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Basic requirements for product assurance of ESA spacecraft and associated equipment

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BASIC REQUIREMENTS FOR PRODUCT ASSURANCE OF ESA SPACECRAFT AND ASSOCIATED EQUIPMENT

ABSTRACT

This specification is the top-level document of the ESA Product Assurance Specification System. It defines the basic requirementsfor all product assurance disciplines involved in the work performed under development contracts for ESA spacecraft and associated equipment.

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FOREWORD

The European Space Agency requires that the contractors engaged on its spacecraft and equipment development projects implement and maintain a parallel activity throughout all phases of the project to provide a high level of assurance of the satisfactory performance in service of the contracted end-item. This product assurance programme must be properly planned and executed with sufficient authority and expertise, and emphasis must be placed on the optimisation of design, timely prevention of deficiencies and verification of the adequate quality of the project.

The cardinal requirements for a product assurance programme which is acceptable to the Agency are delineated in this specification. It is supported by other specifications in the ESA PSS-01 series in which its requirements are expanded in detail and by others which are concerned with related procedures, processes and data.

The requirements in these specifications are wide ranging, and the Agency is aware that their comprehensive nature could place an undue burden on the economy and development schedule of those projects which are subject to special constraints or those which are less demanding, for example, those in which the end product is not required to be of flight standard. The specification system has therefore been structured in a way that facilitates the controlled selection by the Agency of the combination of requirements most appropriate to the type, phase of development, purpose and other features of each project. The applicability of the specifications, or parts thereof, so selected, will be clearly stated in the corresponding ESA work statement. In this way it is hoped to achieve flexibility without compromising the level of assurance which is required and without reducing the economic benefits that should ultimately accrue from the use of the same basic system for all ESA projects.

The revised specifications and specification system also reflect due recognition both of the experience demonstrated by European industry in general in applying the Agency's product assurance requirements in earlier projects and of the need for new, or modified, provisions in the light of advancing technology.

Contractors who wish to have more information on the correlation between old and new ESA product assurance specifications, should apply to the Head, Product Assurance Systems Section at ESTEC for an explanatory leaflet on the subject.

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BASIC REQUIREMENTS FOR PRODUCT ASSURANCE OF ESA SPACECRAFT AND ASSOCIATED EQUIPMENT

1. SCOPE

This specification establishes the ESA basic requirements for an integrated contractor product assurance system. These provisions pertain to reliability, safety, maintainability and quality assurance of spacecraft systems, subsystems and equipment as well as to components, materials, processes, configuration management and control and software quality assurance.

The document is generally addressed to the prime contractor of a programme, herein called the contractor; however, all requirements are valid for any subcontractor, supplier and manufacturer as appropriate to their engagement in the project.

It is the responsibility of the contractor to impose all relevant requirements on his subcontractors and suppliers and to make sure that those requirements are implemented on time and to the extent specified.

2. GENERAL

The contractor shall establish and implement an integrated and cost-effective product assurance programme compatible with contractual requirements. He is fully responsible for the control of product quality and for offering for acceptance by ESA only products determined by him to conform to contractual requirements.

2.1 RELATION TO OTHER REQUIREMENTS

The basic product assurance requirements defined in this specification shall be satisfied in addition to detail requirements contained in any other ESA product assurance specification as referenced in the contract.

2.2 ESA PRODUCT ASSURANCE PERSONNEL AT SOURCE

ESA reserves the right to participate in or execute surveys, audits, reviews, source inspection, test observation, mandatory inspections etc., or have resident or itinerant personnel at the plants of the contractor, subcontractors, suppliers and manufacturers. ESA participation shall not in any way replace or relieve the contractor of his responsibility. The contractor shall make arrangements to permit designated ESA personnel free access to all documentation and to those areas within the contractor's, subcontractors', suppliers' or manufacturers' facilities in which work related to the contract placed on him is being performed.

2.3 ESA ACTIONS ON DOCUMENTS

Product assurance documents shall be sent to ESA for approval, review or information as specified in the contract. All other contractor's and subcontractor's PA documents shall be made available for ESA inspection at the contractor's site.

Approval of contractor's or subcontractors' documents by ESA does not absolve the contractor or subcontractor from the need to comply with any of the ESA specification requirements unless he has received written permission from ESA to do so.

2.4 RELATED DOCUMENTS

The system of ESA product assurance specifications is shown in Annex A. At the end of each section of this specification the level 2 document(s) related to that section is (are) given. The applicability of any of these specifications is defined in the contract.

2.5 DEFINITIONS

The definitions listed in Annex B shall apply.

3. PRODUCT ASSURANCE MANAGEMENT

3.1 GENERAL

The product assurance programme shall be executed through a forceful and authoritative management system, which provides the reporting and communication links and decision-making system necessary for the prevention or early detection of actual and potential deficiencies, system incompatibilities, marginal reliability or quality, trends or any other conditions which could result in unsatisfactory performance. This programme shall provide for the surveillance and control of subcontractors and suppliers.

3.2 ORGANISATION

The contractor shall have suitable facilities and competent product assurance personnel with a sufficient degree of independence from the company's design and manufacturing functions to deal objectively with the relevant product assurance aspects of the space programme. The contractor shall designate a product assurance representative of appropriate experience to manage and co-ordinate all the product assurance activities on the ESA project.

3.3 PLANNING AND DOCUMENTATION

The contractor shall ensure that his product assurance actions and those of his subcontractors and suppliers are fully planned and documented. Emphasis shall be placed on the control of interfaces between different product assurance disciplines and other related activities.

3.4 PRODUCT ASSURANCE PLAN

The contractor shall prepare and submit to ESA a written plan delineating the complete product assurance programme. It shall serve as the master planning and requirements document for each contract phase authorised by ESA to be implemented by the contractor, subcontractors and suppliers. The plan shall provide statements of policy together with a detailed description of the product assurance programme the contractor will implement and shall show how he will verify that the programme has been accomplished. Separate sections of the overall plan or, if necessary, individual subplans shall be devoted to safety, reliability, software quality assurance, maintainability, quality, configuration management and control, selection, control and procurement of components, materials and processes as required for the project.

3.5 PROJECT REVIEWS

The contractor shall establish and conduct a comprehensive programme of project reviews. The reviews shall be planned and documented and shall evaluate the status of the product assurance programme at key points.

3.6 REPORTING

The contractor shall establish a reporting system and report on a regular basis to ESA, taking into account the depth, frequency and relative importance of product assurance activities and related project milestones.

3.7 TRAINING

Training procedures for difficult and critical operations and processes shall be documented and implemented to ensure an effective product assurance programme. Operations and inspections for those critical or difficult operations and processes shall be certified and shall have their competence regularly or continuously monitored in a manner clearly defined by the contractor in training or certification procedure documents. Documentary records of certification status of each operator and inspector shall be maintained.

3.8 PROGRAMME AUDITS

The contractor shall plan, organise and periodically perform product assurance audits of the performance of his own and of subcontractors' and suppliers' activities to ensure that approved procedures are correctly implemented and that adequate quality standards are maintained throughout the contract. Each audit shall include provisions for the examination of all items, materials, operations, facilities, services and documentation, and for the evaluation of actual operations as compared with established requirements to verify the effectiveness of the contractor's/ subcontractors' effort. Recommendations for corrective and preventive actions, and follow-up audit results shall be documented in a report. Follow-up reviews shall be made to ensure that required corrections have been implemented in a timely and effective way.

3.9 STANDARDISATION OF DESIGN AND FABRICATION PRACTICES

The contractor shall maintain a continuous effort to standardise and control design practices and fabrication processes and formalise the result of his efforts in manuals to instruct

personnel. The contractor shall use his existing standards and manuals insofar as practicable, modifying them as necessary, to meet the product assurance and other requirements of the contract. The contractor's design or processing standards shall be incorporated in the subcontractor's design-standards system whenever possible to standardise the design and process approach.

3.10 CONFIGURATION MANAGEMENT AND CONTROL

A documented programme for configuration management and control shall be established and implemented to ensure adequate definition of the design standard and its control of all hardware and related documentation. The programme shall provide for the control, identification and verification of all hardware, related documentation, and changes thereto and for accounting for all items of hardware and software within the project. Interfaces with other systems affecting configuration management and control activities shall be described. A configuration control board shall be installed to review the suitability for release of all manufacturing, assembly and test drawings, specifications, procedures and changes thereto. The membership of the board shall be such as to cover all aspects of the design, materials, process safety, reliability components, quality, testability and interfaces.

3.11 RELATED DOCUMENTS

The document ESA PSS-01-10 'Product Assurance Management and Audit Systems for ESA Spacecraft and Associated Equipment' and subsequent level 3 documents are directly related to this section.

4. COMPONENTS, MATERIALS AND PROCESSES

4.1 GENERAL

The contractor shall establish and implement a documented system covering the engineering, quality assurance and procurement management requirements of components, materials and processes. Procurement negotiations shall start early enough in the project to ensure that orders are placed in sufficient time to obtain delivery matched with project schedule and need. The contractor shall select components, materials and processes which are capable of meeting all requirements specified by the ESA project.

The respective quality assurance requirements are defined in Section 8 of this specification.

4.2 COMPONENTS

The ESA preferred parts list shall be used by the contractor as the basis on which to establish and perform a type reduction and standardisation programme to optimise the use of standard and European components. The use of non-standard/non-European components shall be justified by project needs. Non-standard components may require extensive evaluation and testing prior to their acceptance.

All components to be used in the programme shall be listed, together with their appropriate testing level, actual manufacturer, lot acceptance level, back-up plans etc. Each component, whether standard or non-standard, shall be procured by means of the Space Components Coordination Group (SCCG) procurement-specification system to the maximum extent possible.

4.3 MATERIALS

The contractor shall establish and implement a standardisation programme to optimise the use of space-approved materials of European origin and ensure that other and/or non-European materials are only selected where absolutely necessary. The use of materials for which widespread space application data are not available requires justification, evaluation and testing prior to their acceptance.

All materials to be used in the programme shall be listed together with all data necessary for exact identification and procurement. This list should also be used as an aid in reducing the overall number of materials.

4.4 PROCESSES

The contractor shall prepare a list showing all processes needed for the project and indicate those of a critical nature. The list shall be used to identify all standard and non-standard processes and as an aid in reducing and standardising the overall number of processes. The use of non-standard processes requires evaluation and testing prior to their acceptance.

4.5 RELATED DOCUMENTS

The documents ESA PSS-01-60 'Component Selection, Procurement and Control for ESA Spacecraft and Associated Equipment' and ESA PSS-01-70 'Materials and Process Selection and Quality Control for ESA Spacecraft and Associated Equipment' and subsequent level 3 documents are directly related to this section.

5. RELIABILITY

5.1 GENERAL

The contractor shall establish and implement a documented programme for reliability assurance. It shall be planned, co-ordinated and integrated with other product assurance functions throughout all phases of the project with concentrated emphasis during design and development to ensure that project requirements are met. Trade-off studies shall be performed early in the project to identify the relative merits of alternative designs. All relevant reliability data shall be ready for consideration at respective project reviews. Periodic reviews shall take place to reflect changes and further acquisition of data.

5.2 RELIABILITY ENGINEERING

A timely and sufficient reliability engineering effort shall be provided and integrated with all other engineering activities to ensure that the specified performance is achieved throughout mission life. Reliability engineering shall include reliability analysis, worst-case analysis, contingency analysis and outage analysis to the extent specified in the contract. Components shall be adequately derated and component application reviews performed to verify that nominal and actual stresses are compatible, all critical areas of the design and the effects of any variation of parameters (e.g. tolerance, drift, radiation, aging) being taken into consideration

5.3 FAILURE MODE, EFFECT AND CRITICALITY ANALYSIS (FMECA) AND CRITICAL ITEMS

The contractor shall prepare a failure mode, effect and criticality analysis (FMECA) of the design down to the lowest level of the system definition as required in the contract and so identify all possible failure modes and mission critical functions. The FMECA shall cover both spacecraft hardware and associated equipment. The analysis shall consider each potential failure in the light of its probability of occurrence and of its probable effect on mission success and shall result in identification of critical items. Critical items shall be listed and subjected to special consideration at design reviews and effort shall be maintained to eliminate single-point failures. Critical items shall be designed to be fail-safe.

The FMECA shall also be used to perform contingency analysis for the purpose of diagnosis of failure modes during transfer orbit and orbital operations of the satellite from launch throughout satellite mission.

5.4 RELATED DOCUMENTS

The document ESA PSS-01-30 'Reliability Assurance of ESA Spacecraft and Associated Equipment' and subsequent level 3 documents are directly related to this section.

6. SAFETY

6.1 GENERAL

The contractor is responsible for assuring the safety of personnel and contract hardware during all phases of the project. Particular requirements for safety at the launch site are in principle dictated by the launcher authority and the contractor is required to become familiar with the safety documents defined in the contract. The responsibility for compliance with the national and launcher safety regulations is with the contractor.

6.2 SAFETY PROGRAMME

The safety requirements of the ESA contract are addressed to the timely identification of all possible hazards, their elimination, reduction and control. The contractor is required to establish and maintain a documented safety programme to ensure that the contract hardware is capable of being fabricated, stored, handled, transported, installed and tested safely during all phases of the project. The safety programme shall provide for safety trade-off studies and hazard analyses to identify and classify all hazards and ensure their resolution. When the contractor cannot design to meet the applicable safety requirements he shall submit a waiver request to ESA. For any activity which can result in injury to personnel or damage to hardware, operating procedures controlling hazards shall be established to identify safety equipment, provisions, emergency procedures etc. The contractor shall certify that his hardware is safe and complies with the safety requirements except as defined in approved waivers/ deviations. A safety compliance data package shall be prepared and sent to ESA prior to hardware delivery and shall provide all necessary safety compliance information, records, procedures and reports.

6.3 TEST OPERATIONS SAFETY

The contractor shall review test plans, specifications and procedures for ground tests and flight readiness checkout of critical spacecraft hardware to ensure that tests are adequate to enable potential hazards to be identified and assessed, and shall assure that steps are taken to protect personnel and avoid damage to test items and facilities. In addition, adequate validation tests shall be performed on safety-critical items to determine the degree of hazard or margin of safety of design. All tests shall be supervised by the contractor's quality assurance personnel to ensure adherence to safety principles and compliance with safety requirements and checklists.

6.4 RELATED DOCUMENTS

The document ESA PSS-01-40 'Safety Assurance of ESA Spacecraft and Associated Equipment' and subsequent safety documents of the respective launcher authority are directly related to this section.

7. MAINTAINABILITY AND AVAILABILITY ASSURANCE

7.1 MAINTAINABILITY

A maintainability programme shall be established and implemented which provides maintainability design criteria and measurable parameters for all pertinent operations during all project phases with concentrated emphasis during the design phase. Proposed designs shall be evaluated and maintainability predictions provided in a timely manner so as to influence designs without costly exchanges.

The maintainability design criteria and supporting measurable parameters such as mean time to repair, down time, limited life, fault detection/isolation capability etc. shall be used during item selection, design application, trade-offs and design reviews.

The programme shall give due consideration to spares requirements and storage time on the ground. Where special environmental conditions are required during storage, they shall be compatible with the overall project requirements and constraints.

7.2 AVAILABILITY

In conjunction with the maintainability activity the contractor shall perform studies of the spacecraft's on ground and in orbit readiness to assess its availability. The studies shall demonstrate how the spacecraft users' requirements will be met and shall assist in determining the optimum production/storage/launch strategy. The results of any studies shall be refined on the basis of ground tests and in-orbit data assessment.

7.3 RELATED DOCUMENTS

The document ESA PSS-01-50 'Maintainability and Availability Assurance of ESA Spacecraft and Associated Equipment' is directly related to this section.

8. QUALITY ASSURANCE

8.1 GENERAL

The contractor shall establish and implement an effective programme of quality assurance including quality control, inspection and surveillance during all project phases.

8.2 PROCUREMENT CONTROL

The contractor shall establish and implement systematic controls to ensure the adequacy and quality of all purchased and subcontracted parts, components, materials, equipment, assemblies, subsystems, software and services.

The programme shall distinguish between activities to be implemented on already developed items and those on items that have to be designed and fabricated specifically for the project. This shall include the evaluation and selection of procurement sources and review of procurement documents prior to start of procurement.

8.3 MANUFACTURER, SUPPLIER AND SUBCONTRACTOR SURVEILLANCE

Control and surveillance of manufacturers, suppliers and subcontractors shall be implemented to ensure compliance with the applicable procurement requirements. In general, in-process inspections, critical processes, mandatory inspection points and tests shall be included.

8.4 INCOMING INSPECTION

A documented system of incoming inspection shall be established and implemented to verify that items obtained from manufacturers, suppliers or subcontractors conform to the requirements as defined in the procurement documentation and in the

contract. The depth of incoming inspection activities shall be in line with the control and surveillance activities performed at the source. The contractor shall make provisions for samples of materials and components to be supplied to ESA for the purpose of analysis.

8.5 ITEMS FROM PREVIOUS PROJECTS

The contractor shall evaluate each item he proposes to use from previous programmes to ensure that the quality standard, the complete history and environmental levels of use comply with the requirements of the current project.

8.6 FABRICATION

The quality activity shall support the fabrication operations to ensure that quality criteria specified in technical documents are adhered to in all items to be designed and developed. Detailed fabrication and inspection documents shall be generated and utilised by personnel conducting fabrication or inspection operations. Controls and comprehensive surveillance shall be exercised and mandatory inspections performed.

8.7 INTEGRATION AND TEST

The contractor shall establish and implement an inspection, testing and surveillance activity during integration and test phases. These activities shall provide the assurance and documented objective evidence that the reliability and quality inherent in the design are maintained. The contractor shall stop testing when safety of personnel is in jeopardy, or damage or degradation to the hardware or associated test equipment is possible. Review boards shall be convened prior to tests to assess the configuration and readiness for test and, after tests, to review test data.

8.8 QUALITY RECORDS AND TRACEABILITY

Logbooks shall be prepared, maintained and updated as a means of providing a documented history and as a record of the configuration status of hardware. They shall be initiated at different levels of inspection and test, assembly or operations and for different models as defined in the contract. Provision shall be made for the recording of traceability to the individual responsible for the accomplishment of a particular inspection, test or surveillance.

Traceability of identification and serialisation from spacecraft to the component/item/material level shall be provided as part of the quality-record documentation.

8.9 CLEANLINESS CONTROL

The contractor shall establish and implement a programme for the control of all sources of contamination associated with clean rooms, spacecraft hardware and personnel involved.

8.10 IDENTIFICATION, DATA RETRIEVAL AND STAMP CONTROL

A documented system for identification, data retrieval and stamp control shall be established. It shall provide for the identification, location and traceability of all items. The system shall be developed in conjunction with other systems such as engineering documentation control, configuration management and control and logistics management and common identification numbers and procedures shall be used. Stamp controls shall be exercised over all fabrication and inspection activities.

8.11 NONCONFORMANCE CONTROL

The contractor shall establish and implement a documented, controlled, closed-loop system for the identification, notification, segregation, disposition, correction and close-out of nonconforming items. This shall include all the relevant interfaces with subcontractors and ESA. The system shall provide for the recording and classification (e.g. minor or major) of all nonconformances and for the accumulation of records of nonconformances for summary and trend reports. The contractor shall conduct the appropriate analysis and examination of nonconforming articles, equipment, materials, components and processes to determine the cause for the nonconformance and prevent its recurrence. The nonconformance control system shall cover hardware, software and the interface between hardware and software. If a separate nonconformance system is employed for software its procedure and interface with this nonconformance system shall be defined in the quality assurance plan.

Material Review Board (MRB)

The contractor shall establish and implement a documented procedure for material review boards for the purpose of dispositioning major nonconformances. The procedure shall provide for the MRB to be composed of members with sufficient authority to disposition the nonconformance and specialists in disciplines relevant to the nonconformance being considered, as necessary. Items and processes which are the subject of nonconformances submitted to MRB shall be withheld from further operations until the decision of the Board is obtained.

Failure Analysis

Provision shall be made for the performance of failure analysis if required by the members of the MRB to assist in its determination of the disposition and recommendations for corrective action to preclude recurrence. Failure analysis reports shall be prepared and submitted to the MRB.

8.12 METROLOGY AND CALIBRATION

The contractor shall establish and implement a documented metrology and calibration system to control measuring, inspection and test equipment and standards in order to provide definitive evidence of quality conformance. The standards employed shall be traceable to recognised national or international standards. Measurement processes shall be performed in accordance with established written procedures.

8.13 HANDLING, STORAGE, PRESERVATION, MARKING, LABELLING, PACKING AND SHIPPING

Written procedures and instructions shall be established which provide for the identification, segregation, handling, preservation and transportation of all items and the assurance that no deterioration occurs from the time of receipt through all processes/operations to delivery and receipt at the final destination.

8.14 SAMPLING PLANS

Consideration shall be given to the use of sampling plans only when the inspection or tests are destructive, or data indicate that a reduction in inspection or testing can be achieved without jeopardising achievement of quality, reliability or design intent.

8.15 RELATED DOCUMENTS

The document ESA PSS-01-20 'Quality Assurance of ESA Spacecraft and Associated Equipment' and subsequent level 3 documents are directly related to this section.

9. SOFTWARE QUALITY ASSURANCE

9.1 GENERAL

The contractor shall establish and implement an effective and economical software quality assurance programme which ensures full compliance with the requirements of both this specification and the contract. Provision shall be made for the detection, reporting, analysis and correction of software deficiencies and anomalies which could affect the software itself or related hardware.

9.2 MANAGEMENT

The contractor shall ensure that all activities associated with software are planned and monitored. Software requirements must be clear, complete and unambiguous so that programmes and procedures may be generated which ensure complete fulfilment and compliance with requirements, specific standards and conventions. Practices and procedures shall be standardised to provide a uniform approach. The contractor shall identify the tools, techniques and methodologies to be employed which will support and aid in ensuring that the quality, reliability, maintainability and configuration management and control objectives are met. The development shall be divided into well-defined phases, each with key points identified so that the overall programme may be monitored. This shall be accomplished by regular progress reviews and the generation of progress reports. The contractor shall establish a Software Review Board for configuration management and any nonconformances on software.

9.3 DESIGN, DEVELOPMENT AND VERIFICATION

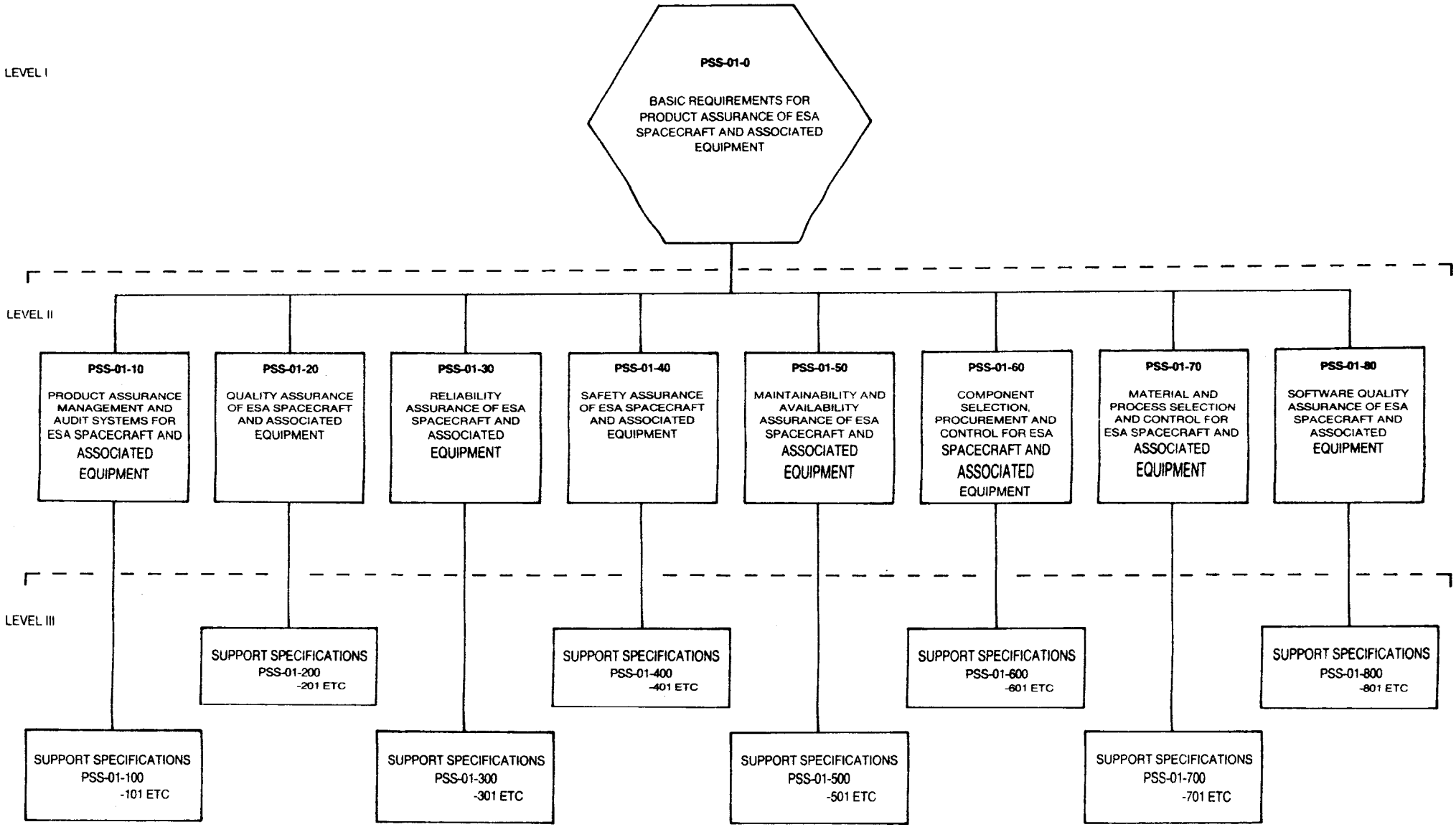
The design and development of software shall be planned in conjunction with other PA disciplines related to hardware. The design should take into account the final use of the software and the relative importance of quality, reliability and maintainability. The software shall be capable of correct and full integration with the hardware and not be prejudicial to other aspects of the system or subsystem. Host computers, associated software and peripheral equipment which will be used to create, store and test software shall be evaluated and identified. Verification of software conformity shall be accomplished by testing, reviews, audits and monitoring of the software and its interfaces. Debugging procedures shall be implemented as an integral part of the development and test programme.

9.4 RECORDS AND CONFIGURATION

A documented system of configuration management and control shall be implemented which defines the procedures to be used to monitor the methods and facilities for maintaining and storing controlled versions of identified software. Methods to be used for identifying the software items, controlling and implementing changes and recording and reporting change implementation status shall be documented. Quality records shall be maintained which provide a complete documented history of the software, its verification and configuration.

9.5 RELATED DOCUMENTS

The document ESA PSS-01-80 'Software Quality Assurance of ESA Spacecraft and Associated Equipment' and subsequent level 3 documents are directly related to this section.



PRODUCT ASSURANCE SPECIFICATION TREE

ANNEX A

ANNEX B

DEFINITIONS

Audit

A planned, purposeful and comprehensive examination and verification of management objectives, assignments of duties, delegations of responsibilities, methods of operation, facilities, hardware and software, conducted periodically and systematically on any contractor, subcontractor, supplier or manufacturer.

Availability

The probability that an item will be functionally ready or operable at some specified point in time.

Certification

The action of determining, verifying and attesting, in writing, to the qualification of personnel or items.

Change

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

Component

A device which performs an electronic, electrical or electromechanical function and is constituted of one or more elements joined together, which normally cannot be disassembled without destruction. The term component may be interchanged with the word part.

Configuration Control

The systematic evaluation, co-ordination, approval or disapproval and implementation of all changes in the configuration of an end item and related documentation.

Configuration Management

A discipline applying technical and administrative direction and surveillance to:-

- identifying and documenting the functional, physical and environmental characteristics of an end item;
- recording and reporting change processing and implementation status.

Contingency Analysis

The ameliorating procedure or activities undertaken or to be undertaken when a foreseen undesirable divergence occurs from planned events.

Critical Item

Any item of software or hardware in which the severity of the effect of its failure in terms of cost, schedule, performance, quality, reliability or interchangeability deserves special additional attention or control over and above that given to items not so categorised.

Critical Processes

Critical processes are those for which the quality of the processed item cannot be determined by inspection or test of the end item and/or which, if not well executed, will give rise to unacceptable risk or failure.

Derating

Derating is the deliberate limiting of physical stress (voltage, current, temperature, etc.) to values which are below the manufacturer's specification limits.

Failure Analysis

Systematic examination of an item and its specification to identify and analyse the origin and mechanism of the observed failure.

Failure Mode, Effect and Criticality Analysis (FMECA)

The systematic investigation of actual or potential single-origin fault conditions from observed cause to performance deviation from nominal conditions and the classification of this deviation in terms of the resulting degree of loss of mission objectives.

Failure Rate

The number of failures of an item per unit measure of life (cycles, time, events, etc. as applicable for the item).

Hazard

Any real or potential condition that can cause injury or death to personnel or damage to or loss of equipment or property.

Hazard Analysis

The identification and evaluation of hazards within a system for the purpose of controlling them. It is directed towards reducing their severity and/or the probability of occurrence.

Maintainability

A characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specific condition within a given period of time when the maintenance is performed in accordance with prescribed procedures and resources.

Major Nonconformance

Any nonconformance which by definition cannot be classed as minor.

Mandatory Inspection Points

Places where inspections must be performed and which are selected because these places provide the maximum visibility of quality.

Minor Nonconformance

A nonconformance to the specified requirements which does not adversely affect: performance, interface, durability, reliability, maintainability, availability, effective use or operation, weight or health and safety.

Nonconformance

An apparent or proven condition of any item or documentation that does not conform to specified requirements. In addition any apparent or proven conditions of any item or documentation which are considered to be potential contributors leading to incorrect operation or failure of the item or mission shall be included as nonconformances.

The term nonconformance is also used for a failure, discrepancy, defect, anomaly, malfunction, deficiency, etc.

Non-standard Component

Non-standard components are those whose technology is subject to continuous evolution or whose level of production is not sufficient to assure a continuously running production and which have little or no previous history of high-reliability applications.

Preferred Parts List

A list of component types/manufacturers preferred by an authoritive organisation.

Reliability Block Diagrams

A reliability block diagram is a pictorial presentation created from a series of geometrical shapes arranged in a form to represent the functional organisation of a circuit, subsystem or system.

Reliability Prediction

For the stated conditions of use, and taking into account the design of an item, the reliability computed from the observed, assessed or extrapolated reliabilities of its elements.

Safety

Freedom from chance of personnel injury or fatality and damage to or loss of equipment or property.

Safety Compliance Data Package

A safety compliance data package is a collection of data which defines all hazards and safety-related items and attests and substantiates in a documentary manner that all the relevant safety requirements have been met.

Safety Critical Items

Any item of hardware or software in which the severity of the effect of its hazard in terms of flight hazard or hazards to equipment/facilities or personnel deserves special attention and warning or control over and above that given to items not so categorised.

Software

Software is computer programme code and its associated data, documentation and operational procedures.

Standard Component

A standard component is one which is fabricated from well-understood and stable technologies according to an effective quality assurance system, usually confirmed by a history of continuous or frequent production runs, and of which widespread application data are available.

Space-Approved Material

A space-approved material is one whose properties are well understood and which has a stable technology produced according to an effective quality assurance system, usually confirmed by a history of continuous or frequent production runs and of which widespread space-application data are available. The material must either be compliant with a recognised set of specifications or have successfully completed an appropriate test programme.

Standard Process

A standard process is one which is documented, has a previous history of use and is well understood and for which standard inspection procedures exist. These processes should generally be covered by an ESA specification or other international or national document.

Traceability

The ability to trace the history, application, use and location of an item through the use of recorded identification numbers.

Waiver

A written authorisation granted before fabrication of an item to depart from a particular performance or design requirement for a specific number of units or a specific period of time.