**REVISION OF SECTION 614**

**TEST FIBER OPTIC CABLE**

**Section 614 of the Standard specifications is hereby revised for this project as follows:**

**Subsection 614.08 shall include the following:**

*Test fiber Optic Cable*. For this project this work shall consist of the testing of Single Mode fiber optic cable as shown and tabulated in the plans. The testing procedures involve an OTDR test and an Optical Power Meter Test.

The guidelines for fiber optic cable testing include:

1. Test jumpers and patch cords must be of the same fiber core size and connector type as the cable system:
	1. Single Mode fiber 8.3/125 μm
2. The light source and OTDR must operate with the range of 1310±10 nm or 1550±20 nm for Single Mode testing in accordance with ANSI/EIA/TIA-526-7.
3. The power meter and the light source must be set to the same wavelength during testing.
4. The power meter must be calibrated and traceable to the National Institute of Standards and Technology (NIST).
5. All system connectors, adapters and jumpers must be cleaned as per manufacturer’s instructions before measurements are taken.

A) Fiber Optic Cable Testing Equipment. The following is required to perform fiber optic cable tests:

1. An OTDR
2. A test reel, of at least 900 feet
3. A light source at the appropriate wavelength
4. Optical Power Measurement Equipment
5. Test Jumpers as specified below
	1. Single Mode Fiber Testing
		1. CPR Test Jumper-1 and Test Jumper-2 shall be 1-5 meters long with connectors compatible with the light source and power meter and have the same fiber construction as the link segment being tested.

B) Optical Fiber Cable Testing with OTDR.The Contractor shall perform an OTDR test of all fibers in all tubes on the reel prior to installation of the fiber. The test results shall be supplied to the Engineer prior to installation of the cable.

If the fiber is specified as “Install Only”, the Contractor shall test the fiber on the reel and provide the test results to the Engineer prior to accepting the cable. After installation, if there are unused portions of cable remaining on the reel, the Engineer may request the Contractor or other qualified technician to perform a reel test. The Contractor shall provide the Engineer the test results prior to delivering the cable to the Engineer. Any cable damaged while in the Contractor’s possession shall be replaced at the Contractor’s expense.

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All fiber testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end OTDR trace performed per TIA/EIA-455-61. The system margin loss measurements shall be provided at 1310 nm and 1550 nm for Single Mode fibers. If the Plans require installation of a fiber optic patch panel, the Contractor shall supply patch cords to patch all terminated fibers through the panel for all fiber testing. If patch cords are specified in the Plans for final equipment installation, these patch cords shall be connected using a test coupling for the end-to-end test.



OTDR readings will be used to ensure proper installation and to troubleshoot faults. OTDR signature traces will be used for documentation and maintenance. An OTDR provides an indirect estimate of the loss of the cable plant, generally, more accurate or reliable values will be obtained by using an Optical Power Meter. For fibers that are identified in the Plans to be left unterminated, an OTDR shall be used to test end-to-end attenuation.

Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

To ensure the traces identify the end points of the fiber under test and the fiber designation, the Contractor shall use a test reel, if required, to eliminate the “dead zone” at the start of the trace so that the start of the fiber under test can be identified on the trace. Indicate the length of the test reel for all test results.

If the fiber designation is not indicated on the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.

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**REVISION OF SECTION 614**

**TEST FIBER OPTIC CABLE**

In compliance with EIA/TIA-455-61 “Measurement of Fiber or Cable Attenuation Using an OTDR” the Contractor shall record the following information during the test procedure:

1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date).
3. Date test is being performed.
4. Optical source wavelength and spectral width.
5. Fiber identification including tube color and fiber color
6. End point locations
7. Launch conditions
8. Method of calculation for the attenuation or attenuation coefficient.
9. Acceptable link attenuation
10. Identify loss event
11. Test direction

C) Optic Fiber Cable Testing with Optical Power Meter. The Contractor shall conduct an Optical Power Meter Test for each fiber installed.

Single Mode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

Fiber Cable Plant and TIA/EIA-526-7 “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”, the following information shall be recorded during the test procedure:

1. Names of personnel conducting the test.
2. Type of test equipment used (manufacturer, model, serial number, calibration date).
3. Date test is being performed.
4. Optical source wavelength, spectral width, and for multimode, the coupled power ratio (CPR).
5. Fiber Identification including tube color and fiber color.
6. Identify loss event
7. End point locations.
8. Test direction.
9. Reference power measurement (when not using a power meter with a Relative Power Measurement Mode).
10. Method of calculation for the attenuation or attenuation coefficient.
11. Measured attenuation of the link segment.
12. Acceptable link attenuation.

The minor attenuation differences due to test direction are on par with the accuracy and repeatability of the test method. Lateral segments within a building are limited to 90 meters. Therefore, attenuation differences caused by wavelength are insignificant, and as a result, single wavelength testing is sufficient.

D) Acceptable Attenuation Values. Acceptable attenuation values shall be calculated for each fiber tested. These values represent the maximum acceptable test values.

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**REVISION OF SECTION 614**

**TEST FIBER OPTIC CABLE**

A connection is defined as the joint made by mating two fibers terminated with re-mateable connectors (e.g. ST, SC, LC).

1. Singlemode Fiber.The general attenuation equation for any Single Mode link segment is as follows:

Acceptable Link Attn. = Cable Attn. + Connector Attn. + Splice Attn.

*8.3 μm Single-mode Attenuation Coefficients:*

* 1. Cable Attn.=Cable Length (km) x (0.34 dB/km@1310 nm or 0.25 dB/km@1550 nm)
	2. Connection Attn. (ST or SC connectors) = (# Connections x 0.39dB) No more than 0.75dB per connector
	3. Splice Attn. (Mechanical or Fusion) = Splices x 0.10dB

E) Test Procedures. All fiber testing shall be performed on all fibers in the completed end-to-end system.

1. Single Mode Fiber.The Single Mode Optical Power Meter fiber test shall be conducted as follows:

	1. Clean the test jumper connectors and the test coupling per manufacturer’s instructions.
	2. Follow the test equipment manufacturer’s initial adjustment instructions.
	3. Connect Test Jumper-1 between the light source and the power meter. Avoid placing bends in the jumper that are less than 100 mm (4 inches) in diameter.



* 1. If the power meter has a Relative Power Measurement Mode, select it. If it does not, reduce the Reference Power Measurement (Pref). If the meter can display power levels in dBm, select this unit of measurement to simplify subsequent calculations.
	2. Disconnect Test Jumper-1 from the power meter. Do NOT disconnect the test jumper from the light source.
	3. Attach Test Jumper-1 to one end of the cable plant to be measured and Test Jumper-2 to the other end.



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**TEST FIBER OPTIC CABLE**

* 1. Record the Power Measurement (Psum). If the power meter is in Relative Power Measurement Mode, the meter reading represents the true value. If the meter does not have a Relative Power Measurement Mode, perform the following calculation:

		1. If Psum and Pref are in the same logarithmic units (dBm, dBu, etc.):
		CPR (dB) = Psum - Pref
		2. If Psum and Pref are in watts:
		3. CPR (dB)= 10 x log10 [Osum/Pref]

 F) 7 Test Acceptance. The Contractor shall demonstrate that each Optical Power Test results in acceptable attenuation values.

The Contractor, solely at the Contractor’s cost, shall remake any fusion splices and/or connectors that have test results exceeding acceptable attenuation values.

The Contractor, solely at the Contractor’s cost, shall retest any fiber links that have been re-spliced.

The Contractor, solely at the Contractor’s cost, shall bring any link not meeting the requirements of this specification into compliance.

G) Submittals.The Contractor shall submit test results documentation as both a hard copy and electronic copy.

After each reel test, the Contractor shall submit four (4) hard copies of the OTDR trace for every fiber on the reel. After installation, the Contractor shall submit four (4) hard copies of the OTDR trace for every spliced fiber. Hard copy traces shall be organized and bound in logical order in an 8 ½” x 11” 3 ring hard cover binder in addition to other documentation listed in this Special Provision and other splicing documentation listed in the project Special Provision package.

The Contractor shall submit, after approval of the hard copy traces, electronic copies of all traces and appropriate software to allow reading the traces.

The Contractor shall submit four (4) copies of all Optical Power Test results.

The Contractor shall submit four (4) copies of the complete contract Plans, including additional drawings issued as part of any change orders, with any deviations clearly marked in color. Deviations to be noted and shall include but not be limited to the following:
Fiber Splice location

1. Fiber Splice configuration
2. Termination layout

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**REVISION OF SECTION 614**

**TEST FIBER OPTIC CABLE**

**Subsection 614.13 shall include the following:**

The complete end-to-end OTDR test on one fiber, including document submission, represents one OTDR test.

The complete end-to-end optical power meter test on one fiber, including document submission, represents one optical power meter test.

The accepted quantities will be paid for at the contract price per pay unit of measurement for the work completed.

**Subsection 614.14 shall include the following:**

Pay Item Pay Unit

Test Fiber Optic Cable Lump Sum