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Product assurance requirements for ESA-MSM payload projects

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Document change record

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2		November	Chapter I: Paragraphs, I.1 ; I.2 ; I.3 ; I.4 Chapter II: Paragraphs, II.1.1 ; II.1.4 ; II. 2.8 ; II.3.2 ; II.4.6 ; II.4.7 ; II.4.8 ; II.5.6 ; II.5.7.1.2 ; II.5.7.3 ; II.6.5 ; II.8 Chapter III: Paragraphs, III.1 ; III.2 Chapter V: All Chapter VI: Paragraphs, VI.1 ; VI.2 ; VI.3 ; VI.4 ; VI.6 Chapter VII: Paragraph, VII.2 Chapter VIII: All Annex 1 Annex 2 Acronyms	Approved by T. Sgobba

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I Introduction

I.1. Scope

This document sets forth the Product Assurance (PA) programmatic requirements, which shall be applied to payload projects, including facilities, instruments, experiment hardware, ground equipment and related services and procedures. The requirements apply for new developments as well as for refurbishments.

This document covers all the PA disciplines. Requirements for Reliability, Maintainability, Safety, Mechanical-parts, Materials and Processes Control, and CAM equipment are further detailed by specific project annexes to take into account the different categories of payloads and related factors summarized in Annex 1.

This document is primarily intended for use by payload projects under the responsibility of the ESA Manned Spaceflight and Microgravity Directorate.

I.2. ESA PA requirements baseline

The present document and the project(s) specific annexes comply with and tailor the following level 2 ECSS specifications:

ECSS-Q-00A
Space Product Assurance – Policy and Principles,

ECSS-Q-20B
Space Product Assurance – Quality Assurance,

ECSS-Q-30B
Space Product Assurance – Dependability,

ECSS-Q-60A
Space Product Assurance – EEE components,

ECSS-Q-70A
Space Product Assurance – Materials, Mechanical Parts and Processes,

ECSS-Q-80B
Space Product Assurance – Software Product Assurance,

ECSS-M-40A
Space Product Assurance – Configuration Management,

ECSS-M-50A
Space Product Assurance – Information, Documentation Management,

I. 3. Applicable documents

The documents listed below are directly applicable to this document to the extent specified herein.

SSP-30512
Space Station Ionizing Radiation Design Environment,

PSS-01-202 Issue 1 (June 1983)
Preservation, storage, handling and transportation of ESA spacecraft hardware,

ECSS-Q-60-11
Space Product Assurance – Derating and EoL Parameter Drifts, EEE Components,

ECSS-Q-60-01A
Space Product Assurance – European Preferred Parts Lists (EPPL) and its Management,

MIL-STD-975 NASA
NASA standards EEE part list,

GSFC preferred part list PPL-20,

GPQ-PR-01
Processing of nonconformances and waivers/deviations for ESA microgravity projects,

GPQ-PR-01-1
Processing and reporting of nonconformances for ISS payloads developed by ESA

GPQ-PR-02
Acceptance data package for ESA microgravity projects,

GPQ-PR-03
Hybrid microcircuits procurement procedure for microgravity projects,

GPQ-PR-04
Material and fracture control certification.

I.4. Reference Documents

ISO 9001 (2000).

I.5. Order of Precedence

In case of conflict between documents applicable to the project, the order of precedence shall be as follows:

1 The performance and design requirements in the contract,
2 The statement of work,
3 This document,
4 The project specific annexes
5 Other documents.

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Chapter II General Product Assurance (PA)

II.1 Product Assurance Programme Management

II.1.1 Product Assurance Programme Plan

The Contractor shall establish and implement a PA programme to ensure compliance with the requirements of this document, as made contractually applicable. A PA Programme Plan shall be generated and maintained to document and control all PA activities.

The PA Programme Plan shall include details as to how the Contractor intends to verify that the programme will be accomplished and how he intends to perform supervisory and monitoring actions on Subcontractors and Suppliers.

Contractor internal company procedures may be referenced in the PA plan, in this case they shall be made available for consultation or supplied. Contractors should be aware that referencing internal company procedures in the PA plan will limit the company's ability to unilaterally change the procedures. All modifications to these procedures shall be considered as modifications to the PA plan.

The Product Assurance Programme Plan shall serve as a master planning and control document for the product assurance programme.

The Prime Contractor PA Programme Plan shall be approved by ESA.

The PA plan shall include a section testifying to the compliance with the requirements of this document and identifying any relevant discrepancy (compliance matrix). Requirements which do not apply to a specific deliverable item or unit, shall be duly identified.

II.1.2 Organisation

The Contractor shall establish and maintain a PA organisation for the project. Personnel responsible for implementing and performing PA functions shall have well defined responsibilities, authority, and organisational independence to develop and implement PA disciplines and controls.

One designated person of the overall company PA organisation shall have the responsibility, authority and requisite seniority for managing the PA activities for the project, and to certify the product conformity to the applicable requirements.

Responsibility for Configuration and Documentation Management can be assigned to a Configuration Manager who is not a member of the contractor PA organisation, although Configuration Management is a PA discipline.

II.1.3 PA status reporting

The Contractor shall periodically prepare and submit to ESA reports on the status of the PA programme, as part of the overall project progress reporting. The relevant DRD and DRL requirements shall apply.

II.1.4 Personnel training and certification

The Contractor shall have trained and competent personnel to implement the PA programme.

Operators performing critical processes (including special processes) shall be trained and certified either by internal or external training programmes accepted by ESA.

Inspectors controlling critical processes, or performing nondestructive testing and evaluation, shall be trained and certified according to national or international training programmes and standards accepted by ESA.

Personnel shall be recertified periodically according to an established programme. Recertification will also occur as a result of unsatisfactory performance, change in techniques or required skills, and/or extensive interruption of work performance.

II.1.5 Product assurance programme audits

The Contractor shall perform audits on his own performance and on his Subcontractors and Suppliers, to verify the implementation and effectiveness of the provisions defined in the PA Programme Plan.

The Contractor shall establish and maintain an audit plan designating the Subcontractors and Suppliers to be audited.

In addition to the planned audits, special audits may be performed when necessary to overcome failure, consistent poor quality, or other problems.

ESA reserves the right to be represented in Subcontractors and Suppliers audits. At least 5 working day's notice shall be given to ESA. An Audit report shall be issued within 15 days of the audit visit and one copy shall be sent to ESA.

ESA reserves also the right to audit the Contractor and any Subcontractor or Supplier at any time, giving notification to the Contractor.

II.2 Design Control

II.2.1 General

The Contractor shall establish and maintain documented procedures to control and verify the design of the product in order to ensure that the specified requirements are met.

The procedures should cover in particular:

- Standard engineering and RAMS analyses, design methods and tools, drawing rules.
- Performance of development tests.
- Performance of design reviews (internal and formal).
- Establishment of technical baselines and interface coordination.
- Tracking and documentation of requirements verification.

II.2.2 Organizational and technical Interfaces

Organizational and technical interfaces between different groups, which input the design process shall be defined and the necessary information documented, transmitted and regularly reviewed.

II.2.3 Design requirements

Design requirements including applicable safety national or international regulations shall be identified, their selection reviewed for adequacy. Incomplete, ambiguous or conflicting requirements shall be resolved with ESA.

II.2.4 Design documents

The Contractor shall establish and maintain procedures for preparation, review and maintenance of specification, engineering drawings and lists.

II.2.5 PA support to design reviews

The contractor PA shall ensure that:

- Documentation for design reviews is complete and consistent with review objectives,

- The design baseline to which engineering and RAMS analyses apply are clearly identified,
- The safety reliability, maintainability and quality requirements are

factored into the design.
- The design is producible, and capable of being inspected and tested.

II.2.6 Verification

Verification is the process of showing that a requirement has been satisfied. Requirements verification shall be performed progressively, as each stage of the project is completed, and provides the organised base of data upon which qualification and acceptance will be incrementally declared.

Qualification is the formal recognition that an item design meets requirements, while Acceptance is the formal recognition of the item conformity to the qualified design.

II.2.6.1 Structured Requirements

The Contractor shall establish and maintain a system for defining and relating the requirements in an organised manner. The system shall be aimed to ensure consistency and completeness of both: top-down requirements allocation and bottom-up requirements verification.

Trace ability to ESA requirements and to verifications results shall be ensured. The Contractor shall describe in the PA plan how the trace ability and verifiability of the requirements system will be achieved.

II.2.6.2 Verification process

The verification process will consist of:

- Verification of compliance between system design and ESA requirements.

- Verification that system design requirements are properly allocated to lower level items.

- Incremental verification up to system level, by analysis and review of design (RoD), of items detailed design compliance to their approved design requirements.

- Incremental demonstration up to system level, by test, of items compliance to their approved design requirements, and validation of the "as designed" documentation.

- Conformity verification by inspection and test, and reconciliation of the "as built" configuration to the "as designed", for each item up to system level.

Project reviews represent the formal checking of the data provided by the verification process to finally decide whether the requirements have been fulfilled.

II.2.7 Qualification

The process of qualification is defined as:

Determination that the item is capable of meeting the established performance, and design requirements with margins commensurate with the application and use environment.

The design is qualified by the Customer when the collected evidence from tests, inspections, reviews, analyses, comparisons prove that requirements have been satisfied.

Qualification shall be achieved from the lowest level upwards so that at each level when qualification takes place, all lower level configuration items will have been previously qualified. Qualification shall apply to all configuration items whether produced by the Contractor or his Co-Subcontractors.

The Contractor shall track and record and periodically report to ESA, the qualification status of all deliverable items as well the progress of the qualification programme.

Qualification Tests

To obtain authorization to initiate qualification tests the contractor shall ensure that requirements in paragraph II.6.5 are met.

Qualification tests shall be performed in accordance with the detailed procedures authorised at the Test Readiness Review (TRR).

All actions emerging from the qualification tests shall be completed to the satisfaction of the Customer.

On completion of qualification tests, a qualification report shall be written which addresses all aspects of the activity and states the conclusions as to the technical proof actually demonstrated. The report shall be submitted for approval to the Customer as the qualifying authority.

Maintenance of Qualification

Once the design has been qualified, all subsequent changes shall be reviewed for their impact on the qualification status.

Qualification by Similarity (use of previous design)

Qualification by similarity may be accepted if the Contractor provides justification and evidence that the new set of performance and design requirements, including safety reliability and maintainability, is within the limits of the previously qualified design.

When the new set of requirements is more stringent than those of the previous qualification, complementary tests and justifications shall be provided to the Customer for approval.

II.2.8 Critical items control programme

The Contractor shall establish and implement a Critical Items Control Programme. Items regarded as functionally critical to the safety and reliability shall be formally identified and controlled. The critical items shall include the Fracture Critical Items if any. A consolidated record of all critical items shall be maintained by the prime contractor.

All designated critical items, shall be subjected to special controls as follows:

- The item shall have a unique drawing number and shall be serialised.
- Design, manufacturing, and testing documentation shall be identified and marked.
- Any special requirements pertaining to procurement, manufacturing and inspection/testing shall be indicated on the drawings (and therefore under configuration control).
- Procurement specifications shall be mandatory and subcontracts shall only be placed on qualified companies.
- Adequate representation is provided for Material Review Boards (MRB), Configuration Control Boards (CCB), and Test/Qualification Review Boards.
- Sequence and content of fabrication operations shall be approved by the design office, prior to implementation, as well as any change thereof.
- A detail inspection plan shall be established and independent checks ensured by the inspection function.
- Records of inspection and test results shall be maintained for all special requirements identified in the drawings.

II.3 Procurement control

II.3.1 General

The Contractor shall control the procurement activity to ensure that all items and services procured conform to technical and PA contract requirements.

The control of procurement activity includes selection of procurement sources, control of purchase documents, PA surveillance of Subcontractors and Suppliers and inspection of incoming items.

II.3.2 Selection of procurement sources

The Contractor PA organisation shall participate in and approve the selection of procurement sources.

II.3.2.1 Selection criteria

The Contractor's selection of Subcontractors and Suppliers shall be based on documented criteria such as previously furnished items, assessment by audits, second party certification and recognised experience.

II.3.2.2 Record and list of procurement sources

The Contractor shall establish and maintain records of procurement sources involved in contract performance.

The Contractor shall submit to the ESA, upon request, the list of procurement sources, including all the information in the records above, for information.

II.3.3 Procurement documents

The Contractor shall ensure that supplies are precisely identified and that all applicable requirements are properly defined in the procurement documents.

When a procurement specification is required, the following content shall apply:

a. Comprehensive technical descriptions of the items and services to be procured.

b. Details of the applicable requirements, such as requirements for preservation, packaging, marking, shipping, accompanying documentation and provisions for limited life items.

c. Details of QA activities to be performed, such as inspection and test, records and reports.

d. Details of Contractor's QA activities at source (if required).

e. Special acceptance conditions.

The Contractor's PA organisation shall review procurement documents prior to release, to verify the correct selection of procurement sources and appropriateness of their content.

II.3.4 PA surveillance of procurement sources

The Contractor shall exercise PA surveillance over all the activities carried out by its Subcontractors or Suppliers during contract performance.

The surveillance programme shall include audits, reviews, inspections, as well as source inspection if any.

II.4 Quality assurance general requirements

II.4.1 Quality assurance documentation

II.4.1.1 Procedures and instructions

All QA activities shall be covered by written procedures. For this purpose the Contractor shall develop and maintain an adequate set of procedures.

In addition, instructions, such as working inspection and test instructions, may be necessary to ensure achievement of the required product quality.

II.4.1.2 Quality records

The Contractor shall maintain quality records to provide objective evidence of complete and effective performance of QA tasks and to demonstrate achievement of the required quality.

Quality records shall be stored in safe conditions, which prevent alterations, loss or deterioration, and shall be retained for a minimum of eight years if not differently specified in the contract

II.4.2 Documentation control

The Quality Assurance organisation shall ensure that only the correct issues of technical and production documents for the work being performed are available to operating personnel, and that obsolete issues are promptly removed from the points of issue or use.

II.4.3 Stamp control

The Contractor shall establish and maintain a stamp control system to ensure a correct and legitimate use of all fabrication and inspection stamps and trace ability to the owner.

Stamps shall be used to signify successful accomplishment of operations, inspection and tests by the person responsible to performing it.

The use of signatures in place of stamps is acceptable provided that similar trace ability and responsibility records are maintained and available.

II.4.4 Traceability

II.4.4.1 General

The Contractor shall implement a trace ability system, which shall be maintained throughout all phases of contract performance.

The trace ability system shall allow to:

a. Establish unequivocal relationship between parts / materials / products and associated documentation / records.

b. Trace personnel and equipment related to procurement, fabrication, inspection, test, assembly, integration and operations activities.

II.4.4.2 Identification

Each part, material or product shall be identified by a unique and permanent part or type number. These numbers shall be related to the engineering drawings.

In addition, parts, materials and products shall be identified as individual entities/groups by means of one or more of the following methods:

a. Date codes indicating date of manufacture, to identify items made by a continuous process or which are subject to degradation with age.

b. Lot or batch numbers, to identify items produced in homogeneous groups and uniform conditions.

c. Critical items must be serialised to identify individual items for which unique data are to be maintained (critical items).

Controls shall be established to ensure that:

a. Identification numbers are assigned in a systematic and consecutive manner.

b. Identification numbers of scrapped or destroyed items are not re-used again.

c. Identification numbers, once allocated, are not changed.

Identification numbers shall be marked on documentation and, where possible, on respective items.

Method of marking on items shall be defined on engineering drawings and specifications.

II.4.5 Metrology and calibration

The Contractor shall control, calibrate and maintain inspection, measuring and test equipment, whether owned by the Contractor, or on loan, to demonstrate the conformance of product to the specified requirements.

The Contractor shall:

a. Identify the measurements to be made, the accuracy required and select the appropriate inspection, measuring and test equipment. Measurement uncertainty shall be known and consistent with required measurement capability;

b. Identify, calibrate and adjust all inspection, measuring and test equipment at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to national/international recognized standards - where no such standards exist, the basis used for calibration shall be documented and agreed by ESA;

c. Establish, document and maintain calibration procedures, including details of equipment type, identification number, location, frequency of checks, check method, acceptance criteria and the action to be taken when results are unsatisfactory;

d. Identify inspection, measuring and test equipment with a suitable indicator or approved identification record to show the calibration status;

e. Maintain calibration records for inspection, measuring and test equipment;

f. Ensure that the environmental conditions are suitable for the calibrations, inspections, measurements and tests being carried out;

g. Ensure that the handling, preservation and storage of inspection, measuring and test equipment is such that the accuracy and fitness for use is maintained;

h. Safeguard inspection, measuring and test facilities, including both test hardware and test software, from adjustments, which would

invalidate the calibration setting;

Where test hardware (e.g. jigs, fixtures, templates, patterns) or test software is used as suitable aids of inspection, they shall be checked to prove that they are capable of verifying the acceptability of [the] product prior to use during production and installation and re-checked at prescribed intervals. The Contractor shall establish the extent and frequency of such checks and shall maintain records as evidence of control.

Test aids, such as test leads, break-out boxes, mains leads and similar items are not subject to the entire set of requirements defined in this section, but shall be validated in a way appropriate to their usage.

II.4.6 Nonconformance control system

The Contractor shall establish and maintain a nonconformance control system in accordance with the detailed requirements in GPQ-PR-01or GPQ-PR-01-1 as applicable.

The system shall provide a systematic approach to the identification and segregation of nonconforming items, the recording, reporting, review, disposition and analysis of nonconformances, and the definition and implementation of corrective and remedial actions.

Nonconformances shall be classified as critical, major or minor, with the following criteria:

Critical Nonconformances are those, which may affect safety, and occur during/after qualification/acceptance testing at any item level.

Major Nonconformances are those which are not critical, but may have an impact on the customer's requirements in the following areas:

a. Operational, functional or contractual requirements;
b. Reliability, maintainability;
c. Lifetime;
d. Interchangeability;
e. Interfaces with hardware and/or software of different contractual responsibility.

Additionally, any nonconformance shall be classified as major in the following cases:

f. Deviation from qualification or acceptance test procedures and expected results at any level of integration;

g. EEE component nonconformities after delivery from the manufacturer shall be classified as major, except the following

Nonconformances at incoming inspection, which may be classified as Minor:

- failures, where no risk for a lot related reliability or quality problem exists;
- the form, fit or function are not affected;
- minor inconsistencies in the accompanying documentation.

Minor Nonconformances are those, which by definition cannot be classified as critical or major. A minor nonconformance is of inconsequential nature as regards the above features, or is trivial with regard to workmanship criteria.

The consequences of several different nonconformances on the same item shall be evaluated.

When GPQ-PR-01-1 applies, all nonconformances shall be screened for possible reporting in the PRACA Data System (PDS).

Critical nonconformances shall be formally notified to ESA within 1 working day after review by the contractor PA.

Major nonconformances shall be formally notified to ESA within 1 week after review by the Contractor PA.

The Contractor shall provide a precise definition of the authority and responsibilities assigned to his Subcontractors for nonconformance processing.

Nonconformances shall be reviewed and dispositioned by a formal Material Review Board, which shall include, at least, representative from the PA and Engineering organisations.

All major nonconformances (not PRACA reportable per GPQ-PR-01-1) shall be dispositioned by an MRB chaired by the Prime Contractor and ESA.

All critical nonconformances and major nonconformances that are PRACA reportable per GPQ-PR-01-1 shall be dispositioned by and MRB chaired by ESA and NASA.

Nonconformances shall be reviewed to identify the root causes, and implement corrective actions to prevent recurrence.

When the disposition of nonconforming item results in the violation of an ESA performance/design requirement, or of an approved configuration baseline, the nonconformance shall be submitted to the customer project manager for approval, by means of a Request for Waiver (RFW), via the Configuration

Control Board.

The Contractor shall maintain records and status list of all nonconformances.

II.4.7 Alert system

The Contractor shall provide for the assessment of relevance for any incoming alert, and the definition, implementation and follow-up of necessary actions at any contractual level.

The Contractor shall register into the ESA Alert System.

II.4.8 Handling, storage, preservation

The Contractor shall provide for protection of items during handling, and for handling devices, procedures and instructions to prevent handling damage during all phases of manufacturing, assembly, integration, testing, storage, transportation and operation.

The Contractor shall have secure storage areas available for incoming materials, intermediate items needing temporary storage and end items before shipping.
Controls shall be maintained over the acceptance into and withdrawal from the storage area.

Limited-life materials, suspended limited-life material, nonconforming items awaiting MRB disposition, and all other items which require to be stored separately for health or safety reasons shall be placed in segregated areas within the storage area. Each segregated area within the stores shall be clearly identified and labelled.

Records shall be maintained to ensure that all stored items are within the useable life limits and adequately controlled and retested, and to provide trace ability within the storage area.

The Contractor shall ensure that items subject to deterioration, corrosion or contamination through exposure to air, moisture or other environmental effects are preserved by methods, which ensure maximum protection consistent with life and usage. The requirements in PSS-01-202 apply.

II.5 Manufacturing, assembly and integration

II.5.1 Planning and associated documents

The planning of manufacturing, assembly and integration operations and inspections shall be reflected in a flow chart, which shall clearly depict the sequence of operations. It shall include the identification of MIPs, together with

the reference to the procedures to perform the various activities and the required cleanliness levels.

Adequate instructions, such as shop travellers, shall direct the actual performance of operations, to ensure that the activities proceed in an orderly manner and according to the planned sequence.

Manufacturing, assembly and integration documents shall be issued and maintained in accordance with established and formal procedures.

The Quality Assurance function shall review and approve such documents, and any modifications thereof, to ensure that they include or refer to:

a. Identification of the item to be manufactured or equipment to be used.

b. Configuration data, including parts lists, drawings, changes and specifications.

c. Identification of the production and inspection equipment (tools, jigs, fixtures...) to be used for the manufacturing, assembly and integration of the item.

d. Detailed definition, by description or reference, of manufacturing, assembly, integration, inspections and test operations to be performed, and special conditions to be maintained.

e. Provisions for inspections and tests to be witnessed by ESA representative.

f. Accept/reject criteria (with tolerances) and workmanship standards.

II.5.2 Control of processes

Processes shall be documented by process specifications or standards, including QA provisions, methods for inspection and test, accept/reject criteria, number of samples and their storage.

The Contractor QA shall monitor all processes to enforce applicable requirements.

II.5.2.1 Critical processes

The Contractor shall ensure that:

a. Critical processes are validated for the intended application.

b. Personnel who perform critical processes or evaluate the process

performance are trained and certified and proficient.

c. Materials, equipment, computer systems and software, and procedures involved in the performance of the critical process are validated and monitored.

d. Coordination is maintained with the cognizant engineering function to ensure proper selection of the nondestructive and/or destructive methods for the evaluation of process performance.

e. Critical processes are performed under the surveillance of the QA function.

II.5.3 Workmanship standards

The Contractor shall employ workmanship standards to ensure acceptable and consistent workmanship quality. Physical samples or visual aids shall be included as necessary.

II.5.4 Control of items conformity status

The Contractor shall ensure that only conforming items are released and used, and that those not required for the operation involved are removed from work operation areas.

The Contractor shall make provisions for a positive identification of the inspection and test status of any item at any stage of the manufacturing, assembly and integration cycle, starting from the incoming inspection up to shipping of the end item.

Items having limited life or definite characteristics of quality degradation or drift with age and/or use shall be marked to indicate the dates, test times or cycles at which life was initiated and at which the useful life will expire.

Items to be processed or manufactured in a controlled environment shall be inspected and tested in a similar environment to prevent quality degradation.

II.5.5 Equipment control

II.5.5.1 Tooling

The Contractor shall make provisions for accountability, identification and maintenance of tooling.

Tooling shall be checked for its dimensional accuracy, and correct function, and approved by Quality Assurance organisation prior to use. The approval shall be stamped on the equipment and recorded.

When reuse of tools is foreseen, the following shall apply:

- Tools shall be checked for accuracy at adequate intervals or prior to use, and shall be submitted to re-approval following any modification;

- Tools shall be properly stored to prevent misuse, damage and deterioration;

II.5.5.2 Equipment for computer aided manufacturing

The Contractor shall ensure that computer aided techniques and data for processing and machining are validated prior to use and controlled during their use.

In particular, provisions shall be made for testing, approval, configuration control and prevention of tampering of the software involved.

II.5.6 Cleanliness and contamination control

The Contractor shall establish cleanliness and contamination control requirements and plan their implementation. The contractor will differentiate the requirements as appropriate (E.G. ground units versus flight unit).

The required cleanliness levels shall be indicated on drawings, specifications, procedures, or other documents controlling the manufacture, assembly, integration and test of the item.

Contamination sensitive items, fabricated or processed in contamination-controlled environments, shall be inspected, tested, modified or repaired in identical or cleaner environments, unless specific precautions are taken to protect them from contamination.

Specific protection measures, such as protective dust covers, shall be implemented to protect contamination sensitive items when they are integrated in higher level of assembly.

Contamination shall be prevented to the maximum extent by operating in clean working areas and by proper handling, preservation, packing and storage.

II.5.7 Inspection

II.5.7.1 Receiving inspection

II.5.7.1.1 General

The Contractor shall inspect all incoming supplies and the associated documentation, prior to use, to verify their conformance to the procurement

documents.

Inspections shall be performed in accordance with established procedures and instructions, to ensure that the quality level is properly determined.

Sampling plans may be used only when tests are destructive, or when reduction in inspection or testing can be achieved without jeopardising the fulfilment of safety and reliability requirements. The Contractor shall use existing national or international standards to establish his sample inspection plans.

Receiving inspection of EEE components shall be in accordance with Chapter V of this document.

Receiving inspectors shall have available the procurement documents, specifications, drawings and any other document relevant to incoming supplies.

II.5.7.1.2 Receiving inspection activities

Receiving inspection activities shall be documented and shall include:

a. Verification of the packing conditions and of the status of any environmental sensors.

b. Visual inspection of the delivered items.

c. Verification of correct identification and, where appropriate, configuration identification for conformance to the ordering data.

d. Verification of the evidence of inspection and tests performed by the Subcontractor/Supplier and associated documentation.

e. Verification of the performance of Contractor's source inspection, when required.

f. Performance of inspection and tests on selected characteristics of incoming supplies and/or test specimen submitted with the supplies.

g. Identification of the shelf life of limited life items.

h. Identification of the inspection status and physical separation of the supplies in the receiving inspection area to avoid unaccepted use according to the following categories:

- Items for which the receiving inspection has not be completed;
- Conforming Items;
- Nonconforming Items.

i. Maintenance of Incoming inspection records to ensure trace ability and the availability of historical data to monitor Subcontractor/Supplier performance and quality trends.

j. Prevention of unauthorised use of uninspected items.

II.5.7.1.3 Inspection of Customer furnished items

Receiving inspection of items supplied by ESA shall consist, as a minimum, in the verification of identity and integrity after transportation.

II.5.7.2 In-process inspection

Inspection and tests shall be planned at those points of the manufacturing, assembly and integration flow where maximum assurance for correct processing and prevention of unrecoverable or costly nonconformances can be obtained.

Self-inspection by the operators performing the associated manufacturing, assembly and integration activities shall not be considered sufficient for items subjected to the critical item control programme.

Among the inspections and tests as part of the manufacturing, assembly and integration flow, some selected inspections (MIPs - Mandatory Inspection Points) shall be performed with participation of representatives from ESA.

MIPs shall be proposed by the contractor among the most significant inspection points and their selection approved by ESA.

A MIP shall require an invitation with the agreed notice before the event, and the participation of ESA, or a written agreement to proceed without its participation.

Inspections and tests shall be performed using equipment, which is employed only for that purpose. Where it is judged necessary to use-manufacturing equipment, such as production jigs, fixtures, master tools, templates, patterns and similar devices, it shall be subjected to the metrology and calibration requirements of section II.4.5 of this document.

II.5.7.3 Final inspection

Final inspection shall always be performed by the contractor QA function

Final inspection shall certify:

- Completion of all operations, inspections and tests,

- Closure of any nonconformance report,

- Correct configuration and marking,

- Complete and correct accompanying QA documentation.

Any open item, if allowed, shall be documented in the accompanying documentation

II.5.7.4 Reinspection and retest

Reinspection and retest shall be conducted when adjustments, modifications, repairs, replacements or reworking are performed after completion of previous inspections and/or tests.

Reinspection and retest may be required at any stage of operations or tests according to a Nonconformance or alert disposition.

II.5.7.5 Non Destructive Inspection (NDI)

NDI methods such as radiography, ultrasonic testing, dye penetrant inspection, magnetic particles and other methods shall comply with the following requirements:

a. Personnel shall be qualified and certified in accordance with section II.1.4 of this document.

b. Materials, equipment, computer systems and software, and procedures involved in the performance of NDI shall be validated and monitored.

c. Quantitative accept/reject criteria shall be established for each NDI application.

d. NDI standards shall be used for calibration of the equipment and establishment of quantitative accept/reject criteria. Existing reference standards may be use when possible, otherwise special standards shall be prepared. NDI standards shall have the maximum representativity of the actual item inspected, and take into account the entire range of potential defects resulting from manufacturing.

II.5.8 Specific requirements for assembly and integration

II.5.8.1 Control of temporary installations and removals

The Contractor shall ensure the control of flight items, which are temporarily removed, or non-flight items, which are temporarily installed.

Records of temporary installations and removals shall be established and maintained.

Temporarily installed items shall be accounted to prevent them from being incorporated in the final flight configuration.

II.5.8.2 Logbooks (Historical Record)

The Contractor shall prepare and maintain logbooks.
Logbooks shall start with the item qualification and/or acceptance testing after assembly.

The logbooks shall contain historical information, which is significant for operation of the item, including nonconformances, deviations and open tasks.

The logbook shall accompany the item whenever it is placed under the custody of another organisation and this organisation shall update it.

II.5.9 Manufacturing, assembly and integration records

Manufacturing, assembly and integration records shall be established and maintained, to provide all manufacturing, assembly, integration and inspection data required for trace ability.

II.6 Testing

II.6.1 General

Qualification and acceptance tests shall be performed under QA surveillance, in controlled facilities, in accordance with an established test plan and formal test procedures and documented in test reports. Readiness for testing and testing accomplishment shall be formally reviewed.

II.6.2 Test Facilities and equipment

The Contractor shall ensure that test facilities, either internal or external, are calibrated and comply with applicable cleanliness and contamination control requirements.

The Contractor shall ensure that all computer aided testing techniques and data are validated prior to use. In particular, provisions shall be made for testing, approval, configuration of control and prevention of tampering with the software involved.

II.6.3 Test documentation

II.6.3.1 Test procedures

Tests shall be performed in accordance with approved procedure.

The contents shall include, as a minimum:

- scope of the test, including the identification of the requirement being verified;
- configuration identification of the test object;
- applicable documents, with their revision status;
- test flow;
- test organisation;
- test conditions;
- test equipment and set-up;
- step-by-step procedure, including definition of specific steps to be witnessed by QA personnel;
- recording of data;
- pass/fail criteria and test data evaluation requirements;
- rules for procedure deviations and sign-off sheet.

Test procedures shall be reviewed and approved by the Contractor PA function and by ESA.

II.6.3.2 Test reports

All tests shall be documented in test reports.

Test reports shall include, as a minimum:

- reference to the applicable test procedure, and description of the deviations from it during the actual testing.
- test data records and evaluation.
- test results summary and evaluation.

II.6.4 Test performance monitoring

The Contractor's QA function shall define the most appropriate way to monitor the performance of test activities, to ensure the adherence to the test procedures, and that any deviation is properly documented and processed.

Witnessing of test activities by Contractor's QA personnel shall be mandatory whenever a single human error during test performance could lead to hazardous conditions for personnel or the test article, or invalidate the test results.

Test witnessing shall be considered when manual intervention is required, at the setting-up, start and end of continuous fully automated test sequences, or when no automatic recording of test parameters/results is available.

Test steps to be subjected to formal QA certification shall be identified as such in the test procedure.

Testing shall be subjected to the requirements for the control of hazardous

operation. Where personnel safety or damage to test articles or associated test equipment is possible, QA personnel shall be given direct authority to stop the test or to have immediate access to whom holds such an authority, in case of need.

II.6.5 Test reviews

Formal reviews shall be held before qualification and acceptance tests. Test review shall be conducted by a formal Test Review Board (TBD).

A Test-Readiness Review (TRR) shall be performed before starting the test to ensure that:

- test facilities are defined and available
- test procedures are ready, and conforming to requirements;
- pass/fail criteria are defined;
- data recording provisions are adequate;
- the configuration of the qualification item is compliant with the specified configuration;
- all non-conformances have been closed;

In case of non-conformances, which cannot be closed, their assessment as not impacting the validity of the test shall be agreed by the Test Review Board.

A Post-Test Review (PTR) shall be performed after the test, to

- verify that all deviations from or modifications to the initial test procedure were properly authorised, and that Nonconformances/failures during the test were recorded and correctly disposed;
- verify the completeness of all required test data and review them for conformance to the relevant requirements;
- attest that test results comply with requirements and the item is acceptable for further tests and/or processing;

Test reviews shall be conducted by a formal Test Review Board (TRB).

The board shall report on each test review activity, showing how the requirements for test reviews are met.

II.7 Acceptance and delivery

II.7.1 General

The Contractor shall establish a formal acceptance process for all configuration items, at any contractual level, to ensure that conformance of the items to be delivered is fully assessed and documented in accordance with Customer requirements.

The Contractor shall also ensure that the preparation of the items for delivery and the physical delivery itself are performed in such a way that quality degradation is prevented.

II.7.2 Acceptance and Data Package (ADP)

The Contractor shall provide an ADP at the delivery of each deliverable item.

The ADP shall constitute the basis for formal acceptance review, and shall provide the set of documents and records for further integration, testing and operation in higher-level assemblies or systems.

ADPs may be integrated into higher level ADPs, or referred to by listing, during subsystem/system integration and testing.

The contents of ADPs shall be in accordance with procedure GPQ-PR-02.

II.7.3 Delivery review

The Contractor shall convene a DRB prior to the delivery of items.

The DRB functions at system level will be fulfilled by the Acceptance Review defined in the contract and chaired by ESA.

The DRB shall be composed, at least, of the following members:

a. Customer's representatives:
   - Project Manager, or authorised representative, as chairman;
   - PA Manager, or authorised representative;
   - Engineering/Design Manager, or authorised representative;

b. Contractor's representatives:
   - Project Manager, or authorised representative;
   - PA Manager, or authorised representative;
   - Engineering/Design Manager, or authorised representative;

ESA reserves the right to attend as an observer DRB's at any lower level. To this end, ESA shall be notified of a DRB's meeting with the notice stated in the contract.

The DRB shall be responsible for authorising the shipment of the items under acceptance, and certifying by writing that:

a. The items conform to the contractual requirements and to the approved design configuration.

b. The items are free from material and workmanship deficiencies.

c. All nonconformances are closed-out.

d. The relevant ADP is complete and accurate.

Delivery shall only be authorised by the unanimous agreement of the DRB members, in particular with reference to any open item (e.g. open NCR, open work).

II.8 Preservation, storage, handling and transportation

Requirements of PSS-01-202 mentioned in applicable document section.

The Contractor shall ensure that the items to be shipped from his plant are inspected for integrity before release and found to be complete, adequately preserved and packaged, correctly marked and accompanied by the required documentation.

Accompanying documentation shall include the ADP and, attached to the outside of the shipping container, the handling and packing/unpacking procedure and any relevant safety procedures.

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Chapter III Safety

III.1 General

The Contractor shall establish and implement a safety programme compliant with the requirements of this chapter. This programme shall be described in a dedicated section of the Product Assurance Plan.

Compliance with the requirements below shall not relieve the Contractor from complying with its own country's national safety regulations and those of the countries where the payload and any related ground support equipment or ground unit is planned to be used.

III.2 Safety assurance programme and organisation

The Contractor PA manager is responsible for ensuring that the Safety Programme is carried out as described in the PA Plan and in accordance with the agreed schedule.

The Contractor shall nominate a person with adequate background and experience as responsible project team member for system safety engineering tasks. Availability and access to the necessary data to adequately perform the safety tasks shall be ensured.

III.3 Safety assurance activities

It is the Contractor's responsibility to evaluate the design and operation of the payload, identify hazards, and control measures, verify their implementation and certify to ESA that the payload is safe and complies with the applicable safety requirements. The Contractor shall ensure that the safety verifications are reflected in the overall payload verification plan.

III.4 Detailed requirements

[Refer to project specific annex (PSA) as made applicable by the SOW].

Chapter IV Reliability and Maintainability

IV.1 General

Reliability is the probability that a system will provide its functions within specified performance limits for a specified period of time in specified conditions.

Maintainability is a characteristic of design and installation, which is expressed as the probability that a system will be retained in or restored to a specific condition within a given period of time.

Reliability and Maintainability assurance is aimed to ensure that design reliability and maintainability will not be compromised by competing requirements such as cost and mass, and to verify and provide evidence of compliance with requirements.

Maintainability requirements for software are not covered by this chapter.

IV.2 Reliability and Maintainability Programme and Organisation

The Contractor shall organize the R&M assurance programme as an integral part of his Product Assurance programme for the project.

The Reliability and Maintainability function shall:

- Apportion system reliability and maintainability requirements to lower level items;
- Participate in the preparation and review of design and test specifications;
- Standardise relevant analyses, tests and demonstration methods, and control their implementation;
- Check for design R&M deficiencies and make recommendations for their solution or reduction/control;
- Track and verify implementation of recommendations and corrective actions;
- Identify items whose reliability is critical for safety and mission success;
- Document deviations to R&M technical requirements and provide rationale for retention. Support their approval by the Customer;
- Perform/support investigations of product problems involving safety, reliability and maintainability;

- Assess formal changes to design.

IV.3 Detailed requirements

[Refer to project specific annex (PSA) as made applicable by the SOW].

Chapter V Electrical, Electronic, Electromechanical (EEE) Parts

V.1 EEE Component Programme Management

V.1.1 General

The Contractor shall establish and implement an EEE component management programme which ensures full compliance with the requirements of this chapter.

V.1.2 EEE component programme policy

In establishing his component programme, the contractor shall include the following policy items:

- maximisation of the use of European components;

- implementation of a component-standardisation programme;

- cost effective approach to obtain good quality parts.

V.1.3 Organisation

The Contractor shall designate an individual or organisation to be responsible for managing the component programme. The designee shall have the authority and adequate and qualified resources to perform the management, component engineering, procurement, quality assurance and administrative functions required. Clear interfaces shall be established between the component group, the project team, subcontractors, manufacturers and any procurement agency that may be used for the execution of the programme.

V.1.4 EEE component control plan

The Contractor shall ensure that the component programme is thoroughly planned, documented and implemented in a timely manner and that back-up plans are initiated whenever there is evidence of possible schedule or technical problems.

The Contractor shall prepare a EEE Component Control Plan, as part of the PA Plan, which describes in detail the proposed approach, methods, procedures and organisation he will adopt to be compliant with the requirements defined in this chapter.

V.2 EEE component engineering

V.2.1 General

The Contractor shall be responsible for the selection of components that are capable of meeting the performance, lifetime, stability, environmental, material, safety, quality and reliability requirements.

V.2.2 Materials

The Contractor shall ensure that exposed materials of components meet the safety requirements established for the project regarding outgassing, flammability, toxicity or other criteria as required for the intended use.

V.2.3 Prohibited components

Components containing materials that may constitute a safety hazard are prohibited from being used without prior approval by ESA for each individual application. Hazardous materials are identified in the applicable PSA.

V.2.4 Components requiring specific authorization

Use of components with the following characteristics shall be prohibited except where specifically agreed on a case-by-case basis:

a Limited life;
b Known instability;
c May cause a safety hazard;
d May create a reliability risk.

Example of such components are:

- Wet slug tantalum capacitors (except for CLR79 construction using double seals and a tantalum case);
- Plastic encapsulated semiconductors except when used on short-duration missions in a pressurized environment);
- Hollow core resistors;
- Wire-link fuses;
- Potentiometers;
- Non-metallurgically bonded diodes;
- Non-solid tantalum capacitors with silver case;
- Dice with no glassivation;
- Unpassivated power transistors;
- Any component whose internal construction uses metallurgic bonding with a melting temperature not compatible with the end-application mounting conditions;

- Components containing: cadmium, lithium, magnesium, mercury,

radioactive material, pure tin (electroplated or fused, bebillium oxide (except if the health and safety hazards are identified in the specifications).

V.2.5 Radiation-sensitive components

For long duration mission payloads, cosmic-ray effects as well as total-dose radiation effects must be considered in accordance with projects requirements in the selection and application of components exposed to a radiation environment. For ISS payloads SSP 30512 shall apply. The acceptable radiation hardness shall be identified by the Contractor and approved by ESA. The contractor shall issue a radiation effect analysis per applicable DRD.

V.2.6 Component approval

All components used in ESA flight-standard hardware require ESA approval. Components shall be submitted for ESA approval via the Declared Components List (DCL) only. If they meet or exceed the quality levels required in V.2.10.2 for the relevant application.

In all other cases a part approval document (PAD) shall be submitted to ESA per relevant DRD.

V.2.7 EEE Component selection

V.2.7.1 Type reduction and standardisation

The Contractor shall establish and implement a programme for the control of the selection of components. This programme shall ensure maximum use of preferred and qualified components and shall restrict the number of component types to a minimum. Such a programme shall be planned and enforced in the design phase, so as to permit effective component standardisation.

V.2.7.2 Derating

Functional/safety critical components shall be derated in the manner outlined in ECSS-Q-60-11. Project-specific stresses, such as temperature, radiation, etc., shall be reviewed as a means of assessing whether additional derating is required.

V.2.7.3 Preferred components

Components for the applications at points a) and b) of V.2.10.2 shall be selected from the following preferred parts lists:

- ECSS-Q-60-01, European preferred parts list and its management
- ESA/MSM-GQ preferred part list.

Components selected from these lists will be approved for use within ESA payloads, provided that the conditions for a particular application are met.

V.2.8 Hybrid circuits

Hermetic hybrid circuits shall be procured in accordance with ESA PSS-01-608 and procedure described in document GPQ-PR-03.

All add-on components shall be selected in the manner defined in Paragraph 2.7 and shall meet the requirements of ESA PSS-01-608. All hybrid circuits, including all add-on components shall be evaluated regarding their suitability for the programme and shall be agreed on a case-by-case basis by ESA.

V.2.9 Off-the shelf components

Components from stocks that have a lot/date code which indicates that more than five years will have elapsed from date of manufacture to date of intended installation in equipment shall meet the following requirements:

- quality requirements specified herein and verified by data review shall be met;
- additional 100% electrical measurement of critical parameters and 100% visual inspection shall be performed;
- DPA shall be performed in cases where degradation of the components in storage may have occurred.

V.2.10 Procurement requirements

V.2.10.1 Procurement specification

Each type of component used by the contractor shall be controlled by a procurement specification, or series of specifications. The following information shall be included as a minimum:

a. Relevant electrical and mechanical parameters;
b. Screening, bur-in, and acceptance requirements;
c. Documentation / Data requirements;
d. Delta limits when applicable;
e. Criteria for percent detective allowable;
f. Lot acceptance test quality conformance inspection (when applicable);
g. Marking;
h. Storage requirements;
i. Requirements for lot homogeneity;
j. Serialization (when applicable);

k. Protective packaging and handling requirements;
l. Radiation verification testing requirements (when applicable).

V.2.10.2 Components quality level

As a minimum, parts to be used in flight hardware shall be screened to the following levels:

a) For safety critical circuits and circuits interfacing ti the spacecraft elements for manned long-duration missions, SCC level B or equivalent:

- Transistors and diodes: MIL-PRF-19500 JAN-S
- Microcircuit: MIL-M-38510 Class S, MIL-I38535 class V,
- Hybrid circuits: MIL-PRF-38534 class K
- Passive parts: ER-MIL failure rate R, S or C (Weibull), D (Weibull).

b) For safety critical circuits and circuits interfacing to the spacecraft mission elements for manned short/medium-duration missions, and for any circuit of manned long-duration mission payloads not covered at point a) above, SCC level C or equivalent:

- Transistors and diodes: MIL-PRF-19500 JAN-TXV
- Microcircuit: MIL-M-38510 Class B, MIL-I38535 class Q,
- Hybrid circuits: MIL-PRF-38534 class H
- Passive parts: ER-MIL failure rate P or failure rate B (Weibull).
- Switches: MIL-STD-1132,
- Indicator lights: MIL-L-6363,
- Relays: MIL-R-39016.

Note: With reference to the MIL QML system, ESA will consider included in the above equivalency also class M parts provided that they will be procured to a DSCC issued source control drawing (SMD-XXXXX). For those EEE parts in the QML for which no SMD drawing exists, ESA approval and a procurement specification are required.

c) For any circuit of manned short/medium-duration mission payloads not covered at point b) above:

- Components from qualified manufacturers: not screened

d) For any circuit of unmanned short-duration mission payloads:

- Commercial components: not screened

All screening tests shall be performed at the component manufacturer's premises or at a source approved for the performance of screening.

V.2.11 Declared component list

The contractor shall submit an issued version of a Declared Components List (DCL), preliminary at PDR and for ESA approval at CDR. This DCL shall contain all component types needed for the current design and shall be kept under configuration control. The DCL format identified in PSS-01-60 shall be used.

V.3 Component quality assurance

V.3.1 Manufacturer selection

For the applications at points a) and B0 of V.a.10.2, the Contractor shall ensure that the components are procured from manufacturers qualified for the type concerned (i.e. in accordance with valid QPL or QML).

For applications at point c) components shall be procured from manufacturers listed in QML or QPL of SCC, MIL or CECC.

V.3.2 Receiving inspection

A receiving inspection shall be performed on all components as specified in section II.5.7.2 of this document to verify compliance with the procurement specifications according to clearly established accept/reject criteria. This inspection shall include as a minimum:

a) Review of the documentation delivered by the manufacturer;

b) External visual inspection;

c) Electrical measurement of critical parameters;

d) Solderability Test (when necessary).

In addition for microcircuits and semiconductors (except non-cavity diodes) to be used in applications at points a) and b) or V.2.10.2, which have been approved for Project use by ESA via a PAD, one DPA per MIL-STD-883d method 5009 shall be performed for each procured lot.

V.4 Component handling and storage

The Contractor shall establish and implement procedures for handling and storage of components in order to prevent possible degradation.

As a minimum, the following areas shall be covered:

a) Control of environment such as temperature, humidity and cleanliness;

b) Appropriate measures and facilities for segregating and protecting components during incoming/acceptance inspection, storage and delivery to manufacturing;

c) Control measures to ensure that components susceptible to electrostatic discharge are identified and handled only by properly trained personnel using antistatic packaging materials and other means, including procedures.

d) Traceability, for components at point a) and b) or V.2.10.2 is required.

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Chapter VI Material Mechanical-Parts, and Processes

VI.1 General

The Contractor shall establish and implement throughout the duration of the project a material, mechanical-part and process programme in compliance with the requirements of this chapter.

The Contractor shall be responsible for the selection of materials, mechanical parts and processes and for demonstrating that they are capable of meeting the operating, environmental, physical, chemical, safety, quality and reliability conditions defined in the applicable specifications.
Particular attention shall be paid to the risks of failure in operation and the natural and induced environmental constraints such as for example:

- mechanical constraints (vibrations, accelerations, shocks),
- chemical constraints (corrosion, contamination, monatomic oxygen...),
- and to the combined action of the environment and stresses (thermoplastic behavior, stress corrosion...).

Materials and mechanical parts selected shall, as far as is practicable, be manufactured in Europe. The selection criteria shall ensure that the number of material and mechanical parts types is restricted to a minimum.

VI.2 Planning

The Contractor shall ensure that the materials, mechanical parts and process programme is thoroughly planned, documented and implemented in a timely manner and that back up plans are initiated whenever there is evidence of possible schedule or technical problems.

It shall be the Contractor's responsibility to ensure that all Subcontractors' material, mechanical-part and process selection and control programmes are consistent with his plan.

The plan for material, mechanical-part and process selection and control shall describe all the activities associated with the selection, testing, inspection, procurement and control of materials, mechanical parts and processes. This material, mechanical part and process plan shall be part of the PA plan.

VI.3 Materials, mechanical parts and processes management

The Contractor shall be responsible for the following tasks :

- Obtaining correct and complete lists from Sub- and Co-contractors.
- Comparing lists and selecting from them any material which has an identical function in different subsystems and, as much as possible, negotiating a reduction of such materials (ideally) to one type only;
- Providing Contractor approval for each list item before submitting lists to ESA, including RFAs;
- Consolidating the various Sub-contractors' lists into a single "Project list" and issuing it (status, evaluation programmes for materials and parts, validation files for processes);
- Submitting the project declared lists to ESA for approval at the time specified by the DRL;

The Contractor shall nominate a person responsible to assist the project team and Sub/Co-contractors in managing and controlling the selection, application, procurement and documentation of materials, mechanical parts and processes.

The lists established by the Contractor and submitted in the standard formats shall include all the information identified in this chapter. Amendments to the approved lists shall be implemented only through established change procedures. ESA reserves the right to request justification of type selection and to obtain documented evidence of test results and or status.

VI.4 Material and mechanical part engineering

Each type of material and mechanical-part used shall be covered by a specification or standard.
The contractor shall make maximum use of approved specifications/standards produced by national or international organisations.

VI.5 Certification

Materials compliance with safety-related requirement (flammability, offgassing etc.) are subjected to formal certification in accordance with the procedure GPQ-PR-04.

VI.6 Detailed requirements

[Refer to project specific annex (PSA) as made applicable by the SOW].

Chapter VII CONFIGURATION AND DOCUMENTATION MANAGEMENT

VII.1 General

Configuration management (CM) applies technical and administrative direction to the development, production and operation life cycle of a product. CM is applicable to hardware, software, services, and related technical documentation. CM is an integral part of life cycle management.

The main objective of CM is to document and provide full visibility of the products present configuration and on the status of achievement of its physical and functional requirements. Another objective is that everyone working on the project at any time in it's life cycle uses correct and accurate documentation.

The CM process comprises the following integrated activities :

- configuration identification,
- configuration control,
- configuration status accounting,
- configuration verification.

Documentation management (DM) provides the processes, necessary disciplines and procedures to identify and control all project documentation, deliverable to the Customer, to ensure timely development, compliance with required format and content, proper distribution, approval, storage and protection from unauthorised change. Documents are independent of the medium on which the information is recorded.

VII.2 Configuration and Documentation Management Programme

The Contractor shall establish and implement an effective programme for configuration and documentation management. The programme shall have clear interfaces with project management, product assurance (with emphasis on software product assurance), design, development, production, integration and test functions. The programme shall include requirements and procedures for hardware and software items. The Configuration and Documentation Management Programme shall be described either in the Product Assurance Plan or in a separate sub plan.

VII.3 Organisation

A person shall be appointed as responsible for the contractor's Configuration and Documentation Management Programme for the project. In this function, he shall act as the single-point contact for all matters relating to CM and DM. He shall have defined responsibilities and sufficient independence and authority to achieve the required objectives. He shall in particular coordinate the following

activities:

- preparation, implementation and maintenance of the project CM and DM plan;
- establishment and identification of Configuration Items;
- establishment of requirements for preparation and maintenance of specifications and drawings;
- establishment and operation of the approval and release system for engineering documents;
- establishment and operation of the Configuration Control Board;
- establishment and distribution of configuration status report;
- provision of adequate and accurate documentation support for reviews;
- processing of changes and waivers, and the release of implementation documents;
- preparation of engineering change proposals;
- maintenance of records of contractual change authorization;
- establishment and operations of a system for the correlation of the "as-built" and "as-designed" configuration;
- maintenance of effectively control (model, types and serial numbers);
- establishment of an interface control system;
- establishment of a general project documentation system;
- establishment and control of document, drawing and software libraries.

For small projects the CM and DM responsibilities above may be delegated by the Project Manager to certain individuals in the project.

VII.4 Configuration Identification

The configuration identification includes the following :

VII.4.1 Product structure and selection of configuration items

The product structure describes relationship and position of configuration items in the breakdown of the product. The product structure is identified through a top-down decomposition process that divides the total product into logically related and subordinated aggregates of hardware, software, services, or a combination thereof, called configuration items, which are selected for CM. Selection of the higher level CIs should start in phase A. Selection of lower level CIs, should be completed early in phase C/D.

The main criteria for selection of configuration items are:

- performance of an end-use function,
- criticality in terms of high risks, safety, mission success or others,
- new or modified technology, design or development,
- interfaces with other items,

- procurement conditions,
- maintenance aspects.

VII.4.2 Documentation of configuration items

All physical and functional characteristics necessary to define a CI throughout its life cycle, including interfaces and changes, shall be described in specific engineering documents (specifications, design documents, drawings, lists, software data and manuals for operation and maintenance). These documents are generally called configuration documents.

VII.4.3 Numbering

Numbering conventions shall be established and applied to the identification of configuration items, configuration documents, changes as well as to parts and assemblies.

The numbering conventions shall take into account the existing Contractor numbering procedures. However, identification numbers must be unique.

The numbering conventions or other information management should permit the management of:

- hierarchical or subordinate relations between configuration items within the product structure,
- hierarchical or subordinate relations of parts and assemblies in each configuration item,
- relations between items and documents,
- relations between documents and changes,
- constitution of typical files,
- other grouping requirements.

VII.4.4 Configuration baselines

Configuration baselines shall be established whenever it is necessary to define a reference configuration during the product life cycle, which serves as a starting point for further activities.

Configuration baselines are established by formal approval, at specific points in time, of a specific set or sub-set of configuration documents.

Configuration baselines plus approved changes to those baselines constitute the current approved CI configuration.

VII.4.5 Configuration identification for software

In addition to the requirements in this section, software configuration identification performed by the contractor shall:

- Identify the documentation and the computer software media containing code, documentation, or both to be placed under configuration control.

- Identify each Computer Software Configuration Item (CSCI) and its components and units.

- Identify the version, release, change status, and any other identification details of each deliverable item.

- Identify the version of each CSCI, component and unit to which the corresponding software documentation applies.

- Identify the specific version of software contained on a deliverable medium, including any change incorporated since a previous release.

VII.5 Configuration control

Configuration control is applied at the CI level; thus all engineering documents and changes will be addressed to the relevant CI.

All contractual levels having design approval or design responsibility for a CI shall also have formal methods to control the CI configuration.

VII.5.1 Configuration control board

The Contractor shall establish a Configuration Control Board (CCB) with the authority to review and approve/disapprove the selection of configuration items, configuration baselines and changes (requests and proposals) to those baselines including deviations and waivers.

The members of the CCB shall be formally appointed by the project manager. All required disciplines should be represented on the CCB, in particular PA shall always be represented. The CCB should be chaired by the Project Manager or a delegate.

The function of the CCB is to verify that:

- it has the correct authority in relation to the relevant configuration baseline,
- the change is necessary,
- the consequences are acceptable,
- the change has been properly documented and classified,
- the plan for the implementation of the change into documents, hardware and/or software is satisfactory.

In addition the CCB is also the logical entity to review technical and non-technical contract and contract documentation changes, which may not affect the configuration.

VII.5.2 Change management

After the release and approval of configuration documents all changes, including deviations and waivers, shall be controlled. The change impact, customer requirements and the configuration baseline affected will decide the degree of formality in processing the change and shall be the base for the classification system used for classifying/categorizing the change.

Change management involves the following activities which should be documented in detail in a change control procedure:

- document and justify change,
- evaluate change consequences,
- approve or disapprove change,
- implement and verify change,
- process deviations and waivers.

VII.5.2.1 Identify and document the need for change

A change may be requested internally or by the customer. A change may be proposed by the contractor and by his subcontractors and suppliers. All change proposals shall be documented and include the following information prior to their submission to the CCB:

- configuration item(s) and related documents to be changed, name(s) and revision status,
- name of the individual preparing the proposal, the organisation and date prepared,
- reason for change,
- class of the change
- description of change,
- urgency.

VII.5.2.2 Change evaluation

The following evaluations concerning the proposed change shall be performed and documented:

- the technical merits of the proposed change,
- impact on interchangeability, interfaces, etc. and the necessity for re-identification,
- impact on contract, schedule and cost,
- impact on manufacturing, test and inspection methods,
- impact on purchases and stocks,

- impact on maintenance, user handbooks, spare parts and spare part manuals.

VII.5.2.3 Change approval

After the change has been evaluated by the CCB, the relevant authority (the Project Manager or the Customer) shall review the documented evaluations and approve/disapprove the change, or propose approval/disapproval of the change.

The decision concerning approval/disapproval shall be documented and notified to the relevant parties.

VII.5.2.4 Change implementation and verification

The implementation and verification of an approved change shall include the following steps:

- Appropriate consequential actions by the affected departments shall be initiated (e.g. issuing of drawings change notice),

- Compliance shall be verified by the PA function.

VII.5.3 Document, drawing and software libraries

In order to protect the integrity of the configuration and provide the basis for control of change, the contractor shall establish a system of libraries or repositories for all documents, drawings and software that form or pertain to internal or formal configuration baselines. Separate and distinct libraries shall be established in accordance to the different level of control required (e.g., development, master and static).

The libraries shall be secured against loss or corruption by library wide backup and recovery mechanisms and shall be protected from unauthorised change or corruption.

Actions taken with respect to the libraries and their contents shall be documented and governed by procedures.

VII.5.4 Configuration control for software

In addition to the requirements in this section, software configuration changes performed by the contractor shall:

- Establish a developmental configuration for each CSCI to maintain internal configuration management during software development in accordance with ESA PSS-05-0;

- Maintain current copies of the deliverable documentation and code;

- Control the preparation and dissemination of changes to the master copies of deliverable software and documents.

VII.6 Configuration Status Accounting

Configuration status accounting (CSA) should commence as and when configuration data is first generated.

CSA shall provide information of all configuration identifications and all departures from the specified configuration baselines. It thus enables trace ability of changes to configuration baselines.

CSA records and reports shall be a by-product of the identification and control activities. Redundant CSA records should be avoided.

VII.6.1 CSA records

CSA records selected data during the configuration identification and control processes. This allows visibility and trace ability for the efficient management of the evolving configuration.

The following types of data are normally recorded for each configuration item and related configuration documents:

- identification (part number, document number, issue/revision, serial number),
- title,
- date,
- release status,
- implementation status (design/build standard).

VII.6.2 CSA reports

The following reports shall be issued at intervals necessary for management purposes:

- list of configuration items,
- list of configuration baseline documents,
- current configuration status (such as "as designed", "as built"),
- status reports on changes, deviations and waivers,
- status reports on change implementation and verification.

VII.6.3 Configuration status accounting for software

In addition to the requirements in this section, software configuration status accounting performed by the contractor shall:

- Provide trace ability of changes to controlled software products.

- Serve as a basis for communicating the status of configuration documentation and associated software.

- Serve as a vehicle for ensuring that delivered documents describe and represent the associated software.

VII.7 Configuration verification

Reviews and configuration audits shall be performed before the acceptance of a configuration baseline to assure that the product complies with its contracted or specified requirements and to assure that the product is accurately reflected by its configuration documents. The configuration verification activities include:

- The formal examination to check that a configuration item has achieved the performance and functional characteristics specified in its configuration documents.

- The formal examination of the 'as built' configuration of a configuration item to check that it conforms to its product configuration documents.

Configuration verification is an integral part of the total verification process described in Section II.2.6.2 of this document.

VII.8 Interface control

The contractor shall perform (or support) the coordination activities necessary to ensure that the functional and physical characteristics of interfacing systems and CIs are compatible.

Changes (including deviations and waivers) to interface requirements under the control of the organisation responsible for the mission shall be documented and processed in compliance with their requirements.

VII.9 Documentation management

Documentation management procedures shall be established for the management of all project documents. This shall encompass the issue of identification numbers, recording, maintenance, care, storage, retrieval and distribution of all documentation and changes released for the project.

The documentation management system shall ensure that:

- All documents required in the statement of work are produced and delivered,

- Documents are numbered and codified,
- Dissemination of periodical information on issued documents status,
- Documents are released and approved in accordance to their class,
- Proper storage and retrieval is implemented.

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Chapter VIII Software Product Assurance (SPA)

VIII.1 Software Product Assurance Management

VIII.1.1 Organisation and tasks

This chapter defines the Software Product Assurance (SPA) requirements to be implemented during the development and operation of software.

SPA activities and milestones are an integral part of software development. They shall be identified in the software management plan (SPMP) and controlled according to the identified life cycle. The software shall be documented in accordance with applicable DRDs identified in the SOW.

The Product Assurance Manager shall assure that the responsible groups are provided with the resources needed to perform the following tasks:

a. Established and maintain the Software Product Assurance Plan (SPAP), as part of the PA plan, in accordance with the applicable DRD.
b. Participate in the assessment and review of project standards, methodologies and tools for software development, project management, verification.
c. Establish and maintain the standards and methodologies for Software Product Assurance and Configuration Management.
d. As part of the software development life cycle, assess and evaluate the characteristics of the software against system requirements (e.g. safety, reliability, and maintainability).
e. Assure that approved standards, methods and tools are applied throughout the software life cycle,
f. Implement a system for the identification and correction of nonconformances.
g. Assure traceability throughout all phases of the software life cycle
h. Assure that the verification and validation activities are adequately planned.
i. Establish and maintain a system for the collection and use of software metrics.

The Software Product Assurance Plan shall specify or reference the following items:

- Quality objectives, expressed in measurable terms whenever possible;
- The software development life cycle, the related milestones and the input and output criteria for each development phase;
- Types of verification and validation activities (including tests) to be carried out;
- Detailed planning of verification and validation activities (including tests) to be carried out, including schedules, resources and approval authorities;
- Specific responsibilities for quality activities such as review and tests,

configuration management and change control, nonconformance control and corrective action;
- Methods, tools and rules to be applied;
- The procedures for determining the criticality category of software processes, function, objects (according to the design methodology adopted), packages, units, files;
- Specific actions and measures for Subcontractors control.

VIII.1.2 Nonconformance control and change control

The nonconformance control requirements, established in paragraph II.4.6 are applicable for reporting, analysing, and correcting software nonconformances.
Nonconformances and configuration control shall start for code at the latest at the time of qualification of a software unit or module in a computer software configuration item (CSCI).
For documentation, configuration control shall start after the first review and approval of the document.
Changes to the documentation shall be handled in accordance with the configuration control requirements in Chapter VII.

VIII.1.3 Software classification

Generally in payload projects it is not allowed to use software to perform safety-critical functions
Software shall be classified according to its functional criticality. The classification system should also take into consideration other factors such as complexity, size language and type of application (e.g., non-deliverable software used for verification of mission software).
ESA shall approve the classification system.
The Contractor shall issue and maintain updated list of software and the resulting classification of each unit/component item.
The SPA function shall assure that the classification is performed using the correct methods.
The SPA function shall modulate its intervention during development and the requirements for testing in accordance to the software classes.
The supplier shall analyse the collected development data to provide evidence that the development of the software is conforming to the requirements.

VIII.1.4 Purchased and refused software

The choice of purchased software shall be described and submitted for ESA acceptance in the form of a software component list.
The list shall include specifications of at least: ordering criteria, receiving inspection criteria, arrangements for maintenance and upgrades to new releases, back-up solutions if the product becomes unavailable, contractual arrangements for the development and maintenance phases.

When selecting the components the following shall be considered:

- The product quality requirements and objectives are in accordance with the contractual requirements.
- The available support documentation, the acceptance and warranty conditions comply with the contractual requirements.
- The conditions of installation, preparation, training and use.
- The maintenance conditions, including possibility of evolutions.
- Copyright constraints.

VIII.1.5 Standard, method and production tools

Proven methods and operational tools should be used for all phases of the development cycle, including the requirements analysis, software specification, coding, and validation and testing.
The choice of development methods and tools shall be justified by demonstrating that:

- The development team has appropriate experience and/or training to supply them.
- The tools and methods are appropriate for the functional and operational characteristics of the product.
- The tools will be available (in an appropriate hardware environment) throughout the development and maintenance lifetime of the product.

If tools are used for automatic code generation the following aspects shall be considered:

- Evolution of the tools in relation to the tools that use the generated code a san input (e.g. Compiler, code management system, etc.).
- Customisation of the tools to comply with project standards.
- Portability requirements for the generated code.
- Collection of the required design and code metrics.
- Verification of software components containing generated code.
- Configuration control of the tools including the parameters for customisation.

Chapter IX Commercial, Aviation and Military (CAM) Equipment

IX.1 General

A Commercial, Aviation and Military equipment is an item which performs an end-use function, which has been developed and manufactured to sound industrial practices and which has been qualified for its originally intended use. Any software used and supplied with the CAM equipment may continue to be used and may be considered CAM software. However if modified software is to be used, the program shall be developed according to the requirements in chapter VIII of this document.

Off-the-shelf assembled PCB's such as, for example, motor controllers or CPU's, and items such as video cameras are to be considered CAM equipment.

IX.2 Detailed requirements

[Refer to project specific annex (PSA) as made applicable by the SOW].

Annex 1 Generic classification of payloads

Type of mission	**Duration**	**Reliability & Maintainability**	**Safety**	**Example**
Manned	Long (years)	Design approach should allow recovery from failures through inflight maintenance or return to ground Consequence of mission failure: - serious disruption of planned activities	Requirements are those of the Agency responsible for: - on-orbit operation - transportation - ground operations	ISS facility level payload
	Medium (months)	Ground maintenance Consequence of mission failure: - serious/moderate impact on planned activities	Requirements are those of the Agency responsible for: - on-orbit operation - transportation - ground operations	ISS sub-pack level payload
	Short (days/weeks)	Ground maintenance Consequence of mission failure: - moderate impact on planned activities	Requirements are those of the Agency responsible for: - flight operation - ground operations	Shuttle payload
Manned special	Short (days/weeks)	Relatively low cost payloads Consequence of mission failure: - acceptable	Requirements take into account the special safety features available to the user	Space Shuttle Get Away Special (GAS)
Un-manned	Short (days/weeks)	Consequence of mission failure: - moderate impact on planned activities	Reduced requirements. As a minimum those of the launch range	Payload on recoverable satellite (i.e. Foton, Bion)
	Very short (sec./min.)	Consequence of mission failure: - acceptable	Launch range requirements	Payload on sounding rocket

Annex 2 Glossary and Acronyms

Glossary

ACCEPTANCE - The formal assent to ownership by the customer or an authorised agent, of a supply (document, product, service) and recognition that it conforms to contractual requirement.

ACCESSIBILITY - The feature of design and installation, which permits quick and easy admission (for performance of visual and manipulative maintenance) to the area in which a failure has been traced.

ANOMALY – An unexpected event, hardware damage, a departure from past experience, established procedures or performance, or a deviation of system, subsystem, and/or hardware performance outside certified design/performance specification limits.

ASSEMBLY - a combination of two or more related subassemblies or parts designed to perform a specific function and capable of disassembly.

AUDIT - A systematic and independent examination to determine whether quality activities and related results comply with planned arrangement and whether these arrangements are implemented effectively and are suitable to achieve objectives.

CALIBRATION - Comparison of two instruments or measuring devices, one of which is a standard of known accuracy traceable to national or international standards, to detect correlate, report or eliminate by adjustment any discrepancy in accuracy of the instrument or measuring device being compared with the standard.

CERTIFICATE OF CONFORMANCE - A Contractor's written statement certifying that supplies or services comply with contract requirements.

CERTIFICATION - The act of an authorised person or group of persons, in documenting compliance with requirements and/or standards of a service, product, process, facility, or person's skills.

CHANGE - An alteration in the configuration of an item delivered, to be delivered, or under development after formal establishment of its configuration identification.

CHANGE REQUEST - The formal document requesting that the organisation with design responsibility for an item investigate an identified problem or a recommended improvement and submit a change proposal.

CHANGE PROPOSAL - the formal document, submitted to a higher-level organization to initiate the change approval process.

CLEANLINESS - Purity of environment in terms of the freedom from particulate and other unwanted contaminating or potentially contaminating effects.

CLEANLINESS LEVEL - A quantitative measure of the degree of removal of particulate and other undesirable contaminant effects from a controlled environment.

COMMERCIAL OFF THE SHELF (SOFTWARE) - A software possessing all the following features: (1) belongs to a supplier's catalogue, (2) marketed as "off-the shelves" software product, (3) usable "as it is", (4) references are available concerning its use outside the context of ESA's projects, (5) corresponds, for its functionality, to an issued requirement document.

COMPONENT - A device that performs an electronic, electrical or electromechanical function and consists of one or more elements so joined together that they couldn't normally be disassembled without destruction. The term component may be interchanged with the word part.

COMPUTER SOFTWARE COMPONENT - A functionally or logically distinct part of a computer software configuration item.

COMPUTER SOFTWARE CONFIGURATION ITEM - A software configuration item.

COMPUTER PROGRAM - A series of instructions or statements in machine-readable form designed to cause the execution of an operation or a series of operations.

CONFIGURATION CONTROL - The activities of evaluation, coordination, approval or disapproval, and implementation of changes to configuration items, including engineering changes as well as deviations and waivers with impact on the configuration, after formal establishment of its configuration documents.

CONFIGURATION - The functional and physical characteristics of a product as set forth in technical documentation and achieved in the product.

CONFIGURATION AUDIT - An examination to determine that a configuration item conforms to its configuration documents.

CONFIGURATION DOCUMENTS - The documents necessary to define requirements, design, build/production, and verification for a configuration item.

CONFIGURATION IDENTIFICATION - The activities of determination of the product structure, selection of configuration items, documenting the configuration item's physical and functional characteristics including interfaces and subsequent changes and allocating identification characters or numbers to configuration items and their documents.

CONFIGURATION ITEM - An aggregation of hardware, software, services, or any of its discrete portions, that is designed for configuration management and treated as single entity in the configuration management process.

CONFIGURATION MANAGEMENT - the technical and organisational activities of (1)

Configuration identification, (2) Configuration Control, (3) Configuration Status Accounting, (4) Configuration Verification.

CONFIGURATION STATUS ACCOUNTING - The formalized recording and reporting of the established configuration documents, the status of proposed changes and the status of the implementation of approved changes.

CONFIGURATION CONTROL BOARD - A group of technical and administrative experts with the assigned authority and responsibility to make decisions on the configuration and its management.

CONTRACTOR - Any person, partnership, company o corporation (or any combination of these) that is party to a contract signed by the Agency. The supplier of the deliverables, identified for delivery under the terms of a specific contract related to the realisation of a project.

CORRECTIVE MAINTENANCE - That maintenance, other that scheduled maintenance, performed to restore an item to a satisfactory condition by providing correction of a malfunction, which has caused degradation of the item below the specified performance.

CORRECTIVE ACTION - Action taken to eliminate the causes of a potential nonconformity, defect, or other undesirable situation in order to prevent occurrence.

CRITICAL ITEM - A critical item is one which in case of failure can adversely affect the safety of the payload or compromise certain payload functions for which a high reliability is required.

CRITICAL PROCESS - A critical process is one:

- which in case of failure can adversely affect the performance or destroy a major part or function of the system;
- the quality of which cannot be assessed solely by examining the end product;
- which has caused problems previously;
- with which the contractor has had no previous applications experience.

CRITICAL SOFTWARE - A defined set of software components which have been evaluated and whose continuous correct operation has been determined to be essential for safe and reliable operation of the system.

CUSTOMER - The recipient of a product provided by a Contractor, Subcontractor or supplier.

DECLARED MATERIAL LIST - Consolidated list of all project materials.

DECLARED MECHANICAL-PART LIST - Consolidated list of all project mechanical-parts.

DECLARED-PROCESS LIST (DPL) - Consolidated list of all project processes.

DELIVERABLE (SOFTWARE) - A software product developed according to a software requirement document, and supplied or intended to be supplied, by a contractor to a customer.

DERATING - The deliberate limiting of stresses on an item to levels less severe than those specified by the manufacturer of the item, for the purpose of gaining an advantage at another point, e.g. improvement of reliability.

DESTRUCTIVE PHYSICAL ANALYSIS - A series of inspections, tests and analyses performed on a sample of components to verify that the material, design and workmanship used for its construction, as well as the construction itself, meet the requirements of the relevant specification and are suitable for the intended application. The item subjected to such an analysis wills permanently loss its ability to perform as required in functional equipment.

DEVELOPMENTAL CONFIGURATION - The contractor's software and associated technical documentation that defines the evolving configuration of a CSCI during development. It is under the development contractor configuration control and describes the software configuration of the design, coding and testing effort. (See also Internal Baseline.)

DOCUMENT REQUIREMENTS DESCRIPTION - A standard document which specifies the exact format and content requirements for a given document item or which provides reference to or source document and its utilization.

DOCUMENT ITEM - Any specific document, drawing, list, manual, specification, etc. prepared by the contractor for delivery in accordance with the DRL and an associated DRD.

DOCUMENTATION - The media for communicating ideas, descriptions, requirements, plans and instructions related to project hardware or software.

DOCUMENTATION MANAGEMENT - The discipline that identifies, approves or accepts, releases and controls changes to document items and manages the external and internal distribution and / or receipt of these document items.

EMBEDDED SOFTWARE - Software, which is directly interfacing with the hardware.

END ITEM - An item, either an individual part or an assembly, in its final or completed state. Term often used to mean configuration item.

ENVIRONMENT - The aggregate of all external and internal conditions (such as temperature, humidity, radiations, magnetic and electric fields, shock, vibration etc.) either natural or man made, or self-induced, that influences the form, performance, reliability or survival of an item.

EQUIPMENT - An item designed and built to perform a specific function as a self-contained unit or to perform a function in conjunction with other units.

FACILITY - A category of payloads designed and build to support the performance of experiments in a specific scientific field.

FAILURE MODE - A particular way in which failure occurs, independent of the reason for failure; the condition or state which is the end result of a particular failure mechanism.

FAILURE - The termination of the ability to perform a function as specified.

FAILURE MECHANISM - The physical, chemical, electrical, thermal or other process which results in failure.

FAILURE EFFECT - The consequence (s) a failure mode has on the operation, function, or status of an item. Failure efforts are classified as local effect, next higher level, and end effect.

FAILURE TOLERANCE - The capability of a system or function to tolerate a defined number of failures or undesired events. [Failure tolerance is normally implemented by way of redundancy, inhibits, back-up devices, failure effect containment, fail passive, safety devices, manual back-up features, etc.]

FAULT ISOLATION - Where a fault is known to exist, a process, which identifies or is designed to identify the location of that fault replaceable unit.

FAULT DETECTION - A process, which discovers or is designed to discover the existence of faults; the act of discovering existence of a fault. One or more tests performed to determine if any malfunctions or faults are present in a unit.

FAULT - A condition that causes a functional unit to fail to perform its required function.

FIRMWARE - The combination of a hardware device and computer instructions or computer data that resides as read-only software on the hardware device.

FUNCTION - The action by which a system, or any entity thereof, fulfils a defined purpose.

FUNCTIONAL CRITICALITY - A classification of the dependence placed on a function in a system with respect to the effect on life, property or mission success of the loss of that function. [The manner in which the function is implemented (e.g. redundant, backup, etc.) shall not be considered.]

HARDWARE/SOFTWARE INTERFACE - The specified boundary between hardware and the software that controls its operation.

INCOMING INSPECTION - The process of inspection applied to items brought in from outside the contractor's organisation. This inspection applies to goods at delivery (receiving inspection) and is also extended where appropriate to monitoring at the supplier's facility.

INSPECTION - (1) For all systems, the process of measuring, examining, testing, gauging or otherwise comparing a unit with the applicable requirements, (2) For softwares, a formal evaluation technique in which software requirements, design or code are examined in detail by a person or group other than the author to detect faults, violations of development standards, and other problems.

INSPECTION, IN-PROCESS - Inspection which is performed during the manufacturing, integration or repair cycle in an effort to prevent defectives from occurring and to inspect the characteristics and attributes which are not capable of being inspected at final inspection.

INSTALLATION SOFTWARE - (1) A single hardware machine capable of running one or more instances of a software product. (2) The process of integrating the system into its operational environment and verifying that it performs as required.

INTEGRATION - A combination of activities and processes to assemble system, subsystem and component elements into a prescribed configuration and to verify compatibility between the constituents of the assembly. Includes checkout performed in conjunction with assembly.

INTERFACE CONTROL DOCUMENT OR DRAWING - A formal, controlled document or drawing which defines the physical and functional interfaces between two configuration items.

INTERFACE - Physical or functional interaction at the boundary between configuration items.

INTERNAL BASELINE - A contractor internally approved configuration document, or set of documents, identification during the development phase. Formal Agency control does not apply. (See also Developmental Configuration.)

ITEM - Any level of hardware or software below a system, e.g., subsystem, equipment, component, assembly, subassembly or part.

LOG BOOK - A dedicated record book which is kept at or in the vicinity of a given item at all times and which contains records of all activities, operations, handling, testing, nonconformances, parts identification etc., relevant to the item.

LOT SAMPLING - The process of drawing a proportion from a collection of units of product bearing identification and treated as a unique entity (lot).

LOT ACCEPTANCE TESTS - A series of tests performed on a sample selected from the procurement lot to ensure that the lot concerned meets the defined quality

requirements.

MAINTAINABILITY ENGINEERING - The engineering discipline, which formulates an acceptable combination of design features, repair policies, and maintenance resources to achieve a specified level of maintainability, as an operational requirement, at optimum life cycle costs.

MAINTAINABILITY DATA - Data (other that administrative data) resulting from the performance of maintainability tasks in direction support of an equipment or system acquisition programme.

MAINTAINABILITY - The characteristic of design and installation, which is expressed as the probability that a system will be retained in or restored to a specific condition within a given period of time.

MAINTAINABILITY ANALYSIS - The formal procedure for evaluating system and equipment design, using prediction techniques, failure mode and effects procedures, and design data to evolve a comprehensive quantitative description of maintainability design status, problem areas, and corrective action requirements.

MAINTAINABILITY ASSURANCE - Implementation of required maintainability controls during design and fabrication of an equipment to assure that maintainability requirements are achieved.

MAINTENANCE - The act of diagnosing and physically repairing, or preventing, equipment failures.

MAINTENANCE CONCEPT - A description of the planned general scheme for maintenance and support of an item in the operational environment. The maintenance concept provides the practical basis for design, layout and packaging of the system and its test equipment and establishes the scope of maintenance responsibility for each level of maintenance and the personnel resources (maintenance manning and skill levels) required to maintain the system.

MANDATORY INSPECTION POINT - A point defined in an appropriate document, beyond which an activity must not proceed without the approval of a designated organisation or authority.

MATERIAL REVIEW BOARD - A formal board established by the contractor for the purpose of reviewing and approving corrective and remedial actions for nonconformances.

MECHANICAL-PART - A non-electrical, non-electronic and non-electromechanical off-the-shelf piece of hardware 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 performance requirements and cannot be broken down without losing this function.

MODIFICATION - A change to an item after acceptance/delivery.

NON-ASSESSED PROCESS - A process that has no history of previous use in the space environment, and for which no or insufficient data are available relevant to the required project application, is deemed non-assessed.

NON-DELIVERABLE (SOFTWARE) - A Software developed or used by a contractor (for its own purposes) and which is not intended for delivery to the customer.

NONCONFORMANCE - An observed condition of an item or material or software in which one or more characteristics do not conform to drawings or specifications. It includes failures, problems, malfunctions, discrepancies, deficiencies, defects are all Nonconformances.

NON-DESTRUCTIVE INSPECTION - Inspection techniques that do not cause physical or chemical changes to the item being inspected, or otherwise impair its adequacy for operational service.

PART - An item, manufactured as a single entity or assembled inseparably. Piece parts include resistors, capacitors, transistors, relays, screws, nuts, gears, brackets, rivets, castings, forgings, etc. Also used as a generic term for end use items.

PAYLOAD - That element of a space system which exists solely or mainly to generate the mission products and is supported by other elements of the system.

PREFERRED PARTS LIST - List of component types/manufacturers preferred by an organisation for the purpose of design standardisation.

PREVENTIVE MAINTENANCE - That maintenance performed to maintain a system or equipment in satisfactorily operational condition by providing scheduled inspection, detection and correction of incipient malfunctions before they occur or develop into major malfunctions.

ORBITAL REPLACEABLE UNIT - The lowest level of item or subsystem hardware that can be removed and replaced on location under orbital conditions.

PROBLEM – A nonconformance which is, or is suspected of being, a failure, an unsatisfactory condition, an unexplained anomaly, or an overstress occurring during or subsequent to production acceptance testing on qualification testing (i.e. after manufacturing or development).

PROCESS CONTROL - Those activities directed to ensure that a process is carried out in conformance with an approved specification.

PRODUCT ASSURANCE - A planned and systematic performance of activities necessary to provide adequate confidence that an item will meet customer's requirements.

PRODUCT - A system segment, equipment, subsystem, component, assembly, part,

computer software or deliverable documentation.

REAL TIME (SOFTWARE) - Pertaining to the process of data by a computer in connection with another process outside the computer according to time requirements imposed by the outside process. This term is also used to describe systems operating in conversational mode, and processes that can be influenced by human intervention, while they are in progress.

REDUNDANCY - The existence of more than one means of accomplishing a function.

REFURBISHMENT - Modification and/or maintenance of activities on a system or item.

RELEASE - The actions required to make a document or computer program media available for use by other than the preparing activity; includes approval, recording, reproduction and distribution.

RELIABILITY - is the probability that a system will provide its functions within specified performance limits for a specified period of time in specified conditions.

REMEDIAL ACTIONS - Action to correct a nonconforming item or material.

REPAIR - The action taken on a nonconforming product so that it will fulfill the intended usage requirements although it may not conform to the originally specified requirements.

REPAIRABLE ITEM - An item, which can be restored to perform all of its required functions by corrective maintenance.

REQUEST FOR APPROVAL - Format for collecting component data as basis for approval.

REUSABLE (SOFTWARE) - software developed within the framework of a space project and which is reusable by another project.

REWORK - The action taken on a nonconforming product so that it will fulfill specified requirements.

SCHEDULED MAINTENANCE - Preventive maintenance performed at prescribed points in the item's life.

SCREENING - A process for inspecting items to remove those that are unsatisfactory or those likely to exhibit early failure. Inspection includes visual examination, physical dimension measurement and functional performance measurement under specified environmental conditions.

SERIAL NUMBER - An identifier used with a part number to denote each unit or article in a family of like items.

SERVICING - The performance of any act needed to keep an item in operating

condition, (i.e. lubricating, cleaning, etc.), but not including preventive maintenance of parts or corrective maintenance tasks.

SINGLE POINT FAILURE - The failure of an item, which would result in a failure of the system and is not compensated for the redundancy or alternative operational procedure.

SOFTWARE - Computer programmes, procedures, rules and associated documentation and data pertaining to the operation of a computer system.

SPACE-PROVEN MATERIAL AND MECHANICAL-PART - A space-proven material or mechanical-part is one whose properties are well understood and which is produced by means of a stable process, usually confirmed by a history of continuous or frequent production runs. The material or mechanical-part must be compliant with a recognized set of specifications. It will have been used in space applications or will have successfully completed an appropriate evaluation programme.

SPECIAL PROCESS – A special process is one the quality of which cannot be assessed solely by non-destructive examination of the end product (e.g., heat treatment, bonding, welding).

SPECIFICATION - A document intended primarily for procurement, which completely and accurately describes the essential technical requirements for a configuration item, including the procedures by which it will be determined that the requirements have been met.

STANDARD/ESTABLISHED PROCESS - A standard/established process is one that is well documented, has a previous history of use, is well understood and for which standard inspection procedures exist. Such a process would generally be covered by ESA specifications or other international or national documents.

SUBCONTRACTOR - A person, partnership or company under contract to a contractor of the Agency to provide supplies or services in support of a contract placed by the Agency.

SUBSYSTEM - A combination of assemblies, units, sets, groups, etc., which performs an operational function within a system and is a major subdivision of the system.

SUPPLIER - A person, partnership or company entering into a contract to deliver finished parts or assemblies to their own specifications and drawings.

SYSTEM - A composite of equipment, skills, and techniques capable of performing or supporting an operational role, or both. A complete system includes all equipment, related facilities, material, software, services and personnel required for its operation and support to the degree that it could be considered a self-sufficient unit in its intended operational environment.

TESTABILITY - A design characteristic, which allows the status (operable, inoperable, or degraded) of a system or any of its subsystems to be confidently determined in a

timely fashion. Testability attempts to quantify those attributes of system designs, which facilitate detection, and isolation of faults that affect system performance.

TRACEABILITY - The ability to trace the history, application or location of an entity by means of recorded identifications.

TRAINING - The formal education, which individuals undergo to reach a given standard of proficiency in the tasks for which they are being subjected to such education. Training usually includes a test to check the degree of proficiency so reached.

UNIT (Software) - The smallest logical entity specified in the detail design which completely describes a single function in sufficient detail to allow implementing code to be produced and tested independently of other units. Commonly referred to as a Computer Software Unit (CSU).

UNIT (Hardware) One complete configuration item or an assembly or any combination of parts, subassemblies and assemblies mounted together, normally capable of independent operation.

UNSCHEDULED MAINTENANCE - See corrective maintenance.

VALIDATION TESTING - Testing performed to confirm specified functional capabilities within the specified operating limits.

VALIDATION OF A PROCESS - A set of data collected (and/or experiments performed) to demonstrate that a process performs as intended (technical requirements) and that sufficient confidence can be placed on the outcome.

VERIFICATION - The process of performing tests, inspections, reviews, analyses, comparisons, and collecting evidence to prove that requirements are fulfilled.

VERSION - Initial release or re-release of a CSCI. It involves a complete compilation or re-compilation of the CSCI.

WAIVER - A written authorization to use or release a product, which does not conform to the specified requirements.

WORKMANSHIP - Proficiency related only to a hardware operation or process undertaken by an individual.

Acronyms

ADP - Acceptance data package
AR - Acceptance review
CAM - Commercial, aviation, and military
CCB - Configuration control board
CDR - Critical design review
CIDL - Configuration item data list
COTS - Commercial off-the shelf
CSCI - Computer software configuration item
DRB - Delivery review board
DRD - Document requirement description
DRL - Document requirements list
EEE - Electrical, electronic, electromechanical
EGSE - Electrical ground support equipment
EIDP - End item data package
FAR - Flight acceptance review
GSE - Ground support equipment
IT - Integration & testing
LAT - Lot acceptance testing
LLI - Limited life item
MGSE - Mechanical ground support equipment
MIP - Mandatory inspection point
MRB - Material review board
NCR - Nonconformance report
NDI - Non-destructive inspection
PDR - Preliminary design review
PDS - PRACA Data System
PFR - Post flight review
PRACA - Problem Reporting and Corrective Action
PSA - Project specific annex
PSS - Procedures specifications and standards
PTR - Post-test review
QA - Quality assurance
QR - Qualification review
RFW - Request for waiver

SCMP- Software configuration management plan
SDE - Software development environment
SOW - Statement of work
SPMP - Software project management plan
SPA - Software product assurance
SPAP - Software product assurance plan
STP - Software test plan
SVVP - Software verification and validation plan
TRB - Test review board
TRR - Test readiness review