OPTICAL FIBRE CABLE ASSEMBLIES WITH SINGLE FIBRE FERRULES

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1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of Optical Fibre Cable Assemblies with Single Fibre Ferrules for space applications. This specification contains the appropriate inspection and test schedules and also specifies the data documentation requirements.

For the purposes of this specification, an optical fibre cable assembly shall include a length of optical fibre or cable terminated by an optical connector either at one end or at both ends in order to achieve an optical interconnect function. The connectors' ferrule shall be single fibre based.

The different component variants such as pigtail, patchcord, hybrid patchcord, mating adapter, hybrid optical fibre assembly, etc., are specified in the Detail Specification.

1.2 APPLICABILITY

This specification is primarily applicable to the granting of qualification approval to components qualified in accordance with one of the following ESCC methods:

- Qualification of Standard Components per ESCC Basic Specification No. 20100.
- Technology Flow Qualification per ESCC Basic Specification No. 25400.

It is also primarily applicable to the procurement of components so qualified.

This specification may also be applied to the procurement of unqualified components, recommendations for which are given in ESCC Basic Specification No. 23100.

2 APPLICABLE DOCUMENTS

The following documents form part of, and shall be read in conjunction with, this specification. The relevant issues shall be those in effect on the date of starting qualification or placing the Purchase Order.

2.1 ESCC SPECIFICATIONS

- No. 20100, Requirements for the Qualification of Standard Electronic Components for Space Application.
- No. 20500, External Visual Inspection.
- No. 20600, Preservation, Packaging and Dispatch of ESCC Components.
- No. 21300, Terms, Definitions, Abbreviations, Symbols and Units.
- No. 21700, General Requirements for the Marking of ESCC Components.
- No. 22600, Requirements for the Evaluation of Standard Electronic Components for Space Application
- No. 22800, ESCC Non-Conformance Control System.
- No. 22900, Total Dose Steady-State Irradiation Test Method
- No. 23100, Recommendations on the use of the ESCC Specification System for the Evaluation and Procurement of Unqualified Components.
- No. 24600, Minimum Quality System Requirements
- No. 24800, Resistance to Solvents of Marking, Materials and Finishes
- No. 25400, Requirements for the Technology Flow Qualification of Electronic Components for Space Application

For qualification and qualification maintenance or procurement of qualified components, with the exception of ESCC Basic Specifications Nos. 20100, 21700, 22800, 24600 and 25400, where Manufacturers' specifications are equivalent to, or more stringent than, the ESCC Basic Specifications listed above, they may be used in place of the latter, subject to the approval of the ESCC Executive.

Such replacements shall be clearly identified in the applicable Process Identification Document (PID). For procurement of unqualified components, where Manufacturers' specifications are equivalent to or more stringent than the ESCC Basic Specifications listed above, they may be used in place of the latter subject to the approval of the Orderer.

Such replacements may be listed in an appendix to the appropriate Detail Specification at the request of the Manufacturer or Orderer, subject to the approval of the ESCC Executive.

Unless otherwise stated herein, references within the text of this specification to "the Detail Specification" shall mean the relevant ESCC Detail Specification.

2.2 OTHER (REFERENCE) DOCUMENTS

- IEC 60050, International Electrotechnical Vocabulary (IEV)
- IEC 60068 Part 2, International Standard: Basic Environmental Testing Procedures.
- IEC 61300, International Standard: Fibre Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedures.
- IEC 61931, International Standard: Fibre Optic – Terminology.
- TIA 455, Telecommunications Industry Association: Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices

2.3 ORDER OF PRECEDENCE

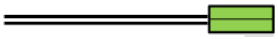
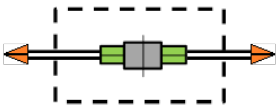
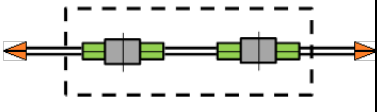
For the purpose of interpretation and in case of conflict with regard to documentation, the following order of precedence shall apply:

(a) ESCC Detail Specification
(b) ESCC Generic Specification
(c) ESCC Basic Specification
(d) Other documents, if referenced herein

3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

The terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply.

In addition, for the purposes of this specification, the following definitions shall apply:

Name	Description	Icon
optical fibre cable assembly	An optical fibre cable assembly shall include a length of optical fibre or cable terminated by an optical connector either at one end or at both ends in order to achieve an optical interconnect function. The connectors' ferrule shall be single fibre based.	-
fibre optic connector set	The complete set of connector components required to provide demountable coupling between one or more pairs of optical fibres (as in IEC 61931 2.6.86).	-
optical (fibre) connector	A component normally attached to an optical fibre or cable, or a piece of apparatus, for the purpose of providing frequent optical interconnection/disconnection (as in IEC 61931 2.6.1). Note 1: This is a male component. Note 2: This is an assembled version of the connector set.	
mating adapter	Female component in which two optical connectors are inserted and aligned (adapted from IEC 61931 2.6.4).	
optical fibre	A filament shaped waveguide made of dielectric materials for guiding optical waves (as in IEV 151-12-35). Note: includes a primary coating as necessary for safe handling.	
optical (fibre) cable	An assembly comprising one optical fibre inside buffer/coating layer(s) designed to protect the fibre from mechanical stresses and other environmental influences while retaining the transmission quality of the fibres (adapted from IEV 731-04-01).	
pigtail	A length of optical fibre or cable terminated by an optical connector at one end.	
patchcord	A length of optical fibre or cable, terminated at both ends with identical optical connectors (adapted from IEC 61931 2.6.15).	
hybrid patchcord	A patchcord terminated with 2 different optical connector types, one being the connector to be tested.	
hybrid patchcord VF	A patchcord terminated with 2 different optical connector types, one being the connector to be tested, with a vacuum feedthrough (VF).	
single connector test assembly	Two hybrid patchcords connected together by means of a mating adapter. Note 1: when being tested within an environmental volume, the extremities of the hybrid patchcords are outside of the volume. Note 2: Both connectors mated to the mating adapter are considered to be under test. In tests where only one connector is tested, it is assumed that the other is similarly tested sequentially. Note 3: For the purposes of Static Side Load and Optical Fibre/Cable Retention testing during Chart F4, the connector test assembly shall have 30cm of free optical fibre/cable length.	
double connector test assembly	A patchcord connected, on each side, to two hybrid patchcords by means of two mating adapters. Note: when being tested within an environmental volume, the patchcord, the two mating adapters and one end of each hybrid patchcord are inside the volume.	

4 REQUIREMENTS

4.1 GENERAL

The test requirements for the qualification of a component shall be in accordance with ESCC Basic Specification No. 20100.

The requirements for Technology Flow Qualification and the listing of qualified component types shall be in accordance with ESCC Basic Specification No. 25400.

The test requirements for procurement of both qualified and unqualified components (see Chart F1) shall comprise:

- Optical Fibre/Cable Lot Acceptance
- Special In-Process Controls
- Screening Tests
- Periodic Testing (for qualified components only)
- Lot Validation Testing if stipulated in the Purchase Order

4.1.1 Specifications

For qualification, qualification maintenance, procurement and delivery of components in conformity with this specification, the applicable specifications listed in Section 2 of this document shall apply in total unless otherwise specified herein or in the Detail Specification.

4.1.2 Conditions and Methods of Test

The conditions and methods of test shall be in accordance with this specification, the ESCC Basic Specifications referenced herein and the Detail Specification.

4.1.3 Manufacturer's Responsibility for Performance of Tests and Inspections

The Manufacturer shall be responsible for the performance of tests and inspections required by the applicable specifications. These tests and inspections shall be performed at the plant of the Manufacturer of the components unless it is agreed by the ESCC Executive (for qualification, qualification maintenance, or procurement of qualified components) or the Orderer (for procurement of unqualified components), to use an approved external facility.

4.1.4 Inspection Rights

The ESCC Executive (for qualification, qualification maintenance, or procurement of qualified components) or the Orderer (for procurement of unqualified components if stipulated in the Purchase Order) reserves the right to monitor any of the tests and inspections scheduled in the applicable specifications.

4.1.5 Final Customer Source Inspection

If stipulated in the Purchase Order, the Orderer may perform a source inspection at the Manufacturer's facility at the end of Screening or during Lot Validation Testing, if applicable (e.g. witness of final Room Temperature Optical and Geometrical Measurements, performance of External Visual Inspection, review of the data documentation package). Details of the inspections to be performed or witnessed and the required period of notification shall be as stipulated in the Purchase Order.

4.2 QUALIFICATION AND QUALIFICATION MAINTENANCE REQUIREMENTS ON A MANUFACTURER

To obtain and maintain the qualification of a component, or family of components, a Manufacturer shall satisfy the requirements of ESCC Basic Specification No. 20100.

To obtain and maintain the qualification of a component produced using a qualified Technology Flow, a Manufacturer shall satisfy the requirements of ESCC Basic Specification No. 25400.

4.3 DELIVERABLE COMPONENTS

4.3.1 ESCC Qualified Components

Components delivered to this specification shall be processed and inspected in accordance with the relevant Process Identification Document (PID).

4.3.2 ESCC Components

Each component, irrespective of qualification status, identified with an ESCC component number and delivered to this specification shall:

- be traceable to its production lot.
- have satisfactorily completed all the tests required by the relevant issues of the applicable specifications.
- be produced from lots that are considered by the Manufacturer to be capable of passing all applicable tests, and sequences of tests, that are defined in Chart F4. The Manufacturer shall not knowingly supply components that cannot meet this requirement. In the event that, subsequent to delivery and prior to operational use, a component is found to be in a condition such that, demonstrably, it could not have passed these tests at the time of manufacture, this shall be grounds for rejection of the delivered lot.

4.3.3 Lot Failure

Lot failure may occur during Screening Tests (Chart F3), or Qualification, Periodic Testing and Lot Validation Testing (Chart F4).

Should such failure occur during qualification, qualification maintenance or procurement of qualified components, the Manufacturer shall initiate the non-conformance procedure in accordance with ESCC Basic Specification No. 22800. The Manufacturer shall notify the Orderer and the ESCC Executive by any appropriate written means, within 5 working days, giving details of the number and mode of failure and the suspected cause. No further testing or analysis shall be performed on the failed components until so instructed by the ESCC Executive.

Should such failure occur during procurement of unqualified components, the Manufacturer shall notify the Orderer by any appropriate written means within 5 working days, giving details of the number and mode of failure and the suspected cause. No further testing or analysis shall be performed on the failed components until so instructed by the Orderer. The Orderer shall inform the Manufacturer within 5 working days of receipt of notification what action shall be taken.

4.4 MARKING

All components procured and delivered to this specification shall be marked in accordance with ESCC Basic Specification No. 21700.

4.5 MATERIALS AND FINISHES

Specific requirements for materials and finishes are specified in the Detail Specification. Where a definite material or finish is not specified, a material or finish shall be used so as to ensure that the component meets the performance requirements of this specification and the Detail Specification. Acceptance or approval of any constituent material or finish does not guarantee acceptance of the finished product.

All materials and finishes of the components specified in the Detail specification shall comply with the restrictions on materials specified in ESCC Basic Specification No. 22600.

4.5.1 Optical Fibre/Cable

The optical fibre/cable type used in the optical fibre cable assemblies shall be as specified in the Detail Specification.

For ESCC qualified optical fibre cable assemblies, the requirements for selection and procurement of the optical fibre/cable used in their manufacture shall be as defined in the PID as approved by the ESCC Executive.

For unqualified optical fibre cable assemblies, the requirements for selection and procurement of the optical fibre/cable used in their manufacture shall be approved by the Orderer.

The optical fibre cable assembly Manufacturer shall assure that the selected supplier(s) of the optical fibre/cable are compliant with the requirements of:

- this ESCC Generic Specification
- the optical fibre cable assembly Detail Specification
- for qualified optical fibre cable assemblies, the PID,
- for unqualified optical fibre cable assemblies, the applicable requirements approved by the Orderer

The optical fibre/cable shall meet the outgassing requirements of ESCC Basic Specification No. 22600.

5 PRODUCTION CONTROL

5.1 GENERAL

Unless otherwise specified, all lots of components used for qualification and qualification maintenance, Lot Validation Testing and for delivery shall be subject to tests and inspections in accordance with Chart F2 in the sequence shown.

Any components which do not meet these requirements shall be rejected and at no future time be resubmitted to the requirements of this specification.

The applicable test requirements are detailed in the paragraphs referenced in Chart F2.

For qualified components, the full production control provisions are defined in the PID.

5.1.1 Rework

Rework may be performed at any time during Chart F2 subject to the rework procedure having been agreed with the ESCC Executive (for qualification, qualification maintenance, or procurement of qualified components) or the Orderer (for procurement of unqualified components).

For qualified components, all rework processes shall have been fully specified, documented and qualified by the Manufacturer, and shall be listed in the PID.

5.2 OPTICAL FIBRE/CABLE LOT ACCEPTANCE

Prior to assembly, each optical fibre/cable lot shall be subjected to optical fibre/cable lot acceptance as follows.

5.2.1 Optical Fibre/Cable Procurement and Process Control

The Manufacturer shall verify correct procurement of the optical fibre/cable, including traceability details, in accordance with the requirements of this ESCC Generic Specification, the Detail Specification and, for qualified assemblies, the PID.

The outgassing performance characteristics for the optical fibre/cable lot shall be verified and recorded.

5.2.2 Optical Fibre/Cable Total Dose Radiation Testing

Unless otherwise specified, components shall be produced from an optical fibre/cable lot which has been subjected to and successfully completed testing in accordance with Para. 8.1.

5.2.3 Documentation

Documentation of Optical Fibre/Cable Lot Acceptance shall be in accordance with Para. 9.5.

5.3 SPECIAL IN-PROCESS CONTROLS

5.3.1 Pre-Assembly Visual Inspection

Prior to assembly, the various component piece parts shall be visually inspected in accordance with Para. 8.2.

5.3.2 Dimension Check

Dimension Check shall be performed in accordance with Para. 8.3 on a sample of 3 components. In the event of any failure, a 100% Dimension Check shall be performed.

5.3.3 Weight

The weight shall be measured on a sample of 3 components and meet the requirements of the Detail Specification. In the event of any failure a 100% measurement shall be performed.

5.4 DOCUMENTATION

Documentation of Special In-Process Controls shall be in accordance with Para. 9.6.

6 SCREENING TESTS

6.1 GENERAL

Unless otherwise specified, all lots of components used for qualification and qualification maintenance, Lot Validation Testing, and for delivery, shall be subjected to tests and inspections in accordance with Chart F3 in the sequence shown.

All components shall be serialised prior to the tests and inspections.

Any components which do not meet these requirements shall be removed from the lot and at no future time be resubmitted to the requirements of this specification.

The applicable test methods and conditions are specified in the paragraphs referenced in Chart F3.

6.2 FAILURE CRITERIA

6.2.1 Environmental and Mechanical Test Failure

The following shall be counted as component failures:

- Components which fail during tests for which the pass/fail criteria are inherent in the test method, e.g. Temperature Cycling, Sinusoidal Vibration, Optical Fibre/Cable Retention, External Visual Inspection.

6.2.2 Parameter Drift Failure

The acceptable change limits are shown in Parameter Drift Values in the Detail Specification. A component shall be counted as a parameter drift failure if the changes during Screening Tests are larger than the drift values (Δ) specified.

6.2.3 Parameter Limit Failure

A component shall be counted as a limit failure if one or more parameters exceed the limits shown in Room Temperature Optical and Geometrical Measurements in the Detail Specification.

Any component which exhibits a limit failure prior to the submission to Temperature Cycling shall be rejected and not counted when determining lot rejection.

6.2.4 Other Failures

A component shall be counted as a failure in any of the following cases:

- Visual failure.
- Mechanical failure.
- Handling failure.
- Lost component.

6.3 FAILED COMPONENTS

A component shall be considered as a failed component if it exhibits one or more of the failure modes described in Para. 6.2.

6.4 LOT FAILURE

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.3.

6.4.1 Lot Failure During 100% Testing

If the number of components failed on the basis of the failure criteria specified in Para. 6.2, subsequent to Parameter Drift Values (Initial Measurements), exceeds 10% (rounded upwards to the nearest whole number) of the components submitted to Temperature Cycling of Chart F3, the lot shall be considered as failed.

If a lot is composed of groups of components of one family defined in one ESCC Detail Specification, but separately identifiable for any reason, then the lot failure criteria shall apply separately to each identifiable group.

6.4.2 Lot Failure during Sample Testing

A lot shall be considered as failed if the number of allowable failures during sample testing, if specified in the Detail Specification, is exceeded.

Unless otherwise specified, if a lot failure occurs, a 100% testing may be performed but the cumulative percent defective shall not exceed that specified in Para. 6.4.1.

6.5 DOCUMENTATION

Documentation of Screening Tests shall be in accordance with Para. 9.7.

7 QUALIFICATION, QUALIFICATION MAINTENANCE AND LOT VALIDATION TESTING

The requirements of this paragraph are applicable to the tests performed on components or test structures as part of qualification or qualification maintenance in accordance with either ESCC Basic Specification No. 20100 or 25400 as applicable. They are also applicable to Lot Validation Testing as part of the procurement of qualified or unqualified components.

7.1 QUALIFICATION TESTING

7.1.1 General

Qualification Testing shall be in accordance with the requirements specified in Chart F4. Unless otherwise specified the tests of Chart F4 shall be performed on the specified sample chosen at random from components which have successfully passed the tests in Chart F3. This sample constitutes the Qualification Test Lot.

The Qualification Test Lot is divided into subgroups of tests and unless otherwise specified all components or test structures assigned to a subgroup shall be subjected to all of the tests in that subgroup, in the sequence shown. The applicable test requirements are detailed in the paragraphs referenced in Chart F4.

The conditions governing Qualification Testing are specified in ESCC Basic Specification No. 20100.

7.1.2 Distribution within the Qualification Test Lot

Where a Detail Specification covers a range, or series of components that are considered similar, then the Qualification Test Lot shall be comprised of component types so selected that they adequately represent all of the various mechanical, structural, and Optical and Geometrical peculiarities of that range or series.

The distribution shall be as specified by, or agreed with, the ESCC Executive.

7.2 QUALIFICATION WITHIN A TECHNOLOGY FLOW

The qualification of a component produced using a qualified Technology Flow shall be in accordance with ESCC Basic Specification No. 25400.

7.3 QUALIFICATION MAINTENANCE (PERIODIC TESTING)

Qualification is maintained through Periodic Testing and the test requirements of Para. 7.1 shall apply. For each subgroup, the sample size, the test requirements and the period between successive subgroup testing shall be as specified in Chart F4. The conditions governing qualification maintenance are specified in ESCC Basic Specification No. 20100.

Qualification of a component, produced using a qualified Technology Flow, is maintained by maintenance of the Technology Flow Qualification itself in accordance with ESCC Basic Specification No. 25400.

7.4 LOT VALIDATION TESTING

For procurement of qualified Components, Lot Validation Testing is not required and shall only be performed if specifically stipulated in the Purchase Order.

For procurement of unqualified components, the need for Lot Validation Testing shall be determined by the Orderer (ref. ESCC Basic Specification No. 23100). When Lot Validation Testing is required, it shall consist of the performance of one or more of the tests or subgroup test sequences of Chart F4. The testing to be performed and the sample size shall be as stipulated in the Purchase Order.

When procurement of more than one component type is involved from a family, range or series, the selection of representative samples shall also be stipulated in the Purchase Order.

7.5 FAILURE CRITERIA

The following criteria shall apply to Qualification, Periodic Testing and Lot Validation Testing.

7.5.1 Environmental and Mechanical Test Failure

The following shall be counted as component failures:

- Components which fail during tests for which the pass/fail criteria are inherent in the test method, e.g. Random Vibration, Torsion, etc.

7.5.2 Optical and Geometrical Failure

The following shall be counted as component failures:

- Components which fail one or more of the applicable limits at each of the relevant data points specified for testing, in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

7.5.3 Other Failures

A component shall be counted as a failure in any of the following cases:

- Visual failure.
- Mechanical failure.
- Handling failure.
- Lost component.

7.6 FAILED COMPONENTS

A component shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 7.5.

When requested by the ESCC Executive (for qualification, qualification maintenance or procurement of qualified components) or the Orderer (for procurement of qualified or unqualified components), failure analysis of failed components shall be performed under the responsibility of the Manufacturer and the results provided.

Failed components shall be retained at the Manufacturer's plant until the final disposition has been agreed and certified.

7.7 LOT FAILURE

For qualification and qualification maintenance, the lot shall be considered as failed if one component in any subgroup of Chart F4 is a failed component based on the criteria specified in Para. 7.5.

For procurement, the lot shall be considered as failed if one component in any test specified for Lot Validation Testing is a failed component based on the criteria specified in Para. 7.5.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.3.

7.8 QUALIFICATION, PERIODIC TESTING AND LOT VALIDATION TESTING SAMPLES

All tests of Chart F4 are considered to be destructive and therefore components so tested shall not form part of the delivery lot.

7.8.1 Test Structures for Qualification, Periodic Testing and Lot Validation Testing (Chart F4)

Unless otherwise specified, testing during Chart F4 shall be performed on specific optical fibre cable assembly test structures based on the components specified in the Detail Specification. The configuration type and quantity of each test structure to be used for each subgroup shall be as specified in Chart F4.

7.9 DOCUMENTATION

Documentation of Qualification, Periodic Testing and Lot Validation Testing shall be in accordance with Para. 9.8.

8 TEST METHODS AND PROCEDURES

If a Manufacturer elects to eliminate or modify a test method or procedure, the Manufacturer is still responsible for delivering components that meet all of the performance, quality and reliability requirements defined in this specification and the Detail Specification.

For a qualified component, documentation supporting the change shall be approved by the ESCC Executive and retained by the Manufacturer. It shall be copied, when requested, to the ESCC Executive. The change shall be specified in an appendix to the Detail Specification and in the PID.

For an unqualified component, the change shall be approved by the Orderer. The change may be specified in an appendix to the Detail Specification at the request of the Manufacturer or Orderer, subject to the approval of the ESCC Executive.

8.1 OPTICAL FIBRE/CABLE TOTAL DOSE RADIATION TESTING

The optical fibre/cable used in the optical fibre cable assemblies shall be tested in accordance with ESCC Basic Specification No. 22900 with the following conditions:

- Test Sample: a single length of 100m of optical fibre/cable from the optical fibre/cable lot.
- Total Dose Radiation Level: 1Mrad(Si).

8.2 PRE-ASSEMBLY VISUAL INSPECTION

Prior to assembly, the various component piece parts shall be inspected in accordance with the requirements of IEC 61300-3-1.

8.3 DIMENSION CHECK

Dimension Check (during Special In-Process Controls only) shall be performed in accordance with ESCC Basic Specification No. 20500 and the Detail Specification on a sample of 3 components. In the event of any failure a 100% Dimension Check shall be performed.

8.4 OPTICAL CONNECTOR END-FACE VISUAL INSPECTION

Optical Connector End-face Visual Inspection is only applicable to components with optical fibre/cable as specified in the Detail Specification.

Optical Connector End-face Visual Inspection shall be performed in accordance with IEC 61300-3-35. Acceptance criteria shall be limited to inspection of zones A (the optical fibre core) and B (the optical fibre cladding).

If necessary, the end-face surface may be cleaned using an appropriate method. For qualified components, the cleaning method shall be specified in the PID.

8.5 EXTERNAL VISUAL INSPECTION

External Visual Inspection of the optical fibre connector assembly shall be performed in accordance with ESCC Basic Specification No. 20500. External Visual Inspection shall exclude inspection of the optical connector end-face.

8.6 OPTICAL AND GEOMETRICAL MEASUREMENTS

8.6.1 General

Optical and geometrical measurements and inspections shall be as follows.

8.6.1.1 Insertion Loss (Attenuation)

Insertion loss shall be measured on the component in accordance with IEC 61300-3-4. Test conditions and limits shall be as specified in the Detail Specification.

When Variation of Insertion Loss is required to be measured, it shall be measured on the component in accordance with IEC 61300-3-3. Test conditions and limits shall be as specified in the Detail Specification.

8.6.1.2 Transient Loss

Transient loss during testing shall be measured on the component in accordance with IEC 61300-3-28. Test conditions and limits shall be as specified in the Detail Specification. Unless otherwise specified in the Detail Specification, the following additional test conditions shall apply:

- Minimum bandwidth: 2kHz
- Detectable Optical Discontinuity: 500µs
- Trigger Level: 0.5dB approximately.

8.6.1.3 Return Loss

Return loss shall be measured on the component in accordance with IEC 61300-3-6. Test conditions and limits shall be as specified in the Detail Specification.

8.6.1.4 Polarization Extinction Ratio

Only applicable to components with polarization-maintaining optical fibre/cable as specified in the Detail Specification.

Polarization Extinction Ratio shall be measured on the component in accordance with TIA 455-193. Test conditions and limits shall be as specified in the Detail Specification.

8.6.1.5 End-Face Geometry

End-face geometry shall be measured on the component as follows:

- Apex Offset: in accordance with measurement of dome eccentricity per IEC 61300-3-47. Measurement limits shall be as specified in the Detail Specification.
- Radius of Curvature: in accordance with IEC 61300-3-47. Measurement limits shall be as specified in the Detail Specification.
- Optical Fibre Protrusion (only applicable to components with optical fibre/cable as specified in the Detail Specification): in accordance with measurements of optical fibre height per IEC 61300-3-47. Measurement limits shall be as specified in the Detail Specification.

8.6.2 Room Temperature Optical and Geometrical Measurements

Room Temperature Optical and Geometrical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against serial numbers.

8.6.3 Parameter Drift Values

At each of the relevant data points during Screening Tests (Chart F3), Parameter Drift Values shall be measured as specified in the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated.

8.6.4 Intermediate and End-Point Optical and Geometrical Measurements

At each of the relevant data points during Qualification, Periodic Testing and Lot Validation Testing (Chart F4), Intermediate and End-Point Optical and Geometrical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated, if specified.

8.7 TEMPERATURE CYCLING

IEC 61300-2-22 with the following conditions:

(a) During Screening Tests (Chart F3):

- Mounting: Unmated
- Non-operating
- Temperature extremes: between minimum operating temperature (+3 -0)°C and maximum operating temperature (+0 -3)°C as specified in Maximum Ratings in the Detail Specification.
- Dwell time at temperature extremes: 1 hour
- Temperature gradient: 1°C/minute, unless otherwise specified in the Detail Specification.
- Number of cycles: 12
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

(b) During Qualification, Periodic Testing and Lot Validation Testing (Chart F4):

- Mounting: Both mating adapters shall be secured to mounting fixtures using their normal mounting provisions. The thermal conduction of the mounting shall be low such that the test structure can be considered thermally isolated.
- Test structures shall be active during the test.
- Temperature extremes: between minimum operating temperature (+3 -0)°C and maximum operating temperature (+0 -3)°C as specified in Maximum Ratings in the Detail Specification.
- Dwell time at temperature extremes: 1 hour
- Temperature gradient: 1°C/minute, unless otherwise specified in the Detail Specification.
- Number of cycles: 100
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.8 SINUSOIDAL VIBRATION

Only applicable if specified in the Detail Specification.

IEC 61300-2-1 with the following conditions:

- Frequency range: 10Hz to 2000Hz
- Amplitude:
  - from 10Hz to 81.3Hz = 0.75mm (p-p)
  - from 81.3Hz to 2000Hz = 10g
- Rate: 1 Octave/minute
- Axis: Z and Y
- Cycles: 1 in each axis
- Duration 15 minutes in each axis
- Mounting: Mated, fixed using normal mounting provisions.
- Non-operating
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

8.9 OPTICAL FIBRE/CABLE RETENTION

IEC 61300-2-4 with the following conditions:

(a) During Screening Tests (Chart F3):

- Mounting: Mated, fixed using normal mounting provisions.
- Non-operating.
- Applied load and duration: 5N for 2 minutes along the connector longitudinal axis.
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

(b) During Qualification, Periodic Testing and Lot Validation Testing (Chart F4):

- Mounting: Using normal mounting provisions.
- Test structures shall be active during the test.
- Applied load and duration: 5N for 2 minutes along the connector longitudinal axis.
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.10 HIGH-POWER BURN-IN

Only applicable to High-Power components as specified in the Detail specification.

High-Power Burn-in shall be performed as follows:

- Mounting: Mated, fixed using normal mounting provisions
- Test structures shall be active during the test.
- Test Temperature: T_{amb} = +23 ±3°C
- Power applied: Maximum Rated Power (as applicable at Test Temperature) at the Nominal Operating Wavelength as specified in the Detail Specification
- Duration: 30 minutes minimum
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

8.11 HUMIDITY CYCLING

IEC 61300-2-46 with the following conditions:

- Mounting: Both mating adapters shall be secured to mounting fixtures using their normal mounting provisions.
- Test structures shall be active during the test.
- Temperature extremes: between T_{min} = +25°C and T_{max} = +55°C.
- Dwell time at temperature extremes: 9 hours
- Temperature gradient: 10°C/hour
- Relative humidity: 95%
- Number of cycles: 6
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.12 RANDOM VIBRATION

IEC 60068-2-64 with the following conditions:

- Mounting: Using normal mounting provisions.
- Test structures shall be active during the test.
- Frequency range: 20Hz to 2000Hz
- Acceleration level: 35g rms
- Shape of acceleration spectral density curve:
  - From 20Hz to 100Hz, power spectral density (PSD) changing by +3dB/Octave
  - From 100Hz to 300Hz, PSD constant at $2.2g^2/Hz$
  - From 300Hz to 2000Hz, PSD changing by -5dB/Octave
- Axis: X, Y and Z
- Duration: 7.5 minutes in each axis
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing and Transient Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.13 MECHANICAL SHOCK

IEC 60068-2-27 with the following conditions:

- Mounting: Using normal mounting provisions.
- Test structures shall be active during the test.
- Pulse shape: Half-sinus
- Peak Acceleration: 500g
- Duration: 2ms
- Axis: X1, Y1 and Z1
- Number of shocks: 3 in each axis (9 total)
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing and Transient Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.14 TORSION

IEC 61300-2-5 with the following conditions:

- Mounting: As specified in IEC 61300-2-5, unless otherwise specified in the Detail Specification.
- Test structures shall be active during the test.
- Tensile load: 3N along connector longitudinal axis.
- Twist angle (1 cycle): ±180°
- Number of twist cycles: 25
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.15 STATIC SIDE LOAD

IEC 61300-2-42 with the following conditions:

- Mounting: Using normal mounting provisions.
- Test structures shall be active during the test.
- Applied load and duration:
  - For connector test assemblies with optical fibre: 0.2N for 1 hour at 90° to the connector longitudinal axis.
  - For connector test assemblies with optical cable: 5N for 1 hour at 90° to the connector longitudinal axis.
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.16 PERMANENCE OF MARKING

ESCC Basic Specification No. 24800.

8.17 HIGH TEMPERATURE STORAGE

IEC 61300-2-18 with the following conditions:

- Mounting: Unmated.
- Test structures shall not be active during the test.
- Test temperature: Maximum storage temperature (+0 -3)°C as specified in Maximum Ratings in the Detail Specification.
- Duration: 1000 hours.
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.18 MATING DURABILITY

IEC 61300-2-2 method A with the following conditions:

- Mounting: The mating adapter is secured using its normal mounting provisions to a rigid mounting fixture.
- Test structures shall be active during the test.
- Number of mating/de-mating cycles: 100 (manual on one side)
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

8.19 HIGH-POWER THERMAL VACUUM

Only applicable to High-Power components as specified in the Detail specification.

High-Power Thermal Vacuum shall be performed as follows:

- Mounting: Mated, fixed using normal mounting provisions
- Test structures shall be active during the test.
- Pressure: ≤ 1 mPa using suitable vacuum feedthroughs
- Test Temperature: Maximum Operating Temperature as specified in the Detail Specification
- Power applied: Maximum Rated Power (as applicable at Test Temperature) at the Nominal Operating Wavelength as specified in the Detail Specification
- Duration: 1000 hours minimum
- Data Points:
  On completion of testing, the components shall be visually examined. There shall be no evidence of damage.

  Optical Connector End-face Visual Inspection in accordance with Para. 8.4 shall be performed both before and after the test.

  Variation of Insertion Loss during testing shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification.

  Insertion Loss, Return Loss, Polarization Extinction Ratio and End-face Geometry shall be measured as specified in Intermediate and End-Point Optical and Geometrical Measurements in the Detail Specification both before and after the test.

9 DATA DOCUMENTATION

9.1 GENERAL

For the qualification, qualification maintenance and procurement for each lot, a data documentation package shall exist in a printed or electronic form.

This package shall be compiled from:

(a) Cover sheet (or sheets).
(b) List of equipment (testing and measuring).
(c) List of test references.
(d) Optical Fibre/Cable Lot Acceptance data (Chart F2)
(e) Special In-Process Controls data (Chart F2).
(f) Screening Tests data (Chart F3).
(g) Qualification, Periodic Testing and Lot Validation Testing (when applicable) data (Chart F4).
(h) Failed components list and failure analysis report (when applicable).
(i) Certificate of Conformity.

Items (a) to (i) inclusive shall be grouped, preferably as subpackages and, for identification purposes, each page shall include the following information:

- ESCC Component Number.
- Manufacturer's name.
- Lot identification.
- Date of establishment of the document.
- Page number.

Whenever possible, documentation should preferably be available in electronic format suitable for reading using a compatible PC. The format supplied shall be legible, durable and indexed. The preferred storage medium is CD-ROM and the preferred file format is PDF.

9.1.2 Qualification and Qualification Maintenance

In the case of qualification or qualification maintenance, the items listed in Para. 9.1(a) to (i) are required.

9.1.3 Component Procurement and Delivery

For all deliveries of components procured to this specification, the following documentation shall be supplied:

(a) Cover sheet (if all of the information is not included on the Certificate of Conformity).
(b) Certificate of Conformity (including range of delivered serial numbers).

9.1.4 Additional Documentation

The Manufacturer shall deliver additional documentation containing data and reports to the Orderer, if stipulated in the Purchase Order.

9.1.5 Data Retention/Data Access

If not delivered, all data shall be retained by the Manufacturer for a minimum of 5 years during which time it shall be available for review, if requested, by the Orderer or the ESCC Executive (for qualified components).

9.2 COVER SHEET(S)

The cover sheet(s) of the data documentation package shall include as a minimum:

(a) Reference to the Detail Specification, including issue and date.
(b) Reference to the applicable ESCC Generic Specification, including issue and date.
(c) ESCC Component Number and the Manufacturer's part type number.
(d) Lot identification.
(e) Range of delivered serial numbers.
(f) Number of the Purchase Order.
(g) Information relative to any additions to this specification and/or the Detail Specification.
(h) Manufacturer's name and address.
(i) Location of the manufacturing plant (specify place of manufacture and test).
(j) Signature on behalf of Manufacturer.
(k) Total number of pages of the data package.

9.3 LIST OF EQUIPMENT USED

A list of equipment used for tests and measurements shall be prepared. Where applicable, this list shall contain inventory number, Manufacturer's type number, serial number, etc. This list shall indicate for which tests such equipment was used.

9.4 LIST OF TEST REFERENCES

This list shall include all Manufacturer's references or codes which are necessary to correlate the test data provided with the applicable tests specified in the tables of the Detail Specification.

9.5 OPTICAL FIBRE/CABLE LOT ACCEPTANCE DATA (CHART F2)

A summary of the results of procurement of the optical fibre/cable lot (with reference to traceability information) shall be compiled and shall provide the following information:

- Optical fibre/cable type reference
- Optical fibre/cable supplier name and location
- Optical fibre/cable lot identification and date code
- Optical fibre/cable procurement specification(s)
- Optical fibre/cable certificate of conformity

In addition, a summary of the outgassing performance characteristics shall be included in the documentation, traceable to the optical fibre/cable lot.

In addition, a total dose radiation test report for the optical fibre/cable lot shall be prepared in accordance with the requirements of ESCC Basic Specification No. 22900 and included in the documentation.

9.6 SPECIAL IN-PROCESS CONTROLS DATA (CHART F2)

A test result summary shall be compiled showing the total number of components submitted to, and the total number rejected after each of the tests.

9.7 SCREENING TESTS DATA (CHART F3)

A test result summary shall be compiled showing the total number of components submitted to and the total number rejected after each of the tests. For each test requiring optical and geometrical measurements, the results shall be recorded against component serial number. Component drift calculations shall be recorded for each specified test against component serial number.

9.8 QUALIFICATION, PERIODIC TESTING AND LOT VALIDATION TESTING DATA (CHART F4)

9.8.1 Qualification Testing

A test result summary shall be compiled showing the components submitted to, and the number rejected after each test in each subgroup. Component serial numbers for each subgroup shall be identified. For each test requiring optical and geometrical measurements, the results shall be recorded against component serial number. Where a drift value is specified during a test, the drift calculation shall be recorded against component serial number.

9.8.2 Periodic Testing for Qualification Maintenance

A test result summary shall be compiled showing the components submitted to and the number rejected after each test in each subgroup. Component serial numbers for each subgroup shall be identified. For each test requiring optical and geometrical measurements, the results shall be recorded against component serial number. Where a drift value is specified during a test, the drift calculation shall be recorded against component serial number.

In addition to the full test data, a report shall be compiled for each subgroup of Chart F4 (as applicable) to act as the most recent Periodic Testing summary. These reports shall include a list of all tests performed in each subgroup, the ESCC Component Numbers and quantities of components tested, a statement confirming all the results were satisfactory, the date the tests were performed and a reference to the full test data.

9.8.3 Lot Validation Testing

A test result summary shall be compiled showing the components submitted to and the number rejected after each test in each subgroup (as applicable). Component serial numbers for each subgroup shall be identified. For each test requiring optical and geometrical measurements, the results shall be recorded against component serial number. Where a drift value is specified during a test, the drift calculation shall be recorded against component serial number.

9.9 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT

The failed components list and failure analysis report shall provide full details of:

(a) The reference and description of the test or measurement performed as defined in this specification and/or the Detail Specification during Optical Fibre/Cable Lot Acceptance, Special In-Process Controls, Screening Tests, and Qualification, Periodic Testing and Lot Validation Testing.

(b) Traceability information including serial number (if applicable) of the failed component.

(c) The failed parameter and the failure mode of the component.

(d) Detailed failure analysis (if requested by the ESCC Executive or Orderer).

9.10 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established in accordance with the requirements of ESCC Basic Specification No. 20100 or 25400.

10 DELIVERY

For procurement, for each order, the items forming the delivery are:

(a) The delivery lot.

(b) The components used for Lot Validation Testing (as applicable), but not forming part of the delivery lot, if stipulated in the Purchase Order.

(c) The relevant documentation in accordance with the requirements of Paras. 9.1.3 and 9.1.4.

In the case of a component for which a valid qualification is in force, all data of all components submitted to Lot Validation Testing shall also be copied, when requested, to the ESCC Executive.

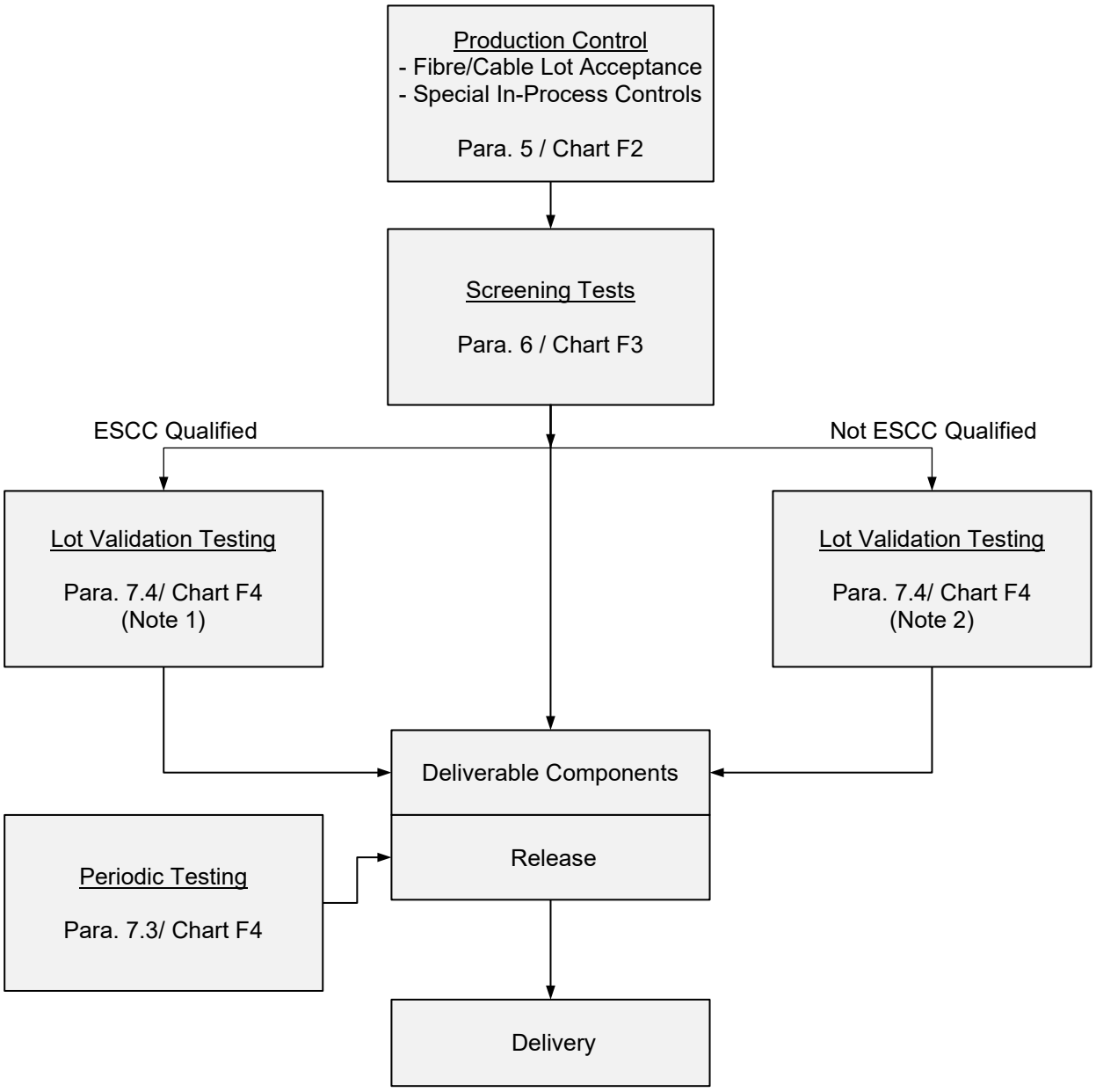
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification No. 20100 or 25400 and the relevant paragraphs of Section 9 of this specification.

11 PACKAGING AND DISPATCH

The packaging and dispatch of components to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 20600.

12 CHARTS

12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



NOTES:

1. Lot Validation Testing is not required for qualified components unless specifically stipulated in the Purchase Order.
2. For unqualified components, the need for Lot Validation Testing shall be determined by the Orderer and the required testing shall be as stipulated in the Purchase Order (Ref. ESCC Basic Specification No. 23100).

12.2 CHART F2 - PRODUCTION CONTROL

COMPONENT LOT MANUFACTURING	
FIBRE/CABLE LOT ACCEPTANCE	
Para. 5.2.1	Optical Fibre/Cable Procurement and Process Control
Para. 5.2.2	Optical Fibre/Cable Total Dose Radiation Testing (1)
SPECIAL IN-PROCESS CONTROLS	
Para. 5.3.1	Pre-Assembly Visual Inspection
-	Component Assembly
Para. 5.3.2	Dimension Check (1)
Para. 5.3.3	Weight (1)
TO CHART F3 – SCREENING TESTS	

NOTES:

1. Performed on a sample basis.

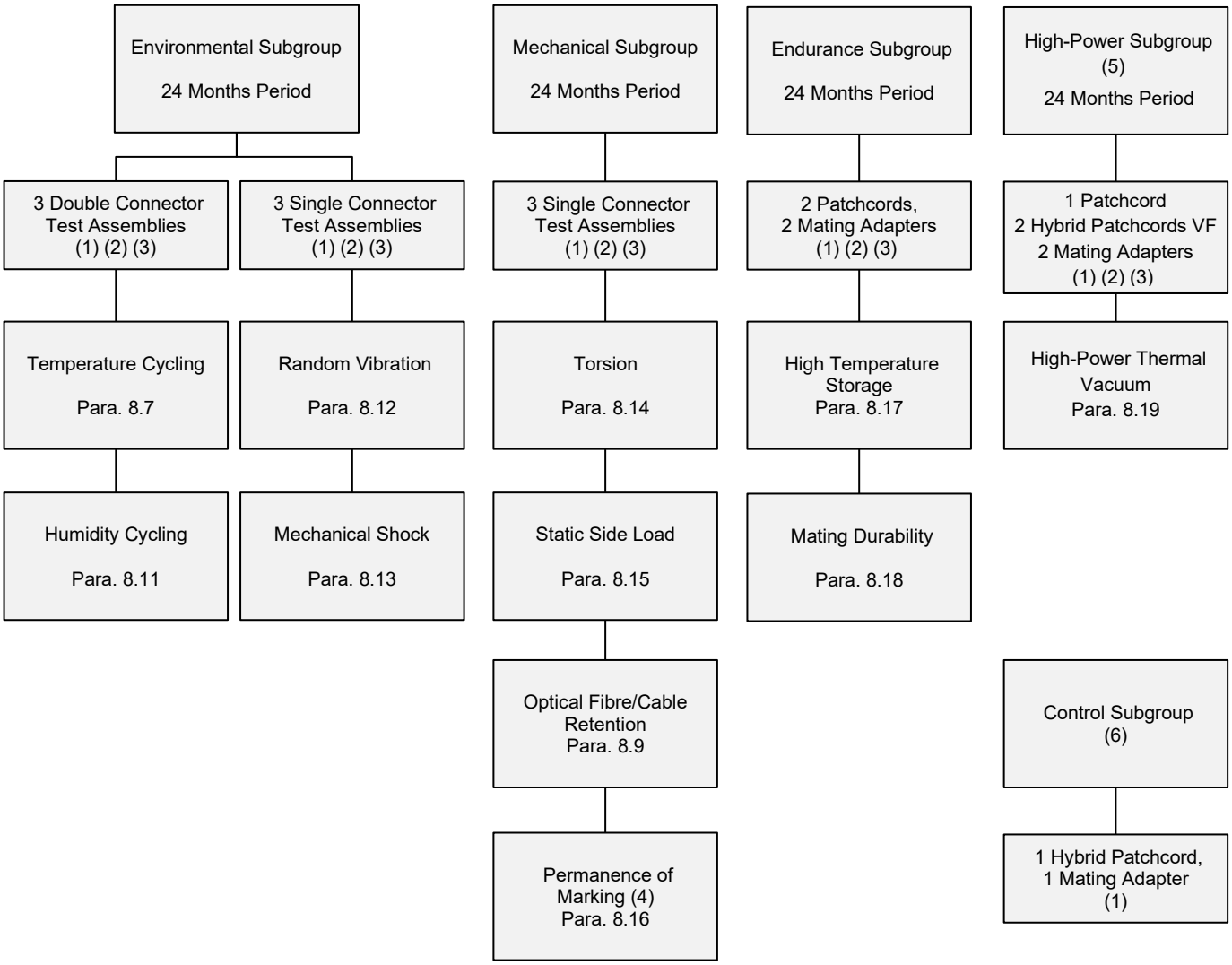
12.3 CHART F3 - SCREENING TESTS

COMPONENTS FROM PRODUCTION CONTROL	
Para. 6.1	Serialisation
Para. 8.4	Optical Connector End-face Visual Inspection
Para. 8.6.2	Room Temperature Optical and Geometrical Measurements
Para. 8.6.3	Parameter Drift Values (Initial Measurements) (1)
Para. 8.7	Temperature Cycling (2)
Para. 8.8	Sinusoidal Vibration (2) (3)
Para. 8.9	Optical Fibre/Cable Retention (2)
Para. 8.4	Optical Connector End-face Visual Inspection (2)
Para. 8.6.3	Parameter Drift Values (Final Measurements) (2)
Para. 8.6.2	Room Temperature Optical and Geometrical Measurements (2) (4)
Para. 8.6.3	Parameter Drift Values (Initial Measurements for High-Power Burn-in) (1) (2) (3) (5)
Para. 8.10	High-Power Burn-in (2) (3) (5)
Para. 8.4	Optical Connector End-face Visual Inspection (2) (3) (5)
Para. 8.6.3	Parameter Drift Values (Final Measurements for High-Power Burn-in) (2) (3) (5)
Para. 8.6.2	Room Temperature Optical and Geometrical Measurements (2) (3) (4) (5)
Para. 8.5	External Visual Inspection (2)
Para. 6.4	Check for Lot Failure (6)
TO CHART F4 WHEN APPLICABLE	

NOTES:

1. Measurements from the previous Room Temperature Optical and Geometrical Measurements may be used for Parameter Drift Values (Initial Measurements).
2. The lot failure criteria of Para. 6.4 apply to this test.
3. Only applicable if specified in the Detail Specification.
4. Measurements of Parameter Drift Values need not be repeated in Room Temperature Optical and Geometrical Measurements.
5. Only applicable to High-Power components as specified in the Detail Specification.
6. Check for Lot Failure shall take into account all failures that may occur during Screening Tests subsequent to Parameter Drift Values (Initial Measurements).

12.4 CHART F4 - QUALIFICATION, PERIODIC TESTING AND LOT VALIDATION TESTING



NOTES:

1. See Para. 3 for definition of test structures.
2. For distribution within the subgroups, see Para. 7.1.2 for Qualification Testing and Periodic Testing, and Para. 7.4 for Lot Validation Testing.
3. No failures are permitted.
4. Performed on one single connector test assembly selected from the 3 previously subjected to Optical Fibre/Cable Retention.
5. Only applicable to High-Power components as specified in the Detail Specification.
6. A control sample shall be used for reference purposes. Whenever optical or geometrical measurements are made on any component under test in any of the other subgroups, the control sample shall also be measured.