233 Intelligent Transportation Systems (ITS)

233.1 General

Intelligent Transportation Systems (ITS) criteria provided in this chapter applies to the placement and installation of ITS devices and systems along Florida's roadways.

The design and layout of ITS facilities should complement the basic highway design and comply with:

- ***Standard Specifications***,
- ***Standard Plans***,
- ***Traffic Engineering Manual (TEM)***,
- ***Structures Manual (Volume 3)***,
- ***Manual on Uniform Traffic Studies (MUTS)***, and
- ***AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals***.

Refer to ***FDM 215*** for information regarding lateral offset requirements for poles, towers, or other structures.

Refer to ***FDM 261*** for information regarding structural support requirements.

Refer to ***FDM 328*** for information regarding ITS Plans content and requirements.

233.1.1 Railroad-Highway Grade Crossing Near or Within Project Limits

Federal-aid projects with a railroad-highway grade crossing near or within the project limits should refer to ***FDM 220.2.4***.

233.1.2 Attachments to Barriers

Refer to ***FDM 215*** for information regarding proposed attachments to bridge traffic railings, concrete median barrier walls, concrete shoulder barrier walls or the evaluation of existing attachments.

233.1.3 ITS Device Approval and Compatibility

ITS devices are traffic control devices and follow approval requirements discussed in ***FDM 232.1.3***.

Ensure that devices which share communications networks or provide related functions are compatible with each other and will not interfere with the operation of other devices or systems. Incorporate features and functions that allow interoperability with other ITS deployments throughout the region and state including existing Regional Transportation Management Center (TMC) hardware and software. Examples of general design characteristics that promote interoperability include:

(1) Systems and products based on open architectures and standards.

(2) Systems and products that are scalable and nonproprietary.

(3) Compatibility with the Department's SunGuide® Software System directly or via support of one or more of its related Interface Control Documents (ICDs).

233.2 Design Criteria

ITS design criteria, require that devices and systems be able to gather, analyze, and distribute real-time information to support the overall goal of improving the safety, efficiency, mobility, security, and integration of transportation systems. Consider the strengths and limitations of various technologies for collecting, analyzing, and disseminating information, and select devices that are most appropriate for a specific application.

Many ITS devices require specific placement and configuration requirements for the equipment to perform properly. ITS design should consider the strengths and limitations of various devices and technologies. Other general considerations for ITS designs include:

(1) Promoting safety for road users.

(2) Monitoring traffic and travel conditions.

(3) Supporting traffic management operations.

(4) Providing equipment access for maintenance personnel.

(5) Disseminating useful information to motorists.

See ***FDM 215*** for lateral offset requirements for poles, sign structures, field cabinets, and communication hubs for deployments. Coordinate any deviation or alternative or special design with the District Design Engineer.

233.2.1 Part 940

If the project involves ITS technologies, comply with the requirements specified in the ***Guidelines for the Implementation of Part 940 in Florida*** (Topic No. 750-040-003). This is to ensure compliance with ***Code of Federal Regulations (CFR) Chapter 23 Part 940 Section 940.11***, and Department requirements.

Authorization of federal funds for construction or implementation of the project, and subsequent reimbursement of approved expenditures cannot proceed until after compliance with ***Part 940*** is demonstrated.

233.3 Motorist Information Systems

Motorist Information Systems include Dynamic Message Sign (DMS), Highway Advisory Radio (HAR) and Road Weather Information System (RWIS).

233.3.1 Dynamic Message Sign (DMS)

DMS sign types include walk-in, front-access, or embedded with monochrome (typically amber text), full-color, or tri-color displays. Select the appropriate sign type based upon specific project needs.

Position the DMS to be legible from the roadway, taking into account the display characteristics of DMS technology (e.g., the vertical and horizontal viewing angles of the LED displays). Determine placement of a DMS installation based on specific project needs, as well as the following requirements:

(1) Compatibility with the message library proposed for use on the project, including text and graphics. Utilize DMS capable of displaying minimum character heights per the ***MUTCD***, Section 2L.04.

(2) Placement on Interstate and Freeway facilities prior to interchanges that offer alternate routes:

   (a) In advance of 1-mile exit signing.

   (b) Maintain minimum 800-foot spacing between existing and planned overhead static sign panels and other signs, per the ***MUTCD***. DMS should be installed on support structures without any static signage. Consider increased spacing when conditions allow.

(c) Maintain minimum of 1450-foot distance from decision points (meets ***MUTCD***/AASHTO Green Book requirements).

(d) In advance of interchanges where interstates meet to allow for advance messaging of traffic conditions on both roadways. Consider locations that are two exits before major interchanges as well as immediately prior to the interchange.

(3) Placement on arterials prior to major intersections and interchanges:

(a) At a distance approximately 1/4 to 1/2 mile in advance of major intersections and interchanges.

(b) At a location at least 600 feet from adjacent signalized intersections.

(c) At a location where the DMS is continuously visible to motorists for at least 600 feet.

(d) At a location where no existing or planned guide signs exist within the 600-foot minimum visibility distance.

(e) At a location with minimum interference from lighting, adjacent driveways, side streets, or commercial signage.

(f) At locations where no historical neighborhoods exist.

(4) Placement in advance of high crash locations and traffic bottlenecks.

(5) At a location where sufficient space is available between the edge of travel lanes and the R/W limits. The space must be wide enough to allow the DMS structure to be located within the R/W limits, while meeting the minimum clear zone requirement.

(6) At a location where no conflict with underground or overhead utilities exists.

(7) Placement that accommodates access for service and maintenance.

(8) Placement in advance of major system interchanges.

(9) Placement along key commuter or evacuation corridors.

(10) At a location downstream of rural interchanges in order to inform entering traffic of conditions ahead.

233.3.2 Highway Advisory Radio (HAR)

A highway advisory radio (HAR) system is an advisory tool that informs the public of traffic and safety related issues. HAR systems may be installed or upgraded with the approval from the Chief Engineer.

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, prerecorded, 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.

Refer to the Federal Communications Commission (FCC) regulations in ***CFR Title 47, Part 90.242*** relating to the operation of travelers' information stations. Additional information on licensing issues, frequency allocation, and other specifics may be obtained by contacting the Department's ITS Telecommunications Office.

Determine placement of a HAR installation based on specific project needs, as well as the following requirements:

(1) Ability to transmit a meaningful message that can be received by motorists traveling through the broadcast zone.

(2) Placement on Interstate and Freeway facilities prior to interchanges that offer alternate routes

(3) Placement in advance of high crash locations and traffic bottlenecks.

(4) Placement that accommodates access for service and maintenance.

(5) Placement along key commuter or evacuation corridors.

(6) Placement of flashing beacon signs within the HAR coverage area prior to exit signs or DMS associated with an interchange.

(7) Wood poles are often recommended by HAR manufacturers for antenna mounting to reduce interference that may occur with conductive poles. Check antenna requirements of proposed HAR manufacturers.

233.3.3 Road Weather Information System (RWIS)

Locate the environmental sensor station (ESS) associated with the road weather information system (RWIS) where its weather observations will be the most representative of the roadway segment of interest.

The poles or structures on which weather instruments are mounted are typically installed 30 to 50 feet from the roadway's edge to avoid the effects of passing traffic (e.g., heat, wind, splash), yet still be able to detect the weather conditions affecting motorists. Avoid standing water or locations where billboards, surrounding trees or other vegetation would affect the weather measurements. Median placement of an ESS on a divided highway is generally not feasible unless the median is 100 feet or wider.

For more information on appropriate location of ESS, refer to the ***FHWA's Road Weather Information System (RWIS) Environmental Sensor Station Siting Guidelines*, *Publication No. FHWA-HOP-05-026***.

Consider the communication link the RWIS installation requires for transmitting the weather data. FDOT RWIS deployments commonly utilize Ethernet communications over a fiber optic network. Satellite-based data collection packages using standards for National Oceanic and Atmospheric Administration (NOAA) and certification standards version 2 (CS2) certification for Geostationary Operational Environmental Satellite (GOES) transmission have also been deployed as part of a statewide wind speed warning system. Coordinate the use of satellite-based systems with the Department's ITS Telecommunications Office.

233.4 Video Equipment

Video Equipment include closed-circuit television (CCTV) systems and video display equipment.

233.4.1 Closed-circuit Television Systems

Closed-circuit television (CCTV) systems consist of roadside cameras, communication devices, as well as camera control and video display equipment. CCTV is located at one or more remote monitoring locations that allow surveillance of roadway and traffic conditions for traffic and incident management. Cameras are also required for visual confirmation of dynamic message signs and ramp signal operation, as well as security purposes.

Determine placement of CCTV device and overall system design based on specific project needs, as well as the following requirements:

(1) A camera on Interstate and Freeway facilities should be located to obtain a complete view of roadway features including lanes, shoulders, ramps, emergency stopping sites, and accident investigation sites. Cameras at interchanges should be able to view arterial traffic.

(2) Camera location should provide the ability to view any nearby DMS for message verification.

(3) Camera location should provide the ability to view crossing features (e.g., streets, rail, bridges).

(4) Device placement should accommodate service and maintenance access with minimal impact on traffic. For example, provide a lowering device to allow cameras to be lowered from the pole top to ground level for servicing with little or no disruption of traffic.

Coordinate the CCTV placement with other design features to assure a clear unobstructed view. Position the camera to reduce the risk that critical views will be blocked by the mounting structure.

Designs and plans must specify camera mounting height. Mounting height should be determined based upon specific project needs, as well as the following:

(1) Required viewing distance.

(2) Roadway geometry and lane configuration.

(3) Roadway functional classification (i.e., arterial, collector, or limited-access facility).

(4) Life-cycle cost, including maintenance impacts.

(5) Environmental factors, such as glare from the horizon or from headlights.

(6) Vertical clearance.

All camera housings, enclosures, lowering devices, and mounts must be designed to withstand sustained wind loads and gust factors specified in ***FDM 261***.

Refer to ***Standard Plans, Index 649-020*** or ***Index 641-020*** for CCTV camera pole and foundation requirements.

233.4.2 Video Display Systems

Video display equipment is utilized in the Transportation Management Center for viewing CCTV images and other information obtained from field locations. Develop a video display system design plan that is based on a detailed, documented analysis of:

(1) The control center room dimensions.

(2) The operator’s console desk layout.

(3) Various distances from the operator’s seating position to the video wall display.

(4) Viewing angles to the display wall at the proposed mounting height for the display supporting structure.

Consider any potential limitations introduced or imposed by existing facility construction that may hinder the installation of the video wall display. The video display components should be capable of being brought into the Transportation Management Center control room and assembled in place without having to make modifications to existing doorways, walls, floors, or ceilings.

233.5 Network Devices

Network devices include a variety of Internet Protocol (IP)-addressable electronic equipment used for the collection and dissemination of video, traffic data, and other information. Coordinate with District IT staff to:

(1) Obtain specific network requirements and information for communication network design.

(2) Assure compatibility with existing network equipment currently in operation.

Network devices should facilitate immediate replacement of defective or damaged units with minimal system downtime.

Consideration should be given to designs that promote open architecture, non-proprietary systems, as well as survivability and reliability. Consider solutions that provide immunity to single-point failure and implement redundant paths for reliability and survivability.

233.5.1 Managed Field Ethernet Switch

The managed field Ethernet switch (MFES) is an environmentally hardened field device that provides Ethernet connectivity from the remote ITS device to the network trunk interconnection point. When developing the design, consider the following:

(1) Distance limitations for common Ethernet media types.

(2) Fiber optic connection to devices outside the local cabinet if the design requires additional protection from transients

(3) Interference that may be induced on copper-based interconnects.

Provide an Ethernet port for the connection of each planned ITS field device along with spare capacity.

233.5.2 Device Server

The device server encapsulates serial data in network packets and transports the packets across IP networks. Designs generally include device servers when remote field devices are connected to an Ethernet network, yet only possess serial communication interfaces.

Equipment that may require the use of device servers include:

(1) Vehicle detection systems.

(2) Road weather information system (RWIS) stations.

(3) Other low-speed data output devices.

233.6 Fiber Optic Cable and Interconnect

Various fiber optic facilities are used for device control and data communications between ITS field devices, transportation management centers (TMCs), regional transportation management centers (RTMCs), and other identified stakeholder facilities. Design network facilities based on specific project needs, as well as include the following information:

(1) Facility diagrams illustrating facility routes.

(2) General network topology.

(3) Network diagrams, including communication hub details

(4) External network connections and demarcation points

Include special provision ***SP0071101-Tolls*** in the contract documents when there are existing communication cables that transmit toll system information near areas where work is to be performed. This special provision expands requirements for preservation of property to specifically address repair of toll collection system components damaged by the contractor. The special provision also makes the contractor responsible for revenue loss that results from such damage. Use of this special provision requires the approval of the District Traffic Operations Engineer.

233.6.1 Fiber Optic Cable

Fiber optic cable is utilized in Department's statewide network infrastructure to provide data and device control communications between ITS field devices, transportation management centers (TMCs), regional transportation management centers (RTMCs), and other identified stakeholder facilities.

233.6.2 Fiber Optic Conduit

The type of fiber optic cable installation will determine the design for the conduit needed. For example, use polyvinyl chloride (PVC), fiberglass, or high-density polyethylene (HDPE) conduit for fiber optic cable that is exposed or placed underground along the roadway.

Indicate in the plans the innerduct type, size, and quantity when specific conduit is required. Proposed conduit systems should avoid chronic wet locations.

233.6.3 Fiber Optic Splices and Terminations

Fiber optic splices provide a continuous optical path for transmission of optical pulses from one length of optical fiber to another. Plans must identify splice points and provide splicing diagrams that detail the interconnection of specific fiber strands to be constructed, their origination and final destination points, and expected link loss.

Plans must identify existing fiber optic cables in the vicinity of the work and the location of the nearest full splices in the existing cables, including distance in each direction. This information is necessary to identify the cable(s) and splice(s) that would need to be reconstructed in the event they are damaged during construction.

Terminate fiber optic cables using a fiber patch panel (FPP). The FPP allows connection of optical fibers to the electronic equipment and devices located throughout the network. Coordinate selection of connector types and other fiber optic system components with District ITS staff.

233.6.4 Fiber Optic Cable Designating System

The fiber optic cable designating system provides visual notification of the presence of the underground fiber optic conduit/cable system, and provides a mechanism for electronically locating the physical presence of the conduit system below ground. The designating system provides a means to identify, locate, and protect the statewide fiber optic network between ITS field devices, TMCs, RTMCs, and other identified stakeholder facilities.

The design and construction of the designating system should meet the following functional requirements based on project needs:

(1) Provide visual notification of the presence of the conduit.

(2) Inform the public of potential hazards and provide contact information for conduit system marking prior to planned excavation.

(3) Provide an end-to-end electrical conductor (locate wire) attached to the conduit system for conductive facility locating.

(4) Provide above-ground access to the locate wire.

The designating system may consist of electronic markers, above-ground route markers' locate wire, access points or buried cable warning tape

233.6.5 Pull, Splice, and Junction Boxes

Provide access points using pull, splice, or junction boxes according to the type, size, and quantity necessary for the project. Consider the following minimum functional requirements for access points:

(1) Provide at-grade access to fiber optic cables housed within conduit systems used for the Department's ITS communications.

(2) Provide assist points to aid in fiber optic cable installation.

(3) Provide protection for the fiber optic cable.

(4) Provide adequate space for storing cable slack/coils and splice enclosures.

(5) Make certain that pull boxes and splice boxes provide sufficient space for entry and routing of the fiber optic cables.

Access points are required at the following locations:

(1) Every 2,500 feet in a continuous straight conduit section if no fiber optic cable splice is required.

(2) At a maximum of 1,000 to 1,500 feet in metropolitan areas.

(3) Major fiber optic cable and conduit junctions.

(4) Planned or future splice locations.

(5) On each side of a river or lake crossing and at each end of a tunnel.

(6) On each side of an above-ground conduit installation (e.g., attachment to bridge or wall).

(7) All turns in the conduit system.

Splice boxes are preferred for access points on fiber optic cable backbone routes. Access or fiber splices to existing fiber optic backbone cables are to be made at the nearest existing splice box. Use pull boxes for access points when the conduit system extending from the backbone to the ITS field devices requires an access point to house only fiber optic drop cables.

233.7 ITS Infrastructure

233.7.1 Grounding and Lightning Protection

Plans involving ITS devices must also include provisions for grounding and surge suppression to protect equipment and to ensure human safety.

Effective grounding and lightning protection is generally achieved through a combination of three primary techniques: proper bonding and installation of grounding rods, air terminals, and surge protective devices (SPDs). These three methods work concurrently to protect ITS equipment installed in the field and must be incorporated, as applicable, in ITS design plans.

When developing plans that include these systems 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. . Include in the plans any pertinent survey data gathered during plans development, such as soil resistivity measurements.

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. Provide details in the plans related to cable routing and other installation details required to maximize the efficiency of grounding and SPDs.

Grounding and SPD placement and overall system design should be determined by project-specific needs, as well as the following general design criteria:

(1) Follow best practices defined in the NFPA 780 Standard for the Installation of Lightning Protection Systems and NFPA 70, National Electric Code.

(2) Place SPD equipment so that grounding connections are as short and straight as possible.

(3) Conductor routing must avoid bending and provide physical separation between low-voltage and high-voltage signal paths.

(4) Avoid routing unprotected wires or grounding wires parallel or adjacent to protected wiring.

233.7.2 CCTV Pole and Lowering Device

Provide a lowering device for pole-mounted devices where height precludes easy access using a bucket truck. Coordinate the use and selection of lowering devices with District ITS office.

If designs call for a lowering device to be attached to an existing pole or similar structure, ensure that the design includes external conduit for housing the cabling, the necessary mounting box hardware at the top of the structure, and any other component details required for installation; e.g., air terminal.

Devices placed on the pole and should not affect the ability to utilize the lowering device. Use of lowering device should not require an operator to stand directly beneath the equipment while it is being lowered.

233.7.3 ITS Field Cabinet

Base the location of the cabinet on safety of the motorist, visibility of roadside devices, and safe access by maintenance staff. ITS field cabinets can be base mounted on a concrete pad, structure mounted, or pole mounted. Do not place cabinets in flood prone areas. Consider safety features such as service slabs and railings for cabinets placed on slopes steeper than 1:2.

Size the cabinet to accommodate the equipment to be installed inside. In addition, the cabinet size should account for ease of access to the equipment and the ability to achieve proper ventilation. The placement of devices in the cabinet must be consistent throughout a project. If a specific cabinet orientation or door swing is required, this can be shown in the plans.

233.7.4 Equipment Shelter

Though equipment shelters are typically prefabricated, include the following in the plans:

(1) Details of the site layout, including the shelter dimensions, site preparation work, fencing, landscape, conduit and pull box installation, as well as details for electrical, lighting, grounding, alarm, and HVAC systems necessary to accommodate the types and quantity of equipment the shelter will house.

(2) Details that illustrate the equipment layout inside the shelter, 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.

(3) Details of back-up power systems such as UPS, generator, fuel tank, security cameras, security alarms, and other security features.

233.8 Vehicle Detection and Data Collection

Select a vehicle detection technology that supports the data collection needs for the project.

Prepare a design that details a complete detection assembly, including all other necessary components to be supplied and constructed. Include the plans the exact location and placement of system components, and provide installation details for the required cables. Design the cabling installation according to the manufacturer's recommendations.

For vehicle detection systems utilizing video, microwave, magnetic field, or AVI technologies, consult with the device manufacturers to ensure that placement and installation plans facilitate proper operation of a particular device type. Consider a technology's capabilities and limitations in a given location to attain the required levels of detection accuracy.