



**Verizon NEBS™ Compliance: Single Fiber,
Single-Mode Mechanical Splices
and Splicing Systems**

Verizon Technical Purchasing Requirements

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CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	10/04/2007	New	New Document
2	03/06/2008	Add Change	Made several changes from sample sizes to addition of new tests
3	10/23/2009	Change	Multiple changes made to sample sizes and optical criteria

* New, Add, Delete, Change, Reissue



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Table of Contents

1.0 PURPOSE	5
2.0 SCOPE	5
3.0 REFERENCES	5
4.0 ACRONYMS	6
5.0 TEST REQUIREMENTS FOR MECHANICAL SPLICES AND SPLICE TOOLS	6



1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement document is to provide FOC testing requirements for Single Fiber, Single-Mode Mechanical Fiber Splices and Splicing Systems based on Telcordia document GR-765-CORE: Generic Requirements for Optical Fiber Splices and Splicing Systems.

2.0 SCOPE

FOC Products

3.0 REFERENCES

GR-63-CORE, Issue 3; March 2006	NEBS Requirements for Physical Protection
GR-326-CORE, Issue 3; September 1999	Generic Requirements for Single Mode Optical Connectors and Jumper Assemblies
GR-765-CORE, Issue 1, September 1995	Generic Requirements for Single Fiber Single-Mode Optical Splices and Splicing Systems
GR-771-CORE, Issue 1, July 1994	Generic Requirements for Fiber Optic Splice Closures
GR-1209-CORE, Issue 3; March 2001	Generic Requirements for Passive Optical Components
GR-1221- CORE, Issue 2; January 1999	Generic Reliability Assurance Requirements for Passive Optical Components
TR-NWT-000264, Issue 2; December 1993	Generic Requirements for Optical Fiber Cleavers
UL 746C, Issue 6; February 20, 2006	Polymeric Materials - Use in Electrical Equipment Evaluations
Memo # 38, Issued 4/12/06	Requirements for Mechanical Fiber Splices and Tools Based on GR-765



4.0 ACRONYMS

FOC	Fiber Optic Components
ITL	Independent Testing Laboratory
IL	Insertion Loss
RL	Return Loss
PDL	Polarization Dependency Loss
SL	Spectral Loss
ST	Splice strength
TL	Transient Loss
ILC	Insertion Loss Change
ILCrel	Insertion Loss Change (reliability values)
RLCrel	Return Loss Change (reliability values)
SLCrel	Spectral Loss Change (reliability values)

5.0 TEST REQUIREMENTS FOR MECHANICAL SPLICES AND SPLICE TOOLS

Verizon is using Mechanical Fiber Splices and Splicing Tools for certain applications. Mechanical Fiber Splices and Splicing Tools shall meet the requirements specified in the following tables, which are based on GR-765-CORE, Generic Requirements for Optical Fiber Splices and Splicing Systems. All the testing must be completed by a Verizon approved ITL.



5.1 Mechanical Splice

Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
Optical Performance Criteria				
Insertion Loss	GR-1209-CORE: §4.2		IL	Wavelength 1310nm, 1490nm, 1550nm, 1625nm. Req IL Max \leq 0.12 dB (1)
Return Loss	GR-1209-CORE: §4.6		RL	Wavelength 1310nm, 1490nm, 1550nm, 1625nm. Req RL Min \geq 55 dB
Polarization-Dependent Loss	GR-1209-CORE: §4.7		PDL	Wavelength 1310nm, 1550nm, 1435nm, 1625nm. Req PDL \leq 0.1 dB
Material Performance				
Flammability	GR-63-CORE: §4.2.3.			UL-94 flame
Fungus Resistance	GR-771: §6.4.10.	3 Disks per Material		
Aging of Materials	GR-765	144 samples		On all splices used for mechanical testing
Mechanical Performance				
Characterization	GR-1209:	12 samples 250 μ m-250 μ m 12 samples 900 μ m-900 μ m 12 samples 250 μ m-900 μ m	IL/RL/PDL	Installation of 4 samples of each group at -5°C, RT and +45°C. IL, RL and PDL measurements at RT, 85°C and -40°C



Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
Impact	GR-1221-CORE: §6.2.1	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL/ST After SLC/RL/ST	Severity: 500g Duration: 1ms Wave form: Half Sine Number of shocks: 5 per axis Axes: 3
Vibration	GR-1221-CORE: §6.2.2	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL/ST After SLC/RL/ST During TL	Temperature: (23 ± 3)°C Sweep range: 20-2000 Hz Sweep rate: 3 octave/min Cross-Over Freq.: 80Hz Severity: Below Cross Over: Amplitude of 0.76 mm Above Cross Over: 20g Axes: 3 Sweeps: 4 sweeps/axis
Torsion	GR-765-CORE: §5.4.5	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL/ST After SLC/RL/ST	Test Temperature: (23°C ± 3°C) Test Humidity: 90% ± 5% RH Clamping distance: 300 mm Torsion: 1080° Duration: 504 hours
Splice Strength	GR-765: §5.4.4.	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before IL/RL After ILC/RLC	Force: 5 N per fiber Rate: 0-full load in 15sec Point of application: 300 mm from plug Duration: 1 minute



Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
Environmental Performance				
Damp Heat Endurance	GR-1221-CORE: §6.2.5	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before During/After ILCrel/RLCrel	Temperature: (+85 ± 2)°C Relative Humidity: (85 ± 5)%RH Test time: 2000 hours
Low Temperature Endurance	GR-1221-CORE: §6.2.6	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLCrel/RLCrel	Temperature: (-40 ± 5)°C Relative Humidity: uncontrolled Test time: 2000 hours
Temperature Cycling Endurance	GR-1221-CORE: §6.2.7.	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL During 100 cyc ILC/RLC After 100 cyc ST After 500 cyc No Loss of functionality	Lowest temperature: (-40 ± 2)°C Highest temperature: (+85 ± 2)°C Dwell time: 2hrs Transition time: 1hrs Number of cycles: 100 PASS/FAIL, 500 for info
Cyclic Moisture Resistance Endurance	GR-1221 - CORE 6.2.8	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL During ILC/RLC After SLC/RLC ST	Lowest temperature: (-10 ± 2)°C Highest temperature: (+65 ± 2)°C Relative humidity: (93 ± 3)% RH Duration time: 24 hrs Total cycles: 15 cycles
Immersion in detergent in water	GR-326-CORE: §5.3.8	12 samples 250µm-250µm	Before SL/RL After SLC/RLC ST	Temperature: (+50 ± 2)°C Fluid: 10 % Igepal



Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
		12 samples 900µm-900µm 12 samples 250µm-900µm		Duration: 7 days
Immersion in Chlorine in water	GR-765-CORE: §5.2.3.4	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+22 ± 2)°C Fluid: 10ml laundry bleach in 1l distilled water Refresh each 4 days Duration: 7 days
Immersion in Fuels	GR-765-CORE: §5.2.3.4	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+22 ± 2)°C Fluid: Diesel Duration: 7 days
Immersion in Aqueous Ammonia	GR-765-CORE: §5.2.3.4	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+22 ± 2)°C Fluid: 10% aqueous ammonia Duration: 7 days
Exposure to wasp and hornet spray	GR-771-CORE: §5.4.9.2	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+22 ± 2)°C Fluid: WASP and HORNET spray Duration: 7 days
Resistance to Airborne Contaminants	GR-63-CORE: §5.5.2	12 samples 250µm-250µm	Before SL/RL After SLC/RLC ST	Temperature: (+30 ± 2)°C Relative Humidity: (70 ± 3) % RH



Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
		12 samples 900µm-900µm 12 samples 250µm-900µm		Atmosphere: 20 ppb CL2 100 ppb H2S 200 ppb NO2 200 ppb SO2 Duration: 10 days
Salt Spray Test	GR-326-CORE: §4.4.4.4.	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+35 ± 2)°C Fluid: 5%±1% NaCl by weight dissolved in distilled water Duration: 7 days
Dust Cap Effectiveness	GR-326-CORE: §5.3.7	12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	Before SL/RL After SLC/RLC ST	Temperature: (+23* 2)°C Dust: Arizona Road Dust Air Velocity: 750 ft/min Dust Concentration: 8.5 ± 0.9g/min Test Duration: 4 x 2 minutes
Transportation and Storage Performance				
High Temperature Exposure and Thermal Shock	GR-63-CORE: §5.1.1.2	36 uninstalled packaged splices 12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	After SL/RL	Lowest temperature: (+23 ± 2)°C Highest temperature: (+70 ± 2)°C Dwell time: 72hrs Transition time UP: 0.5°C/minute Transition time DOWN: < 5minutes



Mechanical Fiber Splice(s) Punch List				
Task Name	Reference Spec.	Sample	Optical Monitor	Comments
Low Temperature Exposure and Thermal Shock	GR-63-CORE: §5.1.1.1	36 uninstalled packaged splices 12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	After SL/RL	Lowest temperature: (-40 ± 2)°C Highest temperature: (+23 ± 2)°C Dwell time: 72hrs Transition time UP: <5 minutes Transition time DOWN: 0.5°C/minute
High Relative Humidity Exposure	GR-63-CORE: §5.1.1.3	36 uninstalled packaged splices 12 samples 250µm-250µm 12 samples 900µm-900µm 12 samples 250µm-900µm	After SL/RL	Temperature: (+40 ± 2)°C Relative Humidity: 90-95 %RH Dwell time: 96hrs Transition time UP: 0.5°C/minute Transition time DOWN: 0.5°C/minute



NOTES:

IL = Insertion Loss

RL = Return Loss

PDL = Polarization Dependent Loss

SL = Spectral Loss

ST = Splice strength

TL = Transient Loss

ILC = Insertion Loss Change

ILCrel = Insertion Loss Change (reliability values)

RLCrel = Return Loss Change (reliability values)

SLCrel = Spectral Loss Change (reliability values)

- 1) During test IL > 0.15 dB is allowed as long as the IL change is within the specifications and the residual loss < 0.12 dB
- 2) Minimum wavelengths to report for all the IL and RL tests are 1310nm, 1490nm, 1550nm, and 1625nm.
- 3) Sample Size: Each group of 36 samples are divided in 3 groups of 12 samples: 12: 250mu-250mu, 12: 250mu-900mu and 12: 900mu-900mu. Each group of 12 samples are divided in 3 groups of 4 samples.
- 4) Test is not sequential. New samples should be used in each test to generate significant sampling size.



5.2 Mechanical Tools

Mechanical Fiber Splice Assembly Tool(s) Punch List				
Task Name	Reference Spec.	Sample	Optical	Comments
Optical Performance Criteria				
Insertion Loss		Note 1	IL	Wavelength 1310nm, 1490nm, 1550nm, 1625nm. Req IL Max \leq 0.12 dB
Return Loss		Note 1	RL	Wavelength 1310nm, 1490nm, 1550nm, 1625nm. Req RL Min \geq 55 dB
Installation at Low Temperature	GR-765-CORE: §5.2.2.1.	1 Tool make 10 samples & 20 cleaves	IL & RL after	Precondition Tool for 2 hrs at - 5 C before performing splices, Test at Room Temperature
Installation in Condensing Environment	GR-765-CORE: §5.2.2.3.	1 Tool make 10 samples & 20 cleaves	IL & RL after	Precondition tool at -40C for 2 hours before performing splices, Test at Room Temperature
Installation at High Temperature and High Humidity	GR-765-CORE: §5.2.2.2.	1 Tool make 10 samples & 20 cleaves	IL & RL after	Precondition tool at 38C 90%RH for 2 hours before performing splices, Test at Room Temperature
Installation at High Temperature and Low Humidity	GR-765-CORE: §5.2.2.4.	1 Tool make 10 samples & 20 cleaves	IL & RL after	Precondition tool at 45C 15%RH for 2 hours before performing splices, Test at Room Temperature



Mechanical Fiber Splice Assembly Tool(s) Punch List

Task Name	Reference Spec.	Sample	Optical	Comments
Battery Unit and Operation, Initial Operation of Cleaver	GR-765-CORE §4,5,2 and .3 and GR-264 §4.2.3 and Initial Operation GR-264 §4.1.2	1 Tool make 100 samples & 200 cleaves	IL & RL after	23C make 100 samples on same batteries without recharge. Perform all applicable items in this section. – also covers initial cleaver operation. 5 operators make 20 each.
Shelf Life	GR-765 4.6.4			One year shelf life requirement. Mfg provided documentation
Index Matching Gel	GR-765 4.6.5			Mfg provided data and info
Initial Operation	GR-765-CORE: §5.2.1	1 Tool make 30 samples	IL & RL after	3 different operators making splices (same tool); experienced, trained and not experienced
Cleave Angel and Criteria	GR-765-CORE: §5.2.1 and GR-264 §4.1.2.	1 Tool make 10 samples & 100 cleaves by three people		23C measure cleave angles – determine if with mfgs spec. Prove information and documentation as applicable.
Extended Operation	TR-NWT-000264 § 4.4	1 Tool make 1000 samples	IL & RL after	20000 operations or the max. Number defined by the Mfg.
Impact Test	UL 746C Counter Supported Clause 58.3	1 Tool make 10 samples & 20 cleaves after	IL & RL after	Unpackaged Tool (installation configuration). Installations performed after sequence on prescribed configurations.



Mechanical Fiber Splice Assembly Tool(s) Punch List				
Task Name	Reference Spec.	Sample	Optical	Comments
		impact		
Resistance to Airborne Contaminants	GR-63-CORE: §5.5.2	1 Tool make 10 samples & 20 cleaves	IL & RL after	Unpackaged Tool (installation configuration). Installations performed after sequence on prescribed configurations. (Replaces Salt Fog)
Dust Test	GR-326-CORE: §5.3.7	1 Tool make 10 samples & 20 cleaves	IL & RL after	Unpackaged Tool (installation configuration). Installations performed after sequence on prescribed configurations.
High Temperature Exposure and Thermal Shock	GR-63-CORE: §5.1.1.2	1 Tool make 10 samples & 20 cleaves	IL & RL after	In carrying case. Installations performed after sequence on prescribed configurations.
Low Temperature Exposure and Thermal Shock	GR-63-CORE: §5.1.1.1	1 Tool make 10 samples & 20 cleaves	IL & RL after	In carrying case. Installations performed after sequence on prescribed configurations.
High Relative Humidity Exposure	GR-63-CORE: §5.1.1.3	1 Tool make 10 samples & 20 cleaves	IL & RL after	In carrying case. Installations performed after sequence on prescribed configurations.
Edgewise Drop and Cornerwise Drop	GR-765 5.2.1.4	1 Tool make 10 samples &	IL & RL after	Unpackaged Tool (installation configuration). Installations performed after sequence on prescribed configurations.



Mechanical Fiber Splice Assembly Tool(s) Punch List				
Task Name	Reference Spec.	Sample	Optical	Comments
		20 cleaves		
Handling Drop Tests	GR-63-CORE: §5.3.1	1 Tool make 10 samples & 20 cleaves	IL & RL after	In carrying case. Installations performed after sequence on prescribed configurations.
Transportation Vibration	GR-765-CORE: §5.2.1.5.	1 Tool make 10 samples & 20 cleaves	IL & RL after	In carrying case. Installations performed after sequence on prescribed configurations.

Notes:

IL = Insertion Loss

RL = Return Loss

1. All the samples listed in Mechanical Tools testing must be multiplied by 4 times and then divided equally in all 4 fiber types G.652D, G.657A, G657B and UBIF (Corning's Clear Curve, OFS's EZBend, Draka's BBElite)
2. During test IL > 0.15dB is allowed as long as the IL change is within the specifications and the residual loss < 0.12 dB
3. Minimum wavelengths to report for all the IL and RL tests are 1310nm, 1490nm, 1550nm, and 1625nm.
4. Tests are not sequential. Samples may be used in multiple tests for economic use of tools
5. If there are no means to measure stand alone splice loss; Following IL and RL criteria with SC-APC connectors can be used; Initial Max IL = 0.4dB for a mated pair; Initial minimum RL = 60dB for a mated pair. End of Test max IL = 0.5dB for a mated pair; End of Test max RL = 60dB for a mated pair; during change per GR-326, Issue 3