RESISTORS, FIXED, FILM

ESCC Generic Specification No. 4001

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1586	Specification upissued to incorporate changes per DCR.

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1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of Resistors, Fixed Film, 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 the 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. 23500, Lead Materials and Finishes for Components for Space Application.
- 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.
- No. 26000, Failure Rate Level Sampling Plans and Procedures

For qualification and qualification maintenance or procurement of qualified components, with the exception of ESCC Basic Specifications Nos. 20100, 21700, 22800, 24600, 25400 and 26000, 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 applicable 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

- ECSS-Q-ST-70-02, Thermal Vacuum Test for the Screening of Space Materials.
- IEC Publication No. 60068 Part 2, Basic Environmental Testing Procedures.
- IEC Publication No. 60115 Part 1, Generic Specification for Fixed Resistors for Use in Electronic Equipment.
- IEC Publication No. 60440, Method of Measurement of Non-Linearity in Resistors.

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 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 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 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.

5.2 SPECIAL IN-PROCESS CONTROLS

5.2.1 Dimension Check
Dimension Check shall be performed in accordance with Para. 8.7 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 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. Seal, 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 or High and Low Temperatures 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 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 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 given 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.

7.1.1.1 Failure Rate Level Qualification Approval

In order to obtain failure rate level qualification approval in accordance with ESCC Basic Specification No. 26000, the Manufacturer shall perform Failure Rate Endurance Testing in accordance with the Failure Rate Endurance Testing Subgroup of Chart F4. Samples to be subjected to Failure Rate Endurance Testing shall be selected in accordance with the failure rate level qualification sampling plans defined in ESCC Basic Specification No. 26000.

The minimum requirement for qualification is to successfully utilise a single sampling plan based on a 60% confidence level to achieve failure rate level R.

A more stringent sampling plan may be employed, at the discretion of the Manufacturer, to achieve a lower failure rate (failure rate level S).

When Failure Rate Endurance Testing is being performed, endurance testing in accordance with the Endurance Subgroup of Chart F4 is not required to be performed.

7.1.2 Distribution within the Qualification Test Lot

With the exception of any samples subjected to Failure Rate Endurance Testing, the Qualification Test Lot shall be comprised in accordance with the following provisions:

When the critical resistance is within the range to be qualified:

- 1/3 of the lot with the critical resistance value.
- 1/3 of the lot with the lowest resistance value
- 1/3 of the lot with the highest resistance value

When the critical resistance is outside the range to be qualified:

- 1/3 of the lot with the lowest resistance value.
- 1/3 of the lot with the highest resistance value.
- 1/3 of the lot with the resistance value in the middle of the range.

Components with the tightest tolerances proposed for Qualification shall be selected.

The component types may be specified by, but in any case shall be agreed with, the ESCC Executive, prior to the commencement of qualification testing and the justification for the selection shall be declared in the qualification test report.

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 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 the maintenance of the Technology Flow Qualification itself in accordance with ESCC Basic Specification No. 25400.

7.3.1 Maintenance of Failure Rate Level Qualification Approval

In order to maintain failure rate level qualification approval, in addition to periodic testing in accordance with Para. 7.3, the Manufacturer shall perform Failure Rate Endurance Testing in accordance with the Failure Rate Endurance Testing Subgroup of Chart F4. Samples to be subjected to, and the maintenance period applicable for, Failure Rate Endurance Testing shall be in accordance with the failure rate level maintenance sampling plan for the applicable failure rate level, in accordance with ESCC Basic Specification No. 26000.

When Failure Rate Endurance Testing is being performed, endurance testing in accordance with the Endurance Subgroup of Chart F4 is not required to be performed.

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 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. Solderability, Robustness of Terminations.

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 the number of permitted failures, based on the criteria specified in Para. 7.5, specified in Chart F4 is exceeded.

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, PERIODIC TESTING AND LOT VALIDATION TESTING SAMPLES

The 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, Periodic Testing 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 OVERLOAD

Overload shall be performed in accordance with the following details:

- Mounting:
  Leaded resistors shall be mounted horizontally in free space with no object closer than 70mm to the resistor case, except the mounting base, which shall be no closer than 50mm below the resistors. Surface mount resistors shall be mounted on a suitable test substrate with an end-cap contact system, in such a way that their temperature does not affect the adjoining resistors.
  Resistors shall be mounted in still air with no circulation other than that caused by the heat of the resistors being operated. The ambient temperature shall be between +15 and +35°C.
- Test Conditions:
  A voltage shall be applied to the terminations of the resistors. Its duration and the maximum voltage which may be applied to the resistor are specified in the Detail Specification.
- Data Points:
  After a recovery period of not less than 1 hour, nor more than 2 hours, the resistors shall be visually examined. There shall be no evidence of damage and the marking shall be legible. Resistance shall be measured as specified in Room Temperature Electrical Measurements in the Detail Specification.

8.2 NON-LINEARITY

The resistors shall be subjected to the measurement of non-linearity in accordance with IEC Publication No. 60440. Acceptance of the units shall be determined by a statistical method. Limits are the mean ± twice the standard deviation unless otherwise specified in the Detail Specification or stipulated in the Purchase Order.

8.3 ELECTRICAL MEASUREMENTS

8.3.1 General

Electrical measurements and methods shall be as follows.

8.3.1.1 Resistance

Measurements of resistance shall be made by using a direct voltage of small magnitude for as short a time as practicable so that the temperature does not rise appreciably during measurement. In the event of conflicting results, attributable to such test voltages, the voltage specified in the following table shall be used for reference purposes:

Rated Resistance (R_n) (Ω)	Measuring Voltage (+0 -10%) (V)
< 10	0.1 (see Note)
10 to 99	0.3
100 to 999	1
1000 to 9999	3
10000 to 99999	10
100000 to 999999	22
≥ 1MΩ	50

NOTES:

1. The measuring voltage shall be chosen such that the resistor dissipates less than 10% of its rated dissipation without exceeding 0.1W.

The accuracy of the measuring equipment shall be such that the error does not exceed 10% of the tolerance. Where the measurement forms part of a test sequence, it shall be possible to measure a change in resistance with an error not exceeding 10% of the maximum change permitted for that test. The Resistance limits at +22 ±3°C are specified in Room Temperature Electrical Measurements in the Detail Specification.

8.3.1.2 Insulation Resistance

This test applies only to insulated resistors.

8.3.1.2.1 Leaded Resistors

- Mounting:
  For resistors having axial terminations, a V-block method can be used. For other types, a metal foil shall be wrapped closely around the whole body of the resistor. A space of 1 to 1.5mm shall be left between the edge of the foil and each termination.

- V-block Method:
  The resistor shall be clamped in the trough of a 90° metallic V-block of such size that the resistor body does not extend beyond the extremities of the block. The clamping force shall be such that adequate contact between the resistor and the block is guaranteed. The terminations shall be so positioned that the distance between them and any point of the V-block is not less than:
  (a) For cylindrical resistors:
  The radius of the resistor body minus the radius of the circumscribed circle of the terminations (the larger circle in the case that the two terminations have different dimensions).
  (b) For rectangular resistors:
  Half the smaller side of the resistor body minus the radius of the circumscribed circle of the terminations (the larger circle in the case that the two terminations have different dimensions).
  Any out-of-centre positioning of the termination at its emergence from the resistor body shall be ignored.

- Test Conditions:
  Insulation Resistance shall be measured with a direct voltage of either 100 ±15V for resistors with an isolation voltage of less than 500V, or 500 ±50V for resistors with an isolation voltage of equal to or above 500V, between both terminations of the resistor connected together as one pole and the metal foil, or the mounting device, (i.e. V-block) as the other pole. The voltage shall be applied for 1 minute or such shorter time as is necessary to obtain a stable reading.
  Insulation Resistance shall be read at the end of that period and be not less than specified in the Room Temperature Electrical Measurements in the Detail Specification.

8.3.1.2.2 Surface Mount Resistors

Insulation Resistance shall be measured with a voltage as specified in Para. 8.3.1.2.1 between test points as shown in IEC Publication No. 60115-1 (Insulation resistance).

The voltage shall be applied for 1 minute or the time necessary to obtain a stable reading. The insulation resistance shall be not less than that specified in Room Temperature Electrical Measurements in the Detail Specification.

8.3.1.3 Voltage Proof

8.3.1.3.1 Leaded Resistors

- Mounting:
  For types without mounting devices, a metal foil shall be wrapped closely around the whole body of the resistor. For types with axial terminations, a space of 1 to 1.5 mm shall be left between the edge of the foil and each termination.
  For types with axial terminations, the foil shall be wrapped around the whole body of the resistor and protrude at least 5mm from each end provided the minimum space of 1mm between foil and termination can be maintained. The ends of the foil shall not be folded over the ends of the resistor. A V-block mounting method can also be used. For types with mounting devices, the resistor shall be mounted in the normal manner on a metal plate (or between two metal plates) extending in all directions at least 12.5mm beyond the mounting face of the resistor.

- Test Conditions:
  An alternating voltage of 40 to 60Hz with a value of 1.4 times the isolation voltage shall be applied for a period of 60 ±5s between the terminations of the resistor, connected together as one pole, and the metal foil or mounting plate(s) as the other pole. The voltage shall be applied gradually at a rate of approximately 100V/s. When tested as specified, using one of the above-mentioned mounting methods, there shall be no breakdown or flash-over.

8.3.1.3.2 Surface Mount Resistors

The electrical conditions and alternating voltage shall be as specified in Para. 8.3.1.3.1 and applied between test points as specified in IEC Publication No. 60115-1 (Voltage proof).

8.3.2 Room Temperature Electrical Measurements

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

8.3.3 High and Low Temperatures Electrical Measurements

High and Low Temperatures Electrical Measurements shall be performed as specified in the Detail Specification. Unless otherwise specified, measurements shall be performed on a sample of 5 components with 0 failures allowed.

For surface mount resistors, where necessary, samples may be mounted as specified in Para. 8.7, however mounting is classed as destructive and therefore mounted samples shall not form part of the delivery lot.

For lots where mounting is not necessary, in the event of any failure, a 100% inspection may be performed.

For lots where mounting is necessary, in the event of any failure, the lot shall be rejected.

8.3.4 Intermediate and End-Point Electrical Measurements

At each of the relevant data points during Qualification, Periodic Testing and Lot Validation Testing, 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.

8.4 BURN-IN

Burn-in shall be performed in accordance with IEC Publication No. 60115-1 (Endurance tests).

The test conditions shall be as specified in Burn-in in the Detail Specification.

Unless otherwise specified in the Detail Specification, components shall be subjected to a total Burn-in period of 168 (+24 -0) hours.

The data point for post-burn-in electrical measurements shall be T (+24 -0) hours (where T is the specified duration).

8.5 SEAL

For the purposes of this specification, an hermetically sealed resistor is a resistor whose resistance element is contained within a sealed enclosure of ceramic, glass or metal, or combinations thereof, the sealing being accomplished by material fusion, welding, brazing or soldering. Hermetically sealed resistors shall be submitted to Test QI of IEC Publication No. 60068-2-17.

The devices shall be placed in a dye solution such as Rhodamine B, fluorescein, Dy-check, Zyglow, FL50 or equivalent, and the chamber pressurised at 620kPa minimum for 3 hours minimum. The devices shall then be removed and carefully washed, using a suitable solvent for the dye used. The devices shall then be examined under a magnification of 7x to 20x, using an ultraviolet light source of appropriate frequency to determine that all dye has been removed from the exterior. Devices shall then be placed in a vacuum chamber and evacuated to less than 650Pa for 30 ±5 minutes.

The devices shall then be removed and examined under magnification of 7x to 20x using an ultraviolet source of appropriate frequency. After removal from the dye solution, clear glass devices may be examined for dye in the cavity.

In the case of non-transparent envelopes, the resistors shall be thoroughly cleansed of external dye and then rotated about their longitudinal axis for a minimum of 2 minutes at a minimum ambient temperature of +80°C. Following rotation, the resistors shall be examined for evidence of dye leakage. Any evidence of dye in the cavity, or of dye effusion, shall constitute a failure.

8.6 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.

8.7 SURFACE MOUNT RESISTOR MOUNTING

Surface mount resistors may be mounted on a suitable substrate in accordance with IEC Publication No. 60115-1 (Mounting of specimens).

8.8 RAPID CHANGE OF TEMPERATURE

The resistors shall be subjected to Test Na of IEC Publication No. 60068-2-14 with the following details:

- Test Conditions:
  The duration of exposure at the minimum and maximum storage temperature ratings, as specified in the Detail Specification, shall be 30 minutes each. The number of cycles shall be 10.

- Data Points:
  (a) On completion of testing the resistors shall be subjected to standard atmospheric conditions for recovery for not less than 1 hour, nor more than 2 hours. After recovery, the resistors shall be visually examined. There shall be no evidence of damage.
  (b) Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.

8.9 VIBRATION

The resistors shall be subjected to Test Fc of IEC Publication No. 60068-2-6 with the following details:

- Test Conditions:
  (a) Frequency Range: 10 Hz to 2000 Hz.
  (b) Amplitude: 1.5mm or 200m/s^2, whichever is the less severe.
  (c) 10 sweep cycles in each of the three mutually perpendicular axes.
  (d) Mounting of components in such a way that they are not exposed to resonances. If the component is provided with specific mounting means, these shall be used.

- Data Points:
  (a) On completion of testing the resistors shall be visually examined and there shall be no evidence of damage.
  (b) Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.

8.10 CLIMATIC SEQUENCE

8.10.1 Initial Measurements

(a) The resistors shall be dried as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification by application of either Procedure 1 or 2:
- Procedure 1:
  For 24 ±4 hours in an oven at a temperature of +55 ±2°C and with a relative humidity not exceeding 20%.
- Procedure 2:
  For 96 ±4 hours in an oven at +100 ±5°C. The resistors shall then be allowed to cool in a desiccator, using a suitable desiccant such as activated alumina or silica gel, and be kept therein from the time of removal from the oven until the beginning of the test

(b) Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

8.10.2 Dry Heat

The resistors shall be subjected to Test Bb of IEC Publication No. 60068-2-2 at the maximum storage temperature rating as specified in the Detail Specification for 2 hours.

On completion of testing the resistors shall be subjected to standard atmospheric conditions for recovery, for not less than 4 hours before being subjected to Damp Heat (First Cycle).

8.10.3 Damp Heat (First Cycle)

The resistors shall be subjected to Test Db, Severity a (40°C), Variant 2, of IEC Publication No. 60068-2-30, for one cycle of 24 hours. On completion of testing after recovery, the resistors shall be immediately subjected to Cold.

8.10.4 Cold

The resistors shall be subjected to Test Ab of IEC Publication No. 60068-2-1 at the minimum storage temperature rating as specified in the Detail Specification. After 1 hour of stabilisation at this temperature, full rated continuous voltage as specified in the Detail Specification shall be applied for 45 minutes. The resistors may be loaded individually or in parallel.

On completion of testing the resistors shall be removed from the chamber and exposed to standard atmospheric conditions for recovery for not less than 4 hours before being subjected to Low Air Pressure.

8.10.5 Low Air Pressure

The resistors, operated with rated continuous voltage as specified in the Detail Specification, shall be subjected to Test M of IEC Publication No. 60068-2-13, using a pressure of 2 ±0.1kPa.

The test shall be performed at a temperature between +15 and +35°C. The duration of the test shall be 1 hour.

On completion of testing the resistors shall immediately be subjected to Damp Heat (Remaining Cycles).

8.10.6 Damp Heat (Remaining Cycles)

The resistors shall be subjected to Test Db, Severity a (40°C), Variant 2, of IEC Publication No. 60068-2-30 for 5 cycles of 24 hours.

On completion of testing the resistors shall be removed from the chamber and subjected to standard atmospheric conditions for recovery for 30 ±5 minutes before being subjected to DC Load.

8.10.7 DC Load

The resistors shall be operated at rated DC voltage as specified in the Detail Specification for 1 minute. The voltage shall be the rated or limiting element voltage, whichever is the smaller.

On completion of testing the resistors shall be subjected to standard atmospheric conditions for recovery until thermal equilibrium is reached, up to a maximum of 2 hours, prior to electrical measurements.

8.10.8 Final Measurements

Resistance, Change in Resistance and Insulation Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification. Change in Resistance shall be related to the initial measurements.

8.11 ROBUSTNESS OF TERMINATIONS

8.11.1 Leaded Resistors

The resistors shall be subjected to Tests Ua, Ub, Uc and Ud of IEC Publication No. 60068-2-21, as applicable. Tests Ub and Uc shall not be applied if the Detail Specification describes the terminations as rigid.

- Test Conditions:
  (a) The resistors shall be subjected to Test Ua1; tensile, with the following details:
  The force shall be:
  - For terminations other than wire terminations: 20N.
  - For wire terminations: See Table below.

Cross-sectional area of wire S (mm^2)	Diameter of round wire d (mm)	Force (N)
$0.5 < S$	$0.8 < d$	20
$0.2 < S \leq 0.5$	$0.5 < d \leq 0.8$	10
$0.07 < S \leq 0.2$	$0.3 < d \leq 0.5$	5
$S \leq 0.07$	$d \leq 0.3$	2.5

  (b) The resistors shall be subjected to Test Ub; bending, with the following details:
  - Test applies to half the number of terminations,
  - Two consecutive bends shall be applied.

  (c) The resistors shall be subjected to Test Uc; torsion, with the following details:
  - Test applies to the other half of terminations.
  - Method 1, Severity 2 (two successive rotations of 180°) shall be applied.

  (d) The resistors shall be subjected to Test Ud, torque (for nuts, threaded terminations and fixing screws).

- Data Points:
  (a) After each of these tests, the resistors shall be visually examined. There shall be no evidence of damage.
  (b) Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.

8.11.2 Surface Mount Resistors

The Shear (Adhesion) test and the Substrate Bending test shall be performed in sequence.

8.11.2.1 Shear (Adhesion) Test

Resistors shall be subjected to testing in accordance with IEC Publication No. 60115-1 (Shear test), with the following details:

- Mounting:
  The resistors shall be mounted as specified in Para. 8.7.
- Test Conditions:
  A force of 5N shall be applied normal to the line joining the terminations and in a plane parallel to the substrate. The force shall be applied progressively (without any shock) and then maintained for a period of 10 ±1s.
- Data Points:
  (a) Resistance and Change in Resistance shall be measured on mounted parts as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.
  (b) On completion of testing resistors shall be visually examined (approximately 10x magnification). There shall be no signs of damage, cracking, lifting, or dry solder joints.

8.11.2.2 Substrate Bending Test

Resistors shall be subjected to testing in accordance with IEC Publication No. 60115-1 (Substrate bending test), with the following details:

- Mounting:
  The resistors shall be mounted as specified in Para. 8.7.
- Test Conditions:
  As specified in the Detail Specification.
- Data Points:
  (a) Resistance and Change in Resistance shall be measured, board in bent position, as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.
  (b) On completion of testing resistors shall be visually examined (approximately 10x magnification). There shall be no signs of damage, cracking, lifting, or dry solder joints.

8.12 RESISTANCE TO SOLDERING HEAT

The resistors shall be subjected to Test Tb of IEC Publication No, 60068-2-20 with the following details:

- Test Conditions:
  As specified in the Detail Specification.
  After testing, resistors shall remain under standard atmospheric conditions for recovery, until thermal equilibrium is reached, up to a maximum of 24 hours.
- Data Points:
  (a) The resistors shall be visually examined. There shall be no evidence of damage and the marking shall be legible. For surface mount resistors, dissolution of the end-face plating (leaching) shall not exceed 25% of the length of the edge concerned.
  (b) Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.

8.13 OPERATING LIFE

Operating Life shall be performed in accordance with the following details:

- Mounting:
  Resistors shall be connected by their terminations to suitable clips on a rack of insulating material. They shall be mounted in a horizontal position in 1 layer only. The distance between the axes of the resistors shall be not less than 7 times the diameter of the resistors. There shall be no undue draught over the resistors. Only natural convection resulting from the hot resistors may occur.

  Surface mount resistors, where necessary, may be mounted as specified in Para. 8.7.

- Test Conditions:
  As specified in Operating Life in the Detail Specification.

  With the exception of Failure Rate Endurance Testing, the duration of Operating Life test shall be 2000 ±48 hours.

  For Failure Rate Endurance Testing, the duration of Operating Life test shall be 8000 ±48 hours.

  Resistors shall be tested with a direct voltage or full wave rectified AC voltage provided the ripple does not exceed 5%. The voltage shall be applied in cycles of 1.5 hour 'on' and 0.5 hour 'off' throughout the test. The 0.5 hour 'off' periods are included in the total test duration. The voltage shall be either the rated or limiting element voltage, whichever is less. The applied voltage shall be within ±5% of this voltage. The size of the testing chamber and the number of resistors under test shall be such that when all resistors are fully loaded, the heat produced by them shall be less than that required to maintain the atmosphere in the chamber at the specified temperature, so that the temperature can still be controlled by the heating elements. The temperature-controlling elements shall be suitably spaced from the resistors and shall be shielded so as not to be directly influenced by the radiation of the resistors. For the purpose of this test, it shall be assumed that the ambient temperature of the resistors is the specified temperature.

- Data Points:
  Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification at 0 hour, 1000 ±48 hours and 2000 ±48 hours plus, when Failure Rate Endurance Testing is being performed, at 8000 ±48 hours.

  Insulation Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification at 2000 ±48 hours or, when Failure Rate Endurance Testing is being performed, at 8000 ±48 hours.

  If drift values are specified, the drift shall always be related to the 0-hour measurement.

  At each data point the removal from the chamber shall take place at the end of the 0.5 hour 'off' period and the resistors shall be subjected to standard atmospheric conditions for recovery until thermal equilibrium is reached, up to a maximum of 2 hours, prior to electrical measurements. The interval between the removal from and return to the test conditions for any resistor shall not exceed 12 hours.

8.14 SOLDERABILITY

The resistors shall be subjected to Test Ta of IEC Publication No. 60068-2-20 with the following details:

- Test Conditions:
  Solder bath Method 1 (+235 ±5°C for 2 ±0.5s).
  After testing resistors shall remain under standard atmospheric conditions for recovery, until thermal equilibrium is reached, up to a maximum of 24 hours.

- Data Points:
  Resistance and Change in Resistance shall be measured as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification both before and after the test. Change in Resistance shall be related to the initial measurements.

8.15 PERMANENCE OF MARKING

Permanence of Marking shall be performed in accordance with 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, Periodic Testing and Lot Validation Testing (when applicable) data (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.

9.1.2 Qualification and Qualification Maintenance

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

9.1.3 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.

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 Manufacturers 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, PERIODIC TESTING AND LOT VALIDATION TESTING 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.

When Failure Rate Endurance Testing has been performed, results shall be recorded against serial number, lot number and ESCC Component 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.

When Failure Rate Endurance Testing has been performed, results shall be recorded against serial number, lot number and ESCC Component 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, 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).

9.9 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.

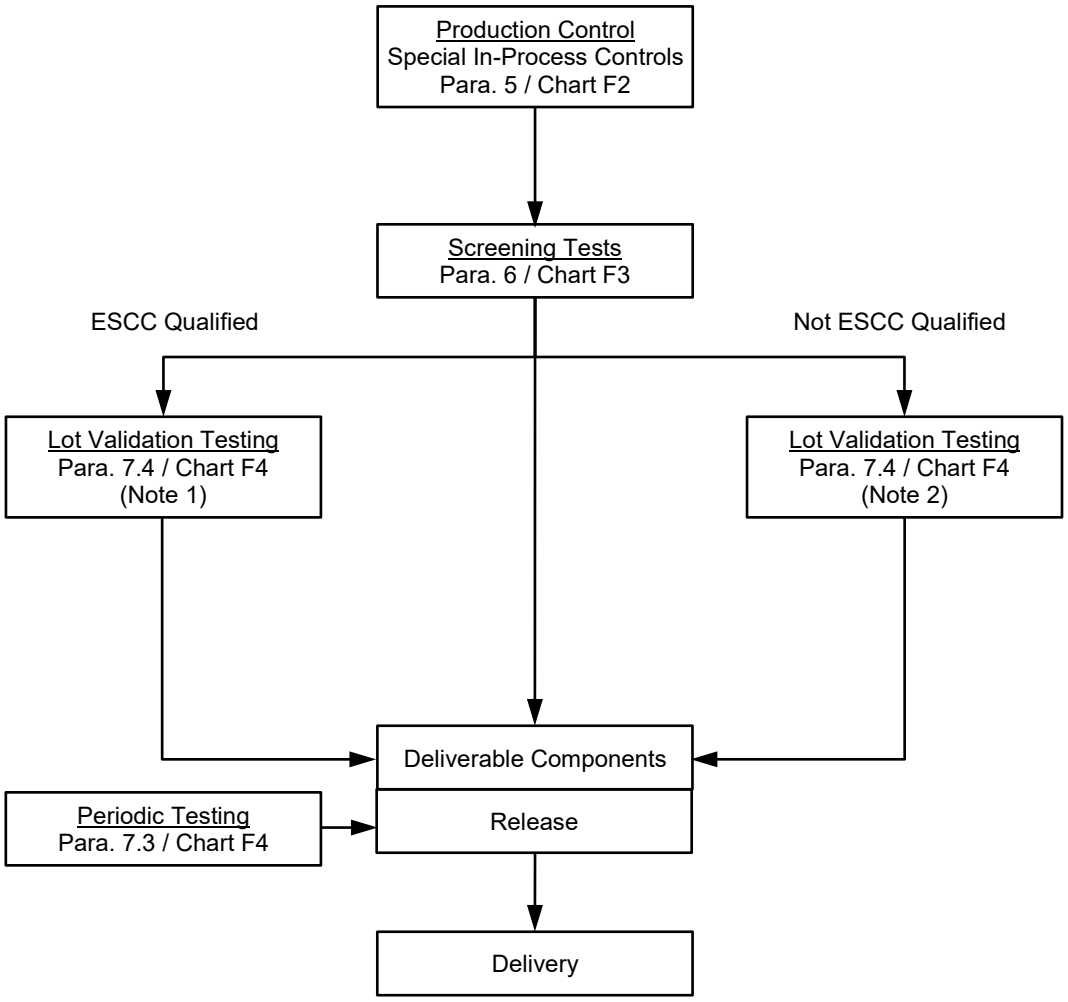
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification Nos. 20100 or 25400 and the relevant paragraphs of Section 9 of this specification.

11 PACKAGING AND DESPATCH

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

12 CHARTS

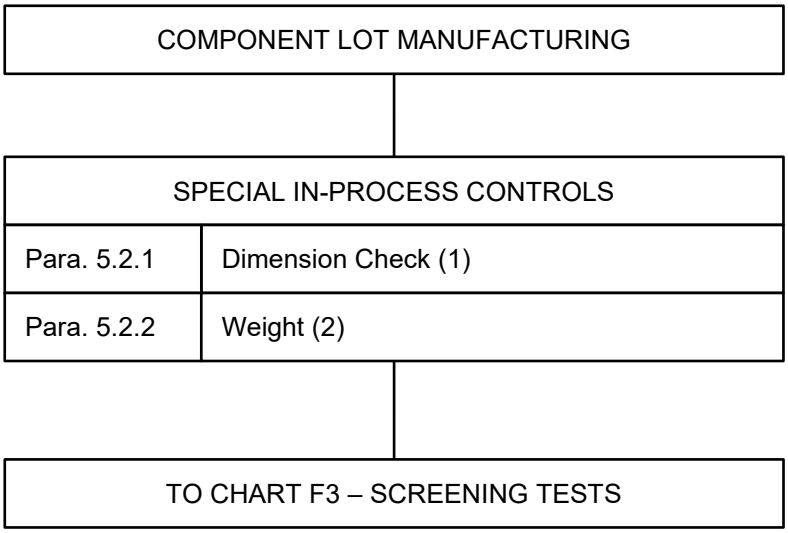
12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



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.

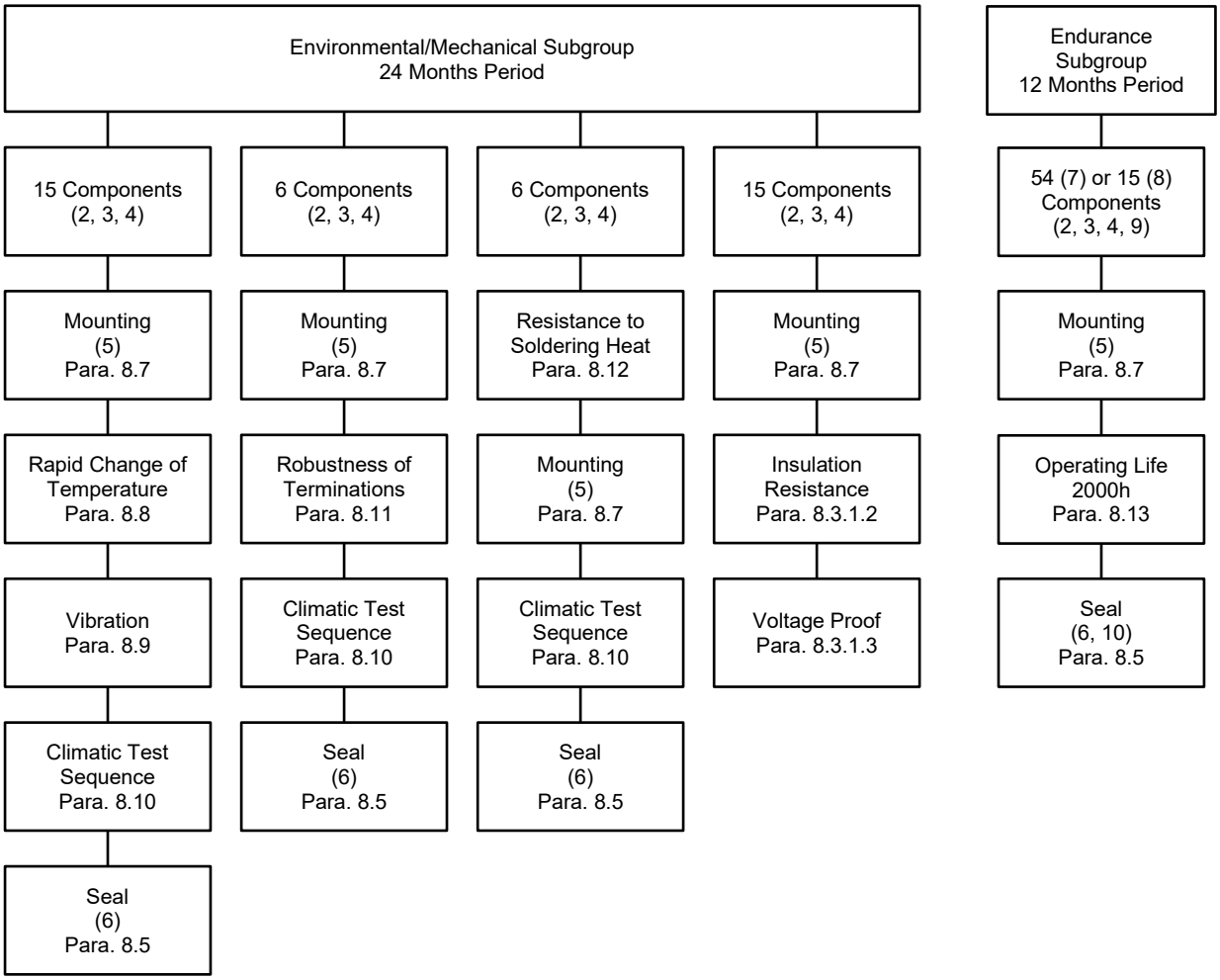
12.3 CHART F3 - SCREENING TESTS

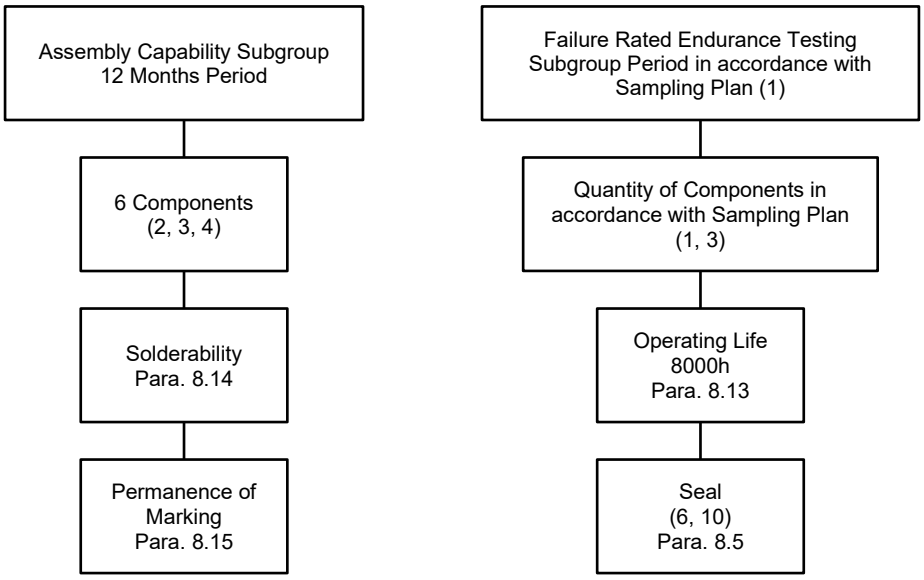
COMPONENTS FROM PRODUCTION CONTROL	
Para. 8.1	Overload
Para. 8.2	Non-Linearity
Para. 8.3.2	Room Temperature Electrical Measurements (1)
Para. 8.4	Burn-in
Para. 8.3.3	High and Low Temperature Electrical Measurements (2, 3)
Para. 8.3.2	Room Temperature Electrical Measurements (2)
Para. 6.4	Check for Lot Failure (4)
Para. 8.5	Seal (5)
Para. 8.6	External Visual Inspection
TO CHART F4 WHEN APPLICABLE	

NOTES:

1. Optional at the Manufacturer's discretion.
2. The lot failure criteria of Para. 6.4 apply to this test.
3. Performed on a sample basis.
4. Check for Lot Failure shall take into account all electrical parameter failures that may occur during Screening Tests in accordance with Para. 8.3.2 and 8.3.3 subsequent to Burn-in.
5. For hermetically sealed resistors only.

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





NOTES:

1. Applicable when Failure Rate Endurance Testing is being performed. The quantity of components to be subjected to Operating Life, the qualification approval maintenance period, and the number of allowed failures shall be in accordance with the applicable sampling plan. See Para. 7.1.1.1 for failure rate level qualification approval and Para. 7.3.1 for maintenance of failure rate level qualification approval.
2. For distribution within the subgroups, see Para. 7.1.2 for qualification and qualification maintenance and Para. 7.4 for Lot Validation Testing.
3. All components shall be serialised prior to testing.
4. No failures are permitted.
5. For surface mount resistors only.
6. For hermetically sealed resistors only.
7. Applicable to Qualification Testing.
8. Applicable to Periodic Testing.
9. Endurance Subgroup testing is not required when Failure Rate Endurance Testing Subgroup testing is being performed.
10. Performed on a sample of 15 components selected from the components subjected to Operating Life.