SPIRE Calibrators & Filters

Product Assurance Plan

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List of Acronyms

Term	Meaning	Term	Meaning
AD	Applicable Document	IR	Infrared
ADC	Analogue to Digital Converter	IRD	Instrument Requirements Document
AIV	Assembly, Integration and Verification	IRTS	Infrared Telescope in Space
AME	Absolute Measurement Error	ISM	Interstellar Medium
AOCS	Attitude and Orbit Control System	JFET	Junction Field Effect Transistor
APART	Arizona's Program for the Analysis of Radiation Transfer	ISO	Infrared Space Observatory
APE	Absolute Pointing Error	LCL	Latching Current Limiter
ASAP	Advanced Systems Analysis Program	LIA	Lock-In Amplifier
ATC	Astronomy Technology Centre, Edinburgh	LVDT	Linear Variable Differential Transformer
AVM	Avionics Model	LWS	Long Wave Spectrometer (an instrument used on ISO)
BDA	Bolometer Detector Array	MAC	Multi Axis Controller
BFL	Back Focal Length	MAIV	Manufacturing, Assembly, Integration and Verification
BRO	Breault Research Organization	MCU	Mechanism Control Unit = HSMCU
BSM	Beam Steering Mirror	MGSE	Mechanical Ground Support Equipment
CBB	Cryogenic Black Body	M-P	Martin-Puplett
CDF	Cardiff, Department of Physics & Astronomy	NEP	Noise Equivalent Power
CDMS	Command and Data Management System	NTD	Neutron Transmutation Doped
CDMU	Command and Data Management Unit	OBS	On-Board Software
CDR	Critical Design Review	OGSE	Optical Ground Support Equipment
CEA	Commissariat a l'Energie Atomique	OMD	Observing Modes Document
CMOS	Complimentary Metal Oxide Silicon	OPD	Optical Path Difference
CoG	Centre of Gravity	PACS	Photodetector Array Camera and Spectrometer
CPU	Central Processing Unit	PCAL	Photometer Calibration source
COM	Cryogenic Qualification Model	PFM	Proto-Flight Model
CVV	Cryostat Vacuum Vessel	PID	Proportional, Integral and Differential (used in the context of feedback control loop architecture)
DAC	Digital to Analogue Converter	PLW	Photometer, Long Wavelength
DAQ	Data Acquisition	PMW	Photometer, Medium Wavelength
DCU	Detector Control Unit = HSDCU	POF	Photometer Observatory Function
DDR	Detailed Design Review	PROM	Programmable Read Only Memory
DM	Development Model	PSW	Photometer, Short Wavelength
DPU	Digital Processing Unit = HSDPU	PUS	Packet Utilisation Standard
DSP	Digital Signal Processor	RAL	Rutherford Appleton Laboratory,
DQE	Detective Quantum Efficiency	RD	Reference Document
EDAC	Error Detection and Correction	RMS	Root Mean Squared
EGSE	Electrical Ground Support Equipment	SCAL	Spectrometer Calibration Source
EM	Engineering Model	SCUBA	Submillimetre Common User Bolometer Array
EMC	Electro-magnetic Compatibility	SED	Spectral Energy Distribution
EMI	Electro-magnetic Interference	SMEC	Spectrometer Mechanics
ESA	European Space Agency	SMPS	Switch Mode Power Supply
FCU	FCU Control Unit = HSFCU	SOB	SPIRE Optical Bench
FIR	Far Infrared	SOF	Spectrometer Observatory Function
FIRST	Far Infra-Red and Submillimetre Telescope	SPIRE	Spectral and Photometric Imaging Receiver
FOV	Field of View	SRAM	Static Random Access Memory
F-P	Fabry-Perot	SSSD	SubSystem Specification Document
FPGA	Field Programmable Gate Array	STP	Standard Temperature and Pressure
FPU	Focal Plane Unit	SVM	Service Module
FS	Flight Spare	TBC	To Be Confirmed
FTS	Fourier Transform Spectrometer	TBD	To Be Determined
FWHM	Full Width Half maximum	TC	Telecommand
GSFC	Goddard Space Flight Center	URD	User Requirements Document
HK	House Keeping	UV	Ultra Violet
HOB	Herschel Optical Bench	WE	Warm Electronics
HPDU	Herschel Power Distribution Unit	ZPD	Zero Path Difference
HSDCU	Herschel-SPIRE Detector Control Unit		
HSDPU	Herschel-SPIRE Digital Processing Unit		
HSFCU	Herschel-SPIRE FPU Control Unit		
HSO	Herschel Space Observatory		
IF	Interface		
IID-A	Instrument Interface Document - Part A		
IID-B	Instrument Interface Document - Part B		
IMF	Initial Mass Function		

Table of Contents

1. Scope

This document describes the Product Assurance procedures and activities to be applied to all deliverables from Cardiff University to the SPIRE project. It covers the Photometer Calibrator (PCAL), the Spectrometer Calibrator (SCAL), and all filters, beam splitters and dichroics for each instrument model from design through to delivery to the project. It is also applicable with limited scope to all GSE provided by Cardiff.

2. Documents

2.1. Applicable Documents

All applicable documents are listed in the AD chapter of the CIDL (HSO-CDF-LI-029).

2.2. Reference Documents

3. Product Assurance Management

3.1. General

This PA plan has been established in accordance with ESA requirements and tailored to meet the needs of the Cardiff program. It is applicable to Cardiff deliverables as shown in Table 1.

Chapter #	PA Requirements	Cardiff SPIRE components (PCAL, SCAL, Filters)				GSE
		STM	CQM	PFM	FS	
3	PA Management	P	A	A	A	P
4	Materials & Process Selection & Control	A	A	A	A	P
5	EEE Parts Control	A	A	A	A	N/A
6	Cleanliness & Contamination	N/A	A	A	A	N/A
7	Reliability Assurance	A	A	A	A	P
8	Safety Assurance	A	A	A	A	A
9	Quality Assurance	P	A	A	A	P
10	Software PA	N/A	N/A	N/A	N/A	P
11	Configuration Management	P	A	A	A	P

Table 1 Applicability of PA program to Cardiff deliverables.

3.2. Organization

Cardiff does not have a dedicated PA manager. The Cardiff SPIRE project manager will carry out all PA requirements related to SPIRE. There is a high degree of commonality in the PA requirements for SPIRE and for PLANCK-HFI, and so the SPIRE and HFI project managers will work closely and implement a common PA plan

3.3. Right of Access

For the purpose of product assurance or technical coordination, ESA, the SPIRE instrument systems team, and the SPIRE PA manager will have access to Cardiff facilities whenever required. A formal demand will be required one week prior to the visits to enable access to the facilities to be arranged.

3.4. Critical Items Identification & Control

A Critical Item List (CIL) will be prepared and maintained, ensuring that all critical items derived from the different PA disciplines are followed up with the required emphasis. This list will be presented at the CDR phase, and updated throughout the project life.

3.5. Management of Subcontractors

Whenever contractors are employed to provide services or equipment, the PA requirements listed in this plan will be imposed on those contractors appropriate to the criticality of the services or products being provided.

Surveillance of PA activities will be carried out by the PA amnager or delegated deputy, who will ensure that appropriate inspections, tests and documentation are specified and completed. Contract reviews will include suitable examination of PA related matters.

Contractors shall be assessed on the basis of their PA system in addition to their technical capability. A PA plan shall be requested where appropriate.

3.6. PA Planning & Documentation

This PA plan will be a controlled document, and should be approved by the Cardiff and SPIRE PA managers. All project documents (plans, specifications, procedures, design documentation etc.) will be reviewed for compliance with this plan, signed-off and submitted to configuration control.

PA events will appear in the project planning. This planning will be updated on a regular basis and sent to a higher level for review.

3.7. Reporting

Reporting on the progress and status of PA matters will form part of the regular project reporting procedure, and will include information on:-

- Status of FMECA and hazard analysis
- Status of material & processes control program
- Status of NCRs and RFWs

- Status of contamination control program
- Overview of major events in the forthcoming period

3.8. Training & Certification

Cardiff will ensure that only experienced technicians will be involved in manufacturing and assembly operations. The technician's level of competence will be evaluated before the beginning of operations, and where necessary, they will be sent on training courses and certification programs. Cardiff may also subcontract some assembly procedures to RAL – e.g. we may use ESA certified soldering technical staff at RAL for wiring.

4. Materials & Process Selection & Control

4.1. General

The Cardiff PA manager has the responsibility for selecting materials and processes, and for demonstrating their suitability for the intended application.

4.2. Control & Selection of Materials & Processes

Preference will be given to materials and processes that have successfully been used in previous space projects. Materials and processes that cannot be considered either space proven or standard/established shall be subjected to an evaluation program to assess the suitability for the intended application. This program will be submitted to the upper level PA manager for approval. Evaluation reports will be issued after qualification.

4.3. Materials Procurement

Materials procurement will be made in accordance with dedicated specifications. Certification of mechanical properties, chemical composition and lot traceability will be included as a minimum.

4.4. Limited Shelf Life Materials

A system to control limited shelf life materials will be established.

4.5. Critical Processes

The PA manager or his representative will witness application of critical processes. Alternatively, application of critical processes may be evaluated on reference samples.

4.6. Reporting & Documentation on Materials & Processes

A Declared Materials List (DML) and a Declared Processes List (DPL) will be issued and submitted for the approval of the upper level PA manager.

4.7. Request for Approval

A Request For Approval (RFA) will be issued when no sufficient application or qualification data does exist and additional evaluation is required to cover the application. The RFA will summarise the proposed evaluation activities.

5. EEE Parts Selection & Control

This chapter is not applicable in the scope of the Cardiff involvement in the project. The identified EEE parts are heater resistors, thermometers and connectors. All EEE parts procurement and management is being handled by RAL, using Technologica as procurement agents.

6. Cleanliness & Contamination Control

6.1. General

The Cardiff PA manager is responsible for monitoring contamination and cleanliness of the Cardiff deliverables throughout the project up to delivery to higher level. MAIV phases will be defined taking into account these requirements.

6.2. Cleanliness Plan

A cleaning procedure and cleanliness plan, taking into account the cleanliness and contamination requirements, will be issued.

6.3. Contamination & Cleanliness Monitoring

Assembly of all flight hardware will take place in a class 10,000 or better clean room.

6.4. Storage

All flight hardware will be protected during non-activity phases. Hardware will be stored temporarily in class 100 laminar flow cabinets, or long term in nitrogen purged boxes in secure areas.

6.5. Witness Mirrors & Flats

No means to monitor cleanliness and contamination is forseen.

6.6. Handling, Packing & Shipping

Handling, packing and shipping will be performed such as to avoid any damage to flight hardware and to ensure the requirements on cleanliness and contamination are met. A dedicated procedure will be issued.

7. Reliability Assurance

7.1. General

Cardiff is responsible for the reliability tasks to be performed for its hardware.

7.2. Reliability Analysis

Analyses will be performed, using both industry standard reliability prediction software and by experiment, and reviewed.
The minimum analysis to be performed on flight hardware is:-

FMECA
Reliability block diagram
Fault tree analysis

Identified critical points and/or single point failures resulting from these analyses will be listed in the critical items list (CIL).
Several mathematical models, developed in-house, will also be used in the reliability analysis procedure.

8. Safety Assurance

8.1. General

8.2. Safety Assurance Analysis

9. Quality Assurance

9.1. General

9.2. Procurement

9.2.1. Selection of Procurement Sources

9.2.2. Procurement Documents

9.2.3. Surveillance

9.3. Manufacturing & Assembly Control

9.3.1. Documentation

The manufacturing and assembly processes will be analysed and the sequence of the various steps thoroughly planned. The Cardiff PA manager (or representative) will perform surveillance of manufacturing and assembly activities, by means of inspection, for critical parameters of the processes, and ensure satisfactory workmanship.
Manufacturing and assembly of flight hardware will be supported by appropriate documentation to ensure full traceability. This documentation will comprise as a minimum:-

- MAIV flow chart detailing relevant inspections
- Drawing list
- Declared materials and parts list
- Declared processes list
- Manufacturing and inspection records

9.3.2. Reviews

Formal reviews will be held prior to release of drawings for manufacture.

9.3.3. Metrology & Calibration

All tools and measuring equipment used for flight hardware manufacture will be submitted to a calibration program. They will also be marked with a serial number and the last & next dates for calibration & maintenance.

9.3.4. Inspection Points

KIP and MIP will be identified in the MAIV flow charts and will be reported in the associated planning so that upper level QA representatives will be kept informed and could attend these inspection points if desired.

9.3.5. Storage

Dedicated secure storage areas will be used to store all materials and components for flight hardware. These areas will only be accessible to authorised personnel.

9.4. Integration & Test Control

9.4.1. Test Procedures

9.4.2. Test Witnessing

9.4.3. Reviews

9.4.4. Test Reports

9.4.5. Logbook

9.4.6. Handling, Storage, Packaging, Marking & Labeling

9.5. Non-Conformance Control

9.5.1. General

9.5.2. Non-Conformance Definition & Classification

9.5.3. Non-Conformance Control System

9.5.3.1. Non-Conformance Detection

9.5.3.2. Internal MRB

9.5.3.3. Action Propositions

9.5.3.4. Upper Level Notification

9.5.3.5. External MRB

9.5.3.6. Performing of Actions & Controls

9.5.3.7. Change Proposal

9.5.3.8. Closure

9.5.3.9. NCR from a Subcontractor

9.5.3.10. NCR Database

9.5.3.11. NCR Reporting

9.6. Acceptance & Delivery

9.6.1. Delivery Review Board

9.6.2. Acceptance Data Package

10. Software Product Assurance

Not applicable in the scope of this project.

11. Configuration Management & Control

11.1. General

A configuration management system will be issued to provide systematic and uniform configuration identification, control, and accounting of a deliverable item throughout design, manufacture and testing, up to and including acceptance by the upper level authority.
The system will be based around an ACCESS (Microsoft) database which will store all documentation and track all components from design through to delivery.

11.2. Configuration Items

Cardiff configuration items include:-

- Deliverable items
- Relevant documentation (applicable documents and project documents)

In addition. the database will store and track all design information (drawings etc) and test reports for all project related items, including GSE and special tools.

11.3. Configuration Items Data List (CIDL)

For each deliverable item, a CIDL will be issued. This CIDL will be composed of:-

- List of applicable documents
- List of drawings
- List of project documents
- List of NCRs
- Configuration file of the deliverable item

This list will be updated for each review and will give the current status of the deliverable item.

11.4. Documentation Control

11.4.1. Identification

Documentation generated by Cardiff will be referenced as explained below:-

HSO-CDF-xxx-nnn-I-R

Where:-

HSO	-	Project
CDF	-	Cardiff
xxx	-	Document type (see Table 2 below)
nnn	-	Sequential number from the documentation database
I	-	Issue of the document
R	-	Revision of the document

Table 2 Document Identification

FC	Flow Chart
ICD	Interface Control Document
LI	List
MoM	Minutes of Meeting
PL	Plan
PR	Procedure
QA	Quality Assurance
RP	Report
SP	Specification
TN	Technical Note

11.4.2. Storage

Cardiff project documents will be stored using their Cardiff reference as the file name.
Documents under configuration control will be stored in a dedicated directory so that they can only be accessed in read-only mode. Changes can only be made to configured documents by authorised personnel with password access.

11.4.3. Backup

Weekly back-ups will be made on CD-ROM.

11.5. Approval Procedure

11.6. Configuration Status Accounting

11.7. Change Processing

11.8. Implementation Verification