EVALUATION TEST PROGRAMME

FOR CONNECTORS

ESCC Basic Specification No. 2263400

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ESA/SCC Basic Specification No. 2263400

space components
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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 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

2.1 GENERAL

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

2.2 ESA/SCC SPECIFICATIONS

No. 3401, Connectors, Electrical, Non-Filtered, Circular and Rectangular.

No. 20500, External Visual Inspection.

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

2.3 OTHER (REFERENCE) DOCUMENTS

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

IEC Publication No. 512, Electromechanical Components for Electronic Equipment; Basic Testing Procedures and Measuring Methods.

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 (P.I.D.) or an identifiable process which shall form the basis for the P.I.D., in sufficient quantities to permit a random sample to be chosen for the evaluation test programme from a quantity of 2X to 3X that required.

The tests specified in the programme shall be performed in the sequence shown in Charts I(a) and I(b). 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 Qualifying Space Agency (QSA) for whom the evaluation of the component concerned is required, by the Manufacturer or at a test laboratory approved by the QSA.

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 12 connector sets and 100 contact sets 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 ESA/SCC format and submit it to the appropriate QSA for provisional approval. This shall then serve as a basis for the ordering and testing of the relevant components.

4.3 INSPECTION RIGHTS

The QSA reserves the right to inspect at any time the components processed for evaluation purposes. The Manufacturer shall notify the QSA at least three working days in advance of the date of pre-assembly 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. Pre-assembly 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 reject. A chart showing the number in/out and failure cause for each fabrication stage shall be submitted to the QSA.

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/SCC requirements may invalidate the evaluation.

5.2 DIMENSIONS (100%)

All devices shall be inspected in accordance with Figure 2 of the Detail Specification and the results recorded together with any non-conformities. Rejected components shall be replaced.

5.3 WEIGHT (100%)

All components shall be weighed to an accuracy of 1/10 gramme. Rejected components shall be replaced.

5.4 ELECTRICAL MEASUREMENTS (100%)

The measurements shall be performed in accordance with Table 2 of the Detail Specification at an ambient temperature of +22 ± 3°C (go-no-go). Rejected components shall be replaced.

5.5 EXTERNAL VISUAL INSPECTION (100%)

All devices shall be inspected in accordance with ESA/SCC 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. WIRING

In accordance with ESA/SCC Generic Specification No. 3401, Para. 9.10.

7. INITIAL MEASUREMENTS (100% read and record)

The measurements shall be made according to Table 2 of the detail specification. In addition, connector sets shall have their mating and unmating forces measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.20 (Chart I(a)) and contact sets shall have their low level contact resistance measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.1.1.3 (Chart I(b)). All characteristics shall be recorded against serial numbers.

8. EVALUATION TEST PROGRAMME (CONNECTORS)

8.1 GENERAL

Mated connector sets fitted with representative contacts shall be submitted to the evaluation tests as specified in Chart I(a). Chart I(a) is designed to evaluate the connector shell (if applicable), insert, method of retention etc. Contacts are evaluated separately by means of Chart I(b) and Para. 9 of this specification. The components shall be randomly divided into three groups and their associated subgroups in the proportions indicated in Chart I(a). When a family of components is under investigation, the variations within that family must be represented in each group/subgroup.

8.2 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.

8.3 GROUP 2 - ENDURANCE TESTS

8.3.1 General

This group shall be randomly divided into two subgroups and then recombined into a third in the proportions indicated in Chart I(a).

8.3.2 Subgroup 2A - Mechanical Endurance

8.3.2.1 Initial Measurements

The resistance of all contacts is to be measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.1.1.3, at low level current. Connectors fitted with removable contacts shall be subjected to the test in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.27.

8.3.2.2 Procedure

The test shall be performed in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.18 but continuing until 1000 cycles have been performed or until the mating/unmating force and/or low level contact resistance have exceeded the limits in the Detail Specification, whichever is the sooner.

8.3.2.3 Intermediate Measurements

After every 100 operations the mating and unmating forces shall be measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.20. On rectangular connectors the low level contact resistance shall be measured, as in Para. 8.3.2.1, on the end columns of contacts and on a column in the middle of the connector. On circular connectors the low level contact resistance shall be measured on the outer ring of contacts and on a ring near the centre of the connector. For connectors having ten or less contacts, all contacts shall be measured. The same contacts shall be measured at each point.

8.3.2.4 Final Measurements

As in Para. 8.3.2.3, except that the resistance of all contacts shall be measured. The entry zone of female contacts shall be examined. Any evidence of wear shall be recorded photographically. Connectors fitted with removable contacts shall be subjected to the test in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.27.

8.3.3 Subgroup 2B - Electrical Endurance

8.3.3.1 Initial Measurements

The rated current contact resistance of half the contacts (rounded up) shall be measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.1.1.3.

8.3.3.2 Procedure

IEC Publications No. 512-5, Test 9b at the maximum operating temperature and maximum rated current specified in the Detail Specification, for a duration of 1000 +24/-0 hrs.

8.3.3.3 Intermediate and Final Measurements

As in Para. 8.3.3.1. These shall be performed every 100 ±24 hours and at 1000 +24/-0 hrs. The same contacts as in Para. 8.3.3.1 shall be measured at each point.

8.3.4 Subgroup 2C - Construction Analysis

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. Each step shall be recorded separately and a summary of the entire process and the results shall be made. At least six devices shall be analysed, and of the analysed devices at least three must have undergone the Subgroup 2A tests and three the Subgroup 2B tests.

(a) **Coupling Mechanism** (Bayonet and Jackscrew)

At least two devices (one from Subgroup 2A and one from Subgroup 2B) shall be submitted to the test in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.20. Then each device shall be tested to destruction by forcing the coupling ring or jackscrew in the engagement direction. The force or torque at that moment is to be recorded as well as the type of failure. A visual examination shall be made of the mating interfaces and a photographic record made.

(b) **Guiding and Locking Devices** (Connectors without Shell)

These shall be torqued to destruction and the force at that moment shall be recorded, as shall the type of failure. A photographic record shall be made.

(c) **Insert Retention In Shell** (Connectors with Shell)

At least two devices (one from Subgroup 2A and one from Subgroup 2B) shall be submitted to the test in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.23. Then each device shall be tested to destruction in the direction most likely to dislodge the insert from the shell and the force at that moment is to be recorded.

(d) **Strength of Insert** (Connectors without Shell)

For long and narrow PCB inserts with no shell, a test shall be performed by applying a force at a point in the middle of the inserts, supported at each end, to evaluate their resistance to breaking. It shall be performed as a step-stress test by applying increasing loads for periods of 30 seconds. After each step, the straightness of the insert shall be checked. The test shall be continued until the insert breaks.

(e) **Removal of Shell** (Rectangular Connectors)

The two halves of the shell shall be separated and removed without causing any damage to the insert.

(f) **Contact Retention** (in Insert)

The test shall be performed in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.17. Then 10 (or all, if there are less than 10) contacts from each connector are to be tested to destruction and the force at that moment is to be recorded.

(g) **Sectioning of Connector**

The connector shall be sectioned so as to examine a number of contacts with the retention system and to ensure that the connector has a homogeneous structure. A photographic record shall be made.

(h) **Outgassing Test** (Insert)

A representative sample of the insert material shall be subjected to the outgassing test in accordance with the requirements of ESA PSS-01-702.

8.4 GROUP 3 - INTERMATEABILITY TESTS

Each connector on test is to be mated with the equivalent connector from all other qualified Manufacturers on the ESA/SCC Qualified Parts List. The mating and unmating forces shall be measured and tabulated as shall the low level contact resistance for all contacts.

9. EVALUATION TEST PROGRAMME (CONTACTS)

9.1 GENERAL

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

9.2 GROUP 1 - CONTROL GROUP

As in Para. 8.2.

9.3 GROUP 2 - DESTRUCTIVE TESTS

9.3.1 Subgroup 2A - Construction Analysis

The components in this subgroup are to be submitted to the following tests. Each step shall be recorded separately and a summary of the entire process and the results shall be made.

(a) **Hardness**

At least five contact sets shall have the hardness measured by the Vickers, Rockwell, etc. method. If the Vickers method is used, the applied load shall be at least 1.0 Kg. This shall be performed on lengthwise sectioned contacts at the engagement ends, and for crimp contacts additionally in several places on the crimping barrel to judge the uniformity of the material hardness.

(b) **Plating Thickness**

This shall be measured on at least five contact sets by microsectioning. Male contacts shall be sectioned lengthwise. Female contacts shall also be sectioned lengthwise but perpendicular to the contact lips for split end contacts, or to contact spring opening for contacts with this technology. A photographic record shall be made.

(c) **Probe Damage** (Female Contacts Only)

At least 20 contacts shall have their engagement and separation forces measured in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.28. Then the probe damage test in accordance with ESA/SCC Generic Specification No. 3401, Para. 9.30 shall be performed. Finally, the engagement and separation forces shall be measured again as specified above, except that the three maximum pin insertions shall be omitted.

(d) **Plating Adhesion** (not Female wound)

At least 20 contact sets (the female contacts subjected to the probe damage test may be used) shall be tested. Each individual contact shall be gripped securely at each end. It shall then be bent through 90° about a circular bar having a diameter of twice the outside diameter of the contact. The plating on the outside of the bend shall be examined for cracks or fissures. A photographic record shall be made.

9.4 GROUP 3 - ENDURANCE TESTS

9.4.1 General

The components in this group shall be randomly divided into two subgroups in the proportions indicated in Chart I(b). Before performance of the tests cables shall be attached as specified in Para. 6.

9.4.2 Subgroup 3A - Thermal Endurance

(a) **Procedure**

The wired contact sets are to be mounted such that the normal depth of engagement is simulated. The contact resistances are to be measured at low level and rated current as in Para. 8.3.2.1. The contact sets shall then be divided into two equal groups and placed in test ovens at 100°C and 180°C respectively. Measurements of contact resistance shall be made every 100 ± 24 hrs at low level current at an ambient temperature of +22 ± 3°C. At the completion of the tests (1000 +24/-0 hrs) the contact resistance shall also be measured at rated current, as above. Care shall be exercised in order not to move the contacts in relation to one another during the measurement operation.

(b) **Microsection of Crimping**

If crimp contacts have been submitted to the above test, five or all sets, whichever is less, shall then be microsectioned to display the structure of the crimp and a photographic record made. Half of the contacts shall be sectioned lengthwise and half transversely.

9.4.3 Subgroup 3B - Joint Strength

In accordance with ESA/SCC Generic Specification No. 3401, Para. 9.15.

10. DATA DOCUMENTATION

10.1 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) Connectors

(1) Sample identification.

(2) Production data.

(3) Inspection data.

(4) Initial measurements.

(5) Group 1 - Control Group Data.

(6) Subgroup 2A - Mechanical Endurance Data.

(7) Subgroup 2B - Electrical Endurance Data.

(8) Subgroup 2C - Construction Analysis Data.

(9) Group 3 - Intermateability Tests Data.

(e) Contacts

(1) Sample identification.

(2) Production data.

(3) Inspection data.

(4) Initial measurements.

(5) Group 1 - Control Group Data.

(6) Subgroup 2A - Construction Analysis Data.

(8) Subgroup 3A - Thermal Endurance Data.

(9) Subgroup 3B - Joint Strength Data.

(f) Summary of results and conclusions.

Items (a) to (f) 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.

10.2 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 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.

10.3 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.

10.4 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.

10.5 CONNECTORS

10.5.1 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.

10.5.2 Production Data (Para. 4.4)

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.

10.5.3 Inspection Data (Para. 5)

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

10.5.4 Initial Measurements (Para. 7)

All data shall be recorded against serial numbers.

10.5.5 Group 1 - Control Group Data (Para. 8.2)

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

10.5.6 Subgroup 2A - Mechanical Endurance Data (Para. 8.3.2)

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

(a) Contact resistances.

(b) Initial maintenance ageing results (Removable contacts).

(c) Graph showing variation of contact resistance with number of mating/unmating cycles.

(d) Photographs of any wear on female contacts.

(e) Final maintenance ageing results (Removable contacts).

10.5.7 Subgroup 2B - Electrical Endurance Data (Para. 8.3.3)

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

(a) Contact resistance tabulated for each measurement point.

(b) Graph showing variation of contact resistance with time.

10.5.8 Subgroup 2C - Construction Analysis Data (Para. 8.3.4)

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

(a) Coupling mechanism failure force or torque (Bayonet or Jackscrew).

(b) Coupling mechanism type of failure (Bayonet or Jackscrew).

(c) Photographs of mating interfaces (Bayonet or Jackscrew).

(d) Guiding and locking devices failure torque (Connectors without Shell).

(e) Guiding and locking devices type of failure (Connectors without Shell).

(f) Photographs of guiding and locking devices failures (Connectors without Shell).

(g) Insert retention results (Connectors with Shell).

(h) Force to remove inserts (Connectors with Shell).

(i) Strength of insert results (Connectors without Shell).

(j) Contact retention results.

(k) Force to remove contacts.

(l) Photographs of sectioned connector.

(m) Results of outgassing test (Insert).

10.5.9 Group 3 - Intermateability Tests Data (Para. 8.4)

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

(a) Mating forces.

(b) Unmating forces.

(c) Contact resistances.

The above shall be recorded for each other make of connector tested.

10.6 CONTACTS

10.6.1 Sample Identification (Para. 4.1)

As in Para. 9.5.1.

10.6.2 Production Data (Para. 4.4)

As in Para. 9.5.2.

10.6.3 Inspection Data (Para. 5)

As in Para. 9.5.3.

10.6.4 Initial Measurements (Para. 7)

As in Para. 9.5.4.

10.6.5 Group 1 - Control Group Data (Para. 9.2)

As in Para. 9.5.5.

10.6.6 Subgroup 2A - Construction Analysis Data (Para. 9.3.1)

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

(a) Hardness results.

(b) Plating thickness results.

(c) Photographs of microsectioning.

(d) Probe damage results (Female contacts).

(e) Plating adhesion results (not female wound).

(f) Photographs of plating on outside of bend.

10.6.7 Subgroup 3B - Thermal Endurance Data (Para. 9.4.2)

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

(a) Contact resistances tabulated for each measurement and temperature.

(b) Graph showing variation of low level contact resistance with time at each temperature.

(c) Photographs of crimp microsectioning.

10.6.8 Subgroup 3C - Joint Strength Test Data (Para. 9.4.3)

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

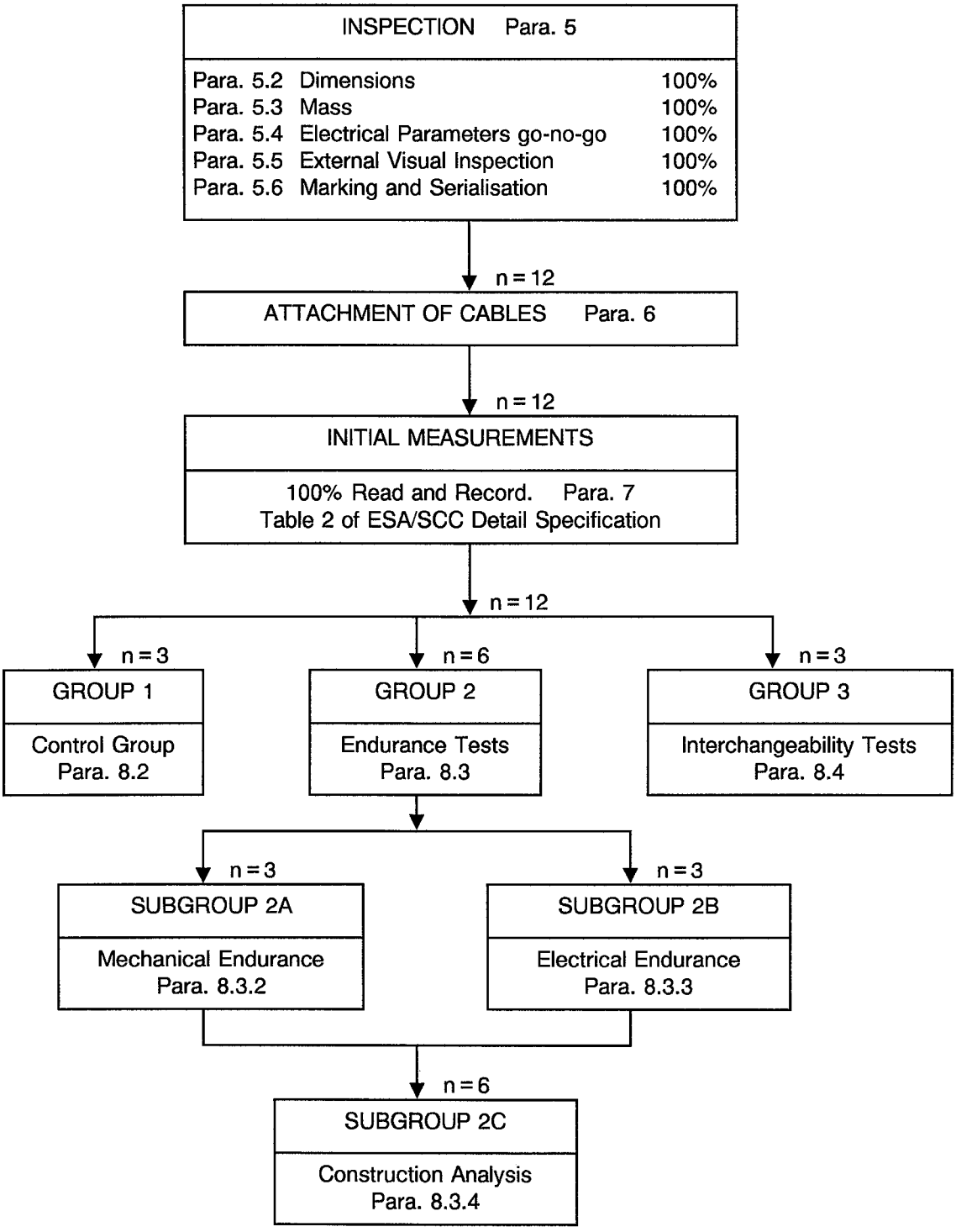
(a) Separation forces.

(b) Separation mode (contact break, wire break or slide out).

10.7 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 P.I.D. shall be outlined.

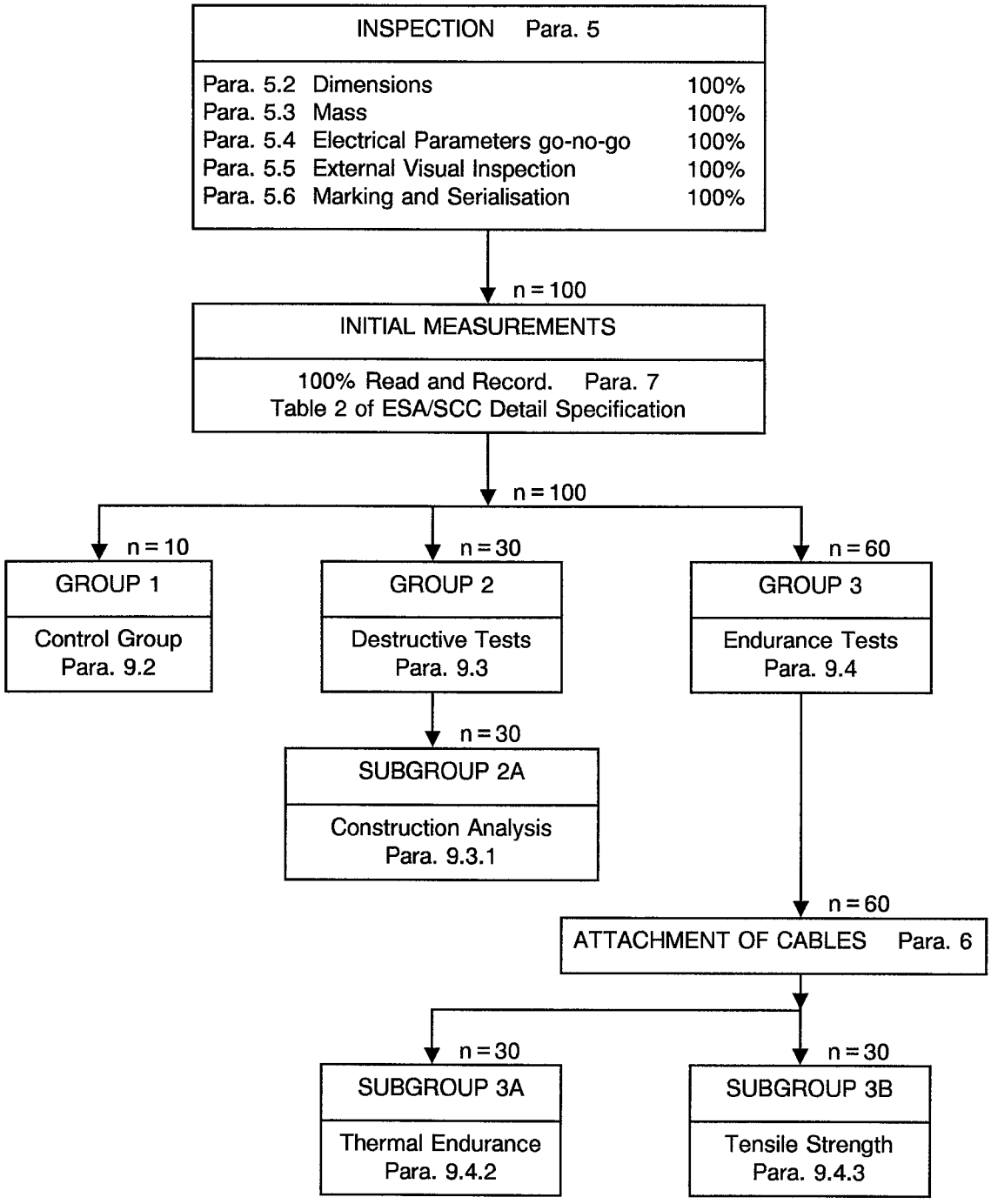
CHART I(a) - EVALUATION TEST PROGRAMME (CONNECTORS)



NOTES

1. All quantities refer to mated connector sets.

CHART I(b) - EVALUATION TEST PROGRAMME (CONTACTS)



NOTES

1. All quantities refer to contact pairs.