



Verizon FOC Compliance: FOC Factory Move Test Requirements

Verizon Technical Purchasing Requirements

VZ.TPR.9404

Issue 4, April 2010





CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	<i>3/30/2007</i>	Reissue	Document reissued and updated into new format.
2	<i>09/24/07</i>	Add	Added the checklist
3	<i>04/21/2008</i>	Change	Clarified ISO requirements
	<i>04/21/2008</i>	Add	Added samples requirements to be tested at lab
4	<i>04/09/2010</i>	Change	Consolidated, Added Clarification, Grouped similar criterion and Added 9404 criterion numbering to the 9404 checklist.
* New, Add, Delete, Change, Reissue			



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1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement document is to provide FOC Factory Moves Test Requirements.

2.0 SCOPE

Suppliers

3.0 REFERENCES

PFOC Memo #16 Rev # 1	Periodic Requalification of PFOC Products; Product Change Notices (PCN) Test Requirements; PFOC Factory Moves Test Requirements.
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4.0 ABBREVIATIONS

FOC	Fiber Optic Components
ITL	Independent Testing Laboratory

5.0 FOC FACTORY MOVES TEST REQUIREMENTS

Requirements/Procedure: If a FOC final assembly location (same product and same assembly/manufacturing processes) is added or moves from one location to another the following will be required:

Either A or B can be implemented:

Note: It is important that the manufacturing facility shall be TL-9000. If the facility is not TL-9000 certified, the facility shall obtain TL-9000 accreditation within 6 months of the Verizon audit.



Procedure A: The products that are assembled at the new or moved location are FOC tested by an approved ITL. The complete applicable test program (GR) will need to be performed prior to shipping product to Verizon from this location.

OR

Procedure B: The supplier will arrange for an on site audit with an approved FOC ITL for an on site audit of the new facilities. This approach is applicable if the product is exactly the same and the process used in assembly/manufacturing is exactly the same. The new location must be up and making all products to be covered on this audit for a period of at least 1 month, "or after a sufficient number of lot runs have established that the product is being produced on a consistent quality basis per specifications". Verizon SIT personnel will be participants during this audit and covered on a time and expense contract through the ITL. The audit may be conducted by one or two Verizon SIT personnel. The audit will follow the guidelines as outlined below. This will include creating bill of material, collecting raw material, incoming inspection, product manufacturing, Quality Inspection and Control, pulling finished product at the end of the assembly line and performing specification testing on site. The samples along with the test results will be collected and sealed by the ITL. Based on the test plan identified before the audit, these samples will be tested by ITL. In general 16 samples will be collected. Any failures of this testing will be considered a product failure, requiring RCA, fixes, and GR qualification testing. Prior to the start of this audit (but after contract is in place with the ITL) an audit and final product test plan will be prepared by Verizon & ITL, specifying tests, sample sizes, and pass/fail criteria. If the audit is stopped for any reason the time/expenses to this point will be billed by Verizon. No products can be shipped to Verizon until the completion of a successful audit.

If the factory audit is successful and the products and factory pass, then GR FOC testing qualification can be delayed for 3 years. Three years after the completion date of the audit a complete FOC test program must commence (for each product that was covered under the audit).



TPR.9404 Checklist

Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
1.	TPR.9404-1	The organization must have an organization chart showing the reporting relationships of the various departments including, sales, engineering, manufacturing, quality, marketing, etc. The organization structure must be defined in order to identify/prevent potential conflicts of interest. The chart must also include upper management and corporate structure.	
2.	TPR.9404-2	The Quality Assurance Manager for the local site must be clearly identified.	
3.	TPR.9404-3	The roles and responsibilities of the quality manager, including responsibility for ensuring compliance with this document and any accreditations, shall be clearly defined in the QMS.	
4.	TPR.9404-4	The Technical managers must be clearly identified.	
5.	TPR.9404-5	The roles and responsibilities of the technical manager(s), including responsibility for ensuring compliance with this document and any accreditations, shall be clearly defined in the QMS.	
6.	TPR.9404-6	Is there an appeals process in place? Used when field or reliability testing related failures are reported	
7.	TPR.9404-7	Does the QA Manager have access to senior management to resolve conflicts?	
8.	TPR.9404-8	The manufacturer's quality system policies and objectives shall be defined in a quality manual (however named).	
9.	TPR.9404-9	What accreditations does the manufacturing facility hold?	
10.	TPR.9404-10	The manufacturer shall establish and maintain procedures to control all documents that form part of its management system (internally generated or from external sources), Are policies and work instructions documented?	
11.	TPR.9404-11	Are policies and work instructions communicated?	
12.	TPR.9404-12	Are policies and work instructions implemented?	
13.	TPR.9404-13	Are policies and work instructions uniquely identified?	
14.	TPR.9404-14	Are policies and work instructions controlled?	
15.	TPR.9404-15	Are policies and work instructions accessible to employees?	
16.	TPR.9404-16	Are reference standards and other external documents controlled?	
17.	TPR.9404-17	Is there a policy and procedure that states: "the latest references standards shall be used." Verify that the latest reference standards are used?	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
18.	TPR.9404-18	Are data collection sheets for QC and final product controlled?	
19.	TPR.9404-19	Are there safeguards in the data collection system to prevent data corruption and/or data tampering?	
20.	TPR.9404-20	Is there a documented policy for handling Non-Conformances?	
21.	TPR.9404-21	Is there a Root Cause Action (RCA) registry?	
22.	TPR.9404-22	Is the RCA system implemented in such a way as to provide a means of tracking and reporting similar “root causes” to aid in the identification of systemic problems.	
23.	TPR.9404-23	Does the organization have a documented Product Recall policy?	
24.	TPR.9404-24	Is the RCA system monitored and reviewed by mgmt?	
25.	TPR.9404-25	Are internal audits regularly scheduled and conducted? Provide latest audit schedule.	
26.	TPR.9404-26	Provide records of CARs and corrective actions from these audits.	
27.	TPR.9404-27	Does the organization conduct quality audits of sub-contractor’s and supplier facilities?	
28.	TPR.9404-28	Provide proof of a sub-contractor audit?	
29.	TPR.9404-29	The supplier shall conduct an audit of its vendors/sub-contractors a minimum of every three years.	
30.	TPR.9404-30	Is product under evaluation made in more than one location? The “move from” locations and “move to” locations must be clearly defined.	
31.	TPR.9404-31	Does the organization have job descriptions for each employee?	
32.	TPR.9404-32	Does the organization have a documented policy and procedure to match required job requirements to the qualification of the employee?	
33.	TPR.9404-33	Does the organization have a documented policy and comprehensive procedure for evaluating an employee’s competence?	
34.	TPR.9404-34	Does the organization have complete training records for each employee on file? In Binders, with certificates. Does the organization evaluate the training effectiveness?	
35.	TPR.9404-35	Does the organization have a documented policy and procedure for In-House Training:	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
		a. Documented Curriculum b. Defined Training Material c. Documented “trainer” qualifications and training plan.	
36.	TPR.9404-36 R8-112 CO3-55 (3.2.1.6)	The organization shall have a calibration program for production, maintenance and test equipment (including equipment used for incoming inspection). The calibration program and equipment controls, at a minimum, must meet the applicable sections of ISO 9001. For each piece of equipment, detailed records shall be kept on maintenance, calibration, and re calibration dates.	
37.	TPR.9404-37	Is production, maintenance and test equipment secured?	
38.	TPR.9404-38	Is production, maintenance and test equipment used by trained operators?	
39.	TPR.9404-39	Is production, maintenance and test equipment safeguarded during handling?	
40.	TPR.9404-40	Is production, maintenance and test equipment safeguarded during storage?	
41.	TPR.9404-41	Is production, maintenance and test equipment safeguarded during transport?	
42.	TPR.9404-42 R8-119 CO3-55	All equipment used in manufacturing (including equipment used in incoming inspection) that requires maintenance (including equipment that does not require calibration) shall be on a maintenance schedule. This includes machines used to form, clean, prepare, or test any part of the product or the complete product, and tools such as cleavers and strippers.	
43.	TPR.9404-43	Determine if equipment calibration is performed by individuals that are part of the local facility (self sourced), a group or company department separate from the local manufacturing organization “in-sourced” or an outside the company organization “outsourced”. Calibration procedures must exist for each piece of equipment that is calibrated.	
44.	TPR.9404-44 R8-116	The organization shall have a calibration system to ensure that tools, gauges, templates, and other measuring and testing equipment are calibrated against certified standards traceable to recognized national standards bodies (where possible) such as NIST or the equivalent.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
45.	TPR.9404-45 R8-114	Are reference standards used to conduct intermediary checks? Automated equipment that is used to make pass or fail decisions during the manufacturing or testing processes, shall be on a routine verification program.	
46.	TPR.9404-46	1. Does the organization use standard test methods and procedures for equipment calibration? 2. Does the organization have a documented policy and procedure for performing equipment calibration where industry standards or standardized test methods do not exist?	
47.	TPR.9404-47 R8-118	1. Calibration records shall include an indication of the as received “as found” condition (in calibration or out of calibration) before recalibration is done. 2. Calibrations records shall also include the “as found” and “as returned” data.	
48.	TPR.9404-48 R8-112 R3-54 (P)	1. Records of the results of calibration and verification shall be maintained. 2. Provide an example of a calibration certification. 3. Calibration records shall contain the item identity number and name, the frequency of calibration, procedure for calibration, date calibrated and due date for calibration, personnel performing the calibration, identity of the standard or master used to calibrate, and deviations from standard values. Calibration certificates issued by outside calibration services shall be retained.	
49.	TPR.9404-49	The organization shall have a method for indicating the calibration status of each piece of equipment? Is equipment that does not require calibration clearly identified, such as with a label that states “calibration not required”?	
50.	TPR.9404-50	Are copies of calibration certificates available to those who have a need to have access and are certificates kept safe from harm?	
51.	TPR.9404-51	Is there a documented policy and procedure for the calibration of rented equipment?	
		GR-1221 Evaluation Criteria	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	3.1	Vendor and Device Qualification	
52.	TPR.9404-52 R3-1 (3.1) R8-2 03-60 (3.2.1.9) 03-61 (3.2.1.9) R8-18 03-8 (3.1.2)	<p>Suppliers of telecommunication equipment shall document and establish formal vendor and device/material qualification programs.</p> <p>The equipment supplier shall have the following records and procedures for the purchase of devices/materials:</p> <ol style="list-style-type: none"> 1. Documented procedures for the qualification of vendors. 2. Requirements for vendor qualification. 3. A vendor rating system that allows vendors performance to be analyzed. 4. Results of incoming inspection or inspection at receipt shall be input into the vendor rating system. 5. A rating system that indicates which vendors are exhibiting substandard performance. 6. Documented procedures that require vendors with poor histories to show corrective action, or else be removed (disqualified) from the approved vendor list (AVL), if practical. 7. An “approved vendors list” and/or “approved parts list” that is updated periodically. 8. Procedures for auditing of vendor performance. 9. Records of vendors including Vendor acceptance reports, summaries of vendor performance history, and corrective actions over at least the last 5 years. 	
53.	TPR.9404-53 03-2 (3.1)	<ol style="list-style-type: none"> 1. As part of vendor qualification, equipment suppliers shall visit the vendors manufacturing locations and examine both the facilities and implemented test practices. 2. Suppliers shall pay particular attention to the Quality Assurance/Quality Control (QA/QC) programs that the vendors have in place and to the quality and reliability data that the vendors have accumulated on their products. 3. Only those fiber optic component vendors who have demonstrated that they are committed to producing reliable devices shall be considered as acceptable sources. 	
54.	TPR.9404-54	To help ensure that their reliability needs are met, equipment suppliers shall obtain the results	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R3-3 (3.1)	of environmental and reliability life tests on the fiber optic components they plan to use.	
55.	TPR.9404-55 R3-4 (3.1.1)	<p>1. All fiber optic components used in system manufacture shall be identified on a purchase specification or some equivalent form of control document.</p> <p>2. Such documents shall identify all relevant performance, quality and reliability requirements, allowable operating conditions (minimum- and maximum-rated operating temperatures, supply voltage, minimum output power, etc.), and lot-to-lot controls.</p> <p>3. Functional parameters shall include most, if not all, of the measurements used to characterize the devices during initial qualification.</p>	
56.	TPR.9404-56 R3-5 (3.1.1)	<p>1. Approved Vendor Lists (AVLs) and Approved Parts Lists (APLs) shall be carefully maintained for routine use by manufacturing, QA, and the purchasing organization.</p> <p>2. AVLs and APLs shall be treated as “controlled” documents (e.g., dated, signed by appropriate management, and removed from use when superseded by newer versions).</p> <p>3. The AVL and APL shall be provided as inputs to the purchase specification process. Only vendors and part types that have completed qualification successfully shall be referenced on purchase specifications and included in AVLs/APLs.</p>	
57.	TPR.9404-57 R3-6 (3.1.2)	<p>1. The criteria for determining vendor acceptance shall include the vendor’s QA/QC procedures (as documented and implemented), Statistical Quality Control (SQC) data, and availability of reliability data.</p> <p>2. Vendors shall be specifically asked to provide typical reliability test data (i.e., qualification test data and where applicable, the results of screening).</p> <p>3. These data shall be examined for evidence that their designs are sound and that their</p>	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
		processing has been consistent over time.	
58.	TPR.9404-58 R3-7 (3.1.2)	[7] The equipment supplier shall clearly document the results of vendor acceptance activities (including vendor surveys, if performed) [per O3-2].	
59.	TPR.9404-59 O3-9 (3.1.2)	Approved vendors shall be revisited every 2 years or more often. [This is in addition to more frequent, regular communication with the vendor to review any problems (or to confirm the lack of such problems).]	
	8.2.1.2.1	Vendor Qualification	
60.	TPR.9404-60 O8-3 (8.2.1.2.1)	The equipment supplier shall have a raw material inspection program that relies on vendor quality assurance, rather than incoming inspection. This program need not be in place if the manufacturer is developing such a program.	
	3.1.3	General Criteria For Device Qualification	
61.	TPR.9404-61 R3-10 (3.1.2.1)	Substitution of tests or changes in test limits shall be supported by reliability consideration and technical justification that shall be available for review on request.	
62.	TPR.9404-62 R3-11 (3.1.3.1) R8-4 (8.2.1.2.2)	The qualification or re-qualification program, e.g., the actual practices and procedures used for device qualification shall be documented.	
63.	TPR.9404-63 R3-12 (3.1.3.1)	Qualification test results shall be clearly recorded and saved for a minimum of 5 years.	
64.	TPR.9404-64	Qualification test results shall be saved for a minimum of 10 years.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	O3-13 (3.1.3.1)		
65.	TPR.9404-65 O3-14 (3.1.3.2)	Appropriate failure analysis and corrective action shall occur before any retest is attempted.	
66.	TPR.9404-66 R3-15 (3.1.3.2)	When the corrective action requires a significant change in the device materials, processing, assembly, or screening, the entire qualification sequence (not just the failed test) shall be repeated. [Telcordia may be contacted to resolve any questions on this matter.]	
	8.2.1.2.2	Part Qualification	
67.	TPR.9404-67 O8-5 (8.2.1.2.2)	Qualification of raw materials shall be a program wherein product is manufactured and subsequently tested.	
	3.1.3.5	Provisional use of devices	
68.	TPR.9404-68 R3-16 (3.1.3.5)	The device code must have successfully passed other qualification requirements outlined in this GR. The minimum number of test cycles/hours is no less than the number given in Table 1, which is based on the total duration of the full test (in progress toward timely completion). Provisional use of the device shall not exceed the periods in Table 1.	
69.	TPR.9404-69 O3-17 (3.1.3.5)	The equipment supplier and/or device manufacturer shall have procedures in place to notify customers of the equipment/device within 5 business days of finding and confirming any reliability problem in the remainder of the test. This notification deadline may be extended to 7 business days for the purpose of obtaining preliminary failure analysis. The equipment supplier and device manufacturer shall have documented procedures for other appropriate actions (beyond notifying its customers, as applicable) to take in response to the problem.	
	3.1.3.6	Low Volume Parts	
70.	TPR.9404-70 R3-18	Exceptions to a full qualification program due to usage in small quantities (or for other reasons) must be evaluated case-by-case, and clearly documented.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(3.1.3.6)		
71.	TPR.9404-71 R3-19 (3.1.3.7)	The moisture content shall be measured after the damp/heat stress test is completed.	
	3.1.3.9	Use of Vendor Supplied Data	
72.	TPR.9404-72 R3-20 (3.1.3.9)	Equipment suppliers who make significant use of vendor-supplied data shall establish a program to verify the accuracy and validity of this information. The audit/monitor program shall be continued as long as vendor-supplied qualification data are used.	
73.	TPR.9404-73 O3-21 (3.1.3.9)	Such programs shall include repeating certain tests (by the equipment supplier or an independent test laboratory), and/or reviewing the component vendor's test methods, facilities, data collection, and analysis practices in detail.	
74.	TPR.9404-74 R3-22 (3.1.3.9)	The results of any verification tests shall be documented.	
75.	TPR.9404-75 O3-23 (3.1.3.9)	Verification test reports shall be saved for a minimum of 5 years.	
	3.1.3.10	Treatment of Internally Manufactured Devices	
76.	TPR.9404-76 R3-24 (3.1.3.10)	Devices manufactured internally by the equipment supplier itself, or by another division of the same parent company, shall meet the same qualification and requalification requirements as specified herein for purchased parts.	
77.	TPR.9404-77 R3-25 (3.1.3.10)	The equipment supplier's manufacturing location(s) must have continuous access to device test data and shall periodically review the information. In addition, the supplier must be readily capable of providing such data if questions arise.	
	3.1.4.1	Environment Considerations	
78.	TPR.9404-78	All materials in the components shall be tested for their toxicities. The results shall comply with the environmental regulations. If toxic materials are used, relevant information shall be	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R3-26 (3.1.4.1)	provided.	
79.	TPR.9404-79 R3-27 (3.1.4.1)	The light emitting components and materials must be labeled according to appropriate standards and regulations.	
	3.1.4.3	Safety Considerations	
80.	TPR.9404-80 R3-28 (3.1.4.3) R8-39	All pigtails and materials shall be tested according to Section 4.2 of GR-63-CORE. Failure results shall be provided to customers.	
81.	TPR.9404-81 R3-29 (3.1.4.3)	All component packages shall be tested according to Section 4.4.2.5 in TR-NWT-000357.	
	3.1.5	Other General Information for Qualification	
82.	TPR.9404-82 R3-30 (3.1.5)	Equivalent time and temperature requirements shall be calculated using the Arrhenius relationship. Technical justification of the activation energy used for different conditions in temperature-dependent life tests is required. ... Acceleration models (for failure mechanisms affected by other stresses, such as optical power or humidity) shall be demonstrated theoretically (if possible) and empirically. Associated acceleration/deceleration factors must be clearly identified.	
83.	TPR.9404-83 R3-31 (3.1.5)	Unless otherwise specified, all failures observed in qualification testing must normally be counted and must be reported, regardless of the failure mode. Omission of any failures from test results must be clearly justified and documented.	
84.	TPR.9404-84 O3-32 (3.1.5)	To simplify review (by customers or their representatives) of failure rate predictions, the format in Table 3-1 is recommended for use by device manufacturers and/or equipment suppliers.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
85.	TPR.9404-85 R3-33 (3.1.5)	The testing data and supporting evidence for Table 3-1 shall be documented and available for review on request.	
86.	TPR.9404-86 O3-34 (3.1.5)	The format for reporting the status of all reliability tests shall follow the format in Table 3-2.	
87.	TPR.9404-87 R3-35 (3.1.5)	The testing data and supporting evidence for Table 3-2 shall be documented and available for review at the request.	
	3.1.6	Re-qualification	
88.	TPR.9404-88 R3-36 (3.1.6) R8-123 (8.2.4.5.1)	<p>1. Periodic re-qualification shall be performed by the equipment supplier and/or device manufacturer if significant changes in design (form, fit, or function), materials, processing, assembly, or screening are made in the product for any reason (enhanced performance, cost reduction, quality or reliability problem in manufacturing or field use, etc.).</p> <p>2. The supplier's on-going reliability monitoring program may be substituted for periodic re-qualification applied to devices if the ongoing reliability program addresses failure mechanisms that were addressed during product qualification. This reliability monitoring program shall include qualification by family, using different codes on a rotational basis. This program must be tied to failure mode engineering analysis and qualification results shall include critical process control information.</p>	
89.	TPR.9404-89 R3-37 (3.1.6) R8-124 (8.2.4.5.1)	<p>1. The equipment supplier and/or device manufacturer shall document the conditions that require all or part of the qualification test sequence to be repeated.</p> <p>2. Any changes that affect form fit or function of the product shall be clearly documented.</p>	
90.	TPR.9404-90	1. The equipment supplier's contract or purchase agreement shall require that its vendors	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	O3-38 (3.1.6) R8-125	notify the supplier in advance of any changes in the performance, quality, reliability, or safety of their products. 2. The equipment supplier shall notify its customers of anticipated design changes that will affect product form, fit, or function.	
91.	TPR.9404-91 O3-39 (3.1.6) R8-126 (8.2.4.5.2)	In the absence of significant changes in the product, each product family shall be re-qualified every 2 years or more often. The re-qualification shall be initiated within 2 years after the completion of the previous (re)-qualification.	
92.	TPR.9404-92 R3-40 (3.1.6)	A reliability monitor program must meet the following conditions for it to be used to satisfy the periodic requalification objective [O3-39] of this document: <ul style="list-style-type: none"> • Results are not reported on a device family basis unless the definition of “family” is based on demonstrated technology similarity. • No reliability problems have been identified from field returns. • The range of tests and conditions used in the monitor program meet or exceed the criteria given for periodic requalification. 	
	3.2	Lot-To-Lot Quality and Reliability Controls	
	3.2.1	General Criteria for Lot Controls	
	3.2.1.1	Definition of a Lot	
93.	TPR.9404-93 O3-41 (3.2.1.1)	From an equipment supplier’s perspective, a lot shall be considered as a unit made up of devices with the same device code and packaging (manufactured by the same supplier), and with a range of less than 6 weeks in package date codes. Maximum lot sizes shall not exceed 1000 parts, unless the equipment supplier has implemented sampling practices that positively ensure the random selection of components for inspection and test. Otherwise, shipments larger than this shall be split into smaller groups that meet the above definition; each of these groups (or lots) shall then be separately subjected to the full set of lot acceptance tests identified in the equipment supplier’s detailed device specification.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
94.	TPR.9404-94 O3-42 (3.2.1.1)	<p>1. Passive optical components are manufactured in a continuous process analogous to general components, the definition of a lot given above [O3-36] applies.</p> <p>2. If passive optical components are manufactured in batches spaced significantly apart in time, the definition of a lot given above [O3-41] is still used. The same criteria for lot controls would also apply unless special exceptions are noted.</p> <p>3. If passive optical components are manufactured in a continuous manner <i>without clearly defined batches</i>, then the associated criteria for lot controls shall be applied based on practically sized “groups” made sequentially in time. ... The equipment supplier or device manufacturer shall demonstrate if other definitions are used for a lot.</p>	
95.	TPR.9404-95 R3-43 (3.2.1.1)	The manufacturer’s definition of a “lot” shall be clearly documented.	
	3.2.1.2	Purchase Specifications	
96.	TPR.9404-96 R3-44 (3.2.1.2)	Lot-to-lot controls shall be documented and shall be referenced in purchase specifications (see Section 3.2.1.4).	
97.	TPR.9404-97 O3-45 (3.2.1.2)	If devices are purchased pre-screened, the PDA or LTPD shall be specified in the purchase specifications.	
	3.2.1.3	Source Inspection/Incoming Inspection	
98.	TPR.9404-98 R3-46 (3.2.1.3) R8-14	The acceptability of all procured materials and components that are part of the product or used in the manufacture and assembly of the product is to be determined by one or more of the following methods:	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(8.2.1.2.5)	<ul style="list-style-type: none"> Vendor quality and reliability evidence Inspection at the material/device manufacturer's location (source inspection on outgoing product) Inspection at the equipment supplier's location (incoming inspection). 	
99.	TPR.9404-99 R3-47 (3.2.1.3) R8-16 (8.2.1.2.5)	<p>When incoming inspection is used to confirm conformance to purchase specifications, a comprehensive testing plan shall be established. The program shall include test conditions, pass/fail criteria, data collection, and effective use of the data. ... Test results shall be made available in a timely manner for review by the organizations receiving and using the components.</p> <p>Inspection instructions shall exist for all materials and components. Inspection instructions shall include</p> <ul style="list-style-type: none"> the procedures for inspection and test the sampling plan to be used the properties, characteristics, dimensions, or parameters to be examined or measured 	
	3.2.1.4	Ship-to-Stock Programs	
100.	TPR.9404-100 R3-48 (3.2.1.4)	Use of ship-to-stock (dock-to-stock) practices for passive optical devices/materials by an equipment manufacturer must be clearly identified.	
101.	TPR.9404-101 R3-49 (3.2.1.4) R8-19 (8.2.1.2.5)	<p>1. Conditions for a <i>possible</i> ship-to-stock (dock-to-stock) program must include the following (to be fully documented by the equipment supplier):</p> <p>2. Devices shall be approved by the equipment supplier for ship-to stock only on the basis of individual device codes. If ship-to stock is approved for a family code, technology similarities to justify the approval shall be demonstrated.</p>	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
		<p>3. The equipment supplier shall be able to demonstrate from incoming inspection records and field data (or substantiate via other means) a history of satisfactory quality and reliability performance for the specific device from this vendor. [A history based on a product family, as described in Section 3.1.3.3, is acceptable for a new device.]</p> <p>4. Final test measurements on all parameters specified by the equipment supplier shall be provided by the manufacturer for each device and included as routine information with the shipped lot - <i>OR</i> - the manufacturer's lot controls must have been previously assessed as meeting the intent of this document (i.e., there are no serious differences from the criteria given here for lot controls, feedback and corrective action, and other related issues).</p> <p>5. Periodically, on an interval of 6 months or less, a lot shall be randomly selected by the equipment supplier and subjected to the full set of lot acceptance tests required by the supplier (in accordance with the relevant criteria here). All devices in the lot shall be tested.</p> <p>6. The equipment supplier shall document specific criteria for approving and removing device codes from its ship-to-stock list.</p>	
102.	TPR.9404-102 R3-50 (3.2.1.4)	A single rejection of a lot based on (a) failure to pass the annual audit [R3-44d] or (b) unresolved problems found in system manufacturing or from field returns shall result in the device code being removed from ship-to-stock status.	
	3.2.1.5	Test Plan (Incoming Inspections)	
103.	TPR.9404-103 R3-51 (3.2.1.5)	Individual device specifications shall either include the actual lot control practices or reference the appropriate document(s) in which the practices are described.	
104.	TPR.9404-104	Lot control practices shall include the tests to be performed, the test method (or its reference), sampling levels, and accept/reject criteria.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R3-52 (3.2.1.5)		
105.	TPR.9404-105 O3-53 (3.2.1.5)	Lot control procedures shall be subject to a document control program (e.g., dated, signed by appropriate management, and removed from use when superseded by newer versions).	
	3.2.1.6	Test Equipment (Used in Incoming Inspection)	
106.	TPR.9404-106 R3-54 (3.2.1.6)	The equipment supplier shall have access to the test equipment necessary to perform lot inspection and screening.	
	3.2.1.7	Data Recording and Retention (Incoming Inspection)	
107.	TPR.9404-107 R3-56 (3.2.1.7)	<p>All information relevant to lot inspection and screening shall be recorded and retained for later review and summary. As a minimum, collected information shall include the following:</p> <ul style="list-style-type: none"> • The device code, supplier, lot size, date code, and/or serial number • The number of devices tested and number of defectives found for each series of tests performed • The disposition of defectives, any follow-up required, and any other special notes (e.g., rejection of entire lot). 	
	3.2.1.8	Treatment of Defective Devices and Lots	
108.	TPR.9404-108 R3-57 (3.2.1.8)	<p>Procedures that describe the handling and disposition of defective devices and rejected lots shall be documented.</p> <p>Nonconforming materials shall be clearly labeled as such.</p>	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
109.	TPR.9404-109 O3-58 (3.2.1.8)	The device vendor shall be required to provide <i>timely</i> feedback on the nature of serious or recurring problems and the corrective actions it has taken.	
	3.2.1.9	Summary of Vendor History Data (Incoming Inspections)	
110.	TPR.9404-110 R3-59 (3.2.1.9)	Results from lot incoming inspection and screening shall be summarized periodically for each device vendor.	
	3.2.1.10	Low Volume Parts	
111.	TPR.9404-111 R3-62 (3.2.1.10)	When lot sizes are small and cannot justify or support the sampling plans needed for lot acceptance testing, the entire lot (100 percent) shall be subjected to the quality and reliability audit tests. For these small lots, any tests considered destructive may be excluded.	
112.	TPR.9404-112 R3-63 (3.2.1.10)	The tracking of 'low volume' device codes shall be included in the data collection and analysis procedures.	
	3.2.1.11	Use of Vendor Supplied Data	
113.	TPR.9404-113 R3-64 (3.2.1.11) R8-22 (8.2.1.2.5)	1. In cases where vendor-supplied data is used for lot-to-lot controls, verifiable test results shall be provided (with the shipment of devices or within a time specified by the equipment supplier) for the supplier's records on lot quality. 2. The vendor supplied and/or certified data that is obtained in place of incoming inspection shall be reviewed by the equipment supplier for conformance to requirements.	
114.	TPR.9404-114	1. The equipment supplier shall periodically audit the results through a documented verification program that it has developed.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R3-65 (3.2.1.11) R8-21 (8.2.1.2.5)	2. Certified data that is obtained in place of incoming inspection shall be periodically verified, by inspection at receipt, third-party testing, or witnessing testing at the vendor's location.	
	3.2.1.12	Treatment of internally Manufactured Devices	
115.	TPR.9404-115 R3-66 (3.2.1.12)	Devices manufactured internally by the equipment supplier itself, or by another division of the same parent company, shall meet the same lot testing and screening requirements as specified herein for purchased devices.	
116.	TPR.9404-116 R3-67 (3.2.1.12)	In cases where equipment assembly locations do not perform incoming inspections of passive optical components made by another division of the company, the assembly locations must have continuous access to the test results or follow the criteria for ship to-stock devices. The supplier must also be readily capable of demonstrating that the correct tests are being run and that lot dispositions are being made properly (normally involving routine review of the test results, plus regular technical meetings with the other divisions).	
	3.2.2	Other General Information for Lot-to-Lot Controls	
117.	TPR.9404-117 R3-68 (3.2.2)	Unless otherwise specified, all failures observed in lot testing must be counted, regardless of the failure mode.	
	3.3	Standardized Test Procedures	
118.	TPR.9404-118 O3-69 (3.3)	Procedures used in the performance of tests and the measurement of parameters required by this document shall be performed in accordance with available national or international standards.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
119.	TPR.9404-119 O3-70 (3.3)	If conflicts occur between national and international standards, United States national standards shall take precedence if the product is manufactured and marketed in the United States.	
	3.4	Feedback and Corrective Action	
120.	TPR.9404-120 R3-71 (3.4)	Equipment suppliers shall collect data relating to device/process dropout/rework levels at each stage of equipment manufacture (first circuit pack test, system level testing, etc.). The data shall also be analyzed to identify any devices/processes that are failing at a higher than expected rate.	
121.	TPR.9404-121 O3-72 (3.4) R8-76 (8.2.3.6)	1. Device replacement data associated with the repair and/or failure analysis of field returns and customer complaints represent additional valuable information that shall be made available to the engineering organization responsible for the company's or division's reliability effort. 2. The supplier shall have procedures in place to feed the failure analysis results back to the cognizant department.	
122.	TPR.9404-122 R3-73 (3.4)	The causes for device failures shall be determined for all common failure modes and summarized in order to help direct the corrective action effort [see Section 3.3.8]. Equipment suppliers shall either have their own internal failure analysis laboratories to perform detailed device failure analysis, or have arrangements with an independent test lab or with the device manufacturer.	
123.	TPR.9404-123 R3-74 (3.4)	In addition to any vendor-supplied data that are received, an equipment supplier shall collect device-level data from the following: ... •Incoming inspection and screening (unless the devices are approved for ship-to-stock or the equipment manufacturer has demonstrated the direct access to its suppliers' testing data) ... •Circuit pack test ... •Circuit pack burn-in	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
		<ul style="list-style-type: none"> ... •System-level test ... •System-level burn-in ... •System installation ... •Repair of field returns. 	
	3.4.1	Incoming and Inspection and Screening	
124.	TPR.9404-124 R3-75 (3.4.1) R8-27 (8.2.1.2.7)	<p>1. The supplier shall have a program in place for informing raw material vendors of reliability and quality problems.</p> <p>2. When problems are found, the device/material vendor shall be formally notified of the problem.</p> <p>3. The vendor shall also be required to respond with its assessment and any corrective actions that it has implemented.</p>	
125.	TPR.9404-125 O3-76 (3.4.3)	<p>From predicted device failure rates, equipment suppliers shall have some estimate of the number of failures that would be expected in field use, over any given period of time, for each device code. Devices that are being removed (during the repair of field returns) at rates higher than expected shall be examined to determine why the additional failures are occurring, and to ensure that a major problem is not developing.</p>	
	3.4.4	Data Collection and Analysis (Equipment Supplier)	
126.	TPR.9404-126 R3-77 (3.4.4) R8-99 (8.2.4.3.1) R8-101 (8.2.4.3.1)	<p>1. The data collection system shall be implemented in such a manner that information such as data from manufacturing processes (such as finished goods tests), can be compiled and analyzed for rapid feedback to all responsible groups (e.g., device engineering, quality assurance, quality control, manufacturing supervisors, etc.).</p> <p>2. Control charts, trend charts, or other methods shall be used to provide feedback into the system at intervals of no greater than one week.</p>	
127.	TPR.9404-	1. Reports summarizing device/material dropout rates and circuit pack or process yields at	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	127 R3-78 (3.4.4)	various stages of assembly and test shall be issued on a periodic basis (no less frequently than every 3 months) for upper level management review. 2. The report shall include number of units received from the field for repair, number of units that are “no trouble founds” (NTFs) or “no fault founds” (NFFs), number of units modified, and number of units repaired.	
128.	TPR.9404-128 O3-79 (3.4.4)	The reports shall track the length of time that identified problems persist and the efforts to resolve them. Follow-up reports shall note specific actions to confirm that a problem was corrected.	
	3.4.5	Unconfirmed Failures	
129.	TPR.9404-129 O3-80 (3.4.5)	1. The equipment supplier shall track NTFs as part of the data collection on field returns. When NTFs exceed thresholds set by the supplier, the causes shall be investigated and corrected. 2. The supplier also shall be prepared to explain and justify the NTF thresholds that it has set.	
130.	TPR.9404-130 R3-82 (3.4.6)	The equipment supplier shall document the conditions that mandate failure analysis of a representative sample of “bad” devices with similar failure modes.	
	3.5	Device/Material Storage and Handling	
131.	TPR.9404-131 R3-84 (3.5) R8-46 (8.2.3.2)	1. The normal flow of fiber optic components and materials from when they are received until they have been successfully tested in the system (including the manufacturing and assembly process) shall be clearly described in flow charts. The flow charts shall include all test and inspection points. 2. Differences from the practices for general electrical or electronic components shall be noted.	
	3.5.1	Non Conforming Material	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
132.	TPR.9404-132 R3-85 (3.5.1) R8-59 (8.2.3.3.1) R8-60 (8.2.3.3.1)	1. Devices and material lots that do not conform to purchase specifications (nonconforming material) must be segregated from good devices/material, rejected material, from parts awaiting test and from field returns. 2. Separate areas shall be set aside to store nonconforming materials.	
	3.5.2	Material Review System	
133.	TPR.9404-133 R3-86 (3.5.2)	Equipment suppliers and device manufacturers shall establish and document practices for handling all nonconforming materials.	
134.	TPR.9404-134 O3-87 (3.5.2) R8-23 (8.2.1.2.5)	If a nonconforming product/material is to be used “as is” or, if some form of additional testing or screening is required, the appropriate component engineering and quality assurance engineers shall be involved in the decisions (through formal sign-offs on the authorization).	
135.	TPR.9404-135 R3-88 (3.5.2) R8-17 (8.2.1.2.5)	1. Detailed records of incoming inspection and the disposition of all nonconforming material shall be maintained for at least 2 year. 2. Summary records shall be retained for at least 5 years. 3. Results shall be reviewed periodically to ensure that the same problems are not being encountered repeatedly.	
136.	TPR.9404-	1. Problems discovered in the quality system shall be resolved within a specified time limit	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	136	using the corrective action or quality improvement process.	
	R3-89 (3.5.2)	2. The timeliness and effectiveness of corrective actions shall be monitored and documented.	
	3.5.3	Stockroom Inventory Practices	
	3.5.3.1	FIFO Inventory Policy	
137.	TPR.9404-137 R3-90 (3.5.3.1) R4-28 (4.4.2) R8-62 (8.2.3.3.2)	<p>1. Stockroom practices must ensure that no items are in storage in excess of their shelf life.</p> <p>2. There shall be a documented program in place for the use of any raw materials that have a shelf life, such as (but not limited to) epoxies, paints, etc.</p> <p>3. Adhesives shall be properly stored and used during its useful shelf life; any adhesive not used shall be discarded when its shelf life has expired.</p>	
138.	TPR.9404-138 R3-91 (3.5.3.1)	Inventory practices and shelf stock shall be audited periodically to check the effectiveness of the stockroom practices.	
139.	TPR.9404-139 O3-92 (3.5.3.1) R8-61 (8.2.3.3.2) R4-27 (4.4.2)	<p>1. A first-in/first-out (FIFO) policy shall be implemented for all identical raw materials and all shelf-life items.</p> <p>2. Rigorous first-in/first-out (FIFO) must be developed and implemented for raw adhesive materials. The inventory dates must be clearly marked.</p>	
	3.5.3.2	Reworked Parts	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
140.	TPR.9404-140 R3-93 (3.5.3.1)	All devices that are reworked must pass incoming inspection before they are returned to the stockroom.	
	3.6	Documentation and Test Data	
141.	TPR.9404-141 R3-94 (3.6) R8-25 (8.2.1.2.6)	1. The program for assuring reliability controls shall be documented. 2. All reliability assurance procedures, practices and test methods shall be documented. Such documents have to be officially recognized and shall be formally controlled.	
142.	TPR.9404-142 O3-95 (3.6)	The supplier's quality and reliability manual shall identify any special reliability assurance requirements (e.g., testing, screening, handling) that are unique to fiber optic components.	
	3.6.1	Availability of Documentation	
143.	TPR.9404-143 R3-96 (3.6.1)	Equipment suppliers and/or device manufacturers shall provide the following information on request: <ul style="list-style-type: none"> • component description • the process flow chart highlighting inspection and testing • assembly procedures (including baking and/or curing steps) • re-work, etc. • The supplier/manufacturer shall provide written explanation giving the extraordinary reasons for any information that it cannot provide (e.g., involving sensitive proprietary information). 	
144.	TPR.9404-144	The equipment supplier and/or device manufacturer shall make available all documents relevant to its reliability assurance program for fiber optic components. These include:	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R3-97 (3.6.1)	<ul style="list-style-type: none"> • vendor qualification practices • device qualification procedures and re-qualification practices • individual device specifications • procedures for adding vendors and devices to the AVL and APL • procedures for removing vendors and devices from the AVL and APL • incoming inspection procedures • screening practices • storage and handling practices • ESD control programs • data collection and analysis procedures • procedures describing the handling, repair, failure analysis, and corrective action associated with field returns • internal auditing procedures to ensure all the above procedures are being observed. 	
	3.6.2	Availability of Other Information	
145.	TPR.9404-145 R3-98 (3.6.2)	<p>The following information must be provided for review on request:</p> <ul style="list-style-type: none"> • long-term environmental life test results on specific devices • recent incoming inspection and screening data on specific devices • drop-out rates or failure levels of specific devices at first circuit pack test, at system test, in system burn-in, and from the repair of field returns • failure analysis results for specific devices • corrective action assignment and follow-up. 	
	3.7	Availability of Devices-	
146.	TPR.9404-146 R3-99 (3.7)	Equipment suppliers shall formally respond to requests for sample devices (plus accompanying functional specifications or performance sheets) in a timely fashion, and shall refuse such requests only if there are extraordinary reasons that would make such availability unacceptable.	
	4.1	Qualification of Passive Optical Devices	
147.	TPR.9404-	The equipment supplier shall perform or obtain verifiable data for the qualification of fiber	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	147 R4-1 (4.1)	optic components and materials, including characterization and reliability tests.	
148.	TPR.9404-148 R4-2 (4.1.1)	Fiber optic components shall be fully characterized for optical performance as part of device qualification. A sample size of at least 11 devices (LTPD of 20%) is required.	
149.	TPR.9404-149 O4-3 (4.1.1)	Table 4-1 lists a typical set of parameters that shall be included for characterization of branching components. The necessary characterization and associated parametric limits that shall be included for other devices may be provided in manufacturer's detailed specifications or Telcordia device-specific GRs.	
150.	TPR.9404-150 O4-4 (4.1.1)	Fiber optic component data also shall be obtained from the vendor (in-house or external) on a much larger population (~ 50-200 units representing a minimum of three different date codes). Distributions of measured parameters shall be compared to specification limits and design requirements to assure that adequate margins exist.	
151.	TPR.9404-151 R4-5 (4.1.2)	Reliability tests for fiber optic components shall include mechanical/physical tests as well as endurance tests. Table 4-2 lists a minimum set of tests that must be performed. The manufacturer must provide testing data and analysis results, including failure analysis, on request.	
152.	TPR.9404-152 R4-6 (4.1.2)	Optical performance tests shall be completed before and after each of the reliability tests. Pass/fail criteria shall be consistent with the performance criteria in the applicable documents (e.g., Section 4.2 of GR-1209-CORE for branching components, Section 4.1 of GR-2854-CORE for dispersion compensators, Section 4.1 of GR-2882-CORE for isolators and circulators, and Section 4.1 of GR-2883-CORE for filters).	
153.	TPR.9404-	If technical data are not available in support of other values, an activation energy of 0.3 eV	



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	153 R4-7 (4.1.2)	shall be assumed for the dry heat test and an effective activation energy of 0.8 eV shall be assumed for the damp heat test. In the latter case, the higher activation energy accounts for the difference between the test's high humidity and "average" operating conditions, such that a separate term for humidity would not be included in the calculation of the acceleration factor.	
154.	TPR.9404-154 R4-8 (4.1.2)	Manufacturers may use a different activation energy from those in R4-7 for the Arrhenius model, or a different model for calculating acceleration, if its use can be supported by empirical data. The empirical data must be based on reliability testing or field returns, and shall be available for review upon request.	
155.	TPR.9404-155 R4-9 (4.1.2)	If the modules are cooled through the use of a thermoelectric cooler (TEC), the component shall be tested: <ul style="list-style-type: none"> • At 70°C and 2000 hours for pass/fail and 5000 hours for information for CO applications; or • At 85°C and 2000 hours for pass/fail and 5000 hours for information for RT/UNC applications. 	
156.	TPR.9404-156 O4-10 (4.1.2)	In order of priority, the following life tests shall be performed as part of any effort to validate alternative acceleration models or activation energies: <ol style="list-style-type: none"> 1. High temperature damp heat = 75°C, 90% RH (or 85°C, 85% RH) 2. High temperature dry heat = 85°C, ~16%RH 3. Moderate temperature damp heat = 45°C, 85% RH. Minimum sample size is 22 devices for each life test. Results shall include estimates of median life or mean-time-to-failure (MTTF), and a "spread" parameter (e.g., standard deviation).	
157.	TPR.9404-157 O4-11 (4.1.2)	The reliability database shall be supplemented by additional accelerated aging data obtained from the vendor and with field data as they become available.	
158.	TPR.9404-158	A temperature cycle life test shall be performed in accordance with the procedures of Section 6.2.7. The minimum and maximum temperatures shall be at least -40°C and +70°C for CO	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R4-12 (4.1.2)	environments and -40°C and +85°C for RT/UNC environments. The minimum sample size is 11 devices (LTPD of 20%). Results after 500 cycles shall be used for “passing” or “failing” the test. Failures between 500 and 1000 cycles shall be investigated and corrective actions shall be implemented. The failure criteria shall be consistent with Section 4.1 of this document.	
	4.3	Quality Assurance and Lot Controls	
	4.3.1	Visual Inspection	
159.	TPR.9404-159 R4-13 (4.3.1)	Incoming lots of fiber optic components shall be visually inspected on at least a sample basis (to be determined in accordance with a statistical sampling plan established by the equipment supplier).	
160.	TPR.9404-160 O4-14 (4.3.1) R8-105 (8.2.4.3.2)	<p>1. Visual inspection (or another step in lot acceptance procedures) shall check at least for the following:</p> <ul style="list-style-type: none"> ... •Package condition ... •Required documentation ... •Product appearance/condition ... •Product identification/markings ... •Inspection of connectors or adaptors. <p>2. For finished goods testing, connector adapters shall be visually inspected for workmanship and appearance.</p>	
	4.3.2	Optical Testing	
161.	TPR.9404-161 R4-15 (4.3.2) R8-55 (8.2.3.2)	<p>1. The supplier shall document and establish a formal, statistically valid sampling plan for all incoming material inspections, in-process tests and inspections that the supplier does not perform on a 100% basis.</p> <p>2. If 100% testing is not performed, adequate data shall be collected and a statistically justified sampling plan must be established. The technical data to support the sampling test program shall be available on request.</p>	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
162.	TPR.9404-162 O4-16 (4.3.2)	Table 4-4 lists a typical set of parameters that shall be included for lot-to-lot controls of branching components. The polarization Dependent Loss is recommended to be measured on a sample basis. The necessary characterization that shall be included for other devices may be provided in manufacturer's detailed specifications or Telcordia device-specific GRs.	
	4.3.3	Stress Screening	
163.	TPR.9404-163 O4-17 (4.3.3)	All fiber optic components shall be subjected to a temperature cycle screen. The recommended screening consists of 10 cycles between temperature limits of at least -40°C and +70°C for CO applications and -40°C and +85°C for RT/UNC applications; if these are outside the component's specifications, the minimum- and maximum-specified storage temperatures shall be used. Sampling screening, other testing conditions, or number of cycles may be allowed if the equivalent effectiveness can be demonstrated.	
164.	TPR.9404-164 O4-18 (4.3.3)	The demonstration of the effectiveness of alternate temperature cycle conditions for screening shall include first characterizing devices after the proposed number of temperature cycles and again after 10 cycles, presumably showing that no significant degradation nor additional failures occurred. The demonstration shall be proved on adequate samples over multiple lots.	
165.	TPR.9404-165 R4-19 (4.3.3)	Optical criteria shall be measured before and after screening. Any "major" changes (as defined and documented by the equipment supplier, in addition to pass/fail criteria) shall result in rejection of a device.	
166.	TPR.9404-166 O4-20 (4.3.3)	The pass/fail criteria shall be no more than 20% changes on the specified parameters.	Verizon doesn't allow any changes to the pass/fail criteria
167.	TPR.9404-167 O4-21	The manufacturer shall record the optical criteria before and after screening on a sample of components as a production audit.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(4.3.3)		
	4.4	Reliability and Quality of Optical Adhesives	
	4.4.1	Qualification and Requalification	
168.	TPR.9404-168 R4-22 (4.4.1) R8-6 (8.2.1.2.3)	A detailed specification shall be generated and used by the manufacturer for the purchase of epoxies and adhesives.	
169.	TPR.9404-169 R4-23 (4.4.1)	The adhesion used in the component or its packages shall be separately qualified and periodically re-qualified. The program shall include testing data and criteria for the curing cycle, glass transition temperature (T _g), viscosity, and air bubbles.	
170.	TPR.9404-170 R4-24 (4.4.1)	Adhesives used as structural elements in the device shall have a glass transition temperature (T _g) equal to or greater than 95°C as measured by the following differential scanning calorimetry (DSC) test procedure: Samples of (uncured) adhesive mixture (5-10 mg) are placed in a standard DSC sample pan and cured under the same conditions as the production adhesive. Each test sample is placed in a calibrated DSC and cooled to 0°C and allowed to reach thermal equilibrium. A thermal scan is recorded as the temperature is raised from 0°C to +200°C at a rate of 10°C per minute. The T _g is the temperature of the midpoint of the transition deflection.	
171.	TPR.9404-171 R4-25 (4.4.1)	The passive fiber optic component manufacturer shall verify the cure cycle by ascertaining that the glass transition temperature (T _g) of the cured adhesive for each lot measured with DSC is not more than 10°C from the T _g of a reference standard. The adhesive tested shall be the production samples. If the above method is not used, one of the methods listed below (or a suitable equivalent) must be used to verify [for each incoming lot] that the adhesive is completely cured.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
		<p>... a. The passive fiber optic component manufacturer shall verify the cure cycle by heating a sample of cured adhesive in a mass spectrometer and monitoring the evolved gases. The sample shall be heated to 350°C at a constant rate. The mass spectrometer shall be scanned from 10 to 600 AMU once per second. The presence of reaction by-products, solvents, vehicles, etc. at temperatures below the decomposition of the adhesive indicates an incomplete or ineffective curing cycle.</p> <p>... b. The passive fiber optic component manufacturer shall perform residual gas analysis (RGA) on sealed hermetic packages that have completed an extended life test at maximum temperature. The presence of reaction byproducts, solvents, vehicles, etc. indicates that a reliability hazard exists due to an incomplete or ineffective curing cycle. The presence of these gases will cause degradation in the uncontrolled environment, where temperature cycling could lead to condensation on optically active surfaces.</p>	
172.	<p>TPR.9404-172</p> <p>R4-26 (4.4.1)</p> <p>R8-9 (8.2.1.2.3)</p> <p>R8-10 (8.2.1.2.3)</p> <p>R4-31 (4.4.3)</p>	<p>1. The passive fiber optic component manufacturer shall have documentation for storage, shelf life, assembly operator training, pot life, cure cycle, manufacturing audit, and requalification in accordance with Section 3.6.</p> <p>2. There shall be documentation and operator instructions for mixing, application, curing, and pot life. These instructions shall be posted at each workstation.</p>	
	8.2.1.2.3	Qualification of Epoxies	
173.	<p>TPR.9404-173</p> <p>R8-8 (8.2.1.2.3)</p>	Storage conditions and storage time shall be documented.	
	4.4.2	Raw Material Storage	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	4.4.3	Lot-To-Lot Controls (Epoxies)	
174.	TPR.9404-174 R4-29 (4.4.3) R8-7 (8.2.1.2.3)	Incoming inspection procedures shall be documented and followed by the component manufacturer. Incoming product shall be inspected to the detail specification.	
175.	TPR.9404-175 R4-30 (4.4.3) R8-11 (8.2.1.2.3)	1. The cure cycle must be verified each time a new lot of adhesive is received (as part of incoming inspection) by performing the cure cycle and verifying the stability of the adhesive. 2. A connectorized pigtail or patchcord shall be drawn from each lot or batch of epoxy that is used in connector assembly, and submitted for the following test: Adhesive Testing in Section 4.4.4.2.	
		GR-326 Section 8 Criteria	
	8.2.1.2	Materials and Components Requirements	
176.	TPR.9404-176 R8-1 (8.2.1.2)	The requirements of Technical Reference TR-NWT-000357, <i>Generic Requirements for Assuring the Reliability of Components Used in Telecommunication Systems</i> , as applicable to the fiber optic component, shall apply.	
	8.2.1.2.4	Raw Material Specifications	
177.	TPR.9404-177 R8-12 (8.2.1.2.4)	All parameters specified in the Material Specifications shall be inspected.	
178.	TPR.9404-178 R8-13	Receiving Inspection Instructions shall reference the appropriate Material Specification.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(8.2.1.2.4)		
	8.2.1.2.5	Determination of Acceptability of Raw Materials	
179.	TPR.9404-179 R8-15 (8.2.1.2.5)	Evidence of quality and reliability, such as certified data, shall include or be accompanied by actual test and inspection data of the received goods.	
180.	TPR.9404-180 R8-20 (8.2.1.2.5)	Procedures for detailed assessment of a first lot delivered from a vendor shall be documented.	
181.	TPR.9404-181 O8-24 (8.2.1.2.5)	Sampling inspection plans used at incoming inspection shall have switching rules in place that allow for reduced or tightened inspection of product.	
	8.2.1.2.6	Reliability Controls	
182.	TPR.9404-182 O8-26 (8.2.1.2.6)	The supplier shall perform reliability tests on critical raw materials on a periodic basis. Raw materials from all approved vendors shall be included in the program.	
	8.2.1.2.7	Feedback and Corrective Action	
183.	TPR.9404-183 R8-28 (8.2.1.2.7)	A corrective action program shall be in place for those problems that are costly or repetitive.	
	8.2.2	Physical Design	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
184.	TPR.9404-184 R8-29 (8.2.2)	The requirements of GR-78-CORE, as applicable to the fiber optic component, shall apply.	
185.	TPR.9404-185 R8-30 (8.2.2)	At the request of an end user or its representative, the supplier shall identify all original equipment manufactured (OEM) products in or associated with its product.	
186.	TPR.9404-186 R8-31 (8.2.2)	Deviations from requirements for OEM equipment shall be identified and documented.	
187.	TPR.9404-187 R8-32 (8.2.2)	On request of an end user or its representative, the supplier shall provide a complete list of known and suspected deviations from requirements of OEM equipment.	
188.	TPR.9404-188 R8-33 (8.2.2)	The supplier shall assess all OEM equipment against Telcordia component reliability assurance, physical design, and product reliability criteria.	
189.	TPR.9404-189 R8-34 (8.2.2)	The supplier shall have in place physical design practices that are appropriate for the quality and reliability needed in telecommunications products.	
190.	TPR.9404-190	The supplier shall assure that all physical design and workmanship requirements are met before volume production begins.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	08-35 (8.2.2)		
	8.2.2.1	Contact of Dissimilar Metals	
191.	TPR.9404-191 R8-36 (8.2.2.1)	The composition and thickness of coatings and finishes on metal parts used to prevent electrolytic corrosion shall be specified.	
192.	TPR.9404-192 R8-37 (8.2.2.1)	The supplier shall be able to show evidence of testing that shows that the coating or finish used to prevent electrolytic corrosion due to contact dissimilar metals is capable of preventing electrolytic corrosion during the service life of the product.	
	8.2.2.2	Flammability	
193.	TPR.9404-193 R8-38 (8.2.2.2)	The supplier shall be able to provide a listing of the available fuel load of polymeric materials used in the fiber optic component product. The listing shall include the name of the part, the type of polymer, its mass, and the known flammability properties of the polymer.	
	8.2.3	Manufacturing and Assembly	
	8.2.3.1	Training	
194.	TPR.9404-194 R8-40 (8.2.3.1)	The supplier shall have an operator-training program in place for assembly, test, and inspection personnel.	
195.	TPR.9404-195 08-41 (8.2.3.1)	The supplier shall have a formal certification program in place.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
196.	TPR.9404-196 CR8-42 (8.2.3.1)	If a certification program is in place, the supplier shall periodically recertify operators.	
197.	TPR.9404-197 R8-43 (8.2.3.1)	[All personnel involved in the manufacture of a new product shall be trained.	
198.	TPR.9404-198 O8-44 (8.2.3.1)	The supplier shall encourage management to participate in reliability and quality training.	
	8.2.3.2	Product Documentation	
199.	TPR.9404-199 R8-45 (8.2.3.2)	The manufacturer shall document all of its manufacturing and assembly steps.	
200.	TPR.9404-200 R8-47 (8.2.3.2)	The supplier's reliability and quality organizations shall review and approve the in-process inspection and test plan.	
201.	TPR.9404-201 R8-48 (8.2.3.2)	The manufacturer shall adhere to its own manufacturing and assembly documentation.	
202.	TPR.9404-202	Acceptance criteria shall be listed on data sheets that are used for test and inspection purposes.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R8-49 (8.2.3.2)		
203.	TPR.9404-203 R8-50 (8.2.3.2)	All numerical values in the documentation that refer to nominal values for equipment settings or measurements shall include tolerances.	
204.	TPR.9404-204 R8-51 (8.2.3.2)	All formal documents shall be under a revision control program, including forms and check sheets used in the collection of in-process and final test and inspection data.	
205.	TPR.9404-205 R8-52 (8.2.3.2)	[Required approvals and distribution lists for all formal documents shall be specified.	
206.	TPR.9404-206 R8-53 (8.2.3.2)	The manufacturer shall have a formal program to ensure that outdated and obsolete manufacturing documentation is properly removed from use in the manufacturing, assembly, and test areas and that revised documentation replaces the old.	
207.	TPR.9404-207 R8-54 (8.2.3.2)	The supplier's documentation shall not contain hand-written changes, unless such changes are authorized (initialed and dated) by management. Any such changes shall be made to all working copies of the document.	
	8.2.3.3	Product Inspection	
208.	TPR.9404-208 R8-56 (8.2.3.3)	The supplier shall prepare manufacturing test and inspection flowcharts to document the appropriate sequence and location of these activities.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
209.	TPR.9404-209 R8-57 (8.2.3.3)	Product or associated paperwork shall show an indication of test and inspection activity at all points.	
	8.2.3.4	Product Assembly	
210.	TPR.9404-210 R8-63 (8.2.3.4)	The tool used for stripping fiber shall be replaced on a periodic basis according to the number of fibers stripped using the tool.	
211.	TPR.9404-211 R8-64 (8.2.3.4)	The manufacturer shall maintain a count of the number of times a particular stripping tool is used, or shall replace the tool based on average production volumes.	
212.	TPR.9404-212 O8-65 (8.2.3.4)	The stripped fiber ends shall be proof tested to 100 kpsi before mounting the connector plugs. The rate at which the proof test load is removed must be sufficiently high to guarantee a minimum strength nearly equal to the proof test stress.	
213.	TPR.9404-213 O8-66 (8.2.3.4)	A count of the fraction of proof test failures shall be kept. Increases in the fraction of proof test failures shall be used to determine how often the stripping tool is replaced.	
	8.2.3.5	Product Traceability	
214.	TPR.9404-214 R8-67	For traceability purposes, customer information shall be retained for at least five years.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(8.2.3.5)		
215.	TPR.9404-215 R8-68 (8.2.3.5)	For traceability purposes, date of manufacture shall be placed on the product (or its container, if impractical to place on the product).	
216.	TPR.9404-216 R8-69 (8.2.3.5)	The supplier shall be able to trace key raw materials used in the manufacture of the product after the product has shipped.	
217.	TPR.9404-217 O8-70 (8.2.3.5)	The supplier shall be able to trace <i>all</i> raw materials used in the manufacture of the product after the product has shipped.	
	8.2.3.6	Customer Complaints	
218.	TPR.9404-218 R8-71 (8.2.3.6)	The supplier shall have a customer complaint program in place, and the program shall be formally documented.	
219.	TPR.9404-219 R8-72 (8.2.3.6)	The supplier shall have an organization that is assigned the responsibility for customer support.	
220.	TPR.9404-220 R8-73 (8.2.3.6)	The supplier shall have a documented system in place for the return of defective a product that is in warranty.	
221.	TPR.9404-	The supplier shall have a documented system in place for the return of a defective product that is	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	221 R8-74 (8.2.3.6)	not in warranty.	
222.	TPR.9404-222 R8-75 (8.2.3.6) R3-83 (3.4.6)	1. The supplier shall have a failure analysis program in place to determine the cause of product failures returned from the field. 2. The equipment supplier shall either maintain its own facilities or make arrangements (prior to actual need) with an independent laboratory or device manufacturer to perform any necessary failure analysis.	
223.	TPR.9404-223 R8-77 (8.2.3.6)	A supplier shall have a documented corrective action program in place for the resolution of serious or repetitive customer complaints.	
224.	TPR.9404-224 O8-78 (8.2.3.6)	The supplier shall have a program in place for customer training, in the areas of engineering, ordering, installation, operation, and testing.	
225.	TPR.9404-225 R8-79 (8.2.3.6) O3-81 (3.4.6)	1. Analysis of field failure data shall be used for identifying the dominant causes of in-service failures. This information shall be summarized periodically and reviewed by design, quality, and manufacturing organizations. 2. Because of their critical nature, <i>all</i> passive optical components failing in the field with less than 1 year of operation (i.e., early failures or infant mortality) shall be submitted for failure analysis.	
226.	TPR.9404-226 O8-80	Analysis of field failure data shall be used for obtaining estimates of the field failure rate of the product.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(8.2.3.6)		
	8.2.3.7	Field Trials	
227.	TPR.9404-227 O8-81 (8.2.3.7)	The supplier shall have conducted, or shall be in the process of conducting, a field trial of the product.	
228.	TPR.9404-228 R8-82 (8.2.3.7)	The program, <i>if in place</i> , shall be documented.	
	8.2.3.8	Statistical Process Control and Quality Data	
229.	TPR.9404-229 R8-83 (8.2.3.8)	The supplier shall have a statistical process control (SPC) program in place to monitor critical steps in the manufacturing process.	
230.	TPR.9404-230 O8-84 (8.2.3.8)	The supplier shall document the rationale for the selection of these SPC areas.	
	8.2.4	Manufacturer Testing	
	8.2.4.1	Test Documentation	
231.	TPR.9404-231 R8-85 (8.2.4.1)	Finished goods test and inspection procedures for the product shall be documented in a formal system. These procedures may be included with or as part of other documentation such as manufacturing and assembly documentation.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
232.	TPR.9404-232 R8-86 (8.2.4.1)	Documented test procedures shall include performance specifications that are verifiable such that acceptance or rejection can be determined.	
233.	TPR.9404-233 R8-87 (8.2.4.1)	Criteria for accepting and rejecting product shall be clearly specified.	
234.	TPR.9404-234 R8-88 (8.2.4.1)	Finished goods test and inspection procedures shall include visual inspection for workmanship and appearance.	
235.	TPR.9404-235 R8-89 (8.2.4.1)	Finished goods tests shall be conducted according to the manufacturer's test procedures.	
236.	TPR.9404-236 R8-90 (8.2.4.1)	Documented test performance specifications for the product shall not be in conflict with any specifications for the identical product published in current advertising literature or internal engineering documents.	
	8.2.4.2	In-Process Testing	
237.	TPR.9404-237 R8-91 (8.2.4.2)	The supplier shall evaluate which in-process tests, if any, are necessary to assure final product quality and reliability.	
	8.2.4.3	Finished Goods Testing	
238.	TPR.9404-238	Product shall be functionally tested at final test.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R8-92 (8.2.4.3)		
239.	TPR.9404-239 R8-93 (8.2.4.3)	Final acceptance testing of product shall simulate field use.	
240.	TPR.9404-240 R8-94 (8.2.4.3)	Reference adapters and plugs used in testing shall simulate those in field use.	
241.	TPR.9404-241 O8-95 (8.2.4.3)	The analysis of final tests and inspections shall be documented in weekly and monthly summaries that are distributed to the affected areas and to upper management.	
242.	TPR.9404-242 R8-96 (8.2.4.3)	Distributed summaries of analyses shall be retained (for reference in any possible manufacturing or field reliability problems) for a minimum of two years.	
243.	TPR.9404-243 R8-97 (8.2.4.3)	The supplier shall document and establish a formal, statistically valid sampling plan for all final tests and inspections that the supplier does not perform on a 100% basis.	
244.	TPR.9404-244 R8-98	Repaired product shall be tested to the same extent as new product.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	(8.2.4.3)		
	8.2.4.3.1	Test Data	
245.	TPR.9404-245 R8-100 (8.2.4.3.1)	Results of finished goods tests shall be retained for a minimum of two years.	
246.	TPR.9404-246 O8-102 (8.2.4.3.1)	A statistical process control (SPC) shall be established to control the process.	
247.	TPR.9404-247 R8-103 (8.2.4.3.1)	Accept/reject criteria shall be established for both loss and reflectance.	
248.	TPR.9404-248 R8-104 (8.2.4.3.1)	Criteria shall not be in conflict with advertised specifications.	
	8.2.4.3.2	Connector Adapters (Finished Goods Testing)	
249.	TPR.9404-249 R8-106 (8.2.4.3.2)	Connector plugs and adapters shall be functionally tested to determine acceptable performance. This may be done on a sample basis by using a sample of adapters with other tests.	
	8.2.4.3.3	Replacement of Testing Parts	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
250.	TPR.9404-250 O8-107 (8.2.4.3.3)	The specified maximum number of times that reference parts are used in finished goods testing shall be no greater than 1000 matings and dematings.	
251.	TPR.9404-251 R8-108 (8.2.4.3.3)	The manufacture shall specify the maximum number of times that reference parts are used in finished goods testing.	
252.	TPR.9404-252 R8-109 (8.2.4.3.3.)	The manufacture shall have a method of determining how many times the reference parts have been used in finished goods testing.	
253.	TPR.9404-253 R8-110 (8.2.4.3.3)	Reference cables shall be checked for wear.	
254.	TPR.9404-254 R8-111 (8.2.4.3.3)	The manufacturer shall specify the frequency of the checks of the reference pieces before the maximum number of insertion is reached.	
	8.2.4.4	Calibration	
255.	TPR.9404-255 R8-113 (8.2.4.4)	All test equipment shall be validated to assure that sufficient accuracy and resolution exists to measure the parameters being tested.	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
256.	TPR.9404-256 R8-115 (8.2.4.4)	The accuracy and resolution of an instrument used to calibrate another instrument shall be greater than the accuracy and resolution of the instrument being calibrated.	
257.	TPR.9404-257 R8-117 (8.2.4.4)	The quality or reliability organization shall audit the records or equipment to ensure that no equipment that is past due for calibration is being used during testing and inspection.	
258.	TPR.9404-258 R8-120 (8.2.4.4)	Maintenance intervals shall be appropriately established with inputs such as equipment manufacturer's recommendations and degree of usage considered.	
	8.2.4.5	Product Qualification Testing	
259.	TPR.9404-259 R8-122 (8.2.4.5)	Documentation of the qualification or re-qualification program shall address: <ul style="list-style-type: none"> • Scheduling for qualification tests • Test procedures • Criteria that determine whether a test has been passed or failed • Specification of the format for the retention of test data • Distribution of the results and reporting of test failures • Corrective action to be taken when test failures occur. 	
	8.2.4.5.2	Periodic Re-qualification Test Schedule	
260.	TPR.9404-256	If requalification testing differs from qualification testing in scope, test procedures, performance criteria, or other area, the manufacturer shall specify these differences in the	



Row #	TPR.9404 Criteria #	TPR-9404 Requirement Criteria	Comments
	R8-127 (8.2.4.5.2)	qualification/ requalification documentation.	
		Additional Requirements	
	REQ (A-1)	The supplier shall supply specification sheets for the specific devices under test.	
	REQ (A-2)	A minimum of Eleven (11) samples of the product under evaluation (or number of samples based on the TPR.9404 Product Test Plan) will be taken from the assembly line. The tests of Table 4-4 (or other applicable product specific test as defined in the test plan) shall be performed. The pass failure criteria shall be the corresponding criteria in 1209 or other applicable documents.	
	REQ (A-3)	The supplier shall provide a quality flow chart and explanation of their quality control process. The supplier shall describe how they guarantee the quality of shipped product.	



Table 4-4. Typical Optical Parameters for Branching Components

Test or Measurement	Test Temperature
Optical Bandpass	room
Insertion Loss	room
Wavelength Isolation ^a	room
Uniformity ^a	room
Directivity ^b	room
Reflectance ^b	room
Channel Width ^c	room

Notes:

- a. If applicable.
- b. See text below.
- c. To replace Optical Bandpass for DWDM applications.

100% measurement of directivity and reflectance (by the device manufacturer and/or system supplier) would not be required if it were known that the transport systems/ services only involved digital applications. For video applications, directivity and reflectance measurements would be critical and could not be reduced to a sample. Since the future use of a local access network (or other application of passive optical devices) cannot be anticipated with



certainty, 100% reflectance measurements are normally necessary. The only exceptions to this would be [1] the direct use of passive optical devices as part of the integral hardware of a digital fiber optic transport system; or [2] the manufacturer specifies that the device is only intended for digital applications.

Table -1 summarizes the optical performance requirements, objectives (in parentheses) and test references for various passive optical device families.

Table -1: Optical Performance Criteria Summary

Optical Characteristics	Ref. Sect	Criteria
All Filters **		
Shortpass Passband (nm)	4.1.2	1280 – 1335 or 1455 – 1610
Longpass Passband (nm)	4.1.2	1510 – 1610
Center Wavelength Range (nm):	4.1.2	
-Fixed Bandpass	4.1.2	1300 – 1330 or 1530 – 1610
-Tunable Bandpass	4.1.2	1290 – 1330 or 1520 – 1610
Shortpass/longpass Loss (dB)	4.2.3	2
Bandpass insertion Loss (dB)	4.2.3	3.5
Flatness (dB)	4.3.3	1
Transmission Crosstalk (dB)	4.4.3	25 (55)
Reflection Crosstalk (dB)	4.4.3	10
Return Loss* (dB)	4.4.3	40 (55)
PDL (dB)	4.7.3	0.2
DWDM Filters		
Criteria as for ‘All Filters’ above plus the following additional overriding criteria:		
Transmission Spectrum:	4.1.2	>0.35 times the channel spacing
-1 dB bandwidth	4.1.2	>0.50 times the channel spacing
-3 dB bandwidth	4.1.2	<1.5 times the channel spacing



-20 dB bandwidth	4.1.2	<2.2 times the channel spacing	
-30 dB bandwidth			
Reflection Spectrum:	4.1.2	<1.6 times the channel spacing	
-0.2 bandwidth	4.1.2	>0.3 times the channel spacing	
-9.6 dB bandwidth	4.1.2	>10 (15)	
Isolation depth (dB)	4.1.2	<0.8	
Out of band insertion loss (dB)	4.1.2	<0.2	
Out of band flatness	4.2.3	1.0	
Bandpass Insertion Loss	4.1.2	20% the channel spacing	
Center wavelength tolerance	4.10	<4 pm/°C	
Temp sensitivity of center wavelength			
Gain Flattening Filters			
Criteria for 'All Filters' above plus the following additional overriding criteria:			
Wavelength independent insertion loss (dB)	4.2.4	<1.0	
Range of insertion loss error func. (dB)	4.2.4	<2.0	
Optical Characteristics	Ref. Sect	Criteria	
Couplers/Splitters ***		Digital (CR)	AM-Video (CR)
<i>M</i> x <i>N</i> Optical Bandpass (nm),	4.2.1	1260 to 1640 (user defined)	1290 to 1330 & (1530 to 1570)‡
1 x <i>N</i> insertion loss (dB)	4.2.1	$0.8 + 3.4 \log_2(N)$	$0.6 + 3.3 \log_2(N)$
2 x <i>N</i> insertion loss (dB)	4.2.1	$1.0 + 3.4 \log_2(N)$	$0.9 + 3.3 \log_2(N)$
1 x <i>N</i> uniformity	4.3.1	$0.6 \log_2(N)$	$0.4 \log_2(N)$
2 x <i>N</i> uniformity	4.3.1	$0.7 \log_2(N)$	$0.6 \log_2(N)$



Coupling Ratio	4.5.1	User defined	
Directivity* (dB)	4.5.1	55	55 (60)
Return Loss* (dB)	4.6.1	55(CR65)	
Polarization Dependent Loss (dB)	4.7.1	0.1 [1+ log ₂ (N)]	
Polarization Mode Dispersion (ps)	4.9.1	0.1 [1 + log ₂ (N)]	
WDMs			
Optical Bandpass (nm)	4.1.2	1260 to 1640 (user defined)	1290 to 1330 & (1530 to 1570)‡
Central Frequency	4.1.2	193.1 + 0.1iTHz (i=integer)	
Central Frequency Deviation	4.1.2	20% of channel spacing	
Insertion Loss L ₁ (dB)	4.2.1	1.5 log ₂ N	1.0 log ₂ N
Insertion Loss Slope (dB/nm)	4.2.1	≤0.1 dB/0.1 nm	
Isolation (dB)	4.4.1	25	55
Directivity* (dB)	4.5.1	50	50 (60)
Return Loss*	4.4.1	40 (65)	55 (65)
PDL (dB)	4.7.1	0.1 (1 + log ₂ N)	0.1 (1 + log ₂ N)
PMD (ps)	4.9.1	0.1 (1 + log ₂ N)	
DWDMs			
Criteria as for 'WDMs' above plus the Following additional overriding criteria:			
Insertion loss	4.2.1	2.2 + 0.6 (N-1)	-
Central Frequency		193.1 + 0.05i THz (i = integer)	
Central frequency deviation	4.1.2	<0.01 of channel spacing	
Wavelength temp. sensitivity	4.1.2		
Loss temperature stability	4.10	Δλ _c ≤ 4 pm/°C	
	4.10	≤ 0.5 dB	
Passive Optical Modules			



Insertion Loss, L_1 (dB)	4.1.2	User Defined	User Defined
Return Loss*, L_{RE}	4.6.1	User Defined	User Defined
Isolators and Circulators			
Optical Bandpass (nm)	4.1.2	1260 to 1680 (user defined)	
Insertion Loss, L_1 (dB)			
-In-Line	4.2.1	1.0	1.0
-Free-Space	4.2.1	0.5	0.5
-Circulator (Ports 1:2 & 2:3)	4.2.1	1.5	1.5
Isolation (dB)(all products)	4.4.2	32	47
Circulator Directivity*(dB)	4.5.2	50	50 (60)
Optical Characteristics	Ref Sect	Criteria	
Return Loss* (dB)	4.6.2	40	55 (65)
PDL (dB)			
-Isolators	4.7.2	0.2	0.2
-Circulators	4.7.2	0.5	0.5
PMD (ps)	4.9.2	0.2	0.2