NASA Planetary Data System
Microwave Subnode of the Geosciences Node

Software Interface Specification

# MIT-MGN-ALTEDRCD

# Magellan Altimetry Experiment Data Record on Compact Disk Read-Only Memory

prepared by

Peter G. Ford

Center for Space Research
Massachusetts Institute of Technology
70 Vassar Street
Cambridge, MA 02139

617-253-6485

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| DOCUMENT CHANGE LOG | | | |
|---|---|---|---|
| REVISION NUMBER | REVISION DATE | SECTION AFFECTED | REMARKS |
| 0.6 | 03/11/94 | All | Numerous changes |
| 0.7 | 03/31/94 | All | Numerous changes |

| ITEMS TO BE DETERMINED | | | |
|---|---|---|---|
| REVISION NUMBER | SECTION AFFECTED | ITEM DESCRIPTION | RESOLUTION |
| none | | | |

# DISTRIBUTION

| | | |
|---|---|---|
| JPL/Magellan | | |
| Thompson, T.W. | 230-260 | twthompson@nasamail.nasa.gov |
| Saunders, R.S. | 230-260 | ssaunders@nasamail.nasa.gov |
| Conner, D.L. | 230-260 | dlc343@mipl3.jpl.nasa.gov |
| Senske, D. | 230-260 | dzf342@ipl.jpl.nasa.gov |
| JPL/SFDU Control Authority | | |
| Grimes, J. | 301-345 | jimg@binky.jpl.nasa.gov |
| Khatchadourian, J. | 301-345 | jacob@binky.jpl.nasa.gov |
| PDS/JPL | | |
| Joyner, R. | 525/3610 | rjoyner@jplpds.jpl.nasa.gov |
| PDS/Washington University | | |
| Arvidson, R.E. | Campus Box 1169 | arvidson@wuddy.wustl.edu |
| Stanford University | | |
| Simpson, R. | Durand 232 | rsimpson@nova.stanford.edu |

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ALT-EDR | Altimetry Experiment Data Record |
| ANSI | American National Standards Institute |
| ASCII | American Standard Code for Information Interchange |
| CCSDS | Consultative Committee for Space Data Systems |
| CD | Compact Disk |
| CD-WO | Compact Disk - Write Once |
| DOS | Disk Operating System |
| DSN | Deep Space Network |
| EDR | Experiment Data Record |
| EOF | End of File |
| GDS | Ground Data System |
| ISO | International Standards Organization |
| JPL | Jet Propulsion Laboratory |
| LSB | Least Significant Byte |
| MB | Megabytes |
| MGN | Magellan (formerly VRM) |
| MIT | Massachusetts Institute of Technology |
| MMC | Martin Marietta Corporation |
| MSB | Most Significant Byte |
| NAIF | Navigation and Ancillary Information Facility |
| NASA | National Aeronautics and Space Administration |
| NAV | Navigation Subsystem/Team |
| NSI | NASA Science Internet |
| PDS | Planetary Data System |
| ROM | Read-Only Memory |
| SAB | SAR and Altimeter Burst |
| SAR | Synthetic Aperture Radar |
| SCET | Spacecraft Event Time |
| SCLK | Spacecraft Clock |
| SFDU | Standard Formatted Data Unit |
| SIS | Software Interface Specification |
| TBD | To Be Determined |
| TDB | Baricentric Dynamical (Ephemeris) Time |
| UTC | Coordinated Universal Time |
| VRM | Venus Radar Mapper (Magellan) |

# CHAPTER 1

# OVERVIEW

This Software Interface Specification (SIS) describes the format and content of the Magellan Altimeter Experiment Data Record on Compact-Disk Read-Only Memory product (ALTEDRCD). This product is the permanent archive version of the Altimeter Experiment Data Record (ALT-EDR) product that was written on 1/2" computer tape during the radar mapping phase of the Magellan mission. The ALTEDRCD combines the data files from the ALT-EDR tapes with PDS labels and tables.

The ALTEDRCD is a deliverable product to the Planetary Data System (PDS) and to the National Space Science Data Center (NSSDC). The formats of all files in the ALTEDRCD are based on PDS standards (Versions 2 and 3).

## 1.1. Scope

The specifications in this document apply to all volumes containing ALTEDRCD data produced at MIT. This document provides a detailed description of the ALTEDRCD interface.

## 1.2. Applicable Documents

(1) ISO 9660-1988. Information Processing - Volume and File Structure on CD-ROM for Information Exchange, April 15, 1988.

(2) Planetary Data System Standards Reference, JPL D-7669, part 2, November 20, 1992

(3) Planetary Science Data Dictionary, JPL D-7116, Rev. C, November 20, 1992

(4) Planetary Data System, Data Preparation Workbook, JPL Publication D-7669, Part 1, Version 3.0, April 21, 1993.

(5) Magellan Software Interface Specification document TPS-101, SAR and Altimeter EDR/TEDR Tapes, E. Wilson, JPL, Rev. D, March 15, 1989.

(6) DSN System Requirements, Detailed Interface Design. DSN Monitor and Control System Interface with Magellan Project, MON-5-12, 820-13, September 1, 1987.

(7) Magellan SCLK/SCET Coefficients File, MGN SIS SES-112, SFOC-1-DCB-MGN-SCLKvSCET, January 1988.

(8) Mapping Quaternions Polynomial Coefficients File, MGN SIS RES-104, SFOC-1-CDB-MGN-Quaterni, January 1988.

(9) Decommutation Report Form, SFOC SIS SFOC0038-00-12-00, SFOC-1-TIS-Any-DecomRpt, August 1, 1988.

(10) MGN Decalibration File to DMD, MGN SIS SES-115, SFOC-1-DMD-Mgn-DECAL, December 1987. Note that this document also describes decommutation data, but this is NOT the decommutation report data that is archived in the ALTEDRCD, which is described by [9], above.

(11) Spacecraft and Planet Ephemerides, NAIF S and P Kernels, SFOC-2-DPS-CDB-Ephemeris, January 8, 1988.

(12) Magellan Telemetry Formats Generated by Telemetry Input Subsystem, SFOC-2-TIS-Any-MgnTelem, November 5, 1987.

(13) Telemetry Minor Frame Formats from Telemetry Input Subsystem, SFOC-2-TIS-Any-Telem, October, 1987.

(14) NJPL SFDU Global Definitions, SFOC SIS SFOC0038-01-04-01, SFOC-5-SYS-*DU-NJPL, July 20, 1988.

(15) SFDUs Generated from TIS for Magellan, SFOC SIS SFOC0038-01-03-01, SFOC-5-TIS-*DU-MgnSFDU, May 16, 1988.

(16) Standard Formatted Data Units Generated from Telemetry Input Subsystem, SFOC SIS SFOC0038-01-04-01, SFOC-5-TIS-*DU-SFDU, August 31, 1988.

(17) VRM Spacecraft System and Subsystem Design Book, Telemetry Measurements and Data Formats, MMC VRM-2-280, June 1987.

(18) Magellan DSN Monitor Data (Mon-5-12), SFOC SIS SFOC0038-01-02-01, SFOC-1-GIF-DSN-MgnGCFMon, February 17, 1988.

(19) MGN Mission Operations System, Radar System Interface Requirements Document, 630-204.

(20) DSN Telemetry Interface with SFOC - Magellan, DSN Detailed Interface Design, 820-13, Module TLM 3-17, February 1988.

(21) An Introduction to SPICELIB, Vols 1 and 2, NAIF, JPL, September 3, 1988.

## 1.3. System Siting

### 1.3.1. Interface Location and Medium

ALTEDRCD volumes are created at MIT using hardware belonging to the Microwave Subnode of the PDS Geosciences Node, with a Young Minds CD-Studio compact disk authoring subsystem. All volumes intended for delivery to PDS shall be on CD-WO media.

### 1.3.2. Data Sources and Destinations

Each ALTEDRCD volume is a collection of products representing, derived from, or needed to analyze a range of orbits of Magellan altimeter data. One copy of each CD-WO is delivered using the most appropriate means to the National Space Science Data Center (NSSDC), while a second copy is retained at the MIT Microwave Subnode of the Planetary Data System (PDS).

### 1.3.3. Generation Method and Frequency

Each ALTEDRCD volume is produced in several stages. First, the ALT-EDR data files are copied from 8mm archive tape into magnetic disk using the UNIX tar command. Then a PDS detached label is created for each data file using the UNIX awk script "write_altedr_cd". Next, the CD-WO is pre-mastered using the Young Minds "makedisc" command. Finally, the CD-Studio hardware is commanded to write one or more CD-WO disks.

## 1.4. Assumptions and Constraints

### 1.4.1. Usage Constraints

Access to the ALTEDRCD volumes will be determined by the Planetary Data System and by the National Space Science Data Center (NSSDC).

### 1.4.2. Documentation Conventions

#### 1.4.2.1. Data Format Descriptions

Data are stored in fields of 8-, 16-. and 32-bit unsigned integers and as character strings. Most integers are stored in VAX least-significant-byte (LSB) format [2]; the first byte contains the least significant bits, while the last contains the most significant bits. Refer to the applicable documents for details.

If a field is described as containing "n" bytes of ASCII character string data, this implies that the leftmost (lowest numbered) byte contains the first character, the next lowest byte contains the next character, and so forth. Character strings are written to CD-WO with lower numbered bytes preceding higher numbered bytes.

#### 1.4.2.2. Limits of This Document

This document applies only to ALTEDRCD volumes.

#### 1.4.2.3. Typographic Conventions

This document has been formatted for simple electronic file transfer and display. Line lengths are limited to 80 ASCII characters, including line delimiters. The last two characters on each line are the carriage-return (ASCII 13) and the line-feed (ASCII 10). No special fonts or structures are included within the file. Constant width characters are assumed for display. Hard copy pagination at the rate of 66 lines per page is assumed. For page numbers consistent with those shown in the Table of Contents, a break in page numbering immediately before "Chapter 1. OVERVIEW" will be required.

### 1.4.3. Time Standards

Within ALTEDRCD label files, times are expressed as a string of 19 or 23 ASCII characters

YYYY-MM-DDThh:mm:ss[.fff]

where "-", "T", ":", and "." are fixed delimiters; "YYYY" is the year "19nn" or "20nn"; "MM" is a two-digit month of year; "DD" is a two-digit day of month; "T" separates the date and time segments of the string; "hh" is hour of day; "mm" is the minutes of hour (00-59); "ss" is the seconds of minute (00-59); and ".fff" gives the fractional seconds. The data type "TIME" is assigned to this format.

When only the date is required the 10-character string

YYYY-MM-DD

may be substituted. The data type "DATE" is assigned to this format.

# CHAPTER 2

# INTERFACE CHARACTERISTICS

## 2.1. Hardware Characteristics and Limitations

### 2.1.1. Special Equipment and Device Interfaces

ALTEDRCD volumes conform to ISO 9660 standards for CD-ROM [1]. Users of the volumes must have access to systems which can read these media.

### 2.1.2. Special Set-Up Requirements

None.

## 2.2. Volume and Size

Each ALTEDRCD volume contains a set of data and ancillary files representing one or more Magellan orbits. The maximum size of the data files copied from ALT-EDR products will be 600 Mbytes. ALTEDRCD disks will be somewhat larger than this due to the additional PDS index table and label files.

## 2.3. Labeling and Identification

### 2.3.1. External Labels

Each ALTEDRCD volume bears a label using the following format:

ACRONYM.SEQUENCE;VERSION

where

| | | |
|---|---|---|
| ACRONYM | = | ALTEDRCD |
| SEQUENCE | = | a three digit number indicating the order in which the CD-WO volumes were produced. |
| VERSION | = | A single digit determining version number of the CD-WO volume. "1" is the original version. |

For example, ALTEDRCD.004;2 is the second version of the fourth ALTEDRCD volume.

### 2.3.2. Internal Labels

The contents of each ALTEDRCD volume will be labeled in accordance with PDS standards. Labeling is described further in subsequent sections.

### 2.3.3. Interface Medium Characteristics

Each ALTEDRCD volume conforms to ISO 9660 standards [1]. The quantity of data stored is no more than 650 MB per disk.

## 2.4. Backup and Duplicates

Pairs of CD-WO disks will be written. One copy will be retained at the PDS Microwave Subnode at MIT; the other will be sent to the NSSDC archive.

# CHAPTER 3

# STRUCTURE AND ORGANIZATION OVERVIEW

## 3.1. Disk Organization

Each ALTEDRCD volume contains a CATALOG directory, a DOCUMENT directory, an INDEX directory, and one or more data directories (Figure 3-1).

### 3.1.1. Root Directory

The root directory contains the following files:

AAREADME.TXT terse description of volume contents [2].

ERRATA.TXT cumulative list of errors on this and on previous ALTEDRCD volumes.

```
root
 |
 |- AAREADME.TXT
 |- ERRATA.TXT
 |- VOLDESC.CAT
 |
 |- CATALOG
 |    |
 |    |----------------------------------------
 |    |                    |                   |
 |    |- CATINFO.TXT       |- INSTHOST.CAT     |- PERSONEL.CAT
 |    |- ALTEDRDS.CAT      |- MISSION.CAT      |- REFS.CAT
 |                                             |- RDRSINST.CAT
 |- DOCUMENT
 |    |
 |    |- DOCINFO.TXT
 |    |- ALTEDRCD.LBL
 |    |- ALTEDRCD.PS
 |    |- ALTEDRCD.TXT
 |
 |- INDEX
 |    |
 |    |---------------------------------
 |    |                 |              |
 |    |- INDXINFO.TXT   |- INDEX.LBL   |- CUMINDEX.LBL
 |                      |- INDEX.TAB   |- CUMINDEX.TAB
 |- Annnn_vv
 |
 |- Annnn_vv
 .
 .
```

Figure 3-1. Example Top-Level ALTEDRCD Directory Structure

| | |
|---|---|
| VOLDESC.CAT | volume object definition [2]. |

#### 3.1.2. CATALOG Directory

The CATALOG directory contains the following files:

| | |
|---|---|
| ALTEDRDS.CAT | PDS data set template. |
| CATINFO.TXT | text description of the directory contents [2]. |
| INSTHOST.CAT | PDS instrument host template. |
| MISSION.CAT | PDS mission template. |
| PERSONEL.CAT | PDS personnel template. |
| REFS.CAT | PDS reference template. |
| RDRSINST.CAT | PDS instrument template. |

#### 3.1.3. DOCUMENT Directory

The DOCUMENT directory contains the following files:

| | |
|---|---|
| ALTEDRCD.LBL | PDS label for the SIS document in PostScript format (ALTEDRCD.PS). |
| ALTEDRCD.PS | a copy of this SIS document in PostScript format, suitable for previewing on a high-resolution graphics terminal or direct printing on a laser printer or photo-typesetter. |
| ALTEDRCD.TXT | a copy of this SIS document in ASCII characters, suitable for display or printing at 66 lines per page with up to 78 constant-width characters per line. |
| DOCINFO.TXT | text description of the directory contents [2]. |

#### 3.1.4. INDEX Directory

The INDEX directory contains the following files:

| | |
|---|---|
| CUMINDEX.LBL | PDS label for the cumulative volume index (CUMINDEX.TAB) [2]. |
| CUMINDEX.TAB | index in tabular form for all volumes in the ALTEDRCD [2]. |
| INDEX.LBL | PDS label for the volume index (INDEX.TAB). Identifies the volume index and describes structure of the index table [2]. |
| INDEX.TAB | volume index in tabular form [2]. |
| INDXINFO.TXT | text description of the directory contents [2]. |

#### 3.1.5. Data Directories

Each ALTEDRCD volume contains directories for one or more orbits of altimetry data from ALT-EDR tapes. Data directories are named

Annnn_vv

where "nnnn" is the orbit number, and "vv" is the version number inherited from the original ALT-EDR product.

### 3.2. Formats

ALTEDRCD volumes conform to the ISO 9660 level 1 Interchange Standard CD-WO format [1], which is compatible with common computer systems including MS-DOS, Macintosh, SunOS, and VMS.

Data that comprise the ALTEDRCD volumes are formatted in accordance with Planetary Data System specifications [2-4].

### 3.3. File Naming Conventions

In this document and on the disks themselves, file and directory names are in upper case characters. This ensures compatibility with operating systems in which these names are case insensitive (e.g., VMS and DOS) and operating systems in which names are automatically translated into one case or the other (e.g., Unix and

MacOS). Within disk directories the characters ";1" are appended to all file names. VMS excepted, most operating systems will hide these suffixes from users.

### 3.3.1. PDS Labels

All files contained on ALTEDRCD volumes are accompanied by PDS labels [2-4]. The label can either be prefixed to the associated primary file, or "detached", in which case the label becomes a file in its own right with the same name as the primary file except for the suffix ".LBL". Detached label files will be located in the same directory as the primary file.

PDS labels, whether prefixed to or detached from their primary file, provide 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:

ˆobject = location

in which the carat character (ˆ, also called a pointer in this context) indicates where to find the object. In a prefixed label, the location is an integer representing the starting record or byte number of the object, where the counting starts from record or byte number 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. For example:

ˆTABLE_HEADER = ("SAB.DAT",1)
ˆTABLE = ("SAB.DAT",1025<BYTES>)

indicates that the TABLE_HEADER object begins at the first byte, and that the TABLE object begins at byte 1025, of the file "SAB.DAT" located in the same directory as the detached label file. Below is a list of the possible formats for the ˆobject definition.

ˆobject = n
ˆobject = n<BYTES>
ˆobject = "filename.ext"
ˆobject = ("filename.ext",n)
ˆobject = ("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 or byte 1),

<BYTES> — indicates that the number given is in units of bytes; default is RECORDS,

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

ext — is the 3 character upper-case file extension.

All lines in detached label files are 80 bytes long, padded on the right with blanks to a length of 78 bytes, and ending with a carriage return character (ASCII 13) followed by a line feed character (ASCII 10) in the last byte. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the label by a multiple of 80 bytes.

### 3.3.2. Document files

Document files (.TXT suffix) may exist in the root, CATALOG, DOCUMENT, INDEX, and data directories. These are ASCII files with embedded PDS labels which employ the TEXT object. All records in document files are 80-bytes in length, with a carriage return character (ASCII 13) in the next-to-last byte and a line feed character (ASCII 10) in the last byte. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

### 3.3.3. Tabular Files

Tabular files (.TAB suffix) exist in the INDEX directory (where they are ASCII files formatted for direct reading into many database management systems).

ASCII tabular files consist of data "fields" separated by commas. Character fields are also enclosed in double quotation marks (") and 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 in tabular files have fixed length. Where necessary, a space character (ASCII 32) is appended to the record to make it of even 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 do not.

All tabular files are accompanied by descriptive, detached PDS labels. The PDS label has the same name as the data file it describes, except for the extension .LBL. For example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same INDEX directory.

### 3.3.4. Catalog files

Catalog files (suffix .CAT) exist in the root and in the CATALOG directory. They are formatted in an object-oriented structure consisting of sets of "keyword=value" declarations.

VOLDESC.CAT in the root provides an overview of the contents of the volume in the form of a completed PDS template.

The files in the CATALOG directory provide a top-level understanding of the mission, instrument and data set. They are presented in the form of completed PDS templates [4].

### 3.3.5. Data files

Data files (.DAT suffix) exist in the per-orbit data directories. They have been copied directly from ALT-EDR product tapes without reformatting. Although many contain newline-delimited ASCII records, they are written in multiples of a basic 32,500 byte logical record block, with any unused space in the last block padded with ASCII carat characters (ASCII 94).

Within the files, the data fields are written without regard for the 32,500-byte record boundaries, i.e. they are written as a data stream. All files begin with SFDU labels, and the data record aggregates are themselves delimited by R-type SFDU marker labels [5,14].

Some data files contain only ASCII data fields, but others contain binary records. In general, all ASCII records except those in HDR.DAT and DQS.DAT are delimited by carriage return (ASCII 13) followed by line feed (ASCII 10). Binary records are generally of fixed length (except for some records in ENG.DAT), and all begin with an I-type SFDU label that contains the record length.

All data files are accompanied by detached PDS label files. The label generating process is capable of detecting certain formatting errors within the SFDU structure of the data files. When this occurs, an error message is written to the NOTE section of the new label file, and a copy is written to the ERR.TXT file in the same data directory. In general, therefore, the label files are a better guide to the location of objects within the data files than the SFDU structures themselves.

# CHAPTER 4

# DETAILED INTERFACE SPECIFICATIONS

## 4.1. Root Files

### 4.1.1. AAREADME.TXT File

The AAREADME.TXT file contains terse volume content and format information. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. The file has an attached PDS label of the form shown in Figure 4-1.

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001
PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
  PUBLICATION_DATE              = 1994-07-01
  NOTE                          = "MAGELLAN ALT-EDR ARCHIVE CD-WO"
END_OBJECT                      = TEXT
```

Figure 4-1. Example Label for *.TXT Files

Labeling requirements applicable to Figure 4-1 are described in [2]; keywords are defined in [3]. For this application, the only keywords that change are

| | |
|---|---|
| PUBLICATION_DATE | the date in YYYY-MM-DD format on which the file was created or last modified (see Section 1.4.3). |
| NOTE | a brief description of the file, including a title if available. |

### 4.1.2. ERRATA.TXT File

The ERRATA.TXT file contains general information about errors on this, and previous, volumes of the ALTEDRCD product. This is an ASCII file with 80 byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

### 4.1.3. VOLDESC.CAT File

VOLDESC.CAT contains a description of the contents of this volume in a PDS format readable by both humans and computers. This is an ASCII file with 80 byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. Figure 4-2 shows a sample

VOLDESC.CAT file for the first ALTEDRCD volume.

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001
PDS_VERSION_ID             = PDS3
OBJECT                     = VOLUME
 VOLUME_SERIES_NAME        = "MISSION TO VENUS"
 VOLUME_SET_NAME           = "MAGELLAN RADAR DATA PRODUCT"
 VOLUME_SET_ID             = "USA_NASA_PDS_MG_3301"
 VOLUMES                   = UNK
 VOLUME_NAME               = "MAGELLAN ALTIMETER EXPERIMENT
                              DATA RECORD ON COMPACT DISK"
 VOLUME_ID                 = "MG_3301"
 VOLUME_VERSION_ID         = "VERSION 1"
 PUBLICATION_DATE          = 1994-07-01
 DATA_SET_ID               = "MGN-V-RDRS-2-ALT-EDR-V1.0"
 VOLUME_FORMAT             = "ISO-9660"
 MEDIUM_TYPE               = "CD-WO"
 DESCRIPTION               = "This volume contains Magellan ALT-EDR
   (Altimeter Experiment Data Record) products. It also contains
   documentation files that describe the ALT-EDRs."
 MISSION_NAME              = "MAGELLAN"
 SPACECRAFT_NAME           = "MAGELLAN"
 SPACECRAFT_ID             = MGN
 OBJECT                    = DATA_PRODUCER
  INSTITUTION_NAME         = "MASSACHUSETTS INSTITUTE OF TECHNOLOGY"
  FACILITY_NAME            = "CENTER FOR SPACE RESEARCH"
  FULL_NAME                = "DR. PETER G. FORD"
  ADDRESS_TEXT             = "CENTER FOR SPACE RESEARCH
                              M.I.T. BUILDING 37
                              70 VASSAR STREET
                              CAMBRIDGE, MASSACHUSETTS 02139 USA"
 END_OBJECT                = DATA_PRODUCER
 OBJECT                    = CATALOG
  ^MISSION_CATALOG         = "MISSION.CAT"
  ^INSTRUMENT_HOST_CATALOG = "INSTHOST.CAT"
  ^INSTRUMENT_CATALOG      = "RDRSINST.CAT"
  ^PERSONNEL_CATALOG       = "PERSONEL.CAT"
  ^REFERENCE_CATALOG       = "REFS.CAT"
  ^DATA_SET_CATALOG        = "ALTEDRDS.CAT"
 END_OBJECT                = CATALOG
END_OBJECT                 = VOLUME
END
```

Figure 4-2. Example VOLDESC.CAT File

#### 4.1.3.1. Keywords and Values

Keywords in Figure 4-2 are defined in [3]. They are used in this application as follows:

| | |
|---|---|
| PDS_VERSION_ID | The version of PDS standards to which this volume adheres; set to "PDS3". |
| VOLUME_SERIES_NAME | The formal name that describes a broad categorization of data products. For the ALTEDRCD, set to "MISSION TO VENUS" |
| VOLUME_SET_NAME | The formal name describing one or more volumes containing a single data set or a collection of related data sets. For the ALTEDRCD, set to "MAGELLAN RADAR DATA PRODUCT" |

| | |
|---|---|
| VOLUME_SET_ID | Identification of a data volume or a set of archive data volumes. For the ALTEDRCD, set to "USA_NASA_JPL_ACRONYM_SEQUENCE" where ACRONYM and SEQUENCE are defined in Section 2.3.1. See also VOLUME_ID, below. |
| VOLUMES | The number of physical volumes in a volume set. Volume sets of ALTEDRCD data will generally be single volumes, so this value will be set to "1". |
| VOLUME_NAME | The formal name of the individual ALTEDRCD volume; a more specific identification than VOLUME_SET_NAME. For the ALTEDRCD, set to "MAGELLAN ALTIMETER EXPERIMENT DATA RECORD". |
| VOLUME_ID | A unique identifier for the volume. Usually the last two components of the VOLUME_SET_ID (see also Section 2.3.1). For the ALTEDRCD, set to "MG_33nn" or "MG_34nn". |
| VOLUME_VERSION_ID | The version of the data volume, starting with "1" for original versions and incrementing by 1 for each subsequent version. |
| PUBLICATION_DATE | The date in YYYY-MM-DD format on which the volume was published or released (see Section 1.4.3). |
| DATA_SET_ID | A unique alphanumeric identifier for the data set. For the ALTEDRCD, set to "MGN-V-RDRS-2-ALT-EDR-V1.0" |
| VOLUME_FORMAT | The logical format used in writing the ALTEDRCD volume. Set to "ISO-9660". |
| MEDIUM_TYPE | The physical storage medium for the ALTEDRCD volume. Set to "CD-WO". |
| DESCRIPTION | A brief text description of the contents of the ALTEDRCD volume. |
| MISSION_NAME | The planetary mission or project under which the data were acquired. A single mission may be associated with one or more spacecraft. For the ALTEDRCD, set to "MAGELLAN" |
| SPACECRAFT_NAME | The full name of the spacecraft with which these data are associated. For the ALTEDRCD, set to "MAGELLAN" |
| SPACECRAFT_ID | A mnemonic uniquely associated with SPACECRAFT_NAME. For the ALTEDRCD, set to "MGN" |
| INSTITUTION_NAME | The name of the institution under which this ALTEDRCD volume was produced. Set to "MASSACHUSETTS INSTITUTE OF TECHNOLOGY". |
| FACILITY_NAME | The name of the department, laboratory, or subsystem under which this ALTEDRCD volume was produced. Set to "CENTER FOR SPACE RESEARCH". |
| FULL_NAME | The name of the individual or organization responsible for producing this ALTEDRCD volume. For the ALTEDRCD, set to "DR. PETER G. FORD". |
| ADDRESS_TEXT | Mailing address for the individual or organization responsible for producing this ALTEDRCD volume. For the ALTEDRCD, set to "CENTER FOR SPACE RESEARCH, M.I.T. BUILDING 37, 70 VASSAR STREET, CAMBRIDGE, MASSACHUSETTS 02139 USA" |
| ˆMISSION_CATALOG | File name in the CATALOG directory under which the PDS mission template is stored. Set to "MISSION.CAT". |
| ˆINSTRUMENT_HOST_CATALOG | File name in the CATALOG directory under which the PDS instrument host template is stored. Set to "INSTHOST.CAT". |

| | |
|---|---|
| ˆINSTRUMENT_CATALOG | File name in the CATALOG directory under which the PDS instrument template is stored. Set to "RDRSINST.CAT". |
| ˆPERSONNEL_CATALOG | File name in the CATALOG directory under which the PDS personnel template is stored. Set to "PERSONEL.CAT". |
| ˆREFERENCE_CATALOG | File name in the CATALOG directory under which the PDS reference template is stored. Set to "REFS.CAT". |
| ˆDATA_SET_CATALOG | File name in the CATALOG directory under which the PDS data set template is stored. Set to "ALTEDRDS.CAT". |

### 4.2. Static Directories

Static directories are those which do not change (or change very little) from one volume to another. They appear on all volumes.

#### 4.2.1. CATALOG Directory

The CATALOG directory contains files used in cataloging the data, including files which provide a detailed description of this volume.

##### 4.2.1.1. CATINFO.TXT File

The CATINFO.TXT file contains a description of the contents of the CATALOG directory. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

##### 4.2.1.2. MISSION.CAT File

The MISSION.CAT file contains PDS catalog information about the Magellan mission. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

##### 4.2.1.3. INSTHOST.CAT File

The INSTHOST.CAT file contains PDS catalog information about the Magellan spacecraft. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

##### 4.2.1.4. RDRSINST.CAT File

The RDRSINST.CAT file contains PDS catalog information about the Magellan radar sensor. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.1.5. PERSONEL.CAT File

The PERSONEL.CAT file contains PDS catalog information about personnel who contributed to this data set. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.1.6. REFS.CAT File

The REFS.CAT file contains PDS catalog information of references to published papers that describe this data set. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.1.7. ALTEDRDS.CAT File

The ALTEDRDS.CAT file contains PDS catalog information about the data set on this archive volume. The file has an attached PDS label of the form shown in Figure 4-1. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

### 4.2.2. DOCUMENT Directory

The DOCUMENT directory contains files which describe the data included in the ALTEDRCD volume.

#### 4.2.2.1. DOCINFO.TXT File

The DOCINFO.TXT file contains a description of the contents of the DOCUMENT directory. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The file has an attached PDS label of the form shown in Figure 4-1. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.2.2. ALTEDRCD.TXT File

The ALTEDRCD.TXT file is the Software Interface Specification for the ALTEDRCD (this document). This is an ASCII file with 80-byte records, suitable for display or printing at 66 lines per page with up to 78 constant-width characters per line. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The file has an attached PDS label of the form shown in Figure 4-1. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.2.3. ALTEDRCD.LBL File

ALTEDRCD.LBL is a detached label that completely describes ALTEDRCD.PS. The length of the ALTEDRCD.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks. Each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example label for an ALTEDRCD volume is shown in Appendix A. Keywords are defined in [3].

#### 4.2.2.4. ALTEDRCD.PS File

The ALTEDRCD.PS file is the Software Interface Specification for the ALTEDRCD (this document). This is a PostScript file with varying length records, suitable for previewing on a high-resolution graphics terminal or direct printing on a laser printer or photo-typesetter. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair.

### 4.2.3. INDEX Directory

#### 4.2.3.1. INDXINFO.TXT File

The INDXINFO.TXT file contains a description of the contents of the INDEX directory. This is an ASCII file with 80-byte records. Each line is terminated with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The file has an attached PDS label of the form shown in Figure 4-1. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

#### 4.2.3.2. INDEX.LBL File

INDEX.LBL is a detached label that completely describes INDEX.TAB. The length of the INDEX.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks. Each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example label for an ALTEDRCD volume is shown in Appendix A. Keywords are defined in [3].

#### 4.2.3.3. INDEX.TAB File

INDEX.TAB is a table listing all ALTEDRCD data files published in this volume. It is an ASCII file with fixed-length 58-byte records. Each record contains 56 data bytes followed by a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The detailed format and content are described by INDEX.LBL.

#### 4.2.3.4. CUMINDEX.LBL File

CUMINDEX.LBL is a detached label that completely describes CUMINDEX.TAB. The length of the CUMINDEX.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks. Each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes.

CUMINDEX.LBL differs from INDEX.LBL (see Appendix A) in only three ways:

* DESCRIPTION should refer to CUMINDEX.TAB rather than to INDEX.TAB
* ^TABLE points to CUMINDEX.TAB rather than to INDEX.TAB
* INDEX_TYPE = CUMULATIVE rather than SINGLE

#### 4.2.3.5. CUMINDEX.TAB File

CUMINDEX.TAB is a table listing all ALTEDRCD data files published in all volumes of the volume set to date. It is an ASCII file with fixed-length 58-byte records. Each record contains 56 data bytes followed by a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The detailed format and content are described by

CUMINDEX.LBL.

### 4.3. Data Directories

ALTEDRCD volumes include directories for each orbit during which useful altimetry data were taken. The data are recorded in 10 separate files, some purely ASCII, the others containing a mixture of ASCII and binary fields.

| | | |
|---|---|---|
| ALT.DAT | Altimeter burst buffer records | Binary |
| CLK.DAT | SCLK/SCET conversion coefficients | ASCII |
| DCM.DAT | Decommutation and decalibration data | ASCII |
| DQS.DAT | EDR Data Quality Summary | ASCII |
| ENG.DAT | Engineering data | Binary |
| EPH.DAT | S/C ephemeris file | ASCII |
| HDR.DAT | Orbit Header | ASCII |
| MON.DAT | DSN monitor records | Binary |
| QTN.DAT | Quaternion pointing coefficients | ASCII |
| SAB.DAT | Radar header records | Binary |

In addition, each DAT file is paired with a PDS detached label file with the same name, e.g., SAB.DAT is paired with SAB.LBL. The label files describe the data files. Finally, each data directory also contains an ERR.TXT file that holds any error messages generated by the software that created the label files. Examples of label files and of ERR.TXT are included in Appendices A and B, respectively.

#### 4.3.1. ALT.DAT

The Altimeter Data File contains all 2464-byte binary altimeter burst records, accompanied by their corresponding 54-byte binary Golay-decoded burst headers that were downlinked during this orbit. The format is described in [5]. During ground data system processing, header labels were added to the blocks. Their formats are described in [12-16].

```
                           root
                            |
   +--------------------------+--------------------------
   |                                               |
Annnn_vv                                        Annnn_vv
   |                                               |
   +------------+-----------+                      +-----
   |            |           |                      |
   |- ALT.DAT   |- ALT.LBL  |- ERR.TXT             |- ...
   |- CLK.DAT   |- CLK.LBL
   |- DCM.DAT   |- DCM.LBL
   |- DQS.DAT   |- DQS.LBL
   |- ENG.DAT   |- ENG.LBL
   |- EPH.DAT   |- EPH.LBL
   |- HDR.DAT   |- HDR.LBL
   |- MON.DAT   |- MON.LBL
   |- QTN.DAT   |- QTN.LBL
   |- SAB.DAT   |- SAB.LBL
```

Figure 4-3. Example ALTEDRCD Data Directory Structure

#### 4.3.2. ALT.LBL

ALT.LBL is a detached label that completely describes the ALT.DAT file. The length of the ALT.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example ALT.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.3. CLK.DAT

The SCLK/SCET Coefficients File was created by the Spacecraft Team. It contains the necessary parameters to translate from Magellan on-board clock time (SCLK) to on-board event time in UTC or TDB. By design and function, this is a cumulative file, slowly growing in size as time passes. This file contains only printable ASCII characters. Its format is defined in [7].

#### 4.3.4. CLK.LBL

CLK.LBL is a detached label that completely describes the CLK.DAT file. The length of the CLK.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example CLK.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.5. DCM.DAT

The Decommutation/Decalibration File contains all necessary information to interpret the ENG.DAT downlink engineering data file. It is divided into 5 segments by SFDU labels: a decommutation segment, described in [9], that defines the location of each data channel, and 4 decalibration segments which assist in the conversion of channel values into engineering units, described in [10]. This file contains only printable ASCII characters.

#### 4.3.6. DCM.LBL

DCM.LBL is a detached label that completely describes the DCM.DAT file. The length of the DCM.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example DCM.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.7. DQS.DAT

The Data Quality Summary File provides a measure of the continuity of ALT.DAT, ENG.DAT, and SAB.DAT data in the current orbit. Each gap of one or more successive whole SAB frames causes a logical record to be added to DQS.DAT. This file contains only printable ASCII characters. Its format is defined in [5].

#### 4.3.8. DQS.LBL

DQS.LBL is a detached label that completely describes the DQS.DAT file. The length of the DQS.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example DQS.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.9. ENG.DAT

The Engineering File contains 100-byte binary data blocks, generated by the spacecraft every 2/3 second. The format is described in [5]. During ground data system processing, header labels are added to the blocks. Their formats are described in [12-16]. The location of particular data channels within the engineering records is defined in the accompanying DCM.DAT file.

#### 4.3.10. ENG.LBL

ENG.LBL is a detached label that completely describes the ENG.DAT file. The length of the ENG.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example ENG.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.11. EPH.DAT

The Spacecraft Ephemeris File contains data for the mapping portion of a single orbit. The entire ephemeris file for each orbit plus 10% overlap on each end of the orbit will be included in EPH.DAT even if data gaps occurred during mapping, downlink, or data processing. This file contains only printable ASCII characters. Its format is defined in [11]. It is intended to be interpreted by SPICELIB software distributed by NAIF [21].

#### 4.3.12. EPH.LBL

EPH.LBL is a detached label that completely describes the EPH.DAT file. The length of the EPH.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example EPH.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.13. HDR.DAT

The Orbit Header Record File identifies the orbit number, time frame, and characteristics of orbital geometry for one orbit. This file contains only printable ASCII characters. Its format is defined in [5].

#### 4.3.14. HDR.LBL

HDR.LBL is a detached label that completely describes the HDR.DAT file. The length of the HDR.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example HDR.LBL file is shown in Appendix A. Keywords are defined in [3].

#### 4.3.15. MON.DAT

The Monitor 5-12 File contains 600-byte binary monitor blocks from the DSN stations that received the downlink data for this orbit. Its format is defined in [6,18,20].

#### 4.3.16. MON.LBL

MON.LBL is a detached label that completely describes the MON.DAT file. The length of the MON.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example MON.LBL file is shown in Appendix A. Keywords are defined in [3].

### 4.3.17. QTN.DAT

The Mapping Quaternion Polynomial Coefficients File is created by the Radar Engineering Team and describes the commanded orientation of the spacecraft in the J2000 coordinate system. This file contains only printable ASCII characters. Its format is defined in [8].

### 4.3.18. QTN.LBL

QTN.LBL is a detached label that completely describes the QTN.DAT file. The length of the QTN.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example QTN.LBL file is shown in Appendix A. Keywords are defined in [3].

### 4.3.19. SAB.DAT

The SAR/Altimeter Burst File contains all 54-byte binary burst header records that were downlinked during this orbit. The format is described in [17,19]. During ground data system processing, header labels were added to the blocks. Their formats are described in [12-16].

### 4.3.20. SAB.LBL

SAB.LBL is a detached label that completely describes the SAB.DAT file. The length of the SAB.LBL file is an integral multiple of 80 bytes. All records are padded to 80 bytes with ASCII blanks, and each record ends with a carriage-return (ASCII 13) line-feed (ASCII 10) pair. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. An example SAB.LBL file is shown in Appendix A. Keywords are defined in [3].

# CHAPTER 5

## SUPPORT STAFF AND COGNIZANT PERSONNEL

For questions concerning this volume set:

Peter G. Ford
Center for Space Research
Building 37, Room 601
Massachusetts Institute of Technology
70 Vassar Street
Cambridge, MA 02139

Telephone: 617-253-6485
Datafax: 617-253-0861
Internet: pds-requests@space.mit.edu
URL: http://delcano.mit.edu/

Planetary Data System:

PDS Operator
MS 525/3610
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Phone: 818-306-6130
NSI/Decnet: JPLPDS::PDS_OPERATOR
Internet: pds_operator@jplpds.jpl.nasa.gov
URL: http://stardust.jpl.nasa.gov/pds_home.html

# APPENDIX A

# EXAMPLE PDS LABELS

## A.1. ALT.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'ALT00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 273

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                 = 'ALT.DAT'
^TABLE                        = ('ALT.DAT',299<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'ALTIMETER_DATA_FILE'
DESCRIPTION                   = "This is the Altimeter Burst Data File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 298
 DATA_RECORDS                 = 10
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = TABLE_HEADER

OBJECT                        = TABLE
 SFDU_FORMAT_ID               = 'NJPL1I00C114'
 INTERCHANGE_FORMAT           = BINARY
 RECORD_TYPE                  = FIXED_LENGTH
```

```
 ROW_BYTES                    = 2484
 ROWS                         = 3563
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is the full set of Altimeter Burst
    Data Records available from the telemetry for that orbit. A maximum
    of ~3000 data records is anticipated from the mapping portion of each
    orbit creating a total file length of about 12 megabytes. For more
    information, refer to TPS-101, SAR and Altimeter EDR/TEDR Tapes,
    Betsy Wilson, JPL, Revision D, March 15, 1989."
END_OBJECT                    = TABLE

END
```

### A.2. ALTEDRCD.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID      = PDS3
RECORD_TYPE         = STREAM
^TEXT               = 'ALTEDRCD.PS'
OBJECT              = TEXT
  PUBLICATION_DATE  = 1994-02-16
  NOTE              = "Software Interface Specification for the Magellan
                      Altimetry Experiment Data Record on Compact Disk
                      Read-Only Memory (ALTEDRCD) Product. Formatted
                      in Adobe PostScript."
END_OBJECT          = TEXT
END
```

### A.3. CLK.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'CLK00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 1

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                 = 'CLK.DAT'
^TABLE                        = ('CLK.DAT',414<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
```

```
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'SCLK/SCET_COEFFICIENT_FILE'
DESCRIPTION                   = "This is the SCLK/SCET Coefficients File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 413
 DATA_RECORDS                 = 14
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = TABLE_HEADER

OBJECT                        = TABLE
 SFDU_FORMAT_ID               = 'NJPL1I000128'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 ROW_BYTES                    = 82
 ROWS                         = 40
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This table is the SCLK/SCET Coefficients
    File created by the Spacecraft Team. By design and function, it is a
    dynamic file, slowly growing in size as mission time passes. For more
    information, refer to SES-112, Magellan SCLK/SCET Coefficients File,
    Preliminary, January 1988."
END_OBJECT                    = TABLE

END
```

### A.4. CUMINDEX.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID           = PDS3
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES             = 58
DATA_SET_ID              = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
DATA_RECORDS             = 440
^TABLE                   = "CUMINDEX.TAB"
SPACECRAFT_NAME          = MAGELLAN
INSTRUMENT_NAME          = 'RADAR SYSTEM'
TARGET_NAME              = VENUS
DESCRIPTION              = "This table locates all ALTEDRCD products
                            on all archive volumes."

/* DESCRIPTION OF THE COLUMNS CONTAINED IN THE TABLE */

OBJECT                   = TABLE
  INTERCHANGE_FORMAT     = ASCII
  ROW_BYTES              = 56
  ROWS                   = 440
  COLUMNS                = 6
```

```
  OBJECT                    = COLUMN
    NAME                    = ORBIT_NUMBER
    DESCRIPTION             = "Orbit number of the data file."
    DATA_TYPE               = 'ASCII INTEGER'
    START_BYTE              = 1
    BYTES                   = 4
  END_OBJECT

  OBJECT                    = COLUMN
    NAME                    = VERSION_NUMBER
    DESCRIPTION             = "Version number of the data file."
    DATA_TYPE               = 'ASCII INTEGER'
    START_BYTE              = 6
    BYTES                   = 2
  END_OBJECT

  OBJECT                    = COLUMN
    NAME                    = FILE_NAME
    DESCRIPTION             = "File name of the data file."
    DATA_TYPE               = CHARACTER
   START_BYTE               = 10
   BYTES                    = 7
  END_OBJECT

  OBJECT                    = COLUMN
    NAME                    = DIRECTORY_NAME
    DESCRIPTION             = "Directory in which the data file resides."
    DATA_TYPE               = CHARACTER
    START_BYTE              = 20
    BYTES                   = 8
  END_OBJECT

  OBJECT                    = COLUMN
    NAME                    = PRODUCT
    DESCRIPTION             = "Unique Product ID of the original ALT-EDR data
                               tape assigned by the Magellan Project."
    DATA_TYPE               = CHARACTER
    START_BYTE              = 31
    BYTES                   = 15
  END_OBJECT

  OBJECT                    = COLUMN
    NAME                    = VOLUME_ID
    DESCRIPTION             = "CD-ROM volume in which the data file resides."
    DATA_TYPE               = CHARACTER
    START_BYTE              = 49
    BYTES                   = 7
  END_OBJECT

END_OBJECT

END
```

### A.5. DCM.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'DCM00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 17

/* LOCATION OF OBJECTS WITHIN THE FILE
^AGGREGATE_HEADER             = 'DCM.DAT'
^DECOM_TABLE_HEADER           = ('DCM.DAT',289<BYTES>)
^DECOM_TABLE                  = ('DCM.DAT',719<BYTES>)
^CHANNEL_TABLE_HEADER         = ('DCM.DAT',247578<BYTES>)
^CHANNEL_TABLE                = ('DCM.DAT',248008<BYTES>)
^STATUS_TABLE_HEADER          = ('DCM.DAT',450492<BYTES>)
^STATUS_TABLE                 = ('DCM.DAT',450929<BYTES>)
^POLYNOMIAL_TABLE_HEADER      = ('DCM.DAT',480980<BYTES>)
^POLYNOMIAL_TABLE             = ('DCM.DAT',481418<BYTES>)
^LOOKUP_TABLE_HEADER          = ('DCM.DAT',482297<BYTES>)
^LOOKUP_TABLE                 = ('DCM.DAT',482728<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'DECOM_DECAL_FILE'
DESCRIPTION                   = "This is the Decom/Decal File and is
    necessary to locate and interpret channelized data in the
    accompanying ENG.DAT file. It consists of 5 separate ANSI-formatted
    SFDUs concatenated together: the Telemetry Decommutation Map, the
    Channel Description, Channel Status, DN-EU Conversion Polynomial
    Coefficients, and DN-EU Conversion Tables."
CONFIDENCE_LEVEL_NOTE         = "The following errors were noted by the
  software that generated this PDS label:
     bad DECAL2 SMARKER label length: 85"

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = AGGREGATE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 288
 DATA_RECORDS                 = 9
```

```
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = AGGREGATE_HEADER

 OBJECT                       = DECOM_TABLE_HEADER
  HEADER_TYPE                 = 'N/A'
  SFDU_FORMAT_ID              = 'CCSD1Z000001'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  BYTES                       = 430
  DATA_RECORDS                = 16
  DESCRIPTION                 = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
 END_OBJECT                   = DECOM_TABLE_HEADER

 OBJECT                       = DECOM_TABLE
  SFDU_FORMAT_ID              = 'NJPL1I000170'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  ROW_BYTES                   = 80
  ROWS                        = 3085
  COLUMNS                     = 'UNK'
  DESCRIPTION                 = "This is the Decommutation Map. It
    consists of a listing of all channels in the Engineering frame, the
    length of each in bits, the offset of each into the data, and the
    value of any parameter that must be specified to ascertain its
    existence. Also included is the name for the location of the channel,
    information not required for machine interpretation. For more
    information, refer to SES-115, Decommutation Report Form, JPL, August
    1, 1988."
 END_OBJECT                   = DECOM_TABLE

 OBJECT                       = CHANNEL_TABLE_HEADER
  HEADER_TYPE                 = 'N/A'
  SFDU_FORMAT_ID              = 'CCSD1Z000001'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  BYTES                       = 430
  DATA_RECORDS                = 16
  DESCRIPTION                 = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
 END_OBJECT                   = CHANNEL_TABLE_HEADER

 OBJECT                       = CHANNEL_TABLE
  SFDU_FORMAT_ID              = 'NJPL1I000171'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  ROW_BYTES                   = 'UNK'
  BYTES                       = 202425
  ROWS                        = 2600
  COLUMNS                     = 'UNK'
  DESCRIPTION                 = "This is the first decalibration data
    file. It contains references to all channels specifying in each case
    the name, type, the unit of measure, alarm limits, and pointers to
    following SFDUs containing additional information. For more
```

```
   information, refer to TPS-129, MGN Decalibration File to DMD,
   December, 1987."
END_OBJECT                    = CHANNEL_TABLE

OBJECT                        = STATUS_TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 437
 DATA_RECORDS                 = 16
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = STATUS_TABLE_HEADER

OBJECT                        = STATUS_TABLE
 SFDU_FORMAT_ID               = 'NJPL1I000172'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 ROW_BYTES                    = 'UNK'
 BYTES                        = 29988
 ROWS                         = 356
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is the second decalibration data
   file. It provides titles for the different states of each status-type
   channel. For more information, refer to TPS-129, MGN Decalibration
   File to DMD, December, 1987."
END_OBJECT                    = STATUS_TABLE

OBJECT                        = POLYNOMIAL_TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 438
 DATA_RECORDS                 = 17
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = POLYNOMIAL_TABLE_HEADER

OBJECT                        = POLYNOMIAL_TABLE
 SFDU_FORMAT_ID               = 'NJPL1I000173'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 ROW_BYTES                    = 204
 ROWS                         = 4
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is the third decalibration data
   file. It provides DN-EU correlation parameters for the polynomial
   (calibration-curve) type of conversion. For more information, refer
   to TPS-129, MGN Decalibration File to DMD, December, 1987."
END_OBJECT                    = POLYNOMIAL_TABLE

OBJECT                        = LOOKUP_TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
```

```
  SFDU_FORMAT_ID              = 'CCSD1Z000001'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  BYTES                       = 431
  DATA_RECORDS                = 16
  DESCRIPTION                 = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
 END_OBJECT                   = LOOKUP_TABLE_HEADER

 OBJECT                       = LOOKUP_TABLE
  SFDU_FORMAT_ID              = 'NJPL1I000174'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  ROW_BYTES                   = 60
  ROWS                        = 788
  COLUMNS                     = 'UNK'
  DESCRIPTION                 = "This is the the fourth decalibration
    data file. It provides DN-EU correlation parameters for the table
    look-up (interpolation) type of conversion. For more information,
    refer to TPS-129, MGN Decalibration File to DMD, December, 1987."
 END_OBJECT                   = LOOKUP_TABLE

END
```

### A.6. DQS.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'DQS00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 1

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                 = 'DQS.DAT'
^TABLE                        = ('DQS.DAT',403<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'DATA_QUALITY_SUMMARY_FILE'
DESCRIPTION                   = "This is the Data Quality Summary File."
CONFIDENCE_LEVEL_NOTE         = "The following errors were noted by the
  software that generated this PDS label:
```

```
     bad DATA_QUALITY_SUMMARY logical record length: 85"

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 402
 DATA_RECORDS                 = 14
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = TABLE_HEADER

OBJECT                        = TABLE
 SFDU_FORMAT_ID               = 'NJPL1I000142'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = FIXED_LENGTH
 ROW_BYTES                    = 85
 ROWS                         = 1
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is a set of Data Quality Summary
    Records which provide a measure of the continuity of SAR, ALT, ENG,
    and SAB Header data in the current file set. Each gap of one or more
    successive whole SAB frames causes a DQS logical record to be
    generated. This file does not report gaps of finer granularity such
    as missing RCD frames. For more information, refer to TPS-101, SAR
    and Altimeter EDR/TEDR Tapes, Betsy Wilson, JPL, Rev, D, March 15,
    1989."
END_OBJECT                    = TABLE

END
```

### A.7. ENG.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'ENG00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 29

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                 = 'ENG.DAT'
^TABLE                        = ('ENG.DAT',309<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
```

```
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'ENGINEERING_DATA_FILE'
DESCRIPTION                   = "This is the Engineering Data File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 308
 DATA_RECORDS                 = 10
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = TABLE_HEADER

OBJECT                        = TABLE
 SFDU_FORMAT_ID               = 'NJPL1I00C108'
 INTERCHANGE_FORMAT           = BINARY
 RECORD_TYPE                  = FIXED_LENGTH
 ROW_BYTES                    = 274
 ROWS                         = 3341
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is a collection of Engineering Data
    records containing data for the mapping portion of the orbit as well
    as all data recorded for the period of up to 20 minutes immediately
    preceding and immediately following mapping. This 20 minutes
    (maximum) includes the spacecraft-turning maneuvers. For more
    information, refer to TPS-101, SAR and Altimeter EDR/TEDR Tapes Betsy
    Wilson, JPL, Revision D, March 15, 1989, and SFOC-5-TIS-*DU-MgnSFDU,
    Standard Formatted Data Units Generated from Telemetry Input
    Subsystem, JPL, August 31, 1988."
END_OBJECT                    = TABLE

END
```

### A.8. EPH.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'EPH00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 4

/* LOCATION OF OBJECTS WITHIN THE FILE
^SPICE_KERNEL_HEADER          = 'EPH.DAT'
```

```
^SPICE_KERNEL                  = ('EPH.DAT',906<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME                = 'MAGELLAN'
MISSION_PHASE_NAME             = 'PRIMARY MISSION'
INSTRUMENT_NAME                = 'RADAR SYSTEM'
TARGET_NAME                    = 'VENUS'
ORBIT_NUMBER                   = 376
START_TIME                     = 1990-09-15T16:22:14.869
STOP_TIME                      = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT   = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT    = '00723813.48.8.0'
NOTE                           = 'SPACECRAFT_EPHEMERIS_FILE'
DESCRIPTION                    = "This is the Spacecraft Ephemeris File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                         = SPICE_KERNEL_HEADER
 HEADER_TYPE                   = 'N/A'
 SFDU_FORMAT_ID                = 'CCSD1Z000001'
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = STREAM
 BYTES                         = 905
 DATA_RECORDS                  = 56
 DESCRIPTION                   = "Combined SFDU keyword label (K-type) and
                                 data aggregate start label (R-type)."
END_OBJECT                     = SPICE_KERNEL_HEADER

OBJECT                         = SPICE_KERNEL
 KERNEL_TYPE                   = EPHEMERIS
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = STREAM
 ROW_BYTES                     = 'UNK'
 BYTES                         = 99949
 ROWS                          = 1445
 DESCRIPTION                   = "This is the Spacecraft and Planetary
    Ephemeris. It contains data for the mapping portion of a single
    orbit. The entire ephemeris for each orbit plus 10% overlap on each
    end of the orbit is included, even if data gaps occurred during
    mapping, downlink, or ground processing. For more information, refer
    to SFOC-2-DPS-CDB-Ephemeris, Spacecraft and Planet Ephemerides, NAIF
    S and P Kernels, Preliminary, January 8, 1988."
END_OBJECT                     = SPICE_KERNEL

END
```

### A.9. HDR.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                 = PDS3
DATA_SET_ID                    = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                     = 'HDR00376;01'
SOURCE_PRODUCT_ID              = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                    = FIXED_LENGTH
```

```
RECORD_BYTES                   = 32500
FILE_RECORDS                   = 1

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                  = 'HDR.DAT'
^TABLE                         = ('HDR.DAT',413<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME                = 'MAGELLAN'
MISSION_PHASE_NAME             = 'PRIMARY MISSION'
INSTRUMENT_NAME                = 'RADAR SYSTEM'
TARGET_NAME                    = 'VENUS'
ORBIT_NUMBER                   = 376
START_TIME                     = 1990-09-15T16:22:14.869
STOP_TIME                      = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT   = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT    = '00723813.48.8.0'
NOTE                           = 'ORBIT_HEADER_FILE'
DESCRIPTION                    = "This is the Orbit Header File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                         = TABLE_HEADER
 HEADER_TYPE                   = 'N/A'
 SFDU_FORMAT_ID                = 'CCSD1Z000001'
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = STREAM
 BYTES                         = 412
 DATA_RECORDS                  = 15
 DESCRIPTION                   = "Combined SFDU keyword label (K-type) and
                                 data aggregate start label (R-type)."
END_OBJECT                     = TABLE_HEADER

OBJECT                         = TABLE
 SFDU_FORMAT_ID                = 'NJPL1I000141'
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = FIXED_LENGTH
 ROW_BYTES                     = 306
 ROWS                          = 1
 COLUMNS                       = 'UNK'
 DESCRIPTION                   = "This is the Orbit Header Record. It
    identifies the orbit number, time frame, and characteristics of
    orbital geometry for one orbit. For more information, refer to
    TPS-101, SAR and Altimeter EDR/TEDR Tapes, Betsy Wilson, JPL, Rev, D,
    March 15, 1989."
END_OBJECT                     = TABLE

END
```

### A.10. INDEX.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID            = PDS3
RECORD_TYPE               = FIXED_LENGTH
RECORD_BYTES              = 58
DATA_SET_ID               = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
```

```
DATA_RECORDS             = 440
^TABLE                   = "INDEX.TAB"
SPACECRAFT_NAME          = MAGELLAN
INSTRUMENT_NAME          = 'RADAR SYSTEM'
TARGET_NAME              = VENUS
DESCRIPTION              = "This table locates all ALTEDRCD products
                            on the current volume."

/* DESCRIPTION OF THE COLUMNS CONTAINED IN THE TABLE */

OBJECT                   = TABLE
  INTERCHANGE_FORMAT     = ASCII
  ROW_BYTES              = 56
  ROWS                   = 440
  COLUMNS                = 6

  OBJECT                 = COLUMN
    NAME                 = ORBIT_NUMBER
    DESCRIPTION          = "Orbit number of the data file."
    DATA_TYPE            = 'ASCII INTEGER'
    START_BYTE           = 1
    BYTES                = 4
  END_OBJECT

  OBJECT                 = COLUMN
    NAME                 = VERSION_NUMBER
    DESCRIPTION          = "Version number of the data file."
    DATA_TYPE            = 'ASCII INTEGER'
    START_BYTE           = 6
    BYTES                = 2
  END_OBJECT

  OBJECT                 = COLUMN
    NAME                 = FILE_NAME
    DESCRIPTION          = "File name of the data file on this CD-ROM."
    DATA_TYPE            = CHARACTER
   START_BYTE            = 10
   BYTES                 = 7
  END_OBJECT

  OBJECT                 = COLUMN
    NAME                 = DIRECTORY_NAME
    DESCRIPTION          = "Directory in which the data file resides
                            on this CD-ROM."
    DATA_TYPE            = CHARACTER
    START_BYTE           = 20
    BYTES                = 8
  END_OBJECT

  OBJECT                 = COLUMN
    NAME                 = PRODUCT
    DESCRIPTION          = "Unique Product ID of the original ALT-EDR data
                            tape assigned by the Magellan Project."
    DATA_TYPE            = CHARACTER
    START_BYTE           = 31
```

```
    BYTES                = 15
  END_OBJECT

  OBJECT                 = COLUMN
    NAME                 = VOLUME_ID
    DESCRIPTION          = "CD-ROM volume in which the data file resides,
                           i.e. this disk."
    DATA_TYPE            = CHARACTER
    START_BYTE           = 49
    BYTES                = 7
  END_OBJECT

END_OBJECT

END
```

### A.11. MON.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'MON00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 51

/* LOCATION OF OBJECTS WITHIN THE FILE
^AGGREGATE_HEADER             = 'MON.DAT'
^STATION_1_TABLE_HEADER       = ('MON.DAT',281<BYTES>)
^STATION_1_TABLE              = ('MON.DAT',357<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'DSN_MONITOR_RECORDS_FILE'
DESCRIPTION                   = "This is the DSN Monitor Records File."
CONFIDENCE_LEVEL_NOTE         = "The following errors were noted by the
  software that generated this PDS label:
     bad MONITOR aggregate length: 356"

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = AGGREGATE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
```

```
 RECORD_TYPE                  = STREAM
 BYTES                        = 280
 DATA_RECORDS                 = 9
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = AGGREGATE_HEADER

 OBJECT                       = STATION_1_TABLE_HEADER
  HEADER_TYPE                 = 'N/A'
  SFDU_FORMAT_ID              = 'CCSD1R000003'
  INTERCHANGE_FORMAT          = ASCII
  RECORD_TYPE                 = STREAM
  BYTES                       = 76
  DATA_RECORDS                = 3
  DESCRIPTION                 = "SFDU data aggregate start label (R-type)."
 END_OBJECT                   = STATION_1_TABLE_HEADER

 OBJECT                       = STATION_1_TABLE
  SFDU_FORMAT_ID              = 'NJPL2I00C115'
  INTERCHANGE_FORMAT          = BINARY
  RECORD_TYPE                 = FIXED_LENGTH
  ROW_BYTES                   = 586
  ROWS                        = 2820
  COLUMNS                     = 'UNK'
  DESCRIPTION                 = "This is a collection of DSN Monitor
    Records generated at five-second intervals by each DSN station
    tracking the spacecraft. For more information, refer to MON-105,
    Magellan DSN Monitor Data, February 17, 1988."
 END_OBJECT                   = STATION_1_TABLE

END
```

**A.12. QTN.LBL Example**

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                = PDS3
DATA_SET_ID                   = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                    = 'QTN00376;01'
SOURCE_PRODUCT_ID             = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 32500
FILE_RECORDS                  = 1

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                 = 'QTN.DAT'
^TABLE                        = ('QTN.DAT',336<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME               = 'MAGELLAN'
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
```

```
START_TIME                     = 1990-09-15T16:22:14.869
STOP_TIME                      = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT   = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT    = '00723813.48.8.0'
NOTE                           = 'MAPPING_QUATERNION_POLYNOMIAL_COEFF_FILE'
DESCRIPTION                    = "This is the Mapping Quaternion
    Polynomial Coefficients File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                         = TABLE_HEADER
 HEADER_TYPE                   = 'N/A'
 SFDU_FORMAT_ID                = 'CCSD1Z000001'
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = STREAM
 BYTES                         = 335
 DATA_RECORDS                  = 12
 DESCRIPTION                   = "Combined SFDU keyword label (K-type) and
                                 data aggregate start label (R-type)."
END_OBJECT                     = TABLE_HEADER

OBJECT                         = TABLE
 SFDU_FORMAT_ID                = 'NJPL1I000127'
 INTERCHANGE_FORMAT            = ASCII
 RECORD_TYPE                   = STREAM
 ROW_BYTES                     = 'UNK'
 BYTES                         = 1964
 ROWS                          = 51
 COLUMNS                       = 'UNK'
 DESCRIPTION                   = "This is the Mapping Quaternion
    Polynomial Coefficients File created by the Radar System Engineering
    Team. For more information, refer to RES-104, Mapping Quaternion
    Polynomial Coefficients File, Preliminary, January, 1988."
END_OBJECT                     = TABLE

END
```

### A.13. SAB.LBL Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                 = PDS3
DATA_SET_ID                    = 'MGN-V-RDRS-2-ALT-EDR-V1.0'
PRODUCT_ID                     = 'SAB00376;01'
SOURCE_PRODUCT_ID              = 'ALT-EDR.00376;01'

/* PHYSICAL DESCRIPTION OF THE FILE
RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 32500
FILE_RECORDS                   = 55

/* LOCATION OF OBJECTS WITHIN THE FILE
^TABLE_HEADER                  = 'SAB.DAT'
^TABLE                         = ('SAB.DAT',301<BYTES>)

/* GENERAL PARAMETERS
SPACECRAFT_NAME                = 'MAGELLAN'
```

```
MISSION_PHASE_NAME            = 'PRIMARY MISSION'
INSTRUMENT_NAME               = 'RADAR SYSTEM'
TARGET_NAME                   = 'VENUS'
ORBIT_NUMBER                  = 376
START_TIME                    = 1990-09-15T16:22:14.869
STOP_TIME                     = 1990-09-15T16:59:29.836
SPACECRAFT_CLOCK_START_COUNT  = '00723776.72.2.0'
SPACECRAFT_CLOCK_STOP_COUNT   = '00723813.48.8.0'
NOTE                          = 'SAR_ALTIMETER_BURST_HEADER_FILE'
DESCRIPTION                   = "This is the SAR and Altimeter Burst
    Header File."

/* DESCRIPTION OF OBJECTS WITHIN THE FILE
OBJECT                        = TABLE_HEADER
 HEADER_TYPE                  = 'N/A'
 SFDU_FORMAT_ID               = 'CCSD1Z000001'
 INTERCHANGE_FORMAT           = ASCII
 RECORD_TYPE                  = STREAM
 BYTES                        = 300
 DATA_RECORDS                 = 10
 DESCRIPTION                  = "Combined SFDU keyword label (K-type) and
                                data aggregate start label (R-type)."
END_OBJECT                    = TABLE_HEADER

OBJECT                        = TABLE
 SFDU_FORMAT_ID               = 'NJPL1I00C111'
 INTERCHANGE_FORMAT           = BINARY
 RECORD_TYPE                  = FIXED_LENGTH
 ROW_BYTES                    = 338
 ROWS                         = 5258
 COLUMNS                      = 'UNK'
 DESCRIPTION                  = "This is the full set of SAR and
    Altimeter Burst (SAB) Headers available from the telemetry for that
    orbit. A maximum of ~6000 SAB Headers is anticipated from the mapping
    portion of each orbit creating a total file length of more than two
    megabytes. For more information, refer to TPS-101, SAR and Altimeter
    EDR/TEDR Tapes, Betsy Wilson, JPL, Revision D, March 15, 1989."
END_OBJECT                    = TABLE

END
```

# APPENDIX B

# EXAMPLES OF OTHER FILES

### B.1. AAREADME.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
  PUBLICATION_DATE              = 1994-07-01
  NOTE                          = "MAGELLAN ALT-EDR ARCHIVE CD-WO"
END_OBJECT                      = TEXT
END

                       MAGELLAN ALT-EDR ARCHIVE CD-WO


1.  Introduction

  This CD-WO contains Magellan ALT-EDR (Altimeter Experiment Data Record)
  products.  It also contains documentation files which describe the ALT-
  EDRs.  Each ALT-EDR data directory contains the raw altimeter data
  returned from one orbit and the ancillary files necessary to understand
  the data.

  The ALT-EDR products archived on this volume are the exact products
  released by the Magellan Project.  Errors and anomalies are noted where
  detected.  Supporting documentation and label files conform to the
  Planetary Data System (PDS) Standards, Version 3.0, Jet Propulsion
  Laboratory (JPL) document JPL D-7669.


2.  Disk Format

  The disk has been formatted so that a variety of computer systems (e.g.
  IBM PC, Macintosh, Sun) may access the data.  Specifically, it is
  formatted according to the ISO 9660 level 1 Interchange Standard.  For
  further information, refer to the ISO 9660 Standard Document: RF# ISO
  9660-1988, 15 April 1988.


3.  File Formats

  Each orbit for which ALT-EDR data exist is represented by a set of 11
  files:

      ALT.DAT   - Altimeter burst buffer records
```

```
CLK.DAT   - SCLK/SCET conversion coefficients
DCM.DAT   - Decommutation and decalibration data
DQS.DAT   - EDR Data Quality Summary
ENG.DAT   - Engineering data
EPH.DAT   - S/C ephemeris file
ERR.TXT   - Errors reported by the label generator
HDR.DAT   - Orbit Header
MON.DAT   - DSN monitor records
QTN.DAT   - Quaternion pointing coefficients
SAB.DAT   - Radar header records
```

Each file (except ERR.TXT) is paired with a detached PDS label file that describes its contents. Further information on ALT-EDR file formats and contents can be obtained from the Magellan Software Interface Specification document TPS-101, "SAR and Altimeter EDR/TEDR Tapes", Betsy Wilson, JPL, Rev. D, March 15, 1989.

All document files (*.TXT) and detached label files (*.LBL) 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. The first two lines are an exception: the first contains a 40-byte SFDU aggregate label, followed by a carriage return and a line feed. The second contains 36 space characters (ASCII 32) followed by a carriage return and a line feed. The first PAIR of lines is therefore 80 bytes long, and all remaining lines are offset from the start of the file by a multiple of 80 bytes. This allows the files to be read by the MacOS, DOS, Unix, and VMS operating systems. The PDS label file has the same name as the data file it describes, with the extension .LBL.

PDS labels are object-oriented. 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 that the object starts at the given location. In an embedded label, the location is an integer representing the starting record number of the object (the first byte in the file is byte 1 of 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. For example:

```
^TABLE = ("ENG.TAB",309<BYTES>)
```

indicates that the TABLE object begins at byte 309 of the file ENG.TAB, in the same directory as the detached label file. Below is a list of the possible formats that use the ^object keyword.

```
^object = n
^object = n<BYTES>
^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.
    filename  is the upper-case file name.
    ext       is the upper-case file extension.
```

4. CD-ROM Contents

The files on this CD-ROM are organized in one top-level directory with several subdirectories. The following table shows the structure and content of these directories. In the table, directory names are enclosed in square brackets ([]), upper-case letters indicate an actual directory or file name, and lower-case letters indicate the general form of a set of directory or file names.

```
FILE                   CONTENTS

Top-level directory
  |
  |- AAREADME.TXT      The file you are reading.
  |
  |- ERRATA.TXT        Overview of errors on this, and previous,
  |                    volumes of ALTEDRCD products.
  |
  |- VOLDESC.CAT       A description of the contents of this CD-ROM
  |                    volume in a format readable by both human and
  |                    computers.
  |
  |- [CATALOG]         A directory containing information about the
  |    |               Magellan ALT-EDR dataset.
  |    |
  |    |- CATINFO.TXT  Description of contents of the CATALOG directory.
  |    |
  |    |- ALTEDRDS.CAT PDS dataset catalog object
  |    |
  |    |- INSTHOST.CAT PDS spacecraft catalog object
  |    |
  |    |- MISSION.CAT  PDS mission catalog object
  |    |
  |    |- PERSONEL.CAT PDS personnel catalog object
  |    |
  |    |- REFS.CAT     PDS reference catalog object
  |    |
  |    '- RDRSINST.CAT PDS instrument catalog object
  |
  |- [DOCUMENT]        A directory containing document files relating
  |    |               to this disk.
  |    |
  |    |- DOCINFO.TXT  Description of contents of the DOCUMENT directory.
  |    |
  |    |- ALTEDRCD.TXT A machine readable version of the MIT-MGN-ALTEDRCD
  |    |               SIS document describing the format and content of
  |    |               the Magellan ALT-EDR Archive CD-WO data files.
  |    |
  |    |- ALTEDRCD.LBL Description of ALTEDRCD.PS.
```

```
|    |
|    '- ALTEDRCD.PS   A copy of ALTEDRCD.TXT in PostScript format,
|                     suitable for previewing on a high-resolution
|                     graphics terminal or direct printing on a
|                     laser printer or photo-typesetter.
|
|- [INDEX]           A directory containing information about the
|    |               contents of this CD-WO volume.
|    |
|    |- CUMINDEX.LBL  Description of CUMINDEX.TAB.
|    |
|    |- CUMINDEX.TAB  Cumulative index of all ALT-EDR archive data files.
|    |
|    |- INDEX.LBL     Description of INDEX.TAB.
|    |
|    |- INDEX.TAB     Index of ALT-EDR archive data files on this volume.
|    |
|    '- INDXINFO.TXT  Description of the contents of the INDEX directory.
|
'- [Annnn_vv]        Directories containing ALT-EDR data files for
     |               orbit 'nnnn', version 'vv'.
     |
     |- ALT.DAT       Altimeter burst record file
     |- CLK.DAT       SCLK/SCET conversion coefficients
     |- DCM.DAT       Documentation and decalibration data
     |- DQS.DAT       EDR Data Quality Summary
     |- ENG.DAT       Engineering data
     |- EPH.DAT       S/C ephemeris file
     |- ERR.TXT       Errors reported by the label generator
     |- HDR.DAT       Orbit Header
     |- MON.DAT       DSN monitor records
     |- QTN.DAT       Quaternion pointing coefficients
     |- SAB.DAT       Radar burst header records
     '- nnn.LBL       PDS labels for the DAT files
```

## 5. Whom to Contact for Information

For questions concerning this volume set:

Peter G. Ford
Center for Space Research
Building 37 Room 601
Massachusetts Institute of Technology
70 Vassar Street
Cambridge, MA 02139

Telephone: 617-253-6485
Datafax: 617-253-0861
Internet: pds-requests@space.mit.edu
URL: http://delcano.mit.edu/

## 6. Cognizant Persons

Magellan Dr. Raymond Arvidson

```
  Archive Project        Washington University
  Coordinator            St. Louis, MO

ALT-EDR Data             Dr. Peter Ford
                         MIT 37-601

Volume generation,       Peter Ford and Joan Quigley
  validation, labels,    MIT
  catalog templates,     Cambridge, MA
  documentation

This disk was produced at MIT by Peter Ford and Joan Quigley.
```

### B.2. ALTEDRDS.CAT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                   = PDS3

OBJECT                           = DATA_SET
 DATA_SET_ID                     = 'MGN-V-RDRS-2-ALT-EDR-V1.0'

 OBJECT                          = DATA_SET_INFORMATION
  DATA_SET_NAME                  = "MGN ALTIMETER EXPERIMENT
                                     DATA RECORD ON COMPACT DISK"
  DATA_SET_COLLECTION_MEMBER_FLG = "N"
  START_TIME                     = 1990-09-15T16:22:14
  STOP_TIME                      = 1992-09-14T02:28:41
  DATA_SET_RELEASE_DATE          = 1994-07-01
  PRODUCER_FULL_NAME             = 'DR. PETER G FORD'
  DETAILED_CATALOG_FLAG          = "N"

  DATA_SET_DESC                  = "This volume contains Magellan
    ALT-EDR (Altimeter Experiment Data Record) archive products.  It
    also contains documentation files which describe the ALT-EDRs.
    Each ALT-EDR data directory contains the raw altimeter data
    returned from one orbit and the ancillary files necessary to
    understand the data.  The ALT-EDR products archived on this volume
    are the exact products released by the Magellan Project.
    Supporting documentation and label files conform to the Planetary
    Data System (PDS) Standards, Version 3.0, Jet Propulsion Laboratory
    (JPL) document JPL D-7669."

  CONFIDENCE_LEVEL_NOTE          = "The PDS labels on this volume
    conform to the Data Dictionary distributed with Release 4.1 of the
    PDS Toolkit. All TEXT, HEADER, SPICE KERNEL and TABLE objects obey
    GENERIC PDS standards, except that some TABLE objects are not
    accompanied by sets of COLUMN sub-objects, in which case format
    information is included in an accompanying DESCRIPTION element.
    The PDS Catalog files, *.CAT, conform to the PDS 'streamlined'
    standards introduced in April 1994.

    All *.DAT files in the data directories were copied directly from
    ALT-EDR product tapes without change, unless otherwise noted in the
    ERRATA.TXT file in the ROOT directory. Error messages from the PDS
```

```
   label generation routines have been copied to the ERR.TXT files
   within the data directories. Most errors are concerned with
   incorrect SFDU lengths, and the object pointers in the label files
   should be used in preference to the object lengths recorded in the
   *.DAT files themselves."

END_OBJECT                       = DATA_SET_INFORMATION

OBJECT                           = DATA_SET_TARGET
 TARGET_NAME                     = VENUS
END_OBJECT                       = DATA_SET_TARGET

OBJECT                           = DATA_SET_HOST
 INSTRUMENT_HOST_ID              = MGN
 INSTRUMENT_ID                   = RDRS
END_OBJECT                       = DATA_SET_HOST

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "BARRY1987"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "BRILL&MEISL1990"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "CUEVAS1989"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "DAVIESETAL1989"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "FORD1992"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "FORD1993"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "FORD&PETTENGILL1992"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "HAGFORS1964"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "HAGFORS&EVANS1968"
END_OBJECT                       = DATA_SET_REFERENCE_INFORMATION

OBJECT                           = DATA_SET_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "LYONS1988"
```

```
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "PDSSR1992"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "PETTENGILLETAL1992"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "SCIEDR"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "SDPS101"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "SE011"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "SNYDER1987"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

 OBJECT                            = DATA_SET_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                 = "TYLER1992"
 END_OBJECT                        = DATA_SET_REFERENCE_INFORMATION

END_OBJECT                         = DATA_SET

END
```

### B.3. CATINFO.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                   = PDS3
RECORD_TYPE                      = STREAM
SPACECRAFT_NAME                  = MAGELLAN
TARGET_NAME                      = VENUS
OBJECT                           = TEXT
  PUBLICATION_DATE               = 1994-07-01
  NOTE                           = "MAGELLAN ALT-EDR ARCHIVE CD-WO"
END_OBJECT                       = TEXT
END

                 DESCRIPTION OF CATALOG FILES ON THIS VOLUME

  This file describes the files present in the [CATALOG] directory on this
volume.  The files are:

      ALTEDRDS.CAT  - PDS dataset catalog object
      INSTHOST.CAT  - PDS spacecraft catalog object
      MISSION.CAT   - PDS mission catalog object
```

```
      PERSONEL.CAT  - PDS personnel catalog object
      REFS.CAT      - PDS reference catalog object
      RDRSINST.CAT  - PDS instrument catalog object
```

### B.4. DOCINFO.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
  PUBLICATION_DATE              = 1994-07-01
  NOTE                          = "MAGELLAN ALT-EDR ARCHIVE CD-WO"
END_OBJECT                      = TEXT
END

              DESCRIPTION OF DOCUMENTATION FILES ON THIS VOLUME

  This file describes the files present in the [DOCUMENT] directory on
this volume.  The files are:

      ALTEDRCD.TXT  - Software Interface Specification for the Magellan
                      Altimetry Experiment Data Record on Compact Disk
                      Read-Only Memory (ALTEDRCD) Product. Formatted
                      for display or printing at 66 lines per page with
                      up to 78 constant-width characters per line. This
                      file begins with a 12-line PDS label, which should
                      be stripped off before printing.

      ALTEDRCD.LBL  - PDS detached label file describing ALTEDRCD.PS.

      ALTEDRCD.PS   - Software Interface Specification for the Magellan
                      Altimetry Experiment Data Record on Compact Disk
                      Read-Only Memory (ALTEDRCD) Product. Formatted
                      in Adobe PostScript.
```

### B.5. ERR.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
  PUBLICATION_DATE              = 1994-07-01
  NOTE                          = "MAGELLAN ALT-EDR ARCHIVE ERROR REPORT"
END_OBJECT                      = TEXT
END

The following errors were noted by the label generator when creating
detached PDS label files for directory A0376_01 of product MG_3301
on Mon May 16 23:16:27 EDT 1994.
```

```
DC1.DAT: bad DECAL2 SMARKER label length: 85
DQS.DAT: bad DATA_QUALITY_SUMMARY logical record length: 85
MON.DAT: bad MONITOR aggregate length: 356
```

### B.6. ERRATA.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
  PUBLICATION_DATE              = 1994-07-01
  NOTE                          = "MAGELLAN ALT-EDR ARCHIVE ERROR REPORT"
END_OBJECT                      = TEXT
END

The PDS labels on this volume conform to the Data Dictionary distributed
with Release 4.1 of the PDS Toolkit. All TEXT, HEADER, SPICE KERNEL and
TABLE objects obey GENERIC PDS standards, except that some TABLE objects
are not accompanied by sets of COLUMN sub-objects, in which case format
information is included in an accompanying DESCRIPTION element.

The PDS Catalog files, *.CAT, conform to the PDS "streamlined" standards
introduced in April 1994.

With exceptions noted below, all *.DAT files in the data directories
were copied directly from ALT-EDR product tapes without change. Error
messages from the PDS label generation routines have been copied to the
ERR.TXT files within the data directories. Most errors are concerned
with incorrect SFDU lengths, and the object pointers in the label files,
e.g. ^TABLE = ("SAB.DAT",566), should be used in preference to the
object lengths recorded in the *.DAT files themselves.

+---------+----------+---------+--------------------------------------------+
| Volume  |    Dir   | File    |          Description of Anomaly            |
+---------+----------+---------+--------------------------------------------+
| MG_3301 |          |         |                                            |
+---------+----------+---------+--------------------------------------------+
```

### B.7. INDEX.TAB Example

```
0376,01,"ALT.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"CLK.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"DCM.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"DQS.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"ENG.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"EPH.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"HDR.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"MON.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"QTN.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
0376,01,"SAB.DAT","A0376_01","ALT-EDR.00376;1","MG_3301"
```

### B.8. INDXINFO.TXT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                  = PDS3
RECORD_TYPE                     = STREAM
SPACECRAFT_NAME                 = MAGELLAN
TARGET_NAME                     = VENUS
OBJECT                          = TEXT
 PUBLICATION_DATE               = 1994-07-01
 NOTE                           = "MAGELLAN ALT-EDR ARCHIVE CD-WO"
END_OBJECT                      = TEXT
END

                   DESCRIPTION OF INDEX FILES ON THIS VOLUME

  This file describes the files present in the [INDEX] directory on this
volume.  The files are:

      INDEX.LBL     - PDS label for the volume index (INDEX.TAB).  It
                      identifies the volume index and describes the
                      structure (columns) of the index table.

      INDEX.TAB     - Volume index in tabular format.

      CUMINDEX.LBL  - PDS label for the cumulative volume index
                      (CUMINDEX.TAB).

      CUMINDEX.TAB  - Cumulative volume index in tabular format.
```

### B.9. INSTHOST.CAT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                    = PDS3

OBJECT                            = INSTRUMENT_HOST
INSTRUMENT_HOST_ID                = "MGN"

 OBJECT                           = INSTRUMENT_HOST_INFORMATION
  INSTRUMENT_HOST_NAME            = "MAGELLAN"
  INSTRUMENT_HOST_TYPE            = "SPACECRAFT"
  INSTRUMENT_HOST_DESC            = "

    Spacecraft Overview
    ===================
      The Magellan spacecraft was built by the Martin Marietta
      Corporation.  The spacecraft structure included four major
      sections: High-Gain Antenna (HGA), Forward Equipment Module
      (FEM), Spacecraft Bus (including the solar array), and the Orbit
      Insertion Stage.  Spacecraft subsystems included those for
      thermal control, power, attitude control, propulsion, command
      data and data storage, and telecommunications.

      Design of the Magellan spacecraft was driven by the need for a
      low-cost, high-performance vehicle.  Protoflight units that had
```

been built for preflight tests or were spares from the Voyager spacecraft were available from storage at no cost. These included the 3.7 meter diameter high-gain antenna (HGA), the spacecraft bus, propulsion system components, thermal control louvers, and much of the radio subsystem. The stockpile of flight spares for the Galileo spacecraft provided Magellan's command and data system, tape recorders, attitude control processor, power subsystem and propulsion components. Further elements were drawn from other projects and from NASA standard designs. Only about 30% (by mass) of the Magellan spacecraft -- primarily the radar electronics and the solar panels -- was especially designed for the mission.

The high-gain antenna (HGA) was used as the antenna for the synthetic aperture radar (SAR) and as the primary antenna for the telecommunications system. The HGA boresight was defined to be the +Z axis for the spacecraft-fixed coordinate system.

The spacecraft bus was a ten sided structure containing the star scanner, medium-gain antenna (MGA), rocket engine modules (REMs), command data and data storage (CDDS) subsystem, attitude control monopropellant tank, and a nitrogen tank for providing propellant pressurization. The solar panel array was attached to the bus; its rotation axis defined the +X axis for the spacecraft-fixed coordinate system. The +Y axis of the coordinate system was in the nominal direction of the star scanner boresight, forming a right-hand coordinate system.

The radar electronics, the reaction wheels, and various other spacecraft subsystem components were contained within the Forward Equipment Module, located between the bus and HGA.

The orbit insertion stage contained a STAR-48 solid rocket motor (SRM) that was used to provide the impulse required to perform the Venus Orbit Insertion (VOI) maneuver.

Thermal control of the spacecraft was accomplished by a combination of louvers, thermal blankets, passive coatings, and heat dissipating elements. The nominal operating temperature for the spacecraft components was between -5 and +40 degrees Celsius. The thermal control subsystem maintained these components at the appropriate temperatures for all orientations of the spacecraft orbit and sun-line and for all spacecraft operating modes. Electrical power was supplied by two large solar panels with a total area of 12.6 square meters. This array was capable of producing a minimum power of 1029 W at the end of the nominal mission; it could rotate about its axis to allow tracking of the Sun despite the changing Earth-Sun-spacecraft geometry during the mission. A dedicated sun sensor optimized power production. Bus voltage regulation was controlled by the power control unit (PCU) with a shunt regulator for diverting excess power from the solar arrays to maintain power as raw power (28-35 v), regulated power at 28 vDC +/-0.56 vDC, and as AC at 2.4 kHz through an inverter. Two 30 amp-hour, 26-cell nickel cadmium batteries provided power during times of solar occultation and allowed normal spacecraft operations independent of real-time solar illumination. These batteries were sized to allow a degraded mission in the event that one of them failed.

The attitude of the Magellan spacecraft was controlled through the use of reaction wheels, with monopropellant rocket motors being used to desaturate the reaction wheels periodically. During both the interplanetary cruise and the orbital portions of the mission, attitude reference was provided by an inertial reference unit (IRU), updated each orbit using celestial references. During the mapping part of each orbit, the spacecraft was initially oriented with the HGA pointing down toward Venus, with the exact attitude being a function of the spacecraft altitude and the SAR mapping objectives. During the downlink transmission part of the orbit, the spacecraft was oriented with the HGA slightly off the Earth-line. The low gain antenna (LGA) was mounted coaxially with the HGA and did not require pointing since it had an omnidirectional beam pattern. The altimeter horn (ALTA) was mounted so that a portion of the fan-shaped beam nominally pointed in the nadir direction during the mapping part of an orbit.

The Magellan propulsion subsystem consisted of two parts. The first, a Star 48 SRM, provided the impulse for VOI. Following that maneuver, the empty casing and parts of its support structure were ejected from the spacecraft. The second part consisted of monopropellant hydrazine thrusters that were used for trajectory correction maneuvers (TCMs) during interplanetary cruise, thrust vector control (TVC) during VOI, orbit trim maneuvers during the mapping mission, and attitude control when the reaction wheels were being desaturated. The rocket motors were clustered in modules located on the end of outrigger booms in order to increase their moment arms and thus decrease attitude control propellant requirements.

Twelve 0.9-N (Newton) and four 22-N rocket motors were used for attitude control, with thrust being provided by eight 445-N rocket motors or by the 0.9-N motors for small TCMs. All engines pointed in the -Z direction, with the exception of the roll motors.

The 0.9-N motors were used for tip-off control following separation of the inertial upper stage (IUS), reaction wheel desaturation, roll control for all times other than VOI, to back up any failed reaction wheels, and for small TCMs or orbit trim maneuvers (OTMs). The 22-N motors were used for roll control during VOI. The 445-N motors were used for controlling the spacecraft rotational axis during VOI, and to provide impulses during all propulsive maneuvers. The monopropellant motors also provided the impulses needed to trim the VOI maneuver.

The command, data and data storage (CDDS) system received uplink commands via the radio frequency subsystem (RFS) and controlled the spacecraft in response to those commands. It also

```
     controlled the acquisition and storage of scientific data and
     sending that data, along with supplemental engineering data, to
     the RFS for downlink transmission to Earth.  The commands were
     sent to the spacecraft as time-event pairs for storage and later
     execution, and also in the form of blocks which the CDDS later
     expanded into spacecraft executable commands.  In the Venus
     orbit phase, commands for up to three days of radar operation
     were stored.  There was also a provision for receiving and
     executing discrete commands sent from the ground.  SAR data were
     stored on two multi-track digital tape records (DTRs) for later
     playback over the high-rate X-band link; there was no provision
     for real-time transmission of the SAR data.  Data storage
     capacity of the two DTRs was approximately 1.8 billion bits.
     Engineering data were normally transmitted to Earth over a
     real-time S-band link.  During those times when a real-time link
     was not possible, the engineering data were recorded on a DTR
     and played back via the X-band high-rate link with the SAR data.
     The recorded data stream was alternately switched between the
     two DTRs so that the data would not be lost during the DTR track
     change.

     The Magellan telecommunications subsystem contained all the
     hardware necessary to maintain communications between Earth and
     the spacecraft.  The subsystem contained the radio frequency
     subsystem, the LGA, MGA, and HGA.  The RFS performed the
     functions of carrier transponding, command detection and
     decoding, and telemetry modulation.  The spacecraft was capable
     of simultaneous X-band and S-band uplink and downlink
     operations.  The S-band operated at a transmitter power of 5 W,
     while the X-band operated at a power of 22 W.  Uplink data rates
     were 31.25 and 62.5 bps (bits per second) with downlink data
     rates of 40 bps (emergency only), 1200 bps (real-time
     engineering rate), 115.2 kbps (kilobits per second) (radar
     downlink backup), and 268.8 kbps (nominal).

     For more information on the Magellan spacecraft see the papers
     by [SAUNDERSETAL1990] and [SAUNDERSETAL1992].  "

 END_OBJECT                         = INSTRUMENT_HOST_INFORMATION

 OBJECT                             = INSTRUMENT_HOST_REFERENCE_INFO
  REFERENCE_KEY_ID                  = "SAUNDERSETAL1990"
 END_OBJECT                         = INSTRUMENT_HOST_REFERENCE_INFO

 OBJECT                             = INSTRUMENT_HOST_REFERENCE_INFO
  REFERENCE_KEY_ID                  = "SAUNDERSETAL1992"
 END_OBJECT                         = INSTRUMENT_HOST_REFERENCE_INFO

END_OBJECT                          = INSTRUMENT_HOST

END
```

**B.10. MISSION.CAT Example**

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                   = PDS3

OBJECT                           = MISSION
 MISSION_NAME                    = "MAGELLAN"

 OBJECT                          = MISSION_INFORMATION
  MISSION_START_DATE             = 1989-05-04
  MISSION_STOP_DATE              = UNK
  MISSION_ALIAS_NAME             = "Venus Radar Mapper (VRM)"
  MISSION_DESC                   = "

    Mission Overview
    ================
      The Magellan spacecraft was launched from the Kennedy Space
      Center on 4 May 1989.  The spacecraft was deployed from the
      Shuttle cargo bay after the Shuttle achieved parking orbit.
      Magellan, using an inertial upper stage rocket, was then placed
      into a Type IV transfer orbit to Venus where it carried out
      radar mapping and gravity studies starting in August 1990.  The
      Mission has been described in many papers including two special
      issues of the Journal of Geophysical Research [VRMPP1983;
      SAUNDERSETAL1990; JGRMGN1992].  The radar system is also
      described in [JOHNSON1990].

      Magellan was powered by single degree of freedom, sun-tracking,
      solar panels.  The spacecraft was 3-axis stabilized by reaction
      wheels using gyros and a star sensor for attitude reference.
      The spacecraft carried a solid rocket motor for Venus orbit
      insertion.  A small hydrazine system was used for trajectory
      corrections and certain attitude control functions.  Earth
      communication with the Deep Space Network (DSN) was by means of
      S- and X-band channels.  The high-gain antenna also functioned
      as the SAR mapping antenna during orbital operations.

      The interplanetary cruise phase lasted until 10 August 1990.
      During the cruise phase there were small trajectory correction
      maneuvers to ensure proper approach geometry.  Using the solid
      rocket motor, the spacecraft was placed into an elliptical orbit
      around the planet, with a periapsis latitude of approximately 10
      degrees north, a periapsis altitude of 295 km, a period of 3.263
      hours, and an apoapsis altitude of approximately 7762 km.

      After orbit insertion, the radar system acquired test data.
      Then, unexpectedly, the signal from the spacecraft was lost
      twice.  Placed in a 'Safe Mode', the spacecraft resumed mapping
      operations on 15 September 1990, after commands were relayed to
      avoid further communication interruptions.

      Each mapping cycle lasted 243 days, which was the time required
      for Venus to make one rotation under the spacecraft orbit.  The
      first mapping cycle ended on 15 May 1991.  Typical activities
      during a single mapping pass on Cycle 1 were as follows.  As the
```

spacecraft neared periapsis, it was oriented so the high-gain antenna pointed slightly to the side of the ground track. At a true anomaly of -59 degrees, the radar was commanded on. The radar continued to take data to a true anomaly of 80 degrees and then the radar was commanded off. On the next pass the swath started at -80 degrees and went to 59 degrees. Alternating north and south swaths were repeated throughout Cycle 1.

The range of latitudes covered by the synthetic aperture radar (SAR) during Cycle 1 was 67 degrees S to 90 degrees N. The range of SAR incidence angles was from just under 20 to just over 40 degrees. The SAR data were taken at a data rate of 750 kilobits/second and were stored in the spacecraft tape recorder. Altimeter and radiometer data were also taken when SAR data were acquired. The altimeter data were taken using a small fan beam antenna at a data rate of 30 kb/s. As the spacecraft moved away from the planet toward apoapsis, the spacecraft reoriented the high-gain antenna towards Earth and the stored radar data were transmitted to DSN stations. This data taking- and transmitting-cycle was repeated for every orbit. By 15 May 1991, the planet had been completely mapped except for the area near the South Pole and a few regions which had been missed because of temporary equipment failures.

Cycle 2 observations focused on filling the gaps in Cycle 1 coverage (including the south pole area), acquiring SAR data at a constant incidence angle (25 degrees), and conducting a suite of ad hoc experiments, including high resolution imaging and radar stereo. To observe the south pole the spacecraft was rotated 180 degrees about its nadir-pointing axis so as to conduct right-looking SAR observations. Gaps in the Cycle 1 coverage were filled by rotating the spacecraft back to its initial left-looking direction. The orbit plane was adjusted slightly at the beginning of Cycle 2 so that altimetry tracks would be offset by about 10 km at the equator, bisecting the orbit-to-orbit offset of altimetry tracks in Cycle 1. The spacecraft was rotated 90 deg about the HGA boresight on orbits 3716-3719 to obtain SAR and radiometry data with VV polarization. Radio occultation measurements were made on orbits 3212-3214.

The principal objective of Cycle 3 was to perform radar stereo mapping of the Venusian surface. About 30 percent of the Cycle 1 coverage was remapped in this cycle with a different, left-looking incidence angle on the surface. Gravity data were collected over Artemis Chasma. In addition, high resolution altimetry data were collected by pointing the high gain antenna straight down during orbits 4919 to 4921. Transmission of acquired radar data to Earth became nearly impossible after spacecraft equipment failures late in Cycle 3, and the radar was not used for science purposes after that.

Cycle 4 was used for full (360 degree) longitudinal collection of gravity data because of favorable planetary and spacecraft geometry. The cycle was extended by about ten days to compensate for passage of the radio ray through the Venus atmosphere during the first ten days. To improve sensitivity to gravity features, orbit periapsis was lowered on orbit 5752. Radio occultation measurements were made on orbits 6369, 6370, 6471, and 6472.

The aerobraking phase of the mission was designed to change the Magellan orbit from eccentric to nearly circular. This was accomplished by dropping periapsis to less than 150 km above the surface and using atmospheric drag to reduce the energy in the orbit. Aerobraking ended on 3 August 1993, and periapsis was boosted above the atmosphere leaving the spacecraft in an orbit that was 540 km above the surface at apoapsis and 197 km above the surface at periapsis. The orbit period was 94 minutes. The spacecraft remained on its medium-gain antenna in this orbit until Cycle 5 began officially on 16 August 1993.

During Cycles 5 and 6 the orbit was low and approximately circular. The emphasis was on collecting high-resolution gravity data. Two bistatic surface scattering experiments were conducted, one on 6 October (orbits 9331, 9335, and 9336) and the second on 9 November (orbits 9846-9848).

## Mission Phases

Mission phases were defined for significant spacecraft activity periods. During orbital operations a 'cycle' was approximately the time required for Venus to rotate once under the spacecraft (about 243 days). But there were orbit adjustments and other activities that made some mapping cycles not strictly contiguous and slightly longer or shorter than the rotation period.

### PRELAUNCH

The prelaunch phase extended from delivery of the spacecraft to Kennedy Space Center until the start of the launch countdown.

```
Spacecraft Id                 : MGN
Target Name                   : VENUS
Mission Phase Start Time      : 1988-09-01
Mission Phase Stop Time       : 1989-05-04
Spacecraft Operations Type    : ORBITER
```

### LAUNCH

The launch phase extended from the start of launch countdown until completion of the injection into the Earth-Venus trajectory.

```
Spacecraft Id                 : MGN
Target Name                   : VENUS
```

```
  Mission Phase Start Time       : 1989-05-04
  Mission Phase Stop Time        : 1989-05-04
  Spacecraft Operations Type     : ORBITER


CRUISE
------
  The cruise phase extended from injection into the Earth-Venus
  trajectory until 10 days before Venus orbit insertion.

  Spacecraft Id                  : MGN
  Target Name                    : VENUS
  Mission Phase Start Time       : 1989-05-04
  Mission Phase Stop Time        : 1990-08-01
  Spacecraft Operations Type     : ORBITER


ORBIT INSERTION
---------------
  The Venus orbit insertion phase extended from 10 days before
  Venus orbit insertion until burnout of the solid rocket
  injection motor.

  Spacecraft Id                  : MGN
  Target Name                    : VENUS
  Mission Phase Start Time       : 1990-08-01
  Mission Phase Stop Time        : 1990-08-10
  Spacecraft Operations Type     : ORBITER


ORBIT CHECKOUT
--------------
  The orbit trim and checkout phase extended from burnout of the
  solid rocket injection motor until the beginning of radar
  mapping.

  Spacecraft Id                  : MGN
  Target Name                    : VENUS
  Mission Phase Start Time       : 1990-08-10
  Mission Phase Stop Time        : 1990-09-15
  Spacecraft Operations Type     : ORBITER


MAPPING CYCLE 1
---------------
  The first mapping cycle extended from completion of the orbit
  trim and checkout phase until completion of one cycle of radar
  mapping (approximately 243 days).

  Spacecraft Id                  : MGN
  Target Name                    : VENUS
  Mission Phase Start Time       : 1990-09-15
  Mission Phase Stop Time        : 1991-05-15
  Spacecraft Operations Type     : ORBITER
```

```
MAPPING CYCLE 2
---------------
  The second mapping cycle extended from completion of the first
  mapping cycle through an additional cycle of mapping.
  Acquisition of 'right-looking' SAR data was emphasized.  Radio
  occultation measurements were carried out on orbits 3212-3214.
  A period of battery reconditioning followed completion of
  Cycle 2.

  Spacecraft Id                 : MGN
  Target Name                   : VENUS
  Mission Phase Start Time      : 1991-05-16
  Mission Phase Stop Time       : 1992-01-17
  Spacecraft Operations Type    : ORBITER


MAPPING CYCLE 3
---------------
  The third mapping cycle extended from completion of battery
  reconditioning through an additional cycle of mapping
  (approximately 243 days).  Acquisition of 'stereo' SAR data
  was emphasized.  The last orbit in the third cycle was orbit
  5747.

  Spacecraft Id                 : MGN
  Target Name                   : VENUS
  Mission Phase Start Time      : 1992-01-24
  Mission Phase Stop Time       : 1992-09-14
  Spacecraft Operations Type    : ORBITER


MAPPING CYCLE 4
---------------
  The fourth mapping cycle extended from completion of the third
  mapping cycle through an additional cycle of mapping.
  Acquisition of radio tracking data for gravity studies was
  emphasized.  Radio occultation measurements were carried out
  on orbits 6369, 6370, 6471, and 6472.  Because of poor
  observing geometry for gravity data collection at the
  beginning of the cycle, this cycle was extended 10 days beyond
  the nominal 243 days.  Orbits included within the fourth cycle
  were 5748 through 7626.  Periapsis was lowered on orbit 5752
  to improve sensitivity to gravity features in Cycle 4.

  Spacecraft Id                 : MGN
  Target Name                   : VENUS
  Mission Phase Start Time      : 1992-09-14
  Mission Phase Stop Time       : 1993-05-25
  Spacecraft Operations Type    : ORBITER


AEROBRAKING
-----------
  The aerobraking phase extended from completion of the fourth
  mapping cycle through achievement of a near-circular orbit.
```

```
    Circularization was achieved more quickly than expected; the
    first gravity data collection in the circular orbit was not
    scheduled until 11 days later.  Orbits included within the
    aerobraking phase were 7627 through 8392.

    Spacecraft Id                : MGN
    Target Name                  : VENUS
    Mission Phase Start Time     : 1993-05-26
    Mission Phase Stop Time      : 1993-08-05
    Spacecraft Operations Type   : ORBITER


  MAPPING CYCLE 5
  ---------------
    The fifth mapping cycle extended from completion of the
    aerobraking phase through an additional cycle of mapping
    (approximately 243 days).  Acquisition of radio tracking data
    for gravity studies was emphasized.  The first orbit in the
    fifth cycle was orbit 8393.

    Spacecraft Id                : MGN
    Target Name                  : VENUS
    Mission Phase Start Time     : 1993-08-16
    Mission Phase Stop Time      : 1994-04-15
    Spacecraft Operations Type   : ORBITER


  MAPPING CYCLE 6
  ---------------
    The sixth mapping cycle extended from completion of the fifth
    mapping cycle through an additional cycle of mapping
    (approximately 243 days).  Acquisition of radio tracking data
    for gravity studies was emphasized.  The first orbit in the
    sixth cycle was orbit 12249.

    Spacecraft Id                : MGN
    Target Name                  : VENUS
    Mission Phase Start Time     : 1994-04-16
    Mission Phase Stop Time      : TBD
    Spacecraft Operations Type   : ORBITER "


MISSION_OBJECTIVES_SUMMARY      = "

  Volcanic and Tectonic Processes
  ===============================
    Magellan images of the Venus surface show widespread evidence
    for volcanic activity.  A major goal of the Magellan mission was
    to provide a detailed global characterization of volcanic
    landforms on Venus and an understanding of the mechanics of
    volcanism in the Venus context.  Of particular interest was the
    role of volcanism in transporting heat through the lithosphere.
    While this goal will largely be accomplished by a careful
    analysis of images of volcanic features and of the geological
    relationships of these features to tectonic and impact
```

structures, an essential aspect of characterization will be an integration of image data with altimetry and other measurements of surface properties.

Explosive pyroclastic volcanism should not occur in the present Venus environment, unless the magma contains amounts of volatiles that are large by terrestrial experience. Thus, evidence for extensive pyroclastic deposits would imply the presence of large amounts of volatiles or, if the deposits are old, may suggest historic changes in atmospheric density. Such ideas can be tested using SAR and altimetry data, combined with knowledge of the local geopotential field and may shed light on magma dynamics. Measurements of longitudinal and transverse slope, flow margin relief, and flow surface relief also provide powerful constraints on flow models, as well as on the rheological properties and physical state of the lava.

A parallel goal was the global characterization of tectonic features on Venus and an appreciation of the tectonic evolution of the planet. This goal addressed issues on several scales. On the scale of individual tectonic features is the mechanical nature of the faulting process, the documentation of geometry and sense of fault slip, and the relationship between mechanical and thermal properties of the lithosphere. On a somewhat broader scale is linking groups of features to specific processes (e.g., uplift, orogeny, gravity sliding, flexure, compression or extension of the lithosphere) and testing quantitative models for these processes with SAR images and supporting topographic, gravitational, and surface compositional data. On a global scale is the question of whether spatially coherent, large-scale patterns in tectonic behavior are discernible, patterns that might be related to an organized system of plates or to mantle convective flow

For more information on volcanic and tectonic investigations see papers by [HEADETAL1992] and [SOLOMONETAL1992], respectively.

## Impact Processes

The final physical form of an impact crater has meaning only when the effects of the cratering event and any subsequent modification of the crater can be distinguished. To this end, a careful search of the SAR images can identify and characterize both relatively pristine and degraded impact craters, together with their ejecta deposits (in each size range) as well as distinguishing impact craters from those of volcanic origin. The topographic measures of depth-to-diameter ratio, ejecta thickness distribution as a function of distance from the crater, and the relief of central peaks contribute to this documentation.

It is expected that several time-dependent processes influence the change in appearance of craters with increasing crater age, including continued bombardment of the surface, variations in the mechanical properties of the lithosphere (as a result of cooling or loss of near-surface volatiles), horizontal deformation of the lithosphere, possible variations in the mass of the atmosphere, volcanism, and finally, surface erosion and deposition. Distinguishing and understanding these processes constitute important components of the study of crater morphology.

Beyond their intrinsic interest in providing a record of impact and deformational processes, craters provide a tool for the relative dating of surface geological units. Relative ages can be established from a comparison of the variations in the areal density of craters of a given size as well as from a comparison of the maximum extent to which different craters are degraded. Together with superpositional relationships (a lava flow that covers an older fault) and transectional relationships (a graben that cuts through an older volcano), the relative temporal evolution of large areas of the Venus surface can be reconstructed.

For more information on investigations of impact processes see [SCHABERETAL1992].

## Erosional, Depositional, and Chemical Processes

The nature of erosional and depositional processes on Venus is poorly known, primarily because the diagnostic landforms typically occur at a scale too small to have been resolved in Earth-based or Venera 15/16 radar images. Magellan images show wind eroded terrains, landforms produced by deposition (dune fields), possible landslides and other down slope movements, as well as aeolian features such as radar bright or dark streaks 'downwind' from prominent topographic anomalies. One measure of weathering, erosion, and deposition is provided by the extent to which soil covers the surface (for Venus, the term soil is used for porous material, as implied by its relatively low value of bulk dielectric constant). The existence of such material, and its dependence on elevation and geologic setting, provide important insights into the interactions that have taken place between the atmosphere and the lithosphere.

Because of the inference drawn from the deuterium-to-hydrogen ratio of the present atmosphere for the past existence of substantial amounts of water on Venus, radar images continue to be searched for evidence of past episodes of fluvial activity (drainage systems) and for lake beds and coastal signatures (strandlines).

The existence of a thick and cloudy atmosphere precludes infrared, visual, ultraviolet, x-ray, or gamma-ray observation of the Venus surface from orbit. Thus it is impossible to obtain information on a global basis about the surface composition or mineralogy using remote-sensing techniques at these wavelengths. Pioneer Venus and Magellan have disclosed that very often the surfaces of elevated regions possess both anomalously high values of normal-incidence radar reflectivity, occasionally exceeding 0.43, and associated low values of radio emissivity, reaching as low as 0.50. In the absence of liquid water, which is known from a variety of evidence not to be present today on Venus, it is necessary to assume a surface composition that would be unusual in terrestrial experience to explain values of dielectric constant implied by these observations. The most acceptable of the current hypotheses requires a significant number of electrically conducting elements in surface materials. If these are iron sulfides, as some chemical evidence suggests, they may possibly be brought to the surface by volcanic activity. The good spatial resolution of the Magellan instrumentation, both in determining the surface reflectivity from the altimetric observations and in measuring the emissivity from radiometric observations, promises to outline the structure of these regions and may shed light on their origin. Results will be applied to testing hypotheses for regional and global buffering of atmospheric composition by reactions with crustal materials.

For more information on erosional, depositional, and chemical processes see papers by [ARVIDSONETAL1992], [GREELEYETAL1992], and [GREELEYETAL1994].

## Isostatic and Convective Processes

Topography and gravity are intimately and inextricably related, and must be jointly examined when undertaking geophysical investigations of the interior of a planet, where isostatic and convective processes dominate. Topography provides a surface boundary condition for modeling the interior density of Venus.

Modeling of the interior density using gravity data is, of course, nonunique. Meaningful interpretation rests on integrating other data sets and/or incorporating specific mechanical models of the interior. For example, a single density interface underlying the known topography can be found that exactly matches any observed gravity field. The interface can be at any depth; the greater the depth, the larger the density contrast needed.

The thickness of the elastic lithosphere of Venus, i.e., the outer region of the planet that behaves elastically over geologically long periods of time, is of special interest. The base of this zone is likely to be defined by a specific isotherm whose location depends on the particular temperature-dependent flow or creep properties of the material underneath. If this isotherm can be mapped in space and time, then models for the thermal evolution of the planet can be developed.

The key to determining lithospheric thickness variations in space and time is through flexure studies. If a mass load, e.g., a shield volcano or a mascon, is placed on the planetary

```
     surface, then the elastic lithosphere will flex under the load.
     The controlling parameter is the flexural rigidity, which is
     dependent on the elastic constants and lithospheric thickness.

     Crucial to applying estimates of flexural rigidity to the task
     of unraveling the thermal history is an estimate of when the
     load was emplaced.  Thus age determinations derived by various
     geologic techniques are essential to this scheme.

     For more information on topography and gravity see papers by
     [FORD&PETTENGILL1992], [KONOPLIVETAL1993], and
     [MCNAMEEETAL1993].  "

END_OBJECT                       = MISSION_INFORMATION

OBJECT                           = MISSION_HOST
 INSTRUMENT_HOST_ID              = "MGN"

 OBJECT                          = MISSION_TARGET
 TARGET_NAME                     = "VENUS"
 END_OBJECT                      = MISSION_TARGET
END_OBJECT                       = MISSION_HOST

OBJECT                           = MISSION_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "ARVIDSON1991"
END_OBJECT                       = MISSION_REFERENCE_INFORMATION

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 REFERENCE_KEY_ID                = "ARVIDSONETAL1992"
END_OBJECT                       = MISSION_REFERENCE_INFORMATION

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END_OBJECT                       = MISSION_REFERENCE_INFORMATION

OBJECT                           = MISSION_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "CAMPBELLETAL1992B"
END_OBJECT                       = MISSION_REFERENCE_INFORMATION

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 REFERENCE_KEY_ID                = "DAVIESETAL1992"
END_OBJECT                       = MISSION_REFERENCE_INFORMATION

OBJECT                           = MISSION_REFERENCE_INFORMATION
 REFERENCE_KEY_ID                = "FORD&PETTENGILL1992"
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  REFERENCE_KEY_ID                = "TYLER1991"
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  REFERENCE_KEY_ID                = "TYLER1992"
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### B.11. PERSONEL.CAT Example

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PDS_VERSION_ID                    = PDS3

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 OBJECT                           = PERSONNEL_INFORMATION
  FULL_NAME                       = "GORDON H. PETTENGILL"
  LAST_NAME                       = PETTENGILL
  TELEPHONE_NUMBER                = "6172534281"
  ALTERNATE_TELEPHONE_NUMBER      = "N/A"
  FAX_NUMBER                      = "6172530861"
  INSTITUTION_NAME                = "MASSACHUSETTS INSTITUTE OF TECHNOLOGY"
  NODE_ID                         = "GEOSCIENCE"
  PDS_AFFILIATION                 = "N/A"
  REGISTRATION_DATE               = 1991-02-27
  ADDRESS_TEXT                    = "Massachusetts Institute of Technology
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                                    CENTER FOR SPACE RESEARCH
                                    BUILDING 37 ROOM 641
                                    CAMBRIDGE, MA  02139"
 END_OBJECT                       = PERSONNEL_INFORMATION

 OBJECT                           = PERSONNEL_ELECTRONIC_MAIL
  ELECTRONIC_MAIL_ID              = "GHP@SPACE.MIT.EDU"
  ELECTRONIC_MAIL_TYPE            = "INTERNET"
  PREFERENCE_ID                   = 1
 END_OBJECT                       = PERSONNEL_ELECTRONIC_MAIL

END_OBJECT                        = PERSONNEL

OBJECT                            = PERSONNEL
 PDS_USER_ID                      = PFORD

 OBJECT                           = PERSONNEL_INFORMATION
  FULL_NAME                       = "PETER G. FORD"
  LAST_NAME                       = FORD
  TELEPHONE_NUMBER                = "6172536485"
  ALTERNATE_TELEPHONE_NUMBER      = "6172534287"
  FAX_NUMBER                      = "6172530861"
  INSTITUTION_NAME                = "MASSACHUSETTS INSTITUTE OF TECHNOLOGY"
  NODE_ID                         = "GEOSCIENCE"
  PDS_AFFILIATION                 = "NODE OPERATIONS MANAGER"
  REGISTRATION_DATE               = 1990-02-06
  ADDRESS_TEXT                    = "Massachusetts Institute of Technology
                                    Center for Space Research
                                    Building 37-601
                                    Cambridge, MA  02139"
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 OBJECT                           = PERSONNEL_ELECTRONIC_MAIL
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  ELECTRONIC_MAIL_TYPE            = "INTERNET"
  PREFERENCE_ID                   = 1
 END_OBJECT                       = PERSONNEL_ELECTRONIC_MAIL

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  ELECTRONIC_MAIL_ID              = "JPLPDS::PFORD"
  ELECTRONIC_MAIL_TYPE            = "NSI/DECNET"
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 REFERENCE_DESC                   = "Arvidson, R. E., V.R. Baker,
  C. Elachi, R.S. Saunders, J.A. Wood, Magellan: Initial Analysis
  of Venus Surface Modification, Science, V. 252, pp. 270 - 275,
1991"
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "ARVIDSONETAL1992"
 REFERENCE_DESC                   = "Arvidson, R. E., R. Greeley,
  M.C. Malin, R.S. Saunders, N. Izenberg, J.J. Plaut, E.R.
  Stofan, and M.K. Shepard, Surface Modification of Venus as
  Inferred from Magellan Observations of Plains, Journal of
  Geophysical Research, 97, 13303-13317, 1992"
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "ASMAR&HERRERA1993"
 REFERENCE_DESC                   = "Asmar, S.W., and R.G.
  Herrera, Radio Science Handbook, JPL D-7938 Volume 4, Jet
  Propulsion Laboratory, Pasadena, CA, 1993."
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "ASMAR&RENZETTI"
 REFERENCE_DESC                   = "Asmar, S.W., and N.A.
  Renzetti, The Deep Space Network as an Instrument for Radio
  Science Research, Jet Propulsion Laboratory Publication 80-93,
  Rev. 1, 15 April 1993."
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "BARRY1987"
 REFERENCE_DESC                   = "Barry, S., Magellan Mission
  Operations System: Radar System Interface Requirements, Hughes
  Aircraft Co. Report HS513-823-3, May 1987"
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "BRILL&MEISL1990"
 REFERENCE_DESC                   = "Brill, R., C. and Meisl,
  Magellan Altimeter Processing: Algorithms and Constants, Jet
  Propulsion Laboratory Document D-6143, 15 February 1990"
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 REFERENCE_KEY_ID                 = "CAMPBELLETAL1992"
 REFERENCE_DESC                   = "Campbell, D. B., N.J.S.
  Stacy, W.I. Newman, R.E. Arvidson, E.M. Jones, G.S. Musser,
  A.Y. Roper, and C. Schaller, Magellan Observations of Extended
  Impact Crater Related Features on the Surface of Venus, Journal
  of Geophysical Research, 97, 16249-16277, 1992"
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 REFERENCE_KEY_ID                 = "CAMPBELLETAL1992B"
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 REFERENCE_DESC                   = "Campbell, B. A., and D.B.
  Campbell, Analysis of Volcanic Surface Morphology on Venus from
  Comparison of Arecibo, Magellan, and Terrestrial Airborne Radar
  Data, Journal of Geophysical Research, 97, 16293-16314, 1992"
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "CUEVAS1989"
 REFERENCE_DESC                   = "Cuevas, C., Magellan Radar
  Sensor Compensation Report, Hughes Aircraft Co. Report HS513-
  5029, 18 August 1989"
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OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "DAVIESETAL1989"
 REFERENCE_DESC                   = "Davies, M.E., V.K. Abalakin,
  M. Bursa, G.E. Hunt, J.H. Lieske, B. Morando, R.H. Rapp, P.K.
  Seidelmann, A.T. Sinclair, and Yu.S. Tyuflin, Report of the
  IAU/IAG/COSPAR Working Group on Cartographic Coordinates and
  Rotational Elements of the Planets and Satellites: 1988,
  Celestial Mechanics and Dynamical Astronomy, 46, 187-204, 1989."
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "DAVIESETAL1992"
 REFERENCE_DESC                   = "Davies, M.E., T.R. Colvin,
  P.G. Rogers, P.W. Chodas, W.L. Sjogren, E.L. Akim, V.A.
  Stepanyantz, Z.P. Vlasova, and A.I. Zakharov, The Rotation
  Period, Direction of the North Pole, and Geodetic Control
  Network of Venus, Journal of Geophysical Research, 97, 13141-
  13151, 1992."
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "FORD1992"
 REFERENCE_DESC                   = "Ford, P. G., Magellan
  Altimetry and Radiometry Composite Data, USA_NASA_JPL_MG_2nnn, 1992."
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 REFERENCE_KEY_ID                 = "FORD1993"
 REFERENCE_DESC                   = "Ford, P. G., Magellan Global
  Altimetry and Radiometry Data Records, USA_NASA_JPL_MG_3nnn, 1993."
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "FORD&PETTENGILL1992"
 REFERENCE_DESC                   = "Ford, P. G., and G.H.
  Pettengill, Venus Topography and Kilometer-Scale Slopes,
  Journal of Geophysical Research, 97, 13103-13114, 1992"
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 REFERENCE_KEY_ID                 = "GEO-10REVD"
 REFERENCE_DESC                   = "DSN Geometry and Spacecraft
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  Visibility, Document 810-5, Rev. D, Vol. I, DSN/Flight Project
  Interface Design, Jet Propulsion Laboratory, Pasadena, CA, 1987."
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "GREELEYETAL1992"
 REFERENCE_DESC                   = "Greeley, R., R.E. Arvidson,
  C. Elachi, M.A. Geringer, J.J. Plaut, R.S. Saunders, G.
  Schubert, E.R. Stofan, E.J.P. Thouvenot, S.D. Wall, C.M. and
  Weitz, Aeolian Features on Venus: Preliminary Magellan Results,
  Journal of Geophysical Research, 97, 13319-13345, 1992"
END_OBJECT                        = REFERENCE

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 REFERENCE_KEY_ID                 = "GREELEYETAL1994"
 REFERENCE_DESC                   = "Greeley, R., G. Schubert
  D. Limonadi, K.C. Bender, W.I. Newman, P.E. Thomas, C.M. Weitz,
  and S.D. Wall, Wind Streaks on Venus: Clues to Atmospheric
  Circulation, Science, 263, 358-361, 1994"
END_OBJECT                        = REFERENCE

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 REFERENCE_DESC                   = "Hagfors, T., Backscattering
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  from the Moon, Journal of Geophysical Research, 69, 3779-3784, 1964."
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 REFERENCE_KEY_ID                 = "HAGFORS&EVANS1968"
 REFERENCE_DESC                   = "Hagfors, T., and J.V. Evans,
  Radar Studies of the Moon, Chapter 5 in Radar Astronomy (Evans,
  J. V., and T. Hagfors, editors), New York: McGraw-Hill, 1968"
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 REFERENCE_DESC                   = "Head, J. W., D.B. Campbell,
  C. Elachi, J.E. Guest, D.P. McKenzie, R.S. Saunders, G.G.
  Schaber, G. Schubert, Venus Volcanism: Initial Analysis from
  Magellan Data, Science, V. 252, pp. 276 - 288, 1991"
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 REFERENCE_DESC                   = "Head, J.W., L.S. Crumpler,
  J.C. Aubele, J.E. Guest, and R.S Saunders, Venus Volcanism:
  Classification of Volcanic Features and Structures,
  Associations, and Global Distribution from Magellan Data,
  Journal of Geophysical Research, 97, 13153-13197, 1992."
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  issues, Journal of Geophysical Research, 97, Nos. E8 and E10,
  13063-13689 and 15921-16382, 1992."
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 REFERENCE_DESC                     = "W.T.K. Johnson, Magellan
  Imaging Radar to unveil Venus, Microwave System News, vol. 20,
  no. 3, pp. 25-31, 1990."
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 REFERENCE_DESC                     = "Konopliv, A.S., N.J.
  Borderies, P.W. Chodas, E.J. Christensen, W.L. Sjogren, and B.G.
  Williams, Venus Gravity and Topography: 60th Degree and Order
  Model, Geophysical Research Letters, 20, 2403-2406, 1993."
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 REFERENCE_DESC                     = "Lyons, D.T., Magellan
  Planetary Constants and Models, JPL D-2300, Jet Propulsion
  Laboratory, Pasadena, Calif., 1988."
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 REFERENCE_DESC                     = "McNamee, J.B., N.J.
  Borderies, and W.L. Sjogren, Venus: Global Gravity and
  Topography, Journal of Geophysical Research, 98, 9113-9128, 1993."
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 REFERENCE_DESC                     = "Moyer, T.D. Mathematical
  Formulation of the Double-Precision Orbit Determination Program
  (DPODP), TR 32-1527, Jet Propulsion Laboratory, Pasadena, CA, 1971."
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 REFERENCE_DESC                     = "Moyer, T.D., Changes to the
  ODP and the ODE for processing X-Band Uplink Data, EM-314-430,
  Jet Propulsion Laboratory, Pasadena, CA, 1987."
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 REFERENCE_DESC                     = "Planetary Data System
  Standards Reference, Jet Propulsion Laboratory Document D-7669,
  Part 2, 20 November 1992"
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 REFERENCE_KEY_ID                  = "PETTENGILL1988"
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  Venus Radar Mapper Science Experiment Plan of the Radar
  Investigation Group (RADIG), MIT/JPL, 1988."
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 REFERENCE_DESC                    = "Pettengill, G. H., P.G.
  Ford, W.T.K. Johnson, R.K. Raney, L.A. Soderblom, Magellan:
  Radar Performance and Data Products, Science, V. 252, pp. 260 -
  265, 1991"
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 REFERENCE_DESC                    = "Pettengill, G. H., P.G.
  Ford, and R.J. Wilt, Venus Surface Radiothermal Emission as
  Observed by Magellan, Journal of Geophysical Research, 13091-
  13102, 1992."
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 REFERENCE_DESC                    = "Phillips, R. J., R.E.
  Arvidson, J.M. Boyce, D.B. Campbell, J.E. Guest, G.G. Schaber,
  L.A. Soderblom, Impact craters on Venus: Initial Analysis from
  Magellan, Science, V. 252, pp. 288 - 297, 1991"
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 REFERENCE_KEY_ID                  = "PLAUT&ARVIDSON1992"
 REFERENCE_DESC                    = "Plaut, J. J., and R.E.
  Arvidson,  Comparison of Goldstone and Magellan Radar Data in
  the Equatorial Plains of Venus, Journal of Geophysical
  Research, 97, 16279-16291, 1992"
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 REFERENCE_KEY_ID                  = "SAUNDERSETAL1990"
 REFERENCE_DESC                    = "Saunders, R.S., G.H.
  Pettengill, R.E. Arvidson, W.L. Sjogren, W.T.K. Johnson, L.
  Pieri, The Magellan Venus Radar Mapping Mission, Journal of
  Geophysical Research, 95, 8339-8355, 1990."
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 REFERENCE_KEY_ID                  = "SAUNDERS1991A"
 REFERENCE_DESC                    = "Saunders, R. S., R.E.
  Arvidson, J.W. Head III, G.G. Schaber, E.R. Stofan, and S.C.
  Solomon, An Overview of Venus Geology, Science, V. 252, pp. 249
  - 252, 1991"
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 REFERENCE_KEY_ID                  = "SAUNDERS1991B"
 REFERENCE_DESC                    = "Saunders, R. S., G.H.
  Pettengill, Magellan: Mission Summary, Science, V. 252, pp. 247
  - 249, 1991"
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 REFERENCE_KEY_ID                  = "SAUNDERSETAL1992"
 REFERENCE_DESC                    = "Saunders, R. S., A.J. Spear,
  P.C. Allin, R.S. Austin, A.L. Berman, R.C. Chandlee, J. Clark,
  A.V. deCharon, E.M. DeJong, D.G. Griffith, J.M. Gunn, S.
  Hensley, W.T.K. Johnson, C.E. Kirby, K.S. Leung, D.T. Lyons,
  G.A. Michaels, J. Miller, R.B. Morris, A.D. Morrison, R.G.
  Piereson, J.F. Scott, S.J. Shaffer, J.P. Slonski, E.R. Stofan,
  T.W. Thompson, and S.D. Wall, Magellan Mission Summary, Journal
  of Geophysical Research, 97, 13067-13090, 1992."
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 REFERENCE_KEY_ID                  = "SCHABERETAL1992"
 REFERENCE_DESC                    = "Schaber, G.G., R.G. Strom,
  H.J. Moore, L.A. Soderblom, R.L. Kirk, D.J. Chadwick, D.D.
  Dawson, L.R. Gaddis, J.M. Boyce, and J. Russell, Geology and
  Distribution of Impact Craters on Venus: What Are They Telling
  Us?  Journal of Geophysical Research, 97, 13257-13301, 1992."
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 REFERENCE_KEY_ID                  = "SCIEDR"
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  Interface Specification: Magellan Science EDR (TPS-101), 30
  January 1991"
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 REFERENCE_DESC                    = "Project Magellan Software
  Interface Specification: Full-Resolution Basic Image Data
  Record, Revision E, 31 August 1992"
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 REFERENCE_KEY_ID                  = "SE011"
 REFERENCE_DESC                    = "Magellan Project Radar
  System: Analysis Methods and Performance Estimates, Hughes
  Aircraft Co. Report HS513-062-49, July 1989"
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 REFERENCE_KEY_ID                  = "SJOGRENETAL1983"
 REFERENCE_DESC                    = "Sjogren, W.L., B.G. Bills,
  P.W. Birkeland, P.B. Espsoito, A.R. Konopliv, N.A. Mottinger,
  R.J. Phillips and S.J. Ritke, Venus Gravity Anomalies and Their
  Correlations with Topography, Journal of Geophysical Research,
  88, 1119-1128, 1983."
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 REFERENCE_KEY_ID                  = "SJOGRENETAL1984"
 REFERENCE_DESC                    = "Sjogren, W.L., B.G. Bills and
  N.A. Mottinger, Venus: Ishtar Gravity Anomaly, Geophysical Research
  Letters, 11, 489-491, 1984"
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 REFERENCE_KEY_ID                  = "SNYDER1987"
 REFERENCE_DESC                    = "Snyder, John P., Map
  Projections -- A Working Manual, U. S. Geol. Surv. Professional
  Paper 1395, 383p., 1987."
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 REFERENCE_KEY_ID                  = "SOLOMON1991A"
 REFERENCE_DESC                    = "Solomon, S. C., J.W. Head,
  W.M. Kaula, D. McKenzie, B. Parsons, R.J. Phillips, G.
  Schubert, and M. Talwani, Venus Tectonics: Initial Analysis
  from Magellan, Science, V. 252, pp. 297 - 312, 1991"
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 REFERENCE_KEY_ID                  = "SOLOMON1991B"
 REFERENCE_DESC                    = "Solomon, S. C., J.W. Head,
  Fundamental Issues in the Geology of Venus, Science, V. 252,
  pp. 252 - 260, 1991"
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 REFERENCE_KEY_ID                  = "SOLOMONETAL1992"
 REFERENCE_DESC                    = "Solomon, S.C., S.E. Smrekar,
  D.L. Bindschadler, R.E. Grimm, W.M. Kaula, G.E. McGill, R.J.
  Phillips, R.S. Saunders, G. Schubert, S.W. Squyres, and E.R.
  Stofan, Venus Tectonics: An Overview of Magellan Observations,
  Journal of Geophysical Research, 97, 13199-13255, 1992, and
  Journal of Geophysical Research, 97, 16381, 1992."
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 REFERENCE_KEY_ID                  = "TYLER1991"
 REFERENCE_DESC                    = "Tyler, G. L., P.G. Ford,
  D.B. Campbell, C. Elachi, G.H. Pettengill, R.A. Simpson,
  Magellan: Electrical and Physical Properties of Venus' Surface,
  Science, V. 252, pp. 265 - 270, 1991"
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 REFERENCE_DESC                    = "Tyler, G. L., G. Balmino,
  D.P. Hinson, W.L. Sjogren, D.E. Smith, R. Woo, S.W. Asmar, M.J.
  Connally, C.L. Hamilton, and R.A. Simpson, Radio Science
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  Research, 97, 7759-7779, 1992"
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "TYLER1992"
 REFERENCE_DESC                   = "Tyler, G. L., R.A. Simpson,
  M.J. Maurer, and E. Holmann, Scattering Properties of the
  Venusian Surface: Preliminary Results from Magellan, Journal of
  Geophysical Research, 97, 13115-13139, 1992"
END_OBJECT                        = REFERENCE

OBJECT                            = REFERENCE
 REFERENCE_KEY_ID                 = "VRMPP1983"
 REFERENCE_DESC                   = "Venus Radar Mapper Project
  Plan, Document 630-1, JPL D-814, 157 pp., Jet Propulsion
  Laboratory, Pasadena, Calif., 1983."
END_OBJECT                        = REFERENCE

END
```

### B.13. RDRSINST.CAT Example

```
CCSD3ZF0000100000001NJPL3IF0PDSX00000001

PDS_VERSION_ID                    = PDS3

OBJECT                            = INSTRUMENT
 INSTRUMENT_HOST_ID               = "MGN"
 INSTRUMENT_ID                    = "RDRS"

 OBJECT                           = INSTRUMENT_INFORMATION
  INSTRUMENT_NAME                 = "RADAR SYSTEM"
  INSTRUMENT_TYPE                 = "RADAR"
  INSTRUMENT_DESC                 = "

    Instrument Specifications
    =========================
      The radar was manufactured by Hughes Aircraft Company and the
      'build date' is taken to be 1989-01-01.  The radar dimensions
      were 0.304 by 1.35 by 0.902 (height by length by width in
      meters) and the mass was 126.1 kg.

      Instrument Id                 : RDRS
      Instrument Host Id            : MGN
      Pi Pds User Id                : GPETTENGILL
      Instrument Name               : RADAR SYSTEM
      Instrument Type               : RADAR
      Build Date                    : 1989-01-01
      Instrument Mass               : 126.100000
      Instrument Length             : 1.350000
      Instrument Width              : 0.902000
      Instrument Height             : 0.304000
      Instrument Manufacturer Name  : HUGHES AIRCRAFT

      For more information on the radar system see the papers by
      [JOHNSON1990] and [SAUNDERSETAL1990].
```

## Instrument Overview

The Magellan radar system included a 3.7 m diameter high gain antenna (HGA) for SAR and radiometry and a smaller fan-beam antenna (ALTA) for altimetry. The system operated at 12.6 cm wavelength. Common electronics were used in SAR, altimetry, and radiometry modes. The SAR operated in a burst mode; altimetry and radiometry observations were interleaved with the SAR bursts.

Between SAR bursts (typically several times a second) groups of altimeter pulses were transmitted from a dedicated fan-beam altimeter antenna directed toward the spacecraft's nadir. The altimeter pulses were identical in waveform and bandwidth to the SAR pulses, resulting in a range accuracy of better than 15 m. The pulse-repetition rate and burst duration differed between the two modes.

Radiometry data were obtained by spending a portion of the time between SAR bursts and after altimeter operation in a passive (receive-only) mode, with the HGA antenna capturing the microwave thermal emission from the planet. Noise power within the 10-MHz receiver bandwidth was detected and accumulated for 50 ms. To reduce the sensitivity to receiver gain changes in this mode, the receiver was connected on alternate bursts first to a comparison dummy load at a known physical temperature and then to the HGA. The short-term temperature resolution was about 2 K; the long-term absolute accuracy after calibration was about 20 K.

## Science Objectives

See MISSION_OBJECTIVES_SUMMARY under MISSION.

## Operational Considerations

The Magellan radar system was used to acquire radar back-scatter (SAR) images, altimetry, and radiometry when the spacecraft was close to the planet. Nominal operation extended from about 20 minutes before periapsis until about 20 minutes after periapsis. In the SAR mode output from the radar receiver was sampled, blocks of samples were quantized using an adaptive procedure, and the results were stored on tape. In the altimetry mode samples were recorded directly, without quantization. Radiometry measurements were stored in the radar header records. During most of the remainder of each orbit, the HGA was pointed toward Earth and the contents of the tape recorder were transmitted to a station of the DSN at approximately 270 kilobits/second. SAR, altimetry, and radiometry data were then processed using ground software into images, altimetry profiles, estimates of backscatter coefficient, emissivity, and other quantities.

```
Calibration Description
=======================
  The radar was calibrated before flight using an active
  electronic target simulator [CUEVAS1989].


Platform Mounting Descriptions
==============================
  The spacecraft +Z axis vector was in the nominal direction of
  the HGA boresight.  The +X axis vector was parallel to the
  nominal rotation axis of the solar panels.  The +Y axis vector
  formed a right-handed coordinate system and was in the nominal
  direction of the star scanner boresight.  The spacecraft
  velocity vector was in approximately the -Y direction when the
  spacecraft was oriented for left-looking SAR operation.  The
  nominal HGA polarization was linear in the y-direction.

  Cone Offset Angle             : 0.00
  Cross Cone Offset Angle       : 0.00
  Twist Offset Angle            : 0.00

  The altimetry antenna boresight was in the x-z plane 25 degrees
  from the +Z direction and 65 degrees from the +X direction.  The
  altimetry antenna was aimed approximately toward nadir during
  nominal radar operation.  The altimetry antenna polarization was
  linear in the y-direction.

  The medium gain antenna boresight was 70 degrees from the +Z
  direction and 20 degrees from the -Y direction.  The low gain
  antenna was mounted on the back of the HGA feed; it's boresight
  was in the +Z direction and it had a hemispherical radiation
  pattern.


Principal Investigator
======================
  The Principal Investigator for the radar instrument was Gordon
  H. Pettengill.


Instrument Section / Operating Mode Descriptions
================================================
  The Magellan radar system consisted of the following sections,
  each of which operated in the following modes:

  Section      Mode
  -------------------------------------------
  SAR          Synthetic Aperture Radar (SAR)
  ALT          Altimetry
  RAD          Radiometry


  (1) SAR Characteristics
  -----------------------
    In the Synthetic Aperture Radar mode, the radar transmitted
```

```
  bursts of phase-modulated pulses through its high gain
  antenna.  Echo signals were captured by the antenna, sampled
  at the receiver output, and stored on tape after being
  quantized to reduce data volume.  Pulse repetition rate and
  incidence angle were chosen to meet a minimum signal-to-noise
  ratio requirement (8 dB) for image pixels after ground
  processing.  Multiple looks were used in processing to reduce
  speckle noise.  Incidence angles varied from about 13 degrees
  at the pole to about 44 degrees at periapsis during normal
  mapping operations (e.g., Cycle 1); but other 'look angle
  profiles' were used during the mission.

  Peak transmit power                 : 350 watts
  Transmitted pulse length            : 26.5 microsecs
  Pulse repetition frequency          : 4400-5800 per sec
  Time bandwidth product              : 60
  Inverse baud width                  : 2.26 MHz
  Data quantization (I and Q)         : 2 bits each
  Recorded data rate                  : 750 kilobits/sec
  Polarization (nominal)              : linear horizontal
  HGA half-power full beam width      : 2.2 deg (azimuth)
                                      : 2.5 deg (elev)
      one-way gain (from SAR RF port) : 35.7 dBi
  System temperature (viewing Venus)  : 1250 K
  Surface resolution (range)          : 120-360 m
                     (along track)    : 120-150 m
  Number of looks                     : 4 or more
  Swath width                         : 25 km (approx)
  Antenna look angle                  : 13-47 deg
  Incidence angle on surface          : 18-50 deg

  Data Path Type                      : RECORDED DATA
                                          PLAYBACK
  Instrument Power Consumption        : UNK


(2) ALT Characteristics
-----------------------
  After SAR bursts (typically several times a second) groups of
  altimeter pulses were transmitted from a dedicated fan beam
  altimeter antenna (ALTA) directed toward the spacecraft's
  nadir.  Output from the radar receiver was sampled, and the
  samples were stored on tape for transmission to Earth.  During
  nominal left-looking SAR operation the ALTA pointed
  approximately 20 deg to the left of the spacecraft ground
  track at periapsis and about 10 deg to the right of the ground
  track near the north and south pole.

  Data quantization (I and Q)           : 4 bits each
  Recorded data rate                    : 35 kbs
  Polarization                          : linear
  ALTA half-power full beamwidth
                         (along track): 11 deg
                         (cross track): 31 deg
       one-way gain referenced to
```

```
                          ALT RF port : 18.9 dBi
  ALTA offset from HGA                : 25 deg
  Burst interval                      : 0.5-1.0 sec
        duration                      : 1.0 millisec
  Dynamic range                       : 30 dB (or more)

  Data Path Type                      : RECORDED DATA
                                          PLAYBACK
  Instrument Power Consumption        : UNK


(3) RAD Characteristics
-----------------------
  Radiometry measurements were made by the radar receiver and
  HGA in a receive-only mode that was activated after the
  altimetry mode to record the level of microwave radiothermal
  emission from the planet.  Noise power within the 10-MHz
  receiver bandwidth was detected and accumulated for 50 ms.  To
  reduce the sensitivity to receiver gain changes in this mode,
  the receiver was connected on alternate bursts first to a
  comparison dummy load at a known physical temperature and then
  to the HGA.  The short-term temperature resolution was about 2
  K; the long-term absolute accuracy after calibration was about
  20 K.  At several times during the mission, radiometry
  measurements were carried out using known cosmic radio
  sources.

  Receiver Bandwidth                  : 10 MHz
  Integration Time                    : 50 millisecs
  Polarization (nominal)              : linear horizontal
  Data Quantization                   : 12 bits
  Data Rate                           : 10-48 bits/sec
  HGA half-power full beam width      : 2.2 deg
  System temperature (viewing Venus)  : 1250 K
  Antenna look angle                  : 13-47 deg
  Incidence angle on surface          : 18-50 deg
  Surface resolution (along track)    : 15-120 km
                     (cross track)    : 20-125 km

  Data Path Type                : RECORDED DATA PLAYBACK
  Instrument Power Consumption  : UNK "

END_OBJECT                     = INSTRUMENT_INFORMATION

OBJECT                         = INSTRUMENT_REFERENCE_INFO
 REFERENCE_KEY_ID              = "CUEVAS1989"
END_OBJECT                     = INSTRUMENT_REFERENCE_INFO

OBJECT                         = INSTRUMENT_REFERENCE_INFO
 REFERENCE_KEY_ID              = "JOHNSON1990"
END_OBJECT                     = INSTRUMENT_REFERENCE_INFO

OBJECT                         = INSTRUMENT_REFERENCE_INFO
 REFERENCE_KEY_ID              = "SAUNDERSETAL1990"
END_OBJECT                     = INSTRUMENT_REFERENCE_INFO
```

```
END_OBJECT                              = INSTRUMENT

END
```