

**BS EN 16602-70:2016**



**BSI Standards Publication**

# **Space product assurance — Materials, mechanical parts and processes**



**National foreword**

This British Standard is the UK implementation of EN 16602-70:2016. It supersedes BS EN 13291-3:2003 which is withdrawn.

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English version

## Space product assurance - Materials, mechanical parts and processes

Assurance produits des projets spatiaux - Matériaux,  
composants mécaniques et procédés

Raumfahrtproduktsicherung - Werkstoffe,  
mechanische Teile und Prozesse

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## European foreword

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This document (EN 16602-70:2016) has been prepared by Technical Committee CEN-CENELEC/TC 5 "Space", the secretariat of which is held by DIN.

This European Standard (EN 16602-70:2016) originates from ECSS-Q-ST-70C Rev.1.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2017, and conflicting national standards shall be withdrawn at the latest by April 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13291-3:2003.

The main changes with respect to EN 13291-3:2003 are listed below:

- new EN number and modified title,
- Reorganization of the content of the document to separate descriptive text and requirements, including clarification, modification of requirements and implementation of change requests,
- Alignment of the three Standards EN 16603-32-08 (based on ECSS-E-ST-32-08C Rev.1), EN 16602-70 (based on ECSS-Q-ST-70C Rev.1) and EN 16602-70-71 (based on ECSS-Q-ST-70-71C),
- Addition of Subclauses 5.1.18 "Bacterial and fungus growth", 5.1.19 "Hydrogen embrittlement" and 5.1.20 "Manned environment" coming from ECSS-Q-ST-70-71A Rev.1.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1

## Scope

---

This European Standard specifies the requirements and statements applicable to materials, mechanical parts and processes to satisfy the mission performance requirements.

This standard also specifies the documentation requirements and the procedures relevant to obtaining approval for the use of materials, mechanical parts and processes in the fabrication of space systems and associated equipment.

This standard covers the following:

- management, including organization, reviews, acceptance status and documentation control;
- selection criteria and rules;
- evaluation, validation and qualification, or verification testing;
- procurement and receiving inspection;
- utilization criteria and rules.

The relationship between activities and programme phases is defined in Annex E.

The provisions of this standard apply to all actors involved at all levels in the production of space systems. These can include manned and unmanned spacecraft, launchers, satellites, payloads, experiments, electrical ground support equipment, mechanical ground support equipment, and their corresponding organizations.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

## 2

## Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

| EN reference   | Reference in text | Title                                                                                                                       |
|----------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------|
| EN 16601-00-01 | ECSS-S-ST-00-01   | ECSS system - Glossary of terms                                                                                             |
| EN 16603-20-06 | ECSS-E-ST-20-06   | Space engineering - Spacecraft charging                                                                                     |
| EN 16601-80    | ECSS-M-ST-80      | Space product assurance - Risk management                                                                                   |
| EN 16602-10    | ECSS-Q-ST-10      | Space product assurance - Product assurance management                                                                      |
| EN 16602-10-04 | ECSS-Q-ST-10-04   | Space product assurance - Critical-item control                                                                             |
| EN 16602-10-09 | ECSS-Q-ST-10-09   | Space product assurance - Nonconformance control system                                                                     |
| EN 16602-20    | ECSS-Q-ST-20      | Space product assurance - Quality assurance                                                                                 |
| EN 16602-40    | ECSS-Q-ST-40      | Space product assurance - Safety                                                                                            |
| EN 16602-70-01 | ECSS-Q-ST-70-01   | Space product assurance - Cleanliness and contamination and control                                                         |
| EN 16602-70-02 | ECSS-Q-ST-70-02   | Space product assurance - Thermal vacuum outgassing test for the screening of space materials                               |
| EN 16602-70-04 | ECSS-Q-ST-70-04   | Space product assurance - Thermal testing for the evaluation of space materials, processes, mechanical parts and assemblies |
| EN 16602-70-06 | ECSS-Q-ST-70-06   | Space product assurance - Particle and UV radiation testing of space materials                                              |
| EN 16602-70-09 | ECSS-Q-ST-70-09   | Space product assurance - Measurements of thermo-optical properties of thermal control materials                            |
| EN 16602-70-21 | ECSS-Q-ST-70-21   | Space product assurance - Flammability testing for the screening of space materials                                         |
| EN 16602-70-22 | ECSS-Q-ST-70-22   | Space product assurance - Control of limited shelf-life materials                                                           |

|                |                 |                                                                                                                                                            |
|----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EN 16602-70-29 | ECSS-Q-ST-70-29 | Space product assurance - Determination of offgassing products from materials and assembled articles to be used in a manned space vehicle crew compartment |
| EN 16602-70-36 | ECSS-Q-ST-70-36 | Space product assurance - Material selection for controlling stress-corrosion cracking                                                                     |
| EN 16602-70-37 | ECSS-Q-ST-70-37 | Space product assurance - Determination of the susceptibility of metals to stress-corrosion cracking                                                       |
| EN 16602-70-71 | ECSS-Q-ST-70-71 | Space product assurance - Materials, processes and their data selection                                                                                    |

## Terms, definitions and abbreviated terms

---

### 3.1 Terms from other standards

- a. For the purpose of this document, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:
  - 1. material

### 3.2 Terms specific to the present standard

#### 3.2.1 critical mechanical part

mechanical part that requires specific attention or control due to fracture mechanics aspects and limited-life aspects, or with which the supplier has no previous experience of using the mechanical part in the specific application and environment or that are new or non-qualified, or that has caused problems during previous use that remain unresolved

#### 3.2.2 critical process

process new to an individual company or non-verified for the application in question or has caused problems during previous use that remain unresolved

#### 3.2.3 critical material

material that is new to an individual company or non-validated for the particular application and environment, or that has caused problems during previous use that remain unresolved

#### 3.2.4 mechanical part

piece of hardware which is not electrical, electronic or electromechanical, and which performs a simple elementary **function** or part of a function in such a way that it can be evaluated as a whole against expected requirements of **performance** and cannot be disassembled without destroying this **capability**

#### 3.2.5 process

set of inter-related resources and activities which transforms a material or semi-finished product into a semi-finished product or final product

#### 3.2.6 request for approval (RFA)

document with which the supplier or user asks the competent body for permission to use a critical material, part or process

### 3.2.7 special process

process where quality cannot be completely ensured by visual inspection of the end article only

## 3.3 Abbreviated terms

For the purpose of this document, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

| Abbreviation | Meaning                                                       |
|--------------|---------------------------------------------------------------|
| AA           | Aluminium Association                                         |
| AOCS         | attitude and orbit control system                             |
| ATOX         | atomic oxygen                                                 |
| AISI         | American Iron and Steel Institute                             |
| CDA          | Copper Development Association                                |
| CDR          | critical design review                                        |
| CFRP         | carbon fibre reinforced polymer                               |
| CI           | configuration item number (as per project definition)         |
| DML          | declared material list                                        |
| DMPL         | declared mechanical part list                                 |
| DPL          | declared process list                                         |
| DRD          | document requirements definition                              |
| EEE          | electrical, electronic and electromechanical                  |
| ESA          | European Space Agency                                         |
| ESMDB        | European Space Materials Database                             |
| GOX          | gaseous oxygen                                                |
| GSE          | ground support equipment                                      |
| LEO          | low Earth orbit                                               |
| LOX          | liquid oxygen                                                 |
| MIP          | mandatory inspection point                                    |
| MMPP         | Materials, mechanical parts and processes                     |
| MMPDS        | Metallic Materials Properties Development and Standardisation |
| MPCB         | Material, Mechanical Parts and Processes Control Board        |
| NASA         | National Aeronautics and Space Administration                 |
| NCR          | nonconformance report                                         |
| NRB          | nonconformance review board                                   |
| PA           | product assurance                                             |
| PDR          | preliminary design review                                     |

| Abbreviation | Meaning                         |
|--------------|---------------------------------|
| PID          | process identification document |
| PMP          | parts, materials, processes     |
| QR           | qualification review            |
| QRR          | qualification review report     |
| RFA          | request for approval            |
| RFD          | request for deviation           |
| SCC          | stress-corrosion cracking       |

### 3.4 Nomenclature

The following nomenclature applies throughout this document:

- a. The word “shall” is used in this standard to express requirements. All the requirements are expressed with the word “shall”.
- b. The word “should” is used in this standard to express recommendations. All the recommendations are expressed with the word “should”.

NOTE It is expected that, during tailoring, recommendations in this document are either converted into requirements or tailored out.

- c. The words “may” and “need not” are used in this standard to express positive and negative permissions, respectively. All the positive permissions are expressed with the word “may”. All the negative permissions are expressed with the words “need not”.
- d. The word “can” is used in this standard to express capabilities or possibilities, and therefore, if not accompanied by one of the previous words, it implies descriptive text.

NOTE In ECSS “may” and “can” have completely different meanings: “may” is normative (permission), and “can” is descriptive.

- e. The present and past tenses are used in this standard to express statements of fact, and therefore they imply descriptive text.

## General requirements

---

### 4.1 MMPP management requirements

#### 4.1.1 Overview

The general MMPP activity within the framework of a project is summarized in Figure 4-1.

#### 4.1.2 MMPP plan

- a. The supplier shall prepare, maintain and implement a MMPP plan, as part of the overall PA plan in conformance with DRD from Annex A of ECSS-Q-ST-10 and this standard or as a separate document.
- b. The MMPP plan shall be submitted to the customer for approval.

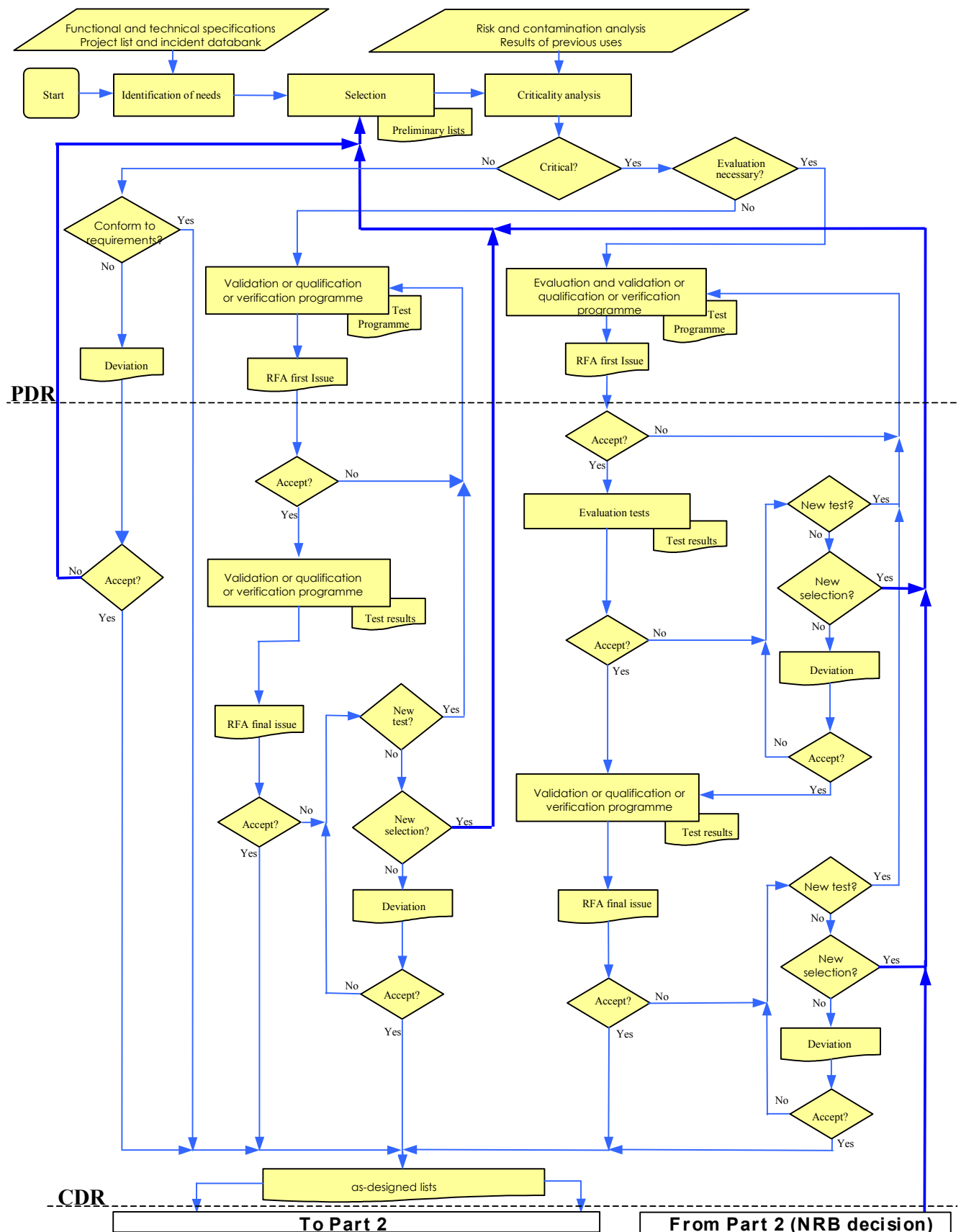


Figure 4-1: Materials, mechanical parts and processes flow chart

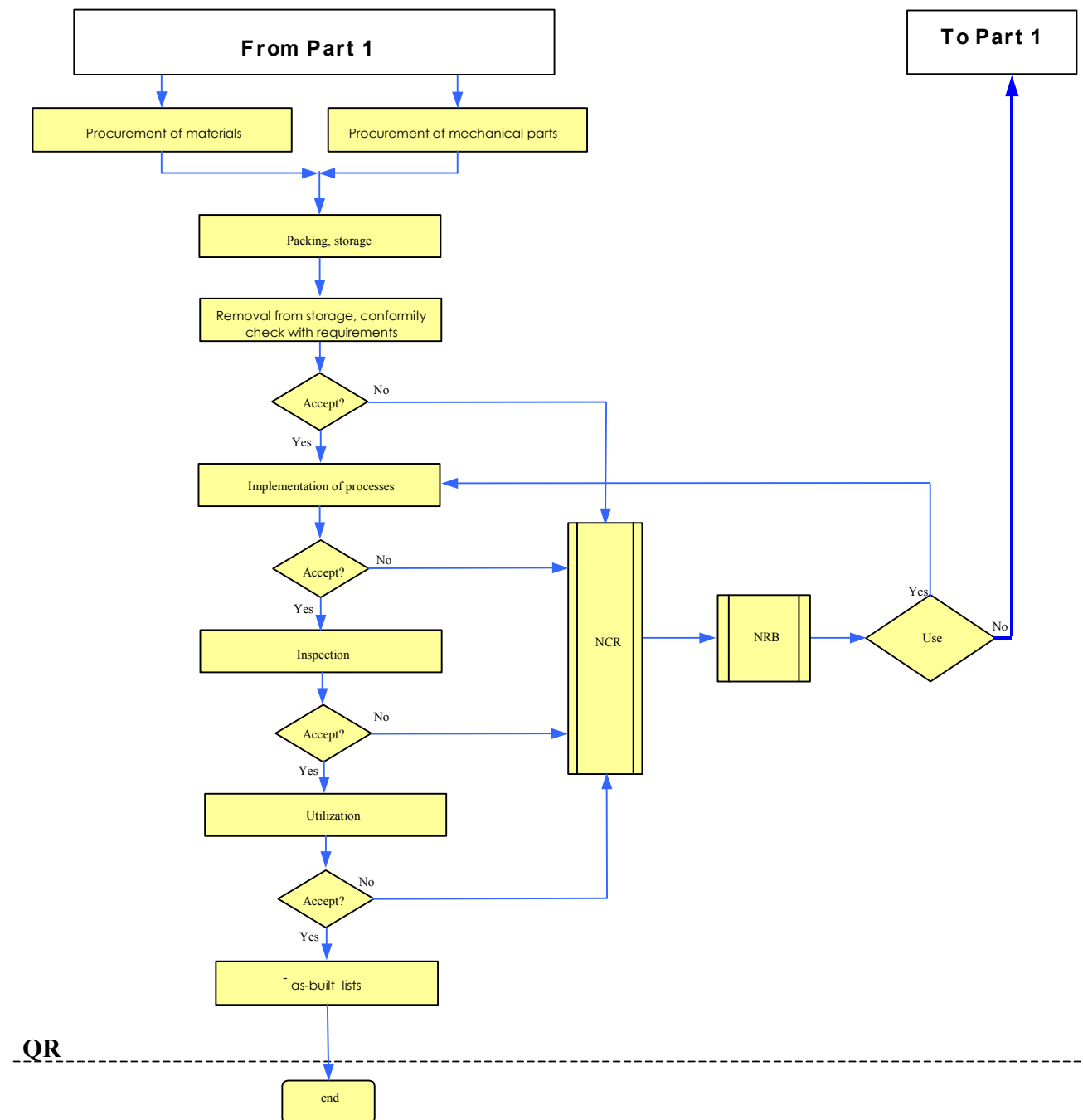


Figure 4-1: Materials, mechanical parts and processes flow chart (continued)

**Table 4-1: Steps to be taken to get approval for materials, mechanical parts and processes (MMPP)**

| Phase                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Materials      |                                                                    | Mechanical parts |                                                                                                      | Processes      |                                                                                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Step           | Comments                                                           | Step             | Comments                                                                                             | Step           | Comments                                                                                                                                                                   |
| Critical Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1              |                                                                    | 1                |                                                                                                      | 1              |                                                                                                                                                                            |
| Evaluation (usually by test methods defined by ECSS standards)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2              | Critical materials are tested, e.g. outgassing, SCC, flammability. | 2                | Mechanical parts are tested by, for example, vibration, thermal analysis, off-gassing and life test. | 2              | Critical processes are evaluated by testing "technology samples" including all, for example, electrical interconnection processes and painting, adhesive bonding, welding. |
| Verification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Not applicable |                                                                    | Not applicable   |                                                                                                      | 3              | Verification tests usually defined in ECSS standards                                                                                                                       |
| Validation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3              |                                                                    | Not applicable   |                                                                                                      | Not applicable |                                                                                                                                                                            |
| Qualification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Not applicable |                                                                    | 3                |                                                                                                      | Not applicable |                                                                                                                                                                            |
| Approval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                | By RFA (Annex D) or DML                                            |                  | By RFA (Annex D) or DMPL/DPL                                                                         |                | By RFA (Annex D) or DPL                                                                                                                                                    |
| <p>NOTE 1 Project approval is always by means of the request for approval (RFA) form and the projects' declared materials list (DML), declared mechanical parts list (DMPL) and declared processes list (DPL).</p> <p>NOTE 2 The details for approvals of MMPP lists are contained in this standard.</p> <p>NOTE 3 To summarize: Materials are validated.<br/>Mechanical parts are qualified.<br/>Processes are verified.<br/>In addition: Skills training schools are ESA-certified.<br/>Outside test or evaluation laboratories are certified by agency or company audits.<br/>Operators for special processes are trained, certified and monitored.</p> |                |                                                                    |                  |                                                                                                      |                |                                                                                                                                                                            |

### 4.1.3 MMPP Manager and MPCB

- a. << deleted >>
- b. << deleted >>
- c. The supplier shall appoint a MMPP manager.
- d. The MMPP Manager shall ensure that the Materials, Mechanical Parts and Processes used to manufacture a spacecraft or a launcher satisfy both the ground and flight functional requirements and constraints of the project.
- e. To obtain the validation status for materials and qualification status for parts and verification status for processes, the MMPP manager shall present to the customer activities which were performed in conformance with requirement 4.1.3d together with the results obtained.

- f. The MMPP manager shall organize Materials, Mechanical Parts and Processes Control Board (MPCB) at all suppliers with the task to review and approve the Materials, Mechanical Parts and Processes as specified in the Clauses 5, 6, and 7.
- g. The MPCB activity shall start not later than at PDR.
- h. The MMPP Manager shall agree with the customer on the MPCB's activities at PDR.
- i. Minimum tasks of the MPCB shall be as follows:
  - 1. Coordination of the initiation and approval of RFA's in conformance with DRD from the Annex D by involving the relevant technical discipline.
  - 2. Review and approval of test programme and related results.
  - 3. Review of preliminary Declared Materials, Mechanical Parts and Processes Lists and of any available evidence to support the approval, by the PDR.
  - 4. Review and approval of Declared Materials, Mechanical Parts and Processes Lists and of the evidence for the approval by the CDR.
  - 5. Review and approval of any change to the approved Declared Materials, Mechanical Parts and Processes Lists.

## 4.2 Management and consolidation of the activities

### 4.2.1 Overview

The relationship between materials and processes activities and programme phases is shown in Annex E.

### 4.2.2 Establishing and processing of lists

- a. Each supplier and sub-supplier shall establish, collect, review and deliver the declared materials, mechanical parts and processes lists including all the items intended for use in the flight equipment.
- b. The lists specified in 4.2.2a shall reflect the current design at the time of issue.
- c. The lists specified in 4.2.2a shall contain the materials, mechanical parts and processes used in the current design to:
  - 1. demonstrate compliance with all requirements of the programme;
  - 2. verify the results of equipment supplier activities;
  - 3. control and monitor the status of materials, mechanical parts and processes in conformance with programme milestones.

NOTE See Annex F.

- d. The following constraints should apply:
  - 1. maximum use of the materials and processes specified in approved data sources and items already approved on similar projects;
  - 2. use of project related preferred lists, if available.

NOTE For approved data sources see example of ESMDDB database in the Annex A of the ECSS-Q-ST-70-71.
- e. The following constraints shall be assessed:
  - 1. requirements originating from the initial technical specification.
  - 2. programmatic project requirements and conditions.
- f. An analysis of the criticality of preliminary lists specified in the 4.2.2a shall be performed such that, after checking the conformity of the materials, mechanical parts and processes, against all the project requirements, allows them to be classified into three categories:
  - 1. Critical items, subject to evaluation, validation, qualification, or verification programmes.
  - 2. Items that are not critical but which do not conform to one or more project requirements.
  - 3. Non-critical items.
- g. For items classified as critical in conformance with 4.2.2f.1 a request for approval shall be submitted in conformance with Annex D.
- h. For items classified as not critical but which are not in conformance with one or more project requirements in accordance with 4.2.2f.2 a justified deviation request should be drafted.

### 4.2.3 Management of the lists

- a. The supplier shall document all materials in the Declared materials list in conformance with Annex A.
- b. The supplier shall document all mechanical parts in the Declared mechanical parts list in conformance with Annex B.
- c. The supplier shall document all processes in the Declared process list in conformance with Annex C.
- d. The supplier shall process the lists of lower level suppliers to ensure exchangeability, traceability, searchability, sortability, storability and retrievability for that set of lists, before submitting it to the customer.
- e. The lists specified in the requirement 4.2.3a, 4.2.3b and 4.2.3c shall be updated during the course of the project.
- f. The preliminary lists specified in the requirement 4.2.3a, 4.2.3b and 4.2.3c shall include the items from suppliers' preliminary needs.

NOTE They are used to identify critical items (available for the PDR).
- g. The as-designed lists shall include the items from the baselines various design files, available for CDR.

- h. Any change after CDR or QR shall be reflected in the list and shall be in accordance with Figure 4-1 (Part 2).

NOTE 1 The MMPP manager is responsible within the programme to ensure that all the information needed is given and that the approval status is consistent with technical and scheduling objectives and data is exchangeable.

NOTE 2 Where no project requirements exist for a separate DMPL, the mechanical parts can be entered into a separate section of the DML.

NOTE 3 The materials of, for example, screws and nuts that are made up of a few materials can be listed in the DMPL. The materials (metals and plastics) of complex parts can be listed in the DML with, for example, outgassing, toxicity, flammability, corrosion and stress corrosion values and reference to the DMPL item.

- i. The supplier shall establish, collect, review and deliver the declared materials, mechanical parts and processes lists in an electronic format in conformance with Annex A, Annex B, and Annex C.
- j. The supplier shall demonstrate that the lists specified in the requirements 4.2.3a, 4.2.3b and 4.2.3c have been formally approved prior to their delivery to the customer.

#### 4.2.4 Supplier role and responsibilities

- a. The supplier shall perform the following tasks:
1. obtaining the correct and complete lists from lower level suppliers;
  2. providing provisional and, later, definitive approval for each list;
  3. submitting the project declared lists for approval prior to initiation of the hardware phase, before CDR.
- b. The lists specified in the requirement 4.2.3i by the suppliers shall include all the information described in this standard.
- c. Amendments to the lists specified in the requirement 4.2.3 a, b and c shall be implemented through established change procedures.
- d. The following documentation shall be delivered to the customer upon request:
1. RFA with reference and issue in conformance with DRD in Annex D;
  2. evaluation reports;
  3. deviation requests.
- e. The material, mechanical parts or process justification files shall be made available to the customer upon request either on the supplier site, or by any other process agreed by both parties.

NOTE For example, by non-disclosure agreement.

## 4.3 Technical constraints

- a. Mechanical parts, and materials and processes shall satisfy the mission's functional requirements and constraints.
- b. Mechanical parts, and materials and processes shall satisfy both ground environment and flight requirements and constraints.

NOTE Examples are:

- Ground environment constraints: manufacture, tests, storage, maintenance, transport and integration
- Flight constraints: launch and orbit.

- c. << deleted >>
- d. The estimated availability of the parts and products obtained from materials and processes used shall be compatible with the space system's life cycle.

NOTE Examples of space system's life cycle are tests, storage and mission.

## 4.4 Cleanliness and contamination control

- a. The supplier shall establish and maintain a contamination and cleanliness control programme including, as a minimum:
  1. cleaning procedures, and
  2. cleanliness monitoring procedures or methods.
- b. The risks of chemical or particle pollution generated by parts, materials or processes used shall be identified and reduced as specified in ECSS-M-ST-80, 7.2, in conformance with mission requirements.

NOTE Cleanliness or contamination analysis is example of mission requirements.

- c. For cleanliness- or contamination-critical applications, a chemical and particle requirement specification and a specific cleanliness control plan shall be established in conformance with DRDs from Annex A and Annex B of ECSS-Q-ST-70-01.

## 4.5 Safety hazardous mechanical parts and materials

- a. Mechanical parts and materials with hazardous characteristics shall be identified, managed and processed in conformance with requirements from Clause 5 to Clause 8 of ECSS-Q-ST-40.