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**EVALUATION TEST PROGRAMME FOR
ELECTROMAGNETIC RELAYS**

ESCC Basic Specification No. 2263600

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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 construction 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**

2.1 **GENERAL**

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

2.2 **ESCC SPECIFICATIONS**

- No. 3601, Relays, Electro-Magnetic, Non-latching.
- No. 3602, Relays, Electro-Magnetic, Latching.
- No. 20400, Internal Visual Inspection.
- No. 20500, External Visual Inspection.

2.3 **OTHER (REFERENCE DOCUMENTS)**

ECSS-Q-70-02, A Thermal Vacuum Test for the Screening of Space Materials.

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, 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 I.

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 **SELECTION OF COMPONENTS FOR EVALUATION TESTING**

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 65 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 configurations and contact types 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 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 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 (but see Para. 4.4).

4.4 CONTROL DURING FABRICATION

The components shall be produced as defined in Para. 3 of this specification. Internal visual inspections 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 number 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 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 (10 RELAYS)

10 devices shall be measured in accordance with Figure 2 of the Detail Specification (go-no-go). Where gauges exist for the performance of measurements, these may be used. Rejected components shall be replaced.

5.3 WEIGHT (10 RELAYS)

10 components shall be weighed. Any devices that exceed 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 Table 2 of the Detail Specification at an ambient temperature of $+22\pm 3$ °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 SEAL TEST (100%)

Fine and gross leak tests shall be performed on all components in accordance with the requirements of Para. 9.4 of ESCC Generic Specification No. 3601 or 3602. Rejected components shall be replaced.

5.7 MARKING AND SERIALISATION (100%)

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

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%)

Electrical measurements shall be performed in accordance with Tables 2 and 3 of the Detail Specification. All characteristics shall be recorded against serial number.

7. EVALUATION TEST PROGRAMME**7.1** GENERAL

The evaluation tests shall be performed as specified in Chart I. The components shall be randomly divided into three groups and their associated subgroups in the proportions indicated in Chart I. When a family of components is under investigation, the variations within that family must be represented in each group/subgroup.

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 measurements are made on any devices under test, these devices shall also be measured.

7.3 GROUP 2- ENVIRONMENTAL TESTS**7.3.1** General

This group shall be randomly divided into 3 subgroups in the proportions indicated in Chart I.

7.3.2 Subgroup 2A- Miss Test Under Vibration

7.3.2.1 *Procedure*

The test shall be performed as follows.

The vibration shall be sinusoidal with an acceleration of 10g. The entire frequency range of 50 to 300 Hertz and return to 50 Hertz shall be traversed in 20 minutes.

The power source for the open-circuit voltage shall not exceed 30 millivolts dc maximum or peak ac at 10 milliamperes maximum.

In each axis, relays shall be submitted to 2 400 cycles of contact operations at a frequency of 2 Hertz while they are vibrated.

7.3.2.2 *Intermediate Measurements*

During the last 100 cycles in each axis, contact voltage shall be monitored on a suitable oscilloscope and any irregularity in the waveform shall be recorded.

7.3.2.3 *Final Measurements and Inspection*

Seal test shall be performed in accordance with Para 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.3.3 Subgroup 2B- Sinusoidal Vibration Step Stress Test

7.3.3.1 *Procedure*

The test shall be performed as specified in Chart II herein in accordance with Para. 9.10 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

– **Test Conditions**

The steps shall be at successive levels as specified in Chart II, starting from step L0 (30g). The frequency range shall be as specified in the Detail Specification. At each step the vibration duration shall be 20 minutes per axis, 10 minutes for sweep-up and 10 minutes for sweep-down. All 3 axes shall be tested before starting the next step.

The test shall be stopped when 50% of the relays have been destroyed or step L7 (100g) has been completed.

A relay shall be considered as destroyed under the following circumstances:

- when mounting means or terminals have been broken.
- when there is no commutation at the first pulse on the coil.
- when a non-latching relay exhibits a permanent change of position of contacts.
- when the Latch or Reset Voltage for latching relays or the Pick-up or Drop-out Voltage for non-latching relays has drifted by more than 15%.

– **Electrical Conditions**

Non-latching relays shall be tested at rated coil voltage with coils energised during sweep-up and coils not energised during sweep-down.

Latching relays shall be tested in latch position during sweep-up and in reset position during sweep-down. The rated coil voltage shall be applied only for contact switchover from one position to another.

– Measurements During Vibration

Contacts shall be monitored during vibration to detect the following events:

- a micro-opening of a closed contact.
- a micro-closure of an opened contact.
- a change of position.

A visual inspection shall be performed after each 10 minutes period in each direction in each axis at each step to determine if any mechanical destruction has occurred.

Detection of any event shall be recorded against step, level, sweep direction and axis.

7.3.3.2 *Intermediate Measurements*

For non-latching relays, after each 20 minutes period in each axis at each step:

- Pick-up and Drop-out Voltages shall be measured in accordance with Table 2 of the Detail Specification.

For latching relays, after each 10 minutes period in each direction in each axis at each step:

- In the event of a change of position, the relays shall be reinitialised and the sweep repeated to confirm the fault.
- Latch and Reset Voltages shall be measured in accordance with Table 2 of the Detail Specification.

7.3.3.3 *Final Measurements and Inspection*

Seal test shall be performed in accordance with Para 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.3.4 Subgroup 2B- Mechanical Shock Step Stress Test

7.3.4.1 *Procedure and Intermediate Measurements*

The test shall be performed as specified in Chart II herein in accordance with Para. 9.11 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

– Test Conditions

The steps shall be of 1/2 sinus shocks at successive levels as specified in Chart II, starting from step L0 (100g).

The test shall be stopped when 50% of the relays have been destroyed or step L9 (3000g) has been completed.

A relay shall be considered as destroyed under the following circumstances:

- when mounting means or terminals have been broken.
- when there is no commutation at the first pulse on the coil.
- when a non-latching relay exhibits a permanent change of position of contacts.
- when the Latch or Reset Voltage for latching relays or the Pick-up or Drop-out Voltage for non-latching relays has drifted by more than 15%.

– Measurements During Shock

Contacts shall be monitored during shock to detect the following events:

- a micro-opening of a closed contact.
- a micro-closure of an opened contact.
- a change of position of contacts.

a visual inspection shall be performed after each shock to determine if any mechanical destruction has occurred.

Detection of any event shall be recorded against step, level, direction and axis.

– Test Sequence and Intermediate Measurements

The test sequence shall be as follows:

(a) Detection of a micro-opening

Once the relays are mounted, latching relays shall be put in Latch position, non-latching relays shall not be energised. The relays shall be tested at each step at increasing shock levels only in the direction most suitable to open the contacts until detection of a micro-opening.

When a contact opening occurs, the relays shall be reinitialised and the shock test repeated in the current direction and axis and at the same shock level to confirm the fault. The relays shall then be tested in the other direction in the same axis plus in both directions of the remaining 2 axes at the same shock level.

Following each step Pick-up and Drop-out Voltages for non-latching relays or Latch and Reset Voltages for latching relays shall be measured in accordance with Table 2 of the Detail Specification.

- (b) Latching relays shall then be put in Reset position, non-latching relays shall be energised. The same test procedure as in (a) shall be repeated.

(c) Detection of a micro-closing

Latching relays shall be put back in Latch position, non-latching relays shall not be re-energised. The relays shall be tested at each step at increasing shock levels in the same direction, starting from the next level from that where detection in (a) occurred until detection of a micro-closing.

When a contact closing occurs, the relays shall be reinitialised and the shock test shall be repeated in the current direction and axis and at the same shock level to confirm the fault. The relays shall then be tested in the other direction in the same axis plus in both directions of the remaining 2 axes at the same shock level.

Following each step Pick-up and Drop-out Voltages for non-latching relays or Latch and Reset Voltages for latching relays shall be measured in accordance with Table 2 of the Detail Specification.

- (d) Latching relays shall be put in Reset position, non-latching relays shall be re-energised. The

same test procedure as in (c) shall be repeated starting from the next level from that where detection in (b) occurred.

(e) Detection of a change of position

Latching relays shall be put back in Latch position, non-latching relays shall not be re-energised. The relays shall be tested at each step at increasing shock levels in both directions of each of the 3 axes, starting from the next level from that where detection in (c) occurred until 50% of the relays have been destroyed or step L9 (3000g) has been completed.

Following each step Pick-up and Drop-out Voltages for non-latching relays or Latch and Reset Voltages for latching relays shall be measured in accordance with Table 2 of the Detail Specification.

7.3.4.2 *Final Measurements and Inspections*

Seal test shall be performed in accordance with Para 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.3.5 Subgroup 2B- Salt Spray (Corrosion)

7.3.5.1 *Procedure*

The relays shall be tested in accordance with MIL-STD-202, Method 101. The following details and exceptions shall apply:

- (a) Applicable salt solution: 5%
- (b) Test condition: B

7.3.5.2 *Final Examination*

The relays shall be examined for evidence of peeling, chipping, blistering of the finish and exposure of the base metal due to corrosion.

7.3.6 Subgroup 2C- Resistance to Soldering Heat Step Stress Test

7.3.6.1 *Applicability*

Only solderable terminals shall be submitted to this test.

7.3.6.2 *Procedure*

The test shall be performed in accordance with Para. 9.18 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

– Test Conditions

The relays shall be split into 3 equal subgroups which shall be respectively submitted to the following steps:

- 260°C 10 seconds, 260°C 20 seconds, 260°C 30 seconds
- 280°C 10 seconds, 280°C 20 seconds, 280°C 30 seconds

- 300°C 10 seconds, 300°C 20 seconds, 300°C 30 seconds

Before each new terminal immersion step, care shall be taken that the case temperature has returned to room ambient.

7.3.6.3 *Intermediate Measurements*

After each immersion, electrical measurements shall be performed in accordance with Table 2 of the Detail Specification and recorded and a fine leak test shall be performed in accordance with Para 9.4.2 of ESCC Generic Specification No. 3601 or 3602 with the exception of steps (b) and (c).

7.3.6.4 *Final Measurements and Inspection*

Seal test shall be performed in accordance with Para 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4 GROUP 3- ENDURANCE TESTS

7.4.1 General

This group shall be randomly divided into 5 subgroups in the proportions indicated in Chart I.

7.4.2 Temperature Rise and Resistive Load Life Test

7.4.2.1 *Continuous Current Temperature Rise*

The temperature rise of relays shall be determined on 3 relays by the following procedure. The temperature rise of terminals of the closed contact and the coils shall be determined by any suitable method, but preferably for the coils by the resistance change method. The temperature rise shall be determined by the following procedure.

7.4.2.1.1 *Method of Mounting*

The relays shall be suspended by their terminals in the test chamber 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 the size AWG24 (diameter 0.64mm) for connecting the coils and of the size specified hereunder for connecting the contacts:

Rated Current (A)	Wire Size	
	AWG	Diameter (mm)
Up to 3	24	0.64
>3 to ≤5	22	0.86
>5 to ≤11	20	1.04
>11 to ≤16	18	1.29
>16 to ≤22	16	1.53
>22 to ≤32	14	1.87

7.4.2.1.2 Ambient Test Temperature

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 relay under test, but not where it will be influenced by the temperature rise of the relay.

The test chamber shall then be stabilised at room temperature without forced-air ventilation or any means of component cooling.

7.4.2.1.3 Initial Measurements

(a) The temperature of closed contacts without current shall be measured on the terminals at the specified ambient temperature at a distance of 3mm from the device body. When the temperature is stabilised, the values shall be recorded.

(b) The DC resistance (r) of the coil shall be measured with one-tenth rated direct current applied at the specified ambient temperature (t). when the resistance of the coil is stabilised, the resistance value shall be recorded.

The ammeter-voltmeter method may be used for determining this resistance, provided that the accuracy of those meters is $\pm 0.5\%$ or better and the resistance of the voltmeter is at least 20000 Ω per volt.

7.4.2.1.4 Test Conditions

The temperature rise shall be measured under the 4 test conditions as follows:

(a) The relay shall be loaded with the rated resistive load contact current specified in Table 1(b) of the Detail Specification flowing in the closed contact without permanent rated coil voltage applied.

(b) The relay shall be loaded with the rated resistive load contact current specified in Table 1(b) of the Detail Specification flowing in the closed contact with permanent rated coil voltage applied.

(c) The relay shall be loaded with resistive overload current specified in Table 1(b) of the Detail specification flowing in the closed contact without permanent rated coil voltage applied.

(d) The relay shall be loaded with resistive overload current specified in Table 1(b) of the Detail specification flowing in the closed contact with permanent rated coil voltage applied.

Forced air circulation shall be shut off when specified current is applied.

7.4.2.1.5 Final Measurements

When the temperature of the coil and on the terminals of closed contact measured at 5 minute intervals, remains constant, the temperature on the terminals and the coil resistance shall be recorded.

(a) Temperature rise of terminals of closed contact

ΔT_R = Temperature rise of terminals of closed contact in $^{\circ}\text{C}$ between final and initial measurements.

T = ambient temperature in $^{\circ}\text{C}$ (at the time forced air circulation is shut off) with specified DC current applied. T shall not differ by more than 5°C .

(b) Temperature rise of coil

If the power is removed, this temperature measurement shall be made within 30 seconds of the removal of power. When the resistance of the coil is stabilised with rated 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:

$$\Delta T_c = (R - r) (t + 234.5) - (T - t), \text{ where}$$

ΔT_c = Temperature rise in $^{\circ}\text{C}$ above the specified ambient temperature of the coil under test.

R=Resistance of coil in Ω with rated direct current applied at temperature $(T+\Delta T)$.

r= Resistance of coil in Ω at temperature (t) , the specified ambient temperature.

t= Stabilised specified ambient temperature in $^{\circ}\text{C}$ of the coil under test with one-tenth current applied.

T= Ambient temperature in $^{\circ}\text{C}$ (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 .

7.4.2.2 *Resistive Load Life Test*

7.4.2.2.1 Procedure

The test shall be performed in accordance with Para. 9.19.1 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- The relays shall be split into 4 equal subgroups which shall be respectively submitted to the following conditions:
 - (a) 28Vdc. The test current shall be 1.5 times rated contact current for relays specified under 5A and 1.2 times for relays specified from 5A to 25A. (Rated resistive load contact current in Table 1(b) of the Detail Specification.
 - (b) 50Vdc. The test current shall be agreed with the Qualifying Space Agency.
 - (c) 70Vdc. The test current shall be agreed with the Qualifying Space Agency.
 - (d) 100Vdc. The test current shall be agreed with the Qualifying Space Agency.
- The coils shall be energised at 90% of the rated coil voltage.
- Half of the relays shall be loaded on break contacts, the other half on make contacts.
- A minimum of one pole per relay shall not be loaded.

7.4.2.2.2 Arc Duration and Transfer Time Measurements

A memory scope shall be used, the contact voltage of the unit under test on channel 1 and the contact voltage of the opposite contact on channel 2, the scope is triggered by the coil pulse. The transfer time is the delay between the opening of a contact under test and the closing on the opposite contact. The arc duration is the delay between the opening of the high-powered contact under test and the drop to zero of the voltage on this contact.

The arc duration and the transfer time measurements shall be performed and recorded for each high-powered contact. If the arc duration is more than 50% of the transfer time, the test current shall be reduced.

7.4.2.2.3 Initial Measurements

Electrical measurements shall be performed in accordance with Table 2 of the Detail specification.

The contact resistances of the unloaded pole(s) shall be measured under 30mVdc with a test current = $100\mu\text{A}$.

7.4.2.2.4 Intermediate Measurements

Every 10000 operations, the contact resistance of the unloaded pole(s)) shall be measured under 30mVdc with a test current = $100\mu\text{A}$. The dynamic contact resistance of the high-powered contacts and the operating voltages shall also be measured. Alternatively, a minimum, maximum and average value of dynamic contact resistance over each 10000 operations is acceptable.

7.4.2.2.5 Final Measurements

First measurement shall be an Insulation Resistance measured as per Para. 9.3.7 of the Generic Specification 3601 or 3602, with a test voltage not greater than 10V. Then the contact resistances of the unloaded pole(s) shall be measured under 30mVdc with a test current = 100 μ A, and electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

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

Seal test shall be performed in accordance with Para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

7.4.3 Subgroup 3B - Intermediate Current

7.4.3.1 *Procedure*

The test shall be performed in accordance with Para. 9.16 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- The number of cycles shall be 100000 minimum.
- Relays with a contact rating equal to or less than 1 ampere shall be tested with a current of 10 milliamperes.

7.4.3.2 *Intermediate Measurements*

At 50000 operations and then every 10000 operations, dynamic contact resistance and operating voltages shall be measured. Alternatively, minimum, maximum and average values of dynamic contact resistance over each 10000 operations is acceptable.

7.4.3.3 *Final Measurements and Inspection*

Seal test shall be performed in accordance with Para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

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

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.4 Subgroup 3B - Terminal Strength Step Stress Test

7.4.4.1 *Procedure*

The test shall be performed in accordance with Para. 9.17 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

The relays shall be split into 3 equal subgroups which shall be respectively submitted to the following steps:

- Pull test (applicable to all terminal types) starting at the value defined in the Detail Specification and steps increasing by the initial value until failure occurs.
- Bend test starting at the value defined in the Detail specification and steps increasing by the initial value until failure occurs.
- Twist test at 20, 45 and 90 degrees (also applicable to solder hook terminals). The 90 degree rotations shall only be applied to the 4 corner terminals.

For larger terminals (screw type), a torque meter may be used.

7.4.4.2 *Intermediate Measurements*

After each step, electrical measurements shall be performed in accordance with Table 2 of the Detail specification and recorded and a fine leak test shall be performed in accordance with para. 9.4.2 of ESCC Generic Specification No. 3601 or 3602 with the exception of steps (b) and (c).

7.4.4.3 *Final Measurements and Inspection*

Seal test shall be performed in accordance with para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.5 Subgroup 3C - Low Level Mechanical Life Tests

7.4.5.1 *Applicability*

This test is only applicable to relays rated at less than 5 Amperes.

7.4.5.2 *Procedure*

The test shall be performed in accordance with Para. 9.19.2 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- The test shall be run for 200000 operations with contact resistance monitoring.
- Subsequently, the relays shall be cycled without contact resistance monitoring up to 1.5 million operations.

7.4.5.3 *Intermediate Measurements*

After 200000, 500000 and 1 million operations, electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.5.4 *Final Measurements and Inspection*

Seal test shall be performed in accordance with para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.6 Subgroup 3C - Inductive Load and Mechanical Life Tests

7.4.6.1 *Applicability*

This test is only applicable to relays rated at 5 Amperes or greater.

7.4.6.2 *Inductive Load*

7.4.6.2.1 *Procedure*

The test shall be performed in accordance with Para. 9.19.3 of ESCC Generic specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- Relays shall be cycled for 50000 operations.
- The relays shall be tested in the position where their terminals are downwards.

7.4.6.2.2 Intermediate Measurements

Every 10000 operations, dynamic contact resistance and operating voltages shall be measured. alternatively, minimum, maximum and average values of dynamic contact resistance over each 10000 operations is acceptable.

Additionally, insulation resistance and voltage proof shall be measured in accordance with Table 2 of the Detail Specification.

7.4.6.2.3 Final Measurements and Inspection

Seal test shall be performed in accordance with para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.6.3 *Mechanical Life Test*

7.4.6.3.1 Procedure

The test shall be performed in accordance with Para. 9.19.4 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- Test conditions
Relays shall be cycled for 500000 operations.

7.4.6.3.2 Intermediate Measurements

Every 100000 operations, electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.6.3.3 Final Measurements and Inspection

Seal test shall be performed in accordance with para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.7 Subgroup 3D - Inrush Current

7.4.7.1 Procedure

The test shall be performed in accordance with Para. 9.19.1 of ESCC Generic Specification No. 3601 for non-latching relays or 3602 for latching relays, with the following exceptions:

- The test current shall be 10 times rated current when the contacts are closing and the pulse duration shall be 100 milliseconds.
- The number of operations shall be 100. The Normally Open and Normally Closed contacts of each

individual switching circuit shall be tested.

7.4.7.2 *Intermediate Measurements*

Contact resistance as well as insulation resistance and voltage proof shall be monitored after each 10 operations.

7.4.7.3 *Final Measurements and Inspection*

Seal test shall be performed in accordance with para. 9.4 of ESCC Generic Specification No. 3601 or 3602.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.8 Subgroup 3E - Coil Tests

7.4.8.1 *Coil Life Test*

7.4.8.1.1 Procedure

The test shall be performed in accordance with Para. 9.20 (a) and (b) of ESCC Generic specification No. 3601 with the following exceptions:

- Maximum coil voltage instead of rated coil voltage shall be applied during the applicable portions of the test. For latching relays, maximum coil voltage shall be continuously applied to either one of the 2 coils.
- Initial Measurements
Before starting the test, the coil current plus the operate, release and bounce times of each relay shall be measured. The contact resistance of the normally closed contacts shall be also measured with conditions and test sequence as follows:
 1. Test voltage: 30mV; Test current: 100 μ A.
 2. Test voltage: 5V; Test current: 1mA.
 3. Test voltage: 5V; Test current: 10mA.

7.4.8.1.2 Intermediate Measurements

As per Para. 9.20 (c) of ESCC Generic Specification No. 3601 with the following exceptions:

- 2 hours prior to the end of the last high temperature cycle, rated current shall be removed from the contacts and the coil shall be de-energised.
- 1 hour prior to the end of the last high temperature cycle, operating voltages shall be measured. Then, maximum coil voltage shall be applied to the relays during the last hour.
- At the end of the last high temperature cycle, the coil shall remain energised while the relays are brought to the minimum temperature extreme. the transfer shall be done in less than 2 minutes. The relay shall remain energised for 1 hour. Then, the coil voltage shall be removed and the contact resistance of the Normally Closed contacts immediately measured and recorded.

7.4.8.1.3 Final Measurements and Inspections

Seal test shall be performed in accordance with Para. 9.4 of ESCC Generic Specification No. 3601.

External visual inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

The coil current plus the operate, release and bounce times of the relay shall be measured. The drifts of the coil current plus the operate and release times from the initial measurements shall not exceed 10%.

The contact resistance of the normally closed contacts shall be measured with the same conditions and sequence as for the initial measurements. The contact resistance shall be as specified in Table 2 of the Detail Specification. Other electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.4.8.2 *Coil Voltage Step Stress Test*

7.4.8.2.1 Procedure

The steps shall be at successive levels as specified in Chart II, starting from step L0 ($1xV_C$).

The test shall be stopped when 50% of the relays have been destroyed or step L4 ($3xV_C$) has been completed.

A relay shall be considered as destroyed when there is no commutation at the first pulse on the coil.

The final measurements from the Coil Life test shall be used as the initial measurements for the Coil Voltage Step Stress test.

– Test Conditions

The relays shall be tested at their maximum high temperature as specified in Table 1(b) of the Detail Specification. The coils shall be energised with pulses of duration 120ms with a cycling rate not exceeding 1 operation per minute. At each step, the number of operations shall be 100. The normally open and normally closed contacts of each individual switching circuit shall be tested.

7.4.8.2.2 Intermediate Measurements

After each step the operate, release and bounce times shall be measured.

7.4.8.2.3 Final Measurements

The coil current plus the operate, release and bounce times of the relay shall be measured. The drifts of the coil current plus the operate and release times from the initial measurements shall not exceed 10%.

Other electrical measurements shall be performed in accordance with Table 2 of the Detail Specification.

7.5 CONSTRUCTION ANALYSIS

7.5.1 General

The purpose of this analysis, consisting of a series of examinations and evaluations, is to examine the construction of a device and to assess potential reliability hazards.

It shall also be used to evaluate the amount of degradation after tests as specified in Chart I.

It shall be performed on any relay of interest from any subgroup, with a minimum of 8 relay to be analysed.

7.5.2 Materials and Finishes

All non-metallic materials and finishes shall be tested for outgassing in accordance with ECSS-Q-70-02.

7.5.3 Equipment

- Iso-Propyl alcohol and brush.
- Can opening tool appropriate to the relay being opened.
- Laminar flow bench cleanliness class < 10000.
- Binocular magnifying glass with annular light and magnification 10X to 40X.
- Finger cots, fine scalpel.
- Clean compartmented box.

7.5.4 Procedure

The relay and the opening tool shall be inspected for cleanliness under a magnification of 10X to 20X. If necessary, brush the relay and the tooling clean with alcohol.

The relay shall be inspected externally in accordance with ESCC Basic specification No. 20500.

The relay shall be opened with extreme caution using an appropriate tooling.

Particles from the opening operation shall be removed from the outside of the relay.

Prior to the opening with a fine scalpel, it is recommended to wrap the opening area with adhesive tape to prevent introduction of opening debris into the can.

The relay shall be brought under the laminar flow bench.

Using finger cots, the relay shall be held with the terminals pointing upwards and the can shall be separated from the relay.

The can shall be inspected internally for any particle or contamination under a 40X magnification.

The relay shall be inspected for any particle under a 40X magnification.

Particles due to the opening operation are easily identifiable (shape and magnetism).

Then the relay, held by its terminals, shall be inspected in accordance with ESCC Basic Specification No. 20400.

Degradation due to previous tests of the sequence shall be observed during this inspection and commented: mechanical degradation for subgroups 2A and 2B, contact degradation for subgroups 3C and 3D.

The coil(s) shall be removed and the finishing tape unwound in order to expose the coil wire to lead wire connection. the solder shall be smooth and bright. At least 3 turns of coil wire around the lead shall be free from solder to act as a strain relief. There shall be no flux residues.

7.5.5 Report

Each step shall be recorded separately and a summary of the entire process and the results shall be written. Photographs shall be supplied for significant points.

7.6 RESIDUAL GAS ANALYSIS

Residual Gas analysis shall be performed on 4 relays for each of the applicable subgroups as shown in Chart I.

Results shall be evaluated with respect to nitrogen and moisture content in particular.

8. DATA DOCUMENTATION

8.1 GENERAL REQUIREMENTS

An evaluation test report shall be established. This shall comprise of 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) Initial measurements.
- (g) Group 1 - Control group data.
- (h) Subgroup 2A - Miss test under vibration.
- (i) Subgroup 2A - Sinusoidal vibration step stress test.
- (j) Subgroup 2B - Mechanical shock step stress test.
- (k) Subgroup 2B - Salt spray (Corrosion).
- (l) Subgroup 2C - Resistance to soldering heat step stress test.
- (m) Subgroup 3A - Temperature Rise and resistive load life test.
- (n) Subgroup 3B - Intermediate current test.
- (o) Subgroup 3B - Terminal strength step stress test.
- (p) Subgroup 3C - Low level mechanical life tests.
- (q) Subgroup 3C - Inductive load and mechanical life tests.
- (r) Subgroup 3D - Inrush current.
- (s) Subgroup 3E - Coil life, Coil voltage step stress and residual gas analysis.
- (t) Construction analysis.
- (u) Summary of results and conclusion.

Items (a) to (u) 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 SHEET(S)

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.
- (e) Location of the Manufacturer/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 (PARA. 4.1)

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 PRODUCTION DATA (PARA. 4.4)

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

8.7 INSPECTION DATA (PARA. 4.5)

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 (PARA. 6)

All data shall be recorded against serial numbers. A histogram of device parameters shall be produced. Minimum, maximum and average values and the standard deviation shall also be produced. For latching relays, the difference between latch and reset voltages shall be provided.

8.9 GROUP 1 - CONTROL GROUP DATA (PARA. 7.2)

All data shall be recorded against serial numbers.

8.10 GROUP 2 - ENVIRONMENTAL TESTS

8.10.1 Subgroup 2A - Miss Test Under Vibration Data (Para. 7.3.2)

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

- (a) Number of contact misses.
- (b) Contact voltage wave irregularities, if any.
- (c) Seal test results.
- (d) Results of External Visual inspection.
- (e) Final electrical measurements results (Table 2 of the Detail Specification).

8.10.2 Subgroup 2A - Sinusoidal Vibration Step Stress Test Data (Para. 7.3.3)

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

- (a) Any micro-opening of a closed contact, any micro-closure of an opened contact, change of position of a contact or mechanical destruction of a device.
- (b) Intermediate measurement results after each direction of each axis and each step, Pick-up and Drop-out Voltages for non-latching relays and Latch and Reset Voltages for Latching relays.
- (c) Seal test results.
- (d) Results of External Visual inspection.
- (e) Final electrical measurements results (Table 2 of the Detail Specification).

8.10.3 Subgroup 2B - Mechanical Shock Step Stress Test (Para. 7.3.4)

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

- (a) Any micro-opening of a closed contact, any micro-closure of an opened contact, change of position of a contact or mechanical destruction of a device.
- (b) Intermediate measurement results after each axis and each step, Pick-up and Drop-out Voltages for non-latching relays and Latch and Reset Voltages for latching relays.
- (c) Seal test results.
- (d) Results of External Visual inspection.
- (e) Final electrical measurements results (Table 2 of the Detail specification).

8.10.4 Subgroup 2B - Salt Spray (Corrosion) (Para. 7.3.5)

All data shall be recorded against serial numbers.

The results of the examination after test shall be clearly documented.

8.10.5 Subgroup 2C - Resistance to soldering Heat Step Stress Test (Para. 7.3.6)

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

- (a) Intermediate measurement results after each step, electrical measurements results (Table 2 of the Detail specification).
- (b) Seal test results.
- (c) Results of external visual inspection.
- (d) Final electrical measurements results (Table 2 of the Detail specification).

8.11 GROUP 3 - ENDURANCE TESTS

8.11.1 Subgroup 3A - Temperature Rise and Resistive Load Life Test (Para. 7.4.2)

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

1. Temperature Rise Test (Para. 7.4.2.1):
 - (a) Initial measurement results, temperature of closed contacts, D.C. resistance of the coil and specified ambient temperature.
 - (b) Final measurement results after each condition of loading, temperature of terminals of closed contacts, resistance of the coil with rated current applied and chamber temperature and specified ambient temperature.
 - (c) Calculated temperature rise of terminals of closed contacts and coil.
2. Resistive Load Life Test (Para. 7.4.2.2):
 - (a) Arc duration time.
 - (b) Initial electrical measurement results (Table 2 of the Detail Specification), contact resistance of unloaded pole(s).
 - (c) Intermediate measurement results after each 10000 operations, Contact Resistance of the unloaded pole(s), Dynamic Contact Resistance, Pick-up and Drop-out Voltages for non-latching relays and Latch and Reset Voltages for latching relays.
 - (d) Final electrical measurement results, Insulation Resistance at 10V max, Contact Resistance of the unloaded pole(s) and electrical measurements (Table 2 fo the Detail Specification).
 - (e) Seal test results.
 - (f) Results of External Visual Inspection.

8.11.2 Subgroup 3B - Intermediate Current Test (Para. 7.4.3)

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

- (a) Intermediate measurement results, dynamic contact resistance and operating voltages measurements after each 10000 operations.
- (b) Seal test results.
- (c) Results of external visual inspection.
- (d) Final electrical measurements results (Table 2 of the Detail specification).

8.11.3 Subgroup 3B - Terminal Strength Step Stress Test (Para. 7.4.4)

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

- (a) Intermediate measurement results after each step, electrical measurements results (Table 2 of the Detail specification).
- (b) Seal test results.
- (c) Results of external visual inspection.
- (d) Final electrical measurements results (Table 2 of the Detail specification).

8.11.4 Subgroup 3C - Low level Mechanical Life Tests (Para. 7.4.5)

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

- (a) Number of misses during the first 200000 operations.
- (b) Intermediate electrical measurements results (Table 2 of the Detail specification).
- (c) Seal test results.
- (d) Results of external visual inspection.
- (e) Final electrical measurements results (Table 2 of the Detail specification).

8.11.5 Subgroup 3C - Inductive Load and Mechanical Life Tests (Para. 7.4.6)

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

- (a) Intermediate measurement results, dynamic contact resistance and operating voltages measurements, insulation resistance and voltage proof after each 10000 operations.
- (b) Seal test results.
- (c) Results of external visual inspection.
- (d) Final electrical measurements results (Table 2 of the Detail specification).

8.11.6 Subgroup 3D - Inrush Current (Para. 7.4.7)

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

- (a) Intermediate measurement results, static contact resistance, insulation resistance and voltage proof after each 10 operations.
- (b) Seal test results.
- (c) Results of external visual inspection.
- (d) Final electrical measurements results (Table 2 of the Detail specification).

8.11.7 Subgroup 3E - Coil Life, Coil voltage Step Stress and Internal Moisture (Para. 7.4.8)

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

1. Coil Life Test (Para. 7.4.8.1)
 - (a) Initial Measurement results, coil current, operate, release and bounce times and contact resistances of the normally closed contacts for each measurement condition.
 - (b) Intermediate Measurement results, coil resistance and contact resistance at room temperature at 250, 500 and 750 hours.
 - (c) Intermediate Measurement results during last high temperature cycle, Pick-up and Drop-out Voltages for non-latching relays and Latch and Reset Voltages for latching relays and during last low temperature cycle, contact resistance of the normally closed contacts.
 - (d) Seal test results.
 - (e) Results of External Visual Inspection.
 - (f) Final Measurement results, coil current, operate, release and bounce times and contact resistances of the normally closed contacts for each measurement condition, electrical measurements (Table 2 of the Detail Specification) and the drift of the coil current, operate and release times between Initial and Final Measurements.

2. Coil Voltage Step Stress Test (Para. 7.4.8.2)
 - (a) Intermediate Measurement results after each step, operate, release and bounce times.
 - (b) Final Measurement results, coil current, operate, release and bounce times, electrical measurements (Table 2 of the Detail Specification) and the drift of the coil current, operate and release times between Initial and Final Measurements.

8.12 CONSTRUCTION ANALYSIS (PARA. 7.5)

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

- (a) Deviations against the applicable specifications.
- (b) Photographs of points of interest.
- (c) Comments on the effects of the previous test(s).

8.13 RESIDUAL GAS ANALYSIS (PARA. 7.6)

All data shall be recorded against serial numbers.

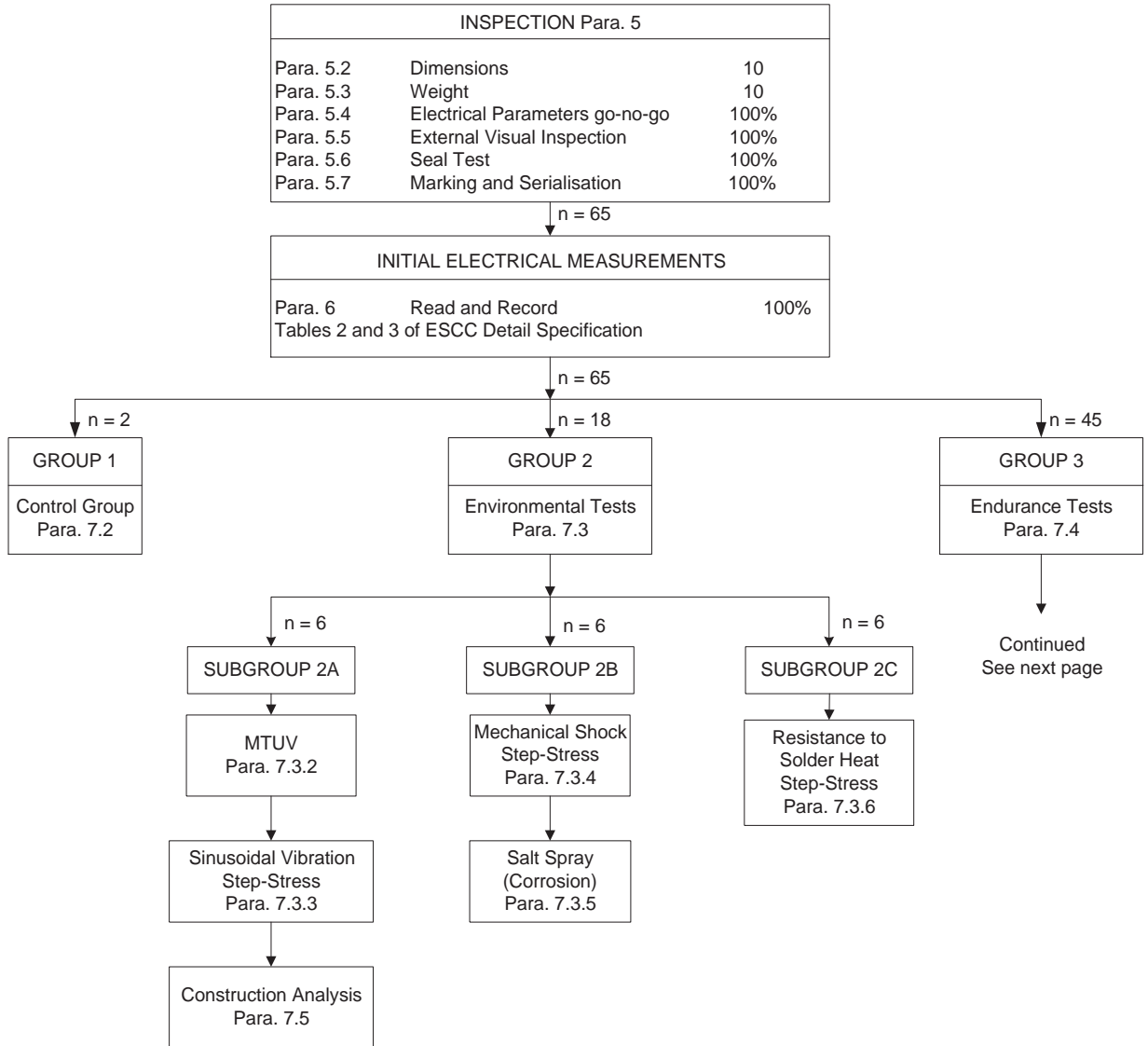
8.14 SUMMARY OF RESULTS AND CONCLUSIONS

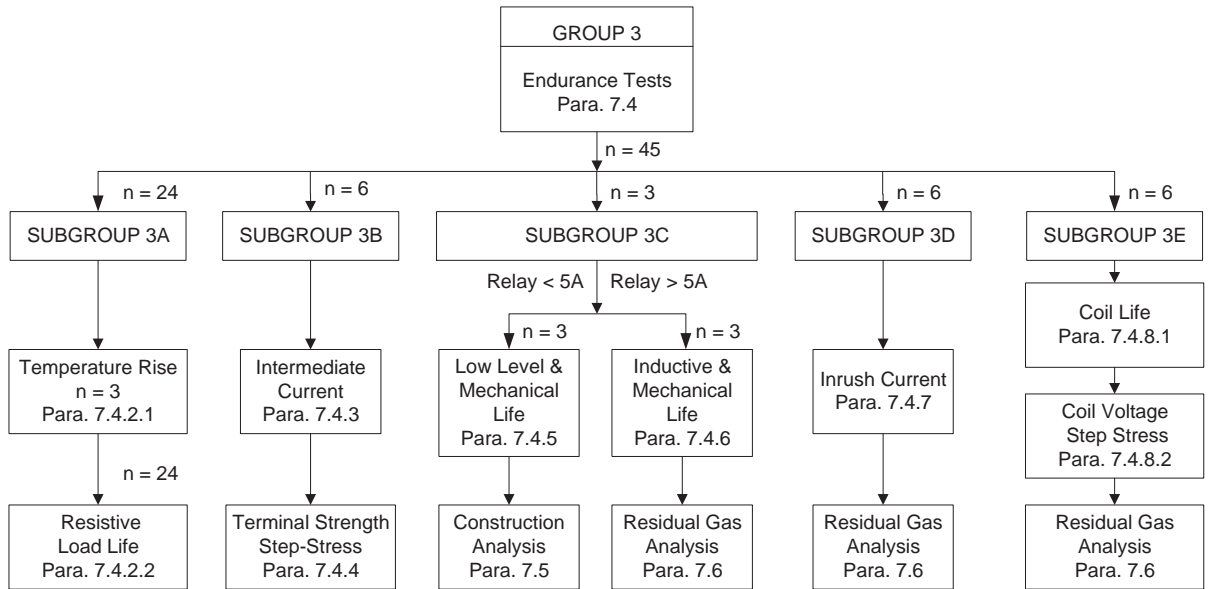
The above shall be briefly reviewed, indicating the success or otherwise of the evaluation test programme. Any production screens that need to be introduced in the PID shall be outlined.

Recommendations/deviations pertaining to the Detail Specifications or the qualification programme shall also be outlined.

9. **CHARTS**

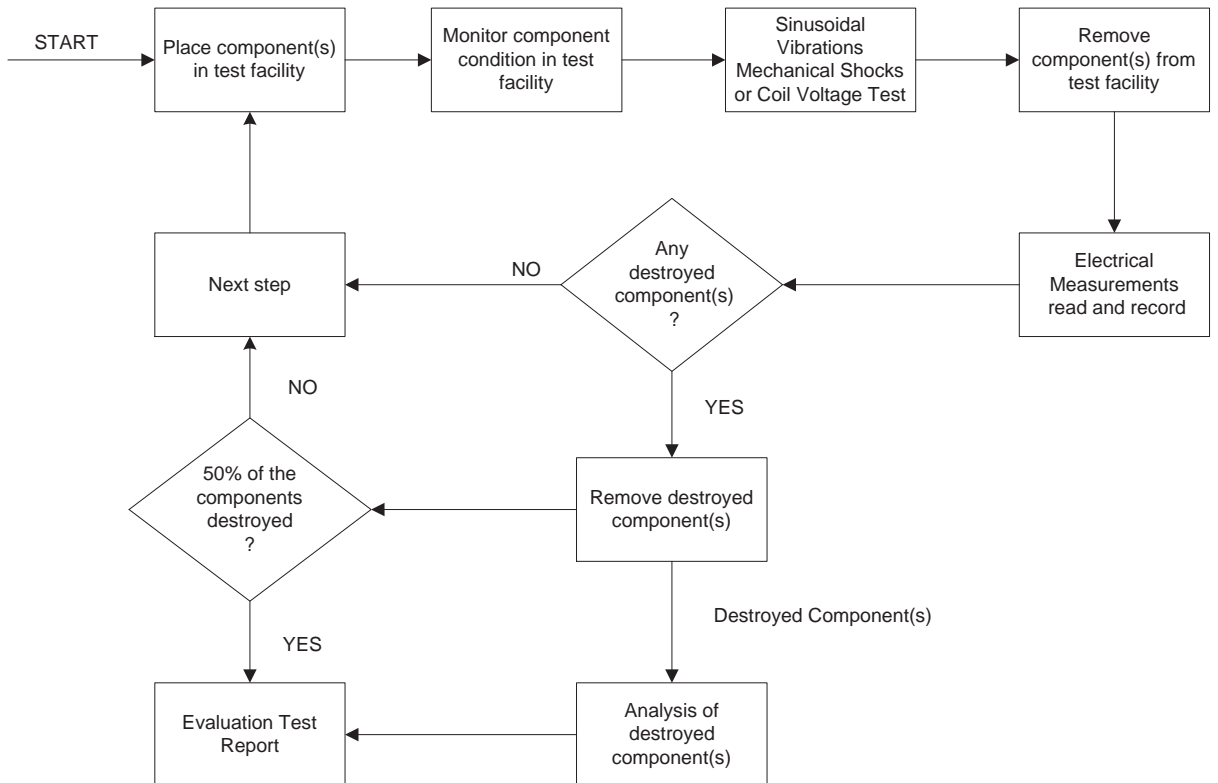
9.1 **CHART I - EVALUATION TEST PROGRAMME**





9.2

CHART II - SINUSOIDAL VIBRATION STEP-STRESS TEST, MECHANICAL SHOCK STEP-STRESS TEST AND COIL VOLTAGE STEP-STRESS TEST



Step Number	Sinusoidal Vibration Steps		Mechanical Shock Steps		Coil Voltage Steps
L0	30g,	10-3000Hz	100g,	11ms	1 x V_c
L1	40g,	10-3000Hz	200g,	6ms	1.5 x V_c
L2	50g,	10-3000Hz	350g,	4ms	2 x V_c
L3	60g,	10-3000Hz	500g,	1ms	2.5 x V_c
L4	70g,	65-300Hz	750g,	0.5ms	3 x V_c
L5	80g,	65-300Hz	1000g,	0.5ms	-
L6	90g,	65-300Hz	1500g,	0.5ms	-
L7	100g,	65-300Hz	2000g,	0.1ms	-
L8	-	-	2500g,	0.1ms	-
L9	-	-	3000g,	0.1ms	-