	**DPU-ICU** **P.A. PLAN**	**IFSI no.: IFSI/ICU/PL/1999-001** **Inst.no.:** n **Issue: 1** **Date: 13TH October 2000** **Category: 2.**

Title:PRODUCT ASSURANCE PLAN FOR THE FIRST-DPU/ICU SUBSYSTEM

Prepared by:	R. Orfei	date:
Checked by:		date:
Agreed : HIFI	H.M.Jacobs	date:
SPIRE	K.King	date:
PACS	O.Bauer	date:
Authorised by:		date:

Distribution:

HIFI: K. Wafelbakker

SPIRE: K. King

PACS: O. Bauer

Document Change Record

Date	**Issue**	**Page/par.**	**Change**
22-11-99	draft 1	all	
02-02-00	draft 2	front page; 1.1; 1.3; 2.1; 2.3.1; 2.3.2; 2.9; 3.2.6; 3.4; 4.2; 4.4.6; 4.8; 4.8.1; 4.9; 4.11; 7.1; 8.4.3; 8.6.1	Updated in line with document HJ/HIFI/PA/MEMO-005 attached in Email of 24-01-00 from H.Jacobs
13-10-00	issue 1		

Table of contents

1 Documents

1.1 Applicable documents, project related:

SRON-U/HIFI/PL/1999-006	EEE components procurement plan
SRON-U/HIFI/PL/1999-008	HIFI PA plan
SRON-U/HIFI/PR/1999-001	Procedure for Process Identification Document (PID)
SRON-U/HIFI/PR/1999-002	Procedure for Mandatory- and Key inspection points.
SRON-U/HIFI/PR/1999-003	Procedure for Test Readiness Review Board (TRRB)
SRON-U/HIFI/PR/1999-004	Procedure for Delivery Review Board (DRB)
SRON-U/HIFI/PR/1999-005	Procedure for Qualification Status Review (QSR).
SRON-U/HIFI/PR/1999-006	Procedure for End Item Data Package (EIDP).
SRON-U/HIFI/PR/1999-007	Procedure for Non Conformance (NCR) control
SRON-U/HIFI/LI/1999-003	Reference guide to HIFI preliminary EEE parts list for selection and approval
SRON-U/HIFI/PR/1999-010	Reference guide to the materials list for selection and approval
SRON-U/HIFI/PR/1999-011	Reference guide to the processes list for selection and approval
ESA-PT-HIFI-02125	FIRST/PLANCK IID-B 0-3_15/01/2000
ESA-PT-PACS-02126	FIRST/PLANCK IID-B 0-3_14/12/1999
PACS-ME-PL-002	DDVP-2-15/07/1999
ESA-PT-SPIRE-02124	FIRST/PLANCK IID-B 0-2_01/08/1999

1.2 Applicable documents, general

The following documents are applicable to the extend specified herein:

ECSS-Q-20	Space Product Assurance, Quality Assurance
ECSS-Q-60A	Electrical, Electronic and Electromechanical Components
ECSS-Q-70A	Materials, Mechanical Parts and processes
PSS-01-201	Contamination and Cleanliness Control
PSS-01-301	De-rating Requirements and Application Rules for Electronics
PSS-01-608	Generic Specification for Hybrid Microcircuits
PSS-01-610	Design guidelines for micro wave hybrid integrated circuits
PSS-01-700	The Technical Reporting and Approval Procedure for Materials and Processes
PSS-01-708	The Manual Soldering of High Reliability Electrical Connections
PSS-01-710	The qualification and procurement of two-side printed circuit boards (Gold plated or Tin-lead Finish)
PSS-01-726	The Crimping of High Reliability Electrical Connections
PSS-01-728	The Repair and Modification of Printed circuits Board and Solder Joints for

	Space Use
PSS-01-738	High reliability soldering for surface-mount and mixed technology PCB's
QC/172/RdM	ESA-ASIC Design and Assurance requirements

1.3 Guideline Documents

The following documents are considered guidelines for the execution of the PA programme:

PSS-01-202	Preservation, Storage, Handling and Transportation of ESA Spacecraft and Associated Equipment
PSS-01-204	Particulate Contamination Control in Clean Room by Particle Fall-out Measurements
PSS-01-303	Failures modes, Effects and Criticality Analysis
PSS-01-401	Fracture Control Requirements
PSS-01-605	The capability approval programme for hermetic thin film hybrid circuits
PSS-01-606	The capability approval programme for hermetic thick film hybrid circuits
PSS-01-701	Data for Selection of Space Materials
PSS-01-702	A Thermal Vacuum test for the screening of space materials
PSS-01-703	Black Anodising of Aluminium with Inorganic Dyes
PSS-01-704	A Thermal Cycling test for the screening of space materials and Processes.
PSS-01-705	The Detection of Organic Contamination of Surfaces by Infrared Spectroscopy
PSS-01-709	Measurement of Thermo-Optical Properties of Thermal Control Materials
PSS-01-736	Material selection for controlling stress corrosion cracking
PSS-01-737	Determination of susceptability of metals to stress corrosion cracking
PSS-01-746	General requirements for threaded fasteners
PSS-01-748	Requirements for ESA approved skills training and certification electronic Assembly techniques.
ESA/SCC QPL	ESA/SCC Qualified Parts List
ESA-SCCG-syst.	Standards, procedures and requirements for electronic components.
RD-02	Outgassing and Thermo-Optical Data for Spacecraft Materials
FED STD-209	Clean Room and Workstation Requirements. Controlled Environment
MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-263	Electrostatic Discharge Control for EEE parts
MIL-STD-271	Requirements for non destructive testing methods
MIL-STD-883	Test methods and procedures for micro electronics
MIL-STD-981	Manufacturing and quality standards for electromagnetic devices
MSFC-HDBK-527	Materials selection list for space hardware
EN 10204	Certificates/documents in materials testing
MIL-P-55110	General specification for printed wiring boards

2 PRODUCT ASSURANCE MANAGEMENT

2.1 Programme plan

The Product Assurance approach as described in this plan is derived from the HIFI PA Plan, meant to provide guidance as well as support for engineering activities for HIFI and here extended to all DPUs-ICU.

Based upon this plan, a common approach for the product assurance activities for all DPU-ICUs in HIFI, PACS and SPIRE, will be established, agreed and maintained.

2.2 Product Assurance policy

Where necessary the three FIRST product assurance managers, and their teams, shall provide active support to system/subsystem and suppliers of the three instruments in the areas of:

Technological developments
Methods for evaluation and qualification of parts, components and/or sub-assemblies.

2.3 Organisation

2.3.1 IFSI PA

The PA manager is responsible for the implementation of the PA requirements related to the project. He is located at IFSI and reports directly to the instrument PA project managers.
In case of conflict, the instrument PA managers have access to their respective Principal Investigators.
In pure PA matters the consortia PA managers are the single point of contact for ESA and the relevant consortium members.

2.3.2 Suppliers PA

The suppliers will establish their own quality organisation, responsible for the implementation and verification of requirements as defined herein, at their own facilities and at their subcontractors.
Activities will be tailored to the specific needs and characteristics of the hardware involved and tailored to the institutes organisations.
The local PA manager reports to the local project manager. In case of a conflict between the local PA manager and the local project manager, the matter shall be taken to IFSI for resolution. The IFSI PA manager shall be consulted.

2.4 Right of access

Both ESA and the instruments consortia product assurance shall have right of access to facilities of the institutes, their subcontractors and suppliers to carry out:

audits and source inspections

witnessing of tests and inspections

review of instrument/subsystem related documentation

review of facilities

Proprietary rights shall be fully respected.

2.5 Reviews and audits

Formal project reviews will be attended by PA personnel and the relevant PA documentation will be prepared.
Progress meetings will be held regularly and PA topics shall appear on the agenda.
No audits are foreseen within the instruments consortia. However, audits may be performed on subcontractors with no previous record on manufacturing space hardware depending on the size and criticality of the subcontract.

2.6 Critical Items Identification and control

A Critical Items List will be prepared and maintained by the consortia. Critical items can be i.e. new technologies, non-qualified components or processes, limited-life items, single point failures and long-lead-time items.
The critical items shall be listed and categorized and the list shall be the baseline for critical item management within the relevant consortium.

2.7 Management of subcontractors

PA requirements as defined herein will be implemented at subcontractors, the level being dependent on the type and criticality of the subcontract and also depending on the previous quality history of the subcontractor.

2.8 Planning and documentation

PA events from the system/sub-system and suppliers will be highlighted in the instrument project planning. Plans, specifications, procedures and design documentation for the project will be reviewed for compliance with PA requirements and will be signed-off. Documents and instructions applicable to interfaces will be available for ESA for review and information if required.

PA related document requirements

1. PA related procedures

2. PA reporting including status on procurement of parts materials and components

3. PA review and surveillance reports
4. Key inspection point reports
5. Non conformances
6. Request for waiver
7. Failure notification
8. Declared parts/materials/processes lists
9. Parts Approval Documents
10. Unique materials specification
11. Unique component specifications
12. Manufacturing Plan
13. Cleanliness and contamination control plan
14. ESD control plan
15. Failure Mode and criticality analysis
16. Component stress analysis, summary
17. Critical items list
18. End item data package
19. Work Breakdown Structure/Work Package Description as part of the instrument management plan
20. Request For Approval
21. Process Identification Document

2.9 Reporting

The PA progress report will be part of the DPU/ICU progress report to the instrument consortia.

2.10 Training and certification

Only experienced technicians will be involved in manufacturing and assembly operations. If new processes and materials are applied, technicians will take part in process and assembly evaluations.
If no previous experience in manufacturing of high reliability space hardware does exist appropriate training of personnel will take place, see also ESA-PSS-748.

3 MATERIALS AND PROCESSES

3.1 Control and selection of materials and processes

Control of and selection materials and processes to be used for the project will be carried out under responsibility of the local PA manager. The instrument PA manager will monitor the selection, evaluation and the application of materials and processes for conformance with ESA ECSS-Q-70A.

3.2 Materials and processes selection

Materials to be used will preferably be selected from the following documents:

ESA PSS 01 701

ESA PSS 01 736

ESA RD-02

MFSC HDBK 527

Materials and processes shall be selected not only on basic application requirements but also on vacuum properties and previous experience.
Preferably materials and processes that have successfully been applied by the instrument consortium members to previous space projects shall be selected.

3.2.1 Vacuum properties of polymeric materials

Polymeric materials with no known vacuum properties shall be evaluated in accordance with ESA PSS-01-702.
Basic acceptable criteria are a TML of 1% and a VCM of 0.1% as a maximum

3.2.2 Materials properties and design

MIL-HDBK-5 shall be used as a baseline for mechanical design with respect to metallic materials. In any case the materials properties as defined in the procurement specification shall be interpreted and applied. Actual data as provided in delivery certificates shall not be used for design.
Evaluation of mechanical materials properties shall be carried-out if no sufficient data or no controlled procurement specification does exist.
To avoid the cost of a consuming fracture control programme, it is advised to follow the “fail-safe” design philosophy.

3.2.3 Fasteners

Fasteners of M4 and larger shall be carefully selected and specified also with respect to materials properties and load factors. See ESA PSS-01-746 for further guidelines.

3.2.4 Corrosion

3.2.4.1 Stress corrosion

Materials shall be selected on the basis of demonstrated resistance to stress corrosion cracking with respect to specific application characteristics. See ESA PSS-01-736 for further guidelines.

3.2.4.2 Corrosion protection

Corrosion protection shall be applied to all metals rated -B- for corrosion in MSFC-HDBK-527, -U- rated materials shall be investigated and -X- rated materials shall not be applied.
Protection may be provided by:

organic coatings

chromate conversion coatings or anodic conversion coatings

platings

All corrosion protection shall meet the requirements as specified in this document.

3.2.4.3 Dissimilar metals

Metallic materials which will be in contact, shall be compatible in accordance with ECSS-Q-70 or shall be suitably protected.
Materials combinations shall be selected to minimise the contact potentials and galvanic corrosion.
Protection may be established by:

placing organic materials in between the metals

chromate conversion coatings or anodic conversion coatings

platings or additional metal layers that minimise contact potentials.

3.2.5 Hydrogen embrittlement

Attention shall be given to metals that will be exposed to electroplating, welding and heat treatments, that may introduce hydrogen to the metals, in particular low alloy and high strength metals.

3.2.6 Lubricants

Not Applicable as there are no moving parts inside the DPU/ICU.

3.3 Materials and process qualification

Already existing and space qualified processes will be used. New processes and materials will be evaluated prior to application and will be qualified during qualification model acceptance testing.

Evaluation reports shall be made available to the instrument consortium for review and approval.

3.4 Materials procurement

Materials and mechanical components shall be procured to existing and recognised procurement specifications or to well defined unique specifications, the contents being dependent on the criticality of the application.
Certification to mechanical properties, composition and lot traceability for critical and/or structural materials, components and fastnerss, shall follow EN-10204-3.1.B as a minimum and inspections for inclusions, nodules and other discontinuities shall be included, where appropriate. If no established procurement specifications do exist for critical materials and components, unique specifications shall be prepared and be made available to the instrument consortium for review and approval.

3.4.1 Procurement sources

Only procurement sources with a known and rigid stores control shall be used, to safeguard traceability.

3.5 Limited shelf -life materials

Each consortium member shall establish, in line with PSS-01-722, a system to control limited shelf life materials such as adhesives, paints, potting, compounds, conformal coating, thick film pasts etc. Manufacturing date and expiring date shall be marked on all containers. Materials and/or process specifications shall provide instructions for storage and measures to extend the shelf life.

3.6 Critical processes

Application of critical processes will be either witnessed by QA and/or will be evaluated on reference samples.

Definition of critical processes

For the purpose of this document, processes are considered critical:

if the process is irreversible and the process is applied to expensive and complex assemblies

if the result of the process cannot be inspected or evaluated on component or subassembly level

if the process has a direct impact on the long term reliable operating of the instrument and adjacent equipment in the spacecraft

3.7 Printed circuit boards

The **design** standard for QM and FM printed circuit boards shall be equal.

Flight model printed circuit boards shall be designed and manufactured to meet the requirements of PSS-01-710 in conjunction with MIL-P-55110.
The referenced design standards shall be adopted to provide a reliable long-term circuit interconnection, also after component replacement and circuit modification. Boards shall preferably be procured from an ESA approved source.

3.8 Reporting and documentation on materials and processes

Declared materials lists and process lists shall be prepared by the sub-system/suppliers and their subcontractors.
The content of the lists shall meet ESA PSS-01-700. Materials and components for critical structural applications and critical processes shall be identified as such in materials and process lists.
The lists will be updated for the successive design reviews and will be reviewed by each consortium PA manager, prior to consortium acceptance and submission to ESA.

3.9 Acceptance or approval of mechanical parts, materials and processes.

The acceptability will initially be considered, based on the materials list and processes list as issued prior to the CDR. Requests for approval (RFA) will have to be issued by the users when no sufficient application or qualification history does exist and additional evaluation is required to cover the application. The RFA shall also summarise or reference the proposed evalution activities.

RFA shall be issued for all materials and processes identified after the final approval of mechanical parts, materials and processes at the CDR.

4 COMPONENTS CONTROL, SELECTION AND PROCUREMENT

4.1 Component control, selection and procurement

The selection and application of electronic and electrical parts will be monitored by PA, for implementation of project requirements. The selection, procurement and management of the consortium parts programme shall be in line with ECSS-Q-60 and shall be as defined in-here.

4.2 Definition

The following catagories may be considered as EEE components:

- General purpose EEE components and hybrids.
- Components and hybrids uniquely designed and manufactured for FIRST instruments, that will be controlled through the approach as defined in Procedure for Process Identification Document (PID) SRON-U/HIFI/PR/1999-001.

4.3 Selection

Parts and related manufacturers will be selected as much as possible from:

ESA-SCC qualified parts list

MIL-QML

The selection of non-qualified parts will be based on previous application history of parts and manufacturers. If no previous procurement history of a non qualified part is available, a dedicated evaluation programme shall be carried out.
Evaluation shall take the evaluation programmes into account for the respective parts categories as laid down in the ESA-SCC system.
Radiation degradation of parts shall be one of the selection criteria.

4.4 Quality levels

4.4.1 Micro circuits, semiconductors.

The minimum required quality levels will be as summarised in Table 1. The quoted quality levels are the minimum accepted levels for components in the instrument.
A flexible approach with respect to required Lot Acceptance Levels may be followed, depending on manufactures qualification status, manufacturers process flow and previous procurement history.
(A quality level designation is equivalent to a certain definition for required screening and lot acceptance testing, workmanship criteria and acceptance criteria, documentation and also including a certain amount of manufacturer surveillance/source control.)
The minimum quality level required for microcircuits may be given in two definitions based on either European or USA based terminology:

ESA-SCC level C but precap visual inspection and other workmanship standards to Mil-STD-883 class b.

Mil-M-38510 class b, Mil-I-38535 level class Q or Mil-STD-883 class b but wafer traceability included to allow lot acceptance testing and radiation testing.

4.4.2 Hybrid microcircuits

Hybrid micro circuits shall be procured or manufactured to ESA-PSS 01-608 from sources with a capability approval, or from sources certified to Mil-STD 1772 and/or accepted products to MIL-H-38534.
ESA PSS-01-608 and Mil-H-38534 require among other items, traceability, screening and lot acceptance testing of passive and active elements (chip components) including sample life testing, bondability testing and if necessary radiation lot acceptance on certain active elements. All parts requirements are applicable to hybrid micro-circuits.

4.4.3 Application Specific Integrated Circuits

ASIC shall be manufactured at sources with an ESA Capability Approval.
Designs shall be generated in close cooperation with the approved manufacturer and shall include the directions of ECSS-Q-60A.
Screening and Lot Acceptance will be in accordance with ESA-SCC 9000.

4.4.4 Transformers and inductors

Transformers and inductors shall be considered as EEE parts. Mil-STD-981 shall be used as a guideline for design, evaluation, manufacturing, testing and workmanship.

4.4.5 Passive parts

Passive components will be procured from qualified sources.

4.4.6 Destructive physical analyses

Destructive physical analysis shall be performed in line with ECSS-Q-60 in particular on components from non-qualified sources and on US DOD QML sources where user precap inspection has not been performed.

4.5 Space radiation

4.5.1 General purpose EEE components

As a goal for selection, components shall be radiation resistant to 20 kRAD (Si). Components with a proven sensitivity between 10 and 20 kRAD may be considered for use but lot acceptance testing shall be applied at the procurement.

When no valid data does exist for a candidate component, radiation evaluation shall be performed. No lot acceptance testing and evaluation is required for components that are guaranteed by the manufacturer for radiation hardness and for components that have a proven hardness in excess of 20 kRAD (Si).
For relevant part types Single Event Upset and/or Proton damage shall be taken into account.

4.5.2 Other Components

General purpose components and hybrids uniquely designed and manufactured for the instruments shall be evaluated for radiation also taking into account detailed sector analysis to establish the local radiation levels. Components shall be evaluated prior to actual application and on a lot to lot basis at manufacturing, prior to assembly, taking the expected radiation values and spectrum into account.

4.6 De-rating

ESA PSS-01-301 shall be applied for de-rating as apart of the design of electronic circuitry. Suggested drift and degradation parameters shall be taken into account or otherwise results of life tests or lot acceptance tests may be taken into account.

4.7 Incoming inspection

Upon arrival parts shall be inspected for:

Compliance of paper work

Visual inspection; mechanical damage, plating, corrosion

Solderability

Electrical measurements of critical parameters

Destructive physical analysis

Incoming inspection may be performed by the subcontractor who is responsible for the procurement or by a separate subcontractor made responsible for the incoming inspection only. Otherwise the self procuring user may perform the incoming inspection provided he has suitable facilities.
Performance critical parts may require a more extensive incoming inspection or characterisation. This may be satisfied by parameter data as derived from screening and lot acceptance testing. The requirement of this data shall be identified in the purchase order.

4.8 EEE parts procurement and management

It is the goal of IFSI to participate in a Common Parts Procurement managed by ESA. Detailed tasks will be defined and managed by the IFSI component procurement plan.

4.8.1 Facilities

The company or consortium member procuring parts shall have sufficient facilities relevant to the component types to be procured:

technical facilities in terms of equipment for incoming inspection, characterisation and failure analysis

sufficient knowledge of parts engineering also with respect to quality and workmanship requirements.

Data management

Generation of procurement specifications.

4.9 Documentation

All procurement and manufacturing activities will be documented, documents concerning EEE parts will be available for review by each consortium. A declared-parts list will be provided by each consortium member.

Parts lists will be the basis for the management activities from the early beginning of the project, both for the users and each consortium.

The consortium member parts lists will be the basis for parts procurement requirements for the equipment under their responsibility.

Procurement of parts will be carried out to well-defined procurement specifications either adopted from the ESA-SCC qualified parts list, ESA-SCC REF/001 (listing of all generated procurement spec. within SCC), from the Mil system for qualified parts, or self generated for non-standard parts.

Procurement specifications shall follow the SCC format, definitions, technical requirements and workmanship criteria as much as feasible.

Components and hybrids uniquely designed and manufactured for the instruments will be controlled through the approach as defined in the Procedure for Process Identification Document (PID) SRON-U/HIFI/PR/1999-001.

4.10 Procurement sources for parts

Procurement sources shall be evaluated for the following:

Availability of parts

lead time of procurement program

previous procurement history including engineering and radiation performance.

Costing

Single sources that may introduce availability risks

4.11 Component acceptance and request for approval

The acceptability of components will initially be considered based on the preliminary parts lists, as will be submitted for the ISVR and PDR.

Only for components and sources that do not have an appropriate qualification status, requests for approval documents will have to be issued by the users. Parts Approval Document (PAD) sheets will function as requests for approval.

PAD sheets will be submitted to each consortium PA organisation for evaluation and approval and shall meet the requirements and format of ECSS-Q-60

PAD shall be issued for all EEE parts identified after the final EEE parts list approval at the CDR.

Components types and sources shall be accepted by each consortium prior to the start of procurement if they are not bought trhough CPP and/or are not typical components for space electronics hardware.

Declared parts lists shall be submitted to HIFI, SPIRE and PACS for screening prior to the start of procurement.

4.12 Co-ordination of component selection

In case a CPP will not be organized, each consortium management may coordinate component selection by :

- Establishing a common components list
- Organising an instrument component users board that initiates standardisation.

Based on needs as expressed within each instrument consortium, a co-ordinated procurement activity may be considered and is highly desired.

Table 1 : Minimum applied EEE parts quality levels

SOURCE	ACTIVE	PASSIVE	REMARKS
ESA/SCC	C	C	Note 1
ER-MIL ; RESISTORS CAPACITORS SMALL INDUCTORS	NA	R	
MIL-PRF-19500	JTXV	NA	Note 2
MIL-PRF-38510	b	NA	Note 2
MIL-PRF-38535	Q	NA	Note 2
NON STANDARD	ESA-SSC level	NA	Note 1
	833 class b	NA	Note 2
HYBRID	C H	C H	ESA PSS-01-608, Note 1 MIL-PRF-38534, Note 2
RELAYS	NA	SCC level B	
CRYSTALS	NA	SCC level B	
ASIC	C	NA	ESA capability approval
Connectors		C	general purpose
		pad sheet only	filter connectors
		pad sheet only	special/cryogenic

Note 1: Mil-STD-883 class b workmanship standards
Note 2 : Including wafer lot traceability also for hybrid or multi-chip devices.

5 Cleanliness and contamination control

A general cleanliness approach and verification from component level through assembly, test, transport and storage will be defined in an Instrument Cleanliness plan.
The plan shall be based on the hardware cleanliness requirements set forth in the Instrument Interface Document part B and unit design requirements. IFSI and its sub-contractor will be responsible for its own cleanliness programme and will issue a cleanliness control procedure identifying:

- cleanliness levels versus specific hardware
- facilities available to prevent contamination
- monitoring and maintenance of facilities, also including test facilities
- cleaning processes; status and experience
- hardware flow through facilities for manufacturing, assembly and test, also including cleanliness conditions of hardware at the respective assembly and test stages.
- approach for packing and transport.

The cleanliness control procedures will be integrated in each overall instrument cleanliness plan.

5.1 Cleanliness levels.

The cleanliness levels will be based on an instrument degradation analysis and good common practice.
No specific cleanliness levels shall be provided for all metal workshop operations. As far as hand-soldering is concerned PCB's may be assembled in an area with restricted access that is kept clean. All mechanical parts, components and PCB assemblies shall be cleaned before final assembly.

5.2 Facility Monitoring.

Clean room facilities shall be monitored and maintained on a regular basis.
Test facilities for optical testing, vibration and vacuum testing shall be evaluated and maintained to meet project requirements and where this is considered necessary, contamination monitors will be included. Test facilities shall be evaluated for compliance with requirements prior to use.

5.3 Materials selection and processing

Materials shall be selected and processed in such a way as to minimise contamination.
Cleaning of hardware prior to assembly shall be such that the requirements can be met at delivery.
Cleaning fluids shall be procured to well defined materials specifications or shall be processed such that required cleanliness levels can be maintained.
Application and evaluation of cleaning processes shall not only cover cleanliness, but also possible adverse effects on materials as applied.

5.4 Bake-out.

Bake-out of components and/or assemblies, will be considered if the review of the materials as applied and the degradation analysis indicates the necessity.

5.5 Storage

All dust and molecular contamination sensitive hardware shall be covered or shielded against the clean-room environment during storage, regardless of the clean-room class.
Exposure during assembly and test shall be limited as much as possible.
Materials used for shielding or covering shall be evaluated or tested for compliance with cleanliness requirements as specified herein.

5.6 Witness mirrors and flats

Each instrument consortium will facilitate the application of witness mirrors and flats, supplied by ESA, as specified in ESA PSS-01-202, to monitor the dust and molecular contamination levels during handling, shipping and test after equipment manufacturing, where applicable. Exposed mirrors will be made available to ESA for evaluation.

5.7 Handling, preservation, marking, packing and shipping

Handling, marking, storage, packing and shipping shall be performed such as to avoid damage of the hardware. For units and assemblies to be transported, adequate shipping containers shall be used to control cleanliness and mechanical environment during transport.

6 RELIABILITY

6.1 General

Application of parts, materials and processes shall be optimised to insure optimum hardware life. Relevant analysis shall be performed and reviewed. The analysis will be initiated during the development phase and will be finalised at the respective design and delivery reviews.
Each institute is responsible for the reliability tasks to be performed for the hardware under its responsibility.
Each consortium will co-ordinate and will initiate the implementation of the results of the respective analysis into hardware, software and testing.

6.2 Failure modes effects and criticality analysis

A FMECA will be carried out parallel to the design activity. The results will be reviewed and will be included in the design.
The FMECA will be carried out on the level of basic functions and assemblies to identify single point failures and to support redundancy considerations.
On board software and instrument test software shall be included in the analysis.
Single Point Failures (SPF) shall be reduced as much as possible.
SPF shall be identified on the Critical Item List as defined in par. 2.6 of this document.

6.3 Worst case analysis

Worst case analysis will be carried out on critical performance parameters as a part of the design activity. Radiation degradation effects will be included.

6.4 Parts de-rating and stress analysis

ESA PSS-01-301 will be applied for the application of EEE parts. Parts stress analysis will be carried out as a part of the design activity and a summary will be included in the design descriptions.

7 SAFETY

7.1 General

In co-operation with each consortium, hazards with respect to ground operations will be identified and appropriate actions will be taken.
During the project, safety data supporting safety reviews will be provided to ESA.

8 QUALITY ASSURANCE

8.1 General

8.1.1 Quality assurance organisation

IFSI PA manager will be responsible for the implementation of QA requirements at the institute, subcontractors, suppliers and service.

8.1.2 Specification review and preparation

QA personnel will take part in the actual preparation of material, component, process or manufacturing specifications in close co-operation with designers or test engineers. In all cases the PA manager shall review and approve the specifications to safeguard the PA requirements.

8.2 Procurement

Procurement sources will be selected from those having shown an adequate quality assurance system. All manufacturers and suppliers shall preferably have previous experience in supplying space-qualified items or materials. Procurement documents and purchase orders will be reviewed for implementation of PA requirements.

8.2.1 Supplier and manufacturer surveillance

Survey of facilities and product assurance systems will be carried out for critical materials, processes and services. The degree of quality assurance surveillance will depend on the evaluation of the company, its past record, its present performance and the complexity and degree of criticality of the goods it is supplying for the project.

8.2.2 Incoming inspection

All materials, services, components and assemblies will be inspected for compliance with the purchase orders. The level of incoming inspection will depend on the procurement history and will also depend on the applied quality assurance provisions and surveillance. Inspection records shall be maintained.

8.3 Manufacturing control, inspection

8.3.1 Documentation

Manufacturing and testing of all deliverable equipment shall be supported by manufacturing documentation that will give full traceability for required and used parts, materials, components, processes and procedures.
The minimum content of the documentation will be:

Detailed assembly and test flow, defining handling, inspection and test sequences.

Drawings, defining the items to be manufactured incl. materials/process requirements.

Parts lists, defining materials, parts and components to be used for a particular drawing.

Kit list, showing traceability of actual kitted materials, parts and components.

Shop travellers, manufacturing and inspection records. QA will give support for the implementation of project requirements.

8.3.2 Workmanship standards

Workmanship standards may follow in-house standards or definitions. Existing standards issued by ESA or US-DOD may be adopted when no satisfactory in-house standards do exist.

8.3.3 Process and material identification

All drawings issued will show a correct application and identification of materials and processes and shall be approved by QA prior to release for manufacturing.

8.3.4 Special tools and equipment

Special tools such as wire strippers, crimping tools, wire bonding equipment etc., shall be traceable to periodic inspection. The serial numbers of those tools or equipment shall be recorded on the manufacturing record.

8.3.5 Electrostatic discharge protection

Electrostatic discharge protection measures such as wrist wraps, conductive floormats and seat covers will be utilised during electronics assembly and test. Electronic parts and assembled boards will be stored in antistatic packing materials.
Each institute shall issue or adopt an electrostatic discharge control plan and associated procedures that shall be based on MIL-HDBK-263, depending on the ESD class of applied parts.

8.3.6 Inspection

The institutes will be fully responsible for the inspection and test of hardware, manufactured under their responsibility. Inspection points shall be in the local AIV flow which is part of the overall instrument AIV flow.
Quality assurance personnel will inspect all deliverable hardware and will monitor tests on critical components, printed circuit boards, assemblies and equipment.

8.3.7 Key Inspection Points (KIP) and Mandatory Inspection Points (MIP).

Definitions:

KIP: A KIP is a quality assurance inspection point at a crucial moment in the sequence of the manufacturing and assembly flow.

MIP: A MIP is a quality assurance inspection point at a crucial moment in the sequence of the manufacturing and assembly flow for which the instrument PA and/or ESA PA or their representatives participate in KIP.

A KIP will be identified in the manufacturing/assembly flow at the following events:

when critical processes are performed.

when the next assembly step renders to inaccessibility.

processing or installation of safety critical items.

at the end of manufacturing, prior to box closure.

A KIP shall be clearly identified in the relevant hardware planning available to the consortium management and shall be executed in accordance with KIP and MIP consortium documents.
Upon the discretion of the instrument PA and ESA, a MIP may be identified.
MIP shall in parallel be identified to both ESA and the instrument PA at least 5 working day's prior the event.

8.3.8 Metrology and calibration

A metrology and calibration system shall be maintained assuring that all measuring equipment concerned is regularly serviced and calibrated and is kept in optimum and operational condition.
Measuring instruments shall be clearly marked with:

a clear indication whether or not the instrument is included in a calibration system.

the last and next date for maintenance and calibration.

Maintenance and calibration shall be performed on the basis of manufacturer directions, experienced stability and frequency of use.
All calibration of measuring instruments shall be traceable to national or international standards.

8.3.9 Quality and traceability

From the finished components to the finished equipment, critical materials and limited shelf life materials shall be traceable to manufacturers lot/batch number. All other materials shall be traceable to bonded store. Active electronic parts shall be traceable to lot number and shall be, depending on the required quality level in respective purchase orders, also be traceable to a serial number. All other parts will be traceable to lot number. Processes shall be traceable in the manufacturing records.

8.3.10 Stores control

Controlled stores will be maintained for all materials, components and parts to be used for deliverable

hardware, and shall be covered by a suitable administration.
Separate stores will be maintained for accepted goods, goods that have not yet been inspected and for rejected goods.

8.4 Integration and test control

Test activities will be executed as part of the AIV program.

8.4.1 Test procedures

All qualification- and acceptance tests will be documented in test procedures.
The minimum contents will be:

Hardware configuration under test.

Test objective.

Test sequence

Test parameters.

Accept/reject criteria.

Used test equipment and facilities.

Environmental conditions.

Hazards (if any).

8.4.2 Test witnessing

Critical development tests and formal qualification and acceptance tests will be monitored or witnessed by QA personnel to ensure that relevant procedures are followed and to give direct technical support when problems occur.

8.4.3 Reviews

Test Readiness Review Board (TRRB):
A test readiness review will be held before the start of unit, sub-system and/or system qualification/acceptance testing.

Main topics are:
-As-designed status
-As built status
-Hardware status incl. open work
-Test plan and procedures
-Results of test-facility reviews

Meeting place: At the premises of the party responsible for the delivery.
The TRRB shall be performed in accordance with each instrument requirements.

Test Review Board/ Delivery Review Board (TRB/DRB):
A test review board and/or delivery review board will be held after qualification/acceptance testing and before delivery (shipment).

Main topics are:
- -As-designed Status
- -As tested Status
- -Test results
- -Non-conformances detected during testing
- -End Item Data Package (for DRB only)

Meeting place: At the premises of the party responsible for the delivery.
The TRB/DRB shall be performed in accordance with each instrument requirements.

Definition: A delivery is a transfer of responsibility related to hardware and software.

Transfer means:
- institute to institute
- Institute to consortium
- Consortium to ESA

The following disciplines will be represented in the review boards:
project management, engineering, AIT and product assurance.
ESA will be invited to participate at review boards on unit, sub-system and system level.
The participants will be notified at least one week before the event.

8.4.4 Historical record (logbook)

Equipment logbooks will be established for all operations and tests starting with the unit TRRB. The logbook shall accompany the hardware at all times.

8.5 Non-conformances Control

A non conformance control system will be operated from the start of the manufacturing and test of qualification model hardware.
The processing of non-conformances, tailored to each consortium requirements, is reflected in a proper document.

8.5.1 Non-conformance definition

Definition: A non-conformance is a deviation which can not be reworked to the original specification and/or configuration.

8.5.2 Non-conformance classification

The following categories are recognised within the control system. The categories are based on the category definition of each instrument document breakdown.

Category 1: NCR's affecting ESA requirements
Category 2: NCR's affecting the instrument system and sub-system requirements
Category 3: NCR's affecting Unit requirements
Category 4: All other NCR's.
In case of any doubt, the next higher category should be selected.

Non-conformances detected on flight standard EEE components are classified per definition category 2.

8.5.3 Material review board (MRB)

Non-conformances shall be recorded, administrated and transmitted to the parties concerned from the moment of occurrence and not later than two days.
The material review board will determine the appropriate disposition with respect to the non-conforming article.
The composition of the MRB depends of the category of the NCR involved.
Basic MRB composition:

PA manager (chairman)

project manager

engineering and or system engineering representatives

representatives from the next higher organisational levels

specialists or consultants

For NCR's classified as category 1, ESA will be invited to participate the MRB.

8.6 Acceptance and delivery

All hardware and software deliverable items will finally be submitted for acceptance to ESA. The hardware will be first accepted by the integrating institution on the basis of a mutual agreed acceptance

test program. The responsibility of the transport lies with the party responsible for the supply. Before shipment of a deliverable item, a formal DRB as defined in par.8.4.3 will take place.

8.6.1 End Item Data Package

It is the purpose of the End Item Data Package (EIDP) to provide the next higher integration level with sufficient information to do their work without continuos support of the supplying party.
The EIDP will contain the information as defined in accordance with each instrument requirements and shall be available at the hardware delivery.