FUSES

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DCR No.	CHANGE DESCRIPTION
897	Specification upissued to incorporate editorial changes per DCR.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of fuses for space applications. This specification contains the appropriate inspection and test schedules and also specifies the data documentation requirements.

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 Qualification of Standard Electronic Components for Space Application.
- No. 20500, External Visual Inspection.
- No. 20600, Preservation, Packaging and Despatch of ESCC Components.
- No. 21300, Terms, Definitions, Abbreviations, Symbols and Units.
- No. 21700, General Requirements for the Marking of ESCC Components.
- No. 22800, ESCC Non-Conformance Control System.
- 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

- ESCC-Q-ST-70-02, Thermal Vacuum Test for the Screening of Space Materials.
- MIL-STD-202, Test Method Standard Electronic and Electrical Component Parts.
- IEC Publication No. 60068 Part 2, Basic Environmental Testing Procedures.

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.

4 REQUIREMENTS

4.1 GENERAL

The 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:

- 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.

4.2 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 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 Special In-Process Controls (Chart F2), Screening Tests (Chart F3) or Qualification and Periodic Tests (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 non-metallic materials and finishes of the components specified in the Detail Specification shall meet the outgassing requirements as outlined in ECSS-Q-ST-70-02.

5 PRODUCTION CONTROL

5.1 GENERAL

Unless otherwise specified herein or in the Detail Specification 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 removed from the lot 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.

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

5.2 SPECIAL IN-PROCESS CONTROLS

5.2.1 Dimension Check
Dimension Check shall be performed in accordance with Para. 8.2 on 3 samples only. In the event of any failure a 100% Dimension Check shall be performed.

5.2.2 Weight
The maximum weight of the component specified in the Detail Specification shall be guaranteed but not tested.

5.2.3 Cold Resistance
In accordance with Para. 8.1.1.1.

5.2.4 Resistance to Soldering Heat
In accordance with Para. 8.13 on a randomly selected sample of 20 surface mount fuses. No failures allowed.

5.2.5 Fusion Characterisation Tests

5.2.5.1 Leaded Fuses
In accordance with Para. 8.5 on a randomly selected sample of 20 fuses. No failures allowed.

5.2.5.2 Surface Mount Fuses
In accordance with Para. 8.5 on the samples used for Resistance to Soldering Heat. No failures allowed.

5.2.6 Documentation
Documentation of Special In-Process Controls shall be in accordance with Para. 9.5.

6 SCREENING TESTS

6.1 GENERAL
Unless otherwise specified herein or in the Detail Specification 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.

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, i.e. External Visual Inspection.

6.2.2 Parameter Limit Failure

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

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

6.2.3 Other Failures

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

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

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. 6.2.2 exceeds 5% (rounded upwards to the nearest whole number) of the components submitted to Burn-in in 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 as specified herein or 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. 9.6.

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

7.1 QUALIFICATION TESTING

7.1.1 General

Qualification testing shall be in accordance with the requirements specified in Chart F4. 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 all components 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 electrical 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 and the period between successive subgroup testing shall be as given 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 the 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, qualification maintenance and Lot Validation Testing.

7.5.1 Environmental and Mechanical Test Failures

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. Robustness of Terminations, Solderability, etc.

7.5.2 Electrical Failures

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 environmental, mechanical and endurance testing in Intermediate and End-Point Electrical 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 given 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 given in Para. 7.5.

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

7.8 QUALIFICATION, QUALIFICATION MAINTENANCE 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.

7.9 DOCUMENTATION
Documentation of qualification, qualification maintenance and Lot Validation Testing shall be in accordance with Para. 9.7.

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 ELECTRICAL MEASUREMENTS

8.1.1 General
Electrical measurements and methods shall be as follows.

8.1.1.1 Cold Resistance
Measurement of R (Cold Resistance) shall be made on the terminals of the fuse by using a 4-wire measurements device. The measurement current shall be ≤ 10% I_R (DC), where I_R is the rated current as defined in Maximum Ratings in the Detail Specification. The measurement accuracy shall be ±1% or better.

The Cold Resistance limits at +22 ±3 °C are given in Room Temperature Electrical Measurements in the Detail Specification.

8.1.1.2 Voltage Drop
Measurements of VD (Voltage Drop) shall be made across the fuse after the fuse has carried 100% I_R (DC), where I_R is the rated current as defined in Maximum Ratings in the Detail Specification, for a period 60s ≤ t ≤ 600s. Measurements shall be taken on the fuse terminals.

The Voltage Drop limits at +22 ±3 °C are given in Room Temperature Electrical Measurements in the Detail Specification.

8.1.2 Room Temperature Electrical Measurements
Room Temperature Electrical Measurements shall be performed as specified in the Detail Specification.

8.1.3 Intermediate and End-Point Electrical Measurements

At each of the relevant data points during Qualification and Periodic Tests Intermediate and End-Point Electrical 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.

8.2 EXTERNAL VISUAL INSPECTION AND DIMENSION CHECK

External Visual Inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

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.

8.3 BURN-IN

- Duration: 168 (-0 +14) hours.
- Test Conditions: As specified in the Detail Specification.

8.4 SOLDERABILITY

For leaded fuses: IEC 60068-2-20, Test Ta, Method 1 (+235 ºC/2s).

For surface mount fuses: IEC 60068-2-58, Test Ta (+235 ºC/2s).

8.5 FUSION CHARACTERISATION TESTS

The Fusion Characterisation Tests shall be as defined below. The sample sizes of the Fusion Characterisation Tests are as follows: 5 components for Current Carrying Capacity, 15 components for Overload Operation.

8.5.1 Current Carrying Capacity

- Duration: As specified in the Detail Specification.
- Test Conditions: As specified in the Detail Specification.
- Stability of test current: ±2.5%.

The test current shall be monitored throughout the test. Fuses shall carry the test current for the specified duration without blowing.

8.5.2 Overload Operation

The 15 samples shall be divided into 3 groups of 5 samples as specified in the Detail Specification.

- Overload Current Conditions: As specified in the Detail Specification.
- Overload Current tolerance: ±1%.
- Stability of Overload Current during test: ±1% of the specified Overload Current and tolerance.
- Test temperature: +22 ±3 °C.
- Applied voltage: ≤ U_R, where U_R is the maximum DC Rated Voltage as defined in Maximum Ratings in the Detail Specification.

The limits of the pre-arcing times, which are specified in the Detail Specification, shall not be exceeded. Measurement of pre-arcing time shall have the following accuracy:

t ≤ 10s: ±5%.

t > 10s: ±2%.

In cases of very short pre-arcing times with high Overload Currents such that the tolerance and stability cannot be maintained as specified above, I^2t (the current clearing value) shall be measured and used to calculate the virtual pre-arcing time.

8.6 VERIFICATION OF OVERLOAD OPERATION AT DC RATED VOLTAGE

Verification of Overload Operation at DC Rated Voltage shall be performed at T_{amb} = 22 ±3 ºC and at T_{amb} = minimum operating temperature as specified in Maximum Ratings in the Detail Specification (+5, -0) ºC.

The Overload Currents to be applied shall be as specified in the Detail Specification. The sampling shall be 5 fuses per Overload Current Condition.

After application of the Overload current the fuses shall operate without:

- permanently arcing
- igniting (combusting)
- bursting

Where applicable, the limits of the pre-arcing times or short circuit interrupt criteria, as specified in the Detail Specification, shall be met.

If applicable, any marking on the fuse shall be checked and shall be completely legible.

8.7 INSULATION RESISTANCE

For Screening Tests, the samples which have been subjected to the Fusion Characterisation Tests shall be used.

Insulation Resistance shall be measured in accordance with MIL-STD-202, Test Method 302. Insulation Resistance shall be measured between each terminal and the case, and between the terminals.

- Test Conditions: as specified in the Detail Specification.

The limits of Insulation Resistance, which are specified in the Detail Specification, shall not be exceeded.

8.8 OPERATING LIFE

Operating Life shall be performed in accordance with MIL-STD-202, Test Method 108, Test Condition F and the following details:

- Test Conditions: As specified in the Detail Specification.
- Data Points: As specified in Intermediate and End-Point Electrical Measurements in the Detail Specification at 0 hours, 1000 ±48 hours and 2000 ±48 hours. If drift values are specified the drift shall always be related to the 0-hour measurement.

8.9 RAPID CHANGE OF TEMPERATURE

IEC 60068-2-14, Test Na, 25 cycles. T_A shall be -55 (+5 -0) °C and T_B shall be +150 (+0 -5) °C. The exposure time, t_1, shall be 30 minutes.

- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.10 VIBRATION

MIL-STD-202, Test Method 204, Condition D.

During vibration one half of the fuses shall be subjected to 100% I_R (DC), where I_R is the rated current as defined in Maximum Ratings in the Detail Specification. The remaining fuses shall be tested with no current.

- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.11 SHOCK

IEC 60068-2-27, Test Ea. Unless otherwise specified in the Detail Specification, the following conditions shall apply:

- Shape of shock pulse: Half-sine.
- Peak acceleration: 1600g.
- Duration of pulse: 0.5ms.
- Number of shocks: 12 (2 shocks in each direction along the 3 perpendicular axes of the test specimen).

During shock one-half of the fuses shall be subjected to 100% I_R (DC), where I_R is the rated current as defined in Maximum Ratings in the Detail Specification. The remaining fuses shall be tested with no current.

- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.12 DAMP HEAT, STEADY STATE

IEC 60068-2-78, Test Cab.

- Test Duration: 56 days.
- Test Conditions: Test temperature +40 ±2 °C, relative humidity 93 ±3%.
- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.13 RESISTANCE TO SOLDERING HEAT

For leaded fuses: IEC 60068-2-20, Test Tb, Method 1A, +260 ºC for 10s.

For surface mount fuses: IEC 60068-2-58, Test Td, +260 ºC for 10s.

- Data Points (for Qualification and Periodic Tests only): On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.14 ROBUSTNESS OF TERMINATIONS

IEC 60068-2-21. For leaded fuses, the test shall be either Ua1 (tensile) or Ub and Uc (bending and torsion). Tests Ub and Uc shall not be applied if the Detail Specification describes the terminations as rigid or if the terminations are radial terminations designed for printed wire applications. For surface mount fuses the test shall be Ue1.

- Test Ua1 Conditions: Loading force = 20N for non-wire terminations and wire having a cross-sectional area >0.5mm^2 ; 10N for wire having a cross-sectional area 0.2mm^2 ≤ A ≤ 0.5mm^2 ; 5N for wire having a cross-sectional area <0.2mm^2.
- Test Ub Conditions: Two consecutive bends shall be applied to one-half of the terminations to be tested.
- Test Uc Conditions: Two successive rotations of 180° shall be applied to the remaining terminations to be tested.
- Test Ue1 Conditions: Depth D = 1 (-0 +0.5) mm.
- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.15 THERMAL VACUUM

The thermal vacuum test shall be performed as follows:

The fuses to be tested shall be placed in a vacuum chamber and the chamber evacuated to a pressure ≤ 5 x 10^{-5} torr (0.007 Pa). The test temperature shall be +125 ±3 °C. The fuses shall carry 90% I_R (DC), where I_R is the rated current as defined in Maximum Ratings in the Detail Specification.

After a period of 48 (-0 +4) hours at the above conditions, one-half of the fuses shall be subjected to 400% I_R (DC) unless otherwise specified in the Detail Specification, where I_R is the rated current as defined in Maximum Ratings in the Detail Specification. I^2t (the current clearing value) shall then be measured and recorded. The recorded I^2t value of each fuse shall be less than the maximum current clearing value given in the Detail Specification.

- Data Points: On completion of testing fuses shall be subjected to Intermediate and End-Point Electrical Measurements as specified in the Detail Specification.

8.16 PERMANENCE OF MARKING

ESCC Basic Specification No. 24800.

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) Special In-Process Controls data (Chart F2).
(e) Screening Tests data (Chart F3).
(f) Qualification and Periodic Tests data including Lot Validation Testing data (when applicable) (Chart F4).
(g) Failed components list and failure analysis report (when applicable).
(h) Certificate of Conformity.

Items (a) to (h) 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.

9.1.1 Qualification and Qualification Maintenance

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

9.1.2 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.

9.1.3 Additional Documentation

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

9.1.4 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) Number of the Purchase Order.
(f) Information relative to any additions to this specification and/or the Detail Specification.
(g) Manufacturer's name and address.
(h) Location of the manufacturing plant.
(i) Signature on behalf of Manufacturer.
(j) 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 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.

9.6 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.

9.7 QUALIFICATION AND PERIODIC TESTS DATA (CHART F4)

9.7.1 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 electrical 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.

9.7.2 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 electrical 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 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.

9.7.3 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 electrical 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 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 Special In-Process Controls, Screening Tests and Qualification and Periodic Tests.
(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).

9.9 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established in accordance with the requirements of ESCC Basic Specification Nos. 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. 9.1.2 and 9.1.3.

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.

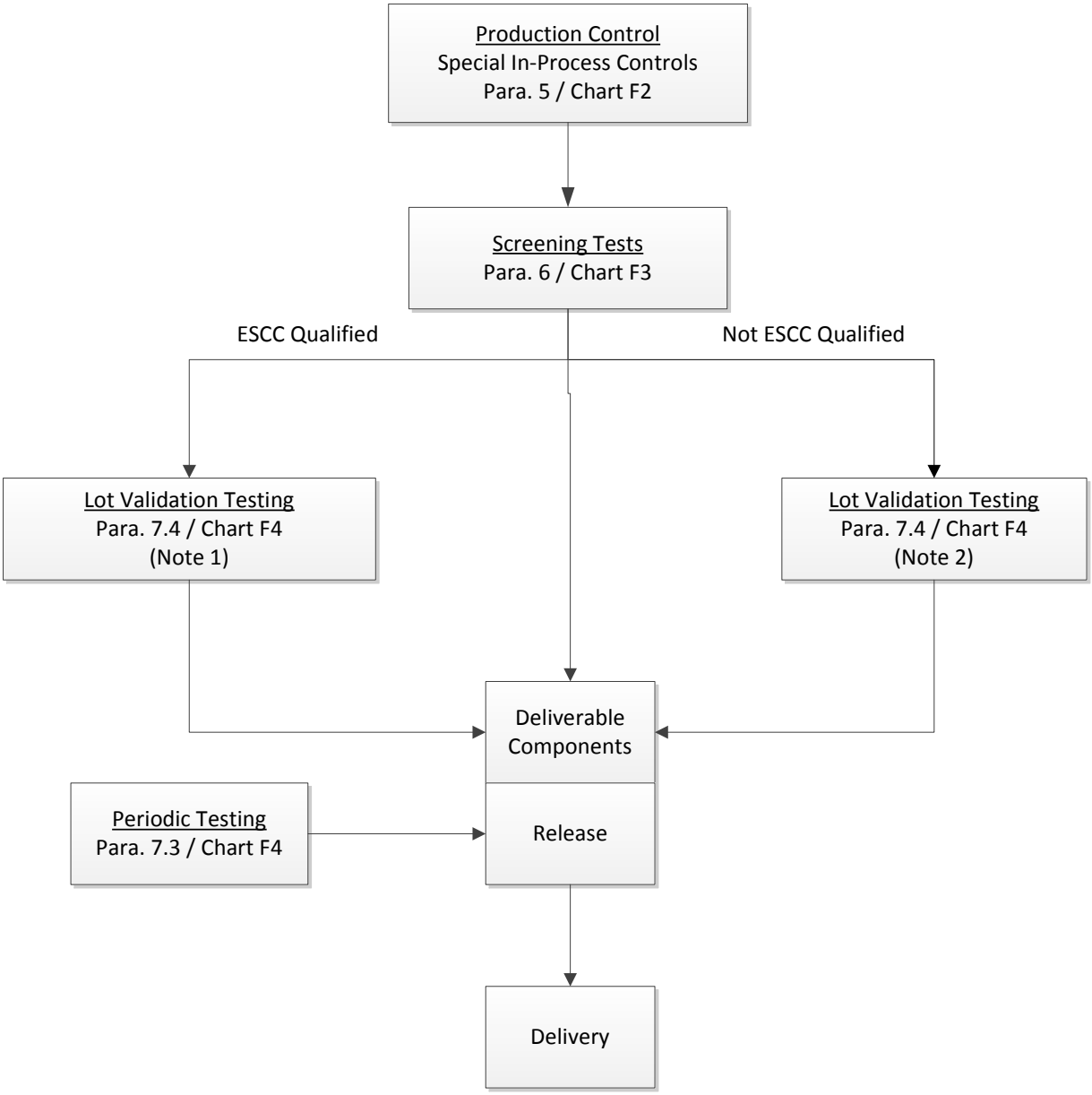
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification No. 20100 and the relevant paragraphs of Section 9 of this specification.

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

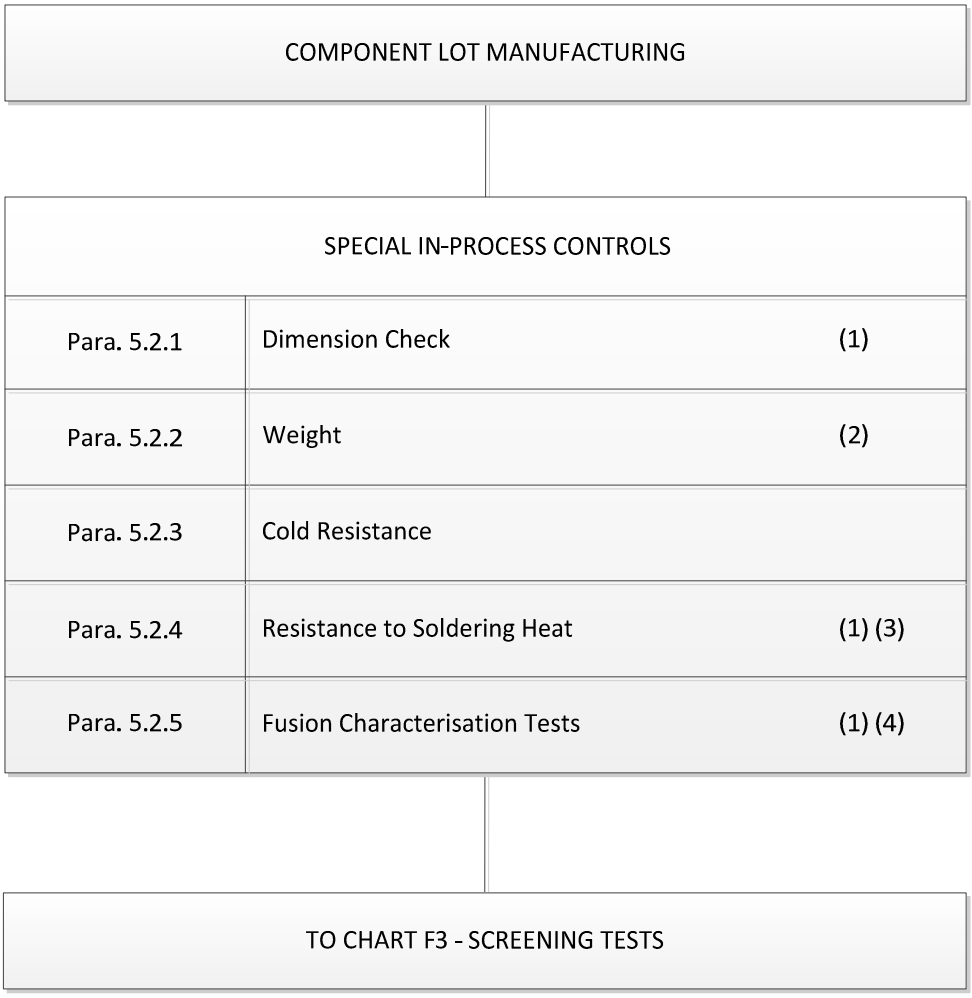
12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



NOTES:

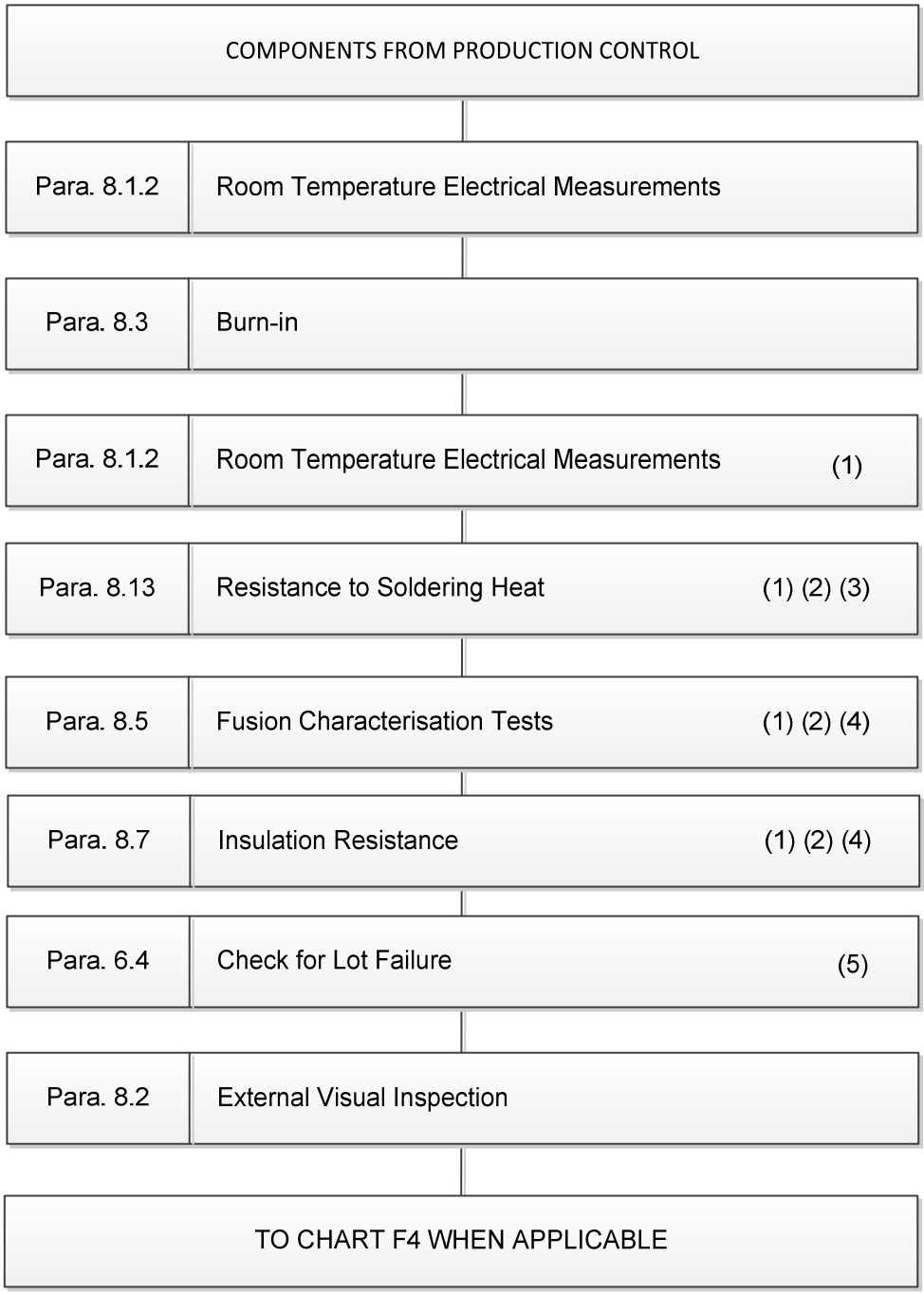
1. Lot Validation Testing is not required for qualified components unless specifically stipulated in the Purchase Order.
2. For unqualified components the need for Lot Validation Testing shall be determined by the Orderer and the required testing shall be as stipulated in the Purchase Order (Ref. ESCC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

12.2 CHART F2 - PRODUCTION CONTROL



NOTES:
1. Performed on a sample basis.
2. Guaranteed but not tested.
3. Only required for surface mount fuses.
4. Surface mount fuses must be soldered to a test board prior to the commencement of testing.

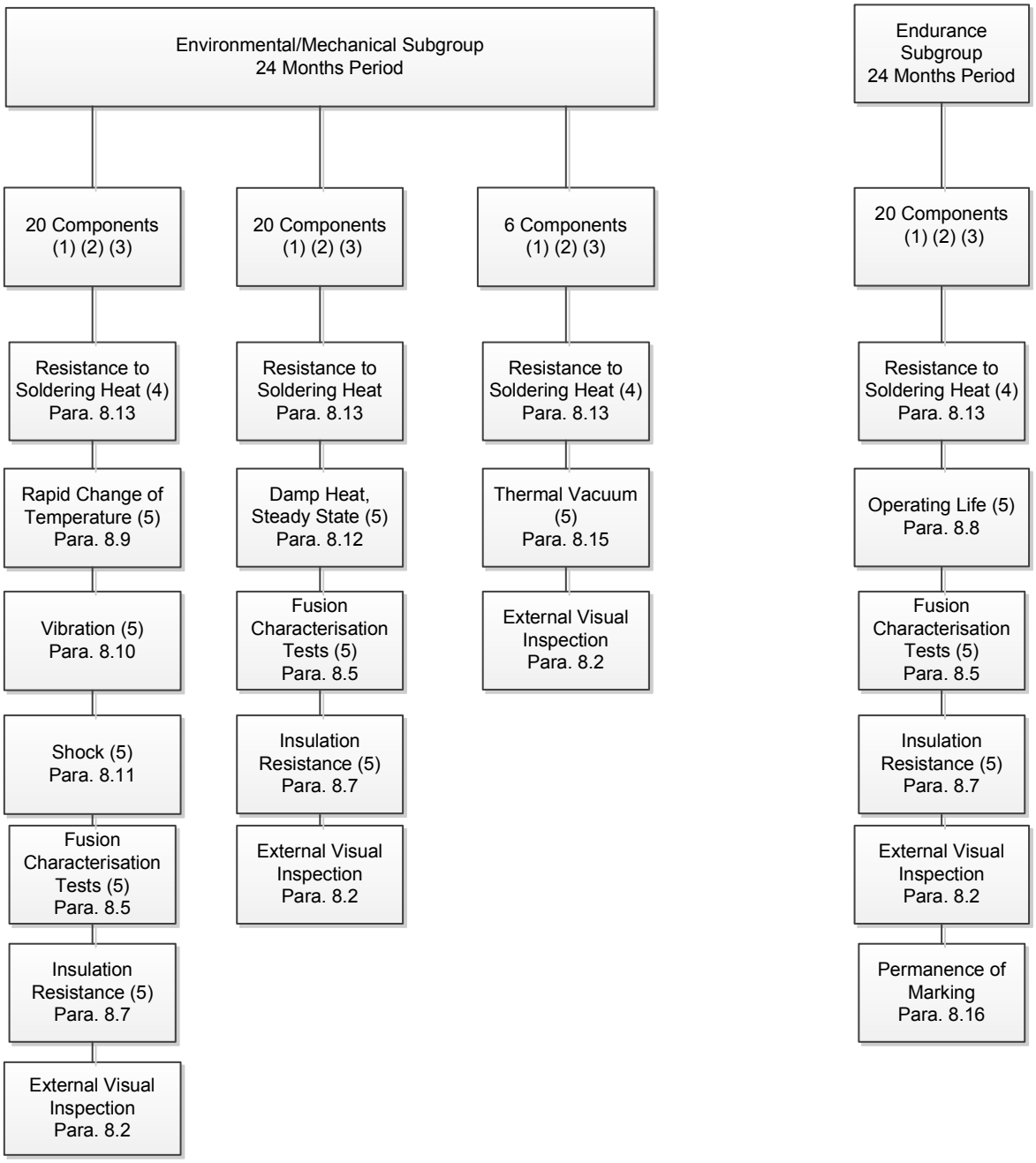
12.3 CHART F3 - SCREENING TESTS

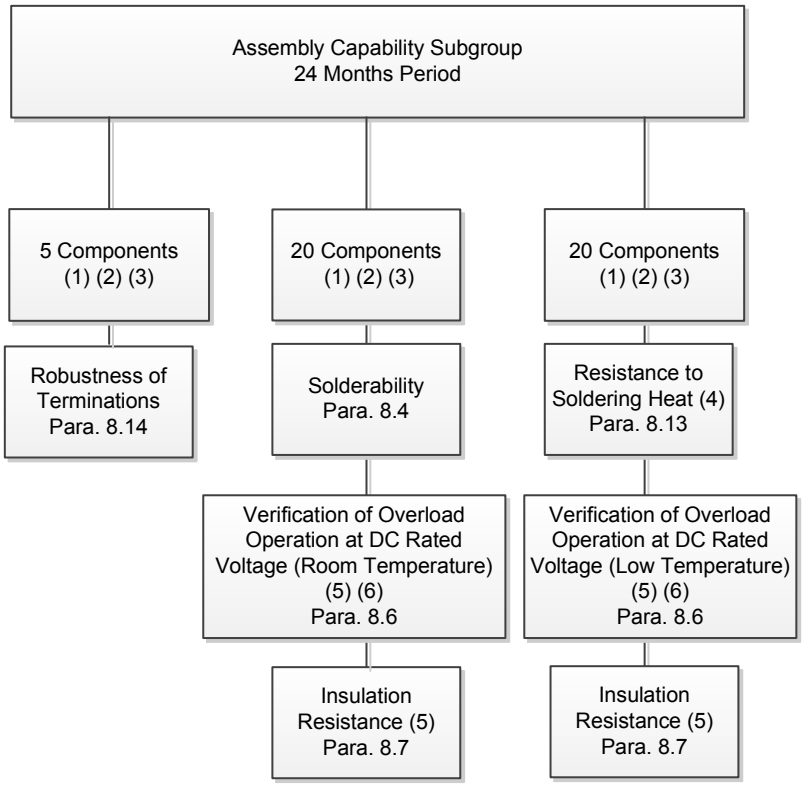


NOTES:

1. The lot failure criteria of Para. 6.4 apply to this test.
2. Performed on a sample basis, no failures allowed.
3. Only required for surface mount fuses.
4. Surface mount fuses must be soldered to a test board prior to the commencement of testing.
5. Check for Lot Failure shall take into account all electrical parameter failures that may occur during Screening Tests in accordance with Paras. 8.1.2, 8.5 and 8.7 subsequent to Burn-in.

12.4 CHART F4 - QUALIFICATION AND PERIODIC TESTS





NOTES:

1. For distribution within the subgroups, see Para. 7.1.2 for Qualification and Periodic Testing and Para. 7.3 for Lot Validation Testing.
2. No failures are permitted.
3. All fuses shall be serialised prior to testing.
4. Only required for surface mount fuses.
5. Surface mount fuses must be soldered to a test board prior to the commencement of testing.
6. If a fuse's maximum rated DC Interrupt Current, as specified in Maximum Ratings in the Detail Specification, is ≤ 50A then the required sample size is 15 components.