



**Verizon NEBS™ Compliance: Hardened  
Fiber Optic Connectors (HFOC)  
Verizon Technical Purchasing Requirements  
VZ.TPR.9418  
Issue 4, August 2008**





**CHANGE CONTROL RECORD:**

<b>Version</b>	<b>Date</b>	<b>Action*</b>	<b>Reason for Revision</b>
1	<i>11/2/2007</i>	New	New Document.
2	<i>2/27/2008</i>	Change	Section 4.3.5 Durability – dropped 50°C requirement
3	<i>5/2/2008</i>	Change	Multiple updates throughout document
4	<i>8/11/08</i>	Change	Multiple updates throughout document
* New, Add, Delete, Change, Reissue			

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## 1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement (VZ.TPR) document is to provide the FOC testing requirements for Hardened Fiber Optic Connectors. This requirement is based on GR-3120 Generic Requirements for Hardened Fiber Optic Connectors and GR-326 Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies.

## 2.0 SCOPE

Hardened Fiber Optic Connectors (HFOC)

## 3.0 REFERENCES

<b>ASTM G21</b>	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
<b>GR-209-CORE, Issue 5, February 2006</b>	Generic Requirements for Product Change Notices (PCNs)
<b>GR-326-CORE, Issue 3, September 1999</b>	Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies
<b>GR-1221-CORE, Issue 2, January 1999</b>	Generic Reliability Assurance Requirements for Passive Optical Components
<b>GR-3120-CORE, Issue 1, October 1994</b>	Generic Requirements for Hardened Fiber Optical Connectors
<b>FOC Memo # 3 GR-771 2005</b>	Applicable to GR-771 Test Conditions
<b>FOC Memo # 3 Rev.1 2005</b>	Applicable to Fiber Monitoring
<b>FOC Memo # 3 Rev.2 2005</b>	Applicable to optical test and criteria clarification
<b>FOC Memo # 9, 2005</b>	Applicable to punch list
<b>FOC Memo # 9, Rev. 1 2005</b>	Applicable to punch list
<b>FOC Memo # 9, Rev. 2 2005</b>	Applicable to punch list
<b>FOC Memo # 9, Rev. 3 2005</b>	Applicable to Freeze/Thaw Test
<b>FOC Memo # 9, Rev. 3 2005</b>	Applicable to HFOC Intermateability
<b>FOC Memo # 9, Rev. 4 06/06</b>	Applicable to GR-3120 Hardened Connector Punch List
<b>FOC Memo # 9, Rev. 4 2006</b>	Applicable to HFOC Intermateability
<b>FOC Memo # 18, Rev 1</b>	Applicable to Intermatability testing
<b>FOC Memo # 18, Rev 1 2005</b>	Applicable to Intermatability testing
<b>FOC Memo # 18, Rev 2</b>	Applicable to Intermatability testing
<b>FOC Memo # 43</b>	Applicable to Extended Thermal Cycling test



<b>IEC 60874-14-6</b>	Connectors for optical fibers and cables - Part 14-6: Detail specification for fiber optic connector - Type SC-APC 9° untuned terminated to single-mode fiber Type B1
<b>IEC 60874-14-7</b>	Connectors for optical fibers and cables - Part 14-6: Detail specification for fiber optic connector - Type SC-APC 9° tuned terminated to single-mode fiber Type B1:
<b>IEC 61300-3-23</b>	Fiber optic interconnecting devices and passive components - Basic test and measurement procedures - Part 3-23: Examination and measurements - Fiber position relative to ferrule endface
<b>VZ.TPR.9405</b>	Generic Reliability Assurance Requirements for Passive Optical Components
<b>VZ.TPR.9407</b>	Freeze/Thaw Test Setup and Procedure
<b>VZ.TPR.9409</b>	Singlemode Optical Connectors and Jumper Assemblies
<b>VZ.TPR.9430</b>	Optical Fiber and Optical Fiber Cable

#### 4.0 ACRONYMS

<b>A</b>	After
<b>B</b>	Before
<b>CIR</b>	Change in Reflectance
<b>CIT</b>	Change in Transmittance
<b>D</b>	During
<b>DUT</b>	Device Under Test
<b>FOC</b>	Fiber Optic Components
<b>HFOC</b>	Hardened Fiber Optic Connector
<b>IL</b>	Insertion Loss
<b>ITL</b>	Independent Test Laboratory
<b>RL</b>	Return Loss
<b>TPR</b>	Technical Purchasing Requirement



## **5.0 TEST REQUIREMENTS FOR HARDENED FIBER OPTIC CONNECTORS (HFOC)**

Verizon purchases Hardened Fiber Optic Connectors for various applications. Hardened Optical Connectors shall meet the requirements specified in the following tables, which are based on to the requirements specified in Telcordia document GR-3120: Generic Requirements for Hardened Fiber Optic Connectors and GR-326: Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies. All the testing must be completed by a Verizon approved ITL.



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
<b>3.0 Detailed Requirements</b>					
<b>3.1 Product Samples</b>		R3-1			Production Samples
		R3-2			Manufacturer's name, model or part number and date code
		R3-3			Identified with the closure/terminal model number in which they are used
<b>3.2 Product Change</b>		R3-4			PCN per GR-209
3.3 Safety and Reliability Considerations		R3-5			No defects, sharp edges, burrs, etc.
		R3-6			Per GR-3120
		R3-7			No hazards materials
					No Index Matching Gels
<b>3.4 Plastic Materials</b>		R3-8	5 test bars x 11 chemicals		Saturate test bars with chemicals (1 chemical per test bar set), store in plastic bag for 30 days. No cracks, stripping, molting, texture or color change allowed.
		CR3-9			
		R3-10	Plaque of polymeric materials, 6"x6"		
<b>3.5 Optical Connectors</b>		R3-12			VZ.TPR.9409 compliant
<b>3.6 Cable Media</b>		R3-13			VZ.TPR.9430 compliant
<b>3.7 Documentation</b>		R3.14			Per GR-3120



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
		CR3-15			Detailed Training packages as required
<b>3.8 Marking, Packaging, and Shipping</b>		R3-16			HFOC and its shipping container shall be readily identifiable and marked with Manufacturer, model number, date of manufacture (Month and Year) and serial Number
		R3-17			Marking minimum of 3/4" in height
		R3-18			Packaging shall prevent damage during shipping. (Small components shall be shipped in sealed packages)
<b>3.9 Quality</b>		R3-19			TL 9000
		R3-20			On-Site Quality Surveillance Program
<b>3.10 Intermateability</b>					
Intermateability		R3-21	5 jumpers/5 mating adapters		Measure Manufacturers product geometry to production print.
Keying		R3-22			Connector plug should be keyed
<b>4.0 Application-Specific Requirements</b>					



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
<b>4.1 Geometry Requirements</b>					
4.1.1 Ferrule Endface Geometry for Non-Angled Physical Contact Connectors	A-1	R4-1			Fiber Undercut and Protrusion: Per GR-3120 and IEC 60874-14-n (n = applicable standard in the series)
		R4-2			Ferrule Endface Radius: Between 7mm and 25mm
		R4-3			Apex Offset: <50um
4.1.2 Endface Geometry Requirements for Angled Physical Contact (APC) Connectors	A1	R4-4			IEC 60874-14-6 for 8° untuned connector and IEC 60874-14-7 for 8° tuned connector: To be conducted before and after all environmental and mechanical testing
4.1.3 Endface Geometry Measurement Areas	A1	R4-5			To be conducted before and after all environmental and mechanical testing, shall meet the requirements specified in IEC 61300-3-23 for measuring radius of curvature and fiber undercut/protrusion.



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
4.1.4 Performance of New Product	A-2	R4-2	All	IL	Table 1: New Product (Max Loss - Requirement)
		O4-3		IL	Table 1: New Product (Max Loss - Objective)
		R4-4		IL	Table 1: New Product (Mean Loss - Requirement)
		O4-5		IL	Table 1: New Product (Mean Loss - Objective)
		R4-6		RL	Table 2: New Product (Mean Reflectance - Requirement)
<b>4.2 Environmental Performance</b>					
4.2.1 Temperature, Humidity and Condensation Tests					
4.2.1.1 Thermal Age Testing	A3	R4-6 thru O4-7	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	85°C/168h
4.2.1.2 Thermal Cycle Test	A4	R4-8 thru O4-9	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	-40°C to +75°C; 7 days; Dwell Time: 1 hour (per GR-326, Figure 4-3) - see note1
4.2.1.3 Humidity Aging Test	A5	R4-10 thru O4-11	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	75° C / 95% RH, 7 days - Measurements every 6hrs minimum



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
4.2.1.4 Humidity/Condensation Cycling Test	A6	R4-12 thru O4-13	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	-10°C to +65°C, 90% - 100% RH; 7 days; (per GR-326, Figure 4-4) - see note2
4.2.1.5 Dry-Out Step	A7		16 pigtailed pair, 10 hot spares		24 hrs @ 75°C, uncontrolled humidity
4.2.1.6 Post-Condensation Thermal Cycle Test	A8	R4-14 thru O4-15	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	-40°C to +75°C; 7 days; Dwell Time: 1 hour (per GR-326, Figure 4-3) - see note1
4.2.2 Vibration Test	A9	R4-16 thru O4-17	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	10 - 55 Hz, 45 Hz/min, 2 hours @ amplitude of 1.5mm; X/Y/Z Axis (Measurements before and after each axis).
4.2.3 Freeze Thaw	A10	R4-18 thru R4-19	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	10 cycles of Freeze Thaw per VZ.TPR.9407; No water intrusion. (Optical Monitoring During at 1625 only)
4.2.4 Water Resistance	A11	R4-20*	16 pigtailed pair, 10 hot spares	None Required	No Water Intrusion after 7 days, 10ft water head.
4.3 Mechanical Performance					
4.3.1 Flex Test	A12	R4-21 thru O4-22	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	8 flex cycles @ 0°, 90°, 0°, -90°, 0°: - 10.0 lbf load; - 30°C and 40°C.



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
4.3.2 Cable Torsion	A13	R4-23 thru R4-25	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	10 Torsion cycles @ 0°, 90°, 0°, -90°, 0°: -30°C and 40°C; Twist 1 meter back.
4.3.3 Proof Test	A14	R4-26 thru CO4-28	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	<p>Requirement: Plug/Cap Straight Pull: 100 lbs for 60 seconds, wait 10 seconds and perform optical measurements @ -30°C and 40°C</p> <p>Objective: Plug/Cap Straight Pull: 167 lbs for 60 seconds, wait 10 seconds and perform optical measurements@ -30°C and 40°C</p> <p>Requirement: Plug/Adapter 90° Side Pull: 15 lbs for 60 seconds, wait 10 seconds and perform optical measurements@ -30°C and 40°C</p> <p>Objective: Plug/Adapter 90° Side Pull: 25 lbs for 60 seconds, wait 10 seconds and perform optical measurements @ -30°C and 40°C</p>



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
					Requirement: Plug/Adapter-Tensile Load: 25 lbs for 60 seconds, wait 10 seconds and perform optical measurements @ -30°C and 40°C Objective: Plug/Adapter-Tensile Load: 50 lbs for 60 seconds, wait 10 seconds and perform optical measurements @ -30°C and 40°C
4.3.4 Transmission With Applied Tensile Load	A15	R4-29 thru O4-31	16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	30 minutes @ 10 lbs: -30°C and 40°C at 0, 90 & 135 degree angles
4.3.5 Durability	A16		16 pigtailed pair, 10 hot spares	IL/RL (B/D/A); CIT/CIR	50 cycles durability, @ -18°C & 40°C, clean every 10 mating. Measurements @ 9,19,29,39,49 without cleaning. Measurements @ 10,20,30,40,after 1 side cleaning. Measurements @ 25 and 50 after 2 sided cleaning.
		R4-34			1 sided or 2 sided cleaning - 90% shall meet requirements



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
		O4-35			1 sided or 2 sided cleaning - 95% shall meet objectives
		O4-36			Without cleaning - 90% shall meet Requirements
		R4-37			After 50 Insertions, shall meet Requirements
		O4-38			After 50 Insertions, shall meet Objectives
		O4-39			Cleanability Objective: Not met if recleaning required
4.3.6 Impact	A17	R4-40	16 pigtailed pair, 10 hot spares	IL/RL (B/A); CIT/CIR	-40°C; Impacted @ 5ft height - 2 impacts horizontal w/ferrule cap.
		O4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
		R4-40			-40°C; Impacted @ 15ft height - 2 impacts vertical w/dust cap. See note <sup>8</sup>
		R4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
		R4-40			-40°C; Impacted @ 15ft height - 2 impacts horizontal w/dust cap.



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
		R4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
4.3.7 Seal Under Load	A18	R4-42	16 pigtailed pair, 10 hot spares	None Required	7 days @ 23°C: 10ft water head; 2.5lb (Req) - 90°; No damage.
		O4-43			7 days @ 23°C: 10ft water head; 5lb (Obj) - 90°; No damage.
4.3.10 End of Test Criteria	A19	VZR-1	16 pigtailed pair, 10 hot spares	IL/RL/CIT/CIR	Optical Requirements "End of Test" (see Table 1 & 2)
		VZR-2			Optical Objectives "End of Test" (see Table 1 & 2)
		R4-1 thru R4-5			Geometry (R4-1 to R4-5)
		VZR-3			No damage that would impair the performance of either the connector plug or the adapter.
4.3.8 Crush Test	B	R4-44	16 pigtailed pair	None Required	300 lbs for 15 minutes: 8 @ -40°C and 8@ 40°C If not meet, provide matrix for pass levels.
		O4-45			
4.3.9 Rodent Resistance/Rockwell Hardness	C	CR4-46	5 Test Bars	None Required	Rockwell hardness (R87)
<b>Facilities for Product Testing</b>					



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
Ambient Laboratory Conditions					Temperature:23°C +2°C Humidity: less than 75%RH
Optical Measurements					Per VZ.TPR.9405 (system validation)
<b>Reliability Test</b>					
<b>4.4 Reliability Performance Testing</b>					
4.1.1 Ferrule Endface Geometry for Non-Angled Physical Contact Connectors	All	R4-1	All as required		Fiber Undercut and Protrusion: Per GR-3120 and IEC 60874-14-n (n = applicable standard in the series)
		R4-2			Ferrule Endface Radius: Between 7mm and 25mm
		R4-3			Apex Offset: <50um
4.1.2 Endface Geometry Requirements for Angled Physical Contact (APC) Connectors	All	R4-4	All as required		IEC 60874-14-6 for 8° untuned connector and IEC 60874-14-7 for 8° tuned connector: To be conducted before and after all environmental and mechanical testing
4.1.3 Endface Geometry Measurement Areas	All	R4-5	All as required		To be conducted before and after all environmental and mechanical testing, shall meet the requirements specified in IEC 61300-3-23



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
					for measuring radius of curvature and fiber undercut/protrusion.
4.1.4 Performance of New Product	A-2	R4-2	All	IL	Table 1: New Product (Max Loss - Requirement)
		O4-3		IL	Table 1: New Product (Max Loss - Objective)
		R4-4		IL	Table 1: New Product (Mean Loss - Requirement)
		O4-5		IL	Table 1: New Product (Mean Loss - Objective)
		R4-6		RL	Table 2: New Product (Mean Reflectance - Requirement)
4.4.1 High Temperature Storage Test (Dry Heat)	D	R4-47 and R4-49 thru R4-51	44 Pigtailed Assemblies and 44 Mating Adapters (LTPD 10%)	IL/RL (B/D/A)	85°C (±5°C), < 40% RH, 2,000 hrs. For qualification and ≥ 5000 hrs (optional) for information. IL measurements initially, and then at 168- (optional), 500-, 1000-, and 2000-hour intervals. Per GR-1221, section 6.24



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
4.4.2 High Temperature Storage Test (Damp Heat)	E	R4-52 and R4-54 thru R4-56	44 Pigtailed Assemblies and 44 Mating Adapters (LTPD 10%)	IL/RL (B/D/A)	75°C (±5°C), 95% (± 5%) RH, 2,000 hrs. For qualification and ≥ 5000 hrs (optional) for information. IL measurements initially, and then at 168- (optional) 500-, 1000-, 2000-hour intervals. Per GR-1221, section 6.25
4.4.3 Temperature Cycling Test (Extended Thermal Cycling)	F	R4-57 and R4-59 thru R4-61	44 Pigtailed Assemblies and 44 Mating Adapters (LTPD 10%)	IL/RL (B/D/A)	- 40°C to 85°C (± 2°C) ≥ 15 minutes dwell time at extremes, 100 cycles pass/fail, 500 cycles pass/fail, 1000 cycles (optional) for information for RT/UNC. Per attached profile - see below
4.4.4 Salt Spray	G	R4-62 thru R4-65	10 samples total: 5 mated pair 5 with dust caps	IL/RL (B/A)	Perform testing per GR-326, section 4.4.4.4 (Closure: 5 samples each, half with mated plugs and half with dust cap)
4.4.5 Airborne Contaminants	H	R4-66 thru R4-68	10	IL/RL (B/A)	Perform testing per GR-326, section 4.4.4.3 (Closure: 5 samples each, half with mated plugs and half with dust cap)



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
4.4.6 UV Resistance	I	R4-70	10 test bars	None Required	90 days, no damage, Tensile/Elongation greater than 20% - per ASTM G-154
4.4.7 Fungus Resistance	J	R4-71	10 test bars	None Required	Per ASTM G21, rating of 0 required
4.4.8 Dust Test	K	R4-72 thru O4-76	10	IL/RL (B/A)	Perform testing per GR-326, section 4.4.4.1 (Closure: 5 samples each, half with mated plugs and half with dust cap)
4.4.9 Groundwater Immersion	L	R7-15*	24	IL/RL (I/D/E)	Configure as: Closure/Connector (chemical only). Test three Config.; Plug/Dust; Plug/Adapter; Adapter/Dust Cap. 2 samples in each fluid. 4 immersion media's (organism not required), 22°C $\pm$ 2°C for 7 days: Measure Initially (upon immersion), after 24 hours, after 7 days (while in fluid)
GR-326 4.4.3.9 End of Test Criteria	ALL	VZR-1	16 pigtailed pair, 5 hot spares	IL/RL/CIT/CIR	Optical Requirements "End of Test" (see Table 3 & 4)
		VZR-2			Optical Objectives "End of Test" (see Table 3 & 4)



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
		R4-1 thru R4-5 VZR-3			Geometry (R4-1 to R4-5) No damage that would impair the performance of either the connector plug or the adapter.
4.4.10 Chemical Resistance - Material Degradation	M	R4-78	5 test bars/ material/chemical 2.5" x 0.5" x 0.125"		Smear samples with appropriate chemical, place in 3-point fixture (0.04" deflection) for 24 hrs. No evidence of cracking of material
4.4.11 Chemical Resistance - Immersion	N-1	R4-79 thru R4-81	3 dogbone samples and 3 pigtailed samples per chemical		Immerse 3 dogbones and 3 pigtailed samples in each chemical for 7 days. No change in weight > 10% or tensile and elongation > 20% for dogbones allowed. No damage to pigtails.
4.3.8 Crush Test	N-2	R4-44 O4-45	12 pigtailed pair		300 lbs for 15 minutes: 8 @ -40°C and 8@ -40°C If not meet, provide matrix for pass levels.
4.3.6 Impact	N-3	R4-40	12 pigtailed pair	IL/RL (B/A); CIT/CIR	-40°C; Impacted @ 5ft height - 2 impacts horizontal w/ferrule cap.



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
		O4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
		R4-40			-40°C; Impacted @ 15ft height - 2 impacts vertical w/dust cap. See note <sup>8</sup>
		R4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
		R4-40			-40°C; Impacted @ 15ft height - 2 impacts horizontal w/dust cap.
		R4-41			If you can meet -40°C; perform Impact testing at -20°C and 0°C (as required).
4.3.7 Seal under Load	N-4	R4-42	12 pigtailed pair	None Required	7 days @ 23°C: 10ft water head; 2.5lb (Req) - 90°; No damage.
		O4-43			7 days @ 23°C: 10ft water head; 5lb (Obj) - 90°; No damage.
4.5 Intermateability Test					See Testing listed below
8.0 Reliability Assurance Program					
8.2 Manufacturing and Process Control					Per VZ.TPR.9445
Repeatability & Accuracy requirement					- Bench Top Optical System - Switch Based



FOC Test Plan for HARDENED Fiber Optical Connectors (HFOC) based on GR-326, 771 & 3120(Task references from GR-326)					
Task	Test Group	Reference Spec.	Samples	Optical Monitor	Comments
					Optical System - End Face Geometry

### Optical Measurements

- Loss (100% of channels to be monitored)
  - B – Before IL & RL Optical Testing @ (1310, 1490, 1550 & 1625 nm)
  - D – During IL & RL Optical Testing @ (1310, 1490, 1550 & 1625 nm)
  - A – After IL & RL Optical Testing @ (1310, 1490, 1550 & 1625 nm)
  - I initial (under load) IL & RL Optical Testing @ (1310, 1490, 1550 & 1625 nm)
  - E – End of test (under load) IL & RL Optical Testing @ (1310, 1490, 1550 & 1625 nm)
  - CIT (Change in Transmittance) Calculation -  $CIT = A^{IL} - \text{New Product}^{IL}$
  - CIR (Change in Reflectance) Calculation -  $CIR = A^{RL} - \text{New Product}^{RL}$
  - No measurements required on hot spares until required.
  
- Concatenation is not allowed.



### **Damage Criteria:**

- At the completion of the respective test the connector plugs and adapters shall be inspected for damage that might impair the performance of the connector. This inspection shall include inspections for:
  - Distortion of housing parts, as indicated by difficulty in insertion, improper Snap-fits, etc.
  - Distortion of ferrules and sleeves, as indicated by change in mating force,
  - Changes in endface geometry, etc.
  - Cracks
  - Presence of debris, shavings, etc.
  - Corrosion or residue
  - Other potentially service-affecting damage
  - Permanent Loss Increase of more than 0.5 dB from the New Product Measurement
  - Permanent Reflectance Increase of more than 5 dB from the New Product Measurement.
  
- Permanent is defined as having the specified level of increase in loss or reflectance at the end of all tests performed on connector assemblies. The connector assemblies may be cleaned up to 2 times, using the specified Cleaning Procedure, at the supplier's option, in an attempt to bring their increases below the criteria level.
  
- Examination shall also include inspection of the polished end of the ferrule under a magnification of 100 power for cracks, chips, or scratches.

## Testing Sequences:

The following table will define the test sequences for the Service Life testing requirements.

<b>Table 1 (Service Life)</b>			
<b>Sample Group</b>	<b>Test Sequence</b>	<b>Title</b>	<b>Section</b>
A	1	Ferrule Endface Geometry	4.1
A	2	New Product Measurement	4.1.4
A	3	Thermal Age Test	4.2.1.1
A	4	Thermal Cycling	4.2.1.2
A	5	Humidity Age	4.2.1.3
A	6	Humidity / Condensation Cycling Test	4.2.1.4
A	7	Dry-out Step	4.2.1.5
A	8	Post-Condensation Thermal Cycle	4.2.1.6
A	9	Vibration	4.2.2
A	10	Freeze Thaw	4.2.3
A	11	Water Resistance	4.2.4
A	12	Flex Test	4.3.1
A	13	Cable Torsion	4.3.2
A	14	Proof Test	4.3.3
A	15	Transmission With Applied Tensile Load	4.3.4
A	17	Impact	4.3.6
A	16	Durability	4.3.5
A	18	Seal Under Side Load	4.3.7
A	19	End of Test Criteria (Optical, Ferrule Geometry and Damage)	4.3.10
B		Crush Test	4.3.8
C		Rockwell Hardness	4.3.9

Testing is to be performed sequentially as defined in the above table.

The following table will define the test sequences for the Reliability testing requirements.

<b>Table 2 (Reliability)</b>			
<b>Sample Group</b>	<b>Title</b>	<b>Section</b>	<b>Sample Type</b>
ALL	Ferrule Endface Geometry (Initially and at the end of testing - all samples)	4.1	
A	New Product Measurement	4.1.4	All
D	Extended Thermal Age	4.4.1	Assembly and adaptor/Terminal or Closure
E	Extended Humidity Age	4.4.2	Assembly and adaptor/Terminal or Closure
F	Extended Thermal Cycling	4.4.3	Assembly and adaptor/Terminal or Closure
G	Salt Spray	4.4.4	Pigtail Assembly
H	Airborne Contaminants	4.4.5	Pigtail Assembly
I	UV Resistance	4.4.6	Test Bars
J	Fungus resistance	4.4.7	Test Bars
K	Dust	4.4.8	Pigtail Assembly
L	Ground Water Immersion	4.4.9	Pigtail Assembly
ALL	End of Test		ALL
M	Chemical Resistance - Material Degradation	4.4.10	Test Bars
N-1	Chemical Resistance - Immersion	4.4.11	Assembly and adaptor/Terminal or Closure
N-2	Crush Test	4.3.8	Assembly and adaptor/Terminal or Closure
N-3	Impact	4.3.6	Assembly and adaptor/Terminal or Closure
N-4	Seal Under load	4.3.7	Assembly and adaptor/Terminal or Closure

Testing is to be performed per the sequences defined in the above table.

- Initially, all samples must meet the new product measurement requirements as defined in Tables 1 and 2 and the End Face Geometry requirements as defined in section 4.1 above and in GR-326.
- At the completion of test, all samples must the optical requirements as specified in Tables 1 and 2, the Damage requirements as specified in this document and the Endface Geometry requirements as specified in section 4.1 above and in GR-326.

**Optical Requirements:**

Table 3: Summary of Optical Performance Criteria: Loss						
Test	Maximum Loss		Mean Loss		Loss Increase	
	(R)	(O)	(R)	(O)	(R)	(O)
New Product	0.4	0.2	0.2	0.15	---	---
During Test, Not Under Load	0.5	0.3	0.3	0.2	0.3	0.2
During Test, Under Load	---	---	---	---	0.5	0.3
End of Test	0.5	0.3	0.3	0.2	---	---

Table 4: Summary of Optical Performance Criteria: RL			
Test	Reflectance	Increase in Reflectance	
	(R)	(R)	(O)
New Product	-65	---	---
During Test, Not Under Load	-65	5	2
During Test, Under Load	-65	5	2
End of Test	-65	5	2

**Notes:**

**Note 1:** Measurement to be performed at every plateau - wait minimum of 30 minutes into cycle before starting. (Cycle may be modified by decreasing transition time and increasing hold times if need to complete measurements)

**Note 2:** Humidity is only controlled above freezing (0°C)

**Note 3:** (Service Life) The tensile test fixturing is to be designed with a bracket to hold the coupling adapter in angular increments of 45° about the axis of the connector. During testing, the sample of product is to be rotated as evenly as possible between the eight angular positions to ensure all angles are tested. (i.e. - sample 1 @ 0°, sample 2 @ 45°, sample3 @ 90°, etc.). The sample rotation criterion applies to Flex, Twist, Proof and Transmission with Applied Load.

**Note 4:** Decrease in reflectance is not of concern. Note that the definition of “reflectance” is that of a negative number, as opposed to Optical Return Loss, which is a positive number. The terms “greater than” and “less than” are applied to the numerical values of the reflectance, and not the absolute values of these numbers. Thus, a -50 dB reflectance is greater than a -60 dB reflectance

**Note 5:** RL readings of >65 db are usually outside of the test set-ups capability and the resultant delta value may be outside the allowable range, thus technically interpreted as a failure. Since the value is excellent and readings are not reliable above the 65 db level for many set-ups, the delta should not be considered as a failure.

**Note 6:** Optical readings - during are to be taken at the maximum sampling rate.

**Note 7:** The most stringent criteria is to be used as the pass/fail criteria i.e.: GR criteria, Verizon specifications, or supplier's specifications. The suppliers spec sheet is to be included in the test plan and report in the product description section of the document.

**Note 8:** For Service Life Environmental Tests, recommended to use adapter with Hardened Connector but use of a closure and/or other mounting arrangements is acceptable.

### Extended Thermal Cycling (Reliability) Test

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

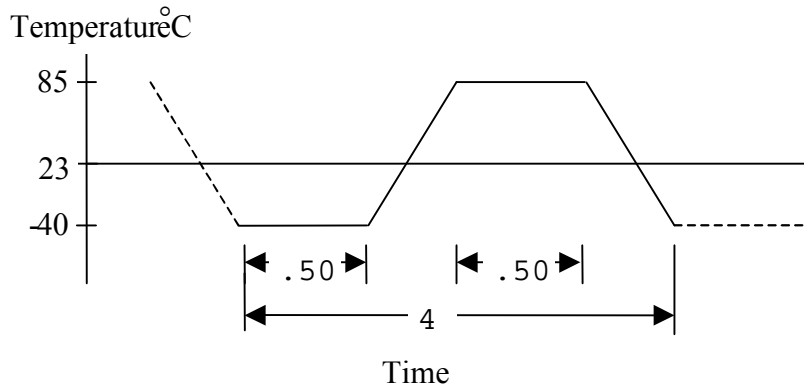


Figure 1: Temperature Profile for Extended Thermal Cycle Test

#### 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

## Intermateability Testing of SC-APC HFOC Connectors and Adapters

### Executive Summary:

The objective of this proposed test program is to provide detailed insight regarding the interconnecting ability of connector and adapters from different suppliers. Using a modified test plan and test protocol from GR-3120-CORE Issue #1, tests and conditioning will be performed on an inter-mated group of connector assemblies. Insertion loss and reflectance readings will be determined before, during and after specific conditionings. The intent of this program is to determine the suitability and interchangeability of connector and adapters of participating vendors and manufacturers.

### Connector Intermateability

#### Test Requirements:

- **Endface Geometry Readings**  
Initial endface readings of all connectors under test will be taken.
- **Insertion Loss and Reflectance Testing**  
Insertion Loss and Reflectance readings are conducted for New Product, during the test and End of Test Criteria at four wavelengths (1310 nm, 1490 nm, 1550 nm, and 1625 nm). New Product measurements are conducted with each manufacturer's HFOC connector and adapter. The appropriate manufacturer's launch cable (reference jumper) will be used for each connector. Please see Figure 2.
- **Environmental Cycle (Modified)**  
Please refer to Figure 3 for the temperature profile and data acquisition times.
- **Vibration Test.**  
Conducted in accordance with this TPR.
- **Proof Test**  
Conducted in accordance with this TPR.
- **Durability Test**  
Conducted in accordance with this TPR.
- **Seal Under Load Test**  
Conducted in accordance with this TPR.
- **End of Test Criteria**  
Insertion Loss, Reflectance, and Endface readings will only be conducted on nonconforming samples. The appropriate manufacturer's launch jumper cable assemblies (same as Step #1 above) will be used for each assembly, if necessary.

NOTE 1: All test samples will be tested sequentially to the test list above.

NOTE 2: Each combination of HFOC connector, adapter, and SC APC pigtail will have a total sample lot as defined in Table 3.

NOTE 3: All testing to be performed at 1310 nm, 1490 nm, 1550 nm, and 1625 nm wavelengths except where noted.

NOTE 4: ITL will use the manufacturer's service provider specific cleaning procedures for the HFOC connector/adapter. Only this specific cleaning procedure will be used on the DUT (Device Under Test). As an example Alcohol and Kim-Wipes and/or Cleatops will be used on surfaces not undergoing testing.

NOTE 5: The manufacturer's HFOC specific installation and maintenance instructions shall be provided prior to testing.

- Samples:

Sample Requirements for Program Participation: The number of samples required for participating in the HFOC Intermateability test program is given in Table 3. Sample configurations are based on the connector definitions given in figure 4 of this document and assume two initial participants. Each succeeding program candidate (connector) is tested against the two most recently approved connectors in reverse chronological<sup>1</sup> order for a maximum of 3 participants per test program. Each test program requires Ten (10) full connectors + 5 hot spares of the new participant test samples and five (5) samples + 3 hot spares of each of the two veteran participants.

**Table 3 Program Sample Requirement**

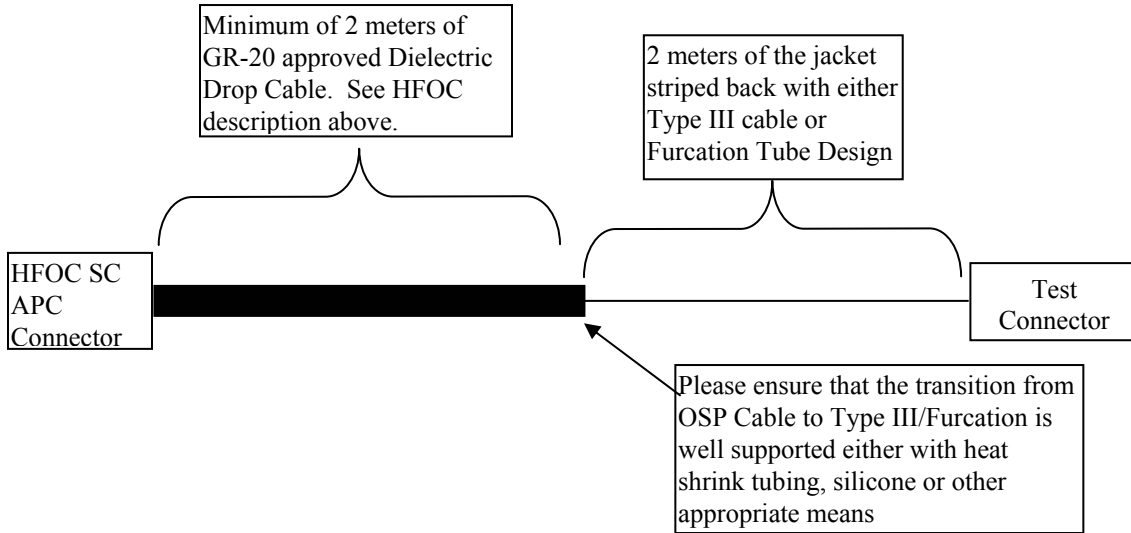
Order of Participation	Manufacturer	Test Combination HFOC → Adapter	Number of Test Samples
Initial 2 participants	A	A → B	A - 10 + 5 for Hot Spares
	B	B → A	B - 10 + 5 for Hot Spares
3 <sup>rd</sup> participant	A	A → C - 5 per	A-5 + 3 for Hot Spares
	B	B → C - 5 per	B-5 + 3 for Hot Spares
	C	C → A - 5 per C → B - 5 per	C - 10 + 5 for Hot Spares
4 <sup>th</sup> participant	B	B → D - 5 per	B - 5 + 3 for Hot Spares
	C	C → D - 5 per	C - 5 + 3 for Hot Spares
	D	D → B - 5 per D → C - 5 per	D - 10 + 5 for Hot Spares
5 <sup>th</sup> participant	C	C → E - 5 per	C - 5 + 3 for Hot Spares
	D	D → E - 5 per	D - 5 + 3 for Hot Spares
	E	E → C - 5 per E → D - 5 per	E - 10 + 5 for Hot Spares

<sup>1</sup> If A, B, and C are already approved and D wishes to participate, then D is tested against B and C.

The following list of samples and supplies are required from each supplier participating in the program. :

- Four (4) – (Test Equipment Connector) to SC-APC 1-meter launch cable. The manufacturing process and end face geometry on the SC-APC launch cable connector shall be representative of all other test samples.
- New Participant samples requirements - 15- test connector to HFOC SC APC jumper cable assemblies. Please see Figure 1, page 3 of 7 for HFOC SC-APC jumper assembly details. (10 required with 5 spares).
- Veteran Participant Sample Requirements: 8- test connector to HFOC SC APC jumper cable assemblies. Please see Figure 1, page 3 of 7 for HFOC SC-APC jumper assembly details. (5 required with 3 spares for each participant).
- To prevent water seepage through the length of the cable during the seal under load test sequence, the drop cable portion of the HFOC connector may be sealed with silicone or other appropriate means as shown in Figure 1 below. Alternatively, if equipped with water blocking capability, lengthening the HFOC drop cable may be used as a method for preventing cable water seepage during the “Seal under load” test. See Insertion loss and reflectance testing of this document for the cable length impact on “Back Reflectance Test Results”.
- (15)-Rookie (10 required with 5 spares), (8)-Veteran (5 required with 3 hot spares) - HFOC adapters
- (15)-Rookie (10 required with 5 spares), (8)-Veteran (5 required with 3 hot spares)– GR-326 approved test connector to SC APC 3-meter jumper cable assemblies.
- Supplies and specific instructions on the cleaning system for the HFOC connector and/or adapter
- Specific Instructions for installing and maintaining the HFOC connector and/or adapter.

- One extra set of O-rings/seals for each connector under test.



**Figure 1: Required Configuration of HFOC Jumper Cable Assemblies**

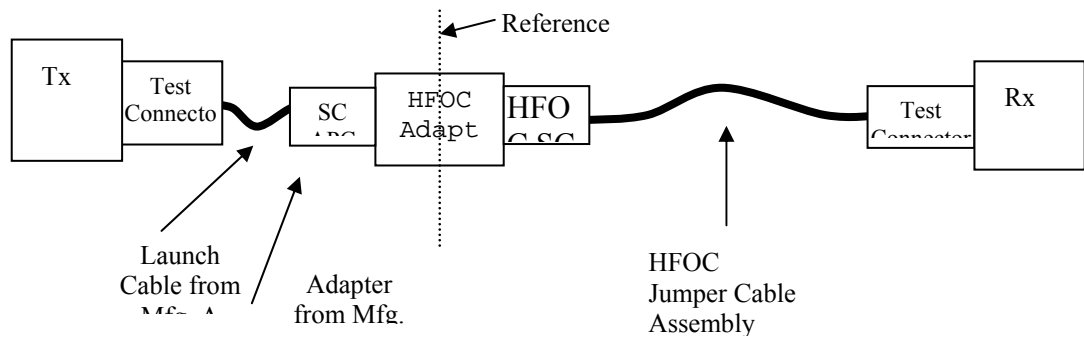
**Test Specifics:**

- **Endface Geometry Readings**

Endface geometry readings will be done on all DUT samples (HFOC and SC APC) as an out of the box “New Product”.

- **Insertion Loss and Reflectance Testing**

New Product Insertion Loss and Reflectance readings will be conducted on all HFOC jumpers utilizing the appropriate launch cable. Please refer to Figure 2 for configuration specifications.

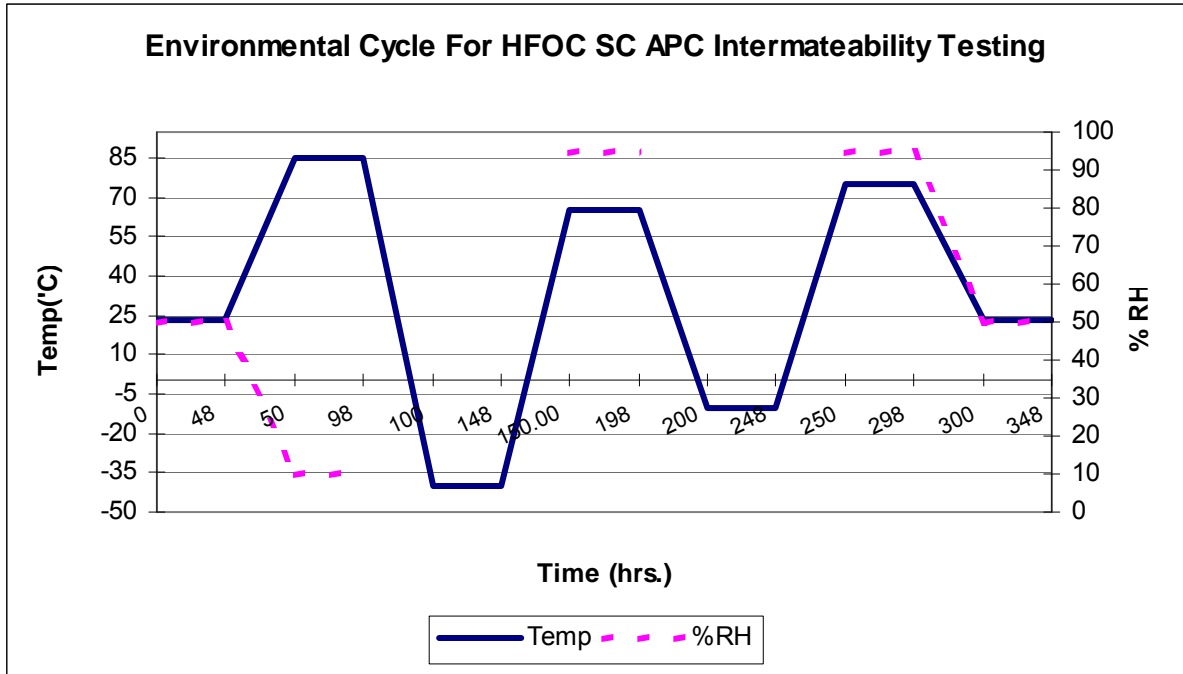


**Figure 2: Test Setup**

If the length of the HFOC drop cable is increased beyond the required minimum (such as to prevent cable water seepage), then the back reflectance measurements conducted during the intermatability test sequence may be adjusted to compensate for the added reflectance of the additional HFOC fiber length. All correction factors and data calculations shall be included in the test report.

- **Environmental Cycle (modified)**

Jumper assemblies and spare O-rings from each of the participating manufacturers will be placed in a conditioning chamber and subjected to the temperature profile shown in Figure 3. Insertion Loss and Reflectance Readings shall be taken every two hours throughout the test.



**Figure 3: Environmental Cycle for HFOC SC APC Intermateability Testing**

- **Vibration Testing {GR-3120, Section 4.2.2}**

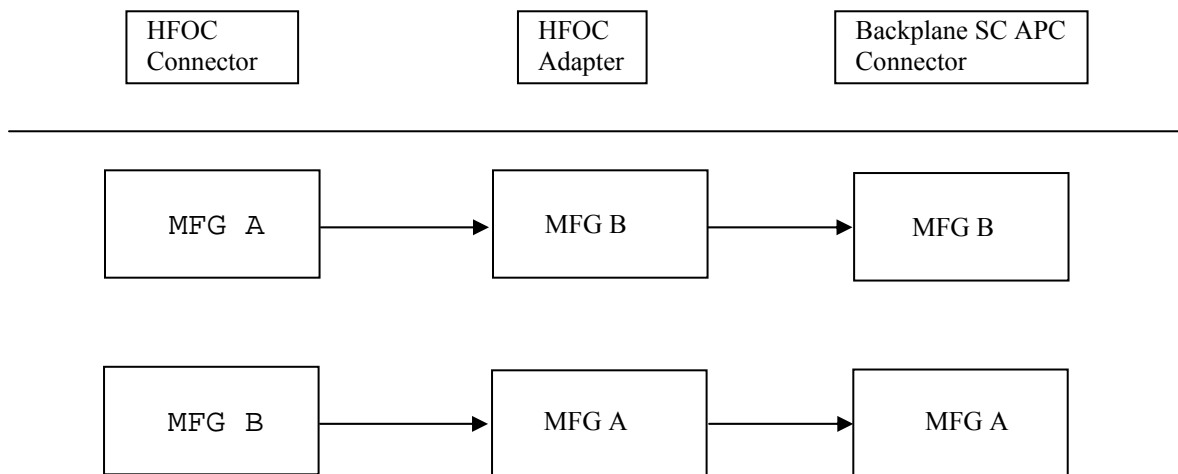
Conducted in accordance with this TPR on all combinations. Please note that the samples will not be monitored during the actual vibration sweeps.

- **Proof Test**

Conducted in accordance with this TPR.

- **Durability Test**

Conducted in accordance with this TPR. Fifty cycles will be performed at -18°C (0°F) and at 46°C (115°F) as per the combinations shown in Table 3. The cleaning procedure will follow GR-3120, Issue #1, Section 4.3.5.



**Figure 4: Combination for the Durability Test**

- The required number of connector assemblies as shown in the Table 3 shall be tested.
- The connectors shall then be conditioned at -18° C for two hours.
- Each connector shall be disconnected and re-connected.
- Insertion loss and reflectance are measured at 1310 nm, 1490 nm, 1550nm and 1625 nm wavelength after each disconnect and re-connect operation.
- The test sequence is continued until all connectors have been cycled (removed and inserted) 50 times. Clean using the service provider instructions every 10 mating/cycles and optically monitor. A seal under load test is performed at the end of the 50<sup>th</sup> cycle. See section 1.3.7 below. The O-rings shall not be replaced prior to the seal under load test.
- The test sequence is repeated with a spare (aged) set of O-rings and a test environment of 46°C.

- **Seal Under Load Test {GR-3120, Section 4.3.7}**  
 Conducted in accordance with this TPR. The test will follow the latest service provider punch-list where the HFOC connector shall be tested in two orthogonal cable orientations and a 2.5-lb load shall be placed on the cable approximately 6-8 inches from the end of the boot.
- **End of Test Criteria**  
 On nonconforming samples, endface geometry shall be re-measured as described in Section 1.3.1 above. Final measurements for Insertion Loss and Reflectance will be repeated using the same methods as described in #2 above.

**Acceptance Criteria**

- **End Face Geometry**  
 As Per this TPR.
- **Initial and Final Loss Measurements**  
 As per this TPR. Connectors shall meet the Requirements listed Table 1 and 2 of this document.
- **Environmental Conditioning**  
 Custom temperature profile, please refer to Figure 2. Connectors shall meet the Requirements listed Table 1 and 2 of this document.
- **Vibration Test**  
 As per this TPR, Connectors shall meet the Requirements listed Table 1 and 2 of this document.
- **Proof Test**  
 As per this TPR, Connectors shall meet the Requirements listed Table 1 and 2 of this document.
- **Durability Test**  
 As per this TPR, Connectors shall meet the Requirements listed Table 1 and 2 of this document.
- **Seal Under Load Test**  
 As per this TPR, samples will be checked for water leaks for a “Pass/Fail” criteria.
- **End of Test Criteria**  
 As per this TPR, Connectors shall meet the Requirements listed Table 1 and 2 of this document. Endface Geometry as per this TRP.