

Operations Division Location and Design Division

INSTRUCTIONAL AND INFORMATIONAL MEMORANDUM

GENERAL SUBJECT: VDOT Fiber Optics Infrastructure	NUMBER: IIM-OD-13-01.4 IIM-LD-230.3
SPECIFIC SUBJECT: Conduit Systems for Fiber Optics	DATE: September 17, 2019
	SUPERSEDES: IIM-OD-13-01.3 IIM-LD-230.2
Approval with Signature on file in office of the Operations Division: OPERATIONS DIVISION APPROVAL: Ali Farhangi, P.E. State Operations Engineer Approved August 5, 2019	
Approval with Signature on file in office of the Location and Design Division: LOCATION AND DESIGN DIVISION APPROVAL: Susan H. Keen, P.E. State Location and Design Engineer Approved September 17, 2019	

Changes are shaded.

CURRENT REVISION

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- Revisions have been made regarding developing cost estimates and the size of conduit.
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EFFECTIVE DATE

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- These instructions are effective upon receipt for all projects included in the first bullet under "POLICY" that have **not** completed the Field Inspection Team Meeting. For projects that have gone beyond this milestone meeting, the Project Manager should discuss applicability with the appropriate Assistant State Location and Design Engineer.

BACKGROUND

- In 1991 Congress created the Intelligent Transportation System (ITS) program with key goals to expand its implementation in a cost effective manner with private sector involvement.
 - ITS programs are considered as effective low cost solutions to improve safety, reduce congestion, and improve travel time reliability.
 - The original ITS program has now evolved to become the core framework for advanced transportation programs including integrated corridor management and connected vehicles.
 - The original ITS programs included heavy infrastructure such as message signs and traffic monitoring. Advanced programs include vehicle to infrastructure communication and multi-modal monitoring. While there is currently less emphasis on installing heavy infrastructure, there is a common need for both the original and emerging strategies; reliable, high bandwidth and scalable communication systems for data exchanges.
 - Fiber optic networks provide these capabilities and an ideal communication foundation for ITS.
 - Communication systems are comprised of fiber optic cables, conduits, junction boxes, marker poles, communication hubs and network equipment.
 - A successful fiber optic system in freeway environments is achieved through ensuring:
 1. safety in the high speed freeway corridor.
 2. minimal impact on the existing transportation system.
 3. a minimal maintenance component.
 4. a location that minimizes any effect on future highway expansion or reconstruction areas.
 5. functionality for future ITS expansion.
 - A Task Force from the American Association of State Highway and Transportation Officials (AASHTO) developed a “Design Guide for Fiber Optic Installation on Freeway Right of Way”, dated December 2002. This document serves as a FHWA publication to be used by State DOT’s as a guideline and is not to be considered a policy issued by FHWA or AASHTO. This document covers the planning, design and construction of fiber optic systems.
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PROCEDURE

- For ALL VDOT owned and maintained roadways, the Project Manager (PM) / Project Coordinator (PC) will include a representative from the Operations Division’s Project Delivery Section (for Tier 2 projects) or the responsible District Traffic Engineer, Regional Traffic Operations Manager or its Designee (for Tier 1 projects) and the Right of Way and Utilities Division at the Scoping meeting on the following projects:

- All limited-access highways, including bridges
 - All primary highways, including bridges
 - Secondary roads leading into and out of VDOT Residencies and District Offices
 - Secondary roads that intersect any interstate highways, or major primaries
- If VDOT fiber optic infrastructure exists, maintenance of those assets during construction will be a key consideration in addition to replacement design. The Regional Traffic Operations Manager shall inform the Designer at the Scoping Meeting if existing VDOT fiber optics are within the project limits.
 - Operations Division's Project Delivery Section, Regional Operations and the Design Team will jointly determine if a project will have the fiber optic conduit system included. This will be based on the location of the new roadway or widening, the length of the project, the long-term plan for the roadway under consideration and VDOT's needs.
 - Once the decision has been made to include multi-duct systems for fiber optics, the Project Manager will include a representative from the Operations Division's Project Delivery Section for Tier 2 projects or the responsible District Traffic Engineer, Regional Traffic Operations Manager or its Designee for Tier 1 projects in all project team meetings and pertinent correspondence. The Design Engineer will be responsible for design and placement of conduit and junction boxes.
 - All fiber optic cables placed in the VDOT right of way shall be installed within a conduit system. It is cost effective, efficient and creates the least impact if all conduits are placed in the same trench at the same time.
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DECISION MAKING PROCESS

- The project team will provide information on potential use of the multi-duct system by VDOT and recommend whether the project should include provisions for future fiber optics.
- Preliminary engineering cost estimates for a multi-duct system are usually done on a per mile unit basis.
- Estimated costs should be prepared based on specific project requirements and may vary considerably based on project environment, context and site conditions such as terrain, soil conditions and amount of right of way available.
- Contractor availability and experience, preferred means and methods, and contract administration flexibility may also influence unit costs. The project team should seek assistance from experts in the Operations and Construction Divisions when preparing preliminary engineering cost estimates.
- It should be noted that a copy of the signed and sealed As-Built Plans for the conduit system shall be submitted to the Regional Traffic Operations Manager by the Area Construction Engineer.

DESIGN

Placement

The installation of the conduit run should be placed in front of the tree line or as far from the travel lane as possible and coordinated with the Design Team.

- The clear zone and unpaved shoulder may be identified as alternative feasible locations for multi-duct systems for fiber optic placement.
- Junction Boxes for fiber optic cable shall be placed along the fiber optic conduit and should be spaced a minimum of every 1500' for Limited Access and non-Limited Access roadways, and at all current or proposed traffic signal or ITS device locations. Spacing requirements for junction boxes should meet the needs of the regional operations teams on each project.
- All Junction Boxes for fiber optic cable shall be placed outside of Sidewalks and Shared use paths whenever possible.
- VDOT has established a standard to not allow installations along the median, except when crossing under or over a roadway or if there is no other alternative. Placing fiber in the median should be done only as a last resort and fiber crossings under roadways should be made as close to perpendicular to the roadway as possible. All other feasible options should be investigated first.
- Coated steel pipe casing may be preferred when locating fiber optic conduit on a bridge or large box culvert. If multiple conduits are required to span across a bridge, it may not be practical to use steel casing because of the weight. In this case, HDPE or PVC is considered an appropriate alternative. The conduit may be attached to the bridge or bored under the roadway or waterway.
- Steep slopes may cause problems for locating fiber optics due to instability and erosion of the soil around guardrail posts. If it is necessary to cross a run of guardrail, Directional Boring should be used.

Depth of Cover

- In most cases a minimum of 30 inches should provide an adequate cover to protect the system. Conduit can be installed in a shallower situation if needed due to pipes or underground structures.

Size and Number of Conduits

- A typical multi-duct system will consist of three conduits, one of which is a spare power conduit. The size of the conduits shall be determined at Field Inspection. One conduit shall be gray and the other two conduits shall have one colored orange and one colored white.
- Additional conduits may be recommended based on the location and VDOT needs.

- Final decision on the number of conduits is to be determined by the Operations Division's Project Delivery Section for Tier 2 projects or the responsible District Traffic Engineer, Regional Traffic Operations Manager or its Designee for Tier 1 projects.

Features to Include

- Conduit lines or multi-ducts.
- Trenching (see Road and Bridge Standards Section 1300 for ECI-1) should be at a minimum depth of 30 inches below grade, except where bedrock is encountered in which case an installation depth of at least 18 inches may be permitted with the Engineer's approval.
- Install junction boxes with cast iron frames and covers when placed in roadways or paved shoulders. Conduit shall enter through a pre-formed knockout or core-drilled hole in the side of the junction box at a minimum depth of 18". Cable racks are to be installed in all junction boxes storing fiber optic cable.
- Standard junction boxes for fiber optic cable shall allow hand access from outside the structure. Typically made from composite materials in a variety of shapes and sizes and are either bottomless or with solid bottoms; typically 24" by 36" but vary; often installed as a single unit with a minimum buried depth of 24", can be stacked to obtain desired height.
- Large Junction Boxes for fiber optic cable should be designed into fiber optic networks where there are existing or planned ITS devices, communication hubs, Traffic Signals or other network facilities and used to allow for easy changes to the network. As a last resort, Large Junction Boxes for fiber optic cable may be constructed some distance from the planned ITS device location due to construction or environmental constraints. These junction boxes are typically 48" X 48" and with a depth of 36".
- Fiber Optic Marker Balls or similar technology and Locator Tape shall be placed in all trenched or plowed conduit runs.
- Large / Standard / Intermediate Fiber Optic Junction Boxes
 - Large Junction Boxes for fiber optic cable are used for splicing points, and the storing of additional fiber optic cable slack.
 - Standard Junction Boxes for fiber optic cable are used for major transition points and the storing of additional fiber optic cable slack.
 - Intermediate Junction Boxes for fiber optic cable are used to assist for pulling during the cable installation.
- All Junction Boxes for Fiber Optic Cable shall have a Non-Skid surface and shall be stamped "VDOT FIBER OPTICS".
- Fiber optic cable and electrical cable shall never be placed in the same conduit or junction boxes.