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Space Product Assurance

Materials, Mechanical Parts & Processes

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Foreword

This standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this standard are defined in terms of what must be accomplished, rather than in terms of how to organise and perform the necessary work. This allows existing organisational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this standard takes into account the existing ISO 9000 family of documents.

This standard has been prepared by the ECSS Product Assurance Working Group, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board.

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General

1.1 Scope

The purpose of this standard is to define the requirements and statements applicable to Materials, Mechanical Parts and Processes to satisfy the mission performance requirements.

1.2 Objectives

This standard covers the following requirement domains:

- Management, including organisation, reviews, acceptance status and documentation control.
- Selection criteria and rules.
- Evaluation, validation/qualification testing.
- Procurement and receiving inspection.
- Utilisation criteria and rules.

The relationship between activities and programme phases is defined in annex A.

1.3 Applicability

The provisions of this document apply to all actors involved at all levels in the production of space systems. These may include manned and unmanned spacecraft, launchers, satellites, payloads, experiments, Electrical Ground Support Equipment, Mechanical Ground Support Equipment, and their corresponding organisations.

a. The requirements of this document shall be tailored to the specific programme needs and class by the Customer.

1.4 Normative Documents

This ECSS Standard incorporates by dated or undated reference, provisions from other publications. These normative references to the extent specified in the text are cited at the appropriate places and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these apply to this ECSS Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ECSS–Q–00	Space Product Assurance – Policy and Principles
ECSS–Q–20	Space Product Assurance – Quality Assurance
ECSS–Q–40	Space Product Assurance – Safety
ECSS–Q–60	Space Product Assurance – EEE Components
ECSS–Q–701	Data for selection of space materials (or MSFC–SPEC–250 Protective finishes for space vehicle structures)
ECSS–Q–702	A thermal vacuum test for the screening of space materials (or ASTM E 595–90 Total mass loss and collected volatible condensable materials from outgassing in a vacuum environment)
ECSS–Q–706	The particle and ultraviolet (UV) radiation testing of space materials
ECSS–Q–721	Flammability testing for the screening of space materials (or NHB 8060 1C Flammability, odour, offgassing and compatibility requirements and test procedures for materials in environments that support combustion)
ECSS–Q–729	The determination of offgassing products from materials and assembled articles to be used in a manned space vehicle crew compartment (or NHB 8060 1C Flammability, odour, offgassing and compatibility requirements and test procedures for materials in environments that support combustion)
ECSS–Q–736	Material selection for controlling stress-corrosion cracking
ECSS–Q–737	Determination of the susceptibility of metals to stress corrosion cracking

1.5 Informative Documents

Informative references to the extent specified in the text are cited at appropriate places and listed hereafter.

ECSS–Q–700	The technical reporting and approval for materials, mechanical parts and processes
ECSS–Q–201	Contamination and cleanliness control
MSFC–HDBK–527	Materials selection list for space hardware systems.

1.6 Definitions and Abbreviations

1.6.1 Definitions

For the purposes of this standard, the definitions given in ECSS–P–001 Issue 1 apply.

The following terms and definitions are specific to this standard and shall be applied.

“Material

A raw, semi-finished or finished purchased item (gaseous, liquid, solid) of given characteristics from which processing into a functional element of the product is undertaken.”

“Mechanical Part

One or more pieces joined together which perform a mechanical optical, thermal or electromechanical (not lying in the sphere of EEE components as defined in ECSS–Q–60) function and cannot be disassembled without permanent destruction or inhibiting the use intended in the design.”

NOTE In the following text, the term “Parts” is used to mean “Mechanical Parts”.

“Process

One or more interrelated production operations during which one or various constituents (Materials, Parts...) are assembled and/or transformed (shape, physical or chemical characteristics) in order to obtain a product (subassembly or functional assembly). This definition excludes mechanical operations such as standard milling, drilling, turning and mechanical assembly. The concept of process also covers all the facilities required: personnel, environment, equipment, tooling and corresponding methods.”

“Critical

A material, part or process is declared critical when:

- it is new or nonvalidated (not qualified in the case of a Part) for the application in question.
- during previous use it has raised problems which remain unsolved.”

“Request For Approval (RFA)

Document with which the supplier/user asks the competent body for permission to use a critical material, part or process.”

NOTE The format of such an RFA should be standardized throughout a project and shall include the following information:

- identification details,
- characteristics and/or function,
- location and environment,
- reference of evaluation/validation/qualification programmes and reports,
- approval status.

“Validation of a Material or a Process

A set of data collected (and/or experiments performed) to demonstrate that a Material or a Process performs as intended (technical requirements) with a sufficient margin and that a sufficient confidence can be placed on the outcome (quality assurance requirements).”

1.6.2 Abbreviations.

The following abbreviations are defined and used within this standard.

Abbreviation	Meaning
CDR:	Critical Design Review
DML:	Declared Material List
DMPL:	Declared Mechanical Part List
DPL:	Declared Process List
EEE:	Electrical, Electronic and Electromechanical
GSE:	Ground Support Equipment
MIP:	Mandatory Inspection Point
MRB:	Material Review Board
PA:	Product Assurance
PDR:	Preliminary Design Review
QR:	Qualification Review
RFA:	Request For Approval

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General Requirements

2.1 Materials, Parts and Processes Programme Management

2.1.1 Product Assurance Plan

Each Supplier shall define in his Product Assurance Plan the Materials, Parts and Processes organisation and tasks in accordance with ECSS–Q–00 and in accordance with the present document

2.1.2 Materials, Parts and Processes Manager

a. To have a contact representing the Supplier who will ensure that the requirement s laid out in this standard are met, each Supplier shall appoint a Materials, Parts and Processes Manager to supervise all related activities.

b. This manager shall be the Customer's contact as far as application of this standard is concerned within the overall PA reporting system. He shall periodically inform the Customer of the progress of tasks relating to its application. He shall ensure that both technical and scheduling aspects of the various actions undertaken are met (Status of Material validation, Part qualification and Process validation).

c. The Materials, Parts and Processes Manager shall ensure that the requirements of this standard are applied by all his Suppliers.

2.1.3 Materials, Parts and Processes Board

To coordinate the fulfilment of the requirements laid out in this standard, particularly as concerns critical Materials, Parts and Processes, a Materials, Parts and Processes Board shall be set up by each Supplier.

2.1.4 Materials, Parts and Processes Reviews

a. To obtain the validation status for Materials and Processes and qualification status for Parts, the Materials, Parts and Processes Manager shall present to the Customer those activities which have been performed in order to comply with this standard together with results obtained.

If necessary, the Materials, Parts and Processes Manager will organise technical meetings with his Suppliers.

2.2 Management and consolidation of the Materials, Parts and Processes

2.2.1

Each Supplier shall establish, collect, review and deliver the Materials, Parts and Processes lists including all the Materials, Parts and Processes intended for use in the flight equipment by his Suppliers and himself. They shall reflect the current design at the time of issue.

The objectives are the following:

- to make sure that all requirements of the programme are met,
- to verify the Materials, Parts and Processes activity of equipment Suppliers,
- to control and monitor the status of Materials, Parts and Processes in accordance with programme milestones.

2.2.2

The Materials, Parts and Processes Manager is in charge of the consolidation of the lists with his Materials, Parts and Processes homologues within the programme so as to ensure that all the information needed is given and that the approval status is consistent with technical and scheduling objectives.

NOTE 1 The consolidation of the lists shall be understood as technical and not as a compilation.

NOTE 2 The consolidation of the lists and the methods to be applied are given in ECSS–Q–70–XX.

The required content of the lists is given hereafter. The standardization of the format is defined in ECSS–Q–700.

2.2.3

These lists are open to modifications, and shall be updated during the course of the project:

– The Preliminary lists include the Materials, Parts and Processes from Suppliers preliminary needs and are used to identify those which are Critical. (Available for the PDR).

– The As-designed lists include the Materials, Parts and Processes from the baseline's various design files. (Available for the CDR).

– The As-built lists include the Materials, Parts and Processes used in the qualification and flight models. (Available for the QR).

Any change after CDR/QR shall be reflected, if applicable, in the lists and RFA issued if necessary.

2.3 Technical Constraints

2.3.1

Materials and Parts shall satisfy the mission's functional constraints with the specified or with sufficient margins.

2.3.2

Materials, Parts and Processes shall satisfy both ground environment constraints (manufacture, tests, storage, maintenance, transport, integration, etc...) and flight constraints (launch, orbit).

2.3.3

The following constraints shall be taken into account according to the mission:

- resistance to corrosion,
- resistance to mechanical load (dynamic or static),
- resistance and performance in vacuum,
- performance in weightlessness,
- resistance to radiation,
- resistance to thermal cycling,
- resistance to fluids according to mission requirements,
- resistance to other conditions specific to the mission (atomic oxygen, offgassing, flammability, odour, etc...).
- resistance to combined actions of the environment and loads (stress corrosion cracking, thermoelastic behaviour, cold welding,...).

2.3.4

The estimated availability of the Parts and products obtained from Materials and Processes used shall be compatible with the final system's life cycle (tests, storage, mission).

2.4 Cleanliness, Contamination Control

2.4.1

Each Supplier shall establish and maintain an effective contamination and cleanliness control programme including as a minimum:

– cleaning procedures,

– cleanliness-monitoring procedures/methods.

2.4.2

Materials, Parts or Processes shall be identified and reduced in accordance with mission requirements (cleanliness/contamination analysis).

2.4.3

For cleanliness/contamination critical applications, a specific cleanliness control plan and requirement specification (chemical and particle) shall be established

Guidelines for contamination and cleanliness control are given in ECSS–Q–201.

2.5 Safety Hazardous Materials and Parts

Materials and Parts with hazardous characteristics shall be identified managed and processed according to ECSS–Q–40.

2.6 Mechanical GSE/Electrical GSE Hardware

When Mechanical GSE/Electrical GSE Materials used in thermal vacuum or interfacing with flight hardware are selected, possible degradation (contamination, surface degradation, electro–mechanical, chemical effects) shall be taken into account.

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Materials Control

3.1 Selection of Materials

3.1.1 Technical Criteria

The following requirements need only be taken into account if the environmental conditions of the mission necessitate their application.

Where its use so justifies, particular attention shall be paid to certain constraints and the resistance of the Material in question may have to be demonstrated.

a. Vacuum:

   Outgassing tests shall be carried out as per specification ECSS–Q–702 or ASTM E 595–90 on Materials whose conditions of use may lead to contamination. The acceptance criteria for Materials used in space applications shall be generally as follows : Total Mass Lost < 1.00%. Collected Volatile Condensable Material < 0.10%

   Materials close to optical surfaces may require additional testing to be evaluated on a case–by–case basis.

   The use of pure mercury, cadmium and zinc is prohibited.

b. Thermal cycling:

   Materials subject to thermal cycling shall be assessed to ensure their capability to withstand the induced thermal stresses.

c. Radiations:

   Materials used on the spacecraft's external surfaces shall be assessed to determine their resistance to the radiation dosage expected during the mission.

   Specification ECSS–Q–706 shall be applied in order to demonstrate resistance of Materials to radiation (electromagnetic and particles).

d. Atomic oxygen:

   As regards the extent to which Materials used in the outer surfaces of space systems in low earth orbit are resistant to atomic oxygen, acceptance criteria shall be defined on a case-by-case basis.

e. Meteoritic environment:

The influence of a meteoritic environment on the Materials shall be examined on a case-by-case basis.

f. Electrochemical compatibility:

When bimetallic contacts are used, the choice of the pair of metallic Materials used shall take into account ECSS–Q–701 or MSFC–SPEC–2 50 data.

Maximum allowed couple is 0.5 V in controlled environments and 0.25 V in uncontrolled environments (no temperature or humidity controls).

g. Corrosion:

Corrosion resistance may have to be demonstrated for Materials subject to corrosion throughout their life cycle (storage, transportation, launch...). Data are available in MFSC HDBK 527 (guideline document).

h. Stress corrosion:

As far as Materials used for the structure are concerned, they shall be chosen in compliance with table 1 of ECSS–Q–736 ; any Material not covered by specification ECSS–Q–736 shall be tested according to specification ECSS–Q–737

i. Offgassing, flammability, odour:

For manned missions the Materials selected shall respect the criteria laid out in specifications ECSS–Q–721 and ECSS–Q–729 (or US document NHB 8060–1C).

j. Biocontamination:

The biocontamination aspect of Materials shall be examined on a case-by-case basis.

k. Fluid compatibility:

Materials that will be in contact with an identified fluid shall be compatible with that fluid. If adequate compatibility data are not available, then testing shall be performed according to NHB 8060–1 (test number 15).

3.1.2 Identification of Needs

a. Materials are to be chosen from the following guide in the order of preference and priority given to:
   - those successfully used for an identical application in other space programmes similar with respect to environment constraints and lifetime to the proposed application,
   - those for which satisfactory evaluation results have been obtained on samples representative of the application with a sufficient margin as regards conditions of use,
   - those included in ESA and NASA data banks containing satisfactory and non obsolete data

b. Whether the Materials are already validated or remain to be validated, their selection shall take into account the following criteria:
   - durability of supply,
   - reproducibility of characteristics.

3.1.3 Declared Material List (DML) Content

a. DML shall be broken down into clear categories to facilitate locating each item in the documentation (an example of such a breakdown is given in ECSS–Q–700)

b. The DML format shall include the following information:

- item number (as the reference of the Material in the DML) ; it shall be the same throughout the duration of the project,
- Material designation (commercial identification).
- Material keys, e.g. American Iron Steel Institute (steel), Aluminium Association (aluminium), Copper Development Association (copper),
- chemical nature and type of product,
- Manufacturer(s); procurement specifications or standards,
- summary of processing parameters (finish, temper condition, mix ratio, curing, etc...),
- use and location,
- environmental code,
- size code, test data (outgassing, stress corrosion cracking, corrosion...),
- approval status (with reference to the approval authority, to test report and similar previous applications).

c. Use of codes: any coding or acronyms used within the list shall be defined within the document.

An example of a suitable DML format is given in ECSS–Q–700.

3.1.4 Criticality Analysis

a. The Supplier shall analyse all the Materials contained in his preliminary lists with respect to criticality and in correlation with the risk analysis performed. This analysis shall reveal what further data are needed in order to meet mission requirements

b. Critical Materials shall be identified in the DML and included in the list of critical items (see ECSS–Q–20).

c. Any Critical Material shall be the subject of a Request For Approval (RFA) to be submitted to next Customer. This RFA shall include details of the subsequent evaluation and validation to be performed.

3.1.5 Evaluation and Validation Phases

a. There shall be an evaluation phase before the validation phase for Critical Materials with unknown characteristics. Such Materials shall be identified on a case-by-case basis.

b. Procurement and verification methods, together with associated documents, shall be available for review at the Contractor' s premises before the start of evaluation and/or validation phases.

3.1.5.1 Evaluation phase

The evaluation should consider the following as a minimum for each Critical Material:

- the limits of the sphere of use,
- the Material's physical, chemical and/or functional characteristics, along with its values and tolerances,
- behavioural tendencies and degradation Processes depending on environment parameters (including sensitivity to pollution),
- acceptance criteria.

a. When evaluation is performed an evaluation programme and report shall be drawn up.

3.1.5.2 Validation phase

a. For each Critical Material, a validation programme shall be drawn up by the Supplier and then implemented to check or confirm that the Materials satisfy the mission requirements with appropriate margins as necessary to obtain validation status.

b. Validation status shall depend on the results obtained (validation report) and the review of corresponding documentation.

3.1.5.3 Deviation request

All Materials not conforming to project requirements, whether at the end of criticality analysis or of evaluation and validation tests, shall form the subject of a duly justified deviation request according to ECSS–Q–20

3.2 Procurement of Materials

3.2.1 Procurement Specifications

a. Each Material shall be covered by a procurement specification or a standard.

b. These specifications shall define the Material properties, requirements, tests methods and acceptance criteria.

c. As a goal, the procurement specifications shall be explicitly accepted by the Material Vendor and/or Manufacturer.

3.2.2 Incoming Inspection Procedure

a. Each Material shall be submitted to an incoming inspection.

b. If necessary, an incoming inspection procedure shall define the inspections and tests to be carried out, particularly for Materials which are known to be variable in their final properties.

3.3 Use of Materials

3.3.1 Validation status of Materials

Each Supplier shall verify that all critical Materials have been validated before being used in the manufacture of qualification and/or flight products. Any modification, change of condition or configuration of application may invalidate the use of the Material and require additional validation testing.

3.3.2 Traceability of Materials

a. Each Supplier shall apply the traceability rules defined in ECSS–Q–20 to his Materials.

Materials should be identified by a unique reference number or code and a lot number to provide the possibility, should there be an incident or non-conformance, or for the purposes of technical investigations following failure or damage, of reconstituting the Material's history, either individually (individual traceability) or by the manufacturing lot it was part of (lot traceability).

3.3.3 Packaging, Storage, Removal from Storage

a. Each Supplier shall define provisions for packaging, storage and removal from storage for Materials.

b. Measurements and inspections used to guarantee the Material integrity and monitoring during storage and removal from storage shall be identified.

3.3.4 Limited-Life Materials before Implementation

Each Supplier shall ensure that all Materials which have limited-life characteristics have their date of manufacture (when available, otherwise date of delivery) and shelf-life expiry date accurately identified and clearly marked on each lot/batch. Materials which have exceeded their shelf-life expiry date may be recertified only after the physical and chemical characteristics have been inspected and the parameters, subject to deterioration, have been evaluated for continued acceptability.

3.3.5 Limited-Life Materials after Implementation

Materials with limited life after implementation (example: propellant, ...) shall be identified and controlled, storage and mission life being taken into account. These Materials shall be assessed as candidates to the list of critical items (see ECSS–Q–20).

3.3.6 Materials Nonconformances and Alerts

Nonconformances and alerts shall be dispositioned in accordance with ECSS–Q–20.

3.3.7 Health and Safety

Material Safety Data Sheet or equivalent shall be available for safety critical material. Precautionary provisions shall be identified as appropriate.

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Mechanical Parts Control

4.1 Selection of Mechanical Parts

4.1.1 Technical Criteria

Each Supplier shall verify that the Materials and Processes used in Parts satisfy the requirements of this standard.

4.1.2 Identification of Needs

a. Parts shall preferably be chosen from those successfully used for an identical application in other space programmes similar with respect to environment constraints and lifetime. Type reduction actions shall be implemented at all levels of the programme.

b. **Whether the Parts are already qualified or remain to be qualified, their selection shall take into account the following criteria:

- durability of supply,
- reproducibility of characteristics.

4.1.3 Declared Mechanical Part List (DMPL) Content

a. DMPL shall be broken down into clear categories to facilitate locating each item in the documentation (an example of such a breakdown is given in ECSS–Q–700

b. The DMPL format shall include the following information:

- item number (as the reference of the part in the DMPL) ; it shall be the same throughout the duration of the project,
- Part designation (commercial identification),
- type of Parts,
- Manufacturer; procurement specifications or standards,
- summary of functions and characteristics
- use and location,
- environmental code,
- approval status (with reference to the approval authority, to test report and similar previous applications).

c. Use of codes: any coding or acronyms used within the list shall be defined within the document

An example of a suitable DMPL format is given in ECSS–Q–700.

4.1.4 Criticality Analysis

a. Each Supplier shall analyse all the Parts contained in his preliminary lists with respect to criticality and in correlation with the risk analyses performed. This analysis shall reveal what further data are needed in order to meet mission requirements.

b. Critical Parts shall be identified in the DMPL and included in the list of critical items (see ECSS–Q–20).

c. Any Critical Part shall be the subject of a Request For Approval (RFA) to be submitted to next Customer. This RFA shall include details of the subsequent evaluation and qualification to be performed.

4.1.5 Evaluation and Qualification Phases

a. Depending on the results of the criticality analysis, the Supplier shall perform either evaluation and qualification phases or a qualification phase only for all Critical Parts.

The choice between these two approaches takes into account:

- knowledge of the Part (new part, new use, change of configuration),
- extension of the application.

b. Procurement and verification methods, together with associated documents, shall be available for review at the Contractor's premises before the start of evaluation and/or qualification phases.

4.1.5.1 Evaluation phase

The evaluation should consider the following as a minimum for each Critical Part:

- the limits of the sphere of use,
- the Part's physical and/or functional characteristics, along with its values and tolerances,
- behavioural tendencies and degradation processes depending on environment parameters (including sensitivity to pollution),
- acceptance criteria.

a. When evaluation is performed an evaluation programme and report shall be drawn up.

b. The behaviour of the parameters to be monitored (variation, change over time) which were also recorded during the evaluation programme tests, shall serve as a reference for the analysis of qualification test results

4.1.5.2 Qualification phase

a. For each Critical Part, a qualification programme shall be drawn up by each Contractor and then implemented to check or confirm whether the Parts satisfy mission requirements with appropriate margins.

b. Qualification status shall depend on the results obtained (qualification report) and the reviews of corresponding documentation.

4.1.5.3 Deviation request

All Parts not conforming to project requirements, whether at the end of criticality analysis or of evaluation and qualification tests, shall form the subject of a duly justified deviation request, according to ECSS–Q–20.

4.2 Procurement of Mechanical Parts

4.2.1 Procurement Specification

a. Each Part shall be covered by a procurement specification or a standard.

b. These specifications shall define the part characteristics, requirements, tests methods, acceptance criteria, lot acceptance testing, source inspection, receiving inspection tests if necessary. As a goal, the procurement specifications shall be explicitly accepted by the Part Manufacturer.

4.2.2 Source Inspection

For complex Parts related to a specific project development, each Supplier shall define the nature and frequency of his own source inspection points. Source inspection shall be carried out by the Supplier on the premises of the Part Manufacturer according to ECSS–Q–20.

4.2.3 Incoming Inspection Procedure

a. Each Part shall be submitted to an incoming inspection.

b. If necessary, an incoming inspection procedure shall define the inspections and tests to be carried out.

4.3 Use of Mechanical Parts

4.3.1 Qualification Status of Parts

Each Supplier shall verify that all Critical Parts have been qualified before being used in the manufacture of qualification and/or flight products. Any modification, change in condition or configuration of application may invalidate the use of the Part and require additional qualification testing.

4.3.2 Traceability of Parts

a. The Supplier shall apply the traceability rules defined in ECSS–Q–20 to his Parts.

Parts should be identified by a unique reference number or code and a lot number to provide the possibility, should there be an incident or nonconformance, or for the purposes of technical investigations following failure or damage, of reconstituting the Part's history, either individually (individual traceability) or by the manufacturing lot it was part of (lot traceability).

4.3.3 Packaging, Storage, Removal from Storage

a. Each Supplier shall define provisions for packaging, storage and removal from storage for Parts.

b. Measurements and inspections used to guarantee the Part integrity and monitoring during storage and removal from storage shall be identified.

4.3.4 Limited Life Parts or Parts Subject to Wearout

a. Limited life Parts after implementation or subject to wearout (example: mechanisms, pyro initiators, "o" rings...) shall be identified and controlled, storage and mission life being taken into account.

b. These parts shall be assessed as candidates to the list of critical items (see ECSS–Q–20).

4.3.5 Parts Nonconformance and Alerts

Nonconformances and alerts shall be dispositioned in accordance with ECSS–Q–20.

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Process Control

5.1 Selection of Processes

5.1.1 Technical Criteria

Each Supplier shall verify that the Materials and the mechanical Parts used during the implementation of Processes satisfy the requirements of this standard.

5.1.2 Identification of Needs

a. Processes are to be chosen from those already validated according to the order of preference and priority given below, i.e.:
   - those covered by Space Agencies or other governmental organisation certification for identical conditions of use,
   - those for which satisfactory evaluation and validation results have been obtained on samples representative of the application with a sufficient margin as regards conditions of use,
   - those already successfully used by the same manufacturer for other space programmes in the same conditions of use.

b. Whether the Processes are already validated or remain to be validated, their selection shall take into account the following criteria:
   - reliability,
   - inspectability,
   - repairability,
   - reproducibility,
   - durability of the Process.

5.1.3 Declared Processes List Content

a. DPL shall be broken down into clear categories to facilitate locating each item in the documentation (an example of such a breakdown is given in ECSS–Q–700.

b. The DPL format shall include the following information:
   - item number (as the reference of the Process in the DPL): it shall be the same throughout the duration of the project,
   - Process identification,

- Process specification,
- Process description (with associated materials designation if possible),
- use and location,
- Process Supplier,
- associated DML item numbers,
- approval status (with reference to the approval authority, to the test report and similar previous applications).

c. Use of codes: Any coding or acronyms used within the list shall be defined within the document

An example of a suitable DPL format is given in ECSS–Q–700.

5.1.4 Criticality Analysis

a. Each Supplier shall analyse all the Processes contained in his preliminary lists with respect to criticality and in correlation with the risk analyses performed. This analysis shall reveal what further data is needed in order to meet mission requirements.

b. Critical Processes shall be identified in the DPL and included in the list of critical items. (See ECSS–Q–20).

c. Any Critical Process shall be the subject of a Request For Approval (RFA) to be submitted to next Customer. This RFA shall include details of the subsequent evaluation and validation to be performed.

5.1.5 Evaluation and Validation Phase

a. Depending on the results of the criticality analysis, the Supplier shall perform either evaluation and validation phases or a validation phase only for all Critical Processes.

The choice between these two approaches takes into account:

- knowledge of the Process (new Process, new use or configuration extension),
- extension of the application.

b. For confidential Processes, the Supplier shall prove that the Process has been validated (e.g. by presenting a validation certificate from Space Agencies or other governmental organisation who shall check the applicability of this validation).

5.1.5.1 Evaluation phase

The evaluation should consider the following as a minimum for each Critical Process:

- the limits of the sphere of use,
- the values, determined using test samples, of implementation parameters and their tolerances,
- the safety margins, determined by pushing the test samples to their limits,
- acceptance criteria.

a. When evaluation is performed each Supplier shall draw up an evaluation programme and report.

5.1.5.2 Validation phase

a. For each Critical Process, a validation programme shall be drawn up by each Contractor and then implemented. The validation programme shall be defined in compliance with existing ECSS or national agency standards of validation.

b. This programme shall check or confirm that the Processes satisfy the mission requirements with appropriate margins and that the parameters needed for

the product design have been defined so as to obtain validation status.

c. Validation status shall depend on the results obtained (validation report) and the review of corresponding documentation.

5.1.5.3 Deviation request

All Processes not conforming to project requirements, whether at the end of criticality analysis or of evaluation and validation tests, shall form the subject of a duly justified deviation request, according to ECSS–Q–20.

5.2 Use of a Process

5.2.1 Validation Status of a Process

Each Supplier shall verify that all Critical Processes have been validated before being used in the manufacture of qualification and/or flight products. Any modification, change in condition or configuration of application may invalidate the use of the Process and require additional validation testing.

5.2.2 Revalidation of a Process

a. Any prolonged stoppage in manufacturing, any major change of the facilities or procedures or any transfer of production to another entity may invalidate partially or completely the initial validation of a Process.

b. When a Process needs to be revalidated, a Request For Approval (RFA) shall be established and a revalidation programme shall be implemented .

5.2.3 Implementation of a Process

a. Before implementation of a Process, each Supplier shall verify that personnel is trained and that means, environment, and documentation are adequate.

b. This verification shall ensure that:

- manufacturing and control means associated with the Process are adequate, calibrated and properly maintained,
- manufacturing and control means are used under appropriate environmental and cleanliness conditions (see clause 2.4 “Cleanliness/Contamination Control”).
- personnel are properly trained and certified when necessary,
- the Processes specifications, manufacturing and inspection procedures and workmanship standards including clear definition of manufacturing operations and clear acceptance criteria (photographically documented if possible for visual acceptance criteria) exist and are adequate.

5.2.4 Special Processes

a. Each Supplier shall identify and control Process where quality cannot be completely ensured by inspection of the end article only (special Processes).

b. In that particular case, Process Control shall be ensured by means of adequate procedures and personnel certification and/or machine survey.

c. Whenever possible, a Statistical Process Control shall be carried out.

5.2.5 Traceability of Processes

a. Each Supplier shall apply the traceability rules defined in ECSS–Q–20.

b. Each Process shall be identified by a code or designation, the operator name and signature (or stamp) and date of implementation.

c. Traceability is used for reconstituting the Process history, either individually (individual implementation traceability) or generally at finished sub assembly

level in the case of any technical investigations (e.g. following failure or damage).

5.2.6 Process Nonconformances and Alerts

Nonconformances and alerts shall be dispositioned in accordance with ECSS–Q–20.

5.2.7 Mandatory Inspection Points (MIP)

Each Supplier shall define the nature and frequency of the mandatory Inspection Points (MIP). Mandatory inspection points (MIP) shall be dispositioned according to ECSS–Q–20.

5.2.8 Packaging/Storage/Removal from Storage

Each Supplier shall define provisions for packaging, storage, removal from storage for products or semifinished products before and after implementation of Processes.

Annex A (informative)

Relationship Between Materials, Parts and Processes Activities and Programme Phases

A.1 Conceptual Phase (Phase A)

In this phase the Materials, Parts and Processes assurance tasks shall be:

a. Identify main programme constraints on Materials, Parts and Processes.

b. Define the Materials, Parts and Processes policy.

c. Plan the Materials, Parts and Processes assurance tasks for the project definition phase.

A.2 Project Definition Phase (Phase B)

In this phase the Materials, Parts and Processes assurance tasks shall be:

a. Define or identify Materials, Parts and Processes requirements.

b. Identify main new Materials, Parts and Processes needed and plan corresponding necessary actions for phase C.

c. Plan the Materials, Parts and Processes assurance tasks for the detailed design, development, manufacturing, integration and test phase and prepare the Materials, Parts and Processes plan as part of the PA plan.

A.3 Detailed Design, Development, Manufacturing, Integration and Test Phase (Phase C/D)

In this phase the Materials, Parts and Processes assurance tasks shall be-

a. Identify Materials, Parts and Processes.

b. Issue Preliminary Materials, Parts and Processes lists.

c. Identify Critical Materials, Parts and Processes.

d. Support Preliminary Design Review.

e. Establish or review RFA.

f. Support Mandatory Inspection Points identification.

g. Establish evaluation programme, perform test and/or review test results.

h. Establish validation/qualification programmes, perform tests and/or review tests results.

i. Support nonconformance processing (MRB, Failure Review Board).
j. Establish the as-designed Materials, Parts and Processes lists.
k. Support the Critical Design Review.
l. Support the Qualification Review.
m. Establish the as-built Materials, Parts and Processes lists.
n. Support release of manufacture of flight hardware.

A.4 Operational Phase (Phase E)

a. Support Final Acceptance Review.
b. Support investigation of operational phase anomalies.