CCR Number: 0002	CRITICALITY: ROUTINE	DUE:12/18/97

DISTRIBUTION SHEET

EO-1 LEVEL II CCB

Mark Perry/EO-1 S/C Systems Engineer

Brain Smith/EO-1 Spacecraft Engineer

Mike Kelly/EO-1 Flight Assurance Manager

Jeff Woytach/NASA/LeRc EO-1 PPT Lead

Ed Bicknell/ALI Systems Engineer

Costas Digenis/ALI Program Manager

Mike Cully/EO-1 Spacecraft Manager

George Andrew/EO-1 Systems Avionics Engineer

Bill Hayden/GSFC MAM IPDT Lead

Matt Jurotich/EO-1 Payload Manager

Pete Spidaliere/EO-1 Mission Systems Engineer

Nick Speciale/EO-1 Mission Technologist

Ken Anderson/EO-1 Instrument Systems Engineer

NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM EO-1

CCR NO. 0002

DATE INITIATED 12/03/97

TITLE Rev A TO EO-1 SPACECRAFT ALI ICD-18

ORIGINATOR Swales Aerospace

ORIGINATOR'S CHG. NO. SAI-018

SPONSOR/CODE M. Jurotich/EO-1 Payload Mgr PHONE x5919

EFFECTIVITY

ITEM: ~~ALI~~

S / N

ITEM:

S / N

ITEM:

S / N

CHANGE CLASS

	I	II
PRELIMINARY	☐	☐
FORMAL	☐	☐

TYPE OF CHANGE

MILESTONE	☐	INTERFACE	☒	SOFTWARE	☐
DOCUMENT	☒	POWER	☐	OTHER	☐
COST	☐	WEIGHT	☐		☐

DOCUMENTS OR SOFTWARE AFFECTED

SAI-ICD-018

PROBLEM

The attached draft version of SAI-ICD-018 (Rev A) Earth Orbiter -1 (EO-1) Spacecraft Advanced Land Imager (ALI) Interface Control Document (ICD) requires updating. The document defines the interfaces of the ALI to EO-1 spacecraft. The document specifies all interface-related agreements concluded between MIT-Lincoln Lab (MIT/LL), the ALI contractor and Swales Aerospace, the spacecraft contractor.

PROPOSED SOLUTION

Approve the attached draft version of SAI-ICD-0018 Rev A, EO-1 ALI ICD, by the EO-1 Level II Configuration Control Board (CCB). The Rev A issue will be formally release after CCB approval. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and Preliminary Interface Revision Notices (PIRNs) for CCB approval. This document is maintained by the EO-1 Configuration Management Office (CMO).

BOARD ACTION

APPROVE	☐
APPROVE WITH CHANGE	☑
DISAPPROVE	☐
WITHDRAW	☐

APPROVAL LEVEL REQUIRED

LEVEL I HQS	☐
LEVEL II GSFC	☒
LEVEL III	☐

CRITICALITY LEVEL

EMERGENCY	☐
URGENT	☐
ROUTINE	☒

PROCUREMENT CHANGE ORDER CLASSIFICATION

ROUTINE		URGENT		EMERGENCY	☐
OPTION 1	☐	OPTION 1	☐		
OPTION 2	☐	OPTION 2	☐		

COMMENTS

Sponsor's recommendations accepted. TBRs moved ~~[illegible]~~ from paragraph level to specific items in question. TBR on ¶ 3.3.2.2.4 deleted. TBR workoff mtg required in 2wk.

CHAIRPERSON [signature] DATE 4 Feb 97

3/28/96

EO-1 ICD-18
Rev A Draft
October 20, 1997

EARTH ORBITER -1
ADVANCED LAND IMAGER (ALI)
INTERFACE CONTROL DOCUMENT

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

SWALES AEROSPACE

CONTRACT NO.: NAS5-32650
TASK NO.: 2103-347
SAI-ICD-018

EO-1 Spacecraft to Advanced Land Imager (ALI) Interface Control Document (ICD)

SAI-ICD-018

OCTOBER 20, 1997

REVISION A

Prepared by:
SWALES AEROSPACE
5050 Powder Mill Road
Beltsville, MD 20705

TBD LIST

Issue	Resolution Date	Comment
Drawing A0750 is preliminary	1 December 97	Working on final connector and purge locations
Solar Calibration Offset	1 April 98	Range will be 0 - 7 degrees

TABLE OF CONTENTS

1.0 SCOPE

This Interface Control Document (ICD) defines all interface requirements between the Advanced Land Imager (ALI) and the Earth Orbiter-1 (EO-1) Spacecraft. The ICD documents all interface-related agreements concluded between MIT-Lincoln Lab (MIT/LL) the ALI contractor, and Swales Aerospace, the spacecraft contractor.

The purpose of this document is to specify the interface requirements in order to assure compatibility between the equipment furnished by the respective contractors. Changes to this document may be proposed by either party for formal approval by the EO-1 Project Office.

This ICD will serve as the controlling technical document between the ALI Instrument and the EO-1 Spacecraft. This ICD shall apply to all phases of ALI/ EO-1 design, assembly, integration, test, launch and operations. This document is controlled by the Goddard Space Flight Center (GSFC) EO-1 project office.

2.0 APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of the ICD to the extent specified in Sections 3 and 4 of this ICD. In the event of conflict between this ICD and the document referenced herein, the contents of this ICD shall be considered a superseding requirement.

SAI-PLAN-130	EO-1 Integration and Test Plan
SAI-PLAN-138	EO-1 Contamination Control Plan
SAI-SPEC-158	EO-1 Verification Plan and Environmental Specification
	WARP to ALI ICD
AM149-0050(155)	Data Systems 1773 ICD EO-1, Litton Amecom
AM149-0030(155)	EO-1 Uplink Command ICD, Litton Amecom
AM149-0031(155)	EO-1 Telemetry Specification, Litton Amecom
AM149-0042(155)	WIS Spectral Purity & Implications to EO-1 Spacecraft Pointing, Litton Amecom
AM149-0020(155)	System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom

2.1 REFERENCED DOCUMENTS

A0750	ALI Interface Control Drawing
	ALI I&T Plan
SAI-STD-056	EO-1 Spacecraft Subsystem Allocations and Description
GSFC-PPL	GSFC Preferred Parts List (Latest issue)
MIL-M-38510	General Specification for Microcircuits
MIL-S-19500	General Specification for Semiconductors
MIL-STD-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-STD-975	Standard (EEE) Parts List
MIL-STD-202	Test Methods for Electronic and Electrical Components
MIL-STD-883	Test Methods and Procedures for Microelectronics
GEVS-SE	General Environmental Verification Specification for Shuttle & Expendable L/V

3.0 INTERFACE REQUIREMENTS

3.1 INTERFACE DEFINITION

The ALI experiment comprises a reflective triplet telescope with VNIR and SWIR focal planes, electronic control for the focal plane, an electronics package, and a power subsystem. The experiment is a visible, near IR, and short wave IR sensor designed as a technology validation instrument for the next generation of Landsat-like instruments. The ALI interfaces with the spacecraft are defined mechanically/thermally at the spacecraft mounting interfaces, and electrically at the ALI connectors.

3.1.1 INTERFACE FUNCTIONS

The functions provided to the ALI by the spacecraft, and conversely, are delineated in the following sections.

3.1.1.1 Spacecraft Interface Functions

The following major interface functions shall be provided by the spacecraft.

a. Transmission of commands from the spacecraft via the 1773 bus.

b. Provision of Primary Power from 28 ±7 VDC power bus.

c. Provision of mounting interface for ALI telescope to spacecraft.

d. Provision of interfaces accommodating mounting, routing, and securing of instrument harness to/on the spacecraft.

3.1.1.2 ALI Interface Functions

The following major interface functions shall be provided by the ALI.

a. Transmission of wideband (image) data to the spacecraft WARP.

b. Transmission of instrument housekeeping telemetry to spacecraft via the 1773 bus.

c. Provision of mounting interface for ALI telescope to spacecraft.

d. Provision of mounting interfaces for GSE handling fixture attach points on the ALI.

3.2 MECHANICAL INTERFACE REQUIREMENTS

The ALI Instrument consists of the telescope, telescope shroud and two electronic units, and interface cabling. The instrument assemblies are mounted on an instrument pallet that is mounted to the nadir-facing deck of the spacecraft. Figure 3.1 is a drawing of the spacecraft.

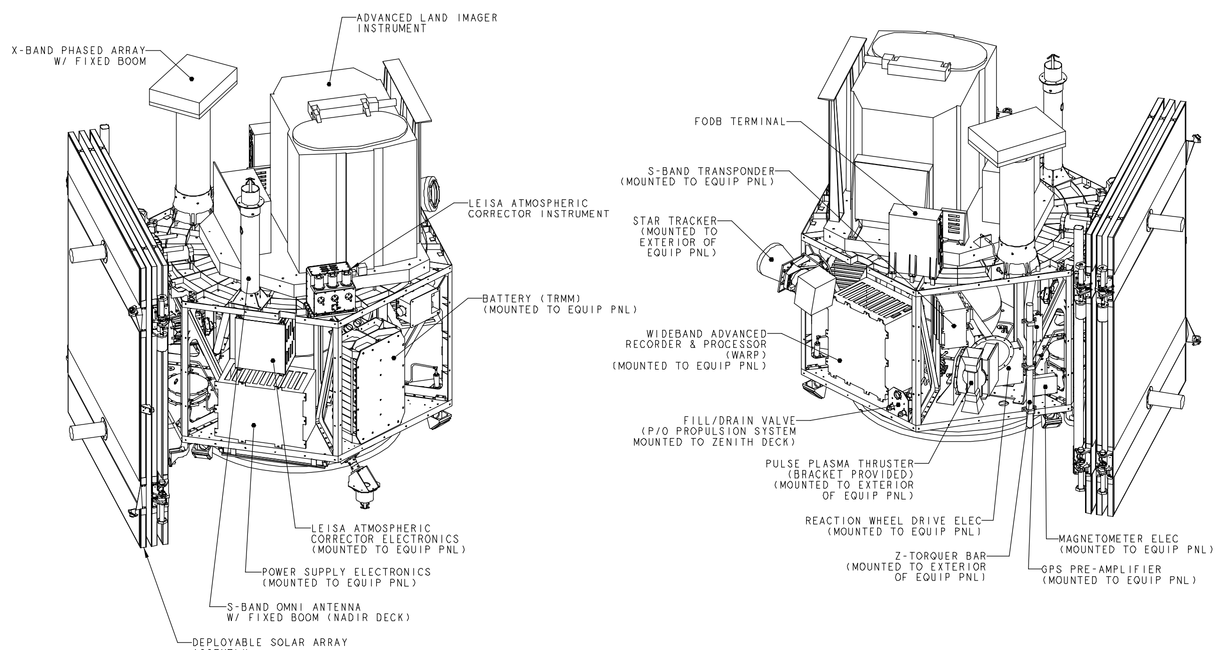


Figure 3.1 EO-1 Configuration (outer panels not shown)

3.2.1 CONFIGURATION

The dimensional drawings of the electronic units and telescope are delineated in ALI Interface Control Drawing A0750. This includes mounting footprints, lift locations, and the location and orientation of electrical connectors. The drawing shows the details of the purge connection and its location.

3.2.1.1 Coordinate System

Orthogonal reference axes are established for the spacecraft and the ALI. The ALI coordinate system is shown in Figure 3.2. The EO-1 coordinate system is shown in Figure 3.3.

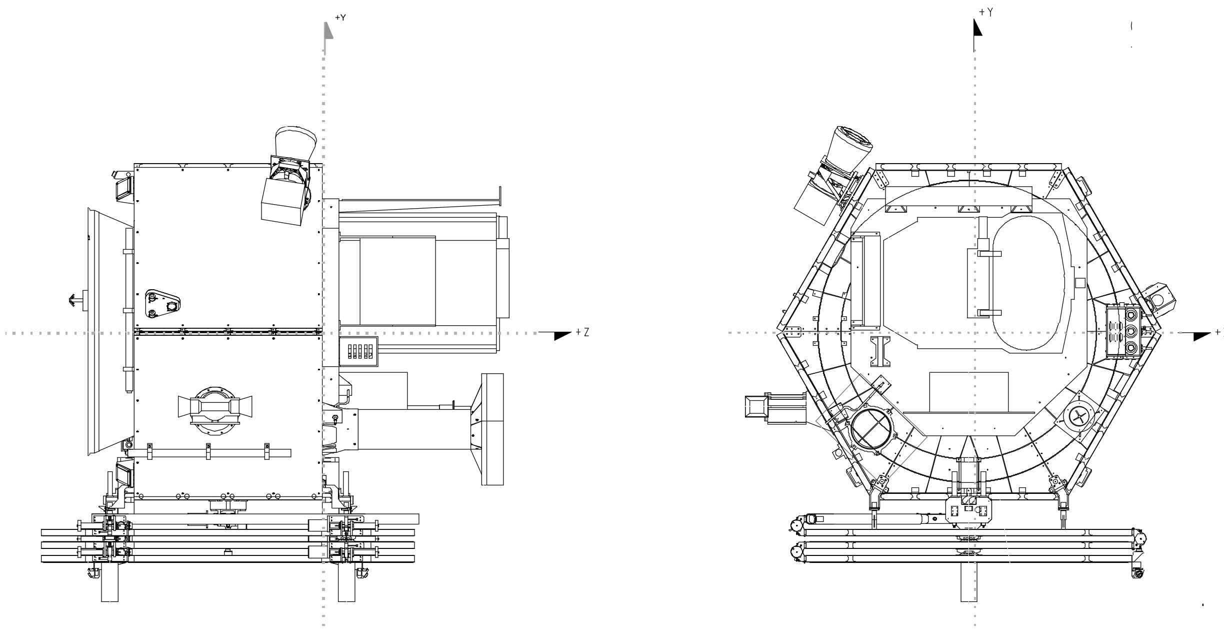


Figure 3.2 ALI Coordinate System

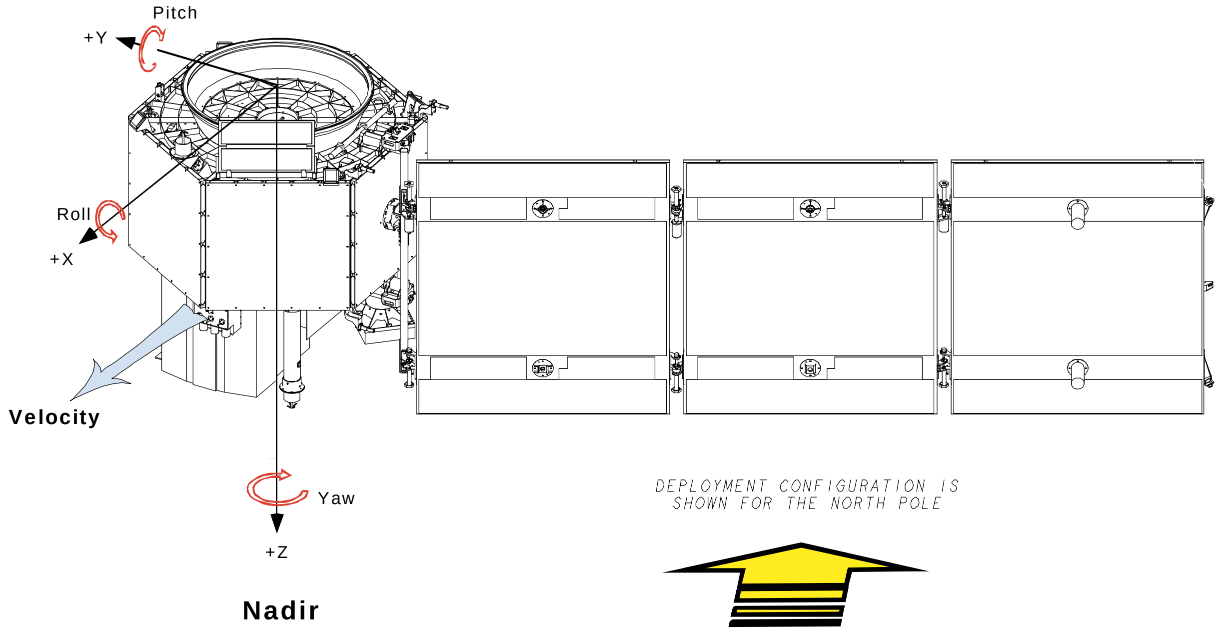


Figure 3.3 Deployed Spacecraft with Coordinate System
(sun is normal to the page)

3.2.1.2 Fields of View

The ALI telescope shall be located on the spacecraft in accordance with the following Field of View (FOV) requirements:

a. The ALI telescope aperture shall have a clear field of view of 2.26° X 15.5° as shown in ALI Interface Control Drawing A0750.

b. The telescopes physical entrance port is located in the telescope's top enclosure plate. The plate is perpendicular to the Z axis and sits approximately 26 inches along the Z axis from the spacecraft/ALI interface.

c. The desired keep-out zone is a constant -Z plane that lies parallel to and intersects the surface of the telescope shroud.

3.2.1.3 Mounting Interface

The ALI telescope pallet is hard mounted to the spacecraft nadir deck with 18 bolts as shown in ALI Interface Control Drawing A0750. Both the pallet and the nadir deck shall have 30 MIL raised bosses at the bolt locations. One bolt at each of 4 footprint extremities of the pallet shall be a shoulder bolt.

3.2.1.3.1 Flatness Specification

The mounting points on the spacecraft shall not be out of plane more than 0.25mm.

3.2.1.3.2 Drill Template

A drill template shall be used to transfer the instrument pallet mounting hole pattern to the spacecraft. The template will be provided by MIT/LL. The template will use the spacecraft tooling holes as reference points.

3.2.1.3.3 Mechanical Stability

Over the lifetime of the mission, the mounting points shall be stable to 0.25 mm.

3.2.1.4 Thermal Mounting Locations
Thermistors and heaters will be supplied by the spacecraft and mounted as shown in ALI Interface Control Drawing A0750.

3.2.2 MASS PROPERTIES

3.2.2.1 Mass
The total weight of the ALI instrument shall not exceed 90 kg. All changes in mass estimates, including expected growth, shall be reported promptly. The final ALI mass shall be reported to an accuracy of 0.25kg.

3.2.2.2 Center of Gravity
The CG of the instrument shall be measured to 5 mm accuracy in X and Y, and 20mm accuracy in Z, relative to the spacecraft coordinate system. The CG of the instrument shall be within the volume defined by a right-angle box with corners at (-1, 0, 8) and (1, 5.5, 12) inches in the ALI Coordinate System.

3.2.2.3 Moment of Inertia
The moment of inertia and products of inertia of the instrument shall be calculated with 5% accuracy. The MOI shall not exceed I_{XX} = 55,000 lb. in^2, I_{YY} = 45,000, and I_{ZZ} = 32,000.

3.2.3 MECHANICAL DESIGN and ANALYSIS REQUIREMENTS

3.2.3.1 Structural Design Safety Factors
All hardware shall be designed and analyzed to the applicable safety factors defined in Table 3.1. The analyses shall indicate a positive margin of safety. MIT/LL is also applying a safety factor of 1.25 on microyield.

All ground support handling hardware shall have a design factor of safety of 5 (ultimate loads) and test to a minimum factor of safety of 2 without any permanent deformation occurring.

Table 3.1

All flight hardware except pressure vessels	Test Qual	Analysis Only
Material Yield Factors =	1.25	2.0
Material Ultimate Factors =	1.4	2.6

3.2.3.2 Structural Test Safety Factors
All hardware shall be tested to safety factors defined in Table 3.2. If hardware is designed to the “analysis - only” safety factor in Table 3.1, then no strength test (quasi-static limit load) is required.

Table 3.2 Limit Load Factors

LAUNCH LOADS	QUAL LEVEL	PROTOFLIGHT LEVEL	ACCEPTANCE LEVEL
Quasi-static limit load	1.25* limit load	1.25* limit load	N/A
Sine vibration	1.25* limit level (see note 1)	1.25* limit level (see note 1)	1.0* limit load (see note 1)
Random vibration	limit level + 3 dB 2 minutes/axis	limit level + 3 dB 1 minute/axis	limit level 1 minute/axis
Acoustics	limit level + 3 dB 2 minutes	limit level + 3 dB 1 minutes	limit level 1 minute
Shock actual device	2 actuations	2 actuations	1 actuations
simulated	1.4 limit level 2* each axis	1.4 limit level 1* each axis	limit level 1* each axis
Note 1: 25 - 35 Hz 1.5 oct/min; 5 - 25 and 35 - 50 Hz: 4 oct/min for Protoflight and acceptance, 2 oct/min for qualification.			

3.2.3.3 Structural Stiffness Requirement

The ALI shall have a first mode frequency greater than 65 Hz.

A finite element model of the spacecraft will be generated to be used in the launch vehicle coupled loads analysis. To aid in this effort, the mass properties of the deliverable hardware will be required. In addition, the first two fundamental structural modes in each of three satellite directions shall be identified. MIT/LL will supply a finite element model.

3.2.3.4 Stress Analysis Requirement

Stress analyses shall be performed to verify the integrity of the component structure and attachments when subjected to the specified loads with the applicable safety factors. Margins of safety shall be determined, dominant failure modes identified and this information transmitted to the satellite integrator. Existing mechanical stress analysis reports and data may be used if applicable.

3.2.3.5 Fastener Capacity

The ALI will be attached to the spacecraft panel using threaded fasteners. The pallet-mounting bolts shall be ¼” NAS 1578, high torque head, with yield and ultimate load factors of at least 2.0 and 2.6. MIT shall supply the fasteners.

3.2.4 THERMAL

The instrument pallet and shroud shall be thermally coupled to the pallet. The instrument electronics boxes shall be thermally isolated from the pallet. The spacecraft is cold biased, using heaters, passive radiators, selective thermal control coatings, and multi-layer insulating (MLI) blankets. The ALI pallet shall contact the spacecraft nadir deck at 16 to 20 points with no insulation between the nadir deck and the ALI pallet. The spacecraft nadir deck will be held between 0° and 30° C.

3.2.4.1 Heat Input to Instrument Radiators

The radiative heat flux from the spacecraft to the focal-plane radiator shall be between 0 and 4 watts with 2 watts as a goal. The FPA Radiator is sized assuming no direct solar heat input. The conductive heat flux from the instrument electronics boxes and radiators shall be between 0 and 5 watts. The radiators are sized assuming hot environment and end-of-life degraded thermal coating properties. The radiators are sized with enough margin to accommodate partial obstruction of the FOV by spacecraft components such as the X-Band antenna boom.

Three reference thermal monitors will be attached to the outside surfaces of the MLI covering the spacecraft deck; one for the focal-plane radiator, and one each for the instrument electronics boxes (reference Section 3.3.3.3.2).

3.2.4.2 Design Responsibility

The spacecraft contractor is responsible for the thermal analysis of the combined instrument and spacecraft. MIT/LL will supply a thermal design, analysis, and model to the spacecraft contractor. If a structure/thermal/optical-performance (STOP) analysis is necessary, MIT/LL will represent the spacecraft using mechanical and thermal data at the interface.

3.2.4.3 Thermal Blankets

MIT/LL is responsible for all externally-located thermal control materials for the instrument. MIT/LL will specify the thermal properties of the exterior surfaces of the MLI located on the nadir deck of the spacecraft and at spacecraft components in view of the electronic boxes and radiators. Solar reflections from spacecraft components in view of electronics boxes and radiators shall be minimized wherever possible. The instrument MLI shall extend 7 cm beyond the pallet with ¾" Velcro (hooks) attached to the side facing the spacecraft.

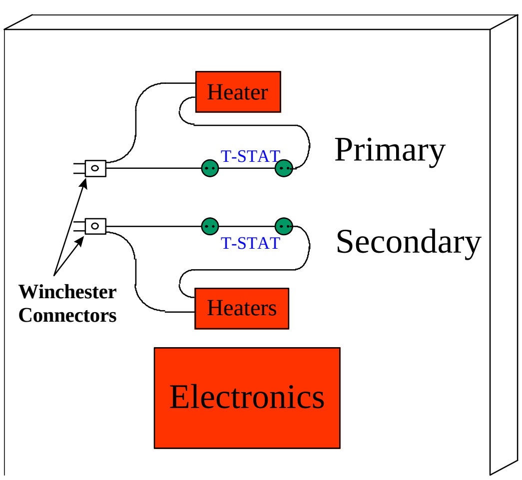
3.2.4.4 Safehold Recovery

The thermal system must operate at nominal performance within 24 hours of exiting safe mode (sun-acquisition attitude) and entering nadir-pointing mode.

3.2.4.5 Survival Heaters

The two electronics boxes shall have redundant, thermostatically-controlled heaters to keep the boxes above survival temperature. MIT/LL will attach the thermostats and heaters to the electronics in the location specified by the spacecraft thermal analysts. The power connection for the heaters will be at the RS-422 interface plate.

The spacecraft shall provide up to 35W of survival heater power to limit the low temperatures of the electronics boxes to -20°C. MIT/LL will provide the Elmwood 3200 series thermostats, and the Minco Kapton insulated thermofoil heaters. The heaters shall be built to the NASA S-311-P-079 specification and each thermostat will be set to open at a temperature not to exceed +6°C. The thermostats shall include Elmwood T120 type terminal and B208 type hermetic bracket. Figure 3.4 shows the heater redundancy concept for each of the two electronics boxes.



Design Philosophy:

Primary thermostat settings are set at a higher set point than the ***secondary*** set points. For Example:

Primary:

Close@-3^{O}C, Open@3^{O}C

Secondary:

Close@-12^{O}C,Open@-6^{O}C

Protects against single thermostat failure and line failure.

Figure 3.4 Survival Heater Redundancy Concept

MIT/LL is responsible for determining the specific location of the heaters and thermostats for each electronics box. The maximum current limit is specified in Table 3.3B.

3.2.5 ALIGNMENT

The total worst case repeatable mechanical mounting alignment of the instrument with the spacecraft shall be less than 15 minutes of arc. No provisions shall be made for making alignment adjustments. With the use of 1-inch optical cube, the mounting of the instrument to the spacecraft coordinate system shall be measured/determined to an accuracy of better than +/- 30 arc seconds.

3.2.5.1 Optical Cube

The location and orientation of the optical cube is shown in ALI Interface Control Drawing A0750.

The line-of-sight of the instrument shall be referenced to the optical cube. An error budget of alignment uncertainties shall show that the vector is known within the accuracy of the instrument or to one arc minute, whichever is greater.

3.2.6 POINTING REQUIREMENTS

3.2.6.1 Control and Knowledge

The spacecraft and instrument shall meet the pointing requirements as defined by the WIS Spectral Purity Error Budget contained in the WIS Spectral Purity and Implications to EO-1 Spacecraft Pointing, Litton Amecom document AM149-0042(155).

3.2.6.2 Stability

The spacecraft will be designed and operated to minimize jitter. The structure is stiff, the solar array first mode is >1 Hz, and the reaction wheels have minimal vibration. During an observation, the solar array will be parked and the reaction wheel speed offset to avoid zero crossings. During observations, the spacecraft will record gyro data for evaluation by the data analysis team.

3.2.6.3 Avoidance

The attitude control system has no autonomous sun-avoidance or moon-avoidance error checking or restrictions.

3.2.6.4 Uncompensated Momentum

The ALI shall not generate any uncompensated momentum within the 5 minutes preceding an observation. This restriction does not apply during solar calibration.

3.2.6.5 Solar Calibration

The spacecraft shall be able to point the ALI boresight towards the sun with an offset of TBR degrees, in the range between 0 and 7 degrees in the +Y direction. Total dwell time at the sun shall not exceed 2 minutes. Solar calibration may be conducted as frequently as once per week.

3.2.6.6 Lunar Calibration

The spacecraft shall be able to perform a Raster scan of the moon such that the scan rate is either 0.137 Deg/sec or 0.275 Deg/sec. The Raster scan shall have five steps to cover each detector chip.

3.2.6.7 Safe Mode

The ALI shall be designed to survive indefinitely in the safe mode, which puts the satellite in an inertial hold where the ALI points away from the sun. The spacecraft shall provide survival heaters for the ALICE and FPE boxes, and, if necessary, a heater for the FPAs (main and grating).

3.2.7 ALI HANDLING OPERATIONS and LIFT POINTS

3.2.7.1 Handling Operations

The ALI Integration and Test document includes the handling and installation procedures for the ALI. Protective covers shall be supplied by the ALI contractor for protection of the hardware and electrical connectors. These covers will be on the instrument at all times, except during testing when removal is required to support testing.

3.2.7.2 Lift Points

The maximum allowable manual lift weight during spacecraft integration is 10 kgs. ALI Interface Control Drawing A0750 shows the lift points of the ALI. ALI lifting slings will be designed such that the bottom of the pallet can clear the top deck of the spacecraft, which will be 90 inches below the lifting hook.

3.2.8 ACCESS REQUIREMENTS

Access requirements to the ALI shall be as defined in the ALI I&T plan. Access requirements include connector mate/demate clearances, removal and replacement clearances for electronic components and protective covers, and access to purge fittings.

3.2.9 GSE APERTURE COVERS

There will be a red flag cover on the ALI telescope aperture. It will be used to protect the aperture door.

3.2.10 NITROGEN PURGE

A clean, dry, oil free, boil-off or MIL-P-27401C Type 1 Grade B nitrogen purge will be maintained to the telescope assembly (A1) at all times up to four hours before launch rocket ignition. The flow rate is 0.1-1 lt/min during I&T and during launch-site operations. The purge may be interrupted for no longer than 2 hours. MIT/LL will provide a portable nitrogen purge cart which will be connected to the instrument through up to 100 feet of purge hose. MIT/LL will supply sufficient liquid nitrogen per day to replenish the boil off from the cart up to transport to the launch pad. MIT/LL will supply the purge cart and I/F requirements.

The spacecraft shipping container will accommodate the ALI purge requirements.

3.3 ELECTRICAL INTERFACE REQUIREMENTS

3.3.1 ELECTRICAL INTERFACES

An RS-422 science-data interface connector panel will be located on the instrument pallet near the -X, -Y corner of the pallet, as shown in ALI Interface Control Drawing A0750. Power and 1773 connections are at the ALICE electronics box. The power connection for the electronic box survival heaters is also at the interface panel. Figure 3.5 is an electrical block diagram of the ALI.

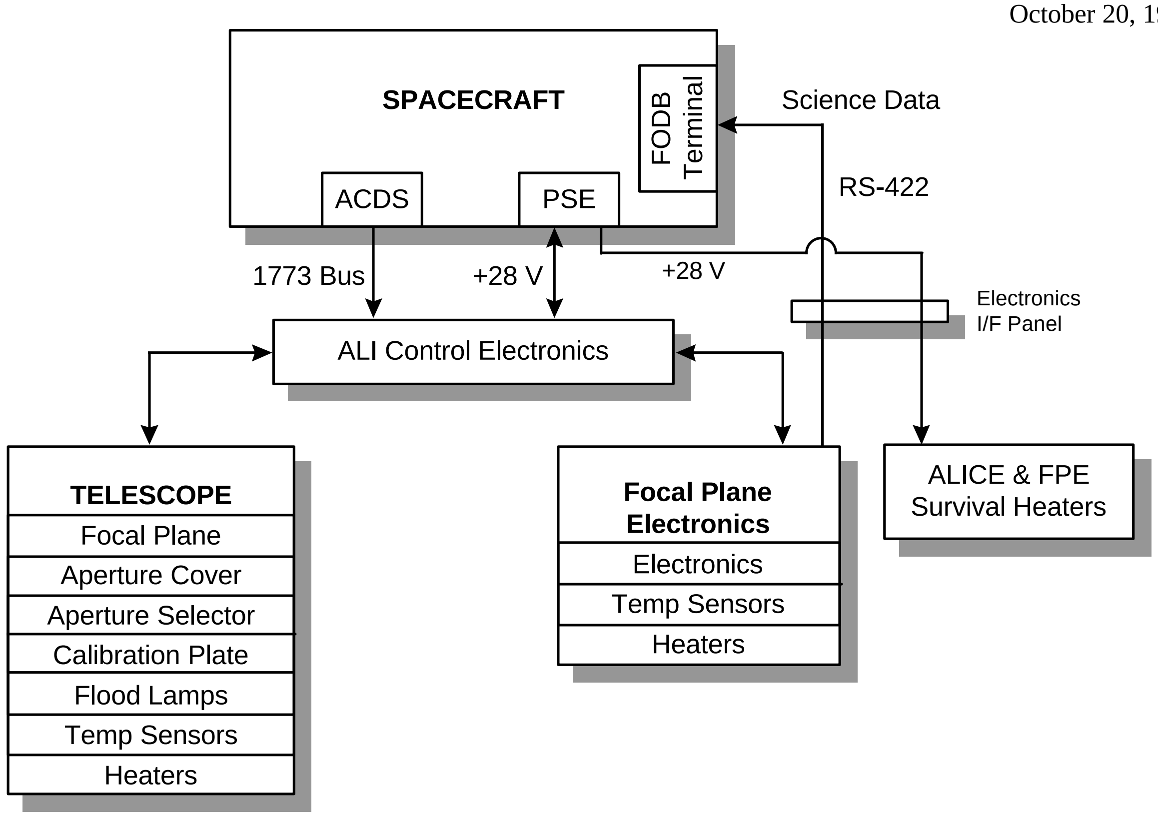


Figure 3.5 Instrument Electrical Block Diagram

3.3.2 POWER REQUIREMENTS

3.3.2.1 Description

The spacecraft operating bus voltage is 28 V ±7, with power characteristics as specified in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155). The instrument provider shall ensure that the instrument shall successfully operate within this power regime.

3.3.2.2 Power/ Load Characteristics

As specified in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.2.2.1 Power Distribution

The total ALI power allocation (including heaters) is as follows:

Nominal operation, orbit average	<75 watts
ALI Power off (survival) modes	<35 watts (heater power supplied by spacecraft)
Peak instrument power	180 watts for three minutes

3.3.2.2.2 Noise Suppression

All inductive loads associated with the instrument, such as relay coil circuits shall be provided with suppression circuits to prevent excessive transients and associated EMC noise due to power interrupts as per System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.2.2.3 Load Profile

The typical load profile of the instrument is illustrated in Figure 3.6. The ALI will be in its idle mode when not gathering data or preparing for gathering data. During safehold (satellite in sun-acquisition attitude), power to the ALI will be off.

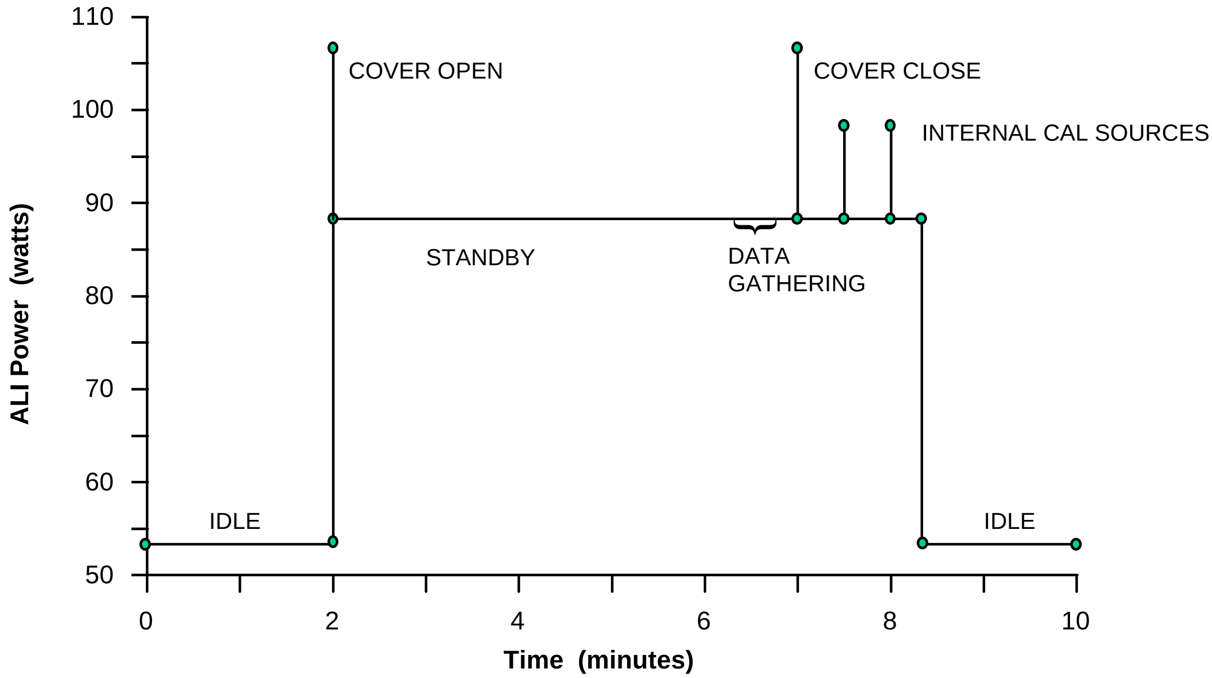


Figure 3.6 Typical ALI Power Profile During an Observation

3.3.2.2.4 Fusing

The power service to the ALI is switched by a solid-state power controller with a current limit of 15 amps. The controller acts as a circuit breaker and can be reset on orbit.

3.3.3 COMMAND and TELEMETRY REQUIREMENTS

All ALI commands and housekeeping telemetry are received from and sent to the spacecraft via the 1773 I/F. Details are described in the command and telemetry handbook.

3.3.3.1 Prime Science Data

Science data is transmitted from the ALI via RS-422, with specifications detailed in the WARP I/F documentation.

3.3.3.2 Mission Elapsed Time (MET)/Universal Time (UT) Interface

MET/UT shall be received via the spacecraft 1773 bus in the form of a time packet broadcast as described in Data Systems 1773 Interface Control Document EO-1, Litton/Amecom document AM149-0050(155). The time sent in the time packet is valid at the previous time tone broadcast. The frame start time for ALI science data shall be reported in the 1773 housekeeping data.

3.3.3.3 Housekeeping Requirements

ALI will have several housekeeping monitors, including current monitors, thermal monitors, and a serial digital status report. When the ALI is in the standby or data-gathering mode, housekeeping rate will be 1024 bps or less. Otherwise, in the idle mode housekeeping rate will be 192 bps less.

3.3.3.3.1 Prime Power Current Monitors

Prime power current monitors are contained within the EO-1 spacecraft power distribution. ALI will monitor current distribution to instrument components and incorporate this information into housekeeping telemetry.

3.3.3.3.2 Thermal Monitors

The EO-1 spacecraft will provide the thermal monitors on the spacecraft nadir deck to provide a gross measurement of the ALI thermal balance, to provide a thermal measurement for EO-1 thermal balance, and for control during safehold. ALI provides no interface other than providing a mounting point on all external monitors. Any critical internal temperature monitors must be coordinated with the spacecraft integrator.

3.3.4 INTERFACE CONNECTORS and PIN ASSIGNMENTS

There are four electrical connections: Optical (1773), power, science-data, and survival-heater power.

3.3.4.1 Description

The instrument provider will fabricate, qualify and provide to the spacecraft integrator all instrument inter-connecting flight harness. The spacecraft provider will supply harnessing up to the electrical I/F plate and up to the ALICE box (1773 and power).

Table 3.3 delineates the connectors, pin assignments and wiring interfaces for the power connection.

The 1773 connections are specified in Data Systems 1773 ICD EO-1, Litton Amecom document AM149-0050(155), and the RS-422 science-data connections are specified in the WARP I/F documents.

The instrument provider shall supply to the spacecraft integrator three complete sets of flight interface connectors, pins and backshells.

The electrical connections from the spacecraft to the ALICE box (1773 and power) shall be on the -X face of the ALICE box.

3.3.4.2 Connectors

All interface connectors (see Tables 3.3A and 3.3B) adhere to the specifications as delineated in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

Refer also to Section 3.5.5 for EMI consideration.

Table 3.3A ALI Power Interface Connectors And Pin Assignments

Pin #	Gauge	Function	Remarks
1	14	Power to ALI, 28 V	Connector type consists of a 5C5 Combo Male Connector, GSFC part # 311P405-10P-B-12
2	14	Power to ALI, 28 V	
3	Spare	Spare	
4	14	Return	
5	14	Return	

Table 3.3B ALI Survival Heater Connector

Pin #	Gauge	Function	Remarks
1	22	ALICE Survival Htr A	Connector type consists of a 9 Pin Female Connector, GSFC part # 311P409-1S-B-12
2	22	FPE Survival Htr A	
3	22	ALICE Survival Htr B	
4	22	FPE Survival Htr B	
5	22	Spare	
6	22	ALICE Htr A Return	
7	22	FPE Htr A Return	
8	22	ALICE Htr B Return	
9	22	FPE Htr B Return	

The primary side, “Htr A”, is limited to 1 amp, maximum current. The redundant side, “Htr B”, is also limited to 1 amp.

3.3.4.3 Connector Mounting Configuration

The configuration drawings in Section 3.2 show the connector location and orientation on the instrument electronics box and for the interface plate.

3.3.5 ELECTROMAGNETIC COMPATIBILITY

3.3.5.1 EMC Requirements

Table 3.4 describes how the ALI shall meet the EMC requirements as specified in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

Table 3.4 ALI EMC Testing Plan

Item	Tests	Where	When
EDU ALICE & Mechanisms - not a clean test (W/ Shield Cover over mechanisms & their cables)	CE01 CE03 CE07 CS01 CS02 CS06 RE01 RE02 RS03 (S & X band TXs only)	At EMC Lab Option: Do in-house	Dec. '97
Flight ALICE - this is a clean test (EDU mechanisms & cables w/shield cover as above)	CE01 CE03 CE07	LL Clean Room in-house test	Feb. '98
ALI Instrument in flight configuration - this is a clean test S-Band CMD/TLM Antenna for "RE02 & RS03". Antenna is placed next to ALI as would the flight antenna on EO-1.	CE01 CE03 CE07 "RE02" (CMD RX Freq.) "RS03" (TLM TX Freq.)	LL Clean Room in-house test	Sept. '98

3.3.5.2 Grounding

The grounding scheme utilized in any subsystem or instrument shall be consistent with the grounding philosophy of the payload integrator as described in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.5.3 ESD

All external surfaces and MLI layers shall be grounded as per the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.6 HARNESS

All internal ALI harnesses shall be mounted to ALI components such as the pallet.

3.3.7 ELECTRICAL GSE

MIT/LL shall deliver EGSE to spacecraft I&T when the ALI is delivered. The EGSE will be compatible with spacecraft EGSE. EGSE will be able to:

- simulate the focal-plane data
- collect, store, and verify received focal-plane data
- transmit and process ALI commands and telemetry

3.4 ORDNANCE REQUIREMENTS

There are no electro-explosive devices used on the ALI.

3.5 RADIO FREQUENCY REQUIREMENTS

There are no ALI radio frequency interfaces.

3.6 ENVIRONMENTAL REQUIREMENTS

3.6.1 LIMIT LOADS

All hardware shall be designed and tested to withstand the quasi-static limit loads (with applicable safety factors) defined in the EO-1 Verification Plan and Environmental Specification, SAI-SPEC-158. These loads are also listed in Table 3.5. Limit loads are defined as the maximum expected flight loads.

Table 3.5 Limit Load Factors

9.1 g axial compression + 7.3 g in any lateral direction
1.0 g axial tension + 5.6 g in any lateral direction
Note: 1. Axial means parallel to the EO-1 satellite thrust (Z) axis. 2. The axial and lateral limit load factors of each of the above two sets are to be applied simultaneously.

3.6.2 RANDOM VIBRATION TEST LEVELS

Table 3.6 Random Vibration Test Levels

Frequency (Hz)	Level	
	Acceptance	Protoflight
20	0.01 g^2/Hz	0.01 g^2/Hz
20 - 40	+3 dB/octave	+3 dB/octave
40 - 1000	0.02 g^2/Hz	0.02 g^2/Hz
1000 - 2000	-3 dB/octave	-3 dB/octave
2000	0.01 g^2/Hz	0.01 g^2/Hz
Overall	5.77 grms	5.77 grms

Notes:

1. Levels are for each of three orthogonal axes, one of which is normal to the mounting surface.
2. Levels to be applied at the interface with the EO-1 spacecraft.
3. Test duration is one minute per axis.
4. The table shows flight acceptance and protoflight test levels. These levels may be reduced (notched) in specific frequency bands, with Project concurrence, if required to preclude damage resulting from unrealistic high amplification resonant response due to the shaker mechanical impedance and/or shaker/fixture resonances. In general, notching may be used to prevent test loads in the primary structure or major elements of the instrument from exceeding 1.25 times flight limit loads. This typically involves only low-order vibration modes with significant modal effective weights.
5. Flight-type attach hardware (including any thermal washers, etc.) shall be used to attach the test article to the test fixture, and preloads and fastener locking features shall be similar to the flight installation. The clearance between the bottom of the ALI pallet and the test fixture shall be the same as the clearance when installed on the spacecraft deck to preclude unrealistic contacts due to vibration.
6. Cross-axis responses of the fixture shall be monitored during the test to preclude unrealistic levels.
7. During the test the test article shall be operated in a mode representative of that during launch.

3.6.3 ACOUSTIC TEST LEVELS

Table 3.7 EO-1 Acoustic Test Levels

One-Third Octave Center Frequency (Hz)	Sound Pressure Level (dB, re 20 μPa)	
	Protoflight	Acceptance Level
25	---	---
31.5	118.5	115.5
40	121.6	118.6
50	125.6	122.6
63	127.3	124.3
80	127.9	124.9
100	129.1	126.1
125	129.7	126.7
160	129.9	126.9
200	130.6	127.6
250	131.7	128.7
315	132.8	129.8
400	131.4	128.4
500	130.0	127.0
630	127.1	124.1
800	124.3	121.3
1000	122.4	119.4
1250	120.5	117.5
1600	119.6	116.6
2000	119.1	116.1
2500	118.7	115.7
3150	117.7	114.7
4000	116.3	113.3
5000	113.8	110.8
6300	109.9	106.9
8000	105.9	102.9
10000	102.9	99.9
Overall	141.1	138.1

Note: Test duration = one minute

3.6.4 SAFETY

The ALI presents no unusual safety hazards. Items presenting potentially hazardous conditions are listed below:

a. Purge System, utilizing gaseous Nitrogen

b. Deployable aperture door

3.7 FUNCTIONAL TESTING

MIT/LL will deliver functional test procedures that collect and check internal lamp data and the FPE test pattern. The procedure will verify correct command and telemetry functionality of the ALI.

4.0 DELIVERABLES

Item	Delivered By	Delivered To	Need Date	Comment
Loads	Swales	MIT/LL	3/1/97	Delivered
ASIST	GSFC	MIT/LL	4/15/97	Delivered
Flight unit ESN	GSFC	MIT/LL	5/31/97	Delivered
Specification of thermal properties of nadir deck MLI	MIT/LL	Swales	6/1/97	Delivered
RSN Operating System	GSFC	MIT/LL	8/1/97	Delivered
ALI Thermal Models	MIT/LL	Swales	8/15/97	Delivered
Drill Template	MIT/LL	Swales	1/1/98	
Focal-Plane Simulator (EGSE-4)	MIT/LL	GSFC	2/1/98	
ALI STM Unit	MIT/LL	Swales	8/1/98	
ALI Flight Unit	MIT/LL	Swales	12/8/98	Must be unpacked & ready to mount on S/C by 12/15/98
Test procedures	MIT/LL	Swales	12/15/98	
Science Data Acquisition System (EGSE-1)	MIT/LL	Swales	12/15/98	
Command & Telemetry Processing (EGSE 2 & 3)	MIT/LL	Swales	12/15/98	
Functional test processing S/W	MIT/LL	Swales	12/15/98	
Radiometric Correction Algorithm S/W	MIT/LL	GSFC	3/31/99	

Date: Thu, 04 Dec 1997 12:22:18 -0500 (Eastern Standard Time)
From: Administrator@hst-nic.hst.nasa.gov
Reply-to: (Brian Smith /426)
Subject: CCR:0002 - DUE: 12/18/97 ROUTINE Level-2 Brian Smith /42 WWW-COMMENTS

USER : (Brian Smith /426) sent the following comments on :

Date: 12/04/1997
CCR Number: 0002
Sponsor: M. Jurotich/EO-1 Payload Mgr
Due Date: 12/18/97

CCR Title: Rev A TO EO-1 SPACECRAFT ALI ICD-18

Remote host: 128.183.212.183 Email Address: brian.smith@gsfc.nasa.gov
----
APPROVAL STATUS: APPROVED
Note:

COMMENTS:

Date: Fri, 12 Dec 1997 09:22:43 -0500 (Eastern Standard Time)
From: Administrator@hst-nic.hst.nasa.gov
Reply-to: (Pete Spidaliere/426)
Subject: CCR:0002 - DUE: 12/26/97 ROUTINE Level-2 Pete Spidaliere/42 WWW-COMMENTS

USER : (Pete Spidaliere/426) sent the following comments on :

Date: 12/12/1997
CCR Number: 0002
Sponsor: M. Jurotich/EO-1 Payload Mgr
Due Date: 12/26/97

CCR Title: Rev A TO EO-1 SPACECRAFT ALI ICD-18

Remote host: 128.183.213.112 Email Address:

APPROVAL STATUS: APPROVED
Note:

COMMENTS:

Date: Tue, 09 Dec 1997 08:37:55 -0500 (Eastern Standard Time)
From: Administrator@hst-nic.hst.nasa.gov
Reply-to: (Terry Smith / Code 735)
Subject: CCR:0002 - DUE: 12/26/97 ROUTINE Level-2 Terry Smith / Code 73 WWW-COMMENTS

USER : (Terry Smith / Code 735) sent the following comments on :

Date: 12/09/1997
CCR Number: 0002
Sponsor: M. Jurotich/EO-1 Payload Mgr
Due Date: 12/26/97

CCR Title: Rev A TO EO-1 SPACECRAFT ALI ICD-18

Remote host: 128.183.152.60 Email Address:

APPROVAL STATUS: APPROVED WITH COMMENTS
Note:

COMMENTS: The Electrical Interfaces Section should reference the ALI RS-422 to WARP/FODB ICD.

EO-1 DISTRIBUTION LIST

Date: 12/15/97

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Action Codes: D = Distribution (Hard Copy)
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- add [illegible] Heater connectors
- Move [illegible] bracket

3.1.1 INTERFACE FUNCTIONS

The functions provided to the ALI by the spacecraft, and conversely, are delineated in the following sections.

3.1.1.1 Spacecraft Interface Functions

The following major interface functions shall be provided by the spacecraft.

a. Transmission of commands from the spacecraft via the 1773 bus.

b. Provision of Primary Power from 28 ±7 VDC power bus.

c. Provision of mounting interface for ALI telescope to spacecraft.

d. Provision of interfaces accommodating mounting, routing, and securing of instrument harness to/on the spacecraft.

3.1.1.2 ALI Interface Functions

The following major interface functions shall be provided by the ALI.

a. Transmission of wideband (image) data to the ~~spacecraft WARP~~. F-ODB INTERFACE BOX.

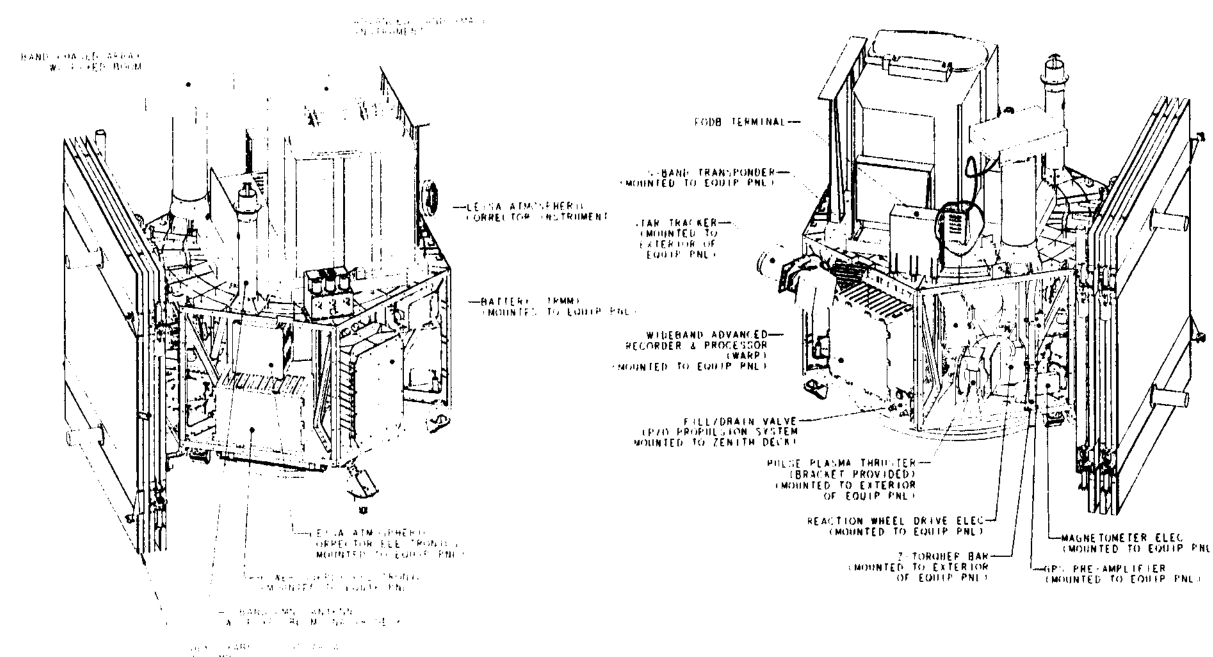
b. Transmission of instrument housekeeping telemetry to spacecraft via the 1773 bus.

c. Provision of mounting interface for ALI telescope to spacecraft.

d. Provision of mounting interfaces for GSE handling fixture attach points on the ALI.

3.2 MECHANICAL INTERFACE REQUIREMENTS

The ALI Instrument consists of the telescope, telescope shroud and two electronic units, and interface cabling. The instrument assemblies are mounted on an instrument pallet that is mounted to the nadir-facing deck of the spacecraft. Figure 3.1 is a drawing of the spacecraft.



Eliminate I/F Bracket

Figure 3.1 **EO-1 Configuration** (outer panels not shown)

3.2.1 CONFIGURATION

The dimensional drawings of the electronic units and telescope are delineated in ALI Interface Control Drawing A0750. This includes mounting footprints, lift locations, and the location and orientation of electrical connectors. The drawing shows the details of the purge connection and its location.

3.2.1 .1 Coordinate System

Orthogonal reference axes are established for the spacecraft and the ALI. The ALI coordinate system is shown in Figure 3.2. The EO-1 coordinate system is shown in Figure 3.3.

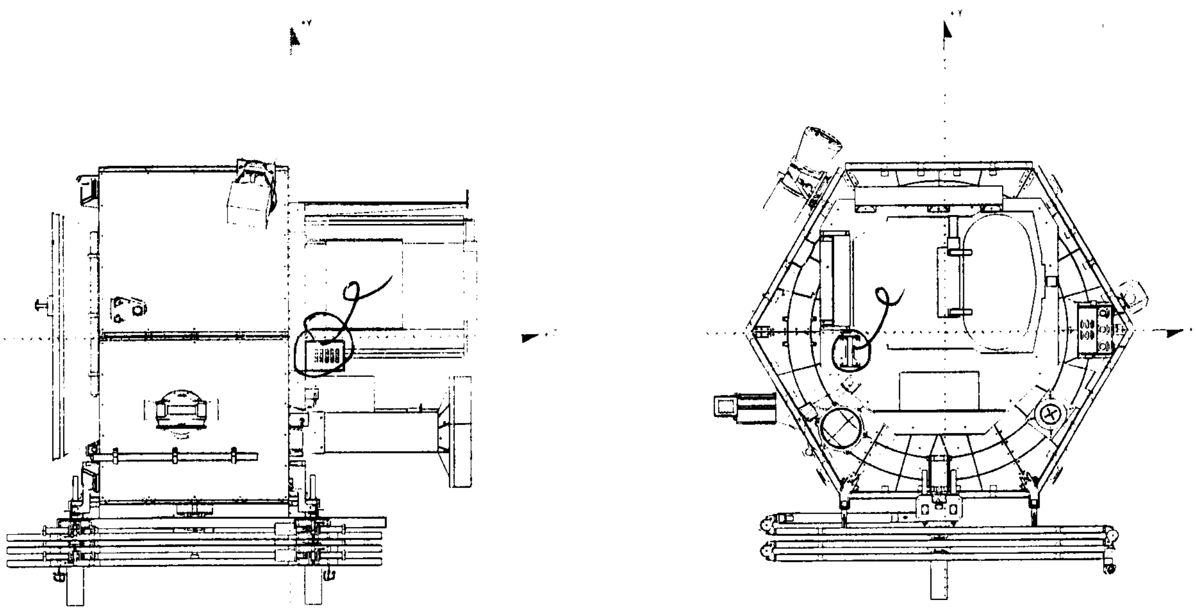


Figure 3.2 **ALI Coordinate System**

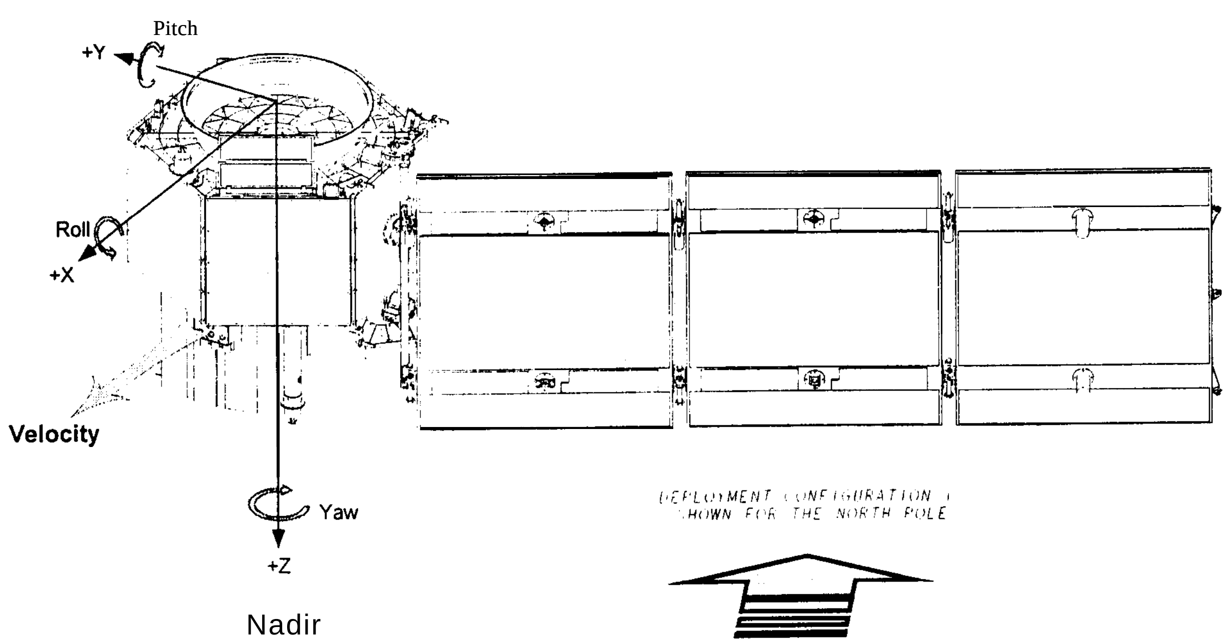


Figure 3.3 **Deployed Spacecraft with Coordinate System**
(sun is normal to the page)

3.2.1.2 Fields of View

The ALI telescope shall be located on the spacecraft in accordance with the following Field of View (FOV) requirements:

a. The ALI telescope aperture shall have a clear field of view of 2.26” X 15.5” as shown in ALI Interface Control Drawing A0750.

b. The telescopes physical entrance port is located in the telescope’s top enclosure plate. The plate is perpendicular to the Z axis and sits approximately 26 inches along the Z axis from the spacecraft/ALI interface.

c. The desired keep-out zone is a constant -Z plane that lies parallel to and intersects the surface of the telescope shroud.

3.2.1.3 Mounting Interface

The ALI telescope pallet is hard mounted to the spacecraft nadir deck with 18 bolts as shown in ALI Interface Control Drawing A0750. Both the pallet and the nadir deck shall have 30 MIL raised bosses at the bolt locations. One bolt at each of 4 footprint extremities of the pallet shall be a shoulder bolt. will supply the standard

3.2.1.3.1 Flatness Specification

The mounting points on the spacecraft shall not be out of plane more than 0.25mm.

3.2.1.3.2 Drill Template

A drill template shall be used to transfer the instrument pallet mounting hole pattern to the spacecraft. The template will be provided by MIT/LL. The template will use the spacecraft tooling holes as reference points.

3.2.1.3.3 Mechanical Stability

Over the lifetime of the mission, the mounting points shall be stable to 0.25 mm.

3.2.1.4 Thermal Mounting Locations

Thermistors and heaters will be supplied by the spacecraft and mounted as shown in ALI Interface Control Drawing A0750. for the nadir deck

3.2.2 MASS PROPERTIES

3.2.2.1 Mass

The total weight of the ALI instrument shall not exceed 90 kg. All changes in mass estimates, including expected growth, shall be reported promptly. The final ALI mass shall be reported to an accuracy of 0.25kg.

3.2.2.2 Center of Gravity

The CG of the instrument shall be measured to 5 mm accuracy in X and Y, and 20mm accuracy in Z, relative to the spacecraft coordinate system. The CG of the instrument shall be within the volume defined by a right-angle box with corners at (-1, 0, 8) and (1, 5.5, 12) inches in the ALI Coordinate System.
6.5

3.2.2.3 Moment of Inertia

The moment of inertia and products of inertia of the instrument shall be calculated with 5% accuracy. The MOI shall not exceed I_{XX} = 55,000 lb. in^2, I_{YY} = 45,000, and I_{ZZ} = 32,000.

3.2.3 MECHANICAL DESIGN and ANALYSIS REQUIREMENTS

3.2.3.1 Structural Design Safety Factors

All hardware shall be designed and analyzed to the applicable safety factors defined in Table 3.1. The analyses shall indicate a positive margin of safety. MIT/LL is also applying a safety factor of 1.25 on microyield.

All ground support handling hardware shall have a design factor of safety of 5 (ultimate loads) and test to a minimum factor of safety of 2 without any permanent deformation occurring.

Table 3.1

All flight hardware except pressure vessels	Test Qual	Analysis Only
Material Yield Factors =	1.25	2.0
Material Ultimate Factors =	1.4	2.6

3.2.3.2 Structural Test Safety Factors

All hardware shall be tested to safety factors defined in Table 3.2. If hardware is designed to the "analysis - only" safety factor in Table 3.1, then no strength test (quasi-static limit load) is required.

Table 3.2 Limit Load Factors

LAUNCH LOADS	QUAL LEVEL	PROTOFLIGHT LEVEL	ACCEPTANCE LEVEL
Quasi-static limit load	1.25* limit load	1.25* limit load	N/A
Sine vibration	1.25* limit level (see note 1)	1.25* limit level (see note 1)	1 .O* limit load (see note 1)
Random vibration	limit level + 3 dB 2 minutes/axis	limit level + 3 dB 1 minute/axis	limit level 1 minute/axis
Acoustics	limit level + 3 dB 2 minutes	limit level + 3 dB 1 minutes	limit level 1 minute
Shock actual device	2 actuations	2 actuations	1 actuations
simulated	1.4 limit level 2* each axis	1.4 limit level 1* each axis	limit level 1* each axis

Note 1: 25 - 35 Hz 1.5 ocffmin; 5 - 25 and 35 - 50 Hz: 4 ocffmin for Protoflight and acceptance, 2 ocffmin for qualification.

3.2.3.3 Structural Stiffness Requirement

The ALI shall have a first mode frequency greater than 65 Hz.

A finite element model of the spacecraft will be generated to be used in the launch vehicle coupled loads analysis. To aid in this effort, the mass properties of the deliverable hardware will be required. In addition, the first two fundamental structural modes in each of three satellite directions shall be identified. MIT/LL will supply a finite element model.

3.2.3.4 Stress Analysis Requirement

Stress analyses shall be performed to verify the integrity of the component structure and attachments when subjected to the specified loads with the applicable safety factors. Margins of safety shall be determined, dominant failure modes identified and this information transmitted to the satellite integrator. Existing mechanical stress analysis reports and data may be used if applicable.

3.2.3.5 Fastener Capacity
The ALI will be attached to the spacecraft panel using threaded fasteners. The pallet-mounting bolts shall be ¼" NAS 1578, high torque head, with yield and ultimate load factors of at least 2.0 and 2.6. MIT shall supply the fasteners.

3.2.4 THERMAL

The instrument pallet and shroud shall be thermally coupled to the pallet. The instrument electronics boxes shall be thermally isolated from the pallet. The spacecraft is cold biased, using heaters, passive radiators, selective thermal control coatings, and multi-layer insulating (MLI) blankets. The ALI pallet shall contact the spacecraft nadir deck at 16 to 20 points with no insulation between the nadir deck and the ALI pallet. The spacecraft nadir deck will be held between 0° and 30° C.

3.2.4.1 Heat Input to Instrument Radiators
The radiative heat flux from the spacecraft to the focal-plane radiator shall be between 0 and 4 watts with 2 watts as a goal. The FPA Radiator is sized assuming no direct solar heat input. The conductive heat flux from the instrument electronics boxes and radiators shall be between 0 and 5 watts. The radiators are sized assuming hot environment and end-of-life degraded thermal coating properties. The radiators are sized with enough margin to accommodate partial obstruction of the FOV by spacecraft components such as the X-Band antenna boom.

Three reference thermal monitors will be attached to the outside surfaces of the MLI covering the spacecraft deck; one for the focal-plane radiator, and one each for the instrument electronics boxes (reference Section 3.3.3.3.2).

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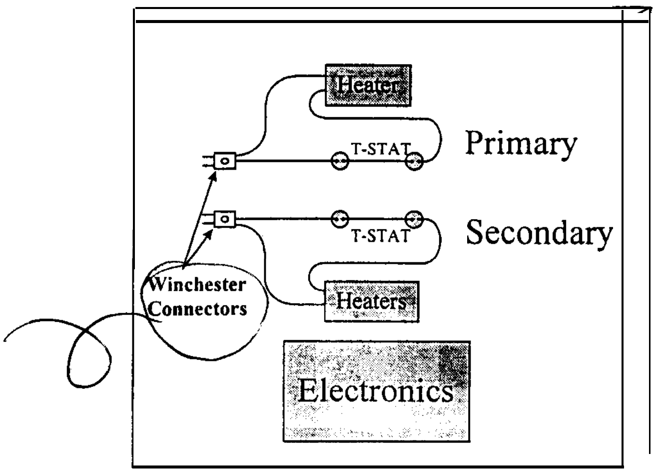
3.2.4.2 Design Responsibility
The spacecraft contractor is responsible for the thermal analysis of the combined instrument and spacecraft. MIT/LL will supply a thermal design, analysis, and model to the spacecraft contractor. If a structure/thermal/optical-performance (STOP) analysis is necessary, MIT/LL will represent the spacecraft using mechanical and thermal data at the interface.

3.2.4.3 Thermal Blankets
MIT/LL is responsible for all externally-located thermal control materials for the instrument. MIT/LL will specify the thermal properties of the exterior surfaces of the MLI located on the nadir deck of the spacecraft and at spacecraft components in view of the electronic boxes and radiators. Solar reflections from spacecraft components in view of electronics boxes and radiators shall be minimized wherever possible. The instrument MLI shall extend 7 cm beyond the pallet with ¾" Velcro (hooks) attached to the side facing the spacecraft.

3.2.4.4 Safehold Recovery
The thermal system must operate at nominal performance within 24 hours of exiting safe mode (sun-acquisition attitude) and entering nadir-pointing mode.

3.2.4.5 Survival Heaters
The two electronics boxes shall have redundant, thermostatically-controlled heaters to keep the boxes above survival temperature. MIT/LL will attach the thermostats and heaters to the electronics in the location specified by the spacecraft thermal analysts. ~~The power connection for the heaters will be at the RS-422 interface plate~~

The spacecraft shall provide up to 35W of survival heater power to limit the low temperatures of the electronics boxes to -20°C. MIT/LL will provide the Elmwood 3200 series thermostats, and the Minco Kapton insulated thermofoil heaters. The heaters shall be built to the NASA S-31 l-P-079 specification and each thermostat will be set to open at a temperature not to exceed +6°C. The thermostats shall include Elmwood T120 type terminal and 8208 type hermetic bracket. Figure 3.4 shows the heater redundancy concept for each of the two electronics boxes.



Design Philosophy:

Primary thermostat settings are set at a higher set point than the secondary set points. For Example:

Primary:

Close@-3°C, Open@3°C

Secondary:

Close@-12°C,Open@-6°C

Protects against single thermostat failure and line failure.

Figure 3.4 Survival Heater Redundancy Concept

MIT/LL is responsible for determining the specific location of the heaters and thermostats for each electronics box. The maximum current limit is specified in Table 3.38.

3.2.5 ALIGNMENT

The total worst case repeatable mechanical mounting alignment of the instrument with the spacecraft shall be less than 15 minutes of arc. No provisions shall be made for making alignment adjustments. With the use of l-inch optical cube, the mounting of the instrument to the spacecraft coordinate system shall be measured/determined to an accuracy of better than +/- 30 arc seconds.

3.2.5.1 Optical Cube

The location and orientation of the optical cube is shown in ALI Interface Control Drawing A0750.

The line-of-sight of the instrument shall be referenced to the optical cube. An error budget of alignment uncertainties shall show that the vector is known within the accuracy of the instrument or to one arc minute, whichever is greater.

3.2.6 POINTING REQUIREMENTS

3.2.6.1 Control and Knowledge

The spacecraft and instrument shall meet the pointing requirements as defined by the WIS Spectral Purity Error Budget contained in the WIS Spectral Purity and Implications to EO-1 Spacecraft Pointing, Litton Amecom document AM149-0042(155).

3.2.6.2 Stability

The spacecraft will be designed and operated to minimize jitter. The structure is stiff, the solar array first mode is >1 Hz, and the reaction wheels have minimal vibration. During an observation, the solar array will be parked and the reaction wheel speed offset to avoid zero crossings. During observations, the spacecraft will record gyro data for evaluation by the data analysis team.

3.2.6.3 Avoidance
The attitude control system has no autonomous sun-avoidance or moon-avoidance error checking or restrictions.

3.2.6.4 Uncompensated Momentum
The ALI shall not generate any uncompensated momentum within the 5 minutes preceding an observation. This restriction does not apply during solar calibration.

3.2.6.5 Solar Calibration
The spacecraft shall be able to point the ALI boresight towards the sun with an offset of TBR degrees, in the range between 0 and 7 degrees in the +Y direction. Total dwell time at the sun shall not exceed 2 minutes. Solar calibration may be conducted as frequently as once per week.

3.2.6.6 Lunar Calibration
The spacecraft shall be able to perform a Raster scan of the moon such that the scan rate is either 0.137 Deg/sec or 0.275 Deg/sec. The Raster scan shall have five steps to cover each detector chip.

Power boards

3.2.6.7 Safe Mode
The ALI shall be designed to survive indefinitely in the safe mode, which puts the satellite in an inertial hold where the ALI points away from the sun. The spacecraft shall provide survival heaters for the ALICE and FPE boxes, and, if necessary, a heater for the FPAs (main and grating).

3.2.7 ALI HANDLING OPERATIONS and LIFT POINTS

3.2.7.1 Handling Operations
The ALI Integration and Test document includes the handling and installation procedures for the ALI. Protective covers shall be supplied by the ALI contractor for protection of the hardware and electrical connectors. These covers will be on the instrument at all times, except during testing when removal is required to support testing.

MIT/LL shall provide the

3.2.7.2 Lift Points
The maximum allowable manual lift weight during spacecraft integration is 10 kgs. ALI Interface Control Drawing A0750 shows the lift points of the ALI. ALI lifting slings will be designed such that the bottom of the pallet can clear the top deck of the spacecraft, which will be 90 inches below the lifting hook.

3.2.8 ACCESS REQUIREMENTS

Access requirements to the ALI shall be as defined in the ALI I&T plan. Access requirements include connector mate/demate clearances, removal and replacement clearances for electronic components and protective covers, and access to purge fittings.

3.2.9 GSE APERTURE COVERS

There will be a red flag cover on the ALI telescope aperture. It will be used to protect the aperture door.

3.2.10 NITROGEN PURGE

A clean, dry, oil free, boil-off or MIL-P-27401C Type 1 Grade B nitrogen purge will be maintained to the telescope assembly (Al) at all times up to four hours before launch rocket ignition. The flow rate is 0.1-l lt/min during I&T and during launch-site operations. The purge may be interrupted for no longer than 2 hours. MIT/LL will provide a portable nitrogen purge cart which will be connected to the instrument through up to 100 feet of purge hose. MIT/LL will supply sufficient liquid nitrogen per day to replenish the boil off from the cart up to transport to the launch pad. MIT/LL will supply the purge cart and I/F requirements.

The spacecraft shipping container will accommodate the ALI purge requirements.

3.3 ELECTRICAL INTERFACE REQUIREMENTS

A PURGE AND SURVIVAL-HEATER

3.3.1 ELECTRICAL INTERFACES

~~An RS-422 science-data~~ interface connector panel will be located on the instrument pallet near the -X, -Y corner of the pallet, as shown in ALI Interface Control Drawing A0750. Power and 1773 connections are at the ALICE electronics box. The power connection for the electronic box survival heaters is ~~also~~ at the interface panel. Figure 3.5 is an electrical block diagram of the ALI.

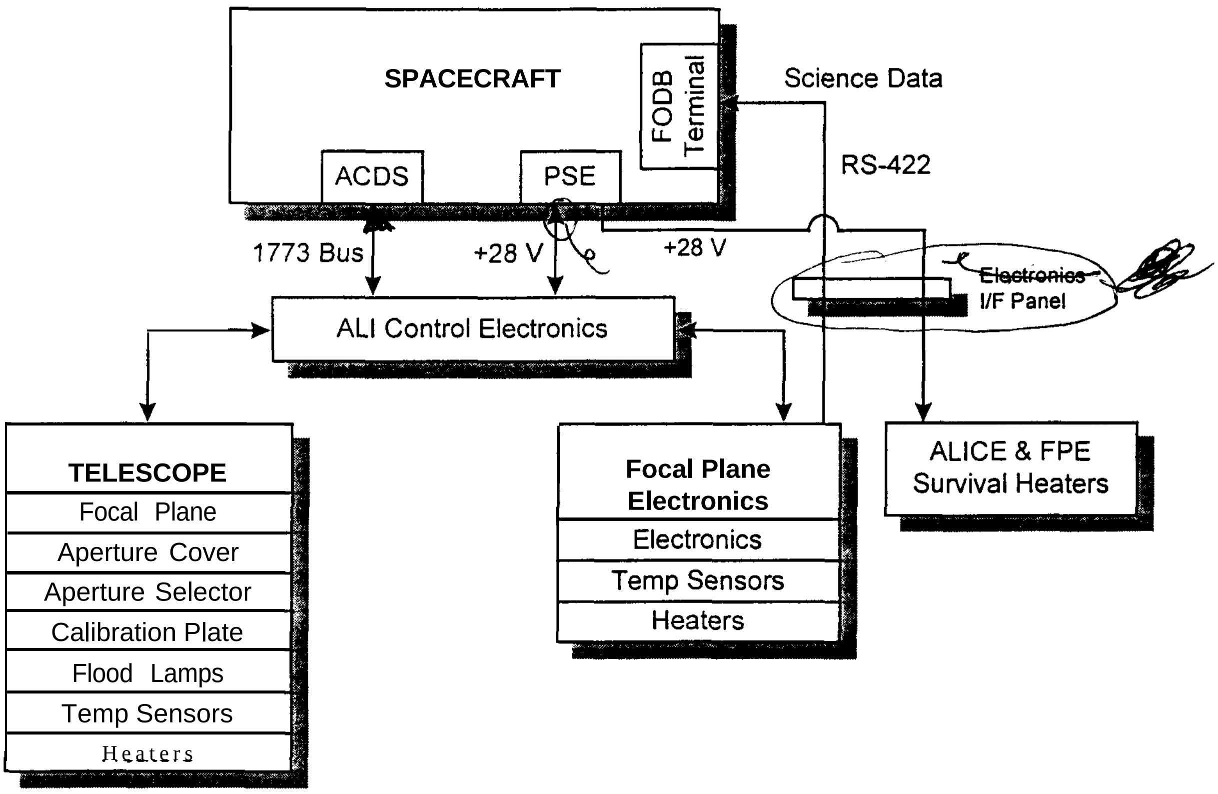


Figure 3.5 Instrument Electrical Block Diagram

3.3.2 POWER REQUIREMENTS

3.3.2.1 Description

The spacecraft operating bus voltage is 28 V ±7, with power characteristics as specified in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155). The instrument provider shall ensure that the instrument shall successfully operate within this power regime.

3.3.2.2 Power/ Load Characteristics

As specified in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.2.2.1 **Power Distribution**

The total ALI power allocation (including heaters) is as follows:

Nominal operation, orbit average	**<75 watts**
ALI Power off (survival) modes	<35 watts (heater power supplied by spacecraft)
Peak instrument power	180 watts for three minutes

3.3.2.2.2 **Noise Suppression**

All inductive loads associated with the instrument, such as relay coil circuits shall be provided with suppression circuits to prevent excessive transients and associated EMC noise due to power interrupts as per System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.3.2.2.3 **Load Profile**

The typical load profile of the instrument is illustrated in Figure 3.6. The ALI will be in its idle mode when not gathering data or preparing for gathering data. During safehold (satellite in sun-acquisition attitude), power to the ALI will be off.

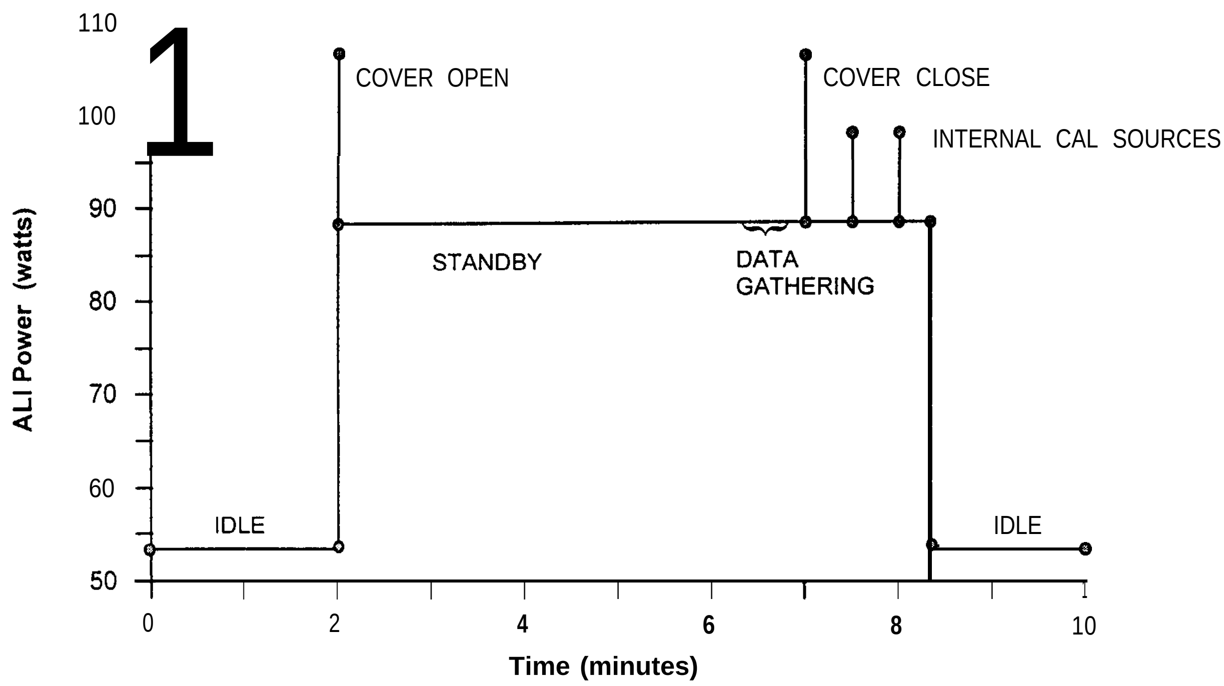


Figure 3.6 Typical ALI Power Profile During an Observation

3.3.2.2.4 Fusing

The power service to the ALI is switched by a solid-state power controller with a current limit of 15 amps. (The switch is de-rated to 10 Amps.) The controller acts as a circuit breaker and can be reset on orbit.

3.3.3 COMMAND and TELEMETRY REQUIREMENTS

All ALI commands and housekeeping telemetry are received from and sent to the spacecraft via the 1773 I/F. Details are described in the command and telemetry handbook.

3.3.3.1 Prime Science Data

Science data is transmitted from the ALI via RS-422, with specifications detailed in the WARP I/F documentation.

3.3.3.2 Mission Elapsed Time (MET)/Universal Time (UT) Interface

MET/UT shall be received via the spacecraft 1773 bus in the form of a time packet broadcast as described in Data Systems 1773 Interface Control Document EO-1, Litton/Amecom document AM149-0050(155). The time sent in the time packet is valid at the previous time tone broadcast. The frame start time for ALI science data shall be reported in the 1773 housekeeping data.

3.3.3.3 Housekeeping Requirements

ALI will have several housekeeping monitors, including current monitors, thermal monitors, and a serial digital status report. When the ALI is in the standby or data-gathering mode, housekeeping rate will be 1024 bps or less. Otherwise, in the idle mode housekeeping rate will be 192 bps or less.

3.3.3.3.1 Prime Power Current Monitors

Prime power current monitors are contained within the EO-1 spacecraft power distribution. ALI will monitor current distribution to instrument components and incorporate this information into housekeeping telemetry.

3.3.3.3.2 Thermal Monitors

The EO-1 spacecraft will provide the thermal monitors on the spacecraft nadir deck to provide a gross measurement of the ALI thermal balance, to provide a thermal measurement for EO-1 thermal balance, and for control during safehold. ALI provides no interface other than providing a mounting point on all external monitors. Any critical internal temperature monitors must be coordinated with the spacecraft integrator.

3.3.4 INTERFACE CONNECTORS and PIN ASSIGNMENTS

There are four electrical connections: Optical (1773), power, science-data, and survival-heater power.

3.3.4.1 Description

The instrument provider will fabricate, qualify and provide to the spacecraft integrator all instrument inter-connecting flight harness. The spacecraft provider will supply harnessing up to the ~~electrical I/F plate and up to the~~ ALICE box (1773 and power).

Table 3.3 delineates the connectors, pin assignments and wiring interfaces for the power connection.

The 1773 connections are specified in Data Systems 1773 ICD EO-1, Litton Amecom document AM149-0050(155), and the RS-422 science-data connections are specified in the WARP I/F documents.

The instrument provider shall supply to the spacecraft integrator three complete sets of flight interface connectors, pins and backshells.

The electrical connections from the spacecraft to the ALICE box (1773 and power) shall be on the -X face of the ALICE box.

3.3.4.2 Connectors

All interface connectors (see Tables 3.3A and 3.38) adhere to the specifications as delineated in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

Refer also to Section 3.5.5 for EMI consideration

Table 3.3A ALI Power Interface Connectors And Pin Assignments

Pin #	Gauge	Function	Remarks
1	~~14~~ 20	Power to ALI, 28 V	Connector type consists of a 5C5 Combo Male Connector, GSFC part # 311 P405-1 OP-B-12
2	~~14~~ 20	Power to ALI, 28 V	
3	Spare	Spare	
4	~~14~~ 20	Return	
5	~~14~~ 20	Return	

Table 3.3B ALI Survival Heater Connector

Pin #	Gauge	Function	Remarks
1	22	ALICE Survival Htr A	Connector type consists of a 9 Pin Female Connector, GSFC part # 311 P409-1 S-B-I 2
2	22	FPE Survival Htr A	
3	22	ALICE Survival Htr B	
4	22	FPE Survival Htr B	
5	22	Spare	
6	22	ALICE Htr A Return	
7	22	FPE Htr A Return	
8	22	ALICE Htr B Return	
9	22	FPE Htr B Return	

The primary side, “Htr A”, is limited to 1 amp, maximum current. The redundant side, “Htr B”, is also limited to 1 amp.

3.3.4.3 Connector Mounting Configuration

The configuration drawings in Section 3.2 show the connector location and orientation on the instrument electronics box and for the interface plate.

3.3.5 ELECTROMAGNETIC COMPATIBILITY

3.3.5.1 EMC Requirements

Table 3.4 describes how the ALI shall meet the EMC requirements as specified in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

3.6.4 SAFETY

The ALI presents no unusual safety hazards. Items presenting potentially hazardous conditions are listed below:

a. Purge System, utilizing gaseous Nitrogen

b. Deployable aperture door

3.7 FUNCTIONAL TESTING

MIT/LL will deliver functional test procedures that collect and check internal lamp data and the FPE test pattern. The procedure will verify correct command and telemetry functionality of the ALI.

4.0 DELIVERABLES

Item	Delivered By	Delivvred	Need Date	Comment
Loads	Swales	MIT/LL	3/1/97	Delivered
ASIST	GSFC	MIT/LL	4/15/97	Delivered
Flight unit ESN	GSFC	MIT/LL	5/31/97	Delivered
Specification of thermal properties of nadir deck MLI	MIT/LL	Swales	6/1/97	Delivered
RSN Operating System	GSFC	MIT/LL	8/1/97	Delivered
ALI Thermal Models	MIT/LL	Swales	8/15/97	Delivered
Drill Template	MIT/LL	Swales	1/1/98	DELIVERED
Focal-Plane Simulator (EGSE-4)	MIT/LL	GSFC	2/1/98	
ALI STM Unit and lifting sling	MIT/LL	Swales	8/1/98	~~[illegible]~~
ALI Flight Unit	MIT/LL	Swales	12/8/98	Must be unpacked & ready to mount on S/C by 12/15/98
Test procedures	MIT/LL	Swales	~~12/15/98~~ 10/15/98	Receive early to accommodate
Science Data Acquisition System (EGSE-1)	MIT/LL	Swales	12/15/98	
Command & Telemetry Processing (EGSE 2 & 3)	MIT/LL	Swales	12/15/98	
Functional test processing S/W	MIT/LL	Swales	12/15/98	
Radiometric Correction Algorithm S/W	MIT/LL	GSFC	3/31/99	

Date: Mon, 26 Jan 1998 08:39:16 -0500 (Eastern Standard Time)
From: Administrator@hst-nic.hst.nasa.gov
Reply-to: (Ed Bicknell/MIT)
Subject: CCR:0002 - DUE: 12/26/97 ROUTINE Level-2 Ed Bicknell/MI WWW-COMMENTS

USER : (Ed Bicknell/MIT) sent the following comments on :

Date: 01/26/1998
CCR Number: 0002
Sponsor: M. Jurotich/EO-1 Payload Mgr
Due Date: 12/26/97

CCR Title: Rev A TO EO-1 SPACECRAFT ALI ICD-18

Remote host: 198.118.115.46 Email Address:

APPROVAL STATUS: APPROVED WITH COMMENTS
Note:

COMMENTS: See attached for comments:

1. Scope

2. Applicable Documents

TBR

AM149-0030 and AM149-0031 were not cited in the signed 6/23/97 version. MIT/LL needs to review these documents.

2.1 Referenced Documents

TBR

ALI Interface Control Drawing A0750 was preliminary on 6/23/97. The FODB Terminal has increased in size thereby increasing thermal loading an ALI radiator. In addition, spacecraft cabling as now shown adds to the radiator thermal loading.

3. Interface Requirements

3.1 Interface Definition

3.1.1 Interface Functions

3.1.1.1 Spacecraft Interface Functions

3.1.1.2 ALI Interface Functions

3.2 Mechanical Interface Requirements

3.2.1 Configuration

3.2.1.1 Coordinate System

3.2.1.2 Fields of Views

Comment

3.2.1.2c had a TBR on 6/23/97. It is suggested that 3.2.1.2 read: The desired keep-out zone is the volume beyond a constant Z-plane that lies parallel to and intersects the surface of the telescope shroud.

3.2.1.3 Mounting Interface

Comment.

.... shall have 30 MIL raised bosses... should read .... shall have 30 mil raised bosses...

3.2.1.3.1 Flatness Specification

3.2.1.3.2 Drill Template

3.2.1.3.3 Mechanical Stability

3.2.1.4 Thermal Mounting Locations

Comment

It is suggested that this paragraph read: Thermistors and heaters shall be mounted as shown in ALI ICD Drawing A0750.

3.2.2 Mass Properties

3.2.2.1 Mass

TBR

It is understood that a revision of this paragraph is being prepared. According to a letter from Dale Schulz dated 1/6/98, the ALI weight limit is 100kg.

3.2.2.2 Center of Gravity

TBR

3.2.2.2 had a TBR on 6/23/97. The ALI does not meet the center of gravity constraint defined in this paragraph. A waiver should be granted if additional hardware design and modifications are not to be undertaken by MIT/LL or Swales, or both.

3.2.2.3 Moment of Inertia

3.2.3 Mechanical Design and Analysis Requirements

3.2.3.1 Structural Design Safety Factors

3.2.3.2 Structural Test Safety Factors

3.2.3.3 Structural stiffness Requirement

Comment

See Section 3.6.1

3.2.3.4 Stress Analysis requirement

3.2.3.5 Fastener capacity

3.2.4 Thermal

Comment

It is suggested that ...nadir deck at 16 to 20 points... should read ...nadir deck at 18 points...

3.2.4.1 Heat Input to Instrument Radiators

TBR

This section does not refer to partial obstruction by the FODB. This section also has omitted the 6/23/97 sentence in the 6/23/97 first paragraph: “The spacecraft shall provide sufficient survival heater power to limit low temperatures of the electronics boxes to -20C and the FPAs (main and grating) to -83C.” See 3.2.4.5. This section also dropped a 6/23/97 paragraph that included a designation of the interface power connection interface point. See 3.3.1.

3.2.4.2 Design Responsibility

3.2.4.3 Thermal Blankets

Comment

The extent of the thermal blanket extension should be reviewed following any possible change in lift point constraints. See 3.2.7.2.

3.2.4.4 Safehold Recovery

3.2.4.5 Survival Heaters

TBR

The 1 Amp current limit now to be provided for heater power supply along with a 28 ± 7 voltage supply swing results in a maximum of 35 watts supplied power, but a minimum of 12.6 watts supplied at the lowest, 21 volt, supply voltage. Thermal analysis indicates the electronic boxes can be below -20C at the at the 21 volt supply voltage. There is a conflict between the need to maintain the electronics boxes at a temperature greater than or equal to -20C and the and the limitations on the heater power supply voltage and current.

3.2.5 Alignment

3.2.5.1 Optical Cube

3.2.6 Pointing Requirements

3.2.6.1 Control and Knowledge

3.2.6.2 Stability

3.2.6.3 Avoidance

3.2.6.4 Uncompensated Momentum

3.2.6.5 Solar Calibration

TBR

3.2.6.5 was a TBR on 6/23/97. Current wording actually refers to an “offset of TBR degrees”... The TBR of the paragraph needs to be resolved with MIT/LL review.

3.2.6.6 Lunar Calibration

TBR

The sequence of events and total time for lunar scan relative to the normal spacecraft orientation must be delineated. In particular, the orientations of the FPA, ALICE, and FPE radiators relative to environmental thermal flux (or lack thereof) must be defined.

3.2.6.7 Safe Mode

Comment

It is suggested that the second sentence of this paragraph read: The spacecraft shall provide power to survival haters for the ALICE and FPE boxes.

3.2.7 ALI Handling Operations and Lift Points

3.2.7.1 Handling Operations

3.2.7.2 Lift Points

TBR

3.2.7.2 had two TBRs on 6/23/97. Consideration is currently being given to changing the Swale's lift point constraints to allow a larger earth shield to be constructed for the ALI FPA radiator.

3.2.8 Access Requirements

3.2.9 GSE Aperture Covers

3.2.10 Nitrogen Purge

TBR

This topic has evolved since 6/23/97. It involves source of the purge, mechanics of the purge, and contamination. Progress has been made in dealing with this subject. However, a clearer and more comprehensive understanding of responsibilities and procedures should be described in the ICD.

3.3 Electrical Interface Requirements

3.3.1 Electrical Interfaces

TBR

It is suggested that this paragraph read:

The ALI focal plane electronics (FPE) box shall be directly connected to the Fiber Optic Data Bus (FODB) as shown on the ALI Interface Control Drawing A0750. Spacecraft power and 1773 connections are at the ALICE electronics box. The power connection for the electronics box survival heaters is at an interface panel also shown on A0750. Figure 3.5 is an electrical block diagram of the ALI.

3.3.2 Power Requirements

3.3.2.1 Description

3.3.2.2 Power/Load Characteristics

3.3.2.2.1 Power Distribution

TBR

3.3.2.2.1 had a TBR on 6/23/97. The TBR concerned Survival Mode heater power, which remains an issue. See 3.2.4.5.

3.3.2.2.2 Noise Suppression

3.3.2.2.3 Load Profile

3.3.2.2.4 Fusing

3.3.3 Command and Telementry Requirements

3.3.3.1 Prime Science Data

3.3.3.2 Mission Elapsed Time/Universal Time Interface

3.3.3.3 Housekeeping Requirements

3.3.3.3.1 Prime Power Current Monitors

3.3.3.3.2 Thermal Monitors

3.3.4 Interface Connectors and Pin Assignments

3.3.4.1 Description

3.3.4.2 Connectors

TBR
Table 3.3B has been added since 6/23/97 and needs to be reviewed by MIT/LL.

3.3.4.3 Connector Mounting Configuration

TBR
Figure 3.2 is does not adequately show detail connector location and orientation.

3.3.5 Electromagnetic Compatibility

3.3.5.1 EMC Requirements

TBR
The dates under the Table 3.4 column “When” need to be brought into agreement with the current schedule scrub.

3.3.5.2 Grounding

3.3.5.3 ESD

TBR
The phrase “as per the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155)” has been added since 6/23/97 and needs to be reviewed by MIT/LL.

3.3.6 Harness

3.3.7 Electrical GSE

3.4 Ordnance Requirements

3.5 Radio Frequency Requirements

3.6 Environmental Requirements

3.6.1 Limit Loads

Comment
The cited load limits have not changed since the reduction of the ALI first mode frequency from 70 to 65 Hz. (Paragraph 3.2.3.3). Why have they not changed?

3.6.2 Random Vibration Test Levels

3.6.3 Acoustic Test Levels

3.6.4 Safety

3.7 Functional Testing

4. Deliverables

TBR

The Item Drill Templates has been delivered. All delivery dates following (in descending order of the table list) ALI STM Unit need to be brought into agreement with the current schedule scrub.

CCR SPONSOR RECOMMENDATION FORM

CCR NUMBER: 0002

CCR TITLE: Rev A to EO-1 Spacecraft ALI ICD-018

CCR SPONSOR: M. Jurotich/GSFC

SUMMARY OF COMMENTS RECEIVED: (list Level 4 CCB and internal reviewers who had comments and address those comments)

Terry Smith/735: The Electrical Interfaces Section should reference the ALI RS-422 to WARP/FODB ICD.

Sponsor Comment: **Reject**. TBR. Will be addressed in **<u>next CCR.</u>**

Mark Perry/Swales:

Section 3.1.1.2 ALI Interface Funcitions: (a) Change ***From***:

a. Transmission of wideband (image) data to the spacecraft WARP.

To: a. Transmission of wideband (image) data to the **FODB Interface Box**.

Sponsor Comment: **Agree**, incorporate with exception to “Interface Box”, use “Instrument Terminal”.

Figure 3.1 EO-1 Configuration: Eliminate I/F Bracket.

Sponsor Comment: **Agree,** however, will accomplish on a **<u>next CCR</u>** to be written, NOT in this B/L version.

Section 3.2.1.4: Thermal Mounting Locations: Change ***From***:

Thermistors and heaters will be supplied by the spacecraft and mounted as shown in ALI Interface Control Drawing A0750.

To: Thermistors and heaters **for the nadir deck** will be supplied by the spacecraft and mounted as shown in ALI Interface Control Drawing A0750.

Sponsor Comment: **Reject.** (SEE ED BICKNELL COMMENT REGARDING SAME)

Section 3.2.2.2 Center of Gravity second sentence: Change ***From***:

The CG of the instrument shall be within the volume defined by a right-angle boxes with corners at (-1, 0, 8) and (1, 5.5, 12) inches in the ALI Coordinate System.

To: The CG of the instrument shall be within the volume defined by a right-angle boxes with corners at (-1, 0, 8) and (1, **6**.5, 12) inches in the ALI Coordinate System.

Sponsor Comment: **Reject:** Put in TBR instead: (1, 5.5 (TBR) 12)

Section 3.2.4.2 Design Responsibility: ***Add*** at the beginning of the first paragraph:

"MIT/LL is responsible for the thermal design of the ALI."

Sponsor Comment: **Agree.**

Section 3.2.4.5 Survival Heaters: ***Delete*** the following text at the end of the paragraph:

"The power connection for the heaters will be at the RS 422 interface plate."

Sponsor Comment: **Reject.** Incorporate "TBR" instead. (Will be addressed in next CCR)

Figure 3-4: ***Delete*** "Winchester Connectors referenced in figure 3-4.

Sponsor Comment: **Agree.** Incorporate change as stated.

Section 3.2.6.7 Safe Mode: Change ***From:***
"The spacecraft shall provide survival heaters for the ALICE…

To: "The spacecraft shall provide **power for the** survival heaters for the ALICE…

Sponsor Comment: **Reject.** In favor of Lincoln Lab revision.

Section 3.2.7.2 Lift Points: Change ***From:***
ALI lifting slings will be designed such that the bottom of the pallet can clear the top deck of the spacecraft, which will be 90 inches below the lifting hook.

To: **MIT/LL shall provide the** ALI lifting slings **which shall** ~~will~~ be designed such that the bottom of the pallet can clear the top deck of the spacecraft, which will be 90 inches below the lifting hook.

Sponsor Comment: **Agree.** Incorporate as written with exception of the stikethrough and bold text noted above.

Section 3.3.1 Electrical Interfaces: Change ***From:***

An RS 422 science data interface connector panel will be located on the instrument pallet near the -x, -y corner of pallet,…

To: A Purge and Survival-Heater interface connector panel will be located on the instrument pallet near the -x, -y corner of pallet,…

Sponsor Comment: **Reject.** This will be addressed in **<u>next CCR.</u>**

Figure 35 Instrument Electrical Block Diagram
Delete: **Electronics** from "Electronics I/F Panel reference.

Add: Arrow head on 1773 Bus from ALI Control Electronics to ACDS on Spacecraft.
Delete: Arrow head on +28 V from ALI Control Electronics to PSE

Sponsor Comment: **Agree.** Incorporate change as noted.

Section 3.3.2.2.4 Fusing: ***Add:*** The following after the first sentence of section.

(The switch is de-rated to 10 AMPs.)

Sponsor Comment: **Agree.** Incorporate as noted with a "TBR" .

Section 3.3.3.3 Housekeeping Requirements: Change last sentence of section ***From:***

Otherwise, in the idle mode housekeeping rate will be 192 bps less.

To: Otherwise, in the idle mode housekeeping rate will be 192 bps **or** less.

Section 3.3.4.1 Description: Change ***From:***

The spacecraft will supply harnessing up to the electrical I/F plate and up to the ALICE box (1773 and power).

To: The spacecraft will supply harnessing up to the ALICE box (1773 and power).

Sponsor Comment: **Reject.** Put TBR**-** Will address in **<u>next CCR.</u>**

Table 3.3A ALI Power Interface connectors and Pin Assignments

Change ***From:*** Gauge 14 (for pins 1, 2, 4 & 5)
To: Gauge **20** (for pins 1, 2, 4 & 5)

Sponsor Comment: **Agree.** Incorporate as noted. With "TBR"

Section 4.0 Deliverables

Add: **"Delivered"** to Drill Template

Change Need date on Test Procedures ***From:*** 12/15/98
To: 10/15/98

Sponsor Comment: **Agree.** Make change as noted, with "TBR".

<u>Ed Bicknell/MIT Comments:</u>

<u>Applicable Documents</u>

TBR
AM149-0030 and AM149-0031 were not cited in the signed 6/23/97 version. MIT/LL needs to review these documents.

Sponsor Comment: **Agree.** Note "TBR".

Referenced Documents

TBR
ALI Interface Control Drawing A0750 was preliminary on 6/23/97. The FODB Terminal has increased in size thereby increasing thermal loading an ALI radiator. In addition, spacecraft cabling as now shown adds to the radiator thermal loading.

Sponsor Comment: **Agree.** Add "TBR"

Comment
3.2.1.2c had a TBR on 6/23/97. It is suggested that 3.2.1.2 read: The desired keep-out zone is the volume beyond a constant Z-plane that lies parallel to and intersects the surface of the telescope shroud.

Sponsor Comment: **Agree.** Incorporate as noted.

Mounting Interface

Comment.
.... shall have 30 MIL raised bosses... should read .... shall have 30 mil raised bosses...

Sponsor Comment: **Agree.** Incorporate as noted.

Flatness Specification

Drill Template

Mechanical Stability

Thermal Mounting Locations

Comment
It is suggested that this paragraph read: Thermistors and heaters shall be mounted as shown in ALI ICD Drawing A0750.

Sponsor Comment: **Agree.** Incorporate as noted.

Mass Properties

Mass

TBR
It is understood that a revision of this paragraph is being prepared. According to a letter from Dale Schulz dated 1/6/98, the ALI weight limit is 100kg.

Sponsor Comment: **Agree.** Incorporate "TBR". Will be addressed in **next CCR**

Center of Gravity

TBR
3.2.2.2 had a TBR on 6/23/97. The ALI does not meet the center of gravity constraint defined in this paragraph. A waiver should be granted if additional hardware design and modifications are not to be undertaken by MIT/LL or Swales, or both.

Sponsor Comment: **Agree.** Incorporate “TBR”. To be addressed in **<u>next CCR.</u>**

Moment of Inertia

Mechanical Design and Analysis Requirements

Structural Design Safety Factors

Structural Test Safety Factors

Structural stiffness Requirement

Comment
See Section 3.6.1

Sponsor Comment: **Reject.** Comment not precise.

Stress Analysis requirement

Fastener capacity

Thermal

Comment
It is suggested that ...nadir deck at 16 to 20 points... should read ...nadir deck at 18 points...

Sponsor Comment: **Agree.** Incorporate as noted.

Heat Input to Instrument Radiators

TBR
This section does not refer to partial obstruction by the FODB. This section also has omitted the 6/23/97 sentence in the 6/23/97 first paragraph: ÒThe spacecraft shall provide sufficient survival heater power to limit low temperatures of the electronics boxes to -20C and the FPAs (main and grating) to -83C.” See 3.2.4.5. This section also dropped a 6/23/97 paragraph that included a designation of the interface power connection interface point. See 3.3.1.

Sponsor Comment: **Agree.** Incorporate “TBR”

Design Responsibility

Thermal Blankets

Comment
The extent of the thermal blanket extension should be reviewed following any possible change in lift point constraints. See 3.2.7.2.

Sponsor Comment: **Agree.** (No action required)

Safehold Recovery

Survival Heaters

TBR

The 1 Amp current limit now to be provided for heater power supply along with a 28 ± 7 voltage supply swing results in a maximum of 35 watts supplied power, but a minimum of 12.6 watts supplied at the lowest, 21 volt, supply voltage.
Thermal analysis indicates the electronic boxes can be below -20C at the at the 21 volt supply voltage. There is a conflict between the need to maintain the electronics boxes at a temperature greater than or equal to -20C and the and the limitations on the heater power supply voltage and current.

Sponsor Comment: **Agree.** Incorporate "TBR".

Alignment

Optical Cube

Pointing Requirements

Control and Knowledge

Stability

Avoidance

Uncompensated Momentum

Solar Calibration

TBR

3.2.6.5 was a TBR on 6/23/97. Current wording actually refers to an Òoffset of TBR degreesÓ... The TBR of the paragraph needs to be resolved with MIT/LL review.

Sponsor Comment: **Agree.** Will be addressed in **next CCR.**

Lunar Calibration

TBR

The sequence of events and total time for lunar scan relative to the normal spacecraft orientation must be delineated. In particular, the orientations of the FPA, ALICE, and FPE radiators relative to environmental thermal flux (or lack thereof) must be defined.

Sponsor Comment: **Reject.** S/C capabilities are being specified, not operational constraints.

Safe Mode

Comment

It is suggested that the second sentence of this paragraph read: The spacecraft shall provide power to survival haters for the ALICE and FPE boxes.

Sponsor Comment: **Agree.** Incorporate as noted.

ALI Handling Operations and Lift Points

Handling Operations

Lift Points

TBR
3.2.7.2 had two TBRs on 6/23/97. Consideration is currently being given to changing the SwaleÕs lift point constraints to allow a larger earth shield to be constructed for the ALI FPA radiator.

Sponsor Comment: **Reject.** See Swales suggestion.

Access Requirements

GSE Aperture Covers

Nitrogen Purge

TBR
This topic has evolved since 6/23/97. It involves source of the purge, mechanics of the purge, and contamination. Progress has been made in dealing with this subject. However, a clearer and more comprehensive understanding of responsibilities and procedures should be described in the ICD.

Sponsor Comment: **Agree.** Incorporate “TBR”. To be addressed in **next CCR**

Electrical Interface Requirements

Electrical Interfaces

TBR
It is suggested that this paragraph read:
The ALI focal plane electronics (FPE) box shall be directly connected to the Fiber Optic Data Bus (FODB) as shown on the ALI Interface Control Drawing A0750. Spacecraft power and 1773 connections are at the ALICE electronics box. The power connection for the electronics box survival heaters is at an interface panel also shown on A0750. Figure 3.5 is an electrical block diagram of the ALI.

Sponsor Comment: **Agree.** Incorporate “TBR”. To be addressed in **next CCR**.

Power Requirements

Description

Power/Load Characteristics

Power Distribution

TBR
3.3.2.2.1 had a TBR on 6/23/97. The TBR concerned Survival Mode heater power, which remains an issue. See 3.2.4.5.

Sponsor Comment: **Agree.** Incorporate “TBR.

Noise Suppression

Load Profile

Fusing

Command and Telementry Requirements

Prime Science Data

Mission Elapsed Time/Universal Time Interface

Housekeeping Requirements

Prime Power Current Monitors

Thermal Monitors

Interface Connectors and Pin Assignments

Description

Connectors

TBR
Table 3.3B has been added since 6/23/97 and needs to be reviewed by MIT/LL.

Sponsor Comment: **Agree.** Incorporate “TBR”.

Connector Mounting Configuration

TBR
Figure 3.2 is does not adequately show detail connector location and orientation.

Sponsor Comment: **Agree.** Incorporate “TBR”.

Electromagnetic Compatibility

EMC Requirements

TBR
The dates under the Table 3.4 column ÒWhenÓ need to be brought into agreement with the current schedule scrub.

Sponsor Comment: **Agree.** Incorporate “TBR”.

Grounding

ESD

TBR
The phrase Òas per the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155)Ó has been added since 6/23/97 and needs to be reviewed by MIT/LL.

Sponsor Comment: **Agree.** Incorporate “TBR”.

Harness

Electrical GSE

Ordnance Requirements

Radio Frequency Requirements

Environmental Requirements

Limit Loads

Comment
The cited load limits have not changed since the reduction of the ALI first mode frequency from 70 to 65 Hz. (Paragraph 3.2.3.3). Why have they not changed?

Sponsor Comment: **Reject.** Stiffness should not effect limit loads.

Random Vibration Test Levels

Acoustic Test Levels

Safety

Functional Testing

<u>Deliverables</u>

TBR
The Item Drill Templates has been delivered. All delivery dates following (in descending order of the table list) ALI STM Unit need to be brought into agreement with the current schedule scru

Sponsor Comment: **Agree.** Incorporate “TBR”.

Sponsor Recommendation: Incorporate Changes to document where noted. Unresolved issues will be addressed in another CCR.

SPONSOR/ORGANIZATION: M.Jurotich/GSFC
DATE: 1/28/98

1.0 SCOPE

This interface Control Document (ICD) defines all interface requirements between the Advanced Land Imager (ALI) and the Earth Orbiter-l (EO-1) Spacecraft. The ICD documents all interface-related agreements concluded between MIT-Lincoln Lab (MIT/LL) the ALI contractor, and Swales Aerospace, the spacecraft contractor.

The purpose of this document is to specify the interface requirements in order to assure compatibility between the equipment furnished by the respective contractors. Changes to this document may be proposed by either party for formal approval by the EO-1 Project Office.

This ICD will serve as the controlling technical document between the ALI Instrument and the EO-1 Spacecraft. This ICD shall apply to all phases of ALI/ EO-1 design, assembly, integration, test, launch and operations. This document is controlled by the Goddard Space Flight Center (GSFC) EO-1 project office.

2.0 APPLICABLE DOCUMENTS (TBR)

The following documents of the exact issue shown form a part of the ICD to the extent specified in Sections 3 and 4 of this ICD. In the event of conflict between this ICD and the document referenced herein, the contents of this ICD shall be considered a superseding requirement.

SAI-PLAN-130	EO-1 Integration and Test Plan
SAI-PLAN-138	EO-1 Contamination Control Plan
SAI-SPEC-158	EO-1 Verification Plan and Environmental Specification
	WARP to ALI ICD
AM149-0050(155)	Data Systems 1773 ICD EO-1, Litton Amecom
AM149-0030(155)	EO-1 Uplink Command ICD, Litton Amecom
AM149-0031(155)	EO-1 Telemetry Specification, Litton Amecom
AM149-0042(155)	WIS Spectral Purity & Implications to EO-1 Spacecraft Pointing, Litton Amecom
AM1 49-0020(155)	System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom

2.1 REFERENCED DOCUMENTS

A0750	ALI Interface Control Drawing
	ALI I&T Plan
SAI-STD056	EO-1 Spacecraft Subsystem Allocations and Description
GSFC-PPL	GSFC Preferred Parts List (Latest issue)
MIL-M-38510	General Specification for Microcircuits
MIL-S-19500	General Specification for Semiconductors
MIL-STD1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-STD-975	Standard (EEE) Parts List
MIL-STD202	Test Methods for Electronic and Electrical Components
MIL-STD-883	Test Methods and Procedures for Microelectronics
GEVS-SE	General Environmental Verification Specification for Shuttle & Expendable *W*

3.0 INTERFACE REQUIREMENTS

3.1 INTERFACE DEFINITION

The ALI experiment comprises a reflective triplet telescope with VNIR and SWIR focal planes, electronic control for the focal plane, an electronics package, and a power subsystem. The experiment is a visible, near IR, and short wave IR sensor designed as a technology validation instrument for the next generation of Landsat-like instruments. The ALI interfaces with the spacecraft are defined mechanically/thermally at the spacecraft mounting interfaces, and electrically at the ALI connectors.

3.1.1 INTERFACE FUNCTIONS

The functions provided to the ALI by the spacecraft, and conversely, are delineated in the following sections.

3.1.1.1 Spacecraft Interface Functions

The following major interface functions shall be provided by the spacecraft.

a. Transmission of commands from the spacecraft via the 1773 bus.
b. Provision of Primary Power from 28 ±7 VDC power bus.
c. Provision of mounting interface for ALI telescope to spacecraft.
d. Provision of interfaces accommodating mounting, routing, **and** securing of instrument harness to/on the spacecraft.

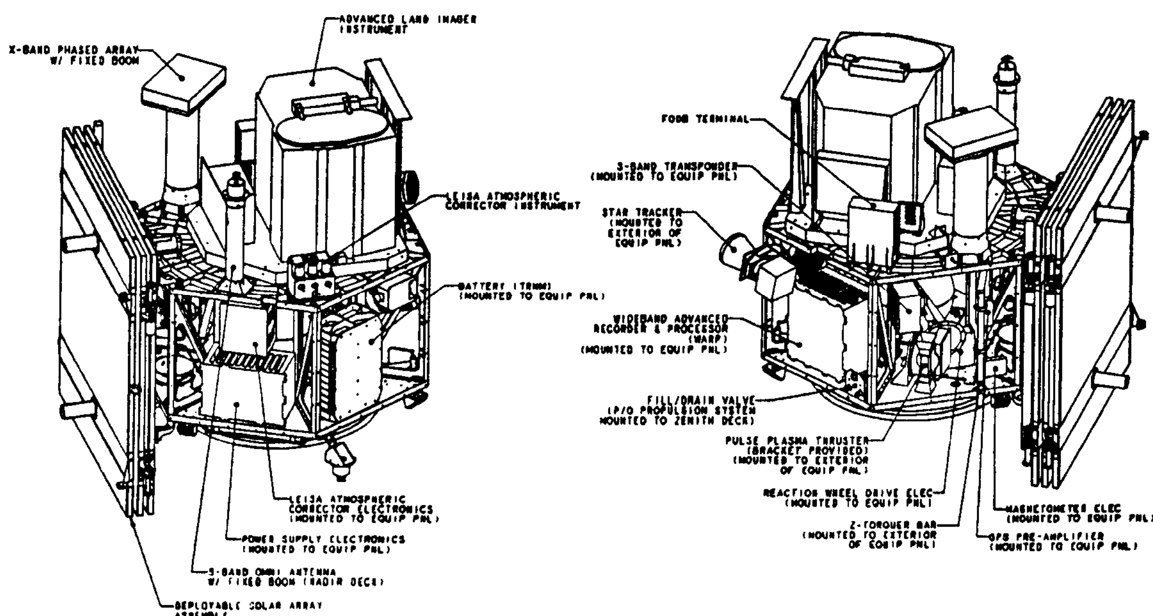
3.1.1.2 ALI Interface Functions

The following major interface functions shall be provided by the ALI.

a. Transmission of **wideband** (image) data to the ~~spacecraft WARP~~. FODB INSTRUMENT TERMINAL
b. Transmission of instrument housekeeping telemetry to spacecraft via the 1773 bus.
c. Provision of mounting interface for ALI telescope to spacecraft.
d. Provision of mounting interfaces for GSE handling fixture attach points on the ALI.

3.2 MECHANICAL INTERFACE REQUIREMENTS

The ALI Instrument consists of the telescope, telescope shroud and two electronic units, and interface cabling. The instrument assemblies are mounted on an instrument pallet that is mounted to **the nadir-**facing deck of the spacecraft. Figure 3.1 is a drawing of the spacecraft.



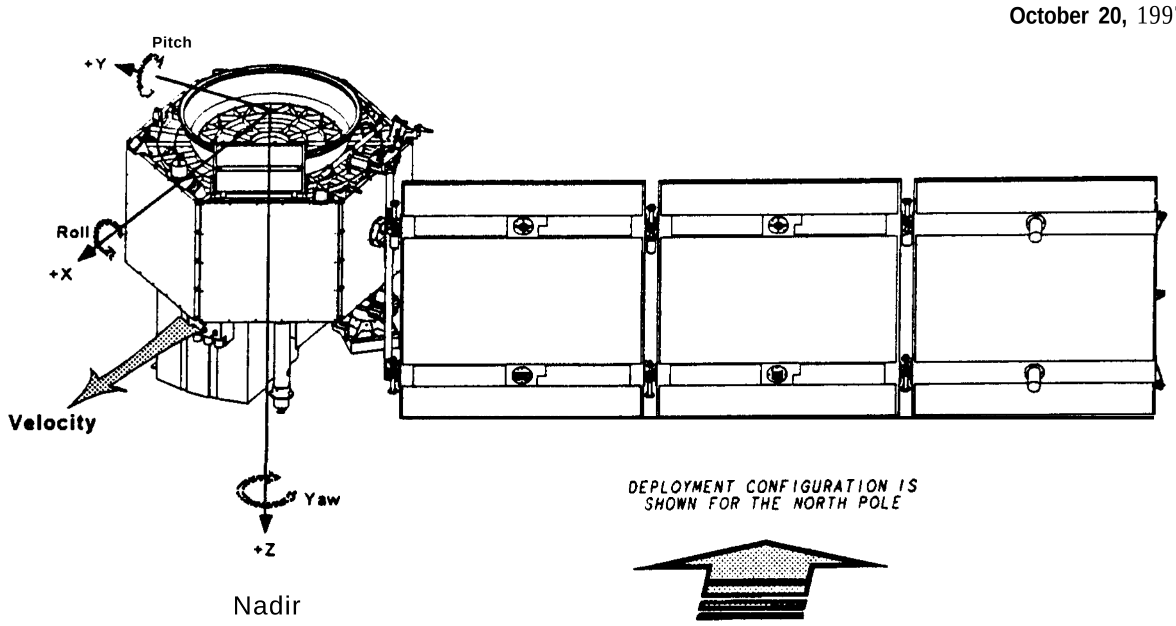


Figure 3.3 **Deployed Spacecraft** with **Coordinate System**
(sun is normal to the page)

3.2.1.2 Fields of View
The **ALI** telescope shall be located on the spacecraft in accordance with the following Field of **View (FOV)** requirements:

a. The **ALI** telescope aperture shall have a clear field of view of 2.26' X 15.5" as shown in **ALI** Interface Control Drawing **A0750.**

b. The telescopes physical entrance port is located in the telescope's top enclosure plate. The plate is perpendicular to the Z axis and sits approximately 26 inches along the Z axis from the **spacecraft/ALI** interface.

c. The desired keep-out zone **is a** constant -Z plane that lies parallel to and intersects the surface of the telescope shroud.

3.2.1.3 Mounting Interface
The **ALI** telescope pallet is hard mounted to the spacecraft nadir deck with 18 **bolts as shown** in **ALI** Interface Control Drawing **A0750.** Both the pallet and the nadir deck shall have 30 **Mil** raised bosses at the bolt locations. One bolt at each of 4 footprint extremities of the pallet shall be a shoulder bolt.

33.1.3.1 Flatness Specification
The mounting points **on** the spacecraft shall not be out of plane more than **0.25mm.**

3.2.1.3.2 Drill Template
A drill template shall be used to transfer the instrument pallet mounting hole pattern to the spacecraft. The template will be provided by **MIT/LL.** The template will use the spacecraft tooling holes as reference points.

3.2.1.3.3 Mechanical Stability
Over the lifetime of the mission, the mounting points shall be stable to 0.25 mm.

3.2.1.4 Thermal Mounting Locations

Thermistors and heaters ~~will be supplied by the spacecraft and~~ mounted as shown in ALI Interface Control Drawing A0750. shall be

3.2.2 MASS PROPERTIES

3.2.2.1 **Mass** (TBR)

The total weight of the ALI instrument shall not exceed 90 kg. All changes in mass estimates, induding expected growth, shall be reported promptly. The final ALI mass shall be reported to an accuracy of 0.25kg.

3.2.2.2 Center of Gravity (TBR)

The CG of the instrument shall be measured to 5 mm accuracy in X and Y, and 20mm accuracy in Z, relative to the spacecraft coordinate system. The CG of the instrument shall be within the volume defined by a right-angle box with comers at (-1, 0, 8) and (1, 5.5, 12) inches in the ALI Coordinate System. (TBR)

3.2.2.3 Moment of Inertia

The moment of inertia and products of inertia of the instrument shall be calculated with 5% accuracy. The MOI shall not exceed I_{XX} = 55,000 lb. in^2, I_{YY} = 45,000, and I_{ZZ} = 32,000.

3.2.3 MECHANICAL DESIGN and ANALYSIS REQUIREMENTS

3.2.3.1 Structural Desian Safetv Factors

All hardware shall be designed and analyzed to the applicable safety factors defined in Table 3.1. The analyses shall indicate a positive margin of safety. MIT/LL is also applying a safety factor of 1.25 on microyield.

All ground support handling hardware shall have a design factor of safety of 5 (ultimate loads) and test to a minimum factor of safety of 2 without any permanent deformation occurring.

Table 3.1

All flight hardware except pressure vessels	Test Qual	Analysis Only
Material Yield Factors =	1.25	2.0
Material Ultimate Factors =	1.4	2.6

3.2.3.2 **Structural Test Safetv Factors**

All hardware shall be tested to safety factors defined in Table 3.2. If hardware is designed to the "analysis - only" safety factor in Table 3.1, then no strength test (quasi-static limit load) is required.

Table 3.2 Limit Load Factors

LAUNCH LOADS	QUAL LEVEL	PROTOFLIGHT LEVEL	ACCEPTANCE LEVEL
Quasi-static limit load	1.25' limit load	1.25' limit load	N/A
Sine vibration	1.25* limit level (see note 1)	1.25' limit level (see note 1)	1 .0* limit load (see note 1)
Random vibration	limit level + 3 dB 2 minutes/axis	limit level + 3 dB 1 minute/axis	limit level 1 minute/axis
Acoustics	limit level + 3 dB 2 minutes	limit level + 3 dB 1 minutes	limit level 1 minute
Shock actual device	2 actuations	2 actuations	1 actuations
simulated	1.4 limit level 2' each axis	1.4 limit level 1* each axis	limit level 1' each axis

Note 1: 25 - 35 Hz 1.5 oct/min; 5 - 25 and 35 - 50 /min for qualification.

3.2.3.3 Structural Stiffness Reauirement
The ALI shall have a first mode frequency greater than 65 Hz.

A finite element model of the spacecraft will be generated to be used in the launch vehicle coupled loads analysis. To aid in this effort, the mass properties of the deliverable hardware will be required. In addition, the first two fundamental structural modes in each of three satellite directions shall be identified. MIT/LL will supply a finite element model.

3.2.3.4 Stress Analvsis Rwuirement
Stress analyses shall be performed to verify the integrity of the component structure and attachments when subjected to the specified loads with the applicable safety factors. Margins of safety shall be determined, dominant failure modes identified and this information transmitted to the satellite integrator. Existing mechanical stress analysis reports and data may be used if applicable.

3.2.3.5 Fastener Capacity
The ALI will be attached to the spacecraft panel using threaded fasteners. The pallet-mounting bolts shall be ¼" NAS 1578, high torque head, with yield and ultimate load factors of at least 2.0 and 2.6. MIT shall supply the fasteners.

3.2.4 THERMAL

The instrument pallet and shroud shall be thermally coupled to the pallet. The instrument electronics boxes shall be thermally isolated from the pallet. The spacecraft is cold biased, using heaters, passive radiators, selective thermal control coatings, and multi-layer insulating (MLI) blankets. The ALI pallet shall contact the spacecraft nadir deck at ~~16 to 20~~ 18 points with no insulation between the nadir deck and the ALI pallet. The spacecraft nadir deck will be held between 0° and 30° C.

3.2.4.1 Heat Input to Instrument Radiators (TBR)
The radiative heat flux from the spacecraft to the focal-plane radiator shall be between 0 and 4 watts with 2 watts as a goal. The FPA Radiator is sized assuming no direct solar heat input. The conductive heat flux from the instrument electronics boxes and radiators shall be between 0 and 5 watts. The radiators are sized assuming hot environment and end-of-life degraded thermal coating properties. The

radiators are sized with enough margin to accommodate partial obstruction of the FOV by spacecraft components such as the X-Band antenna boom.

Three reference thermal monitors will be attached to the outside surfaces of the MLI covering the spacecraft deck; one for the focal-plane radiator, and one each for the instrument electronics boxes (reference Section 3.3.3.3.2).

3.2.4.2 Design Responsibility MIT/LL is responsible for the thermal design of the ALI.

The spacecraft contractor is responsible for the thermal analysis of the combined instrument and spacecraft. **MIT/LL** will supply a thermal design, analysis, and model to the spacecraft contractor. If a structure/thermal/optical-performance (STOP) analysis is necessary, **MIT/LL** will represent the spacecraft using mechanical and thermal data at the interface.

3.2.4.3 Thermal Blankets

MIT/LL is responsible for all externally-located thermal control materials for the instrument. **MIT/LL** will specify the thermal properties of the exterior surfaces of the MLI located on the nadir deck of the spacecraft and at spacecraft components in view of the electronic boxes and radiators. Solar reflections from spacecraft components in view of electronics boxes and radiators shall be minimized wherever possible. The instrument MLI shall extend 7 cm beyond the pallet with **¾"** Velcro (hooks) attached to the side facing the spacecraft.

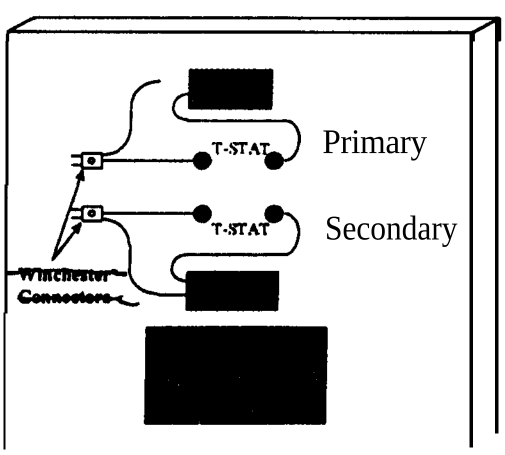
3.2.4.4 Safehold Recovery

The thermal system must operate at nominal performance within 24 hours of exiting safe mode **(sun-**acquisition attitude) and entering nadir-pointing mode.

3.2.4.5 Survival Heaters (TBR)

The two electronics boxes **shall have** redundant, thermostatically-controlled heaters to keep the boxes above survival temperature. **MIT/LL** will attach the thermostats and heaters to the electronics in the location specified by the spacecraft thermal analysts. The power connection for the heaters will be at the RS-422 interface plate.

The spacecraft shall provide up to **35W** of survival heater power to limit the low temperatures of the electronics boxes to **-20°C. MIT/LL** will provide the **Elmwood** 3200 series thermostats, and the **Minco** Kapton insulated thermofoil heaters. The heaters shall be built to the NASA S-31 l-P-079 specification and each thermostat will be set to open at **a** temperature not to exceed **+6°C.** The thermostats shall include **Elmwood** T120 type terminal and 8208 type hermetic bracket. Figure 3.4 shows the heater redundancy concept for each of the two electronics boxes.



Design Philosophy:

Primary thermostat settings are set at **a** higher set point than the ***secondary*** **set** points. For Example:

Primary:

Close@-3°C, Open@3°C

Secondary:

Close@-12°C,Open@-6°C

Protects against single thermostat failure and line failure.

Figure 3.4 Survival **Heater Redundancy Concept**

MIT/LL is responsible for determining the specific location of the heaters and thermostats for each electronics box. The maximum current limit is specified in Table 3.38.

3.2.5 ALIGNMENT

The total worst case repeatable mechanical mounting alignment of the instrument with the spacecraft shall be less than 15 minutes of arc. No provisions shall be made for making alignment adjustments. With the use of l-inch optical cube, the mounting of the instrument to the spacecraft coordinate system shall be measured/determined to an accuracy of better than **+/-** 30 arc seconds.

3.2.5.1 Optical Cube

The location and orientation of the **optical** cube is shown in **ALI** Interface Control Drawing **A0750.**

The line-of-sight of the instrument shall be referenced to the optical cube. An error budget of alignment uncertainties shall show that the vector is known within the accuracy of the instrument or to one arc minute, whichever is greater.

3.2.6 POINTING REQUIREMENTS

3.2.6.1 Control and Knowledae

The spacecraft and instrument shall meet the pointing requirements as defined by the **WIS** Spectral Purity Error Budget contained in the **WIS** Spectral Purity and Implications to EO-1 Spacecraft Pointing, Litton Amecom document **AM149-0042(155).**

3.2.6.2 Stability

The spacecraft will be designed and operated to minimize jiier. The structure is stiff, the solar **array** first mode is **>1** Hz, and the reaction wheels have minimal vibration. During an observation, **the solar array** will be parked and the reaction wheel speed offset to avoid zero crossings. During observations, **the spacecraft will record gyro data for evaluation by the data analysis** team.

3.2.6.3 Avoidance

The attitude control system has no autonomous sun-avoidance or moon-avoidance error checking or restrictions.

3.2.6.4 Uncompensated Momentum

The **ALI** shall not generate **any** uncompensated momentum within the 5 minutes preceding **an** observation. This restriction does not apply during solar calibration.

3.2.6.5 Solar Calibration (TBR)

The spacecraft shall be able to point the **ALI** boresight towards the sun with an offset of TBR degrees, in the range between 0 and 7 degrees in the +Y direction. Total dwell time at the sun shall not exceed 2 minutes. Solar calibration may be conducted as frequently as once per week.

3.2.6.6 Lunar Calibration

The spacecraft shall be able to perform a Raster scan of the moon such that the scan rate is either 0.137 **Deg/sec** or 0.275 **Deg/sec.** The Raster scan shall have five steps to cover each detector chip.

3.2.6.7 Safe Mode

The ALI shall be designed to survive indefinitely in the safe mode, which puts the satellite in an inertial hold where the ALI points away from the sun. The spacecraft shall provide survival heaters for the ALICE and FPE boxes, and, if necessary, a heater for the FPAs (main and grating). Power to

3.2.7 **ALI** HANDLING OPERATIONS and LIFT POINTS

3.2.7.1 Handling Operations

The ALI Integration and Test document includes the handling and installation procedures for the ALI. Protective covers shall be supplied by the ALI contractor for protection of the hardware and electrical connectors. These covers will be on the instrument at all times, except during testing when removal is required to support testing.

3.2.7.2 Lii Points

The maximum allowable manual lift weight during spacecraft integration, which shall is 10 kgs. ALI Interface Control Drawing A0750 shows the lift points of the ALI. MIT/LL shall provide the ALI lifting slings will be designed such that the bottom of the pallet can clear the top deck of the spacecraft, which will be 90 inches below the lifting hook.

3.2.8 ACCESS REQUIREMENTS

Access requirements to the ALI shall be as defined in the AU I&T plan. Access requirements include connector mate/demate dearances, removal and replacement clearances for electronic components and protective covers, and access to purge fittings.

3.2.9 GSE APERTURE COVERS

There will be a red flag cover on the ALI telescope aperture. It will be used to protect the aperture door.

3.2.10 NITROGEN PURGE (TBR)

A clean, dry, oil free, boil-off or MIL-P-27401C Type 1 Grade B nitrogen purge will be maintained to the telescope assembly (Al) at all times up to four hours before launch rocket ignition. The flow rate is 0.1-1 lt/min during I&T and during launch-site operations. The purge may be interrupted for no longer than 2 hours. MIT/LL will provide a portable nitrogen purge cart which will be connected to the instrument through up to 100 feet of purge hose. MIT/LL will supply sufficient liquid nitrogen per day to replenish the boil off from the cart up to transport to the launch pad. MIT/LL will supply the purge cart and I/F requirements.

The spacecraft shipping container will accommodate the ALI purge requirements.

3.3 ELECTRICAL INTERFACE REQUIREMENTS

3.3.1 ELECTRICAL INTERFACES (TBR)

An RS-422 science-data interface connector panel will be located on the instrument pallet near the -X, -Y comer of the pallet, as shown in ALI Interface Control Drawing A0750. Power and 1773 connections are at the ALICE electronics box, The power connection for the electronic box survival heaters is also at the interface panel. Figure 3.5 is an electrical block diagram of the ALI.

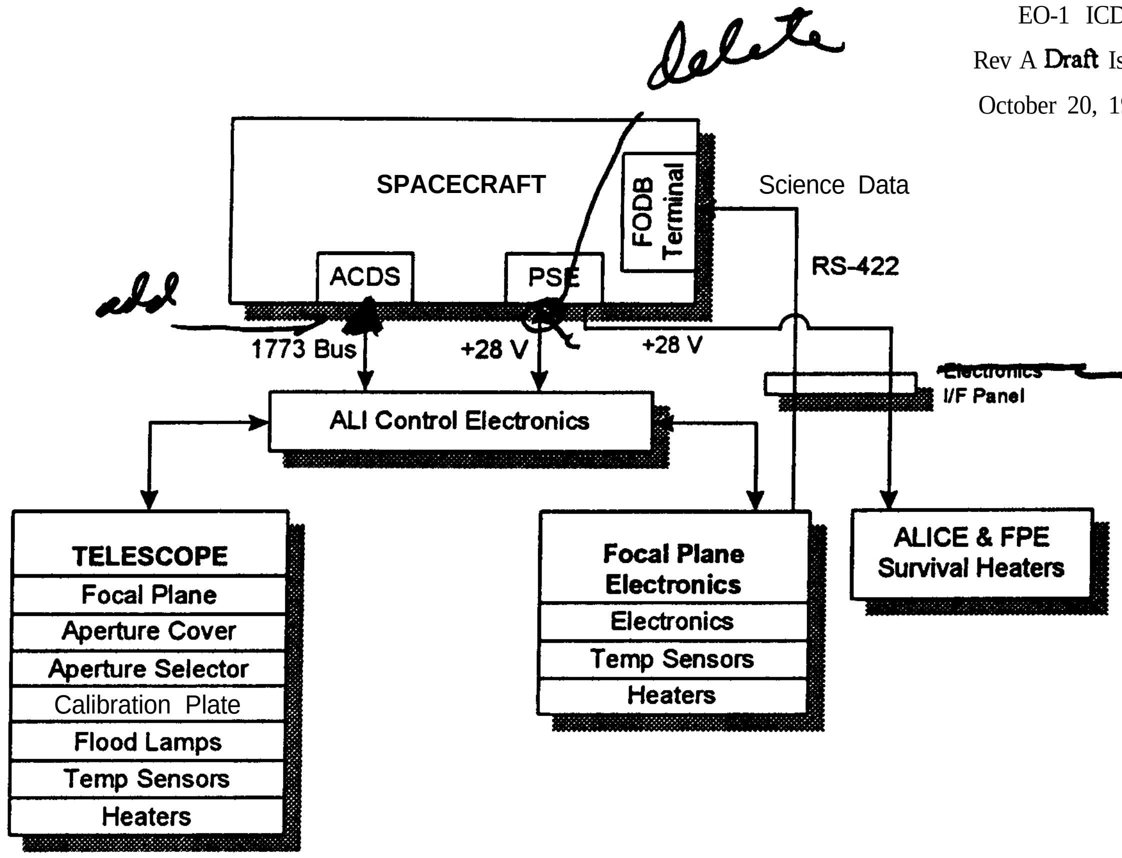


Figure 3.5 Instrument Electrical Block Diagram

3.3.2 POWER REQUIREMENTS

3.3.2.1 **Description**

The spacecraft operating bus voltage is 28 V **±7,** with power characteristics as specified in System Level Electrical Requirements NMP **EO-1** Flight, Litton Amecom document **AM149-0020(155).** The instrument provider shall ensure that the instrument shall successfully operate within this power regime.

3.3.2.2 Power/ Load Characteristics

As specified in System Level Electrical Requirements NMP EC-1 Flight, Litton Amecom document **AM149-0020(155).**

3.3.2.2.1 Power Distribution (TBR)

The total **ALI** power allocation (including heaters) is as follows:

Nominal operation, orbit average	**<75** watts
ALI Power off (survival) modes	**<35** watts (heater power supplied by spacecraft)
Peak instrument power	180 watts for three minutes

3.3.2.2.2 **Noise Suppression**

All inductive loads associated with the instrument, such as relay coil circuits shall be provided with suppression circuits to prevent excessive transients and associated EMC noise due to power Interrupts as per System Level Electrical Requirements NMP EC-1 Flight, Litton Arnecom document **AM149-0020(** 155).

3.3.2.2.3 Load Profile

The typical load profile of the instrument is illustrated in Figure 3.6. The ALI will be in its idle mode when not gathering data or preparing for gathering data. During safehold (satellite in sun-acquisition attitude), power to the ALI will be off.

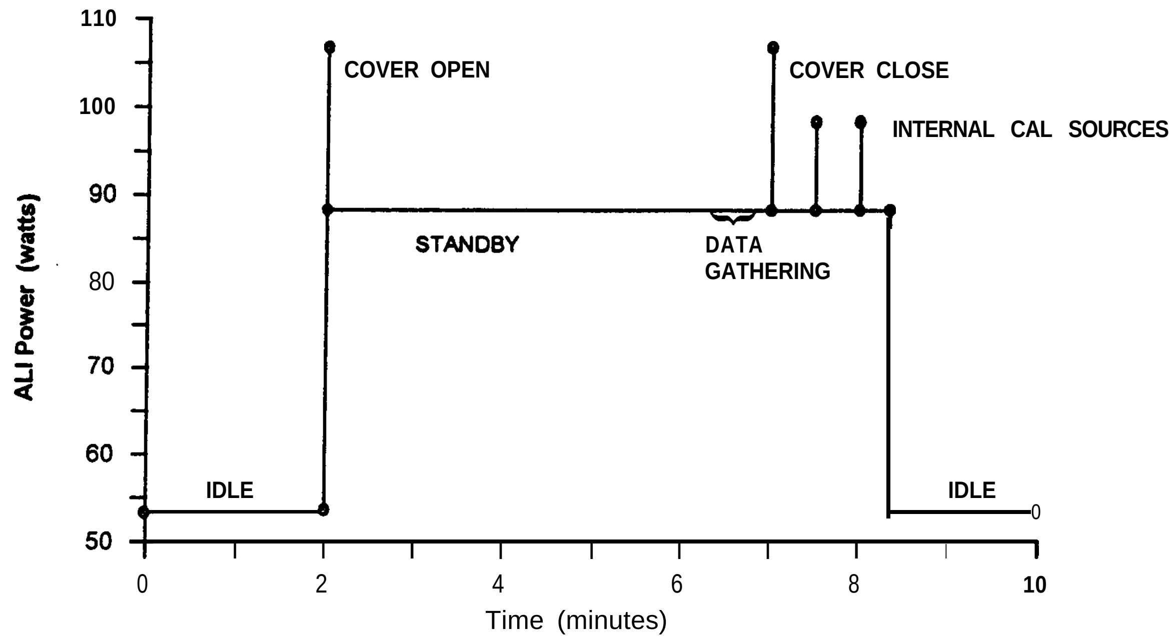


Figure 3.6 **Typical ALI Power Profile During an Observation**

3.3.2.2.4 **Fusing** (TBR)

The power service to the ALI is switched by a solid-state power controller with a current limit of 15 amps. The controller acts as a circuit breaker and can be reset on orbit. (The switch is derated to 10 Amps.)

3.3.3 COMMAND **and TELEMETRY REQUIREMENTS**

All ALI commands and housekeeping telemetry **are** received from and sent to the spacecraft via the 1773 I/F. Details are described in the command and telemetry handbook.

3.3.3.1 Prime Science **Data**

Science data is transmitted from the ALI via RS-422, with specifications detailed in the WARP I/F documentation.

3.3.3.2 Mission **Elapsed Time (MET)/Universal Time (UT) Interface**

MET/UT shall be received via the spacecraft 1773 bus in the form of a time packet broadcast as described in Data Systems 1773 Interface Control Document **EO-1, Litton/Amecom** document **AM149-0050(155).** The time sent in the time packet is valid at the previous time tone broadcast. The frame start time for ALI science data shall be reported in the 1773 housekeeping data.

3.3.3.3 **Housekeeping** Requirements

ALI will have several housekeeping monitors, including current monitors, thermal monitors, and **a** serial digital status report. **When** the **ALI** is in the standby or data-gathering mode, housekeeping rate will be 1024 bps or less. Otherwise, in the idle mode housekeeping rate will be 192 bps less.

3.3.3.3.1 Prime Power Current Monitors

Prime power current monitors are contained within the EO-1 spacecraft power distribution. **ALI** will monitor current distribution to instrument components and incorporate this information into housekeeping telemetry.

3.3.3.3.2 **Thermal** Monitors

The EO-1 spacecraft will provide the thermal monitors on the spacecraft nadir deck to provide **a** gross measurement of the **ALI** thermal balance, to provide a thermal measurement for EO-1 thermal balance, and for control during safehold. **ALI** provides no interface other than providing a mounting point on all external monitors. Any critical internal temperature monitors must be coordinated with **the** spacecraft integrator.

3.3.4 INTERFACE CONNECTORS **and PIN ASSIGNMENTS**

There are four electrical connections: Optical **(1773),** power, science-data, and survival-heater power.

3.3.4.1 Description (TBR)

The instrument provi**der will fa**bricate, qualify and provide to the spacecraft integrator all instrument inter-connecting flight harness. The spacecraft provider will supply harnessing up to the electrical **I/F** plate and up to the ALICE box (1773 and power).

Table 3.3 delineates the connectors, pin assignments and wiring interfaces for **the** power connection.

The 1773 connections are specified in Data Systems 1773 ICD **EO-1,** Litton Amecom document **AM149-0050(155),** and the RS-422 science-data connections are specified in the WARP **I/F** documents.

The instrument provider shall supply to the spacecraft integrator three complete sets of flight interface connectors, pins and backshells.

The electrical connections from the spacecraft to **the** ALICE box (1773 and power) shall be on the **-X** face of the ALICE box.

3.3.4.2 **Connectors**

All interface connectors (see Tables **3.3A** and 3.38) adhere to the specifications as delineated in System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document **AM149-0020(155).**

Refer also to Section 3.5.5 for **EMI** consideration.

Table 3.3A ALI Power Interface Connectors And Pin Assignments (TBR)

Pin #	Gauge	Function	Remarks
1	~~14~~ 20	Power to **ALI,** 28 V	Connector type consists of a
2	~~14~~ 20	Power to **ALI,** 28 V	**5C5** Combo Male Connector,
3	Spare	Spare	GSFC **part #**
4	~~14~~ 20	Return	311 **P405-1** OP-B-12
5	~~14~~ 20	**Return**	

Table 3.38 ALI Survival Heater Connector (TBR)

Pin #	Gauge	Function	Remarks
1	22	ALICE Survival Htr A	Connector type consists of a 9 Pin Female Connector, GSFC part # 311 P409-1 S-B-l 2
2	22	FPE Survival Htr A	
3	22	ALICE Survival Htr B	
4	22	FPE Survival Htr B	
5	22	Spare	
6	22	ALICE Htr A Return	
7	22	FPE Htr A Return	
8	22	ALICE Htr B Return	
9	22	FPE Htr B Return	

The primary side, 'Htr A", is limited to 1 amp, maximum current. The redundant side, 'Htr B", is also limited to 1 amp.

3.3.4.3 Connector Mountina Configuration

The configuration drawings in Section 3.2 show the connector location and orientation on the instrument electronics box and for the interface plate.

3.3.5 ELECTROMAGNETIC COMPATIBILITY

3.3.5.1 EMC Requirements (TBR)

Table 3.4 describes how the ALI shall meet the EMC requirements as specified in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document AM149-0020(155).

Table 3.4 **ALI** EMC Testing Plan

Item	Tests	Where	When
EDU ALICE 8 Mechanisms **- not** a clean test **(W/ Shield Cover over mechanisms & their cables)**	CE01 CE03 CE07 CS01 cso2 CS06 RE01 RE02 RS03 (S & X band TXs only)	**At EMC Lab** **Option: Do in-house**	**Dec. '97**
Flight ALICE -this is a clean test (EDU mechanisms & cables w/shield **cover as above)**	CE01 CE03 CE07	LL Clean Room **in-house test**	Feb. '98
ALI Instrument in flight configuration - this is a clean test S-Band **CMD/TLM Antenna for "RE02 & RS03". Antenna is placed next to ALI as would the flight antenna on EO-1.**	CE01 CE03 CE07 "RE02" (CMD RX Freq.) "RS03" (TLM TX Freq.)	LL Clean Room **in-house test**	Sept. '98

3.3.5.2 Grounding

The grounding scheme utilized in any subsystem or instrument shall be consistent with the grounding philosophy of the payload integrator as described in the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document **AM149-0020(155).**

3.3.5.3 ESD (TBR)

All external surfaces and MLI layers shall be grounded as per the System Level Electrical Requirements NMP EO-1 Flight, Litton Amecom document **AM149-0020(155).**

3.3.6 HARNESS

All internal **ALI** harnesses shall be mounted to **ALI** components such as the pallet.

3.3.7 ELECTRICAL GSE

MIT/LL shall deliver EGSE to spacecraft **I&T when** the **ALI** is delivered. The EGSE will be compatible with spacecraft EGSE. EGSE will be able to:

- simulate the focal-plane data
- collect, store, and verify received focal-plane data
- transmit and process **ALI** commands and **telemetry**

3.4 ORDNANCE REQUIREMENTS

There are no electro-explosive devices used on the **ALI.**

3.6.4 SAFETY

The **ALI** presents no unusual safety hazards. Items presenting potentially hazardous conditions are listed below:

a. Purge System, utilizing gaseous Nitrogen

b. Deployable aperture door

3.7 FUNCTIONAL TESTING

MIT/LL will deliver functional test procedures that collect and check internal lamp data and the FPE test pattern. The procedure **will** verify correct command and telemetry functionality of the **ALI.**

4.0 DELIVERABLES (TBR)

Item	Delivered By	Delivered To	Need Date	Comment
Loads	Swales	MIT/LL	3/1/97	Delivered
ASIST	GSFC	MIT/LL	4/15/97	Delivered
Flight unit ESN	GSFC	MIT/LL	5/31/97	Delivered
Specification of thermal propet-ties of nadir deck MLI	MIT/LL	Swales	6/1/97	Delivered
RSN Operating System	GSFC	MIT/LL	8/1/97	Delivered
ALI Thermal Models	MIT/LL	Swales	8/15/97	Delivered
Drill Template	MIT/LL	Swales	1/1/98	Delivered
Focal-Plane Simulator (EGSE-4)	MIT/LL	GSFC	2/1/98	
ALI STM Unit	MIT/LL	Swales	8/1/98	
ALI Flight Unit	MIT/LL	Swales	12/8/98	Must be unpacked & ready to mount on S/C by 12/15/98
Test procedures	MIT/LL	Swales	~~12~~/15/98	
Science Data Acquisition System (EGSE-1)	MIT/LL	Swales	12/15/98	
Command & Telemetry Processing (EGSE 2 & 3)	MIT/LL	Swales	12/15/98	
Functional test processing SAN	MIT/LL	Swales	12/15/98	
Radiomettic Correction Algorithm S/W	MIT/LL	GSFC	3/31/99	