CRaTER
Science Operation Center
Requirements Document

Dwg. No. 32–01209

Revision B
October 25, 2006
## List of TBDs/TBRs

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Location</th>
<th>Summary</th>
<th>Ind./Org.</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interface/export</td>
<td>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.</td>
<td>Kepko 07/25/06</td>
<td>08/14/06</td>
</tr>
<tr>
<td>2</td>
<td>CRATER_IF_540</td>
<td>Does CRaTER still require a weekly reset command?</td>
<td>Kepko 07/25/06</td>
<td>08/14/06</td>
</tr>
<tr>
<td>3</td>
<td>Figure 3-1</td>
<td>SOC interfaces will need to be reworked once TBR #1 is resolved</td>
<td>Kepko 07/25/06</td>
<td>08/14/06</td>
</tr>
<tr>
<td>4</td>
<td>Section 1.3</td>
<td>Possible need for real-time data links to SEC and SRAG.</td>
<td>Ford 10/25/06</td>
<td></td>
</tr>
</tbody>
</table>
Table of Contents

LIST OF TBDS/TBRS ............................................................................................................. iii

1  INTRODUCTION.................................................................................................................. 1
   1.1 Purpose .............................................................................................................................. 1
   1.2 Scope ................................................................................................................................. 1
   1.3 Assumptions and Constraints ........................................................................................... 1
   1.4 Applicable Documents ...................................................................................................... 1

2  FUNCTIONAL REQUIREMENTS .......................................................................................... 2
   2.1 Operational requirements ................................................................................................ 2
   2.2 Testing requirements ....................................................................................................... 3

3  INTERFACE REQUIREMENTS ............................................................................................ 4
   3.1 SOC Import ...................................................................................................................... 5
   3.2 SOC export ..................................................................................................................... 5

4  PERFORMANCE REQUIREMENTS ....................................................................................... 6

APPENDIX A REQUIREMENTS TRACE: HIGHER-LEVEL TO SOC .......................... 7
APPENDIX B REQUIREMENTS TRACE: SOC TO HIGHER-LEVEL ................................. 8
APPENDIX C ACRONYMS ........................................................................................................ 9
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.

<table>
<thead>
<tr>
<th>Document Number</th>
<th>Document Title and Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESMD-RLEP-00100</td>
<td>LRO Mission Requirements</td>
</tr>
<tr>
<td>431-OPS-000042</td>
<td>LRO Mission Requirements Document</td>
</tr>
<tr>
<td>431-RQMT-000048</td>
<td>Detailed Mission Requirements LRO Ground System</td>
</tr>
<tr>
<td>431-ICD-000104</td>
<td>Spacecraft to CRATER Data Interface Control Document</td>
</tr>
<tr>
<td>431-ICD-000049</td>
<td>Interface Control Document for the Lunar Reconnaissance Ground System</td>
</tr>
</tbody>
</table>
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](image)

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

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirement Text</th>
<th>SOC Requirements</th>
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<tbody>
<tr>
<td>RLEP-LRO-P90</td>
<td><strong>Measurement Investigation Requirements</strong>&lt;br&gt;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.</td>
<td>CRATER_FN_010&lt;br&gt;CRATER_FN_020&lt;br&gt;CRATER_FN_030&lt;br&gt;CRATER_FN_040</td>
</tr>
<tr>
<td>RLEP-LRO-P100</td>
<td><strong>Measurement Investigation Requirements</strong>&lt;br&gt;Data products delivered to the PDS shall be documented, validated, and calibrated in physical units useable by the exploration and science communities at large.</td>
<td>CRATER_FN_03&lt;br&gt;CRATER_FN_04&lt;br&gt;CRATER_IF_500&lt;br&gt;CRATER_PF_100</td>
</tr>
<tr>
<td>RLEP-LRO-P110</td>
<td><strong>Measurement Investigation Requirements</strong>&lt;br&gt;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.</td>
<td>CRATER_FN_010&lt;br&gt;CRATER_FN_020&lt;br&gt;CRATER_FN_040</td>
</tr>
<tr>
<td>RLEP-LRO-P120</td>
<td><strong>Data Policies and Validation Requirements</strong>&lt;br&gt;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.</td>
<td>CRATER_FN_040</td>
</tr>
<tr>
<td>RLEP-LRO-P140</td>
<td><strong>Data Policies and Validation Requirements</strong>&lt;br&gt;Initial data analyses for the LRO measurement investigations shall be accomplished by the PIs and their teams.</td>
<td>CRATER_FN_040&lt;br&gt;CRATER_PF_100</td>
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## Appendix B Requirements Trace: SOC to Higher-level

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Requirement ID</th>
<th>Higher-level Requirements</th>
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| CRATER_FN_010  | RLEP-LRO-P90   | Measurement Investigation Requirements  
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_020  | RLEP-LRO-P90   | Measurement Investigation Requirements  
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  | RLEP-LRO-P100  | Measurement Investigation Requirements  
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_040  | RLEP-LRO-P110  | Measurement Investigation Requirements  
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  | Data Policies and Validation Requirements  
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  | Data Policies and Validation Requirements  
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