NASA CR-170424

DEFINITION PHASE EFFORT OF THE SPACELAB-2 INFRARED TELESCOPE EXPERIMENT (IRT)

NAS5-26097

FINAL REPORT
FOR THE PERIOD 12 MARCH, 1980 TO 31 MAY, 1981

PRINCIPAL INVESTIGATOR
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PREPARED FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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The Smithsonian Astrophysical Observatory
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Center for Astrophysics

1.0 INTRODUCTION

This report serves two functions:

a. It is a final report for Contract NAS5-26097

b. It reports monthly progress for the period January 1, 1981, through March 31, 1981.

In Section 2 is a narrative history that includes Item b (above) as well as a summary of previous activity. Subsequent sections give results, conclusions, and recommendations.

2.0 HISTORY

In November 1978 the Smithsonian Astrophysical Observatory submitted to NASA a proposal for the reflight of the Small Helium-Cooled Infrared Telescope (IRT) on behalf of a partnership that includes the Steward Observatory of the University of Arizona and the Space Sciences Laboratory of the Marshall Space Flight Center. The IRT is scheduled to makes its maiden voyage into space with Spacelab 2.

The proposers envisioned a modest program of refurbishment and reflight to complete the infrared sky mapping to be started aboard Spacelab 2, to extend its measurements of the Shuttle-induced environment (especially water vapor, carbon dioxide, and particulates), and to augment earlier data on superfluid-helium management in space.

In response, the Goddard Space Flight Center issued Contract No. NAS5-26097 in March 1980. However, because of Shuttle program schedule changes and funding limitations only about 15% of the proposed Definition Phase effort was funded. The rest of the work was to be spread over several years. The first year's activity focused on documentation.

Spacelab-2 document requirements called for an Experiment Requirements Document, but it was superseded by an Instrument Interface Agreement and thereafter became obsolete. Hence a major task for the IRT team was to revise and update the ERD. The other major task was to prepare an Investigation Development Plan for the refurbishment and reflight of the IRT.

The instrument itself, plans for Spacelab 2, and plans for the preparation of the ERD and IDP were discussed in a meeting at GSFC on July 31, 1980. The IRT team felt that the meeting was more than satisfactory in that it was a two-way exchange; much helpful advice was received from the GSFC personnel attending, while Spacelab-2 experience and observations from the IRT personnel were well received. Martin Eiband's summary comprises Appendix A.

By the fall of 1980 draft versions of both ERD and IDP were ready. The Requirements Review was held at GSFC on December 10, 1980. Between January and May 1981 comments and suggestions from the review were considered and appropriate modifications made to the ERD and IDP.

3.0 RESULTS

The results of the effort under this contract are the enclosed ERD and IDP.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Being a reflight experiment, the IRT called for an approach to the Definition Phase that is somewhat different from that followed by new-instrument developers. Unfortunately activity was terminated before all the possibilities for efficient reflight could be explored.

Clearly the use of existing documentation is an attractive cost-saving measure. If NASA's original intention to develop Spacelab-integration expertise at several Centers had been continued it would be important to have agency-wide standards for Spacelab documentation. Otherwise someone -- be they contractor or NASA personnel -- would have to "translate" documents when a reflight were planned.

A so-called Definition Phase is important if a reflight is to be conducted by a different Center. It affords that Center's personnel and the Instrument Developer's staff time to develop the rapport so necessary for successful integration. This was true in the case of the IRT and GSFC. In addition, the Definition Phase enables the Developer to consider changes in keeping with new information and Spacelab changes since the instrument design was originally frozen. To the IRT this meant consideration of a DEP, an option rejected in 1978 because the technology was too new.

It also seems appropriate for NASA to adopt an approach to reliability and quality assurance for reflown instruments. Questions of durability, for example, may be dismissed rather lightly if hardware is to be used on one Spacelab mission lasting a week, but become increasingly important for equipment that must survive several launches and function for far longer periods of time in space. The reliability of devices for resealing prior to reentry takes on added importance. Verification of previously flown hardware demands special attention and can be an area where cost savings should be possible.

It is indeed regrettable that circumstances forced the termination of the IRT reflight study before these and many similar considerations could be fully explored.

APPENDIX A

PROCEEDINGS OF THE
PI/SPIRE ENGINEERING SUPPORT MEETING

FOR THE
S.A.O. REFLIGHT OF THE SPACELAB - 2
INFRARED TELESCOPE
EXPERIMENT

HELD AT
GODDARD SPACE FLIGHT CENTER

JULY 31, 1980

APPENDIX A

AGENDA

ATTENDEES PRELIMINARY REVIEW IR REFLIGHT

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ORI

PROGRAM INFORMATION REQUEST/RELEASE

PIR NO.	PROGRAM	SEQUENCE NO.	REV. NO.
1	GSFC SPIRE SS 20		

FROM	TO
A. Siegel	M. Eiband

DATE SENT	DATE INFO. REQUIRED	REFERENCE DOC. NO.	PAGE	OF
8/7/80			1	5

SUBJECT

SPIRE Spacelab Interface Briefing for the S.A.O. Infrared Telescope Reflight

INFORMATION REQUESTED/RELEASED

A briefing was held at GSFC on Thursday, July 31, 1980 between the Smithsonian Astrophysical Observatory personnel and SPIRE Project personnel to discuss Spacelab interfaces for the research proposal submitted to NASA by the S.A.O. A summary of that briefing follows.

I. Opening Remarks - M. Eiband

M. Eiband gave a short presentation on the objectives of the mission. He also briefly discussed the list of 35 documents that should be referenced by the experimenter and the typical instrument flow.

II. Instrument Objectives - Dr. Fazio

The Principal Investigator, Dr. Giovanni G. Fazio, presented a summary of both scientific and engineering objectives of the experiment. Several highlights of his presentation follow:

- There will be a 12-16 month timeframe for refurbishment, plus integration, to prepare for the reflight.
- There are 9 IR detectors and 1 stellar position sensor.
- Power is required during pre-launch for a 110 Volt vacuum pump. KSC has informed S.A.O that power would not be lost for more than 3 hours. However, power must be off when the umbilical is attached.
- Experiment uses a modified commercial helium dewar.
- Experiment requires slight nose-up and nose-forward attitude.
- There are 3 HRM channels and clocks.
- Using SPAH hardpoints to fit experiment onto the single pallet.

III. Mechanical - Bill Browne

- S.A.O. will not be required to redesign instrument to meet GSFC criteria. Any criteria setforth by MSFC and met by S.A.O. will be sufficient for the reflight.

IV. Thermal

No presentation given.

V. Power

- No presentation given, however, S.A.O. stated that the experiment has no on-off switch and no power protection.
- 110 volt power is required for pre-launch .
- Peak power = 450 watts
  Average power = 250 watts

VI. Verification and System Safety - Virgil Cleveland

- Safety program objectives were discussed including hazard analysis, warning devices and reviewing safety requirements as much as possible.
- Safety requirements specified in NHB 1700.7.
- All verification and safety plans should be brief, but to the point.
- Plans should be a separate appendix to the IDP.
- In response to a question about the S.A.O. pressure vessel, it was stated that all relief valves are being qualified via tests at this time.
- In the case of the S.A.O. experiment, the Similarity technique would be applicable for their Instrument Verification Plan.

VII. Product Assurance - Wilkinson

- The principal investigator must follow the general guidelines and requirements as stated in "General Guidelines and Requirements For Spacelab Experiments", GSFC S-420-10, dated Sept. 28, 1979.

- S.A.O. had no requirement from MSFC for a Product Assurance Plan concerning their experiment aboard the Spacelab-2 mission.
- GSFC recommended using a better grade of parts instead of the commercial grade.
- S.A.O. is very sensitive to contamination, not only for their experiment, but to others around it. As a result of this sensitivity, a cautious approach to environmental measurements has been adopted.

VIII. Flight Operations (POCC) - J. Johnson

- Reference should be made to Appendix 'G' of JSC 14433, Vol. 1, "POCC Applications Document." A revised edition is due in the near future.
- No DEP in the Infrared Telescope.
- Data rates were explained, i.e., Downlink = 50 Mgbits/sec Uplink = 20 bits/sec. - very slow due to overhead.
- S.A.O. to supply requirements concerning Bright Object Avoidance.

IX. Shuttle Guidance - K. Dolan

No presentation given.

X. Ground Operation (KSC) - Bill Hoggard

- An overview of ground operations at KSC was presented.
- Experiment integration is approximately 7 to 13 months prior to launch for the 5 Spacelab missions.

XI. C&DH - R. Westcott

- Review of the instrument control and data handling guidelines was presented.
- S.A.O. has 3 pages of display.
- Cabling from coldplate to the instrument is MPE.

- The rotary seal has been extensively tested and does not present a safety problem.
- Shut down procedure is automatic with an override capability. The shut down stops the scan and closes the shutter and cover.
- Payload specialists are required only for extraordinary procedures, i.e., to take appropriate action to correct any out-of-limit condition when the Orbiter is not in ground contact. An example is overpressure that requires venting.

XII. Action Item Review

Item	Responsibility
• Provide instrument verification matrix in the IDP.	S.A.O
• Review Structural Qualifications memo and send out to all P.I.'s.	GSFC
• Provide predict for thermal environment (worst case) in the bay.	GSFC (COYLE)
• Consider adding power switching and power protection information in the IDP.	S.A.O.
• Provide existing safety documentation to GSFC.	S.A.O.
• Provide Fracture Mechanics Analysis memo to P.I.'s.	GSFC
• Specify critical contamination sources in the ERD.	S.A.O.
• Notification to the P.I. of data quality at GSFC.	GSFC

Item	Responsibility
• Provide 2 copies of "Astronomy Spacelab Payloads" Final Study Report, Vol. 1 Document to S.A.O. (SD 76-SA-0128) NAS 5-23203	GSFC (DOLAN)
• Cost out the addition of a DEP during refurbishment and include in the IDP.	S.A.O.
• Specify GSE access for valve checks in the ERD.	S.A.O.
• Provide copies of "Tips to Experimeters" to each P.I.	GSFC
• Provide power profile to GSFC.	S.A.O.
• Mating half of connectors not available. Must be ordered.	Info. only
• Add access requirements at KSC for checking and setting cryo valves.	S.A.O.