Scope:

This note contains the test sheets defined by Astrium for the EQM testing for Herschel/SPIRE (see HP-2-ASED-TN-0004).

Change Log:

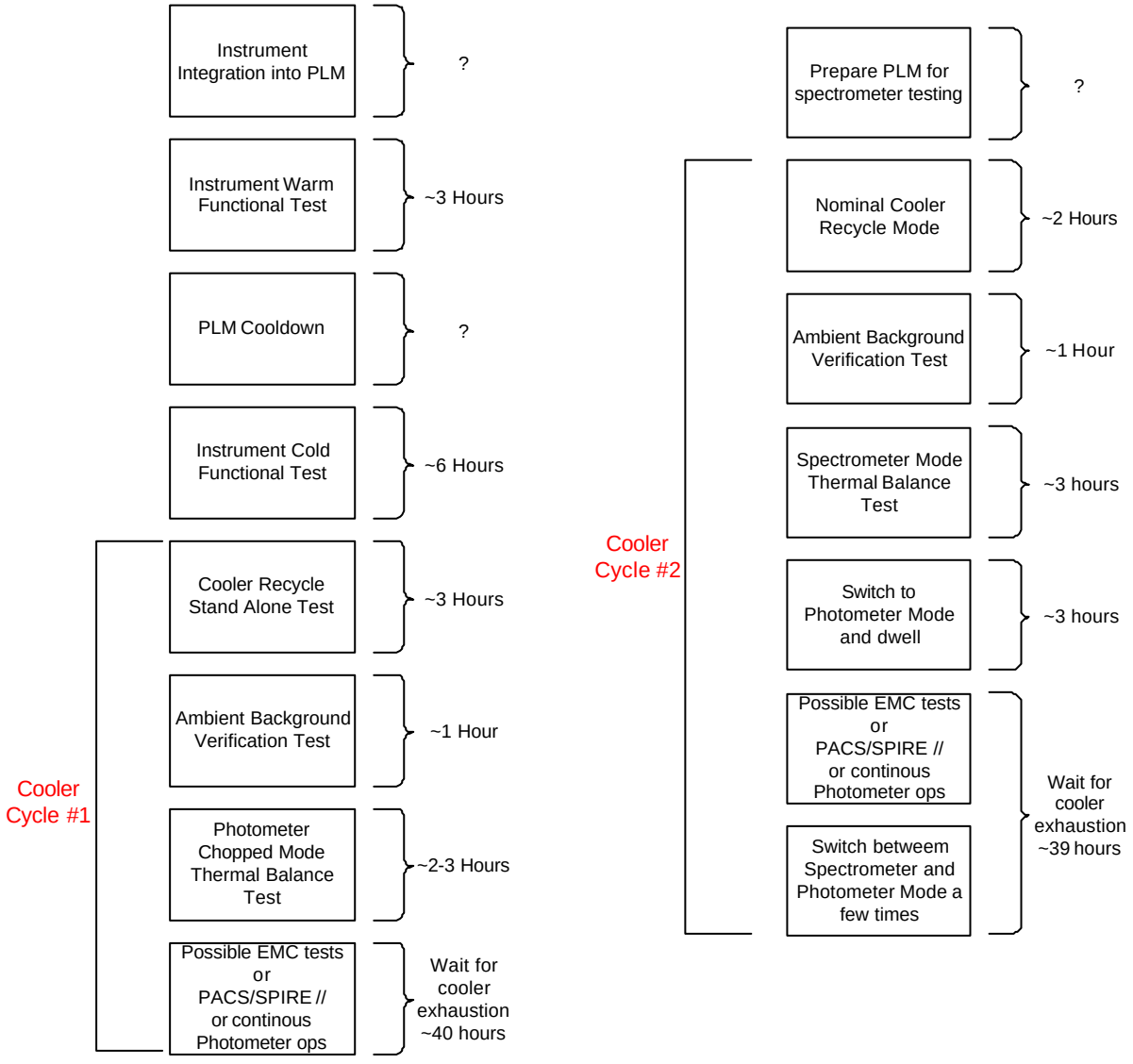
Date	Issue	Change/Comment
27/9/01	Draft for comment	Five tests defined for with first issue of note for presentation at EQM meeting (H-P-ASPI-MN-406 refers
26/10/01	0.1	Same five basic tests with refined requirements on background power Outline test sequence inserted PACS/SPIRE Parallel mode test not yet defined
19/2/02	0.2	Added test sheets for WFT and CFT Define firm temperature limits for L0;L1 and L2

Outline Test Sequence for Herschel/SPIRE EQM testing

The SPIRE test sequence is based on need to look at the following aspects of SPIRE operations:

- Recovery from cooler recycle
- Settling time for photometer mode switch on
- Switching from photometer to spectrometer mode
- Switching from SPIRE prime to PACS/SPIRE parallel
- Total cooler hold time during nominal operations

The testing of the SPIRE instrument has to be based around the recycling of the 300 mK cooler. At least one full operational cycle of the cooler (nominal 48 hours) is required in order to evaluate the hold time of the cooler under nominal in flight operating conditions. It is proposed that two full cooler recycle periods be used for the SPIRE EQM testing. These need not be contiguous. A proposed outline test sequence is shown below.



Test Case Form

Title:	*Experiment:*
Flight Operations Thermal Balance Test – **Cooler Recycle**	Herschel/SPIRE

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during and after cooler recycle mode operations
To prepare the instrument for operation with the photometer or spectrometer detectors

Test Description:
The cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight. The SPIRE cooler recycle sequence will be carried out and the temperatures of the various stages monitored.
The results will be compared to those from the SPIRE Instrument Thermal Model (ITMM)

Instrument Configuration:	*Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):*
CQM PFM	At least 17 degrees tilted around Z-axis towards +Y This operation can be carried out with the PLM rotated to 90 degrees in same direction.

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Mass flow rate as close as possible to that expected in flight
Shield temperatures as close as possible to expected in flight temperatures certainly as follows
L0 < 1.8 K
L1 < 6 K
L2 < 15 K
These should be maintained for the duration of the test and thereafter for the start of the follow on photometer test.

Success Criteria:
Cooler is successfully recycled and temperatures settle to within operational limits as predicted by the SPIRE ITMM

Duration:	*Applicable:*	
~3 hours	PLM EQM	☒
	PFM	☒

Test Case Form

Title:
Warm Functional Test

Experiment:
Herschel/SPIRE

Objectives:
To check out the functionality of the SPIRE instrument following integration at payload module level before cooldown commences.

Test Description:
The S/C-instrument interfaces are checked by switch on procedure (TBD)
The instrument is placed into a state ready to receive and execute commands (READY – TBC)
Each sub-system is commanded as appropriate to verify its function (TBD)
The instrument is switched off

Instrument Configuration:
CQM
PFM

Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):
None

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
None

Success Criteria:
Instrument housekeeping data monitored via SCOS2000 and QLA. Comparison with values obtained during ILT shows no change in function.

Duration:
~3 hours

Applicable: PLM EQM ☒
PFM ☒

Test Case Form

Title:	*Experiment:*
Cold Functional Test	Herschel/SPIRE

Objectives:
To check out the functionality of the SPIRE instrument following integration at payload module level after the instrument has been cooled down. This test is also the "Short Functional Test".

Test Description:
The S/C-instrument interfaces are checked by switch on procedure (TBD)
The instrument is placed into a state ready to receive and execute commands (READY – TBC)
Each sub-system is commanded as appropriate to verify its function (TBD)
The instrument is switched back to READY
The instrument may be switched OFF or to another mode if further tests are planned

Instrument Configuration:	*Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):*
CQM PFM	PLM

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Temperatures need to be as follows for the test to be valid.
Level 0 – <1.8 K
Level 1 - < 6 K
Level 2 < 15 K

Success Criteria:
Instrument housekeeping data monitored via SCOS2000 and QLA. Comparison with values obtained during ILT shows no change in function.

Duration:	*Applicable:*	
~6 hours	PLM EQM	☒
	PFM	☒

Test Case Form

Title:	*Experiment:*
Flight Operations Thermal Balance Test – **Photometer Chop Mode**	Herschel/SPIRE

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during photometer chopped mode operations.

Test Description:
The EQM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient background in the instrument is such as to allow meaningful signals from the detectors to be seen. This will be verified by a dedicated measurement
The SPIRE cooler has been recycled and the instrument is at nominal temperature
The photometer JFETs are switched on and the instrument temperatures allowed to settle
A simulated photometer chop observation is carried out – this will include operation of the photometer calibrator and beam steering mirror.
The results will be compared to the ILT and the SPIRE ITMM

Instrument Configuration:	*Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):*
CQM PFM	No restriction on the tilt

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Mass flow rate as close as possible to those expected in flight
Shield temperatures as close as possible to those expected in flight temperatures certainly as follows
L0 < 1.8 K
L1 < 6 K
L2 < 15 K
These conditions should be maintained following the cooler recycle (see Cooler Recycle sheet)
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE
This may be achieved using the SPIRE shutter (TBD)

Success Criteria:
The instrument temperatures stay within pre-defined limits as predicted by the SPIRE ITMM
No excess background is seen on the detectors during operations

Duration:	*Applicable:*		
~1 hour		PLM EQM	☒
		PFM	☒

Test Case Form

Title:
Flight Operations Thermal Balance Test – **Ambient Background Verification**

Experiment:
Herschel/SPIRE

Objectives:
To check the photon background on the photometer detectors after cooler recycle and before all other tests

Test Description:
The EQM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The SPIRE cooler has been recycled and the instrument is at nominal temperature
The photometer JFETs are switched on and the instrument temperatures allowed to settle
The SPIRE shutter may be closed (TBD)
Load curves are taken on the photometer detectors by varying the bias voltage

Instrument Configuration:
CQM
PFM

Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):
No tilt requirements

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Mass flow rate as close as possible to those expected in flight
Shield temperatures as close as possible to those expected in flight temperatures certainly as follows
L0 < 1.8 K
L1 < 6 K
L2 < 15 K
These conditions should be maintained following the cooler recycle (see Cooler Recycle sheet)

Success Criteria:
Data analysed in real time to calculate the background flux on the detectors. Background should be within limits defined for the follow on test

Duration:
~1 hour (TBC)

Applicable:		
	PLM EQM	☒
	PFM	☒

Test Case Form

Title:	*Experiment:*
Flight Operations Thermal Balance Test – **Spectrometer Mode**	Herschel/SPIRE

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during spectrometer mode operations

Test Description:
The EQM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient background in the instrument is such as to allow meaningful signals from the detectors to be seen. This will be verified by a dedicated test.
The SPIRE cooler has been recycled and the instrument is at nominal temperature
The spectrometer JFETs are switched on and the instrument temperatures allowed to settle
The spectrometer calibrator is switched on
A simulated spectrometer chop observation is carried out – this will include operation of the photometer calibrator and beam steering mirror.
The results will be compared to the ILT and the SPIRE ITMM

Instrument Configuration:	*Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):*
CQM PFM	At least 85 degrees tilted around z-axis in either +Y or –Y direction

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Mass flow rate as close as possible to those expected in flight
Shield temperatures as close as possible to those expected in flight temperatures certainly as follows
L0 < 1.8 K
L1 < 6 K
L2 < 15 K
These conditions should be maintained following the cooler recycle (see Cooler Recycle sheet)
Photon background in the 300-670 µm band within x5 (TBC) of that expected in flight – this is equivalent to a black body <~ 20 K in the beam of SPIRE
This may be achieved using the SPIRE shutter (TBD)

Success Criteria:
The instrument temperatures stay within pre-defined limits as predicted by the SPIRE ITMM
No excess background is seen on the detectors during operations

Duration:	*Applicable:*		
~1 hours		PLM EQM	☒
		PFM	☒

Test Case Form

Title:	*Experiment:*
EQM EMC Test – **EMC Test Ready**	Herschel/SPIRE

Objectives:
To set the instrument into its most sensitive mode to allow the effects of EMI to be verified

Test Description:
The EQM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient photon background in the instrument is low enough such that meaningful noise measurements can be made on the detectors. The background shall be verified by a dedicated test
The SPIRE cooler has been recycled and the instrument is at nominal temperature
The photometer JFETs are switched on and the instrument temperatures allowed to settle.
Noise traces are taken from the detectors at the highest data sampling frequency allowed by the electronics before and during **conducted** and **radiated** EM testing.
The results will be compared to the ILT and the SPIRE EMC model.

Instrument Configuration:	*Specific Requirements on PLM (e.g. PLM tilted about 30° around z-axis):*
Standby->Phot Standby->Standby	No tilt requirement. The PLM cover should allow for **radiated** EMC into the cryostat

Particular Environmental Constraints (e.g. level 0-2 temperatures, mass-flow - during what time):
Mass flow rate as close as possible to those expected in flight
Shield temperatures as close as possible to those expected in flight temperatures certainly as follows
L0 < 1.8 K
L1 < 6 K
L2 < 15 K
These conditions should be maintained following the cooler recycle (see Cooler Recycle sheet)
Photon background as low as practically possible to attempt to have the noise dominated by the intrinsic detector noise. This shall at least be such as to meet the expected background in flight in the 420-580 µm band – this is equivalent to a black body of <~12 K in the beam of SPIRE.

Success Criteria:
No excess noise is seen on the detectors during **conducted** and **radiated** EMC testing. Noise levels should be lower than those set by the SPIRE project (TBD).

Duration:	*Applicable:*	
TBD	PLM EQM	☒
	PFM	TBD

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Critical commands	None
Critical instrument H/K parameters	Define critical? Could be the same as for flight? In which case defined in Data ICD
ESD critical connectors	All JFET connectors Flying leads to detectors (TBD)
Red/green tagged items relevant to the test	FPU Aperture Cover
Specific handling constraints	See integration procedure
Protective covers to be used	FP Aperture cover to be left on until ready to close instrument shield Shorting sockets on JFETs to be removed as part of installation procedure only Possible shorting sockets on detector flying leads (TBD)
Warm-up times	TBD
Specific PLM orientations	20 degrees to +Y for cooler recycle