Herschel/SPIRE **SPIRE-MSS-PRJ-001020**

MULLARD SPACE SCIENCE LABORATORY
UNIVERSITY COLLEGE LONDON **Author: A Dibbens**

SPIRE – PRODUCT ASSURANCE PLAN

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Author:	T Dibbens	Date:
Checked:	C Brockley-Blatt	Date:
Approved:	B Winter	Date:

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1. INTRODUCTION

This document presents the Product Assurance Plan which has been designed so that the MSSL contribution to the Herschel/SPIRE mission, as specified by ESA, can be met. It details the product assurance organisation and program plan which is to be used by MSSL and the methods by which the requirements of the Project will be achieved.

2. APPLICABLE AND REFERENCE DOCUMENTS

IID A
IID B

ECSS-Q-20A	ESA Quality Assurance
PSS-01-70	Material and Process Selection and Quality Control for ESA Spacecraft and Associated Equipment
PSS-01-700	The Technical Reporting and Approval Procedure for Materials and Processes
PSS-01-701	Data for the Selection of Space Materials
NASA RP-1124	Outgassing Data for Selecting Spacecraft Materials
MSSL/PA/PS/Q001	Change Control System

General Product Assurance

PX-RS-0017 Product Assurance Requirements for XMM Experiments

Quality Assurance

PSS-01-20 Quality Assurance of ESA Spacecraft and Associated Equipment
PSS-01-201 Contamination and Cleanliness Control
XMM-OM/MSSL/SP/0027 Cleanliness Control Plan
FED-STD-209D Clean Room and Work Station Requirements, Controlled Environment

3. GENERAL REQUIREMENTS

3.1 Organisation

MSSL has appointed a product assurance manager for the instrument. The PA manager shall be responsible for the implementation of the PA requirements related to the project at MSSL and will work directly with the instrument project manager. In case of conflict, the PA manager has direct access to MSSL management. The consortium PA manager will be involved in:-

1. Establishing procedures relating to the quality plan and based on requirements from ESA
2. Interfacing between MSSL and the PI on quality matters and parts procurement
3. Witnessing hardware inspections and instrument testing
6. Supporting consortium reviews

The Instrument Manager is the sole formal point of contact between MSSL and the PI. All communications relating to PA matters will be routed from the Project Manager to the Instrument PA manager.

3.2 Product Assurance Planning and Documentation

PA events 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 subject to a sign-off procedure if critical. Documents and instructions applicable to interfaces will be available for ESA for review and information, as required.

3.3 Contractor and Supplier Surveillance

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 experience of the subcontractor. Regular contract reviews will be held and will include product assurance matters.

3.4 Status Reviews, Facility Reviews

Formal project reviews will be attended by PA personnel and the relevant PA documentation will be prepared. Visibility in implementation of PA requirements will be provided to ESA at design reviews and progress meetings.

Where necessary, tools and calibrations will be checked before and during periods when major manufacturing is taking place. Otherwise materials, facilities, equipment, services will be checked as part of the normal operations. Documentation will be reviewed when a job is released for manufacture. A similar requirement will be placed on external contractors that the above items will be checked prior to manufacture of items under that contract. The statements made by the contractor under this requirement will be reviewed as part of the regular contract meetings if appropriate, or if the statements made by the contractor are inadequate, a formal facility review will be made. ESA will be invited to attend these reviews if the results are critical to the project.

3.5 ESA Participation in Inspections and Tests

For the purposes of Product Assurance and technical co-ordination, ESA will be allowed access to MSSL in-house facilities, given adequate notice. It is not planned to allow ESA access to any contractor for complete Q.A. audits.

The proprietary rights of MSSL and all third parties will be fully respected by ESA.

3.6 Product Assurance Progress Reporting

Internal project progress meetings will be held regularly and PA topics shall appear on the agenda.

4. QUALITY ASSURANCE

4.1 General

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

4.2 Procurement Controls

Orders are usually placed by senior research/engineering or technical staff. They are trusted to act responsibly and with reference to relevant guideline documents and lists of preferred parts and materials. Quality assurance provisions shall be defined in purchase orders and contracts, that are adequate to ensure and to verify/document that all requirements of the procurement specification are met. Copies of orders are kept and are available for examination by P.A. staff at their discretion. Suppliers will be required to provide adequate documentation to support their deliverable items.

4.3 Incoming inspections

Incoming inspections are carried out by the individual placing orders or by delegated technical staff. Special attention shall being given to handling, visual inspection and measurements to confirm agreement with details specified on the order. e.g. cleanliness, interface measurements etc.
Following inspection care shall be taken:-

1. to place components and materials in appropriate storage.
2. to file Certificates of Conformance and other documents of identification to facilitate traceability

4.4 Surveillance of Manufacturing/Integration

Manufacturing, assembly and integration shall be the responsibility of the technical staffs of the workshops and laboratories who are under the surveillance of the senior research/engineering staff who appoint them. The competence and dedication of technical staff shall be continually monitored by supervising staff. Inspection of items shall be carried out before any procedures occur that would prevent subsequent inspection, e.g. sleeving, assembly of small subsystems into a larger configuration etc. Mandatory inspections may be prescribed on the drawings in special cases only.

4.5 Test Witnessing, Pre-test, Post-test Review

QA personnel shall be involved in planning and execution of critical development and formal qualification and acceptance tests. It is not planned that QA personnel shall witness all tests.
Before the start of formal tests, a test readiness review will be held. The post-test review will be part of a regular project progress meeting.
ESA has the right to witness formal tests.

4.6 Logbooks and Traceability

Equipment logbooks shall be established for all operations and tests starting with the final inspection of the hardware after the manufacturing/assembly phase and shall include the following items:-

1. Historical record sheets, typically
   dates of operations/test/transport
   name of operation/test/transport from/to

applicable procedure and/or report
responsible organisation and signature for entry
remarks e.g. on NCRs or unplanned events

2. Operating time/cycle record for limited life items
4. Temporary installations record
5. Open work/deferred work records

The log books shall accompany the hardware and form part of the Acceptance Data Package.
Critical materials and limited shelf life materials shall be traceable to manufacturers' lot/batch number.
Processes shall be traceable in the manufacturing records.

4.7 Cleanliness and Contamination Controls

A detailed cleanliness control plan has been prepared, reference XMM-OM/MSSL/SP/0027. This document has identified the requirements for cleanliness and the controls that shall be applied to achieve them. Facilities shall be provided to control the environmental cleanliness of Instrument hardware during manufacturing and test.

4.8 Non-conformance Control.

4.8.1 Definitions

NCRs shall be defined as **MAJOR** or **MINOR**.

MAJOR NCR: A non conformance or failure shall be defined as MAJOR if it affects an aspect of the instrument as defined below:-

1. Safety
2. Cleanliness: General Instrument cleanliness and materials outgassing, including magnetic cleanliness, where applicable.
3. Mechanical

Mass, moment of inertia, centre of gravity, mountings, instrument envelope
Mechanical performance relevant to the mechanical behaviour of the payload

4. Thermal
5. Processes and materials for electrical, mechanical and thermal interfaces

MINOR NCR: A non conformance or failure will be defined as MINOR if it does not affect the aspects of the instrument as defined above. It must be inconsequential as regards the requirements and must not influence fitness for use and safety. Alternatively it must be trivial with regard to workmanship criteria applicable to deliverable items.

4.8.2 Components

All component failures after delivery from the supplier will be classified as MAJOR, except at incoming inspection where the following non-conformances may be classified as MINOR:-

- random failures where no risk for a lot related or quality problem exists.
- minor inconsistencies in delivered documentation.

4.8.3 Ground Support Equipment

Non-conformances on GSE will be treated as MAJOR only if safety is involved and the non-conformance occurred in formal acceptance testing.

4.8.4 Reporting of NCRs

The report on all NCRs will contain the following information:-

1. Unique NCR number
2. Identification of the non conforming item
3. Date and time of occurrence

4. Inspection or test and description of environmental conditions if relevant
5. Description of non-conformance
6. Cause of non-conformance as far as is already known
7. Immediate actions taken or proposed
8. Remarks on schedule etc.

A notification report on all MAJOR NCRs shall be submitted to ESA within 10 working days of occurrence and will contain as much of the above information as possible.
The final NCR report shall contain the above items plus full information on failure analysis and actions to be taken to correct them. Any relevant actions to avoid reoccurrence will also be reported.
MAJOR NCRs shall be signed off only by the Instrument QA manager and the Instrument Manager.
MINOR NCRs will be treated in the same way, except that ESA will not be informed as a matter of course. Documentation on minor NCRs will be made available to ESA at convenient times, e.g. at formal instrument reviews.
The NCR approval procedure is shown in Figure 4.8.5.
ESA will be invited to attend any Material Review Board on MAJOR NCRs.

4.9 Metrology and Calibration

All measuring instruments shall be carefully used and stored in order to avoid impairment of their original accuracy. Measuring instruments shall be selected to be appropriate in quality and accuracy for the task in question. For some critical tasks, where it is judged necessary, a special instrument shall be purchased of the type, quality, and accuracy needed, or a special calibration of an otherwise suitable existing instrument will be arranged, either in-house or by a suitable contractor.

4.10 Handling, Storage, Packaging, Marking and Labelling, Transportation Control.

Handling, storage, packaging, marking/labelling and transportation shall be performed such as to avoid damage/degradation of the hardware. Procedures shall be written and used for these activities.
Implementation of the procedures will be monitored by PA personnel.
For transportation of units and assemblies, adequate shipping containers shall be used to control cleanliness and extremes of humidity, temperature, pressure and vibration/shock.
Labelling of boxes for packaging, storage and transport shall include:-

1. nomenclature, model name and serial number (if appropriate) of the item
2. cleanliness level, packing integrity indication
3. caution/warning notes for dangerous or toxic contents
4. package orientation arrows
5. for large items, weight and centre of gravity, handling and lifting points
6. conditions and instructions for handling and unpacking
7. name, address, phone number of sender and recipient

4.11 Alerts

The nominated PA Manager shall be the central point of contact for ALERTS.

NCR Procedure Flow Chart

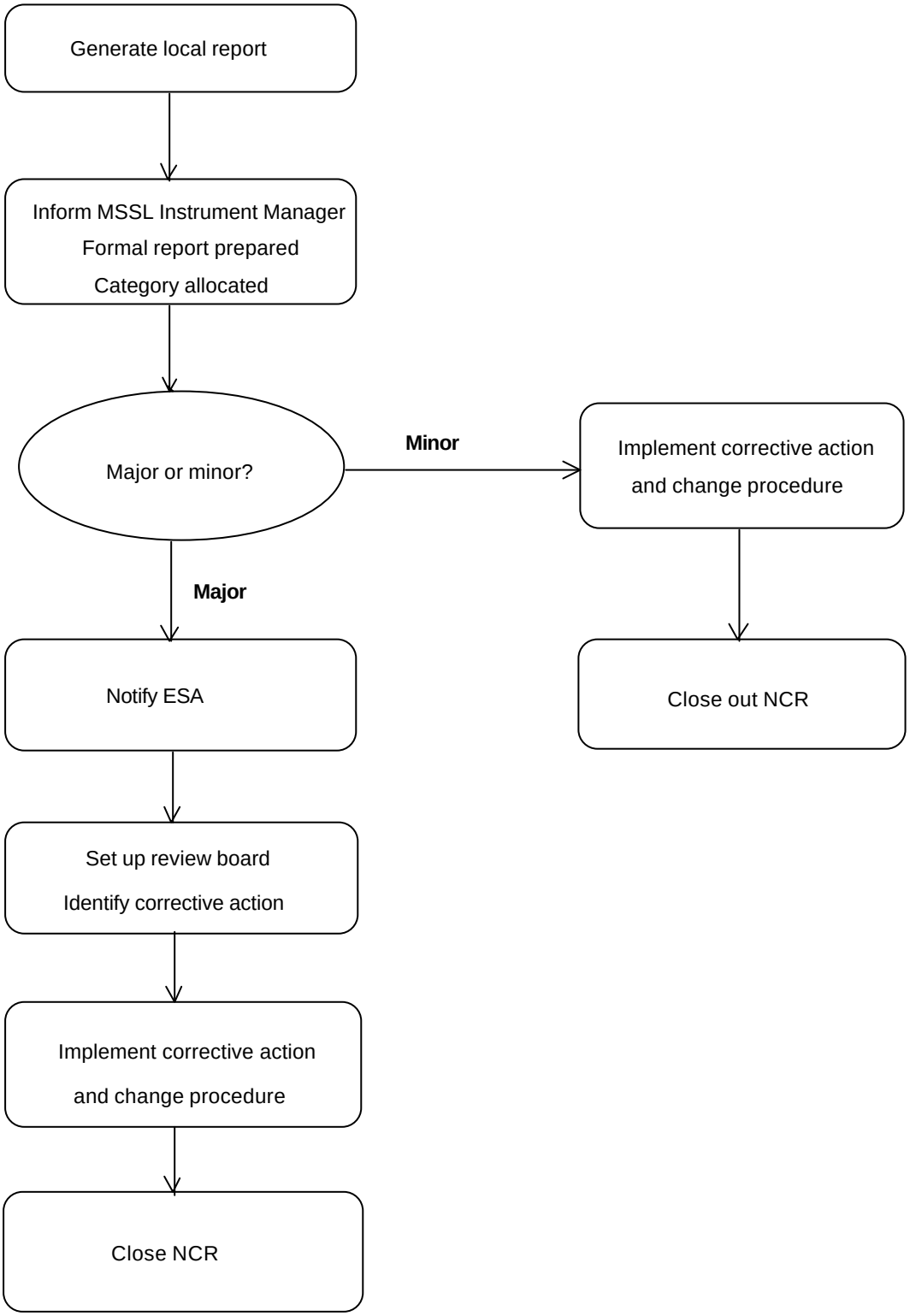

Figure 4.8.5

5. RELIABILITY ASSURANCE

It is fundamental to reliability that the instrument design shall be designed and developed on sound principles established by a background of experience and then proven by test. Goals for orbital life may be specified. The process begins with appropriate analysis which, at the discretion of review boards, can be presented for review. The parameters for these analyses shall be settled by the responsible engineers during development model assembly and test.
Mechanical stress analysis shall be performed during design, held on file and be available for examination. The subsystems shall be designed to perform as required, taking into account the total environment in which they have to survive and operate. This environment includes temperature extremes, vibration, radiation, vacuum and EM radiation.
The basic design for critical interfaces shall allow sufficient margin for worst case parameters at extremes of temperature and at the end of life of the spacecraft, not to effect the performance of the subsystem beyond acceptable limits.

6. SAFETY ASSURANCE

6.1 General

All personnel shall be alert to the need to identify potential hazards. Once identified, steps shall be taken to eliminate them, or reduce them to levels judged acceptable. Effort shall be concentrated on the essential objective of safety.
The central point of contact for safety matters will be the Instrument Manager.

6.2 Applicable Requirements

In matters of safety the objective shall be to conform with applicable parts of National Standards and of any other regulations judged relevant, such as the payload safety policy for the launcher in question.

6.3 Safety Assurance Tasks

Potential hazards shall be identified as a part of the normal design process and eliminated or reduced as far as possible. Safeguards shall be determined for outstanding hazards which will reduce their possible effects to the lowest reasonable level. These outstanding hazards shall be reported to the central programme authority at the earliest opportunity and subsequent progress shall be reported, including necessary proof that the relevant requirements have been satisfied.

7. MATERIALS AND PROCESSES SELECTION AND CONTROL

7.1 Materials

Consortia shall select materials, as far as possible, from their preferred list which has been established for many years. Even when using materials from this list personnel must be aware of the varying needs and sensitivities of spacecraft and payloads and must select materials with great care, not only for their fitness for the immediate purpose, but also to avoid possible undesirable effects on other systems.
Materials sometimes have to be used which do not appear on the preferred list. In such cases they must be very carefully screened for total suitability before use.
Outgassing performance of materials, such as TML and CVCM should usually be determined from

NASA RP-1124 (Outgassing Data for Selecting Spacecraft Materials), but importance is also given to other parameters such as the quantity of the material present.
Materials shall be purchased from reputable specialist suppliers and stored in suitable conditions, labelled as to specification. Short life materials shall be dated on receipt and not used for flight or flight representative hardware beyond their expiry date. Materials such as adhesives shall be kept refrigerated in order to control their chemical degeneration and ensure that their shelf life will be achieved without doubt. In exceptionally critical cases, appropriate composition and performance tests shall be carried out on a material.
The material to be used shall be defined on each component detail drawing, but a separate materials list shall be provided for the project.

7.2 Small Parts
Small mechanical parts such as nuts, bolts, rivets, screw locking devices etc., shall be regarded as standard items, held in stock, and replenished from reputable suppliers to National Specifications. Special fasteners and other small parts shall be screened for suitability for the particular application.

7.3 Processes
Processes shall also be defined on the detail drawings, but a separate list of processes shall be prepared.
Process specifications shall be written as judged necessary, usually for safety critical items only.

8. CONFIGURATION MANAGEMENT AND CONTROL

8.1 General
A system of configuration control shall be employed to monitor the status of the deliverable hardware and ground support equipment hardware. The document/drawing recording system shall be implemented from the start of the programme, but the formal change control procedure shall be introduced when the initial system or subsystem development has been completed and prior to qualification, i.e. at some point in the QM programme.

8.2 Project Documentation
The requirements for the flight hardware and GSE shall be defined in a set of specifications. A project record of all documents and drawings shall be maintained by the MSSL project office, not only to provide a directory of available information, but also to act as a medium for approval and change control.
The issues/revisions of all specifications and drawings which define the instrument and its sub-assemblies shall be recorded in a configuration document, the Configuration Item Data List (CIDL). This system shall be used to identify the hardware design status at various points in the development programme, e.g. QM, FM, at associated verification tests and at reviews.

8.3 Configuration Management
Changes to documents and drawings that are under configuration control shall be subject to formal approval. The processing of these changes shall be performed by the MSSL project office, in conjunction with the PA Manager.

8.4 Contractor and Supplier Configuration Management

The configuration of items supplied shall be controlled via the contract placed on the supplier. A procedure for changing or updating the contract shall be agreed when the contract is placed. The 'as-built status' shall be compared with the 'as-designed baseline' at formal reviews and on delivery.

9. ACCEPTANCE REVIEW, ACCEPTANCE DATA PACKAGE

Before shipment to the PI, a formal acceptance review shall be held, which will cover the following subjects:-

1. Identification of actual build status and differences from the design qualification baseline
2. Evaluation of test and inspection results for verification of specification and interface requirements
3. Applicable Non-Conformance Reports and Waiver Requests
4. Acceptability of residual hazards
5. Historical records, limited life item reports, open work records, temporary installation records
6. Availability and acceptability of manuals for the instrument and GSE

The following documents shall be supplied upon delivery of each experiment model:

Experiment Logbook.
Waivers which have been granted.
NCRs and close out reports.
Mass property report.
Mechanical, optical, thermal and electrical conformance reports against EID A and B.
Test procedures and test reports for all functional and environmental tests.
Cleaning procedures.
Cleanliness verification records and certificate.
Calibration procedure and calibration report.
Interface control and manufacturing drawings (just for interface verification).
Parts, materials and processes lists for delivered model.
Bench test procedure.
Assessment criteria and reference data for bench test.
Handling procedure for model.