AATSR Verification Plan

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Document Change Record

Issue	Date	Affected Pages	Comments
Draft A	27-Feb-2001	All	First Draft for comment
Draft B	23-May-2001	All	Updated following FOS progress meeting 2nd March 2001
Issue 1.0	25-June-2001	All	Minor revisions following RAL review Version not released.
Issue 1.1	12-Sept-2001	All	Further revisions from RAL review
Issue 1.2 Draft A	31-Oct-2001	All	Various revisions following comments from DEFRA, Mike Fletcher, Gareth Davies, Hannah Tait and Marianne Edwards. All changes in red and barmarked.
Issue 1.2	12th March 02	All	Finalised revisions following Various revisions following comments from DEFRA, Mike Fletcher, Gareth Davies, Hannah Tait and Marianne Edwards. All changes in red and barmarked.
Issue 1.3	2nd August 02	All	Updated in line with comments received from Marianne Edwards (LU), Hannah Tait (ESA) Mike Fletcher (Astrium) and Sophia Oliver (DEFRA)
Issue 1.4	28th March 03	All	Updated comments in line with comments received from Sophia Oliver (DEFRA) / Hannah Tait (ESA)
Issue 1.5	30th June-2003	5	Updated contents page
		11	Minor corrections
		13, 15	Corrections to telemetry IDs
		13	A5511 deleted The analysis is covered by A2020 and A5550, A5511 is not required.
		17	A0430 – A0450 removed from list since data was not provided by FOCC at the start of the mission –

			performance of visible channel auto-offset loop covered by monitoring –XBB counts
		17	Dynamic Range and digitisation Deleted "histogram of" Added "This will be carried out every 6 months, during routine operations."
Issue 1.6	29th July-2003	17	A0430 – A0450 reinstated in list. Parameters provided by ESOC from July 02 onwards. Parameters now used and included in routine S band monitoring.

CONTENTS

1 SCOPE OF DOCUMENT

This document describes the plan for verifying the in-flight performance of AATSR. The plan includes:

- The key instrument performance requirements to be verified.
- Definition of the operations environment under which the verification plan will be executed.
- The tasks to be performed.
- Specification of the analysis tools required[1].
- Identification of the support required.

This document does not cover validation of the science data products.

AATSR is designed to be autonomous and will require negligible levels of macrocommanding once the commissioning activities are complete. There are therefore no 'verification procedures' as such. In general, any commanding that is performed (e.g. periodic outgassing, anomaly recovery) will use procedures already defined in the IOM. Procedures where required will be detailed during the commissioning period, for example, the actual criteria that must be met before performing an outgassing need to be defined – this plan only specifies the data that will be looked at. In the case of outgassing the criteria will be derived during the commissioning phase, once set a procedure will then be defined.

[1] Much of the analysis for the in-orbit verification will use the outputs from the EDS, i.e. daily and long-term trend plots of instrument housekeeping telemetry and derived parameters from the science data. It was necessary to define the tools before work on the verification plan started so that they could be developed and ready by the launch of ENVISAT-1. The EDS requirements are based on the experience from ATSR-2 and AATSR calibration and the anticipated use during commissioning and verification. The tools will cover all of the requirements in the verification plan.

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD 1	PO-RS-GAD-AT-0002	AATSR Instrument Performance Requirements - Issue 2
AD 2	PO-MA-MMB-AT-0002	AATSR Instrument Operations Manual – Issue 5.1
AD 3	PO-SW-GAD-AT-0005	Statement of Work for AATSR Pre-Launch Flight Operations Support – Draft F
AD 4	PO-PL-RAL-AT-0501	AATSR Commissioning Plan
AD 5	PO-ID-ESA-AT-00427	AATSR/ENVISAT-1 RAL/FOCC ICD
AD 6	PO-PL-ESA-GS-1092	ENVISAT Calibration and Validation Plan
AD 7	FOCC-ICD-598-1-4	ENVISAT PAS Web Extensions Interface Control Document
AD 8	PO-PL-GAD-AT-005(3)	AATSR Validation Implementation Plan
AD 9	PO-RS-RAL-AT-0501	AATSR EDS Requirements Issue 2
AD10	PO-TN-RAL-GS-0503	Routine Viscal Production

2.2 REFERENCE DOCUMENTS

RD 1	PO-TN-RAL-GS-10003	Input Output Data Definition (IODD) Issue 1 Rev. 12
RD 2	PO-TN-RAL-GS-10004	Level 1B Detailed Processing Model (L1B DPM) Issue 1 Rev. 6
RD 3	PO-TN-RAL-GS-10005	Level 2 Detailed Processing Model (L2 DPM) Issue 1 Rev. 5
RD 4	PO-TN-RAL-GS-10007	Test Definition and Procedures Document (TD&P) Issue 3 Rev. 0

3 ACRONYMS

ATSR	Along Track Scanning Radiometer
AATSR	Advanced Along Track Scanning Radiometer
AND	Alpha Numeric Display
AOS	Acquisition of Signal
CCU	Cooler Control Unit
CRC	Cyclic Redundancy Check
DEFRA[2]	Department for Environment, Food and Rural Affairs
EDS	Engineering Data System
EDS-S	Engineering Data System – S Band (for HK telemetry formats)
EDS-X	Engineering Data System – X Band (science data)
ESOC	European Space Operations Centre
FOCC	Flight Operations Control Centre
FOP	Flight Operations Procedures
FOS	Flight Operations Support
FPA	Focal Plane Assembly
GBTR	Gridded Brightness Temperatures and Radiances
GRD	GRaphical Display
HK	HouseKeeping
ICU	Instrument Control Unit
IR-FPA	Infra Red Focal Plane Assembly
IVR	Infrared and Visible Radiometer
LOS	Loss Of Signal
MERIS	MEdium Resolution Imaging Specrometer Instrument
MIPAS	Michelson Interferometer for Passive Atmospheric Sounding
MMS	Matra Marconi Space
MPL	Mission PLanning [file]
MPS	Mission Planning System
MRB	Materials Review Board
OBT	On Board Time
PDS	Payload Data Segment
PEB	Payload Equipment Bay

[2] DEFRA stands for DEFRA or their appointed agent

PPO	Position Pick Off
PRT	Platinum Resistance Thermometer
RAL	Rutherford Appleton Laboratory
RDMOP	Restituted Detailed Mission Operations Plan
RT	Real Time
RTF	Real Time Format
RTR	Real Time Reduced (Format)
RTT	Real Time Test Format
SCIAMACHY	SCanning Imaging Absorption SpectroMeter for Atmospheric ChartographY
SFTP	Secure File Transfer Protocol
SMU	Scan Mechanism Unit
SODAP	Switch On and Data Acquisition Phase
SST	Sea Surface Temperature
SSTD	Space Science and Technology Department
TBC	To be confirmed
TBD	To be defined
UBTR	Ungridded Brightness Temperatures and Radiances
UCOUNTS	Ungridded Counts
VISCAL	Visible Calibration System

4 OBJECTIVES

The key aims of verification are:

- Assessment of the AATSR instrument performance using instrument housekeeping and science data.
- Using daily and long-term trends to make predictions about the likely future performance of the instrument and assess the need for instrument operations such as FPA out-gassing and revising visible gain settings.
- Communicating the status of the instrument to DEFRA
- Identification and reporting of any instrument anomalies.

In addition to the above tasks the AATSR Flight Operations Support Team at RAL will also:

- Provide a point of contact for co-ordinating any day-to-day AATSR operations activities.
- Report to DEFRA.
- Support AATSR validation.
- Provide mission planning files (MPL files) to the ENVISAT FOCC as required.
- Provide expert engineering support to assist in the technical understanding of the instrument behaviour in-flight and for in-orbit troubleshooting.

5 REQUIREMENTS

Table 1 lists the instrument performance requirements taken from AD 1 that will be monitored throughout the AATSR mission. The list is a subset of the commissioning requirements (AD 4) but with the emphasis on routine monitoring as opposed to the initial demonstration of the instrument's in-orbit performance.

Table 1: Principal instrument performance requirements to be verified.

No.	Requirement	Reference	Verification
1	Verify that the temperature of the instrument optics enclosure is 260±5K when the instrument is in MEASUREMENT mode.	AD1: R02/018	§6.2.1
2	Verify that the temperatures of the cold and heated blackbodies are 260±5K and 305±5K when the instrument is in MEASUREMENT mode.	AD1: R02/047	§6.2.1, §6.2.3
3	Verify that the blackbody temperatures are stable to <0.03°C over a two-minute period.	AD1: R02/053	§6.2.3
4	Verify that the temperature of the aperture stop is stable to <0.2°C over a two minute period and the temperature of the FPA baffle tube is stable to <0.8°c over two minutes.	AD1: R02/063	§6.2.1
5	Verify that all 12 digitisation bits are present for all channels.	AD1: R02/017	§6.2.5
6	Verify that the dynamic range and noise for all AATSR channels are within specified limits.	AD1: R02/016	§6.2.5
7	Verify performance of the auto gain/offset loops. Compare blackbody pixel data for all seven channels with expected values.	AD1: R02/19,20,21,22	§6.2.5
8	Check rotation of scan mechanism. Verify that the average rotation period is 150ms.	AD1: 031	§6.2.2
9	Check for scan mirror jitters.	AD1: 032	§6.2.2
10	Check performance of the visible calibration system. Ensure that the VISCAL unit is illuminated by the sun every orbit, the signal agrees with the expected level, and is stable to 1% between successive orbits.	AD1: R02/57, 62 and 64.	§6.2.4

6 VERIFICATION

This section defines the verification tasks to be performed.

6.1 COMMISSIONING

The commissioning phase activities, covering the initial activation, checkout and optimisation of the AATSR flight segment are described in detail in AD 4. Nevertheless, many of the verification activities and procedures described in this document will also be employed during commissioning.

6.2 ROUTINE MONITORING

The bulk of the verification activities will be concerned with the routine monitoring and evaluation of the AATSR in-orbit performance. It is important to make a distinction between the roles of the FOCC at ESOC and RAL.

ESOC are responsible for the direct control and monitoring of the spacecraft. However, ESOC's monitoring role will be limited to maintaining instrument operations, i.e. checking that critical parameters are within operational limits and employing approved corrective procedures in the event of an anomaly. Emphasis will be very much on 'real-time' analysis and interpretation of the data.

The role of RAL will be to evaluate the instrument performance based on daily and long-term data. The understanding gained will be used to make predictions about the likely future performance and if necessary recommend appropriate corrective action. The main monitoring activities are described below and will utilise the engineering data system tools currently under development at RAL.

6.2.1 DAILY/LONG-TERM HOUSEKEEPING ANALYSIS

Daily trend plots of the parameters listed in tables 7.1 and 7.2 of AD 5 will be produced routinely by the S-Band engineering data system (EDS-S). The data for these plots will be systematically transferred from the AATSR directories on the FOCC at ESOC (see Figure 2) and archived. The plots will display logical groups of parameters. These are:

Status words, power and electronics units
SCP telemetry
SMU temperatures
Blackbody temperatures
Cooler amplitudes, temperatures, power etc..
FPA temperatures and fore-optics temperatures
VISCAL temperatures
Structure temperatures
Electronics units temperatures
PEB temperatures (MERIS, SCIAMACHY, MIPAS).

The plots will be inspected daily and checked for occurrences of out-of-limits values, and any other non-nominal behaviour. As a rule, only those parameters that are transmitted in

'real-time-formats' will be plotted. For parameters that are only available in test format, plots will only be made on request if sufficient data exists.

In addition to the routine daily trend plots, long-term plots showing the daily averages, maximum and minimum values for each parameter will be plotted.

6.2.2 SCAN MECHANISM PERFORMANCE

The following parameters will be routinely monitored to detect any deviation from the nominal performance of the mechanism.

Parameter	Description	Source	Notes
A2020, A5550	Scan Counter	Real Time Formats, Science Data	Although the counter is under sampled in the real time telemetry, the values will increment at regular steps over each 16-second interval. Any significant departure in the mechanism performance will show clearly in the trend plots.
A4011D A4021D	Mechanism Temperatures	Real Time Formats	The scan mechanism will be automatically commanded OFF if the scan-encoder temperature exceeds 35°C. The trends in these values should be carefully monitored for any signs of departure from the baseline trends.
A3511	Equipment Bus Power	Real Time Formats, Report Formats, Science Data	The daily trends, report formats and science data will be scanned for occurrences of high power spikes > 3.5A. This will not be sufficient to cause a switch-down to standby unless 4 consecutive acquisitions exceed the switch-down limit. However, these power spikes could indicate a potential problem with the scan mechanism and will be carefully monitored.
A2111	Snapshot-2 Scan	Real Time Formats	Monitoring for changes in the snapshot-2 register gives the first indication of occurrences of scan mechanism jitter. The S-EDS should plot the times when the value of A2111 changes as a coarse indication of the jitter.
A2120-A2180 (IDF12-IDF18)	Snapshot-2 Data	Test Format Science Data	A more detailed analysis of jitter can be obtained using the snapshot-2 telemetry from the science data. The X-EDS should plot the times where the contents of the snapshot-2 for all channels change. The science data analysis method requires using the SQADS that is available from the Payload Data Segment by ordering L1b child products.

Parameter	Description	Source	Notes
A0041-A0121 (ICU4-ICU11)	Gains and Offsets	Test Formats Science data	If severe scan mechanism problems occur, for example when the scan synch pulse is not present, the irradiance values used by the gain-offset loops no longer correspond to the data collected over the blackbodies. The result is that the updated gains and offsets are not correct.
	Images	Science Data	Although the snapshot-2 data gives an indication of scan mirror jitters where the scan length exceeds 2000 pixels, the parameter does not indicate events where the scan period is less than 2000 pixels. The only indication of such events is by visual inspection of the AATSR images. This is only meant to be a back up to the numerical jitter analysis and will not be performed routinely by the FOS team, but rather on a case by case basis.

6.2.3 BLACKBODY PERFORMANCE

The on-board blackbodies are critical to the success of the AATSR mission. The key parameters affecting the radiometric calibration are:

- Heaters: The optimum temperature difference between the hot and cold blackbodies is about 40°C. The blackbody temperatures will be monitored to ensure that this difference is being maintained. Corrective action will be required if a heater fails or the temperature difference is not maintained (the procedures and key activities for troubleshooting are outlined in section §6.5)

- Thermometry: The radiometric calibration is traced to the precision PRTs mounted in the blackbody base-plates and baffles. The infrared calibration has been verified to an accuracy of better than 50mK. Over the lifetime of the AATSR mission it is expected that the sensors will degrade with time. Although it is not possible to measure the absolute calibration drift (except by ground validation measurements) the relative drift of the sensors can be measured. Experience with other, ground based, resistance thermometers has shown that these sensors will degrade at varying rates. During the pre-launch radiometric calibration the relative temperatures of each PRT was measured with the blackbodies at different temperatures. By comparing the in-flight values against the pre-launch and beginning of life differences it is possible to identify any sensors that are degrading rapidly and may affect the calibration.

- Emissivity. The absolute calibration of the blackbody emissivities cannot be verified in flight.

The following parameters will be routinely monitored to detect any deviation from the nominal performance of the blackbodies.

Parameter	Description	Source	Notes
A6014D – A6074D A6104D-A6154D	Blackbody temperatures	Real-Time Formats Science Data	The daily and long-term trends of the blackbody temperatures should be carefully monitored for any signs of departure from the baseline trends. Check that the temperature difference between the two blackbodies is maintained. If the temperature difference decreases then this may indicate a problem with the heater. Monitor the temperature difference between each baseplate thermometer. Any sensors deviating by more than 2 standard deviations away from the mean baseplate temperature should not be used for calibration.
A6094D	BBU temperature	Real-Time Formats Science Data	The daily and long-term trends of the BBU temperature should be carefully monitored for any signs of departure from the baseline trends.

6.2.4 VISCAL

The VISCAL unit provides the AATSR visible channels with an upper calibration signal corresponding to approximately 15% reflectance. A Russian Opal diffuser is illuminated by the Sun once per orbit for 30s approximately 150s before the spacecraft crosses the night-day terminator.

The experience of ATSR-2 has shown that the VISCAL signal will vary in orbit for two main reasons.

- The build up of condensation on the relay lens surface between the IR-FPA and the VIS-FPA causing an oscillation in the calibration signal. The condensation behaves as an interference film on the relay lens producing maxima in the transmitted signal at $n\lambda/2$, $n\lambda$, $3n\lambda/2$ …. The trend is broken when the IR-FPA is allowed to warm up for outgassing.

- Degradation of the instrument optics caused by exposure to the space environment resulting in gradual loss of optical throughput. For ATSR-2 the degradation rate of the whole optical system (including the foreoptics) was between 5%-7% per year depending on wavelength.

It should be noted that the AATSR Operational Processing system requires regular updating of the ATS_VC1_AX (Viscal file), these updates will be sent on a routine basis to the PDS. Viscal Monitoring will be based on the VC1 files output as part of this process. A description of the routine VISCAL production process is described in AD10.

The following data are to be examined on a routine basis.

Parameter	Description	Source	Notes
A4541	VISCAL Monitor	Real Time Telemetry Science Data	Monitor the orbital and long term trends of the VISCAL monitor signal.
	Viscal Pixel counts	Science Data	Plot orbital trends of the average counts/per scan of the viscal pixels for each AATSR visible channel. Note the illumination time and maximum signal during full Solar illumination.
	-XBB Pixel counts	Science Data	Plot orbital trends of the average counts/per scan of the -XBB pixels for each AATSR visible channel. If the auto-offset loop is running the value around an orbit should be 100±1 count for each channel.
	Viscal Signal	Science Data (From generation of VC1 file)	Plot the Viscal signal, corrected for the sun-earth distance, for each processed orbit as a time series.

In addition, data from stable terrestrial targets such as remote deserts and ice caps will be used to monitor the change in the calibration. This activity will be performed by the validation team (see AD 9).

6.2.5 SIGNAL CHANNEL PERFORMANCE

The verification plan does not cover the calibration and validation of science products, since this is the responsibility of the AATSR validation team. Nevertheless, the AATSR FOS team will monitor the basic performance of the signal channels. The main factors to monitor are:-

- Gain - (Table 1 Req. 7)
- Radiometric Noise - (Table 1 Req. 6)
- Dynamic Range - (Table 1 Req. 6)
- Digitisation - (Table 1 Req. 5)

Data for this analysis will be generated using the EDS tools.

Parameter	Description	Source	Notes
A0240 – A0290	IR Channel Blackbody radiance averages	Real time telemetry Science data	Monitor daily and long term trends of the blackbody radiance averages. If the values remain stuck at 0 or 4095 then it is possible that a channel has failed. If the value remains at 555hex, then the auto-gain offset loop may not be running.

Parameter	Description	Source	Notes
A0220-A0230 A0430-A0450	Vis Channel Blackbody radiance averages	Real time telemetry Science data	Monitor daily and long term trends of the blackbody radiance averages. The values should be 100±1 count if the auto-offset loop is running. If the values remain stuck at 0 or 4095 then it is possible that a channel has failed. If the value remains at 555hex, then the auto-gain offset loop may not be running.
A0051 A0061 A0071	IR Channel Gain	Science Data Test Format	Plot single orbit and long-term trends of the signal channel gains.
A0091 A0101 A0111	IR Channel Offsets	Science Data Test Format	Plot single orbit and long-term trends of the IR channel offsets.
A0081 A0401 A0411 A0421	Visible Channel Offsets	Science Data Test Format	Plot single orbit and long-term trends of the visible channel offsets.
	Radiometric Noise	Science Data	Plot single orbit and long-term trends of the standard deviations of +XBB and –XBB pixel counts.
	Dynamic Range	Science Data	Plot pixel counts from Ucounts images for whole orbit. This will be carried out every 6 months, during routine operations.
	Digitisation	Science Data	Plot pixel counts from Ucounts images for single orbit. The result should show a continuum from 0 to 4095 counts. This will be carried out every 6 months, during routine operations.

6.2.6 COOLER PERFORMANCE

During commissioning the following should have been achieved:

- Optimisation of the balance of the cooler displacers and compressors at the running amplitudes needed to obtain FPA temperature, with telemetered PPO amplitudes and drive currents noted.
- Correlation of the cooler temperatures with the instrument thermal model and confirmed value for cooler body temperature response to drive level.
- Maximum compressor amplitude set to give a limited headroom on all normal running
- Nominal cooldown and warm-up curves established.
- Optimisation of the cool-down and out-gassing command procedures.
- Nominal electronic gain values as set by auto-gain offsets for clean FPA optics.
- Estimation of the rate of water vapour build-up from the time when AATSR is first cooled (see §6.3.1).

- Evaluation of the baseline cooler signal pick-up seen, if any, on blackbody signals.
- Evaluation of the baseline around orbit temperature changes, platform/neighbouring instrument thermal effects, and thermal stability seen at the FPA (short-term and around an orbit).

Once nominal operation of the cooler has been established, the daily houskeeping plots provided by the EDS-S will be examined for any unexpected behaviour. Over a longer timescale, the trends will be examined to determine the need for outgassing or other cooler operation. When an ENVISAT event occurs (e.g. payload switchdown, loss of yaw steering…), the cooling system will need to be checked to ensure that it has returned to nominal, with the control loops running correctly, etc.

Parameter	Description	Source	Notes
A0171 A7021 A7201 A7211	Cooler compressor amplitude	Real time telemetry	Plot daily and long-term trends. Values should be carefully monitored for any signs of departure from the baseline trends.
A0340	Compressor A Amplitude Increment	Real time telemetry	Plot daily and long-term trends. Values should be carefully monitored for any signs of departure from the baseline trends.
A0191 A7041 A7221 A7231	Displacer Amplitude	Real time telemetry	Plot daily and long-term trends. Values should be carefully monitored for any signs of departure from the baseline trends.
A5021 A5031 A5041 A5051 A5061	FPA Temperatures	Real time telemetry	Plot daily and long-term trends. Temperatures should be 80±0.1K.
A7081 – A7151	Cooler Temperatures	Real time telemetry	Plot daily and long term trends. All temperatures should be within the safe operational limits defined in the IOM.
A7311 – A7391	CCU Temperatures	Real time telemetry	Plot daily and long term trends. All temperatures should be within the safe operational limits defined in the IOM.

6.2.7 DESCOPING

AATSR only has one mode of operation that continuously transmits the science data for all channels at full resolution and full swath width. It is also expected that with the solid state recorders and improved ground station coverage, ENVISAT will be able to record and transmit all AATSR science data. Hence there are not expected to be any descoped regions. However, there may be periods when the recorders are inactive or a particular ground station cannot receive data. In such cases a data unavailability report will be issued from ESOC to RAL. RAL will notify DEFRA of any such events via the AATSR engineering web site.

6.2.8 LEVEL-0 DATA QUALITY CHECKS

All science data tapes processed by the EDS-X will be scanned for the following anomalies.

- Missing scan counts- indicated by change in scan counter (A2020) > 1
- Missing source packets – indicated by a change in the source sequence count > 1
- CRC error
- Packet length error
- Write cycle error (A2511)
- Read cycle error (A2512)
- Aux data check (A2514)

A record of all occurrences will be stored in a log file. It should be noted that the occurrence of such errors would not necessarily mean a fault with the instrument hardware.

6.3 OPERATIONS REQUESTS

AATSR should require minimal levels of commanding when in MEASUREMENT mode since the instrument is autonomous. However, there will be occasions when changes to the operational configuration are required. The most likely requests will be for out-gassing, extended range mode (low-gain mode) operations and occasional updates of the visible channel gain settings. This section describes the processes for handling operational requests.

In most cases an operational request will be raised by RAL to perform minor adjustments to optimise the instrument performance (for example, changes to the visible channel gains to compensate for optical degradation). Other requests may be raised by an AATSR MRB in response to an anomaly investigation or recommendations of the data quality group.

All operational requests will be scrutinised to assess the impact on the safety of the instrument, the quality of data products and any validation activities, and must be authorised by the AATSR project manager and systems scientist. Operation requests will be sent to DEFRA and Astrium. DEFRA may instruct Astrium to review the IOR before final authorization is granted. All requests will use the basic procedures defined in the IOM and FOP that have been previously exercised during ground testing or commissioning.

The FOCC will be notified of the operational request by RAL and will receive a fax copy of the authorised procedure.

The FOCC will execute the procedure in co-operation with the RAL point of contact.

The FOCC will notify RAL of the outcome of the procedure upon completion.

Astrium UK will be notified of all operations requests but will not be required to give approval.

DEFRA will be notified of all operations requests and the likely impact on the availability and quality of science data. DEFRA will inform the validation team and users where necessary.

6.3.1 OUTGASSING

Some water vapour and other materials are inevitably carried into space with the satellite, so when the IR-FPA is cooled to 80K there will be a build up of condensation affecting the cooler performance and the optical throughput. It will be necessary to warm the IR-FPA periodically to evaporate the condensate and allow the instrument performance to recover. The need to outgas will be based on an evaluation of the trends of the following parameters

Parameter	Description	Source	Notes
A0171 A7021 A7201 A7211	Cooler compressor amplitude	Real time telemetry	Monitor long-term trends.
A0051 A0061 A0071	IR Channel Gain	Science Data Test Format	Monitor long-term trends of the signal channel gains.
A0091 A0101 A0111	IR Channel Offsets	Science Data Test Format	Monitor long-term trends of the IR channel offsets.
	Viscal Signal	Science Data (Output from VC1 processing)	Monitor long-term trends of the VISCAL signals.

From experience of ATSR-1 and ATSR-2, the frequency of out-gassing is likely to be

- 2-3 weeks after the initial cool down
- 3 months after, depending on condensation rates
- 6 months thereafter.

In practice, most out-gassings occurred opportunistically when the instrument was forced into STANDBY as a result of a platform or payload anomaly, and therefore it has only been necessary to perform a few scheduled out-gassings.

When an out-gassing is planned, a mission-planning file (MPL) will be generated specifying the start and end times of the out-gassing sequence. A typical out-gassing period would be two days including 8 hours for cool-down. The MPL files will be transferred to the FOCC by SFTP. The format and naming conventions of the files are defined in AD 5.

6.3.2 EXTENDED RANGE MODE

DEFRA's baseline plan is not to use the extended range mode (or low-gain mode) for AATSR, so the rules for using this mode have not been defined.

In the event that extended range mode is to be used, a mission planning (MPL) file will need to be generated at RAL containing the start times and the number of scans. The file will be transmitted to the FOCC no later than one week before the planned activity. If extended

range mode activation is required at shorter notice, a MPL file will be sent as before but also the FOCC will have to be notified by phone/fax of the request.

6.4 VALIDATION SUPPORT

AATSR is a fully autonomous instrument with only one MEASUREMENT mode. Science data for all channels will be transmitted continually at full digital resolution and swath width. Therefore requests for specific acquisitions should not be necessary. However, all validation investigators should inform DEFRA of any planned activities to aid planning for instrument maintenance (e.g. out-gassing), to minimise the impact of instrument operations on their campaigns where possible. DEFRA will pass on this information to the validation scientist who will co-ordinate validation issues.

6.5 TROUBLESHOOTING

It is highly probable that an event of some kind will occur during the AATSR mission that will have an impact on the scientific performance of the instrument. If and when such an event does occur it is vital that the problem is identified and remedied, if possible, as quickly as possible to minimise the impact on the science programme. The speed of the response will inevitably depend on the complexity of the problem. RAL will be responsible for co-ordinating all in-flight anomaly investigations. We stress that a cautious approach will be adopted to protect the long-term mission.

A procedure for investigating problems is shown in Figure 1. The key activities are listed below.

- Identify Problem
  - All abnormal instrument behaviour will be first reported to the AATSR flight operations support team.
- Monitor the problem
  - A small team will be established at RAL to collect and collate all data from the anomaly to assist the investigation process.
  - A monitoring strategy will be set up to follow the progress of the anomaly. For example RAL may request the FOCC to set limits on a particular parameter and be ready to shut down a subsystem or the instrument if the limit is exceeded.
- Inform DEFRA
- Inform ESA
  - ESA will be notified of all anomalies as a matter of course
- Inform DEFRA if science data is affected. (DEFRA will inform users)
- Convene a MRB
  - The review board will convene to investigate the cause and eventual solution.
  - The review panel should comprise a representative of DEFRA, RAL, the FOCC and appropriate specialists from industry and the data quality group.
  - RAL will be responsible for co-ordinating the board's activities.
  - The review board will determine the investigation strategy.
  - The review board will examine and approve the proposed solution to the problem.
- Identify corrective action
  - This may be action to reduce the impact on the quality of the science data while a more permanent solution is being investigated
  - All potential solutions will be reviewed by the MRB

- Implement changes
- Monitor the outcome
    - Once a change to the instrument configuration has been implemented the result will be carefully monitored.
    - If no change to the instrument performance has resulted the review board will reconvene.
- Close the investigation
    - If the action appears successful the review board will reconvene to formally close out the investigation.

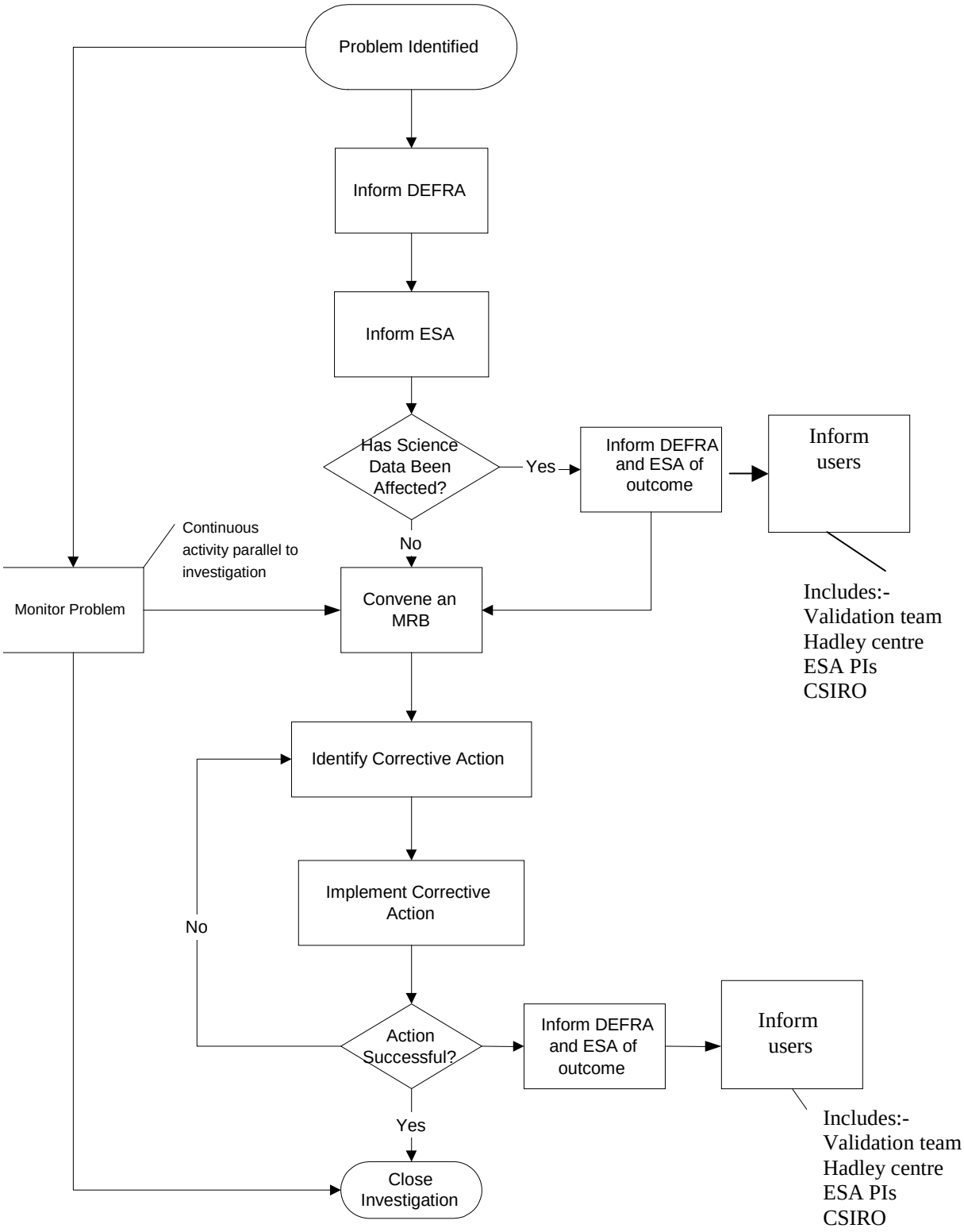

Figure 1: Flowchart showing anomaly investigation procedure.

6.6 PATCH/DUMP OPERATIONS

On-board software maintenance is the responsibility of Astrium UK and the FOCC. The role of RAL will be to schedule the activities so that any software modifications do not affect validation campaigns.

7 DATA REQUIREMENTS

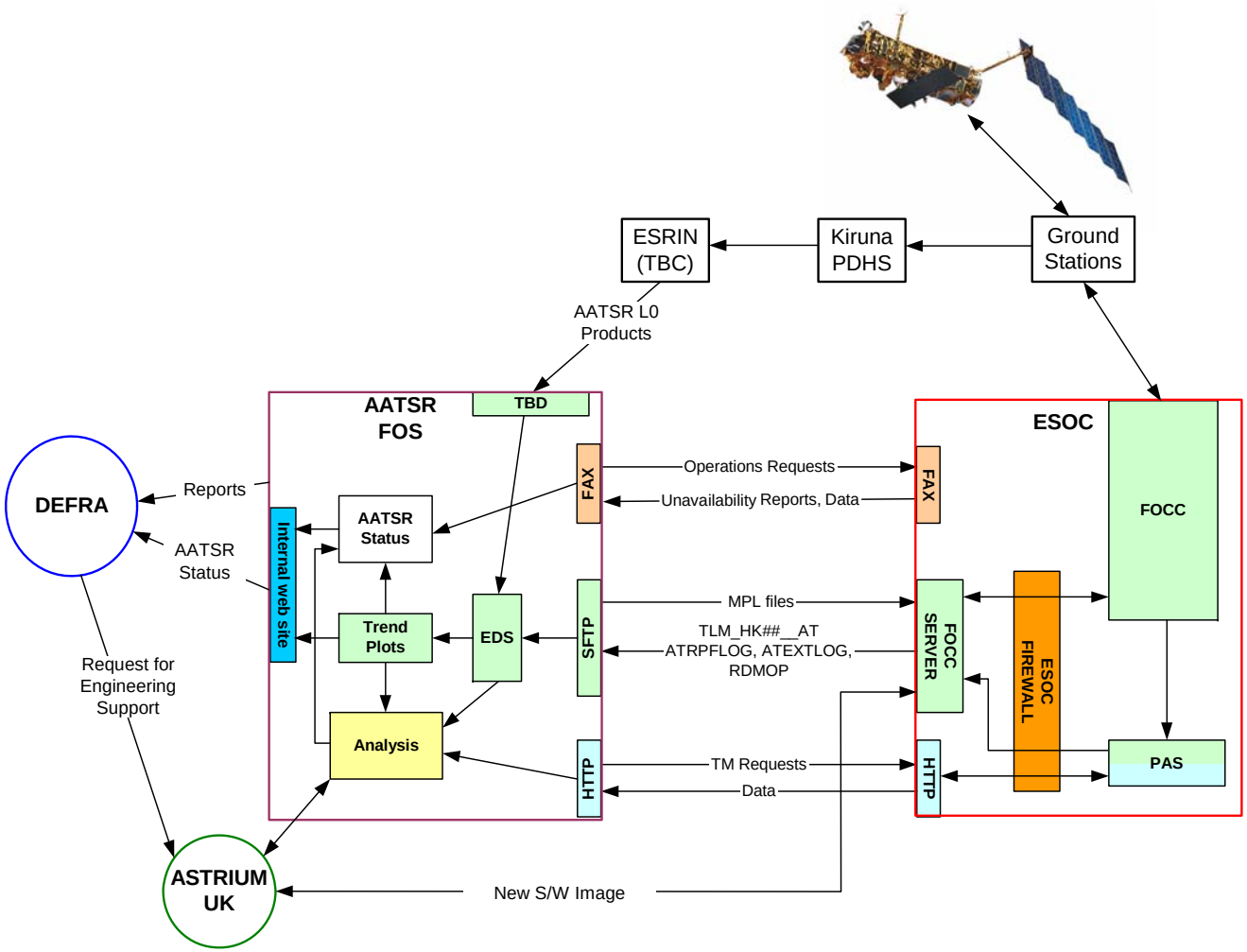

Figure 2: Information flow for AATSR flight operations

7.1 DATA TO RAL

The sources of data for the verification are identified in Figure 2 and include:

7.1.1 AATSR HK TELEMETRY FILES

AATSR housekeeping telemetry files extracted from 'real time' housekeeping formats. The TLM_HK##__AT files will be copied daily from the FOCC server via S-FTP to RAL. These files will contain all the critical AATSR HK parameters and parameters from other ENVISAT instruments that will be useful for interpreting the AATSR performance. The contents of these files have been defined in the AATSR/FOCC ICD (AD 5). The data will be processed through the EDS to produce orbital trend plots and a daily mean, maximum and minimum summary for each parameter.

7.1.2 REPORT FORMAT FILES

AATSR history report files extracted from the 'report' formats also copied via S-FTP from the FOCC. These give a record of command execution, occurrence of on-board anomalies and maximum and minimum values of housekeeping parameters.

7.1.3 GENERIC FILES

Files containing generic information about the ENVISAT mission will be fetched daily from the FOCC public server. These include

Manoeuvre Planning
Predicted and restituted orbit data

7.1.4 SPECIAL REQUESTS

On a less frequent basis, additional ENVISAT housekeeping data may be obtained on request using the ENVISAT PAS Web Extensions (AD 7).

7.1.5 AATSR LEVEL-0 DATA PRODUCTS

It is expected that during commissioning Level-0 data tapes for all available orbits will be sent to RAL within 3 working days of acquisition.

After commissioning one full orbit per day will be sent to RAL on a single Exabyte tape once a week. This is the minimum requirement for Level-0 data.

Level-0 child products for each orbit, containing at least 10 minutes covering the period when the VISCAL is illuminated, will be required. These products will be processed on a

daily basis to give daily trends and averages of parameters not present in the HK formats. The mechanism for delivery is the DDS.

7.2 DATA TO FOCC FROM RAL

7.2.1 MPL FILES

Files containing details of events to be scheduled by the ENVISAT MPS (low-gain mode and out-gassing). The files will be transferred from RAL to the FOCC server via S-FTP in accordance with AD 5.

7.2.2 OPERATIONS REQUESTS

Operations requests, including any changes to the instrument configuration or test sequences, will be sent as a fax to the ENVISAT FOCC from the AATSR operations engineer. The fax will contain the following:

- Details of parameters to be updated or test sequence
- Justification for change/test
- Stepwise procedure including macro-commands, telemetry monitoring and timing.
- Approval signatures

8 REPORTING

8.1 EVENT LOG

If any instrument or relevant spacecraft activities have occurred an event log entry will be posted on the EDS web site. The EDS website is primarily intended for use by the FOS team and DEFRA. Applications from other parties / users for access to this site should be made through DEFRA.

8.2 WEEKLY REPORTS

A weekly report will be produced. An electronic copy will be made available on the AATSR FOS web site. The report will contain:

- A brief statement of instrument and relevant spacecraft activities.
- High level statement of instrument performance
  - In the case of an instrument performance issue / concern detailed information will be included.
- The status of any instrument or relevant spacecraft anomalies.
- Details of any descoping, if any. (ie data descoped regions)

The following will also be available from the EDS web site:

- Daily and long-term trend plots and data files (§6.2.1)
- Results of data reduction (§6.2.2-§6.2.8)
- Instrument status / history
- Archive of all S band data.
- ESOC housekeeping calibration files.

It should be noted that there will also be reporting at FOS contract progress meetings, and RAL will report on instrument status at SAG meetings if asked to do so by DEFRA.

8.3 VERIFICATION REPORT

A verification report, up-issued annually throughout the mission, will be produced. It will bring together all the analysis/ trends information and include a performance assessment.

9 ROLES AND RESPONSIBILITIES

RAL will be responsible to DEFRA for co-ordinating the day-to-day operation of AATSR. RAL will keep DEFRA informed of the instrument health/performance, any spacecraft/instrument events such as instrument unavailability using the data and information provided by the ESOC FOCC.

9.1 PROJECT MANAGER

The project manager will:

- Be responsible for the day-to-day management of the AATSR post-launch support contract.
- Liase with DEFRA and ESA.
- Preparation and monitoring of schedules; ensuring that the schedules are realistic and are properly distributed and agreed with the participating team members.
- Reporting to DEFRA as required on manpower usage.
- Preparation and submission of progress reports.
- Attend meetings as required but limited to the number agreed in the post delivery support contract.
  Reporting on FOS status/activities will also be made at FOS contract progress meetings.
- Set up regular progress meetings, and ensure that minutes are circulated.
- Obtain agreement with DEFRA on scope of work to be undertaken.

9.2 OPERATIONS ENGINEER

AATSR operations support at RAL will be required to provide a daily point of contact to the FOCC. The main responsibilities include

- Review instrument performance from daily engineering plots.
- Inform the operations support team and DEFRA on anomalies, data unavailability.
- Formal issue of operations requests including the transfer of mission planning files.
- Report on the execution of command sequences.

9.3 INSTRUMENT SYSTEMS SCIENTIST

The instrument systems scientist will be conversant with the functions of the instrument, the scientific and engineering performance requirements, and able to interpret the science and housekeeping telemetry.

9.4 DATA PROCESSING SUPPORT

To process AATSR Level-0 data through the EDS system to generate the necessary data products required by the operations support team to perform the verification tasks.

Support and maintain the EDS web site.

9.5 FLIGHT OPERATIONS CONTROL CENTRE (ESOC)

The FOCC at ESOC will be the interface with AATSR and the outside world. The main responsibilities will be:

- Routine monitoring of critical instrument housekeeping.
- Respond to authorised command requests and MPL files.
- Verify execution of command requests and MPL files
- Support RAL in requests for data to support instrument investigations.
- Report to RAL on spacecraft, ground segment, instrument anomalies.
- Ensure that FOCC/RAL server is maintained.

9.6 INDUSTRY SUPPORT

The support of Astrium may be requested through their PDS contract with DEFRA. As prime contractor for the instrument build, they may be called upon to provide relevant expertise to:

- Support anomaly investigations.
- On-Board Software Updates
- Advise on IORs

9.7 PRODUCT ASSURANCE MANAGER

In the event of an instrument anomaly, a member of the RAL SSTD Quality Assurance section will:

- Convene and run the MRB
- Compile and manage the MRB paperwork.
- Verify the completion of actions defined by the MRB before 'close-out' of the non-conformance.

10 SCHEDULE

The activities described in this document will start during the instrument commissioning phase and conclude at the end of the ENVISAT-1 mission.