Introduction

This note outlines the tests that will be required for the SPIRE sub-systems for space qualification – hereafter denoted as 'type approval' to differentiate from the instrument Cryogenic Qualification Model. An outline test matrix showing which tests should be carried out for each sub-system is given and an example type approval programme for the detector assembly is included as an appendix.

Assumptions

It is assumed that all sub-systems will have been through a type approval programme of one or more models before the Cryogenic Qualification version of the sub-system is delivered for the instrument AIV. This implies:

1. The testing carried out on the CQM instrument should NOT be considered to be the qualification test for each individual sub-system. The tests carried out on the instrument CQM will be neither exhaustive nor at the correct level for sub-system qualification.
2. It is intended that the tests listed in this note are carried out on a specific type approval model or models. It is expected that acceptance tests will be done on each delivered model (CQM, Flight and Flight Spare) as part of the general instrument AIV – these will be detailed in the instrument AIV plan. The type approval test programme does not replace the need for acceptance testing of each model.

Qualification Tests

Vibration:	All sub-systems are to be vibrated at levels appropriate to their location within the instrument. The temperature at which the vibration will be done is subject to negotiation between the project and ESA. The group responsible for the structure will define the level at which each sub-system will be vibrated. This will either be by calculation or vibration of test structures.
Thermal cycle:	All FPU sub-systems will be cooled down and warmed up a large number of times over the period leading up to launch. An accelerated thermal cycle test is therefore required for all FPU sub-systems. The temperatures; rate of temperature change and number of cycles are TBD.
Vacuum cycle:	All sub-systems will be operating in vacuum. The long term performance of all sub-systems in vacuum as well as their response to vacuum cycling must be assessed. All sub-systems will be vacuum cycled and critical items will under go long term life tests under vacuum conditions.
Lifetime:	Where novel material processing or unqualified mechanisms are employed in a sub-system, accelerated life tests will be mandatory. For all ASICs and micro-machined components a programme of device selection will be required to guard against infant mortality.
Soak/cycle:	All electronic sub-systems and/or components will need to be soak tested and operationally cycled as part of their lifetime test programme.

Radiation tolerance: All unqualified electronics sub-systems and/or components will have to be exposed to the appropriate level of radiation dose to ensure survival in orbit.

Thermal range: The operating temperature range of a sub-system will be characterised. If a sub-system does not operate within specification, or at all, at temperatures that are within the expected limits, it cannot be considered qualified.

Thermal stability: The response of a sub-system to thermal instabilities will be characterised as will the impact of a sub-system operations on the thermal stability of the instrument. A sub-system that causes large thermal instability in the instrument during its normal operational cycle or is over sensitive to the expected level of thermal instability cannot be considered qualified.

Microphonics: The level of mechanical vibration from a sub-system will be characterised as well as the response of the sub-system to microphonic interference. Any sub-system that causes excessive mechanical vibration during its normal operation or is over sensitive to the expected level of mechanical vibration cannot be considered qualified.

Ionising radiation: The response of a sub-system (e.g. the detectors) to high energy ionising radiation (basically protons), will be characterised. A sub-system will not be considered qualified if its performance is significantly reduced by the impact of high energy ionising radiation.

EMI: The sensitivity of a sub-system to electromagnetic interference will be characterised. If a sub-system is over sensitive to the expected level of electromagnetic emission it will be deemed not qualified.

EMC: The emitted and conducted electromagnetic emission of a sub-system will be characterised. Any sub-system that emits significant levels of electromagnetic radiation or interferes with power supplies or ground lines will not be considered qualified.

Materials conformance: All materials used in the manufacture of a sub-system must be approved for space use by ESA. Any materials not on an approved list must under go a materials approval test as laid down by ESA.

Test Matrix:

	Structure	Optics	FTS Mechanism	Chopper	Detector arrays	Cooler	Filters/grids/dichroics	Calibration Sources	DCRU	SPU	DPU
Vibration:	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Thermal cycle:	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**			
Vacuum cycle			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Lifetime:		**P**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Soak/cycle:			**X**	**X**	**X**	**X**		**X**	**X**	**X**	**X**
Radiation tolerance:			**P**	**P**	**X**	**P**	**X**	**X**	**X**	**X**	**X**
Thermal range:			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Thermal stability:		**P**	**X**	**X**	**X**	**X**	**P**	**X**	**X**	**X**	**X**
Microphonics:		**P**	**X**	**X**	**X**	**X**	**P**	**P**			
Ionising radiation:					**X**						
EMI:			**X**	**X**	**X**	**P**		**P**	**X**	**X**	**X**
EMC:			**X**	**X**	**X**	**P**		**P**	**X**	**X**	**X**

Table 1: Test matrix for the SPIRE sub-systems qualification programme. Tests marked with an X are mandatory, those marked with a P are possibly required depending on the detailed design of the sub-system and/or the new of novel materials.

For some sub-systems the qualification and lifetime testing will be more appropriately carried out at component or test item level rather than at the level of the integrated sub-system. At what stage and under what conditions the tests are to be carried out is a matter for detailed consideration by the groups responsible for the sub-systems delivery.