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CRaTER
Science Operation Center
Requirements Document

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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.

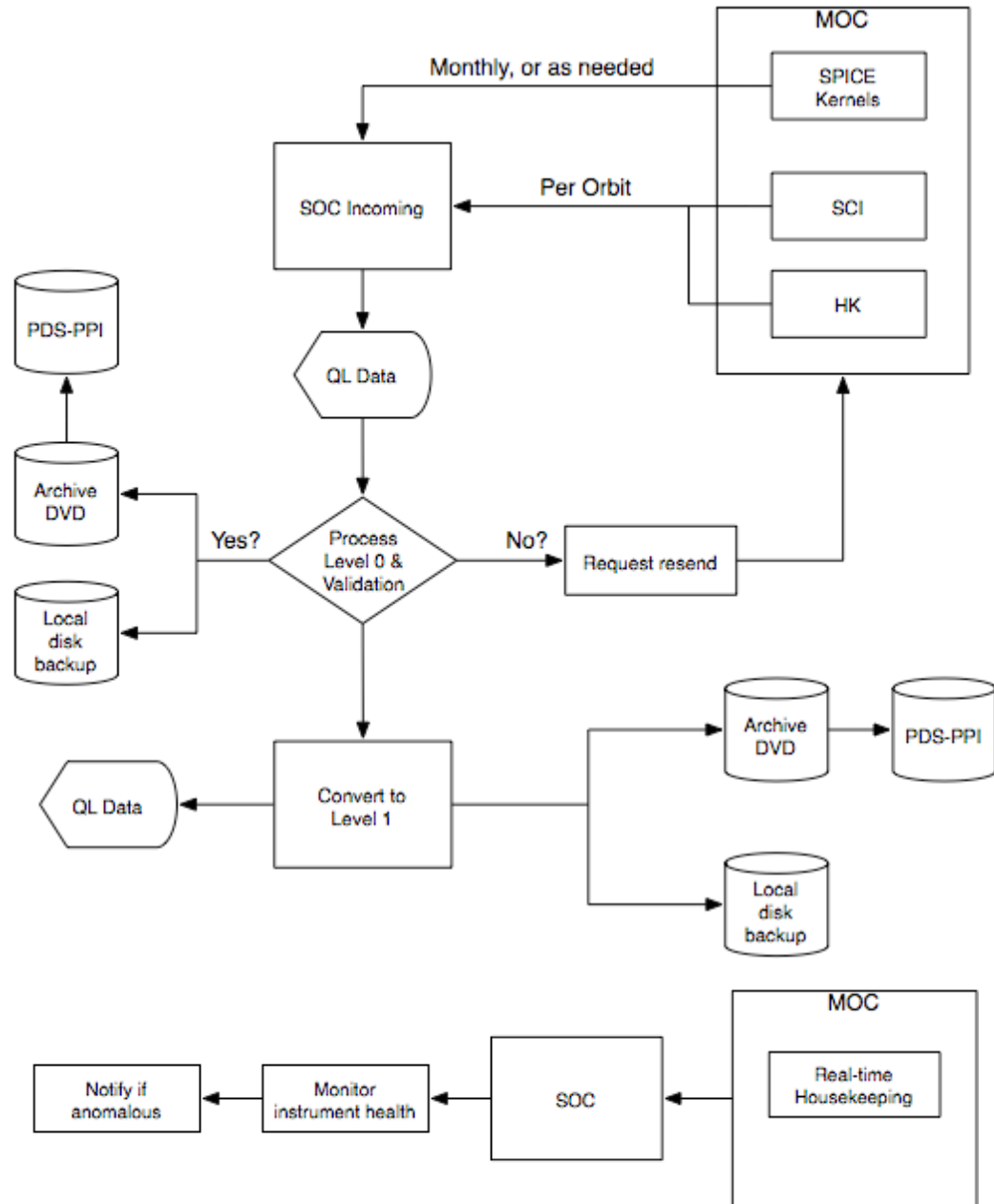


Figure 3-1 SOC Interfaces

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 process CRATER measurement data for the entire extended mission, if the mission is 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

Higher-level Requirements		SOC Requirements
Requirement ID	Requirement Text	Requirement IDs
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_010 CRATER_FN_020 CRATER_FN_030 CRATER_FN_040
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_030 CRATER_FN_040 CRATER_IF_500 CRATER_PF_100
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_010 CRATER_FN_020 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.	CRATER_FN_040 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 CRATER_FN_020 CRATER_FN_030 CRATER_FN_040	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 CRATER_FN_040 CRATER_IF_500 CRATER_PF_100	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_010 CRATER_FN_020 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 CRATER_PF_100	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
IT	Information Technology
LRO	Lunar Reconnaissance Orbiter
LSK	Leapseconds 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