




**CAPACITORS, FIXED, TANTALUM,
NON-SOLID ELECTROLYTE
ESCC Generic Specification No. 3003**

**ISSUE 1
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CAPACITORS, FIXED, TANTALUM,



NON-SOLID ELECTROLYTE

ESA/SCC Generic Specification No. 3003



**space components
coordination group**

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**1. INTRODUCTION****1.1 SCOPE**

This specification defines the general requirements for the qualification approval, procurement, including lot acceptance testing, and delivery of Capacitors, Fixed, Tantalum, Non-solid Electrolyte, for space application.

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 a component in accordance with ESA/SCC Basic Specification No. 20100 and the procurement of such components from qualified Manufacturers.

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 placing the purchase order.

2.1 ESA/SCC SPECIFICATIONS

No. 20100, Requirements for the Qualification of Standard Electronic Components for Space Application.

No. 20500, External Visual Inspection.

No. 20600, Preservation, Packaging and Despatch of SCC Electronic Components.

No. 21300, Terms, Definitions, Abbreviations, Symbols and Units.

No. 21700, General Requirements for the Marking of SCC Components.

No. 22800, ESA/SCC Non-conformance Control System.

No. 24600, Minimum Quality System Requirements.

No. 24800, Resistance to Solvents of Marking, Materials and Finishes.

With the exception of ESA/SCC Basic Specifications Nos. 20100, 21700, 22800 and 24600, where Manufacturers' specifications are equivalent to, or more stringent than, the ESA/SCC Basic Specifications listed above, they may be used in place of the latter, subject to the approval of the appropriate Qualifying Space Agency.

Such replacements shall be clearly identified in the applicable Process Identification Document (P.I.D.) and listed in an Appendix to the appropriate Detail Specification.

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

2.2 OTHER (REFERENCE) DOCUMENTS

IEC Publication No. 68, Basic Environmental Testing Procedures.

IEC Publication No. 384-1, Terms and Methods of Tests for Fixed Capacitors.

IEC Publication No. 410, Sampling Plans and Procedures for Inspection by Attributes.

ESA PSS-01-702, A 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) ESA/SCC Detail Specification.
- (b) ESA/SCC Generic Specification.
- (c) ESA/SCC Basic Specification.
- (d) Other documents, if referenced herein.

3. TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

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

4. REQUIREMENTS

4.1 GENERAL

The test requirements for qualification approval of a component shall comprise final production tests (see Chart II), burn-in and electrical measurements to testing level "B" (see Chart III) and qualification testing (see Chart IV).

The test requirements for procurement of components shall comprise final production tests (Chart II), burn-in and electrical measurements to testing level "B" or "C" as required (Chart III) together with, when applicable, a level of lot acceptance testing (see Chart V) to be specified by the Orderer.

If a Manufacturer elects to eliminate a final production test by substituting an in-process control or statistical process control 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.

4.1.1 Specifications

For qualification approval, procurement (including lot acceptance testing) and delivery of components in conformity with this specification, the 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 ESA/SCC 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 Qualifying Space Agency prior to commencing qualification testing, or procurement, to use an approved external facility.

4.1.4 Inspection Rights

The Qualifying Space Agency (for qualification approval or for a procurement) reserves the right to monitor any of the tests and inspections scheduled in the applicable specifications.



4.2 QUALIFICATION APPROVAL REQUIREMENTS ON A MANUFACTURER

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

4.3 DELIVERABLE COMPONENTS

Components delivered to this specification shall be processed and inspected in accordance with the relevant Process Identification Document (P.I.D.). Each delivered component shall be traceable to its production lot. Components delivered to this specification shall have completed satisfactorily all tests to the testing level and lot acceptance level specified in the purchase order (see Para. 4.3.2).

ESA/SCC qualified components delivered to this specification shall be produced from lots that are capable of passing all tests, and sequences of tests, that are defined in Charts IV and V. 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 it could not have passed these tests at the time of manufacture, this shall be grounds for rejection of the delivered lot.

Components failing inspections and tests of the higher testing level (i.e level "B") shall not be supplied against any order for components of the lower testing level.

4.3.1 Lot Failure

Lot failure may occur during burn-in and electrical measurements (Chart III), qualification testing (Chart IV) or lot acceptance testing (Chart V).

Should such failure occur, the non-conformance procedure shall be initiated in accordance with ESA/SCC Basic Specification No. 22800.

Should such failure occur during procurement, the Manufacturer shall notify the Orderer by telex within 2 working days, giving details of the number and mode of failure and the suspected cause.

In the case where qualification approval has been granted to the component, he shall, at the same time by the same means, inform the Qualifying Space Agency in order that the latter may consider its implications.

No further testing shall be performed on the failed components except on instruction from the Orderer. The Orderer shall inform the Manufacturer and the Qualifying Space Agency within 2 working days of receipt of the telex, by the same means, what action shall be taken.



In the case when lot failure occurs during qualification testing, the Manufacturer shall immediately notify the appropriate Qualifying Space Agency who will define a course of action to be followed. No further testing shall be performed on the failed components.

4.3.2 Testing and Lot Acceptance Levels

This specification defines 2 levels of testing severity which are designated by the letters "B" and "C" (see Chart I) and 3 levels of lot acceptance testing (see Chart V).

The lot acceptance levels are designated 1, 2 and 3 and are comprised of tests as follows:-

- Level 3 (LA3) - Electrical Subgroup.
- Level 2 (LA2) - Endurance Subgroup
plus Electrical Subgroup.

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Level 1 (LA1) - Environmental and Mechanical Subgroup
plus Endurance Subgroup
plus Electrical Subgroup.

The required testing level and lot acceptance level shall both be specified in a purchase order.

4.4 MARKING

All components procured and delivered to this specification from a source qualified according to ESA/SCC Basic Specification No. 20100 shall be marked in accordance with ESA/SCC Basic Specification No. 21700. Thus, they shall bear the ESA symbol to signify their conformance to the ESA/SCC qualification approval requirements and full compliance with the requirements of this specification and the Detail Specification.

Components procured from sources which are not ESA/SCC qualified, provided that they fully comply with the procurement requirements of this specification and the Detail Specification, may bear the SCC marking **with the exception of the ESA symbol.**

4.5 MATERIALS AND FINISHES

All non-metallic materials and finishes that are not within a hermetically sealed enclosure, of the components specified herein shall meet the outgassing requirements as outlined in ESA PSS-01-702.

Specific requirements for materials and finishes are specified in the Detail Specification.

5. PRODUCTION CONTROL

5.1 GENERAL

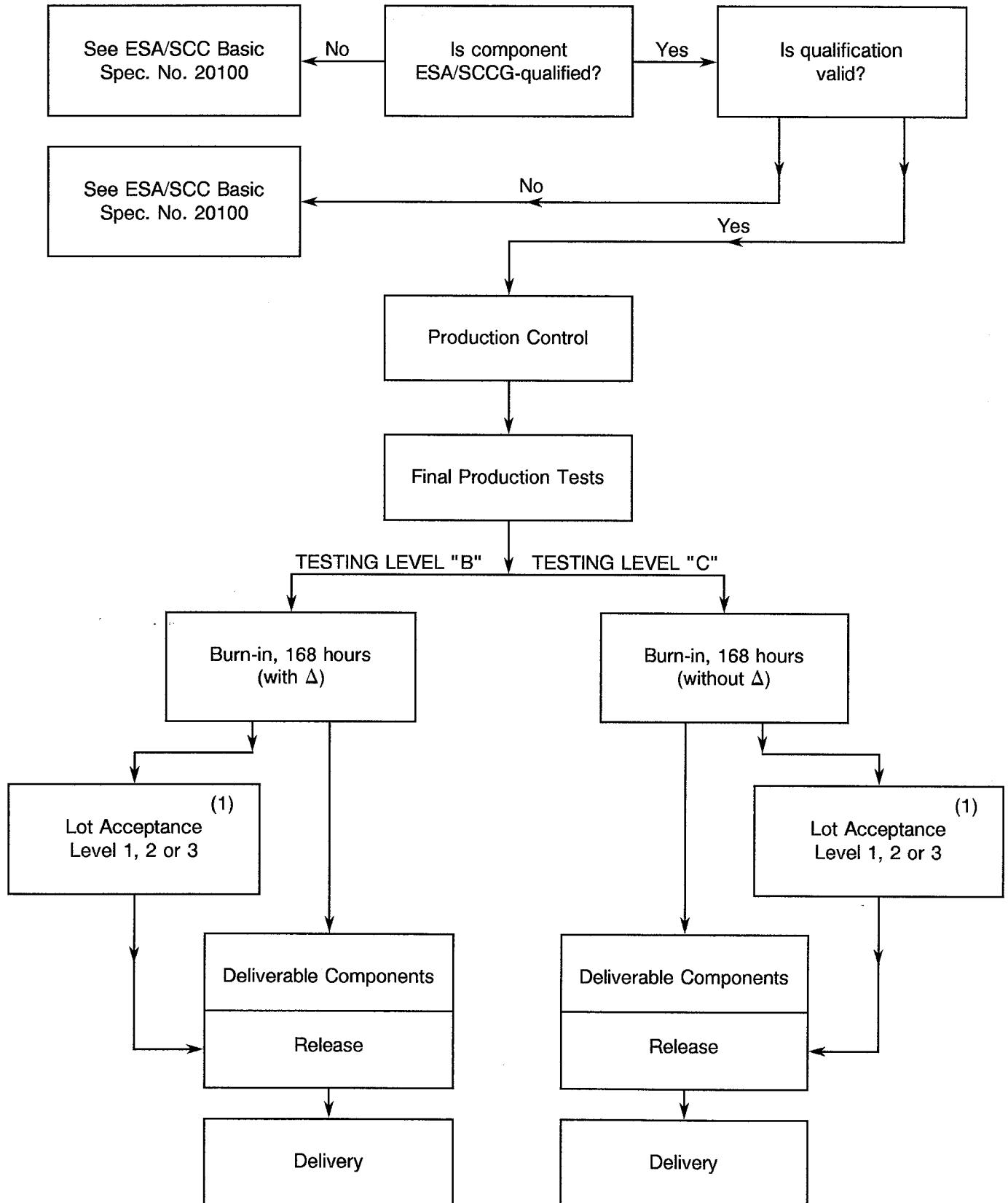
The minimum requirements for production control, which are equally applicable to procurement, are defined in ESA/SCC Basic Specification No. 20100, Para's 5.1 and 5.2.

5.2 SPECIAL IN-PROCESS CONTROLS

Where applicable, special in-process controls shall apply as specified in the Detail Specification.



CHART I - TESTING LEVELS



NOTES

1. When applicable.

**6. FINAL PRODUCTION TESTS****6.1 GENERAL**

Unless otherwise specified in the Detail Specification, all components used for qualification testing and all components for delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart II.

Unless otherwise specified in the Detail Specification, the tests shall be performed in the order shown.

Any components that do not meet these requirements shall be removed from the lot and at no future time be re-submitted to the requirements of this specification.

6.2 TEST METHODS AND CONDITIONS

The applicable test methods and conditions are specified in the paragraphs referenced in Chart II of this specification.

6.3 DOCUMENTATION

Documentation of final production test data shall be in accordance with the requirements of Para. 10.6 of this specification.

7. BURN-IN AND ELECTRICAL MEASUREMENTS**7.1 GENERAL**

Unless otherwise specified in the Detail Specification, all components used for qualification testing and all components for delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart III.

Unless otherwise specified in the Detail Specification, the tests shall be performed in the order shown.

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

Components of testing level "B" shall be serialised prior to the tests and inspections.

7.1.1 Conditions of Test

The conditions for burn-in shall be as shown in Table 5 of the Detail Specification.

Unless otherwise specified in the Detail Specification, components of both levels "B" and "C" shall be subjected to a total burn-in period of 168 hours.

7.1.2 Data Points

For components of testing level "B", undergoing a total burn-in period of 168 hours, the data points for parameter drift measurement shall be 0 hours (initial) and 168 (+24 - 0) hours (final).

For components of testing level "C", undergoing a total burn-in period of 168 hours, the data point for post-burn-in electrical measurements shall be 168 (+24 - 0) hours.



7.2 FAILURE CRITERIA

7.2.1 Parameter Drift Failure

The acceptable delta limits are shown in Table 4 of the Detail Specification. A component of testing level "B" shall be counted as a parameter drift failure if the changes during burn-in are larger than the delta (Δ) values specified.

7.2.2 Parameter Limit Failure

A component shall be counted as a limit failure if one or more parameters exceed the limits shown in Tables 2 or 3 of the Detail Specification.

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

7.2.3 Other Failures

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

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

7.3 FAILED COMPONENTS

A component shall be considered as a failed component if it exhibits one or more of the failure modes described in Para. 7.2 of this specification.

7.4 LOT FAILURE

In case of lot failure, the Manufacturer shall act in accordance with the requirements of Para. 4.3.1 of this specification.

7.4.1 Lot Failure during 100% Testing

If the number of components failed on the basis of the failure criteria described in Para. 7.2, exceeds 5% (rounded upwards to the nearest whole number) of the number of components submitted to burn-in and electrical measurements, the lot shall be considered as failed.



7.4.2 Lot Failure during Sample Testing

A lot shall be considered as failed if the number of allowable failures during sample testing, in accordance with General Inspection Level II of IEC Publication No. 410 and the applicable AQL, as specified in the Detail Specification, is exceeded.

If a lot failure occurs, a 100% testing may be performed with the lot failure criteria given in Para. 7.4.1.

7.5 DOCUMENTATION

Data documentation of burn-in and electrical measurements shall be in accordance with Para. 10.7 of this specification.

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8. QUALIFICATION APPROVAL AND LOT ACCEPTANCE TESTS

8.1 QUALIFICATION TESTING

8.1.1 General

Qualification testing shall be in accordance with the requirements of Chart IV of this specification. The tests to Chart IV shall be performed on the specified sample, chosen at random from components which have successfully passed the tests in Charts II and III for testing level "B". 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 IV.

The conditions governing qualification testing are given in ESA/SCC Basic Specification No. 20100, Para. 5.3 and, for the extension or renewal of qualification approval, in Paras 6.3 and 6.4.

8.1.2 Distribution within the Qualification Test Lot

A sample of 140 components shall be submitted to qualification testing (Chart IV). The sample shall consist of specimens having the lowest and highest voltages and, for these voltages, the smallest and largest case size. If there are more than 4 case sizes, an intermediate case size shall also be tested. Of each of these case size/voltage combinations (values), the highest capacitance shall be chosen. Thus, for the approval of a range, testing is required of either 4 or 6 values. Where a range consists of less than 4 values, the number of specimens to be tested shall be that required for 4 values.

The distribution shall be as specified by, or agreed with, the Qualifying Space Agency.

8.2 LOT ACCEPTANCE TESTING

8.2.1 General

The sample sizes of the 3 lot acceptance levels are specified in Chart V. All components assigned to a subgroup shall be subjected to all of the tests of that subgroup in the sequence shown.

The tests to Chart V shall be performed on the specified sample which shall have been chosen, whenever possible, at random from the proposed delivery lot (but see Para. 8.2.3(b)).



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

As a minimum for procurement of non-qualified components, lot acceptance level 3 tests shall apply. For procurement of qualified components, lot acceptance testing shall be performed if specified in a purchase order. Procurement lots ordered with a lot acceptance test level shall be delivered only after successful completion of lot acceptance testing.

8.2.2 Distribution within the Sample for Lot Acceptance Testing

Where a Detail Specification covers a range or series of components that are considered similar, then it may be necessary that the sample for lot acceptance testing be comprised of component types so selected that they adequately represent all of the various mechanical, structural and electrical peculiarities of the procured range or series.

The distribution of the component types will normally vary from procurement to procurement and shall be as specified by the Orderer, following as closely as possible the requirements prescribed in Para. 8.1.2. of this specification.

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8.2.3 Lot Acceptance Level 3 Testing (LA3)

Lot acceptance level 3 tests are designated as the electrical subgroup and comprise electrical measurements of characteristics and tests to prove the assembly capability of the component. For LA3 testing, the following requirements and conditions shall apply:-

- (a) LA3 testing shall be performed by the Manufacturer's quality assurance personnel using dedicated quality assurance equipment whenever possible. LA3 testing shall not be a repetition of routine measurements made by production personnel during final production tests and burn-in and electrical measurements.
- (b) When tests to Tables 2 and 3 of the Detail Specification have been performed on a sample basis, then the components for LA3 testing shall be selected from this sample.
- (c) The electrical measurements for LA3 are considered to be non-destructive and therefore components so tested may form part of the delivery lot.
- (d) The solderability test is considered to be destructive and therefore components so tested may not form part of the delivery lot. Post-burn-in electrical rejects may be used for this test.
- (e) When required in the purchase order, the Manufacturer shall notify the Orderer at least 2 working weeks before the commencement of LA3 testing. The Orderer shall indicate immediately whether or not he intends to witness the tests.

8.2.4 Lot Acceptance Level 2 Testing (LA2)

Lot acceptance level 2 testing shall comprise the tests for LA3 (electrical subgroup) plus tests on an endurance subgroup. For the electrical subgroup, the requirements and conditions as for LA3 (see Para. 8.2.3) shall apply.

For the endurance subgroup, the following shall apply:-

- (a) Components of testing level "C", selected for the endurance subgroup, shall be serialised prior to the tests.
- (b) The tests in this subgroup are considered to be destructive and therefore components (of testing level "B" or "C") so tested shall not form part of the delivery lot.

8.2.5 Lot Acceptance Level 1 Testing (LA1)

Lot acceptance level 1 testing shall comprise the tests for LA3 (electrical subgroup) and LA2 (endurance subgroup) plus tests on an environmental and mechanical subgroup. For the electrical and endurance subgroups, the requirements and conditions for LA3 (see Para. 8.2.3) and LA2 (see Para. 8.2.4) respectively shall apply.

For the environmental subgroup, the following shall apply:-

- (a) Components of testing level "C", selected for the environmental subgroup, shall be serialised prior to the tests.
- (b) The tests in this subgroup are considered to be destructive and therefore components (of testing level "B" or "C") so tested shall not form part of the delivery lot.

8.3 FAILURE CRITERIA

The following criteria shall apply to qualification testing and to lot acceptance testing.



8.3.1 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. seal, solderability, robustness of terminations, etc.

8.3.2 Electrical Failures

The following shall be counted as component failures:-

- (a) Components which, when subjected to electrical measurements on completion of environmental tests, in accordance with either Table 2 or Table 6, as specified in the Detail Specification, fail one or more of the applicable limits.
- (b) Components which, when subjected to electrical measurements at intermediate and end-points during endurance testing, in accordance with Table 6 of the Detail Specification, fail one or more of the applicable limits.
- (c) Components which, when subjected to measurement of electrical characteristics, in accordance with Tables 2 and 3 of the Detail Specification, fail one or more of the applicable limits.

8.3.3 Other Failures

The following additional failures may also occur during qualification testing or lot acceptance testing:-

- (a) Components failing to comply with the requirements of ESA/SCC Basic Specification No. 20500.
- (b) Lost components.

8.4 FAILED COMPONENTS

A component shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 8.3 of this specification. The allowable number of failed components per subgroup, the aggregate failure constraints and the permitted distribution of such failures are shown at the foot of Charts IV and V of this specification.

When requested by the Qualifying Space Agency or the Orderer, failure analysis of failed components shall be performed by the Manufacturer and the results provided.

Failed components from successful lots shall be marked as such and be stored at the Manufacturer's plant for 24 months.

8.5 LOT FAILURE

A lot shall be considered as failed if the allowable number of failures according to Chart IV or V of this specification, as relevant, has been exceeded.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.1 of this specification.

8.6 DOCUMENTATION

For qualification testing, the qualification test data shall be documented in accordance with the requirements of Para. 10.8 of this specification.

In the case of lot acceptance testing, the data shall be documented in accordance with the requirements of Para. 10.9 of this specification.



CHART II - FINAL PRODUCTION TESTS

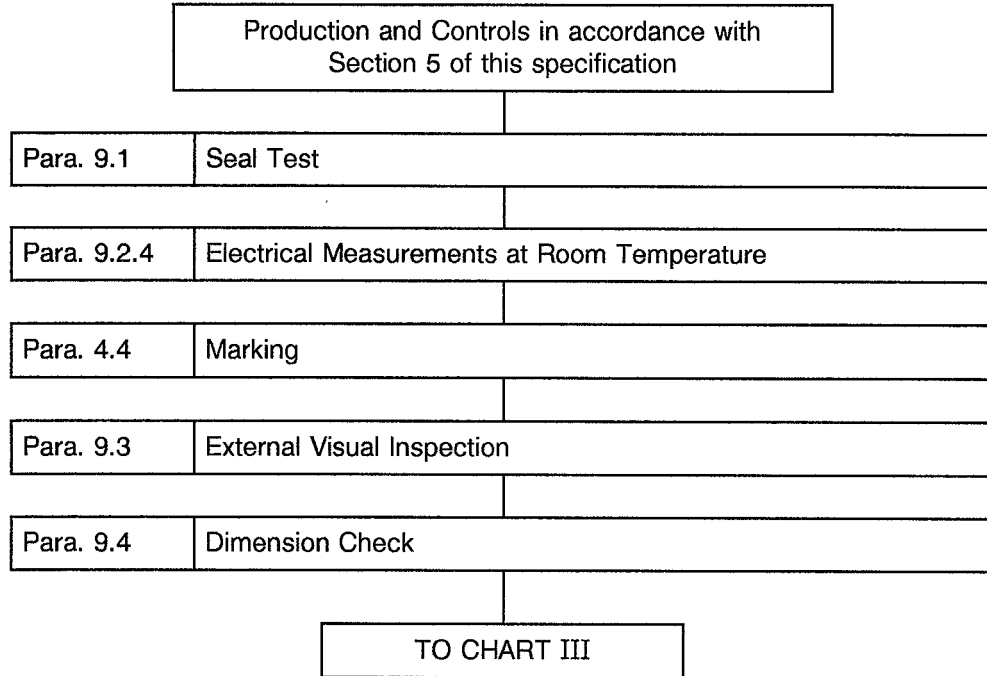




CHART III - BURN-IN AND ELECTRICAL MEASUREMENTS

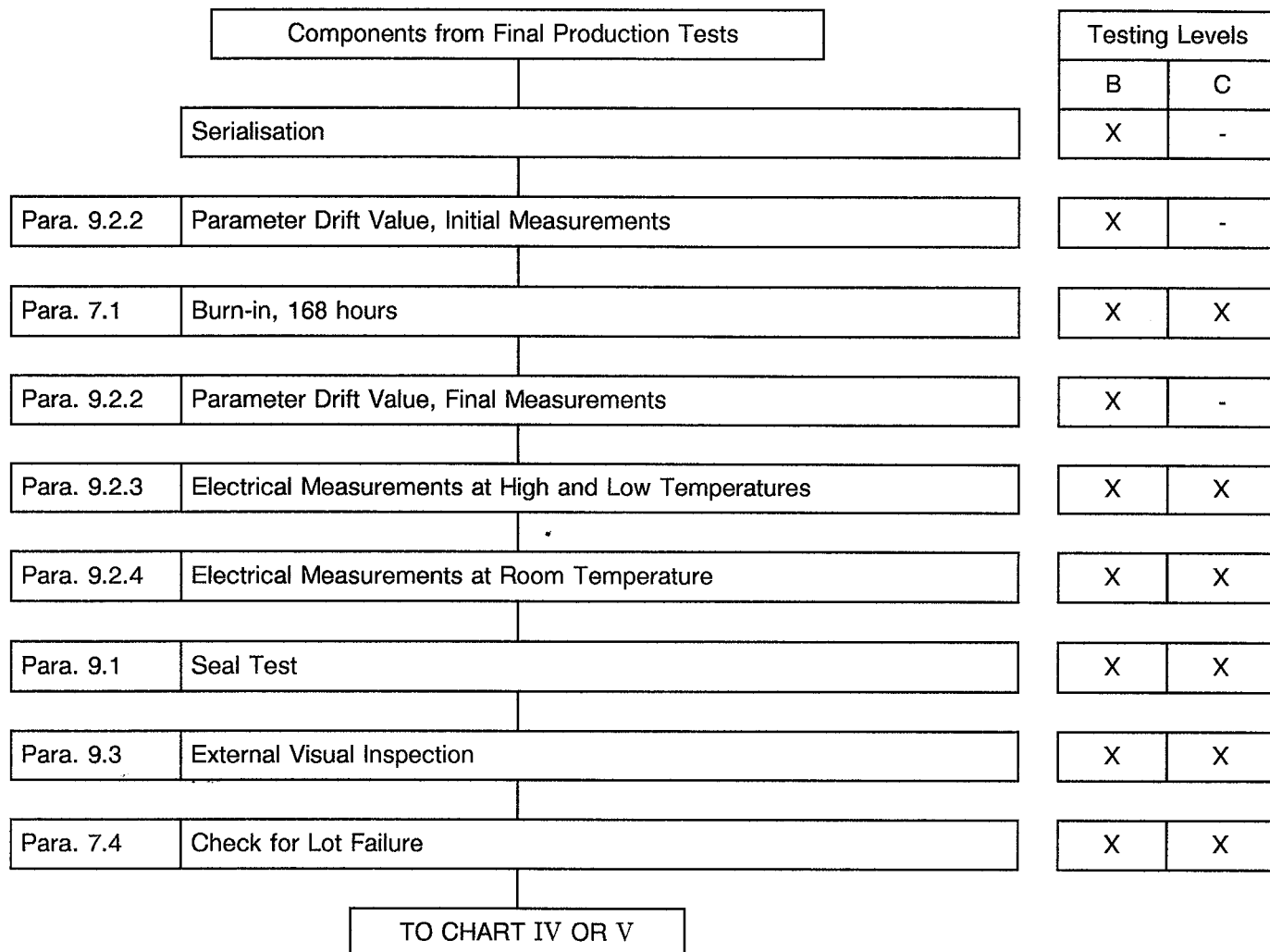
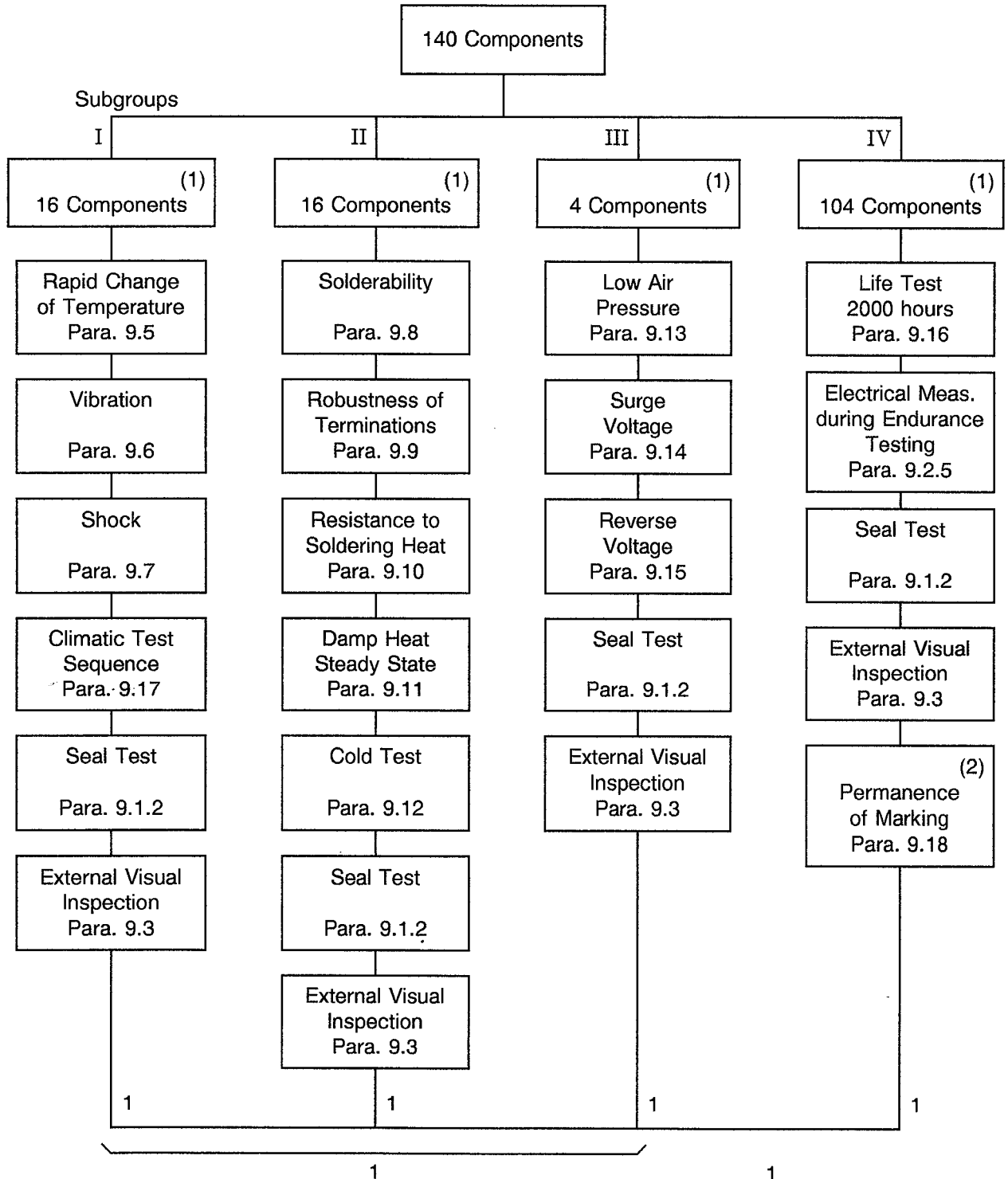




CHART IV - QUALIFICATION TESTS



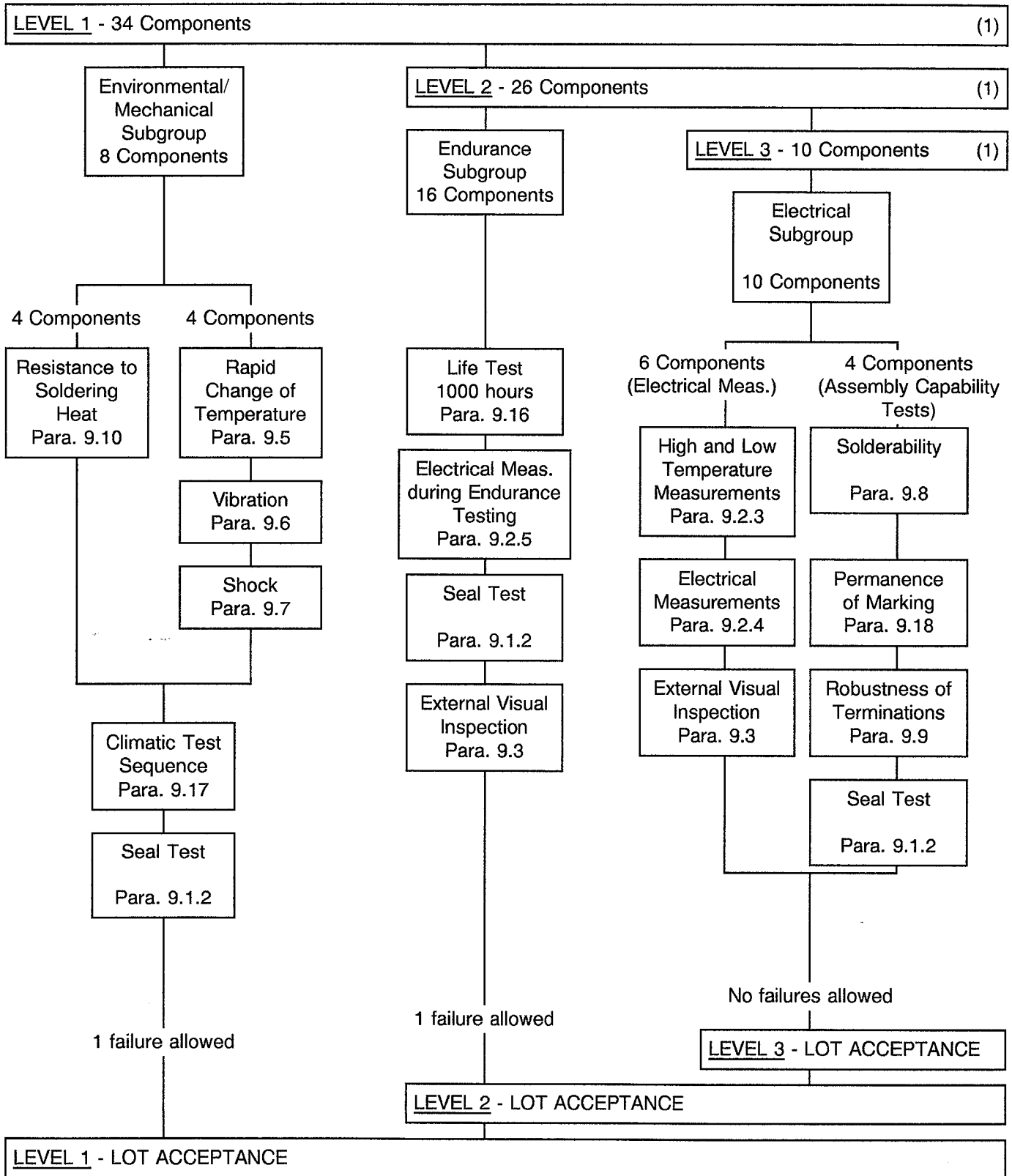
Total allowable number of failed components: 2.

NOTES

1. Distribution of the lot shall be as specified in Para. 8.1.2.
2. Permanence of Marking test shall be performed on 6 components only.



CHART V - LOT ACCEPTANCE TESTS



NOTES

1. For distribution within the subgroups, see Para. 8.2.2.

**9. 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.

Documentation supporting the change shall be approved by the Qualifying Space Agency and retained by the Manufacturer. It shall be copied, when requested, to the Qualifying Space Agency.

The change shall be specified in the Detail Specification and in the P.I.D.

9.1 SEAL TEST**9.1.1 Container Sealing, Gas Leakage (Gross Leak)**

The capacitors shall be subjected to Test Qc of IEC Publication No. 68-2-17, Method 2, at +126 to +130°C. There shall be no evidence of repetitive bubbling. The oil shall be fluorinated carbon, silicon oil, or similar.

9.1.2 Tracer Gas Method with Mass Spectrometer (Fine Leak)

The capacitors shall be subjected to Test Qk of IEC Publication No. 68-2-17. The preferred tracer gas is helium and the permissible leakage rate is not greater than 10^{-8} m.bar dm³/s air equivalent.

9.2 ELECTRICAL MEASUREMENTS**9.2.1 General**

Unless otherwise stated in the Detail Specification, the following measurements shall be made under standard conditions.

9.2.1.1 d.c. Leakage

d.c. Leakage shall be measured with the d.c. rated voltage applied. The electrification period shall be 5.0 ± 0.5 minutes. In the case of non-polarised capacitors, measurements shall be made in both directions. d.c. Leakage shall always be the first measurement when d.c. leakage, capacitance and dissipation factor measurements are made concurrently.

9.2.1.2 Capacitance

Capacitance shall be measured in accordance with IEC Publication No. 384-1. The following details shall apply:

- Test frequency: 100 to 120 Hz.
- Magnitude of a.c. voltage: Between 0.1V and 1.0V peak alternating voltage.
- d.c. bias voltage: 2.1V to 2.5V. For capacitors rated 50V and higher: 9V to 10V.
- Ratio of a.c. voltage to d.c. bias voltage: To be such that no reversal of d.c. voltage occurs across the capacitor.
- Limit of accuracy: $\pm 2\%$ of nominal capacitance value.

9.2.1.3 Dissipation Factor

The dissipation factor shall be determined by a polarised bridge.

d.c. bias voltage: 2.1V to 2.5V. For capacitors rated 50V and higher: 9V to 10V.

Measurement accuracy shall be such that the error does not exceed 10% of the specified value or .001, whichever is the greater.



9.2.1.4 Insulation Resistance

The insulation resistance shall be measured on insulated capacitors only. The points of measurement shall be between the capacitor case and a V-block in intimate contact with the sleeving. Electrification time shall be 1 minute ($-0+15$ seconds) and the d.c. voltage shall be 500V unless otherwise specified in the Detail Specification.

9.2.2 Parameter Drift Value Measurements

At each of the relevant data points for components of testing level "B", measurements shall be made of all parameters listed in Table 4 of the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated.

9.2.3 Electrical Measurements at High and Low Temperatures

For components of testing levels "B" and "C", the electrical measurements at high and low temperatures shall be made in accordance with Table 3 of the Detail Specification. Where sample testing is applied, note the requirements of Para. 8.2.3(b). For testing level "B", all values obtained shall be recorded against serial numbers.

9.2.4 Electrical Measurements at Room Temperature

For components of testing levels "B" and "C", the measurements of electrical characteristics shall be made in accordance with Table 2 of the Detail Specification. Where sample testing is applied, note the requirements of Para. 8.2.3(b). For testing level "B", all values obtained shall be recorded against serial numbers, except during Final Production Tests (Chart II).

9.2.5 Electrical Measurements during Endurance Testing

At each of the relevant data points specified for endurance testing, measurements shall be made of all parameters listed in Table 6 of the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated, if required.

9.3 EXTERNAL VISUAL INSPECTION

In accordance with ESA/SCC Basic Specification No. 20500.

9.4 DIMENSION CHECK

In accordance with ESA/SCC Basic Specification No. 20500 and the Detail Specification. To be performed on 5 samples per case size only.

If 1 failure occurs, the complete lot shall be checked.

9.5 RAPID CHANGE OF TEMPERATURE

The capacitors shall be tested in accordance with Test 'Na' of IEC Publication No. 68-2-14. The following shall apply:

- The period of exposure shall be 30 minutes at each -55 and $+125^{\circ}\text{C}$.
- Prior to the first cycle, the capacitors shall be conditioned for 15 minutes under room ambient conditions. Capacitance values shall be recorded.
- 30 cycles shall be applied.
- d.c. Leakage, capacitance and dissipation factor shall be measured after cycling as specified in Para. 9.2.1. The capacitance change compared to the initial capacitance measurement, d.c. leakage and dissipation factor, shall not exceed the values specified in Table 6 of the Detail Specification.
- In addition, the capacitors shall be externally examined for leakage of electrolyte. Detection of leakage of electrolyte shall be determined by the use of Thymol blue or other suitable chemical indicator solution.



9.6 VIBRATION

The capacitors shall be tested in accordance with Test 'Fc' of IEC Publication No. 68-2-6, Procedure B4. The following details shall apply:

- Frequency range: 10 to 2000 Hz, vibration amplitude 1.5mm and 196m/s² (20g). The body of the capacitor shall be rigidly mounted to the vibration test apparatus.
- The motion shall be applied for a total of 30 hours (15 hours in each of the 2 mutually perpendicular directions: one parallel and the other perpendicular to the cylindrical axis).
- Half rated d.c. voltage shall be applied.
- During the last 30 minutes of vibration in each direction, an electrical measurement shall be made on the capacitors to determine intermittent contact or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption of 0.5 millisecond or longer duration.
- After the test, the capacitors shall be visually examined for mechanical damage and leakage of electrolyte.

9.7 SHOCK TEST

The capacitors shall be tested in accordance with Test 'Ea' of IEC Publication No. 68-2-27. The following details shall apply:

- Pulse shape half sine wave, duration of pulse 6 milliseconds, peak acceleration 981m/s² (100g).
- Capacitors with axial wire lead terminals shall be rigidly mounted on a mounting fixture by the body with their terminals secured to rigidly supported stud-terminals, so spaced that the length of each terminal from the capacitor is approximately 10mm when measured from the edge of the supporting stud-terminal. Capacitor terminals shall be within 30 degrees of being parallel. When securing capacitor terminals, care shall be taken to avoid them being pinched.
- d.c. Rated voltage shall be applied to the capacitor during the test. Observations shall be made to determine intermittent contact or arcing or open- or short-circuiting. Detecting equipment shall be sufficiently sensitive to detect any interruption of 0.5 millisecond or longer duration.
- The capacitors shall be visually examined for evidence of arcing, breakdown, mechanical damage and leakage of electrolyte.

9.8 SOLDERABILITY

All terminals shall be tested in accordance with Test 'Ta' of IEC Publication No. 68-2-20. The terminals shall be immersed up to 1.5mm of the welded joint or up to 3.5mm of the body, whichever applies.

9.9 ROBUSTNESS OF TERMINATIONS

All capacitors shall be tested in accordance with Test 'U' of IEC Publication No. 68-2-21.

Anode terminals shall be tested 50% as detailed in Para. 9.9.1 and 50% as detailed in Para. 9.9.3.

Cathode terminals shall be tested 50% as detailed in Para. 9.9.1 and 50% as detailed in Para. 9.9.2.

After the tests, the terminals, terminal weld or solder, and seals shall be examined for loosening or permanent damage.

**9.9.1 PULL TEST**

The capacitors shall be tested in accordance with Test 'Ua' of IEC Publication No. 68-2-21. The following details shall apply:

- Applied force: 10 Newtons.
- Duration of applied force: 30(+5-0) seconds.

9.9.2 BEND TEST

The capacitors shall be tested in accordance with Test 'Ub' of IEC Publication No. 68-2-21. The following details shall apply:

- For wire terminals without external welds: 2 consecutive bends.

9.9.3 SPECIAL WIRE-LEAD BEND TEST FOR WIRE TERMINATIONS WITH EXTERNAL WELDS

The terminal shall be inserted into the hole of the test block fixture and the nut shall be tightened. There shall be a minimum of 4.5mm, but not more than 8.0mm, of terminal length between the test block fixture and the end of the case (or tantalum anode riser wire weld).

With the fixture firmly supported in a horizontal position, the case shall be forced over in such a manner that the tantalum anode riser wire is maintained in its axial position as closely as practicable while bending the terminal until the end of the case touches the top surface of the fixture. When the case is returned to the starting position, one complete bend of the test will have been completed. The second bend shall be completed in the same manner as the first one except that it shall be in the reverse direction.

Successive bends shall alternate in direction similar to the first and second bends. All terminals shall be subjected to four bends. The first rate of bend shall be approximately 5 seconds per bend.

9.10 RESISTANCE TO SOLDERING HEAT

The capacitors shall be tested in accordance with Test 'Tb' of IEC Publication No. 68-2-20A, Method 1B. They shall be visually examined for evidence of mechanical damage or leakage of electrolyte.

9.11 DAMP HEAT STEADY STATE

The capacitors shall be tested in accordance with Test 'Ca' of IEC Publication No. 68-2-3. The following details shall apply:

- After recovery, the d.c. leakage, capacitance and dissipation factor shall be measured as specified in Para. 9.2.1. The change in capacitance compared to the initial measurements, d.c. leakage and dissipation factor shall not exceed the values specified in Table 6 of the Detail Specification.
- Voltage proof shall be tested in accordance with IEC Publication No. 384-1, Clause 9. A test voltage of 1000Vdc shall be applied between the capacitor case and a V-block in intimate contact with the sleeving.
- Insulation resistance shall be measured in accordance with IEC Publication No. 384-1, Clause 8. The measurement shall be made between the capacitor case and a V-block in intimate contact with the sleeving after an electrification time of 1 minute ± 5 seconds. The value shall exceed the minimum limit specified in Table 6 of the Detail Specification.
- After testing, the capacitors shall be visually examined for breakdown, evidence of harmful corrosion, mechanical damage, obliteration of marking and leakage of electrolyte.

**9.12** COLD TEST

The capacitors shall be tested in accordance with Test 'Aa' of IEC Publication No. 68-2-1. The temperature shall be -55 ± 3 °C for 72 hours.

After recovery, d.c. leakage, capacitance and dissipation factor shall be measured as specified in Para. 9.2.1. The change in capacitance compared to the value measured after the Damp Heat Steady State test, d.c. leakage and dissipation factor shall not exceed the value specified in Table 6 of the Detail Specification.

After testing, the capacitors shall be externally examined for leakage of electrolyte.

9.13 LOW AIR PRESSURE

The capacitors shall be tested in accordance with Test 'M' of IEC Publication No. 68-2-13. The following details shall apply:

- They shall be mounted by their terminals in a suitable chamber which will maintain the temperature at $+22 \pm 3$ °C.
- Atmospheric pressure shall be reduced to 20 ± 2 m.bar.
- Duration of the test shall be 6 minutes. During the last minute, rated voltage shall be applied. There shall be no flash-over, arcing or signs of damage.

9.14 SURGE VOLTAGE

The capacitors shall be tested in accordance with IEC Publication No. 384-1. The following details shall apply:

- The capacitors shall be subjected to 1000 cycles of the applicable d.c. surge voltage specified in Table 1(b) of the Detail Specification. The ambient temperature during cycling shall be $+85$ °C.
- Each cycle shall consist of a 30 second surge voltage application followed by a 5.5 minute discharge period. Voltage application shall be through a resistance of approximately 1000Ω , including the source in series with the capacitor and the voltage source.
- Each surge voltage cycle shall be performed in such a manner that the capacitor is discharged through the 1000Ω resistor at the end of the 30 second application.
- The test shall be terminated on the discharge portion of the cycle. After the test, the capacitors shall be visually examined for mechanical damage and leakage of electrolyte.

9.15 REVERSE VOLTAGE (Applicable to Polar Capacitors only)

Initial capacitance measurements shall be recorded.

The capacitance shall be subjected to a 3.0 volt d.c. potential applied in the reverse polarity direction for a period of 125 hours at $+125$ °C. This shall be followed by the application of the appropriate category voltage in the forward polarity direction for a further 125 hours at $+125$ °C.

After recovery, the measurements detailed in Para. 9.2.1 shall be performed. The capacitance change related to the measurement at the commencement of the test, d.c. leakage and dissipation factor shall not exceed the values specified in Table 6 of the Detail Specification.

**9.16** LIFE TEST

The initial capacitance is the value measured after burn-in at room temperature. This initial measurement shall be used as reference measurement for all subsequent measurements under the same conditions.

The capacitors shall be submitted to an operating life test of 2000 or 1000 hours as required by Chart IV or V at the voltage and ambient temperature defined in Table 5 of the Detail Specification.

The impedance of the voltage source, as seen from the terminals of each capacitor, shall not exceed 10Ω . Storage batteries, or an electronic power supply, capable of supplying at least 100 milliamperes when a capacitor is shorted out, shall be used. For non-polarised capacitors, the voltage shall be reversed every 125 ± 10 hours.

After approximately 500, 1000 and 2000 hours for qualification testing and 500 and 1000 hours for lot acceptance testing, the d.c. leakage, capacitance and dissipation factor shall be measured as specified in Para. 9.2.1 at $+22 \pm 3$ °C after 24 ± 2 hours recovery at room temperature.

Voltage proof shall be tested in accordance with IEC Publication 384-1, Clause 9. A test voltage of 1000Vdc shall be applied between the capacitor case and a V-block in intimate contact with the sleeving.

The capacitance change, compared to the value measured prior to the test, d.c. leakage, dissipation factor and insulation resistance shall not exceed the values specified in Table 6 of the Detail Specification.

9.17 CLIMATIC SEQUENCE

The capacitors shall be tested in accordance with IEC Publication No. 384-1, Clause 22. The test sequence shall be be:

- Initial Measurements.
- Dry Heat.
- Damp Heat Accelerated, First Cycle.
- Cold.
- Low Air Pressure.
- Damp Heat, Remaining Cycles.
- Final Measurements.

The following detail shall apply:



- Initial Measurements
d.c. Leakage, capacitance and dissipation factor shall be measured as specified in Para. 9.2.1.
- Dry Heat
Test 'Ba' of IEC Publication No. 68-2-2, conditioned at $+125^{\circ}\text{C}$ for 16 hours. Recovery as specified in IEC Publication No. 68-2-2. The capacitors shall be visually examined for evidence of mechanical damage and leakage of electrolyte.
- Accelerated Damp Heat
First cycle: Test 'Da' of IEC Publication No. 68-2-4. One cycle of 24 hours, no voltage applied. Recovery as specified in IEC Publication No. 68-2-4. The capacitors shall be visually examined for evidence of mechanical damage and leakage of electrolyte.



- Cold
Test 'Aa' of IEC Publication No. 68-2-1. Two hours at -55°C . Recovery as specified in IEC Publication No. 68-2-1. The capacitors shall be visually examined for evidence of mechanical damage and leakage of electrolyte.
- Low Air Pressure
Test 'M' of IEC Publication No. 68-2-13. 2kN/m^2 (20m.bar) to be applied for 6 minutes at $+22 \pm 3^{\circ}\text{C}$. Rated d.c. voltage applied during last minute. There shall be no signs of breakdown or flash-over. The capacitors shall be visually examined for evidence of mechanical damage and leakage of electrolyte.
- Accelerated Damp Heat, Remaining Cycles
Test 'Da' of IEC Publication No. 68-2-4. Five cycles of 24 hours, no voltage applied. Recovery as specified in IEC Publication No. 68-2-4.
- Final Measurements
d.c. Leakage, capacitance and dissipation factor shall be measured as specified in Para. 9.2.1. The d.c. leakage, capacitance change and dissipation factor, compared to the values of the initial measurements, shall not exceed the values specified in Table 6 of the Detail Specification.

9.18 PERMANENCE OF MARKING

In accordance with ESA/SCC Basic Specification No. 24800.

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10. DATA DOCUMENTATION

10.1 GENERAL

For the qualification approval records and with each component delivery, a data documentation package is required. Depending on the testing level and lot acceptance level specified for the component, 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 control test data.
- (e) Final production test data (Chart II) (but see Para. 10.6).
- (f) Burn-in and electrical measurement data (Chart III).
- (g) Qualification test data (Chart IV).
- (h) Lot acceptance test data (Chart V) (when applicable).
- (i) Failed component list (see Para's 7.3 and 8.4) and failure analysis report (see Para. 8.4).
- (j) Certificate of Conformity.

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

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

10.1.1 Qualification Approval



In the case of qualification approval, the items listed in Para. 10.1 (a) to (j) less item (h) are required.

10.1.2 Testing Level "B"

10.1.2.1 Qualified Components

For deliveries of qualified components, 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).
- (c) Attributes record of measurements, tests and inspections performed in Chart II, Chart III (including PDA figure) and Chart V (where applicable).
- (d) Failed components list.

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10.1.2.2 Unqualified Components

For deliveries of unqualified components, the documentation to be supplied shall be in accordance with Para. 10.1.2.1 plus the following:-

- (a) Read and record data from Chart III.
- (b) Special in-process control data (where applicable).
- (c) Failure analysis report on failed components.

10.1.3 Testing Level "C"

10.1.3.1 Qualified Components

For deliveries of qualified components, the following documentation shall be supplied:-

- (a) Certificate of Conformity.



10.1.3.2 Unqualified Components

For deliveries of unqualified components, the documentation to be supplied shall be in accordance with Para. 10.1.3.1 plus the following:-

- (a) Cover sheet (if all of the information is not included on the Certificate of Conformity).
- (b) Attributes record of all measurements, tests and inspections performed in Charts II, III and V (when applicable).
- (c) Failed components list (including Failure Analysis Report).
- (d) Special in-process control data (when applicable).

10.1.4 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 to the Qualifying Space Agency and the Orderer, if requested, for review. The Manufacturer shall deliver variables Data/Reports to the Orderer if required by the Purchase Order.

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10.2 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 ESA/SCC Generic Specification, including issue and date.
- (c) Component type and number.
- (d) Lot identification.
- (e) Range of delivered serial numbers (for components of testing level "B").
- (f) Number of purchase order.
- (g) Information relative to any additions to this specification and/or the Detail Specification.
- (h) Manufacturer's name and address.
- (j) Location of the manufacturing plant.
- (k) Signature on behalf of Manufacturer.
- (l) Total number of pages of the data package.

10.3 LIST OF EQUIPMENT USED

A list of equipment used for tests and measurements shall be prepared, if not in accordance with the data given in the Process Identification Document (P.I.D.). 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.

10.4 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.

10.5 SPECIAL IN-PROCESS CONTROL DATA

As specified in the Detail Specification.

10.6 FINAL PRODUCTION TEST DATA (CHART II)

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

- Seal test (Para. 9.1).
- Electrical measurements at room temperature (Para. 9.2.4).
- External visual inspection (Para. 9.3).
- Dimension check (Para. 9.4).

The final production test data shall form an integral part of the data documentation package, but it is not a mandatory requirement that it be delivered with the qualification lot or delivery lot. However, the data package to be delivered shall contain the information as detailed in Paras. 10.1.2 and 10.1.3 or at least shall contain a list of final production tests actually performed and a certification that the data is available for review.

**10.7 BURN-IN AND ELECTRICAL MEASUREMENT DATA (CHART III)****10.7.1 Testing Level "B"**

For components of testing level "B", all data shall refer to the relevant serial numbers. Against these serial numbers, data shall be recorded for the following:-

- (a) 0-hour measurement for burn-in.
- (b) 168-hour measurement for burn-in.
- (c) Delta values after burn-in.
- (d) Values obtained during measurements at high and low temperatures (Table 3 of the Detail Specification).
- (e) Values obtained during measurements of electrical characteristics (Table 2 of the Detail Specification).
- (f) Failures during seal test.
- (g) Failures during external visual inspection.

10.7.2 Testing Level "C"

For components of testing level "C", a test result summary (i.e. the total number of components subjected to, and the total number rejected from, each of the tests and inspections) shall be prepared.

10.8 QUALIFICATION TEST DATA (CHART IV)

All data shall be referenced to the relevant serial numbers. Detailed records shall be provided of the components submitted to each test in each of the subgroups and of those rejected. Detailed data shall be provided of all electrical measurements made in accordance with Table 6 of the Detail Specification, as and where applicable.

10.9 LOT ACCEPTANCE TEST DATA (CHART V)**10.9.1 Testing Level "B"**

All data shall be referenced to the relevant serial numbers. Detailed records shall be provided of the components submitted to each test in each of the subgroups (as relevant to the lot acceptance level) and of those rejected.

Detailed data shall be provided of all electrical measurements made in accordance with Table 6 of the Detail Specification, as and where applicable.

10.9.2 Testing Level "C"

A test result summary (i.e. the total number of components submitted to, and and the total number rejected from, each of the tests and inspections) as relevant to the lot acceptance level shall be provided.

In the case of lot acceptance 2 testing, all data in respect of electrical measurements made in accordance with Table 6 of the Detail Specification shall be referenced to the relevant serial numbers (see Para. 8.2.4(a)).

In the case of lot acceptance 1 testing, all data in respect of electrical measurements made in accordance with Table 6 of the Detail Specification shall be referenced to the relevant serial numbers (see Para. 8.2.5(a)).

**10.10 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT**

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

- (a) The reference number and description of the test or measurement performed as defined in this specification and/or the Detail Specification.
- (b) The 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.

10.11 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established as defined in ESA/SCC Basic Specification No. 20100.

11. DELIVERY

For qualification approval, the disposition of the qualification test lot and its related documentation shall be as specified in ESA/SCC Basic Specification No. 20100 and the relevant paragraphs of Section 10 of this specification.

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

- (a) The delivery lot.
- (b) The components used for lot acceptance testing, (when applicable), but not forming part of the delivery lot (see Para's 8.2.3(d), 8.2.4(b) and 8.2.5(b)).
- (c) The relevant documentation in accordance with the requirements of Section 10 of this specification.

In the case of a component for which a valid qualification approval is in force, all data of all components submitted to LA1 and LA2 testing shall also be copied, when requested, to the relevant Qualifying Space Agency.

12. PACKAGING AND DESPATCH

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