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SPIRE STRUCTURE– FMECA

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Change Record

ISSUE	DATE	
0.1	September 2001	New document
1.0	November 2001	Issued
1.1	December 2001	Updated to ESA ECSS-Q-30-02A Standard, functional diagram added, Critical Items List added

Table of Contents

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.

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 experimentor cause damage to or interfere with, the proper functioning of the SPIRE instrument or HERSCHEL spacecraft.

Most of the pheomena 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: Catastrophic - The failure results in loss of the instrument's function or loss of missions or damage to another instrument (SN = 4)
- Category 2: Critical - The failure results in loss of the subsystem's function but the effect is confined to the subsystem. (SN = 3)
- Category 3: Major - Degradation of subsystem functionality. (SN = 2)
- Category 4: Negligible - Any other effect (SN = 1)

The following failure modes have been considered:

- Total
  - Collapes
  - Breaks
  -
- Intermittent
  - Distortion
  - Thermal or light leak
- Partial
  - Plastic deformation
  - Misalignment

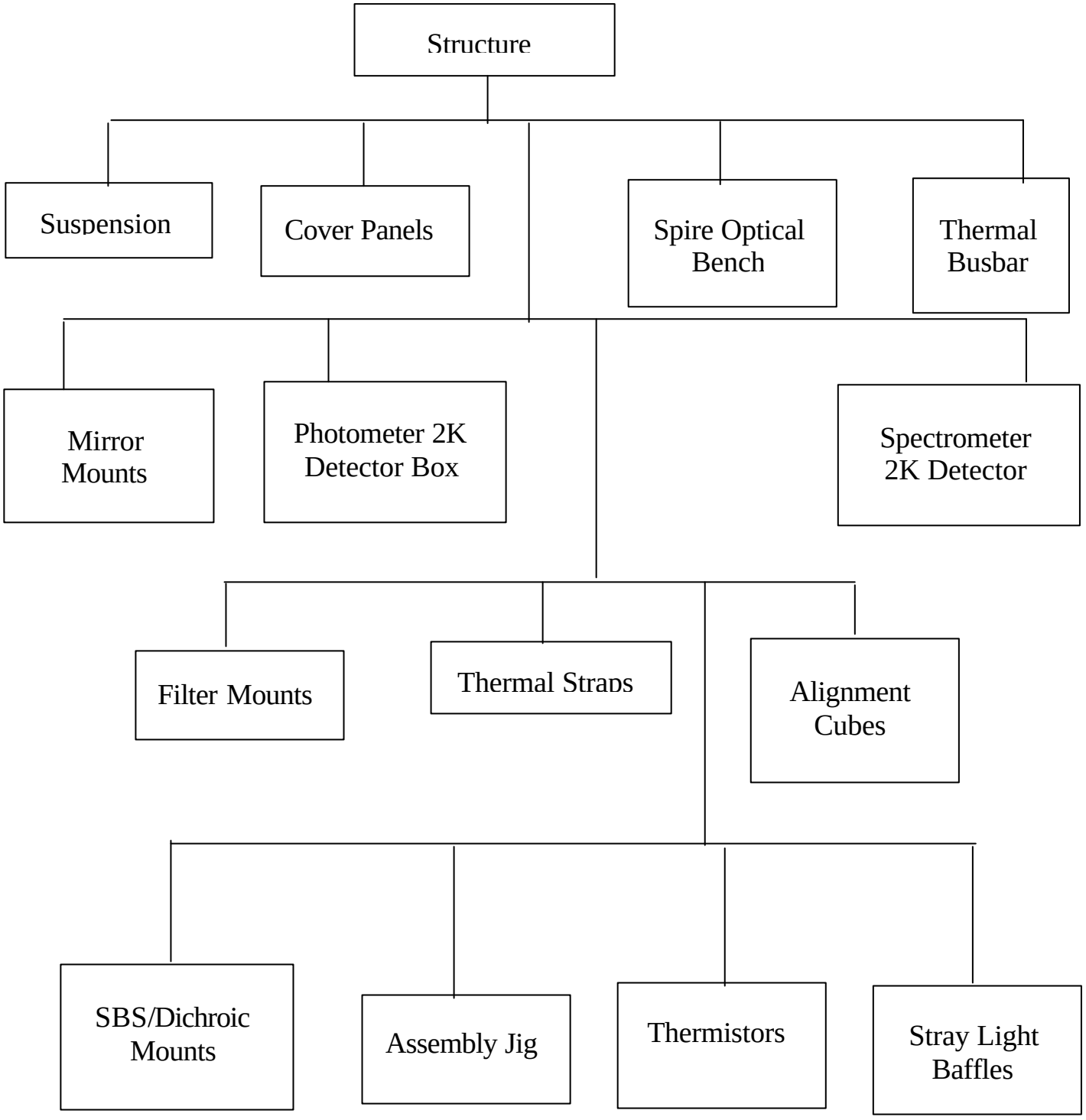
- Degration
  - Degradation

The probability figures are:

- Probable PN = 4
- Ocassional PN = 3
- Remote PN = 2
- Extremely remote PN = 1

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

3.1 Functional Diagram



3.2. Column Descriptions

The following data elements are shown in the FMECA analysis sheet:

- Identification Number – Each failure mode and effect will have an unique number for treaceability purposes.
- Item – The name of the item of the subsystem being analysed.
- Function – A statement of the function performed by the item.
- Failure mode – All potential failure modes of the item under analysis are identified and described.
- Failure Cause – The most probable cause associated with the failure mode.
- Mission Phase – The phase of the mission in which the failure is most likely to occur, be it testing or flight for example.
- Failure Effects – The consequences of each assumed failure, be it local or end effects.
- Severity Classification – The severity category.
- Failure Detection Method – A description by which occurrence of the failure mode is detected or observed, be it warning devices, sensing or none.
- Compensating Provisions – The actions that reduce or nullify the effects of the failure
- Severity Number, SN – The number assigned which is consistent with the severity category
- Probability Number, PN – The number assigned to the probability of the occurrence of the failure.
- Criticality Number, CN – The multiplication of the severity and probability numbers.
- Corrective actions – Corrective actions to prevent failure.
- Remarks – Any pertinent remarks relevant to and clarifying any other column.

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS001	Suspension	Supports Instrument on HOB	Collapses or breaks	Launch	Flight	Loss of instrument	1	Thermal performance	None	4	2	8	Sufficient design margin Replace Suspension	
SS002				Another instrument hitting SPIRE	Flight/Test	Thermal short, misalignment	1	Thermal performance	None	4	2	8	Sufficient design margin, non contact constraint	
SS003				Pre-flight handling and integration	Flight	Thermal short, misalignment	1	Thermal performance	None	4	3	12	Visual check before launch	
SS004			Plastic deformation	Launch	Flight	Loss of instrument	1	Alignment	None	4	2	8	Sufficient design margin	
SS005				Another instrument hitting SPIRE	Flight/Test	Thermal short, misalignment	1	Thermal performance	None	4	2	8	Sufficient design margin, non contact constraint	
SS006				Pre-flight handling and integration	Flight	Thermal short, misalignment	1	Alignment, using the optical cube	None	4	3	12	Replace suspension	

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method /Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS007	Cover panels	Stiffness and stray light and RF shielding	Stray light or RF leak	Dent	Test	Minor misalignment of instrument internally	2	Identify a misalignment or thermal short	None	3	3	9	Visual inspection before launch	
SS008	Spire Optical Bench	Stiffness and mounting provision for all other subsystems	Distortion	Prestress due to mishandling	Integration	Misalignment	2	Misalignment	None	3	2	6	Prelaunch check Training in integration procedure	
SS009	Thermal Straps	Provide conduction path	Breaks	Fatigue	Test/Flight	Loss of thermal conductance	1	Thermal performance, instrument performance	None	4	3	12	Sufficient margin Design for non fatigue critical	
SS010			Deformation	Mishandling	Test/Flight	Thermal short	1	Thermal performance, instrument performance	None	4	2	8	Visual inspection before launch	
SS011			Degradation of contact	Thermal or mechanical cycling	Flight	Loss of thermal conductance	1	Thermal performance, instrument performance	None	4	1	4	Instrument health check. sufficient design margin & qualification testing with regard to fatigue	

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS012	Thermal Busbar	Provide 0.3K thermal path to detectors	Loss of suspension	Mechanical overload	Test/Flight	Loss of one detector	2	Thermal performance, detector performance	None	3	2	6	Sufficient design margin Engineering tests	
SS013					Test/Flight	Loss of all detectors	1	Thermal performance, detector performance	None	4	2	8	Sufficient design margin Engineering tests	
SS014			Work hardening	Repeated integrations	Test/Flight	Degradation of performance	2	Thermal performance, detector performance	None	3	3	9	Engineering tests, CQM and FM Tests	Sufficient design margin
SS015			Breaking	Repeated integrations or mechanical loading	Test/Flight	Loss of one detector	2	Thermal performance, detector performance	None	3	2	6	Engineering tests, CQM and FM Tests	Sufficient design margin
SS016					Test/Flight	Loss of all detectors	1	Thermal performance, detector performance	None	4	2	8	Engineering tests	Sufficient design margin

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS017	Mirror Mounts	Supports mirrors	Misalignment	Mishandling during integration	Test	Misalignment	1	Instrument performance	None	4	2	8		Alignment verification
SS018			Break	Launch	Flight	Loss of alignment - common mirror	1	Instrument failure	None	4	2	8		Sufficient design margin
SS019					Test/Flight	Loss of alignment -a mirror in spectrometer or photometer	2	Instrument performance	None	3	2	6	Q-Test	Sufficient design margin
SS020	Photometer 2K Detector box and supports	Supports photometer detectors, stray light	Breakage	Launch	Flight	Loss of instrument	1	Measuring thermal performance	None	4	2	8	Qualification testing	Sufficient design margin
SS021				Pre-flight handling or integration	Flight	Thermal short or misalignment	1	Measuring thermal performance	None	4	2	8	Qualification testing	Sufficient design margin
SS022			Plastic deformation	Launch	Flight	Misalignment	1	Instrument performance	None	4	2	8	Visual inspection and Protoflight testing	Sufficient design margin Qualification testing

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS023				Pre-flight handling or integration	Flight	Thermal short or misalignment	1	Alignment	None	4	2	8	Visual inspection and Protoflight testing	Sufficient design margin
SS024	Spectrometer 2K detector box and supports	Supports spectrometer detectors, stray light and RF baffle	Breakage	Launch	Flight	Loss of instrument	1	Measuring thermal performance	None	4	2	8	Qual-ification testing	Sufficient design margin
SS025				Pre-flight handling or integration	Flight	Thermal short or misalignment	1	Measuring thermal performance	None	4	2	8	Visual inspection and protoflight testing	Sufficient design margin
SS026			Plastic deformation	Launch	Flight	Misalignment	1		None	4	2	8		
SS027				Pre-flight handling or integration	Flight	Thermal short or misalignment	1	Alignment	none	4	2	8	Visual inspection and protoflight testing	Sufficient design margin

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS028	Stray light Baffles :General	Stray light shielding	Bent	Mishandling during integration	Test/Flight	Increase in background noise for detectors	3	Instrument performance	None	2	3	6	Visual check	Careful handling
SS029					Test/Flight	Loss of field of view	2	Instrument performance	None	3	3	9	Visual check	Careful handling
SS030					Test/Flight	Obscures common beam	1	Instrument performance	None	4	3	12	Visual check	Careful handling
SS031	Feed thorough	Stray light shielding at thermal strap entry to different thermal zones	4K- thermal short	Misalignment	Test/Flight	Degradation of thermal performance	2	Thermal performance	None	3	2	6	Visual check and measure	Tolerance on alignment

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS032	Feed Through		2K-thermal short	Misalignment	Test/Flight	Degradation of thermal performance	1	Thermal performance	None	4	2	8	Visual check and measure	Tolerance on alignment
SS033	Filters	Supports of the filters	Popping out its frame	Differential in pressure	Test	Damage to filters	2		None	3	2	6		Ensure adequate venting/control pump down
SS034	Beam Spilitters/ Dichroics	Supports the beam and splitters and dichroics	Distortion	Asymmetric stressing	Test/Flight	Misalignment	2	Instrument performance	None	3	2	6		Mounts design symmetrical - 3 point mount
SS035			Break	Launch	Flight	Loss of alignment - common mirror	1	Instrument failure	None	4	1	4		
SS036					Flight	Loss of alignment -a mirror in spectrometer or photometer	2	Instrument performance	None	3	2	6	Qualification testing	Sufficient design margin

ID	Item	Function	Failure Mode	Failure Cause	Mission Phase	Failure Effect a) Local Effects b)End Effects	Severity	Failure Detection Method/ Observable symptoms	Provisions	Severity Number SN	Probability PN	Criticality Number CN	Actions	Remarks
SS037	Alignment cubes	Tool for alignment of instrument	Misalignment	Wrong reference for alignment of instrument	Test	Delay in test schedule	3	??????		2	3	6	Careful handling	
SS038	Thermistors	Measure the temperature of a part	Failure to operate	Broken or disconnected	Test/Flight	wrong temperature reading	3	Thermal testing	Redundancy	2	3	6		
SS039					Test/Flight	no temperature	3	Thermal testing	Redundancy	2	3	6		
SS040	Assembly jig	Support instrument during integration	Damage to instrument	Over constrained or lack of stiffness	Integration	misalignment	2	Visual inspection		3	2	6	No hypostatic mounting (no more than 6 degrees of freedom)	
SS041			Misalignment	Over constrained or lack of stiffness	Integration	Misalignment	3	Visual inspection		2	2	4	no hypostatic mounting adherence to integration alignment requirements (the way the alignment)	

4. Critical Items List

Item	Action
Suspension	Sufficient design margin, non contact constraint, Replace suspension between models
Thermal Busbar	Instrument health check. sufficient design margin & qualification testing with regard to fatigue
Mirror Mounts	Alignment verification, Sufficient design margin
Photometer 2K Detector box and supports	Sufficient design margin, Qualification testing
Sprctrometer 2K Detector box and supports	Sufficient design margin, Qualification testing
Straylight Baffle	Visual check
Feed through	Visual check and measure, Tolerance on alignment
Beam Splitters	Sufficient design margin, Qualification testing

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