SPIRE ICC

User Requirements Document
for
Assembly, Integration and Verification

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Introduction

1.1 Purpose & Scope

This document defines those requirements put on the ICC by the need to be able to test and calibrate the instrument deliverable models, both at RAL and at ESA centres (ESTEC and Kourou). The Electrical Ground Support Equipment (EGSE) used for these tests requires the availability of some of the ICC systems to support data processing, display and storage.

1.2 Definitions of Terms and Acronyms

AIV	Assembly, Integration and Verification
COTS	Commercial Off-The-Shelf
EGSE	Electrical ground Support Equipment
FIRST	Far InfraRed and Submillimetre Telescope
ICC	Instrument Control Centre
ILT	Instrument Level Test
OBS	On-Board Software
OS	Operating System
PV	Performance Verification
SPIRE	The Spectral and Photometric Imaging REceiver for FIRST
URD	User Requirement Document

In addition two web pages are available describing terms applicable to SPIRE:

http://www.ssd.rl.ac.uk/spire/consortium/information/FIRSTacronyms.shtm
http://www.ssd.rl.ac.uk/spire/consortium/information/FIRSTdefinitions.asp

1.3 Related Documents

1.3.1 Applicable Documents

AD1 EGSE User Requirements Document (FIRST-SPI-DOC-000102)

1.3.2 Reference Documents

RD-1	SPIRE ICC URD Scope Descriptions (SPIRE-ICS-DOC-000484)
RD-2	FIRST-FSC URD
RD-3	FIRST-FSC Actor list

1.4 Overview

Several models of the SPIRE instrument will be built and used to qualify the design, characterise the instrument, verify operating modes and calibrate the flight model(s) on the ground before launch. These activities are carried out as a series of tests, which form part of the Assembly, Integration and Verification (AIV) plan for the instrument.

In order to perform these tests, Electrical Ground Support Equipment (EGSE) will be provided to allow the instrument to be commanded, to collect telemetry from the instrument and to provide input instrument stimuli relevant to each test. It has been decided that to minimise development effort and to remove the necessity to translate the instrument database (command and telemetry data structures) the environment in which the instrument is tested should be as far as possible identical to the operational environment. This is also true for the test environment used by the spacecraft Prime Contractor.

As a consequence, the EGSE will be based on the use of the SCOS2000 spacecraft control system, which will be used in the Mission Operations Centre (MOC), and the ICC must provide those components of the operational ICC necessary for; generation of commands for each test; collection and storage of telemetry data from the instrument (and EGSE); and provision for display and analysis of such data.

A more detailed description of the test environment and the requirements on both the EGSE and ICC components are to be found in the EGSE Users Requirements Document (AD1). In this document those high-level User Requirements applicable to the ICC have been extracted. Section 2 describes the users of the AIV facility and Section 3 describes those requirements placed on the ICC components by those users.

2 User Characteristics

2.1 Test Controller

Each test will be under the control of a Test Controller who has the responsibility to; configure the AIV facility for the test; to carry out the test according to a test plan; and to monitor the health and safety of the instrument during the test. It may be assumed that all the necessary test procedures and command sequences have already been produced and are available to the Test Controller.

2.2 Test Scientist

The Test Scientist is responsible for defining the tests to be carried out at each step of the AIV programme, for providing the necessary test procedures, test scripts, command sequences, databases and data analysis procedures to enable the test to be carried out. He/she will also be responsible for the analysis of the results of those tests and the evaluation of the scientific performance of the instrument.

2.3 Instrument Engineer

The Instrument Engineer is responsible for the analysis of the data produced by the instrument with respect to instrument performance, and characterisation. He/she may also need to generate additional diagnostic tests and associated information (commands, scripts, data analysis procedures etc) in the event of an anomaly being reported by the Test Controller, or as a result of the analysis of test results.

2.4 Calibration Scientist

The Calibration Scientist is responsible for the definition, and data analysis of the calibration tests carried out on the instrument.

3 Requirements

3.1 Commanding Capabilities

3.1.1 Command Sequences

A mechanism for generation of command sequences shall be provided.

Commanding of the instrument will be made through the SCOS2000 system. In general for a test, sets of commands may be generated off line and stored as command sequences to be uplinked by the Test Controller, as required by the test procedure. These command sequences must be compatible with the SCOS2000 mechanism for command uplink (i.e. from 'schedules').

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [late development]

3.1.2 Command Sequence Scripts

Command sequences shall be specifiable in the form of a script composed of general purpose programming statements (providing; named variables; selection statements: if-else-then, switch etc.; and iteration statements: do-loop, do-while etc) and command definitions in the form of mnemonics plus parameters.

This will allow the Instrument Engineer and Test Scientist to specify specific sequences of commands to the instrument.

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [late development]

3.1.3 Observations

It shall be possible to translate an observation input (AOT + parameters) into a command sequence.

The Test and Calibration Scientists will need to generate 'typical' observations to test the instrument operating modes, calibration strategy and data processing software

1. **Source** [AD1]
2. **Importance/Priority** [Medium]
3. **Risk** [Medium]
4. **Phase** [ILT]

3.1.4 OBS Maintenance

It shall be possible to maintain the instrument On-Board Software

The On Board Software will be provided by IFSI. The development system need to maintain this will be provided as a stand-alone system (TBC) which generates complete memory images. These need to be transferred to the SCOS2000 system for conversion into command sequences to implement the changes on-board.

1. **Source** [AD1]
2. **Importance/Priority** [High/

3. **Risk** [High]
4. **Phase** [ILT]

3.2 Storage Capabilities

3.2.1 Data storage

The ICC shall provide a data storage facility.

This facility will be a copy of, or a part of the Ground Segment data storage facility (a.k.a. FINDAS). If it is a copy, then provision shall be made to ingest the data held into the central Ground Segment facility at a later date.

This facility will be used to store all test input data, generated telemetry data and test results. The amount of data storage provided should hold the data from at least one week of testing (~20Gbyte, TBC).

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [ILT]

3.2.2 Test Input Data Storage

All input data to a test shall be available from the data storage facility

This includes; test procedures; test scripts; command sequences; OBS memory patches, the instrument database, data analysis procedures, operations procedures. All such data shall be readable by the SCOS2000 system.

1. **Source** [AD1]
2. **Importance/Priority** [Medium]
3. **Risk** [Low]
4. **Phase** [ILT]

3.2.3 Telemetry Data Storage

All telemetry received from the EGSE shall be stored into the data storage facility according to the object model required for operations.

The EGSE will collect telemetry data from the instrument and test equipment and make it available in real time to the ICC components of the AIV facility. The data needs to be stored in the same way as in operations in order to be able to use the ICC data analysis software without changes.

1. **Source** [AD1]
2. **Importance/Priority** [Medium]
3. **Risk** [Low]
4. **Phase** [ILT]

3.3 Analysis Capabilities

3.3.1 Data Analysis

The ICC shall provide system for data analysis and display.

The system should allow extraction of data, processing methods and display parameters to be selected by a 'processing script' or interactively. It should be possible for the 'processing script' to be triggered automatically by a parameter in the instrument telemetry data stream.

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [late development**]**

3.3.2 Real-Time processing

The data analysis system shall be able to process data in real-time.

The data collected from the instrument and test equipment will normally be stored into the data storage facility and processed from there. If this storage and retrieval takes a significant amount of time (or the facility is not available) it shall be necessary for the data analysis system to take the data directly from the SCOS2000 system. Again the data analysis system should be able to be controlled from 'processing scripts'.

The instrument generates data at ~100kbps. The EGSE will also generate its own telemetry data from the test equipment used. It should be assumed that the total data rate will be ~200kbps.

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [late development**]**

3.3.3 Real-Time Display

The data analysis system shall be able to display telemetry data in real-time.

In this context 'real-time' implies the display of (science) data within a few seconds of it being generated by the EGSE. The extent of the processing required to generate the displays is TBD. Note: fully processed data may be displayed after a test has been completed.

1. **Source** [AD1]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [late development**]**

3.4 Constraints

3.4.1 Test Environment

The ICC components shall operate in an environment compatible with the RAL AIV facility infrastructure and network design

The ICC systems should not place requirements on the AIV Facility infrastructure beyond those normally provided for office environments (power, heat, light, telephone and network connections etc)

When the ICC communicates via a network, this should be compatible with the RAL network design requirements (i.e. should be able to operate through firewalls etc).

1. **Source** [KJK]

2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [ILT**]**

3.4.2 Network Isolation

The data storage facility shall not require continuous access to the Internet.

In order to reduce the possibility of interference from outside sources, the test environment will be isolated from the laboratory, and global, networks. This means that the data storage facility must not depend on continuous communication with other facilities to do its work. If it forms part of a distributed facility, it must be able to store changes for some time (at least 1 week, TBC) and make the updates at the end of this period.

1. **Source** [KJK]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [ILT**]**

3.4.3 Development tools

The ICC components shall be based on maintainable tools and development software.

This provides insurance for the long-term maintainability of the system. These tools could be COTS from companies with a long track record in developing and maintaining such software, or tools based on Open Source development programmes.

1. **Source** [KJK]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [ILT**]**

3.4.4 Hardware

The amount, and different types, of hardware required to operate the ICC components shall be minimised.

The space available for AIV operations is limited. If possible, more than one ICC component should be able to be run on a single machine.

If possible, the ICC components should run on the same type of machine as the EGSE, to reduce the total number of types of machines required (including backup hardware). In practice this means that the ICC component should operate on SUN (solaris) workstations) and/or IBM PC compatible platforms (OS TBD).

1. **Source** [KJK]
2. **Importance/Priority** [High]
3. **Risk** [High]
4. **Phase** [early development**]**

3.5 Maintenance

3.5.1 Test Data and Scripts

The ICC shall maintain a facility to allow the update and verification of test scripts and databases.

This will require the provision of editors for modifying the scripts and databases and the availability of subsystem and instrument simulators to allow verification of test and database changes before use with the real instrument

3.5.2 Software

The ICC shall provide editors, compilers, simulators and debugging software to enable the maintenance and update of ICC software.