



**Verizon NEBS™ Compliance: Test
Requirements for Improved Bend
Performance Fibers**
Verizon Technical Purchasing Requirements
VZ.TPR.9441
Issue 3, February 2011





CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	12/10/2007	New	New Document
2	04/04/2008	Change Add	Updated High Power Included Definition of Samples
3	2/14/11	Change Add	Clarified Sample sizes for all Criteria Added WDL and Place Holder for MPI Spectral Sweep for Macrobend Pass/Fail criteria for BIF Fiber
* New, Add, Delete, Change, Reissue			



Trademark Acknowledgement – NEBS is a trademark of Telcordia Technologies, Inc.

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1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement document is to provide test requirements to evaluate any improved bend performance fiber type.

2.0 SCOPE

Optical Fiber

3.0 REFERENCES

FOC Memo # 41	Bend Optimized Fiber Testing Requirements
GR-20-CORE, Issue 2, July 1998	Generic Requirements for Optical Fiber and Optical Fiber Cables
GR-326-CORE, Issue 3, September 1999	Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies
IEC 60793-2-50	Optical fibers - Part 2: Product specifications - General
TIA/EIA 492CAAB	Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak

4.0 ACRONYMS

A	After
B	Before
D	During
FOC	Fiber Optic Components
IL	Insertion Loss
nm	Nano Meter
Pin	Input Power
RL	Return Loss

5.0 TEST REQUIREMENTS FOR IMPROVED BEND PERFORMANCE FIBER

Verizon is considering using improved bend performance fibers for all applications as required. The following are test requirements for qualifying the new fiber. All of the tests must be conducted.



Table 1

Criteria	Description	Reference Specification	Test Condition	Sample Quantity
1.	Glass Comp	GR-20. Section - 4.1.1	As specified	Cert of Compliance
2.	Attenuation Coefficient Criteria per RFP	GR-20. Section - 4.2.1	As specified	5 separate reels from 5 different pre-forms Test length \geq 2 km
3.	Point Discontinuities	GR-20. Section - 4.2.2	As specified	5 separate reels from 5 different pre-forms Test length \geq 2 km
4.	Chromatic Dispersion	GR-20. Section - 4.2.3	As specified	5 separate reels from 5 different pre-forms Test length \geq 2 km
5.	Cutoff Wavelength	GR-20. Section - 4.2.4	As specified	3 separate reels from 3 different pre-forms Five 22-meter test samples from each of the 3 reels. (15 total samples)
6.	Mode Field Diameter	GR-20. Section - 4.2.5	As specified	Five samples from 3 different fiber reels from 3 different pre-forms 22 m test length



Criteria	Description	Reference Specification	Test Condition	Sample Quantity																																																
				(Total of 15 samples)																																																
7.	<p>Macrobend Loss</p> <p>The criteria pertain to the individual Macrobends.</p> <p>Macrobends are performed individually.</p>	<p align="center">Verizon UBIF Criteria (B3)</p> <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>30 mm</td> <td>5 turns</td> <td>1550</td> <td>TBD¹</td> </tr> <tr> <td>20 mm</td> <td>5 turns</td> <td>1550</td> <td>TBD</td> </tr> <tr> <td>15 mm</td> <td>5 turns</td> <td>1550</td> <td>TBD</td> </tr> <tr> <td>10 mm</td> <td>5 turns</td> <td>1550</td> <td>0.500</td> </tr> <tr> <td>10 mm</td> <td>1 turn</td> <td>1550</td> <td>0.100</td> </tr> <tr> <td>10 mm</td> <td>5 turns</td> <td>1625</td> <td>1.500</td> </tr> <tr> <td>10 mm</td> <td>1 turn</td> <td>1625</td> <td>0.300</td> </tr> </tbody> </table> <p align="center">G.657.A1 Type Fiber Macrobend Criteria</p> <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>30 mm</td> <td>10 turns</td> <td>1550</td> <td>0.250</td> </tr> <tr> <td>20 mm</td> <td>1 turn</td> <td>1550</td> <td>0.750</td> </tr> <tr> <td>20 mm</td> <td>1 turn</td> <td>1625</td> <td>1.500</td> </tr> </tbody> </table> <p align="center">G.657. A2 & B2 Type Fiber Macrobend Criteria</p>	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	30 mm	5 turns	1550	TBD ¹	20 mm	5 turns	1550	TBD	15 mm	5 turns	1550	TBD	10 mm	5 turns	1550	0.500	10 mm	1 turn	1550	0.100	10 mm	5 turns	1625	1.500	10 mm	1 turn	1625	0.300	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	30 mm	10 turns	1550	0.250	20 mm	1 turn	1550	0.750	20 mm	1 turn	1625	1.500	As specified	3-Fiber samples taken from 5 separate reels from 5 different preforms (Total of 15 samples)
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¹ TBD-Shall be much improved over BIF.



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20 mm	1 turn	1550	0.100																					
15 mm	1 turn	1550	0.500																					
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8.	Macrobend Wavelength Dependent Loss	<p>MWDL $\leq (3.00 * [\text{Macrobend Loss at 1550nm}])$ dB over the wavelength range of 1550 nm – 1630 nm</p> <p>Over the wavelength range of 1550 nm to 1630 nm the macrobend wavelength dependent loss shall not have a local maximum greater than 0.1 db in any 10 nm window. Local Maximum definition = max WDL – Min WDL in any 10 nm window.</p>	Determine WDL from 1550 nm to 1630 nm during the fibers minimum rated macro bend test conditions above.	3-Fiber samples taken from 5 separate reels from 5 different preforms (Total of 15 samples)																				



Criteria	Description	Reference Specification	Test Condition	Sample Quantity								
9.	Macro Bend Uniformity (Only Applicable to UBIF)	<p style="text-align: center;">Verizon Criteria</p> <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>10 mm</td> <td>1 turn</td> <td>1550</td> <td>0.050</td> </tr> </tbody> </table>	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	10 mm	1 turn	1550	0.050	The bends are performed one at a time in four Cartesian directions. -x, +x, -y, +y and repeat the process with the axis rotated 45°. (Total of 8 bend directions)	3-Fiber samples taken from 5 separate reels from 5 different preforms (Total of 15 samples)
Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)									
10 mm	1 turn	1550	0.050									
10.	Multi-Path Interference (MPI)	TBD	TBD	TBD								
11.	Geometrical Requirements	GR-20. Section - 4.3	As specified	Five samples are taken from ≥ 3 separate reels from at least 3 different pre-forms (Total of 15 samples)								
12.	Tensile Proof Strength	GR-20. Section - 4.4.1	As specified	Cert of Compliance								
13.	Coating Strip Force	GR-20. Section - 4.4.2	As specified	Samples taken from 3 reels (at least 3 different pre-forms), 5 samples per reel per test								



Criteria	Description	Reference Specification	Test Condition	Sample Quantity
				condition. Note: 6 conditions (3x6x5) = 90 samples
14.	Dynamic Tensile Strength	GR-20. Section - 4.4.3	As specified	30 aged 30 unaged samples from 5 different pre-forms.
15.	Stress Corrosion Parameter	GR-20. Section - 4.4.4	As specified	15 samples per each of the four strain rates, aged and unaged fibers taken from 5 different pre-forms. (4x15x2) = 120 samples
16.	Fiber Cleavability	GR-20. Section - 4.5.1	As specified	Samples taken from 5 different fiber reels (from at least 5 different preforms), 2 samples per reel, cleave each sample 3 times (Total of 30 cleaves)
17.	Fiber Fusibility - single fiber, homogeneous and heterogeneous	GR-20. Section - 4.5.2	As specified	Tested on one Verizon approved splicer, Example BIF:BIF, BIF:Std, 25 splices per product pair, total of 50 splices.



Criteria	Description	Reference Specification	Test Condition	Sample Quantity
18.	Fiber Fusibility - 12f ribbon	To be specified by vendor	As specified	2 - twelve fiber IBP fiber Ribbons 1- twelve fiber STD Ribbon 6 Splices of IBP: IBP 6 splices of IBP: STD measure and report average splice loss.
	Environmental Tests			
19.	Change of Temperature (Method Na, transition in less than 3 minutes, Dwell 2 hrs, 2 cycles) -40°C to 85°C Coating Strip Force Visual inspection. (no cracks or deterioration)	IEC 60793-2-50 IEC 60068-2-14 IEC 60793-1-32	As specified	20 meters from each of 2 preforms



Criteria	Description	Reference Specification	Test Condition	Sample Quantity								
20.	Atten. Coeff. with Temperature-Humidity Cycle Max Atten limit per RFP	TIA/EIA 492CAAB	As specified	3 fiber (reels) from at least 3 different preforms Length \geq 2000m 3 samples								
21.	Atten. Coeff. with Dry Heat Soak Max Atten limit per RFP After-Coating Strip Force	IEC 60793-2-50 IEC 60793-1-51 IEC 60793-1-32	As specified	3 fiber (reels) from at least 3 different preforms Length \geq 2000m Strip – 5 samples per reel (Total of 15 samples)								
22.	Atten. Coeff. with Damp Heat Max Atten limit per RFP After-Dynamic Tensile Strength	IEC 60793-2-50 IEC 60793-1-50 IEC 60793-1-31	As specified	3 fiber (reels) from at least 3 different preforms 30 samples 15 aged and 15 un-aged								
23.	Macrobend TD & aged fiber; Fibers are aged with 5 turns at minimum bend radius. Choose from Minimum Bend Radius of 10, 15, 20mm diameters or other	Choose from Minimum Bend Radius of 10, 15, 20mm diameters or other minimum specified bend radius. UBIF Criterion <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>10 mm</td> <td>5 turns</td> <td>1550</td> <td>0.500</td> </tr> </tbody> </table>	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	10 mm	5 turns	1550	0.500	Fiber Length = 15 meters, TD (-40C to +70C) 2 cycles 30 day Hot Humid (85C/85%RH) TD (-40C to +70C) 2 cycles 30 day Hot Humid	5 - 15 meter samples one from each of 5 different fiber reels (a minimum of 5 pre-forms). (total of 5 samples)
Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)									
10 mm	5 turns	1550	0.500									



Criteria	Description	Reference Specification	Test Condition	Sample Quantity																
	fiber minimum specified bend radius per manufacturer's spec.	<p align="center">G.657.A1 Type Fiber Macrobend Criteria</p> <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>20 mm</td> <td>5 turns</td> <td>1550</td> <td>3.75</td> </tr> </tbody> </table> <p align="center">G.657. A2 & B2 Type Fiber Macrobend Criteria</p> <table border="1"> <thead> <tr> <th>Bend Mandrel Diameter(mm)</th> <th>Number of turns</th> <th>Wavelength nm</th> <th>Max (dB)</th> </tr> </thead> <tbody> <tr> <td>15 mm</td> <td>5 turns</td> <td>1550</td> <td>2.50</td> </tr> </tbody> </table>	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	20 mm	5 turns	1550	3.75	Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)	15 mm	5 turns	1550	2.50	(85C/85%RH) TD (-40C to +70C) 2 cycles	
Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)																	
20 mm	5 turns	1550	3.75																	
Bend Mandrel Diameter(mm)	Number of turns	Wavelength nm	Max (dB)																	
15 mm	5 turns	1550	2.50																	
24.	<p>Dynamic Tensile Strength of Bend Radius performance enhanced fiber,</p> <p>Age samples at minimum bend radius.</p> <p>The entire gauge length for each sample must be aged at the minimum bend diameter. Match coefficient of expansion of mandrel to that of fiber.</p>	<p>Measure strength post exposure (pre strength tests are performed under test 11 above.)</p> <p>Strength: 15% >= 400 kpsi & 50% >= 440 kpsi</p> <p>Microscopic Exam, 100X: No coating tears, splits or delaminations</p>	<p>TD (-40C to +70C) 2 cycles 30 day Hot Humid (85C/85%RH)</p> <p>TD (-40C to +70C) 2 cycles 30 day Hot Humid (85C/85%RH)</p> <p>TΔ (-40X τo +70X) 2 χψχλεσ</p>	Take 30 samples from each of five different fiber reels (from at least 5 different preforms).																



Criteria	Description	Reference Specification	Test Condition	Sample Quantity
25.	High Power Two Point Bend Test, at minimum bend radius, 168 hours (7d)	No damage to coating/jacket, Perform infrared scan to verify power emitted from bend point	1) Pin = \geq 23 dBm,	1
26.	Evidence of meeting fiber specification		Manufacturing data	N = 30
27.	Evidence of meeting applicable ITU Specifications ITU-675 A or B		Provided by Manufacturer	

The intent of the following “Fiber Testing in a connector Application” is to ensure that the Bend Performance Improved Fiber will function properly when used in a connector applications mated to like type fiber/connector or with other fiber types in use in the Verizon Network. The fiber under test may be protected with any media type as defined in TPR.9409. The connectors shall be previously Verizon Qualified and Accepted SC/APC type connectors.

Fiber Testing in a Connector Application			
Interoperability - Endface Geometry ²	Per GR-326, section 4.4.5.2 (APC only)		Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.

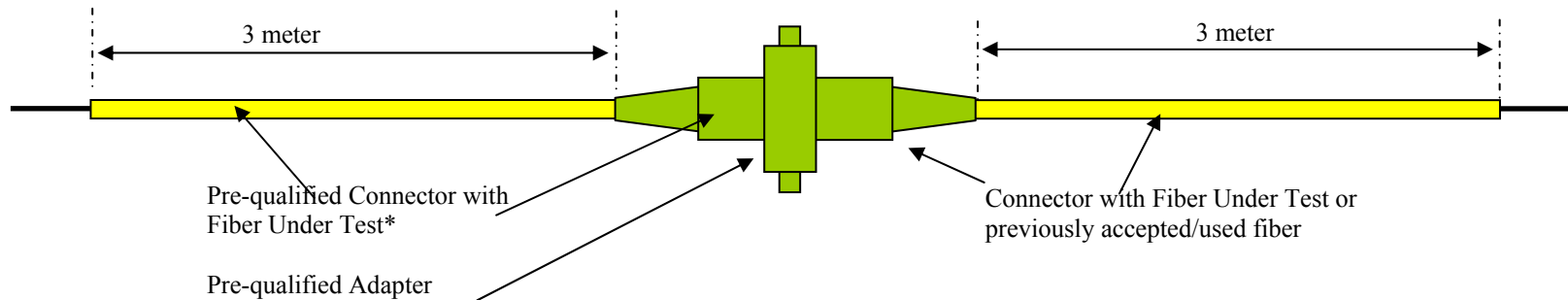
² Initial Endface Geometry is only required to validate the test samples. Only valid test samples may be tested.



Pre-Test IR/RL	Per GR-326 Sections 4.4.2.1 – 4.4.2.6 To be run in sequence on the same set of samples followed by Interoperability and Final IR/RL ³ .	IL/RL	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
Interoperability – Environmental	Per GR-326, section 4.4.2	IL/RL (B/D/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
4.4.2.1 Thermal Age Testing	85°C/168h	IL/RL (B/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
4.4.2.2 Thermal Cycle Test	-40°C to +75°C; 7 days; Dwell Time: 1 hour (per GR-326, Figure 4-3) - see note1	IL/RL (B/D/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
4.4.2.3 Humidity Aging Test	75° C / 90% RH, 7 days - Measurements every 6hrs min.	IL/RL (B/D/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
4.4.2.4 Humidity/Condensation Cycling Test	-10°C to +65°C, 90% - 100% RH; 7 days; (per GR-326, Figure 4-4) - See note2	IL/RL (B/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
4.4.2.5 Dry-Out Step	24 hrs @ 75°C, uncontrolled humidity		Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.

³ Final Endface Geometry is only required for those test samples that failed the optical criterion. Endface geometry measurements for the failed samples may be used as a RCA tool.

4.4.2.6 Post-Condensation Thermal Cycle Test	-10°C to +65°C, 90% - 100% RH; 7 days; (per GR-326, Figure 4-4) - see note2	IL/RL (B/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
Interoperability - Durability	200 cycles durability, per GR-326, section 4.4.3.8	IL/RL (B/D/A)	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.
IR/RL	Per GR-326	IL/RL	Ten (10) mated pairs of each fiber type. See the definition of samples and sample configurations below.



Samples Under Tests are provided as connectorized SC/APC jumper cable assemblies with one side of the assembly utilizing the “Fiber Under Test” and the other end utilizing the fiber types as indicated below.

- 10 mated pairs of FUT to G.652 fiber (Verizon Accepted)
- 10 mated pairs of FUT to G.657 A1 fiber (Verizon Accepted)
- 10 mated pairs of FUT to G.657 B2 fiber (Verizon Accepted)
- 10 mated pairs of FUT to G.657 B3 fiber (Verizon Accepted)
- 10 mated pairs of FUT to FUT



Sample Selection: Samples of bend insensitive fibers must be selected from a minimum of three reels (lots)