and plan. 4G (up to 30Mbps or higher (download) and up to 15 Mbps and higher (upload). 5G: up to 10 times as fast as 4G	MPLS/Ethernet: more expensive per Mbps per month recurring fees when compared to similar bandwidth broadband internet costs, reliance on service provider, security considerations. Cellular: Adequate cellular signal strength must be verified at site. Availability of service (impact of surges) in/near urban areas, reliance on service provider, recurring monthly fees, security considerations
4	Leased Traditional Telephone Service	56 Kbps	Limited to low bandwidth applications, impact of usage surges may affect service and availability, reliance on service provider, recurring fees

- ✓ Availability of a service is limited by both the availability of existing infrastructure to extend to the deployment sites and a usable transmission session when the need for data transmission arises.

- ✓ Commercial communication services that are “shared use” in nature can be affected by usage surges, which often occur during and near places of major events and incidents.

- ✓ In a shared-use arrangement, a potentially large number of users may be sharing a fixed data bandwidth, so a minimum bandwidth cannot be guaranteed unless special priority arrangements are made.

- ✓ It is advisable to obtain data service with guaranteed performance (bandwidth and quality of service), where offered by the service provider, for high-bandwidth data streams such as those related to video transmission.

5.2.3 Fiber Optic Cable / Conduit Placement Guidelines

A. General Placement Guidelines

- ☐ The preferred method of installation is underground conduit and cable, but occasionally, it may be acceptable to use an existing pole line with aerial cable.
- ☐ Electric and communication conduits may occupy same trench, but show as separate lines on the Plans. Electrical power feeds and fiber cannot share the same conduit.
- ☐ When conduit must pass under the paved or graded shoulders boring shall be specified.
- ☐ When conduit is installed outside the shoulder, either open trench installation, boring and/or plowing may be used.
- ☐ When conduit is installed under the travel lanes or under ramps, boring shall be required.
- ☐ Conduit over streams and wetlands are preferred to be bridge attached. In some cases, conduit can be bored under smaller streams or box culverts.
- ☐ At locations where the freeways pass over cross streets or at interchanges, the conduit may be installed following the right-of-way topology, and bored under the crossing route.
- ☐ Bores are preferred over aerial-supported conduit. (Note: MDOT terminology of aerial-supported conduit is the same as bridge attached conduit).
- ☐ The designer should also be aware that the boring machinery and setup will require a work area of approximately 25 feet in length to position the rig for the bore.
- ☐ Aerial-supported conduit may be attached to underside of bridge, beneath parapet. All conduits attached to bridges will require approval by the MDOT bridge division.
- ☐ For bridges over railroads, permits from the railroad company may be required as well.

- ☐ At approaches to bridges, route conduit around end wall. Abutment core-cutting is not desired.

- ☐ For all bridge attachments, plans must include excerpt (profile view) from original bridge plans, with conduit(s) and pull boxes shown, or as directed by the MDOT Bridge Design Division.

- ☐ Show a gradual sweep in advance of bores under ramps, rather than showing an abrupt change in conduit direction to bore under ramp at 90 degree angle.

- ☐ Bridge attached conduit duct banks shall be terminated in a pull box outside the shoulder of the roadway beyond, but near the end of the bridge.

- ☐ Bridge attached conduit (aerially supported) shall follow standard bridge attachment details and be approved by the Bridge Design Division.

- ☐ ITS plans need to show the routing of the cable, and designers need to make sure that MDOT utility coordination personnel are coordinating with the utility companies prior to preparing the design.

- ☐ Designer shall consider any widening projects currently programmed by MDOT.

B. Urban Freeways and Arterials

- ☐ Fiber optic trunk or backbone cables should be located on one side of the freeway.

- ☐ Location of fiber optic trunk cable should be determined by ITS device location and clearance from utilities.

- ☐ If underground conduit is selected, conduit shall be located outside of the paved area and back of curb for curbed sections and outside of the clear zone in non-curbed sections if possible.

  - Designers shall obtain underground utility information and locate conduit on the side of the road with the least utility conflicts.

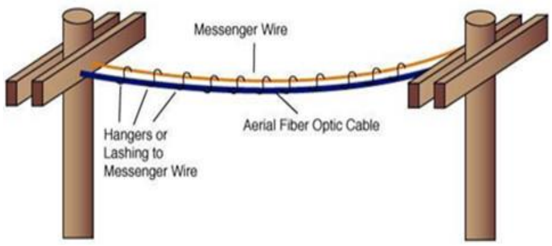
  - Conduit should be located outside of the clear zone or at the back edge of the right-of-way (typically 5 to 10 feet if possible, even if clearing and grubbing is required) for best protection from being damaged in the future.

  - Conduit should be located away from sign structures.

- Conduit may not be installed in roadway shoulders.
- Crossovers connecting a fiber optic trunk cable to devices on the opposite side of the freeway shall be bored installation under lanes.
- When cable is installed in underground conduit, the designer shall determine the number and size of conduits as has been discussed in previous sections for freeway installation.

☐ Only if the area outside the clear zone is inaccessible or must be avoided for adequate reason (such as to avoid utilities or easements), and the median is accessible and wide enough, should the roadway median area be considered for the FO trunk line. In such a case approval for median placement should be given by the ITS Project Manager.

☐ If aerial installation is selected, the designer shall review the feasibility of installing aerial cable with MDOT utility coordination personnel and the utility companies occupying the utility poles early in the design process to make sure it is possible and to determine the extent of make-ready work.



- When this method is used the work shall be in accordance with the pole owner requirements and the National Electric Code (NEC).
- The utility companies are responsible for the design and point of attachment information.
- The cost and time for make-ready work may make this option cost prohibitive, in which case the FO trunk cable shall be installed in underground conduit.
- Another element that needs to be determined as early as possible is whether any utility poles will need guy wires and anchors. If guy wires and anchors are required, designers must ensure there is enough right-of-way to install them.
- If there is inadequate right-of-way, then locating the cable aerially may be a difficult option to implement because ITS projects typically do not include right-of-way acquisition.

C. Rural Freeways and Rural Roadways

☐ For projects on rural roadways, the placement of fiber optic communications shall be a case-by-case basis as directed by the MDOT.

- The complexity of the project and proximity to existing fiber optic facilities to tie into shall be considered.

- Underground installations in rural areas will be very similar to the installations on urban freeways with the differences being at cross streets. Conduit installations in rural areas will require bored crossings under cross streets and significant driveways.

- Fiber runs in rural settings may also have opportunity to be installed along shared overhead utility lines as is described herein.

D. Fiber Optic Cables for Other Agencies

In some cases, allocating fiber within an MDOT cable will greatly benefit a local agency at a much reduced cost than cable if installed under a separate project.

- ☐ Designers should discuss this option with the MDOT District and MDOT ITS Project Manager to determine if this design should be considered and might be justified.

- ☐ If a significant number of fibers are to be dedicated for a local agency within a specific link or between two logical network nodes (i.e., HUT to HUT or interchange to HUT), the designer should consider and discuss the upsizing of the cable along that link to a larger number of fibers. Refer to Section 5.2.5 (C) for MDOT's fiber utilization plan for sharing with other agencies.

- ☐ If fiber sharing is authorized, a connection will be provided only at an interchange (if on a freeway), as selected by the local agency.

- ☐ A connecting conduit should be designed to run from a mainline pull box (where a fiber splice will be made) to a pull box on the shoulder of a crossing roadway where a connection to the local fiber can be made.

- ☐ If connecting major local agency and MDOT fiber runs, the designer should consider placing a communications hut at the interchange.

- ☐ Designing a continuous cable with pull boxes at the interchange or cross streets enables maximum flexibility for accessing and using the cable in the future.

- ☐ Placing the pull box on the crossing roadway allows the local agency access to the cable from an arterial street rather than on the freeway, which could require further agreements and documentation. Additionally, this design keeps MDOT's cables separate from the local agency's cable.

- ☐ Before local agency allocations are made, an agreement between the local agency and MDOT for fiber use must be executed in case the fiber is damaged.

5.2.4 Wireless and Leased Broadband Placement Guidelines

- ☐ The designer may be directed to provide project plans for ITS deployments at isolated sites and these may be designed for connection to the statewide network using leased broadband communications.

- ☐ The leased services are a MPLS network. Individual sites are connected by leased DS-1 (unless otherwise directed by MDOT) to remote locations which may have multiple cameras (usually a PTZ and two fixed cameras) and detector(s) on a steel support pole.
- ☐ Other leased broadband applications will include communications for a remote center, a regional TMC, or a remote field site connected via leased DS-3.
- ☐ Remote field sites may be composed of one or more individual device sites connected either by fiber optic cable or via wireless hops to a communications demarcation point.
- ☐ The link into the statewide center is a leased 100Mbps MPLS Network connection or as directed by the MDOT.

5.2.5 Selection of Cabling and Components

A. Cabling and Component Pay Item Numbers and Specifications

Communications cabling and component design pay item numbers for use on new MDOT ITS projects and system upgrade projects are as follows (see discussion on options below):

Table 43: MDOT Communications Cabling and Component Pay Item Numbers, Specifications and Industry Standards[1]

No.	Pay Item Number	Type Description and Specifications
Fiber Cabling[2]		MDOT Special Provisions Section 907-661-X Fiber Optic Cable (OSP) MDOT Standard Specifications Section 722 Materials for Traffic Signal Installation

No.	Pay Item Number	Type Description and Specifications
Table 43: MDOT Communications Cabling and Component Pay Item Numbers, Specifications and Industry Standards[1]		
1	907-661-A00X	Fiber Optic Cable, No. Strands, Mode
2	907-661-B00X	Fiber Optic Drop Cable, No. Strands, Mode
3	907-661-C001	Fiber Optic Cable, No, Strands, Mode, Aerial
Other Cabling		MDOT Standard Specifications Section 722 Materials for Traffic Signal Installation
1	907-641-D001	Radar Vehicle Detection Cable
2	907-643-B001	Video Vehicle Detection Cable
3	907-643-F001	Multi-Sensor Vehicle Detection Cable
4	907-663-D001	Category 6 Cable, Installed in Conduit
Conduit[3]		MDOT Standard Specifications Section 637 Traffic Signal Conduit and Pull Boxes MDOT Standard Specifications Section 722 Materials for Traffic Signal Installation
1	907-637-C0XY	Conduit, Underground, Type, No., Size
2	907-637-D0XY	Conduit, Underground, Drilled or Jacked, Type, No., Size
3	907-637-E0XY	Conduit, Underground, Structural Conduit, Type, No., Size
4	907-637-F0XY	Conduit, Underground, Aerial Supported, Type, No., Size
5	907-637-G0XY	Conduit, Underground, Encased in Concrete, Type, No., Size
6	907-637-H00X	Conduit Bank, Underground, Type, No., Size
7	907-637-I00X	Conduit Bank, Underground, Drilled or Jacked, Type, No., Size
8	907-637-J00X	Conduit Bank, Underground, Structural Conduit, Type, No., Size
Pull Boxes[4]		MDOT Standard Specifications Section 637 Traffic Signal Conduit and Pull Boxes MDOT Standard Specifications Section 722 Materials for Traffic Signal Installation
1	907-637-A0XY	Pull Box Enclosure, Type, Tier
2	907-637-B00X	Pull Box Enclosure, Structure Mounted, Type5

1. All MDOT specifications, details and industry standards referenced assume the latest version or edition
2. Pay item includes connectors, fiber patch / distribution panels, messenger, splice closures, splicing, attachment hardware and sno-shoes (if aerial), above ground markers, installation and testing
3. Pay item includes equipment, trenching, backfilling trench, plowing, directional boring, restoration, warning/marking tape, pull tape, duct plugs, fittings, conduit detection wire, testing, bore logs and installation
4. Pay item includes precast Class B concrete or composite enclosure and cover, installation, crushed gravel underlayment, concrete collars, replacement of sod or existing grass, and clean-up
5. Cast iron surface mounted junction box, inside flanged and gasket for NEMA 4 rating

B. Cabling and Termination Components

Fiber Count

- ☐ The options to consider are cable type, cable construction, fiber mode, and fiber count. This is generally agency driven and options should be discussed early in the design process.

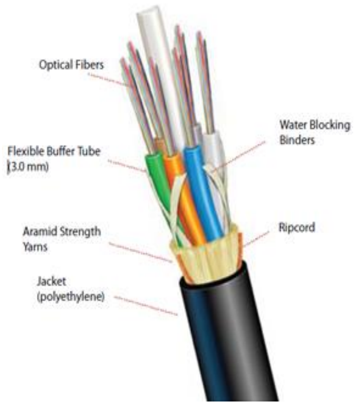
- ☐ Fiber-optic cable sizing depends on the project communications requirements. Typical sizes used by MDOT are as follows:

Table 44: Fiber Cable Size versus Roadway Type

Fiber Size (No. Strands)	Urban Freeways & Arterials (MDOT)	Rural Freeways & Rural Roadways (MDOT)
48		X
72	X	X
96	X	

- ☐ The typical MDOT drop cable required for freeway projects is 12 fibers minimum, with all twelve fibers from the drop cable spliced at each device field cabinet, including several spare fibers.

Fiber Cable Type



- ☐ The type of fiber optic cable selected depends on whether it is intended for outside installation (outside plant cable or OSP) or inside installation (inside plant cable or ISP). Most cable used on MDOT ITS projects will be OSP.

- ☐ Upon entrance to a building, OSP FO cable must terminate and transition to ISP cable within 50' of OSP cable exposure (if it is not in rigid steel conduit) in a building.

- ☐ Designer is responsible for designing ISP in conformance with NEC, building and fire codes.

- ☐ Outside plant cable for MDOT drop cables (used between the trunk cable and individual device field cabinets) can be either pre-terminated drop cable assemblies or loose tube cables that are spliced to a pigtail as approved by MDOT.

- ☐ Typically, each field device will require a 12 fiber pre-terminated drop cable assembly with LC connectors

- The majority of fiber optic cable on existing MDOT freeway ITS projects is single mode, but some multi-mode remains. Only single mode fiber optic cables are specified for new construction / future projects.

Fiber Optic Splicing

- Underground fiber optic closures shall be sized based on the size of the fiber trunk cable. Some room for expansion shall be provided as required by MDOT.

- Fiber optic splice, fusions, will be included at every closure location. Fusion splices are how the fiber optic cables are connected – the drop cable to trunk cable or one trunk cable reel to another. The following is the typical splices required per situation.
  - Reel-to-reel – the number of splices will match the size of the trunk cable
  - Device location with 12-fiber drop cable – number of splices as shown on the splice details in the Plans

- Fiber optic cable is typically available in reels of up to 20,000 feet of cable. Depending on the number of fibers, reel to reel splices should be anticipated and planned for at convenient locations. Contractors perform reel-to-reel splicing as required by the project special provisions.
  - Reel to reel splicing for freeway applications should be planned approximately every 10,000 feet of roadway.
  - For freeway installations, reel to reel splices should be placed in Type 5 PBs where no other splices exist.
  - When determining reel to reel splicing locations, the contractor should account for slack cable coiled in pull boxes and electrical pull boxes.
  - On arterials, it is typically most practical to perform reel to reel splices at other splice locations, such as at device drops.
  - Reel to reel splicing for both aerial and underground arterial applications is typically every 3,000 to 5,000 feet of cable.
  - Reel to reel splicing for both arterial and freeway applications should be kept to a minimum, meeting the distance requirements stated above, and not requiring excessive splicing.
  -

C. Fiber Utilization Plan

Communications Path

- ☐ The typical communications path from a field device to the Hut or TMC is as follows:

  ITS Field Device → Drop Cable → Trunk Cable → HUT/TMC

- ☐ Each field device is connected by a drop cable. The drop cable is spliced to a trunk cable. When a device communicates as part of a string with other devices, as discussed later, the other side of the trunk cable fiber is used to communicate with the next device. The final destination for fiber optic trunk cables is a termination at a Communications Hut or TMC.

Fiber Allocation for Specific Uses and Users

- ☐ MDOT ITS projects typically install a 72-strand fiber cable along its freeway roadway systems although 96 strand fiber cables are also installed depending on project requirements. The fibers in the 72-strand cable are in 6 buffer tubes with 12 fibers in each and in 8 buffer tubes for 96-strand cables.

- ☐ The Fiber Color Standard graphic demonstrates the standard color assignments for individual fiber strands and buffer tubes.

- ☐ The fibers will have the following general utilization or allocation (shown with a 72-strand fiber cable) unless otherwise directed by the MDOT. The designer shall coordinate with MDOT for specific fibers to use for their project design.

Fiber Color Standard (per EIA-598-C)

1	BL	Blue	7	RD	Red
2	OR	Orange	8	BK	Black
3	GR	Green	9	YL	Yellow
4	BR	Brown	10	VI	Violet
5	SL	Slate	11	RS	Rose
6	WH	White	12	AQ	Aqua

Blue Buffer (MDOT Backbone or Trunk Communications): Used for creating backbone communications between Hut to Hut and Hut to TMC, TMC to TMC.

Orange Buffer (MDOT Distribution Communications): Used for creating from one device Layer 2 network switch to the next back to a Communications Hut Layer 3 switch communications between Hut to Hut and Hut to TMC.

Green Buffer (MDOT Distribution Communications): Same as the Orange Buffer

Brown Buffer (Agency Sharing): Intended to be used to share fiber with other districts, cities and municipalities

Slate Buffer (MDOT Project Specific Connections): Used to accommodate field connections to non-typical existing and new sites such as microwave tower sites, connections for C2C connections and future ITS needs

White Buffer (MDOT ITS Future Growth): Reserved to accommodate future ITS needs

D. Conduit

- ☐ Several different conduit types are used in ITS projects: Roll Pipe (HDPE), Schedule 40 (Sch 40) and Schedule 80 (Sch 80) PVC conduit and rigid galvanized steel (RGS) conduit.

- ☐ For typical fiber optic trunk cable applications, roll pipe (HDPE) is the preferred conduit choice. The typical HDPE installation will have a conduit quantity and size configuration that is installed on the road.

- ☐ Conduit types and typical MDOT uses are shown in the following table:

Table 45: MDOT Conduit Types	
Conduit Type	**Use Description**
RGS, Type 1	Use for above-ground (i.e., Hut building or device entrance) or bridge-attached communications or electrical power cables as required
Rigid Copper/Nickel/Steel, Type 2	As shown on the Plans and directed by MDOT
Non-Metallic, Type 3 and 4 (PVC) Schedule 40 or 80	Use Sch 80 used on bridge decks or other areas requiring additional strength for protection. Use Sch 40 or 80 for underground communications or electrical installations
Flexible (HDPE)	Use in exposed locations for difficult access locations or areas that could move or vibrate
PVC Coated	Use in above-ground locations for electrical cables and conductors
Roll Pipe (HDPE)	Underground installations in earth or concrete for communications and device cables. Use with an SDR of ≤ 11. Cable of being coiled or reeled in continuous lengths

- ☐ Conduit configuration guidance is as follows:
  - All underground conduits (whether trenched, plowed or bored) shall be 2-inch “roll pipe” (high-density polyethylene (HDPE)). Typically 2 – 2” conduits are installed together in trunk lines. One has fiber and the other is empty for future use.
  - All above-ground and exposed conduits shall be UV-stabilized and corrosion resistant.
  - All aerial-supported (i.e., structure mounted) conduits shall be 2-inch rigid galvanized steel (RGS) or PVC coated.
  - All bridge attached conduit shall be RGS or Fiberglass as approved by MDOT Bridge Division.
  - All directional drilled / bored conduit under railroads or paved surfaces shall include an outer protective conduit sleeve for added protection as required by the AHJ.
  - Provide longitudinal conduit configurations as defined as Conduit Bank, U/G, ROLL PIPE, 2@2-inch, or 3@2-inch, or 4@2-inch. In all cases provide a minimum of two 2-inch conduits (one for the fiber cable and one will be a spare).
  - Provide one 2-inch conduit for lateral fiber drops from the trunk PB to the device PB or direct to the field cabinet.
  - Provide one 2-inch conduit for all electrical power feeds from the utility source unless otherwise required per the Plans and approved by MDOT.

- All conduit installed for fiber optic cables shall maintain a minimum bend radius of 20 times the cable outside diameter.
- Two RDS communication cables require two separate conduits (in shared trench).
- Electrical conduit may be installed in the same trench/bore, but separate Electrical PBs must be used.

☐ Conduit depth shall be as follows::

- When using open trench installation, the conduit duct bank shall be installed such that the top of the duct bank is at a minimum depth of 36 inches.
- If the 36-inch depth cannot be achieved due to underground obstacles, then the duct bank may be installed at a shallower depth. A 12-inch poured concrete encasement is recommended for such installations, and under no circumstances should the top of duct bank be less than 18 inches below finished grade.
- Conduit shall be directional drilled at a minimum of 5 feet below stream beds or as directed by MDOT.
- Conduit shall by directionally drilled at a minimum of 10 feet below railroad beds or as directed or required by the railroad company.

☐ When designing boring runs on the Plans, designer should not draw the conduit route with sharp bends, but rather use sweeping bends as can be expected for either trenching or boring.

☐ Transitioning between conduit types requires a transition in a pull box.

E. Pull Boxes

☐ Pull boxes (PB) used for electrical are designated as Type 2 and PBs used for communications (i.e., fiber optic cable) are designated as Type 4 or 5.

☐ PB types and typical uses are as follows:

Table 46: MDOT Pull Box Types			
Pull Box Type	**Dimensions (inches) (W x L x D)**	**Use Description**	**Maximum Spacing (feet)**
1	11” x 18” x 12”	Surface-mounted junction boxes along aerial-supported conduits (i.e., bridges) for pulling electrical or communications cables.	600
2	13” x 24” x 18”	Located at demarcation points and at the base of field cabinets for electrical power cables and conductors	650
3	17” x 30” x 24”	Same as Type 2 except provide more space for larger installs.	650
4	24” x 36” x 24”	Use for fiber optic cables where access, pulling points, a change of direction or at a device location is needed. Also use for storing fiber optic cable slack	1,300
5	30” x 48” x 24”	Use for fiber optic cables where splices are anticipated and for housing Splice Closures. Also use for storing fiber optic cable slack without violating the manufacturer’s specified bending radius of the cable	As Req’d

- ☐ PB configuration guidance is as follows:
    - PBs used for fiber optic cables are typically spaced 800 to 1300 feet apart.
    - A PB should also be located at each end of a directional bore. Bored installations may require additional PBs and a Type 5 PB is typically used at least one end of the bore. The Type 5 and Type 4 pullboxes are

    - Device locations usually dictate the placement of PBs, because a PB is required for a drop cable splice at each device in most cases.
    - If fiber drop is ≤ 30 feet in length, PB needed only at backbone end of the drop.
    - A PB and/or electrical PB is required immediately before and after a bridge or any other situation where there is a conduit transition, for example at a device location or a fiber optic trunk cables junction point.
    - For urban freeway or arterial installations, the Type 5 PB is commonly used when several conduits and large fiber optic cables are required or along the fiber optic trunk cable for maintenance slack, device drops, or reel to reel splices.
    - Pull boxes are not typically placed at locations that are not expected to have vehicles routinely present. Pull box loading designations or ratings shall be as called out on the Plans representing one of the following:

- ANSI Tier 15 – 15,000 lbs design load and 22,500 lbs test load. Designed for driveway, parking lot, and off roadway applications subject to occasional non-deliberate heavy vehicular traffic.
- ANSI Tier 22 – 22,500 lbs design load and 33,750 lbs test load. Designed for driveway, parking lot, and off roadway applications subject to occasional (higher probability than Tier 15 boxes) non-deliberate heavy vehicular traffic.
- AASHTO H-20 – not typically used by MDOT. Designed for deliberate vehicular traffic applications only.

- Sharp bends or frequent changes to alignment will require an additional PB.
- Cable slack lengths in PBs shall be as required in the fiber specifications specified herein and shown below. Slack cable is not measured for separate payment.

Table 47: MDOT Typical Cable Coil Guide
(Feet of Coil Length per Entering Cable)

Cable Type	Type 2 PB	Type 4 PB on Trunk	Type 4 PB on Drop	Type 5 PB
Fiber Optic Cables (Trunk)		25		200
Fiber Optic Cables (Drop)			10	100
Electrical Service Conductors	10			
VDS and RWIS Sensor Lead-In Cables			10	
RDS Communications Cable		20	20	20
DMS Communications Cable			10	

☐ Type 2 Pull Boxes

- Located at electrical demarcation points and at the base of field cabinets

☐ Type 4 Pull Boxes

- Located at the base of ITS device poles
- Located on one end of structure mounted conduit (other end is Type 5 PB)
- Located on end of each bore which has worse maintenance access (other end is Type 5)
- At base of equipment pole if drop length is > 30 feet. (not required if ≤ 30 feet)

☐ Type 5 Pull Boxes:

- Located at splice locations to house splice closures
- Located at a minimum of every 2,600 feet along fiber backbone
- Located on one end of structure mounted conduit (other end is Type 4 PB)

- Located on end of each bore which has better maintenance access (other end is Type 4)

5.2.6 Selection of Communications Network Equipment

A. Communications Network Equipment Pay Item Numbers and Specifications

Communications network equipment design pay item numbers for use on new MDOT ITS projects and system upgrade projects are as follows (see discussion on options below):

Table 48: MDOT Communications Network Equipment Pay Item Numbers, Specifications and Industry Standards[1]		
No.	**Pay Item Number**	**Type Description and Specifications**
Network Equipment[2]		MDOT Special Provisions Section 907-663-X *Networking Equipment*
1	907-663-A001	**Network Switch, Type A**, Layer 2 switch installed in field cabinets providing network connectivity for ITS devices. Six 10/100 Mbps copper ports + two GE optical ports
2	907-663-A002	**Network Switch, Type B**, Layer 2 switch installed in field cabinets providing additional network ports for additional ITS devices at a location. Twelve 10/100 Mbps copper ports + two GE optical ports
3	907-663-A003	**Network Switch, Type C**, Layer 2 / 3 network switch installed in the Communications Huts and TMCs
4	907-663-A004	**Network Switch, Type D**, Layer 2 / 3 network switch consisting of chassis design accepting up to four modular cards supporting T-1, DS3 or Metro Ethernet Interfaces, cellular interface, terminal server module and power supply module
5	907-663-A005	**Network Switch, Type E**, Layer 2 / 3 network switch installed in locations where multiple fibers converge or high concentration of ports are needed for a field location.
6	907-663-A006	**Network Switch, Type F**, Layer 2 / 3 network switch installed in field locations with wireless communications or access points.
7	907-663-B001	**Terminal (Port) Server,** provide network connectivity for ITS devices that use serial communications. Server includes four bi-directional RS-232/422/485 serial interface ports providing communications over Ethernet
8	907-663-C001	**Cellular Router[3]**, provide connectivity for ITS devices where it is not feasible to connect via fiber. Cellular router shall be compatible with MDOT cellular service carrier of 4G or higher service
Wireless Equipment[4]		MDOT Standard Specifications Section 662 *Radio Interconnect System*
1	907-662-C001	Radio Interconnect, Signal Control, low-power frequency radio providing communications between a master and local intersections.
2	907-662-D001	Radio Interconnect, Broadband, Long Range, single or multiband, licensed and unlicensed (high-power frequency), providing greater than 10 mile range.
3	907-662-D002	Radio Interconnect, Broadband, Short Range, same as long range radio except range is ≤ 10 mile range
4	907-662-E001	Radio Interconnect, TVBR, Short Range, unlicensed radio, LOS and NLOS wireless radio transmitting on available channels in the broadcast TV frequency band, up to 2 mile range with bandwidth of > 25Mbps.
5	907-675-A001	Antenna Tower
8	907-675-B001	Antenna Tower Communication Hut

1. All MDOT specifications, details and industry standards referenced assume the latest version or edition
2. Type A, B, D, E and F switches along with the Terminal Server are environmentally hardened. Type C switches are to be placed in Communications Huts or TMC buildings.
3. All cellular designs shall include a determination of signal strength and service coverage at all proposed sites.
4. All wireless designs shall include Wireless Path and Loss Budget Evaluation prior to making design recommendations. Any FCC licensing required shall be provided by the designer on behalf of the MDOT.

B. Field Switch

Fiber optic networks require field switches in device cabinets to transmit the data. There are two types of field switches, Layer 2 and Layer 3. Layer 2 switches are installed in all field cabinets while Layer 3 switches are installed in Communications Huts and TMCs.

- ☐ There are currently several types field switch types that may be used on MDOT ITS projects. To determine the type of field switch needed, designers must determine the number of devices and trunk fibers to be supported. MDOT Special Provision 907-663 defines the various types of field switches to select from.

- ☐ A Network Switch, Type A switch is installed in field cabinets providing network connectivity for ITS devices. The Ethernet ports on the switch are for devices, such as IP CCTV camera, DMS controller, RDS, VDS, BDS, RWIS RPU, and/or any other devices that need communication from a remote location. Six 10/100 Mbps copper ports + two GE optical ports

- ☐ A Network Switch, Type B switch is installed in field cabinets providing additional network ports for additional ITS devices at a location. Twelve 10/100 Mbps copper ports + two GE optical ports

- ☐ A Network Switch, Type C is installed in the Communications Huts and TMCs.

- ☐ A Network Switch, Type D switch consists of chassis design accepting up to four modular cards supporting T-1, DS3 or Metro Ethernet Interfaces, cellular interface, terminal server module and power supply module.

- ☐ A Network Switch, Type E switch is installed in locations where multiple fibers converge or where high concentration of ports is needed for a field location.

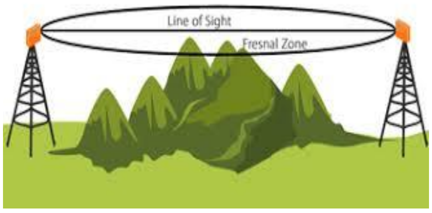
- ☐ A Network Switch, Type F switch is installed in field locations with wireless communications or access points.

- Currently, there are a variety of different types of SFPs. The following is a list of SFP categories and data transmitting distances.
  - The SX will only be used when maintaining legacy systems.
  - The LX/LH and ZX are the two SFPs installed on MDOT projects. LX/LH typically provides 10 km (6.2 miles) optical range and ZX typically provides up to 70 km (43.5 miles) optical range under ideal conditions.
  - Each field switch should be called out on the plans with two SFPs. Most device locations will call for two LX SFPs, but at the beginning and end of a project there should be one LX and one ZX since those locations are usually transmitting the data back to the Communications Hut or TMC.

C. Wireless / Radio

- Wireless radios are a versatile communication method that provides relatively reliable communication without major infrastructure and without the cost of installing conduit and fiber optic cabling.
  - Radios are the less preferred communication option due to their bandwidth limitation and reliability. However, as a substitute based on cost, environmental factors, and/or location limitations, wireless communication can provide quality communications.
  - Radios differ from cellular routers in that wireless radios must communicate to another cabinet that has access to the rest of the network, whereas cellular does not.

- When installing wireless radios on a project the designer must verify line of sight between radios.



  - A path evaluation and line of sight survey can be completed during the design stage to confirm the radio design. Line-of-sight means the two radio antennas must be in relative view of each other, meaning that there cannot be extensive foliage, building, structures, mountains, and/or terrain between the two radio antennas.
  - Given its lower frequency, radio can be used to operate as a repeater in locations where environmental factors do not provide line-of-sight.
  - Radio Interconnect, Short Range radio should be used for point to point links when the limitations of the lower frequency radio cannot be met, whether it is bandwidth or distance.
  - Radio Interconnect, Long Range radio should be used as a trunk or backhauling radio.

  - This would be where multiple cabinets and devices in the area are augmented together at a single location.
  - The Long Range radio would then transmit all the data to another cabinet via wireless. The cabinet receiving the trunk data may be connected to another Long Range radio or to fiber optic cable.
  - The preferred option would be to design the radios so the Long Range radio would communicate to a cabinet that is tied to fiber optic cable; therefore, the data can be transferred via fiber to the TMC.

- ☐ The antenna receives and sends data to and from the radio via a category cable. For example, a Cat-6 cable could be used for interconnection.

- ☐ The data and power is provided to the antenna over the Ethernet cable using POE and a POE injector. Therefore, based upon the category cabling used the distance the antenna can be from the injector cannot be greater than 328 ft.

- ☐ The POE injector will fit into any ITS cabinet provided for the ITS device. The POE injector will not be a limiting factor to the sizing of the cabinet.

- ☐ A networking switch can be specified to interconnect to the radio antenna to provide more network interconnections for devices.

5.3 Communications Network Design

There are several ways of interconnecting networking devices to create a network topology. Each topology has pros and cons to both and all topologies should be considered when designing a fiber optic network.

Examples of MDOT ITS Network Topology Drawings and Details

Examples of MDOT ITS network topology and other details can be found on the MDOT ITS web-site (Refer to Section 1.7 for link to website)

Designer shall coordinate with MDOT IT in regards to specific network drawings and details required for inclusion in the Project Plans submittal

A. Communications Interface

- ☐ An interface is a shared boundary across which information is passed. It is the hardware or software component that connects two or more other components for passing information from one to another.

Use of Open Communications Standards

- ☐ Where available, communication protocols should use open data communication standards such as NTCIP. NTCIP allows the TMC to communicate with a variety of field devices on the same communications network channel.

- ☐ Proprietary or closed standards should only be considered where open standards are not available as approved by MDOT.

Other Communications Interface

- ☐ If an open, standards-based communications interface is not specified for a roadside system, then it is important that the communications interface used and provided by the vendor be thoroughly documented. The documentation should be made fully available to MDOT.

- ☐ The vendor will provide a perpetual, non-exclusive, irrevocable license, at no additional cost, to MDOT to use for its communications interface.

- ☐ The license shall allow MDOT (or its employees, agents or contractors) to reproduce, maintain and modify the communications interface without restriction for MDOT's use and benefit and to use the communications interface on multiple processors with no additional licensing fee.

- ☐ Upon providing MDOT with the communications interface documentation, the vendor will provide and perform test procedures that will demonstrate to MDOT that the documentation provided is accurate and correct.

Functional Description of Communications Protocol

Communications Interface for CCTV Cameras

The communications interface between the CCTV camera system and the TMC is needed to facilitate the following functions:

- ☐ Configure the CCTV Camera System. This feature allows an operator to determine the identity of the field device and its capabilities. This feature also allows an operator to configure the pre-sets, pan/tilt/zoom limits, home position, step sizes (for pan/tilt) and timeout parameters.

- ☐ Control the CCTV Camera System. This feature allows an operator to control the pan/tilt unit, lens and camera. It allows an operator to control the zoom, command the camera to pre-set positions, activate camera features (e.g., wipers, washers, blower, auto iris, auto focus), set and clear alarms and alarm thresholds, and set camera zones and labels.

- ☐ Monitor the CCTV Camera System Status. This feature allows an operator to monitor the overall status of the field device, the status of each sensor, the output states and the status of each zone. This feature also allows an operator to determine pre-sets, the position of pan/tilt unit, the status of features supported by the camera (wipers, washers, blower, auto iris, auto focus) and monitor alarms.

Communications Interface for Dynamic Message Signs

The communications interface between the dynamic message sign systems and the TMC is needed to facilitate the following functions:

- ☐ Configure the DMS. This feature allows an operator to determine the identity of the DMS, determine its capability, manage fonts, manage graphics and manage brightness.

- ☐ Control the DMS. This feature allows an operator to control the message, control the brightness output, control external devices connected to the DMS, reset the DMS and perform preventative maintenance. This feature also allows a DMS to be controlled from more than one location.

- ☐ Monitor the Status of the DMS. This feature allows an operator to monitor the current message and perform diagnostics.

- ☐ Upload Event Logs. This feature allows an operator to upload any event logs maintained by the DMS.

Communications Interface for Traffic Detection and Monitoring

The communications interface between the traffic detection and monitoring (field) devices and the TMC is needed to facilitate the following functions:

- ☐ Configure the traffic detection and monitoring devices. This feature allows an operator to determine the identity of the field device and its capabilities, and to configure the sensor zones and outputs.

- ☐ Control the traffic detection and monitoring devices. This feature allows an operator to reset the field devices, initiate diagnostics and manage the camera zones for video detection devices.

- ☐ Monitor field device status and report equipment malfunctions. This feature allows an operator to monitor the overall status of the field device, the status of each sensor, the output states and the status of each zone.

- ☐ Upload event logs. This feature allows an operator to upload any event logs that are maintained by the field devices.

- ☐ Collect data from the field devices. This feature allows an operator to retrieve the data from the in-progress sample period (started but not yet completed), the most recent completed sample period and historical sample periods.

Communications Interface for RWIS

The communications interface between the RWIS sensors and the TMC is needed to facilitate the following functions:

- ☐ **Monitor RWIS Equipment Status:** This feature allows an operator to determine if any doors on the RWIS equipment are open, to monitor the electrical power for the RWIS equipment to ensure proper operation and to monitor the movements of a mobile RWIS station.

- ☐ **Monitor Weather Conditions:** This feature allows an operator to monitor the weather conditions that can directly or indirectly affect the transportation system, including wind conditions, temperature, humidity, precipitation and visibility. This feature also allows an operator to visually inspect and verify reported weather conditions through images collected at the RWIS equipment location.

- **Monitor Pavement Conditions:** This feature allows an operator to monitor the road conditions and conditions below the road surface that may adversely affect transportation operations, including pavement surface temperature, moisture conditions and surface friction

- **Monitor Water Level:** This feature allows an operator to monitor the depth of water at one or more locations, such as over a road or in a stream

- **Upload Event Logs:** This feature allows an operator to upload any event logs that are maintained by the RWIS equipment.

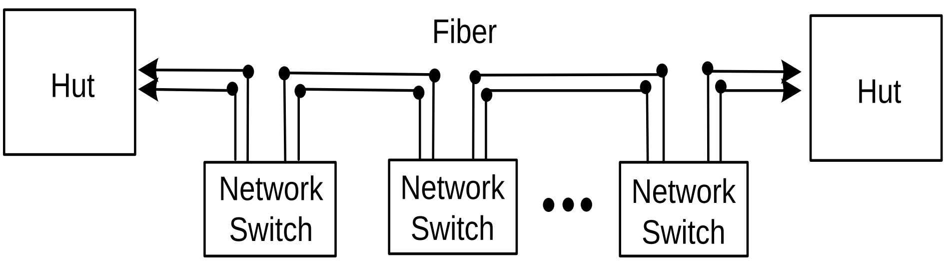
B. Communications Strategies and Network Topology

There are three primary communications scenarios used in MDOT ITS Design projects.

New Fiber Optic Trunk Cable with New ITS Devices

- New ITS devices shall follow a native Ethernet communication architecture.

- A hardened field network switch is installed at each device location, and devices on the same side of the freeway are daisy chained as shown in the following figure.



  - Field device daisy chains are a group of field devices, usually adjacent to each other, which communicate on a single pair of fibers as shown in the below figure:
  - Each field device daisy chain must communicate in a loop to allow redundancy for the network, in case of isolated power failure at a field cabinet, or a single fiber optic cable cut. It is preferable that the communications loop utilize a unique Communications Hut or field cabinet at either end.
  - The maximum number of field devices which should be accommodated on a field device daisy chain is 8 field switches at field cabinet locations or 6 CCTV cameras, whichever is reached first.

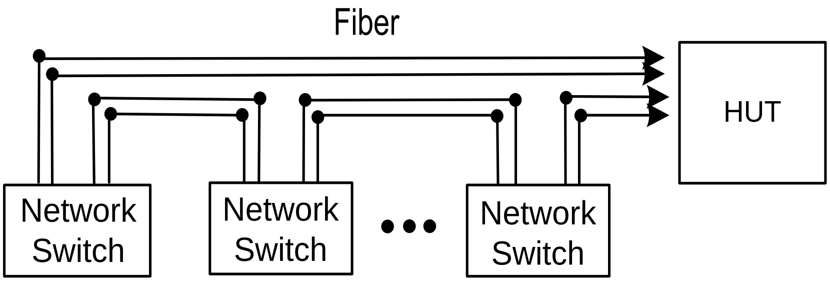
- The daisy chain utilizes a pair of trunk fibers which are terminated at designated Communications Huts.
- Each daisy chain reserves two pairs of trunk fiber for daisy chain spares.

- A 12 fiber drop cable is installed at each location with up to 12 splices at each location.

- Multiple devices such as RDS, DMS, and HAR can be connected to the field switch at each cabinet location without impacting the communications performance.

- The only exception is CCTV cameras, for which the quantity is limited due to high and continuous network bandwidth requirements.

- In the event that only one Communications Hut is present and the daisy chain needs to be completed with both ends terminating in the same Hut, the last Field Switch on one side of the freeway will be connected to a pair of trunk fibers connecting back to the Hut which is called a Folded Ring as shown below.



Existing Fiber Optic Trunk Cable with New ITS Devices

- If single-mode fiber optic trunk cable is existing, ITS devices are daisy chained with a pair of trunk fibers, and 2 spare daisy chain pairs, as described above.

- In the event that only multi-mode fibers are available and there are suitable existing conduits for installing new fiber, a new single-mode fiber optic trunk cable may be installed with MDOT approval.

Existing Fiber Optic Trunk Cable and ITS Devices

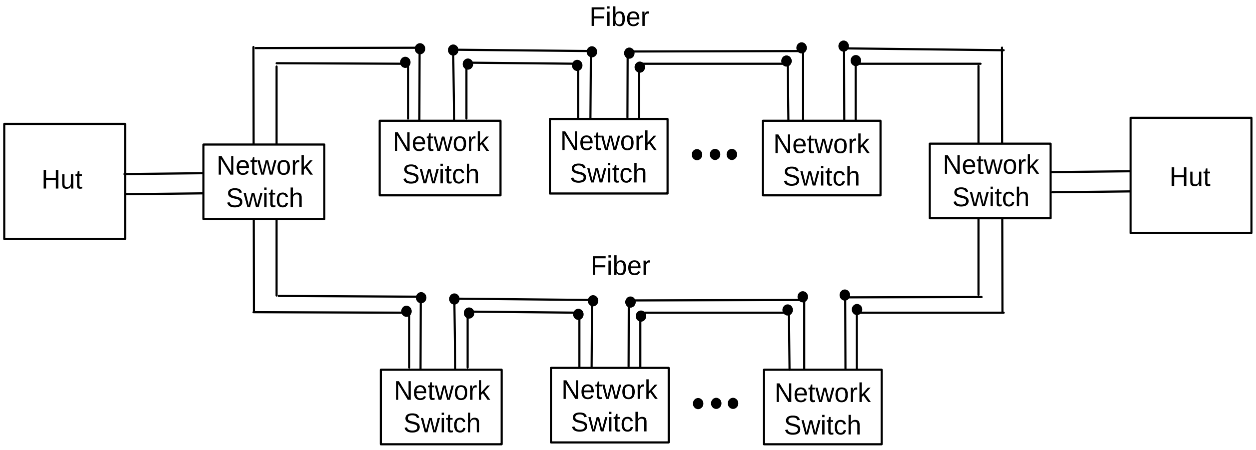
- If there are single-mode trunk fibers available, the ITS device will communicate with the Communications Huts through a pair of trunk fibers, as described above.

- A 12 fiber drop cable as well as a field switch is installed at each location.

Physical Ring Topology

- This topology operates by having a geographically diverse path for the interconnection back to a Communications Hut or TMC.

- The following physical ring topology diagram shows the network devices being interconnected in a series with the first and last device connecting.



- The difference from this topology to the earlier topologies is that the connection from the first device to the last device is on a physically and geographically different cable, whereas the folded ring topology utilizes the same cable for the redundant link.

- The pro of this topology is that since the redundant link is on a physically different cable, it lessens the possibility of losing connectivity with network devices. If a break happens in one link, the redundant link should still be operational. The con of this topology is the increased amount of cable required to achieve the redundant link.

C. Network Integration Considerations

- The designer shall coordinate with MDOT IS in regards to network design including network design drawings including the following:
  - Network switch and SFP types
  - Network equipment configuration requirements
    - IP, mask, and gateway addresses
    - Network protocols settings: RSTP/STP, IGMP snooping, PVST+ for redundancy, operational and unused TX ports, and multicast protocols

- Port security to restrict port to one MAC address only
- VLANs (management, data, video (multicast), etc.) per subnet as directed by MDOT
- Admin user/password encryption MDS and other as directed by MDOT
- VPN / Firewall requirements as needed

  - Network staging plan if the project will be deployed in segments
  - Network test plan and procedures

D. Communications Network Design Examples

The diagrams on the following pages illustrate the typical communications concepts utilized at specific device type locations.

The MDOT ITS website (see Section 1.7 for access information) provides further details and information to facilitate the design of the ITS and communications system.

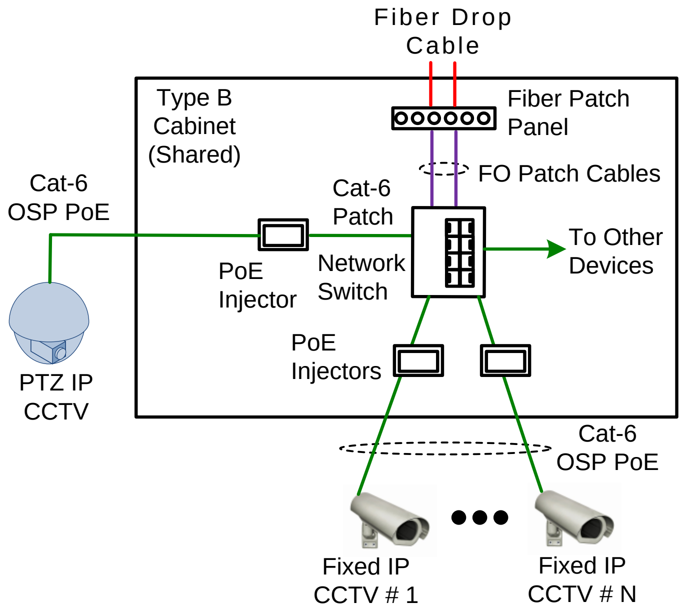


Figure 4: Typical PTZ and Fixed CCTV Camera Site Detail

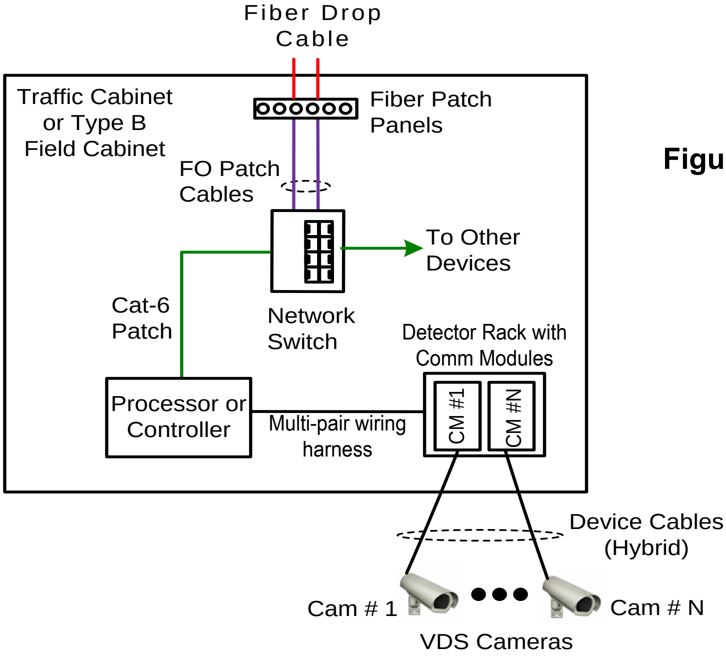


Figure 5: Typical VDS Site Detail

Figure 6: Typical DMS Site Detail

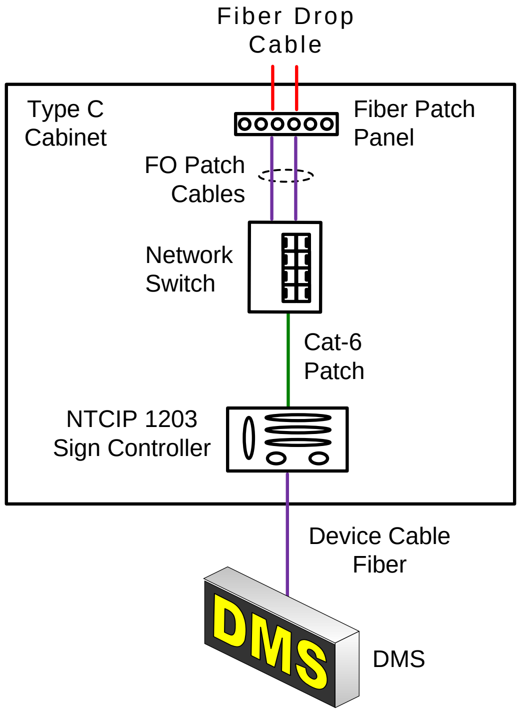


Figure 8: Typical RDS Site Detail

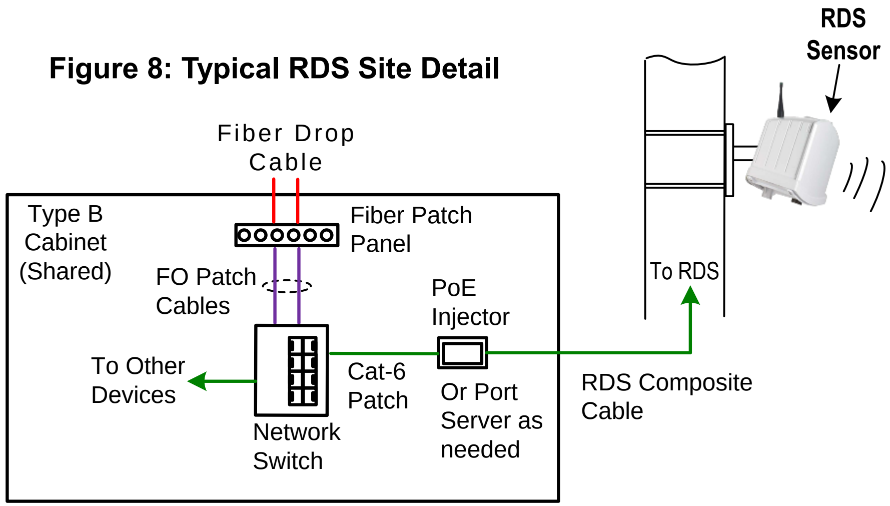


Figure 7: Typical BDS Site Detail

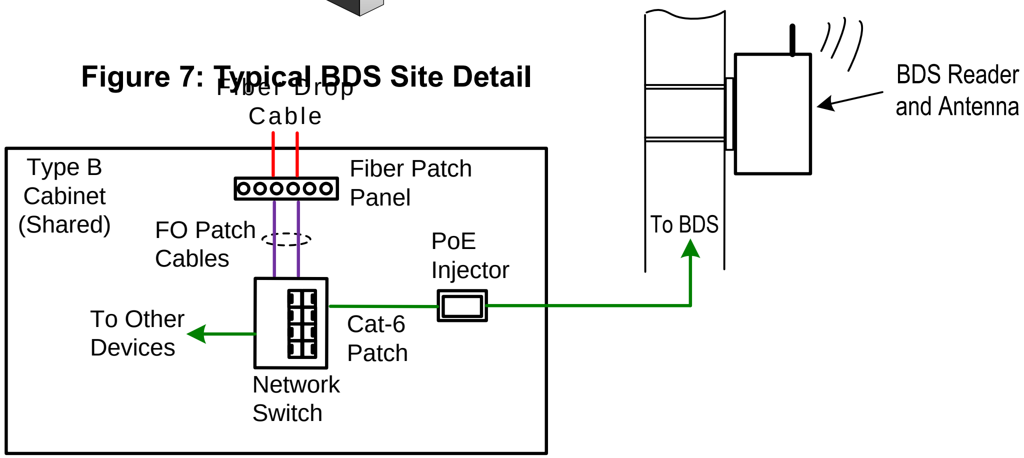


Figure 9: Typical RWIS Site Detail

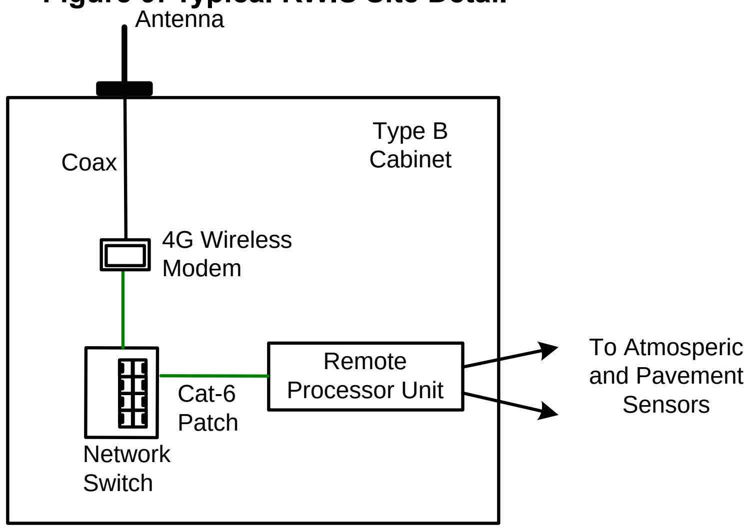
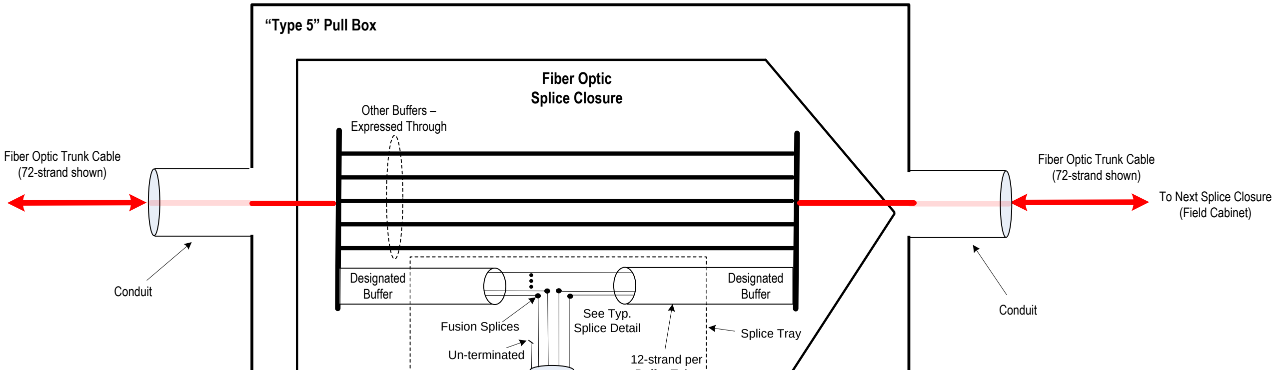
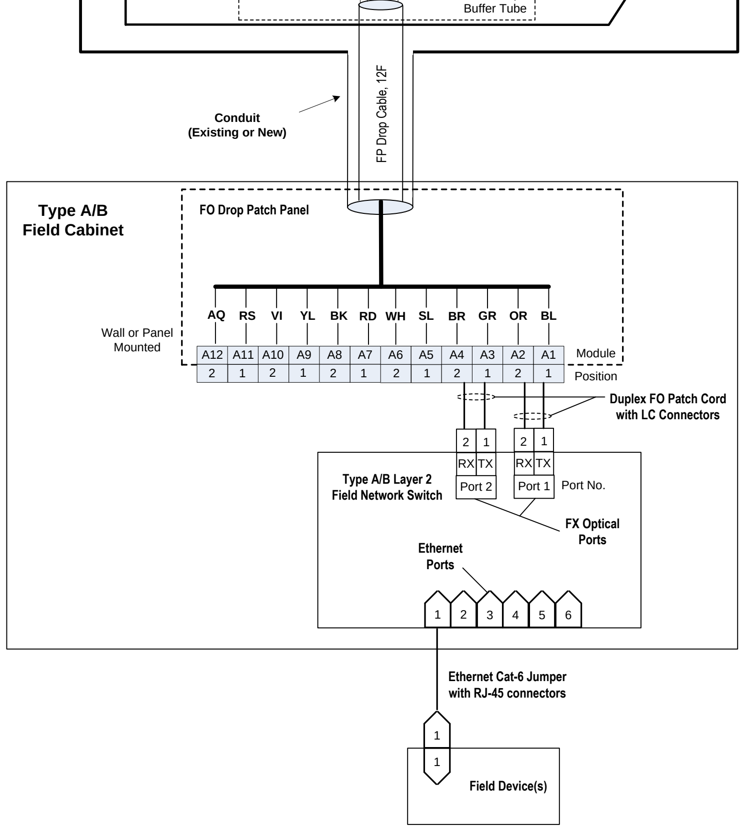
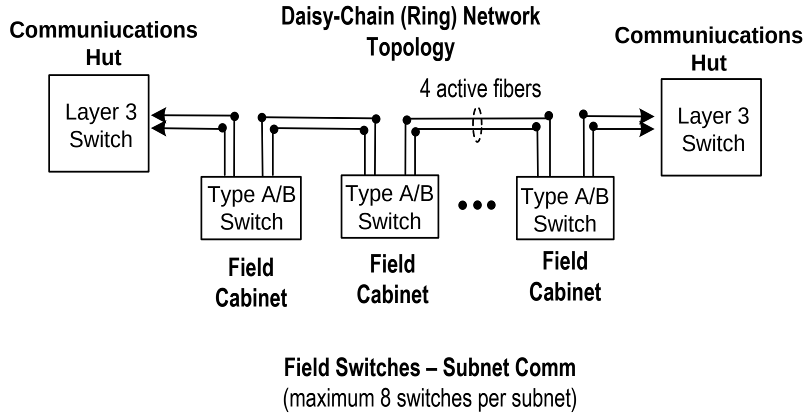
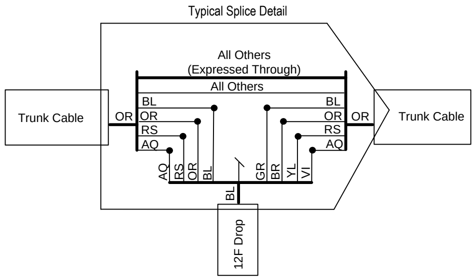


Figure 11: Distribution Network Topology Option A





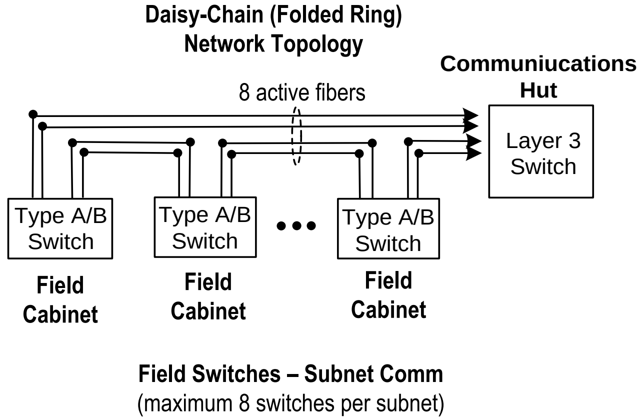




Fiber Color Standard (per EIA-598-C)

1	BL	Blue	7	RD	Red
2	OR	Orange	8	BK	Black
3	GR	Green	9	YL	Yellow
4	BR	Brown	10	VI	Violet
5	SL	Slate	11	RS	Rose
6	WH	White	12	AQ	Aqua

Figure 12: Distribution Network Topology Option B



6. PS&E Assembly for ITS Projects

Previous sections have presented guidelines and criteria for design and placement of ITS elements on Mississippi roadways. These designs shall be presented in a set of Contract Plans and Specifications that can be clearly understood by designers, contractors, suppliers and Department personnel assigned to supervise and inspect the work.

ITS designs are sometimes developed as an entirely standalone effort, but are more commonly incorporated into contract documents for roadway/bridge construction or other infrastructure improvements. Chapter 15 of the MDOT Roadway Design Manual, 2001, provides contract plan assembly guidelines and requirements that are applicable to all MDOT construction projects.

It is assumed the reader has a working knowledge of the information presented therein. The purpose of this section is to reinforce and supplement those guidelines and requirements.

6.1 Contract ITS Plans

To ensure a consistent interpretation of the Contract Plans, individual sheets shall have standard format and content, and the sequence of assembling the various ITS plan sheets shall generally be the same.

6.1.1 Typical Content, Sequence and Numbering

"ITS-only" contract plans usually contain the following types of sheets assembled in the sequence below:

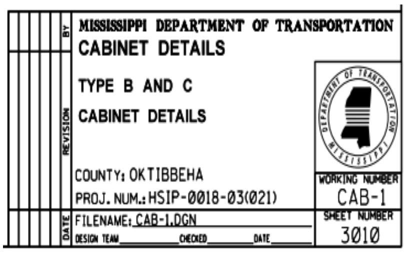
1. Title Sheet
2. Detailed Index & ITS Legend
3. General Notes
4. Summary of Quantities (Recap)
5. Estimated Quantities (Sheet-by-Sheet)
6. Project Location Plan
7. ITS Plan Sheets (layout sheets depicting locations, routing and details of ITS site components and elements)
8. ITS Design Detail Sheets (sheets presenting ITS design details and notes)
9. Standard Roadway Design and/or Bridge Standard Drawings

Where ITS designs are integrated into a roadway/bridge project, separate Title and Index Sheets are normally not required. However, a separate Summary of Quantities (ITS-only) sheet may still be prepared, because the ITS elements are often bid upon by a different contractor from the roadway/bridge contractor.

In a set of roadway/bridge contract plans, the roadway plan-profile sheets will serve as the primary layout sheets, and the ITS Plan Sheets will be included among the Special Design Sheets.

Working numbers are assigned to groups of particular sheets for identification during the design process. Working numbers are temporary and have little value after the plans are printed for PS&E Assembly, except that working numbers recorded on the Title Sheet and Project Location Plan serve as a useful "sheet key" for reference purposes.

Sheet numbers are assigned when the plans have been completed and are ready for PS&E Assembly. MDOT has reserved blocks of numbers for various types of sheets. (Roadway and) ITS-related plan sheets will normally fall between sheet numbers 3001 and 3100. For cases where sheet numbers must exceed 3100, the designer shall use 3100.01, 3100.02, etc., for the additional sheet numbers. This is because MDOT has reserved sheet numbers 3101 through 3365 for Roadway Design Standard Drawings. The designer shall refer to Chapter 15 of the MDOT Roadway Design Manual, 2001, for additional details.



Both the working number and the sheet number are recorded in a block located in the lower right corner of each plan sheet (except for the Title Sheet).

6.1.2 Project Identification

Each sheet in the Contract Plans shall be clearly identified with the project number.

- On the Title Sheet, this number is provided in the center heading and in a block located in the upper right corner of the sheet, and also at the bottom of the sheet.
- On all other sheets, the project number is recorded in a block in the upper right corner and in a block in the lower right-hand corner.
- The designer shall obtain the project number from the MDOT ITS Project Manager (or his designee).

6.1.3 ITS Sheets

Table 49 provides a detailed listing of the ITS related sheets that typically comprise a set of ITS Contract Plans.

- ☐ The designer shall note that the exact number and types of sheets will vary, depending on the scope and limits of the ITS design.
- ☐ The designer may also refer to the example ITS plan and detail sheets assembled *on the MDOT ITS website (refer to Section 1.7)*
- ☐ These sheets do not represent a single complete set of plans; rather, they are selected individual sheets to serve as examples for particular conditions.
- ☐ The designer shall strive to match the format and overall content presented for each type of sheet.

Table 49: Typical Sheets Comprising Set of ITS Contract Plans

SHEET DESCRIPTION	WORKING NUMBER(S)
Title Sheet	-
Detailed Index & ITS Legend	DI-1
General Notes	GN-1
Summary of Quantities – *recap of all project quantities*	SQ-1, SQ-2… SQ-n
Estimated Quantities – *sheet-by-sheet & other special quantity tabulations*	EQ-1, EQ-2… EQ-n
Project Location Plan – *serves as key map for ITS Plan Sheets*	LP-1
ITS Plan Sheets:	
Mainline – *identify route/street name and station limits*	ITS-1, ITS-2… ITS-n
• *Additional route/street names and station limits, as required*	ITS-p, ITS-q… ITS-z
ITS Design Detail Sheets:	
Aerial-Supported Conduit – *structure attachment details*	ASC-1, ASC-2… ASC-n
Cabinet Details – *details for Type A, B or C cabinets, where required*	CAB-1, CAB-2… CAB-n
CCTV Details – *details for pole- or structure-mounted CCTV cameras*	CCTV-1, CCTV-2… CCTV-n
RDS Details – *pole- and structure-mounted radar detector details*	RDS-1, RDS-2… RDS-n
DMS Details – *includes elevation- and plan-view clearance diagrams and other details for each overhead and roadside DMS installation*	DMS-1, DMS-2… DMS-n

Table 49: Typical Sheets Comprising Set of ITS Contract Plans	
TTS Details – *travel time sign details*	TTS-1, TTS-2… TTS-n
HAR Details – *coverage area, system details & sign details*	HAR-1, HAR-2… HAR-n
Erosion Control Plan – *miscellaneous notes/details, as required by project scope*	EC-1, EC-2… EC-n
Equipment Details – *structure attachment details*	ED-1, ED-2… ED-n
Fiber Optic Details – *includes details for conduit trenching & boring; pull boxes; termination cabinets; FO cable splicing, system block diagram*	FO-1, FO-2… FO-n
Electrical Details – *miscellaneous notes/details pertaining to power service*	POW-1, POW-2… POW-n
Traffic Control Plan – *miscellaneous notes/details, as required by project scope*	TC-1, TC-2… TC-n
Traffic Control Details – *miscellaneous sheets furnished by RWD Division*	TCP-__
Other detail sheets – *as required by project scope*	-
Standard Roadway Design and/or Bridge Design Drawings:	
Note: *Standard drawings to be chosen from list, based on project scope.*	-

6.1.4 Standard Legend

Commonly used standard symbols and line-types are depicted on the above-referenced example ITS plan sheets (refer to Section 1.7).

- ☐ In particular, the designer shall refer to the “Detailed Index & ITS Legend” and “ITS Plan” model sheets provided.
- ☐ Appendix D provides examples of how various ITS elements should be labelled on the ITS Plan sheets.
- ☐ The designer shall adhere to these standard symbols, line-types and labels in the preparation of all ITS contract plans.
- ☐ Some of these standards are included in the cell libraries furnished with the Department’s standard CADD interface. Refer to the current edition of the MDOT RWD CADD Manual, or contact the RWD CADD coordinator for additional information.

- Other standard symbols and line-types, configured for use within the MicroStation CADD software, may be furnished by the MDOT ITS Project Manager (or his designee) upon request.

6.1.5 Standard Details

The Department has not officially adopted any standard detail drawings for MDOT's ITS, and therefore, all necessary ITS details must be prepared by the designer and included among the Special Design Sheets in each set of Contract Plans.

- Table 49 includes a list of commonly used ITS detail sheets and the example plan sheets assembled *on the MDOT ITS website (refer to Section 1.7)* include some helpful examples from past projects.

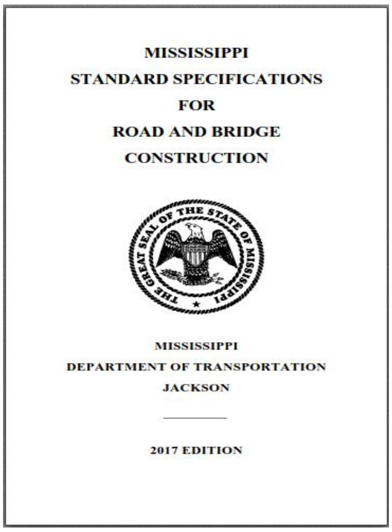
- The most current examples of these typical ITS details are available for download (in PDF and DGN format) at the web address indicated in Section 1.7.

- ITS detail drawings obtained from the MDOT website are furnished by the Department for information and guidance purposes only.

- The designer is ultimately responsible for preparing all appropriate detail drawings needed to clearly and completely describe the work required for a particular project.

6.2 ITS Specifications

The Mississippi Standard Specifications for Road and Bridge Construction, 2017, (also known as the MDOT "Red Book"), contains the governing specifications for all MDOT construction projects. These standard specifications describe various construction work items and define the Department's relationship with contractors.


MISSISSIPPI
STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE
CONSTRUCTION

MISSISSIPPI
DEPARTMENT OF TRANSPORTATION
JACKSON

2017 EDITION

- Since the technical advances and specifications for ITS may change faster than updates are made to the Standard Specifications, the designer must supplement the Standard Specifications to adequately specify the most current ITS equipment and installation requirements.
- As described below, these supplemental requirements take the form of Special Provisions and NTB documents, which are updated more frequently than the Standard Specifications, sometimes on a project-by-project basis.

6.2.1 Special Provisions

The Department maintains a file of Special Provisions to identify current amendments (additions, deletions and revisions) to the Standard Specifications. They are intended to convey the basic requirements for ITS elements used on all MDOT projects.

- These Special Provisions are typically included with the bid documents for any MDOT project, as appropriate (i.e., where amendments affect certain work items). The MDOT ITS website has the latest Special Provisions.
- Project-specific modifications shall be kept to a minimum, and must be approved by the MDOT ITS Project Manager (or his designee). Such modifications will normally be approved only if the changes provide needed clarification or capture technological advancements that are likely to be incorporated into future MDOT projects.

As noted above, there the Special Provisions are subject to frequent updates. The latest ITS Special Provisions are available for download from the website (refer to Section 1.8 for URL)

- Where certain project-specific requirements must be communicated to the Contractor, these are normally described in a NTB.
- The designer shall submit a list of anticipated Special Provisions in conjunction with the Preliminary (50%) ITS Plans submittal.

6.2.2 Notice to Bidders

A NTB is a special document included in the contract proposal for the purpose of describing certain project-specific requirements.

Among other functions, a NTB may:

- ☐ Clarify certain aspects of the Department's relationship with contractors that are not readily apparent in the Standard Specifications
- ☐ Establish new requirements arising from recent changes to federal contracting law
- ☐ Communicate certain requirements that vary based on a project's location
- ☐ Establish contract requirements that are inherently project-specific, such as time of performance or liquidated damages
- ☐ Establish technical requirements of the work that are inherently project-specific
- ☐ All NTBs are assigned a special number, which is normally project-specific and assigned by the MDOT Construction Division just before the contract proposal is completed.

> *The designer is responsible for preparing all Notices to Bidders needed to clearly and completely describe the ITS-related work requirements.*

- ☐ Table 50 provides a list of typical NTB examples prepared for previous ITS projects. Further details for these examples may be found in Appendix E. The designer shall submit a list of anticipated NTBs in conjunction with the Preliminary (50%) ITS Plans submittal.

Table 50: ITS Notices to Bidders	
Subject	**Description/Comments**
ITS Equipment Cabinet Modifications	Provides site-specific work requirements for modifications to existing traffic signal/ITS field cabinets.
Networking Equipment	Provide site-specific network switches and SFP modules as required for the overall communications design.
Location and Configuration of Communications Nodes	Provide details on specific project Hut configuration, rack elevations, cable management, electrical, Hut equipment and UPS.
Radio Interconnect	Provide site-specific radio / wireless design details including antenna site selection, path analysis and training,
TMC Modifications	Provides project- and site-specific requirements for work at the TMCs including descriptions of additional equipment to be installed, any additional software licenses or servers, and all other work required to fully connect and integrate new ITS elements into the Department's existing facilities so they are fully operable as intended.

6.3 ITS Cost Estimates

A planning-level construction cost estimate (for ITS elements) shall be established early in the project development process, preferably during the initial ITS scoping phase. In some instances, the MDOT ITS Project Manager may provide a cost estimate (or range) to serve as a guide during concept development.

- The cost estimate shall be refined and submitted in conjunction with the Preliminary (50%) ITS Plans.
- A more detailed cost estimate shall be submitted with the ITS Office Review and Final ITS Plans. MDOT Construction Division maintains a list of pay items and average unit prices for all MDOT construction projects, including those with ITS elements. In addition, the MDOT ITS Project Manager maintains a file of bid tabulations for recent ITS projects.
- Before finalizing the list of pay items and estimated quantities for any ITS project, the designer shall request current copies of this information.

6.4 ITS-Related Permits and MOAs/MOUs

The designer shall note that, in some instances, a project's ITS elements may:

- Involve partnerships with local governments and/or interfaces with local government facilities
- May give rise to a time consuming permitting process, or require lengthy negotiations with private interests or local public agencies
- Cross a railroad or utility company's right-of-way
- Encroach upon private property
- Cross federally regulated streams or other environmentally sensitive resources
- Otherwise require special coordination with entities outside the state's jurisdiction

The designer shall identify any special circumstances early in the project development process, preferably during the initial ITS scoping phase.

As early as the Preliminary (50%) ITS Plans submittal, the designer shall be ready to assist the MDOT ITS Project Manager with preparation of any required permit applications, MOAs or MOUs between the Department and outside agencies.

APPENDICES

Appendix A
Site Review Checklists

Checklist: Pre-Site Review

Before performing site reviews the following checklist items are to be taken into account:

- ☐ Check with the MDOT to obtain any prior roadway plans, ITS as-built plans, KMZ files and/or aerial photography of the project area. Confirm the location of existing devices and infrastructure such as poles, field cabinets, guide signs, overhead structures and other fixed roadway features that may be used as a proposed device reference point.

- ☐ Check with the MDOT and MDOT Environmental Division to ascertain any historical, environmental sensitive or future land field conditions within the project limits

- ☐ Coordinate with the MDOT ITS Project Manager to arrange to have the appropriate personnel on-site for access to existing field cabinets, huts, and other facilities.

- ☐ Prepare field data collection forms to accurately record site conditions and procedures followed during the design. Include a list of all tools and devices (i.e. camera, GPS, etc.) required to complete the field work. All completed field forms shall be made available to the MDOT upon request.

- ☐ If possible, prior to the field visit, create topographic or aerial photo base mapping / plan sheets, with all routes, lane configurations, key topographic features, major landmarks, R/W survey lines shown, and other pertinent information clearly defined. When locating future ITS devices in the field consider the following:
    - Use a GPS device to locate the precise location of the future device and utility point-of-service.
    - Use of mile markers is acceptable and encouraged to identify device locations.
    - Do not use small signs or guardrail ends as the only reference, as these may be damaged, relocated or removed without notice.
    - Reference signs and significant interchange informational signs shall be noted and displayed on Plans

- ☐ Identify and obtain personal safety equipment as required for site reviews. MDOT requires consultants working on projects to provide high visibility clothing for workers on the right-of-way.

Checklist: Site Review

While on the site review(s) the following checklist items / criteria are to be taken into account:	
☐	Examine and document the locations and contents of existing facilities (field cabinets, huts, equipment rooms) where co-location of equipment is desired under the supervision of the appropriate ITS staff to confirm the as-built condition (space availability, internal electrical capacity, switch port availability, etc.).
☐	Locate proposed ITS devices, field cabinets and poles/structures such that they are not adversely impacted by, or interfere with, existing objects, such as guide signs, other roadway structures, drainage structures (i.e., culverts, etc.) and areas where water tends to stand. Document the location on the plans and record the GPS coordinates of the location.
☐	Ensure that there is appropriate sight-distance for each of the proposed ITS devices and that the location meets the requirements for that device type.
☐	Document locations of guide and reference signs, significant interchange informational signs, potential monuments and drainage structures.
☐	Locate power service locations that are easily accessible and close (500-feet) to the proposed device.
☐	Determine routing of conduit and pull boxes such that they avoid drainage structures and other items that would possibly impact the routing of conduit and placement of pull boxes.
☐	All proposed ITS device locations, especially those near bridges, shall be carefully examined to ensure that the ITS device and field cabinet is easily accessible. Likewise, avoid locations where bucket truck or service vehicles cannot be positioned safely.
☐	If it is necessary to place a pole with a field cabinet on a steep slope, then provide a maintenance access platform to enable cabinet access for a technician.
☐	At sites where boring or trenching may be required, locate pull boxes and conduit with installation requirements in mind such that trenching/boring equipment can be safely set up and operated.
☐	Take pictures and make sketches where appropriate. Location of field sites shall be able to be clearly determined from pictures and GPS coordinates.

Appendix B
Design Checklists Direct Links

Appendix B
Design Checklists

Checklist: Common (Power, Communications, and Guardrail)

Power Requirements			
Step	**Yes**	**No**	**N/A**
Have the power point of service been located for each proposed device location?	☐	☐	☐
Has coordination with the utility company been completed?	☐	☐	☐
If required, have the step-up and stepdown calculations been performed?	☐	☐	☐
Does power meet NFPA 70 / NEC requirements?	☐	☐	☐
Is the device capable of being solar powered or Power over Ethernet (PoE) or low voltage (12/24 VAC/DC)?	☐	☐	☐
Do the power requirements meet MDOT Special Provisions section?	☐	☐	☐
Communications and Infrastructure			
Step	**Yes**	**No**	**N/A**
Will communications interface to cabinet be fiber-based?	☐	☐	☐
Will communications interface to cabinet be wireless?	☐	☐	☐
Will communications interface to cabinet be DSL or other?	☐	☐	☐
If cellular communications, ha the required signal strength Been verified at the site(s)?	☐	☐	☐
Have the communications requirements and network design for the device type(s) been determined?	☐	☐	☐
Do the communications requirements meet MDOT Special Provisions?	☐	☐	☐
Has conduit, pull box and other supporting infrastructure design been completed?	☐	☐	☐

	Guardrail (as needed)
☐	Consider and make note of existing guardrail for candidate device locations taking into account the following guard-rail guidelines: ○ The first choice for design is to place the ITS devices so that new guardrail is not needed. ○ Designers must follow appropriate roadside safety standards as presented in the AASHTO Roadside Design Guide and MDOT Roadway Design Manual to determine where new guardrail is needed, where changes to existing guardrail are required, and how to design the guardrail.

Situations that occur often on ITS urban and rural freeway projects are described below:

☐ Extending existing guardrails

If a new strain pole is placed behind existing guardrail (either upstream or downstream of the existing protected feature/object), verify the existing guardrail meets all current standards. This can be challenging because the designer will have to consider the existing feature/object that is being protected and the new support that will be installed.

The appropriate length of guardrail needs to be designed both upstream and downstream of the objects.

Note that when guardrail is extended, the anchor at the end being extended will be removed, new guardrail added, and a new anchor must be installed to current standards.

☐ Closing the gap between two runs of guardrail

If the new guardrail is close to an upstream or downstream existing guardrail, designers shall use engineering judgment and determine if the new guardrail shall close the gap to create one continuous guardrail.

☐ Shortening the guardrail post spacing

The offset behind the guardrail to the support pole or object shall generally be 4 feet or more to allow for deflection.

If this offset cannot be achieved, review the applicable guardrail standards and determine if the allowable minimum post spacing can be reduced.

Checklist: CCTV Camera (PTZ and Fixed) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Was the maximum camera coverage obtained using the least number of cameras as possible?	☐	☐	☐
Has designer coordinated with MDOT's traffic operations to get general idea of overall roadway where CCTV is being installed?	☐	☐	☐
Will there be any future overhead obstructions (i.e.; bridge, overhead sign)?	☐	☐	☐
Are cameras located at high enough elevations to get the best viewing distance possible?	☐	☐	☐
If Urban freeways			
Are cameras located to provide unobstructed view of freeways with travel lanes, shoulders, and clear zones?	☐	☐	☐
Are cameras located to provide coverage of ramps and gore areas at major interchange with limited access roadways?	☐	☐	☐
Are cameras located to provide complete vision of tunnel as NFPA 502 requirements?	☐	☐	☐
If space is available, cameras are to be located on the same side along with the fiber optic backbone.	☐	☐	☐
If Urban arterials and highways			
Is camera located at signalized intersection to provide clear coverage to both major and minor streets?	☐	☐	☐
Are cameras to be located on Signal Mast Arms or Signal Poles? Coordinate with Signal Engineer regarding any necessary adjustments to pole height	☐	☐	☐
If Rural freeways and roadways			
Is camera located at major interchange or with heavy traffic arterials?	☐	☐	☐
Is camera located to provide coverage at known accident and crash locations?	☐	☐	☐
Is camera providing full coverage of evacuation corridor and extreme weather areas as directed by MDOT?	☐	☐	☐
If Major Interchange			
Is there a PTZ camera located at each interchange?	☐	☐	☐
Is there a fixed camera located at for each travel direction not covered by the PTZ camera default direction	☐	☐	☐
DMS Message Verification			
Does camera provide clear view of DMS message and take into account the cone of vision and distance?	☐	☐	☐
Is camera located between 300 and 1000 feet upstream of sign display face where messages can be easily read?	☐	☐	☐

Safety and Device Protection			
Confirm that cameras are not located within the median unless there is no other option.	☐	☐	☐
Is pole located to avoid a slope steeper than 3:1?	☐	☐	☐
Vegetation Obstruction			
Is CCTV coverage obstructed by existing vegetation? If yes, coordinate with MDOT for possible trimming.	☐	☐	☐
Will CCTV coverage be obstructed by future vegetation growth?	☐	☐	☐
Will an additional camera be installed where trimming or relocation of vegetation is not possible?	☐	☐	☐
Airport Flight Path			
Are poles located within restricted flight paths or FAA approved project locations?	☐	☐	☐
If applicable, have you made contact and coordinated with airport officials and submitted FAA Form 7460?	☐	☐	☐
External Lighting			
Are cameras located so that the brightness of road lighting does not affect its performance? If not, consider an alternate camera or an alternate camera location.	☐	☐	☐
Vibration / Oscillation			
Are cameras located to avoid unnecessary vibration or oscillations?	☐	☐	☐
Future Construction			
Has future planned construction projects in the area been accounted for?	☐	☐	☐

CCTV Field Cabinet			
Step	**Yes**	**No**	**N/A**
Is CCTV cabinet mounted to pole (to minimize the cost)?	☐	☐	☐
Will cabinet be ground (base) mounted with a maintenance concrete pad to avoid access issues?	☐	☐	☐
If required, camera equipment can be co-located in signal cabinet if adequate space exists in the signal cabinet.	☐	☐	☐
The total cable run distance between camera assembly and the field cabinet does not exceed 300 feet.	☐	☐	☐
Is ground (pad) mounted cabinet located to avoid steeper slope than 4:1?	☐	☐	☐
Will the CCTV cabinet site chosen with consideration to protecting a maintenance person when looking at the field cabinet?	☐	☐	☐
Will the CCTV cabinet be placed at 30-inches (to the bottom) from ground surface?	☐	☐	☐
Is the cabinet installed easily accessible?	☐	☐	☐
Is there sufficient clearance around the camera pole base for the cabinet's door to open?	☐	☐	☐

Camera Pole and Mount			
Step	**Yes**	**No**	**N/A**
Have Department standards been followed in the design of the pole mount/structure and foundation?	☐	☐	☐
Will the camera be mounted on a new 50-foot steel pole?	☐	☐	☐
Will the camera be mounted on a new 60 to 80-foot steel pole? If so, a camera lowering device should be included.	☐	☐	☐
Will the camera be mounted on an existing traffic signal pole with extension arms?	☐	☐	☐
Has coordination with other agencies (traffic signal, etc.) been completed?	☐	☐	☐
Will the camera be mounted on a new 30-foot pole (as needed)?	☐	☐	☐
Will the camera be mounted on an existing overhead sign structure using vertical extension?	☐	☐	☐

Checklist: Dynamic Message Boards (DMS) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Is DMS located to provide motorists sufficient time to recognize the sign, read the message on the sign, and to make adjustments of route?	☐	☐	☐
Is DMS located clearly visible and unobstructed?	☐	☐	☐
Is DMS placed on straight sections of the road when possible? If not, the cone of vision should be 1000 feet and must be verified by MDOT.	☐	☐	☐
Is DMS placed without any conflicts with underground or overhead utilities?	☐	☐	☐
Is DMS located to avoid a fill slope of greater than 1V:3H?	☐	☐	☐
Is DMS placed fulfils the FHWA visibility requirements?	☐	☐	☐
Is DMS located close to the existing communications and power as possible?	☐	☐	☐
If Urban freeways			
Are DMS placed generally 5 to 6 miles (in the same direction) apart to each other?	☐	☐	☐
Is DMS located approximately ¼ to ½ mile in-advance of any major interchange, merging, and major decision points?	☐	☐	☐
Is DMS spaced a minimum of 800 feet away from existing or planned overhead static guide sign panels or other signs?	☐	☐	☐
DMS shall not be located near entrance and exit ramps.	☐	☐	☐
Is DMS located in advance of high crash locations and traffic bottlenecks?	☐	☐	☐
If Urban arterials and highways			
Is DMS located near special events locations and other state emergencies, or special conditions specified by MDOT??	☐	☐	☐
Will the DMS be placed on arterials prior to select major intersections and interchanges?	☐	☐	☐
Is current version of MUTCD used to design the sign placement?	☐	☐	☐
Is DMS located with minimum interference from lighting, adjacent driveways, side streets, or commercial signage?	☐	☐	☐
If Rural freeways and roadways			
Is power and communication available in a rural area DMS is being installed?	☐	☐	☐
Vertical Placement			
Is DMS located to avoid curves and excessive changes?	☐	☐	☐
Is DMS located on relatively flat surface to avoid uphill approaches?	☐	☐	☐
Is DMS placed to comply with minimum vertical clearance?	☐	☐	☐

Is there any additional sight distance required for drivers to clearly view and read the sign?	☐	☐	☐
Sign View Angle			
Is a sign viewing angle appropriate for the road alignment and DMS structure? 30 degrees is typical and recommended for most conditions.	☐	☐	☐
Maintenance/Sign Access			
Has the site been chosen so that it will minimize maintenance costs (e.g., there is sufficient shoulder to park a bucket truck without the need for a full lane closure. Walk-in instead of rear or front access DMS)	☐	☐	☐
Has the site been chosen with consideration for protecting the DMS structure; undue maintenance necessary to the structure and the surrounding site?	☐	☐	☐
Are DMS sites able to be maintained by a bucket truck?	☐	☐	☐

DMS Field Cabinet			
Step	**Yes**	**No**	**N/A**
Is the DMS field cabinet located within the right of way approximately 100 feet or more?	☐	☐	☐
Will a desired location provide adequate protection for the field cabinet?	☐	☐	☐
Will a concrete maintenance pad be provided at the cabinet's main door?	☐	☐	☐
Is cabinet placed where the door can be opened at least 90 degrees?	☐	☐	☐
Does the location easily accessible by maintenance crew?	☐	☐	☐
Are the field cabinet and electrical components above flood elevation?	☐	☐	☐
Are proximity of DMS cabinet and AC power source considered when installing?	☐	☐	☐

DMS Mount			
Step	**Yes**	**No**	**N/A**
Is the DMS type appropriate for proposed location (Type 1, Type 2, and Type 3)? (Refer to Table 11 of this manual.)	☐	☐	☐

Checklist: Radar Detection System (RDS) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Is RDS placed at side-fire position to get better data?	☐	☐	☐
Is one RDS device used to achieve full accuracy?	☐	☐	☐
Is RDS mounted on either lighting poles or CCTV pole to minimize cost?	☐	☐	☐
Are any additional precautions considered when specifying RDS subsystems?	☐	☐	☐
Is RDSs installed mid-way between traffic signals or within the bounds of interchanges?	☐	☐	☐
Is sign truss used to for RDS's side fire location? If used, follow manufacturer's recommendations.	☐	☐	☐
Will RDS be mounted standalone? If yes, designer should consider using breakaway pole.	☐	☐	☐
Are obstructions like metal sings, tree leaves and clear zone avoided from RDS's detection zones?	☐	☐	☐
RDS should be mounted without any signs and other flat surface.	☐	☐	☐
If Urban Freeways			
Are RDS installed 1 mile (typical) apart if using for data collection?	☐	☐	☐
Is one RDS located between all interchange? RDS shall not be used to count entrance and exit ramps.	☐	☐	☐
Is one RDS installed to cover all lanes of traffic (when sight distances are not obscured)?	☐	☐	☐
Are two RDSs installed on same side of freeway if short median barrier is less than 200 feet from E.O.T.L.	☐	☐	☐
Is RDS co-located with CCTV camera and field cabinet when possible?	☐	☐	☐
If Urban Arterials and Highways			
Has MDOT provided any particular spacing for RDS installation? If not, use minimum of 1 mile spacing between two RDS.	☐	☐	☐
Will RDS be installed where free-flowing traffic occurs if speed detection is required?	☐	☐	☐
Will RDS be installed to avoid detection of turn-only lane when only through movement detection is required?	☐	☐	☐
Rural Freeways and Rural Roadways			
Will RDS be located along the critical routes for traffic monitoring and at or near the interchange areas?	☐	☐	☐
Is RDS located where free-flow traffic less likely to affected by stop conditions?	☐	☐	☐

RDS Quantity Guidelines			
Are there two RDS installed where detection zone exceeds 200 feet?	☐	☐	☐
Will a single RDS installed on either side of the road be capable of covering all travel lanes? If not, additional RDSs can be installed after coordination with MDOT.	☐	☐	☐
RDS Set-Back and Mounting Height Guidelines			
Has designer considered manufacturer's set-back distance recommendation?	☐	☐	☐
Has the site been chosen so that it will maintain the set-back distance from 25 to 35 ft. or a minimum of 4 feet behind guardrail?	☐	☐	☐
Has designer considered any near embankment or hill area? RDS structure height will be less or higher than recommended heights for installations at these locations.	☐	☐	☐

RDS Field Cabinet			
Step	**Yes**	**No**	**N/A**
Is side-mount radar field cabinet accessible form front and back?	☐	☐	☐
Does located cabinet provide sufficient clearance around the pole base (i.e., Opening of cabinet doors to 90 degrees)?	☐	☐	☐
Is a cabinet location can be accessible by bucket truck?	☐	☐	☐
Will Type A Cabinet (recommended) be installed for stand-alone location at proposed location?	☐	☐	☐
Is proposed RDS located near a CCTV location? If so, it is desired to co-locate RDS with a CCTV camera cabinet.	☐	☐	☐
Length of cable runs between the RDS unit and field cabinet should not exceed 100 feet.	☐	☐	☐

Checklist: Bluetooth Detection System (BDS) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Are BDS installed approximately 10 feet above the surface (or as required by MDOT)?	☐	☐	☐
Has designer considered spacing of BDS based on the data that needs to be collected?	☐	☐	☐
Are BDSs spaced to provide data as required by the application or as directed by MDOT?	☐	☐	☐

BDS Cabinet			
Step	**Yes**	**No**	**N/A**
Does located cabinet provide sufficient clearance around the pole base?	☐	☐	☐
Is cabinet can be accessible by a bucket truck?	☐	☐	☐
Will Type A cabinet be installed at proposed location?	☐	☐	☐
Will a concrete maintainer's pad be provided at the cabinet's main door?	☐	☐	☐
Does located cabinet provide sufficient clearance around the pole base?	☐	☐	☐

Checklist: Road Weather Information System (RWIS) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement Guidelines			
Does the proposed RWIS location and installation follow FHWA–HOP-05-0226 guidelines for selection of a location?	☐	☐	☐
Has designer considered known weather issue areas (e.g., bridge deck icing, fog, standing water)?	☐	☐	☐
Is RWIS being installed at a location where it doesn't trigger any false readings?	☐	☐	☐
Is RWIS tower being installed between 30 and 50 feet from edge of the roadway?	☐	☐	☐
Is RWIS installed at locations which avoid standing water, billboards, and vegetation?	☐	☐	☐
Has designer considered the height and orientation of RWIS installation?	☐	☐	☐
Has designer considered factors like topography, soil type, land use, microclimate zones, and utilities while determining the proposed RWIS sites?	☐	☐	☐
Is RWIS tower located in right-of way and is easily accessible for maintenance crew?	☐	☐	☐
RWIS Tower / Structure Placement Guidelines			
Is tower based attached to a fenced concrete pad? (Use barrier or guardrail if in the clear zone)	☐	☐	☐
Is fence 15 feet away from any face of the tower?	☐	☐	☐
Median placement is not recommended unless median is 100 feet or wider.	☐	☐	☐
Is access for maintenance provided that accommodate vehicle (also a bucket truck) and personnel?	☐	☐	☐
Is RWIS located near electrical and communication services?	☐	☐	☐
Is RWIS tower located when surrounding terrain is low or at least 50 feet form tower?	☐	☐	☐
Is RWIS tower placed to avoid slopes within 300 feet that could impact wind measurement?	☐	☐	☐
Is installed RWIS location avoids swampy areas, steep cut sections, and standing water?	☐	☐	☐
Are anti-climb panels installed to RWIS tower to restrict use?	☐	☐	☐

RWIS Field Cabinet			
Step	**Yes**	**No**	**N/A**
Is the RWIS field cabinet and other MDOT field cabinet co-located (to minimize cost)?	☐	☐	☐
Is field cabinet ground mounted where the structure/pole is difficult to access?	☐	☐	☐
Is the field cabinet easily accessible?	☐	☐	☐
Is the field cabinet placed in safest possible location?	☐	☐	☐
Is a field cabinet oriented in a direction that the maintainer is facing the road while performing maintenance at the cabinet location?	☐	☐	☐
Will cabinet be located where it can be easily accessible without using stepladder?	☐	☐	☐
Has designer considered elevating the critical electronic components above the flood elevation?	☐	☐	☐
Will proposed cabinet be a NEMA standard cabinet?	☐	☐	☐

RWIS Mounting Structure Type Functional Requirements			
Step	**Yes**	**No**	**N/A**
Is the installed RWIS structure a tower, pole, or ITS Gantry?	☐	☐	☐
Will a foundation size be designed for specific site condition?	☐	☐	☐
Is RWIS structure meets manufacturer's requirements for deflection?	☐	☐	☐
Is tower 30 feet high if installing wind sensor?	☐	☐	☐
Is tower located between 35 to 50 feet from edge of paved surface?	☐	☐	☐

Checklist: Highway Advisory Radio (HAR) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Is the HAR system located at key decision points along the transportation system?	☐	☐	☐
Will the HAR be installed located prior to interchanges that offer alternate routes?	☐	☐	☐
Is the HAR located near key commuter or evacuation corridors?	☐	☐	☐
Will proposed HAR be installed outside of the right-of way?	☐	☐	☐
Is the HAR installed provides sufficient distance away from the HUB and other structures?	☐	☐	☐
Is the HAR located within an interchange (if possible)?	☐	☐	☐
Has designer considered providing phone line service in addition to fiber optic communication?	☐	☐	☐
Transmitter / Antenna Placement			
Is transmitter/antenna site free from significant vertical obstruction (e.g., buildings, tall trees, lighting, etc.)?	☐	☐	☐
Will the transmitter be installed located where there is sufficient open ground for cabinet and antenna installation?	☐	☐	☐
Is transmitter located on the highest ground possible?	☐	☐	☐
HAR Sign/ Beacon Placement			
Is sign/beacon co-located with an existing CCTV camera? (for visual verification purpose)	☐	☐	☐
Is flashing beacon sign installed within the HAR coverage area prior to exit signs or DMS?	☐	☐	☐
Has MUTCD sign standards been followed?	☐	☐	☐
Is HAR completely visible to motorists?	☐	☐	☐
Is HAR located in advance enough that permits travellers to modify their routes based on message?	☐	☐	☐
Has designer considered doing signal strength test if wireless communication is used?	☐	☐	☐
Is sign placed at least 800 feet from other static or dynamic signs or other visual obstructions?	☐	☐	☐
Is sign located inside the outer edge of the broadcast transmitter range?	☐	☐	☐
Will sign be installed far enough to give motorists time to locate radio channel and listen to the message (120 seconds)?	☐	☐	☐

HAR Field Cabinet			
Step	**Yes**	**No**	**N/A**
Is the HAR cabinet placed on the HAR ground mounted pole or sign structure?	☐	☐	☐
Is the HAR cabinet located at a convenient location with easier access if HAR structure/pole is difficult to access?	☐	☐	☐
Is field cabinet accessible from front and back?	☐	☐	☐
Does located cabinet provide sufficient clearance around the pole base?	☐	☐	☐
Will Type B or Type C cabinet be installed at proposed location?	☐	☐	☐
Will a concrete maintainer's pad be provided at the cabinet's main door?	☐	☐	☐

Checklist: Video Detection System (VDS) Field Review

Location / Placement Guidelines			
Step	**Yes**	**No**	**N/A**
General Placement			
Has designer considered the mounting heights of camera, as it is critical to the accuracy of the device?	☐	☐	☐
Is VDS located directly in line with lane directions, or at any angle in-between?	☐	☐	☐
Will proposed VDS be co-located on existing structure and meet clearance requirements?	☐	☐	☐
Will there be two cameras installed (one at ramp and one for main line) if installing VDS at ramp location?	☐	☐	☐
Are different mounting heights of camera been considered as VDS detects different lanes at different heights?	☐	☐	☐
Urban Freeways			
Are VDS installed approximately 1-mile (typical) apart if the detectors are part of a corridor data collection system?	☐	☐	☐
Urban Arterials and Highways			
Are VDS installed at recommended 1-mile (typical) spacing?	☐	☐	☐
Is VDS mounted on traffic signal mast arms (preferred locations for urban areas)?	☐	☐	☐
Rural Freeways and Rural Roadways			
Coordination with MDOT is required before selecting a VDS location for Rural Freeways.	☐	☐	☐

VDS Functional Requirements			
Step	**Yes**	**No**	**N/A**
Has designer looked at opportunity to setup multiple detection zones using camera?	☐	☐	☐
Has designer considered the possible performance impact from inclement weather as well as strong winds?	☐	☐	☐
Will cameras be mounted at 30 to 50 feet of height?	☐	☐	☐
Will cabinet by ground (base) mounted with maintainer concrete pad?	☐	☐	☐
Are VDS cameras rigid mounted?	☐	☐	☐

VDS Field Cabinet			
Step	**Yes**	**No**	**N/A**
Have Department standards been followed in the design of the pole mount/structure and foundation?	☐	☐	☐
Is field cabinet accessible from front and back?	☐	☐	☐
Does located cabinet provide sufficient clearance around the pole base?	☐	☐	☐
Is cabinet can be accessible by a bucket truck?	☐	☐	☐
Will Type A or Type B cabinet be installed at proposed location?	☐	☐	☐
Will a concrete maintainer's pad be provided at the cabinet's main door?	☐	☐	☐
Length of cable runs between VDS unit and field cabinet should not exceed 100 feet.	☐	☐	☐

Appendix C
Plans Checklists

Checklist: Preliminary Design (50%) ITS Plans Submittals

Title Sheet (if stand-alone ITS project)	
☐	Project name & numbers, route numbers, county(ies)
☐	Annotated state map w/project location & approx. latitude /longitude. coordinates
☐	Annotated location map w/project limits, sheet key & other pertinent info.
☐	Scale(s) & north arrow
Detailed Index & ITS Legend (if stand-alone ITS project):	
☐	Index listing sheet descriptions & working numbers
☐	Standard legend for existing and proposed ITS elements (NOTE: If ITS-specific Detailed Index is not prepared, show ITS Legend on another detail sheet.)
General Notes	
☐	General and ITS-specific notes, as required by project scope
☐	Utility contact information
Quantities Sheet(s):	
☐	List of project pay items & quantities (NOTE: Detailed tabulation of quantities (e.g., cable/conduit lengths) not required for this submittal.)
Project Location Plan:	
☐	Annotated map with project limits, major device locations, sheet key
☐	Scale & north arrow
ITS Plan Sheets:	
☐	Topographic or aerial photo base mapping, with all routes, lane configuration, key topographic features, major landmarks and other pertinent information clearly identified
☐	Annotated baseline for each route
☐	Match lines referencing adjacent plan sheets
☐	Existing ITS elements clearly identified
☐	Proposed ITS elements clearly identified, including: ○ Device stations and offsets ○ Conduit bank locations – SIZES, LENGTHS NOT REQUIRED ○ Communications cable types – LENGTHS NOT REQUIRED ○ Electric cable – SIZES, LENGTHS, # OF CONDUCTORS NOT REQUIRED ○ Pull boxes & types ○ Equipment pole types & lengths ○ Field cabinet types & locations ○ Cabinet equipment ○ Notes & details for any modifications to existing cabinets ○ Communication demarcation points ○ Electric demarcation points – LOCATIONS ONLY

- Guard rail – PRELIMINARY LOCATIONS, LENGTHS ONLY
- References to ITS detail sheets (e.g., DMS details), as appropriate

☐ Project limits (on applicable sheets)

☐ Scale & north arrow

Special Design Sheets

☐ Aerial Supported Conduit Details (as required)

- ☐ Details and notes for all structure attachments

☐ Cabinet Details (as required)

- ☐ Typical details and notes for each cabinet type used on project

☐ CCTV Details (if the project includes CCTV cameras):

- ☐ Typical notes and details for fixed and PTZ-type camera equipment used on project
- ☐ Typical notes and details for steel poles and other structures where cameras are mounted

☐ Communications Hut Details (if the project includes installation of Comm. Hut)

- ☐ Hut layout, showing location and dimensions

☐ DMS Details (if the project includes dynamic message signs):

- ☐ Plan and elevation view details and notes for a typical DMS installation

☐ Equipment Details (as required by the project scope):

- ☐ Typical schematic block diagram for ITS installations

☐ Fiber Optic Details (as required by project scope):

- ☐ Pull box and conduit installation details, including:
  - *Pull box types, dimensions, details & notes*
  - *Conduit bank trenching detail(s)*
  - *Pull box & fiber optic cable marker/label details*
- ☐ Cable management details, including:
  - *Treatment of fiber optic cable in pull boxes, including slack/storage requirements*
  - *Treatment of electric cable in pull boxes*

HAR Details (if the project includes highway advisory radio):

☐ HAR system coverage map, including:

- ☐ Annotated location map showing HAR transmitter locations, sign locations, approximate transmission coverage limits, sheet key & other pertinent info.
- ☐ Legend, scale & north arrow

☐ HAR system details, including:

- ☐ Typical notes and details—HAR transmitter, field cabinet and supporting equipment
- ☐ Grounding plane layout

☐ HAR sign & flashing beacon details, including:

- ☐ Typical HAR sign & support details
- ☐ Details of beacon types, dimensions and supporting equipment

Electrical Details (as required by the project scope):

☐ Typical notes and details for power service and supporting equipment

RDS Details (if the project includes radar detection systems):

☐ Typical notes and details for RDS equipment used on project

☐	Typical notes and details for poles and other structures where RDS equipment is mounted
VDS Details (if the project includes video detection systems):	
☐	Typical notes and details for VDS equipment used on project
☐	Typical notes and details for poles and other structures where VDS equipment is mounted

Checklist: Pre- and Final Design (90/100%) ITS Plans Submittals

Title Sheet (if stand-alone ITS project):

- ☐ Project name & numbers, route numbers, county(ies)
- ☐ Annotated state map with project location & approximate latitude/longitude coordinates
- ☐ Annotated location map with project limits, sheet key & other pertinent info.
- ☐ Scale(s) & north arrow
- ☐ **Approx. project length**
- ☐ **Engineer seals & signatures**

Detailed Index & ITS Legend (if stand-alone ITS project):

- ☐ **Index listing sheet descriptions, revision dates, working numbers & sheet numbers**
- ☐ **Listing of all applicable MDOT Standard Drawings**
- ☐ **"PS&E Plans" block with date, FMS project numbers and plan revision notations**
- ☐ Standard legend for existing and proposed ITS elements
(NOTE: If ITS-specific Detailed Index is not prepared, show ITS Legend on another detail sheet.)

General Notes:

- ☐ **General and ITS-specific notes, as required by project scope**
- ☐ **Utility contact information**

Summary of Quantities Sheet(s):

- ☐ **Recap of project quantities—listing each pay item, unit and preliminary estimate**
- ☐ **Footnotes for each pay item, as needed to clearly communicate the work required (NOTE: If project limits include multiple counties, quantities must be sub-totalled by County.)**

Estimated Quantities Sheet(s):

- ☐ Sheet-by-sheet project quantities—listing each pay item, unit and preliminary estimate
- ☐ Other misc. quantity blocks/tabulations (e.g., guard rail), as required by Department

Project Location Plan:

- ☐ **Annotated map with project limits, major device locations, sheet key & other pertinent info**
- ☐ Scale & north arrow

ITS Plan Sheets:

- ☐ Topographic or aerial photo base mapping, with all routes, lane configurations, key topographic features, major landmarks and other pertinent information clearly identified
- ☐ Annotated baseline for each route
- ☐ Match lines referencing adjacent plan sheets
- ☐ Existing ITS elements clearly identified
- ☐ Proposed ITS elements clearly identified, including:
  - ☐ Device **ref. numbers**, stations and offsets
  - ☐ Conduit bank sizes, **types and lengths**

- ☐ Electric cable **sizes, lengths and # of conductors**
  - ☐ Pull boxes & types
  - ☐ Equipment pole types & lengths
  - ☐ Field cabinet types and locations
  - ☐ **Cabinet equipment (e.g., field switches, etc.), as required**
  - ☐ **Notes & details for any modifications to existing cabinets**
  - ☐ Communication demarcation points
  - ☐ Electrical demarcation points, **include required voltage & estimated power demand**
  - ☐ **Guard rail lengths**
  - ☐ Reference to ITS details sheets (e.g., DMS details), as appropriate
- ☐ Project limits (on applicable sheets)
- ☐ Scale & north arrow

Special Design Sheets

- ☐ Aerial Supported Conduit Details (as required):
  - ☐ **Typical plan, elevation and section view details and notes for all structure attachments**
  - ☐ **Typical surface-mounted pull box detail**
  - ☐ **Typical aerial conduit expansion assembly detail**
  - ☐ **Annotated images of existing bridge drawings, showing attachment locations and other details (where required by MDOT Bridge Division)**
- ☐ Cabinet Details (as required):
  - ☐ **Typical details and notes for each cabinet type used on project**
- ☐ CCTV Details (if the project includes CCTV cameras):
  - ☐ Typical notes and details for fixed-and PTZ-type camera equipment used on project
  - ☐ Typical notes and details for steel poles and other structures where cameras are mounted
- ☐ Communications Hut Details (of the project includes installation of Comm. Hut)
  - ☐ **Site-specific details and notes for Communications Huts, including:**
    - ***Hut layout, showing location (stations, offsets) and dimensions***
    - ***Typ. section & other details for gravel access roads, as required***
    - ***Details & tabulations of all required equipment inside Communications Hut***
    - ***References to Special Provision and applicable Notice to Bidders, as appropriate***
- ☐ DMS Details (if the project includes dynamic message signs):
  - ☐ **Plan and elevation view details and notes for each DMS installation, including:**
    - ***Existing lane configurations***
    - ***Stations & offsets for all DMS signs, supports, cabinets and other equipment***
    - ***Approx. structure span length (for overhead supports)***
    - ***Guard rail and roadside clearance details & dimensions, as required***
- ☐ **Erosion Control Plan (if required by the project scope):**

- ☐ **Typical notes and details for erosion & sediment control during installation of conduits, pull boxes, foundations, etc.**

☐ Equipment Details (as required by the project scope):

- ☐ **Typical notes and schematic block diagrams for ITS device installations/modifications**

☐ Fiber Optic Details (as required by the project scope):

- ☐ Pull box and conduit installation details, including:
  - *Pull box types, dimensions, details & notes*
  - *Conduit bank trenching detail(s)*
  - *Pull box & fiber optic cable marker/label details*
- ☐ **Fiber routing schematic, depicting:**
  - ***Existing ITS devices, TMC(s) and other system elements***
  - ***Proposed ITS devices, equipment and connections/interfaces***
- ☐ **Fiber splicing details, including:**
  - ***Tabulation of all fiber splice and network switch locations***
  - ***Typical details (w/ reference #'s) specifying fibers to be spliced at certain locations***
- ☐ **Termination cabinet tables, including:**
  - ***Tabulation of all connections/patches in fiber trunk termination cabinets***
  - ***Misc. termination details (e.g., termination module detail; patch cable connections at fiber drop panels, switches and field devices)***
- ☐ **Other cabinet/equipment tabulations, as warranted**
- ☐ Cable management details, including:
  - *Treatment of fiber optic cable in pull boxes, including slack/storage requirements*
  - *Treatment of electric cable in pull boxes*

☐ HAR Details (if the project includes highway advisory radio):

- ☐ HAR system coverage map, including:
  - ***Annotated location map showing HAR transmitter locations, HAR sign locations, approx. HAR transmission coverage limits, sheet key & other pertinent info.***
  - *Legend, scale & north arrow*
- ☐ HAR system details, including:
  - *Typical notes and details – HAR transmitter, field cabinet and supporting equipment*
  - *Grounding plane layout*
- ☐ HAR sign & flashing beacon details, including:
  - *Typical HAR sign & support details*
  - *Details of beacon types, dimensions and supporting equipment*
- ☐ **HAR sign schedule, including:**
  - ***Tabulation of HAR sign dimensions, lettering styles and dimensions***
  - ***Tabulation of quantities for HAR signs, supports & foundations***

☐ Electrical Details (as required by the project scope):

	☐	**Typical notes and details for power service demarcation points, including all required meters, cabinets, disconnects, grounding, transformers and other supporting equipment**
☐	RDS Details (if the project includes radar detection systems):	
	☐	Typical notes and details for RDS equipment used on project
	☐	Typical notes and details for poles and other structures where RDS equipment is mounted
☐	**Traffic Control Plan (as required by the project scope):**	
	☐	**Typical notes and details for work zone traffic control during installation of ITS elements in close proximity to active roadways**
	☐	**Specific traffic control detail drawings (e.g., shoulder closure, etc.), as required by the Department**
☐	VDS Details (if the project includes video detection systems):	
	☐	Typical notes and details for VDS equipment used on project
	☐	Typical notes and details for poles and other structures where VDS equipment is mounted

***** NOTE: Items highlighted in bold were not required for Preliminary Design (50%) submittal. *****

Appendix D
Typical Label Formats for MDOT ITS Projects

This appendix includes formatting requirements for MDOT ITS projects.

If other miscellaneous cabinet modifications are required (e.g., installation of new power supply, re-splicing of cables, etc.), then include CABINET MODIFICATION in list or required items. There is a "per each" pay item for cabinet modifications.

In bottom half of label, specify the Notice to Bidders # for Cabinet Modifications. This NTB will spell out requirements and method(s) of payment for modifications needed at each cabinet.

Type A & B Cabinets:

TYPE _____ CABINET (______MOUNTED)

TYPE _______NETWORK SWITCH (________MOUNTED)

[PROVIDE LOCATION INFO, ONLY IF PAD-MOUNTED]

In top half of label, insert cabinet type (A or B) and mounting type, where indicated.

In the bottom half, fill-in any site-specific equipment for which we have separate pay items.

Currently available options are:

TYPE __ NETWORK SWITCH

In bottom half of label, indicate whether cabinet is to be pad-mounted or pole-mounted.

If pad-mounted, provide station, offset from E.O.T.L. and supplemental location reference.

Example Label:

TYPE B CABINET (POLE MOUNTED)
STA. 570+30, 40' FROM E.O.T.L.
200' SOUTH FROM EXISTING MM 32 SIGN

1-NETWORK SWITCH, TYPE A

DMS (Type C) Cabinets:

PAD-MOUNTED DMS CABINET W/ TYPE ____ NETWORK SWITCH
(SWITCH PAID SEPARATELY; CABINET, CONC. PAD AND ALL
OTHER COMPONENTS ABSORBED IN ITEM 907-656-A)

STA. _______+___, ___’ FROM E.O.T.L.
[ADDITIONAL LOCATION REFERENCE]

FIBER TERMINATION CABINET:
TYPE C (GROUND MOUNTED)
+ __________ TERMINAL PANELS

STA ___ + ____, 10-FEET FROM EOTL
TERMINATE ALL / ____ FIBERS
[ALL OTHER COMPONENTS BESIDES CABINET TO BE USED TO BE ABSORBED IN ITEM 970-661]

CCTV/RDS Site:

CCTV #__, __ PTZ (IP) & __ FIXED (IP)
RDS #__
___’ CAMERA POLE

STA. ____+__, ___’ FROM E.O.T.L.
[ADDITIONAL LOCATION REFERENCE]

Stand-alone RDS Site:

RDS #__
___’ DETECTOR POLE

STA. ____+__, ___’ FROM E.O.T.L.
[ADDITIONAL LOCATION REFERENCE]

Structure-mounted RDS:

RDS #__

ATTACH TO EXISTING _____________
(SEE TYP. DETAIL ON WK. NO. ____-__)

DMS Power & Comm.:

COND. BANK (2 – 2" ROLL PIPE) (_______')

DMS POWER & COMM.
(CABLES ABSORBED IN ITEM 907-656-A)

Trunk Fiber and Power Run:

COND. BANK (3 – 2" ROLL PIPE) (_______')

1-F.O. CABLE (______')
__-POW #__ (______')

Fiber drop from Type 5 pull box to device immediately adjacent to fiber trunk:

1 – F.O. DROP (15') (TO CABINET)
--- {hexagonal label for pull box}
SEE DETAIL __ ON WK. NO. FO-__

Power feed from Type 2 pull box to adjacent cabinet:

__ – POW #____ (15') (TO CABINET)
--- {hexagonal label for pull box}

Combined fiber drop and power feed from pull boxes to device/cabinet immediately adjacent to fiber trunk:

1 – F.O. DROP (15') (TO CABINET)
__ – POW #____ (15') (TO CABINET)
--- {hexagonal label for pull box}
SEE DETAIL __ ON WK. NO. FO-__

Power Demarcation Point:

ELECTRICAL DEMARCATION

MAX _____W
AVG _____W
______V, ________ PHASE
__' WOOD POLE REQUIRED

Modifications to existing field cabinets:

EXISTING CABINET
[ADDITIONAL LOCATION REFERENCE]
____________, _____________ &
__________________ REQUIRED

SEE NTB #__________ FOR DETAILS

Appendix E
Notice to Bidders (NTB) Examples

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 904 - NOTICE TO BIDDERS NO. XXXX

DATE: **06/05/2017**

SUBJECT: **ITS Equipment Cabinet Modifications**

PROJECT: **SP-9999-01(007) / 107364301 – Lee, Pontotoc and Union County**

Bidders are hereby advised that the following additional requirements for Cabinet Modifications shall be required on this project. Work and materials not paid for under other pay items shall be included in the price bid for Pay Item Number 660-B.

Cabinet Modifications:
Furnish, install, configure, test and integrate all proposed ITS communication, network, video and associated equipment as shown in the plans into the proposed and existing traffic signal controller and ITS cabinets. This shall be paid for under the associated pay items of: Radar Detection Systems (641-C & D), On Street Video Equipment (SP 907-650-A), Fiber Optic Cable (SP 907-661-A), Radio Interconnect System (662-B & D), Networking Equipment, terminal servers, and CAT-6 (SP 907-663-A, B, & D), and Bluetooth Detection System (SP 907-666-A). Install all incidentals, cabling and materials necessary to provide communications, power, and surge protection to the equipment cabinet, ITS devices, networking equipment, traffic signal controllers, cameras, and detector units.

This shall include the following existing Traffic Signal Cabinets at the intersections of:

- Coley Rd. with
  - McCullough Rd. (Sta. 6007+45)
  - US Highway 78 Eastbound Ramps (Sta. 6039+25),
  - US Highway 78 Westbound Ramps (Sta. 6044+00),
- State Route 145 with
  - US Highway 278/State Route 6 (Sta. 4073+50),
  - Shell St. (Sta. 4092+65),
  - S. Green St. (Sta. 4127+00),
  - W. Eason Blvd. (Sta. 4147+50),
  - Garfield St. (Sta. 4186+00),
  - Crossover Rd. (Sta. 4197+90),
  - Daybrite Dr. (Sta. 4208+30),
  - President Ave. (Sta. 4212+50),
  - Varsity Dr. (Sta. 4219+40),
  - Robert E. Lee Dr. (Sta. 4227+65),
  - Walmart signal (Sta. 4233+85),

- Main St. (Sta. 4246+20),
- Jefferson St. (Sta. 4251+90), and
- E. Jackson St. (Sta. 4271+20).

Work will include installing and connecting Radio Interconnect antennas and ITS devices as shown on the plans. All labor, equipment and materials necessary to provide the physical entrance for communication and power cables into the cabinet, whether via existing spare conduit or with a new and separate conduit entrance, shall be included in the bid price for Pay Item Number 907-660-B, unless specifically identified for separate payment in the Plans. Materials and construction methods for all cabinet entrances shall conform to details shown in the Plans and all other requirements set forth in the Plans and specifications. At locations where communications currently exist, the contractor shall make every effort to limit communication down-time to existing ITS and Traffic Signal devices. The Contractor shall submit a change-over plan which details the proposed cut-over and anticipated down time to MDOT for approval prior to disrupting current equipment communications.

In addition, the existing cabinets shall be modified so that the existing and proposed ITS devices will be connected to the existing and proposed equipment, as set forth in the Plans and specifications, and configured to communicate to the Communications Node in the MDOT District 1 Headquarters office (via the Antenna Tower and Communications Node Hut being installed on this project) and on to the Statewide Traffic Management Center.

Installation and Configuration: The Contractor shall install the radio interconnect, network switches, and terminal servers as shown on the plans, shall provide and connect communication cables as necessary to the devices and traffic signal controller, and configure the traffic signal controller to communicate with the existing traffic signal controller management software in the Statewide TMC.

All work, equipment, cords, configuration, and incidental cabling to modify the traffic signal controller to communicate and be integrated with the existing traffic signal controller management software in the TMC equipment room will be considered incidental and shall be included in the cost of Pay Item Number 907-659-A.

All work, equipment, cords, configuration, and incidental cabling required at the existing cabinets to connect equipment at existing locations, but not covered under other pay items, shall be considered incidental and shall be included in the cost of Pay Item Number 660-B. All existing equipment that is removed shall be delivered to the MDOT District Office.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 904 - NOTICE TO BIDDERS NO. XXXX

DATE: **06/06/17**

SUBJECT: **Networking Equipment**

PROJECT: **SP-9999-01(007) / 107364301 – Lee, Pontotoc and Union County**

Bidders are hereby advised that the following additional requirements for Networking Equipment shall be required on this project. Work and materials not paid for under other pay items shall be included in the price bid for Pay Item Number 907-663-A.

Networking Equipment:
The Contractor shall provide Type A and B switches with additional optional SFP modules which will allow for 20km of optical range. Contractor is also still responsible for providing proper attenuation to protect this and other SFP modules.

The Contractor is responsible for registering the switches with the switch manufacturer in MDOT's specified account name. As such, following receipt of project submittal approval and prior to ordering switches, the Contractor shall be required to contact MDOT Information Systems (IS) so that the Networking equipment to be ordered is established in MDOT's name for maintenance and support purposes.

The Contractor shall also ship all C, D, E and F switches to MDOT IS at least two (2) months before desired installation. Switches shall be shipped to:

MDOT Information Systems Division
Attn: Kerby McFarland
MDOT Administration Building
401 North West Street
Jackson, MS 39201

MDOT IS will be responsible for configuring C, D, E and F switches and delivering back to the Contractor for installation.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 904 - NOTICE TO BIDDERS NO. XXXX

DATE: 06/05/2017

SUBJECT: Location & Configuration of Communications Nodes

PROJECT: SP-9999-01(007) / 107364301 – Lee, Pontotoc and Union County

<u>Communications Node</u>

Bidders are hereby advised that:

- MDOT is to provide the network switch that is to be installed in the Communications Node Hut.
- Communications Node Huts, Communications Node Vaults, and all Communications Node Training shall be paid under Pay Item 907-664-B
- Modifications to existing equipment at the District 1 Headquarters office and the MDOT Statewide TMC shall be paid under TMC Modifications Pay Item 907-659-A.

All ancillary components to comprise a fully functional and operable final system shall be provided by the Contractor. The Contractor shall coordinate with MDOT to determine the necessary components. This may include, but is not limited to, network management / maintenance software licensing, optical transceivers, node chassis and power supplies. Any part substitutions due to revision or version changes must be approved by the MDOT Project Manager. All required components shall be included in the price bid for Item No. 907-664-B.

<u>Communications Node HUT</u>

Communications Node Huts, Vaults, and grounding systems, placed near the Antenna Tower at the MDOT District 1 Headquarters office located at 1909 N. Gloster Street, Tupelo, MS, 38804, will be provided as part of this project and shall be paid under Pay Item 907-664-B.

<u>Communications Node Installation, Configuration</u>

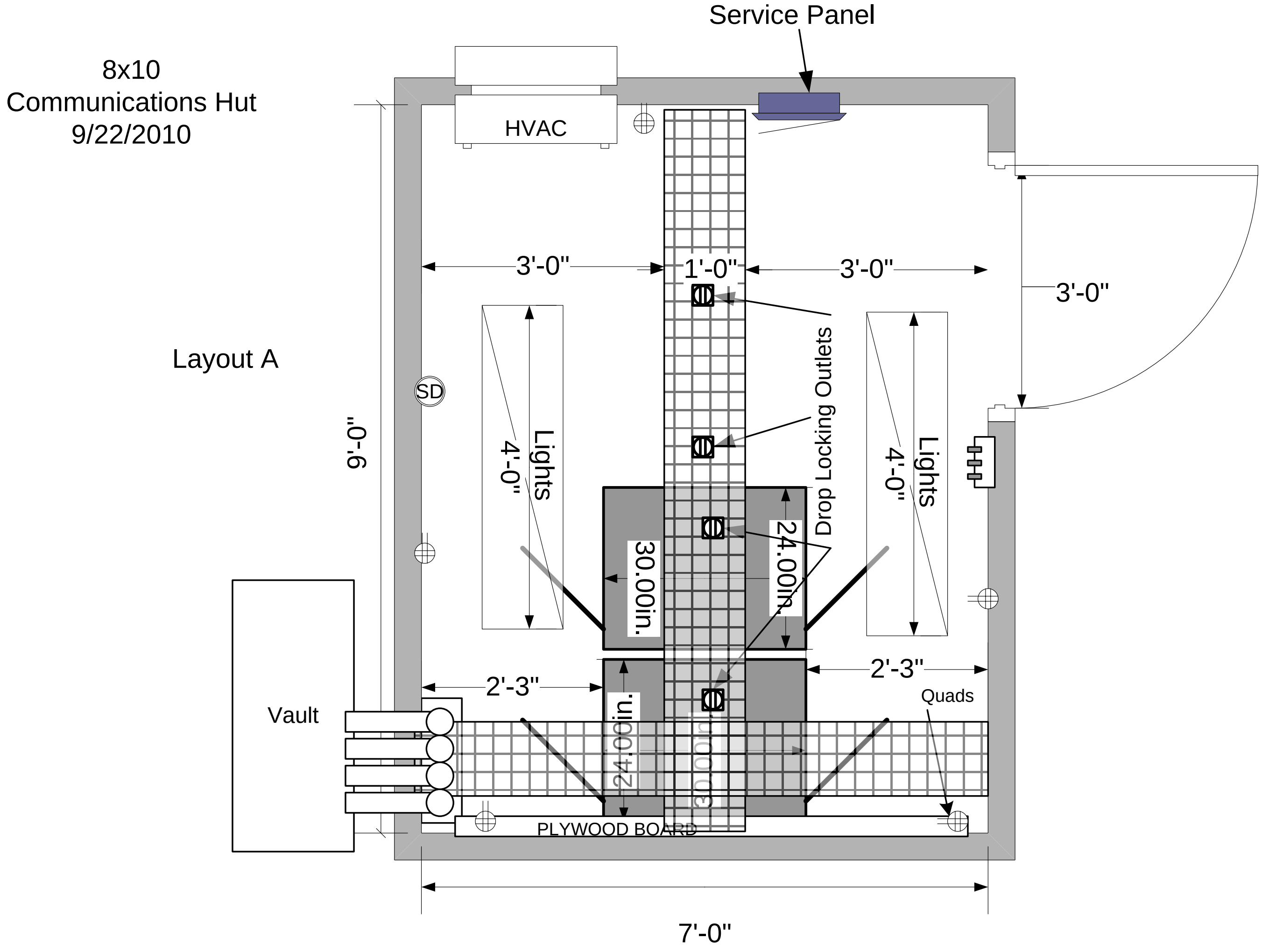
- All Parts, components, installation, configuration, and cabling of the Communications Node and ITS equipment located in the Communications Node Hut, except the MDOT provided Network Switch itself and switch configuration as covered in the Networking Equipment NTB, shall be paid under Pay Item 907-664-B.
- The Contractor shall provide electrical service during project and burn-in period.
- The Contractor shall arrange for transfer of electrical service to MDOT after project acceptance as directed by the MDOT ITS Program Manager.
- The Contractor shall interface and configure the Communications Node near the Antenna Tower to the MDOT District 1 Headquarters office Communications Node to provide communications between the two.
- The Network Switch will be connected by the Contractor in the Hut as follows:
  - The contractor is responsible to mount the Network Switch in the Contractor provided 19 inch racks at the Communications Node Huts.

- The contractor shall provide fiber optic patch cords at least 6 ft in length. In addition, the contractor shall provide 10 spare fiber optic patch cords per Communication Node Hut.
- The Contractor shall submit to the ITS Engineer for approval, a cable connection diagram done in Visio and an excel spreadsheet with port connections one week prior to connecting the Network Switch in the HUT buildings.
- **<u>Communications Node Hut near the Antenna Tower</u>**
  - At the proposed Communications Hut near the Antenna Tower, the contractor shall terminate all 72 proposed FO trunk fibers.
  - The ports, as listed in the table below, from each of the appropriate 72 fiber termination panels will connect in pairs to the SFP (Optical ports) of the Network Switch via appropriate single mode fiber optic patch cords, unless otherwise directed and/or approved by the ITS Engineer or his designee.

	Buffer Tube		
Trunk	BL	OR	SL
To D1 HQ			49,50,59,60

- WEB based rack mounted remote environmental monitoring system with the following elements:
  - H.264 IP based PTZ camera provided per SPECIAL PROVISION NO. 907-650 shall be connected to the Network Switch in the HUT via network cables.
  - Environmental sensors for heat and humidity
  - Power monitoring sensor
  - Alarm management system with email forwarding function

Layout of Communications HUT



8' x 10' outside Dimensions

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 904 - NOTICE TO BIDDERS NO. xxxx

DATE: 06/06/2017

SUBJECT: Radio Interconnect

PROJECT: SP-9999-01(007) / 107364301 – Lee, Pontotoc and Union County

Bidders are hereby advised that the following Radio Interconnect specifications will be required on this project. Work and materials not paid for under other pay items shall be included in the price bid for Pay Item Number 662-B and D.

Radio Interconnect

Scope of Work: The Mississippi Department of Transportation desires to implement a wireless RF Data network as indicated in the plans. It shall be incumbent upon the Contractor to design and install a 100% functional wireless system capable of providing video and data to the projects sites as shown on the plans. The Contractor may utilize Line-Of-Sight and Non-Line-Of-Sight, license restricted and license free spectrums to provide communications. MDOT is not specifying a specific technology or mix of technologies. A variety of frequency bands can be used. However, the communication system must meet the requirements of Section 662 of the 2017 Edition of the Mississippi Standard Specifications for Road and Bridge Construction. The radio channel infrastructure must be designed to support the full requirements of these specifications. It is expected that the system will transmit data over standard conventional radio channels. The system shall utilize necessary equipment to be able to provide Ethernet or Serial capability as needed.

The RF infrastructure provided in this project must cover all intersections and connections as shown in the plans and provide communications back to the MDOT District 1 Headquarters office located at 1909 N. Gloster Street, Tupelo, MS, 38804. The system must be expandable to cover future intersections which MDOT may choose to add at a future date.

Project Locations/Sites: Predictable and consistently reliable RF communications coverage shall be required for all MDOT connection locations shown in the plans. The MDOT has supplied limited information on many of the suggested sites in Appendix A of the Tupelo Antenna Tower NTB. However, it will be the Contractor's responsibility to forecast coverage from these sites using their own methods. These forecasts must meet MDOT's requirements for the desired system coverage and future growth. The Antenna Tower shall be placed within reasonable proximity to the location shown on the plans, unless otherwise approved by the project engineer; however, the Contractor is not limited to the locations shown for other antennas. It is the responsibility of the Contractor to select the antenna locations that will guarantee MDOT the desired system coverage outlined in these specifications and maintaining the ability for future growth. However, MDOT must approve all new antenna locations. MDOT will negotiate any necessary agreements and access permits with the local municipalities or owners and therefore must be made aware of these needs as early as practicable.
It is also the Contractor's responsibility to determine the number of radio channels needed to meet the minimum system requirements. The MDOT will not be liable for any costs incurred by

the Contractor in preparing a response to these specifications. The Contractor will submit a response at his own risk and expense.

The Contractor is responsible for the RF link performance. If the RF coverage performance of the installed system does not meet the requirements of these specifications, the Contractor will modify or otherwise cause the system to meet the minimum requirements at no cost, directly or indirectly to the MDOT and must state a time commitment for correcting such a condition.

The minimum bandwidth provided per each individual link shall be the cumulative minimum bandwidth of each device type and number of each per device utilizing that link according to the following table of minimum bandwidth requirements.

Device Type	Min Bandwidth per Device
CCTV PTZ	1.256 Mbps
CCTV Fixed	256 kbps
Detection	256 kbps
Traffic Signal Controller	128 kbps

References: The Contractor must be a reputable, established, and financially stable provider of wireless networks and must be a licensed Competitive Local Exchange Carrier (CLEC) and have held a CLEC license for at least the last three years with no interruption in licensure.

Training: After the installation is complete, the Contractor shall provide formal classroom training and "hands-on" operations training for proper operation and maintenance of the Radio Interconnect Systems. The training shall be provided for up to six personnel designated by the ITS Engineer and shall be a minimum of four hours in duration. The training shall cover as a minimum preventive maintenance, troubleshooting techniques, fault isolation and connection analysis. All training materials shall be provided by the Contractor.

1) Prior to training, submit resume and references of instructor(s). Also, submit an outline of the training course in a Training Plan. Submit the Training Plan within 90 days of Contract Notice-to-Proceed. Obtain approval of the Plan from the Engineer and the Traffic Engineering ITS Department. Explain in detail the contents of the course and the time schedule of when the training will be given.
2) Furnish all handouts, manuals and product information.
3) For the training, use the same models of equipment furnished for the project. Furnish all media and test equipment needed to present the training.
4) Training shall be conducted in the Tupelo area.
5) Training instructor(s) shall be manufacturer-certified, experienced in the skill of training others.

The training shall be conducted by a trainer with a minimum of four years of experience in training personnel on the operation and maintenance of Radio Interconnect Systems.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SECTION 904 - NOTICE TO BIDDERS NO. xxxx

DATE: **06/07/2017**

SUBJECT: **Traffic Management Center (TMC) Modifications**

PROJECT: **SP-9999-01(007) / 107364301 – Lee, Pontotoc and Union County**

Bidders are hereby advised that the following Traffic Management Center (TMC) Modifications will be required for this project.

MDOT TMC Modifications

Site 1: Tupelo Regional TMC – 1909 N. Gloster Street, Tupelo, Mississippi (MDOT District 1 Headquarters)
Site 2: The MDOT Statewide TMC is located at 2567 North West Street, Jackson, MS, 39216. The center is in the MDOT Shop Complex, Building A, on the 3rd Floor.

SITE #1:
Software: The Contractor shall initially use vendor supplied software to test the Traffic Signal Controllers, Radar Detection Systems (RDS), Bluetooth Detection Systems (BDS), and Closed Circuit Television Camera (CCTV) systems installed, interfaced or configured on this project and demonstrate full compliance with the contract requirements. The Contractor shall test each using the leased line. A minimum of Two (2) licensed copies of each system of the vendor supplied software must be provided to MDOT upon completion of the testing for each component.

Equipment: Layout of the equipment, video systems, and workstations for the Tupelo Regional TMC shall be as directed and approved by the MDOT Project Engineer. Contractor must coordinate with the MDOT District 1 IT representative prior to installation of equipment.

- **Video Systems:**
  The Contractor shall provide, install, and integrate any equipment needed to support displaying and monitoring existing and new video from MDOT Statewide TMC VDMS systems and this project in the Tupelo Regional TMC. The contractor to include at a minimum two 60 inch video monitors and a PC at Site 1 (lower level, west wing conference room) that can support both monitors at 4K resolution. The video system shall be configured and support the ability to show the MDOT VDMS First responders page running a minimum of 12 simultaneous videos on one screen and the MDOT ATMS software status screen on the other monitor or both screens running MDOT VDMS videos, each with 12 simultaneous videos displayed.
  The video monitors at a minimum shall have the following:
    - Minimum of 60 inches each.
    - Supports 4k resolution.
    - Minimum of 3 HDMI inputs
    - RGB input.

  The Video PC at a minimum shall:
    - Support display to both monitors

- Support running MDOT VDMS and ATMS running at the same time such that:
  - Displaying the VDMS with 12 Simultaneous videos on each display or VDMS with 12 simultaneous videos on one display and ATMS status screen on the other display.

- **Tupelo Regional EOC Operator Workstation:**
  The Contractor shall provide, install, and integrate in the Tupelo Regional TMC, a PC and two connected monitors that shall communicate on the MDOT Statewide TMC network and function as an EOC Operators Workstation. The Operator Workstation shall be capable of logging into the Statewide TMC and running any software or application that any Statewide TMC operator’s workstation is capable of. This includes but not limited to the TMC ATMS, the MDOT VDMS, HAR clients, RWIS Clients. The workstation shall support the ability to display up to four simultaneous displays and initially be configured with two displays that are a minimum of 32 inch monitors. The operator workstation shall support at a minimum displaying the VDMS with 12 Simultaneous videos on one display and ATMS screen on the other display.
- **Tupelo Regional TMC Operator Workstation:**
  The Contractor shall provide and install necessary power and network cabling to support the installation of a future TMC operator workstation and video display systems at location as directed by the Project Engineer.
- **Leased Line Service:**
  The Contractor shall be responsible for all coordination, installation, materials, and any equipment necessary to install an AT&T METRO - E leased line service, that is part of the MPLS service, to connect the Tupelo Regional TMC, new project devices, and new project tower to the Statewide TMC network. The Contractor shall provide the address of the Tupelo Regional TMC and any information required for AT&T to provide service to the Tupelo Regional TMC. The Contractor shall be responsible that the leased line service is provisioned to support the bandwidth necessary to support:
  - The projects new devices and the Tupelo’s region’s existing devices communicating to the Statewide TMC systems, including cameras dual stream video.
  - The Projects new tower and network interfaces
  - The new Tupelo Regional TMC and operators remote logging into the Statewide systems to support streams to the video displays and operator stations and its displays. The Contractor shall be responsible to coordinate with MDOT and AT&T for testing the configurations of the new leased circuit between the statewide and Tupelo Regional TMC. The Contractor shall coordinate with MDOT to install and configure an MDOT provided router to connect and interface to the MPLS network on the AT&T leased line.
- **Network Switch Connections:**
  The ports, as listed in the table below, from each of the appropriate 72 fiber termination panels will connect in pairs to the SFP (Optical ports) of the Network Switch via appropriate single mode fiber optic patch cords, unless otherwise directed and/or approved by the ITS Engineer or his designee.

	Buffer Tube		
Trunk	BL	OR	SL
To Tower			49,50,59,60

SITE #2:

Software: The Contractor shall initially use vendor supplied software to test the Traffic Signal Controllers, Radar Detection Systems (RDS), Bluetooth Detection Systems (BDS), and Closed Circuit Television Camera (CCTV) systems installed, interfaced or configured on this project and demonstrate full compliance with the contract requirements. The Contractor shall test each using the leased line. A minimum of Two (2) licensed copies of each system of the vendor supplied software must be provided to MDOT upon completion of the testing for each component.

MDOT ATMS Software: The Contractor shall update the licenses and license keys for the existing MDOT ATMS software to include all ITS devices, existing and provided by the Contractor under this project, that the existing ATMS has modules and device drivers for. The Contractor is required to fully configure the existing ATMS software for operation, status monitoring, configuring, and control of any of the RDS sensors, BDS sensors, and CCTV systems installed, interfaced or configured on this project. At a minimum, this shall include:

- Update and configure the existing map to show the locations of all ITS devices existing and provided by the Contractor that the existing ATMS has modules and device drivers for, including but not limited to: the RDS, BDS, and CCTV with dynamic icons.
- Install and configure all ITS devices existing and provided by the Contractor that the existing ATMS has modules and device drivers for, including but not limited to: RDS, BDS, and CCTV systems into the software's database.
- Configure Speed Map for new RDS and Blue Tooth Devices and travel time segments as directed by the MDOT Statewide TMC Manager.
- Provide configurations, licenses, and software required for BDS data (raw, reports, and XML feeds) integration to ATMS and reporting software.
- Install and Configure New Video Display systems in Tupelo Regional TMC to use First Responders Page of the MDOT VDMS system with existing and new video system devices.
- Install and configure an Emergency Operations Center (EOC) workstation in the Tupelo Regional TMC to use TMC and ATMS software by logging into the MDOT Statewide TMC
- Install and configure network systems to pass network data and video between field site devices, new communication tower installed on this project and the fiber connected between tower and the Tupelo Regional TMC, the leased line Service, and the MDOT Statewide TMC.

The Contractor is required to arrange for the ATMS vendor to be on-site to complete this configuration and provide the required testing to show that the software is fully functioning for each RDS, BDS, and CCTV.

SITE #1 and #2:

Testing: The Contractor shall submit a proposed test plan for review and approval by MDOT. The Test Plan shall demonstrate full compliance with all requirements in the plans and specifications.

Training: 6 hours of training and assistance for a maximum of 12 people shall be provided for operations, testing, and maintenance of the TMC & EOC Systems provided on this contract.

All work, materials, equipment and related items described in this NTB shall be included in the lump sum pay item for Traffic Management Center Modifications, 907-659.