



Pages 1 to 18

**EVALUATION TEST PROGRAMME FOR FERRITE
MICROWAVE COMPONENTS
(ISOLATORS AND CIRCULATORS)**

ESCC Detail Specification No. 2263202

Issue 2	September 2004
---------	----------------



Document Custodian: European Space Agency - see <https://escies.org>

LEGAL DISCLAIMER AND COPYRIGHT

European Space Agency, Copyright © 2004. All rights reserved.

The European Space Agency disclaims any liability or responsibility, to any person or entity, with respect to any loss or damage caused, or alleged to be caused, directly or indirectly by the use and application of this ESCC publication.

This publication, without the prior permission of the European Space Agency and provided that it is not used for a commercial purpose, may be:

- copied in whole, in any medium, without alteration or modification.
- copied in part, in any medium, provided that the ESCC document identification, comprising the ESCC symbol, document number and document issue, is removed.

DOCUMENTATION CHANGE NOTICE

(Refer to <https://escies.org> for ESCC DCR content)

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

TABLE OF CONTENTS

1.	<u>PURPOSE</u>	<u>6</u>
2.	<u>APPLICABLE DOCUMENTS</u>	<u>6</u>
2.1	ESA/ESCC Specifications	6
2.2	Other (Reference) Documents	6
3.	<u>PROCEDURE</u>	<u>6</u>
4.	<u>TEST PROGRAMME SEQUENCE AND SAMPLE DISTRIBUTION</u>	<u>6</u>
4.1	General	6
4.2	Detail Specification(s)	7
4.3	Inspection Rights	7
4.4	Control During Fabrication	7
5.	<u>INSPECTION</u>	<u>7</u>
5.1	General	7
5.2	Dimensions (100%)	7
5.3	Weight (100%)	8
5.4	Electrical Measurements (100%)	8
5.5	External Visual Inspection (100%)	8
5.6	Marking and Serialisation (100%)	8
5.7	Materials and Finishes	8
5.8	Completion of Inspection	8
6.	<u>INITIAL ELECTRICAL MEASUREMENTS (100% READ AND RECORD)</u>	<u>8</u>
7.	<u>EVALUATION TEST PROGRAMME</u>	<u>8</u>
7.1	General	8
7.2	Group 1 - Control Group	9
7.3	Group 2 - Destructive Tests	9
7.3.1	General	9
7.3.2	Subgroup 2A - Step-Stress Tests	9
7.3.2.1	General	9
7.3.2.2	Subgroup 2A (i) - Temperature Step-Stress Test	9
7.3.2.3	Subgroup 2A(ii) - Power Step-Stress Test	9
7.3.2.4	Analysis of subgroup 2A	9
7.3.3	Subgroup 2B - Special Tests	9
7.3.3.1	General	9
7.3.3.2	Intermateability Tests	10
7.3.4	Subgroup 2C- Environmental/Mechanical Tests	10
7.3.4.1	Vibration	10
7.3.4.2	Rapid Change of Temperature	10
7.3.4.3	Damp Heat (Steady-State)	10
7.3.4.4	Connector Durability	10
7.3.5	Subgroup 2D - Construction Analysis	10
7.4	Group 3 - Accelerated Electrical Endurance Test	11
8.	<u>DATA DOCUMENTATION</u>	<u>11</u>
8.1	General Requirements	11
8.2	Cover Sheets	12
8.3	List of Equipment Used	12
8.4	List of Test References	12
8.5	Sample Identification	12

8.6	Product Data	12
8.7	Inspection Data	12
8.8	Initial Electrical Measurements	12
8.9	Group 1 - Control Group Data	13
8.10	Subgroup 2A Step-Stress Tests Data	13
8.10.1	Subgroup 2A(ii) - Temperature Power Step-Stress Test Data	13
8.10.2	Subgroup 2A(ii) - Power Step-Stress Test Data	13
8.11	Subgroup 2B - Special Tests Data (If Applicable)	13
8.12	Subgroup 2C - Environmental/Mechanical Tests Data	13
8.13	Subgroup 2D - Construction Analysis Data	13
8.14	Group 3 - Accelerated Electrical Endurance Test Data	14
8.15	Summary of Results and Conclusions	14
9.	CHARTS	15
9.1	Chart 1 - Evaluation Test Programme	15
9.2	Chart 2 - Temperature Step-stress Sequence	16
9.3	Chart 3: Power Step-stress Sequence	17
9.4	Chart 4: Accelerated Electrical Endurance Test	18

1. **PURPOSE**

The purpose of this specification is to establish the procedure to be followed in the evaluation of component capabilities as required for space applications and thereby to anticipate, as far as possible, component behaviour during qualification testing. Therefore, the aim of such testing shall be to overstress specific characteristics of the component concerned with a view to the detection of possible failure modes. Additionally, a detailed destructive physical analysis shall be performed to detect any design and construction defects which may affect the reliability of the component and to facilitate failure analysis activities.

2. **APPLICABLE DOCUMENTS**

The following documents form part of, and shall be read in conjunction with, this specification.

2.1 **ESA/ESCC SPECIFICATIONS**

No. 3202, Ferrite Microwave Components (Isolators and Circulators).

No. 3402, Connectors, RF, Coaxial.

No. 3402/xxx, RF, Coaxial Connector Detail Specifications.

No. 20500, External Visual Inspection.

Unless otherwise stated herein, reference within the text of this specification to the Detail Specification shall mean the relevant ESCC Detail Specification.

2.2 **OTHER (REFERENCE) DOCUMENTS**

ESA PSS-01-702, A Thermal Vacuum Test for the Screening of Space Materials.

ESA PSS-01-713, Measurement of the Peel and Pull-off Strength of Coatings and Finishes with Pressure-sensitive Tapes.

3. **PROCEDURE**

Standard components shall be selected from a homogeneous lot at the Manufacturer to be evaluated. These components shall not have been submitted to any screening or burn-in, but must have been manufactured in conformity with high reliability practice and an established Process Identification Document (PID) or an identifiable process which shall form the basis for the PID.

The tests specified in the programme shall be performed in the sequence shown in Chart 1. All results shall be recorded and failed components submitted to a failure analysis. Probable failure modes and mechanisms shall be determined.

The evaluation test programme shall be performed, under the supervision of the ESCC Executive for whom the evaluation of the component concerned is required, by the Manufacturer or at a test laboratory approved by the ESCC Executive.

4. **TEST PROGRAMME SEQUENCE AND SAMPLE DISTRIBUTION**

4.1 **GENERAL**

The number of components chosen for evaluation testing shall depend upon whether a single component type or a family of parts is evaluated and the number of component types chosen to represent the family.

Not less than 15 specimens shall be used for each test programme. The component types chosen to represent a family shall cover the range of components to be evaluated and be representative of the different electrical and mechanical configurations under consideration. They shall also be the most suitable for highlighting those characteristics and parameters that are pertinent to an investigation into failure modes and weaknesses. The Subgroup 2A and Group 3 tests may be performed on specimens operating at frequencies for which the RF power is readily available.

If isolators are produced by the addition of a load to a circulator, structural similarity may be invoked such that only isolators need to be evaluated, otherwise both isolators and circulators must be evaluated.

If coaxial isolators are structurally similar except for the addition of a connector for connectorised variants, structural similarity may be invoked by the testing of an isolator with one tab termination and one connector termination. The samples shall be as specified by, or as agreed with, the ESCC Executive.

The above mentioned quantity shall be submitted to the full evaluation procedure whenever a new technology has been applied to the components concerned, where there is insufficient experience in their production.

4.2 DETAIL SPECIFICATION(S)

Should a Detail Specification(s) for the device(s) to be evaluated not exist, the Manufacturer shall prepare such a document(s) in accordance with the established ESA/ESCC format and submit it to the appropriate ESCC Executive for provisional approval. This shall then serve as a basis for the ordering and testing of the relevant components.

4.3 INSPECTION RIGHTS

The ESCC Executive reserves the right to inspect at any time the components processed for evaluation purposes. The Manufacturer shall notify the ESCC Executive at least three working days in advance of the date of internal visual inspection.

4.4 CONTROL DURING FABRICATION

The components shall be produced as defined in Para. 3. Pre-assembly visual inspection shall be performed on the lot to be tested to the extent that this forms part of the Manufacturer's standard procedures. Progress of the components shall be observed closely and recorded together with an analysis of any rejects. A chart showing the numbers in/out and failure cause for each fabrication stage shall be submitted to the ESCC Executive.

5. INSPECTION

5.1 GENERAL

The components shall be checked to verify their suitability for the Evaluation Test Programme. Defects or deviations from the established ESA/ESCC requirements may invalidate the evaluation. For each measurement or inspection performed, the results shall be summarised in terms of quantity tested, quantity passed and quantity rejected. If devices are rejected, the reason shall be clearly identified.

5.2 DIMENSIONS (100%)

All devices shall be inspected in accordance with Physical Dimensions of the Detail Specification (go-no-go) and the results recorded together with any non-conformities. Where coaxial devices have integral connectors the interface dimensions of these shall also be checked. Rejected components shall be replaced.

5.3 WEIGHT (100%)

All devices shall be weighed. Any device that exceeds the weight defined in the Detail Specification shall be rejected and replaced.

5.4 ELECTRICAL MEASUREMENTS (100%)

These measurements shall be performed in accordance with Room Temperature Electrical Measurements of the Detail Specification at an ambient temperature of $+22 \pm 3^{\circ}\text{C}$ (go-no-go). Rejected components shall be replaced.

5.5 EXTERNAL VISUAL INSPECTION (100%)

All devices shall be inspected in accordance with ESCC Basic Specification No. 20500. Rejected components shall be replaced.

5.6 MARKING AND SERIALISATION (100%)

All components shall be marked and serialised in accordance with the standard procedures of the Manufacturer concerned.

5.7 MATERIALS AND FINISHES

All non-metallic materials and finishes, that are not within a hermetically sealed enclosure, of the components specified herein shall be tested in accordance with ESA PSS-01-702 to verify its outgassing requirements, unless relevant data is available.

5.8 COMPLETION OF INSPECTION

The completion of inspection shall result in a batch of components that have been verified as to their suitability for the Evaluation Test Programme, i.e. each component has satisfied the requirements of Paras. 5.2 to 5.7 inclusive.

6. INITIAL ELECTRICAL MEASUREMENTS (100% READ AND RECORD)

These measurements shall be made according to Room, High and Low Temperature Electrical Measurements of the Detail Specification. All characteristics shall be recorded against serial numbers.

7. EVALUATION TEST PROGRAMME

7.1 GENERAL

The evaluation tests shall be performed as specified in Chart 1. The components shall be randomly divided into three groups and their associated subgroups in the proportions indicated in Chart 1. The Subgroup 2A tests shall be completed and the results analysed before the Group 3 tests are commenced.

All failed components shall be analysed. The depth of analysis shall depend upon the circumstances in which failure occurred and upon whether useful information may be gained. As a minimum, the failure mode shall be determined in each case. Components not failing catastrophically, i.e. those displaying out-of-tolerance electrical parameters, shall not be removed from the test sequence but monitored to observe degradation trends.

7.2 GROUP 1 - CONTROL GROUP

This group shall be retained for comparison purposes. Whenever electrical measurements are made on any devices under test, these devices shall also be measured.

7.3 GROUP 2 - DESTRUCTIVE TESTS

7.3.1 General

This group shall be randomly divided into four subgroups in the proportions indicated in Chart 1.

7.3.2 Subgroup 2A - Step-Stress Tests

7.3.2.1 *General*

This subgroup shall be randomly divided into two further subgroups in the proportions indicated in Chart 1. The step-stress sequence shall be terminated when 50% (rounded up) of the specimens have been destroyed, unless practical reasons prevent this. For both subgroups 2A(i) and 2A(ii) the isolator outputs shall be short circuited.

7.3.2.2 *Subgroup 2A (i) - Temperature Step-Stress Test*

The tests in this subgroup shall be performed as specified in Chart II at the maximum rated (continuous) power specified in the Detail Specification. Electrical measurements shall be made as defined in Room Temperature Electrical Measurements of the Detail Specification. The starting temperature (which will be no higher than the maximum operating temperature as defined in the Detail Specification) and the temperature steps (with a maximum step of 25°C) to be employed will be decided by the ESCC Executive.

7.3.2.3 *Subgroup 2A(ii) - Power Step-Stress Test*

The tests in this subgroup shall be performed as specified in Chart 3 at the maximum operating temperature specified in the Detail Specification. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification. The starting power (which will be no higher than the maximum rated (continuous) power as defined in the Detail Specification) and the power steps (with a maximum step of 20%) to be employed will be decided by the ESCC Executive.

7.3.2.4 *Analysis of subgroup 2A*

The analysis of Subgroup 2A shall be presented to the ESCC Executive in a graphical form, supported by the actual results, as follows:

- The number of functional failures shall be plotted against each power level or temperature applied. The cumulative failure rate shall also be plotted.
- The parameters (as defined in Paras. 7.3.2.2 and 7.3.2.3) shall be monitored, recorded and plotted against time for each power level or temperature applied, as appropriate.
- The average drift of the parameters at each step shall be plotted against temperature or power as appropriate.

The analysis of the results of Subgroup 2A(i and ii) shall be used to determine the most effective temperature and power for the accelerated electrical endurance test (Group 3).

7.3.3 Subgroup 2B - Special Tests

7.3.3.1 *General*

This group is only applicable to those connectorised devices where the connector is formed as an integral

part of the device.

7.3.3.2 *Intermateability Tests*

The integral connectors shall be mated with the equivalent connectors from every qualified Manufacturer listed in the ESCC Qualified Parts List or a gauge as defined in the applicable ESCC 3402/xxx Detail Specification may be used. The engagement and separation forces shall be measured and tabulated.

7.3.4 Subgroup 2C- Environmental/Mechanical Tests

7.3.4.1 *Vibration*

All devices shall be subjected to the test in accordance with ESCC Generic Specification No. 3202, Para. 9.5 with the conditions specified for use during Charts 4 or 5.

7.3.4.2 *Rapid Change of Temperature*

All devices shall be subjected to the test in accordance with ESCC Generic Specification No. 3202, Para. 9.4 with the conditions specified for use during Charts 4 or 5 - 20 cycles instead of 10 cycles. Electrical measurements shall be made in accordance with Room Temperature Electrical Measurements of the Detail Specification after 10 cycles and at the end of the test.

7.3.4.3 *Damp Heat (Steady-State)*

All devices shall be subjected to the test in accordance with ESCC Generic Specification No. 3202, Para. 9.23. After the test, electrical measurements shall be performed in accordance with Room Temperature Electrical Measurements of the Detail Specification and the devices shall be visually inspected paying particular attention to the porosity, cleanliness, etc. of the plating and any brazed joints.

7.3.4.4 *Connector Durability*

(a) *Applicability*

This group is only applicable to those connectorised devices where the connector is formed as an integral part of the device.

(b) *Procedure*

The components shall be subjected to the test in accordance with ESCC Generic Specification No. 3402, Para. 9.18, but 20% more cycles than specified shall be performed.

7.3.5 Subgroup 2D - Construction Analysis

(a) *Plating*

(i) *General*

These tests may be performed on piece parts from the same lot/batch as the completed device(s).

(ii) *Peel Adhesion Test*

This test shall be performed in accordance with ESA PSS-01-713.

(iii) *Baking Test (Silver Plating only)*

The specimens shall be heated to 180°C for 30 minutes and then cooled at 2-3°C/min. The samples shall then be visually inspected for evidence of inadequate plating adhesion.

(iv) *Microsectioning*

The specimens shall be microsectioned to verify the thickness and uniformity of the plating. Particular attention shall be paid to any blind holes to be plated.

- (b) Castings
Radiographic inspection shall be applied to detect any cracks or porosity in the specimen. Microsectioning shall be applied to verify the radiographic results.
- (c) Non-metallic Materials
Samples of all non-metallic materials shall be verified that they meet the outgassing requirements of ESA PSS-01-702.
- (d) Adhesives
Samples of all adhesives employed shall be used to stick together representative pieces of the complete device. The tensile and shear strengths shall be evaluated.
- (e) Internal Joints (Coaxial only)
Any internal joints shall be visually inspected and a photographic record made. Half the joints shall be microsectioned to verify the joint consistency, etc. and half shall be subjected to a tensile test and the results recorded.
- (f) Solderability (Tab termination only)
The tab terminations shall be subjected to the test in accordance with ESCC Generic Specification No. 3202, Para. 9.21.

7.4 GROUP 3 - ACCELERATED ELECTRICAL ENDURANCE TEST

This test shall not be performed until the Group 2 tests have been completed and analysed, and the test conditions selected. The test shall be performed as specified in Chart 4.

The temperature shall be chosen such that within approximately 1000 hours, the parameter(s) defined in Room Temperature Electrical Measurements of the Detail Specification can be expected to have drifted to an extreme of the permitted range. The isolator outputs shall be short circuited.

Intermediate electrical measurements shall be performed in accordance with the Room Temperature Electrical Measurements of the Detail Specification at the following times: 168(+24-0) hours, 500(+24-0) hours and 1000(+24-0) hours. Failed components shall be removed for analysis as specified in Para. 7.1.

8. DATA DOCUMENTATION

8.1 GENERAL REQUIREMENTS

An evaluation test report shall be established. This shall comprise the following:

- (a) Cover sheet (or sheets).
- (b) List of equipment (testing and measuring).
- (c) List of test references.
- (d) Sample identification.
- (e) Production data.
- (f) Inspection data.
- (g) Initial electrical measurements.
- (h) Group 1 - Control Group data.
- (i) Subgroup 2A (i) - Temperature Step-Stress test data.
- (j) Subgroup 2A (ii) - Power Step-Stress test data.
- (k) Subgroup 2B - Special tests data.
- (l) Subgroup 2C - Environmental/Mechanical tests data.
- (m) Subgroup 2D - Construction Analysis data.

- (n) Group 3 - Steady-State Accelerated Life test data.
- (o) Summary of results and conclusions.

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

- Manufacturer's/test house's name.
- Lot identification.
- Date of establishment of the document.
- Page number.

8.2 COVER SHEETS

The cover sheet (or sheets) of the evaluation test report shall include as a minimum:

- (a) Reference to this document, including issue and date.
- (b) Component type and number.
- (c) Lot identification.
- (d) Manufacturer's/test house's name and address.
- (e) Location of the manufacturing plant/test house.
- (f) Signature on behalf of the Manufacturer/test house.
- (g) Total number of pages of the evaluation test report.

8.3 LIST OF EQUIPMENT USED

A list of equipment used for tests and measurements shall be included in the evaluation test report. Where applicable, this list shall contain the inventory number, Manufacturer type number, serial number etc. This list shall indicate for which tests such equipment was used.

8.4 LIST OF TEST REFERENCES

This list shall include all references or codes which are necessary to correlate the test data provided with the applicable tests.

8.5 SAMPLE IDENTIFICATION

This shall identify the criteria used for the selection of the particular components used for the tests, when evaluating a range of components by means of representative samples.

8.6 PRODUCT DATA

The progress of the components through the normal manufacturing processes shall be documented. The components failing a particular process shall be detailed, together with the reason for their removal.

8.7 INSPECTION DATA

The number of components subjected to each test shall be identified together with the number and reason for any rejects.

8.8 INITIAL ELECTRICAL MEASUREMENTS

All data shall be recorded against serial numbers. A histogram of device parameters shall be produced.

- 8.9 GROUP 1 - CONTROL GROUP DATA
All data shall be recorded against serial numbers.
- 8.10 SUBGROUP 2A STEP-STRESS TESTS DATA
- 8.10.1 Subgroup 2A(ii) - Temperature Power Step-Stress Test Data
All data shall be recorded against serial numbers. This shall include:
- (a) Starting temperature.
 - (b) Temperature steps.
 - (c) Electrical measurements tabulated for each step.
 - (d) Graphical output as defined in Para. 7.3.2.4.
 - (e) Analysis of any failed components as defined in Para. 7.1.
- 8.10.2 Subgroup 2A(ii) - Power Step-Stress Test Data
All data shall be recorded against serial numbers. This shall include:
- (a) Starting power.
 - (b) Power steps.
 - (c) Electrical measurements tabulated for each step.
 - (d) Graphical output as defined in Para. 7.3.2.4.
 - (e) Analysis of any failed components as defined in Para. 7.1.
- 8.11 SUBGROUP 2B - SPECIAL TESTS DATA (IF APPLICABLE)
All data shall be recorded against serial numbers. This shall include:
- (a) Engagement forces.
 - (b) Separation forces.
- The above shall be recorded for each other make of connector tested.
- 8.12 SUBGROUP 2C - ENVIRONMENTAL/MECHANICAL TESTS DATA
All data shall be recorded against serial numbers. This shall include:
- (a) Vibration test data.
 - (b) Rapid Change of Temperature test data.
 - (c) Damp heat test data.
 - (d) Connector durability test data.
- 8.13 SUBGROUP 2D - CONSTRUCTION ANALYSIS DATA
All data shall be recorded against serial numbers. This shall include: .
- (a) Peel adhesion test data
 - (b) Baking tests data (if applicable).
 - (c) Microsectioning data.
 - (d) Castings data (if applicable).

- (e) Outgassing test data.
- (f) Adhesives test data.
- (g) Internal joints data (if applicable).
- (h) Solderability data.

8.14 GROUP 3 - ACCELERATED ELECTRICAL ENDURANCE TEST DATA

All data shall be recorded against serial numbers. This shall include:

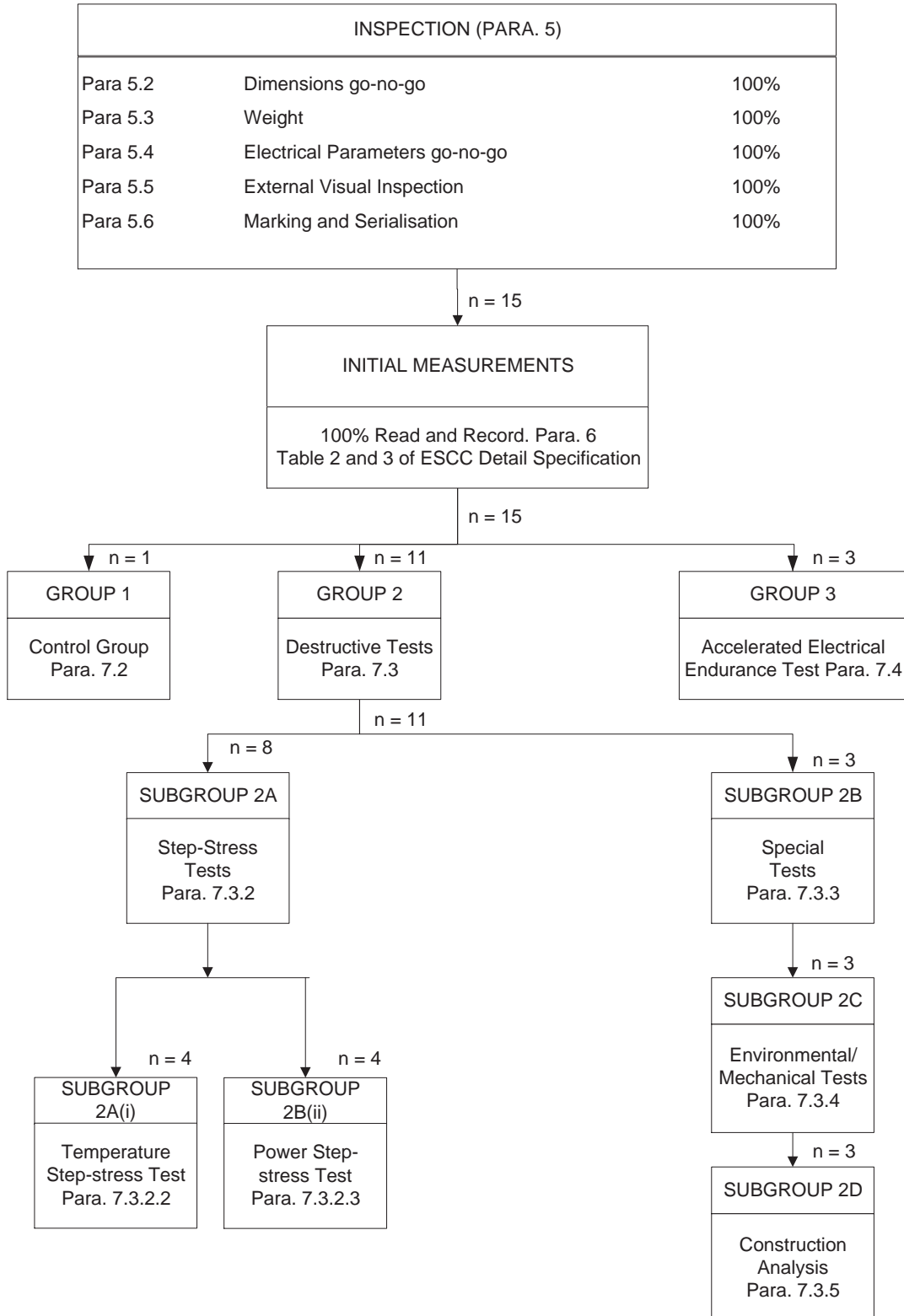
- (a) Temperature chosen.
- (b) Power chosen.
- (c) electrical measurements tabulated and plotted for each intermediate time as defined in Para. 7.4.
- (d) Drift values referred to the initial electrical measurements (Para. 6).
- (e) Analysis of any failed components as defined in Para. 7.1.

8.15 SUMMARY OF RESULTS AND CONCLUSIONS

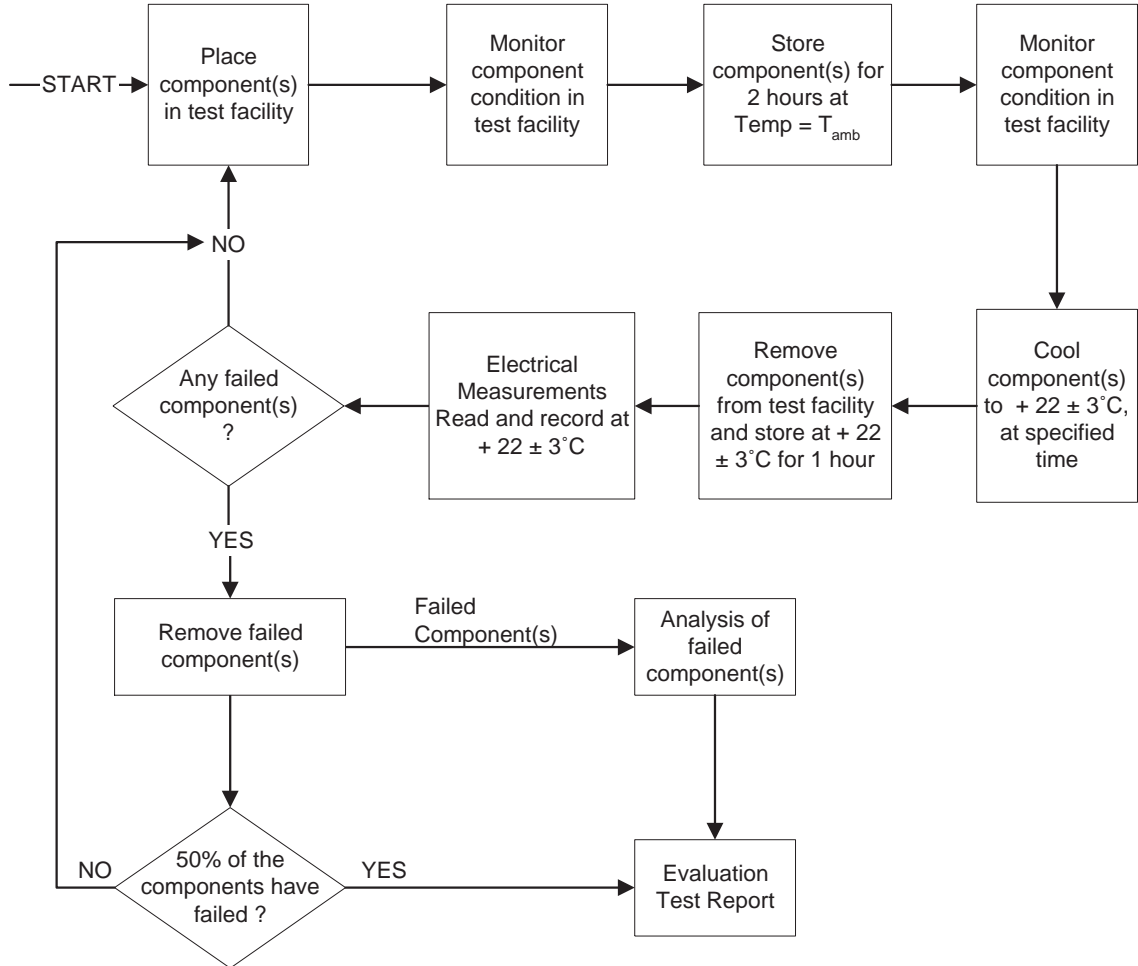
The above shall be briefly reviewed, indicating the success or otherwise of the evaluation test programme. Any production screens that need to be introduced into the PID shall be outlined.

9. **CHARTS**

9.1 **CHART 1 - EVALUATION TEST PROGRAMME**



9.2 CHART 2 - TEMPERATURE STEP-STRESS SEQUENCE



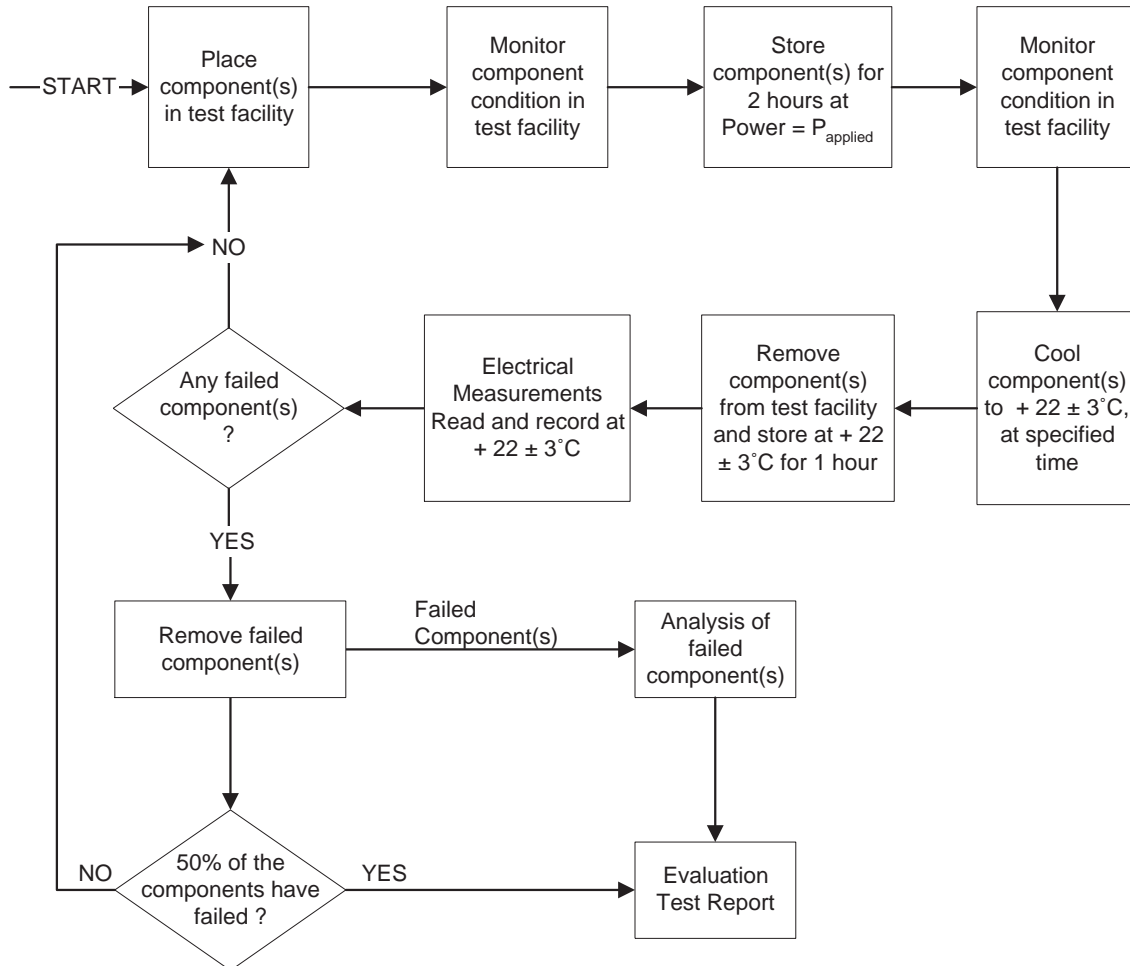
NOTES:

Temperature steps with T_{amb} :-

First step	:	T_0	°C
		T_1	°C
		T_2	°C
Last step	:	T_n	°C

With $(T_n > \dots T_2 > T_1 > T_0)$

9.3 CHART 3: POWER STEP-STRESS SEQUENCE



NOTES:

Power steps with $P_{applied}$:-

First step	:	P_0	W
		P_1	W
		P_2	W
Last step	:	P_n	W

With $(P_n > \dots > P_2 > P_1 > P_0)$

9.4

CHART 4: ACCELERATED ELECTRICAL ENDURANCE TEST

