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| 01   | 32-157 | Initial Release for comment | L. Kepko |          |          |
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| A    |        | Some TBRs resolved          | L. Kepko |          |          |
| B    | 32-163 | Resolved TBRs               | P. Ford  | RFG      | 11/02/06 |
|      |        |                             |          |          |          |
|      |        |                             |          |          |          |

**CRaTER**  
**Science Operation Center**  
**Requirements Document**

Dwg. No. 32-01209

Revision B  
 October 25, 2006

# Lunar Reconnaissance Orbiter CRaTER – Science Operations Center Requirements Document

**List of TBDs/TBRs**

| <b>Item No.</b> | <b>Location</b>  | <b>Summary</b>  | <b>Ind./Org.</b>  | <b>Completed</b> |
|-----------------|------------------|---|-------------------|------------------|
| 1               | Interface/export | Determine if we need a requirement for near real-time to SEC and SRAG. May reword requirement to reflect transmission of data to SEC/SRAG w/o levying a particular time window or format. | Kepko<br>07/25/06 | 08/14/06         |
| 2               | CRATER_IF_540    | Does CRaTER still require a weekly reset command?   | Kepko<br>07/25/06 | 08/14/06         |
| 3               | Figure 3-1       | SOC interfaces will need to be reworked once TBR #1 is resolved   | Kepko<br>07/25/06 | 08/14/06         |
| 4               | Section 1.3      | Possible need for real-time data links to SEC and SRAG.   | Ford<br>10/25/06  |                  |

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## 1 Introduction

### 1.1 Purpose

This is the Science Operations Center (SOC) Requirements Document for the Lunar Reconnaissance Orbiter (LRO) Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument team.

### 1.2 Scope

This document contains all requirements levied on the Lunar Reconnaissance Orbiter (LRO) CRaTER Science Operations Center (SOC). Requirements contained herein include functional, interface, and performance requirements placed on the SOC.

### 1.3 Assumptions and Constraints

May need discussion of real-time data links to SEC and SRAG. TBD.

### 1.4 Applicable Documents

The following documents (or latest revisions available) are applicable to the development and execution of this document.

| Document Number | Document Title and Publication Date                                   |
|-----------------|---|
| ESMD-RLEP-00100 | LRO Mission Requirements  |
| 431-OPS-000042  | LRO Mission Requirements Document                                     |
| 431-RQMT-000048 | Detailed Mission Requirements LRO Ground System                       |
| 431-ICD-000104  | Spacecraft to CRATER Data Interface Control Document                  |
| 431-ICD-000049  | Interface Control Document for the Lunar Reconnaissance Ground System |

## 2 Functional Requirements

The functional requirements for the SOC follow.

### 2.1 Operational requirements

CRATER\_FN\_010: The SOC shall perform measurement data processing to produce CRaTER standard data products.

CRATER\_FN\_020: The SOC shall perform measurement data reprocessing to update CRaTER standard data products as required by the science team.

Rationale: If it is determined that, for example, the calibration of the detectors has changed during the course of the mission, the CRATER standard data products will need to be reprocessed.

CRATER\_FN\_030: The SOC shall create the following CRaTER primary data products:

- a. Time-ordered listing of event amplitude in each detector (Level 1).
- b. Linear Energy Transfer (LET) for each processed event (Level 2).
- c. Time-ordered listing of secondary science data (Level 1).
- d. Time-ordered listing of housekeeping data (Level 1).

CRATER\_FN\_040: The SOC shall provide the CRaTER data products (CRATER\_FN\_030) and Level 0 data to the PDS Planetary Plasma Interactions (PPI) Node for archive and distribution.

CRATER\_FN\_050: The SOC shall provide sufficient disk space for:

- a. 10 days of incoming data from the MOC
- b. 10 days of Level 1 derived products
- c. 10 days of Level 2 derived products

CRATER\_FN\_060: The SOC shall provide backup storage for disk space used for software development, user accounts and on-line disk space used for analysis.

CRATER\_FN\_070: The SOC shall provide sufficient disk resources to stage PDS deliverables.

CRATER\_FN\_080: The SOC shall support priority assignment of processing jobs based on input from the science team.

Rationale: For particularly interesting or important events (large Solar Energetic Particle (SEP) events in particular) the SOC may reprioritize the normal processing queue to make these events quickly available to the wider community.

CRATER\_FN\_090: The SOC shall be capable of providing operational and testing configurations.

CRATER\_FN\_110: The SOC networking connections shall be capable of capturing, storing and processing CRATER science and housekeeping at the maximum data rate possible.

Rationale: CRATER has a variable data rate. During high flux events the maximum data rate may be reached, which would lead to file sizes of ~40 megabytes/hour.

## ***2.2 Testing requirements***

CRATER\_FN\_500: The SOC shall provide resources to support the development and maintenance of CRATER measurement data processing software.

CRATER\_FN\_510: The SOC shall provide resources to support testing with the LRO Ground System.

CRATER\_FN\_520: The SOC shall provide resources to support testing with the PDS Planetary Plasma Interactions Node.

### 3 Interface Requirements

The interface requirements for the SOC are included in this section. Figure 3-1 illustrates the SOC interfaces.

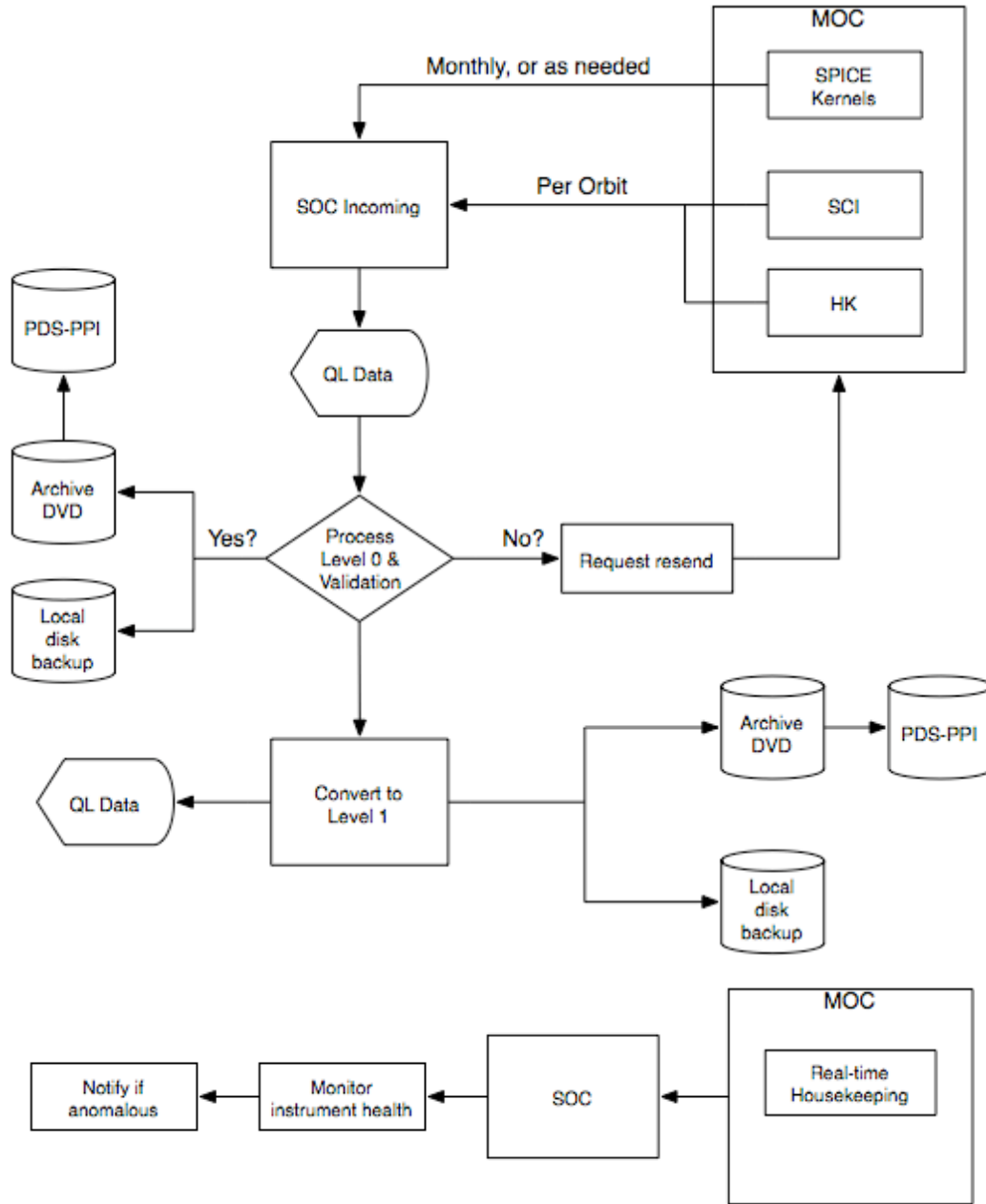


Figure 3-1 SOC Interfaces

The interface requirements for the SOC follow.



### **3.1 SOC Import**

CRATER\_IF\_010: The SOC shall obtain on a per orbit basis CRATER instrument Level 0 science data from the LRO MOC.

CRATER\_IF\_020: The SOC shall obtain on a per orbit basis CRATER instrument housekeeping data from the LRO MOC

CRATER\_IF\_030: The SOC shall obtain real-time housekeeping data provided by the MOC.

CRATER\_IF\_030: The SOC shall obtain the daily stored command load from the LRO MOC.

CRATER\_IF\_040: The SOC shall obtain LRO SPICE SPK data from the LRO MOC on a monthly basis.

CRATER\_IF\_050: The SOC shall obtain LRO SPICE CK data from the LRO MOC on a monthly basis.

CRATER\_IF\_060: The SOC shall obtain CRATER Level 0 data needed for reprocessing from the LRO MOC.

CRATER\_IF\_070: The SOC shall obtain LRO SPICE SCLK, LSK and FK kernels from the LRO as needed.

### **3.2 SOC export**

CRATER\_IF\_500: The SOC shall provide the PDS Planetary Plasma Interactions Node with the following CRATER data products:

- a. Energy deposited in each detector for every processed event.
- b. Linear energy transfer in each detector for every processed event.
- c. CRaTER mass model

CRATER\_IF\_510: The SOC will provide to the LRO MOC instrument command sequences.

## 4 Performance Requirements

The performance requirements for the SOC follow.

CRATER\_PF\_010: The SOC shall take action to start the ingest of incoming data within 3 hours after they are made available by the LRO MOC.

CRATER\_PF\_020: The SOC shall receive data from the LRO MOC on a daily basis 24 hours per day, 7 days per week, and 52 weeks per year.

CRATER\_PF\_030: The SOC shall process CRATER measurement data for the entire nominal mission.

CRATER\_PF\_040: The SOC shall be capable of processing CRATER measurement data for an extended mission, should the mission be extended.

CRATER\_PF\_050: The SOC shall provide standard data products to the PDS PPI Node every 3 months starting at launch +6 months.

CRATER\_PF\_060: The SOC shall provide adequate on-line storage to buffer 10 days of incoming data.

CRATER\_PF\_070: The SOC shall provide adequate on-line storage to buffer 10 days of outgoing data.

CRATER\_PF\_080: The SOC shall provide adequate on-line storage for 10 days of CRATER standard data products.

CRATER\_PF\_100: The SOC shall provide a mechanism for the science team to validate incoming data.

Rationale: Examination of the raw data is not enough to determine if the instrument is functioning properly. The SOC will need to produce quicklook plots that succinctly summarize the incoming data to aid in spotting detector issues.

CRATER\_PF\_110: The SOC shall provide performance and trending information.

**Appendix A Requirements Trace: Higher-level to SOC**

| <b>Higher-level Requirements</b> |  | <b>SOC Requirements</b>  |
|----------------------------------|--|--|
| <b>Requirement ID</b>            | <b>Requirement Text</b>  | <b>Requirement IDs</b>   |
| RLEP-LRO-P90                     | <b>Measurement Investigation Requirements</b><br>The LRO investigation teams shall be responsible for collecting the measurement, engineering, and ancillary information necessary to validate and calibrate the measurement data prior to delivery to the PDS.  | CRATER_FN_010<br>CRATER_FN_020<br>CRATER_FN_030<br>CRATER_FN_040 |
| RLEP-LRO-P100                    | <b>Measurement Investigation Requirements</b><br>Data products delivered to the PDS shall be documented, validated, and calibrated in physical units useable by the exploration and science communities at large.  | CRATER_FN_03<br>CRATER_FN_04<br>CRATER_IF_500<br>CRATER_PF_100   |
| RLEP-LRO-P110                    | <b>Measurement Investigation Requirements</b><br>The time required to complete this process and make the initial data products available via the PDS to the Headquarters and the Program office shall be six months or less from delivery to Earth. New or improved data product releases and derived data products shall be delivered to the PDS as soon as they are available. | CRATER_FN_010<br>CRATER_FN_020<br>CRATER_FN_040                  |
| RLEP-LRO-P120                    | <b>Data Policies and Validation Requirements</b><br>Principal Investigators (PIs) selected for measurement investigations shall plan to archive their Data Products and supporting data in the Planetary Data System (PDS) in a PDS-compliant data format.   | CRATER_FN_040  |
| RLEP-LRO-P140                    | <b>Data Policies and Validation Requirements</b><br>Initial data analyses for the LRO measurement investigations shall be accomplished by the PIs and their teams.   | CRATER_FN_040<br>CRATER_PF_100                                   |

## Appendix B Requirements Trace: SOC to Higher-level

| SOC Requirements   | Higher-level Requirements |  |
|--|---------------------------|--|
| Requirement ID   | Requirement ID            | Requirement Text   |
| CRATER_FN_010<br>CRATER_FN_020<br>CRATER_FN_030<br>CRATER_FN_040 | RLEP-LRO-P90              | <b>Measurement Investigation Requirements</b><br>The LRO investigation teams shall be responsible for collecting the measurement, engineering, and ancillary information necessary to validate and calibrate the measurement data prior to delivery to the PDS.  |
| CRATER_FN_030<br>CRATER_FN_040<br>CRATER_IF_500<br>CRATER_PF_100 | RLEP-LRO-P100             | <b>Measurement Investigation Requirements</b><br>Data products delivered to the PDS shall be documented, validated, and calibrated in physical units useable by the exploration and science communities at large.  |
| CRATER_FN_010<br>CRATER_FN_020<br>CRATER_FN_040                  | RLEP-LRO-P110             | <b>Measurement Investigation Requirements</b><br>The time required to complete this process and make the initial data products available via the PDS to the Headquarters and the Program office shall be six months or less from delivery to Earth. New or improved data product releases and derived data products shall be delivered to the PDS as soon as they are available. |
| CRATER_FN_040  | RLEP-LRO-P120             | <b>Data Policies and Validation Requirements</b><br>Principal Investigators (PIs) selected for measurement investigations shall plan to archive their Data Products and supporting data in the Planetary Data System (PDS) in a PDS-compliant data format.   |
| CRATER_FN_040<br>CRATER_PF_100                                   | RLEP-LRO-P140             | <b>Data Policies and Validation Requirements</b><br>Initial data analyses for the LRO measurement investigations shall be accomplished by the PIs and their teams.   |

## Appendix C Acronyms

|        |   |
|--------|---|
| CDR    | Calibrated Data Record  |
| CK     | Pointing (“C-matrix”)   |
| CODMAC | Committee on Data Management and Computation                    |
| COTS   | Commercial Off The Shelf  |
| CRaTER | Cosmic Ray Telescope for the Effects of Radiation               |
| DEM    | Digital Elevation Model   |
| EDR    | Engineering Data Record   |
| EOM    | End of Mission  |
| E/PO   | Education / Public Outreach                                     |
| FK     | Reference frame specifications                                  |
| GSFC   | Goddard Space Flight Center                                     |
| HK     | Housekeeping  |
| ICD    | Interface Control Document                                      |
| IT     | Information Technology  |
| LRO    | Lunar Reconnaissance Orbiter                                    |
| LSK    | Leap-seconds kernel   |
| MOC    | Mission Operations Center                                       |
| MRD    | Mission Requirements Document                                   |
| NAIF   | Navigation and Ancillary Information Facility                   |
| NASA   | National Aeronautics and Space Administration                   |
| PDS    | Planetary Data System   |
| PPI    | Planetary Plasma Interactions                                   |
| QL     | Quick Look  |
| RDR    | Reduced Data Record   |
| SPICE  | Spacecraft, Planet, Instrument, C-matrix (pointing), and Events |
| SEC    | Space Environment Center (NOAA/Boulder)                         |
| SCLK   | Spacecraft Clock correlation data                               |
| SPK    | Spacecraft and Planet Ephemeris                                 |
| SEP    | Solar Energetic Particles                                       |
| SOC    | Science Operations Center                                       |
| SRAG   | Space Radiation Analysis Group (NASA/JSC)                       |
| TBD    | To Be Determined  |