Herschel SPIRE Beam Steering Mirror Product Assurance Plan

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HERSCHEL SPIRE BEAM STEERING MIRROR PRODUCT ASSURANCE PLAN

V 1.2

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VERSION CONTROL

Note areas in yellow require input.

Date	Index	Remarks
07.May.01	0.1	Creation of the document
11.May.01	0.2	References added, typo's fixed, test procedures updated, appendices re-structured Appendix cross references need fixing.
14.May.01	0.3	Added clean room procedure, Added CTD procedure. Appendix cross references fixed.
6.Jun.01	0.4a 0.4b 0.4c	Added IE, IL, IRB, RGR's comments. Added drawing number and build scheme as implemented by IP & TAP Revised serial number marking to 'where required'. Updated workshop effort request scheme as per new ATC procedure. Brought PA forms into line with ATC documents where available.
12.Jul.01	1.0	Released for comment to RAL/SPIRE. (in pdf format)
12.Dec.01	1.1	Up-issue with minor additions and corrections. TBW sections filled in. Project staff updated
15.Jul.02	1.2	Re-issue with updated CTD procedure and Inspection Pro-Forma

Contents

Overview

Introduction

Given the high cost, the adverse environments and remote location of space missions, a rigorous quality assurance framework is adopted as a normal requirement. This approach applies to the ESA Herschel SPIRE instrument.

The ATC's contribution to the flight hardware – the Beam Steering Mirror - is a critical part of the SPIRE mission, and is required to embody, and to demonstrate, the required quality and performance levels.

The end customer is the SPIRE PI (Dr. Matt Griffin). However, the direct delivery of the hardware and documentation by ATC is to the SPIRE project office at the Rutherford Appleton Laboratory Space Science Department (RAL SSD). The integrated SPIRE instrument is then delivered by RAL to ESA. The ATC funding stream is from the UK SPIRE budget, via PPARC Swindon Office.

The typical assurance process for space missions is to develop a Product Assurance (PA) plan - which deals with product specific aspects of space qualification - within a global organisational Quality Assurance (QA) framework.

Given the UK ATC's organisation, a single document describing both the QA and PA aspects of the BSM development is appropriate.

The end goal of the ATC's PA plan is to

- provide a level of traceability and assurance to the customer of overall quality levels,
- provide a specific assurance that the product is fit for purpose in the space environment.

In addition to retained in-house records, the end deliverable of the PA plan is the Acceptance Data Package (ADP) which accompanies the delivered hardware to the customer.

Documents

Scope of this document

This document contains three main sections:

1. The Quality Assurance section outlines the overall framework of product design, manufacture, integration and test within the UK ATC as applied to the BSM.
2. The Product Assurance section describes the space-specific processes and procedures applied by the UK ATC to the design, manufacture, integration, test and delivery of the BSM to ensure and demonstrate quality.
3. The Appendices include detailed procedures, pro-forma and flowcharts.

Applicable documents

Applicable documents are project specific and may be assumed to apply fully to the BSM, unless stated otherwise

Ref	Title	Author	Reference	Date
AD 1	SPIRE Beam Steering Mirror Subsystem Specification	Ian Pain	SPIRE-ATC-PRJ-000460 v3.3	30.Jan.02
AD 2	SPIRE Beam Steering Mirror Subsystem Development plan	Ian Pain	SPIRE-ATC-PRJ-0466 v4.0	08.Apr.01
AD 3	SPIRE Beam Steering Mirror Design Description	Ian Pain	SPIRE-ATC-PRJ-000466 v4.1	08.Feb.02
AD 4	SPIRE Product Assurance Plan	Dave Kelsh, G. Douglas	SPIRE-RAL-PRJ-000017 issue 1.0	11.Apr.01
AD 5	Parts Procurement Agreement between the Principal Investigators and ESA	N/A	SPIRE-ESA-DOC-000684	latest

Reference documents

Reference documents are generic and may only apply in part to the project, or may be for information or reference only.

Ref	Title	Author	Reference	Date
RD 1	UK ATC project management procedures	I.Egan	189-PMG-01-001 Issue 1	May 2001
RD 2	SPIRE Instrument Development Plan	K.J.King	SPIRE-RAL-PRJ-000035 issue 1.1 (draft)	12.Apr.01
RD 3	PPARC financial memorandum Procurement Policy and Procedure	PPARC/NERC	FM-401	7.Nov.00
RD 4	SPIRE Document Management Plan	K.J.King	SPIRE-RAL-PRJ-000032 issue 1.1	13.Sep.00
RD 5	SPIRE AIV plan	B.Swinyard	SPIRE-RAL-DOC-000410 issue 2.0	23.Feb.01
RD 6	SPIRE Instrument Interface Document – Part A (IID-A)	ESA	SCI-PT-IIDA-04624 rev 1/0	1/9/00
RD 7	SPIRE Instrument Interface Document – Part B, SPIRE (IID-B)	ESA	SCI-PT-IIDB-02124 issue 1/0	1/9/00

Ref	Title	Author	Reference	Date
RD 8	SPIRE Instrument Requirements Document (IRD)	B.Swinyard	SPIRE/RAL/N/0034 iss 0.30	May.00
RD 9	MAPTIS database	MSFC	Search engine for MSFC-HDBK-527	latest
RD 10	Material Selection List for Space Hardware Systems	MSFC	MSFC-HDBK-527 Rev F	30.Sep.88
RD 11	Spectrometer Mirror Mechanism Subsystem Development Plan	D.Poulique n	LAM.PJT.SPI.NOT.2 00001 Ind 8	03.Apr.01
RD 12	Data for selection of space materials	ECSS	ESA-PSS-01-701 iss 1 rev 3	
RD 13	Contamination and Cleanliness Control	ECSS	ESA-PSS-01-201 Issue 1	
RD 14	Reliability Assurance of ESA spacecraft and associated equipment	ESA	ESA-PSS-01-30 Issue 2	
RD 15	Space product Assurance: Failure modes, effects and criticality analysis (FMECA)	ESA	ECSS-Q-30-02A	7.Sep.01
RD 16	Failure rates for ESA space systems	ESA	ESA-PSS-01-302 Issue 1 Draft 4	
RD 17	Component selection, procurement and control for ESA space systems	ESA	ESA-PSS-01-60 Issue 2	
RD 18	Material and process selection and quality control for ESA space systems and associated equipment	ESA	ESA-PSS-01-70 Issue 3	
RD 19	The Technical Reporting and Approval Procedure for Materials, Mechanical Parts and Processes	ESA	ESA-PSS-01-700 2	
RD 20	Measurement of Thermo-optical Properties of Thermal Control Materials	ESA	ESA-PSS-01-709 1	
RD 21	The Repair and Modification of Printed-Circuits Boards and solder Joints	ESA	ESA-PSS-01-728 2	
RD 22	Outgassing and thermo optical data for spacecraft materials	ESA	ESA-RD:01 Rev 1	
RD 23	Outgassing data for selecting spacecraft materials	NASA	NASA Ref. Publication RP1124 Rev 2	Nov 1990
RD 24	GGFC preferred parts list	GGFC	GSFC/PPL20	

Ref	Title	Author	Reference	Date
RD 25	Materials selection guide	NASA	NASA-MSG-A	Aug. 1990
RD 26	Test methods and procedures for microelectronics		MIL-STD-883	
RD 27	Airborne particulate cleanliness classes in clean rooms and clean zones		FED-STD-209 E	
RD 28	Reliability prediction of electronic equipment		MIL-HDBK-217F	
RD 29	NASA standard electrical and electromechanical (EEE)Parts list		MIL-STD-975L (NASA)	
RD 30	Non electrical parts reliability data		NPRD-3	
RD 31	European preferred parts list	ESA ECSS	ESA ECSS-Q-60-01A	
RD 32	Space Product Assurance – Quality and principle	ESA ECSS	ECSS-Q-00 A	
RD 33	Space Product Assurance – Quality Assurance	ESA ECSS	ECSS-Q-20 B	8.Mar.02
RD 34	Non conformance control system	ESA ECSS	ECSS-Q-20-09 A	
RD 35	Space Product Assurance – Dependability	ESA ECSS	ECSS-Q-30 A	
RD 36	Space Product Assurance – Material, Mechanical Parts and Processes	ESA ECSS	ECSS-Q-70 A	
RD 37	A thermal vacuum test for the screening of space materials	ESA ECSS	ESA ECSS-Q-70-02A	
RD 38	The control of limited life materials	ESA ECSS	ESA ECSS-Q-70-22A	
RD 39	The wire wrapping of high reliability electrical connections	ESA ECSS	ESA ECSS-Q-70-30A	
RD 40	Space Product Assurance – Software product Assurance	ESA ECSS	ECSS-Q-80 A	
RD 41	ECSS Glossary of terms	ESA ECSS	ECSS-P-001 A	
RD 42	The Manual Soldering of High-Reliability Electrical Connections	ESA ECSS	ECSS-Q-70-08 A	6.Aug.99
RD 43	The Crimping of High Reliability Electrical Connections	ESA ECSS	ECSS-Q-70-26 A	
RD 44	Material selection for controlling stress-corrosion cracking	ESA ECSS	ECSS-Q-70-36 A	20.Jan.98

Ref	Title	Author	Reference	Date
RD 45	(SCC sensitive materials)	MSFC	MSFC-SPEC-527-B	
RD 46	(SCC testing)	ASTM	ASTM G44-75	
RD 47	Determination of the susceptibility of metals to stress-corrosion cracking	ESA	ECSS-Q-70-37 A	20.Jan.98
RD 48	Compatible couples for Bi-metallic contacts	xxx	P50 DOC	
RD 49	Xxx	ESA	ESA-PSS-01-702	
RD 50	Xxx	ASTM	ASTM-E-595-84	
RD 51	Xxx	JSC	JSC/SPR-0022A	
RD 52	Xxx	ESA	ESA-PSS-01-301	
RD 53	Space Engineering, Mechanical - Part 3: Mechanisms	ESA ECSS	ECSS-E-30-3A	25.Apr.00
RD 54	(outgassing test data)	NASA	Publication 1124 Rev 3	Sept 1993
RD 55	ATC SPIRE Document Numbering System	G.Reynolds	SPI-BSM-DOC-0004 Issue: 1.0	6-July-01

Glossary

AD	Applicable Document	LAM	Laboratoire d'Astrophysique de Marseille
ADP	Acceptance Data Package	LAT	Lot Acceptance Tests
ARB	The Acceptance Review Board	MAPTIS	Materials and Processes Technical Information Service
BSM	Beam Steering Mirror	MSFC	Marshall Space Flight Center
BSMe	Beam Steering Mirror electronics	MCU	Mechanism Control Unit
CAE	Computer Aided Engineering	MIP	Mandatory Inspection Point
CDR	Critical Design Review	MGSE	Mechanical Ground Support Equipment
CoG	Centre of Gravity	MPIA	Max Planck Institute for Astronomy
CIL	Critical Items List	MSSL	Mullard Space Science Laboratory
CQM	Cryogenic Qualification Model	NASA	National Aeronautical Space Agency
CTD	Change to Drawing/Document	NA	Not Applicable
DCL	Declared Components List	NCR	Non Conformance Report
DDR	Detailed Design Review	NCRP	Non Conformance Review Panel
DM	Development Model	OGSE	Optical Ground Support Equipment
DML	Declared Materials List	PA	Product Assurance
DPA	Destructive Physical Analysis	PAD	Part Approval Document
ECSS	European Cooperation for Space Standardisation	PFM	Proto Flight Model
EGSE	Electrical Ground Support Equipment	PPARC	Particle Physics and Astronomy Research Council
ESA	European Space Agency	PI	Principal Investigator
FMEA	Failure Modes and Effects Analysis	QA	Quality Assurance
FMECA	Failure Modes, Effects and Criticality Analysis	RAL	Rutherford Appleton Laboratory
FPGA	Field Programmable Gate Array	RAL SSD	RAL Space Science Department
FPU	Focal Plane Unit	RD	Reference Document

FSM	Flight Spare model	SMEC	Spectrometer Mechanism
GSFC	Goddard Space Flight Center	SPIRE	Spectral and Photometric Imaging REceiver
GSE	Ground Support Equipment	TBC	To Be Confirmed
HoS	Head of Specialism	TBD	To Be Defined
Herschel	ESA Mission name (formerly FIRST)	TBW	To Be Written
IBDR	Instrument Baseline Design Review	UK ATC	United Kingdom Astronomy Technology Centre
KIP	Key Inspection Point	UK SPO	UK SPIRE Project Office
		WE	Warm Electronics

1 ATC QUALITY ASSURANCE

1.1 Framework

1.1.1 Quality Assurance Statement

The UK Astronomy Technology has a mission to *"be the UK's National Centre for the design and production of state of the art astronomical technology"*.

Quality management is the process of ensuring that the quality expected by the customer is achieved. The customer's quality expectations must be understood at the beginning of a project and balanced against any constraints that time and cost may impose. All work packages must be traceable back to the customer requirements to ensure that all requirements are met.

This document, in conjunction with the Project Development Plan [AD 2] acts as the Quality Plan for the management of the project.

ATC practice is that the project engineers are responsible for the quality of the work they carry out with supervisory aspects covered by their Head of Specialism. The Chief Engineer is responsible for approving the overall quality of the products delivered to customers.

1.2 ATC Organisation

The UK Astronomy Technology Centre (ATC) has an established history of delivering world class facility instruments for ground based astronomical observatories. Space based products (e.g. ISOCam) have also been developed.

The ATC is a matrix managed structure with vertically organised disciplines (science, applied optics, mechanical engineering, electrical engineering) and strong horizontal project teams. The ATC Project Management Procedures are described fully in **RD 1**.

The ATC has a quality assurance framework appropriate to the organisation's primary customers, who do not generally require a formal QA framework. Projects are run by a team including: a project manager; a project engineer (where appropriate); and a project scientist.

The quality of the product is assured by the close attention of the project management and science team, by the Heads of Specialism (HoS) responsible for the output from each discipline, and by a process of comprehensive internal and external review. Adherence to **RD 1** is ensured by the HoS for project management, the ATC Programme Manager.

The Beam Steering Mirror has a tighter requirement for documented Product Assurance (PA), and this PA Plan addresses that need. For the SPIRE BSM project, a Product Assurance Manager is designated to ensure that the unique quality aspects of space flight projects are fully met.

1.3 Personnel

1.3.1 Project Team

The dedicated BSM project team includes significant proportions of the following staff's time:

Dr Gillian Wright	Local Co-I, Project Scientist
Ian Pain, C.Eng	Project Manager, Lead/Mechanical Engineer, Product Assurance manager
Colin Cunningham, C.Eng	Deputy Director/Chief Engineer, SPIRE systems engineer, BSM consultant
Tully Peacocke,	Optical Engineer
Brian Stobie, C.Eng	Electronics & Controls engineer
Tom Paul,	Mechanical Design Engineer
Ken Wilson, Tom Baillie	Project Technicians
Alison Toni	Project Assistant

1.3.2 PA Manager

Given the ATC's organisational structure, and small scope of the BSM project, the most appropriate person to perform the role of PA manager is also the project manager and lead engineer.

This consolidation of roles in a single post provides for a strong product overview and enhanced ownership of product quality. An appropriate balance between time/cost issues and quality/performance issues is retained given the strong role of the Project Scientist and the Heads of Specialism. In the event of unresolved issues, resolution will be upwards within the ATC reporting chain, or by consultation with the SPIRE PI.

Limited support on specialist space PA advice (e.g. radiation sensitivity), is anticipated from the UK-SPO (RAL) QA function.

1.4 UK ATC Organogram

The latest version of the UK ATC organogram is maintained on the ATC intranet at http://intra.roe.ac.uk/atc/admin/personnel/orgatc.pdf

A copy at the date of issue of this document is attached in Appendix **1**

2 PROCUREMENT CONTROL

2.1 General

This section outlines the QA requirements for purchase of components and materials

2.2 Purchasing procedures

The responsible engineer specifies components to meet the requirements of the project. These are communicated to the ATC finance section via a CD1 or CD2 form, [per RD 2], see Appendix **2**.

Purchase orders and attached specifications are processed and documented in accordance with UK ATC and PPARC procedures, [RD 3]. Full records are retained by the finance office, and an information copy by the project team.

The Purchase Orders or attached specifications will identify the required QA level, traceability and accompanying documentation of components.

2.3 Supplier Selection

Suppliers will be selected based primarily on their ability to meet the specification., including quality assurance levels. As the requirements of the space environment are substantially more rigorous that those applying to many ATC projects, special criteria will be applied in selecting suppliers.

Where a choice of qualifying suppliers exist, preference will be given, to those :

- supplying components with proven space heritage
- with a proven track record with the UK ATC,
- with a proven track record with a SPIRE consortium member
- European based
- US based

2.4 Incoming Inspections

Upon receipt at the ATC, the products will be inspected for compliance with the purchase order's requirements. Until inspected, goods will be quarantined such that they cannot be incorporated into a higher level build. Goods will be released from quarantine only when accompanying documentation (see Route Card Documentation section) has been raised Incoming inspection activities include :

- verification of the packaging conditions and status of environmental sensors,
- visual inspection,
- verification of correct identification and conformance to ordering data,
- certificate of conformance,
- supplier's inspections and control results,
- remaining lifetime (for products with limited lifetimes).

For non-configuration controlled items, the PO invoice section alone will be completed [RD 2].

For components to be incorporated in a configuration controlled model , as outlined in AD 2 (Model Philosophy) an inspection report will be completed, as outlined in the Inspection Records section of this document.

3 MANUFACTURING AND ASSEMBLY CONTROL

3.1 General

This section describes the QA management of in-house manufacture and assembly. The ATC has a dedicated workshop with a wide range of precision machines and experienced staff. The decision to place work in-house versus outside manufacture is made by the BSM Project Manager in consultation with the workshop manager and in accordance with guidelines in **RD 1**.

3.2 In- house manufacture requests

Components for in-house manufacture, rework or repairs are passed to the workshop, together with appropriate manufacturing specifications, including drawings.

A workshop effort request document will be raised for all work performed, see Appendix **3**.

This information is entered into a database of work in progress, and is retained upon completion. Each request is allocated a unique work request reference number which accompanies the component through to delivery to the project.

3.3 Route Card Documentation

For BSM components where a work request document has been raised, a route card document will be created, see Appendix **3.2**. The unique work request reference is marked on the manufacturing drawings which will accompany (travel with) the request and will be closely associated with the component material through manufacture, inspection and assembly.

The route card is create electronically, and a hardcopy will accompany the component from issue of material through to manufacture, inspection and assembly. The route card identifies, as a minimum:

- The work request number/document
- The drawing number and additional specifications
- The responsible engineer
- The required manufacturing, including any off-site processing stages
- Required inspection stages
- Provision for sign off of work and inspection at each stage

3.4 Inspection Points

The quality of work performed at each stage is the responsibility of the staff member performing the work. Usually they will also sign off the inspection at each stage. At the discretion of the ATC Workshop Manager, an independent qualified staff member will perform final inspection.

Where required, any SPIRE project level Key inspection Points (KIPs) or Mandatory Inspection Points (MIPs) will be identified. A KIP or MIP will be witnessed by an independent member of the SPIRE consortium, or ESA team.

3.5 Inspection Records

All inspections will be documented. As a minimum, the inspection record included in Appendix **3.3** will be completed. Additional inspection information, such as critical dimensions, coordinate measurement machine data or photographs will also be added where required. Critical dimensions are identified by an enclosing box on the drawing.

3.6 Document Package

Upon delivery of a component to final assembly the full documentation : work request hardcopy, route card and a copy of the inspection records will be delivered to the BSM PA manager.

3.7 Calibration of Measuring, Inspection and Test Equipment

Calibrated instruments shall be used at least for all measurements which are to be verified against interfaces or functional specifications.

Calibrated instrumentation with the accuracy, stability and range appropriate to the intended application shall be available when needed in the various phases of manufacturing, integration and tests.

Calibration of instruments shall be traceable to national standards. Re-calibration shall be performed at intervals on the basis of the stability, purpose and use of the instrument.

Calibration labels attached to instruments shall indicate the last and next date of calibration and they shall allow traceability to the applicable calibration records.

Certain equipment is maintained in calibration by the relevant ATC discipline, but other equipment used less frequently is calibrated immediately before use. To avoid program delays the BSM PA manager will wherever practical discuss inspection requirements with the relevant HoS in advance to allow sufficient time for calibration.

4 NON-CONFORMANCE PROCESS

4.1 General

A non-conformance reporting (NCR) system will be implemented for the BSM. The aim of the NCR system is to document problems, allow tracking of their close-out and identify required improvement areas.

4.2 Nonconformance Reporting System

A non-conformance report shall be raised whenever an inspection indicates that a component or assembly does not comply to the drawing or specification. The BSM project will use an electronic NCR system, Q-Pulse. The system and NCR format is described in Appendix **5**.

Additionally, an NCR may be raised for any other design, process or product non-conformance.

4.3 Quarantine

Components identified as non-conforming will be quarantined such that they cannot be incorporated into a higher level build until the NCR is resolved.

4.4 Nonconformance Classification

An NCR shall be classified as <u>major</u> where the following are potentially affected:

- an interface control document to the SPIRE system is affected
- where the sub-system specification [AD 1] is affected, particularly form, fit, function, performance
- where the instrument AIV plan [RD 5] is affected.

Major non conformances shall be reported to the UK-SPO PA Manager within 72 hours. All other NCR's shall be classified as <u>minor.</u>

4.5 Nonconformance Disposition and Reporting

NCR's will be reviewed as soon as practicable after being raised, and at a minimum within two weeks. The NCR register will be reviewed at BSM project meetings, and will be available to the SPIRE project office.

For components or assemblies, the NCR review panel (NCRP) will be at a minimum:

- the responsible engineer identified on the Workshop Effort Request,
- the BSM PA manager
- the member of staff raising the NCR.

Additional staff will be involved as required. The UK-SPO and/or ESA may be involved in review of major NCR's.

The objective of the NCR review is to investigate and close out each NCR, with a recommendation for disposition of the item and corrective action required to prevent re-occurrence. The classification for each NCR will be reviewed or, where missing, allocated. The NCR will be then be identified for disposition as:

- 'Use as is', without requirement for waiver
- 'Use as is', but with a Request for Waiver or Specification Change request being raised where a formal specification is not met. See Appendix **10** for the relevant request formats.
- 'Re-work or Repair', with attached repair instructions where required.
- 'Scrap'

Corrective action will be noted in a BSM project document and circulated to the relevant HoS.

4.6 Non-conformance Close Out

The cause of the discrepancy and the dispositions and actions agreed by the NCRP are to be documented on the Non-conformance Report or in associated NCRP minutes. The BSM PA manager shall verify the completion of all actions and re-verification defined by the NCRP and when that has been achieved successfully, the NCR may be "closed out" with reference to re-verification reports or updated documents and QA-signature on the NCR form.

5 PRODUCT ASSURANCE MANAGEMENT

5.1 GENERAL

5.1.1 Product Assurance Plan

This section describes the processes and procedures hardware applied by the UK ATC specific to a space-qualified item.

5.1.2 Right of Access

For the purpose of PA and technical coordination, the SPIRE PI, UK-SPO (RAL) and ESA will have right of access by appointment to all relevant in-house facilities [RD 4].

Where audit of suppliers for PA purposes is required, ATC will arrange for equivalent visits by appointment.

5.1.3 Reviews

A minimum internal review structure is described in RD 1. The SPIRE Project Development Plan [RD 2] indicates the external review structure. All relevant reviews will include a PA section. Of particular relevance to the PA program for the BSM:

- the sub-system Detailed Design Review will mark the commencement of general configuration control for flight qualified design and associated hardware models, and the full introduction of the PA plan across the project
- The acceptance test review will demonstrate close-out of NCR's
- The IBDR will finalise material and process selection.
- The Acceptance Data Pack (ADP) will document the full PA process for each delivered hardware item.

The BSM project will hold monthly project meetings involving the full BSM team, where PA items will be reviewed, in particular this will include review of the project risk analysis, the NCR register and all open PA related actions.

5.2 DESIGN QUALITY ASSURANCE

5.2.1 Design Process

The ATC design process is described in overview in **RD 1**. The BSM Design Description [RD 3] documents the current design state, and design history is obtained via electronic documents describing the evolution of the design.

Product assurance during the design process consists of :

- Verifying the presence of all necessary inputs,
- Safety and reliability studies,
- The formalisation of the functional analysis,
- Verifying interactivity between mechanical-electrical and software design,
- Verifying the presence and compliance of "latest design" files and documents.

5.2.2 Design Staff

The BSM project team incorporates a team of experienced professional engineers, and additional expertise is available for design input from the relevant ATC Specialism.

5.2.3 Design Review Framework

A minimum internal review structure is described in **RD 1**. The SPIRE project development plan [RD 2] indicates the external review structure.

5.3 CONFIGURATION MANAGEMENT AND CONTROL

5.3.1 Science Performance

The requirements of the science mission are specified in RD 8 and incorporated into the BSM specification, AD 1. The relevance of the science goals and the ability of the BSM to meet these requirements is assured by the ATC project scientist, who holds co-PI status within the consortium. The Co-PI ensures any changes required in the light of developments (within the BSM program, the SPIRE program, or the general astronomy field) is fed into the SPIRE consortium.

5.3.2 Engineering Specification

The BSM specification is described in AD 1. The relevance of the specification is assured by the external review structure and the operations of a Systems Engineering approach by the SPIRE project office.

5.3.3 Document Control

ATC documents shall be stored in an electronic database management system, Q-Pulse. Each document is uniquely identified and stored, and status and versions are correctly identified. Q-Pulse may be used for document circulation and approval within the ATC. The Q-pulse system is secure, being subject to ATC Information Services Group security procedures and individual PIN number access. The ATC Information Services Group maintain a system of network backups.

Documents formally circulated outside ATC will be via the SPIRE Project Office, where the ESA Livelink System will be used. The internal Q-Pulse system provides a field for entry of external reference numbers, such as those generated by RAL or ESA to allow cross reference of ATC and external documents.

The outline procedure for filing and accessing documents is described in Appendix **7**.

5.3.4 CAE/Drawing Control

The control of engineering drawings and data is via the PTC Intralink software application and is administered by the ATC Information Services Group in conjunction with the engineering specialisms.

Electronic files are allocated a directory space for SPIRE, within which the following version and release level scheme operates:

For Pro/Engineer drawing files, access and configuration is controlled by the Pro/Intralink database application. The ATC BSM drawing numbering scheme is :

ATC-SPIRE-BSM-bbb-aaa-ppp

The assembly, model and related 2D drawings each have a filename and a description, as well as a release level, revision and version.

Where bb is the 'build', aaa is the assembly or sub assembly within that build, ppp is the part number within the assembly (note for the assembly itself, the field -ppp is blank)

5.3.4.1 Build

Build 000 and 010	are reserved for uncontrolled prototype and in house test equipment
Build 020	DM1
Build 023	DM2
Build 030	the STM
Build 040	the QM
Build 050	the CQM
Build 060	the PFM
Build 070	the FSM

Within each build, the following blocks of numbers are allocated:

- bb0 : assembly and component drawings (e.g. SPIRE-BSM-020-001)
- bb1 : ICD drawings (e.g. SPIRE-BSM-021-001)
- bb2 : supplementary process instructions, manufacturing jigs etc (e.g. SPIRE-BSM-022-001)

The build identifier is used to allow tracking of the configuration status of an assembly. The DM, build 020, will be released as the first configuration controlled set.

Where a part differs from that used in other builds (e.g. the STM flex pivots may be replaced by a fixed stub shaft, a modification may be made to a model after testing on an earlier model, etc) the new/modified part will have the new build number applied.

A subsequent build may in general incorporate a preceding build's component where the design and PA requirements are unchanged. For example, it is expected that the PFM (build 060) will be substantially similar to the QM (build 040), so majority of PFM parts will be numbered SPIRE-BSM-04-aaa-ppp.

A change to a part which results in its release as a higher level revision will apply to all builds in which that part is incorporated.

For NC machining within the ATC, CAD drawings are sometimes required in AutoCAD rather than native Pro/E format. These are numbered and controlled using the ATC's 'Ambush' system. The outline procedure for filing and accessing files is described in Appendix **5**. A database is kept in the CTD register of equivalence between any master Pro/E drawing and the respective AutoCAD format file.

5.3.4.2 Component Control

Where possible, all manufactured components will be identified by a part number marked on the component or physically attached. These markings will be placed in accordance with the engineering drawing instructions, and in general will be engraved on mechanical parts.

The marking will include the drawing number and revision, and a unique serial number for each manufactured component, where required. A register of serial numbers produced will be kept, and each assembly log will record the serial numbers of items as assembled.

For small components (e.g. fasteners), or consumables (e.g. adhesives) control will be identification of the storage container and control of the storage area to prohibit uncontrolled movement of parts.

5.3.5 Engineering Change Requests

An Engineering Change Request will be raised for any design change requests.

The ECR handling procedure and blank forms is described in appendix **12**. The ECR is raised by a Change to Drawing/Document (CTD) form. CTD's are uniquely identified for the project and work-scope module. (Although module numbers do not apply to the BSM, as the entire sub-system is treated as a single module).

A CTD log book is raised for the project and contains a register of CTD's raised, to be actioned or completed. At the time of writing this is a paper based procedure.

Each CTD request will be reviewed by the Project Manager and at least one project engineer. The change request will be actioned appropriately, including:

- actioned as described
- actioned with modifications
- held for review at a later stage (for example where the CTD request addresses a model yet to be designed fully)
- rejected, with reasons.

5.4 Applicability Of PA Requirements To The Different Models

The BSM model philosophy is described in AD 2. The models are identified below. Note that the single and 2 axis prototypes are not subject to PA requirements (though themselves may be used to exercise newly introduced PA procedures for subsequent models).

PA REQUIREMENTS	INSTRUMENT MODELS AND GSE					
	DM	QM	CQM	PFM	FS	GSE
PA Management	P	A	A	A	A	A
Material and Process Selection and Approval	P	A	P(1)	A	A	P
EEE Parts Selection and Control	N	P(5)	P(1)	A(2)	A(2)	P(3)
Cleanliness and Contamination Control	P	A	A	A	A	P(4)
Reliability Assurance	N	A	A	A	A	P(4)
Safety	N	A	A	A	A	A
<u>Quality Assurance</u>						
Procurement Control	P(1)	P(1)	P(1)	A	A	P(3)
Manufacturing Control	P(5)	P	P	A	A	P(3)
Integration and Test Control	P(5)	P(5)	P(5)	A	A	P(3)
Handling, Storage, Packaging	N	P (5)	A	A	A	A
Non-conformance Control	P(5)	P(5)	P(5)	A	A	A
Alerts		A	A	A	A	N
Acceptance and Delivery		N	A	A	A	A
Software PA	N	N	N	N	N	N

A = Applicable; P= Partially Applicable; N = Non-Applicable

1. Space rated parts are not required, but performance should be equivalent (e.g. Mil-Spec)
2. Applied via LAM
3. Applicable for components coming into direct contact with flight standard hardware (e.g. interfacing connectors from GSE cables).
4. Applicable to elements directly interfacing with the flight hardware, when an impact on the flight hardware is possible.
5. Applicable to all activities related to design verification

5.5 MATERIAL AND PROCESS SELECTION AND CONTROL

5.5.1 General

Space missions experience an arduous environment, with complex interactions of components. Materials choice is critical in ensuring no degradation in the space environment. The engineering requirements of vacuum and cryogenic engineering are well known to the UK ATC. Additional risks are imposed by:

- integration bake-out procedures (thermal cycles)
- cleanliness requirements (outgassing, design for clean room compatibility)
- prolonged storage prior to launch (deterioration, stress corrosion cracking)
- launch loads (vibration, shock)
- microgravity
- radiation
- fail safe and criteria

5.5.2 Materials and Processes

Material and process controls will be implemented with respect to hazardous and forbidden materials, outgassing, strength and stress corrosion resistance on structural items. Materials that may constitute a safety hazard or can cause contamination shall not be used without prior approval from the UK-SPO.

Space missions express a strong preference for previously used materials as a method of risk mitigation. The BSM will select materials from

- the ESA approved materials list RD 12
- NASA approved materials, RD 9, RD 10

Preference will be given to materials with:

- Proven flight heritage within the SPIRE consortium,
- proven cryogenic heritage within ATC or SPIRE consortium

A Declared Materials List (DML) will be maintained as part of the design package, presented at relevant design reviews and incorporated into the ADP. See Appendix **14**.

Material approval and evaluation activities will be scheduled such that they will be finalised by the Instrument Baseline Design Review (IBDR) (start of manufacturing of qualification flight hardware).

5.5.3 Selection and Approval

The following guidelines will be followed when choosing materials:

5.5.3.1 Stress Corrosion

Materials which are sensitive to stress corrosion and which are exposed to long term external (including assembly stresses) or residual internal (frequently present in welded constructions) tensile stresses in the terrestrial atmosphere shall not be used. This requirement shall also apply to GSE lifting devices for loads higher than 300N. Metals shall be selected from ESA: ECSS-Q-70-36 [RD 44] Table 1 where possible. For the listing of SCC sensitive materials MSFC-SPEC-522B [RD 45]can be regarded to be equivalent to ESA ECSS-Q-70-36 and for SCC testing ASTM G44-75 [RD 46] equivalent to ESA ECSS-Q-70-37 [RD 47]

5.5.3.2 Corrosion

All steps possible will be taken to minimise galvanic and surface corrosion by the correct selection of materials and surface finishes. Where electric currents flow through metallic junctions, e.g. grounding, only contacts having a compatible coupling of less than 0.5V should be chosen. Ref.: Compatible couples for Bi-metallic contacts. P50 document [RD 48] Table 7.2.1.

5.5.3.3 Outgassing

Condensable outgassing products of materials may obscure optical elements and detectors severely degrading their performance. Water vapour condensing on cold moving parts and forming ice may cause mechanisms to cease functioning, similarly water vapour condensing on cooled detectors can cause failure.

Materials shall have a low outgassing rate with Total Mass Loss (TML) <1% and Volatile Condensable Material (VCM) < 0.1% when tested per specification ESA-PSS-01-702 [RD 49]. ASTM-E-595-84 [RD 50]and JSC/SPR-0022A [RD 51]may be regarded as equivalent to ESA-PSS-01-702. Documents ESA RD:01 [RD 22] and NASA Ref. Publication 1124 Rev 3 Sept 1993 [RD 54] contain data from many previous outgassing tests. If the instrument is determined to be particularly susceptible to outgassing contamination the figures for TML and VCM will be reduced by the UK-SPO by a factor 10 to <0.1% and 0.01%,

NB: Volatile metals e.g. Cadmium, Zinc shall not be used.

5.5.4 Material Sources

5.5.4.1 Stockist and Specifications

Materials shall only be procured from stockists registered with the British Standards Institute or equivalent national organisation to recognised national or international specifications.

5.5.4.2 Conformance Documentation

Conformance and test documentation shall be inspected and retained by the BSM PA manager for traceability as part of the stock control system.

5.5.4.3 Contamination and Corrosion

Materials shall be examined for cleanliness and corrosion. The tolerable level will depend on the material and the possibility of cleaning. The required condition of the material on delivery will be stated in the procurement specification if critical.

5.5.5 Limited Life Materials

A register of limited life materials shall be maintained. The expiry date shall be recorded and the use of the materials shall be controlled to ensure out-of-date materials are not used in an uncontrolled manner. Out-of-date materials may be used if certain requirements are met. Appropriate tests of the material shall demonstrate that the required properties of the material have not been compromised for their intended use.

Where no date is provided an expiry date (current date + 0.5 shelf life) shall be marked on the container on incoming inspection.

5.5.6 Storage

All materials shall be held in a controlled store.

5.5.7 Processes

Previously qualified and/or approved aerospace processes and techniques shall be used in the fabrication of the BSM.

Process procedures shall include sufficient inspections and controls during and at the end of the processing steps to assure that the characteristics of the product are within the required limits. Process procedures will be documented.

Critical processes will be identified on the Declared Process List (DPL); see Appendix **14**. A process will be considered critical if it falls into one or more of the following categories:

- - The end product cannot be assessed by final inspection and/or test alone.
- - Contamination cannot be removed after completion of the process.
- - Process not qualified or approved for space applications.

5.5.8 Evaluation Program

No materials or processes not previously evaluated for space or cryogenic use will be identified or specified for the BSM..

5.5.9 Alerts

ATC will participate in the ESA alert scheme via the UK-SPO (TBC).

5.6 ELECTRONIC PARTS SELECTION AND CONTROL

5.6.1 General

The SPIRE instrument design and resulting consortium structure is such that the control electronics for the BSM are detailed for manufacture, produced and space qualified by the Laboratoire d'Astrophysique de Marseille (LAM) as part of the SMEC Mechanisms Control Unit (MCU).

The MCU includes the MAC board for the control of the mechanisms and the interface FPGAs; the analog boards for the SMECm and the BSMm and the backplane board. The MCU is integrated in the SPIRE DRCU Unit..

5.6.2 BSMe Warm Electronics Scope

In overview, ATC remain responsible for the specification and outline design of the BSM electronics (BSMe) and for integration and test of the BSMe in conjunction with LAM.

Per RD 11, LAM responsibility covers :

- The performance requirements of the SMEC subsystem (SMECm+MAC+SMEC analog board).
- the technical requirements at the MCU level
- the technical requirements at the SMECm level.
- the interface requirements MCU – DPU, MCU – DRCU, MCU – BSMm and SMECm – Structure and optics.
- development, manufacture and qualification / acceptance of the SMECm and MCU.
- implementation of the UKATC electronic functional design on the BSMm analog board in the MCU.
- implementation of the UKATC BSMm control algorithms.

- delivery of the SMECm and MCU models, their associated simulators, tools and documentation to RAL.

The ATC is responsible for

- the functional design of the BSMm analog board.
- the BSMm development, manufacturing and qualification / acceptance.
- the BSM end to end performances.
- the BSMm control algorithms.

5.6.3 BSMe cryogenic electronics scope

In addition to the BSMe WE, the BSM requires a limited set of electronics incorporated to the cold mechanism, as detailed in RD 3. Broadly, this includes a set of cryogenic actuator coils, feedback sensors; thermometry and the appropriate harness and connectors.

The BSM project participates in the SPIRE Common Parts Procurement Process described in AD 5.

NB: Connector savers will be used on all interfaces where connections are likely to be mated/demated for test/integration purposes on flight and flight spare equipment. The mate/demate log must be completed for each mate/demate. See Appendix **11** for format.

5.6.4 Parts Procurement

5.6.4.1 Parts Procurement Agency (CPPA)

The parts procurement agency will procure all of the hi-rel parts required by the programme to the project requirements, if ordered in time.

5.6.4.2 Use of Third party Facilities

The use of other contractors for hi-rel parts related activities requires the approval of ESA unless the facility is already approved by ESA.

5.6.4.3 Procurement Policy

Tecnologica are the SPIRE CPPA's. It should be noted that there is the cut off date for the common procurement programme. All purchase orders must be with CPPA by that date.

5.6.4.4 Engineering models

For engineering models (prototype models, DM) components shall be used which are equivalent in form, fit, function and materials with the capability of operating in the thermal and vibration environment (including cleanliness) of the qualification test programme but otherwise may be of an agreed lower quality.

5.6.5 Part Selection and Approval

5.6.5.1 Prohibited Materials and Parts

No prohibited materials and parts are envisaged.

5.6.5.2 Radiation Sensitive Parts

Radiation sensitivity issues will be referred to the UK-SPO(RAL) PA manager and/or LAM for advice.

5.6.5.3 Part Derating

Components shall not be stressed to the maximum rated values established by the manufacturers but only to the de-rated values specified in ESA-PSS-01-301 [RD 52].

To implement the de-rating requirements the component operating conditions and environment shall be assessed.

Drift and degradation of performance parameters (e.g. increase of leakage currents of diodes) as specified in ESA-PSS-01-301 shall be taken into account in the design of electronic circuitry. If insufficient data are specified there, the end-of-life limits of qualification tests may be used.

5.6.5.4 Purchase orders

The following apply to purchases of EEE parts in addition to the general QA procurement requirements:

- The quantities of parts procured include needs + attrition + parts for LAT and DPA if required.
- All purchase orders shall state parts to be supplied from single manufacturing lot.
- All parts shall be delivered with a certificate of conformance and supplier's inspections and tests results (when applied).

5.6.5.5 Non qualified components.

It is envisaged that the BSMe cryogenic actuator coils and magneto-resistive position sensors will be electronic components which are not on the preferred or qualified parts list.

Selection of these components will be made through the following process :

- Selection of the best quality level available for the part,
- Definition of a test program (up-screening + LAT + DPA…) to reach the overall quality level required /for the project; in compliance with ESA SCC. ATC will request RAL and specialist advises and technical validation of the test program.
- Contact is made with the supplier to define the implementation of the tests (who, where and when), with the best cost/efficiency criteria.

A Part Approval Documents (PAD) shall be prepared and submitted for parts which are not preferred components A simplified PAD format is defined in Appendix **13**

The PAD shall include:

- Non-repetitive PAD number/Issue/Date
- DCL Number and Issue on which parts listed
- Project/Experiment/Sub-System/Assembly
- Part number (i.e. Procurement Specification)
- Similar To Style (Generic or commonly used identification number)
- Manufacturer.
- Country of origin
- Part category.
- Part Description
- Specification (inc. Issue) and date
- Quality Level
- Number used
- Present qualification status (with reference)
- Applied screening level.
- Extra Testing / LAT Level

- Radiation hardness data.
- Proposed evaluation programme.
- Results of preliminary evaluation, Functional Test SEM/Precap/DPA Analysis/Life Test.
- Rationale/Justification for use.
- Additional supporting comments/information.

5.6.6 Declared Component List

All components to be used on flight or flight spare hardware, shall be listed in a Declared Component List (DCL) which is to be completed stepwise as the selection of components and the approval process progresses. Formal issues are to be submitted to every Design Review, the HERSCHEL list submitted for the Instrument Baseline Design Review may be regarded as the HERSCHEL choice of components which is subject to further efforts on standardisation and co-ordination. The DCL format is shown in Appendix **14**.

The final version must be available at the time of the Instrument Critical Design Review.

The DCL shall identify the instrument/experiment unit and the design status to which it is applicable. The parts shall be grouped according to the families or categories identified in the PPL and the list shall contain the following entries for each part:

- Part I/D i.e. Generic or commonly used number.
- Description
- Manufacturer .
- Country of Origin.
- Specification. (Specification used to procure part)
- Quality (i.e. Screening Level).
- Notes: to include, Interface part, LAT level if appropriate, PAD reference, reference to supporting information e.g. radiation test data.

The Declared Components List with supporting information will be supplied to ESA via the UK-SPO.

5.7 CLEANLINESS AND CONTAMINATION CONTROL

5.7.1 General

A clean room is available at ATC premises, from range 100 to 1 000. Cleanliness, temperature and hygrometry are monitored intermittently during periods where the room is not in active use by a project.

For the BSM project, cleanliness will be checked and logged on a weekly basis. During final assembly of the delivery models cleanliness will be monitored on a daily basis.

All assembly operations on qualification and deliverable models are performed in the clean room, and where possible these models will also be integrated to the ATC test dewar within the clean room (space and safety constraints permitting). The ATC clean room procedures are listed in Appendix **9**.

In addition to clean room practice, the adjacent laboratory and all SPIRE BSM related equipment will be operated in a best practice manner, including:

- minimisation of dirt ingress to laboratory
- covering of exposed components
- surfaces to be cleaned or covered with lint-free material prior to placing components on them

- routine use of gloves when handling all cryogenic equipment

5.7.2 Particulate contamination

To be written; assumed compliant with the RAL SPIRE particulate contamination plan unless otherwise stated.

5.7.3 Molecular contamination

To be written; assumed compliant with the RAL SPIRE particulate contamination plan unless otherwise stated.

5.8 SOFTWARE PRODUCT ASSURANCE

5.8.1 General

The BSM is controlled by a combination of spacecraft software and programmable electronics incorporated in the DRCU. This software is not written by the ATC. However the ATC specifies the programming requirements for the FPGA's on the BSMe which are programmed by LAM. Supporting test software is also developed for use with BSM model testing at the ATC.

5.8.2 FPGA specification

To be written

5.8.3 GSE & Test software

To be written

5.9 RELIABILITY ASSURANCE

5.9.1 General

Product reliability is built in through design and manufacture and verified against the specification by test. Reliability assurance activities will:

- verify compliance with the above
- increase reliability and safety by identifying and/or eliminating failure modes
- provide useful input to the instrument operating manual in the identification and recovery action for non-nominal conditions
- identify hazardous conditions required to be notified in the UK-SPO hazard analysis reporting system.

5.9.2 Reliability Block Diagram

The Reliability Block Diagram (RBD) differs from an assembly drawing or bill of materials in identifying the functional performance tree and indicating redundant or fallback modes.

An RBD will be created for the BSM, and placed under configuration control. It will clearly cross reference the design and specification state at which it is performed.

5.9.3 Single Point Failures

Single Point Failures (SPF) identified in the RBD will be clearly reported via the BSM Design Description [AD 2] and BSM Development Plan [AD 3] .

5.9.4 FMEA/FMECA

Failure Mode and Effects Analysis (FMEA) is a systematic study of the potential failure modes of a system. The technique assists in identifying failure behaviour which might lead to loss of functionality or equipment FMEA may be extended to cover criticality of effects on the system. Where full data exists (typically for electronic parts) this analysis may be extended numerically.

A Failure Modes Effects And Criticality Analysis (FMECA) shall be prepared on all functional elements of the BSM including electronic circuits (but excluding structural elements whose integrity will be assessed with stress analysis and fracture mechanics analysis as necessary) which can cause failure effects within the subsystem or damage to or interfere with, the proper functioning of the instrument or spacecraft

Interfacing elements of GSE supplied with the instrument shall also be evaluated to demonstrate that single point failures in the GSE cannot damage or degrade the instrument or the spacecraft.

Each failure effect identified will be given a criticality category according to the definition below:

Category 1**:** The failure effect is not confined to the instrument. When this failure results also in loss or degradation of the instruments function this shall be stated.

Category 2: The failure results in loss or degradation of the instruments function but the effect is confined to the instrument.

Category 3: Minor internal instrument failures [confined to the subsystem].

The following attributes shall be added to the criticality category as appropriate:

- "R", if the design contains a redundant item which can perform the same function
- "SH", if the failure effect causes a safety hazard
- "SPF" if the failure is caused by a single point failure.

The following failure modes shall be considered as a minimum:

Premature operation
Failure to operate (at the prescribed time)
Failure to cease operation (at the prescribed time)
Failure during operation
Degradation or out of tolerance operation
For failure at component level e.g. hardware interface
short circuit, open circuit, incorrect function e.g. out of range value from sensor
Incorrect commands or sequence of commands
Incorrect software functions

Design specifications, descriptions functional diagrams etc. used in the preparation of the FMEA/FMECA shall be attached or referenced.

RD 15 shall be used for guidance and presentation of FMEA/FMECA results.

5.9.5 Cumulative Operating Time

The BSM mechanism and electronics are subject to repeated cycles of use both on the ground and in orbit. Cumulative operating time on the ground must be carefully monitored to ensure that component life is not exceeded.

The design life of these components will be in accordance with RD 6, RD 53 and incorporates an element of on-orbit life and ground test life each with appropriate margins applied. The design is verified by analysis, by Qualification Model life tests and by component tests at the manufacturer, where specified.

A list of life sensitive components will be compiled, and maintained as part of the Critical Items List (CIL) described in the Critical Items Identification and Control section of this document. A log of all tests that impact the life sensitive components will be maintained to indicate the number of tests and the mechanism environment. This log will be supplied with the ADP and maintained thereafter during the AIV program by the SPIRE Project Office.

5.9.6 Environmental Assurance

To be written.

5.9.7 Environmental Testing

Environmental testing will include bake-out, cryogenic cooldown , warm vibration, cold vibration, thermal interface tests. The test programme is described in AD 2.

5.9.8 Critical Items Identification and Control

A critical items list (CIL) shall be prepared as a summary of data from different sources to ensure critical items are highlighted and recognised at the next higher level. See Appendix **14** for format. The list will be derived mainly from the following sources:

- Single point failures
- Limited life items
- Hazardous items of categories catastrophic and critical
- Critical technologies
- Other critical items e.g. vulnerable items

NB. Items which are equivalent to FMECA category 1, and need special attention and treatment will be categorised MAJOR . All others are minor.

5.10 INTEGRATION AND TEST CONTROL

5.10.1 Assembly, Integration and Test

5.10.2 Test Procedures

Test procedures will be documented.

5.10.3 Test Witnessing

Where required, tests will be witnessed by a representative of the SPIRE PI or UK-SPO.

5.10.4 Test Reports

Test results will be documented. Where appropriate they will be issued as reports.

5.10.5 Fault Logging

During test phases of the development plan, the option is open to use the ATC Fault Logging system, Appendix **6** rather than to raise an NCR.

This will be used to log test events to facilitate diagnosis, particularly for recurrent problems (e.g. software reboots, test dewar warm-ups). The fault logs, where used, will be reviewed on an approximately monthly basis and where applicable an NCR will be raised.

5.10.6 Historical Record (Logbook)

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

- historical record sheets (an index to the diary of events Appendix **14.6**);
  with:
  - dates of operation / test / transport
  - name of operation / test / transport from / to
  - applicable procedure and / or report
  - responsible organisation and signature for entry
  - remarks e.g. on NCR's or unplanned events
- Diary
  - chronological logbook for recording the details and progress or otherwise of all activities shall form the major part of the logbook. The pages shall be numbered and referenced by the history record. The diary shall be used freely and include comments on operations as they take place.
  - When future action is required a note of the action shall be made in the diary and flagged for easy identification:
- Connector Mate / Demate Log
  - Every mate or demate of a flight or flight spare connector shall be logged by the operator responsible for the current activity to ensure the number of these operations is restricted - connector savers shall be used wherever possible. Inspections of the connectors will be carried out at regular intervals as defined on the mate - demate log: (Appendix **11**):
- operating time/cycle record for limited life items
- age sensitive items records
- temporary installations record
- open work/deferred work records.

The log books shall accompany the hardware whenever it is placed under the custody of another organisation and this organisation shall update and maintain these records. The instrument log book will form part of the ADP

5.10.7 Handling, Storage, Packaging, Marking and Labelling, Transportation

Mechanical ground support equipment will be provided for lifting and manipulating the instrument as required during integration and testing. When components and sub-systems are handled appropriate precautions will be taken to prevent contamination or damage.

Handling requirements will be clearly displayed on all equipment and packaging and detailed in the ADP.

ATC will implement a controlled storage of parts, per AD 4 "Each operational group in the consortium will operate a controlled store for parts and assemblies to be used on flight, flight spare and qualification equipment." The storage location comprises lockable storage cabinets (keys held by nominated BSM project team members) within a secure laboratory (keys held by nominated ATC staff).

When the instrument, sub-assemblies or associated units are to be stored or transported they will be placed in air-tight bags, or air-tight transit containers, which will act as a moisture barrier. When contamination sensitive items are bagged they will be flushed with dry nitrogen. An additional or outer bag will be used when transporting items and that bag will not enter controlled clean areas. Desiccant and humidity indicators will be placed between the inner and outer bags.

All packaged or bagged items will be clearly marked or labelled to identify the item and specify the environment and conditions required when the package is opened.

Transport containers will be used to protect the equipment and its packaging in transit and where necessary arrangements will be made for purging and flushing the equipment with clean, dry nitrogen. Containers will be fitted with castors, shock absorbers, lifting attachments, etc as necessary to facilitate transportation and prevent damage.

As necessary recording equipment will be employed during storage and transit to record temperature and humidity fluctuations, vibration, shock, etc, the resultant records will for part of the equipment log book.

5.11 ACCEPTANCE AND DELIVERY

5.11.1 Development plan delivery flow

The BSM development plan [AD 2] outlines the flow of deliverables.

All BSM deliverable models are integrated with an equivalent PCAL model.

For the deliverable BSM models (except the STM), the BSMm is accepted and tested at the UK ATC before delivery to LAM. It is then integrated with the BSMe and undergoes final acceptance testing before delivery to RAL for integration to SPIRE.

5.11.2 Acceptance and Delivery Process

Upon completion of final tests and inspection and before shipment of a deliverable item to LAM or RAL a review will be held covering all deliverable documentation, hardware and software items. The object of this Acceptance Review is establish that there is adequate documentary evidence to demonstrate that the product satisfies all the requirements applicable at that stage. The Acceptance Review Board (ARB) shall compose of the following members or nominated representatives

- ATC Project Manager
- ATC PA manager
- ATC Project Scientist
- Representatives of the SPIRE project team
- Additional staff as required.

The ARB shall cover the following points under the headings:

- Acceptance Data Package
- Hardware, including GSE
- Software, where applicable

5.11.3 Acceptance Data Package

The acceptance data pack (ADP) forms the primary deliverable document to accompany each model. The STM, CQM,PFM and FSM will be delivered with an ADP. The QM ADP will be maintained at ATC but is not deliverable.

The PFM ADP will contain the items below (TBC).

ADP Section	Contents	Required	Comments
1	Shipping Documents	Yes	
2	Procedures for Transport Handling & Installation	Yes	
3	Certificate of Conformance/Delivery Review board MOM AI Lists	Yes	
4	Qualification Status/Test Matrix	Yes	
5	Top Level Drawings incl. Family Tree	Yes	
6	Interface Drawings	Yes	
7	Functional Diagrams (Block Diagram)	Yes	
8	Electrical Circuit Diagrams	Yes	Flight circuitry from LAM
9	As built configuration lists	Yes	Incl. drawing numbers & issues, mod sheets and manufacturing NCR's
10	Serialised Components List	Yes	Electronics as part of LAM ADP. Mechanical per ATC serial number logbook
11	List of Waivers	Yes	
12	Copies of Waivers	Yes	
13	Operation Manual	Yes	Liaison with LAM required, operation via MAC
14	Historical Record	Yes	Linear log of assembly & test activities
15	Logbook/Diary of Events	Not deliverable	Available as required, but not delivered
16	Operating Time/Cycle Record	Yes	
17	Connector Mating Record	Yes	Includes connector savers
18	Not used	N/A	
19	Test Record	Yes	
20	Calibration Data record	Yes	
21	Temporary Installation Record	Yes	Shipping locks, Red Tag (remove before flight), Green Tag (insert before flight) Items
22	Open Work / Deferred Work / Open Tests	TBD	Expected on STM, CQM, QM
23	List of Non-Conformance reports (NCR's)	Yes	

ADP Section	Contents	Required	Comments
24	Copies of Non-Conformance reports (NCR's)	Yes	Includes manufacturing NCR's and fault logs
25	Test Reports	Yes	
26	Not used	N/A	
28	Mass records / Power Budgets	Yes	Or Ref. to ADP section 6
29	Cleanliness Statement	Yes	
30	Compliance Matrix	Yes	
31	Photographs	Yes	Or Ref. to ADP section 13

5.11.4 Post Delivery Operations

ATC staff will support integration at LAM and the AIV programme at RAL, either remotely whilst based at ATC or at the local site.

Where applicable, ATC staff will follow PA procedures at the host site. Where relevant, a record of work performed will in addition be recorded within the ATC PA framework.

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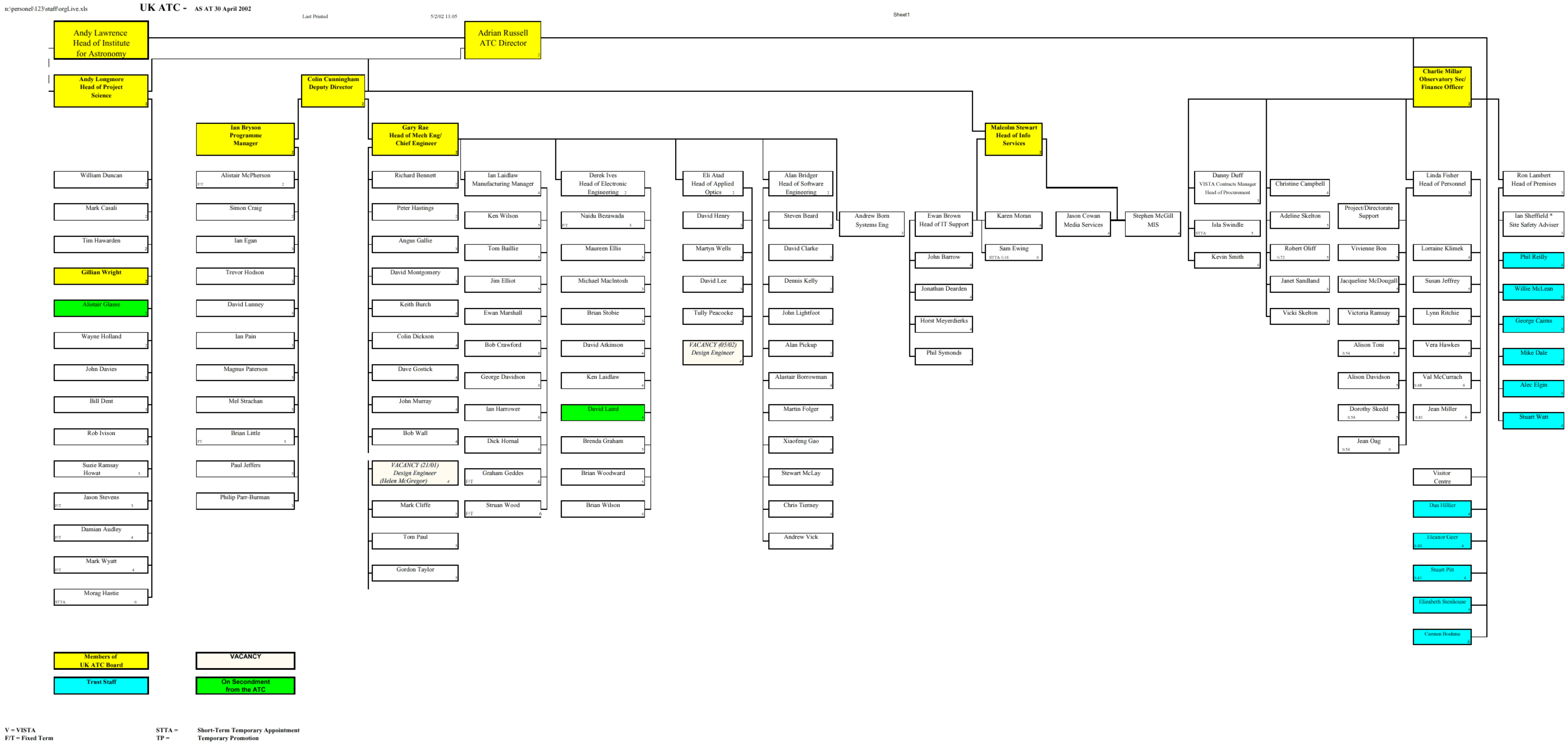
APPENDICES

1 UK ATC ORGANOGRAM



2 PROCUREMENT CONTROL PROCEDURE

UK ATC PURCHASING PROCEDURES

Small Value Orders (CD2)

1. An order requisition (CD2) must be filled in with supplier name, description of goods, quantity & price, T2 budget code, demanding officer and authorising signature for the relevant budget.
2. It is the demanding officers responsibility to source the supplier, price and delivery of the requested goods and any preference for the purchase order being telephoned, faxed or sent by post to the supplier. It is essential that the demanding officer informs purchasing that the company is being used for the first time and gives all address details.
3. The (CD2) can either be filled in in ink or electronically.
4. If the demanding officer doesn't have signing authority on the relevant T2 budget code then the (CD2) must be passed or e-mailed to the appropriate person for authorisation. The budget holder, if other than the demanding officer, is responsible for passing or e-mailing the (CD2) to purchasing in the finance office for processing. If the supplier has issued a quotation attach this to the (CD2).
5. The purchase order will then be processed timeously. The green and yellow copy of the purchase order is returned to the demanding officer.
6. If there is any communication between the supplier and the demanding officer or purchasing, concerning any matters relevant to the order this should be passed on immediately e.g.. change in delivery date, availability etc. It is the responsibility of purchasing to follow up late deliveries and pass on this information.
7. When the goods arrive it is essential that the demanding officer checks the delivery. The green copy should be signed, dated and returned without delay to the finance office. If a part order is received then the green should be photocopied, signed dated with the quantity received indicated and passed immediately to the finance office. The green is signed, dated and passed to the finance office when the whole order has been received. The yellow copy is retained by the demanding officer.

Tenders (CD1)

A (CD1) form must be filled in for orders £2000 or more excluding vat. This form is available from the finance office. All contracts are placed under PPARC standard terms & conditions.

(a) Multi Tenders

1. The (CD1) should be filled in by the demanding officer with a description of the required goods along with at least three company names, addresses, telephone number, contact name and the date the invitations to tender are due back. The form needs to be signed by the relevant budget holder. Any documentation that the companies require to enable them to tender should be included, and a copy for the contract file.
2. The invitations to tender responses from companies come back to the finance office and are all opened at 12 noon on the appropriate date. The demanding officer will then receive the file containing all documentation. It is PPARC policy to accept the lowest tender unless it can be shown otherwise.
3. The purchase order will then be issued per the conditions on the tender and the green and yellow returned to the demanding officer. All correspondence in relation to the tender must go through the finance office. It is the responsibility of purchasing to follow up on delivery date.

4. When the goods arrive and after checking the green should be signed, dated and sent immediately to the finance office by the demanding officer.

(b) Simplified Method

1. If the goods are "off the shelf items" but over the tender limit then it is possible to source three price quotations from companies and fill in the (CD1). The budget holder must authorise and pass all quotes with the (CD1) to purchasing for processing. It is PPARC policy to accept the lowest quotation.
2. The purchase order will be issued under PPARC terms and conditions with reference to the quotation number, price and delivery. The green and yellow copy is sent to the demanding officer. All correspondence in relation to the tender must go through the finance office. It is the responsibility of purchasing to follow up on delivery date.
3. When the goods arrive and after checking the green should be signed, dated and sent immediately to the finance office by the demanding officer.

(c) Single Tenders

1. In some cases there is only one company that can supply the requested goods. If this is so then the reverse side of the (CD1) should be completed with reasons for single tender action and authorised by the budget holder before passing to purchasing for processing along with any quotation.
2. The invitation to tender documentation will be sent to the company for them to complete.
3. When this is received back the purchase order will be issued under PPARC terms and conditions with reference to the information on the tender documents. The green and yellow copies will be sent to the demanding officer. All correspondence in relation to the tender must go through the finance office. It is the responsibility of purchasing to follow up on delivery date.
4. When the goods arrive and after checking the green should be signed, dated and sent immediately to the finance office by the demanding officer.

Procedure written by:

Adeline Skelton

Senior Finance Assistant

12th June 2000

3 UK ATC WORKSHOP PROCEDURES

3.1 Effort Request document.

The entry screen for a typical workshop request (in this case a SPIRE prototype part) is shown. The entry form and workshop database are accessed from the URL: http://saturn.roe.ac.uk/workshopdb/

UK Astronomy Technology Centre

Edit Record's Details

Ref_no.:	10086
Drg. No.:	01a24a
Description:	Structure Assy machining
Project:	115 Spire
Module:	11510 Beam Steering Mirror
Issue:	A
Work Detail:	machine 9.5mm bores
Priority:	1
Quantity:	1
Make Time hrs (est):	8
Required Date (dd/mm/yy):	06/07/01
Status:	INW

[Update Modules] [Update Record] [Previous Screen] [Main Menu]

The database is accessible on a read only basis to all ATC users, and on a password restricted basis to Workshop staff for entry of records.

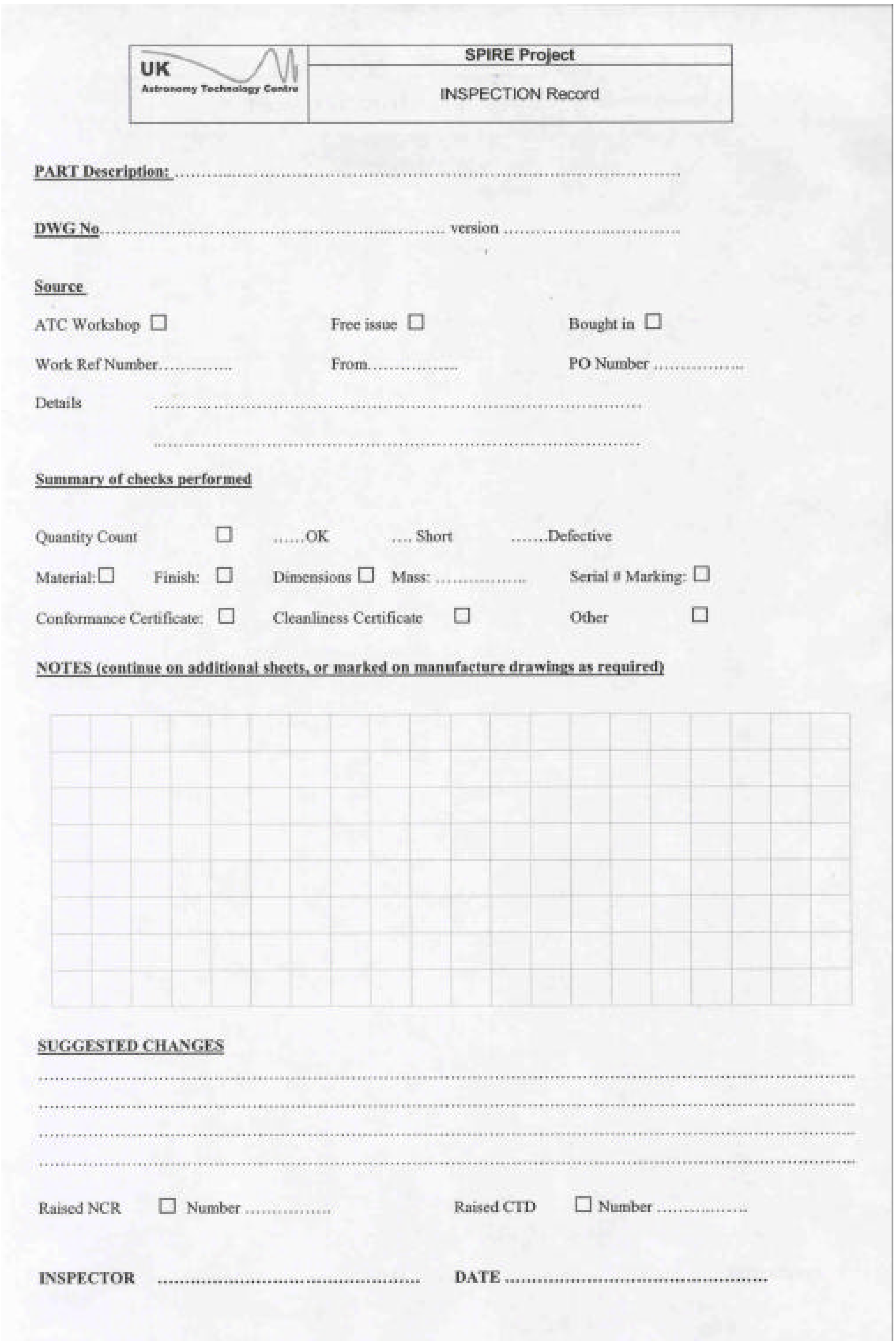
3.2 ATC Route Card

WORKSHOP ROUTE CARD					UK Astronomy Technology Centre
Project			Module		
Drg No		Desc			issue
Material		Inspection	date received		date required
OP.NO.	DETAILS		TECH.	D.ST.	D.FIN.
	Page of Pages				

3.3 Manufacturing and Assembly Control (Inspection Forms)

ASSEMBLY / INTEGRATION TEST LOG				
PROJECT:			PAGE:	
UNIT:				
ITEM:			DRAWING NO:	
SERIAL NO:				
DATE	ACTIVITY	NAME	SIGNATURE	Q.A.

ASSEMBLY / INTEGRATION / TEST RECORD		
PROJECT		**PAGE:**
DATE	**ACTIVITY**	**SIGNATURE**



UK Astronomy Technology Centre

SPIRE Project

INSPECTION Record

PART Description: ....

DWG No.. version ....

Source

ATC Workshop ☐ Free issue ☐ Bought in ☐

Work Ref Number.............. From.................. PO Number ....

Details ....

....

Summary of checks performed

Quantity Count ☐ ......OK .... Short ....Defective

Material:☐ Finish: ☐ Dimensions ☐ Mass: .... Serial # Marking: ☐

Conformance Certificate: ☐ Cleanliness Certificate ☐ Other ☐

NOTES (continue on additional sheets, or marked on manufacture drawings as required)

SUGGESTED CHANGES

....

....

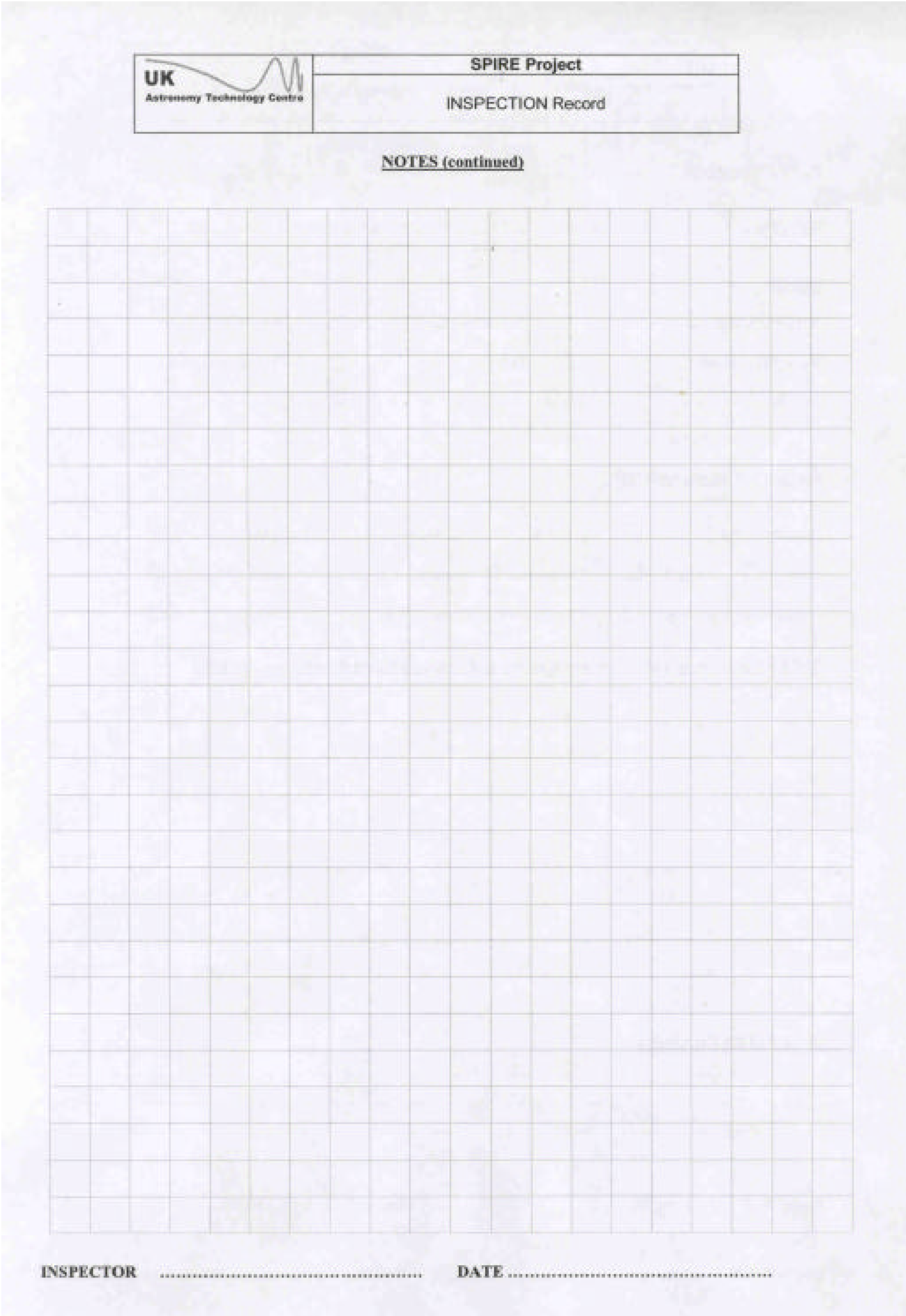
....

....

Raised NCR ☐ Number .... Raised CTD ☐ Number ....

INSPECTOR .... **DATE** ....

Figure 1 SPIRE Project Inspection Record, Side 1



UK Astronomy Technology Centre

SPIRE Project

INSPECTION Record

NOTES (continued)

INSPECTOR .... DATE ....

Figure 2 SPIRE Project Inspection Record, Side 2

4 CALIBRATION OF MEASURING, INSPECTION AND TEST EQUIPMENT

ATC procedure is TBW.

Pending issue of an ATC procedure:

For SPIRE BSM models, measurement equipment used will be noted in inspection records, and a note made to confirm that the equipment was in valid calibration at the time of the test.

5 NON CONFORMANCE REPORTING SYSTEM

- The ATC will utilise the Q-PULSE documentation control software application to raise, record, track and manage NCR's.
- Q-Pulse has a dedicated NCR module, and example form is shown below.
- The following fields are completed as a minimum:
- NCR number (assigned automatically)
- NCR description. The NCR should cover a single item, enabling close-out of the NCR. The description to identify component part, build and drawing number, serial number and defect found
- selected from pull down menus.
- Source,
- Project,
- Department/Supplier,
- Name of person raising NCR,
- Name of person responsible for CA (corrective action),
- Cause/reason ,
- Severity, status,
- Corrective action is identified at a n NCR review Panel and the CA fields completed, including :
- Corrective action description
- Person responsible for CA
- Supporting actions may be identified - these also have a person responsible assigned.
- Preventative actions (PA) may also be identified, with named persons
- upon completion of CA, PA, SA
- CA completion date
- Closure of CA and amendment of NCR status to closed
- Note - All supporting, preventative actions must be closed before a CA may be marked as complete.

\- A number of reports are available from Q-Pulse to flag outstanding actions by person, etc. These tools are used by the BSM PA manager to assist in tracking of progress and close-out of NCRs

6 ATC FAULT LOGGING SYSTEM

The ATC uses a fault logging system available site-wide at http://helpdesk.roe.ac.uk/scripts/bugup.exe.

The following screenshots indicate the fault logging tool's functionality.

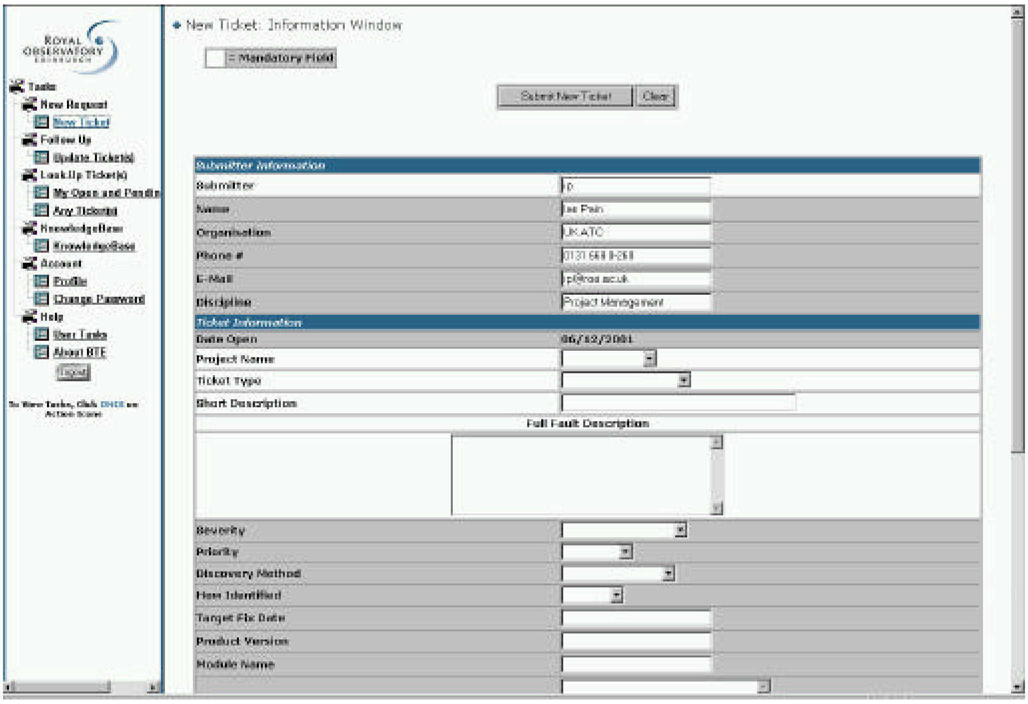


Figure 3 : Fault logging entry screen 1/2

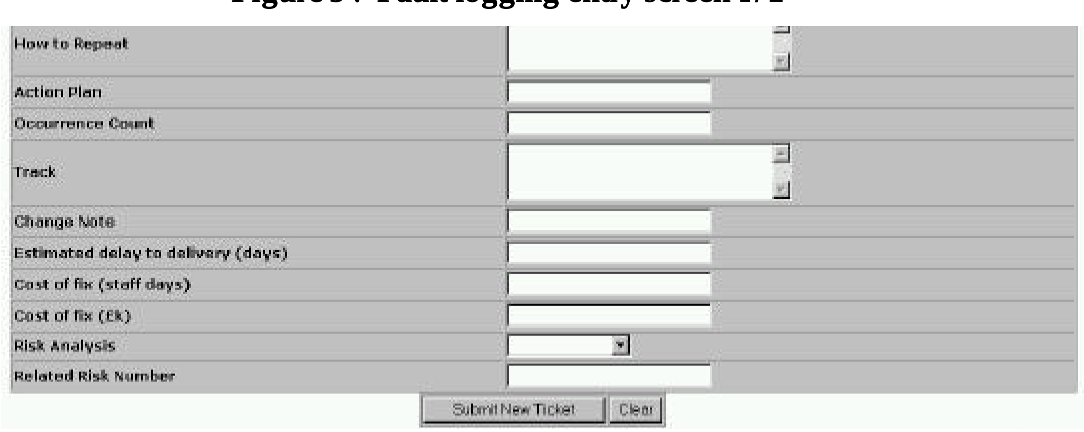


Figure 4 : Fault logging entry screen 2/2

7 DOCUMENT CONTROL

- The ATC uses a document management system available site wide.

Document entry into the database is restricted to ensure control of the data. In addition to system administrators, only the Project Assistant and project manager can add or edit entries in the document database.

Documents are numbered per **RD 55**

Procedure:

1. Project staff pass a document to the project assistant, or indicate the document location for items on the server.
2. The title, document type and author must be clear, and are confirmed before entry
3. The document is entered into Q-Pulse and a unique number assigned automatically
4. The master document is held by Q-pulse and when accessed via Q-pulse only a temporary file is available.
5. The master document is stored automatically on H:\SPIRE\documents

8 CAE / DRAWING CONTROL

8.1 Procedure for Pro/IntraLink entry

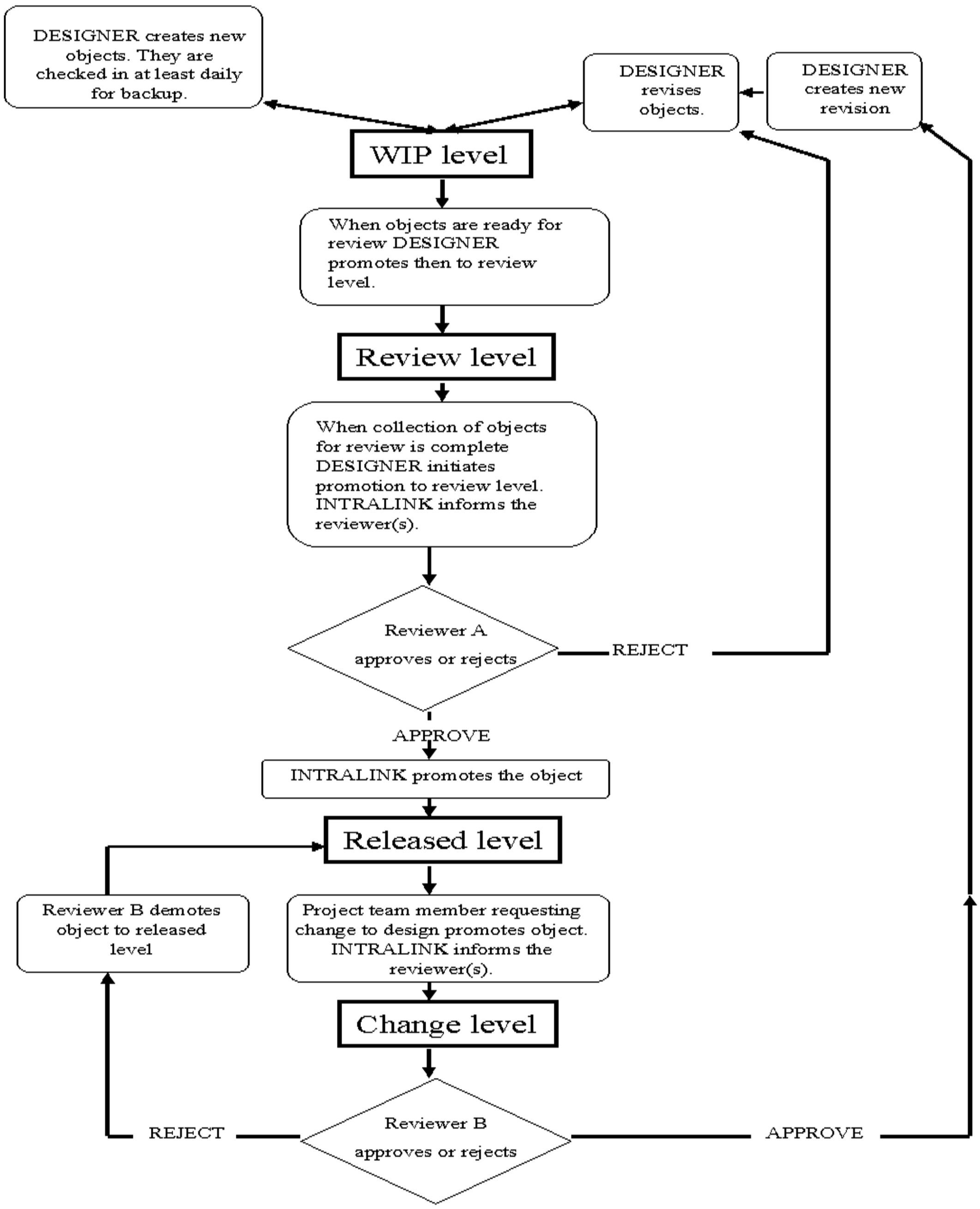


Figure 5: Pro / IntraLink entry

Note - reviewer 'A' and 'B' may be the same person or distinct individuals. The Intralink systems manager sets reviewer privileges.

8.2 Procedure for Ambush AutoCAD control

1. The project creates a sub-directory on the ATC's H:/ 'project' drive for current AutoCAD drawings.
2. A standard drawing frame is applied to the 2D or 3D model. This prompts for a number of drawing fields, including
   - Part Number
   - Revision
   - Latest CTD number
   - Engineer
   - Material
   - Finish
3. Within an AutoCAD session, the LISP macro 'post' is invoked by the design engineer.
4. The drawing is automatically promoted to the current directory 'posted'. An index of the current directory is available as a text file, and is created automatically.
5. Drawing numbers are alpha-numeric and based on an ATC module scheme. The full ATC scheme is described below, though is not expected to be fully applied to SPIRE drawings, which are for a limited range of components not covered by intralink:

   DRAWING SET FORMAT & NUMBERING

   The format of the drawing number shall be : @@*####$.DWG

   Where:

   @@, *, and $ are module number, file type("-"), and alphanumeric version as described in section 2.3 above
   #### = four character Drawing number which breaks down as
   ££&% where
   ££ = Two digit part/drawing number for that Module - leading zeros must always be included in the filename (see section 4.1.3 below).
   & = an alphabetic character defining the Drawing type such that
   "a" for normal 2-D assembly dwgs
   "e" for electronic drawings
   "s" for solid models
   "k" for sketches (hand drawn)
   "l" for layout drawings
   "m" for mechanical drawings
   "x" for exploded view assembly drawings and illustrations used in documentation
   and, in the engineering database only,
   "w" for workshop data related to drawings (SmartCam shape files)
   "p" for parts-lists
   % is the sheet number for that drawing. This must be added for all drawings and so in most cases will be a "1". The maximum number of sheets on any Drawing will thus be 9.

   Drawing numbers shall be used sequentially above ££ = 10 for component details. 00 to 09 should be reserved as follows:-

   00 = the top assembly drawing (in several sheets if preferred) of the module.
   01..05 = sub-assembly drawings as required.

06 = the layout drawing for the design stages (and overall solid model if used)
07 = schematic drawings as required
08,09 = documentation and presentation drawings as required.

Where there is insufficient space on a large drawing sheet for all the views of an assembly or part additional sheets may be used (indicated, for example, by "sheet 1 of 3"). Sheets with the same drawing number will not be used for different components .

For AutoCad drawings the DOS path and filename will be :

H:\SPIRE\drawings\mech\acad\current\@@-££&%.DWG

9 CLEAN ROOM PROCEDURES

Procedure for using Clean room

ONLY PERSONNEL AUTHORISED BY HEAD OF ELECTRONICS MAY ENTER THE CLEAN ROOM.

Before entering the clean room select the appropriate size garments from one of the lockers in the changing (grey) area. Each locker contains one complete set and is labelled with that set's size and number. The garments must then be donned in the following order;

1. Hood. Ensure that all of your hair is tucked into the hood.
2. Coverall. Prevent coverall from touching the floor as much as possible. Ensure that the hood is tucked into the coverall and it is zipped up.
3. Overboots. Ensure that the coverall trousers are tucked into the overboots.
4. Mask. Ensure that your mouth and nose is covered, preventing contamination when breathing.
5. Gloves. Ensure that the coverall cuffs are tucked into the gloves.

As you enter the clean room ensure that you step (with both feet) onto the tacky mat to remove any dirt from your feet that may be picked up in the changing area.

Note the date and your purpose for using the clean room in the log on the bench.

When leaving the clean room the garments must be removed in the opposite order from above and placed in the same locker that they were taken from. You can then use this set for the remainder of the week.

The dirty garments will be collected on Monday afternoon ready for uplift by Microclean, who will deliver clean garments from the previous week on the Tuesday morning. These will then be placed in the lockers.

When working in the clean room always be aware of actions that may cause particles such as cutting. Think carefully before taking anything in to the clean room

If there are any problems with the area, consumables, garments contact Brenda Graham.

CLEANLINESS CERTIFICATE
Use one sheet for each item of hardware (box, harness and MLI)
UNIT IDENTIFICATION (Instrument Box Name and Model)
HARNESS BAKEOUT CONDITIONS AND TIME
MLI BAKEOUT CONDITIONS AND TIME
SUPPLIER
MATERIALS LIST REFERENCE
THERMAL VACUUM/BALANCE TEST DATES AND REPORT NUMBER
QCM AND REGA NUMBER
RESULTS OF WITNESS PLATE MEASUREMENTS FROM TV TEST
RESULTS OF WIPES FROM TV TEST (Wipe Positions and Data)
RESULTS OF WIPES AT ACCEPTANCE (Wipe Positions and Data)
PARTICLE CLEANLINESS (Positions and Data, e.g. Tape Lift)
CERTIFIED (PI Representative) AND DATE OF ACCEPTANCE

10 REQUEST FOR WAIVER OR SPECIFICATION CHANGE

PROJECT:		**Request for Waiver/Deviation**		
[1] Title (Max 25 Spaces):			RFW-Nr. Issue/Rev.: Date: Page of	
			Related NCR (if any)	
[2] End Item(s) affected (hardware, software):				
Name		CI-Number		Model(s)
[3] Requirement/Interface Documents affected:				
Specification/Drawing Title	Number	Issue	Date	Appl. Paragr.
[4] Description of Deviation/Discrepancy/Non-Conformance:				
[5] Other Items or Requirements (potentially) Affected				
[6] Need for RFW and Rationale for Acceptance:				
[7] Originator:	Sign: Date:		Attachments	
[8] Approvals:				
	Engineering Name/Date	Product Assurance Name/Date		CCB Chairman Name/Date
Prin. Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Co-Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Prime Contractor	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr[[ ] Rej	[ ] Appr [ ] Rej
ESA Project Office	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej

11 MATE / DE-MATE LOG

<table>
<tr><th colspan="14">CONNECTOR MATE / DEMATE LOG</th></tr>
<tr><td colspan="5">PROJECT</td><td colspan="9">EXPERIMENT</td></tr>
<tr><td colspan="5">S / SYSTEM</td><td colspan="5">UNIT</td><td colspan="4">IDENT NO.</td></tr>
<tr><td colspan="2">ID</td><td colspan="2">ID</td><td colspan="2">ID</td><td colspan="2">ID</td><td colspan="2">ID</td><td colspan="4"></td></tr>
<tr><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td colspan="4"></td></tr>
<tr><td colspan="14">AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)</td></tr>
<tr><td>CONNECT I/D</td><td>DEBRIS</td><td>BENT PINS</td><td>REMARKS</td><td>PASS</td><td>FAIL</td><td>SIGNATURE</td><td colspan="7"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="7"></td></tr>
<tr><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td>Mate Date</td><td>Demate Date</td><td colspan="4"></td></tr>
<tr><td colspan="14">AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)</td></tr>
<tr><td>CONNECT I/D</td><td>DEBRIS</td><td>BENT PINS</td><td>PIN HTS</td><td>REMARKS</td><td>PASS</td><td>FAIL</td><td>SIGNATURE</td><td colspan="6"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6"></td></tr>
<tr><td colspan="14">NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager</td></tr>
</table>

12 CHANGE REQUEST PROCEDURE AND FORMS

- The SPIRE Change to Document (CTD) procedure is noted below, it is based on the ATC procedures with SPIRE specific additions. The system is essentially paper based, using books of pink CTD pro-formas and white carbonless copies.
- The Project Master CTD Folder is held by the Project Assistant and consists of three sections:-
  1. The Register – which enables one to see the overall state of CTD's and outstanding CTD's in the system. An access database is used for this purpose.
  2. List of CTD's to be actioned, with description of contents.
  3. Original pink copies of CTD's actioned and signed off.

12.1 CTD System procedure :-

- A CTD may be raised by any member of the SPIRE BSM project team or ATC staff member. CTDs will not only be used for drawings, but will also raised for changes required to such items as specifications and documents.
- Each CTD request will be reviewed by the Project Manager and at least one project engineer. The change request will be actioned appropriately, including:
  - actioned as described
  - actioned with modifications
  - held for review at a later stage (for example where the CTD request addresses a model yet to be designed fully)
  - rejected, with reasons
- The completed pink request will be passed to the project assistant, who will input the details into the tracking database and then forward the pink to the person actioned. The project assistant may chase CTDs when they have been outstanding for a reasonable length of time, and more usually, prior to monthly Product Assurance Project Meeting. When work is complete it will be signed off on the pink by both the person actioned and a counter-signature, usually that of the Project Manager, the pink copy is then returned to the project assistant for filing in the Master CTD Folder. (The white copy in the book is the safety net in case the pink gets lost.)
- When a CTD is raised, the initiator/person responsible for that module/area of change usually actions the CTD there and then. This should be encouraged as it keeps outstanding paperwork to a minimum, but does not preclude the requirement to review the CTD as noted above.
- If the CTD cannot/does not require to be actioned immediately, the change should be made very explicit. i.e. attaching marked up drawings/documents if required. It should then be placed in the CTD Master Folder along with any actioned CTD's in the appropriate section and the Register filled in.
- When the Drawing/Documentation is updated, it will be re-issued with the next issue letter/number and the relevant modification area filled in together with the CTD no.

ROYAL OBSERVATORY EDINBURGH

Change to drawing/document	Project	Book	No.

To :	Originator :	Date :

Drawing/document numbers	Issue	Drawing/document numbers	Issue

Description of and reason for change :

Action taken :

Certified : Date :

Figure 6 : Sample ATC CTD document

13 PAD SHEET

PART APPROVAL DOCUMENT (PAD)	
Spacecraft / Project: System / Experiment: Sub-System: Assembly:	PAD No.: Issue No.: Date : Ref. DCL No.: DCL Issue No.: Sheet ..1.... of ......
Part Number : Manufacturer : Part Category : Description : Specification : Date: Quality Level :	Similar to style : Country of Origin : No. Used :
Present Qualification Status	
Applied Screening Level:	
Extra Testing / LAT Level:	
Radiation Hardness: Total Dose in kilorads:. Project Required Level :) Fails to Meet Specification at : Functional Failure at : SEU : Latch Up : Source Reference /.	

14 DECLARED LISTS

The following are blank ATC formats for:

- Critical Items List (CIL) & Single Point Failures (SPF)
- Declared Components List (DCL)
- Declared Materials List (DML)
- Declared Processes List (DPL)
- FMECA format
- Integration and Test Logs

14.1 *Critical Items List (CIL) & Single Point Failures (SPF)*

CRITICAL ITEMS AND SINGLE POINT FAILURE LIST **ORIGINATOR:**

EQUIPMENT / INSTRUMENT:	**Subsystem / System:**	**Doc. Number:**
Operating Mode:	**Operating / Mission Phase:**	**Issue/ Rev:**
Diagram / Drawings:	**Related FMECA:**	**Date:**
		Page of

(a) No.	(b) FMECA Ref. No.	(c) Single Point Failure Critical Component / Function	(d) Failure Effect and Estimated Probability	(e) Criticality	(f) Retention Rationale (References as Applicable)	(g) Remarks

14.2 Declared Components List (DCL

DECLARED COMPONENT LIST		ORIGINATOR: UK ATC	
SPACECRAFT / PROJECT:	Herschel	Doc. Number	SPIRE-ATC-PRJ-xxx
SYSTEM / EXPERIMENT:	SPIRE	Sheet No	Page 65 of 69
SUB-SYSTEM:	BSM	Issue:	0.1
		Date:	24.Jun. 01

Part ID (used on)	Description	Manufacturer / Supplier	Country	Specification	Quality	Notes

14.3 *Declared Materials List (DML)*

DECLARED MATERIAL LIST		ORIGINATOR: UK ATC	
SPACECRAFT / PROJECT:	**Herschel**	**Doc. Number**	**SPIRE-ATC-PRJ-xxx**
SYSTEM / EXPERIMENT:	**SPIRE**	**Sheet No**	**Page 66 of 69**
SUB-SYSTEM:	**BSM**	**Issue:**	**0.1**
		Date:	**24.Jun. 01**

BSM Material List ID	Component ID	Name & Type of Product, Form and Condition	Specification	Size Code	Processing Parameters	Outgassing SCC-Res. Data and Refer	**OK to bake at 80°C?**	**Thermal & Vacuum stable?**	**OK at 4°K?**	Manufacturer	Remarks, Approval Reference
1.											
2.											
3.											
4.											
5.											

14.4 Declared Processes List (DPL)

DECLARED PROCESS LIST		**ORIGINATOR: UK ATC**	
SPACECRAFT / PROJECT:	**Herschel**	**Doc. Number**	**SPIRE-ATC-PRJ-xxx**
SYSTEM / EXPERIMENT:	**SPIRE**	**Sheet No**	**Page 67 of 69**
SUB-SYSTEM:	**BSM**	**Issue:**	**0.1**
		Date:	**24.Jun. 01**

Process ID	Process	Specification (Incl. Issue)	Description / Identification	Use and Location	User Code	Associated DML Items	Criticality of Process	Approval / Status
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

14.5 FMECA format

Mechanical Failure Modes Effect and Criticality Analysis		
Product: **SPIRE**	Prepared by:I.Pain	Document Reference: SPIRE-ATC-PRJ-0711
Project/Phase: **Mission Observing**	Approved by: G.Wright	Issue: 2
System/Subsystem/Equipment: **BSM**	Date: 22.Jan.02	Page 1 of 1

Ident. number		Item/block	Function	Failure Mode	Failure Cause	Mission phase/ op.mode	Failure effects a. Local effects b. End effects	Severity	Failure detection method/ observable symptoms	Compensation provisions	Correction actions	Remarks

14.6 Integration and Test Logs

EXPERIMENT:		HISTORICAL RECORD			CORR ACT	TEST	TRANS	STORAGE	FAILURE	PAGE NO				
UNIT / ASSEMBLY:		DRAWING NO:		SERIAL NO:										
NO	DESCRIPTION OF ACTIVITY / EVENT	TIME From/To	OPERATING TIME	REMARKS / REF. DOC.	(tick box)						PERF. BY	DATE	SIG.	QA Sig.

Document Ends