431-ICD-000085
Revision *B DraftA*
Effective Date: July 17, 2006
Expiration Date: July 17, 2011

Lunar Reconnaissance Orbiter Project

Cosmic Ray Telescope for the Effects of Radiation to Spacecraft Mechanical Interface Control Document

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

CM FOREWORD

This document is a Lunar Reconnaissance Orbiter (LRO) Project Configuration Management (CM)-controlled document. Changes to this document require prior approval of the applicable Configuration Control Board (CCB) Chairperson or designee. Proposed changes shall be submitted to the LRO CM Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

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LUNAR RECONNAISSANCE ORBITER PROJECT

DOCUMENT CHANGE RECORD

REV LEVEL	DESCRIPTION OF CHANGE	APPROVED BY	DATE APPROVED
Rev-	Released per 431-CCR-000034	C. Tooley	10/18/2005
Rev A	Released per 431-CCR-000168	C. Tooley	7/11/2006

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 is focused on obtaining new data that will facilitate returning humans safely to the moon. This mission will launch late in 2008 and will take measurements of the moon for at least one year.

The LRO spacecraft is made up of several modules. The propulsion module interfaces to the launch vehicle and houses the propulsion system. The avionics module houses most of the electronics equipment to run the spacecraft. At the top of the spacecraft is the instrument module where LRO's six instruments are located. LRO also has two deployable components, a solar array and a high gain antenna.

LRO has six instruments to perform its exploration measurements. They are Cosmic Ray Telescope for the Effects of Radiation (CRaTER), Diviner Lunar Radiometer Experiment (DLRE), Lyman-Alpha Mapping Project (LAMP), Lunar Exploration Neutron Detector (LEND), Lunar Orbiter Laser Altimeter (LOLA) and the Lunar Reconnaissance Orbiter Camera (LROC).

The CRaTER will characterize the global lunar radiation environment and its biological impacts. CRaTER will focus on radiation above the 10 Mega-electron Volt (MeV) range. CRaTER employs a stack of detectors embedded within aluminum structure and tissue-equivalent plastic to establish the linear energy transfer of cosmic radiation relevant for human and electronic parts considerations.

1.1 SCOPE

The purpose of this document is to establish the unique mechanical interfaces between the Lunar Reconnaissance Orbiter and CRaTER.

1.2 APPLICABLE DOCUMENTS

431-PLAN-000110	Lunar Reconnaissance Orbiter Contamination Control Plan
431-RQMT-000112	Lunar Reconnaissance Orbiter Technical Resource Allocations
431-SPEC-000008	Lunar Reconnaissance Orbiter Electrical Systems Specification
431-SPEC-000012	Lunar Reconnaissance Orbiter Mechanical Systems Specification
431-SPEC-000113	Lunar Reconnaissance Orbiter Pointing and Alignment Specification
32-01203	Cosmic Ray Telescope for the Effects of Radiation Contamination Control Plan
32-02003.02	Cosmic Ray Telescope for the Effects of Radiation Mechanical-Thermal Interface Drawing
2086898	Spacecraft Assembly Drawing

2.0 COORDINATE SYSTEMS

2.1 SPACECRAFT REFERENCE COORDINATE SYSTEM

The reference coordinate system for the LRO is show in Figure 2.1.1. The origin for this coordinate system is at a center of the spacecraft/launch vehicle interface. The X axis is pointed in the main thrust direction of the orbiter. The Z axis is pointed in the nadir, instrument aperture, direction and the Y axis completes the right handed coordinate system.

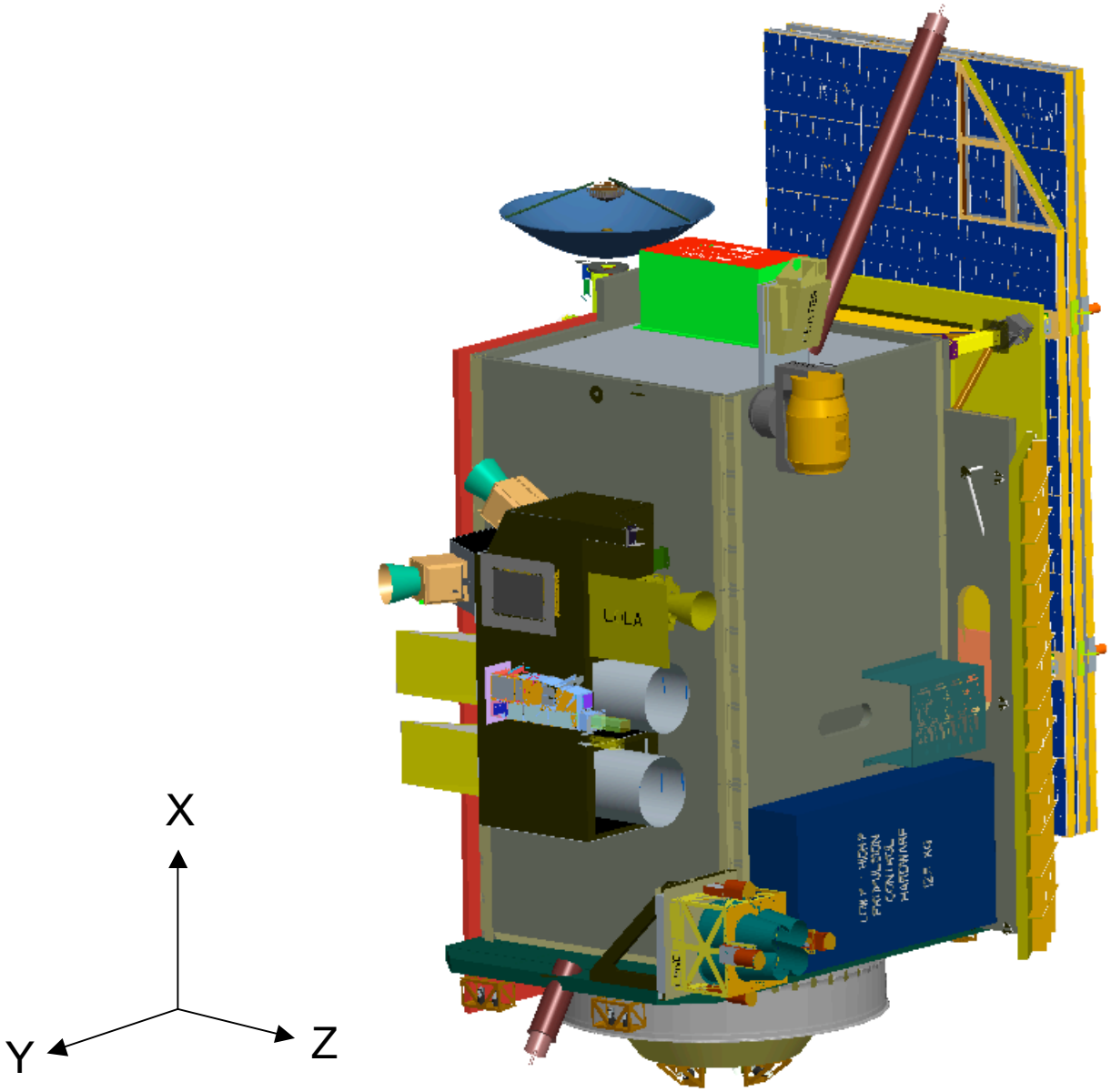

Figure 2-1. LRO Reference Coordinate System

2.2 INSTRUMENT COORDINATE SYSTEMS

The reference coordinate system for CRaTER has its origin at the spacecraft to CRaTER interface and its axes are aligned with the spacecraft reference coordinate system. The CRaTER reference system is shown on the CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

3.0 PHYSICAL PROPERTIES

3.1 MASS PROPERTIES

The mass of the CRaTER instrument shall not exceed its allocation listed in the Lunar Reconnaissance Orbiter Technical Resource Allocations Requirements (431-RQMT-000112).

3.1.1 Mass of Each Instrument Assembly

The CRaTER detector and electronics are all housed within the same assembly. The final as-built mass of the CRaTER Assembly shall be verified by test.

3.1.2 Center of Mass

The center of mass for CRaTER is shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02). The final as-built center of mass *in each axis shall be calculated.*location in the two axes parallel to the mounting plane shall be verified by test. The center of mass location in the axis perpendicular to the mounting plane shall be calculated.

3.1.3 Moments and Products of Inertia

The moments and products of inertia for CRaTER are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02). The final as-built moments and products of inertia for CRaTER shall be calculated.

3.2 PHYSICAL ENVELOPES

*CRaTER and its thermal blanket shall remain within the physical envelope*The physical envelope of CRaTER and its thermal blanket is shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

3.3 FIELDS OF VIEW

3.3.1 Field of Regard

The CRaTER has two fields of regard, one that points in the nadir direction and one that points in the zenith direction. The nadir facing field of regard is an 80 degree full cone angle and the zenith facing field of view is 35 degree full cone angle. These fields of regard are shown on the CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

4.0 MOUNTING

CRaTER attaches to the LRO spacecraft through six mounting feet.

4.1 MOUNTING SURFACE

4.1.1 Spacecraft Mounting Surface

The spacecraft mounting surface flatness for CRaTER shall be no greater than 0.005 inches per 12.0 inches. Surface finish requirements are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

4.1.2 Instrument Mounting Surface

The mounting surface flatness for CRaTER shall be no greater than 0.005 inches over 12 inches. The mounting surface will have a finish of 32 microinches and plating requirement of MIL-C-5541, Class 2.

4.2 MOUNTING HOLE LOCATIONS

CRaTER shall be mounted to the LRO spacecraft with six fasteners through its feet. The locations of these mounting holes are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

4.3 MOUNTING HARDWARE

Standard NAS-1351 shall be used per CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

4.4 MOUNTING HARDWARE PROVIDER

National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center (GSFC) shall provide all fasteners and washers required to mount CRaTER to the spacecraft. All mounting hardware shall be included in the CRaTER mass allocation.

4.5 GROUNDING STRAPS

The CRaTER instrument shall comply with the grounding requirements in Section 3.2 of the Lunar Reconnaissance Orbiter Electrical Systems Specification (431-SPEC-000008). CRaTER will meet this requirement through its mounting feet.

The CRaTER instrument multi-layer insulation (MLI) shall comply with the grounding requirements in Section 3.2 of the Lunar Reconnaissance Orbiter Electrical Systems Specification (431-SPEC-000008). Grounding tabs for the thermal blankets are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

4.6 CONNECTOR LOCATIONS

CRaTER has four connectors. Their locations and keep out zones are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

5.0 ALIGNMENT

The alignment and pointing requirements for CRaTER are documented in Lunar Reconnaissance Orbiter Pointing and Alignment Specification (431-SPEC-000113).

5.1 SPACECRAFT ALIGNMENT REFERENCE

CRaTER does not need to be aligned to the spacecraft reference.

5.2 INSTRUMENT ALIGNMENT CUBE

CRaTER does not have an alignment cube.

5.3 JITTER AND DYNAMIC DISTURBANCES

5.3.1 Spacecraft Jitter and Dynamic Disturbances

Dynamic disturbances from the spacecraft experienced at the base of CRaTER are documented in the LRO Pointing and Alignment Specification (431-SPEC-000113).

5.3.2 Instrument Jitter and Dynamic Disturbances

CRaTER does not have any moving parts and does not produce any dynamic environments.

6.0 ENVIRONMENTS AND VERIFICATION REQUIREMENTS

All mechanical environments and verification requirements are documented in the Lunar Reconnaissance Orbiter Mechanical Systems Specification (431-SPEC-000012). This document includes requirements for mechanical environments, minimum frequency, factors of safety and test factors.

7.0 GROUND SUPPORT EQUIPMENT

7.1 HANDLING FIXTURES

CRaTER does not require any handling fixtures.

7.2 INTEGRATION AND TEST

7.2.1 Ambient Test Hardware

CRaTER will use a hand held calibration source for ambient testing. No other hardware is required.

7.2.2 Thermal Vacuum Test Hardware

CRaTER does not require any hardware for thermal vacuum testing.

8.0 LAUNCH VEHICLE CONSIDERATIONS

8.1 ACCESSS IN LAUNCH VEHICLE FAIRING

CRaTER does not require access while in the launch vehicle fairing. CRaTER will tie into GN2 purge post fairing installation. *The GN2 purge outlet cover must be removed when is hooked up to the the spacecraft purge system.*

8.2 RED TAG ITEMS

CRaTER has no red tag, remove before flight, items.

8.3 GREEN TAG ITEMS

CRaTER has no green tag, install before flight, items.

9.0 CONTAMINATION/ PURGE REQUIREMENTS

9.1 CONTAMINATION CONTROL PLAN

The contamination control requirements for CRaTER are documented in the Lunar Reconnaissance Orbiter Contamination Control Plan (431-PLAN-000110) and the CRaTER Contamination Control Plan (32-01203).

9.2 PURGE

9.2.1 Purge Port Location and Access

CRaTER requires a GN2 purge for at least ten minutes per week through out integration and test, and during launch vehicle processing at the Kennedy Space Center (KSC). The location and access for the purge port are shown on CRaTER Mechanical-Thermal Interface Drawing (32-02003.02).

9.2.2 Other Contamination Considerations

CRaTER has no other contamination considerations.

10.0 MODEL REQUIREMENTS

10.1 COMPUTER AIDED DESIGN (CAD) MODEL REQUIREMENTS

CAD models will be delivered to and from CRaTER in Solid Works format.

10.2 FINITE ELEMENT MODEL REQUIREMENTS

The first frequency of CRaTER is over 75 Hertz and does not need to deliver a finite element model to the LRO Project.

10.3 MASS SIMULATORS

The CRaTER program shall deliver a mass simulator that represents the mass and center of mass of CRaTER. The mass of the mass simulator shall be within 5% of the calculated mass of the CRaTER instrument and the center of mass of the mass simulator shall be within +/- 0.5 inches of the calculated mass of the CRaTER instrument. The mounting hole locations on this simulator shall be to the same tolerances as the flight unit. The mass simulator will be used to verify mounting hole locations on the spacecraft.

Appendix A. Abbreviations and Acronyms

Abbreviation/ Acronym	DEFINITION
CCB	Configuration Control Board
CCR	Configuration Change Review
CM	Configuration Management
CMO	Configuration Management Office
CRaTER	Cosmic Ray Telescope for the Effects of Radiation
DLRE	Diviner Lunar Radiometer Experiment
GN2	Nitrogen
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
KSC	Kennedy Space Center
LAMP	Lyman-Alpha Mapping Project
LEND	Lunar Exploration Neutron Detector
LOLA	Lunar Orbiter Laser Altimeter
LRO	Lunar Reconnaissance Orbiter
LROC	Lunar Reconnaissance Orbiter Camera
MeV	Mega-electron Volts
MIT	Massachusetts Institute of Technology
MLI	Multi-Layer Insulation
NASA	National Aeronautics and Space Center
RLEP	Robotics Exploration Program
RQMT	Requirement
SPEC	Specification
TBD	To be determined
TBR	To be reviewed/resolved