



**Verizon NEBS™ Compliance: Multi-Fiber
Optical Connectors**
Verizon Technical Purchasing Requirements
VZ.TPR.9431
Issue 2, February 2009





CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	10/31/2007	New	New Document.
2	2/13/2009	Change	Sec 3.0- Added reference to 61755-3-31 PAS Changed references <i>from</i> 61755-3.3 <i>to</i> 61755-3-31 throughout document Sec 4.4.3- Added clarification that Media Types are per GR-1435 Corrected Media Types and load requirements and objectives Corrected Test Setup Figure- added second plug Removed references to O-rings in the Intermateability Testing Section Renumbered Tables and Figures- previous numbers were not unique

* New, Add, Delete, Change, Reissue

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1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement (VZTPR) document is to provide the FOC testing requirements for Multi-Fiber Optical Connectors. These requirements are based on GR-1435 Generic Requirements for Multi-Fiber Optical Connectors and GR-326 Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies.

2.0 SCOPE

Multi-Fiber Optical Connectors

3.0 REFERENCES

ASTM D2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM G21	Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
FOC Memo # 31: Feb. 28, 2006	Applicable to punch list
FOC Memo # 31: March 6, 2006	Applicable to punch list
FOC Memo # 43: October 3, 2006	Applicable to Extended Thermal Cycling test
GR-326-CORE, Issue 3, September 1999	Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies
GR-1221-CORE, Issue 2, January 1999	Generic Reliability Assurance Requirements for Passive Optical Components
GR-1435-CORE, Issue 1, October 1994	Generic Requirements for Multi-Fiber Optical Connectors
IEC 61300-3-30	Fiber optic interconnecting devices and passive components. Basic test and measurement procedures. Examinations and measurements. Polish angle and fiber position on single ferrule multifiber connectors
IEC 61755-3-31 PAS (Publicly Available Standard)	Part 3-31: Optical interface- 8 degrees angled PC end-face PPS rectangular ferrule, single mode fiber
IEC 61755-3-3 (Original Draft Standard Proposal that was not approved)	Fiber optic interconnecting devices and passive components - Fiber optic connector optical interfaces - Part 3-3: Optical interface angled PC end face rectangular ferrule, single mode fibers



4.0 ACRONYMS

A	After
B	Before
CIR	Change in Reflectance
CIT	Change in Transmittance
D	During
FOC	Fiber Optic Components
IL	Insertion Loss
ITL	Independent Test Laboratory
“O”	Requirement
“R”	Objective
RL	Return Loss
TPR	Technical Purchasing Requirement

5.0 TEST REQUIREMENTS FOR MULTI-FIBER OPTICAL CONNECTORS

Verizon purchases Multi-Fiber Optical connectors for various applications. Multi-Fiber Optical Connectors shall meet the requirements specified in the following tables, which are based on to the requirements specified in Telcordia document GR-326-CORE, “Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies” and GR-1435-CORE, “Generic Requirements for Multi-Fiber Optical Connectors”. All the testing must be completed by a Verizon approved ITL.



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
3.0 General Requirements					
3.1 Documentation					
Test Reports		R3-1			
Product Documentation		R3-2			
3.2 Packaging and Shipping		R3-3			Samples shall be packaged and shipped to the ITL as shipped to the field
3.3 Design Features					
3.3.1 Materials					
Metallic Elements		R3-4			Verified from Salt Fog and Thermal Cycling/Humidity results
Index Matching Fluid or Gel		R3-5			Non-used
Fungus Resistance		R3-6	5 plugs & adapters		ASTM-G21-70. Rating of 0
Flammability		R3-7	Plaque of polymeric materials, 6"x6"		V-1 or better / UL 94, Oxygen index of 28% or > per ASTM D-2863-87 Plaque of polymeric materials, 6"x6"
Cable Media Type		R3-8			GR-20 and/or GR-409 cable
3.3.2 Cleanability		O3-9	5 jumpers/5 mating adapters		5 jumper assemblies with minimum length jumper cords, 5 adapters
3.4 Intermateability					
Intermateability		CR3-10	5 jumpers/5 mating adapters		FOCIS-n (FOCIS-5D for MT Connectors) (new product measurements and after



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
					service life tests)
Ferrule Extension Contact Force		CR3-11	5 jumpers/5 mating adapters		Per FOCIS-n doc
Length Requirements		CR3-12	5 jumpers/5 mating adapters		Per FOCIS-n doc.
Adapter Sleeve Latch Spacing		CR3-14	5 jumpers/5 mating adapters		Latch spacing per FOCIS-n
Glass Transition		CR3-15	5 jumpers/5 mating adapters		Glass Transition > 100°C
3.4.1 Latching Intermateability		CO3-16	288 plugs & 144 adapters		Per GR-326 (record forces for both mating and unmating)
3.5 Product Marking and Packaging					
Product Marking		R3-17			Supplier, model or series, vintage code (adapters - 6 months; plugs - 3 months)
Color Code APC		CR3-19			APC - Green Plug body or Green Boot
3.5.1 Keying		O3-21			Connector plug should be keyed
3.6 Safety					
Radiation Hazard		R3-22			Documentation Review
Cleaning Materials		R3-23			Documentation Review
3.7 Intermateability Testing Requirements		R3.24			Intermateability Testing to be performed as specified in this TPR. End Face Geometry per IEC 61755-3-31- (Intermateability Testing of (MFC) Multi-Fiber Connector Jacks and Plugs)
4.0 Connector Tests and Criteria (Service Life)					See Table 1
4.2.2.5 Handling of Nonconformance		R4-1			
4.4 Statement of Criteria					



FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435 (Task references from GR-326)					
Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
4.4.5 Geometry Requirements					
4.4.5.1 Ferrule Endface Geometry: per IEC 61755-3-31	1 -A	R4-60	All		IEC 61755-3-31: Protrusion/Undercut, Coplanarity, Endface Angle
4.4.5.3 Endface Geometry Measurements: Per IEC 61300-3-30	1 -A	R4-61	All		IEC 61755-3-31: Undercut/Undercut, Coplanarity, Endface Angle
4.4.1 Performance of New Product	1-B	R4-2	All	IL	Table 3: New Product (Max Loss - Requirement)
		O4-3		IL	Table 3: New Product (Max Loss - Objective)
		R4-4		IL	Table 3: New Product (Mean Loss - Requirement)
		O4-5		IL	Table 3: New Product (Mean Loss - Objective)
		R4-6		RL	Table 4: New Product (Mean Reflectance - Requirement)
4.4.2 Temp/Hum/Cond Test					
4.4.2.1 Thermal Age Testing	1-C	R4-7* O4-8**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	85°C/168h
4.4.2.2 Thermal Cycle Test	1-D	R4-9* O4-10**	16 pigtailed pair, 5 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 note ¹
4.4.2.3 Humidity Aging Test	1-E		16 pigtailed pair, 5 hot	IL/RL (B/D/A);	75° C / 95% RH, 7 days - Measurements



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
		R4-11* O4-12**	spares	CIT/CIR	every 6hrs min.
4.4.2.4 Humidity/Condensation Cycling Test	1-F	R4-13* O4-14**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	-10°C to +65°C, 90% - 100% RH; 7 days; (per GR-326, Figure 4-4) . see note ²
4.4.2.5 Dry-Out Step	1-G		16 pigtailed pair, 5 hot spares		24 hrs @ 75°C, uncontrolled humidity
4.4.2.6 Post-Condensation Thermal Cycle Test	1-H	R4-15* O4-16**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	-10°C to +65°C, 90% - 100% RH; 7 days; (per GR-326, Figure 4-4) . see note ²
4.4.3 Mechanical Tests					
4.4.3.1 Vibration Test	1-I	R4-17* O4-18**	16 pigtailed pair, 5 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)
4.4.3.2 Flex Test	1-J	R4-19* O4-20**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	Media Type II (per GR-1435) (only): 100 flex cycles @ 0°, 90°, 0°, -90°, 0°: - 2.0 lbf load. Product shall not uncouple during test.
4.4.3.3 Twist Test	1-K	R4-21* O4-22**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	Media Type I (per GR-1435): 0, +2.5 rev, 0, -2.5 rev; 10 cycles @ 23°C; 0.5 lbf (Req)
		R4-23* O4-24**			Media Type I (per GR-1435): 0, +2.5 rev, 0, -2.5 rev; 10 cycles @ 23°C; 0.25 lbf/fiber (Obj)
		R4-25* O4-26**			Media Type II (per GR-1435): 0, +2.5 rev, 0, -2.5 rev; 10 cycles @ 23°C; 3.0 lbf



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
4.4.3.4 Proof Test	1-L	R4-27* O4-28**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	Media Type II (per GR-1435) (only): 10lbf (Req) @ 0°
		R4-29* O4-30**			Media Type II (per GR-1435) (only): 15lbf (Obj) @ 0°
		R4-31* O4-32**			Media Type II (per GR-1435) (only): 7.5 lbf (Req) @ 90°
		R4-33* O4-34**			Media Type II (per GR-1435) (only): 10 lbf (Obj) @ 90°
4.4.3.5 Transmission With Applied Tensile Load	1-M	R4-35***	16 pigtailed pair, 5 hot spares	IL/RL (B/D/A); CIT/CIR	Media Type I (per GR-1435): 0° @ 0.5 lbf (Required)
		O4-36****			Media Type I (per GR-1435): 0° @ 0.25 lbf/fiber (Objective)
		R4-37***			Media Type II (per GR-1435): 0° @ 5.0 lbf (Required)
		O4-38****			Media Type II (per GR-1435): 0° @ 10.0 lbf (Objective)
		R4-39***			Media Type II (per GR-1435): 90° @ 0.5 lbf (Required)
		O4-40****			Media Type II (per GR-1435): 90° @ 1.0 lbf (Objective)
		R4-41***			
		O4-42****			
		R4-43***			
		O4-44****			
		R4-45***			
O4-46****					
4.4.3.7 Impact	1-N	R4-47* O4-48**	16 pigtailed pair, 5 hot spares	IL/RL (B/A); CIT/CIR	Impacted @ 1.5 meter height - 8 impacts
4.4.3.8 Durability	1-O		16 pigtailed pair, 5 hot spares	IL/RL (B/D/A); CIT/CIR	200 cycles durability, measure every 5 cycles - clean per GR-326



FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435 (Task references from GR-326)					
Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
		R4-49* O4-50** R4-51* R4-52* O4-53** O4-54			1 sided or 2 sided cleaning - 95% shall meet 1 sided or 2 sided cleaning - 95% shall meet Without cleaning - 90% shall meet After 200 Insertions, shall meet After 200 Insertions, shall meet Cleanability Objective: Not met if recleaning required
4.4.6 Connector installation	1-P	R4-55* O4-56**	16 pigtailed pair, 5 hot spares	IL/RL (B/D/A); CIT/CIR	Perform testing per GR-326, section 4.4.6 - 70mm (Req) Perform testing per GR-326, section 4.4.6 - 57mm (Req)
4.4.3.9 End of Test Criteria	1-Q	R4-57***** O4-58***** R4-60 R4-59	16 pigtailed pair, 5 hot spares	IL/RL/CIT/CIR	Optical Requirements "End of Test" Optical Objectives "End of Test" Geometry per IEC 61755-3-31 No damage that would impair the performance of either the connector plug or the adapter.
5.0 Facilities for Product Testing					
5.1 Ambient Laboratory Conditions					Temperature:23°C +2°C Humidity: less than 75%RH
5.2 Optical Measurements					Per VZ.TPR.9413 (System validation)
7.0 Reliability Test					
7.1 Description of Reliability Test					See Table 2



FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435 (Task references from GR-326)					
Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
4.4.5 Geometry Requirements	All				
4.4.5.1 Ferrule Endface Geometry: per IEC 61755-3-31	All	R4-60	All		IEC 61755-3-31: Undercut/Undercut, Coplanarity, Endface Angle
4.4.5.3 Endface Geometry Measurements: Per IEC 61300-3-30	All	R4-61	All		IEC 61755-3-31: Undercut/Undercut, Coplanarity, Endface Angle
4.4.1 Performance of New Product	All	R4-2	All	IL	Table 3: New Product (Max Loss - Requirement)
		O4-3		IL	Table 3: New Product (Max Loss - Objective)
		R4-4		IL	Table 3: New Product (Mean Loss - Requirement)
		O4-5		IL	Table 3: New Product (Mean Loss - Objective)
		R4-6		RL	Table 4: New Product (Mean Reflectance - Requirement)
Extended Thermal Age	2	R7-1*	22 Jumper Cable 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 (See note ⁸)
		O7-2**			
Extended Humidity	3	R7-3* O7-4**	22 Jumper Cable Assemblies and 44 Mating Adapters (LTPD 10%)	IL/RL (B/D/A)	75°C (±5°C), 85% (± 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



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
Extended Thermal Cycling	4	R7-5*	22 Jumper Cable Assemblies and 44 Mating Adapters (LTPD 10%)	IL/RL (B/D/A)	-40°C to 85°C (± 2°C) for RT/UNC, ≥ 15 minutes dwell time at extremes, 500 cycles pass/fail, 1000 cycles (optional) for information. Per GR-1221, section 6.27
		O7-6**			
4.4.4.1 Dust Test	5	R7-7*	20 Pigtail Assemblies and 10 Mating Adapters	IL/RL (B/D/A)	Perform testing per GR-326, section 4.4.4.1: half mated/half unmated
		O7-8**			
4.4.4.2 Adhesive Testing	6	R7-9	5 pigtailed assemblies / 5 ceramic ferrule blanks / 5 plugs	Protrusion/Undercut, Coplanarity, Endface Angle	Endface Geometry before and after testing. 65°C, 7 days, 7 lb load.
4.4.4.3 Airborne Contaminants	7	R7-10*	20 Pigtail Assemblies and 10 Mating Adapters	IL/RL (B/A)	Perform testing per GR-326, section 4.4.4.3
		O7-11**			
4.4.4.4 Salt Spray	8	R7-12*	20 Pigtail Assemblies and 10 Mating Adapters	IL/RL (B/A)	Perform testing per GR-326, section 4.4.4.4
		O7-13**			
4.4.4.5 Immersion/Corrosion Test	9	R7-14	8 pigtailed assemblies / 8 plugs / 8 mating adapters	Protrusion/Undercut, Coplanarity, Endface Angle	85°C for 2 weeks, 0.015mm change from initial (8 mated pigtails for ferrule deformation and 8 plugs for fiber dissolution)
4.4.4.6 Groundwater Immersion	10	R7-15*	20 Pigtail Assemblies /5 per fluid and 20 mating adapters	IL/RL (I/D/E)	4 immersion media's (organism not required), 22°C ±2°C for 7 days: Measure Initially (upon immersion), after 24 hours, after 7 days (while in fluid)
		O7-16**			
4.4.3.9 End of Test Criteria	1-Q	R4-57*****	ALL	IL/RL/CIT/CIR	Optical Requirements "End of Test"
		O4-58*****			Optical Objectives "End of Test"
		R4-60			Geometry per IEC 61755-3-31



**FOC Test Plan for Multi-Fiber Optical Connectors– based on GR-326 & GR-1435
(Task references from GR-326)**

Task	Test Group	Requirement No.	Samples	Optical Monitor	Comments
		R4-59			No damage that would impair the performance of either the connector plug or the adapter.
8.0 Reliability Assurance Program					
8.2 Manufacturing and Process Control					Per VZ.TPR.9445



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 - $CIR = A^{RL} - \text{New Product}^{RL}$

- * Tables 3 & 4: "During Test, Not Under Load" (Requirements)
- ** Tables 3 & 4: "During Test, Not Under Load" (Objectives)
- *** Tables 3 & 4: "During Test, Under Load" (Requirements)
- **** Tables 3 & 4: "During Test, Under Load" (Objectives)
- ***** Tables 3 & 4: "End of Test" Requirements
- ***** Tables 3 & 4: "End of Test" Objectives

Media Types per GR-1435:

- Media Type I: Ribbon Fiber
- Media Type II: Jacketed Ribbon Fiber
- Media Type III: 900um Buffered Fiber

Geometry Criteria:

Product Geometry is to be performed per the most recent revision of IEC 61755-3-31 and measurements are to be performed to the most recent revision of IEC 61300-3-30

FOCIS-5D Document to be utilized in conjunction with IEC 61300-3-30. If requirement is not specified in either document, utilize the manufacturer's specifications.

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.

Table 1 (Service Life)			
Sample Group	Test Sequence	Title	Section
1	a	Ferrule Endface Geometry	4.4.5
1	b	New Product Measurement	4.4.1
1	c	Thermal Age Test	4.4.2.1
1	c	Thermal Cycling	4.4.2.2
1	e	Humidity Age	4.4.2.3
1	f	Humidity / Condensation Cycling Test	4.4.2.4
1	g	Dry-out Step	4.4.2.5
1	h	Post-Condensation Thermal Cycle	4.4.2.6
1	l	Vibration Test	4.4.3.1
1	j	Flex Test	4.4.3.2
1	k	Twist Test	4.4.3.3
1	l	Proof Test	4.4.3.4
1	m	Transmission With Applied Tensile Load	4.4.3.5
1	n	Impact Test	4.4.3.7
1	o	Durability	4.4.3.8
1	p	Connector Installation Test	4.4.6
1	q	End of Test Criteria (Optical, Ferrule Geometry and Damage)	4.4.3.9 & 4.4.5

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.

Table 2 (Reliability)			
Sample Group	Title	Section	Sample Type
ALL	Ferrule Endface Geometry (Initially - all samples)	4.4.5	
2	Extended Thermal Age	GR-1221, Section 6.2.4	Pigtail Assembly
3	Extended Humidity Age	GR-1221, Section 6.2.5	Pigtail Assembly
4	Extended Thermal Cycling	GR-1221, Section 6.2.7	Pigtail Assembly
5	Salt Spray	4.4.4.4	Pigtail Assembly
6	Airborne Contaminants	4.4.4.3	Pigtail Assembly
7	Dust	4.4.4.1	Pigtail Assembly
8	Ground Water Immersion (Organism testing not required)	4.4.4.6	Pigtail Assembly
9	Immersion/Corrosion Test	4.4.4.5	Pigtail Assembly & Plugs
ALL	Ferrule Endface Geometry (Finals - all samples)	4.4.5	

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 3 and 4 and the End Face Geometry requirements as defined in IEC 61755-3-31.
- At the completion of test, all samples must the optical requirements as specified in Tables 3 and 4, the Damage requirements as specified in this document and the Endface Geometry requirements as specified in IEC 61755-3-31.



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	0.3	0.3	0.3	0.3	---	---
During Test, Not Under Load	0.4	0.4	0.4	0.4	0.3	0.3
During Test, Under Load	---	---	---	---	0.45	0.45
End of Test	0.45	0.45	0.45	0.45	---	---

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°, sample4@90°, etc.). Tensile Testing encompasses 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.



Extended Thermal Cycling (Reliability) Test

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

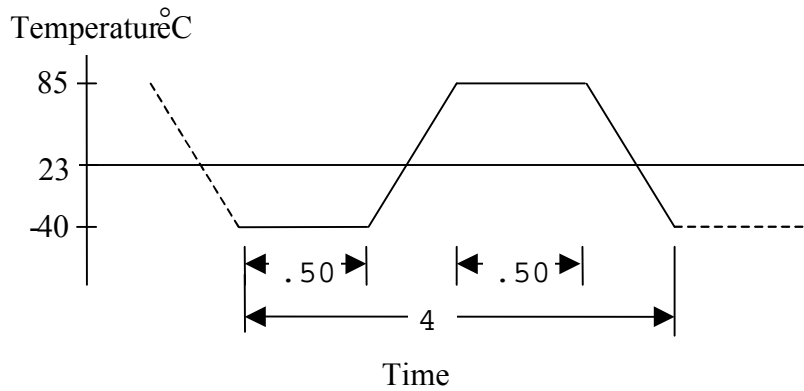


Figure 1: Temperature Profile for Extended Thermal Cycle Test

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 (MFC) Multi-Fiber Connector Jacks and Plugs

Executive Summary:

The objective of this proposed test program is to provide detailed insight regarding the interconnecting ability of multi-fiber connector jacks and plugs from different suppliers. 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 jacks and plugs of the participating vendors and manufacturers. It is the supplier's responsibility to ensure that worst-case configurations are evaluated under this test program. It may be necessary to evaluate multiple sample types to qualify products provided by suppliers. Differences between cable types and lengths, etc may influence the outcome of testing.

Connector Intermateability

- **Test Requirements:**
- **Endface Geometry Readings**
See: IEC 61755-3-31 (most recent revision) for Multi-Fiber Optic Connector and IEC 61300-3-30 for measurement methodology.
- **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 will be conducted with each vendor/ manufacturer's MFOC plug and jack. All fiber joints are to be measured for the New Product, during the test and End of Test Criteria.
The appropriate manufacturer's launch cable (reference jumper) will be used for each connector. Reference Figure 3 for configuration.
- **Environmental Cycle (Modified)**
Reference Figure 4 for the temperature profile and data acquisition times.
- **Vibration Test**
Conducted in accordance with the test matrix contained within this TPR.
- **Proof Test**
Conducted in accordance with the test matrix contained within this TPR.



- **Durability Test**

Conducted in accordance with the test matrix contained within 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 1.1.2 above) will be used for each assembly, if necessary.

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

NOTE 2: Each combination of plugs and jacks will have a sample lot as defined in Table 5.

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 manufacturer service provider specific cleaning procedures for the plugs and jacks. 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 plugs and jacks 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 MFOC Intermateability test program is given in Table 5. The sample configurations are based on the connector definitions given in Figure 5 of this document and assume two initial participants. Each succeeding program candidate "rookie" (connector) is tested against the two most recently approved connectors in reverse chronological¹ order for a maximum of three (3) participants per test program. Each test program requires ten (10) full connectors and five (5) hot spares of the new participant test samples and five (5) samples and three (3) hot spares of each of the two previously tested "veteran" participants.

NOTE - * A hot spare is defined as a mated plug and jack that is not optically monitored.

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



Table 5 Program Sample Requirement

Order of Participation	Manufacturer	Test Combination Plug → Jack	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 rd 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 th 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 th 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*

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

- Four (4) sets – Hybrid jumpers capable of interfacing with the test measurement equipment with a MFOC 1-meter launch fiber optic cable are required. Two (2) styles of launch cables will be needed, one for the plug and one for the jack for a total of eight (8) test cables. The manufacturing process and end face geometry on the MFC launch cable connector shall be representative of all other test samples.
- New Participant samples requirements – 15 each (plugs and jacks) jumper cable assembly’s hybrid jumpers capable of interfacing with the test measurement equipment. Please see Figure 2, for plug/jack assembly details. (10 samples required with 5 spares).
- Veteran Participant Sample Requirements: 8- hybrid jumpers capable of interfacing with the test measurement equipment. Please see Figure 2, for plug/jack 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 plug and jack connector may be sealed



with silicone or other appropriate means as shown in Figure 2 below. Alternatively, if equipped with water blocking capability, lengthening the plug and jack 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 “Reflectance Test Results”.

- Supplies and specific instructions as used by the service provider for the cleaning system for the MF-HFOC plug and jack.
- Specific Instructions for installing and maintaining the MFOC connector and/or adapter.

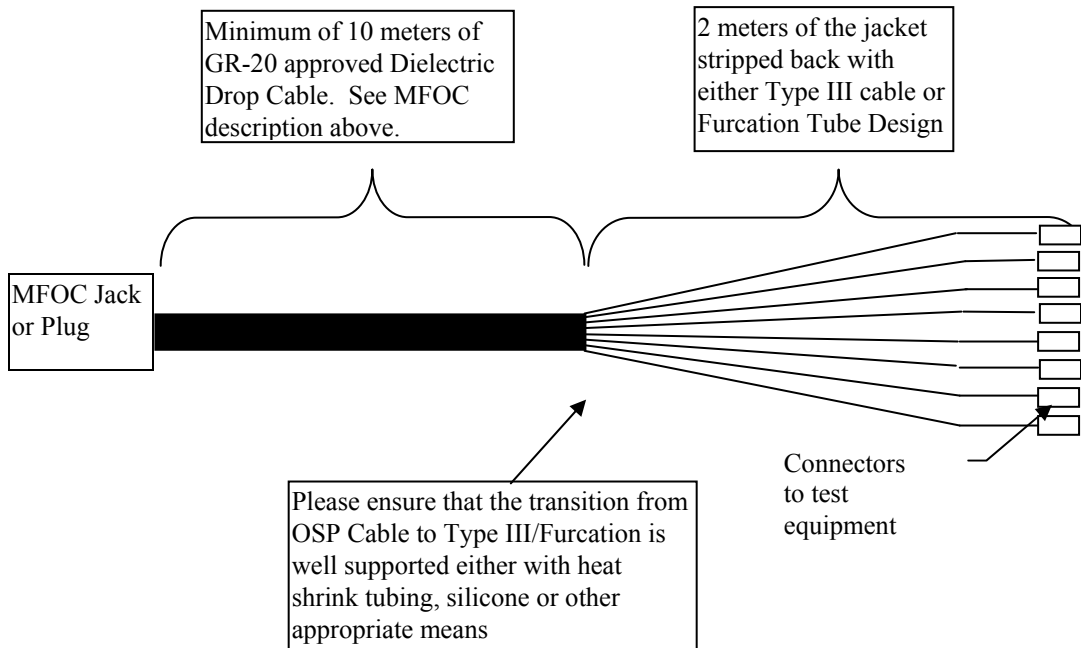


Figure 2: Required Configuration of MFOC Jumper Cable Assemblies

- **Test Specifics:**
- **Endface Geometry Readings**
Endface geometry readings will be performed on all DUT samples (Jacks and Plugs) 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 MFOC jumpers utilizing the appropriate launch cable. Please refer Figure 3 for configuration specifications.

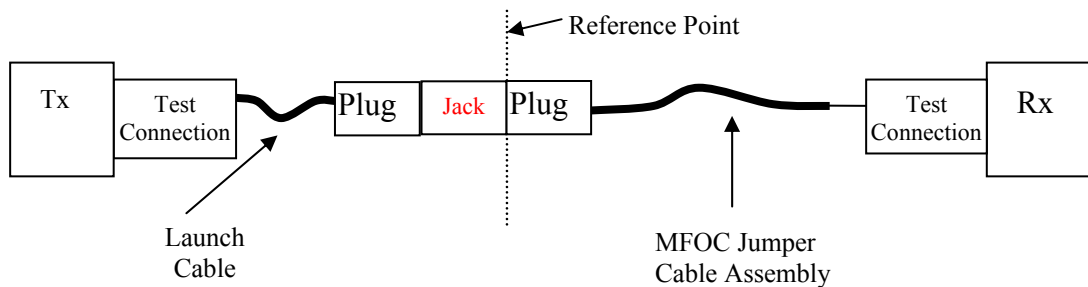


Figure 3: Test Setup

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



- **Environmental Cycle**

The connector assembly, which includes a minimum of 25 feet of the connector cable from each of the participating manufacturers will be placed in a conditioning chamber and subjected to the temperature profile shown in Figure 4 below. Insertion Loss and Reflectance Readings shall be taken every two hours throughout the test.

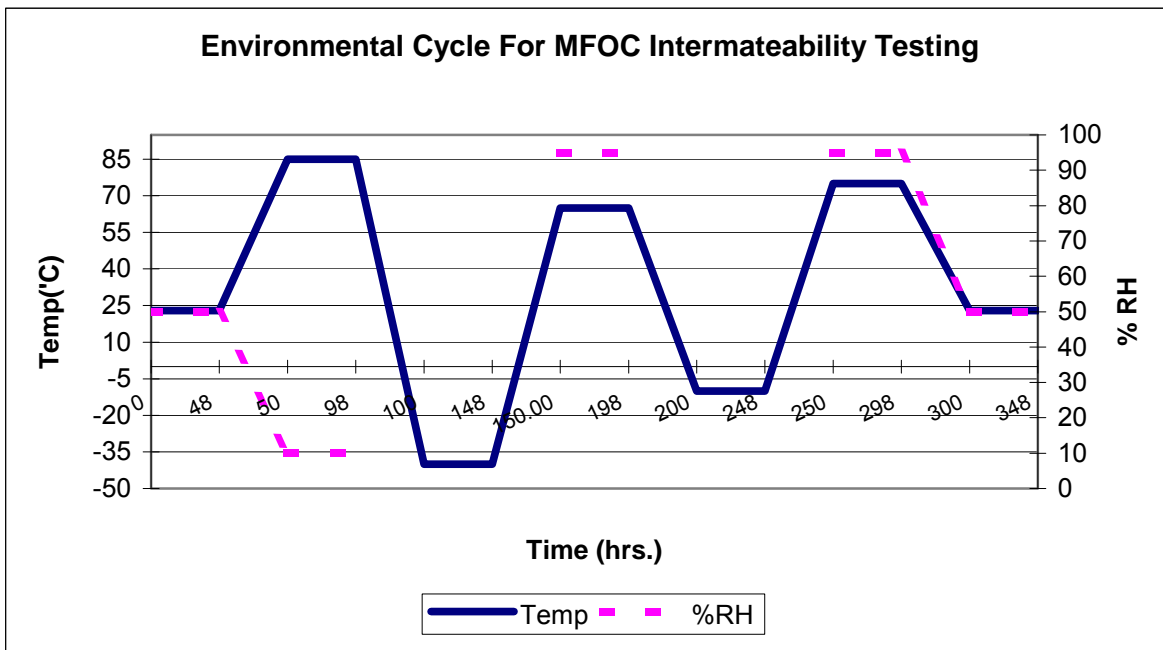


Figure 4: Environmental Cycle for MFOC Intermateability Testing

- **Vibration Testing**

Conducted in accordance with the test matrix contained within this TPR. Please note that the samples will not be monitored during the actual vibration sweeps.

- **Proof Test**

Conducted in accordance with the test matrix contained within this TPR.

- **Durability Test**

Fifty cycles will be performed at -18°C (0°F) and fifty cycles will be performed at 40°C (115°F) as per the combinations shown in Table 5. Conducted in accordance with the test matrix contained within this TPR.

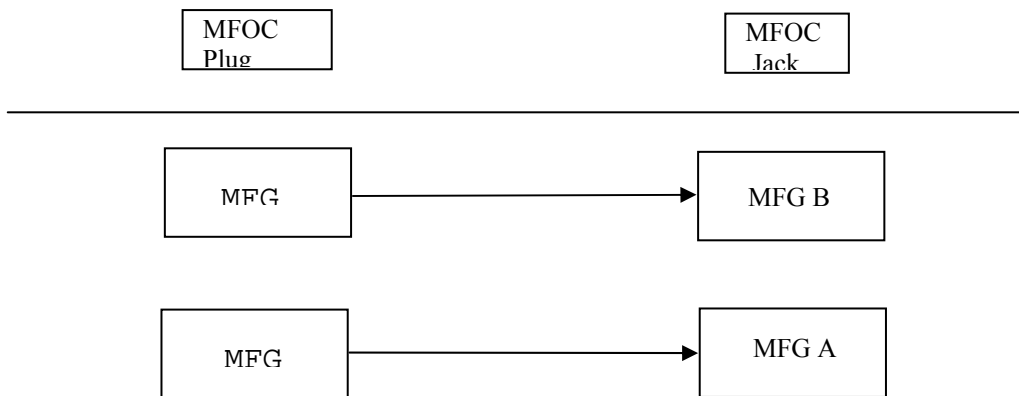


Figure 5: Combination for the Durability Test

- The required number of connector assemblies as shown in Table 5 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 50th cycle. See section 1.3.7 below.

- **End of Test Criteria**

On nonconforming samples, end-face geometry shall be re-measured as described in Section 1.3.1 above. Final measurements of Insertion Loss and Reflectance (nonconforming samples) shall be repeated using the same methods as described in Section 1.3.2 above.

- **Acceptance Criteria**

Conducted in accordance with the test matrix contained within this TPR, except as noted below.



- **End Face Geometry**
- **Initial and Final (if necessary) Loss Measurements**
- **Environmental Conditioning**
 - Custom temperature profile, refer to Figure 4.
- **Vibration Test**
- **Proof Test**
- **Durability Test**
- **End of Test Criteria (if necessary)**