

MULLARD SPACE SCIENCE LABORATORY

UNIVERSITY COLLEGE LONDON Author: C BROCKLEY-BLATT

## SPIRE – FMECA

Document Number: MSSL/SPIRE/PA005.1 29 November 2001

Distribution:

Spire Project Office

B Winter

ESA PX

A Heske

J Bruston

J Rautakoski

RAL

B Swinyard

K King

J Delderfield

J Long (Project Office)

Mullard Space Science Laboratory

A Smith

J Coker

C Brockley-Blatt

A Dibbens

ATC

C Cunningham

I Pain

T Paul

Cardiff

M Griffin

P Hargrave

JPL

J Bock

J Lilienthal

CEA

L Duband

Herschel Project

Herschel.Planck@esa.int

Author:

C Brockley-Blatt

Date:

Checked:


B Winter

Date:

Approved:


T Dibbens

Date:

	<b>SPIRE</b>	<b>Project Document</b>	<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>	<b>Issue:</b> 1.0
			<b>Date:</b> November 2001
			<b>Page:</b> Page 2 of 13


## Change Record

ISSUE	DATE	
0.1	September 2001	New document
1.0	November 2001	Issued

	<b>SPIRE</b>	<b>Project Document</b>	<b>Ref:</b> Mssl/spire/pa005.01
			<b>Issue:</b> 1.0
		<b>FMECA</b>	<b>Date:</b> November 2001
			<b>Page:</b> Page 3 of 13

## Table of Contents

1. Scope of Document
2. Documents
3. FMECA

	<b>SPIRE</b>	<b>Project Document</b>	<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>	<b>Issue:</b> 1.0
			<b>Date:</b> November 2001
			<b>Page:</b> Page 4 of 13

## Glossary


All terms are listed in the CIDL.

### 1. Scope of Document

This document presents the results of the FMECA carried out on the SPIRE Structure.

### 2. Documents

All documents are listed in Figure 3.2 of the CIDL.

	<b>SPIRE</b>	<b>Project Document</b>	<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>	<b>Issue:</b> 1.0
			<b>Date:</b> November 2001
			<b>Page:</b> Page 5 of 13

### 3. FMECA

A failure mode effects and criticality analysis has been performed on all functional elements of the structure which can cause failure effects within the experimenter cause damage to or interfere with, the proper functioning of the SPIRE instrument or HERSCHEL spacecraft.

Most of the phenomena can be captured by structural failure which can be detected by qualification

Each failure effect identified has been given a criticality category according to the definition below:


- Category 1: The failure effect is not confined to the subsystem. When this failure also results in loss or degradation of the instrument's function, this shall be stated.
- Category 2: The failure results in loss or degradation of the subsystem's function but the effect is confined to the subsystem.
- Category 3: Minor internal subsystem failures.

The following attributes have been added to the criticality category as appropriate:

- "R", if the design contains a redundant item which can perform the same function
- "SH", if the failure effect causes a safety hazard
- "SPF", if the failure is caused by a single point failure


The following failure modes have been considered:

- Total
  - Premature operation
  - Failure to operate (at the prescribed time)
  - Failure to cease operation (at the prescribed time)
  - Failure during operation
  - Mechanical failure
- Intermittent
  - For failure at component level e.g. hardware interface
    - Short circuit
    - Open circuit
    - Incorrect function e.g. from single event upset – ex:latch ups
  - Incorrect commands or sequence of commands
- Partial
  - Incorrect software functions
- Degradation
  - Degradation or out of tolerance operation

	<b>SPIRE</b>	<b>Project Document</b>	<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>	<b>Issue:</b> 1.0
			<b>Date:</b> November 2001
			<b>Page:</b> Page 6 of 13


Design specifications, descriptions, functional diagrams etc, used in the preparation of the FMECA shall be attached or referenced.




	<h1>SPIRE</h1>	Project Document		Ref:	Mssl/spire/pa005.01
		FMECA		Issue:	0.1
				Date:	September 2001
				Page:	Page 8 of 13

ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions
2	Cover panels	Stiffness and stray light and RF shielding	Stray light or RF leak	Dent	Minor misalignment of instrument internally	2	Identify a misalignment or thermal short	Visual inspection before launch	
3	Spire Optical Bench	Stiffness and mounting provision for all other subsystems	Distortion	Prestress due to mishandling	Misalignment	2	Misalignment	Prelaunch check	Training in integration procedure
4	Thermal Straps	Provide conduction path	Breaks	Fatigue	Loss of thermal conductance	1SFP	Thermal performance, instrument performance	Sufficient margin	Design for non fatigue critical
			Deformation	Mishandling	Thermal short	1SFP	Thermal performance, instrument performance	Visual inspection before launch	
			Degradation of contact	Thermal or mechanical cycling	Loss of thermal conductance	1	Thermal performance, instrument performance	Instrument health check and sufficient design margin and qualification testing	Qualification testing with regard to fatigue




	<h1>SPIRE</h1>	Project Document		Ref:	Mssl/spire/pa005.01
		FMECA		Issue:	0.1
				Date:	September 2001
				Page:	Page 9 of 13


ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions
5	Thermal busbar	Provide 0.3K thermal path to detectors	Loss of suspension	Mechanical overload	Loss of one detector	2	Thermal performance, detector performance	Sufficient design margin	Engineering tests
					Loss of all detectors	1	Thermal performance, detector performance	Sufficient design margin	Engineering tests
			Work hardening	Repeated integrations	Degradation of performance	2	Thermal performance, detector performance	Sufficient design margin	Engineering tests, CQM and FM Tests
			Breaking	Repeated integrations or mechanical loading	Loss of one detector	2	Thermal performance, detector performance	Sufficient design margin	Engineering tests, CQM and FM Tests
					Loss of all detectors	1	Thermal performance, detector performance	Sufficient design margin	Engineering tests

	<h1>SPIRE</h1>	Project Document		Ref:	Mssl/spire/pa005.01
		FMECA		Issue:	0.1
				Date:	September 2001
				Page:	Page 10 of 13


ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions
6	Mirror Mounts	Supports mirrors	Misalignment	Mishandling during integration	Misalignment	1	Instrument performance	Alignment verification	
			Break	Launch	Loss of alignment - common mirror	1	Instrument failure	Sufficient design margin	Q-Test
					Loss of alignment - a mirror in spectrometer or photometer	2	Instrument performance	Sufficient design margin	Qualification testing
7	Photometer 2K Detector box and supports	Supports photometer detectors, stray light	Breakage	Launch	Loss of instrument	1SPF	Measuring thermal performance	Sufficient design margin	Qualification testing
				Pre-flight handling or integration	Thermal short or misalignment	1	Measuring thermal performance	Sufficient design margin	Visual inspection and Protoflight testing
			Plastic deformation	Launch	Misalignment	1SPF	Instrument performance	Sufficient design margin	Qualification testing
				Pre-flight handling or integration	Thermal short or misalignment	1	Alignment	Sufficient design margin	Visual inspection and Protoflight testing

	<h1>SPIRE</h1>	<b>Project Document</b>		<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>		<b>Issue:</b> 0.1
				<b>Date:</b> September 2001
				<b>Page:</b> Page 11 of 13

ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions
	8 Spectrometer 2K detector box and supports	Supports spectrometer detectors, stray light and RF baffle	Breakage	Launch	Loss of instrument	1SPF	Measuring thermal performance	Sufficient design margin	Qualification testing
				Pre-flight handling or integration	Thermal short or misalignment	1	Measuring thermal performance	Sufficient design margin	Visual inspection and protoflight testing
			Plastic deformation	Launch	Misalignment	1SPF			
				Pre-flight handling or integration	Thermal short or misalignment	1	Alignment	Sufficient design margin	Visual inspection and protoflight testing
	9 Stray light Baffles								
9a	General	Stray light shielding	Bent	Mishandling during integration	Increase in background noise for detectors	3	Instrument performance	Careful handling	Visual check
					Loss of field of view	2	Instrument performance	Careful handling	Visual check
					Obscures common beam	1	Instrument performance	Careful handling	Visual check

	<h1>SPIRE</h1>	<b>Project Document</b>		<b>Ref:</b>	Mssl/spire/pa005.01
		<b>FMECA</b>		<b>Issue:</b>	0.1
				<b>Date:</b>	September 2001
				<b>Page:</b>	Page 12 of 13

ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions
9b	Feed thorough	Stray light shielding at thermal strap entry to different thermal zones	4K- thermal short	Misalignment	Degradation of thermal performance		Thermal performance 2	Tolerance on alignment	Visual check and measure
			2K- thermal short	Misalignment	Degradation of thermal performance		Thermal performance 1	Tolerance on alignment	Visual check and measure
10	Non Mirror Optics mounts								
10a	Filters	Supports of the filters	Popping out its frame	Differential in pressure	Damage to filters	2		Ensure adequate venting/control pump down	
10b	Beam Splitters/Dichroics	Supports the beam and splitters and dichroics	Distortion	Asymmetric stressing	Misalignment		Instrument performance 2	Mounts design symmetrical - 3 point mount	
			Break	Launch	Loss of alignment - common mirror		Instrument failure 1		
					Loss of alignment -a mirror in spectrometer or photometer		Instrument performance 2	Sufficient design margin	Qualification testing
ID	Item	Function	Failure Mode	Failure Cause	Failure Effect	Severity	Detection	Provisions	Actions

	<b>SPIRE</b>	<b>Project Document</b>		<b>Ref:</b> Mssl/spire/pa005.01
		<b>FMECA</b>		<b>Issue:</b> 0.1
				<b>Date:</b> September 2001
				<b>Page:</b> Page 13 of 13

11	Alignment cubes	Tool for alignment of instrument	Misalignment	Wrong reference for alignment of instrument	Delay in test schedule		3??????	Careful handling	
12	Thermistors	Measure the temperature of a part	Failure to operate	Broken or disconnected	wrong temperature reading		3R	Thermal testing	
					no temperature		3R	Thermal testing	
13	Assembly jig	Support instrument during integration	Damage to instrument	Over constrained or lack of stiffness	misalignment		2	Visual inspection	No hypostatic mounting (no more than 6 degrees of freedom) Sound engineering practice
			Misalignment	Over constrained or lack of stiffness	Misalignment		3	Visual inspection	no hypostatic mounting (no more than 6 degrees of freedom), adherence to integration alignment requirements (the way the alignment) Sound engineering practice

Page left intentionally blank