End Item Data Package (EIDP)

SPIRE - Dichroics - PFM

SPIRE Ref.: SPIRE-UCF-DOC-002798
Cardiff Ref.: HSO-CDF-EIDP-114 Issue 1.0
6th March 2006

Prepared by: Peter Hargrave
Cardiff SPIRE Technical Manager

Approved by: Ian Walker
Cardiff AIG Programme Manager

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Change Record

Issue	Section	Date	Changes
1.0		6/03/06	First issue

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SECTION 01 - Shipping Documents & DRB minutes

Minutes of SPIRE Flight Model Dichroics DRB
Cardiff

Present:

DRB scope and objectives
Review subsystem documentation, qualification and performance status of PFM Dichroics
Formal acceptance for delivery of the hardware
List of relevant documents and status

Review of comments received on EIDP

EIDP run-through

- Section 2: Transportation, Packing, Handling & Integration Procedures – all OK
- Section 3: Certificate of conformance - all OK
- Section 4: Qualification Status List / Compliance Matrix:
- Section 5: Top Level Drawings (Inc. Family Tree) - all OK
- Section 6: Interface drawings - all OK
- Section 7: Functional, Block & Mechanical drawings - all OK
- Section 8: Electrical Circuit Diagrams
- Section 9: As Built Configuration Items Status List - all OK
- Section10: Serialised Components List - OK
- Section 11: List of Waivers – no waivers, OK
- Section 12: Copies of Waivers – no waivers, OK
- Section 13: Operations manual – all OK
- Section 14: Historical Record – OK
- Section 15: Logbook / Diary of Events – OK
- Section 16: Operating Time / Cycle Record – OK
- Section 17: Connector Mating Record
- Section 18: Age Sensitive Items Record
- Section 19: Pressure Vessel History / Test Record
- Section 20: Calibration Data Record – OK
- Section 21: Temporary Installation Record - OK

- Section 22: Open work / Deferred Work / Open Tests:
- Section 23: List of Non-Conformance Reports
- Section 24: Copies of Non-Conformance Reports
- Section 25: Test reports
- Section 26: Assembly Record
    - Statement to be added to make it clear that the information is contained in the log-book kept at Cardiff.
- Section 27: Reference list of EIDPs
- Section 28: Mass Records – OK
- Section 29: Cleanliness Statement – to be signed off on delivery.
- Section 30: Other Useful Information - photographs OK
- Section 31: DPL/DML - OK
- Section 32: List of Appendices / Attachments

- Conclusions and summary of outstanding work

DRB Check-list

If all listed points are satisfactory then the item may be accepted. If not, the item may be accepted with the caveat that the requirement in question will be met within an agreed time scale.

No.	Record applicable answers and provide explanations in comment column	Yes/No/NA	Comments
1	Are all documents, drawings, etc. complete, approved, and under configuration control?		
2	Do the released items above reflect all approved changes?		
3	Is the hardware identical to other hardware delivered? If not provide difference list?		
4	Does the hardware fulfil its functional requirements, specifications, RFWs, ICDs etc.?		
5	Does the As-built Configured Items List reflect hardware as delivered?		
6	Have all required environmental tests and analyses been completed?		
7	Are all the required test and qualification procedures and reports completed and available to review?		
8	Have all the Declared Lists, i.e. DML, DMPL, DPL and components (EEE Parts) list been released? (Need not necessarily be included in EIDP, but must be available)		
9	Have PADS been raised and approved where required?		
10	Are relevant Test Readiness Review (TRR) minutes and the Post Test Reviews (PTR) complete and available?		
11	EIDP check: Are all agreed sections of the EIDP complete? Record any anomalies.		

		Signature	Date
Ian Walker	Cardiff SPIRE PA Manager		
Peter Hargrave	Cardiff SPIRE Technical Manager		
Matt Griffin	DRB chair		

SECTION 02 - Transportation, Packing, Handling & Integration Procedures

Handling

- Dichroics to be handled and installed by Cardiff personnel, or by authorised RAL delegate.
- Dichroics to be handled by rings only. NEVER touch dichroic surface.
- Handle following RAL flight hardware procedures.

Storage

- Dichroics must be stored in the shipping containers provided.

Installation

- Dichroics to be installed by Cardiff personnel, or by authorised RAL delegate.

Cleaning & Bakeout

- Dichroics must only be cleaned by Cardiff personnel.
- Never touch the dichroic surface.

SECTION 03 - Certificate of Conformance

Cardiff University Astronomy Instrumentation Group hereby certifies that the following equipment,	
Spacecraft / Project:	**Herschel**
Instrument:	**SPIRE**
Model:	**PFM**
Subsystem:	**Dichroics – PDIC1, PDIC2**
Serial No:	**FILT-PFM3-310, FILT-PFM3-320**
As described in this End Item Data Package: **HSO-CDF-EIDP-114**	
Complies with the requirements set out in: **SPIRE Instrument Requirements Document - SPIRE-RAL-PRJ-000034** **Filters subsystem specification document – HSO-CDF-SP-002 issue 2.2** **Filters interface control document - HSO-CDF-ICD-012 issue 3.0**	

Responsible Authority		***Signature***
Cardiff Product Assurance	Dr I.Walker	
Cardiff SPIRE Management	Dr P.Hargrave	
Cardiff Filter Management	Dr C. Tucker	

SECTION 04 - Qualification Status List / Compliance Matrix

Test	Status	Applicable document	Test Institute
Dimension and tolerances to specification	Compliant	Filters ICD - HSO-CDF-ICD-012	UWC
Visual inspection (internal & external)	Passed	Cardiff SPIRE Filters logbook	UWC
Mass	Compliant	Filters ICD - HSO-CDF-ICD-012	UWC
Thermal / vacuum cycles	Passed. Prior to delivery, the dichroics underwent a total of seven thermal / vacuum cycles to <15-K.	Section 14 & 15 Historical record & Logbook	UWC
Power consumption	N/A		
Vibrations 300K	Passed	AIV-2005-021-VIB	RAL
Vibrations 4K	Passed	AIV-2005-021-VIB	RAL
Environmental condition - Vacuum $3x10^{-1}$mBar	Compliant	Section 14 & 15 Historical record & Logbook	UWC
Differential pressure (a pumping-out rate of 10mB/sec)	Compliant	Section 14 & 15 Historical record & Logbook	UWC
Pre-bake out (not exceeding 80˚C)	Performed & compliant	Section 14 & 15 Historical record & Logbook	UWC
Outgassing	Compliant	By design	UWC
Cleanliness checks, by visual inspection.	Passed	Cardiff SPIRE Filters logbook	UWC
Degradation due to high energy radiation.	Compliant	By design	UWC
Spectral behaviour - Near-band transmission	Compliant		
Spectral behaviour - out-of-band blocking, at $\lambda<15\mu m$	N/A for these components		
Filter flatness	Compliant – flatness verified by FTS reflectance measurements	Cardiff SPIRE Filters logbook	UWC
Inspection for surface defects	Compliant	Cardiff SPIRE Filters logbook	UWC
Cold (80K) transmission	Compliant	Cardiff SPIRE Filters logbook	UWC

Compliance with filter specifications document

Name	Filter type	Requirements			Function T = Transmit B = Block; R = Reflect		PFM filter performance		Difference from specification	Compliant with requirements?
		Trans	cm-1	μm			50% edge (cm-1)		(cm-1)	
PDIC1	LPE dichroic	90%	31.1	321.9	T	15 - 32.7 cm-1 666.7 - 306 μm	T	33.0	0.3	90% point at 29.5cm-1. 50% edge at 33.0cm-1. 10% point at 34.0cm-1. Not compliant on 90% point.
		50%	32.7	305.8						
		10%	34.3	291.2	R	33.3 - 50 cm-1 300 - 200 μm	R	33.4	0.1	
PDIC2	LPE dichroic	90%	22.0	453.7	T	15 - 23.2 cm-1 666.7 - 431 μm	T	23.4	0.2	90% point at 22.5cm-1. 50% edge at 23.4cm-1. 10% point at 24.2cm-1. Compliant.
		50%	23.2	431.0						
		10%	24.4	410.5	R	23.8 - 50 cm-1 420.2 - 200 μm	R	23.9	0.1	

The PDIC1 component is out of tolerance on the 90% edge position, due to a slight rounding of the transmission profile. A waiver will be sought on this small non-compliance.

SECTION 05 - Top Level Drawings (Inc. Family Tree)

TOP LEVEL DRAWING LIST

Drawing No.	Title
	Top level drawings are the ICDs – see next section.

SECTION 06 - Interface Drawings

INTERFACE DRAWING LIST

Drawing No.	Title	Notes
SPIRE_FILT_400-001-1.0	PDIC1 ICD	This is the flight model interface drawing
SPIRE_FILT_500-001-1.0	PDIC2 ICD	This is the flight model interface drawing

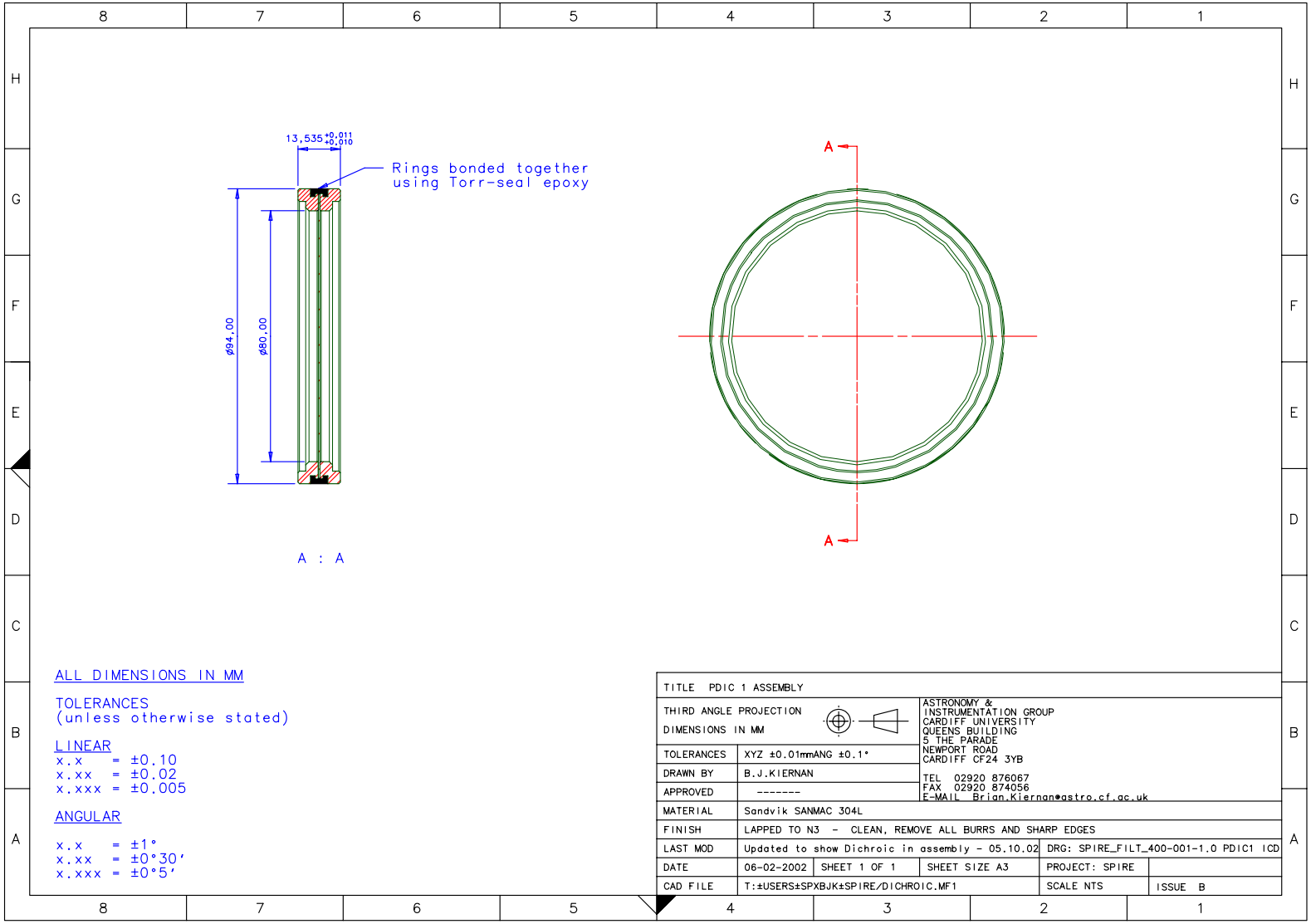

Figure 1 Mechanical interface drawing for PDIC1

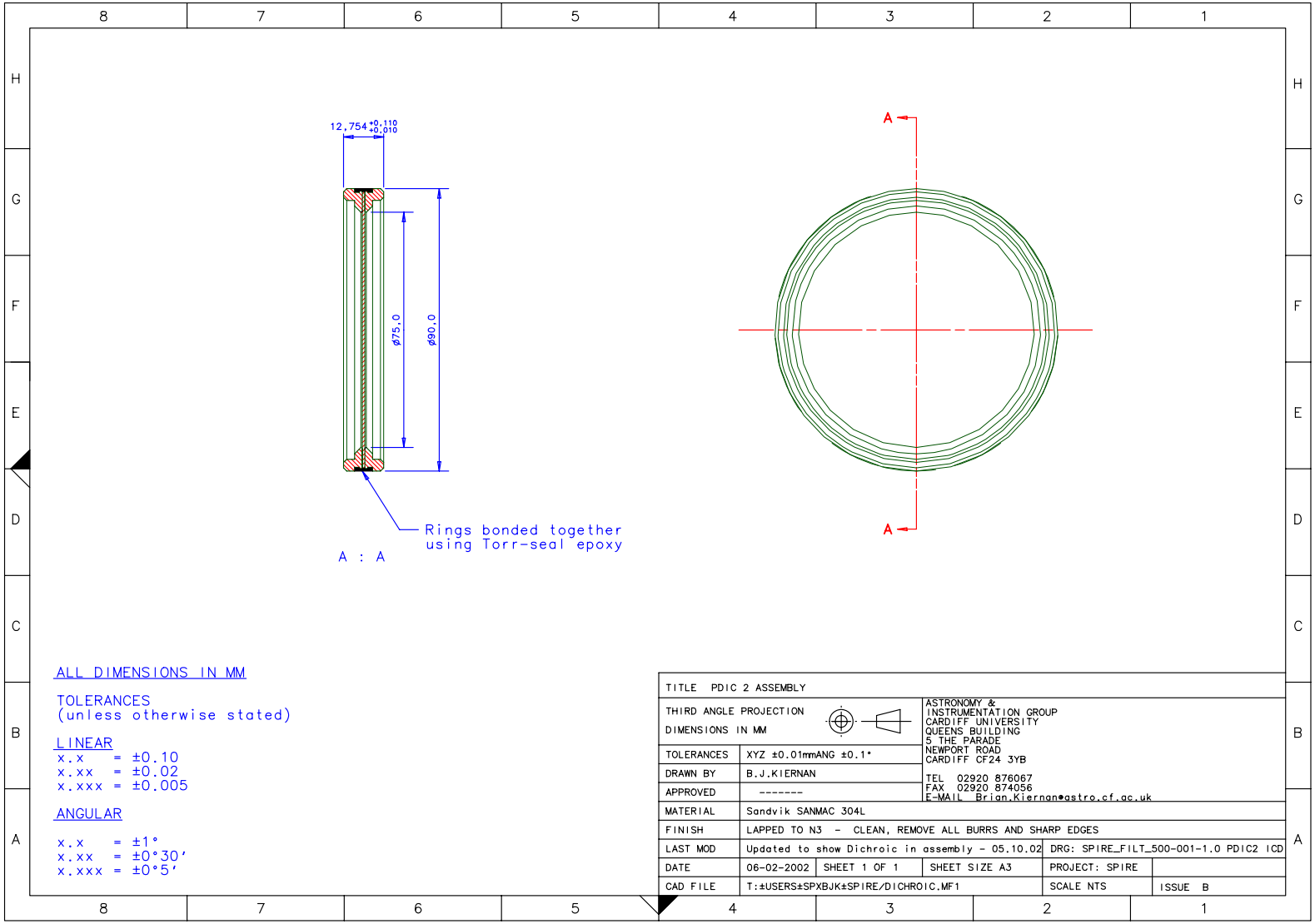

Figure 2 Mechanical interface drawing for PDIC2

SECTION 07 - Functional, Block & Mechanical Drawings

Component drawings are given in this section.

FUNCTIONAL & BLOCK DRAWING LIST – N/A

Drawing No.	Title

MECHANICAL COMPONENT DRAWING LIST

Drawing No.	Title	Notes
SPIRE_FILT_401-001-1.0	PDIC1 mounting ring	
SPIRE_FILT_501-001-1.0	PDIC2 mounting ring	

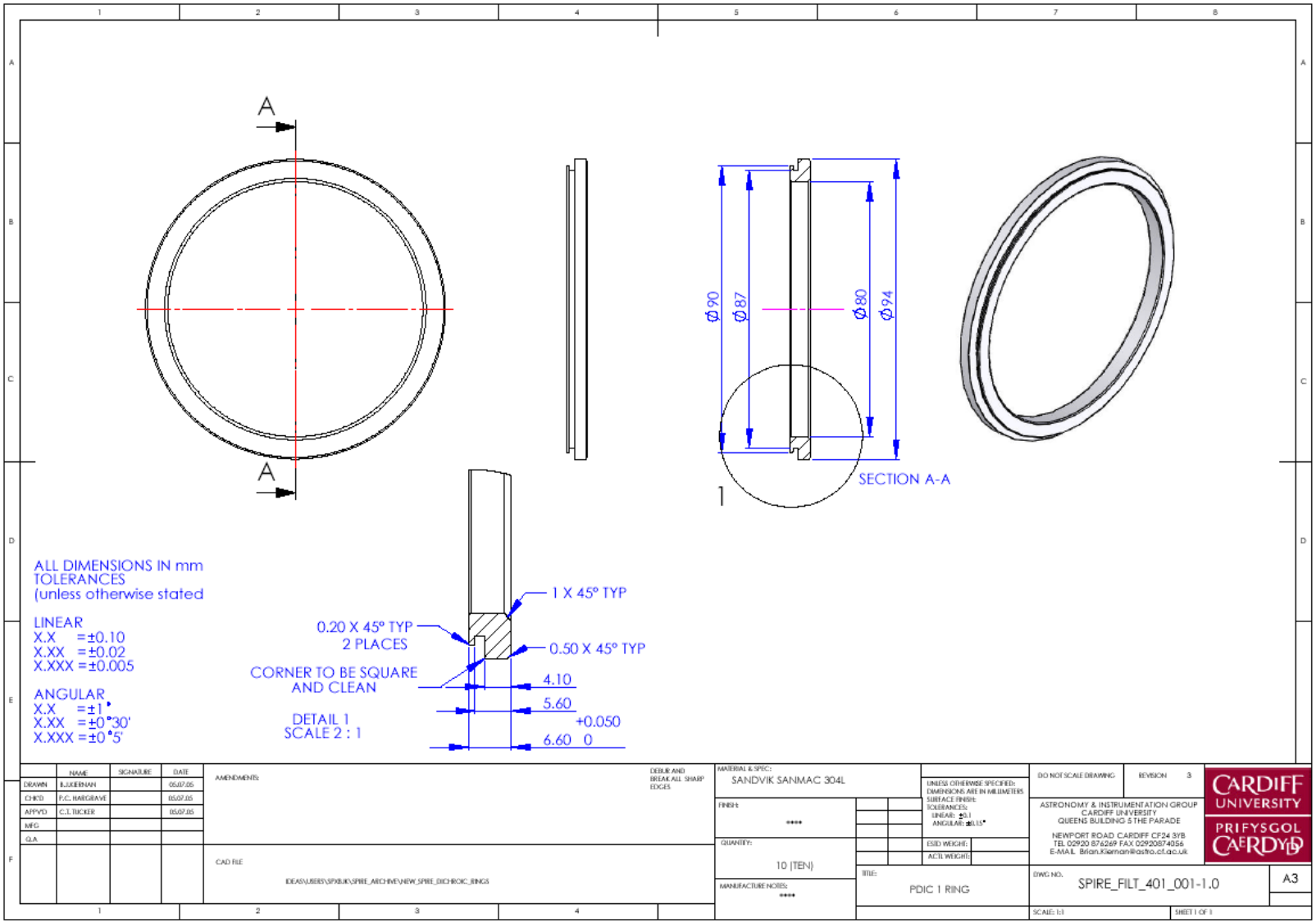

Figure 3 PDIC1 mounting ring

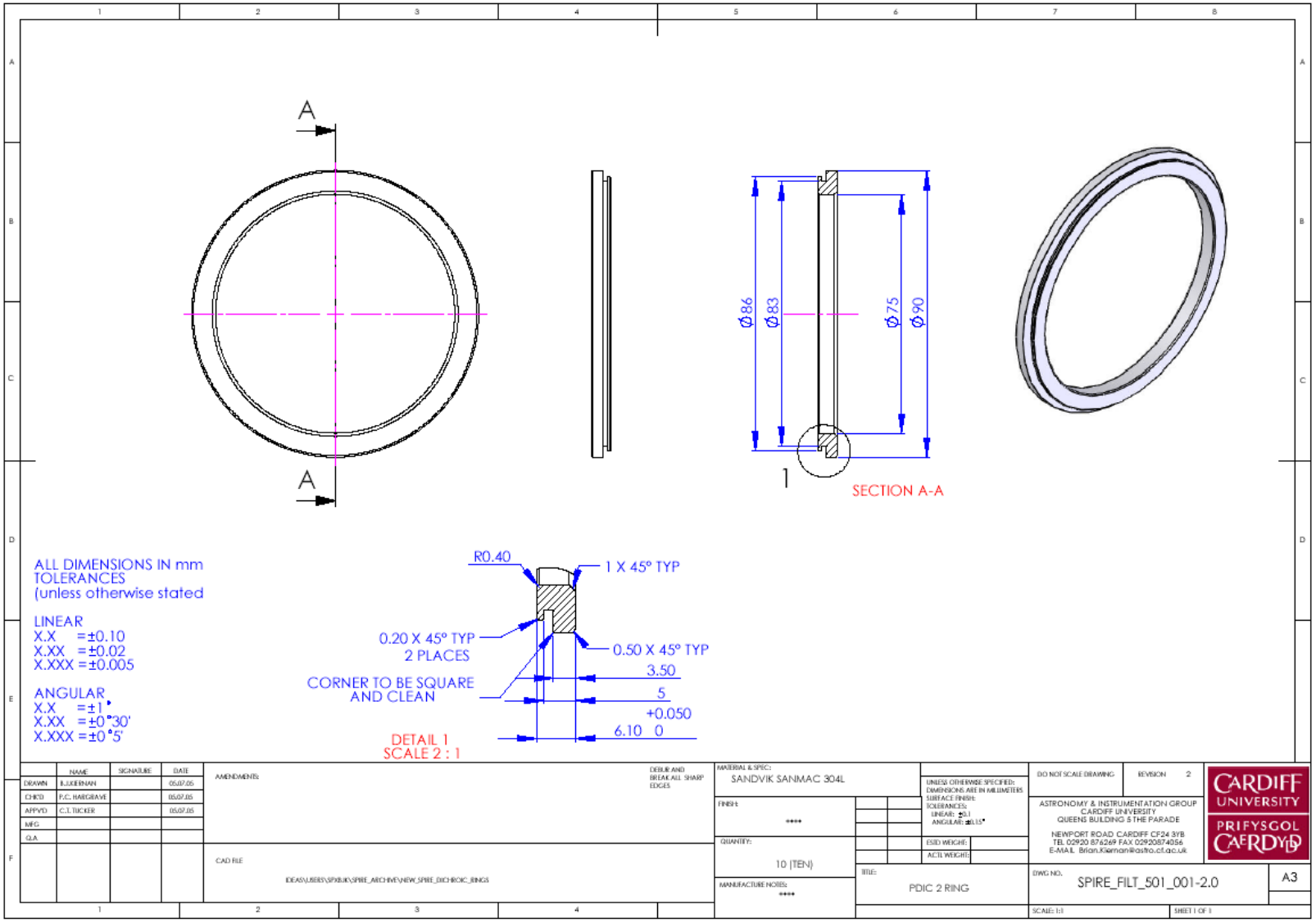

Figure 4 PDIC2 mounting ring

SECTION 08 – Electrical Circuit Diagrams

N/A

SECTION 09 - As Built Configuration Items Status List

Files are located in the directories indicated below, and on the accompanying CD-ROM.

Item	Reference	Location	Notes
Dichroic drawings and manufacturing files		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_Documents\Filters\Dichroics\PFM-build\Drawings	
Material certificates of conformance		Available at Cardiff for inspection	
Calibration data files		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_Documents\Filters\PFM-filter-summary\Calibration-data	
Test data		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_Documents\Filters\Dichroics\PFM-build\Test data	
Test reports		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_Documents\Filters\Dichroics\PFM-build\Test reports	

Part number	Description	Details	C. of C. / Batch number
FILT-PFM3-311	PDIC1 mounting rings	Manufactured by Electro-mec (Reading) LTD, 28 Portman road, Reading, Berks, RG30 1EA	25473
FILT-PFM3-321	PDIC2 mounting rings	Manufactured by Electro-mec (Reading) LTD, 28 Portman road, Reading, Berks, RG30 1EA	25473
FILT-PFM3-312	PDIC1 shims	Photofabrication services LTD	J 4178101, J 4178301
FILT-PFM3-322	PDIC2 shims	Photofabrication services LTD	J 4178201, J 4178401
FILT-PFM3-313	PDIC1 grids	Cardiff University AIG	F 1489
FILT-PFM3-323	PDIC2 grids	Cardiff University AIG	F 1487
FILT-PFM3-310	PDIC1 assembly	Filter number 1489	
FILT-PFM3-320	PDIC2 assembly	Filter number 1487	
Epoxy	Epoxy	Torr-seal	

SECTION 10 – Serialised Components List

N/A

SECTION 11 - List of Waivers

Waiver Number	Title	Status
HSO-CDF-RFW-119	Request for waiver against PDIC2 edge shape requirements	Open

SECTION 12 - Copies of Waivers

Rutherford Appleton Laboratory	REQUEST FOR WAIVER / DEVIATION (RFW/RFD)	PRODUCT ASSURANCE Space Science and Technology Department

RFW/RFD Number:	HR-SP-CDF-RFW-XXX, HSO-CDF-RFW-119

Spacecraft / Project	HERSCHEL	Originator's Name	Peter Hargrave	
System / Experiment / Model	SPIRE-PFM	Signature / Date	10/03/06	
Sub-System	Filters - Dichroics	Request Type (Highlight applicable request)	Waiver (RFW)	Deviation (RFD)
Assembly	Dichroics	Organisation	Cardiff University	
Sub-Assembly		Ref. Doc. / Drwg No.		
Item	PDIC2	References		
Serial No.	FILT-PFM3-320			
RFW/RFD Title	Request for waiver against PDIC2 edge shape requirements			

End Items(s) Affected (Hardware, Software)

Name	CI-Number	Model(s)
SPIRE PFM PDIC2 assembly		Flight

Requirement / Interface Documents Affected

Specification/Drawing Title	Number	Issue	Date	App. Paragraph
Filters specification document	HSO-CDF-SP-002	2.2	29/10/02	3.2.1 and Table 1

Description of Deviation / Discrepancy / Non-Conformance

This note requests a waiver on the shape of the transmission profile edge for PDIC2. The table below shows the specification, and the actual performance.

Edge transmission	Specification (cm-1)	PFM performance (cm-1)	Difference (%)
90%	31.1	29.5	5.1
50%	32.7	33.0	0.9
10%	34.3	34.0	0.9

The non-conformance is shown in red. The specified tolerance on edge positions is ±1% in frequency.

Other Items or Requirements (Potentially) Affected

None

Need for RFW/RFD and Rationale for Acceptance

The dichroic performance is within specification on the 50% edge position, but the shape of the edge is slightly less sharp than anticipated originally. This shape was chosen as a compromise to reduce in-band fringing, which would be caused by a sharper (steeper) edge. This small shift in the 90% edge will have negligible impact on instrument performance.

	Approved	Rejected	Name	Date
Engineering:				
Product Assurance:				
CCB-Chairman:				
Principle Investigator				
Product Assurance:				
Co-Investigator				
Prime Contractor				
ESA Project Office				

ISO9: Form PA 016 Request for Waiver/deviation (RFW/RFD) Issue 04 Page 1 of 1

SECTION 13 - Operations Manual

N/A

SECTION 14 - Historical Record

Filter 1489 PDIC1

Date	Action	UWC Test reference
26/9/05	Filter 1489 manufactured in class 1000 clean room	F 1489
29/9/05	Filter 1489 spectroscopically tested in reflection in the range 5-60cm-1 at 300K	S2711r1
29/9/05	Filter 1489 thermally cycled to 77K and spectroscopically tested in transmission.	S2711r1, S2711r6, S2711rb
4/10/05	Filter 1489 thermally cycled to 77K and spectroscopically tested in reflection 5-60cm-1.	S2713rr, S2713ru, S2713rv, S2713rw, S2713rx, S2713ry
10/10/05	Filter 1489 thermally cycled to 4K. 4 cycles.	
17/10/05	Filter 1489 spectroscopically tested in transmission in the range 20-600cm-1 at 300K	T0695r11
18/10/05	Filter 1489 spectroscopically tested in transmission in the range 5-40cm-1 at 300K	T0696r5
18/10/05	SPIRE PFM PDIC1 cleaned with acetone (rings only) and ion gun.	
18/10/05	SPIRE PFM PDIC1 baked for 17hours at 350K	
19/10/05	SPIRE PFM PDIC1 packaged in membrane box ready for dispatch	
19/10/05	SPIRE PFM PDIC1 delivered to RAL	

Filter 1487 PDIC2

Date	Action	UWC Test reference
14/9/05	Filter 1487 manufactured in class 1000 clean room	F 1487
15/9/05	Filter 1487 spectroscopically tested in reflection in the range 5-60cm-1 at 300K	T0683r12
6/10/05	Filter 1487 thermally cycled to 77K and spectroscopically tested in reflection 5-60cm-1.	S2714r1, S2714r3, S2714r5, S2714r6
10/10/05	Filter 1487 thermally cycled to 4K. 4 cycles.	
17/10/05	Filter 1487 spectroscopically tested in transmission in the range 20-600cm-1 at 300K	T0695r5
18/10/05	Filter 1487 spectroscopically tested in transmission in the range 5-40cm-1 at 300K	T0696r9
18/10/05	SPIRE PFM PDIC1 cleaned with acetone (rings only) and ion gun.	
18/10/05	SPIRE PFM PDIC1 baked for 17hours at 350K	
19/10/05	SPIRE PFM PDIC1 packaged in membrane box ready for dispatch	
19/10/05	SPIRE PFM PDIC2 delivered to RAL	

SECTION 15 - Logbook / Diary of Events

See historical record.
Laboratory logbook “SPIRE Filters #1” stored securely at Cardiff University.

SECTION 16 - Operating Time / Cycle Record

See also section 14 and section 15.

PDIC1 has undergone a total of four thermal / vacuum cycles 300K – 4K – 300K as a stand-alone thermal cycle qualification.
In addition, it was cycled twice from 300K-77K-300K as part of the spectroscopic test cycle.

PDIC2 has undergone a total of four thermal / vacuum cycles 300K – 4K – 300K as a stand-alone thermal cycle qualification.
In addition, it was cycled once from 300K-77K-300K as part of the spectroscopic test cycle.

SECTION 17 – Connector Mating Record

N/A

SECTION 18 – Age Sensitive Items Record

There are no age-sensitive items.

SECTION 19 – Pressure Vessel History / Test Record

N/A

SECTION 20 - Calibration Data Record

The calibration files to be used for PDIC1 and PDIC2 transmission and reflection data are stored in the following directory:-

\\Darkstar\Astroworld\Projects\SPIRE\\Cardiff_workpackages\Configured_Documents\Filters\PFM-filter-summary\Calibration-data

Filter	Reference	Data file	Notes
PDIC1	1489 FILT-PFM3-310	pfm3-pdic1-flight-T.txt	Transmission data. Note – this component was not used prior to PFM3 testing.
		pfm3-pdic1-flight-R.txt	Reflection data. Note – this component was not used prior to PFM3 testing.
PDIC2	1487 FILT-PFM3-320	pfm3-pdic2-flight-T.txt	Transmission data. Note – this component was not used prior to PFM3 testing.
		pfm3-pdic2-flight-R.txt	Reflection data. Note – this component was not used prior to PFM3 testing.

A summary of the calibration data for all SPIRE filters, beam dividers and dichroics may be found in the configured document “SPIRE-PFM-filters-HSO-CDF-NOT-117.doc”, stored in the directory \\Darkstar\Astroworld\Projects\SPIRE\\Cardiff_workpackages\Configured_Documents\Filters\PFM-filter-summary\

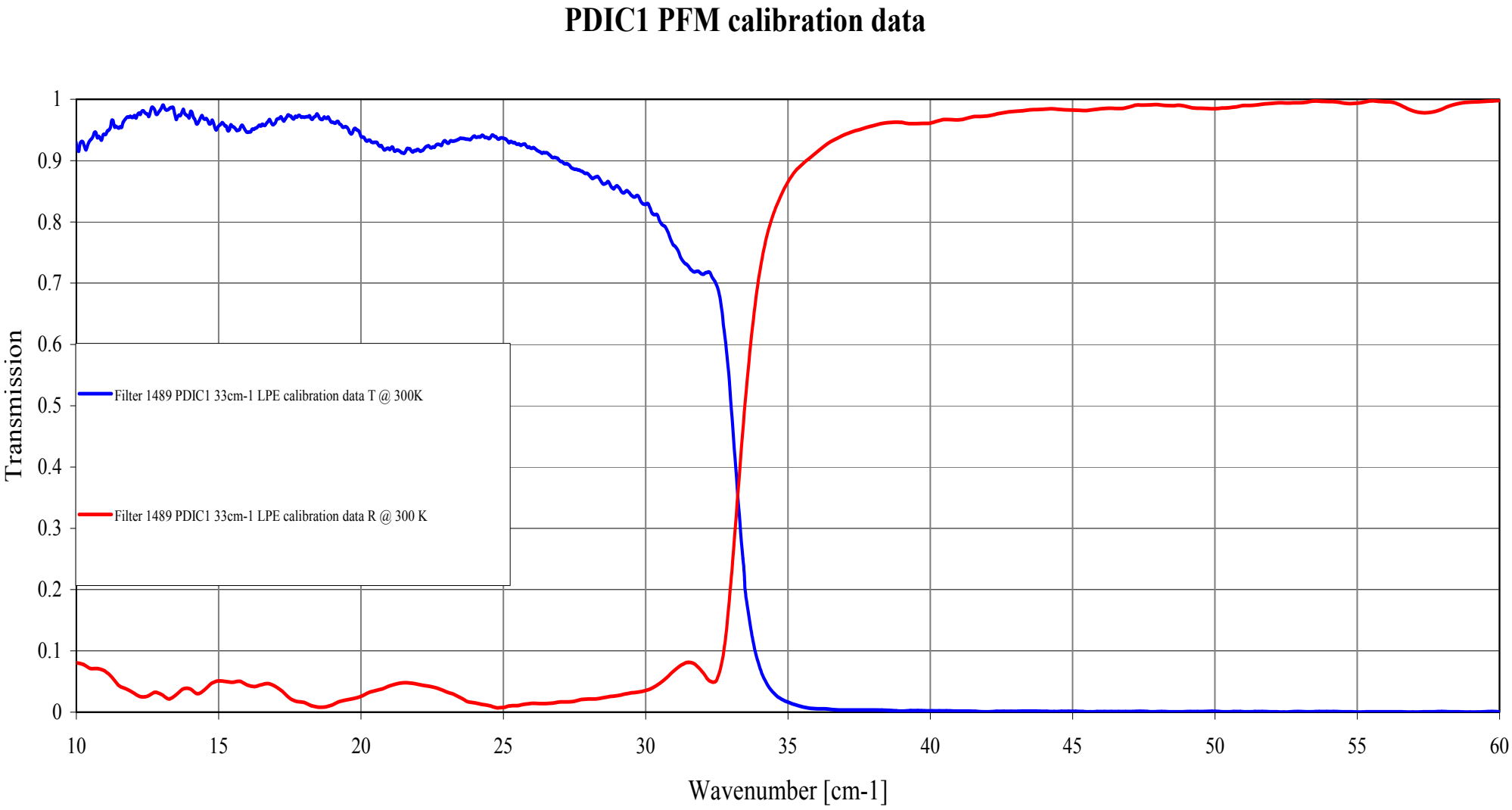

Figure 5 PDIC1 PFM calibration data

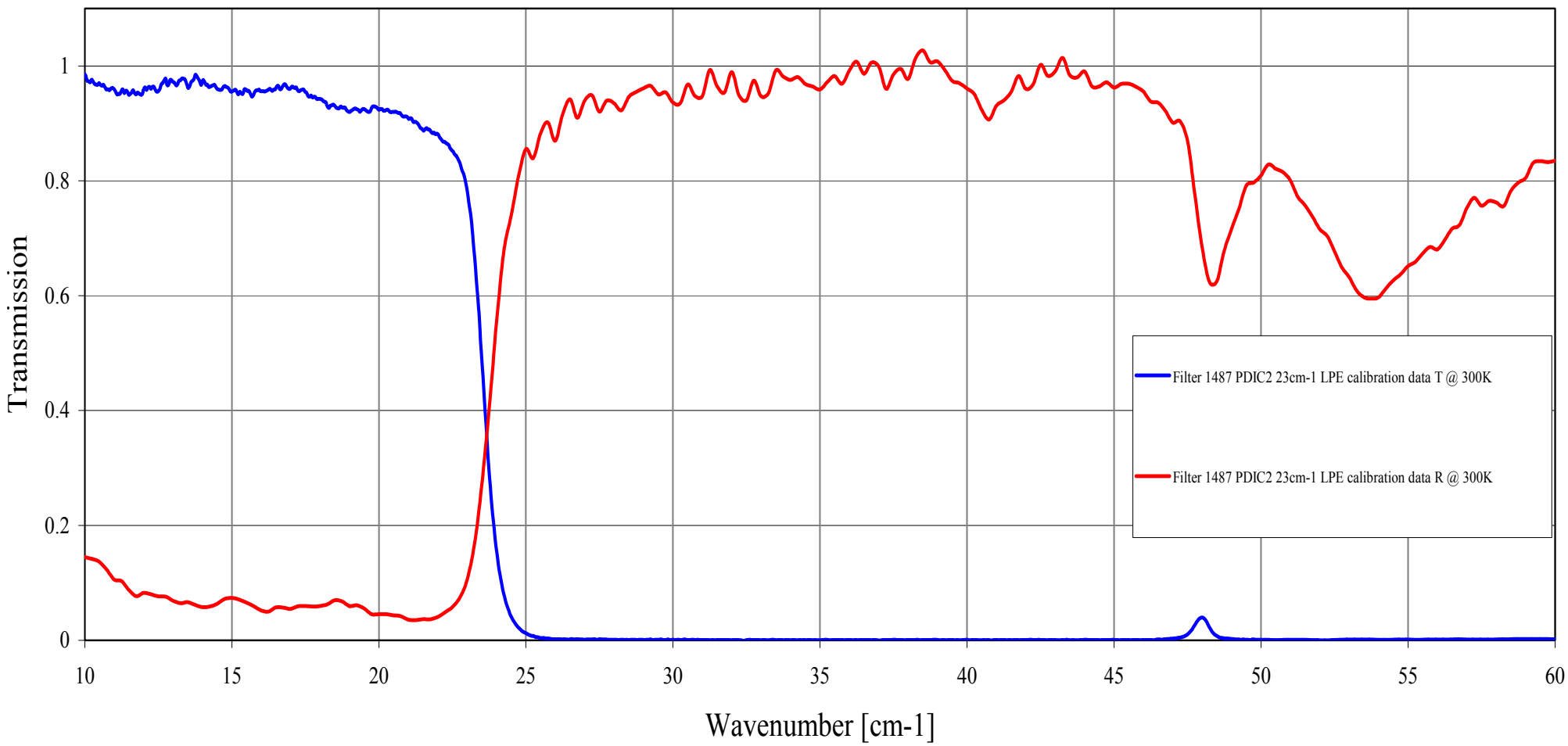

Figure 6 PDIC2 PFM calibration data

SECTION 21 - Temporary Installation Record

See section 14 – Historical record.

SECTION 22 - Open Work / Deferred Work / Open Tests

None.

SECTION 23 - List of Non-Conformance Reports

NCR Number	Title	Status
HSO-CDF-NCR-108	Hot-pressed dichroic cold warpage	Closed
HSO-CDF-NCR-109	VG Dichroic cold transmission shift	Closed
HSO-CDF-NCR-113	VG dichroic cold transmission shift	Closed

SECTION 24 - Copies of Non-Conformance Reports

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

NON-CONFORMANCE REPORT (NCR)

Astronomy Instrumentation Group

NCR Number:	HSO-CDF-NCR-108

Spacecraft / Project	**Herschel**	**Originator's Name**	Peter Hargrave	
Experiment / Model	SPIRE / PFM	**Signature**		
Sub-System	Filters, beam dividers & dichroics	**Date**	26th April 2005	
Assembly	PFM Hot-pressed dichroic candidates	**Level** (Highlight if applicable)	Major	Minor
Sub-Assembly				
Item		**NRB Reference**		
Serial Number				

NCR Occurred During (Highlight if applicable)	Manufacture	Inspection	Test	Integration	Other

NCR Title	**Dichroic cold warpage**

NCR Description

The flight model candidate dichroics were seen to have warped following thermal cycling to 4K. The dichroics went through 4 cycles between 300K and 4K, each time taking around 4 hours to cool from 300K to 4K.

Cause of NCR

These components were built following the same procedure as those components which failed as logged in HSO-CDF-NCR-087. The conclusions of the NRB following this previous failure were that the failure was due to the thermal-cycling set-up. These components were thermally cycled with good venting gaps to ensure no differential pressure build-up was possible across the dichroic membrane.

SPIRE-CQM had one hot-pressed dichroic, and one vacuum-gap component. Both of these components were fully qualified, and have survived thermal cycles and cold-vibration at system level.

However, in producing the components for PFM, we have had an 80% failure rate following thermal cycles.

It is thus concluded that the design of these components is highly marginal.

Disposition / Corrective Action

Hot-pressed dichroic technology will not be used for flight in SPIRE. Although this technology works for smaller diameter rings, the larger SPIRE rings cannot grip the polypropylene filter substrate sufficiently well against the thermal contraction of the material.
Vacuum-gap dichroics will be used for flight, with no change to any interfaces.

Document or Drawing Affected (Title, Number & Issue)

Filters SSSD – HSO-CDF-SP-002

Estimated COST OF NCR (cost of : correction, Materials, Resource, and delay to Project etc.)

	PA Manager (Or Deputy)	Project Manager (Or Deputy)	Date
NCR CLOSED (Signatures Required)		Peter Hargrave	2nd May 2005

Ref ISO/SPAP 004 ISO9: Form PA 006 Non-Conformance Report(NCR) Issue 07 Page 1 of 1

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

NON-CONFORMANCE REPORT (NCR)

Astronomy Instrumentation Group

NCR Number:	HSO-CDF-NCR-109

Spacecraft / Project	**Herschel**	**Originator's Name**	Peter Hargrave	
Experiment / Model	SPIRE / PFM	**Signature**		
Sub-System	Filters, beam dividers & dichroics	**Date**	4th May 2005	
Assembly	PFM vacuum-gap dichroic candidates	**Level** (Highlight if applicable)	Major	Minor
Sub-Assembly				
Item		**NRB Reference**		
Serial Number				

NCR Occurred During (Highlight if applicable)	Manufacture	Inspection	Test	Integration	Other

NCR Title	**Dichroic cold transmission shift**

NCR Description

The flight model candidate dichroics were seen to have significantly modified transmission characteristics at 77K, such that the pass-band does not meet the requirements for flight.

Cause of NCR

Following the failure of the hot-pressed dichroic technology, as recorded in HSO-CDF-NCR-108, it was decided to revert to the baseline vacuum-gap technology.

SPIRE-CQM had one hot-pressed dichroic, and one vacuum-gap component. Both of these components were fully qualified, and have survived thermal cycles and cold-vibration at system level.

However, the rings for these components were built from a different material batch (Sanmac-304L, Sandvik). Tests on spare rings, manufactured in the same batch as the rings used for these dichroics, show a degree of warpage when cycled to 77K (examined using optical flat and monochromatic light source). We can replicate the degradation of the transmission analytically by increasing the spacing of the dichroic grids to a degree consistent with the observed ring-warping.

Disposition / Corrective Action

Following internal NRB, it is concluded that the failure has been caused by residual stresses (casting, machining) in the ring material causing the rings to warp upon cooling. Therefore the following changes will be implemented:-

- Manufacture new ring blanks by wire-eroding – all dimensions 500 micron oversized
- Modify ring profile to enhance strength
- Vacuum anneal these blanks after wire erosion
- Machine residual material off to final dimensions
- Lap rings as before
- Thermal test for warpage (optical flat) prior to starting assembly

Document or Drawing Affected (Title, Number & Issue)

PDIC1 ring SPIRE_FILT_400_001-1.0
PDIC2 ring SPIRE_FILT_500_001-1.0
SPIRE vacuum-gap dichroic manufacturing procedure.

Estimated COST OF NCR (cost of : correction, Materials, Resource, and delay to Project etc.)

Machining new rings - ~£7,000
Delay to dichroics delivery of approximately 4 months.

NCR CLOSED (Signatures Required)	**PA Manager (Or Deputy)**	**Project Manager (Or Deputy)**	**Date**
		Peter Hargrave	9th May 2005

Ref ISO/SPAP 004 ISO9: Form PA 006 Non-Conformance Report(NCR) Issue 07 Page 1 of 1

NON-CONFORMANCE REPORT (NCR) — Astronomy Instrumentation Group

NCR Number:	HSO-CDF-NCR-113

Spacecraft / Project	**Herschel**	**Originator's Name**	Peter Hargrave	
Experiment / Model	SPIRE / PFM	**Signature**		
Sub-System	Filters, beam dividers & dichroics	**Date**	16th September 2005	
Assembly	PFM vacuum-gap dichroic candidates	**Level** (Highlight if applicable)	Major	Minor
Sub-Assembly				
Item		**NRB Reference**		
Serial Number				

NCR Occurred During (Highlight if applicable)	Manufacture	Inspection	Test	Integration	Other

NCR Title	**Dichroic cold transmission shift**

NCR Description

The flight model candidate dichroics were seen to have significantly modified transmission characteristics at 77K, such that the pass-band does not meet the requirements for flight.

Cause of NCR

These dichroics were built using modified rings, and a modified ring manufacture process, following the recommendations of the NRB following HSO-CDF-NCR-109, and documented in HSO-CDF-ECR-107 and HSO-CDF-PR-111.

The rings, at component level, were found to still exhibit a small degree of "dishing" warpage upon cold cycling, but not the "saddling" distortion previously observed. It was assumed that the gross saddle distortion was the cause of previous problems.

Modelling of the observed cold transmission shows, with a high degree of confidence, that the outer grid on either side of the dichroic is being displaced by 70 microns from its nominal position. Everything remains parallel, as we observe Fabry-Perot peaks. Therefore, the NRB has concluded that the problem is due to the outer grids adhering to the lapped stainless-steel ring surface, and as this surface dishes out on cooling, it pulls the outer grids out in a symmetrical, parallel manner. The PFM rings are lapped to a far higher quality than those used for CQM, and the thin mylar grid substrates appear to be adhering well to this surface. The CQM rings were also seen to dish when cold, but the lapping quality probably prevented adhesion of the mylar.

Update – 26th September 2005

It was noticed that, over time at 77K, the dichroic transmission approached the 300K transmission. This pointed to a thermal problem. The dichroic is attached to a 77K cold finger in the test FTS. The dichroic is in close proximity to the FTS chamber walls at 300K, and to the FTS light source (Mercury arc lamp). This will place a large thermal load on the dichroic substrate, and will explain the implied displacement of the outer grids.

The dichroics were re-tested with shielding at 77K, which shielded all of the dichroic area, apart from that which intercepts the FTS beam area. The devices were re-tested in this configuration, and no deviation from the 300K transmission profile was observed, with the units at 77K. This correlates well with the good performance of the CQM vacuum-gap dichroic in SPIRE-CQM (this component was never tested cold at unit level).

Therefore we conclude that all problems experienced with modified transmission characteristics of the VG dichroics at 77K were artifacts due to an incorrect test set-up.

Disposition / Corrective Action

Replacement dichroics will be assembled for flight with the addition of an extra spacer shim to de-couple the mylar substrates from the stainless-steel lapped surface. The overall support ring thickness will be lapped down to compensate for the additional spacers in order to remain within the thickness stated in the ICD.

Update – 26th September 2005

Following the results of extensive testing with the revised, shielded test set-up on all previously measured vacuum-gap components (six components), we conclude that no further corrective action is necessary. We will choose the dichroic pair with the best transmission profiles for flight, from the original design. No modification of the type detailed above (extra spacer shim) is necessary.

Document or Drawing Affected (Title, Number & Issue)

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NON-CONFORMANCE REPORT (NCR) — Astronomy Instrumentation Group

NCR Number:	HSO-CDF-NCR-113

PDIC1 ring SPIRE_FILT_400_001-1.0
PDIC2 ring SPIRE_FILT_500_001-1.0
SPIRE vacuum-gap dichroic manufacturing procedure.

Estimated COST OF NCR (cost of : correction, Materials, Resource, and delay to Project etc.)

Assembly of new dichroics – 1 week
Spare components already manufactured – zero additional cost.

	PA Manager (Or Deputy)	Project Manager (Or Deputy)	Date
NCR CLOSED (Signatures Required)		Peter Hargrave	26th September 2005

SECTION 25 - Test Reports

See appendices.

SECTION 26 – Assembly Record

Recorded in Cardiff AIG filter group logbooks and database (“Hundred_acre_wood.mdb”), and stored securely at Cardiff University.

SECTION 27 - Reference List of EIDP's

None

Associated

Title (Listed in alphabetical order)	ID (Serial No.)	Acronym	Document No.	Issue	Date

Lower Level

Title (Listed in alphabetical order)	ID (Serial No.)	Acronym	Document No.	Issue	Date

SECTION 28 - Mass Records

Assembly	Final measured mass
PDIC1-PFM FILT-PFM3-310	172.1g
PDIC2-PFM FILT-PFM3-320	165.4g

SECTION 29 - Cleanliness Statement

Statement

The PFM dichroics (FILT-PFM3-310, FILT-PFM3-320) have been cleaned, assembled and tested within a class 1000 clean room to meet the requirements of the Cardiff PA plan (HSO-CDF-PL-007).

Signed ……Peter Hargrave, Technical Manager, Cardiff-SPIRE deliverables.

Signed ……Ian Walker, Programme Manager, Cardiff AIG.

Signed ……Carole Tucker, Filter & Clean-room Manager, Cardiff AIG.

Date ……..6th March 2006

Extra Information

A dedicated Herschel-Planck clean room is available in the Cardiff AIG labs, class 1 000, with class 100 laminar flow cabinets.

For cooldown tests (thermal cycles) the PFM assemblies were integrated to the Cardiff test dewar within the clean room annex (approx. Class 10,000 – exposure ~15 minutes per thermal cycle).

SECTION 30 - Other Useful Information

SECTION 31 - DPL/DML

Refer to the Cardiff-SPIRE PFM deliverables lists.

Cardiff-SPIRE-DML	HSO-CDF-LI-074
Cardiff-SPIRE-DMPL	HSO-CDF-LI-075
Cardiff-SPIRE-DPL	HSO-CDF-LI-076

SECTION 32 – List of Appendices/Attachments

Appendix #	Title (Listed in alphabetical order)	Document No.	Issue	Date	Notes

Appendix A

Appendix B

Appendix C

Reports from cryogenic vibration tests

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H