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Robotic Lunar Exploration Program

Lunar Reconnaissance Orbiter (LRO)

LRO-to-CRaTER Thermal Interface Control Document (TICD)

05/16/2005

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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CM FOREWORD

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ROBOTIC LUNAR EXPLORATION PROGRAM

DOCUMENT CHANGE RECORD

Sheet: 1 of 1

REV LEVEL	DESCRIPTION OF CHANGE	APPROVED BY	DATE APPROVED

List of TBDs/TBRs

Item No.	Location	Summary	Ind./Org.	Due Date

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1.0 INTRODUCTION

The Lunar Reconnaissance Orbiter (LRO) is the first mission of the Robotic Lunar Exploration Program (RLEP). The LRO mission objective is to conduct investigations that will be specifically targeted to prepare for and support future human exploration of the Moon. This mission is currently scheduled to launch in October 2008 and is planned to take measurements of the Moon for at least one year.

1.1 GENERAL

This Interface Control Document (ICD) defines and controls the top level thermal interface between the LRO spacecraft and the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument necessary to manifest, build, test, and successfully fly the LRO mission.

1.2 PURPOSE

The purpose of this ICD is to ensure compatibility between the CRaTER instrument and the LRO spacecraft by:

a. Defining and controlling the interfaces between the instrument and the spacecraft; and

b. Defining top level constraints that shall be observed by the instrument and the LRO spacecraft. The top-level requirements are the general requirements that all subsystems must comply with to fly aboard the LRO mission.

1.3 APPROVAL

Approval of this ICD by the Configuration Control Board shall baseline the LRO spacecraft to instrument interfaces.

1.4 RESPONSIBILITY

The Goddard Space Flight Center (GSFC) has the final responsibility for the LRO mission, the LRO spacecraft, its subsystems, and any requirements specifically assigned to LRO in this document.

Boston University (BU) has the final responsibility for the CRaTER instrument, its subsystems, and any requirements specifically assigned to CRaTER in this document.

CRaTER shall be accompanied by all mechanical, electrical, and thermal GSE necessary to allow for full handling and testing and will be provided by BU.

1.5 CHANGE AUTHORITY

Written revision requests may be generated by BU or GSFC using the ICD Change Request/Approval form of Figure 1-1 and shall be submitted to the LRO Project Manager (GSFC Code 431). Dispositioned changes shall reflect project decisions and will document new, changed, and/or deleted requirements. Internal changes to LRO or CRaTER that do not affect external form, fit, function, or the requirements of this document are not subject to this restriction. It is the responsibility of the LRO Project Manager to distribute the revision requests to the Configuration Control Board for impact evaluation. Upon joint approval of one or more changes, a letter revision of this ICD will be prepared and distributed by the LRO Project Manager. This ICD, with all revisions incorporated, will be stored and maintained by the Code 431 Configuration Management Office. The original issue of this approved ICD shall be effective until modified by revision action. ICD revisions shall become effective when jointly approved.

1.6 APPLICABLE DOCUMENTS

The documents that form a part of this ICD to the extent specified herein are provided in Table 1-1.

Table 1-1: Applicable Documents

DOCUMENT NO.	TITLE
GEVS-SE Rev. A	"General Environmental Verification Specification for STS and ELV Payloads, Subsystems and Components"
431-RQMT-000092	"LRO Thermal Math Model Requirements"
431-SPEC-000091	"LRO General Thermal Subsystem Specification"
431-ICD-00008	"LRO Electrical ICD" {TBR GSFC}
431-ICD-000094	"CRaTER EICD" {TBR GSFC}
431-PLAN-000110	"LRO Contamination Control Plan" {TBR GSFC}
431-ICD-000084	"Instrument Mechanical Interface Control" {TBR GSFC}
431-ICD-000085	"CRaTER MICD" {TBR GSFC}
{TBS BU}	CRaTER TID {TBS BU}

ICD DOCUMENT 431-ICD-000118 CHANGE REQUEST/APPROVAL FORM		
LRO	Date Prepared:	Date Required:
Attach additional pages if required		
Description of Change:		
Justification:		
Submitted by:	Name: Organization: Date:	

Figure 1-1: LRO ICD Change Form

2.0 LRO REFERENCE COORDINATE SYSTEM

The LRO mechanical and thermal reference coordinate system is defined in Document 431-ICD-000085 ("LRO CRaTER Mechanical Interface Control Document"). Figure 2-1 is a copy of the defined coordinate system. Unless otherwise noted, this document shall refer to the LRO reference coordinate system.

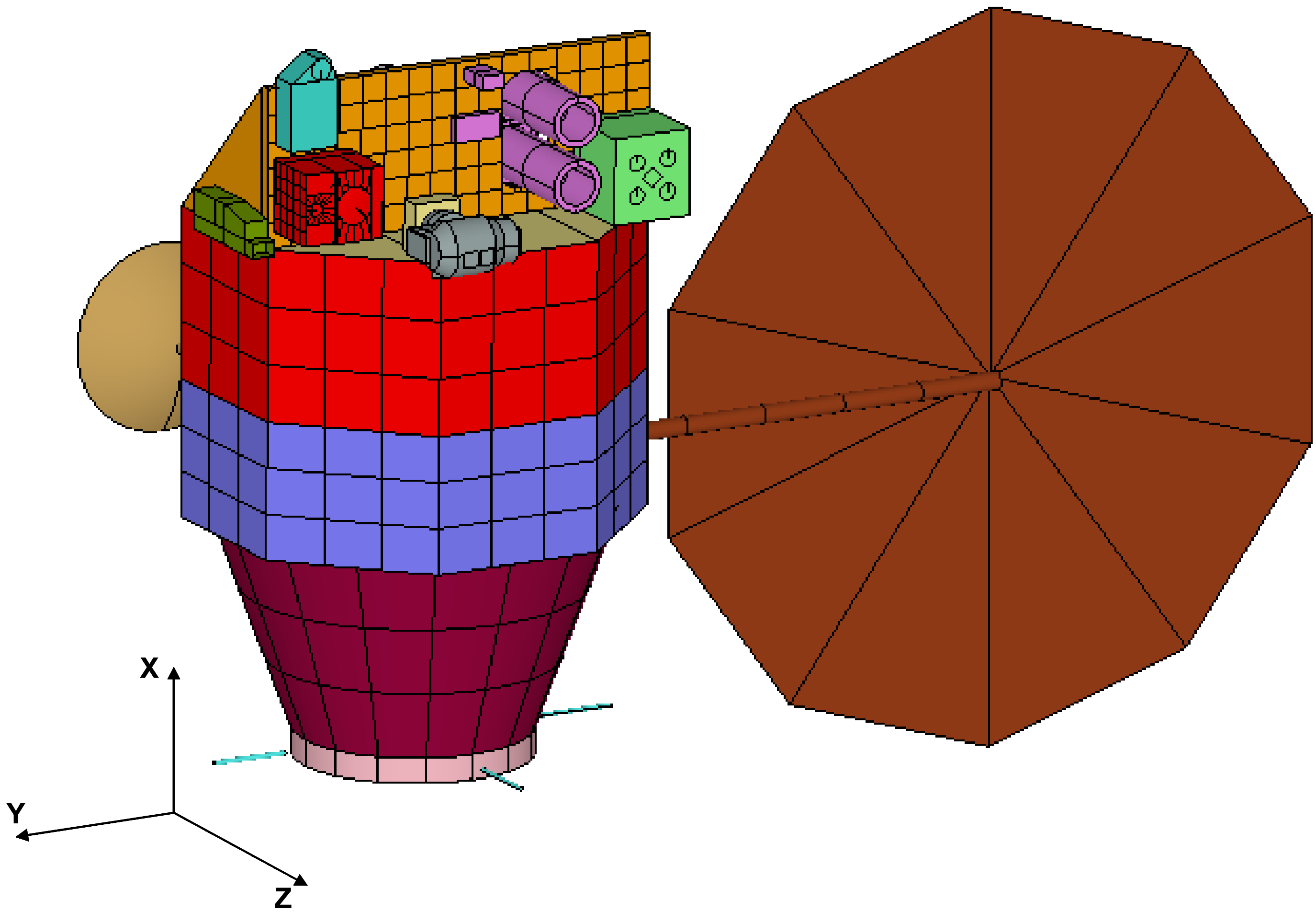

Figure 2-1: LRO Reference Coordinate System Definition

3.0 THERMAL INTERFACES

These requirements apply to all instruments.

3.1 INTERFACE DEFINITIONS

The spacecraft-side interface is defined as the mounting surface on the spacecraft side of the interface.

The instrument-side interface is defined as the mounting surface on the instrument side of the interface.

3.2 INSTRUMENT REFERENCE LOCATIONS

Each Instrument Development Team (IDT) shall choose at least one reference location on each separate instrument assembly (e.g., electronics box, optical component, or detector assembly) at which temperature measurements can validate the thermal design. To support this validation, each location must be equipped with a spacecraft-monitored temperature sensor, be thermally separate from the spacecraft (at least to the degree that heat flow to/from the spacecraft can be quantified) and correspond to a node in the thermal model.

3.3 INSTRUMENT TEMPERATURE LIMITS

Each IDT shall provide four (4) sets of operational limits and four (4) sets of survival limits associated with the above reference location(s). These are the Survival, Current Best Estimate (CBE), Flight Design, and Qualification temperature limits. Refer to Section 2.1 of Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification") for a complete definition of these temperature limit types.

3.4 SPECIFICATION OF INSTRUMENT-SIDE TEMPERATURES

Each IDT shall, in this document:

a. Provide the reference location(s) on a Thermal Interface Control Drawing (TICD) and a brief description of each location and its significance

b. Provide the survival, CBE, flight design and qualification temperature limits for operational and survival modes associated with each reference location per Section 3.2 of this document

c. Identify the node in the reduced thermal models delivered to GSFC corresponding to each reference location

3.5 ADDITIONAL THERMAL INFORMATION

For locations in the instrument that have significantly different temperature limits from the reference location, the IDT shall make each such location a node in its thermal model to be delivered to GSFC.

For locations in the instrument that have significantly different temperature limits from the reference location, the IDT shall provide the flight design limit for each node to the LRO Lead Thermal Engineer. No spacecraft-monitored temperature sensors are required for these additional locations; however, it may be advantageous to place instrument monitored temperature sensors at some or all of these locations.

4.0 SPACECRAFT THERMAL DESIGN CONCEPT {TBR GSFC:WSC}

The instruments and principal component/subsystems comprising LRO are depicted in Figure 4-1. The configuration shown reflects the design 'E' concept. LRO is divided into three (3) major segments plus the Solar Array Assembly (SAA) and High Gain Antenna (HGA). The three segments are the Instrument Module (IM), Avionics Module (AM) and Propulsion Module (PM).

The IM consists of the instrument deck and an optical bench (OB). The instruments are mounted to the OB along with the {TBD GSFC:wsc} (IRU). The OB is a 5.08 cm (2.0 in) thick panel with aluminum honeycomb core sandwiched between two {TBD GSFC:wsc} cm ({TBD GSFC:wsc} in) thick K13C {TBR GSFC:wsc} face sheets. The –Z side of the OB serves as a radiating surface. The +Z side of the OB is covered with multi-layered insulation (MLI) having 15-layers {TBR GSFC:clb}. The outermost layer of the MLI will be 3-mil Kapton.

The AM is an eight-sided structure consisting of panels mounted to a skeletal frame. Each panel is {TBD GSFC:wsc} cm ({TBD GSFC:wsc} in) thick with aluminum honeycomb core sandwiched between two {TBD GSFC:wsc} cm ({TBD GSFC:wsc} in) thick K13C {TBD GSFC:wsc} face sheets. The AM houses the Battery, Command and Data Handling (C&DH) box, Propulsion & Deployable Electronics (PDE) box, Power System Electronics (PSE) box, S-Band Transponder and four (4) Reaction Wheel Assemblies (RWA) {TBD GSFC:wsc}. The RWAs are mounted on the bottom deck while the remaining avionics boxes are mounted on the inboard face of some of the panels. The outboard faces of these panels serve as radiating surfaces to dissipate the heat rejected by the avionics boxes. The remaining panels are covered with multi-layered insulation (MLI).

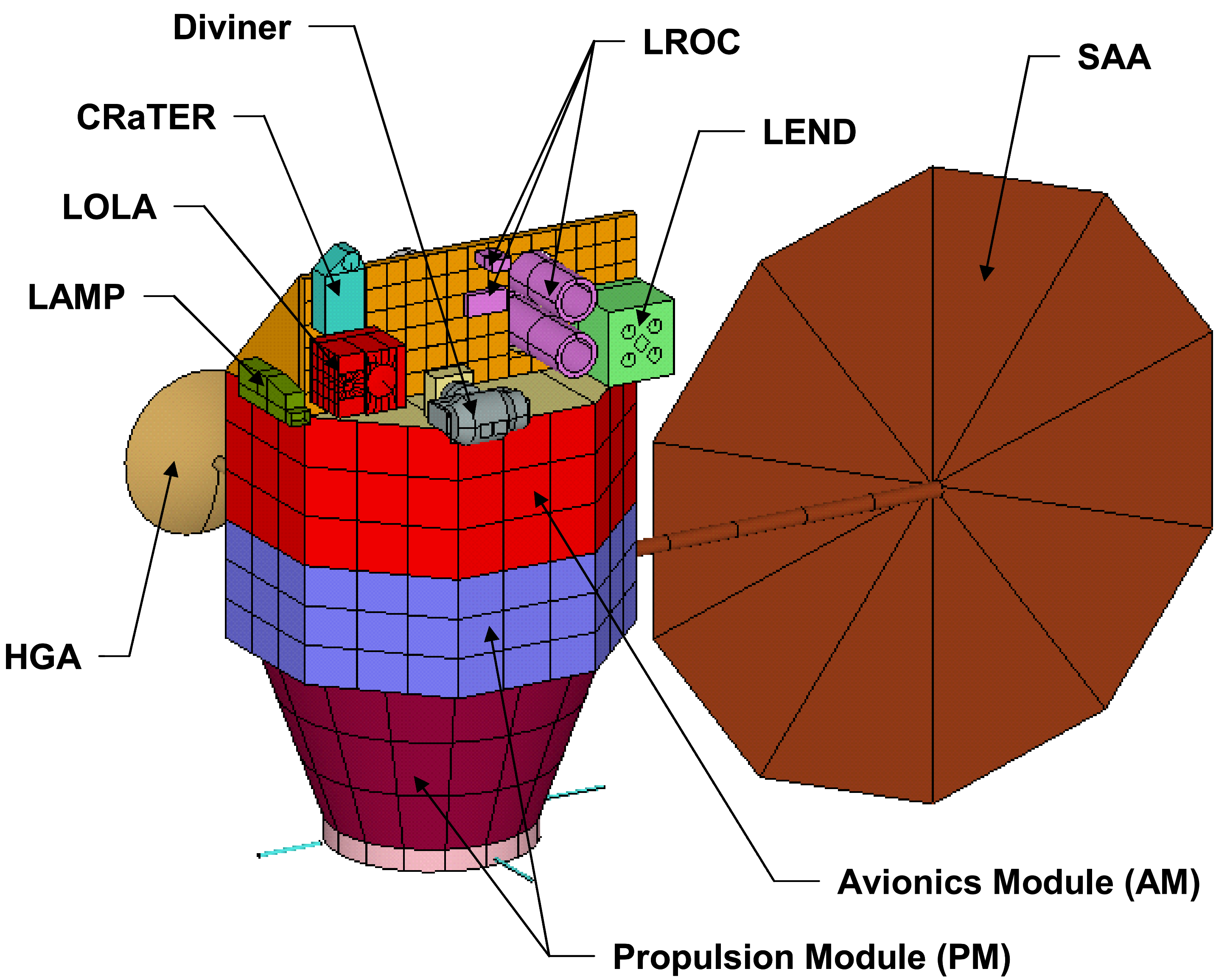
Diviner
LROC
SAA
CRaTER
LEND
LOLA
LAMP
HGA
Avionics Module (AM)
Propulsion Module (PM)

Figure 4-1: LRO Orbiter (Design 'E')

5.0 CRATER THERMAL DESIGN CONCEPT

Provide a brief description of the instrument and thermal design. Provide a picture below. {TBS BU}

Insert picture of CRaTER {TBS BU}

Figure 5-1: CRaTER Instrument

5.1 THERMAL COUPLING

5.1.1 CRaTER-To-Spacecraft Conductive Coupling

The spacecraft shall provide a conductive interface under the footprint of the CRaTER mounting feet.

CRaTER shall conduct no more than {TBD GSFC:wsc} W of power either into or out of the spacecraft during operational modes.

CRaTER shall conduct no more than {TBD GSFC:wsc} W of power either into or out of the spacecraft while in survival mode.

5.1.2 CRaTER-To-Spacecraft Radiative Coupling

The spacecraft Optical Bench (OB) in the vicinity of CRaTER and directly underneath it's footprint shall be covered by MLI. The outer layer of the MLI shall be 3-mil Kapton with an emittance > 0.76. {TBR GSFC:wsc}.

5.1.3 Heat Balance

The total heat exchange rate (conduction and radiation) either into or out of the spacecraft shall be less than {TBD GSFC:wsc} W for all operational modes.

The total heat exchange rate (conduction and radiation) either into or out of the spacecraft shall be less than {TBD GSFC:wsc} W during survival mode.

5.2 INTERNAL CONTROLS

Specify how internal controls will be handled where applicable (e.g., how are operational and survival heaters controlled, how are decontamination heaters controlled, etc.) {TBS BU}

5.3 INTERNAL POWER DISSIPATIONS

Specify minimum and maximum power dissipations and provide power profiles (i.e., mission modes, sunlight vs. eclipse, etc.). {TBS BU}

5.4 THERMAL CONTROL COATINGS

Specify and describe the coatings on all external surfaces that view the spacecraft and/or neighboring instruments/subsystems. Properties for these coatings must be approved by GSFC for use on LRO. {TBS BU}

5.5 THERMAL BLANKETS

BU shall provide and install all MLI that will cover the CRaTER instrument. Blankets shall be 15-layer MLI {TBR BU}. The outermost layer of MLI viewing the spacecraft and neighboring instruments/components will be 3-mil Kapton {TBR BU}. Blanket details are specified in the CRaTER TID {TBD BU}.

5.5.1 Venting Requirements

Blankets shall be adequately vented in accordance with Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification").

Blanket venting details for the CRaTER instrument are provided in CRaTER TID {TBS BU}.

5.5.2 Grounding Requirements

Blankets shall be adequately grounded in accordance with Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification") and Document 431-ICD-00008 ("LRO Electrical ICD").

Blanket grounding details for the CRaTER instrument are provided in CRaTER TID {TBS BU}.

5.5.3 Cleanliness Requirements

Blankets shall be baked-out and meet cleanliness requirements in accordance with Document 431-PLAN-000110 ("LRO Contamination Control Plan").

5.5.4 Blanket Interface with Spacecraft

Refer to Document 431-SPEC-000091 ("LRO General Thermal Subsystem Requirements") for details regarding blanket interface between the spacecraft and the instrument.

6.0 INTERFACE TEMPERATURE REQUIREMENTS

6.1 TEMPERATURE RANGE REQUIREMENTS

The spacecraft has two (2) thermal modes of operation, the operational mode and survival mode. The spacecraft thermal control system (TCS) shall maintain the temperature on the spacecraft-side of the interface within the temperature ranges specified below and in Section 2.3 of Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification") {TBR GSFC:wsc}. Where contradictory values are found, the temperature ranges listed below shall take precedence.

- Operational Range: -30°C to +35°C {TBD GSFC:wsc}
- Survival Range: -40°C to +50°C {TBD GSFC:wsc}

The temperature ranges provided are based on CRaTER being powered "ON" in operational mode and powered "OFF" in safe-hold mode.

BU is responsible for meeting all performance requirements for the CRaTER instrument under the specified temperature range during all mission modes.

6.2 TEMPERATURE RATE-OF-CHANGE REQUIREMENTS

The spacecraft TCS shall maintain the rate-of-change of temperature at the spacecraft-side of the interface within {TBR GSFC:wsc}°C/min during all mission modes.

BU is responsible for meeting all performance requirements for the CRaTER instrument under the specified temperature rate-of-change during all mission modes.

6.3 TEMPERATURE GRADIENT REQUIREMENTS

The spacecraft TCS shall maintain the temporal and spatial temperature difference between any two mounting feet on CRaTER within the values specified below and in Sections 2.4 and 2.5 of Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification") {TBR GSFC:wsc}. Where contradictory values are found, the temperature gradients listed below shall take precedence.

- Temporal Gradient: < {TBS BU}°C
- Spatial Gradient: < {TBS BU}°C

BU is responsible for meeting all operational performance requirements for the CRaTER instrument under the specified temperature gradient during all operational modes.

7.0 TEMPERATURE MONITORING

7.1 CRATER REFERENCE LOCATIONS

The spacecraft shall allocate two (2) spacecraft-monitored temperature sensors to the CRaTER instrument to be located on the instrument-side of the interface at their discretion. GSFC is responsible for providing the temperature sensors. The type of sensor used is specified in Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification").

A description of sensor locations along with their representative node in the thermal model is provided in Table 7-1. Operational and survival temperature limits for these locations are provided in Sections 7-5 and 7-6, respectively, {TBR GSFC:wsc} of this document. Refer to CRaTER TID {TBD BU} for exact locations.

Table 7-1: CRaTER Reference Locations

#	DESCRIPTION	INT. / EXT.	SUBMODEL	NODE #
1	{TBS BU}	Internal		
2	{TBS BU}	External		

7.2 EXTERNALLY MOUNTED S/C TEMPERATURE SENSORS

GSFC is responsible for installing all externally mounted spacecraft-monitored temperature sensors specified in the CRaTER TID {TBR BU}.

7.3 INTERNALLY MOUNTED S/C TEMPERATURE SENSORS

BU is responsible for installing all internally mounted spacecraft-monitored temperature sensors specified in the CRaTER TID {TBR BU}.

7.4 INSTRUMENT MONITORED TEMPERATURE SENSORS

BU is responsible for providing and installing all temperature sensors that will be monitored by the instrument. The locations of these sensors are specified in the CRaTER TID {TBR BU}.

7.5 OPERATIONAL TEMPERATURE LIMITS

During all mission operational modes when the instrument is powered "ON", GSFC shall be responsible for maintaining the instrument within its flight design operational temperature limits via the spacecraft thermal control system. A list of survival, CBE, flight design and qualification operational temperature limits is provided in Table 7-2.

Table 7-2: CRaTER Reference Location Operational Temperature Limits

#	DESCRIPTION	NODE#	MIN/MAX TEMP. LIMITS (°C)			
			SURV.	CBE	DESIGN	QUAL.
1	{TBS BU}					
2	{TBS BU}					

7.6 SURVIVAL TEMPERATURE LIMITS

During all mission safe-hold modes when the instrument is powered "OFF", GSFC shall be responsible for maintaining the instrument within its qualification survival temperature limits via the spacecraft thermal control system. A list of survival, CBE, flight design and qualification survival temperature limits is provided in Table 7-3.

CRaTER shall survive without damage or permanent performance degradation if powered "ON" anywhere within the qualification survival temperature limits.

Table 7-3: CRaTER Reference Location Survival Temperature Limits

#	DESCRIPTION	NODE#	MIN/MAX TEMP. LIMITS (°C)			
			SURV.	CBE	DESIGN	QUAL.
1	{TBS BU}					
2	{TBS BU}					

7.7 ADDITIONAL THERMAL INFORMATION

In addition to the reference locations provided above, there are {TBD BU} critical components that shall be monitored by the instrument and/or tracked in the thermal models. A listing of the operational and survival temperature limits and their representative nodes in the thermal model is provided in Tables 7-4 and 7-5.

Table 7-4: CRaTER Critical Node Operational Temperature Limits

#	DESCRIPTION	NODE#	MIN/MAX TEMP. LIMITS (°C)			
			SURV.	CBE	DESIGN	QUAL.
1	{TBS BU}					
2	{TBS BU}					

Table 7-5: CRaTER Critical Node Survival Temperature Limits

#	DESCRIPTION	NODE#	MIN/MAX TEMP. LIMITS (°C)			
			SURV.	CBE	DESIGN	QUAL.
1	{TBS BU}					
2	{TBS BU}					

8.0 HEATERS

8.1 GENERAL REQUIREMENTS

Sizing of operational and survival heater capacity shall be based on 70% duty cycle (43% margin) at 24V {TBR GSFC:clb} bus voltage and cold case thermal conditions. Heater elements must be capable of operating over the voltage range of 28 ± 7V.

Each instrument will provide space for mounting thermostats and temperature sensors.

Watt densities of the operational and survival heaters shall be appropriate for the type of heater and bonding method. Watt densities (at the maximum voltage) above 0.16 W/cm^2 (1.0 W/in^2) shall be discussed with the GSFC LRO Lead Thermal Engineer and may require (if a Kapton heater) bonding with Stycast 2850FT and aluminum over-taping up to 1.24 W/cm^2 (8.0 W/in^2).

8.2 OPERATIONAL HEATERS

GSFC shall provide any operational heaters, cabling and thermostats that are necessary. Any such heaters and associated hardware may be mounted either on the spacecraft, the CRaTER, or both. The placement of heaters shall be negotiated between GSFC and BU. GSFC shall install and the spacecraft shall control any such operational heaters, as needed, to maintain the temperatures on the spacecraft-side of the mounting interface within the operational temperature range specified in Section 6.1 {TBR GSFC:wsc} of this document.

8.3 SURVIVAL HEATERS

GSFC shall provide any survival heaters, cabling and thermostats that are necessary. Any such heaters and associated hardware may be mounted either on the spacecraft, the CRaTER, or both. The placement of heaters shall be negotiated between GSFC and BU. GSFC shall install and the spacecraft shall control any such survival heaters, as needed, to maintain the temperatures on the spacecraft-side of the mounting interface within the survival temperature range specified in Section 6.1 {TBR GSFC:wsc} of this document.

8.4 DECONTAMINATION HEATERS

BU to provide a description of decontamination heaters (if applicable), its size, location, and method of control and list any relevant documents/drawings {TBD BU}

9.0 THERMAL MODEL REQUIREMENTS

9.1 GENERAL REQUIREMENTS

Each IDT shall deliver reduced thermal models and temperature predictions for relevant mission modes to GSFC. These models will be integrated with the spacecraft model that is used to generate flight predicted temperatures for various mission phases.

GSFC shall deliver either reduced thermal models of the Orbiter or environmental heating and spacecraft backload information to each IDT. Reduced thermal models allow each IDT to substitute their detailed model for the reduced representation of the instrument and perform any analyses deemed necessary. Environmental heating and spacecraft backload information will be based on the worst hot/cold operational and safe-hold cases for the spacecraft. Each IDT should bear in mind that the worst hot/cold case for the spacecraft may not necessarily be the worst hot/cold case for their instrument.

9.2 ENVIRONMENTAL CONSTANTS

Each IDT shall utilize the environmental constants specified in Document 431-SPEC-000091 ("LRO General Thermal Subsystem Specification").

9.3 THERMAL MODEL FORMATS

Each IDT shall deliver their geometry and thermal math models in the format specified in Document 431-RQMT-000092 ("LRO Thermal Math Model Requirements"). Said document provides specific requirements for model formats, naming conventions, etc. to facilitate integration of instrument models with the spacecraft model and shall be strictly adhered to.

9.4 INSTRUMENT REDUCED THERMAL MODEL REQUIREMENTS

The delivered thermal models shall be a reduced version of the detailed thermal models. The reduced geometry math model (RGMM) and reduced thermal math model (RTMM) shall include an adequate level of detail to predict, under worst case hot and cold conditions, all critical temperatures, including those that drive operational and survival temperature limits and heater power where applicable. Worst case conditions will include variations in season, orbit selection, orbital time, and environmental flux parameters (seasonal and spatial) and a rational combination of the effects of design tolerances, fabrication uncertainties, and degradation due to aging.

The RGMM and RTMM shall be correlated to the detailed models within ±2°C for critical nodes and components and shall include a representative node(s) at the reference location(s).

BU shall deliver an RGMM having no more than 50 surfaces and an RTMM having no more than 75 thermal nodes.

9.5 THERMAL MODEL DOCUMENTATION

The RGMMs and RTMMs delivered to GSFC shall be accompanied by appropriate model documentation as specified in Document 431-RQMT-000092 ("LRO Thermal Math Model Requirements").

9.6 ORBITER DELIVERABLES

GSFC shall deliver either a set of reduced geometry and thermal models of the Orbiter or environmental heating and spacecraft backload information to each IDT.

9.6.1 Reduced Orbiter Thermal Models

For those vendors utilizing the TSS and SINDA software tools, GSFC shall provide an RGMM and RTMM of the complete Orbiter. Each vendor shall delete the representation of their instrument/component and replace it with their own detailed versions of the same. The models may then be used to perform any thermal analyses deemed necessary by the vendor.

The RGMM and RTMM shall be accompanied by model documentation per Document 431-RQMT-000092 ("LRO Thermal Math Model Requirements").

9.6.2 Environmental Heating and Spacecraft Backload Information

For those vendors utilizing thermal software tools other than TSS and SINDA, GSFC shall provide environmental and spacecraft backload information. Backload information will be mapped onto the external surfaces/nodes of the reduced thermal models that were provided to GSFC. In the absence of delivered models, backload information will be mapped onto reduced models developed by GSFC based on information that was available.

Backload information will be based on Orbiter hot, cold, and survival cases only. Note that the Orbiter hot and cold cases may not necessarily be the hot and cold cases for your particular instrument.

Backload information will be provided for each surface/node on a per unit area basis. It will be the responsibility of each vendor to map the backload data onto their detailed models.

10.0 THERMAL VACUUM TEST CONSIDERATIONS

The purpose of this section is to encourage vendors to anticipate, as much as possible, any special requirements and/or needs that may arise during Orbiter Thermal Vacuum (TVAC) testing. These may include, but not necessarily limited to, such items as test heaters or internal test temperature sensors as described below.

10.1 HIGH-VOLTAGE POWER SUPPLIES

During Orbiter TVAC testing, GSFC shall allow any instrument with a high-voltage power supply to outgas for a minimum of twenty-four (24) hours prior to turning on the high-voltage power in the TVAC chamber. {TBR GSFC:clb}

10.2 TEST HEATERS

During Orbiter TVAC testing, the test configuration of the Orbiter in the vicinity of each instrument may not be flight like due to placement of heater panels and cold plates to facilitate testing that will obviously not be present during flight. The primary objective during Orbiter TVAC will be to thermally test the LRO spacecraft. Consequently, test conditions may dictate that the effective sink temperature for some instruments may be colder than during the mission. Each IDT shall anticipate, to the extent possible, such possibilities and provide test heaters to keep the instrument within survival limits.

In such cases, the IDTs shall be responsible for providing their own test heaters, cabling and means of control. Any such heaters and associated hardware need not be flight qualified and shall be mounted on the instrument, not the spacecraft. The IDTs shall install and control any such test heaters, as needed, to maintain the safety of the instrument during TVAC.

Heater leads should be properly labeled and be of sufficient length to allow connection to test chamber heater harnesses.

10.3 TEST SENSORS

Where there is a desire to monitor temperatures of internal components during TVAC, each IDT shall deliver their instruments with the temperature sensor already installed. Temperature sensors used only during testing need not be flight qualified.

Temperature sensor leads should be properly labeled and be of sufficient length to allow connection to test chamber wire harnesses.

10.4 GREEN TAG ITEMS

A list of green tag items to be installed before flight is provided in Document 431-ICD-000085 ("LRO CRaTER Mechanical Interface Control Document"). Table 10-1 lists those green tag items that are applicable with respect to thermal vacuum testing for the CRaTER instrument.

Table 10-1: CRaTER Green Tag Items

ITEM	DESCRIPTION
1	{TBS BU}
2	
3	

10.5 RED TAG ITEMS

A list of red tag items to be removed before flight is provided in Document 431-ICD-000085 ("LRO CRaTER Mechanical Interface Control Document"). Table 10-2 lists those red tag items that are applicable with respect to thermal vacuum testing for the CRaTER instrument.

Table 10-2: CRaTER Red Tag Items

ITEM	DESCRIPTION
1	{TBS BU}
2	
3	

APPENDIX A: ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	DEFINITION
AM	Avionics Module
BU	Boston University
CBE	Current Best Estimate
C&DH	Command and Data Handling
CPL	Capillary Pump Loop
CRaTER	Cosmic Ray Telescope for the Effects of Radiation
Diviner	Diviner Lunar Radiometer Experiment
EICD	Electrical Interface Control Document
ESS	Edge Space Systems, Inc.
FAC	Scale factor card used in SINDA
FOV	Field Of View
GMM	Geometric Math Model
GSFC	Goddard Space Flight Center
HGA	High Gain Antenna
ICD	Interface Control Document
IDT	Instrument Development Team
I/F	Interface
IM	Instrument Module
LAMP	Lyman-Alpha Mapping Project
LEND	Lunar Exploration Neutron Detector
LHP	Loop Heat Pipe
LOLA	Lunar Orbiter Laser Altimeter
LROC	Lunar Reconnaissance Orbiter Camera
LRO	Lunar Reconnaissance Orbiter
MICD	Mechanical Interface Control Document
MID	Mechanical Interface Drawing
MLI	Multi-Layer Insulation
NAC	Narrow Angle Component
NASA	National Aeronautics and Space Administration
OB	Optical Bench
PDE	Propulsion and Deployables Electronics
PSE	Power Systems Electronics
PM	Propulsion Module
RGMM	Reduced Geometric Math Model
RLEP	Robotic Lunar Exploration Program
RTMM	Reduced Thermal Math Model
RWA	Reaction Wheel Assembly
SAA	Solar Array Assembly
SAHGA	Solar Array/High Gain Antenna

S/C	Spacecraft
SCS	Sequencing & Compressor System
SINDA	Systems Improved Numerical Differencing Analyzer
TBD	To Be Determined
TBR	To Be Reviewed
TBS	To Be Supplied
TCS	Thermal Control System
TICD	Thermal Interface Control Document
TID	Thermal Interface Drawing
TMM	Thermal Math Model
TSS	Thermal Synthesizer System
VCHP	Variable Conductance Heat Pipe
VDA	Vapor Deposited Aluminum
VDG	Vapor Deposited Gold
WAC	Wide Angle Component