2001 Mars Odyssey
Martian Radiation Environment Experiment

MARIE STANDARD PRODUCTS
ARCHIVE VOLUME
SOFTWARE INTERFACE SPECIFICATION

(MARIE Archive Volume SIS)

Version 1.06

rev. October 9, 2002

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List Of Figures:

List Of Tables:

1 Preface

This document describes the format and content of the 2001 Mars Odyssey MARIE standard products archive collection on CD and DVD media.

Table 1: Distribution List

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1.1 Document Change Log

Table 2: Document Change Log

Change	Date	Affected Portions
Initial Draft	5/17/02	All
Minor editing	7/18-7/24/02	i, ii, 2
Update and editing	9/11-9/12/02	All
Update of GEOMETRY sections; general editing	9/13/02	All
Update personnel information	10/9/02	i, 35

1.2 TBD Items

Items which are currently TBD or not finalized, but need to be defined in the next few months:

Table 3: List of TBD items

Item	Section	Pages
Data product sizes and production rates	3.3	9
Support staff and cognizant persons table	6.0	30
Detailed definitions for data columns	5.2.7, 5.2.8	25-32

1.3 Acronyms and Abbreviations

Table 4: Acronyms and Abbreviations

Acronym/Abbreviation	1.3.1.1.1.1.1 Translation
ASCII	American Standard Code for Information Interchange
CD-R	Compact Disc - Recordable media
CD-ROM	Compact Disc - Read-Only Memory
DVD	Digital Versatile Disc
DVD-R	DVD recordable media.
FTP	File transfer protocol
GB	Gigabyte(s)
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
LMT	Lockheed Martin Corporation
MARIE	Martian Radiation Environment Experiment
MB	Megabyte(s)
MDVT	MARIE Data Validation Team
NAIF	Navigation and Ancillary Information Facility
NSSDC	National Space Science Data Center
PDS	Planetary Data System
PPI	Planetary Data System, Planetary Plasma Interactions Node
REDR	Reformatted Experimenter Data Record
RDR	Reduced Data Record
SIS	Software Interface Specification
SDP	Standard Data Product
TBD	To Be Determined
UCLA	University of California, Los Angeles
UDF	Universal Directory Format

1.4 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. 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 – High-level 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 spectral table, or a time series table.

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

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*.

2 Introduction

2.1 Content Overview

Mars is substantially exposed to the harshest elements of space weather. Unlike Earth, Mars does not have a global magnetic field to shield it from solar flares and cosmic rays. In addition, Mars' atmosphere is less than 1% as thick as that of the Earth. These two factors make Mars vulnerable to space radiation. The MARIE instrument was designed to measure the amount of harmful radiation in the Mars environment.

The radiation particles which are harmful to humans falls mostly in the energy range of 15 MeV to 500 MeV per nucleon. These are the particles with enough energy to damage human DNA. Some of the particles with 500 MeV/n and above pass through the human body so quickly there is not enough time to transfer their energy into the surrounding tissue. The MARIE instrument is designed to measure particles in the range of 15 MeV to 500 MeV/n. The data gathered are combined into an energy spectrum that tells the story of how many particles were present at what energy level.

The potential for harmful late effects including cancer, cataracts, neurological disorders, and non-cancer mortality risks from galactic cosmic rays (GCR) pose a major threat for the human exploration of Mars. Because of their high energies, the GCR are extremely penetrating and cannot be eliminated by practical amounts of shielding. The high charge and energy (HZE) ion portion the GCR presents unique challenges to biological systems such as DNA, cells, and tissue; the risk to humans from this radiation is highly uncertain at this time. Another threat in deep space arises from solar particle events, which could induce acute radiation syndromes including death if the event is large enough. However, shielding by the Mars atmosphere and spacecraft structures along with early warning and detection systems may be effective as mitigation measures and the biological effects of protons are well understood being similar to gamma rays. Safety assurances and dose limits for the human exploration of Mars cannot be provided at this time due to the uncertainties in the biological effects of HZE ions. Important physical data on the GCR isotopic and energy spectrum composition near Mars and on the Mars surface will be needed prior to human exploration. Developing methods for the accurate prediction of the modulation of the isotopic composition and energies of the GCR after nuclear and atomic interactions with Mars atmosphere and soil and the accurate determination of secondary neutron spectra will be essential for the design and execution of such missions.

Robotic precursor missions to Mars can provide valuable data on the radiation environment to be encountered in future human exploration missions of the red planet and on validation of models used for mission design. These measurements should include direct physical measurements with radiation spectrometers of the energy spectra of protons, heavy ions, and neutrons. Physical data related to the Mars altitude, and atmospheric and soil compositions, also will be valuable in developing models of astronauts and equipment exposures, and in designing shielding habitat.

The standard data products generated by the MARIE instrument are listed in Table 5.

Table 5: Standard Data Products in MARIE Archive Collection

Acronym	**Standard Data Product**
REDR	Reformatted Experimenter Data Record (Raw Data)
RDR	Reduced Data Record (Calibrated Data)

Each MARIE product is a time ordered table of radiation measurements. The data in the REDR files have been extracted from the raw telemetry data, assigned time tags and energy channels, and formatted into simple binary tables of values in engineering units (raw counts). The measurements recorded in the RDR files have been corrected for instrumental and spacecraft effects (calibrated) and are provided in physically meaningful units. The REDR and RDR data products are generated for all mission phases during which data are acquired.

This Software Interface Specification (SIS) describes the format, content, and generation of the MARIE Standard Product Archive Volumes. Section 3, Archive Volume Generation, describes the procedure for transferring data products to archive media. Section 4, Archive Volume Contents, describes the structure of the archive volumes and the contents of each file. Section 5, Archive Volume Format, describes the file formats used on the archive volumes. Finally, Section 6, Support Staff and Cognizant Persons, lists the individuals responsible for generating the archive volumes.

2.2 Scope

The specifications in this document apply to all MARIE standard product archive volumes that are produced on compact disk media for all phases of the Mars Odyssey mission.

2.3 Applicable Documents

ISO 9660-1988, Information Processing - Volume and File Structure of CD-ROM for Information Exchange, April 15, 1988.

Planetary Science Data Dictionary Document, July 15, 1996, Planetary Data System, JPL D-7116, Rev. D.

Planetary Data System Data Preparation Workbook, February 1995, Version 3.1, JPL D-7669, Part 1.

Planetary Data System Standards Reference, June 15, 2001, Version 3.4. JPL D-7669, Part 2.

Report of the IAU/IAG Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites: 2000.

2.4 Audience

This specification is useful to those who wish to understand the format and content of the MARIE standard product archive collection. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

3 Archive Volume Generation

The MARIE standard product archive collection is produced by the PDS Planetary Plasma Interactions (PPI) Node at the University of California, Los Angeles (UCLA), in cooperation with the MARIE Instrument Team. PPI activities are funded by the NASA Planetary Data System and the MARIE team is funded by NASA through the Mars Project office. The archive volume creation process described in this chapter describes the roles and responsibilities of each of these groups throughout the process. This assignment of tasks describe here has been agreed to by both parties during the process of creating the initial draft of this document.

Standard data products will be created by the MARIE team and delivered to the PPI Node of the PDS electronically once every 3 months. The data volume (~2.5 Gb) of a single data delivery (consisting of hundreds of data files) is less than the volume of a single sided DVD-R media (4.7 Gb). The PPI Node will validate the data provided in each delivery, and will make these data available electronically to PDS users as soon as the data are validated. Once a sufficient amount of data has accumulated to fill a DVD-R volume, an archive volume will be created.

3.1 Data Transfer Methods and Delivery Schedule

Data will be delivered by the MARIE team to the PPI Node of PDS in “standard product packages” consisting of 3 months of data apiece. Each standard product package will consist of a collection of data and ancillary data files, organized into directory structures consistent with the volume design described in chapter 4, and packaged into a single deliverable file by using the ZIP software. When the deliverable file is “unzipped” at the PPI Node in the appropriate location, all of the files will be organized into the correct volume structure. Deliverable data files will be transferred by using the File Transfer Protocol (FTP). The MARIE team will sign into a user account on the PPI computer system, transfer the file(s) in binary mode, and inform the PPI Node that a data delivery has been made. The PPI Node will move the deliverable file to its appropriate location within the PPI file system, unpackage the data, and verify that both the file transfer and unpackaging were successful. Once PPI has verified that it has received a valid data delivery, an electronic receipt will be sent to the MARIE team, the Odyssey Project data management representative, and the PDS Central Node.

After the PPI Node receives a data delivery, it will generate PDS labels for each of the data products and organize the data into PDS archive volume structure within its online data system. PPI will generate all of the required files associated with a PDS archive volume (index file, readme files, etc.) as part of its routine processing of incoming MARIE data deliveries. Data will be made available publicly through the PPI online system within seven (7) working days of receipt of data once data transfer and processing becomes routine. The first two data deliveries will require somewhat more time for the PPI Node to process prior to making the publicly available.

The Mars Odyssey prime mission runs from the beginning of mapping in February 2002 through August 2004. Table 6 formalizes the data delivery schedule and contents for all of the MARIE prime mission data, and data acquired during the interplanetary cruise. It is possible that the Odyssey mission will be extended beyond the current end-of-mission date. Should this occur, it is assumed that any additional data acquired will be archived according to the procedures defined during the prime mission. REDR deliverable data packages will be delivered 6 months after the receipt by the MARIE team of the last data point contained within the data delivery interval. The reduced data (RDR) will take longer to prepare and validate than the raw data. The RDR data deliveries will be made 9 months after the end of the 3 month data collection period.

Table 6: MARIE data delivery schedule and contents

Delivery Data	REDR data contents	RDR data contents
July 1, 2002	Launch – August, 2001	Launch – August, 2001
Jan 1, 2003	March – June, 2002	none
April 1, 2003	July – September, 2002	March-June, 2002
July 1, 2003	October – December, 2002	July – September, 2002
October 1, 2003	January – March, 2003	October – December, 2002
January 1, 2004	April – June, 2003	January – March, 2003
April 1, 2004	July – September, 2003	March-June, 2003
July 1, 2004	October – December, 2003	July – September, 2003
October 1, 2004	January – March, 2004	October – December, 2003
January 1, 2005	April – June, 2004	January – March, 2004
April 1, 2004	July – August, 2004	March-June, 2004
July 1, 2004	N/A	July – August, 2004

3.2 Data Validation

The MARIE data archive volume set will include data acquired during all phases of the Mars Odyssey mission. The archive validation procedure described in this section applies to volumes generated during all phases of the mission (cruise, prime, extended).

PDS standards require that all data included in the formal archive be validated through the peer review process. The peer review process is designed to verify that the both the data and documentation are of sufficiently high quality to ensure that the data set will be useful to future generations of scientists. In cases such as this one, where the data volumes are large and the data sets are archived while still in a dynamic state, it is impractical to convene a review panel to examine each and every archive volume. In these cases, an archive volume is created using data from the initial phase of data acquisition and reviewed. In addition, the process by which the archive products are created is reviewed. The peer review panel determines if the data included in the archive are appropriate to meet the stated science objectives of the instrument. The documentation is reviewed for quality and completeness and the archive product generation process is reviewed for robustness and ability to detect problems in the end products. The peer review panel may suggest changes or improvements to any of the areas under review.

The peer review panel will consist of members of the instrument team, PPI and Central Node of the PDS, and at least two outside scientists actively working in the field of energetic particles research. The PDS personnel will be responsible for validating that the archive volume(s) are fully compliant with PDS standards. The instrument team and outside science reviewers will be responsible for verifying the content of the data set, the completeness of the documentation, and the usability of the data in its archive format. After the initial volume completes the review process, and any liens against the product are appropriately resolved, the initial volume will be accepted into the archive and the process will move into the production phase. Once the production phase begins, all subsequent archive volumes will be validated by the MARIE Data Validation Team (MDVT). This team will consist of one member each from the MARIE instrument team, PPI, and the PDS Central Node. Outside science reviewers will not be required.

In the event that a production volume is found to contain errors, the MDVT can recommend one of two courses of action: fix the disk, or publish it as-is with a note in the ERRATA.TXT file. If the errors are minor, typically minor errors in the documentation, then the volume can be published if the appropriate notes are added to the volume's errata file and the error(s) are corrected on subsequent volumes. If the errors are major, typically involving errors in the data themselves, then the volume must be corrected, re-generated, and sent back to the MDVT for review. If the error is the result of a previously undetected problem in the archive production software, the software will be updated to correct the problem and then regression tested to ensure that new problems in the software were not introduced during the update.

A single archive volume set of MARIE data is produced for the entire Mars Odyssey mission (see Figure 1, Generation of MARIE Standard Product Archive Volumes). Seven (7) physical media copies of each volume are produced for validation prior to being formally included in the archive. Two copies are sent back to the MARIE team (JSC and LMT) and one copy is sent to the PDS Central Node for review. Included are a Manifest that lists the contents of the volume in detail, and an Error Report Log that describes any known deviations from the Manifest or other anomalies. The remaining four copies stay at UCLA for online access, backup, and offsite backup. Upon approval of a volume from the MDVT, the volume is considered officially released to the PDS as defined by the Mars Odyssey data release policy. The PPI Node then sends the one of the offsite backup copies of the volume to the PDS Central Node to be forwarded to the NSSDC.

It is possible that as the MARIE team develops expertise with the instrument and data, that the team will decide that it needs to change the structure or contents of its standard data products. If this occurs, the new data product and archive volume will need to undergo a full PDS peer review (same process as the initial volume). In addition, this document will need to be revised to reflect the modified archive. Table 2 (section 1.1) lists all such modifications to the archive structure and contents.

3.3 Data Product Sizes and Archive Volume Estimates

The MARIE data are organized into files each typically spanning a single day of data acquisition. Files vary in size depending on the number of events occurring each day. Table 7 summarizes the expected sizes of the MARIE standard data products (REDR, RDR), and ancillary data files. The file size estimates are based on the size of the largest files created during the interplanetary cruise phase of the mission. It is likely that the actual file sizes, and number of archive volumes required to store them all, will be less than this estimate. All MARIE data are organized onto a single archive volume covering a time interval determined by the archive volume media. The current plan is to archive data on DVD-R media that can store 4.7 Gb of data. The PDS produces DVD-R volumes in UDF bridge format with ISO partitions. The MARIE archive volumes will comply with this standard.

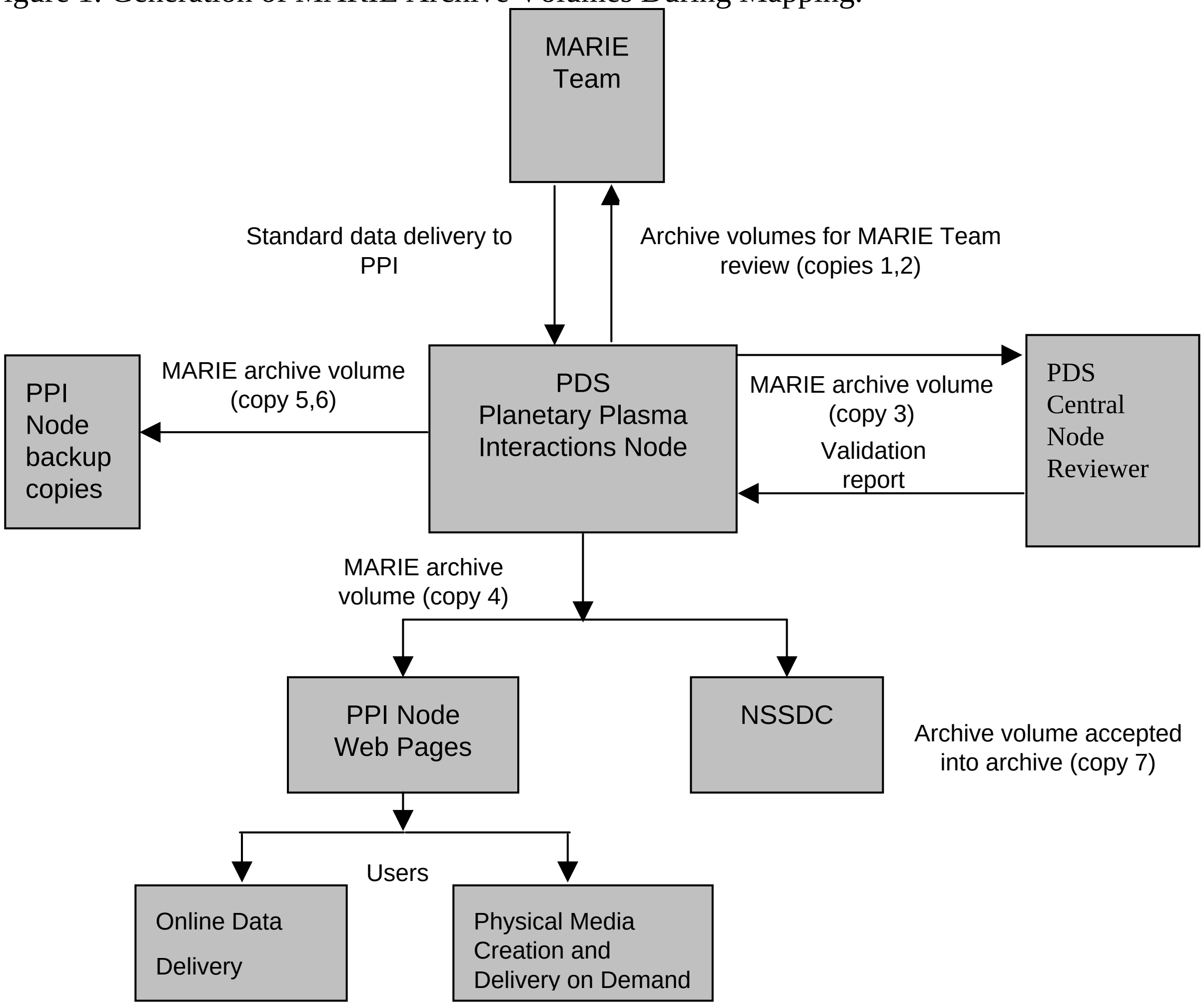
Table 7: MARIE Standard Data Product Sizes and Archive Volume Production Rates

Product	Product Size	Production Rate (approximate)	Months to Fill One 4.7 Gbyte Volume	Volumes for 3 Year Primary Mission
REDR	5 MB	1 SDP per day	N/A	N/A
RDR	15 MB	1 SDP per day	N/A	N/A
Total			7	5

The MARIE data are accumulated at the rate of about 21 MB per day so the DVD volumes that contain these data will be created about once every 7 months. Data will be made available to the science community for online access long before archive media are ready for review. In general, the PPI Node prepares data to archive standards and makes them available on its web pages with a week of receipt. Providing online access to the MARIE data is PPI's top priority. Once the data are available to online users, archive volumes will be created. The anticipated time to produce and validate an archive volume is approximately two weeks after the data delivery that fills the volume has been made available online.

The MARIE Team generates MARIE standard data products and delivers them to the Planetary Plasma Interactions Node of the PDS. PPI generates archive volumes on recordable media. Seven (7) copies of each archive volume are made. Two (2) copies are sent back to the MARIE Team (JSC and LMT) and another to the PDS Central Node for validation. Four (4) copies are kept as backups at the PPI Node one of which is placed online in the PPI web pages under an "in review, use caution" banner. The MDVT sends validation reports to the Mars Odyssey Project Science Group, which recommends either that the volume be released or, in case of errors, that it be regenerated. When a volume passes validation and is approved by the Mars Odyssey Project for release, one of the PPI CD-R copies is delivered to the NSSDC. The PPI Node then removes the "in review" banner and distributes data to users online or on physical media by request.

Figure 1: Generation of MARIE Archive Volumes During Mapping.



3.4 Backup and Duplicates

UCLA keeps three copies of each archive volume. One copy is the primary archive volume, another is an onsite backup copy, and the final copy is a local, off-site backup copy. The volumes sent to the MARIE Team and the PDS Central Node are to be kept by those institutions. Once the archive volumes are fully validated and approved for inclusion in the archive, a copy of the data is sent to the NSSDC for long-term archive in a NASA approved deep storage facility. The PPI Node at UCLA may maintain additional copies of the archive volumes, either on or off site as deemed necessary.

3.5 Labeling and Identification

Each MARIE data volume bears a unique volume ID using the last two components of the volume set ID [PDS Standards Reference, 1995]. For each physical media, the volume set ID is USA_NASA_PDS_ODMA_nnnn, where nnnn is the sequence number of the individual volume. Hence the first MARIE volume has the volume ID ODMA_0001.

Each data set in the PDS is also given a unique identifier (DATA_SET_ID). Identifiers are constructed by applying the formation rule described in the PDS Standard Reference, chapter six. Accordingly, the PDS DATA_SET_ID for the REDR data set is ODY-M-MAR-2-REDR-RAW-DATA-V1.0 and the DATA_SET_ID for the RDR data set is ODY-M-MAR-3-RDR-CALIBRATED-DATA-V1.0

4 Archive Volume Contents

This section describes the contents of the MARIE standard product archive collection volumes, including the file names, file contents, file types, and organizations responsible for providing the files. The complete directory structure is shown in Appendix A. All the ancillary files described herein appear on each MARIE volume, except where noted.

4.1 Root Directory Contents

The following files are contained in the root directory, and are produced by the PPI Node at UCLA. All of these files are required by the PDS volume organization standards.

Table 8: Root directory contents

File Name	File Contents	File Provided By
AAREADME.TXT	This file completely describes the volume organization and contents (PDS label attached).	PPI Node
ERRATA.TXT	A text file containing a cumulative listing of comments and updates concerning all MARIE Standard Data Products on all MARIE volumes in the volume set published to date.	PPI Node
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers.	PPI Node

4.2 INDEX Directory Contents

The following files are contained in the INDEX directory and are produced by the PPI Node. The INDEX.TAB file contains a listing of all data products on the archive volume. In addition, there is a cumulative index file (CUMINDEX.TAB) file that lists all data products in the MARIE archive volume set to date. There are two analogous files (MANIFEST.TAB and CUMMANIF.TAB) that contain complete listings of all files: data, ancillary data, documentation, etc. for the individual volume and volume set respectively. The index and index information (INDXINFO.TXT) files are required by the PDS volume standards. The manifest tables are added by the PPI Node for completeness and are not required files. The cumulative index file is also a PDS requirement; however, this file is not reproduced on each data volume. An online and web accessible cumulative index file will be maintained at the PPI Node while data volumes are being produced. Only the last data volume in the volume series will contain a cumulative index file.

Table 9: INDEX directory contents

File Name	File Contents	File Provided By
INDXINFO.TXT	A description of the contents of this directory	PPI Node
CUMINDEX.TAB	A table listing all MARIE data products published so far in this volume set, including the data on this volume	PPI Node
CUMINDEX.LBL	A PDS detached label that describes CUMINDEX.TAB	PPI Node
INDEX.TAB	A table listing all MARIE data products on this volume	PPI Node
INDEX.LBL	A PDS detached label that describes INDEX.TAB	PPI Node
CUMMANIF.TAB	A table listing all files published so far in this volume set, including those on this volume	PPI Node
CUMMANIF.LBL	A PDS detached label that describes CUMMANIF.TAB	PPI Node
MANIFEST.TAB	A table listing all files on this volume	PPI Node
MANIFEST.LBL	A PDS detached label that describes MANIFEST.TAB	PPI Node

4.3 DOCUMENT Directory Contents

The document directory contains documentation that is considered to be either necessary or simply useful for users to understand the archive data set. These documents are not necessarily appropriate for inclusion in the PDS catalog. Documents may be included in multiple forms (ASCII, PDF, MS Word, HTML with image file pointers, etc.). PDS standards require that any documentation deemed required for use of the data be available in some ASCII format if at all possible. HTML and PostScript are acceptable as ASCII formats in addition to plain text. The following files are contained in the DOCUMENT directory and are produced or collected by the PPI Node.

Table 10: DOCUMENT directory contents

File Name	File Contents	File Provided By
DOCINFO.TXT	A description of the contents of this directory	PPI
VOLSIS.PDF	The Archive Volume SIS (this document) in PDF format	MARIE Team, PPI
VOLSIS.DOC	The Archive Volume SIS (this document) in Microsoft Word format	MARIE Team, PPI
VOLSIS.ASC	The Archive Volume SIS (this document) in ASCII format	MARIE Team, PPI
VOLSIS.LBL	A PDS detached label that describes VOLSIS.ASC, VOLSIS.PDF and VOLSIS.DOC.	PPI
MARIEDS.DOC	MARIE data description in DOC format	MARIE Team
MARIEDS.PDF	MARIE data description in PDF format	MARIE Team, PPI
MARIEDS.ASC	MARIE data description in ASCII format	MARIE Team, PPI
MARIEDS.LBL	A PDS detached label that describes MARIEDS.ASC, MARIEDS.PDF and MARIEDS.DOC.	PPI
MARIERAW.DOC	MARIE raw data description in Microsoft Word format.	MARIE Team
MARIERAW.ASC	MARIE raw data description in ASCII format.	MARIE Team, PPI
MARIERAW.PDF	MARIE raw data description in PDF format.	MARIE Team, PPI
MARIERAW.LBL	A PDS detached label that describes MARIERAW.ASC, MARIERAW.PDF and MARIERAW.DOC.	MARIE Team, PPI
MARIERES.PDF	MARIE research description in PDF format.	MARIE Team
MARIERES.LBL	A PDS detached label that describes MARIERES.PDF.	PPI
Other Documents and labels TBD	Other documents deemed necessary by the MARIE team or peer review panel to complete the archive documentation	MARIE Team, PPI

4.4 CATALOG Directory Contents

The files in the CATALOG directory provide a top-level understanding of the Odyssey mission, spacecraft, instruments, and data sets in the form of completed PDS templates. The information necessary to create most of the files is provided by the MARIE team and formatted into standard template formats by the PPI Node. The files in this directory are coordinated with PDS data engineers at both the PPI and the PDS Central Nodes.

Table 11: CATALOG directory contents

File Name	File Contents	File Provided By
CATINFO.TXT	A description of the contents of this directory	PPI Node
REDR_DS.CAT	PDS data set catalog description of the MARIE REDR data	MARIE Team, PPI
RDR_DS.CAT	PDS data set catalog description of the MARIE RDR data	MARIE Team, PPI
ODYSSEY.CAT	PDS instrument host (spacecraft) catalog description of the Mars Odyssey spacecraft	Geosciences Node, Odyssey Project
INST.CAT	PDS instrument catalog description of the MARIE instrument	MARIE Team, PPI
MISSION.CAT	PDS mission catalog description of the Mars Odyssey mission	Geosciences Node, Odyssey Project
PERSON.CAT	PDS personnel catalog description of MARIE Team members and other persons involved with generation of MARIE data products	MARIE Team, PPI
REF.CAT	MARIE-related references mentioned in other *.CAT files	MARIE Team, PPI

4.5 GEOMETRY Directory Contents

Some basic orbit information is tabulated for the user and included with the archive in the GEOMETRY directory. The primary product in this directory is an ASCII table containing spacecraft position and MARIE sensor orientation data table (ODY_TRAJ_01.TAB) provided at one minute sampling resolution. This file is an ancillary data file provided by the PPI Node as information necessary to understand the MARIE standard data products. In addition to the geometry data table, the GEOMETRY directory contains a SPICE instrument kernel for MARIE and a SPICE planetary constants kernel for Mars. Users who need a complete set of SPICE kernels (SPK and CK files) can acquire those data from the NAIF Node of the PDS.

Table 12: GEOMETRY directory contents

File Name	File Contents	File Provided By
GEOMINFO.TXT	A description of the contents of this directory	PPI Node
ODY_TRAJ_01.TAB	ASCII table containing spacecraft position vectors in multiple coordinate systems as a function of time.	PPI Node
ODY_TRAJ_01.LBL	Detached PDS label describing ODY_TRAJ_01.TAB.	PPI Node
M01_MARIE_V10.TI	SPICE kernel describing the MARIE instrument field of view and mounting.	NAIF Node
M01_MARIE_V10.LBL	PDS label for M01_MARIE_V10.TI.	NAIF Node
MARS_IAU2000_V0.TPC	SPICE kernel containing Mars planetary constants.	NAIF Node
MARS_IAU2000_V0.LBL	PDS label for MARS_IAU2000_V0.TPC.	NAIF Node

4.6 DATA (Standard Products) Directory Contents and Naming Conventions

The DATA directory contains the actual data products and ancillary information files produced by the MARIE team. There are two standard data products produced by the MARIE team. The REDR product is raw data, reformatted into simple table structures, organized into proper time sequence, time tagged, and edited to remove obviously bad data. The RDR data product contains calibrated data in physical units at the full instrument sampling resolution. These data have been processed to remove instrument response and other non-physical information from the data set. In addition to the data files, some ancillary (engineering) information files are provided in order to support data processing and analysis. The trajectory data table described in this section is one such file.

4.6.1 Required Files

In every directory beneath the DATA directory there is a file named INFO.TXT that is an ASCII text description of the directory contents. Every file in the DATA path of an archive volume must be described by a PDS label. Text documentation files will have internal (attached) PDS labels and data files will have external (detached) labels. Detached PDS label files have the same root name as the file they describe but have the suffix ".LBL". In directories where there are multiple data files with the same internal table structure, the table column description is included in a single format file (.FMT) that is referenced by a pointer within each PDS label file. This prevents the needless repetition of information that is not changing within the PDS label files.

4.6.2 DATA / RAW_DATA Directory Contents

The REDR standard data product consists of two (2) binary data files and four (4) ASCII tables containing instrument housekeeping data. Each file in the standard set spans the same time interval, typically one day or a fraction of a day. The binary data files constitute the primary data and are housed in the DATA/RAW_DATA directory. The ASCII tabular data are ancillary data and are housed in the DATA/ANCIL directory, to be described later in this document.

The first and largest of the binary data tables is the "events" data table. This file contains one record for each observed energetic particle event. The second data file is the "counts" data table. This file contains the particle event counts.

Table 13: REDR data subdirectory contents

File Name	File Contents	File Provided By
INFO.TXT	A description of the contents of this directory	PPI Node
EVNyyddd_nn.DAT	Events binary data file	MARIE Team
EVNyyddd_nn.LBL	PDS label describing the events data file	PPI Node
CNTyyddd_nn.DAT	Counts binary data file	MARIE Team
CNTyyddd_nn.LBL	PDS label describing the counts data file	PPI Node

In order to keep the number of data files in an individual data directory manageable, while keeping all of the individual components of the standard product collocated on the archive volume, the RAW_DATA directory is divided into ten (10) day subdirectories. The subdirectory names will follow a year, day-of-year naming convention (Tyy_ddd, i.e. T02_001, T02_010, T02_020, …). The subdirectory containing data at the end of year will accommodate only 5 or 6 days of data, while the subdirectory at the beginning of the year will accommodate only 9 days of data.

4.6.2.1 REDR File Naming Convention

The REDR files in the DATA/RAW_DATA directory comply with the following naming convention:

TTTYYDDD_NN.DAT

where TTT is the data type (EVN = event, CNT = count)

YY = 2 digit year

DDD = 3 digit day of year (where Jan. 1 = 001)

NN = 2 digit number to distinguish multiple files in a day (for example, 01 denotes first file of day)

4.6.3 DATA / REDUCED Directory Contents

The RDR standard data product consists of one file type, an ASCII table containing event data. These tabular files are generated at the PPI Node through processing of the REDR files using software provided by the MARIE Team. Each file in the standard set spans the same time interval, typically one day or a fraction of a day.

Table 14: RDR data subdirectory contents

File Name	File Contents	File Provided By
INFO.TXT	A description of the contents of this directory	PPI Node
EVNyyddd_nn.TAB	Events ASCII data file	PPI Node
EVNyyddd_nn.LBL	PDS label describing the events data file	PPI Node

4.6.3.1 RDR File Naming Conventions

The RDR files comply with the following naming convention:

EVNYYDDD_NN.TAB

where

YY = 2 digit year

DDD = 3 digit day of year (where Jan 1 = 001)

NN = 2 digit number to distinguish multiple files in a day (for example, 01 denotes first file of day)

4.6.4 DATA / ANCIL Directory Contents

The DATA/ANCIL subdirectory houses four (4) kinds of ancillary files. These tabular files are part of the REDR dataset, but unlike the primary REDR (EVN and CNT) files, are in ASCII format. The types of ancillary files are: BRD (board temperatures); DET (detector temperatures); EXT (electronics high voltage); and PWR (instrument power consumption). Each file type has its own subdirectory, named BRD, DET, EXT or PWR, in ANCIL.

Table 15: Ancillary data subdirectory contents

File Name	File Contents	File Provided By
INFO.TXT	A description of the contents of this directory	PPI Node
BRDyyddd_nn.DAT	Board temperatures ASCII file	MARIE Team
BRDyyddd_nn.LBL	PDS label describing the board temperatures file	PPI Node
DETyyddd_nn.DAT	Detector temperatures file	MARIE Team
DETyyddd_nn.LBL	PDS label describing the detector temperatures file	PPI Node
EXTyyddd_nn.TAB	Electronics high voltage ASCII file	MARIE Team
EXTyyddd_nn.LBL	PDS label describing the electronics high voltage file	PPI Node
PWRyyddd_nn.TAB	Power consumption ASCII file	MARIE Team
PWRyyddd_nn.LBL	PDS label describing the power consumption file	PPI Node

4.6.4.1 ANCIL File Naming Convention

The ancillary data files in the DATA/ANCIL directory comply with the following naming convention:

TTTYYDDD_NN.XXX

where TTT is the data type

BRD = board, DET = detector, EXT=high voltage, PWR=power

YY = 2 digit year

DDD = 3 digit day of year (where Jan 1 = 001)

NN = 2 digit number to distinguish multiple files in a day (for example, 01 denotes first file of day)

XXX = DAT (binary data), TAB (ASCII data table).

5 Archive Volume Format

This section describes the format of MARIE standard product archive volumes. Data that comprise the MARIE standard product archives will be formatted in accordance with Planetary Data System specifications [Planetary Science Data Dictionary, 1996; PDS Data Preparation Workbook, 1995; PDS Standards Reference, 1995].

5.1 Disk Format

DVD archive volumes have a UDF bridge format file system with an ISO partition that is compatible with DVD readers and drivers for the MS-DOS, MS-Windows (95 or higher) Macintosh, and Solaris. The MARIE volumes will be created in accordance with the ISO 9660 level 2 Interchange Standard [ISO 9660, 1988] so that CDR products can be created from the archive without modifying file names or other parameters.

5.2 File Formats

The following section describes file formats for the kinds of files contained on archive volumes. For more information, see the PDS Data Preparation Workbook [1995], Appendix B.

5.2.1 Document File Format

Document files with the .TXT suffix exist in all directories. They are ASCII files with embedded PDS labels. All document files contain 80-byte fixed-length records, with a carriage return character (ASCII 13) in the 79th byte and a line feed character (ASCII 10) in the 80th byte. This allows the files to be read by the MacOS, DOS, Windows, UNIX, OS2, and VMS operating systems.

In general, documents are provided in ASCII text format. However, the documents contained in the DOCUMENT directory contain formatting and figures that cannot be rendered as ASCII text. Hence these documents are also given in two additional formats: PDF and Microsoft Word. The PDF file can be viewed by many Web browsers.

5.2.2 Tabular File Formats

Tabular files (.TAB suffix) exist in the DATA, INDEX and GEOMETRY directories. Tabular files are ASCII files formatted for direct reading into many database management systems on various computers. Columns are fixed length, separated by commas or whitespace, 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 detached PDS label files. A detached 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.

5.2.3 PDS Label Format

All data files in the MARIE Standard Product Archive Collection have PDS labels [Planetary Science Data Dictionary, 1996; PDS Standards Reference, 1995]. These labels all are detached from the data files (same file name prefix, .LBL suffix).

A PDS label, whether embedded or detached from its associated file, provides descriptive information about the associated file. The PDS label is an object-oriented structure consisting of sets of 'keyword = value' declarations. The object that the label refers to (e.g. IMAGE, TABLE, etc.) is denoted by a statement of the form:

^object = location

in which the carat character (^, also called a pointer in this context) indicates where to find the object. In a PDS label, the location denotes the name of the file containing the object, along with the starting record or byte number, if there is more than one object in the file. For example:

^HEADER = ("98118.TAB",1)

^TABLE = ("98118.TAB",1025 <BYTES>)

indicates that the HEADER object begins at record 1 and that the TABLE object begins at byte 1025 of the file 98118.TAB. The file 98118.TAB must be located in the same directory as the detached label file.

Below is a list of the possible formats for the ^object definition in labels in this product.

^object = n

^object = n <BYTES>

^object = "filename.ext"

^object = ("filename.ext", n)

^object = ("filename.ext", n <BYTES>)

where

n is the starting record or byte number of the object, counting from the beginning of the file (record 1, byte 1),

<BYTES> indicates that the number given is in units of bytes (the default is records),

filename is the up-to-8-character, alphanumeric upper-case file name,

ext is the up-to-3-character upper-case file extension.

All detached labels contain 80-byte fixed-length records, with a carriage return character (ASCII 13) in the 79th byte and a line feed character (ASCII 10) in the 80th byte. This allows the files to be read by the MacOS, DOS, Windows, UNIX, OS2, and VMS operating systems.

5.2.4 Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. They are plain text files formatted in an object-oriented structure consisting of sets of 'keyword = value' declarations.

5.2.5 Index File Formats

A PDS index table contains a listing of all data products on an archive volume. When a data product is described by a detached PDS label, the index file points to the label file (which in turn points to the data file). When a data product is described by an attached PDS label, the index file points directly to the data product. A PDS index is an ASCII table composed of required columns (file name, creation_time, data_set_id, product_id) and optional columns (user defined). When values are constant across an entire volume, it is sometimes permissible to promote the value out of the table and into the PDS label for the index table (no need for a column whose contents is constant). For the MARIE data sets, the file names and product_id's are identical so the product_id column is dropped. In order to facilitate users searches of the MARIE data submission, a few optional columns will be included in the index table. In particular, the file start and stop times will be included as well as a count of the number of events each file contains. Table 17 contains a description of the MARIE archive volume index files. Index files are by definition fixed length ASCII files containing comma-delimited fields. Character strings are quoted using double quotes (“”). Start bytes give the location of the first byte of the column within the file, skipping over delimiters and quotation marks.

Table 16: Index file structure and contents

Column Name	Data Type	Start Byte	Bytes	Description
File_specification_name	Char	2	80	The full specification of file name and the path to the file, relative to the root of the archive volume.
Start_time	Time	85	24	The time of the first record in the data file.
Stop_time	Time	112	24	The time of the last record in the data file.
Events	Integer	138	6	The number of particle events observed in the file.
Data_set_id	Char	147	40	The PDS ID of the data set of which this file is a member.
Product_creation_date	Time	191	10	The date when the product was delivered to the PDS.

PPI also maintains a cumulative index file that describes the location of every data product across every volume of a multi-volume archive. The cumulative index file has all of the same columns as the index file, plus one additional column: the PDS VOLUME_ID. The volume id column is the first column in the table. It is an eleven byte character string beginning at byte 2 (begin quote at byte 1). All of the other columns in the index table are displaced by 15 bytes such that the file_specification_name column begins at byte 17 rather than byte 2, etc.

In addition to the PDS index file, the PPI Node feels that it is important to maintain a mapping between data sets and all files associated with that data set on an archive volume. Data sets include documentation files (ancillary information files, PDS catalog files, documents, calibration files, browse plots, etc.) that are necessary (or useful) for a user to fully understand the contents of the data file. For this reason, the PPI Node creates a manifest table that provides this mapping. If a file is associated with more than one data set on an archive volume (such as the trajectory data table), the file is listed in the manifest multiple times to clarify that relationship. The manifest table, maintained at PPI, may or may not appear on archive volumes.

Table 17: Manifest table contents and structure

Column Name	Data Type	Start Byte	Bytes	Description
Data_set_id	Char	1	40	The PDS ID of the data set of which this file is a member.
File_specification_name	Char	41	80	The full specification of file name and the path to the file, relative to the root of the archive volume.

5.2.6 Geometry File Formats

Trajectory data for the Mars Odyssey spacecraft are provided in the file ODY_TRAJ_01.TAB in three coordinate systems (planetocentric J2000, MSE, and MSO). During the cruise phase, (2001-04-08 to 2001-10-24) the spacecraft position is given every hour. During aerobraking and mapping, position vectors are provided every minute. All distances are provided in units of Mars radii where 1 Rm = 3397 km. Angles are provided in units of degrees, and the local hour angle field is given in units of decimal hours.

The planetocentric J2000 coordinate system uses the IAU 2000 definition of the Mars planetary constants (see “Report of the IAU/IAG Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites: 2000"). Both the current parameter definitions and the changes from previous values are described in the file MARS_IAU2000_V0.TPC, and references contained therein, which is located in the GEOMETRY directory of this archive volume. The trajectory parameters associated with this coordinate system are Range, Latitude, and Longitude. Range is measured from the Mars center of mass to the spacecraft. Latitude is the angle between the Mars equatorial plane and the line connecting the Mars center of mass and the spacecraft. Positive values indicate that the spacecraft is 'above' or 'north' of the equator. Longitude is measured east from the prime meridian.

The Mars Solar Equatorial (MSE) coordinate system is defined such that the Z-axis lies along the Mars rotational axis (positive in the direction of angular momentum) and the X-Z plane contains the instantaneous Mars->Sun vector. Positive X is towards the Sun. The Y axis completes the right handed set, and points towards 'dusk'.

The Mars Solar Orbital (MSO) coordinate system is defined such that the X axis points from the instantaneous Mars center of mass to the Sun's center of mass (positive towards the Sun). The X-Y plane is the orbital plane of Mars about the Sun, and the Z axis is parallel to the normal of the orbital plane. Positive Z is taken 'above' or 'north' of the orbital plane, and positive Y opposes the Mars velocity vector. This coordinate system is sometimes referred to a Sun-State coordinates since the principal vectors are the components of the state vector of the Sun as viewed from Mars.

The column structure of the ODY_TRAJ_01.TAB file is provided in Table 12.

Local hour angle is the angle (HA) between the observer's (Odyssey's) sub-Martian meridian and the anti-sunward meridian, measured in the Martian equatorial plane in the direction of planetary rotation (see figure 2). Local time is the result of converting of the local hour angle into units of time by using the conversion factor that equates one hour to fifteen degrees of longitude. Local time values are provided in units of decimal hours.

Figure 2: Local time definition

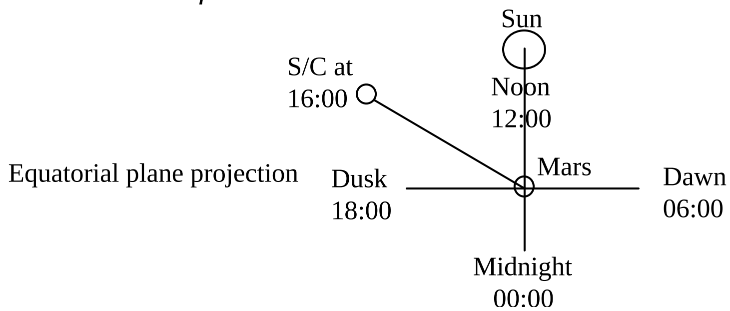
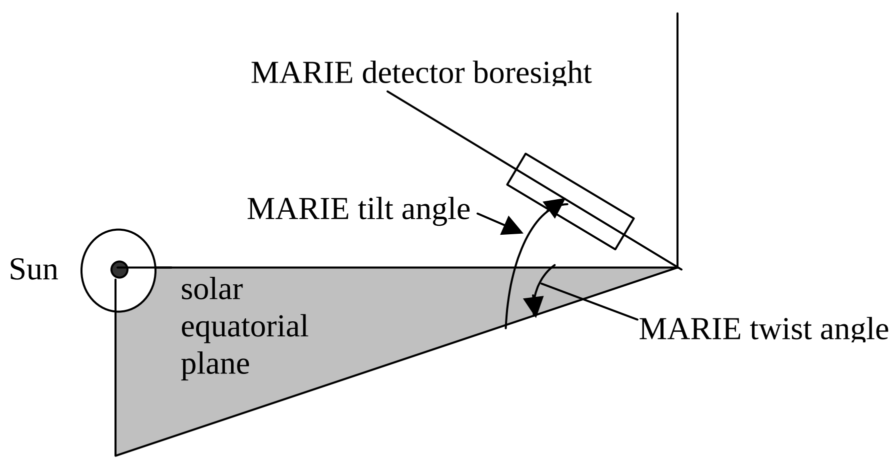


Figure 3: MARIE detector tilt and twist angle definitions



The MARIE detector tilt and twist angles are measured with respect to the Sun direction and solar equatorial plane as shown in Figure 3. The tilt angle is the angle between the solar equatorial plane and a line along the MARIE instrument boresight. Tilt angles have values in the range ± 90 degrees. The detector twist angle is the angle between the boresight direction and the Odyssey-Sun line (positive counterclockwise) measured in the solar equatorial plane. Twist angles are in the range 0-360°.

Table 18: ODY_TRAJ_01.TAB file structure and contents.

Column Name	Data Type	Start Byte	Bytes	Description
Time	Time	1	24	Spacecraft event time of this record (A24).
Range	ASCII real	26	10	Odyssey range from the Mars center of mass, in Rm (F10.3).
Latitude	ASCII real	37	8	Odyssey planetocentric latitude, in deg (F8.3).
Longitude	ASCII real	46	8	Odyssey planetocentric (east) longitude, in deg (F8.3).
Local Time	ASCII real	55	8	Odyssey local time relative to Mars, in hours (F8.3).
X_MSE	ASCII real	64	10	X component of Odyssey range in MSE coords, in Rm (F10.3).
Y_MSE	ASCII real	75	10	Y component of Odyssey range in MSE coords, in Rm (F10.3).
Z_MSE	ASCII real	86	10	Z component of Odyssey range in MSE coords, in Rm (F10.3).
X_MSO	ASCII real	97	10	X component of Odyssey range in MSO coords, in Rm (F10.3).
Y_MSO	ASCII real	108	10	Y component of Odyssey range in MSO coords, in Rm (F10.3).
Z_MSO	ASCII real	119	10	Z component of Odyssey range in MSO coords, in Rm (F10.3).

The remaining files in the GEOMETRY file are SPICE kernels in ASCII (not quite transfer) format. There is an instrument mounting (IK) kernel, a leap seconds (LSK) kernel, and a spacecraft clock (SCK) kernel. Once the ASCII line termination is modified to meet the form used on the system where the DVD volume is mounted, these files are directly accessible by the SPICELIB software routines that use them.

5.2.7 MARIE REDR Data Product Formats

As described in section 4.7.2, the MARIE REDR standard data product consists of five (5) file types: a binary events data table, a binary counts data table, and ASCII tables of housekeeping data that include detector and electronics temperatures and power consumption data. Tables 17-21 describe the file structures and contents for each of the file types associated with the REDR standard data product.

Table 19: Events data table contents and structure

Events Data Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
Type_id	MSB unsigned integer	1	1	Identifies the type of the record
Inst_id	MSB unsigned integer	2	1	Identifies the instrument.
Run_id	MSB unsigned integer	3	1	Identifies the current run
Record_id	MSB unsigned integer	4	1	Running count of records.
Length	MSB unsigned integer	5	2	Size of actual record on flash.
Check_sum	MSB unsigned integer	7	2	A checksum for the data record.
Number_events	MSB unsignedi nteger	9	1	Total of events per 100 msec.
Time	Charac-ter	10	6	Time stamp for the record. Actually a 6-byte floating point real, but treated as a character string for PDS labeling purposes.
Events	MSB unsigned integer	16	46	An array of 23 detector events. Each event is stored in a 2 byte LSB unsigned integer. Array provides detector information in the following detector order: DetA1, DetA2, DetB1T, DetB1B, DetB2T, DetB2B, DetC1, DetP1REv1Mag, DetP1REv1Pos, DetP1REv2Mag, DetP1REv2Pos, DetP1CEv1Mag, DetP1CEv1Pos, DetP1CEv2Mag, DetP1CEv2Pos, DetP2REv1Mag, DetP2REv1Pos, DetP2REv2Mag, DetP2REv2Pos, DetP2CEv1Mag, DetP2CEv1Pos, DetP2CEv2Mag, DetP2CEv2Pos
Flags	MSB unsigned integer	62	11	Flags for various aspects of the data, in the following order: FlagA1, FlagA2, FlagA3, FlagB1, FlagB2, FlagB3, FlagC1, FlagP1_S1, FlagP2_S1, FlagP1_S2, FlagP2_S2

Table 20: Counts data table structure and contents

Counts Data Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
X	Character	1	6	Description TBD. A 6-byte floating point real, treated as a character string for PDS labeling purposes.
Type_id	MSB unsigned integer	7	1	Identifies the type of record.
Inst_id	MSB unsigned integer	8	1	Identifies the instrument.
Run_id	MSB unsigned integer	9	1	Identifies the run.
Record_id	MSB unsigned integer	10	1	Identifies the record.
Len	MSB unsigned integer	11	2	Length indicator for the record.
Time	Character	13	6	Time tag for the record. Actually a 6-byte floating point real, but treated as a character string for PDS labeling purposes.
Check_sum	MSB unsigned integer	19	2	A checksum for the data.
Counts	MSB unsigned integer	21	10	An array of 5 detector counts. Each event is stored in a 2 byte LSB unsigned integer. Array provides detector information in the following detector order: CntA1F, CntA2F, CntB1F, CntB2F, CntC1F

All of the ASCII housekeeping data files have a seven (7) line header that gives column names, units, etc. After the header, the data are tabular with fixed length columns. Header records are padded with blank spaces to the data table record length. Tables 19-21 describes the tabular structure of the data beginning at record 8 in the housekeeping data files.

Table 21: Detector temperature table contents and structure

Detector Temperatures Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
UTC_time	Character	1	20	Universal time of the sample at the spacecraft. The time appears as two ASCII columns. The first of these columns has the format DDMMMYY, where DD is the two-digit day of month, MMM is the three-letter uppercase month abbreviation, and YY is the two-digit year. The second column is the time of day, in the format HH:MM:SS.SS, where HH is the hour, MM is the minute, and SS.SS is the decimal second. The columns are separated by two ASCII space characters (.i.e. 02MAY05 17:47:22.343).
Julian Seconds	ASCII Real	21	18	Julian time, in seconds, for data in the row. This column provides a second representation of the time (F18.7).
A1 Temperature	ASCII Real	42	14	Temperature of Detector A1 in the MARIE instrument in degrees Celsius (F14.7).
A2 Temperature	ASCII Real	58	14	Temperature of Detector A2 in the MARIE instrument in degrees Celsius (F14.7).
B1-B2 Temperature	ASCII Real	74	14	Temperature of Detectors B1 and B2 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
B3-B4 Temperature	ASCII Real	90	14	Temperature of Detectors B3 and B4 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
C Temperature	ASCII Real	106	14	Temperature of Detector C in the MARIE instrument in degrees Celsius (F14.7).
Power Temperature	ASCII Real	122	14	Temperature of the power card in the MARIE instrument in degrees Celsius (F14.7).
CPU Temperature	ASCII Real	138	14	Temperature of the CPU card in the MARIE instrument in degrees Celsius (F14.7).
PSD1 Temperature	ASCII Real	154	14	Temperature of Detector PSD1 in the MARIE instrument in degrees Celsius (F14.7).
PSD2 Temperature	ASCII Real	170	14	Temperature of Detector PSD2 in the MARIE instrument in degrees Celsius (F14.7).

Table 22: Electronics (board) temperature table contents and structure

Electronics Temperatures Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
UTC_time	Char	1	20	Universal time of the sample at the spacecraft. The time appears as two ASCII columns. The first of these columns has the format DDMMMYY, where DD is the two-digit day of month, MMM is the three-letter uppercase month abbreviation, and YY is the two-digit year. The second column is the time of day, in the format HH:MM:SS.SS, where HH is the hour, MM is the minute, and SS.SS is the decimal second. The columns are separated by two ASCII space characters (.i.e. 02MAY05 17:47:22.343).
Julian Seconds	ASCII Real	21	18	Julian time, in seconds, for data in the row. This column provides a second representation of the time (F18.7).
A1 Temperature	ASCII Real	42	14	Temperature of the electronics for detector A1 in the MARIE instrument in degrees Celsius (F14.7).
A2 Temperature	ASCII Real	58	14	Temperature of the electronics for detector A2 in the MARIE instrument in degrees Celsius (F14.7).
B1-B2 Temperature	ASCII Real	74	14	Temperature of the electronics for detector B1 and B2 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
B3-B4 Temperature	ASCII Real	90	14	Temperature of the electronics for detector B3 and B4 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
C Temperature	ASCII Real	106	14	Temperature of the electronics for detector C in the MARIE instrument in degrees Celsius (F14.7).
Power Temperature	ASCII Real	122	14	Temperature of the power card in the MARIE instrument in degrees Celsius (F14.7).
CPU Temperature	ASCII Real	138	14	Temperature of the CPU card in the MARIE instrument in degrees Celsius (F14.7).
PSD1 Temperature	ASCII Real	154	14	Temperature of the electronics for detector PSD1 in the MARIE instrument in degrees Celsius (F14.7).
PSD2 Temperature	ASCII Real	170	14	Temperature of the electronics for detector PSD2 in the MARIE instrument in degrees Celsius (F14.7).

Table 23: Power consumption data table contents and structure

Power Consumpion Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
UTC_time	Char	1	20	Universal time of the sample at the spacecraft. The time appears as two ASCII columns. The first of these columns has the format DDMMMYY, where DD is the two-digit day of month, MMM is the three-letter uppercase month abbreviation, and YY is the two-digit year. The second column is the time of day, in the format HH:MM:SS.SS, where HH is the hour, MM is the minute, and SS.SS is the decimal second. The columns are separated by two ASCII space characters (.i.e. 02MAY05 17:47:22.343).
Julian Seconds	ASCII Real	21	18	Julian time, in seconds, for data in the row. This column provides a second representation of the time (F18.7).
A1 Temperature	ASCII Real	42	14	Power consumption, in milliwatts, of detector A1 in the MARIE instrument in degrees Celsius (F14.7).
A2 Temperature	ASCII Real	58	14	Power consumption, in milliwatts, of detector A2 in the MARIE instrument in degrees Celsius (F14.7).
B1-B2 Temperature	ASCII Real	74	14	Power consumption, in milliwatts, of detectors B1 and B2 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
B3-B4 Temperature	ASCII Real	90	14	Power consumption, in milliwatts, of detectors B3 and B4 (on the same board) in the MARIE instrument in degrees Celsius (F14.7).
C Temperature	ASCII Real	106	14	Power consumption, in milliwatts, of detector C in the MARIE instrument in degrees Celsius (F14.7).
Power Temperature	ASCII Real	122	14	Power consumption, in milliwatts, of the power card in the MARIE instrument in degrees Celsius (F14.7).
CPU Temperature	ASCII Real	138	14	Power consumption, in milliwatts, of the CPU card in the MARIE instrument in degrees Celsius (F14.7).
PSD1 Temperature	ASCII Real	154	14	Power consumption, in milliwatts, of detector PSD1 in the MARIE instrument in degrees Celsius (F14.7).
PSD2 Temperature	ASCII Real	170	14	Power consumption, in milliwatts, of detector PSD2 in the MARIE instrument in degrees Celsius (F14.7).

Table 24: High voltage table contents and structure

Electronics Temperatures Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
UTC_time	Char	1	20	Universal time of the sample at the spacecraft. The time appears as two ASCII columns. The first of these columns has the format DDMMMYY, where DD is the two-digit day of month, MMM is the three-letter uppercase month abbreviation, and YY is the two-digit year. The second column is the time of day, in the format HH:MM:SS.SS, where HH is the hour, MM is the minute, and SS.SS is the decimal second. The columns are separated by two ASCII space characters (.i.e. 02MAY05 17:47:22.343).
Julian Seconds	ASCII Real	21	18	Julian time, in seconds, for data in the row. This column provides a second representation of the time (F18.7).
A1 Voltage	ASCII Real	42	14	Voltage measured for board A1 (F14.7).
A2 Voltage	ASCII Real	58	14	Voltage measured for board A2 (F14.7).
B1-B2 Voltage	ASCII Real	74	14	Voltage measured for boards B1 and B2 (F14.7).
B3-B4 Voltage	ASCII Real	90	14	Voltage measured for boards B3 and B4 (F14.7).
C Voltage	ASCII Real	106	14	Voltage measured for board C (F14.7).
Power Voltage	ASCII Real	122	14	Voltage of board of the power card, minus BAT voltage (F14.7).
CPU Voltage	ASCII Real	138	14	Voltage of the CPU card, minus junk voltage (F14.7).
PSD1 Voltage	ASCII Real	154	14	Voltage of board of detector PSD1, plus 5v.
PSD2 Voltage	ASCII Real	170	14	Voltage of board of detector PSD1, plus 5v.

5.2.8 MARIE RDR Data Product Format

The MARIE RDR standard data product consists of an ASCII table file, which is generated from an REDR file by processing. Table 24 describes the file structures and contents for the RDR files.

Table 25: RDR data structure and contents

RDR Data Table				
Column Name	**Data Type**	**Start Byte**	**Bytes**	**Description**
Time	Character	1	20	Time tag consisting of two physical columns: (1) year, (2) decimal day of year (with beginning of Jan. 1 = 1.0).
Event_number	ASCII real	21	7	Number of event.
A1		28	8	Energy deposited in detector A1.
A2		36	8	Energy deposited in detector A2.
B1		44	8	Energy deposited in detector B1.
B2		52	8	Energy deposited in detector B2.
B3		60	8	Energy deposited in detector B3.
B4		68	8	Energy deposited in detector B4.
C1		76	7	Uncalibrated pulse height from Cerenkov detector.
P1RM		83	6	Row magnitude from PSD1.
P1RP		89	6	Row position from PSD1.
P1CM		95	6	Column magnitude from PSD1.
P1CP		101	6	Column position from PSD1.
P2RM		107	6	Row magnitude from PSD2.
P2RP		113	6	Row position from PSD2.
P2CM		119	6	Column magnitude from PSD2.
P2CP		125	6	Column position from PSD2.
E_tot		131	10	Sum of energies deposited in A1, A2, and B1-B4.
Theta		141	7	The particle's incident angle, as calculated from the position information in the two PSDs.

6 Support Staff and Cognizant Persons

Table 26: MARIE Archive Collection Support Staff

MARIE Team			
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Appendix A. Directory Structure for Archive Volumes

The following directory structure is applicable to each MARIE Standard Product Archive Volume. This structure may vary slightly from disk to disk. The directories are explained in the text of this document.