

## 5.1 Specifying test

### 5.1.1 General provision

- a. The customer shall provide a request for thermal test in conformance with the DRD in Annex A.
- b. ECSS-Q-ST-20 shall be made applicable in the request for thermal cycling test.
- c. ECSS-Q-ST-10-09 shall be made applicable in the request for thermal cycling test.
- d. For safety and security, the test centre shall comply with ECSS-Q-ST-20-07, clause 9.

NOTE Examples of safety issues are “hazard” and “health”. An example for security issues is “access control”.

- e. The supplier shall provide a thermal cycling test proposal in conformance with the DRD in Annex B for customer approval.

### 5.1.2 Specifying the test means

#### 5.1.2.1 Facilities

- a. The work area shall be nominally clean with minimum dust, but not necessarily a cleanroom environment.
- b. Air used for ventilation shall be nominally filtered to prevent contamination of the sample.
- c. The ambient conditions for the process and work areas shall be  $(22 \pm 3) ^\circ\text{C}$  with a relative humidity of  $(55 \pm 10) \%$ .

#### 5.1.2.2 Equipment

- a. The supplier shall specify the list of the equipment necessary to set up and run the approved test procedures.

NOTE If the test procedure proposed in Annex D is executed by the supplier, the corresponding equipment specification is described in Annex E.

### 5.1.3 Specifying the thermal cycling test procedures

#### 5.1.3.1 Test procedures

- a. The test procedures shall address the test conditions control and monitoring of:
  - 1. temperature,
  - 2. vacuum,
  - 3. contamination.

- b. The test procedure for controlling and monitoring the temperature shall contain the following information:
  - 1. sample temperatures measurement and recording methods,
  - 2. temperature data acquisition during testing.

NOTE There is a difference between real sample temperature and temperature of the holder.

- c. The test procedure for controlling and monitoring the vacuum shall contain the following information:
  - 1. sample vacuum and residual atmosphere measurements and recording methods,
  - 2. pressure data acquisition during testing.
- d. The test procedure for controlling and monitoring the contamination shall contain the following information:
  - 1. contamination check methods used during tests,
  - 2. contamination results.
- e. ECSS-Q-ST-20 shall apply for the establishment of the test procedures.

### **5.1.3.2 Controlling the contamination**

- a. In case of optical or thermo-optical properties measurements, contamination effects on the sample shall be controlled.

NOTE 1 Cross contamination can occur between samples or be induced by internal vacuum chamber residual pressure.

NOTE 2 Contamination control evaluation can be performed with any method: witness sample, UV absorption, Infrared analysis of contaminants deposit on  $\text{CaF}_2$  or ZnSe windows and/or QCM measurements.

### **5.1.3.3 Measuring the temperatures**

- a. The method used to measure the temperature shall be agreed between customer and supplier.
- b. During thermal testing, the temperature of the sample (test item) shall be measured.
- c. The test temperature range shall be based on the operating temperature range of the material in space
- d. The test supplier shall specify the temperature measurement procedure and accuracy.

## **5.2 Preparing and performing Test**

### **5.2.1 General**

- a. The test proposal shall include the thermal cycling test procedures.

## **5.2.2 Preparing the item to be tested**

### **5.2.2.1 Identification**

- a. Materials, processes and mechanical parts submitted for thermal cycling test shall be clearly identified in order to maintain traceability.
- b. Assemblies submitted for thermal cycling test shall be identified by:
  - 1. trade name and batch number;
  - 2. name of supplier through whom the purchase was made;
  - 3. configuration control status of the assembly.

### **5.2.2.2 Preparation**

- a. The material samples shall be prepared according to the relevant process specifications or manufacturer's data.
- b. It shall be agreed with the customer that the material samples are representative of batch variance.
- c. If it is not practicable to test completed assemblies, the supplier shall submit samples made from the same materials and by the same processes as those used in the manufacture of the assemblies.
- d. The sample for testing shall have one flat surface which does not overlap the dimensions of the sample holder to be used in the test.
- e. The flat surface shall be in continuous contact with the sample holder, attached by any form of clamping arrangement which does not cover more than 10 % of the sample's remaining surfaces.
- f. The maximum thickness of the sample shall be such that, under vacuum of  $10^{-5}$  Pa, any point of extremity does not differ by more than 5 °C from the temperature of the sample holder.

NOTE This parameter depends on the thermal conductivity properties of the sample.

### **5.2.2.3 Cleaning**

- a. The cleaning and other treatments of the sample shall be the same as that applied to the finished article, which the sample is intended to represent, prior to integration into the spacecraft.

NOTE Further cleaning or other treatments should be avoided.

### **5.2.2.4 Handling and storage**

- a. Samples shall only be handled with clean nylon or lint free gloves.
- b. Samples shall be stored in a controlled area, with an ambient temperature of  $(22 \pm 3)$  °C and relative humidity of  $(55 \pm 10)$  %.

- c. Coated surfaces shall be shielded from contact by using polyethylene or polypropylene bags or sheets.
- d. Physical damage shall be avoided by packing the polyethylene or polypropylene wrapped workpieces in clean, dust- and lint free material.
- e. Limited life materials shall be labelled with their shelf lives and dates of manufacture or date of delivery if date of manufacture is not known.

### **5.2.3 Preparing the facilities and equipment**

- a. The work area shall be as defined in clause 5.1.2.1a.
- b. Contamination of the samples shall be avoided (when handling or storing) and monitored.

NOTE Monitoring of the sample contamination can be done by witness samples described in ECSS-Q-ST-70-01.

- c. The ambient conditions for the process and work areas shall be  $(22 \pm 3) ^\circ\text{C}$  with a relative humidity of  $(55 \pm 10) \%$ .
- d. The specific equipments shall be defined in the thermal cycling test proposal.
- e. The supplier shall provide evidence that all test measuring equipment, are calibrated.

### **5.2.4 Running the thermal cycling test procedures**

- a. The supplier shall run the approved thermal cycling test procedures, produced in conformance with the DRD in Annex B.

NOTE An example of an approved thermal cycling test procedure is given in Annex D.

## **5.3 Recording and reporting the test results**

### **5.3.1 Test records**

- a. The test records of the thermal cycling test shall be retained for at least ten years or in accordance with project business agreement requirements.
- b. The test records shall contain the following:
  - 1. trade names and batch numbers of the materials under test;
  - 2. name of the supplier through whom the purchase was made;
  - 3. summary of the preparation and conditioning schedule;

NOTE For example: mixing proportions, coating thickness, cure time and temperature, post-cure, cleaning procedure.

- 4. details of the testing room environment conditions and test equipment used for the thermal cycling in vacuum;
- 5. details of the test parameters outlined in the approved thermal cycling test procedures.

NOTE Those details also include any variation in working vacuum pressure during the test.

6. details of equipment used for visual, mechanical, chemical and physical property measurement or inspection, as outlined in approved thermal cycling test specifications and procedures;
  7. comments concerning any unusual occurrence during the temperature cycling;
  8. the list of all samples subjected to thermal cycling under vacuum tests;
  9. reports of the results, subsequent to visual examination and testing, to the customer;
  10. number of sample tests;
  11. results of any failure analysis;
  12. details of failure mode (if applicable):
    - (a) deficient design;
    - (b) poor workmanship;
    - (c) wrong fabrication or application procedure;
    - (d) wrong choice of materials;
    - (e) others.
- c. The test records of the thermal cycling test shall be composed of:
1. the request for thermal cycling test which conforms to the DRD in Annex A,
  2. the thermal cycling test proposal which conforms to the DRD in Annex B,
  3. the thermal cycling test report which conforms to the DRD in Annex C,
  4. a conclusion with respect to the compliance with the project requirements (acceptance criteria) and any associated nonconformances.

### **5.3.2 Test report**

- a. The supplier shall establish a test report in conformance with the DRD in Annex C, for customer approval.
- b. The supplier shall apply ECSS-Q-ST-20, clause 5.6.3.2 for the establishment of the test.

### **5.3.3 Acceptance criteria and nonconformance**

- a. Acceptance criteria shall be defined (beforehand) in common agreement between the test authority and the customer.
- b. Any suspected or actual equipment failure shall be recorded as project nonconformance report so that previous results can be examined to ascertain whether or not re-inspection and re-testing is needed.
- c. The test procedures shall contain an instantiation or adaptation for the test item of the nonconformance processing flow chart as described in ECSS-Q-ST-10-09 figure 4.1.

NOTE In the frame of research and development activities, this is not necessary.

- d. The supplier shall notify the customer of the nonconformance details.
- e. Traceability shall be maintained throughout the process from incoming inspection to final measurements and calculations, including details of the test equipment and personnel employed in performing the task.
- f. Samples which have passed the test criteria and is not damaged by the execution of the approved thermal cycling test procedures shall have passed this test.
- g. During and upon completion of the test sequence the sample shall be investigated for signs of cracking, fracture, overheating and significant electrical degradation.
- h. Photomicrographs shall be taken of the sample to the requirements of the customer.

NOTE Evaluation of other properties can be invoked by the customer, such as those indicated in D.2.