SPIRE

SUBJECT: **SPIRE Science Implementation Plan**

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DOCUMENT No: **SPIRE/RAL/D/0018.01**

ISSUE: **Draft 1** **Date:** **16 February 1998**

CHECKED BY: **………………………………….** **Date:** **………………………….**

APPROVED BY: **………………………………….** **Date:** **………………………….**

Important note: this version of this document is an INITIAL DRAFT, it describes the current thinking, but is (by definition) incomplete and still subject to negotiations within the consortium!

Distribution

Change Record

ISSUE	DATE	
Draft 1	Feb 16th 1998	Initial Draft, submitted for information with SPIRE Proposal

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Glossary

AOT	Astronomical Observation Template
DAPSAS	Data Processing and Science Analysis Software
DPOP	Daily Prime Operational Phase
DTCP	Daily Telecommunications Phase
FINDAS	FIRST Integrated Network and Data Archive System
FIRST	Far Infra-Red and Sub-millimetre Telescope
FSC	FIRST Science Centre
GSAG	Ground Segment Advisory Group
ICC	Instrument Control Centre
MOC	Mission Operations Centre
RTA/QLA	Real Time Assessment/Quick Look Analysis (software)
SPIRE	Spectral and Photometric Imaging REceiver
WWW	World Wide Web

References

Applicable Documents

AD1	FIRST Science Operations Implementation Requirements Document (SIRD) (PT-03646)
AD2	FIRST Science Management Plan (ESA/SPC(97)22)
AD3	Science Management Plan for the combined Planck and FIRST mission
AD4	FIRST/PLANCK Operations Interface Requirements Document (FP-ESC-RS-0001)
AD5	FIRST/PLANCK Ground Segment Interface Document (GSID) (PT-04829)
AD6	Product Assurance Requirements for FIRST/PLANCK Scientific Instruments (PT-RQ-04410)
AD7	Guide to applying the ESA Software Engineering Standards (PSS-05-0) to small Software Projects (BSSC-96-2)

Reference Documents

RD1	FIRST Science Operations Concept and Ground Segment Document (PT-03056)
RD2	SPIRE Product Assurance Plan

1. INTRODUCTION

The SPIRE Science Implementation Plan (SIP) is the formal response, by the SPIRE consortium, to the FIRST Science Operations Implementation Requirements Document (AD1), and describes the work necessary to design, implement, validate and operate the SPIRE Instrument Control Centre (ICC).

The SPIRE ICC is one of three ICCs operated by the teams responsible for building the instruments which form the scientific payload of FIRST. Along with the Mission Operations Centre (MOC) and the FIRST Science Centre (FSC) they form the major elements of the FIRST ground segment as described in the FIRST ground Science Operations Concept and Ground Segment Document (RD1). For FIRST a novel distributed system for the ground segment is envisaged in which the mission operations team, science centre and instrument teams are not (necessarily) at the same location. In this concept the various groups access and transmit data and software through a distributed database system (the FIRST Integrated Network Data Archive System, FINDAS). Because of the distributed nature of FIRST operations the teams can be located where most of the knowledge and expertise, appropriate for the work, is already present.

The FIRST Science Management Plan (AD2) specifies the responsibilities of the PI teams with regard to setting up and operating an ICC. These responsibilities are translated in the SIRD into a set of requirements for implementation of the ICC and its operation. These are addressed in the following sections; Section 2 describes the assumptions under which the ICC has been designed to be developed and operated; Section 3 gives an overview of the way in which the ICC will operate, its interfaces with the rest of the ground segment and the management plans for ensuring a timely, appropriate and efficient implementation. Subsequent Sections describe the activities and organisation of the ICC during the major mission phases from development through post operations. Finally, detailed information that is subject to change as the project progresses (e.g. personnel associated with the ICC, facilities available to the ICC, work package breakdown, schedule etc.) are contained in a series of appendices.

2. ASSUMPTIONS

2.1 Scope and Exclusions

The following items are assumed to be excluded from the scope of the SIP and therefore from the resources and work estimated:

- The SPIRE ICC will not provide an environment for validation of the Data Processing and Science Analysis Software (DAPSAS). It is expected that the FSC will provide a test environment, identical to that in which the DAPSAS will run to allow generation of test products for validation of the software by the ICC.

2.2 Prerequisites

The ICC will be implemented as part of a closely integrated ground segment development programme. There will therefore be areas of work where it is important that the different groups adhere to agreed timescales and tasks, otherwise other parts of the programme will be affected. These are described below.

2.2.1 Availability of FINDAS

The FINDAS will be the prime means of transferring data and information between the teams contributing to the FIRST ground segment. It will also provide facilities for configuration control of software developed at the different centres. For the instrument teams, these activities start with the storage of documentation (which is already being generated), software, test data and procedures well before the start of the development phase for the ICCs themselves. For this reason it is important that;

- FINDAS be available as soon as possible after the instrument selection with the capability to store and retrieve data and documentation and to support configuration control of software.
- FINDAS be upgraded to allow real-time interaction with the instrument EGSE and Quick-Look Facility in time for integration tests of the instrument checkout equipment (July 1999, TBC)
- FINDAS has the capability to house all the SPIRE data from the mission, including documentation, ground test data, in-flight instrument data, documentation and software.

2.2.2 Communications

As described above, it is necessary to use the facilities of FINDAS early in the instrument development and test programme. This will require high speed links between the centre housing the FINDAS and the ICC from the time of the start of instrument testing (January 2000, TBC)

2.2.3 Commonality

Wherever possible, development of (software) systems that are common between centres will be carried out in collaboration with the other ground segment groups. For such development efforts joint teams will be established under the control of a single team leader. In many cases the software will first be used by the instrument hardware teams (usually during the instrument-level test activities). This will require early input by the ESA project team at a time when traditionally this is not provided. An example of this is the Command Translator software.

It is assumed that a common definition of the computing environment under which the software produced by the ICC will run will be negotiated and defined in the Ground Segment Interface Document (AD5). This must be in place before development of the ICC software begins (July 2001, TBC).

3. ICC DESIGN

3.1 The FIRST Ground Segment Concept

In the FIRST ground segment, the FSC has the responsibility to manage the execution of observations submitted as part of observing proposals from both guaranteed-time and open-time observers. By monitoring progress of the various proposals and subsequently adjusting scheduling properties the FSC ensures that observations are scheduled such that the scientific aims of the mission are fulfilled. In routine operations the FSC prepares sets of science and calibration observations to be executed within the next scheduling period. A detailed observing schedule is then created by the MOC by interleaving these science observations with the necessary satellite operations taking into account the constraints on visibility of the targets and timing. The final schedule is subsequently translated into satellite and instrument commands and uplinked via the FIRST ground station during the 2 hour Daily Telecommunications Phase (DTCP). In the subsequent 22 hour Daily Prime Operational Phase (DPOP) observations are executed and data from the instruments is stored into an on-board memory unit. This data is telemetered to the ground station in the next DTCP and transmitted to the MOC where it is temporarily stored before being delivered, with associated ground data, to the FINDAS. (In routine operations the data will be available on FINDAS within 1 min (TBC) of its reception by the MOC). The MOC monitors the instrument health and safety from the telemetry data and, if any problems are found, takes appropriate action based on procedures supplied by the instrument teams (this may include switching the instrument off or disabling particular observation types etc.). The FSC and instrument ICC will be notified of any problems found and the action taken. The observation data on FINDAS is used for analysis of the instrument performance (by the ICC) and, subsequently for processing into scientific products (by the FSC).

3.2 The role of the ICC

Within the ground segment, the prime operational responsibility of the ICC is to maintain the scientific performance of the instrument through the mission and to make possible the processing of the instrument data into scientifically useful products. It does this by continuously monitoring the health and status of the instrument, analysing its engineering and scientific performance, scheduling test and calibration observations, adjusting observational and operational procedures, generating calibration data and developing data processing software.

This clearly requires the ICC to have access to personnel with an intimate knowledge of the instrument hardware at system and subsystem level, its operational modes and their scientific purpose, how to process the data from the instrument and how to calibrate it. Thus it is important that the maximum amount of the expertise gained during the design, manufacture and, in particular, the testing of the instrument hardware is retained during the instrument operational phase. I.e. the ICC should make use of existing staff with directly relevant expertise as much as possible.

3.3 System Overview

This concept is implemented by locating a SPIRE ICC Operations Centre at RAL, which also has the responsibility for the testing and calibration of the instrument, and by siting SPIRE ICC Data Processing and Science Analysis Software (DAPSAS) Centres at ICSTM(UK) and CEA, Saclay(France), both of which have significant relevant expertise in data processing software (e.g. for ISO). The staff from these Centres will participate in the instrument development, AIV and calibration activities during the ICC development phase in order to build up expertise in the instrument and its operation.

The Operations Centre will be, primarily, responsible for maintaining the operational status and performance of the instrument. The Centre will be staffed from personnel who have been involved in the development and testing of the instrument and its associated software and will be supported by the consortium members from other groups as and when necessary. This centre will also be the single interface between the ICC and the rest of the Ground Segment.

However, the scientific knowledge and experience which is essential for monitoring the scientific quality of the science products, and for designing the science processing and analysis software, is distributed through the whole SPIRE consortium and it is unrealistic to expect that Co-Is will relocate to a central ICC for the whole period of the development and operations phases. It is for this reason, that this work will be carried out by the two DAPSAS Centres. They will provide co-ordination of all the scientific data processing and analysis software development and maintenance activities.

The DAPSAS (UK) centre will additionally be responsible for the generation, to ESA standards, of each version of the ‘pipeline’ software delivered to the FSC. (Note: the Operations Centre will be responsible for its delivery and configuration control.)

3.3.1 ICC Development

Many of the activities of the ICC during the development phase are distributed amongst the groups contributing to the instrument hardware development, manufacture and testing as this is where the expertise resides. It is intended that those involved in this work will transfer to the ICC for the Operations Phase, bringing this expertise.

To co-ordinate the work amongst these groups an ICC Steering Group will be formed under the chairmanship of an ICC Scientist. This group will comprise the PI, the Co-PI, The Project Scientists, the Instrument Scientist, the Systems Engineer, the managers of the three ICC Centres and an ICC Development Manager. This group will define and co-ordinate the work to be carried out and assign responsibilities to appropriate centres. The ICC Development Manager will be responsible for overseeing the implementation of these decisions through the ICC Centres' Managers. He/she will also be the formal interface between the ICC and ESA and will attend all Ground Segment related meetings.

3.3.2 ICC Operations

The SPIRE Operations Centre is responsible for the routine operation and monitoring of the instrument on a day to day basis. It forms the single formal point of contact between the ICC and the FSC and MOC for deliveries of software, data files and other information identified in the ICC/FSC and ICC/MOC interface documents. For this reason the ESA provided link to the FINDAS will connect to this centre.

The DAPSAS Centres are responsible for; monitoring the scientific quality of the processed data from the instrument and upgrading the data processing and science analysis software to reflect improved knowledge and experience of the instrument; carrying out periodic reviews of the calibration status and AOT optimisation in the light of in-flight instrument performance; and analysis of data from parallel and serendipity modes. They will also provide support to the FSC (via the Operations Centre) in relation to these matters.

Co-ordination of this work will be through a Data Analysis Group (consisting of all interested parties), which will meet regularly; to discuss the quality of the scientific products; to identify processing anomalies and effects; to suggest ways of investigating these; to determine solutions and to assign tasks for carrying these out.

3.4 Interfaces

With a distributed development and operational system, communications is one of the most important issues to resolve early and completely. A Communications Plan will be written which will contain all details (required hardware, facilities,etc.) and procedures relevant for ICC communications.

Interfaces to the other ground segment Centres will be detailed in the GSID (AD5).

3.4.1 ICC Internal

The prime medium for transfer of information between the ICC Centres will be FINDAS;

- The ICC will have regular internal meetings. Depending on the phase of the mission these will be daily (PV, check out, ILT's), weekly (operations) monthly or quarterly (development and post operations). Subgroups within the ICC will have separate working level meetings as needed. At all meetings, minutes (or as a minimum, clear decision and/or action lists) will be made which will be added to the FINDAS for later reference.

- All team leaders will submit status reports with a frequency of TBD, again depending on the phase of the project. These will be compiled by the ICC Manager into overall ICC status reports that will be stored in FINDAS and accessible to all ICC members. They will also be the basis for status reports to ESA.
- Documents, progress reports, meeting minutes and action lists will all be made available through FINDAS.

The ICC will also make use of the SPIRE Project World Wide Web (WWW) site to inform the wider SPIRE community of the status of ICC work. This may involve duplication of some of the information on FINDAS for those sites which do not have access to it.

The ICC will use the SPIRE Project Office facilities for dissemination of information throughout the SPIRE consortium.

When needed personnel will be stationed at different consortium institutes for longer periods.

The ICC will also make use of standard facilities such as telephone, FAX, electronic mail and other internet facilities (joint whiteboarding etc.).

During development it is likely that to save on travel expenses many meetings will be held as videoconferences.

3.4.2 Instrument Hardware Group

The instrument hardware group will have access, via FINDAS and the WWW, to all information that the ICC provides and the reverse will also be true..

During the development phase many members of the ICC will spend part of their time performing as members of the instrument development teams.

ICC Development Manager (or deputy) is always present in the SPIRE project meetings.

3.4.3 FIRST Project

The formal point of contact from the ICC to the FIRST Project office is the ICC (Development or Operations) Manager. He/she will attend meetings of the GSAG.

Deliveries of items such as documents and software will be made through FINDAS.

3.4.4 MOC

Throughout the development phase the main communication to the MOC will be through the GSAG (via the ICC (Development or Operations) Manager.

Deliverables and delivery procedures (wherever possible using FINDAS facilities) will be established jointly and documented in the GSID (AD5).

3.4.5 FSC

Throughout the development phase the main communication to the FSC will be through the GSAG (via the ICC (Development or Operations) Manager.

Deliverables and delivery procedures (wherever possible using FINDAS facilities) will be established jointly and documented in the GSID (AD5).

3.4.6 Other ICCs

Throughout the development phase the main communication to the other ICCs will be through the GSAG (via the ICC (Development or Operations) Manager.

Deliverables and delivery procedures (wherever possible using FINDAS facilities) will be established jointly and documented in the GSID (AD5).

3.5 Management

The ICC management organisation is shown in figures 3.1a-b. The ultimate responsibility for the ICC rests with the PI but the day to day management of the ICC schedule and resources is carried out by the ICC Development Manager, during the development phase, who reports to the SPIRE Project Manager. During operations the ICC is managed by the ICC Operations Manager, who reports directly to the PI. These managers will represent the ICC at the GSAG and in SPIRE project meetings.

Each of the three ICC Centres has its own local manager who will provide status reports to the Development/Operations Manager.

The development of the ICC will be under the direction of an ICC Steering Group, chaired by the ICC Scientist, and comprising the PI, the Co-PI, the Project Scientists, the Instrument Scientist, the Systems Engineer, the ICC Development Manager and the managers of the three ICC Centres. It shall define the policies for ICC development and the tasks to be carried out by the two DAPSASCs.

These policies will be implemented by the ICC Development Manager, who will establish, distribute and monitor the work packages given in appendix D. The ICC Development Manager also will compile the status reports from the ICC Centres into general ICC status reports. He will plan and chair ICC progress meetings and monitor progress on action items to be fulfilled by ICC Centres.

During the operations phase the ICC Operations Manager replaces the Development Manager and reports directly to the PI. An additional group, the Data Analysis Group, consisting of all interested parties, will advise the Operations Manager on the tasks to be carried out, particularly by the DAPSASCs, and their priority.

3.5.1 Work Breakdown

The work breakdown is provided in figures 3.2a-d. The corresponding work packages are given in Appendix D.

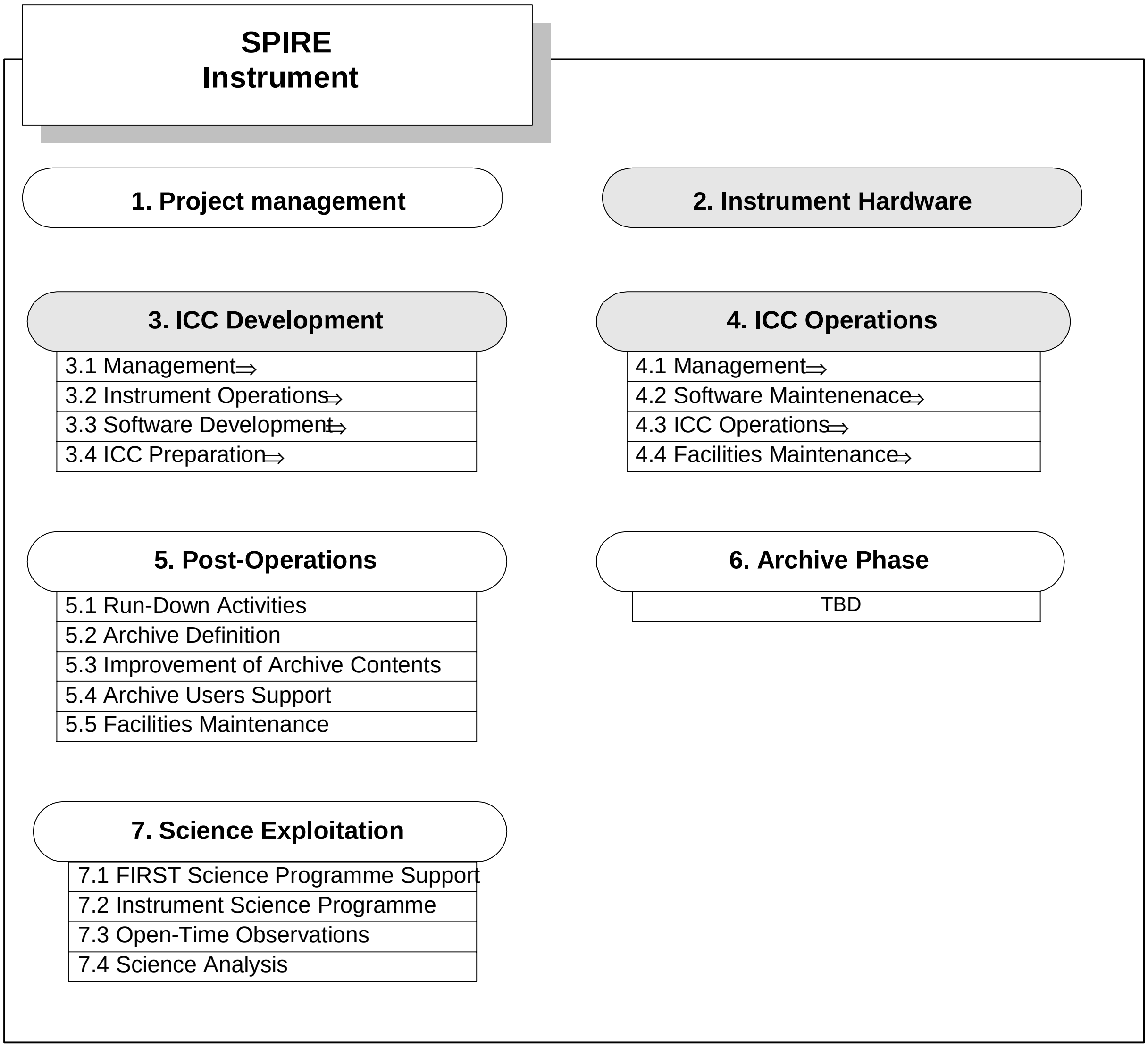

Figure 3.2a: The SPIRE ICC Work Breakdown (Top Level)

3.1 Management

- 3.1.1 Support to ESA
- 3.1.2 Control and maintenance of ICC Schedule
- 3.1.3 Product Assurance
- 3.1.4 Team Setup and Management

3.2 Instrument Operations

- 3.2.1 Provision of Instrument Users Manual
- 3.2.2 Provision of Instrument Database
- 3.2.3 Provision of Calibration Database
- 3.2.4 Definition of Instrument Observations ⇒
- 3.2.5 Definition of Operating Procedures

3.2.4 Definition of Instrument Observations

- 3.2.4.1 Definition of Instrument Modes
- 3.2.4.2 Definition of AOTs
- 3.2.4.3 Implementation of AOTs

3.3 Software Development

- 3.3.1 Provision of Instrument Time Estimator
- 3.3.2 Provision of Instrument Command Translator
- 3.3.3 Provision of RTA/QLA
- 3.3.4 Provision of Trend Analysis System
- 3.3.5 Provision of Calibration Analysis System
- 3.3.6 Provision of Interactive Analysis System
- 3.3.7 Provision of Science Processing Software
- 3.3.8 Provision of Science Analysis Software
- 3.3.9 Provision of Diagnostic Tools

Figure 3.2b: The SPIRE ICC Development Phase Work Breakdown

3.4 ICC Preparation

- 3.4.1 ICC Planning ⇒
- 3.4.2 ICC Implementation ⇒
- 3.4.3 Integration and Test ⇒
- 3.4.4 FINDAS Support
- 3.4.5 Operations Planning ⇒
- 3.4.5 Training ⇒

3.4.1 ICC Planning

- 3.4.1.1 Provision of SIP
- 3.4.1.2 Definition of PV Phase Test Plan
- 3.4.1.3 Provision of Science Validation Plan
- 3.4.1.4 ICC Design

3.4.2 ICC Implementation

- 3.4.2.1 ICC Infrastructure ⇒
- 3.4.2.2 ICC Hardware ⇒
- 3.4.2.3 Commissioning Phase System
- 3.4.2.4 Provision of Instrument Simulator
- 3.4.2.5 Provision of OBS Maintenance Facility

3.4.2.1 ICC Infrastructure

- 3.4.2.1.1 ICC Ops centre Infrastructure
- 3.4.2.1.2 DAPSAS(UK) Infrastructure
- 3.4.2.1.3 DAPSAS(Fr) Infrastructure

3.4.2.2 ICC Hardware

- 3.4.2.2.1 ICC Ops Centre Hardware
- 3.4.2.2.2 DAPSAS(UK) Hardware
- 3.4.2.2.3 DAPSAS(Fr) Hardware

3.4.3 Integration and Test

- 3.4.3.1 ICC Ops centre Integration and Test
- 3.4.3.2 DAPSAS(UK) Integration and Test
- 3.4.3.3 DAPSAS(Fr) Integration and Test
- 3.4.3.4 ICC Internal Interface Test
- 3.4.3.5 ICC Ops Test
- 3.4.3.6 Ground Segment Testing

3.4.5 Operations Planning

- 3.4.5.1 Provision of ICC Operations Plan
- 3.4.5.2 Definition of ICC Operations Procedures
- 3.4.5.3 Definition of ICC/FSC Operational I/Fs
- 3.4.5.4 Definition of ICC/MOC Operational I/Fs

3.4.6 Training

- 3.4.6.1 ICC Ops Team Training
- 3.4.6.2 FSC and MOC Training
- 3.4.6.3 DAPSAS(UK) Training
- 3.4.6.4 DAPSAS(Fr) Training

Figure 3.2c: The SPIRE ICC Preparation Work Breakdown

4.1 Management

- 4.1.1 Operations Management
- 4.1.2 Product/Quality Assurance

4.2 Software Maintenence

- 4.2.1 OBS Maintenance
- 4.2.2 ICC Software Maintenance
- 4.2.3 Science Processing Software ⇨
- 4.2.4 Science Analysis Software ⇨

4.2.3 Science Processing Software

- 4.2.3.1 Update SPS
- 4.2.3.2 SPS Acceptance Testing
- 4.2.3.3 SPS Validation
- 4.2.3.4 SPS Delivery to FSC

4.2.4 Science Analysis Software

- 4.2.4.1 Update SAS
- 4.2.4.2 SAS Acceptance Testing
- 4.2.4.3 SAS Validation
- 4.2.4.4 SAS Delivery to FSC

4.3 ICC Operations

- 4.3.1 Support to MOC
- 4.3.2 Support to FSC
- 4.3.3 Health and Status Monitoring
- 4.3.4 Performance Monitoring
- 4.3.5 Calibration
- 4.3.6 Trend Analysis
- 4.3.7 Science Processing Quality Checking
- 4.3.8 Performance Maintenance
- 4.3.9 Ground Segment Interaction
- 4.3.10 Parallel Mode Analysis
- 4.3.11 Serendipity Mode Analysis
- 4.3.12 Support to the Community ⇨
- 4.3.13 Consortium Support to the ICC

4.3.12 Support to theCommunity

- 4.3.12.1 Consortium Support
- 4.3.12.2 National Community Support

4.4 Facilities Maintenance

- 4.4.1 Infrastructure Maintenance
- 4.4.2 Hardware Maintenance
- 4.4.3 System Mangement

Figure 3.2d: The SPIRE ICC Operations Phase Work Breakdown

3.5.2 Schedule

The schedule is based on the Ground Segment Milestones provided in the SIRD but also take into account the fact that the instrument hardware schedule also impacts on the ICC schedule. The major ICC milestones are given below. The ICC schedule is provided in Appendix C.

3.6 Product Assurance

The PA Manager for the SPIRE project shall be responsible for ICC product assurance and configuration control. The PA Manager will make change proposals where necessary to bring ICC products to the standards as laid out in the FIRST Product Assurance Requirements Document.(AD6). There will be persons responsible for PA activities appointed at each of the ICC Centres.

The following rules apply (as a minimum) for all ICC deliverables (internal or external):

- PA/QA for ICC related matters shall follow the general PA/QA strategy detailed in the SPIRE Product Assurance Plan (RD2).
- All software deliverables shall be constructed according to the Guide to applying the ESA Software Engineering Standards (PSS-05-0) to small Software Projects (AD7).
- All ICC documentation will be maintained using the FINDAS configuration control system.
- All ICC software will be maintained using the FINDAS configuration control system.

3.6.1 Quality Assurance

A system shall be set up to provide facilities for reporting software problems and managing their resolution.

3.6.2 Configuration Management

This will use the facilities provided in the FINDAS.

3.6.3 Review Procedures

Reviews of all stages of major software systems shall be attended by the PA Manager or his representative.

3.7 Science

The performance of the instrument and the quality of the data and calibration are best evaluated in the context of the science that is to be carried out with the instrument. Therefore all (qualified) ICC personnel will be given the opportunity to spend a reasonable amount of time on scientific research based on data obtained with the FIRST instruments. They will be encouraged to participate especially in the SPIRE guaranteed time projects.

At all times, ICC work will take priority over science. Therefore ICC composition is aimed to be such that under normal operational conditions between 10 and 20% of the time can be dedicated to scientific research. It is expected that no significant time will be available around the busy in orbit check out and performance verification phases.

4. DEVELOPMENT PHASE

This phase is defined to start with instrument selection and to continue until the end of the Ground Segment testing, culminating with the Ground Segment Readiness Review. At this point the ICC comes under the control of the ICC Operations Manager.

Many of the activities of the ICC during the development phase are distributed amongst the groups contributing to the instrument hardware development, manufacture and testing as this is where the expertise resides. It is intended that those involved in this work will transfer to the ICC for the Operations Phase, bringing this expertise.

To co-ordinate the work amongst these groups an ICC Steering Group will be formed under the chairmanship of an ICC Scientist. This group will comprise the PI, the Co-PI, The Project Scientists, the Instrument Scientist, the Systems Engineer, the managers of the three ICC Centres and an ICC Development Manager. This group will define and coordinate the work to be carried out and assign responsibilities to appropriate centres. The ICC Development Manager will be responsible for overseeing the implementation of these decisions through the ICC Centres' Managers. He/she will also be the formal interface between the ICC and ESA and will attend all Ground Segment related meetings.

4.1 Activities

Development activities fall into four areas;

4.1.1 Management

4.1.1.1 Support to Ground Segment Meetings

The ICC Development Manager will be a member of the GSAG and will attend all relevant ground segment meetings and reviews.

4.1.1.2 Control and Maintenance of ICC Schedule

This follows on from the definition of the responsibilities of the different ICC contributors and the work packages provided in this document. Managers if the SPIRE ICC Centres will report regularly to the ICC Development Manager against an agreed set of work packages and schedule. These reports will form the basis of the status report from the ICC development Manager to ESA.

4.1.1.3 Product/Quality Assurance

The SPIRE Project PA Manager will be responsible for these activities.

4.1.1.4 Team Setup and Management

During this phase the ICC teams will come together to set up the ICC facilities and be trained in their use, in preparation for operations. This will happen 1 year before launch (TBC).

4.1.2 Instrument Operations

Most of the work related to instrument operations will be performed by the Instrument Scientist's Test Team, responsible for preparation and execution of the instrument level testing and calibration. It is expected that some members of this team will transfer to the ICC for operations to maintain expertise in the operation of this instrument. It is therefore appropriate that they carry out these activities.

4.1.2.1 Instrument Users' Manual

The Instrument Users Manual is a repository of information from many of the groups involved in the definition and manufacture of the instrument. The Instrument Scientist will be responsible for co-ordinating inputs from the other consortium members into a single coherent document.

4.1.2.2 Instrument Databases

The ICC will require databases of information relating to the instrument operation (instrument parameters, conversion curves, limits etc.) and its calibration. This information will be mostly generated as a direct result of data collected during the testing and calibration activities at RAL. The teams responsible for these activities will also, as part of their work, define the instrument databases in FINDAS and generate the data for them.

4.1.2.3 Operating Procedures

These procedures (command sequences) will be defined by the Test Team as part of the preparation for the AIV and calibration activities and validated during the instrument and system level testing. They are likely to be refined as these activities proceed. They will be stored in FINDAS.

4.1.2.4 Observation Definition

The Project Scientists will be responsible for defining the scientific requirements on the instrument operating modes and the way in which they should be combined to make astronomical observations. The Instrument Scientist and his team will translate these into a series of standard operating sequences, which they will then implement in the FIRST command script language so that they may be checked during the instrument and system level testing.

4.1.3 Software Development

Responsibility for these activities will be distributed between the institutes housing the three ICC centres. The exact division will be determined by the ICC Steering Group. The following software has been identified;

4.1.3.1 Instrument Time Estimator

This software will provide observers with information about the observing time necessary to carry out their observations based on astronomical inputs. It will not provide scheduling information about prospective sources (e.g. visibility) nor will it attempt to estimate fluxes (or line strengths) for particular targets. This will be the observer's responsibility.

4.1.3.2 Instrument Command Translator

All operations of the instrument will be defined in a scripting language that allows the generation of commands for the instrument, and their timing. In the interests of commonality it is expected that the same language will be used to define instrument test sequences, at the instrument and system level, and astronomical observations. The software that implements this language and provides the translation to instrument command sequences will be developed as a joint effort between the instrument teams, satellite checkout contractor and the MOC.

4.1.3.3 RTA/QLA

This software provides a means to assess the status of the instrument and to analyse its performance during an sequence of operations. It is used to monitor the housekeeping parameters from the instrument and to display science data. It is used during all phases of the instrument development and operations.

The software will be based on the ISO RTA/QLA system, adapted to run under the environment adopted for FIRST (in particular to allow access to its input data from FINDAS), with additional facilities to allow remote operation and monitoring (TBD). This will allow the ICC to follow the instrument tests at remote sites and during the instrument commissioning phase.

4.1.3.4 Trend Analysis

This software will provide general purpose facilities to extract data from the instrument housekeeping and science data and display it as a function of time, instrument configuration etc.

4.1.3.5 Calibration Analysis

4.1.3.5.1 Calibration Data Processing

This software will process the instrument data from calibration (and possibly other) observations into a calibration database. It will be based on the data processing software (see later) but may omit or replace processing steps. The purpose of the software is to build up a set of data from which it is possible to generate the calibration files used by the data processing software.

4.1.3.5.2 Calibration File Generation

This software processes the data in the calibration database to produce the calibration data files used by the data processing software

4.1.3.6 Interactive Analysis

This system will provide a user interface to allow users; to perform and control each step in the science data processing chain; to 'plug in' new modules to replace the current version at each step; and to display and/or modify the data at the end of each step before continuing with the processing. It is expected that initially some of the steps in the data processing chain will also require interactive input from the user and that several iterations round a series of steps may also be necessary. Hopefully later versions of the software will require less interaction. This system will provide the prime method of testing new data processing modules and their associated calibration files. These tested modules will form the basis of the data processing software provided to the FSC. (It is presently assumed that the SPIRE 'pipeline' will be a cut down version of the Interactive Analysis System, delivered to the FSC for processing of Open-time observers data. This may require the software to be run by the observer at their own institute, or be made available to be run by the observer at the FSC.)

4.1.3.7 Science Processing Software

This software consists of a set of modules which are executed by the interactive analysis software in order to process data from the instrument into standard data products. These are essentially the instrument data with instrument artefacts removed and calibrated (TBD).

4.1.3.8 Science Analysis Software

This software consists of a set of modules which are executed by the interactive analysis software (TBD) in order to process data products into a more scientifically useful form (e.g. maps or averaged spectra).

4.1.3.9 Diagnostic Tools

These tools will typically be generated, as needed, during the instrument development and test activities. They will be documented and made available during operations.

4.1.4 Preparation for Operations

These activities are the basic tasks for implementing the ICC and validating it, before launch.

4.1.4.1 ICC Planning

4.1.4.1.1 Science Implementation Plan

This is contained in this document

4.1.4.1.2 PV Phase Test Plan

This document will contain the test plan for checking the performance of the instrument and its calibration against the requirements. These tests will be carried out following the instrument commissioning phase.

4.1.4.1.3 Science Validation Plan

This plan will detail the way in which the AOTs and the data processing software will be validated.

4.1.4.1.4 ICC Design

TBW

4.1.4.2 Implementation

4.1.4.2.1 ICC Infrastructure

Each Centre in the SPIRE ICC will be responsible for providing office accommodation, communications facilities and secretarial assistance to the staff located there.

4.1.4.2.2 ICC Hardware

Each Centre in the SPIRE ICC will be responsible for providing computing hardware and support to allow the staff to carry out their tasks.

4.1.4.2.3 Commissioning Phase System

This system runs the RTA/QLA software during the instrument commissioning phase. It is delivered to the MOC before launch and will stay there throughout the operations phase, in case it is required for further testing of the instrument. The system is identical to those used during the instrument and system-level testing and should require little testing for integration into the MOC.

4.1.4.2.4 Instrument Simulator

With the instrument having two computers on board, it will be difficult to simulate the instrument in software alone. The Simulator is TBD at present.

4.1.4.2.5 OBS Maintenance Facility

The developers of the on-board software running in the DPU (based in Italy)will provide the facility to maintain the software in the ICC. This is expected to be a PC-based package of software (TBC). At least one of the staff provided by Italy will be familiar with the operation and use of this facility and the on-board software (TBC).

4.1.4.2.6 SPU S/W Maintenance Facility

The developers of the on-board software running in the DPU (based in France) will provide the facility to maintain the software in the ICC. This is expected to be a PC-based package of software (TBC). At least one of the staff provided by France will be familiar with the operation and use of this facility and the on-board software (TBC). It is still TBD whether this facility will be located in the ICC Operations Centre of the DAPSASC (Fr). In any case it will be available in the Operations Centre during the instrument commissioning and PV phases.

4.1.4.3 Integration and Tests

The ICC and its subsystems will be subjected to a series of tests at several levels to verify its readiness for operations.

4.1.4.3.1 Subsystem Tests and Acceptance

Each subsystem delivered to the ICC will undergo acceptance testing before integration into the ICC.

4.1.4.3.2 ICC Interface Tests

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4.1.4.3.3 ICC System Tests

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4.1.4.3.4 Ground Segment Tests

The ICC Operations Centre will participate in the FIRST Ground Segment and End-to End tests.

4.1.4.4 FINDAS Support

All information pertinent to SPIRE will be stored in FINDAS. This means that documentation, data as well as software will follow the standard FINDAS configuration control mechanism. Thus all this information will be traceable, and its change history will reflect all changes that have been made. Because of this FINDAS will be a cornerstone in the communication between the different groups within the ICC and the SPIRE consortium (during the development as well as during the operations phase described below). Therefore design of SPIRE specific data items shall commence early in the ICC development phase.

The relevant FINDAS work contains (at least) the following components:

- definition of storage objects for SPIRE data (science and house keeping telemetry and data products)
- definition of storage objects for SPIRE calibration and characterisation parameters
- definition of telecommand objects for control of the SPIRE instrument
- definition of the SPIRE documentation objects
- definition of SPIRE interaction objects (action lists, meeting lists etc)

4.1.4.5 Operations Planning

The Operations Manager will be responsible for the provision of an ICC Operations Plan with associated Operations Procedures. This will require participation in the definition of the operations interfaces to the rest of the FIRST Ground Segment.

4.1.4.6 Training

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4.2 Organisation

4.3 Schedule

4.4 Resources

WBS	Task Name	1998	1999	2000	2001	2002	2003	2004	2005	SY	Eqpmnt £K	SIRD Requirement(s)
3.1	**Management**											
3.1.1	Support to Ground Segment Meetings	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	**0.80**		ICCF-030,035,MNGT-022,023
3.1.2	Conrol and Maintenance of ICC Schedule	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	**1.60**		ICCF-020,MNGT-024
3.1.3	Product/Quality Assurance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	**1.20**		ICCF-180,185,190,PAQA-001,002,030,032,033
3.1.4	Team Setup and Management		0.02	0.02	0.05	0.05	0.40	0.80	1.00	**2.34**		ICCF-015,ICCO-005
3.2	**Instrument Operations**											
3.2.1	Provision of Instrument Users' Manual					0.25	0.50	0.50		**1.25**		ICF-090
3.2.2	Provision of Instrument Database			0.50	0.10	0.10	0.10	0.30	0.10	**1.20**		ICCF-050,070,085,160
3.2.3	Provision of Calibration Database		0.40	0.10	0.10	0.10	0.10	0.50	0.50	**1.80**		ICCF-135,140,145
3.2.4	Definition of Instrument Observations			0.35	0.55	0.95	1.10	1.20	0.65	**4.80**		ICCF-055,060,070,080
3.2.5	Definition of Operating Procedures					0.25	0.50	0.50	0.50	**1.75**		ICCF-065,095,100
3.3	**Software Development**											
3.3.1	Provision of Instrument Time Estimator			0.10	0.30	0.30	0.45	0.20	0.20	**1.55**		ICCF-105,PAQA-011
3.3.2	Provision of Instrument Command Translator	0.10	0.50	0.50	0.10	0.10	0.10	0.10	0.10	**1.60**		ICCF-110
3.3.3	Provision of RTA/QLA	0.30	1.00	1.00	0.50	0.50	0.50	0.50	1.00	**5.30**		ICCF-130,PAQA-011
3.3.4	Provision of Trend Analysis				0.25	0.25	0.10	0.10	0.10	**0.80**		ICCF-130,PAQA-011
3.3.5	Provision of Calibration Analysis		0.10	0.10	1.00	1.50	1.50	1.50	1.50	**7.20**		ICCF-130,PAQA-011
3.3.6	Provision of Interactive Analysis		0.25	0.25	1.00	1.00	1.00	1.00	1.00	**5.50**		
3.3.7	Provision of Science Processing Software				0.50	0.50	1.50	1.50	1.50	**5.50**		
3.3.8	Provision of Science Analysis Software					0.25	0.70	1.50	1.50	**3.95**		ICCF-130,PAQA-011
3.3.9	Provision of Diagnostic Tools			0.10	0.10	0.20	0.35	0.20	0.20	**1.15**		ICCF-130,PAQA-011
3.4	**ICC Preparation**											
3.4.1	ICC Planning	0.40	0.20	0.10	0.10	0.10	0.10	0.10	0.10	**1.20**		ICCF-005,010,025,040,PAQA-010,MNGT-010,011,025
3.4.2	Facilities											
3.4.2.1	Provision of ICC Infrastructure							0.10	0.10	**0.20**	70	ICCF-045
3.4.2.2	ICC Hardware		0.60	0.15	0.15	0.15	0.15	0.25	0.25	**1.70**	225	
3.4.2.3	Commissioning Phase System						0.20	0.20	0.25	**0.65**	10	ICCF-205
3.4.2.4	Provision of Instrument Simulator		0.20	0.20	0.40	1.50	0.50	0.25	0.25	**3.30**		ICCF-150
3.4.2.5	Provision of On Board Software Maintenance Facility						0.40	0.35	0.10	**0.85**	5	ICCF-155
3.4.3	Integration and Test						1.00	2.00	4.00	**7.00**		ICCF-195,200,PAQA-020,022,023,024,025,026
3.4.4	FINDAS Support		0.10	0.10	0.10	0.10	0.10	0.10	0.10	**0.70**		ICCF-120,125,175
3.4.5	Operations Planning				0.10	0.10	0.25	0.25	0.50	**1.20**		ICCF-115,165,170
3.4.6	Training							0.10	0.40	**0.50**		ICCO-005,010
	Totals	**1.25**	**3.82**	**4.02**	**5.85**	**8.70**	**12.05**	**14.55**	**16.35**	**66.59**	**310**	

5. Operations Phase

5.1 Activities

5.1.1 Software maintenance

5.1.1.1 On-Board Software

The SPIRE instrument warm electronics contains two subsystems with embedded microprocessors that can be reprogrammed in flight. Maintenance systems and trained staff will be provided in the ICC to allow these updates to be made. The ICC will also retain access to the instrument Flight Spare Model and test facility and a copy of the software simulator to enable testing of the upgraded software before its use on the satellite.

5.1.1.1.1 DPU Software

This software is responsible for accepting commands from the satellite, controlling the overall operation of the instrument and collecting and packaging telemetry data. These functions are not expected to change very frequently, if at all.

5.1.1.1.2 SPU Software

This software is responsible for the synchronisation of detector data collection with instrument mechanisms, processing of data to allow data reduction (e.g. deglitching) and data compression. It is likely that the optimisation of these functions cannot be made until the instrument is operating in flight and so this software is likely to undergo substantial changes in the early parts of the operational phase. Staff with the expertise to make these changes will initially be located at the operations centre, until the software has stabilised (TBC).

5.1.1.2 ICC Operations Software

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5.1.1.3 Data Processing and Science Analysis Software

5.1.1.3.1 Software Upgrades

Initial versions of the data processing software will be produced during the development phase, based on requirements identified during the AIV and ground calibration activities. Subsequently, when operations begin, it will become necessary to upgrade the software to take account of anomalies and problems with the data processing and science analysis software identified during the execution of the above monitoring functions. Facilities to allow the development and testing of software modules and the analysis and investigation of their utility will be provided in the Interactive Analysis System

New and updated processing algorithms will be prototyped and tested within this system by members of the consortium, particularly those with expertise related to instrument subsystems, until satisfactory performance is achieved. Subsequently, these algorithms will be ‘converted’ into new modules following the ESA software development standards before submission to the FSC (see later).

5.1.1.3.2 Validation

It is assumed that a ‘cut down’ version (i.e. one which provides only the required facilities) of the Interactive Analysis system will be provided to the FSC as the instrument ‘pipeline’. Nevertheless it is probable that the environment in which the ‘pipeline’ runs will be different to that under which the Interactive Analysis is supported (e.g. the data input interface may be different in the two cases; via FINDAS or via files). Therefore a data processing testbed will be required to emulate the processing environment in the FSC. It is expected that the FSC will provide access to such a ‘test pipeline’ to be used by the ICC for testing prior to the formal delivery of the instrument software.

This testbed will be used to acceptance test any proposed new science processing software delivery by processing a set of observations which will be selected to exercise all modules in the software. (This test-set will expand during the Operations Phase as new modules are produced and ‘problem’ observations are found.) The complete set of tests and expected results will be documented in an Acceptance Test Plan. The acceptance test results will be provided with the delivered software.

After acceptance, an additional set of observations will be processed, selected to allow validation of the scientific results from the data processing. The products from these observations will be made available to the PI of the observation for them to report on the acceptability of the product. (Note: in general these observations will be selected from the guaranteed-time of the consortium, but they may include open-time observations, if these are the only data available to validate parts of the data processing chain) These reports, and any caveats on the use of the data products produced, will be provided with the delivered software.

5.1.1.3.3 Delivery

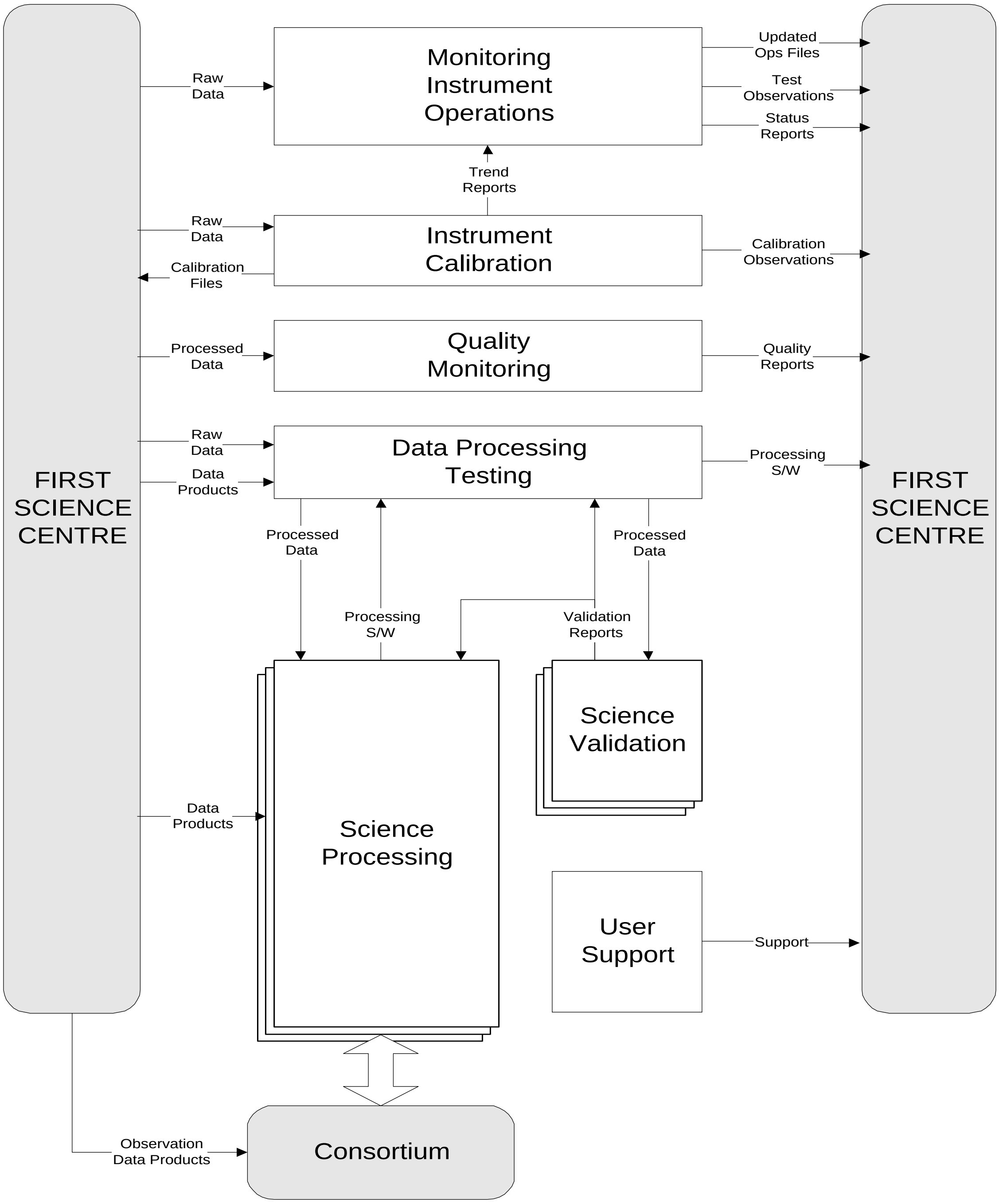
Delivery will be made via FINDAS.

5.1.2 ICC Operations

Figure 1 shows the functions carried out by the ICC during the Routine Operations Phase.

FIRST Bolometer

INSTRUMENT CONTROL CENTRE FUNCTIONAL OVERVIEW



5.1.2.1 Support to MOC

5.1.2.2 Support to FSC

5.1.2.3 Health and Status Monitoring

Data from the instrument for each 22 hour Daily Prime Operational Phase (DPOP) is received on the ground, during the following 2 hour Daily Telecommunications Phase (DTCP). Initially, the ICC will provide 7 days a week operation (during normal office hours) to allow it to monitor the instrument status daily. This will provide reaction to any instrument problems within 48hrs of their occurrence. This may be relaxed as confidence in the instrument is gained.

The accumulated instrument science data will take, on average, 5-6 hrs to transmit from the MOC, through FINDAS, to the ICC (8hrs of data @ 40kbps through a 64kbps link), with the time possibly extended if other FINDAS/ICC communications are taking place at the same time. The ICC cannot, therefore, monitor the instrument and take action in real time, based on the complete set of telemetry data available from the satellite. The monitoring activity will then be spilt into two stages; the first taking place during the DTCP when the possibility of commanding the instrument in real time is available; the second, after the DTCP when the full telemetry from the instrument is available.

5.1.2.3.1 During DTCP

The ICC instrument monitoring will take advantage of the ability of the satellite Data Handling Sub-System (DHSS) to transmit to the ground a mixture of real-time telemetry and selected data stored in the Solid State Recorder Mass Memory (SSR).

The ICC will receive, in parallel, the real-time instrument housekeeping telemetry and the ‘event packets’ in the stored instrument housekeeping telemetry. These will be monitored for: parameters out of limits; unexpected instrument configurations; correct command execution and autonomous actions taken by the instrument On Board Computer.

In the case of a serious problem, the ICC will have the option to execute any agreed contingency procedures (which may include real-time commanding of the instrument and require real-time instrument science data) in order to clarify, and possibly correct, the situation. The ICC may then take the decision; to continue with the scheduled observations, to reset the instrument to its normal mode and continue with the schedule, or to suspend the schedule until the problem has been diagnosed. A report on the instrument health will be generated daily.

5.1.2.3.2 Post DTCP

The ICC will request the complete instrument telemetry, both housekeeping and science data, from the previous DPOP and will monitor the instrument status information through that period. A report on the instrument status will be generated.

During this activity, data for the analysis of trends in instrument parameters, both housekeeping and science, will be generated and stored in Trend Data Files.

5.1.2.4 Performance Monitoring

In addition to the health and status monitoring described above, the Operations Team will also monitor the scientific performance of the instrument primarily through data produced and displayed on the RTA/QLA system. This will include and assessment of detector behaviour (sensitivity, saturation, spiking, noise, dark current),TBC

5.1.2.5 Calibration

The results of instrument calibration activities will be placed in a Calibration Database held in the FINDAS. The initial database will be generated and populated during the AIV and Ground Calibration periods and will evolve throughout the mission as a result of regular Calibration Observations. These will be detailed in an SPIRE In-flight Calibration Plan.

Calibration Observations will be carried out by execution of both standard Astronomical Observation Templates (AOTs) and custom written observations, using the common script language in which the AOTs will be implemented. The processing of both types of observation is likely to be non-standard and will be carried out by the ICC using calibration-specific software. This software is divided into two parts; the first will allow processing of individual Calibration Observations to provide data to be input into the Calibration Database, and the second allows subsequent processing of the Database into the Calibration Files used by the uplink and downlink software.

Further processing of the Calibration Database will be made to provide Trend Data Files for calibration parameters. These are used to monitor instrument long term stability.

5.1.2.6 Trend Analysis

Regularly (weekly, or as required) analysis of the Trend Data Files, produced during instrument monitoring and calibration activities, will be performed and a report on the instrument long term status will be produced.

5.1.2.7 Science Data Processing Quality Checking

The purpose of this function is to assess the quality of the products being provided by the FSC through the use of the instrument science processing software. Products from selected observations will be requested, routinely, from the FSC (via FINDAS) and analysed to identify possible problems with the science processing. This will include analysis of the processing status reports (e.g. identification of failed processing steps, comparison of instrument science parameters (e.g. detector noise) with expected values, etc.) and analysis of the final products for obvious anomalies (e.g. zero detector output, negative fluxes, etc.). Status reports will be generated for each observation assessed.

Assessment of the scientific quality of the products from an observation cannot be made without the involvement of the PI for that observation. For this reason the members of the instrument consortium will be fully involved in the scientific quality assessment of their own guaranteed-time observations. They will make use of the instrument Interactive Analysis and Scientific Analysis software systems described below.

5.1.2.8 Performance Maintenance

When anomalies are reported by e.g. the Operations Team or end-users investigating their science observations an investigation will be made to find the cause and any possible remedy. A team will be formed from appropriate staff from the ICC to look at the relevant data and/or housekeeping parameters and produce a report.

The team may request additional special observations to be made and these will be implemented by the Operations Team.

5.1.2.9 Ground Segment Interaction

It is expected that during operations it will be found that the operating modes of SPIRE as defined pre-launch are sub-optimal for space conditions. In this case the operating modes will be adapted by modifying the relevant software. The modifications will be tested on the instrument simulator to verify that they were implemented correctly and have the desired effect on instrument operations. Subsequently the modified operational mode will be delivered to FINDAS together with specific test observations for testing on the satellite. After evaluation of these tests by the ICC has shown the correct implementation of the change the operational mode can be installed on the operational system for scheduling scientific observations.

The ICC Operations Team will define the changes to the operational mode and implement them in the command script language (used to define AOTs). Testing will be carried out by the Software Team under the control of the PA/QA engineer.

5.1.2.10 Parallel Mode Analysis

TBW

5.1.2.11 Serendipity Mode Analysis

TBW

5.1.2.12 Support to the Community

The FSC has the responsibility for supporting the astronomical community in the use and exploitation of the FIRST instruments. The ICC will provide instrument-specific support to this work by offering training opportunities to personnel from the FSC during the Development Phase (it is hoped that FSC staff will take part in the AIV and Ground Calibration activities and Ground Segment tests) and by responding to questions during the Operations Phase.

All requests for help will be made through the ICC Operations Centre, who will pass them on to the appropriate personnel.

5.1.2.13 Consortium Support to the ICC

The staff of the three ICC Centres cannot encompass the expertise held within the consortium as a whole. At times consortium members will be required to support the ICC staff in their work. They will be expected to be available for the following tasks; support to analysis of data in the PV phase; support to Operations centre in the investigation of instrument anomalies; and support to the DAPSAS Centres in the investigation of data processing anomalies.

5.1.3 Facilities Maintenance

5.1.3.1 Infrastructure Maintenance

5.1.3.2 Hardware Maintenance

5.1.3.3 System Management

5.2 Organisation

5.2.1 Operations Centre

5.2.1.1 Operations Teams

These teams perform the functions of the SPIRE ICC Operations Centre as described above. In the initial phases of the operations (Commissioning and PV phases) they will be augmented by staff from other consortium institutes.

All Operations Centre staff will be encouraged to take part in analysis and scientific data processing activities in order to contribute to the software development work at the DAPSAS centres.

The Operations Centre will consist of three teams;

5.2.1.1.1 Operations Team

This team will be responsible for;

- monitoring the status of the instrument
- trend data extraction and analysis
- calibration data extraction (generation of calibration files is a responsibility of the DAPSAS centres, TBC)
- anomaly investigation (with help from instrument subsystem experts)
- generation of new observations (new calibration observations, investigative observations etc)
- update of the AOT implementation
- generation of new and updated operations procedures

The Operations Team will be available normally during office hours 5 days a week. However, the requirement to monitor the instrument status on a daily basis will mean that this function (probably taking one person a few hours) will be performed 7 days a week by rote.

During the Commissioning and PV phases the Operations Centre will be staffed 7 days a week and the Operations Team will be augmented by visiting staff from other institutes.

5.2.1.1.2 Software Team

This team will be responsible for;

- maintenance of the ICC software
- maintenance of the On-Board Software

- maintenance of the Signal Processing Unit Software (TBC)
- acceptance testing of new science processing software and calibration files and its installation into the testbed
- delivery of science processing software updates to the FSC after validation.
- Configuration control of all deliverable software and data.

This team will operate during office hours for 5 days per week.

5.2.1.1.3 Facilities Team

The Facilities Teamwill be responsible for maintenance of the computer hardware and other equipment at the Operations Centre. They will operate during office hours for 5 days a week (possibly being on call at weekends to support the Operations Team)

5.2.1.2 Infrastructure and Hardware

The Operations Centre is responsible for the routine operation and monitoring of the instrument on a day to day basis. It forms the single formal point of contact between the ICC and the FSC and MOC for deliveries of software, data files and other information identified in the ICC/FSC and ICC/MOC interface documents. For this reason the ESA provided link to the FINDAS will connect to this centre.

Facilities provided will include a Project Office for management, administrative and secretarial support, offices, meeting rooms and equipment for the Operations Centre teams and additional office space for visitors expected during the Instrument Commissioning and Performance Verification Phases and at other times.

The Operations Centre will be provided with the following computing hardware;

- a Quick Look Facility (with redundancy), comprising a workstation plus additional displays running the RTA/QLA software developed during the AIV and Calibration activities, which will provide display and analysis facilities for monitoring of the instrument status. It is expected that this will be a copy of the Quick Look Facility used during the instrument testing and provided to the MOC for the Satellite Commissioning Phase with additional software for use in an operational environment.
- an Operations Computer to support the work of the Operations Team in data processing and analysis. This machine will also have to be able to run software provided by ESA, such as time estimators, command translator etc. A server-class machine is envisaged with large on-line disk space (for temporary storage of data under analysis) and peripherals (storage devices, printers etc.) with terminals for each team
- a Software Development Computer (identical to the Operations Computer, to provide redundancy in the case of failure of the prime machine) used by the software maintenance team for its tasks.
- a copy of the instrument software simulator to allow testing of updated instrument command sequences, AOTs etc.
- An On-Board Software Maintenance Facility, to allow generation and testing of updates to the on-board software.
- A Signal Processing Unit Software Maintenance Facility (TBC), to allow generation and testing of updates to the SPU software.
- A substantial data storage facility (TBC) to provide storage for large amounts of data used in testing and validation of data processing software. (With the link rate available (64kbps) it

would take a long time to extract all the data needed for a validation exercise from FINDAS every time.)

In addition the Operations Centre will retain the Flight Spare Model of the instrument and the calibration and test facilities available, at short notice, in order to support investigation of anomalies and to test new command sequences during the routine phase.

5.2.2 DAPSAS Centres

These centres are responsible for; monitoring the scientific quality of the processed data from the instrument and upgrading the data processing and science analysis software to reflect improved knowledge and experience of the instrument; carrying out periodic reviews of the calibration status and AOT optimisation in the light of in-flight instrument performance; and analysis of data from parallel and serendipity modes. They will also provide support to the FSC (via the Operations centre) in relation to these matters.

Co-ordination of this work will be through a Data Analysis Group (consisting of all interested parties), which will meet regularly; to discuss the quality of the scientific products; to identify processing anomalies and effects; to suggest ways of investigating these; to determine solutions and to assign tasks for carrying these out.

5.2.2.1 Infrastructure and Hardware

Each will provide infrastructure and computing facilities for their expected staff, plus visitors, and will be linked via the internet (using ISDN, TBC) to the Operations Centre. They will also provide internet access for remote login by consortium members not located at a DAPSAS Centre to allow their participation in the software development and maintenance.

5.3 Schedule

5.4 Resources

WBS	Task Name	2006	2007	2008	2009	2010	SY	Eqpmnt £K	SIRD Requirement(s)
4.1	**Management**								
4.1.1	Operations Management	1.00	1.00	1.00	1.00	1.00	**5.00**		MNGT-024
4.1.2	Product/Quality Assurance	0.70	0.70	0.70	0.70	0.70	**3.50**		PAQA-002,030
4.2	**Software Maintenance**								
4.2.1	OBS Maintenance	0.20	0.20	0.20	0.20	0.20	**1.00**		ICCO-020
4.2.2	ICC Software Maintenance	1.50	1.50	1.50	1.20	1.20	**6.90**		ICCO-080
4.2.3	Science Processing Software Maintenance	1.50	1.50	1.50	1.50	1.50	**7.50**		ICCO-065
4.2.4	Science Analysis Software Maintenance	0.50	0.50	0.50	0.50	0.50	**2.50**		ICCO-065
4.3	**ICC Operations**								
4.3.1	Support to MOC	1.00					**1.00**		ICCO-015
4.3.2	Support to FSC	0.30	0.30	0.30	0.30	0.30	**1.50**		ICCO-025
4.3.3	Health and Status Monitoring	1.20	1.20	1.00	1.00	1.00	**5.40**		ICCO-035
4.3.4	Performance Monitoring and Diagnostics	1.50	1.20	1.20	1.20	1.20	**6.30**		ICCO-040,045
4.3.5	Calibration	2.50	2.50	2.00	2.00	2.00	**11.00**		ICCO-050
4.3.6	Trend Analysis	0.50	0.50	0.50	0.50	0.50	**2.50**		ICCO-050
4.3.7	Science Quality Checking	1.00	1.00	1.00	1.00	1.00	**5.00**		ICCO-070
4.3.8	Performance Maintenance	0.25	0.25	0.25	0.25	0.25	**1.25**		ICCO-055,075
4.3.9	Ground Segment Interaction	0.50	0.50	0.50	0.50	0.50	**2.50**		ICCO-030,085
4.3.10	Parallel Mode Analysis	0.50	0.50	0.50	0.50	0.50	**2.50**		
4.3.11	Serendipity Mode Analysis	0.50	0.50	0.50	0.50	0.50	**2.50**		
4.3.12	Support to the Community	1.50	1.50	1.50	1.50	1.50	**7.50**		
4.3.13	Consortium Support to the ICC	2.00	2.00	2.00	2.00	2.00	**10.00**		ICCO-065,070
4.4	**Facilities maintenance**	1.00	1.00	1.00	1.00	1.00	**5.00**	70	ICCO-080
	Totals	**19.65**	**18.35**	**17.65**	**17.35**	**17.35**	**90.35**	**70**	

6. COMMISSIONING PHASE

6.1 Activities

6.2 Organisation

6.3 Schedule

6.4 Resources

7. PERFORMANCE VERIFICATION PHASE

7.1 Activities

7.2 Organisation

7.3 Schedule

7.4 Resources

8. Post-Operations Phase

8.1 Activities

8.2 Organisation

8.3 Schedule

8.4 Resources

9. ARCHIVE PHASE

9.1 Activities

9.2 Organisation

9.3 Schedule

9.4 Resources

10. APPENDICES

10.1 Appendix A - Personnel

10.2 Appendix B - ICC Location and Facilities

10.3 Appendix C - Timeline

10.4 Appendix D - Work Packages

The numbering Scheme for the ICC work packages takes into account the numbering scheme of the SPIRE project;

3 ICC Development
3.1 Management
3.1.1 Support to ESA
3.1.2 Control and Maintenance of ICC Schedule
3.1.3 Product Assurance
3.1.4 Team Setup and Management
3.2 Instrument Operations
3.2.1 Provision of Instrument User's Manual
3.2.2 Provision of Instrument Database
3.2.3 Provision of Calibration Database
3.2.4 Definition of Instrument Observations
3.2.4.1 Definition of Instrument Modes
3.2.4.2 Definition of AOTs
3.2.4.3 Implementation of AOTs
3.2.5 Definition of Operating Procedures
3.3 Software Development
3.3.1 Provision of Instrument Time Estimator
3.3.2 Provision of Instrument Command Translator
3.3.3 Provision of RTA/QLA
3.3.4 Provision of Trend Analysis System
3.3.5 Provision of Calibration Analysis System
3.3.6 Provision of Interactive Analysis System
3.3.7 Provision of Science Processing Software
3.3.8 Provision of Science Analysis Software
3.3.9 Provision of Diagnostic Tools
3.4 ICC Preparation
3.4.1 ICC Planning
3.4.1.1 Provision of SIP
3.4.1.2 Definition of PV Phase Test Plan
3.4.1.3 Provision of Science Validation Plan
3.4.1.4 ICC design
3.4.2 ICC Implementation
3.4.2.1 ICC Infrastructure
3.4.2.1.1 ICC Ops Centre Infrastructure
3.4.2.1.2 DAPSAS(UK) Infrastructure
3.4.2.1.3 DAPSAS(Fr) Infrastructure
3.4.2.2 ICC Hardware
3.4.2.2.1 ICC Ops Centre Hardware
3.4.2.2.2 DAPSAS(UK) Hardware
3.4.2.2.3 DAPSAS(Fr) Hardware
3.4.2.3 Commissioning Phase System
3.4.2.4 Provision of Instrument Simulator
3.4.2.5 Provision of OBS Maintenance Facility

3.4.3 Integration and Test
3.4.3.1 ICC Ops Centre Integration and Test
3.4.3.2 DAPSAS (UK) Integration and Test
3.4.3.3 DAPSAS (Fr) Integration and Test
3.4.3.4 ICC Internal Interface Test
3.4.3.5 ICC Ops Test
3.4.3.6 Ground Segment Testing
3.4.4 FINDAS Support
3.4.5 Operations Planning
3.4.5.1 Provision of ICC Operations Plan
3.4.5.2 Definition of ICC Operations Procedures
3.4.5.3 Definition of ICC/FSC Operational Interfaces
3.4.5.4 Definition of ICC/MOC Operational Interfaces
3.4.5 Training
3.4.6.1 ICC Ops Team Training
3.4.6.2 FSC and MOC Training
3.4.6.3 DAPSAS(UK) Training
3.4.6.4 DAPSAS(Fr) Training

4 ICC Operations

4.1 Management

4.1 Operations Management

4.2 Product/Quality Assurance

4.2 Software Maintenance

4.2.1 OBS Maintenance

4.2.2 ICC Software Maintenance

4.2.3 Science Processing Software

4.2.3.1 Update SPS

4.2.3.2 SPS Acceptance Testing

4.2.3.3 SPS Validation

4.2.3.4 SPS Delivery to FSC

4.2.4 Science Analysis Software

4.2.4.1 Update SAS

4.2.4.2 SAS Acceptance Testing

4.2.4.3 SAS Validation

4.2.4.4 SAS Delivery to FSC

4.3 ICC Operations

4.3.1 Support to MOC

4.3.2 Support to FSC

4.3.3 Health and Status Monitoring

4.3.4 Performance Monitoring

4.3.5 Calibration

4.3.6 Trend Analysis

4.3.7 Science Processing Quality Checking

4.3.8 Performance Monitoring

4.3.9 Ground Segment Interaction

4.3.10 Parallel Mode Analysis

4.3.11 Serendipity Mode Analysis

4.3.12 Support to the Community

4.3.1.2.1 Consortium Support

4.3.1.2.2 National Community Support

4.3.13 Consortium Support to the ICC

4.4 Facilities Maintenance

4.4.1 Infrastructure Maintenance

4.4.2 Hardware Maintenance

4.4.3 System Management

10.5 Appendix E - List of Deliverables

10.6 Appendix F - SIRD/SIP Compliance Matrix

Functional Requirements

ICCF-005								
ICCF-010								
ICCF-015								
ICCF-020								
ICCF-025								
ICCF-030								
ICCF-035								
ICCF-040								
ICCF-045								
ICCF-050								
ICCF-055								
ICCF-060								
ICCF-065								
ICCF-070								
ICCF-075								
ICCF-080								
ICCF-085								
ICCF-090								
ICCF-095								
ICCF-100								
ICCF-105								
ICCF-110								
ICCF-115								
ICCF-120								
ICCF-125								
ICCF-130								
ICCF-135								
ICCF-140								
ICCF-145								
ICCF-150								
ICCF-155								
ICCF-160								
ICCF-165								
ICCF-170								
ICCF-175								
ICCF-180								
ICCF-185								
ICCF-190								
ICCF-195								
ICCF-200								
ICCF-205								

Operational Requirements

ICCO-005								
ICCO-010								
ICCO-015								
ICCO-020								
ICCO-025								
ICCO-030								
ICCO-035								
ICCO-040								
ICCO-045								
ICCO-050								
ICCO-055								
ICCO-060								
ICCO-065								
ICCO-070								
ICCO-075								
ICCO-080								
ICCO-085								

Post-Operational Requirements

ICCA-005								
ICCA-010								
ICCA-015								
ICCA-020								
ICCA-025								
ICCA-030								
ICCA-035								
ICCA-040								
ICCA-045								
ICCA-050								

Performance and Availability Requirements

PERF-002								
PERF-003								
PERF-004								
PERF-060								
PERF-060b								
PERF-061								
PERF-062								

Product Assurance and Quality Assurance Requirements

PAQA-001								
PAQA-002								
PAQA-003								
PAQA-010								
PAQA-010a								
PAQA-010b								
PAQA-010c								
PAQA-011								
PAQA-012								
PAQA-020								
PAQA-021								
PAQA-022								
PAQA-023								
PAQA-024								
PAQA-025								
PAQA-026								
PAQA-030								
PAQA-031								
PAQA-032								
PAQA-033								

Management Requirements

MNGT-001								
MNGT-002								
MNGT-003								
MNGT-004								
MNGT-010								
MNGT-011								
MNGT-011a								
MNGT-011b								
MNGT-011c								
MNGT-011d								
MNGT-011e								
MNGT-011f								
MNGT-012								
MNGT-020								
MNGT-021								
MNGT-022								
MNGT-023								
MNGT-024								
MNGT-024a								
MNGT-024b								
MNGT-024c								
MNGT-024d								
MNGT-024e								
MNGT-024f								
MNGT-024g								
MNGT-025								