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**COILS, RF AND POWER, FIXED
(INDUCTORS AND TRANSFORMERS)**

ESCC Generic Specification No. 3201

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1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of coils, RF and power, fixed (inductors and transformers) 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](#).
- Qualification of a component within an approved capability domain per ESCC Basic Specification No. [24300](#).
- 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 Dispatch of ESCC Components.
- No. [21300](#), Terms, Definitions, Abbreviations, Symbols and Units.
- No. [21700](#), General Requirements for the Marking of ESCC Components.
- No. [22600](#), Requirements for the Evaluation of Standard Electronic Components for Space Application.
- No. [22800](#), ESCC Non-Conformance Control System.
- No. [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. [24300](#), Requirements for the Capability Approval of Electronic Component Technologies 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](#), [24300](#), [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: Electronic and Electrical Component Parts.

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:

- ESCC Detail Specification.
- ESCC Generic Specification.
- ESCC Basic Specification.
- 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 approval of a capability domain and the qualification of a component (type approval testing) within an approved domain shall be in accordance with ESCC Basic Specification No. [24300](#).

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.

4.1.5 Pre-Assembly Customer Source Inspection

If stipulated in the Purchase Order, the Orderer may perform a source inspection at the Manufacturer's facility prior to assembly (including, for example, performance of Internal Visual Inspection). Details of the inspections to be performed or witnessed and the required period of notification shall be as stipulated in the Purchase Order.

4.2 QUALIFICATION AND QUALIFICATION MAINTENANCE REQUIREMENTS ON A MANUFACTURER

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

To obtain and maintain the qualification of a component in a capability approved domain, a Manufacturer shall satisfy the requirements of ESCC Basic Specification No. [24300](#).

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

4.3 DELIVERABLE COMPONENTS

4.3.1 ESCC Qualified Components

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

4.3.2 ESCC Components

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

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

4.3.3 Lot Failure

Lot failure may occur during Screening Tests (Chart F3), or Qualification 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 materials and finishes of the components specified in the Detail Specification shall comply with the restrictions on materials specified in ESCC Basic Specification No. [22600](#).

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 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.

5.2.3 Weight

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

5.2.4 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. Thermal Shock and 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 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](#), [24300](#) or [25400](#) as applicable. They are also applicable to Lot Validation Testing as part of the procurement of qualified or unqualified components.

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

7.1 QUALIFICATION TESTING

7.1.1 General

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

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

The conditions governing qualification testing are specified in ESCC Basic Specification No. [20100](#).

7.1.2 Distribution within the Qualification Test Lot

The Qualification Test Lot shall be comprised in accordance with the following provisions, depending on whether it is required to obtain qualification for a single component type or for a family of component types.

7.1.2.1 *Single Component Type*

When it is proposed to submit a single component for qualification testing, the sample quantity shall be as specified in Chart F4, Note 1. However, when such a single component type is to be qualified in more than one type of package, each package variation must be equally represented in, the Environmental/Mechanical, Endurance and Assembly Capability Subgroups. For this purpose, the applicable sample distribution shall be the same as for the qualification of a family of component types as specified in Para. 7.1.2.2.

7.1.2.2 *Family of Component Types*

A family of component types is a series of components produced by the same manufacturing techniques, up to and including final assembly, using the same types of machines and apparatus and using the same design rules. Such components will have the same shape of magnetic core and the same production processes and techniques related to windings, internal assembly, impregnation, encapsulation, moulding, etc., as applicable.

Qualification may be granted to a family of components subject to the successful outcome of the qualification testing of certain specified component types to represent the family. The component types selected must adequately represent all of the various mechanical, structural and electrical elements encountered within the family.

The component types chosen must be those that employ the extremes of design rules and tolerances and contain the maximum of internal complexity, i.e. usually those that give the greatest risk of rejection.

When qualification is required for component types in more than one type of package, each package must be adequately represented in the Environmental/Mechanical, Endurance and Assembly Capability subgroups.

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.

The number of component types selected as representative of the family will therefore determine the total number of components comprising the qualification test lot. The sample size for each type selected shall be as specified in Chart F4, Note 2.

7.2 QUALIFICATION WITHIN A CAPABILITY APPROVED DOMAIN

The qualification of a component within a capability approved domain shall be in accordance with ESCC Basic Specification No. [24300](#).

7.3 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](#).

7.4 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 within a capability approved domain is maintained by maintenance of the approval of the capability domain itself in accordance with ESCC Basic Specification No. [24300](#).

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](#).

7.5 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.

7.6 FAILURE CRITERIA

The following criteria shall apply to qualification, qualification maintenance and Lot Validation Testing.

7.6.1 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. Thermal Shock, Barometric Pressure, Terminal Strength, etc.

7.6.2 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.

7.6.3 Other Failures

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

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

7.7 FAILED COMPONENTS

A component shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 7.6.

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.

7.8 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. 7.6.

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. 7.6.

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

7.9 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.

7.10 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.

For all tests, unless otherwise specified, the components shall be mounted by their normal mounting means on a suitable test fixture.

8.1 INTERNAL VISUAL INSPECTION

Prior to assembly, the different elements of the components shall be inspected in accordance with the requirements of ESCC Basic Specification No. [20400](#).

8.2 THERMAL SHOCK

[MIL-STD-202, Method 107](#) with the following details:

- (a) During Screening Tests (Chart F3):
 - Test condition: A-1 (25 cycles) except that the high temperature step shall be at the maximum operating temperature as specified in Maximum Ratings in the Detail Specification.
 - Data Points:
On completion of testing, the components shall be visually examined. There shall be no evidence of damage or loosening of terminals.
- (b) During Qualification and Periodic Testing (Chart F4):
 - Test condition: A-3 (100 cycles) except that the high temperature step shall be at the maximum operating temperature as specified in Maximum Ratings in the Detail Specification.
 - Data Points:
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage or loosening of terminals.
After a recovery period of 24 hours minimum at ambient room conditions, Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification.

8.3 ELECTRICAL MEASUREMENTS

8.3.1 General

Electrical measurements and test methods shall be as follows. The electrical tests specified herein do not necessarily include all of the electrical tests that may be requested in the Detail Specification.

The required electrical measurements and test conditions shall be as specified in the Detail Specification.

8.3.1.1 *Inductance*

The inductance of all windings shall be measured using suitable equipment, at the test voltage, test frequency and with or without the DC rated current applied as specified in the Detail Specification.

8.3.1.2 *DC Resistance*

DC resistance of all windings shall be measured using suitable equipment. Unless otherwise specified, the test current shall be as small as practical and in any case shall not exceed the rated values specified in Maximum Ratings in the Detail Specification.

8.3.1.3 *Insulation Resistance*

[MIL-STD-202, Method 302](#) with the following details:

- Test condition: B (500Vdc), unless otherwise specified.
- Electrification time:
 - during Screening Tests (Chart F3): 5s minimum.
 - during Qualification and Periodic Testing (Chart F4): 1 minute minimum.
- Points of measurement:
 - between each winding, all other windings being connected together.
 - between each winding and the case or core, all windings not under test grounded to the case or core or to normal mounting means.

8.3.1.4 Dielectric Withstanding Voltage

MIL-STD-202, Method 301 with the following details:

- Magnitude of test voltage: unless otherwise specified, the AC test voltage shall be a minimum of 500Vrms for encapsulated components and 200Vrms for conformally-coated components. When a test voltage greater than 1000Vrms is specified in the Detail Specification, it shall be applied gradually at a rate not exceeding 500Vrms/s.
- Electrification time:
 - During Screening Tests (Chart F3): 5s minimum.
 - During Qualification and Periodic Testing (Chart F4): 1 minute minimum.
- Points of measurement:
 - between each winding, all other windings being connected together.
 - between each winding and the case or core, all windings not under test grounded to the case or core or to normal mounting means.
- Data Points:

During and on completion of testing, the components shall be visually examined. There shall be no evidence of arcing, flashover, breakdown of insulation or any damage.

8.3.1.5 Turns Ratio and Voltage Ratio

The ratio as specified in the Detail Specification, shall be determined by the voltmeter method or any other suitable means.

8.3.1.6 Polarity

Winding polarity shall be determined by comparing the voltages of windings or any other suitable means.

8.3.1.7 Capacitance

MIL-STD-202, Method 305 for distributive or winding to winding capacitance as specified in the Detail Specification, with the following details:

- Test frequency: as specified in the Detail Specification.
- Magnitude of polarizing voltage: as specified in the Detail Specification.

8.3.1.8 Quality Factor

Quality factor (Q) shall be measured using suitable equipment with test conditions as specified in the Detail Specification.

8.3.1.9 Centre-tap Resistive and Inductive Unbalance.

For centre-tapped windings, the resistive unbalance shall be calculated as follows, where R1 and R2 are the resistances of each part of the winding and R1 > R2:

$$B = \frac{R1 - R2}{R2} \times 100\%$$

For inductive unbalance, replace R1 by L1 and R2 by L2.

8.3.1.10 Phase Shift

The phase shift shall be measured by a phase shift meter or other suitable method, with test conditions as specified in the Detail Specification.

8.3.1.11 *Primary Impedance*

The transformer primary impedance shall be measured with all normally loaded secondaries loaded with their specified impedances, and with the test current specified in the Detail Specification flowing in the windings. The resistance and reactance looking into the primary shall be measured by a bridge or equivalent method at the input frequency and voltage specified in the Detail Specification.

8.3.1.12 *Frequency Response*

Frequency response shall be measured with all normally loaded secondaries loaded with their specified impedances, and with the test current specified in the Detail Specification flowing in the windings. The input and output voltages are then measured at the specified frequencies.

Frequency response is determined as follows:

$$Rf = 20 \log \frac{E_f}{E_r}$$

Where:

- E_r = output voltage at reference frequency
- E_f = output voltage at any other frequency

8.3.1.13 *Self-Resonant Frequency*

The self-resonant frequency shall be determined using suitable equipment. Starting at the lowest frequency within the specified frequency range, the frequency shall be increased and the Z_o impedance observed. The frequency at which the impedance Z_o is maximum shall be recorded as the self-resonant frequency.

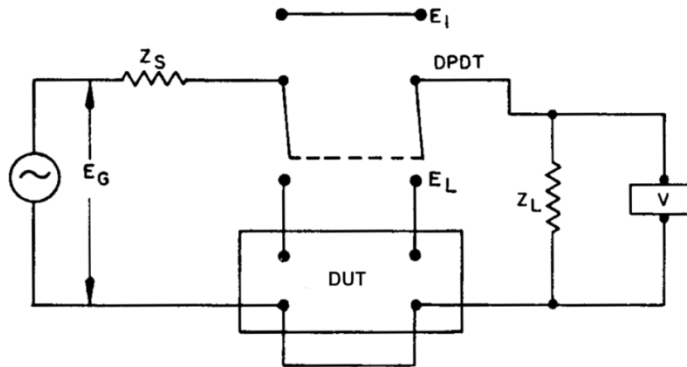
NOTE: Z_o = Primary impedance with no secondary load (unless otherwise specified).

8.3.1.14 *Harmonic Distortion*

The transformer shall be terminated in its proper source and load impedance. A sine-wave voltage of specified frequency shall be applied such that the specified output conditions are achieved and the total harmonic distortion shall then be determined using suitable equipment.

8.3.1.15 Insertion Loss

Insertion loss shall be determined using the circuit shown hereunder. The load voltage with and without the transformer in the circuit, with a constant generator voltage E_G , shall be measured at the specified frequency.



The insertion loss shall be calculated using the following formula:

- (a) Insertion loss for equal input and output impedance:

$$IL = 20 \log \frac{E_1}{E_2}$$

Where:

- IL = insertion loss with ($E_G = E_L$) constant
- E_1 = voltage with the transformer not in the circuit at the specified frequency
- E_2 = load voltage with the transformer in the circuit at the specified frequency

- (b) Insertion loss for unequal input and output impedance:

$$IL = 20 \log \frac{E_G}{2E_L} + 20 \log \frac{Z_L}{Z_S}$$

Where:

- IL = insertion loss
- E_G = constant voltage across the generator
- E_L = load voltage with transformer in circuit
- Z_S = source impedance (to match the reflected input design impedance)
- Z_L = load impedance

8.3.1.16 Waveshape

The waveshape shall be determined using suitable equipment, with the source and load conditions as specified. The waveform parameters shall be measured as follows:

- Pulse amplitude: the amplitude voltage of the pulse shall be measured excluding peaks and portions unwanted or not relevant.
- Pulse rise time and the pulse decay time: the intervals between the instants where the signal reaches 10% to 90% of the pulse amplitude shall be measured.
- Pulse width: the intervals between the instants where the signal reaches 50% of the pulse amplitude shall be measured.
- Pulse peak power: the maximum pulse peak voltage shall be multiplied by the pulse peak duration.

8.3.2 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. In the event of any failure, a 100% measurement may be performed.

8.3.3 Room Temperature Electrical Measurements

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

8.3.4 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

[MIL-STD-202, Method 108](#) with the following details:

- Duration: 168 (+24 -0) hours unless otherwise specified.
- Test conditions: $T_{amb} = +125 (+0 -3)^{\circ}\text{C}$ in a non-operating condition, unless otherwise specified.
- Data Points:
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage or loosening of terminals.

8.5 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.

8.6 BAROMETRIC PRESSURE

[MIL-STD-202 Method 105](#) with the following details:

- Test condition: C (4.4kPa), unless otherwise specified.
- Data Points:
While the components are still at the specified low pressure, they shall be subjected to Dielectric Withstanding Voltage as follows and as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification, unless otherwise specified:
 - For component working voltage $\leq 50\text{V}$: 100Vrms minimum.
 - For component working voltage $> 50\text{V}$: 300Vrms or 1.25 x working voltage minimum, whichever is greater.
- During and on completion of testing, the components shall be visually examined. There shall be no evidence of arcing, flashover, breakdown of insulation or any other damage.

8.7 TEMPERATURE RISE

The temperature rise of components shall be determined by any suitable method, but preferably by the resistance-change method. The following details shall apply:

- Method of mounting: the components shall be suspended by their terminals during the test. They shall be separated from each other by a distance of not less than 25mm. During the test, radiant shields may be placed between units, so that overheating of one unit will not affect a nearby unit. Lead wires shall be of copper, 150mm long, and of size specified hereunder:

Rated Current (A)	Wire Size	
	AWG	Diameter (mm)
Up to 3	24	0.64
> 3 to ≤ 5	22	0.85
> 5 to ≤ 11	20	1.04
> 11 to ≤ 16	18	1.29
> 16 to ≤ 22	16	1.53
> 22 to ≤ 32	14	1.87

- Ambient test temperature: Unless otherwise specified in the Detail Specification, the test temperature shall be the same as ambient room conditions. The test chamber shall be free of test area draughts and direct thermal radiation. A temperature indicating device with an accuracy of $\pm 0.5^{\circ}\text{C}$ shall be located in the area surrounding the component under test, but not where it will be influenced by the temperature rise of the component. The test chamber shall be stabilised at the required ambient test temperature without forced-air ventilation or any means of component cooling.
- Test conditions: the device with all normally loaded secondaries loaded with their specified impedances, shall have their windings loaded with the rated currents and voltages at the minimum frequency specified in the Detail Specification. Forced-air circulation shall be shut off when the electrical conditions are applied.
- Data Points:
 - Initial measurements: the DC resistance (r) of a winding (preferably the primary) shall be measured with one-tenth rated DC current applied at the specified ambient test temperature (t). When the resistance of the component has stabilised, the resistance value shall be recorded. The ammeter-voltmeter method may be used for determining this resistance, provided that the accuracy of the meters is $\pm 0.5\%$ or better and the resistance of the voltmeter is at least $20000\Omega/V$.
 - Final measurements: when the resistance of a winding, measured at 5 minute intervals, remains constant, the temperature of the winding shall be measured. If the power is removed, this temperature measurement shall be made within 30s of the removal of power. When the resistance of the component has stabilised with rated DC current applied, the resistance (R) and the test chamber temperature (T) shall be recorded.

The temperature rise (ΔT) shall be calculated by the following formula:

$$\Delta T = \frac{(R - r)}{r} (t + 234.5) - (T - t)$$

where:

- ΔT = temperature rise above the specified temperature of the component under test.
- R = resistance of winding with rated DC current applied at temperature ($T + \Delta T$).
- r = resistance of winding at temperature (t), the specified ambient test temperature.
- t = stabilised specified ambient test temperature of the component under test with one-tenth current applied.
- T = ambient test temperature (at the time forced-air circulation is shut off) with rated DC current applied. T shall not differ from t by more than 5°C.

On completion of testing, the components shall be visually examined. There shall be no evidence of any damage.

8.8 OVERLOAD

The components with all normally loaded secondaries loaded with their specified impedances, shall have their windings loaded with 1.5 times the rated AC or DC current, as specified in the Detail Specification, for a period of 30 minutes.

- Data Points:
After the test, the components shall be examined and there shall be no evidence of cracked cases, charred windings, distorted or softened insulation, loose windings or terminals, or any other damage.
After a minimum of 24 hours, Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification.

8.9 RESISTANCE TO SOLDERING HEAT

Terminals to be used for soldered connections shall be tested in accordance with [MIL-STD-202 Method 210](#) with the following details:

- Special preparation of specimens: sample units shall not have been soldered in any previous tests.
- Depth of immersion in molten solder: to a minimum of 6.35mm from the nearest insulating material or to one-half of the exposed length of the terminal, whichever point is closer to the insulating material. Terminals of SMD components shall be completely immersed.
- Test condition:
 - For all component types except SMD: A (+350°C, 4 to 5s)
 - For SMD components: B (+260°C, 20s)
- Data Points:
After all terminals have returned to room temperature, Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification.
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage or loosening of terminals.

8.10 MECHANICAL SHOCK

[MIL-STD-202 Method 213](#) with the following details:

- Mounting: the components shall be securely fastened by their normal mounting means.
- Test condition: I (sawtooth, 100g, 6ms)
- Data Points:
On completion of testing, all windings shall be checked for electrical continuity by any suitable means that will not introduce currents in excess of the rated value. The components shall then be visually examined. There shall be no evidence of any damage.

8.11 VIBRATION

[MIL-STD-202 Method 204](#) with the following details:

- Mounting: the components shall be securely fastened by their normal mounting means.
- Test condition: G (30g peak)
- Data Points:
On completion of testing, all windings shall be checked for electrical continuity by any suitable means that will not introduce currents in excess of the rated value. The components shall then be visually examined. There shall be no evidence of any damage.

8.12 IMMERSION

[MIL-STD-202 Method 104](#) with the following details:

- Test condition: B (2 cycles, 15 minutes each, in saturated solution of sodium chloride and water).
- Data Points:
On completion of testing, all windings shall be checked for electrical continuity by any suitable means that will not introduce currents in excess of the rated value. The components shall then be subjected to Dielectric Withstanding Voltage and Insulation Resistance as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification, unless otherwise specified. The components shall then be visually examined. There shall be no evidence of flow of impregnating material from the case, corrosion or any other damage.

8.13 MOISTURE RESISTANCE

[MIL-STD-202 Method 106](#) with the following details:

- Mounting: the components shall be mounted on racks or on a PCB.
- Thermal shock: before starting the moisture resistance test, a thermal shock test shall be performed in accordance with [MIL-STD-202 Method 107](#) test condition A (5 cycles) except that the high temperature step shall be at the maximum operating temperature as specified in Maximum Ratings in the Detail Specification.
- Polarisation: unless otherwise specified, a polarising voltage of 100Vdc shall be applied during Steps 1 to 6 inclusive. The voltage shall be positive in respect to the mounting hardware or case.
For components that do not have mounting hardware, the polarising voltage shall be applied as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification.

- Data Points:
Unless otherwise specified, the units shall be removed to ambient room conditions after the 1.5 to 3.5 hour high humidity conditioning period. Within 30 minutes of removal, the components shall be subjected to Dielectric Withstanding Voltage and Insulation Resistance as specified in Intermediate and End-Point Electrical Measurements in the Detail Specification. Within 1 hour of these measurements, Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification. The components shall then be visually examined. There shall be no evidence of corrosion or any other damage.

8.14 OPERATING LIFE

[MIL-STD-202 Method 108](#) with the following details:

- Mounting: the components shall be mounted on racks or on a PCB.
- Duration: 2000 \pm 48 hours.
- Ambient test temperature: as specified in the Detail Specification.
- Operating conditions: Unless otherwise specified in the Detail Specification, the component with all normally loaded secondaries loaded with their specified impedances, shall be loaded with 100% rated power as specified in the Detail Specification.
- Data Points:
Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification at 0, 1000 \pm 48 and 2000 \pm 48 hours. If drift values are specified, the drift shall always be related to the 0-hour measurement.
The components shall be stabilised at ambient room conditions for a minimum of 30 minutes after removal from the test chamber, prior to the performance of measurements. Components shall remain at room temperature for no longer than is necessary to perform the required measurements before being returned to the test chamber.
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage.

8.15 PERMANENCE OF MARKING

ESCC Basic Specification No. [24800](#).

8.16 SOLDERABILITY

Terminals to be used for soldered connections shall be tested in accordance with [MIL-STD-202 Method 208](#) with the following details and exceptions:

- (a) For all component types except SMD:
- Special preparation of specimens: sample units shall not have been soldered in any previous tests.
 - Number of terminations to be tested of each winding: 2.
 - Depth of immersion in flux and solder: both terminals shall be immersed to within 1.25mm of the body.
 - Data Points:
On completion of testing, the components shall be visually examined. The dipped portion of the terminals shall conform to the solid wire termination criteria of [MIL-STD-202 Method 208](#).

(b) For SMD components:

Note: This test is not applicable to weldable terminations.

- Special preparation of specimens: sample units shall not have been soldered in any previous tests. Prior to the solderability test, components shall be aged with 4 hours dry heat at +125°C unless otherwise specified.
- Number of terminations to be tested: all terminations
- Depth of immersion in flux and solder: the terminals shall be completely immersed.
- Procedure: the temperature shall be +245 ±5°C and the duration of immersion 5 ±1s unless otherwise specified.
- Data Points:
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage or loosening of terminals. At least 75% of the terminations shall be covered by a smooth solder coating. The remaining 25% may contain small pin-holes or rough spots, but these shall not be concentrated in one area.

8.17 TERMINAL STRENGTH

(a) For all component types except SMD:

Terminals shall be tested in accordance with [MIL-STD-202 Method 211](#) with the following details:

- Test condition: A (pull test), all terminals.
- Applied force: 22 (+1 -0)N for 5 ±1s in the direction of the axes of the terminations.
- Data Points:
On completion of testing, all windings shall be checked for electrical continuity by any suitable means that will not introduce currents in excess of the rated value. The components shall then be visually examined. There shall be no evidence of loosening or rupturing of terminals, or any other damage.

(b) For SMD components:

All terminals shall be subjected to an adhesion test in accordance with the following:

- Preparation of specimens: SMD components shall be mounted on a suitable substrate. The test substrate shall be such that it shall not influence the results of any test. The metallised land areas shall be of proper spacing so that adjacent components do not affect one another. During soldering, the period and the high temperature shall not exceed the maximum ratings specified in the Detail Specification.
- Procedure: 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 shall be maintained for a period of 10 ±1s.
- Data Points:
On completion of testing, the components shall be visually examined. There shall be no evidence of any damage or loosening of terminals.

9 DATA DOCUMENTATION

9.1 GENERAL

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

This package shall be compiled from:

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

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

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

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

9.1.1 Qualification and Qualification Maintenance

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

9.1.2 Component Procurement and Delivery

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

- (a) Cover sheet (if all of the information is not included on the Certificate of Conformity).
- (b) Certificate of Conformity.

9.1.3 Additional Documentation

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

9.1.4 Data Retention/Data Access

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

9.2 COVER SHEET(S)

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

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

9.3 LIST OF EQUIPMENT USED

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

9.4 LIST OF TEST REFERENCES

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

9.5 SPECIAL IN-PROCESS CONTROLS DATA (CHART F2)

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

9.6 SCREENING TESTS DATA (CHART F3)

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

9.7 QUALIFICATION AND PERIODIC TESTS DATA (CHART F4)

9.7.1 Qualification Testing

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

9.7.2 Periodic Testing for Qualification Maintenance

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

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

9.7.3 Lot Validation Testing

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

9.8 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT

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

- (a) The reference and description of the test or measurement performed as defined in this specification and/or the Detail Specification during Special In-Process Controls, Screening Tests and Qualification and Periodic Tests.
- (b) Traceability information including serial number (if applicable) of the failed component.
- (c) The failed parameter and the failure mode of the component.
- (d) Detailed failure analysis (if requested by the ESCC Executive or Orderer).

9.9 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established in accordance with the requirements of ESCC Basic Specification Nos. [20100](#), [24300](#) 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.

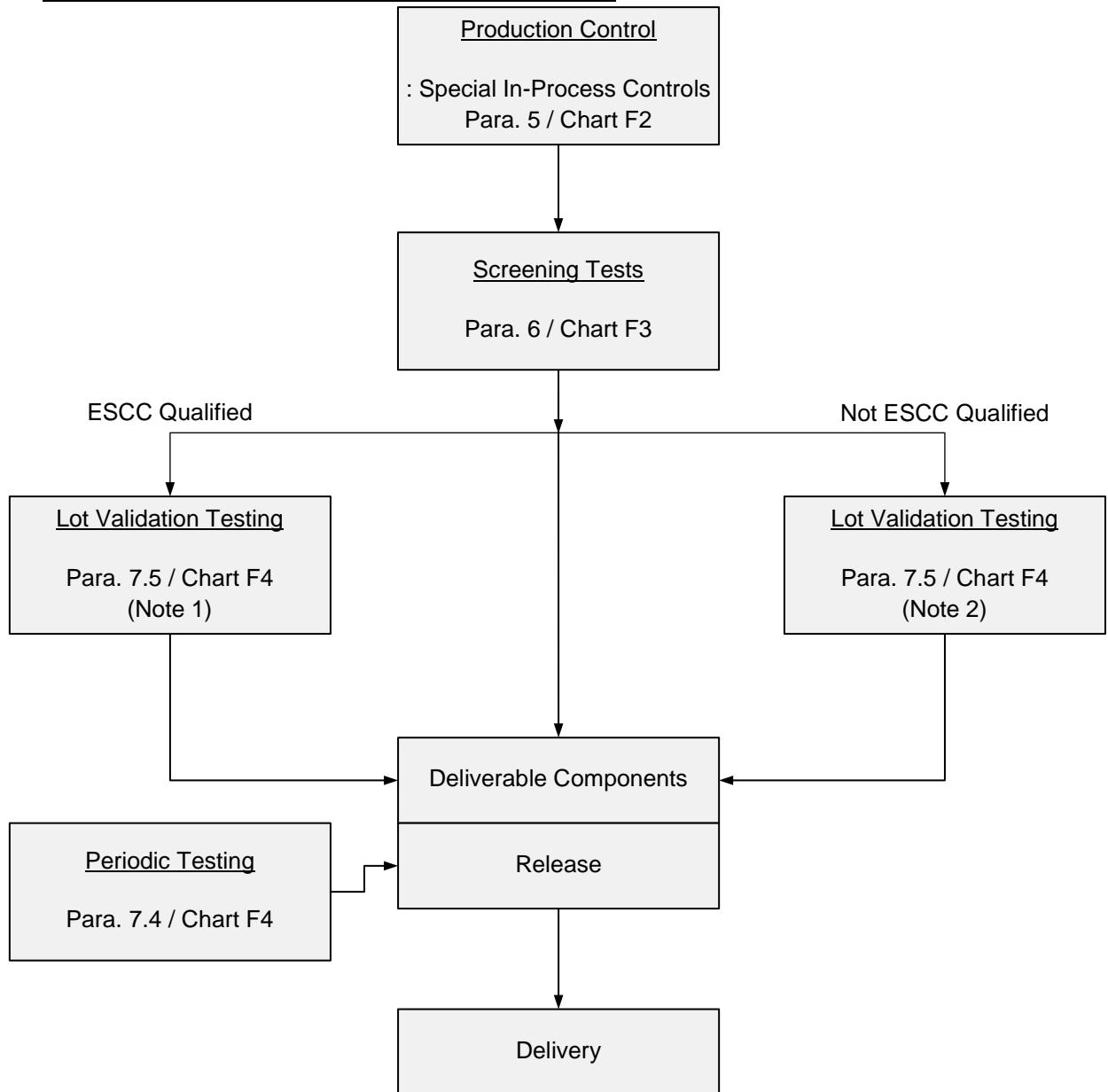
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification Nos. [20100](#), [24300](#) or [25400](#) and the relevant paragraphs of Section 9 of this specification.

11 PACKAGING AND DISPATCH

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

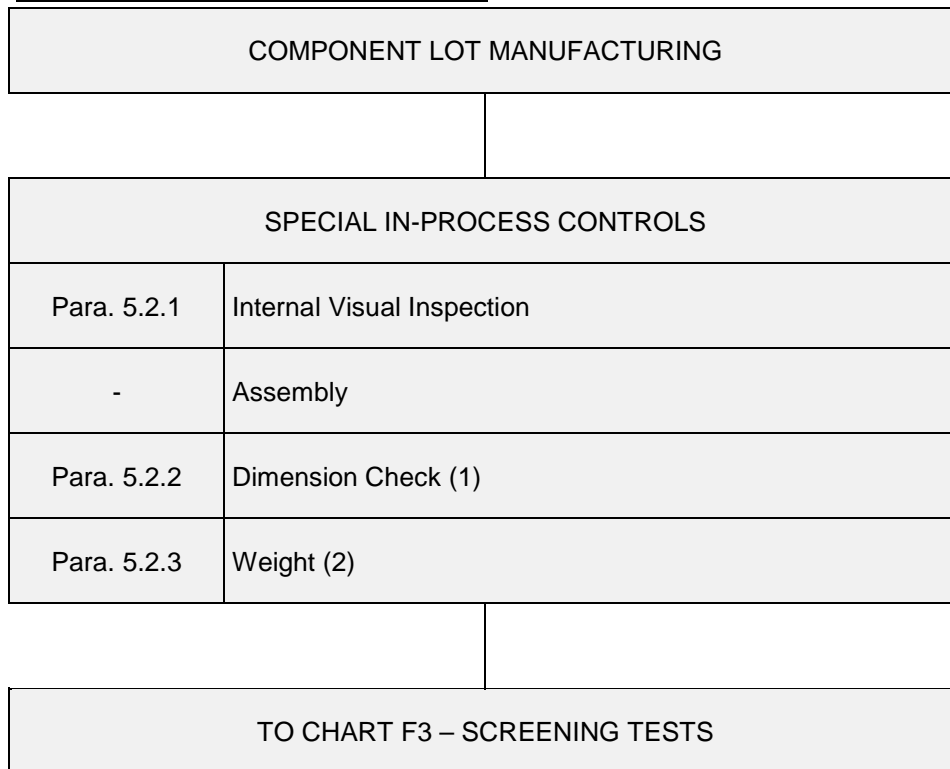
12 CHARTS

12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



NOTES:

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

12.2 CHART F2 - PRODUCTION CONTROL**NOTES:**

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

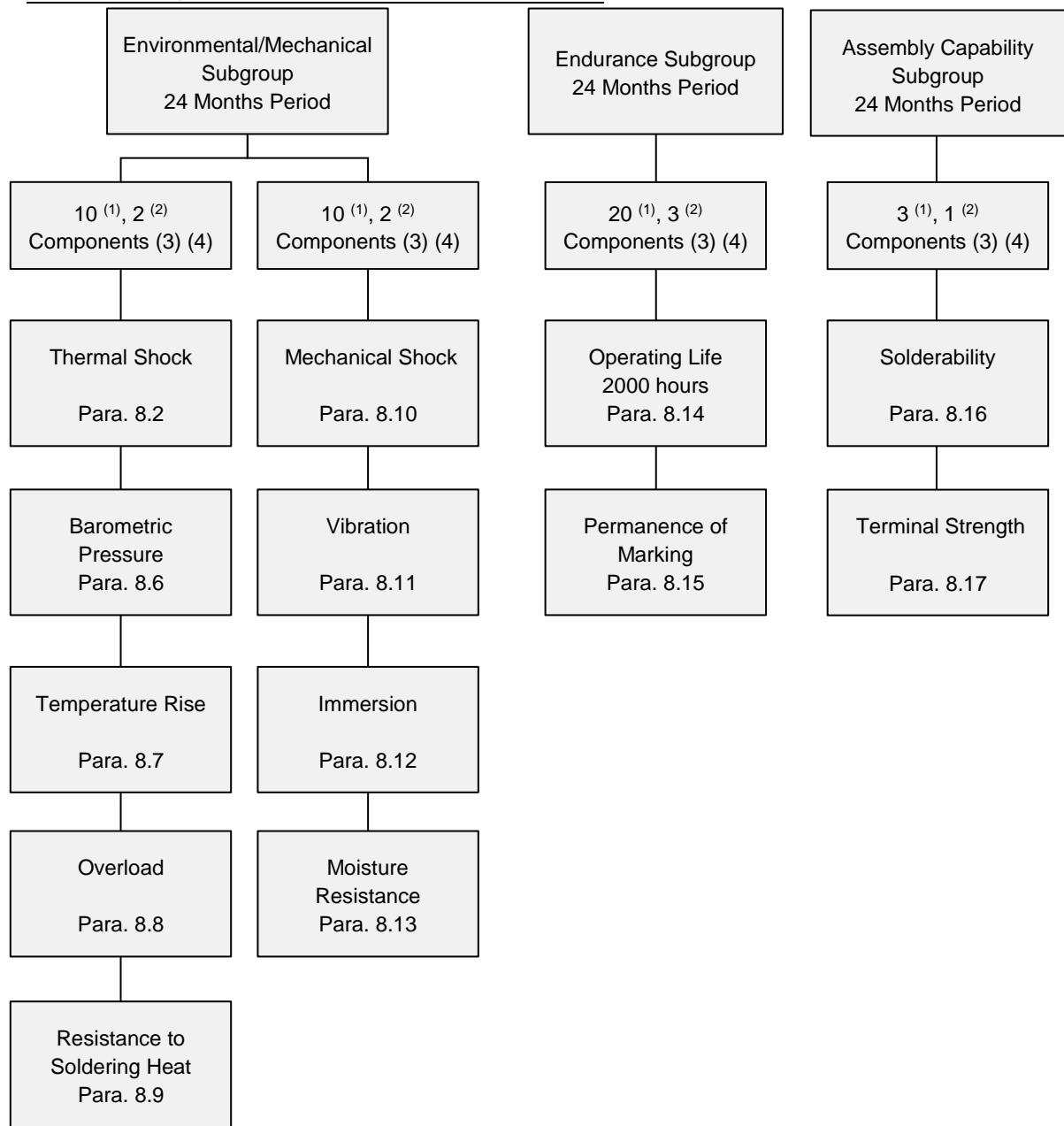
12.3 CHART F3 - SCREENING TESTS

COMPONENTS FROM PRODUCTION CONTROL	
Para. 8.2	Thermal Shock
Para. 8.3.3	Room Temperature Electrical Measurements
Para. 8.4	Burn-in
Para. 8.3.2	High and Low Temperatures Electrical Measurements (1) (2)
Para. 8.3.3	Room Temperature Electrical Measurements (1)
Para. 6.4.1	Check for Lot Failure (3)
Para. 8.5	External Visual Inspection
TO CHART F4 WHEN APPLICABLE	

NOTES:

1. The lot failure criteria of Para. 6.4 apply to this test.
2. Performed on a sample basis.
3. 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.

12.4 CHART F4 - QUALIFICATION AND PERIODIC TESTS



NOTES:

1. Quantity for qualification or qualification maintenance of a single component type (see Para. 7.1.2.1)
2. Minimum quantity per component type for qualification or qualification maintenance of a family of component types. A minimum of 6 component types shall be selected (see Para. 7.1.2.2)
3. For distribution within the subgroups, see Para. 7.1.2 for qualification and qualification maintenance, and Para. 7.5 for Lot Validation Testing.
4. No failures are permitted.