



**Verizon NEBS™ Compliance: Field  
Spliceable Optical Connectors**  
Verizon Technical Purchasing Requirements  
VZ.TPR.9447  
**Issue 5, May 2011**





**CHANGE CONTROL RECORD:**

| <b>Version</b> | <b>Date</b> | <b>Action*</b> | <b>Reason for Revision</b>   |
|----------------|-------------|----------------|--|
| 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 |
| 5              | 05/10/11    | Change         | Modified sample configuration and pass/fail criteria for wavelength dependency test.   |
|                |             |                | Cleanability Deleted reference to Verizon cleaning procedure   |
|                |             |                | Immersion/corrosion Deleted reference to the 4 fiber types   |
|                |             |                | Added criteria Table 1 and Table 2.  |
|                |             |                | Note 2, Referenced table 1 and table 2   |
|                |             |                | Extended Thermal Cycle, Re-defined measurement times   |

\* 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**

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

## 4.0 **ACRONYMS**

|            |                                |
|------------|--------------------------------|
| <b>FOC</b> | Fiber Optic Components         |
| <b>ITL</b> | Independent Testing Laboratory |
| <b>MDU</b> | 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"> <li>GR-1081 4.2 requires measurements from 1260nm to 1630 at all wavelengths, with peak-to-peak variation not to exceed 0.4dB.</li> <li>This test shall be conducted with &gt; minimum fiber length on the transmit side and = to minimum fiber length on the receive side.               <ul style="list-style-type: none"> <li>Refer to Note -7 for test setup</li> </ul> </li> </ul> |



**Field Spliceable Connector Test Requirements**

| <b>Task Name</b>                                 | <b>Optical Monitoring</b>     | <b>Samples</b>  | <b>Comments</b>  |
|--|-------------------------------|---|--|
| 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). |
| <b>GEL Tests</b>                                 |                               |   |  |
| Gel Tests: Fluid/Oil Separation                  |                               | 5 samples of Gel  | 24hrs @ 100 <sup>0</sup> C per FTM 791 (321.2)   |
| Gel Tests: Evaporation                           |                               | 5 samples of Gel  | 24hrs @ 100 <sup>0</sup> 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)   |



| <b>Field Spliceable Connector Test Requirements</b>                   |                           |                   |  |
|---|---------------------------|-------------------|--|
| <b>Task Name</b>  | <b>Optical Monitoring</b> | <b>Samples</b>    | <b>Comments</b>  |
| Gel Tests: Glass Transition of the Gel                                |                           | 10 samples of Gel | 5 samples tested for >85 <sup>0</sup> C and 5 samples tested for <-40 <sup>0</sup> C                     |
| Gel Test: Refractive Index  |                           | 5 samples         | Provide Refractive Index of the Gel. Suppliers to work with their Gel suppliers to identify the test     |
| <b>Boot Tape Tests</b>  |                           |                   |  |
| Boot Tape: Glass Transition; only if there is any                     |                           | 10 samples        | 5 samples tested for >85 <sup>0</sup> C and 5 samples tested for <-40 <sup>0</sup> C                     |
| Boot Tape: Adhesive; only if there is any                             |                           | 10 samples        | Check adhesion for 5 samples after conditioning at 85 <sup>0</sup> C and 5 samples at -40 <sup>0</sup> C |
| <b>Cleanability &amp; Intermateability</b>                            |                           |                   |  |
| GR-326; 3.3.2 Cleanability  |                           | 11 samples        | ?  |
| 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                   |
| <b>Product Marking</b>  |                           |                   |  |
| GR-326; 3.5.1 Product Marking   |                           |                   | Per GR-326   |



| <b>Field Spliceable Connector Test Requirements</b> |                           |                |   |
|---|---------------------------|----------------|---|
| <b>Task Name</b>                                    | <b>Optical Monitoring</b> | <b>Samples</b> | <b>Comments</b>                                   |
| GR-326; 3.5.2 Color Code                            |                           |                | Per GR-326  |
| GR-326; 3.5.3 Keying                                |                           |                | Per GR-326  |
| <b>Safety</b>                                       |                           |                |   |
| 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    |
| <b>Environmental Performance</b>                    |                           |                |   |
| 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                         |
| <b>Mechanical Tests</b>                             |                           |                |   |
| 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                            |



| <b>Field Spliceable Connector Test Requirements</b> |                           |                |   |
|---|---------------------------|----------------|---|
| <b>Task Name</b>                                    | <b>Optical Monitoring</b> | <b>Samples</b> | <b>Comments</b>   |
| 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  |
| <b>Reliability Tests GR-326; 7.0</b>                |                           |                |   |
| 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 |
| GR-326; 4.4.4.2: Adhesive Test                      |                           | F=5            | Per GR-326  |
| <b>Factory Audit</b>                                |                           |                |   |



**Field Spliceable Connector Test Requirements**

| <b>Task Name</b>   | <b>Optical Monitoring</b> | <b>Samples</b> | <b>Comments</b>                          |
|--|---------------------------|----------------|--|
| GR-326; Section 8  |                           |                | Factory audit; conduct per TPR 9445/9404 |
| <b>Notes:</b>  |                           |                |  |
| 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<br>End of Test max IL = 0.5dB for a mated pair; End of Test max RL = 60dB for a mated pair; during change per Table 1 and Table 2 below.<br>This criteria is for both aligned and misaligned cleaves in the connector  |                           |                |  |
| 3. Sample A = 24<br>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<br>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 <ul style="list-style-type: none"> <li>o This test shall be performed with samples from all four fiber types</li> <li>o This test shall be conducted with &gt; minimum fiber length on the transmit side and = to minimum fiber length on the receive side as shown below:</li> </ul>   |                           |                |  |



**Field Spliceable Connector Test Requirements**

| Task Name   | Optical Monitoring | Samples | Comments |
|---|--------------------|---------|----------|
|   |                    |         |          |
| <ul style="list-style-type: none"> <li>• DUT = Mated Mechanical Splice on connector</li> <li>• 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)</li> </ul> |                    |         |          |

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 |

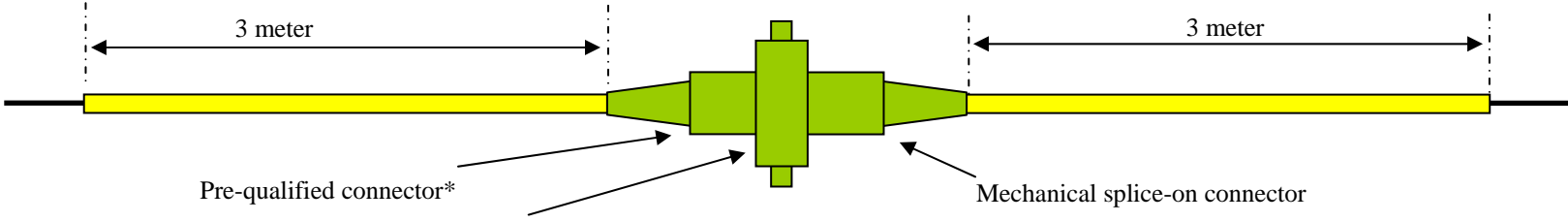
**Field Spliceable Connector Test Requirements**

| 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

- 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:

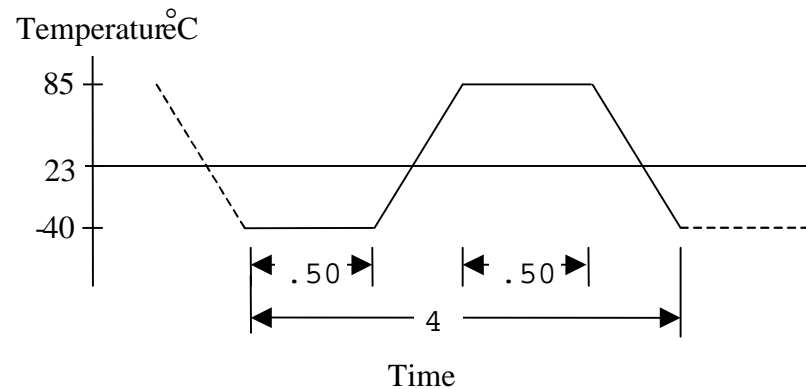


- Pre-qualified adapter and pre-qualified connector means that the connector and adapter used in this GR-1081 qualification program must have previously successfully undergone GR-326 qualification testing (per VZ.TPR.9409) and must be accepted by Verizon. The cable media type used on the pre-qualified 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 the sample configuration as shown above. 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,  
Data shall be taken initially, and then at the completion of 125 cycles and at the completion of 500 cycles.



**Table 1 Loss Criteria**

| Test                           | Maximum Loss<br>SC & LC, APC mated<br>connector | Loss Increase<br>SC & LC, APC mated<br>connector |
|--------------------------------|---|--|
|                                | (R)   | (R)  |
| New Product                    | 0.40  | ---  |
| During Test,<br>Not Under Load | 0.50  | 0.30 <sup>1</sup>                                |
| During Test,<br>Under Load     | ---   | 0.50   |
| End of Test                    | 0.50  | ---  |

**Table 2 Return Loss Criteria**

| Test                           | Minimum Return Loss<br>SC & LC, APC mated<br>connector | Decrease in Return Loss<br>SC & LC, APC mated<br>connector |
|--------------------------------|--|--|
|                                | (R)  | (O)  |
| New Product                    | 60   | ---  |
| During Test,<br>Not Under Load | 60   | 2 <sup>2</sup>   |

<sup>1</sup> Loss increase is not a concern as long as Max Loss is not exceeded during or at the end of the test.

<sup>2</sup> Decrease in RL is not an issue as long as the decrease does not cause the min RL to fall below the minimum limit.



|                            |    |                |
|----------------------------|----|----------------|
| During Test,<br>Under Load | 60 | 2 <sup>3</sup> |
| End of Test                | 60 | ---            |

---

<sup>3</sup> Decrease in RL is not an issue as long as the decrease does not cause the min RL to fall below the minimum limit.