



**Verizon NEBS™ Compliance: Field
Spliceable Optical Connectors**
Verizon Technical Purchasing Requirements
VZ.TPR.9447
Issue 4, April 2010





CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	5/08/2007	New	New Document
2	11/5/2007	Add	Clarification of Extended Thermal Cycling (Reliability) Test
3	10/23/2009	Change	Multiple changes
4	04/22/2010	Add	Clarification of sample quantity and sample configuration, separate sample group for wavelength dependency test, and various additional clarifications
* New, Add, Delete, Change, Reissue			



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1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement document is to provide FOC testing requirements for Field Spliceable Optical Connectors.

2.0 SCOPE

FOC Products

3.0 REFERENCES

GR-264-CORE	Generic Requirements for Optical Fiber Cleavers
GR-326-CORE	Generic Requirements for Single mode Optical Connectors and Jumper Assemblies
GR-765-CORE	Optical Splices and Splicing Systems
GR-1081-CORE	Generic Requirements for Field-Mountable Optical Fiber Connectors
GR-1221-CORE	Generic Reliability Assurance Requirements for Passive Optical Fiber Components

4.0 ACRONYMS

FOC	Fiber Optic Components
ITL	Independent Testing Laboratory
MDU	Multi-Dwelling Unit

5.0 TEST REQUIREMENTS FOR FIELD SPLICEABLE OPTICAL CONNECTORS

Verizon is considering using field spliceable connectors for the MDU applications. The following table contains the test requirements for qualifying a field spliceable optical connector. All the testing must be completed by a Verizon approved ITL. All the samples shall be made using the tools designated by supplier.



Field Spliceable Connector Test Requirements			
Task Name	Optical Monitoring	Samples	Comments
Generic Requirements Criteria GR-1081; 3.0			
GR-1081; 3.1 Conformance to GR326 Section 3 (See below)	GR326 Section 3 - see below		
GR-1081; 3.2 Field Mounting Kit			Use GR-765 modified with GR-264
GR-1081; 3.3 Instruction Manual			
GR-1081; 3.4 Field Test Criteria			
GR-1081; 3.5 Shelf Life			
GR-1081; 3.6 Electric Power			
GR-1081; 3.7 Safety			
Connector Tests GR1081; 4.0			
GR-1081; 4.1 Conformance to GR326 - issue 3 Section 4	GR326, Section 4 - See below		
GR-1081; 4.2 Wavelength Dependency		<p>N=20</p> <p>5 mated pairs of connectors made with all 4 fiber types cables G.652D, G.657A, G.657B and G.657.B3 (UBIF) (Corning's Clear Curve, OFS's EZBend, Draka's BBElite) ; Total 20 mated pairs</p>	<ul style="list-style-type: none"> GR-1081 4.2 requires measurements from 1260nm to 1630 at all wavelengths, with peak-to-peak variation not to exceed 0.2dB. This test shall be conducted with > minimum fiber length on the transmit side and = to minimum fiber length on the receive side. <ul style="list-style-type: none"> Refer to Note -7 for test setup



Field Spliceable Connector Test Requirements

Task Name	Optical Monitoring	Samples	Comments
GR-1081; 4.3 Assembly Test		Total = total number of samples needed for the test program; 11% @ -5 C, 23C & 45C by 3 installers;	Refer to Note-8 for test details
GR-1081; 4.4 Yield Criteria		Use data collected from all samples in 4.3 Assembly Test	End Face Geometry AND IL and RL
GR1081; 5.3 Reliability	GR-326, Section 7 – See below		
General Design Criteria GR-326; 3.0			
Documentation & Packaging			
GR-326; 3.1 Documentation			
GR-326; 3.2 Packaging and Shipping			
Design Features			
GR-326; 3.3.1 Materials		5	Note: Exempted from GR-326 Section 3.3.1, R3-5 (Connector shall not incorporate index matching gel).
GEL Tests			
Gel Tests: Fluid/Oil Separation		5 samples of Gel	24hrs @ 100 ⁰ C per FTM 791 (321.2)
Gel Tests: Evaporation		5 samples of Gel	24hrs @ 100 ⁰ C per ASTM D-972
Gel Tests: Apparent Viscosity		5 samples of Gel	ASTM D-1084
Gel Tests: Microscopic Particulate Contamination		5 samples of Gel	FTM 791 (3005.3)



Field Spliceable Connector Test Requirements			
Task Name	Optical Monitoring	Samples	Comments
Gel Tests: Glass Transition of the Gel		10 samples of Gel	5 samples tested for >85 ⁰ C and 5 samples tested for <-40 ⁰ C
Gel Test: Refractive Index		5 samples	Provide Refractive Index of the Gel. Suppliers to work with their Gel suppliers to identify the test
Boot Tape Tests			
Boot Tape: Glass Transition; only if there is any		10 samples	5 samples tested for >85 ⁰ C and 5 samples tested for <-40 ⁰ C
Boot Tape: Adhesive; only if there is any		10 samples	Check adhesion for 5 samples after conditioning at 85 ⁰ C and 5 samples at -40 ⁰ C
Cleanability & Intermateability			
GR-326; 3.3.2 Cleanability		11 samples	Use Verizon Cleaning procedure
GR-326; 3.4.1 Intermateability		144 + 5	Equally divide between fiber types, temperatures and craft persons.
GR-326; 3.4.2 Ferrule Extension Contact Force			Per GR-326
GR-326; 3.4.3 Length Requirements			Per GR-326
GR-326; 3.4.3 Adapter Sleeve Frictional Forces and Latch Spacing			Per GR-326
GR-326; 3.4.5 Glass Transition Temperature			Per GR-326 (this test is for connector not for Gel)
GR-326; 3.4.6 Latching Intermateability for Push-Pull Type Connectors			Per GR-326. Only MSOC side of test sample must be tested for Latching Intermateability
Product Marking			
GR-326; 3.5.1 Product Marking			Per GR-326



Field Spliceable Connector Test Requirements			
Task Name	Optical Monitoring	Samples	Comments
GR-326; 3.5.2 Color Code			Per GR-326
GR-326; 3.5.3 Keying			Per GR-326
Safety			
3.6.1; Radiation Hazard			Per GR-326
3.6.2; Cleaning Materials			Per GR-326
Service Life Tests GR-326; 4.0 and 6.0			
GR-326; 4.4.5: Endface Geometry	Before and After	All	Per GR-326
GR-326; 4.4.1: New Product Measurements: IL and RL	Before and After	All	Per GR-326; See Note -2 for IL and RL criteria
Environmental Performance			
GR-326; 4.4.2.1: Thermal Aging	Before and After	A=24	85C for 7 days;
GR-326; 4.4.2.2: Thermal Cycle	During	A=24	Cycle: -40C to 75C; 7days
GR-326; 4.4.2.3: Humidity Aging	During	A=24	75C and 95% RH; 7 days
GR-326; 4.4.2.4: Humidity/Condensation Cycle	During	A=24	Cycle: -10C to 65CHum at Heat; 7 days
GR-326; 4.4.2.5: Dry-Out Step	During	A=24	24 Hrs at 75C
GR-326; 4.4.2.6: Post Condensation Thermal Cycle	During	A=24	Cycle: -40C to 75C; 7days
Mechanical Tests			
GR-326; 4.4.3.1: Vibration Test	Before and After	A=24	10-55 Hz, 2h/axis, 1.5mm peak-to-peak, sine sweep
GR-326; 4.4.3.2: Flex Test	Before and After	A=24	+/- 90 deg; 100 cycles



Field Spliceable Connector Test Requirements

Task Name	Optical Monitoring	Samples	Comments
GR-326; 4.4.3.3: Twist Test	Before and After	A=24	+/- 5 complete turns; 10 cycles
GR-326; 4.4.3.4 Proof Test	Before and After	A=24	Per GR-326
GR-326; 4.4.3.5: Trans/w applied load	Before, During and After	A=24	Per GR-326
GR-326; 4.4.3.7: Impact	Before and After	A=24	Per GR-326
GR-326; 4.4.3.8: Durability Test	Before, During and After	A=24	Per GR-326
GR-326; 4.4.6: Connector Installation	Before and After	A=24	Per GR-326
GR-326; 4.4.3.9, 4.4.5 - End of Test Criteria	Before and After	A=24	Per GR-326
Reliability Tests GR-326; 7.0			
GR-1221; 6.2.4 Extended Thermal Aging	Before and After	B=44	85C for 84 days
GR-1221; 6.2.5 Extended Humidity	Before and After	C=44	75C and 95% RH; 84 days
GR-1221; 6.2.7 Extended Thermal Cycling	Before and After	D=44	Cycle: -40C to 85C; 84 days
GR-326; 4.4.4.4: Salt Spray	Before and After	H=44	Half of sample mated and half un-mated
GR-326; 4.4.4.3: Airborne Contaminants	Before and After	G=44	
GR-326; 4.4.4.1: Dust Test	Before and After	E=44	Half of sample mated and half un-mated
GR-326; 4.4.4.6: Ground Water Immersion	Before and After	J=44	11 samples per chemical, 4 chemicals
GR-326; 4.4.4.5: Immersion / Corrosion		I=16	8 mated pairs plus 8 MSOC pigtailed and 8 mating adapters (equally divided into the 4 fiber types)
GR-326; 4.4.4.2: Adhesive Test		F=5	Per GR-326



Field Spliceable Connector Test Requirements

Task Name	Optical Monitoring	Samples	Comments
Factory Audit			
GR-326; Section 8			Factory audit; conduct per TPR 9445/9404

Notes:

1. Wavelengths used during testing: 1310, 1490, 1550, and 1625 nm
2. IL/RL includes connector mated pair and mechanical splice; Initial Max IL = 0.4dB for a mated pair; Initial minimum RL = 60dB for a mated pair
End of Test max IL = 0.5dB for a mated pair; End of Test max RL = 60dB for a mated pair; during change per GR-326, Issue 3
This criteria is for both aligned and misaligned cleaves in the connector
3. Sample A = 24
Samples made at -5C, +23C, +45C for all tests - made in chamber after all materials and tools have stabilized for at least 1 hour, these temperatures are harsher than those specified in GR-1081 and will be used for assembly of all samples. An equal number to be made at each temperature, i.e.: A=24 (5 connectors made with per fiber type and 1 hot spare per fiber type) 5 mated pairs of connectors made with all 4 fiber types cables G.652D, G.657A , G.657B and G.657.B3 (UBIF) (Corning’s Clear Curve or OFS’s EZBend or Draka’s BBELite); Total = 24 mated pairs (20 for test and 4 hot spares)
4. Samples B, C, D, E, H, G and J = 44 each
Samples made at -5C, +23C, +45C for all tests - made in chamber after all materials and tools have stabilized for at least 1 hour, these temperatures are harsher than those specified in GR-1081 and will be used for assembly of all samples. An equal number to be made at each temperature, i.e.: B = C = D = E = H = G = J = 44 (11 connectors made per fiber type) 11 mated pairs of connectors made with all 4 fiber types cables G.652D, G.657A , G.657B and G.657.B3 (UBIF) (Corning’s Clear Curve or OFS’s EZBend or Draka’s BBELite); G.657.B3 or UBIF means Bend Radius = 5mm
5. Test Program Samples will use SCAPC connectors
6. Follow the media type guidelines for testing connectors with multiple media types per TPR 9444
7. Wavelength Dependency Test (group N): This test is designed to measure the MPI and wavelength dependency of the mechanical splice on connectors
 - o This test shall be ~~repeated~~ performed with samples from all four fiber types
 - o This test shall be conducted with > minimum fiber length on the transmit side and = to minimum fiber length on the receive side as shown below:



Field Spliceable Connector Test Requirements

Task Name	Optical Monitoring	Samples	Comments
<ul style="list-style-type: none"> • DUT = Mated Mechanical Splice on connector • Where D = minimum length of fiber that is required to avoid any higher order modes in the fiber from a source to the detector (specified by the manufacturer) 			

8. Assembly Test and Yield Criteria:

- Supplier must provide the manufacturing yield on the mechanical splice on connectors (when spliced in field)
- Calculate the total number of samples needed for the test program (including hot spares, service life and reliability and all fiber type)
- Divide the total number by the yield provided by the manufacturer
- That will be the number of samples that will be shipped by the manufacturer to ITL
- Divide all the samples equally in four categories based on per fiber type to be used to make assemblies
- In each fiber category 11% of the samples will be made at -5C by craft person -1; then 11% of the samples will be made at 23C by craft person -1; then 11% of the samples will be made at 45C by craft person -1. Repeat the same step with craft person 2 and 3
- Repeat the above step for remaining 3 fiber types
- After the samples are completed report following yields:

	Cable with Fiber - G.652D			Cable with Fiber - G.657A			Cable with Fiber - G.657B			Cable with Fiber - UBIF		
	-5C	23C	45C	-5C	23C	45C	-5C	23C	45C	-5C	23C	45C

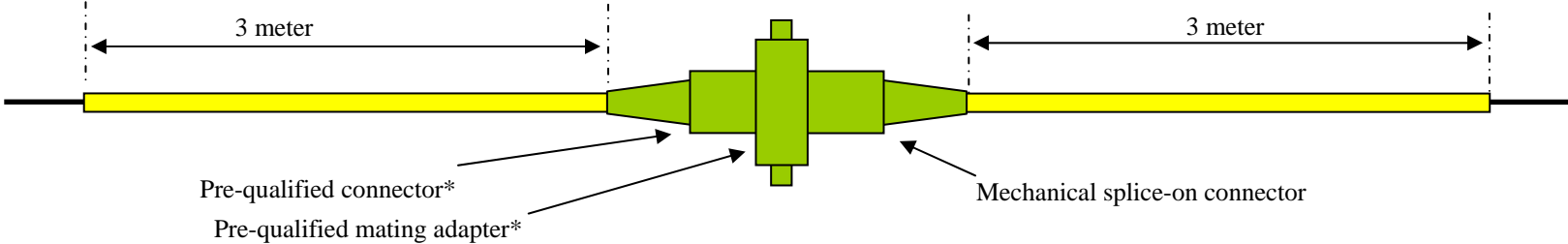
Field Spliceable Connector Test Requirements

Task Name	Optical Monitoring	Samples	Comments
Craft -1			
Craft -2			
Craft-3			

- Finally calculate the overall yield including all the samples and compare it with the yield provided by the supplier
- The final yield is calculated by counting the total number of EFG failures AND the total number IL/RL failures (e.g. 10 MSOC connectors fail EFG after the assembly test and 10 pigtail assemblies fail either IL or RL, then the total number of failures is 20 (even if a particular MSOC connector sample that failed EFG then subsequently also failed IL/RL))

9. Test Sample Configuration for ALL groups (except group N)

- Samples for all groups shall be pigtail assemblies and shall be made up from one MSOC and one pre-qualified connector mated with one pre-qualified mating adapter as shown:



- Pre-qualified adapter and pre-qualified connector means that the connector and adapter used in this GR-1081 qualification program must have previously successfully undergone GR-326 qualification testing (per VZ.TPR.9409) and must be accepted by Verizon. The cable media type used on the pre-qualified connector side is not specified and the fiber type used on the pre-qualified connector side shall be per G.652.D (R=30mm). Only the MSOC is assembled as part of the assembly test in accordance with note 8.
- Samples for group N (wavelength dependency test) shall use a MSOC on BOTH sides of the mated pair and the length of fiber / cable used on each side of the mated pair shall be in accordance with note 7 above. The MSOC samples for the wavelength dependency test shall also be made during the assembly test and shall be included in the yield calculation.



Extended Thermal Cycling (Reliability) Test

The test conditions for the Extended Thermal Cycle Test are shown in Figure 1 below.

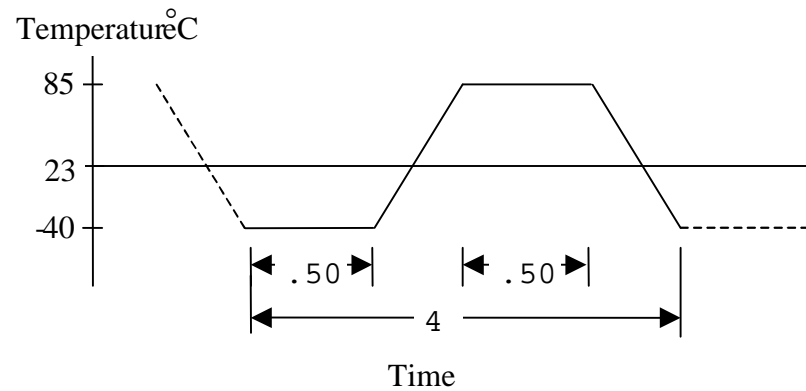


Figure 1: Temperature Profile for Extended Thermal Cycle Test

Extended Thermal Cycle Test Conditions

Temperature: Cycle in Figure 1 (-40°C to 85°C).

All ramp times are 1.4°C per minute, all plateaus are 30 minutes

Humidity: Uncontrolled

Duration: 500 cycles in 2000 hours

Measurement of Insertion Loss and Reflectance: Data shall be taken initially, and then at 100, 168, 500, 1000, and 2000-hour intervals