

**LUNAR CRATER OBSERVATION AND SENSING  
SATELLITE (LCROSS)  
ARCHIVE VOLUME  
SOFTWARE INTERFACE SPECIFICATION**

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## ACRONYMS AND ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
CD-ROM	Compact Disk - Read-Only Memory
CD-WO	Write-Once Compact Disk
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
NSSDC	National Space Science Data Center
PDS	Planetary Data System
PSG	Project Science Group
SDVT	Science Data Validation Team
SIS	Software Interface Specification
TBD	To Be Determined

## GLOSSARY

**Archive** – An archive consists of one or more data sets along with all the documentation and ancillary information needed to understand and use the data. An archive is a logical construct independent of the medium on which it is stored.

**Archive Volume, Archive Volume Set** – A volume is a unit of media on which data products are stored; for example, one CD-ROM or DVD-ROM. An *archive volume* is a volume containing all or part of an archive; that is, data products plus documentation and ancillary files. When an archive spans multiple volumes, they are called an *archive volume set*. Usually the documentation and some ancillary files are repeated on each volume of the set, so that a single volume can be used alone.

**Catalog Information** – Descriptive information about a data set (e.g. mission description, spacecraft description, instrument description), expressed in Object Description Language (ODL) which is suitable for loading into a PDS catalog.

**Data Product** – A labeled grouping of data resulting from a scientific observation, usually stored in one file. A product label identifies, describes, and defines the structure of the data. An example of a data product is a planetary image, a spectrum table, or a time series table.

**Data Set** – An accumulation of data products. A data set together with supporting documentation and ancillary files is an archive.

**Standard Data Product** – A data product generated in a predefined way using well-understood procedures, processed in "pipeline" fashion. Data products that are generated in a nonstandard way are sometimes called *special data products*.

# 1. Introduction

## 1.1. Purpose and Scope

This Software Interface Specification is intended to be used by those who wish to understand the format and content of the Lunar Crater Observation and Sensing Satellite (LCROSS) Science Data Archive. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

The specifications in this document apply to all LCROSS standard product archive volumes that are generated by the LCROSS Project.

## 1.2. Content Overview

The LCROSS instruments were selected to provide multiple, complementary observations. These instruments are:

Name	Type	Observations of	Data Products
VIS	Visible Camera	Context, plume morphology	Raw images only w/ metadata
NIR1	Near-IR Camera	Context, plume morphology	Raw and calibrated images w/ metadata
NIR2	Near-IR Camera	Context, plume morphology; impact location	
MIR1	Mid-IR Camera	Pre-impact terrain; Ejecta Blanket; impact location	Raw and calibrated images w/ metadata
MIR2	Mid-IR Camera	Pre-impact terrain; Ejecta Blanket	
NSP1	Near-IR Spectrometer	Ice, Vapor, Grain Size, Hydrates	Raw and calibrated reflectance spectra w/ metadata; flash (high speed, low spectral resolution) spectra
NSP2	Near-IR Spectrometer	Ice, Vapor, Grain Size, Hydrates	Raw and calibrated absorption spectra w/ metadata
VSP	Visible & UV Spectrometer	H <sub>2</sub> O <sup>+</sup> (619 nm); OH (308nm); Search organics	Raw and calibrated reflectance spectra w/ metadata
TLP	Photometer	Flash light curve	Raw and calibrated voltage history w/ metadata

The resulting images and spectra will be delivered as an integrated archive by the LCROSS Science Team, facilitated by the LCROSS Principle Investigator, Payload Scientist and Software Lead.

The LCROSS data sets have the following data set identifiers assigned by PDS.

<b>Data Set Contents</b>	<b>PDS Data Set ID</b>
Raw visible camera (VIS) images	LCROSS-E/L-VIS-2-RAW-V1.0
Raw near infrared camera 1 (NIR1) images	LCROSS-E/L-NIR1-2-RAW-V1.0
Calibrated near infrared camera 1 (NIR1) images	LCROSS-E/L-NIR1-3-CAL-V1.0
Raw near infrared camera 2 (NIR2) images	LCROSS-E/L-NIR2-2-RAW-V1.0
Calibrated near infrared camera 2 (NIR2) images	LCROSS-E/L-NIR2-3-CAL-V1.0
Raw mid infrared camera 1 (MIR1) images	LCROSS-E/L-MIR1-2-RAW-V1.0
Calibrated mid infrared camera 1 (MIR1) images	LCROSS-E/L-MIR1-3-CAL-V1.0
Raw mid infrared camera 2 (MIR2) images	LCROSS-E/L-MIR2-2-RAW-V1.0
Calibrated mid infrared camera 2 (MIR2) images	LCROSS-E/L-MIR2-3-CAL-V1.0
Raw, pre-hadamard transformation NSP1 data	LCROSS-E/L-NSP1-2-PREHAD-V1.0
Raw near infrared spectrometer 1 (NSP1) spectra	LCROSS-E/L-NSP1-2-RAW-V1.0
Calibrated near infrared spectrometer 1 (NSP1) spectra	LCROSS-E/L-NSP1-3-CAL-V1.0
Raw near infrared spectrometer 1 (NSP1) flash spectra	LCROSS-E/L-NSP1-FL-2-RAW-V1.0
Calibrated near ir spectrometer 1 (NSP1) flash spectra	LCROSS-E/L-NSP1-FL-3-CAL-V1.0
Raw, pre-hadamard transformation NSP2 data	LCROSS-X-NSP2-2-PREHAD-V1.0
Raw near infrared spectrometer 2 (NSP2) spectra	LCROSS-X-NSP2-2-RAW-V1.0
Calibrated near infrared spectrometer 2 (NSP2) spectra	LCROSS-X-NSP2-3-CAL-V1.0
Raw near infrared spectrometer 1 (NSP1) flash spectra	LCROSS-X-NSP2-FL-2-RAW-V1.0
Calibrated near ir spectrometer 1 (NSP1) flash spectra	LCROSS-X-NSP2-FL-3-CAL-V1.0
Raw visible and UV spectrometer (VSP) spectra	LCROSS-E/L-VSP-2-RAW-V1.0
Calibrated visible and UV spectrometer (VSP) spectra	LCROSS-E/L-VSP-3-CAL-V1.0
Raw total luminance photometer (TLP) data	LCROSS-L-TLP-2-RAW-V1.0
Calibrated total luminance photometer (TLP) data	LCROSS-L-TLP-3-CAL-V1.0

This Software Interface Specification (SIS) describes the format, content, and generation of the LCROSS Science Data Archive. Section 2, Archive Volume Generation, describes the procedure for transferring data products to archive media. Section 3, Archive Volume Contents, describes the structure of the archive volumes and the contents of each file. Section 4, Archive Volume Format, describes the file formats used on the archive volumes. Finally, Section 5, Support Staff and Cognizant Persons, lists the individuals responsible for generating the archive volumes.

### 1.3. Applicable Documents and Constraints

This Archive Volume SIS is intended to be consistent with the following documents:

1. LCROSS Project Archive Generation, Validation and Transfer Plan, 04.05.PDSArchivePlan.01.v1.
2. LCROSS Science Team and PDS Geosciences, Imaging, and NAIF Nodes Interface Control Document (ICD), Version 1.1, October 18, 2007.
3. Lunar CRater Observation and Sensing Satellite (LCROSS) Project Planetary Data System Data Product Software Interface Specification, 02.01.MP.01.v12.
4. *Planetary Data System Archive Preparation Guide*, August 29, 2006, Version 1.1, JPL D-31224.
5. *Planetary Data System Standards Reference*, March 20, 2006, Version 3.7. JPL D-7669, Part 2.
6. ISO 9660-1988, Information Processing - Volume and File Structure of CD-ROM for Information Exchange, April 15, 1988.

### 1.4. Relationships with Other Interfaces

This document describes the output of the LCROSS Science Data Processing Pipeline, and changes to this document could impact tools implementing that pipeline. Due to the relatively low volume of data produced by LCROSS, this pipeline will be implemented partially by automation and partially by hand.

This Archive Volume SIS could be affected by changes to the design of the LCROSS Science standard data products (Applicable Document #3).

## 2. Archive Volume Contents

This section describes the contents of the LCROSS Science Data Archive volumes, including the file names, file contents, file types, and organization responsible for providing the files.

### 2.1. Root Directory Contents

Files in the Root Directory include an overview of the archive, a description of the volume for the PDS Catalog, and a list of errata or comments about the archive. The following files are contained in the Root Directory.

File Name	File Contents	File Provided By
AAREADME.TXT	Volume content and format information	LCROSS
AAREADME.LBL	A PDS detached label that describes both AAREADME.TXT and AAREADME.HTM (optional, could be attached to AAREADME.TXT).	LCROSS
ERRATA.TXT	A cumulative listing of comments and updates concerning all archive volumes published to date	PDS Node

VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	LCROSS
DATA	Directory containing data files. There may be more than one data directory.	LCROSS
DOCUMENT	Directory containing the Data Product SIS, Archive Volume SIS, and other documentation	LCROSS
CATALOG	Directory containing text descriptions of the data set, instrument, spacecraft, mission, personnel, and references, which will become part of the PDS Catalog	LCROSS
CALIB	Directory containing calibration plans, reports, and data (optional)	LCROSS
EXTRAS	Directory containing release data in non-PDS formats including FITS versions of all images and animations indicating how the instrument fields of view moved during the experiment.	LCROSS

## 2.2. Data Directory Contents and Naming

The Data directory contains one subdirectory for each payload data collection period during the mission. These are:

Directory	Description
20090620022900_QUICKLOOK	Initial payload activation and instrument checkout
20090622034600_STARFIELD	Telescope aperture door deployment and confirmation of gross instrument orientation before the lunar swingby
20090623121800_SWINGBY	Calibration data collection for all instruments except TLP
20090801094900_EARTHLOOK1	Observations of the Earth
20090817074500_MIRLOOK	Observations of the Moon and Earth intended primarily to generate a point-spread function to evaluate and correct MIR2 focus
20090918180600_EARTHLOOK2	Observations of the Earth
20091009015100_SEPARATION	Images of the Centaur immediately after separation from the LCROSS Shepherding Spacecraft.
20091009104100_PREIMPACT	Pre-impact instrument checkout and calibration
20091009113022_IMPACT	Data collection from 1 minute before centaur impact to shepherding spacecraft impact and the end of the mission

Where the numbers at the start of each directory name describes the start of the data collection period in UTC as <year><month><day><hour><minute><second>.

Each payload activation directory contains a PDS data set collection, one per instrument, like so:

Directory	Description
VIS	Directory containing data collected by the Visible Light Camera
NIR1	Directory containing data collected by Near Infrared Camera 1
NIR2	Directory containing data collected by Near Infrared Camera 2
MIR1	Directory containing data collected by Mid Infrared Camera 1
MIR2	Directory containing data collected by Mid Infrared Camera 2
NSP1	Directory containing data collected by Near Infrared Spectrometer 1
NSP2	Directory containing data collected by Near Infrared Spectrometer 2
VSP	Directory containing data collected by the Visible and UV Spectrometer
TLP	Directory containing data collected by the Photometer

Each data set directory contains one or more subdirectories. Each subdirectory differs from the others by the level of processing of the files contained in them. The following table describes each of these directories. Note <Timestamp> is the UTC time when the image was captured.

Directory	Description	Sample Filename(s)
VIS/	Directory containing data collected by the Visible Light Camera	
RAW/	Level 0 images in PDS format (integer pixels); 3 channels (RGB)	VIS_RAW_<timestamp>.img
NIR1/	Directory containing data collected by Near Infrared Camera 1	
RAW/	Level 0 images in PDS format (integer pixels); 3 channels (RGB)	LCROSS_NIR1_RAW_<timestamp>.img
CAL/	Level 1 (calibrated) images in PDS format (floating point pixels); 3 channels (RGB); pixel values represent radiance	LCROSS_NIR1_CAL_<timestamp>.img
NIR2/	Directory containing data collected by Near Infrared Camera	
RAW/	Level 0 images in PDS format (integer pixels); 3 channels (RGB)	LCROSS_NIR2_RAW_<timestamp>.img
CAL/	Level 1 (calibrated) images in PDS format (floating point pixels); 3 channels (RGB);	LCROSS_NIR2_CAL_<timestamp>.img

	pixel values represent radiance	
MIR1/	Directory containing data collected by Mid Infrared Camera 1	
RAW/	Level 0 images in PDS format (integer pixels); single channel	LCROSS_MIR1_RAW_<timestamp>.img
CAL/	Level 1 (calibrated) images in PDS format (floating point pixels); 1 channel; pixel value represent temperature.	LCROSS_MIR1_CAL_<timestamp>.img
MIR2/	Directory containing data collected by Mid Infrared Camera 2	
RAW/	Level 0 images in PDS format (integer pixels); single channel	LCROSS_MIR2_CAL_<timestamp>.img
CAL/	Level 1 (calibrated) images in PDS format (floating point pixels); 1 channel; pixel value represent temperature	LCROSS_MIR2_CAL_<timestamp>.img
NSP1/	Directory containing data collected by Near Infrared Spectrometer 1	
CAL/	Level 1 spectra after hadamard transform in an ascii table format	LCROSS_NSP1_CAL_<timestamp>.tab
PREHAD/	Level 0 spectra before hadamard transform in an ascii table format	NSP1_DNL_<timestamp>.tab
FL_CAL/	Level 1 low resolution spectra in an ascii table format	LCROSS_NSP1_FL_CAL_*.TAB LCROSS_NSP1_FL_CAL_META_*.TAB
FL_RAW/	Level 0 low resolution spectra in an ascii table format	LCROSS_NSP1_FL_RAW_*.TAB LCROSS_NSP1_FL_RAW_META_*.TAB
RAW/	Level 0 spectra after hadamard transform in an ascii table format	NSP1_RAW_<timestamp>.tab
NSP2/	Directory containing data collected by Near Infrared Spectrometer 2	
CAL/	Level 1 spectra after hadamard transform in an ascii table format	LCROSS_NSP2_CAL_<timestamp>.tab
DNL/	Level 0 spectra before hadamard transform in an ascii table format	NSP2_DNL_<timestamp>.tab
FL_CAL/	Level 1 low resolution spectra in an ascii table format	LCROSS_NSP2_FL_CAL_<timestamp>.TAB LCROSS_NSP2_FL_CAL_META_*.TAB

FL_RAW/	Level 0 low resolution spectra in an ascii table format	LCROSS_NSP2_FL_RAW_<timestamp>.TAB LCROSS_NSP2_FL_RAW_META_*.TAB
RAW/	Level 0 spectra after hadamard transform in an ascii table format	NSP2_RAW_<timestamp>.tab
VSP/	Directory containing data collected by the Visible and UV Spectrometer	
RAW/	Level 0 spectra in an ascii table format	VSP_RAW_<timestamp>.tab
CAL/	Level 1 spectra in an ascii table format	VSP_CAL_<timestamp>.tab
TLP/	Directory containing data collected by the Photometer	
RAW/	Single file containing raw, level 0 values	TLP_RAW_<timestamp>.tab
CAL/	Single file containing raw, level 1 values representing temperature-corrected detector voltage	TLP_CAL_<timestamp>.tab

Here's an example to tie these tables together. The first image in the Near Infrared Camera #1 dataset taken during the impact period is LCROSS\_NIR1\_CAL\_20091009113033466.IMG. The image was taken at 11:30:33.466 on 10/9/2009, which is encoded in the filename, and it's a calibrated image. Both of these are apparent from the filename. This file has a corresponding label file called LCROSS\_NIR1\_CAL\_20091009113033466.LBL.

This file appears within the DATA\20091009113022\_IMPACT\NIR1\CAL directory within the volume. Note that the directory name contains the data collection period (IMPACT) preceded by a timestamp indicating when that data collection period started. That start time is just before the time the image was taken, which is consistent. Within the 20091009113022\_IMPACT directory, there is a NIR1 directory containing only NIR1 images and all of them. Within that, there are two directories, CAL and RAW.

### 2.3. Index Directory Contents

Files in the Index Directory are provided to help the user locate products on this archive volume and on previously released volumes in the archive. An index table lists information about all the data products for a data set on the archive volume. The following files are contained in the Index Directory.

File Name	File Contents	File Provided By
INDXINFO.TXT	A description of the contents of this directory	LCROSS

VIS_RAW_INDEX.TAB, .LBL	List of all raw VIS data products, with PDS label	LCROSS
NIR1_RAW_INDEX.TAB, .LBL	List of all raw NIR1 data products, with PDS label	LCROSS
NIR1_CAL_INDEX.TAB, .LBL	List of all calibrated NIR1 data products, with PDS label	LCROSS
NIR2_RAW_INDEX.TAB, .LBL	List of all raw NIR2 data products, with PDS label	LCROSS
NIR2_CAL_INDEX.TAB, .LBL	List of all calibrated NIR2 data products, with PDS label	LCROSS
MIR1_RAW_INDEX.TAB, .LBL	List of all raw MIR1 data products, with PDS label	LCROSS
MIR1_CAL_INDEX.TAB, .LBL	List of all calibrated MIR1 data products with PDS label	LCROSS
MIR2_RAW_INDEX.TAB, .LBL	List of all raw MIR2 data products, with PDS label	LCROSS
MIR2_CAL_INDEX.TAB, .LBL	List of all calibrated MIR2 data products, with PDS label	LCROSS
NSP1_RAW_INDEX.TAB, .LBL	List of all raw NSP1 data products, with PDS label	LCROSS
NSP1_CAL_INDEX.TAB, .LBL	List of all calibrated NSP1 data products, with PDS label	LCROSS
NSP2_RAW_INDEX.TAB, .LBL	List of all raw NSP2 data products, with PDS label	LCROSS
NSP2_CAL_INDEX.TAB, .LBL	List of all calibrated NSP2 data products, with PDS label	LCROSS
VSP_RAW_INDEX.TAB, .LBL	List of all raw VSP data products, with PDS label	LCROSS
VSP_CAL_INDEX.TAB, LBL	List of all calibrated VSP data products, with PDS label	LCROSS
TLP_RAW_INDEX.TAB, LBL	List of all raw TLP data products, with PDS label	LCROSS
TLP_CAL_INDEX.TAB, .LBL	List of all calibrated TLP data products, with PDS label	LCROSS

Each index table will include at minimum the following columns.

- VOLUME\_ID
- PATH\_NAME
- FILE\_NAME (name of PDS label that points to data)
- PRODUCT\_ID
- PRODUCT\_CREATION\_TIME
- MISSION\_PHASE\_NAME
- START\_TIME
- STOP\_TIME
- SPACECRAFT\_CLOCK\_START\_COUNT
- SPACECRAFT\_CLOCK\_STOP\_COUNT

## 2.4. Document Directory Contents

The Document Directory contains documentation to help the user understand and use the archive data. The following files are contained in the Document Directory.

<b>File Name</b>	<b>File Contents</b>	<b>File Provided By</b>
DOCINFO.TXT	A description of the contents of this directory	LCROSS
DPSIS..HTM	The Data Product SIS as text or hypertext	LCROSS
DPSIS.PDF	The Data Product SIS as a PDF file	LCROSS
DPSIS.LBL	A PDS label that describes both DPSIS.HTM and DPSIS.PDF	PDS
ARCHSIS.HTM	The Archive Volume SIS (this document) as text or hypertext	LCROSS
ARCHSIS.PDF	The Archive Volume SIS (this document) as a PDF file	LCROSS
ARCHSIS.LBL	A PDS label that describes both ARCHSIS.HTM and ARCHSIS.PDF.	PDS
OPS.HTM	LCROSS Measurement and Operations Specification as hypertext	LCROSS
OPS.PDF	LCROSS Measurement and Operations Specification as PDF	LCROSS
OPS.LBL	A PDS label that describes both OPS.HTM and OPS.PDF.	PDS
CALRPT.HTM	Instrument Calibration Summary as hypertext	LCROSS
CALRPT.PDF	Instrument Calibration Summary as PDF	LCROSS
CALRPT.LBL	A PDS detached label that describes both CALRPT.HTM and CALRPT.PDF.	PDS
SCIPLAN.HTM	Mission Science Plan as hypertext	LCROSS
SCIPLAN.PDF	Mission Science Plan as PDF	LCROSS
SCIPLAN.LBL	A PDS detached label that describes both SCIPLAN.HTM and SCIPLAN.PDF.	PDS

## 2.5. Catalog Directory Contents

The files in the Catalog Directory provide a top-level understanding of the mission, spacecraft, instruments, and data sets. The files in this directory are coordinated with the PDS data engineer, who is responsible for loading them into the PDS catalog. PDS provides a template for each type of catalog file, but the contents are provided by instrument and mission personnel. The following files are found in the Catalog Directory.

<b>File Name</b>	<b>File Contents</b>	<b>File Provided By</b>
CATINFO.TXT	A description of the contents of this directory	PDS Node
VIS_RAW_DS.CAT	Raw VIS data set description	LCROSS
NIR1_RAW_DS.CAT	Raw NIR1 data set description	LCROSS
NIR1_CAL_DS.CAT	Calibrated NIR1 data set description	LCROSS
NIR2_RAW_DS.CAT	Raw NIR2 data set description	LCROSS
NIR2_CAL_DS.CAT	Calibrated NIR2 data set description	LCROSS
MIR1_RAW_DS.CAT	Raw MIR1 data set description	LCROSS
MIR1_CAL_DS.CAT	Calibrated MIR1 data set description	LCROSS
MIR2_RAW_DS.CAT	Raw MIR2 data set description	LCROSS
MIR2_CAL_DS.CAT	Calibrated MIR2 data set description	LCROSS

NSP1_RAW_DS.CAT	Raw NSP1 data set description	LCROSS
NSP1_CAL_DS.CAT	Calibrated NSP1 data set description	LCROSS
NSP1_FL_RAW_DS.CAT	Raw flash mode spectra	LCROSS
NSP1_FL_CAL_DS.CAT	Calibrated flash mode spectra	LCROSS
NSP1_PREHAD_DS.CAT	Raw mask data used to generate NSP1_RAW_DS	LCROSS
NSP2_RAW_DS.CAT	Raw NSP2 data set description	LCROSS
NSP2_CAL_DS.CAT	Calibrated NSP2 data set description	LCROSS
NSP2_FL_RAW_DS.CAT	Raw flash mode spectra	LCROSS
NSP2_FL_CAL_DS.CAT	Calibrated flash mode spectra	LCROSS
NSP2_PREHAD_DS.CAT	Raw mask data used to generate NSP2_RAW_DS	LCROSS
VSP_RAW_DS.CAT	Raw VSP data set description	LCROSS
VSP_CAL_DS.CAT	Calibrated VSP data set description	LCROSS
TLP_RAW_DS.CAT	Raw TLP data set description	LCROSS
TLP_CAL_DS.CAT	Calibrated TLP data set description	LCROSS
INSTHOST.CAT	LCROSS instrument host (i.e., spacecraft) description	LCROSS
VIS_INST.CAT	VIS instrument description	LCROSS
NIR1_INST.CAT	NIR1 instrument description	LCROSS
NIR2_INST.CAT	NIR2 instrument description	LCROSS
MIR1_INST.CAT	MIR1 instrument description	LCROSS
MIR2_INST.CAT	MIR2 instrument description	LCROSS
NSP1_INST.CAT	NSP1 instrument description	LCROSS
NSP2_INST.CAT	NSP2 instrument description	LCROSS
VSP_INST.CAT	VSP instrument description	LCROSS
TLP_INST.CAT	TLP instrument description	LCROSS
MISSION.CAT	LCROSS mission description	LCROSS
PERSON.CAT	Personnel information (Team and PDS personnel responsible for generating the archive)	LCROSS
REF.CAT	Complete citations of references mentioned in other *.CAT files	PDS Node

## 2.6. Calib Directory Contents

The Calib Directory contains calibration files used to process the data products, or calibration data needed to use the data products. The following files are contained in the Calib Directory.

File Name	File Contents	File Provided By
CALINFO.TXT	A description of the contents of this directory	LCROSS
CALRPT.HTM	Instrument Calibration Summary as hypertext	LCROSS
CALRPT_files/	Directory containing images for CALARPT.HTM	LCROSS
CALRPT.PDF	Instrument Calibration Summary as PDF	LCROSS
NSP1_CAL.TXT	NSP1 full-resolution mode calibration coefficients	LCROSS

NSP1_FL_CAL.TXT	NSP1 low-resolution mode calibration coefficients	LCROSS
NSP2_CAL.TXT	NSP2 full-resolution mode calibration coefficients	LCROSS
VSP_CAL.TXT	VSP calibration coefficients	LCROSS

## 2.7. Extras Directory Contents

The Extras Directory contains documentation, utility programs, or other materials that the user may find helpful, but that are beyond the scope of the required elements of the archive. The contents of this directory are exempt from PDS requirements for labeling, etc. The following files are contained in the Extras Directory.

File Name	File Contents	File Provided By
EXTRINFO.TXT	A description of the contents of this directory	LCROSS
CALIB/	Extra calibration files	LCROSS
FITS/	FITS versions of all image files	LCROSS
MOVIES/	Movies and animations intended help explain the context of the observations	LCROSS

## 3. Archive Volume Format

This section describes the format of LCROSS Science Data Archive Volumes. Data that comprise the Archive will be formatted in accordance with Planetary Data System specifications [Applicable Documents 4 and 5].

### 3.1. File Formats

This section describes file formats for the kinds of files contained on Archive Volumes.

#### 3.1.1. Document File Format

Document files with the .TXT suffix exist in the Root, Index, Software, Catalog, Document and Label directories. They are ASCII files which may have embedded PDS labels. Lines in a .TXT file end with a carriage return character (ASCII 13) and a line feed character (ASCII 10). This allows the files to be readable under various operating systems.

Documents in the Document directory may contain formatting and figures that cannot be rendered as ASCII text. Therefore each document is given in two formats, hypertext and PDF. The hypertext file contains ASCII text plus hypertext markup language (HTML) commands that enable it to be viewed in a Web browser such as Netscape Navigator or Microsoft Internet Explorer. The hypertext file may be accompanied by ancillary files such as images and style sheets that are incorporated into the document by the Web browser. The second format, PDF (Portable Document Format) is a proprietary format of Adobe Systems Incorporated that is frequently used for distributing documents. Adobe offers free software, Acrobat Reader, for viewing PDF files (<http://www.adobe.com>).

### 3.1.2. Tabular File Format

Tabular files (.TAB suffix) exist in the Index and Data directories. Tabular files are ASCII files formatted for direct reading into many database management systems on various computers. All fields are separated by commas, and character fields are enclosed in double quotation marks ("). (Character fields are padded with spaces to keep quotation marks in the same columns of successive records.) Character fields are left justified, and numeric fields are right justified. The "start byte" and "bytes" values listed in the labels do not include the commas between fields or the quotation marks surrounding character fields. The records are of fixed length, and the last two bytes of each record contain the ASCII carriage return and line feed characters. This allows a table to be treated as a fixed length record file on computers that support this file type and as a text file with embedded line delimiters on those that don't.

All tabular files are described by PDS labels, either embedded at the beginning of the file or detached. If detached, the PDS label file has the same name as the data file it describes, with the extension .LBL; for example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

### 3.1.3. PDS Label Format

All data files in the archive have PDS labels, either embedded at the beginning of the file or detached in a separate file. For examples of PDS labels for each type of data product, see the Data Product SIS [Applicable Document 3].

A PDS label, whether embedded or detached from its associated file, consists of lines of ASCII text in the form of keyword = value statements that provide descriptive information about the data file. The label is intended to be readable both by humans and by software. Details of the syntax and semantics of PDS labels can be found in the PDS Standards Reference (Applicable Document 5), and definitions of the keywords used in the label can be found by using the PDS Data Dictionary Lookup web service at [http://pds.jpl.nasa.gov/tools/data\\_dictionary\\_lookup.cfm](http://pds.jpl.nasa.gov/tools/data_dictionary_lookup.cfm). Lines of text in detached labels end with a carriage return character (ASCII 13) and a line feed character (ASCII 10). This allows the files to be read under various operating systems.

### 3.1.4. Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. Like PDS labels, they are text files formatted as keyword = value statements. They contain descriptions of the data set, instrument, spacecraft, and mission, as well as personnel contact information and references to published literature. They are called Catalog Files because they are loaded into the PDS online catalog to make the information available to users searching for data.

### 3.1.5. Science Data File Formats

Science data from the VIS, NIR1, NIR2, MIR1, and MIR2 cameras are stored as PDS images with detached labels. Data from the NSP1, NSP2, and VSP spectrometers and from the TLP are stored as ASCII tables with integer and single-precision floating-point data and with detached PDS labels.

For the VIS, NIR1 and NIR2 cameras, the data products are all 720x486 RGB images expressed in PDS IMG format with a detached label. The uncalibrated images will be 24-bit RGB (8 bits

per channel) images, pixel interleaved. The calibrated images will be single-precision floating point per channel, with the same resolution.

The VIS camera is intrinsically color, and the RGB channels are independent. The NIR cameras are black-and-white, but are transmitting their images to the DHU across a color NTSC channel. Therefore, the RGB channels should be identical except for NTSC transmission and A-to-D noise between the camera and the DHU.

The MIR1 and MIR2 images are single channel, 160x120, and 14 bits per pixel. The uncalibrated images will be 16 bits per pixel (the lower 14 bits of which hold data). The calibrated images are single precision floating point.

The NSP1, NSP2 and VSP spectrometer files are ASCII table (comma-separated value) files holding integers (uncalibrated) and single-precision floating point (calibrated) data.

The TLP files are ASCII TBL files holding integers (uncalibrated) and single-precision floating point (calibrated) data. ]

For more information about the format and content of the data products, see the Data Product SIS [Applicable Document 3].

## **4. Archive Volume Generation**

### **4.1. Data Transfer and Validation Methods**

Science data provided by the LCROSS science team will meet the specifications detailed in the Data Product SISs.

The LCROSS science team, with the assistance of the PDS Geosciences Node, are responsible for the assembly and production not only of PDS formatted data, but of a complete PDS-compliant archive.

Before final delivery of the archive, the PDS will conduct both peer review and validation on the single submitted volume. The purpose of the peer review is to confirm that the archive will be useable by members of the science community, both present and future, who are not familiar with the mission and/or instruments. Reviewers include members of the PDS, representatives of the LCROSS science team, and members of the science community not associated with the mission.

Validation consists of two parts, science validation and PDS standards validation. The LCROSS team will perform validation for science content of the data. The PDS Nodes that receive the data products will perform validation for compliance with PDS standards, including checking for correct PDS syntax, for accepted standard values of keywords, and for internal consistency of label items.

### **4.2. Data Product Sizes and Delivery Rates**

Data from all LCROSS instruments will be delivered to the PDS in one integrated archive that is expected to be approximately 30 Gb. This delivery will occur 6 months after the LCROSS impact, so the delivery is currently planned for 4/9/2010.

### **4.3. Interface Media Characteristics**

All volumes in the LCROSS Science Data Archive conform to ISO 9660 standards [ISO 9660, 1988].

### **4.4. Backup and Duplicates**

The LCROSS Science Team will deliver science data products to the Imaging and Geosciences Node and SPICE data products to the NAIF Node by electronic (FTP) transfer initiated by the receiving Node. It is expected that there will be only one delivery to PDS for this mission, as discussed in the Archive Plan. Until the electronic transfer has been received by PDS, it is the responsibility of the LCROSS Project to ensure that the archive volume contents are stored on electronic media with a reliable backup copy. Subsequent to the transfer, it is the responsibility of the PDS to ensure a reliable backup copy exists.

The PDS is responsible for ensuring that a copy of the LCROSS archive is delivered to the National Space Science Data Center (NSSDC) for permanent storage, in accordance with agreements in place between the PDS and NSSDC.

## **4.5. Labeling and Identification**

There is a single archive labeled USA\_NASA\_ARC\_LCRO\_XXXX containing data from all mission phases for all instruments.

## **5. Support Staff and Cognizant Persons**

### **5.1. Data Providers**

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### **5.2. PDS Contacts**

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