



**THERMISTORS
(THERMALLY SENSITIVE RESISTORS)
ESCC Generic Specification No. 4006**

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1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of Thermistors (Thermally Sensitive Resistors) 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. 20400, Internal Visual Inspection.
- No. 20500, External Visual Inspection.
- No. 20600, Preservation, Packaging and Despatch of ESCC Components.
- No. 20900, Radiographic Inspection of Electronic 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, Requirements for 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.

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 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

- MIL-STD-202, Test Method Standard for Electronic and Electrical Component Parts.
- ECSS-Q-ST-70-02, Thermal Vacuum Test for the Screening of Space Materials.

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 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 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.

5.2 SPECIAL IN-PROCESS CONTROLS

5.2.1 Internal Visual Inspection

Internal Visual Inspection shall be performed in accordance with Para. 8.1.

5.2.2 Thermal Shock

Thermal Shock shall be performed in accordance with Para. 8.2.

5.2.3 Room Temperature Electrical Measurements

Room Temperature Electrical Measurements shall be performed as specified in Para. 8.3.4.

5.2.4 External Visual Inspection

External Visual Inspection shall be performed in accordance with Para. 8.5 on 3 samples only. If any failure occurs the lot shall be rejected.

5.2.5 Dimension Check

Dimension Check shall be performed in accordance with Para. 8.5 on 3 samples only.

In the event of any failure a 100% Dimension Check shall be performed.

5.2.6 Weight

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

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

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

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

6.2 FAILURE CRITERIA

6.2.1 Environmental and Mechanical Test Failure

The following shall be counted as component failures:

Components which fail during tests for which the pass/fail criteria are inherent in the test method, i.e. Radiographic Inspection and External Visual Inspection.

6.2.2 Parameter Drift Failure

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

6.2.3 Parameter Limit Failure

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

6.2.4 Other Failures

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

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

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

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 described in Para. 6.2 subsequent to Burn-in equals or exceeds 10% (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 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.

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

The distribution within the Qualification Test Lot shall be comprised as follows:

- 1/2 of the lot with the lowest zero power resistance.
- 1/2 of the lot with the highest zero power resistance.

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 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. Solderability, Terminal Strength, 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 specified in Para. 7.5.

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

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

7.8 QUALIFICATION, 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 INTERNAL VISUAL INSPECTION

ESCC Basic Specification No. 20400.

8.2 THERMAL SHOCK

Thermal Shock shall be performed in accordance with MIL-STD-202, Test Method 107. The Test Conditions shall be as specified in the Detail Specification.

The dwell time between temperature extremes shall be not less than 10 minutes and not more than 15 minutes.

No measurements shall be made either before or after cycling.

8.3 ELECTRICAL MEASUREMENTS

8.3.1 General

Electrical measurements and methods shall be as follows.

8.3.1.1 *Zero Power Resistance*

Zero power resistance measurements shall be made in a controlled uniform medium capable of maintaining an accuracy of:

±0.01°C for beads, beads in rods and beads in probes.

±0.05°C for all other thermistor types.

– Test Equipment Requirements

To measure the resistance a Wheatstone Bridge, or equivalent, of accuracy ±0.05% (or better) shall be used. The time response of the equipment used to measure the temperature shall be compatible with that of the thermistor under test.

– Procedure

Thermistors shall be mounted by their normal mounting means in corrosion-resistant clips mounted on brass rods. The mounting plates used shall be made of micarta, polytetrafluoroethylene or other suitable insulating material. Flat clips shall be used on thermistor beads. For all other thermistor types, any suitable type of clip may be used. For thermistors with solid leads, the clips shall grip the leads 25.4 ±1.59mm from the end of the thermistor's body. With the input voltage source disconnected, adjust the output indicator to the zero output position. Connect the input voltage source, measure the zero power resistance and then disconnect the input voltage source.

Sufficient time must be allowed between measurements for the medium and the thermistors to stabilise at the required temperatures.

A thermistor shall be considered a failure if the output indicator does not return to its initial zero output position within a tolerance equivalent to ±0.05 of the resistance value.

8.3.1.2 *Dissipation Constant*

– Initial Measurements

The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C and +75°C.

– Procedure

Measurements of the potential across the thermistor under test (E_{TH}) and the current through the thermistor under test (I_{TH}) shall be performed using a high impedance measuring circuit with an accuracy of ±1% or better. The thermistors shall be placed in a still-air controlled chamber of temperature +25 ±1°C and a minimum volume of 1000 times the thermistors body and test fixture combined. The initial zero power resistance value measured at +75°C shall be reproduced by adjusting E_{TH} and I_{TH} . After the loading has been applied for a period of 15 minutes, E_{TH} and I_{TH} shall be adjusted accordingly, then measured and recorded.

The dissipation constant can then be calculated using the following formula

$$P(\text{mW}/^{\circ}\text{C}) = \frac{E_{TH}(\text{mV}) \times I_{TH}(\text{mA})}{[75(^{\circ}\text{C}) - 25(^{\circ}\text{C})]}$$

and recorded.

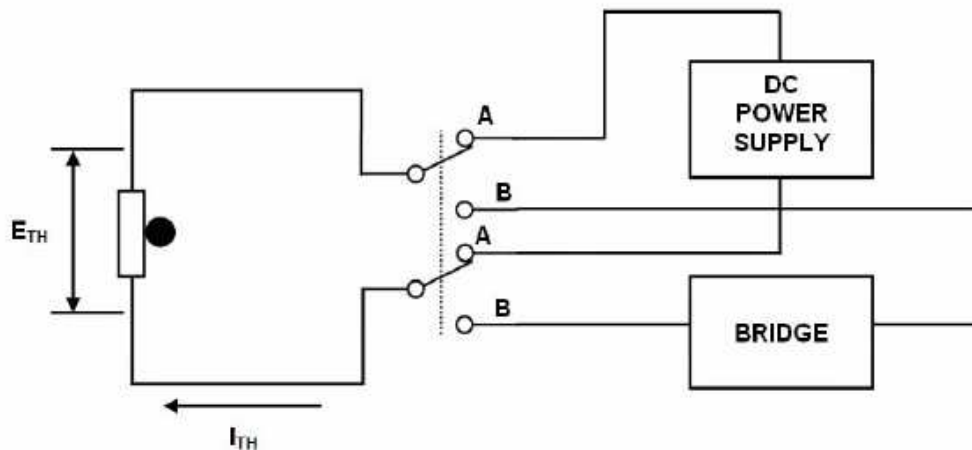
8.3.1.3 *Thermal Time Constant*

Thermistors shall be mounted by their normal mounting means in corrosion-resistant clips mounted on brass rods. Flat clips shall be used on thermistor beads. For all other thermistor types, any suitable type of clip may be used. For thermistors with solid leads, the clips shall grip the leads $25.4 \pm 1.59\text{mm}$ from the end of the thermistor's body.

- Initial Measurements
The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at $+43.4^\circ\text{C}$ and $+75^\circ\text{C}$.
- Procedure
The test procedure used to measure thermal time constant depends on the thermistor type. Procedure (a) applies to Disks, Rods and Beads; Procedure (b) applies to Beads in Probes and Beads in Rods.

(a) Test Procedure for Disks, Rods and Beads

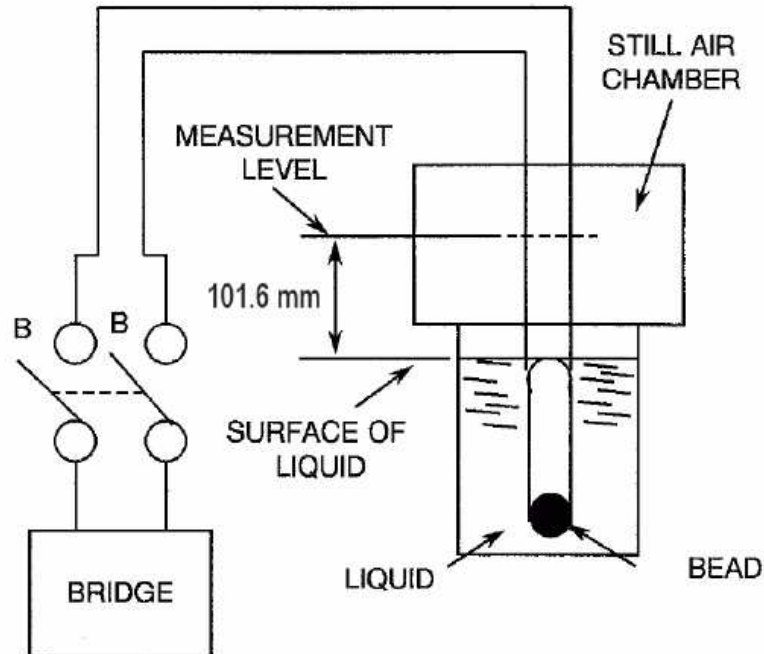
The thermistors shall be inserted into the test circuit shown below:



The thermistors shall be placed in a still-air controlled chamber of temperature $+25 \pm 1^\circ\text{C}$ and a minimum volume of 1000 times the thermistor's body and test fixture combined. With the switch in position AA (i.e. as shown above), and after a period of 15 minutes to allow for thermistor stabilisation, adjust the E_{TH}/I_{TH} ratio equal to the zero power resistance at $+75^\circ\text{C}$. Set the bridge for "Null" with the zero power resistance value measured at $+43.4^\circ\text{C}$ in Initial Measurements. Throw the switch to position BB and measure and record the time from the instant the switch is thrown to the time when the bridge indicator passes through the "Null" point. This time is the thermal time constant of the thermistor.

(b) Test Procedure for beads in Probes and Beads in Rods

The test set-up is shown below:



Completely submerge the thermistor in a temperature-controlled ($+75 \pm 1^\circ\text{C}$) bath of low viscosity ($\sim 1\text{cSt}$) liquid. The medium must not be subject to surface evaporation when the thermistor is removed. Position a still-air controlled chamber of temperature $+25 \pm 1^\circ\text{C}$ and a minimum volume of 1000 times the thermistor's body and test fixture combined over the liquid bath. Set the bridge for "Null" with the zero power resistance value measured at $+43.4^\circ\text{C}$ in Initial Measurements. Throw the switch to position BB and lift the thermistor from the bath into the still-air chamber at a uniform speed of $50.8 \pm 6.35\text{mm/s}$ by means of a controlled drive mechanism or other suitable method. The vertical travel of the thermistor shall be $101.6 \pm 2.54\text{mm}$ from the surface of the liquid bath.

Measure and record the time from the instant the thermistor bead (contained in the probe or rod) leaves the surface of the bath to the time when the bridge indicator passes through the "Null" point. This time is the thermal time constant of the thermistor.

NOTE:

A low-persistence screen oscilloscope with a graduated time scale may be used for this measurement.

8.3.1.4 Insulation Resistance

Insulation resistance shall be tested in accordance with MIL-STD-202, Test Method 302, Test Condition A. The following details shall apply:

- Special Preparation
Thermistors shall be clamped in the trough of a 90° metal V-block of such size that the body does not extend beyond the extremities of the block. The clamping force shall be such that adequate contact between the thermistor and block is guaranteed.
The thermistor leads shall be so positioned that the distance between them and any point of the V-block is not less than the radius of the thermistor minus the radius of the lead wire.
- Points of Measurement
Between the thermistor terminals (shorted together) and the V-block.

– Time for Measurement Acquisition

The voltage shall be applied continuously during one minute (maximum) before the reading of the resistance is performed. When the specified R_1 limit is met and shows to be steady, or increasing in value, the test may be stopped at that point, even if the one minute of test has not been completed.

8.3.2 Parameter Drift Values

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

8.3.3 High and Low Temperatures Electrical Measurements

High and Low Temperatures Electrical Measurements shall be performed as specified in the Detail Specification. The measurements shall be performed on 100% of devices.

8.3.4 Room Temperature Electrical Measurements

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

8.3.5 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.

8.4 BURN-IN

Thermistors shall be subjected to Burn-in for a period of 168 (+14 -0) hours. The applicable Test Conditions are specified in the Detail Specification.

8.5 EXTERNAL VISUAL INSPECTION AND DIMENSION CHECK

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

Dimension Check shall be performed in accordance with ESCC Basic Specification No. 20500 and the Detail Specification.

8.6 RADIOGRAPHIC INSPECTION

ESCC Basic Specification No. 20900.

8.7 SHOCK (SPECIFIED PULSE)

Shock (Specified Pulse) shall be performed in accordance with MIL-STD-202, Test Method 213, Test Condition D. The following details shall apply:

- **Mounting Method**

The thermistors shall be mounted on appropriate jig fixtures with their bodies restrained from movement and their leads supported at a distance of 6.35mm from the thermistor body. The fixtures shall be constructed in a manner so as to ensure that the points of the thermistor mounting supports will have the same motion as the test table.

Thermistors shall be mounted in relation to the test equipment in such a manner that the most detrimental stress is applied. The test leads used during this test shall be stranded wire no larger than AWG 20 so that the influence of the test lead on the thermistors will be held to a minimum. The test lead length shall be no longer than necessary.

- **Number and Direction of Applied Shocks**

The thermistors shall be subjected to a total of 10 shocks in each of two mutually perpendicular planes (one perpendicular, the other parallel to the longitudinal axis of the thermistors).

- **Initial Measurements**

The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C.

- **Data Points**

During the test, an electrical measurement shall be made to determine intermittent contact or open or short-circuiting. The accuracy of the detection equipment shall be sufficient to detect an interruption of 0.1ms (or longer) duration.

On completion of testing, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C. The change in zero power resistance with regard to the initial measurement shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

The thermistors shall be visually inspected and there shall be no evidence of damage.

8.8 VIBRATION

Vibration shall be performed in accordance with MIL-STD-202, Test Method 204, Test Condition D. The following details shall apply:

- **Mounting Method**

The mounting method for Shock (Specified Pulse) shall apply, with the exception that the body of the thermistor shall not be restrained in any manner and shall be allowed to respond to the vibration forces applied.

- **Direction of Motion**

Vibration shall be applied in two mutually perpendicular directions (one perpendicular, the other parallel to the longitudinal axis of the thermistors).

- **Initial Measurements**

The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C.

- **Data Points**

During the test, an electrical measurement shall be made to determine intermittent contact or open or short-circuiting. The accuracy of the detection equipment shall be sufficient to detect an interruption of 0.1ms (or longer) duration.

On completion of testing, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C. The change in zero power resistance with regard to the initial measurement shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

The thermistors shall be visually inspected and there shall be no evidence of damage.

8.9 DIELECTRIC WITHSTANDING VOLTAGES

8.9.1 Dielectric Withstanding Voltage at Atmospheric Pressure

Dielectric Withstanding Voltage shall be performed in accordance with MIL-STD-202, Test Method 301. The following details shall apply:

- Special Preparation: The Special Preparation for Insulation Resistance (Electrical Measurements) shall apply.
- Magnitude of Test Voltage: 500Vrms.
- Nature of Potential
An AC supply of commercial line frequency and waveform (but no more than 100Hz).
- Duration of Application of Test Voltage: 2 minutes.
- Rate of Application of Test Voltage: 100V per second.
- Points of Application of Test Voltage
Between the thermistor terminals (shorted together) and the V-block.
- Data Points
There shall be no sign of breakdown or flash-over during the test. On completion of testing the thermistors shall be visually inspected and there shall be no evidence of damage, arcing or breakdown.

8.9.2 Dielectric Withstanding Voltage at Reduced Barometric Pressure

Dielectric Withstanding Voltage shall be performed in accordance with MIL-STD-202, Test Method 105, Test Condition C. The following details shall apply:

- Special Preparation: The Special Preparation for Insulation Resistance (Electrical Measurements) shall apply.
- Magnitude of Test Voltage: 200Vrms.
- Nature of Potential
An AC supply of commercial line frequency and waveform (but not more than 100Hz).
- Duration of Application of Test Voltage: 2 minutes.
- Points of Application of Test Voltage
Between the thermistor terminals (shorted together) and the V-block.
- Data Points
There shall be no sign of breakdown or flash-over during the test. On completion of testing the thermistors shall be visually inspected and there shall be no evidence of damage, arcing or breakdown.

8.10 RESISTANCE TO SOLDERING HEAT

Resistance to Soldering Heat shall be performed in accordance with MIL-STD-202, Test Method 210. The following details and exceptions shall apply:

- Requirements for Sample Selection
Samples shall not have been soldered in any previous tests.
- Depth of Immersion in Molten Solder
To a point between 3.18mm and 4.76mm from the thermistor body.
- Temperature of Solder: $+300 \pm 10^{\circ}\text{C}$.
- Duration of Immersion: 2 ± 0.5 seconds.
- Data Points
On completion of testing and after a cooling time of 24 ± 4 hours, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at $+25^{\circ}\text{C}$. The value shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.
The thermistors shall be visually inspected and there shall be no evidence of damage.

8.11 MOISTURE RESISTANCE

Moisture Resistance shall be performed in accordance with MIL-STD-202, Test Method 106. The following details and exceptions shall apply:

- **Mounting**
Thermistors shall be soldered by their leads to insulated stand-off terminals on a suitable panel so that there will be at least 25.4mm of free air space around each thermistor. The spacing of the mounts shall be such that the length of each thermistor lead is 19.05mm maximum when measured from the edge of the supporting terminal to the thermistor body.
- **Initial Measurements**
Not less than 1.5 hours after completion of Initial Conditioning and the thermistors have been removed from the drying oven, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at $+25 \pm 0.05^{\circ}\text{C}$.
- **Loading**
During the first two hours of steps 2 and 5, a test potential which will maintain the thermistors at their maximum power as specified in the Detail Specification shall be applied to two thermistors. The remaining thermistor will be tested with no application of voltage.
- **Post-Humidity Conditioning**
Upon completion of step 6 of the final cycle the thermistors shall be maintained at the high humidity conditions, at a temperature of $+25 \pm 2^{\circ}\text{C}$, for a period of 1.5 to 3.5 hours. The thermistors shall not be subjected to forced circulating air during conditioning.
- **Data Points**
Within 24 hours of completion of testing, the thermistors shall be subjected to the following measurements:
 - Zero power resistance as specified in Para. 8.3.1.1, at $+25 \pm 0.05^{\circ}\text{C}$.
 - Insulation resistance as specified in Para. 8.3.1.4.

The change in zero power resistance with regard to the initial measurement, and the insulation resistance, shall not exceed the respective limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

8.12 DISSIPATION CONSTANT

Dissipation Constant shall be tested during Production Control and Qualification and Periodic Tests in accordance with the method and test procedure described in Electrical Measurements herein.

For Production Control tests the measured value of Dissipation Constant shall not exceed the limit specified in Room Temperature Electrical Measurements in the Detail Specification.

For Qualification and Periodic Tests the measured value of Dissipation Constant shall not exceed the limit specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

8.13 THERMAL TIME CONSTANT

Thermal Time Constant shall be tested during Production Control and Qualification and Periodic Tests in accordance with the method and relevant test procedure described in Electrical Measurements herein.

For Production Control tests the measured value of Thermal Time Constant shall not exceed the limit specified in Room Temperature Electrical Measurements in the Detail Specification.

For Qualification and Periodic Tests the measured value of Thermal Time Constant shall not exceed the limit specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

8.14 SOLDERABILITY

Solderability shall be performed in accordance with MIL-STD-202, Test Method 208. The following details shall apply:

- Requirements for Sample Selection
Samples shall not have been soldered in any previous tests.
- Number of Terminations to be tested for each Thermistor: All terminations.
- Depth of Immersion in Flux and Solder
Terminals shall be immersed to within 1.25mm of the thermistor body.

8.15 TERMINAL STRENGTH

Terminal Strength shall be performed in accordance with MIL-STD-202, Test Method 211. The specific Test Conditions, details and exceptions depend on the thermistor type being tested.

(a) Disk and Bead-Type Thermistors

- Test Condition: A.
- Initial Measurements
The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C.
- Clamping
The thermistors shall be firmly clamped.
- Applied Force
Each terminal shall be individually subjected to the pull conditions specified in the Detail Specification.
- Data Points
On completion of testing, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C. The change in zero power resistance with regard to the initial measurement shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.
The thermistors shall be visually inspected and there shall be no evidence of damage.

(b) Rod-Type Thermistors

- Test Conditions: A and C.
- Initial Measurements
The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C.
- Clamping
The thermistors shall be firmly clamped.
- Applied Force
 - (i) Pull Test: Each terminal shall be individually subjected to the pull conditions specified in the Detail Specification.
 - (ii) Bend Test: Each terminal shall be individually subjected to the load conditions specified in the Detail Specification.
- Data Points
On completion of testing, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C. The change in zero power resistance with regard to the initial measurement shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.
The thermistors shall be visually inspected and there shall be no evidence of damage.

8.16 SHORT TIME LOAD

Short Time Load shall be performed in accordance with the following details and conditions:

- Ambient Temperature: +25 ±3°C.
- Maximum Power Rating
Using the values of nominal zero power resistance and dissipation constant specified in the Detail Specification, calculate the average values of E_{TH} and I_{TH} required to raise the thermistor to its maximum power rating.
- Power Supply
A filtered, regulated DC or battery power supply shall be used.
- Method
 - (i) Place the thermistor in a suitable circuit to produce the calculated maximum power rating.
 - (ii) Energise the circuit for 5 minutes and de-energise for 10 minutes, then repeat this cycle a further nine times.
- Data Points
On completion of testing, the zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C. The value shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.
The thermistors shall be visually inspected and there shall be no evidence of arcing, burning or charring.

8.17 LOW TEMPERATURE STORAGE

Low Temperature Storage shall be performed in accordance with the following details and conditions:

- **Method of Mounting**
The mounting method used for Zero Power Resistance is optional. However, the thermistors shall be isolated from the metal surfaces of cold boxes.
- **Procedure**
 - (i) The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C.
 - (ii) Within one hour of this measurement, the thermistors shall be placed in a cold chamber at room temperature. The temperature shall then be reduced to $-62\pm 3^{\circ}\text{C}$ and the thermistors shall be maintained at that temperature for a period of not less than 3 hours.
 - (iii) The thermistors shall then be removed from the chamber and be stabilised at room ambient temperature.
- **Data Points**
The zero power resistance of the thermistors shall be measured and recorded, as specified in Para. 8.3.1.1, at +25°C and the change in zero power resistance with regard to the initial measurement shall not exceed the limits specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.
The thermistors shall be visually inspected and there shall be no evidence of damage.

8.18 OPERATING LIFE

Operating Life shall be performed in accordance with MIL-STD-202, Test Method 108. The following details shall apply:

- **Method of Mounting**
The thermistors shall be mounted by a suitable means of mounting, and be positioned in such a way that the temperature of each thermistor does not appreciably influence the temperature of any other. There shall be no undue draught over the thermistors; only natural convection due to the hot thermistors may occur.
- **Test Circuit**
A suitable DC circuit which is capable of altering the potential across the thermistor under test (E_{TH}) and the current through the thermistor under test (I_{TH}) shall be used.
- **Operating Life Conditions:** As specified in Operating Life in the Detail Specification. The duration of Operating Life test shall be 2000 ± 48 hours.
- **Data Points**
Electrical Measurements shall be performed in accordance with Intermediate and End-Point Electrical Measurements in the Detail Specification at 0, 1000 ± 48 and 2000 ± 48 hours.
If drift values are specified, the drift shall always be related to the 0-hour measurement.

8.19 PERMANENCE OF MARKING

ESCC Basic Specification No. 24800.

8.20 HIGH TEMPERATURE STORAGE

High Temperature Storage shall be performed in accordance with the following details and conditions:

- Duration: 2000 hours.
- Method of Mounting
The mounting method used for Zero Power Resistance is optional. However, the thermistors shall be isolated from the metal surfaces of ovens.
- Test Conditions
 - (i) The temperature shall be within $\pm 2^{\circ}\text{C}$ of the maximum storage temperature defined in Maximum Ratings in the Detail Specification.
 - (ii) No load.
- Data Points
Electrical measurements shall be performed in accordance with Intermediate and End-Point Electrical Measurements in the Detail Specification at 0, 1000 ± 48 and 2000 ± 48 hours. If drift values are specified, the drift shall always be related to the 0-hour measurement.

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.
- (i) Radiographic Inspection photographs.

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

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

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

9.1.2 Qualification and Qualification Maintenance

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

9.1.3 Component Procurement and Delivery

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

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

9.1.4 Additional Documentation

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

9.1.5 Data Retention/Data Access

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

9.2 COVER SHEET(S)

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

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

9.3 LIST OF EQUIPMENT USED

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

9.4 LIST OF TEST REFERENCES

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

9.5 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. For each test requiring electrical measurements the results shall be recorded against component serial number. Component drift calculations shall be recorded for each specified test against component serial number.

9.7 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 No. 20100 or 25400.

10 **DELIVERY**

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

- (a) The delivery lot.
- (b) The components used for Lot Validation Testing (as applicable), but not forming part of the delivery lot, if stipulated in the Purchase Order.
- (c) The relevant documentation in accordance with the requirements of Paras. 9.1.2 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.

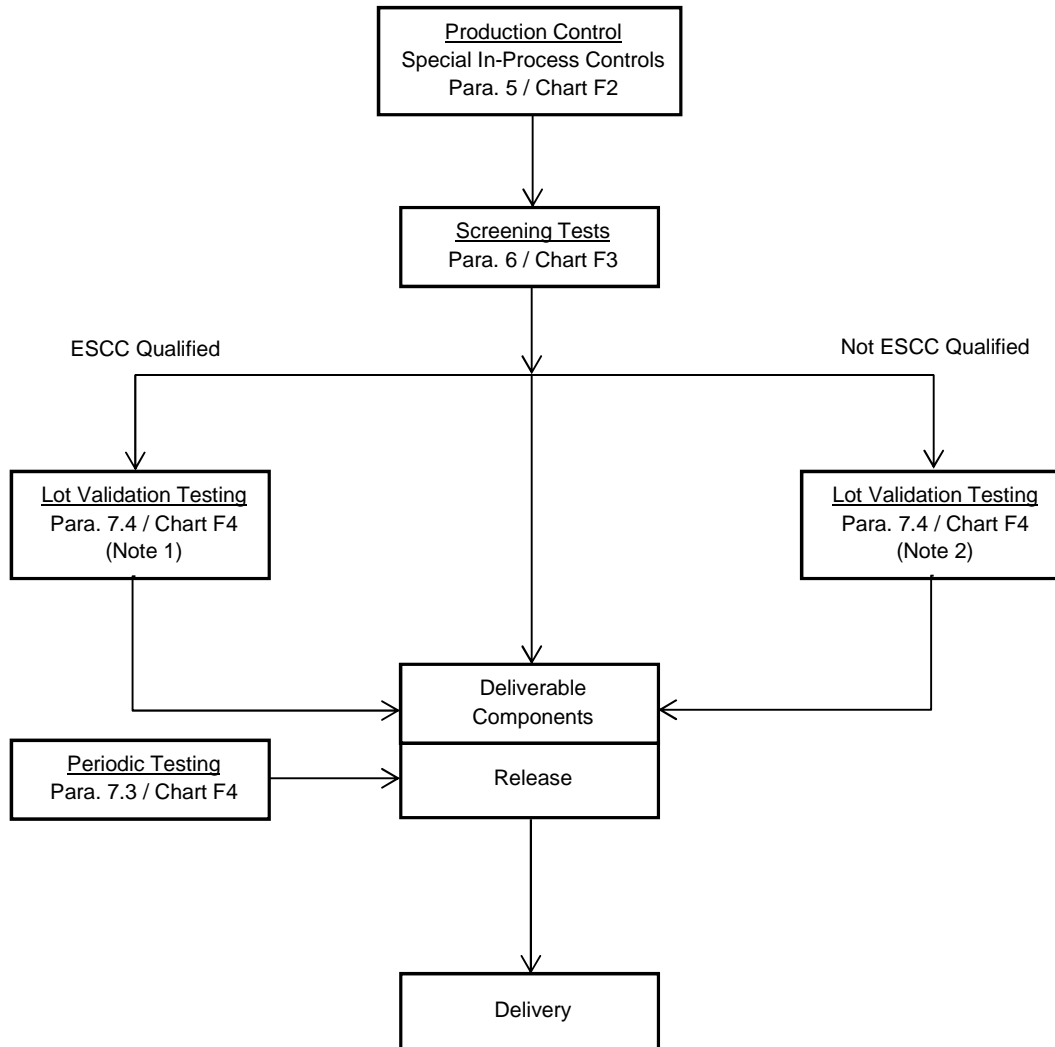
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification No. 20100 or 25400 and the relevant paragraphs of Section 9 of this specification.

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

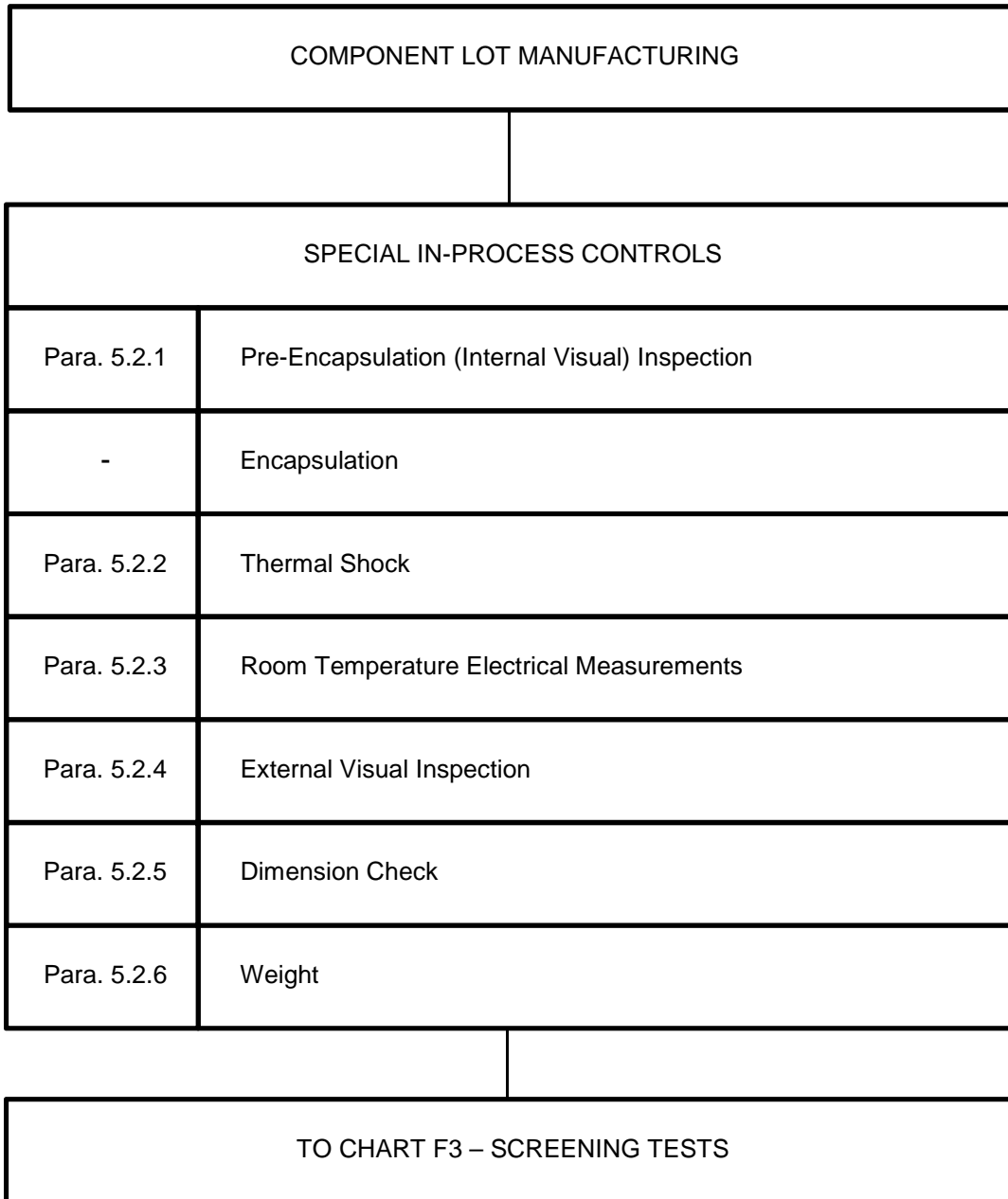
12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



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).

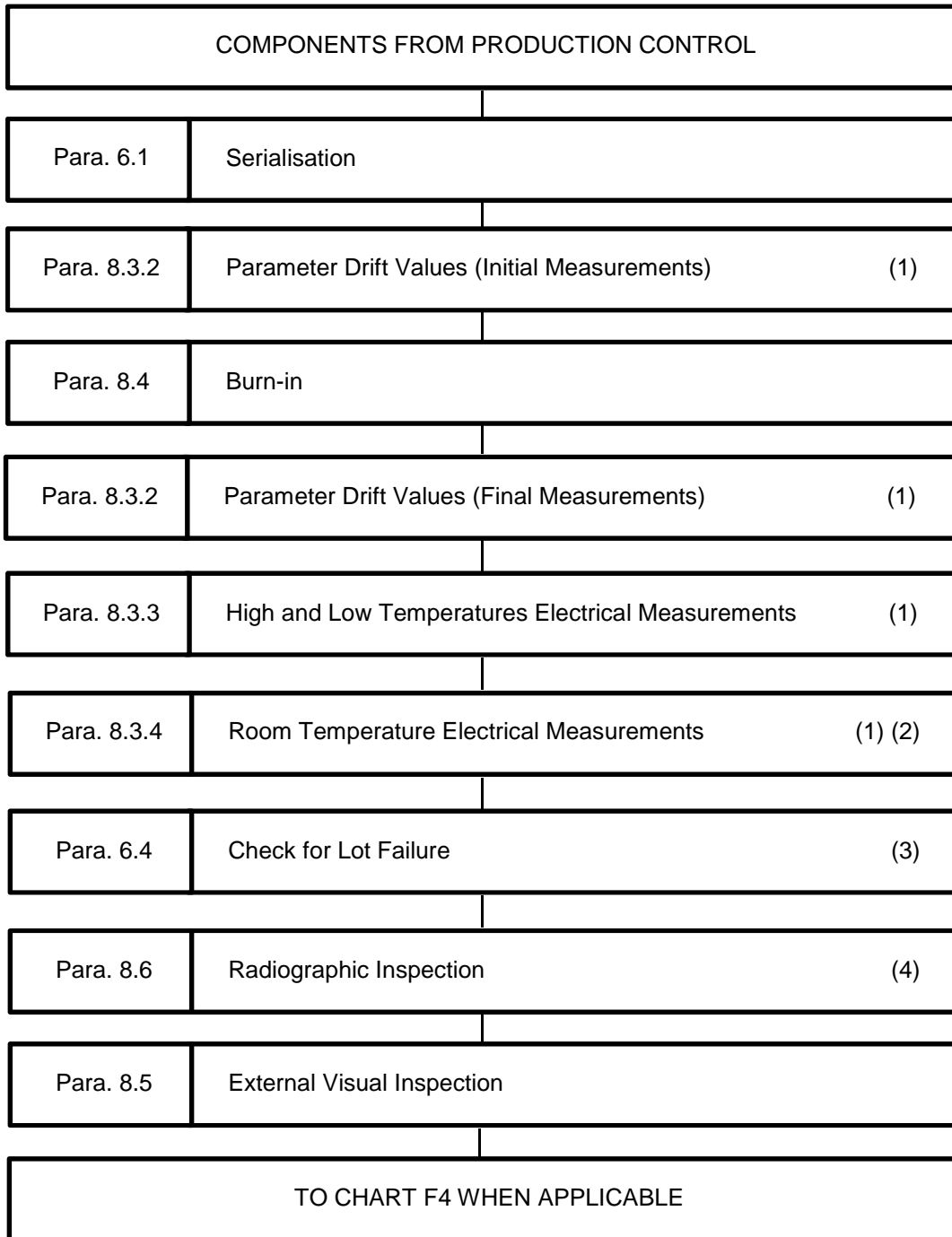
12.2 CHART F2 - PRODUCTION CONTROL



NOTES:

1. Performed on a sample basis.
2. Guaranteed but not tested.

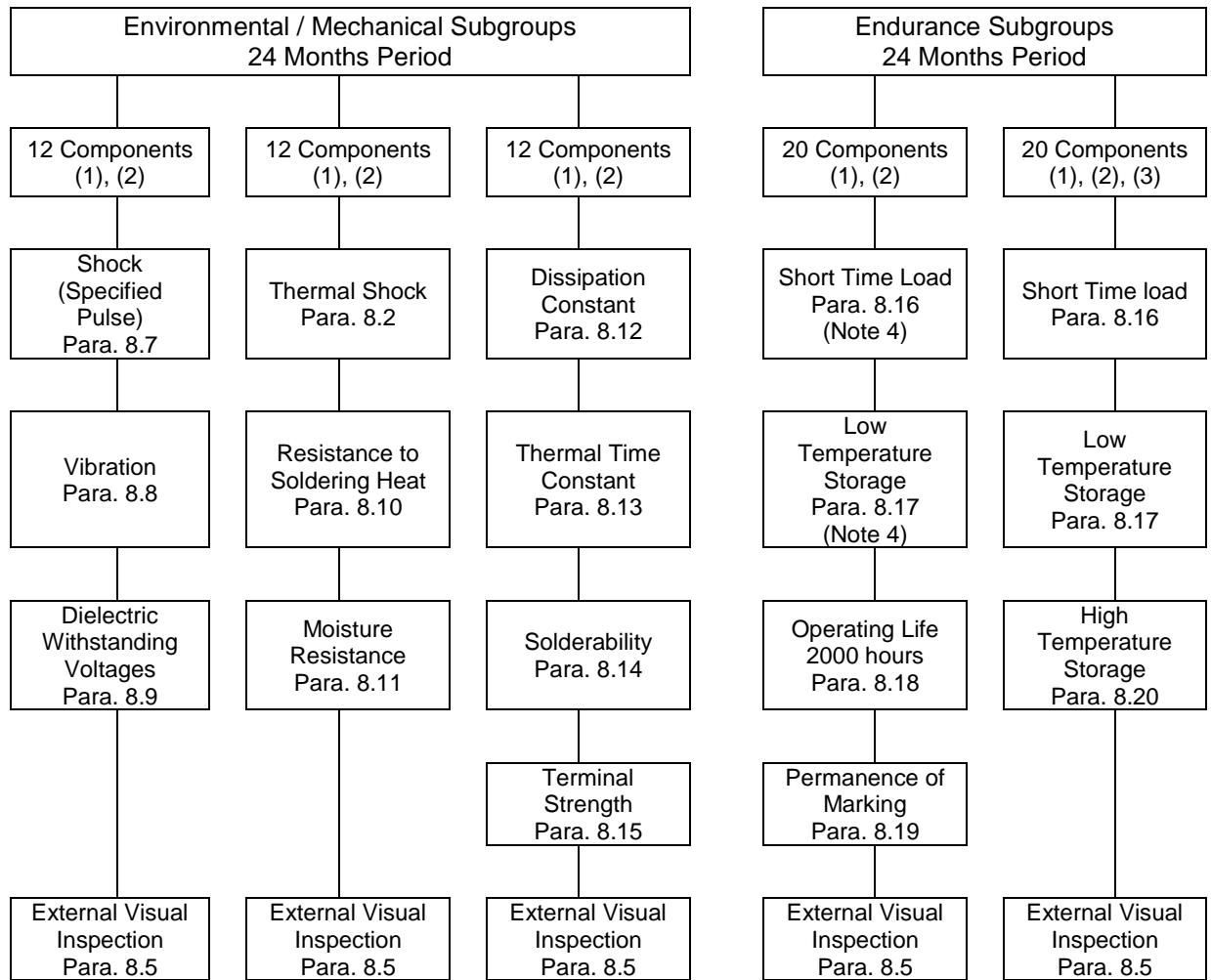
12.3 CHART F3 – SCREENING TESTS



NOTES:

1. The lot failure criteria of Para. 6.4 apply to this test.
2. Measurements of Parameter Drift Values need not be repeated in Room Temperature Electrical Measurements.
3. Check for Lot Failure shall take into account all electrical parameter failures that may occur during Screening Tests subsequent to Serialisation.
4. Radiographic Inspection may be performed at any point during Screening Tests after Serialisation.

12.4 CHART F4 – QUALIFICATION AND PERIODIC TESTS



NOTES:

1. For distribution within the subgroups see Para. 7.1.2 for qualification and qualification maintenance and Para. 7.4 for Lot Validation Testing.
2. No failures are permitted.
3. This Subgroup of tests shall be performed only if the maximum storage temperature of the devices is higher than their maximum operating temperature.
4. To be performed only if the maximum storage temperature of the devices is equal to their maximum operating temperature.