

**Mars Global Surveyor
Mars Orbiter Laser Altimeter**

**MOLA STANDARD PRODUCT
ARCHIVE VOLUME
SOFTWARE INTERFACE SPECIFICATION

(MOLA Archive Volume SIS)**

Version 4.6
rev. February 27, 2003

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TABLE OF CONTENTS

1. Preface.....	1
1.1 Distribution List.....	1
1.2 Document Change Log	1
1.3 TBD Items	2
1.4 Acronyms and Abbreviations	2
1.5 Glossary	3
2. Introduction.....	4
2.1 Content Overview	4
2.2 Scope.....	5
2.3 Applicable Documents	5
2.4 Audience	5
3. Archive Volume Generation	5
3.1 Data Transfer and Validation Methods	5
3.2 Data Product Sizes and Delivery Rates	6
3.3 Interface Media Characteristics	7
3.4 Backup and Duplicates.....	7
3.5 Labeling and Identification	7
4. Archive Volume Contents.....	8
4.1 Root Directory Contents	8
4.2 Index Directory Contents	8
4.3 Document Directory Contents	9
4.4 Label Directory Contents	10
4.5 Catalog Directory Contents.....	10
4.6 Software Directory Contents	11
4.7 Standard Products Data Directory Contents.....	12
4.7.1 AEDR Data Directory Contents and Naming	12
4.7.2 PEDR Data Directory Contents and Naming.....	13
4.7.3 Gridded Product Data Directory Contents and Naming.....	13
4.8 Special Products Data Directory Contents	13
5. Archive Volume Format	14
5.1 Disk Format	14
5.2 File Formats	14
5.2.4 Document File Format	14
5.2.5 Tabular File Format.....	14
5.2.6 PDS Label Format	15
5.2.7 Software File Format.....	16
5.2.8 Catalog File Format.....	16
5.2.9 Science Data File Formats	16
5.2.9.1 AEDR Data Product Format.....	16
5.2.9.2 PEDR Data Product Format	16
5.2.9.3 Gridded Data Product Format.....	16
6. Support Staff and Cognizant Persons	18

APPENDIX A. MOLA PEDR VIRTUAL ARCHIVE VOLUME	20
A1. Archive Volume Generation	20
A1.1 Purpose of the PEDR Virtual Archive Volume	20
A1.2 Data Product Size and Delivery Rate	20
A1.3 Data Preservation	20
A1.4 Labeling and Identification	20
A2. Archive Volume Contents.....	20
A2.1 Root Directory Contents	21
A2.2 Index Directory Contents.....	21
A2.3 Document Directory Contents	21
A2.4 Label Directory Contents.....	22
A2.5 Catalog Directory Contents.....	22
A2.6 Software Directory Contents	22
A2.7 PEDR Data Directory Contents	23
A3. Archive Volume Format	23
A3.1 Disk Format.....	23
A3.2 File Formats.....	23

TABLES AND FIGURES

Table 1 – Standard Data Products in MOLA Archive Collection	4
Table 2 – MOLA Standard Product Sizes and Delivery Rates.....	6
Table 3 – MOLA Archive Collection Support Staff.....	18
Figure 1 – Generation of MOLA Archive Volumes.....	19

1. Preface

This document describes the format and content of the MOLA Standard Product Archive Collection on CD-WO and CD-ROM media. Appendix A describes the format and content of the online MOLA PEDR archive volume.

1.1 Distribution List

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 T. Anderson
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 P. Jester
 D. Hanks
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 M. Martin
 T. Sesplaukas
 D. Smith
 T. Thorpe
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 R. Walker

1.2 Document Change Log

Change	Date	Affected Portions
Original outline	7/31/92	All
Updates to reflect PDS Standards	12/1/92	File names: CUMINDEX.*, *.ASC for SISs, Vol.Set ID
Updates to include Washington U. generation of write-once CDs (CD-WOs)	12/7/92	TBD item list, Scope, Interface, Media format and contents, Appendix A, Figure 1.
Updates to include reviewers' comments, new values for data volumes, W.U. separation of gridded products	2/1/93	All
Updates to reflect production of two volume sets, one for raw data and one for derived data	8/9/93	All
Revised for Mars Global Surveyor in place of Mars Observer	8/24/94	All
Revised to reflect new MGS MOLA products	10/24/97	All
Revised with minor corrections	8/6/98	All
Revised sections 4.7 and 5.2.4 regarding software on archive volumes; removed discussion of calibration directory; removed appendices showing directory structure (redundant with section 4); other minor corrections	10/29/98	4.4, 4.7, 5.2.4; appendices A.1 and A.2
Added description of BROWSE directory; changed description of SOFTWARE directory to replace PDCODE with PEDR2TAB; added a few missing files to	2/23/99	2.1, 4.8, 5.2.4, 4.8, 5.2.6.4

directory contents listings		
Products aggregated by day instead of by orbit during mapping;	11/18/99	2.1, 4.7.1, 5.2.6
MOLA orbit number = Project orbit number + 10000 for Mapping Phase products	11/18/99	4.7.1, 4.7.2
Change to data directory names and structure	11/18/99	4.7.1, 4.7.2
Revised description of gridded products	11/18/99	4.7.3, 5.2.6.3
Removed description of BROWSE directory (no browse data provided during mapping)	11/18/99	4.7.3
Added section 4.8, Special Products Data Directory Contents	5/16/00	4.8
Revised description of gridded products	8/11/00	2.1, 3.2, 4.7.3, 5.2.6.3
Added Appendix A for online PEDR archive	2/27/03	Appendix A

1.3 TBD Items

None.

1.4 Acronyms and Abbreviations

AEDR	Aggregated Experiment Data Record
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
Mb	Megabytes
MGS	Mars Global Surveyor
MOLA	Mars Orbiter Laser Altimeter
NSSDC	National Space Science Data Center
PDB	Project Database
PDS	Planetary Data System
PEDR	Precision Experiment Data Record
PSG	Project Science Group
SDVT	Science Data Validation Team
SFDU	Standard Formatted Data Unit
SIS	Software Interface Specification
TBD	To Be Determined

1.5 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 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*.

Virtual Volume – An archive volume that is stored on a hard disk and served as an online resource. The volume contents are organized as a single volume according to PDS standards for archive volumes. A virtual volume may be larger than a single physical CD or DVD.

2. Introduction

2.1 Content Overview

The Mars Orbiter Laser Altimeter, MOLA, is an instrument on the Mars Global Surveyor (MGS) orbiter. Standard data products generated by the MOLA instrument are listed in Table 1.

Table 1 – Standard Data Products in MOLA Archive Collection

Acronym	Standard Data Product
MOLA-AEDR	Aggregate Experiment Data Record
MOLA-PEDR	Precision Experiment Data Record
MOLA-IEGDR	Initial Experiment Gridded Data Record
MOLA-MEGDR	Mission Experiment Gridded Data Record

Each MOLA-AEDR product is an aggregation of MOLA telemetry packets (i.e., the raw data). Each MOLA-PEDR product contains AEDR data that has been converted to engineering and physical units using precision orbit data. AEDRs and PEDRs from the Orbit Insertion mission phases contain one orbit's worth of data per product. Products from the Mapping Phase contain one day's worth of data, covering several orbits. The MOLA-IEGDR and MOLA-MEGDR products, together known as the gridded products, are sets of global maps at different resolutions created by binning the MOLA-PEDR products. The MOLA standard data products are generated by the MOLA Instrument Team and archived by the Planetary Data System (PDS). The PDS Geosciences Node is responsible for compiling the MOLA archive volumes on CD-ROM media.

This Software Interface Specification (SIS) describes the format, content, and generation of the MOLA 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.

Appendix A describes the format and content of the MOLA PEDR virtual archive volume, which holds the complete reprocessed MOLA PEDR data set. The revised PEDR data set is not distributed on CD media, but is available online from the Planetary Data System Geosciences Node. The online data set is provided as a single large volume containing only PEDR data, no other MOLA data products. The volume structure as described in Appendix A differs from that of the original PEDR volumes described in the main body of this SIS.

2.2 Scope

The specifications in this document apply to all MOLA standard product archive volumes that are produced on compact disk media during the Mapping Phase of the Mars Global Surveyor mission. Most of the specifications in this document also apply to MOLA archive volumes containing data acquired during the Orbit Insertion Phase of the mission, prior to the Mapping Phase. The chief difference between the Orbit Insertion Phase and Mapping Phase volumes is that AEDRs and PEDRs are archived together on Orbit Insertion Phase volumes, while during the Mapping Phase they are archived on separate volumes.

2.3 Applicable Documents

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

Arvidson, R., E. Guinness, and S. Slavney, Mars Global Surveyor Project Archive Generation, Validation, and Transfer Plan, MGS Document #542-312, 1998.

Mars Global Surveyor MOLA (Mars Orbiter Laser Altimeter) Aggregated Experiment Data Record Software Interface Specification (MOLA AEDR SIS), September 24, 1998, Version 2.1, NASA Goddard Space Flight Center.

Mars Global Surveyor MOLA (Mars Orbiter Laser Altimeter) Any-Experiment Gridded Data Record Software Interface Specification (MOLA ?EGDR SIS), March 31, 1997, Version 1.0, NASA Goddard Space Flight Center.

Mars Global Surveyor MOLA (Mars Orbiter Laser Altimeter) Precision Experiment Data Record Software Interface Specification (MOLA PEDR SIS), December 12, 1998, Version 2.7, NASA Goddard Space Flight Center.

Planetary Science Data Dictionary Document, August 28, 2002, Planetary Data System, JPL D-7116, Rev. E.

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

Planetary Data System Standards Reference, October 2002, Version 3.5. JPL D-7669, Part 2.

2.4 Audience

This specification is useful to those who wish to understand the format and content of the MOLA Standard Product Archive Collection. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

3. Archive Volume Generation

3.1 Data Transfer and Validation Methods

The MOLA Standard Product Archive Collection is produced by the PDS Geosciences Node at Washington University, in conjunction with the MOLA Instrument Team. The Washington University activities are funded by the Mars Global Surveyor Project.

The Archive Collection includes data acquired during the Orbit Insertion and Mapping Phases of the MGS mission. The archive validation procedure described in this section applies to volumes generated during the Mapping Phase of the mission. The few volumes produced with Orbit Insertion data, before mapping begins, are validated using PDS peer review procedures.

During the Mapping Phase of the MGS mission, two archive volume sets of MOLA data are produced: one contains the MOLA-AEDR products, and the other contains the MOLA-PEDR and gridded products. (see Figure 1, Generation of MOLA Standard Product Archive Volumes). Upon notification by the MOLA Team, the Geosciences Node extracts standard products by electronic file transfer from the MOLA Team's processing facility and generates associated documentation and ancillary products (e.g. index tables). Each volume of standard products, documentation and ancillary products is stored on a write-once CD-ROM (CD-WO) generated at Washington University. All data formats are based on the Planetary Data System standards as documented in the PDS Standards Reference [section 2.3, Applicable Documents].

Four copies of each volume are produced. Two are sent to the MOLA Team and the SDVT for review, along with 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. A third copy remains at Washington University for backup. Upon approval of a volume from the MOLA Team and the SDVT, the volume is considered officially released to the PDS as defined by the Mars Global Surveyor data release policy [Arvidson et al., 1998]. The Geosciences Node then sends the fourth copy of the volume to a CD-ROM vendor for replication.

The Geosciences Node provides the vendor with a mailing list for distribution of copies. The list includes MGS personnel who have expressed interest in receiving the data, the Planetary Data System, and the National Space Science Data Center (NSSDC). The PDS requests enough copies to serve its anticipated user needs, and funds those copies. The PDS is responsible for making additional future copies as needed.

In the event that a volume is found to contain errors, the reviewers can recommend one of two courses of action: (1) if the errors are minor, the volume may be published anyway, with an explanatory note added to the volume's errata file and the errors corrected on subsequent volumes; (2) if the errors are major, the volume must be re-generated to correct them.

3.2 Data Product Sizes and Delivery Rates

Table 2 summarizes expected sizes and delivery rates for the MOLA Standard Products.

Table 2– MOLA Standard Product Sizes and Delivery Rates

Product	Product Size	Production Rate (approximate)	Days to Fill One 650-Mbyte Volume	Volumes for 687-Day Primary Mission
AEDR	1.50 Mb	1 product per day 8 Mb per day	81.25	9
PEDR	0.38 Mb	1 product per day 34 Mb per day	19.12	36

IEGDR	0.50 Mb	1 product after the first 30 days of mapping	N/A	<1*
MEGDR	12.00 Mb	1 product after completion of the Primary Mission	N/A	<1*
*Since the gridded products are relatively small, they are not placed on separate volumes, but instead are included on the PEDR archive volumes.				

Each MOLA Standard Product Archive Volume contains at most 650 Mbytes of data, including documentation and ancillary files, based on the storage capacity of CD-ROMs readable by most CD-ROM drives.

The Archive Volumes are produced as enough data are accumulated to fill each disk. The MOLA-AEDRs are accumulated at the rate of about 56 Mb per week, so CD-WO volumes containing these data are produced about every 11 weeks. The MOLA-PEDRs are accumulated at the rate of about 238 Mb per week, resulting in a new volume every 2 to 3 weeks. The MOLA IEGDR consists of a single product generated after the first 30 days of mapping, and the MOLA MEGDR is a single product generated after the primary mission is completed. As they become available, these products are included on PEDR volumes, as their small size does not justify placing them on separate volumes.

The MOLA Team expects to issue revised versions of PEDR products as more precise orbit information is obtained in the course of the mission. The plan is for three revisions of the orbit information, although the number of versions of an individual PEDR product may vary. The EGDR products may also be revised using increasingly higher resolutions.

3.3 Interface Media Characteristics

All volumes in the MOLA Standard Product Archive Collection conform to ISO 9660 standards [ISO 9660, 1988].

3.4 Backup and Duplicates

Washington University keeps a backup copy of each CD-WO volume. The backup copy can be used if the CD-WO sent to the vendor becomes lost or damaged. The two CD-WO volumes sent to the MOLA Team and the SDVT for review do not need to be returned to Washington University.

3.5 Labeling and Identification

Each MOLA CD-WO bears a volume ID using the last two components of the volume set ID [PDS Standards Reference, 1995]. For archive volumes containing data acquired during the Mapping Phase, the AEDR volume set ID is **USA_NASA_JPL_MGSL_1nnn**, and the PEDR/gridded product volume set ID is **USA_NASA_JPL_MGSL_2nnn**, where nnn is the sequence number of the individual volume. Hence the first AEDR volume has the volume ID **MGSL_1001**, and the first PEDR and gridded products volume has the volume ID **MGSL_2001**. For archive volumes containing pre-Mapping Phase data, AEDR and PEDR

products will be combined on the same volume. The volume set ID is **USA_NASA_JPL_MGSL_0nnn**.

4. Archive Volume Contents

This section describes the contents of the MOLA Standard Product Archive Collection volumes, including the file names, file contents, file types, and organization responsible for providing the files. The complete directory structure is shown in Appendix A. All the ancillary files described herein appear on both the AEDR volumes and the PEDR / gridded products volumes, except where noted. See the MOLA Data Product SIS documents [MOLA AEDR SIS, 1998; MOLA Any-EGDR SIS, 1997; MOLA PEDR SIS, 1998] for examples of PDS labels for each type of product.

4.1 Root Directory Contents

The following files are contained in the Root Directory, and are produced by the Geosciences Node at Washington University:

File Name	File Contents	File Provided By
AAREADME.TXT	Volume content and format information	Geosciences Node
AAREADME.HTM	Hypertext version of AAREADME.TXT	Geosciences Node
AAREADME.LBL	A PDS detached label that describes both AAREADME.TXT and AAREADME.HTM.	Geosciences Node
ERRATA.TXT	A cumulative listing of comments and updates concerning all MOLA Standard Products Data Products on all MOLA compact disk volumes published so far	Geosciences Node
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	Geosciences Node

4.2 Index Directory Contents

The following files are contained in the Index Directory and are produced by the Geosciences Node.

File Name	File Contents	File Provided By
INDXINFO.TXT	A description of the contents of this directory	Geosciences Node
AEDCMIDX.TAB	A table listing all MOLA-AEDR products published so far in this volume set, including the data on this volume (AEDR volumes only)	Geosciences Node
AEDCMIDX.LBL	A PDS detached label that describes AEDCMIDX.TAB (AEDR volumes only)	Geosciences Node
AEDINDEX.TAB	A table listing all MOLA-AEDR products on this volume (AEDR volumes only)	Geosciences Node
AEDINDEX.LBL	A PDS detached label that describes AEDINDEX.TAB (AEDR volumes only)	Geosciences Node

EGDCMIDX.TAB	A table listing all MOLA EGDR products published so far in this volume set, including the data on this volume (PEDR/EGDR volumes only)	Geosciences Node
EGDCMIDX.LBL	A PDS detached label that describes EGDCMIDX.TAB (PEDR/EGDR volumes only)	Geosciences Node
EGDINDEX.TAB	A table listing all MOLA EGDR products on this volume (PEDR/EGDR volumes only)	Geosciences Node
EGDINDEX.LBL	A PDS detached label that describes EGDINDEX.TAB (PEDR/EGDR volumes only)	Geosciences Node
PEDCMIDX.TAB	A table listing all MOLA-PEDR products published so far in this volume set, including the data on this volume (PEDR/EGDR volumes only)	Geosciences Node
PEDCMIDX.LBL	A PDS detached label that describes PEDCMIDX.TAB (PEDR/EGDR volumes only)	Geosciences Node
PEDINDEX.TAB	A table listing all MOLA-PEDR products on this volume (PEDR/EGDR volumes only)	Geosciences Node
PEDINDEX.LBL	A PDS detached label that describes PEDINDEX.TAB (PEDR/EGDR volumes only)	Geosciences Node

4.3 Document Directory Contents

The following files are contained in the Document Directory and are produced or collected by the MOLA team.

File Name	File Contents	File Provided By
DOCINFO.TXT	A description of the contents of this directory	Geosciences Node
AEDRSIS.CSS	HTML style sheet used in AEDRSIS.HTM	MOLA Team
AEDRSIS.HTM	The AEDR SIS as hypertext (on AEDR volumes only)	MOLA Team
AEDRSIS.PDF	The AEDR SIS as a PDF file readable with Adobe Acrobat Reader software	MOLA Team
AEDRSIS.LBL	A PDS detached label that describes both AEDRSIS.HTM and AEDRSIS.PDF.	Geosciences Node
ARCHSIS.HTM	The Archive Volume SIS (this document) as hypertext	Geosciences Node
ARCHSIS.PDF	The Archive Volume SIS (this document) as a PDF file readable with Adobe Acrobat Reader software	Geosciences Node
ARCHSIS.LBL	A PDS detached label that describes both ARCHSIS.HTM and ARCHSIS.PDF.	Geosciences Node
MOLALOGO.GIF	MOLA logo image used in AEDRSIS.HTM and PEDRSIS.HTM	MOLA Team
PEDRSIS.CSS	HTML style sheet used in PEDRSIS.HTM	MOLA Team
PEDRSIS.HTM	The PEDR SIS as hypertext (on PEDR/EGDR volumes only)	MOLA Team
PEDRSIS.PDF	The PEDR SIS as a PDF file readable with Adobe Acrobat Reader software	MOLA Team
PEDRSIS.LBL	A PDS detached label that describes both PEDRSIS.HTM and PEDRSIS.PDF.	Geosciences Node

EGDRSIS.CSS	HTML style sheet used in EGDRSIS.HTM	MOLA Team
EGDRSIS.HTM	The EGDR SIS as hypertext (on PEDR/EGDR volumes only)	MOLA Team
EGDRSIS.PDF	The EGDR SIS as a PDF file readable with Adobe Acrobat Reader software	MOLA Team
EGDRSIS.LBL	A PDS detached label that describes both EGDRSIS.HTM and EGDRSIS.PDF.	Geosciences Node

4.4 Label Directory Contents

The following files are contained in the Label Directory and are produced by the MOLA team.

File Name	File Contents	File Provided By
LABINFO.TXT	A description of the contents of this directory	MOLA Team
MOLASCI.FMT	The format file that describes the science-mode record format of the AEDR product (AEDR volumes only)	MOLA Team
MOLASCFR.FMT, MOLASCCT.FMT	Additional format files referenced by MOLASCI.FMT (AEDR volumes only)	MOLA Team
MOLAMNT.FMT	The format file that describes the maintenance-mode record format of the AEDR product (AEDR volumes only)	MOLA Team
PEDRSEC1.FMT	The format file that describes the first 500 bytes of a PEDR record (PEDR/EGDR volumes only)	MOLA Team
PEDRENG1.FMT, PEDRENG2.FMT, PEDRENG3.FMT, PEDRENG4.FMT, PEDRENG5.FMT, PEDRENG6.FMT, PEDRENG7.FMT	The format files that describe the 28 bytes of engineering information in a PEDR (bytes 501-528). There are seven different types of record structures, one for each frame. (PEDR/EGDR volumes only)	MOLA Team
PEDRSEC3.FMT	The format file that describes bytes 529 through the end of a PEDR record (PEDR/EGDR volumes only)	MOLA Team

4.5 Catalog Directory Contents

The files in the Catalog directory provide a top-level understanding of the Mars Global Surveyor Mission, spacecraft, instruments, and data sets in the form of completed PDS templates. The files are produced or collected by the MOLA team. The files in this directory are coordinated with the PDS data engineer.

File Name	File Contents	File Provided By
CATINFO.TXT	A description of the contents of this directory	Geosciences Node
AEDRDS.CAT	PDS data set catalog information about MOLA AEDRs	MOLA Team
PEDRDS.CAT	PDS data set catalog information about MOLA PEDRs	MOLA Team
EGDRDS.CAT	PDS data set catalog information about MOLA EGDRs	MOLA Team
INSTHOST.CAT	PDS instrument host catalog information about the MGS spacecraft	Geosciences Node

INST.CAT	PDS instrument catalog information about the MOLA instrument	MOLA Team
MISSION.CAT	PDS mission catalog information about the MGS mission	Geosciences Node
PERSON.CAT	PDS personnel catalog information about MOLA Team members responsible for generating data products	Geosciences Node
REF.CAT	References mentioned in other *.CAT files	Geosciences Node

4.6 Software Directory Contents

Two programs are provided on the PEDR/EGDR volumes for accessing PEDR data. They are:

MPROF	Script for use with the commercial image processing software IDL to plot elevation profiles from PEDR data. For Sun/UNIX and PC computers that have IDL installed. Written by C. David Brown, Washington University.
PEDR2TAB	Fortran program that generates ASCII tables from PEDR files. For Sun/UNIX and PC computers. Written by Gregory Neumann, NASA/Goddard Space Flight Center.

These programs are also available from the PDS Geosciences Node web site, <http://www.pds.wustl.edu>, and from the MOLA Team web site, <http://ltpwww.gsfc.nasa.gov/tharsis/mola.html>. They are subject to change during the course of the mission. The MOLA site may include variants of the software for computer platforms other than those listed here. Updates to the software, as well as additional programs, are posted on the web sites as they become available. The archive volumes contain the latest version of programs available at the time the volume is generated.

The Software Directory is divided into subdirectories for each program, and then further divided by computer platform. The Software Directory appears only on PEDR/EGDR volumes, not on AEDR volumes.

File Name	File Contents	File Provided By
SOFTINFO.TXT	A description of the contents of this directory	MOLA Team / Geosciences Node
MPROF	Subdirectory containing IDL scripts	
PC	Subdirectory containing files for PC platforms	
MPRFINFO.TXT	Instructions for using MPROF	Geosciences Node
MPROF.PRO	PC version of IDL script to plot elevation profiles	Geosciences Node
SUN	Subdirectory containing files for Sun/UNIX platforms	
MPRFINFO.TXT	Instructions for using MPROF	Geosciences Node
MPROF.PRO	Sun/UNIX version of IDL script to plot elevation profiles	Geosciences Node
PEDR2TAB	Subdirectory containing PEDR2TAB program files	

P2TINFO.TXT	A description of the contents of the PEDR2TAB directory	MOLA Team / Geosciences Node
PC	Subdirectory containing files for PC platforms	
MOLA.LBL	Example of PDS label for PEDR2TAB output file	MOLA Team
P2TINFO.TXT	Instructions for using PEDR2TAB	MOLA Team / Geosciences Node
PEDR2TAB.EXE	Executable file compiled for Solaris 2.4	MOLA Team / Geosciences Node
PEDR2TAB.F	Fortran 77 source code for Sun/UNIX platforms	MOLA Team
PEDR2TAB.PRM	Preferences file to be edited by user	MOLA Team
SUN	Subdirectory containing files for Sun/UNIX platforms	
MOLA.LBL	Example of PDS label for PEDR2TAB output file	MOLA Team
P2TINFO.TXT	Instructions for using PEDR2TAB	MOLA Team / Geosciences Node
PEDR2TAB.EXE	Executable file compiled for MS-DOS/Windows	MOLA Team / Geosciences Node
PEDR2TAB.F	Fortran 77 source code for PC platforms	MOLA Team
PEDR2TAB.PRM	Preferences file to be edited by user	MOLA Team

4.7 Standard Products Data Directory Contents

The Standard Products data directories contain the actual data products produced by the MOLA team.

Two volume sets are produced during the Mapping Phase of the mission, one containing raw data (AEDRs) and one containing derived data (PEDRs and the gridded products, IEGDRs and MEGDRs). The contents of data directories on these two volume sets are described below. Volumes containing Orbit Insertion Phase data will have the same contents as Mapping Phase volumes, the only difference being that AEDR and PEDR products are combined on the same volume.

4.7.1 AEDR Data Directory Contents and Naming

The AEDR Data Products are aggregations of MOLA telemetry packets. Each file contains one day's worth of data, with one telemetry packet per record. The maximum number of packets in one orbit is approximately 486 [MOLA PEDR SIS, 1998]. Files are named according to the form **AAnnnnnv.B**, where the first A stands for Altimeter, the second A stands for the product type, AEDR, nnnnn is the number of the first orbit covered in the product, and v indicates the version. For example, the file AA10134F.B contains AEDR data starting with orbit 134, version F.

Note that during the Mapping Phase the MOLA Team uses a different orbit numbering scheme than the MGS Project. The Project reset the orbit count to 1 at the beginning of mapping, at the descending equator crossing of actual orbit 1683. To preserve a unique orbit number for identifying MOLA products, the MOLA Team adds 10000 to the Project orbit number for products created during the Mapping Phase.

The AEDR Data Products are contained in the DATA directory. If a large number of products are present on a volume, they are organized into subdirectories by groups of orbits. These subdirectory names are of the form **AA~~nnn~~XX** where ~~nnn~~XX is the number of the first orbit in the directory. For example, the subdirectory AA001XX is the subdirectory of AEDR products covering orbits 100 through 199.

4.7.2 PEDR Data Directory Contents and Naming

The PEDR Data Products contain corrected along-track, time series range and planetary radius data in engineering and physical units, created from the raw telemetry data (AEDRs) using precision orbit information. The products also contain engineering and housekeeping data from the telemetry packets, as well as data correction values that were used to process the telemetry data into the PEDR data. Each record covers a two-second time span, called a frame, that is retrieved from the 14-second AEDR telemetry packet. Hence for every AEDR record, seven PEDR records will be generated. The names of PEDR files follow the format **Ap~~nnnn~~nv.B**, where A is for Altimeter, P is for PEDR, ~~nnnn~~ is the number of the first orbit covered in the product, and v is the version. For example, the file AP00125K.B contains the PEDR product from orbit 125, version K.

The PEDR Data Products are contained in the PEDR directory. If a large number of products are present on a volume, they are organized into subdirectories by groups of orbits. These subdirectory names are of the form **AP~~nnn~~XX** where ~~nnn~~XX is the number of the first orbit in the directory. For example, the subdirectory AP001XX is the subdirectory of PEDRs covering orbits 100 through 199.

4.7.3 Gridded Product Data Directory Contents and Naming

The gridded products are located in the data directory EGDR. Tabular data files are named according to the convention **xEG~~ddd~~[d]v.TAB**, where x is replaced by I or M; ~~ddd~~ or ~~dddd~~ is a decimal fraction indicating the product's resolution (bin size), such as 025 for one-quarter degree bins; and v is a letter indicating the version. Image data files are named according to the convention **xEG~~ddd~~[d]z.iIMG**, where x is replaced by I or M, ~~ddd~~ or ~~dddd~~ is the resolution, and z is a letter indicating the data type: a for areoid, c for counts, r for radius, and t for topography. Each product has a detached PDS label in a separate file with the same name, extension .LBL. See section 5.2.6.3 for a description of the format of the gridded products.

4.8 Special Products Data Directory Contents

The MOLA Team may create special data products derived from the standard MOLA products. The Team may choose to publish the special products on the standard product archive volumes if appropriate; for example, if the special product is so small that publication on a separate CD volume is not practical. Special products published on standard product volumes will be fully compatible with PDS standards, accompanied by a data product SIS, and described by a PDS catalog object. A special product will be stored on the archive volume in a separate directory appropriately named for the product.

5. Archive Volume Format

This section describes the format of MOLA Standard Product Archive Volumes. Data that comprise the MOLA 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

Archive Volumes have a compact disk format that is compatible with the computer operating systems MS-DOS, Macintosh, and SunOS. The MOLA CD-ROM format is in accordance with ISO 9660 level 1 Interchange Standard [ISO 9660, 1988].

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] and Appendix B.

5.2.4 Document File Format

Document files with the .TXT suffix exist in the Root, Index, Software, Catalog, and Label 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, Unix, OS2, and VMS operating systems.

Documents in the Document directory 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.

5.2.5 Tabular File Format

Tabular files (.TAB suffix) exist in the Index directory. 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 AEDINDEX.TAB is accompanied by the detached label file AEDINDEX.LBL in the same directory.

5.2.6 PDS Label Format

All data files in the MOLA Standard Product Archive Collection have PDS labels [Planetary Science Data Dictionary, 1996; PDS Standards Reference, 1995]. For AEDR and PEDR products, these labels are embedded at the beginning of the data files. The IEGDR and MEGDR products have detached PDS labels. For examples of PDS labels for each type of data product, see the Data Product SISs [MOLA AEDR SIS, 1998; MOLA PEDR SIS, 1998; MOLA Any-EGDR SIS, 1997].

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 to which the label refers (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 an embedded label, the location is an integer representing the starting record number of the object (the first record in the file is record 1). In a detached 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 = ("F01.IMG",1)

^IMAGE = ("F01.IMG",1025 <BYTES>)

indicates that the IMAGE object begins at byte 1025 of the file F01.IMG, in the same directory as the detached label file. Below is a list of the possible formats for the ^object definition.

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

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

ext is the 3 character upper-case file extension,

dirlist is a period-delimited path-list of parent directories, in upper case, that specifies the object file directory (used only when the object is not in the same directory as the label file). The list begins at the directory level below the root directory of the CD-ROM. '[dirlist]' may be omitted when the object being described is located either in the same directory as the detached label, or in a subdirectory named LABEL that is located in a higher level of the directory tree, typically the CD-ROM root itself.

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, Unix, OS2, and VMS operating systems.

5.2.7 Software File Format

Two programs are provided for accessing PEDR data products. MPROF is a script for use with the commercial software IDL. It is provided as an ASCII text file in two versions, one for use on Sun/UNIX computers and one for PC/Windows computers. PEDR2TAB is a Fortran program for use on Sun/UNIX and PC computers. Binary executable files compiled for Solaris 2.4 and MS-DOS/Windows are also provided. Documentation for both MPROF and PEDR2TAB is provided as ASCII text files.

5.2.8 Catalog File Format

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

5.2.9 Science Data File Formats

5.2.9.1 AEDR Data Product Format

An AEDR product is organized as a table of binary data for a single day. Each record contains one packet of telemetry data. For information about the format and contents of an AEDR product, see the MOLA AEDR SIS [1998].

5.2.9.2 PEDR Data Product Format

A PEDR product is organized as a table of binary data for a single day. Each record represents a 2-second time span, called a frame, that is generated from the 14-second telemetry packet (the AEDR). For information about the format and contents of a PEDR product, see the MOLA PEDR SIS [1998].

5.2.9.3 Gridded Data Product Format

Gridded products are global maps of planetary radius, areoid radius, topography, and number of observations, derived from the PEDRs and aggregated into latitude-longitude bins. The values are stored either as columns in a table, with each row in the table representing a latitude-longitude bin, or as images. Multiple versions of each gridded product may be released at increasingly higher resolutions.

For information about the format and content of the gridded products, see the MOLA Any-EGDR SIS [1997].

6. Support Staff and Cognizant Persons

Table 3 – MOLA Archive Collection Support Staff

MOLA Team			
Gregory A. Neumann	NASA/Goddard Space Flight Center Code 926 Space Geodesy Greenbelt, MD 20771	301-286-9291	neumann@tharsis.gsfc.nasa.gov
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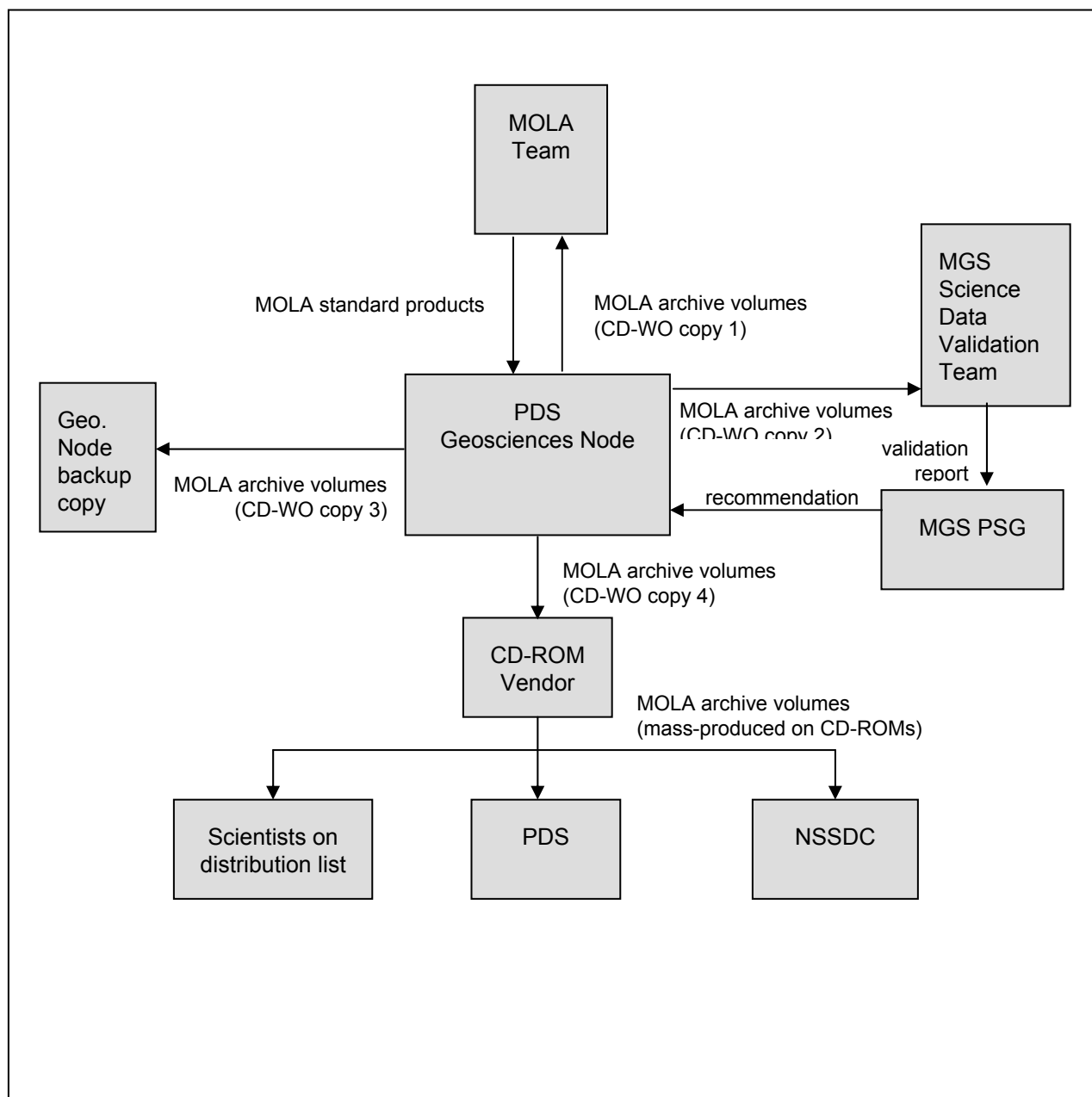


Figure 1 – Generation of MOLA Archive Volumes During Mapping. The MOLA Team generates MOLA standard data products. The Geosciences Node extracts MOLA standard products from the MOLA Team's processing facility and generates archive volumes on write-once CD-ROM media. Four copies of each archive volume are made. One is sent back to the MOLA Team and another to the MGS Science Data Validation Team (SDVT) for validation. A third copy is kept as a backup at the Geosciences Node. The SDVT sends validation reports to the MGS Project Science Group, who 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 MGS Project for release, the fourth CD-WO copy is delivered to a CD-ROM vendor for replication. The vendor mails the CD-ROM archive volumes to a distribution list including planetary scientists, the PDS, and the NSSDC.

APPENDIX A. MOLA PEDR VIRTUAL ARCHIVE VOLUME

A1. Archive Volume Generation

A1.1 Purpose of the PEDR Virtual Archive Volume

The MOLA PEDR Virtual Archive Volume was produced by the PDS Geosciences Node at Washington University in conjunction with the MOLA Instrument Team.

The PEDR Virtual Archive Volume includes data acquired during the Orbit Insertion, Mapping, and Extended Mission Phases of the MGS mission. By the end of MOLA laser range data acquisition in June 2001, the PEDR data set included products that had been generated with various revisions of the MOLA processing software. In order to provide an internally consistent data set, the complete set of PEDRs was regenerated using the latest software revision. The revised PEDRs are intended to replace the original PEDRs file for file.

The original version of the PEDR data set was distributed to the user community both online and on CD-ROMs. CD-ROM distribution ceased at the beginning of the Extended Mission due to the high cost, and online distribution of PEDRs from the PDS Geosciences Node web site became the primary distribution method. Accordingly, the PEDR Virtual Volume is intended for online distribution only. The data and ancillary files are organized as one large archive volume. The Virtual Volume may be accessed from MGS MOLA section of the Geosciences Node web site, <http://wwwpds.wustl.edu/>.

A1.2 Data Product Size and Delivery Rate

The complete revised MOLA PEDR data set is about 22.8 gigabytes in size. It was delivered from the MOLA Science Team to the PDS Geosciences Node electronically.

A1.3 Data Preservation

Copies of the MOLA PEDR data set are preserved for long-term archiving on DVD media at the PDS Geosciences Node, the PDS Central Node, and the National Space Science Data Center. The Geosciences Node is responsible for creating and delivering the archive copies.

A1.4 Labeling and Identification

The Virtual Volume may be accessed from MGS MOLA section of the Geosciences Node web site, <http://wwwpds.wustl.edu/>.

The online volume ID for this data set is MGSL_21XX.

The MOLA PEDR data set ID is MGS-M-MOLA-3-PEDR-L1A-V1.0.

A2. Archive Volume Contents

This section describes the contents of the MOLA PEDR Virtual Archive Volume, including the file names, file contents, file types, and organization responsible for providing the files. See the MOLA PEDR SIS for examples of PDS labels for PEDR files.

A2.1 Root Directory Contents

The following files are contained in the Root Directory, and are produced by the Geosciences Node at Washington University:

File Name	File Contents	File Provided By
AAREADME.TXT	Volume content and format information	Geosciences Node
AAREADME.HTM	Hypertext version of AAREADME.TXT	Geosciences Node
AAREADME.LBL	A PDS detached label that describes both AAREADME.TXT and AAREADME.HTM	Geosciences Node
ERRATA.TXT	A cumulative listing of comments and updates concerning all MOLA Standard Products Data Products on all MOLA volumes published so far	Geosciences Node
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	Geosciences Node

A2.2 Index Directory Contents

The following files are contained in the Index Directory and are produced by the Geosciences Node.

File Name	File Contents	File Provided By
INDXINFO.TXT	A description of the contents of this directory	Geosciences Node
PEDINDEX.TAB	A table listing all MOLA-PEDR products on this volume	Geosciences Node
PEDINDEX.LBL	A PDS detached label that describes PEDINDEX.TAB	Geosciences Node

A2.3 Document Directory Contents

The following files are contained in the Document Directory and are produced by the MOLA team.

File Name	File Contents	File Provided By
DOCINFO.TXT	A description of the contents of this directory	Geosciences Node
ARCHSIS.HTM	The Archive Volume SIS (this document) as hypertext	Geosciences Node
ARCHSIS.PDF	The Archive Volume SIS (this document) as a PDF file readable with Adobe Acrobat Reader software	Geosciences Node
ARCHSIS.LBL	A PDS detached label that describes both ARCHSIS.HTM and ARCHSIS.PDF	Geosciences Node
PEDRSIS.HTM	The PEDR SIS as hypertext	MOLA Team
PEDRSIS.PDF	The PEDR SIS as a PDF file readable with Adobe Acrobat Reader software	MOLA Team
PEDRSIS.LBL	A PDS detached label that describes both PEDRSIS.HTM and PEDRSIS.PDF	Geosciences Node

CALIB.PDF	The MOLA calibration document as a PDF file	MOLA Team
CALIB.LBL	A PDS detached label for CALIB.PDF	Geosciences Node
CALFIGS.PDF	Figures for the calibration document	MOLA Team
CALFIGS.LBL	A PDS detached label for CALFIGS.PDF	Geosciences Node

A2.4 Label Directory Contents

The following files are contained in the Label Directory and are produced by the MOLA team.

File Name	File Contents	File Provided By
LABINFO.TXT	A description of the contents of this directory	MOLA Team
PEDRSEC1.FMT	The format file that describes the first 500 bytes of a PEDR record	MOLA Team
PEDRENG1.FMT, PEDRENG2.FMT, PEDRENG3.FMT, PEDRENG4.FMT, PEDRENG5.FMT, PEDRENG6.FMT, PEDRENG7.FMT	The format files that describe the 28 bytes of engineering information in a PEDR (bytes 501-528). There are seven different types of record structures, one for each frame	MOLA Team
PEDRSEC3.FMT	The format file that describes bytes 529 through the end of a PEDR record	MOLA Team

A2.5 Catalog Directory Contents

The files in the Catalog directory provide a top-level understanding of the Mars Global Surveyor Mission, spacecraft, MOLA instrument, and PEDR data set in the form of PDS catalog objects. The files in this directory are coordinated with a PDS data engineer.

File Name	File Contents	File Provided By
CATINFO.TXT	A description of the contents of this directory	Geosciences Node
PEDRDS.CAT	PDS data set catalog information about MOLA PEDRs	MOLA Team
INSTHOST.CAT	PDS instrument host catalog information about the MGS spacecraft	Geosciences Node
INST.CAT	PDS instrument catalog information about the MOLA instrument	MOLA Team
MISSION.CAT	PDS mission catalog information about the MGS mission	Geosciences Node
PERSON.CAT	PDS personnel catalog information about MOLA Team members responsible for generating data products	Geosciences Node
REF.CAT	References mentioned in other *.CAT files	Geosciences Node

A2.6 Software Directory Contents

The contents of the software directory are the same as described in section 4.6 of the main body of this Archive Volume SIS.

A2.7 PEDR Data Directory Contents

The PEDR Data Products contain corrected along-track, time series range and planetary radius data in engineering and physical units, created from the raw telemetry data (AEDRs) using precision orbit information. The products also contain engineering and housekeeping data from the telemetry packets, as well as data correction values that were used to process the telemetry data into the PEDR data. Each record covers a two-second time span, called a frame, that is retrieved from the 14-second AEDR telemetry packet. Hence for every AEDR record, seven PEDR records will be generated. The names of PEDR files follow the format APnnnnnv.B, where A is for Altimeter, P is for PEDR, nnnnn is the number of the first orbit covered in the product, and v is the version. For example, the file AP12007L.B contains the PEDR product from orbit 12007, version L. All PEDR products on this virtual volume have a version of L.

The PEDR Data Products are contained in the DATA directory. They are organized into subdirectories with names of the form **APnnXXX**, where nnXXX represents a group of 1000 orbits. For example, the subdirectory AP12XXX contains PEDR data acquired in orbits 12000 through 12999.

A3. Archive Volume Format

A3.1 Disk Format

The PEDR Virtual Volume is stored in the online data repository at the PDS Geosciences Node. Copies of the Virtual Volume are recorded on write-once DVDs for long-term storage.

A3.2 File Formats

File formats used for the PEDR Virtual Volume are the same as described in section 5.2 of the main body of this Archive Volume SIS.