

END-TO-END FIBER OPTIC ACCEPTANCE TEST

****From Hartford-Sharon FITS(503)**

- xx. DESCRIPTION. This work shall consist of conducting fiber optic acceptance testing.
- xx. GENERAL REQUIREMENTS. After installation of Fiber Optic Cable (FOC) is complete, the Contractor shall conduct fiber loss tests of the entire length of cable demonstrating that all requirements of this specification are met. These tests shall be conducted at both 1310 nm and 1550 nm light wavelengths. All testing shall be performed with an Optical Time Domain Reflectometer (OTDR). The use of mechanical splices is permitted during the end-to-end acceptance testing. The use of a launch box is not required, but the OTDR launch cord shall be a minimum 100'. Bidirectional testing is required for the end-to-end acceptance testing. Testing shall be conducted on all components of the FOC outside the plant, including fiber cables and splice points. All splice losses shall be documented by the OTDR. All fusion splices shall be in accordance with the ANSI/TIA-568-C.3 maximum splice loss of .3dB on a bidirectional average. The Contractor shall provide the Engineer with four (4) certified copies of the loss test results for comparison with the test made on the cable prior to delivery and during on-reel acceptance testing. All tests will be recorded on USB flash drive and submitted to VTrans for approval.
- xx. CONSTRUCTION REQUIREMENTS. The OTDR used for testing shall meet the following requirements:
- (a) The OTDR used shall include a flash drive USB for storage of all FOC signatures. Signatures of all cables tested shall be stored on a USB drive and supplied by the Contractor. The Contractor shall supply OTDR emulation software manufactured by the OTDR manufacturer which is capable of reading the stored signatures from the disk(s) and performing all measurement and analysis on the stored signatures as if the OTDR were connected live to the FOC. The analysis shall include, but not be limited to, readout of fiber loss per unit length, splice loss measurement (amount of loss and distance from OTDR), connector loss measurement (amount of loss and distance from OTDR), total FOC length, generation of event tables, and identification and measurement of any other reflective events or faults.
 - (b) The OTDR shall be located at both ends of the FOC backbone during the testing.
 - (c) The pulse width setting of the OTDR shall be set to the lowest possible setting while allowing the full length of FOC to be measured for faults or reflective events.
 - (d) The Contractor shall document the OTDR readings by supplying hard copies of the OTDR signatures for all FOC. The Contractor shall also supply hard copy of the reflective event table for all optical fibers, which shall be directly printed out from the OTDR.

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The personnel involved and responsible for the testing of the cable shall meet the following minimum requirements:

- (a) Provide documentation that the OTDR test equipment has been calibrated within one year of the test date, for review by the Engineer.
- (b) Documented proof of three (3) years experience with the installation of single-mode FOC, including splicing, termination, and testing. The installation experience should be applicable to the work required for this project and shall include projects of similar or larger scope, providing mid-span access points and fusion splicing in field conditions.
- (c) The Contractor shall provide the names and phone numbers of references to the Engineer.
- (d) At least thirty (30) days prior to the installation of the FOC, the Contractor shall submit to the Engineer documentation outlining the information above.

The Contractor shall provide the Engineer with four (4) copies of the cable manufacturer's recommendations and requirements, listed below, for each FOC type and size:

- (1) A list of the cable manufacturer's approved pulling lubricants for use on the cable. No other lubricants will be permitted.
- (2) The maximum pulling tensions of the cable, which shall specify both pulling from the cable's strength member(s) and for pulling from the outer jacket.
- (3) The minimum bending radius of the cable, which shall specify a radius for both the installation and for long-term installation.

The Contractor is responsible for following the test procedures as specified below:

- (a) The Contractor shall place a team of technicians at the start of the project, at the I-91 NB Hartford Rest Area.
- (b) The Contractor shall place a team of technicians at the end of the project, at the I-89 Exit 2, VT.132 end of line pole location.
- (c) Remove the cable sheath or jacket to expose a minimum of 3' buffer tubes.
- (d) Clean and remove all internal wraps, protective yarns, or tapes.
- (e) Remove a 2' minimum of fiber optic buffer tube cover, to expose the bare fibers.
- (f) Clean and completely remove all internal gels and waterlocking agents from bare fibers.

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- (g) Test buffer tubes in consecutive order in accordance with the /EIA -598-A, "Optical Cable Color Coding".
- (h) Setup the OTDR to test the individual fiber strands, with the same settings as tested by the manufacturer, including but not limited to the specific test wavelengths, pulse width, acquisition time, Index of Refraction (IR), cable span, and event thresholds.
- (i) Strip the outer protective coating from the bare exposed fiber. Test fibers in consecutive order in accordance with the TIA/EIA - 598-A, "Optical Cable Color Coding."
- (j) Clean exposed bare fiber and cleave end.
- (k) Place the cleaned fiber in an approved mechanical splice adapter. Mechanical adapters shall be the 3M FIBERLOK or an approved equal.
- (l) Test the fiber at 1310 nm for a minimum of 15 seconds, from the start of the project to the end.
- (m) Analyze the tested fiber for anomalies and verify the fiber characteristics, such as length and signal loss, versus the specified engineering requirements.
- (n) Record the test data. Label the fiber trace with the reel number and associated fiber number. The approved convention for recording fiber test results is as follows: XXXXYYY-mm/dd/yyyy where XXXX denotes the reel number, YYY denotes the fiber number, and mm/dd/yyyy denotes the test date. It is required for each fiber strand tested that the documented information includes a trace image, detailed OTDR settings per trace, and any associated event tables.
- (o) Save all test report files to an individual file. All test result files are to be stored on a flash drive and submitted to the Engineer for approval.
- (p) Repeat the requirements of parts (l) through (o), in the opposite direction.
- (q) Examine Bidirectional Test results.
- (r) The Contractor shall now conduct the Optical Return Loss (ORL) test between the two OTDR units.
- (s) Repeat the requirements of parts (k) through (p) at the wavelength of 1550 nm for all fibers.
- (t) Once all fibers have been tested, cut the fibers and buffer tubes at the location where the sheath has been removed. Bare fibers shall be completely re-coated with a protective room temperature vulcanizing (RTV) coating gel, or similar approved substance, prior to the application of the sleeve so as to protect the fiber from scoring, dirt, or microbending.

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- xx. METHOD OF MEASUREMENT. The quantity of Special Provision (End-To-End Fiber Optic Acceptance Test) to be measured for payment will be on a lump unit basis in the complete and accepted work.

- xx. BASIS OF PAYMENT. The accepted quantity of Special Provision (End-To-End Fiber Optic Acceptance Test) will be paid for at the Contract lump unit price. Payment of the Contract lump unit price will be made upon completion of the end-to-end fiber optic testing with test results within engineered specifications. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.650 Special Provision (End-To-End Fiber Optic Acceptance Test)	Lump Unit