

DOCUMENT

Product and Quality Assurance Requirements for In-Orbit Demonstration CubeSat Projects

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1 INTRODUCTION

1.1 Scope and Purpose

The document defines the product and quality assurance requirements applicable to ESA CubeSat projects with in-orbit demonstration as the main objective.

It is an applicable document to the ESA Statement of Work of the CubeSat project and shall be complied with by the Contractor during the project execution.

Note that a Product/Quality Assurance (PA) Plan and its Document Requirements Definition (DRD) is specified in the ESA Statement of Work and other applicable documents, and is therefore not covered by this document.

1.2 Project Classification

CubeSats are defined here as nano-satellites whose designs are compliant with the CubeSat Design Specification [AD1] and are multiples of a single CubeSat unit (10x10x10 cm, <1.33 kg) ranging from 2 units up to 6 units.

CubeSat projects for In-Orbit Demonstration (IOD) purposes in Low Earth Orbit are generally characterized by the following attributes:

- Complete stand-alone systems including platform, payload, ground segment & operations
- Higher risk acceptance profile
- Low level of complexity (relative to other ESA space projects)
- Low cost and short schedule (typically <1 MEuro and <2 years to flight readiness)
- Short operational lifetime (typically <1 year in low altitude LEO)
- Acceptance of single point failures
- Limited redundancy (where possible within the constraints)
- Limited fault tolerance (where possible within the constraints)
- Robust safe mode (thermal and power safe in any attitude)
- Extensive use of commercial off-the-shelf elements (modules that have previous flight heritage and are supplied by small industrial suppliers at a fixed price)
- Extensive testing focussed on system level (functionality and environmental qualification/acceptance)
- Simple project organisation with well integrated teams (single entity for system engineering, AIV and operations, very few suppliers or subcontractors)

Due to the very small satellite class, very low procurement cost, simple project organisation, short development schedule and short duration operations, IOD CubeSats in the ESA context are classified according to [AD2] as “other space-related procurement activities such as technology and pre-development” which are “non-complex procurement



activities, with simple industrial structures, conducted as lower-cost and shorter-duration contracts”. As such, section 5 of [AD2] states “For such activities, the majority of the standards contained in the ESA approved list of standards may not be relevant and only a few may be selected as applicable.”

From this, it is clear that the design, development, manufacturing and AIV process cannot follow a classical ESA project approach to management, engineering, reviews and PA/QA with associated application of the ECSS standards. Furthermore, the majority of the standards documents are not relevant/suitable for this type of project. Therefore, the ECSS-Q Quality standards are not considered to be applicable to this type of project.

However, a minimum set of requirements have been defined in this document in order to ensure the reliability of the CubeSat during its short mission in LEO.

1.3 Applicable Documents

- [AD1] CubeSat Design Specification, revision 12, California Polytechnic, 1 August 2009.
- [AD2] Application of ESA approved standards, ESA/ADMIN/IPOL(2007)11, 20 July 2007.
- [AD3] ESA-ADMIN-IPOL(2008)2 - Space Debris Mitigation for Agency Projects.

1.4 Reference Documents

- [RD1] ECSS Standard on Space Product Assurance: Manual soldering of high-reliability electrical connections, Q-ST-70-08C.
- [RD2] ECSS Standard on Space Product Assurance: Procurement of printed circuit boards, Q-ST-70-11C.
- [RD3] ECSS Standard on Space Product Assurance: Preparation, assembly and mounting of RF coaxial cables, Q-ST-70-18C.
- [RD4] ECSS Standard on Space Product Assurance: Crimping of high-reliability electrical connections, Q-ST-70-26C.
- [RD5] ECSS Standard on Space Product Assurance: The wire wrapping of high-reliability electrical connections, Q-ST-70-30C.
- [RD6] ECSS Standard on Space Product Assurance: High-reliability soldering for surface-mount and mixed technology, Q-ST-70-38C.
- [RD7] ECSS Standard on Space Product Assurance: Requirements for manufacturing and procurement of threaded fasteners, Q-ST-70-46C.

1.5 Acronyms

AD	Applicable Document
AIV	Assembly, Integration and Verification
CCB	Change Control Board
CDR	Critical Design Review
CI	Configuration Item
CM	Configuration Management
COTS	Commercial Off The Shelf
CSCI	Computer Software Configuration Item



CVCM	Collected Volatile Condensable Material
DM	Document Management
DRD	Document Requirements Definition
EEE	Electrical, Electronic and Electromechanical
FDIR	Failure Detection Isolation and Recovery
IOD	In-Orbit Demonstration
LEO	Low Earth Orbit
NCR	Non-Conformance Report
NCTS	Non-Conformance Tracking System
OBDH	On-Board Data Handling Subsystem
PA	Product Assurance
PCB	Printed Circuit Board
QA	Quality Assurance
RD	Reference Document
RFD	Request For Deviation
RFW	Request For Waiver
SEE	Single Event Effect
SPF	Single Point Failure
TML	Total Mass Loss
UV	Ultra Violet



2 PRODUCT & QUALITY ASSURANCE REQUIREMENTS

2.1 Risk management

2.1.1 Risk Register

Each member of the Contractor engineering team shall be responsible for continuously assessing the risks on their part of the project through the project lifecycle, recording this in the form of a project-level Risk Register, and communicating the risk assessment via the Risk Register to the Project Manager and System Engineer.

The Project Manager shall maintain the Risk Register and delegate to the System Engineer the responsibility to properly address these risks with the engineering team through the planning of specific activities to mitigate them. The Project Manager and System Engineer shall then assign the responsibility for carrying out the risk mitigation actions to individual members of the project engineering team.

The Project Manager shall use the Risk Register to regularly communicate the project risks and mitigation action plans to ESA as part of the formal reporting requirements of the contract.

2.1.2 Critical Items Control

Items regarded as functionally critical to the safety and reliability shall be formally identified and controlled. Critical items shall include the Fracture Critical Items if any.

A consolidated list of all critical items shall be maintained by the 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
- Records of inspection and test results shall be maintained for all special requirements identified in the drawings.

2.2 Procurement Control

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

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



2.2.1 Selection of procurement sources

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

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.

2.2.2 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.

2.2.3 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.

The Contractor shall maintain records of all Procurement documentation including incoming inspection reports & goods receipts.

2.3 Quality Management

The Contractor shall employ a Quality Management System for:

- Configuration control of engineering data and project documentation
- Keeping quality control records
- Traceability of material items
- Maintaining calibrated equipment suitable for inspections and tests
- Reporting non-conformances in a systematic manner
- Handling, storage and preservation of flight items

The Contractor quality management system shall be certified to EN 9100.



If the Contractor quality management system is not EN 9100 certified, the Contractor shall include in its PA plan measures to compensate for the lack of one or more elements of the quality management system.

2.3.1 Configuration Control

The Contractor shall establish the Configuration Items to be controlled, e.g. requirements, technical specifications, engineering drawings/schematics, interface definitions, and determine how they shall be identified.

Once CIs have been placed under control, the Contractor shall ensure that Engineering Change Requests are prepared, and submitted to a Configuration Control Board for review and authorisation.

The CCB shall involve all parties necessary to decide on the change to the configuration. The Contractor shall execute the change as approved.

2.3.2 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 the duration of the project plus a minimum of 1 additional year, if not differently specified in the contract.

2.3.3 Traceability

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

The traceability 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.

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.

2.3.4 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) Maintain calibration records for inspection, measuring and test equipment;
- d) Ensure that the environmental conditions are suitable for the calibrations, inspections, measurements and tests being carried out;
- e) Ensure that the handling, preservation and storage of inspection, measuring and test equipment is such that the accuracy and fitness for use is maintained;
- f) Safeguard inspection, measuring and test facilities, including both test hardware and test software, from adjustments, which would invalidate the calibration setting.

2.3.5 Non-conformance Reporting

During the verification control process, the Contractor shall identify any non-conformances of the design or flight configuration to the requirements, register a Non-Conformance Report in the ESA NCTS, and notify the Agency. If the Contractor already possesses a software tool for the processing of non-conformances, this can be used if it complies with the requirements of the present section and it is accessible on-line to ESA.

The Contractor shall assess the criticality of the NCR, and together with the Agency decide what course of action shall be taken, either rectification, request for deviation or waiver of the requirement, or use 'as-is' in low risk cases.

Non-conformances shall be classified as critical, major or minor, with the following criteria:

- Critical Non-conformances are those, which may affect safety, and occur during/after qualification/acceptance testing at any item level;
- Major Non-conformances are those which are not critical, but may have an impact on the defined requirements in the following areas:
 - Operational, functional or contractual requirements;
 - Reliability, maintainability;
 - Lifetime;
 - Interchangeability;

Additionally, any non-conformance shall be classified as major in the following cases:



- Deviation from qualification/acceptance test procedures and expected results at any level of integration;
- EEE component non-conformities after delivery from the manufacturer shall be classified as major, except the following non-conformances 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 non-conformances are those, which by definition cannot be classified as critical or major. A minor non-conformance is of inconsequential nature as regards the above features, or is trivial with regard to workmanship criteria.

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

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

All critical and major non-conformances shall be dispositioned by the Contractor and ESA.

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

In the case of RFD or RFW, the relevant forms shall be produced by the Contractor and attached to the NCR entry in the database. The form shall then be reviewed and dispositioned by all relevant parties (Agency, launch safety authority etc).

2.3.6 Handling, storage, preservation and transportation of flight hardware

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, 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 Contractor shall 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.

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.

The Contractor shall ensure that the items to be shipped from his premises 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 handling and packing/unpacking procedure and any relevant safety procedures attached to the outside of the shipping container.

2.4 Manufacturing, Assembly and Integration

2.4.1 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.

The Contractor shall ensure a good quality of workmanship in the manufacture, assembly and integration process by employing ESA standard processes where possible, for example with crimping, soldering, wire wrapping, fasteners, PCB procurement etc. See [RD1-7].

2.4.2 Control of items conformity status

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

2.4.3 Cleanliness and Contamination Control

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



The Contractor shall assess the sensitivity of the satellite components to contamination and set requirements for cleanliness during the manufacturing, assembly and integration cycle, starting from the incoming inspection up to shipping of the end item.

The Contractor shall then ensure that the flight hardware is stored and transported in the required cleanliness environment in order to mitigate the risk of contamination on sensitive surfaces.

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.

2.4.4 Incoming Inspections

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.

Incoming 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) Performance of inspection and tests on selected characteristics of incoming supplies and/or test specimen submitted with the supplies.
- e) Identification of the shelf life of limited life items.

2.4.5 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.

2.4.6 Logbooks

The Contractor shall prepare and maintain logbooks covering the integration and testing activities following manufacturing and assembly of items.

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



2.5 Space Debris Mitigation

The project shall comply with ESA space debris mitigation requirements [AD3].

2.6 Safety

The project shall adhere to all applicable safety standards, including the relevant launch authority safety regulations.

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

2.7 Reliability & Maintainability

It is recognised that such small satellite systems are largely single-string with little volume and mass available for redundancy against single point failures. The emphasis shall therefore focus on prevention of failure propagation. If failures do occur, then they may be accepted provided that they do not propagate to cause other elements of the system to fail. In this case, an effective failure isolation shall be performed.

In any case, no single point failure (SPF) or error shall have critical or catastrophic consequences, ie. loss of satellite or no data return. If a SPF cannot be eliminated from the design, then it shall be designated as a Critical Item, and the related risk shall be assessed and carefully controlled.

Rules shall be derived in order to prevent failure propagation, e.g. no SPF shall affect the behaviour of the main power bus.

Ground commands needed to recover the satellite in case of a failure (when the satellite is in Safe mode) shall be specifically tested on ground during the system verification programme prior to launch.

The satellite shall possess tolerance to faults occurring in the On-Board Data Handling subsystem due to Single Event Effects (SEEs). The OBDH shall be able to recover from these faults. This capability shall be verified during ground testing.

Regarding maintainability, the on-board software and mission parameters stored in on-board memory shall be able to be patched during the mission.



2.8 EEE Components Selection

2.8.1 Selection process

It is recognised that CubeSat projects widely use COTS components in order to reduce costs. The Contractor shall therefore perform a careful selection process on EEE components in order to ensure that they are fit for purpose in the operational environment over the required mission lifetime and do not adversely affect the operation of other elements of the system. In particular, the Contractor shall consider the following aspects in the selection process:

- Operating margins and de-rating of mission-critical components
- Radiation tolerance (both total ionising dose and Single Event Effects)
- Outgassing properties in vacuum (both TML and CVCM values) in order to control any contamination of sensitive surfaces (e.g. optics)
- Avoidance of materials known to degrade significantly in the space environment (e.g. atomic oxygen, UV, vacuum), leading to failure

If any of the selected EEE components lack sufficient data in the above areas and are deemed to be mission-critical, then they shall be tested such that the test results allow to judge their suitability for the mission. This shall include early irradiation testing with results available at CDR (note: the Agency facilities may be used if the Contractor does not have access to such facilities).

The declared components list shall be reviewed by the Agency at major project reviews.

2.8.2 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.

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);
- 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), beryllium oxide (except if the health and safety hazards are identified in the specifications).

2.8.3 COTS Components

Components from stocks that have a lot/date code which indicates that more than 7 years will have elapsed from date of manufacture to date of intended installation in equipment shall be reviewed for their suitability for flight, and shall undergo visual inspection and additional 100% electrical measurement of critical parameters.

2.9 Materials, Mechanical Parts and Processes Selection

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 behaviour, stress corrosion...).

The Contractor shall submit the declared materials and processes lists to ESA for major project reviews.

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.

2.10 Configuration and Document Management

2.10.1 Overview

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 its life cycle uses correct and accurate documentation.

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.

2.10.2 Configuration Items

Configuration Items of a product are identified as part of the product tree, which describes the relationship and position of configuration items in the breakdown of the product. The product tree 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.

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 (e.g. specifications, design documents, ICDs, drawings, lists, software data and manuals for operation and maintenance). These documents are generally called configuration documents.

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.

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.

2.10.3 Configuration Control

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.



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.

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.

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

- the technical merits of the proposed change,
- impact on interchangeability, interfaces, etc,
- impact on contract, schedule and cost.

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.

2.10.4 Configuration Status

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).

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.

2.10.5 Document 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.

2.11 Software

2.11.1 Software Configuration Control

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

Software configuration changes performed by the contractor shall:

- Establish a developmental configuration for each CSCI to maintain internal configuration management during software development;
- 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.

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.

2.11.2 Software Criticality

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).

The Contractor shall issue and maintain an updated list of software and the resulting criticality classification of each unit/component item.

2.11.3 Software Verification

The Contractor shall perform a complete and thorough testing (up to full branch coverage) of software items classified as critical to mission success. This includes the introduction of realistic failure cases, and test coverage of critical FDIR functions (without Hardware in the loop).



A minimum level of regression testing shall be performed to confirm the reliability of on-board software and changes to the on-board software via uplinked patches.

The Contractor shall maintain a Bug tracking system during software development and maintenance in order to record known bugs in the software configuration.

The Contractor shall issue Software Problem Reports in case of test failures on critical software. Such reports shall be handled as part of the Non-conformance tracking procedures and system defined in section 2.3.5.