Appendix B. Complete PDS Catalog Object Set

This appendix provides a complete set of the PDS catalog objects. Each section includes a description of the object, lists of keywords and sub-objects, guidelines to follow in assigning values, and a specific example of the object. The catalog objects provide high-level information suitable for loading a database to facilitate searches across data sets, collections and volumes.

The catalog objects included on a PDS volume also provide local, high-level documentation. The full set of catalog objects is required in the CATALOG directory of every PDS archive volume. See the *File Specification and Naming* chapter of this document for pointer and file names used with catalog objects.

Not every object described in this section is required in all cases. A PDS Central Node Data Engineer will supply a set of blank catalog object templates to be completed for any specific delivery, and can also supply additional examples if desired.

Description Field Formatting

The examples in the following sections conform to the current recommendations with respect to format and content. Lines in descriptive text fields (DATA_SET_DESC, INSTRUMENT_DESC, etc.) should not exceed 80 characters, including the <CR><LF> line delimiters. The underlining convention for headings and subheadings provide organization levels for human readers and auto-formatting routines:

Heading	Heading Indent	Text Indent	Underscoring Character
Primary	2 characters	4 characters	=
Secondary	4 characters	6 characters	–

Primary, or main, headings are double-underlined through the use of the equal-sign key (=) which corresponds to ASCII decimal 61. Secondary, or subheadings, are single-underlined through the use of the hyphen key (-) which corresponds to ASCII decimal 45. This underlining convention enhances legibility, and in the future will facilitate the creation of hypertext links.

Also, PDS has adopted a convention for indenting primary headings, secondary headings, and textual descriptions to facilitate readability and to make a better presentation. Primary headings start at Column 3. Text under primary headings and secondary headings starts at Column 5. Text under secondary headings starts at Column 7.

Again for ease of readability, there should be 2 blank lines before the start of a primary or secondary heading. If a secondary heading immediately follows a primary heading, then only 1 blank line should separate the secondary heading from the primary heading.

PDS has developed a Windows based program (FORMAT70) that will automatically format the description fields of any catalog template.

Following is a template layout for a DATA_SET_DESC field. This example assumes the keyword DATA_SET_DESC itself starts in the first byte.

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890123456789012

DATA_SET_DESC                  = "
(blank line)
(blank line)
  Primary Heading - starts at Column 3
  ====================================
    Text under headings start at Column 5
    more text starting at Column 5...
(blank line)
(blank line)
     Secondary Heading - starts at Column 5
    --------------------------------------
      Text under subheadings start at Column 7
      more text starting at Column 7...
(blank line)
(blank line)
  Primary Heading - starts at Column 3
  ====================================
(blank line)
    Secondary Heading - starts at Column 5
    --------------------------------------
      Text under subheadings start at Column 7
      more text starting at Column 7...
```

Order of Keywords and Sub-Objects

The examples in the following sections illustrate the preferred ordering for keywords and sub-objects. The order used provides a logical flow that makes the catalog files somewhat easier for a human reader to follow.

Chapter Contents

B.1 DATA_SET

The DATA_SET catalog object is used to submit information about a data set to the PDS. The DATA_SET object includes a free-form text description of the data set as well as sub-objects for identifying associated targets, hosts, and references.

B.1.1 Required Keywords

1. DATA_SET_ID

B.1.2 Optional Keywords

None

B.1.3 Required Objects

1. DATA_SET_HOST
2. DATA_SET_INFORMATION
3. DATA_SET_REFERENCE_INFORMATION
4. DATA_SET_TARGET
5. DATA_SET_MISSION

B.1.4 Optional Objects

None

B.1.5 Usage Notes

One DATA_SET_INFORMATION catalog object must be completed for each data set. One DATA_SET_TARGET catalog object must be completed for each target associated with the data set. That is, if there is more than one target, this object is repeated. Similarly, one DATA_SET_HOST catalog object must be completed for each host/instrument pair associated with the data set, and one DATA_SET_REFERENCE_INFORMATION catalog object is required for each individual reference associated with the data set. All references should be included that are relevant to providing more detailed / specific data set information; such as, description of the data set, calibration procedures, processing software, data set documentation, review results, etc. These references may include published articles, books, papers, electronic publications, etc.

Note that the DATA_SET_TARGET, DATA_SET_HOST and DATA_SET_REFERENCE objects associate a particular target, host or reference ID with the data set, but do not themselves define the attributes of the corresponding target, host or reference. For each new ID referenced in one of these fields, a high-level description must be provided in the corresponding catalog object. For example, if the REFERENCE_KEY_ID listed in a DATA_SET_REFERENCE object does not already exist, a new REFERENCE object, defining that REFERENCE_KEY_ID, must also be submitted with the delivery. The Central Node data engineers can assist in locating existing catalog objects that may be referenced in any of the above fields.

B.1.6 Example

```
/* Template: Data Set Template                                    Rev: 1993-09-24  */
/*                                                                                  */
/* Note: Complete one for each data set. Identify multiple targets associated with */
/* the data set by repeating the 3 lines for the DATA_SET_TARGET object.           */
/* Identify multiple hosts associated with the data set by repeating the 4 lines   */
/* for the DATA_SET_HOST object. Identify multiple references associated           */
/* with the data set by repeating the 3 lines of the                               */
/* DATA_SET_REFERENCE_INFORMATION object.                                          */

/* Hierarchy:   DATA_SET                                                           */
/*              DATA_SET_INFORMATION                                               */
/*              DATA_SET_TARGET                                                    */
/*              DATA_SET_HOST                                                      */
/*              DATA_SET_REFERENCE_INFORMATION                                     */

PDS_VERSION_ID                       = PDS3
LABEL_REVISION_NOTE                  = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                          = STREAM

OBJECT                               = DATA_SET
  DATA_SET_ID                        = "MGN-V-RDRS-5-GVDR-V1.0"

  OBJECT                             = DATA_SET_INFORMATION
    DATA_SET_NAME                    = "MGN V RDRS DERIVED GLOBAL VECTOR DATA RECORD V1.0"
    DATA_SET_COLLECTION_MEMBER_FLG   = "N"
    DATA_OBJECT_TYPE                 = TABLE
    START_TIME                       = 1990-08-01T00:00:00
    STOP_TIME                        = 1993-12-31T23:59:59
    DATA_SET_RELEASE_DATE            = 1994-07-01
    PRODUCER_FULL_NAME               = "MICHAEL J. MAURER"
    DETAILED_CATALOG_FLAG            = "N"
    DATA_SET_TERSE_DESC              = "The Global Vector Data Record (GVDR)
                                         is a sorted collection of scattering and
                                         emission measurements from the Magellan
                                         Mission"
    ABSTRACT_DESC                    = "The Global Vector Data Record (GVDR) is a sorted
                                        collection of scattering and emission measurements from
                                        the Magellan Mission.  The sorting is into a grid of
                                        equal area ‘pixels’ distributed regularly about the
                                        planet.  For data acquired from the same pixel but in
                                        different observing geometries, there is a second level
                                        of sorting to accommodate the different geometrical
                                        conditions.  The ‘pixel’ dimension is 18.225 km.  The
                                        GVDR is presented in Sinusoidal Equal Area (equatorial),
                                        Mercator (equatorial), and Polar Stereographic (polar)
                                        projections.

                                        The GVDR is intended to be the most systematic and
                                        comprehensive representation of the electromagnetic
                                        properties of the Venus surface that can be derived from
                                        Magellan data at this resolution.  It should be useful
                                        in characterizing and comparing distinguishable surface
                                        units."
    CITATION_DESC                    = "Maurer, M.J., MGN V RDRS DERIVED GLOBAL VECTOR
```

```
                                        DATA RECORD V1.0, MGN-V-RDRS-5-GVDR-V1.0, NASA
                                        Planetary Data System, 1994."
  DATA_SET_DESC                     = "
```

Data Set Overview
=================

The Global Vector Data Record (GVDR) is a sorted collection of scattering and emission measurements from the Magellan Mission.The sorting is into a grid of equal area 'pixels' distributed regularly about the planet. For data acquired from the same pixel but in different observing geometries, there is a second level of sorting to accommodate the different geometrical conditions. The 'pixel' dimension is 18.225 km. The GVDR is presented in Sinusoidal Equal Area (equatorial), Mercator (equatorial), and Polar Stereographic (polar) projections.

The GVDR is intended to be the most systematic and comprehensive representation of the electromagnetic properties of the Venus surface that can be derived from Magellan data at this resolution. It should be useful in characterizing and comparing distinguishable surface units.

Parameters
==========

The Magellan data set comprises three basic data types: echoes from the nadir-viewing altimeter (ALT), echoes from the oblique backscatter synthetic aperture radar (SAR) imaging system, and passive radio thermal emission measurements made using the SAR equipment. The objective in compiling the GVDR is to obtain an accurate estimate of the surface backscattering function (sometimes called the specific backscatter function or 'sigma-zero') for Venus from these three data types and to show its variation with incidence (polar) angle, azimuthal angle, and surface location.

The ALT data set has been analyzed to yield profiles of surface elevation [FORD&PETTENGILL1992] and estimates of surface Fresnel reflectivity and estimates of meter-scale rms surface tilts by at least two independent methods [FORD&PETTENGILL1992;TYLER1992]. The 'inversion' approach of [TYLER1992] provides, in addition, an empirical estimate of the surface backscatter function at incidence angles from nadir to as much as 10 degrees from nadir in steps of 0.5 degrees.

Statistical analysis of SAR image pixels for surface regions about 20 km (across track) by 2 km (along track) provided estimates of the surface backscatter function over narrow angular ranges (1-4 degrees) between 15 and 50 degrees from normal incidence [TYLER1992]. By combining results from several orbital passes over the same region in different observing geometries, the backscatter response over the full oblique angular range (15-50) could be compiled. In fact, the number of independent observing geometries attempted with Magellan was limited, and some of these represented changes in azimuth rather than changes in incidence (or polar) angle. Nevertheless, data from many regions were collected in more than one SAR observing geometry. Histograms of pixel values and quadratic fits to the surface backscattering function over narrow ranges of incidence angle were computed by [TYLER1992].

Passive microwave emission by the surface of Venus was measured by the Magellan radar receiver between ALT and SAR bursts. These measurements have been converted to estimates of surface emissivity [PETTENGILLETAL1992]. With certain assumptions the emissivity derived from these data should be the complement of the Fresnel reflectivity derived from the ALT echo strengths.In cases where the two quantities do not add to unity, the assumptions about a simple dielectric (Fresnel) interface at the surface of Venus must be adjusted.

Processing
==========

The processing carried out at the Massachusetts Institute of Technology (MIT) to obtain altimetry profiles and estimates of Fresnel reflectivity and rms surface tilts has been described elsewhere [FORD&PETTENGILL1992]. In brief it involves fitting pre-computed templates to measured echo profiles; the topographic profiles, Fresnel reflectivities, and rms surface tilts are chosen to minimize differences between the data and templates in a least-squares sense. The estimates of emissivity require calibration of the raw data values and correction for attenuation and emission by the Venus atmosphere [PETTENGILLETAL1992]. These data have been collected by orbit number on a set of compact discs [FORD1992] and into a set of global maps, also distributed on compact disc [FORD1993].

At Stanford ALT-EDR tapes were the input for calculation of near-nadir empirical backscattering functions. For oblique backscatter, C-BIDR tapes from the Magellan Project and F-BIDR files obtained via Internet from Washington University were the input products. Output was collected on an orbit-by-orbit basis into a product known as the Surface Characteristics

Vector Data Record (SCVDR). The SCVDR has been delivered to the Magellan Project for orbits through 2599; processing of data beginning with orbit 2600 and continuing through the end-of-Mission is spending completion of the first version of the GVDR.

Data
====

The GVDR data set comprises several 'tables' of results based on analysis of each of the data types described above. These include:

(1) Image Data Table
(2) Radiometry Data Table
(3) MIT ALT Data Table
(4) Stanford ALT Data Table

(1) Image Data Table
This table contains results from analysis of SAR image strips.The results are parameterized by the azimuth angle, the incidence (polar) angle, and the polarization angle. Quantities include the number of image frame lets used to compute the scattering parameters; the median, the mode, and the one-standard-deviation limits of the pixel histogram; and the three coefficients and the reference angle of the quadratic approximation to sigma-zero as a function of incidence angle.

(2) Radiometry Data Table
This table contains results from MIT analysis of the radiometry data. The results are parameterized by the azimuth angle, the incidence angle, and the polarization angle. The results include the number of radiometry footprints used to compute the estimate of thermal emissivity, the emissivity, and its variance.

(3) MIT ALT Data Table
This table contains results derived from the MIT altimetry data analysis. The results include the number of ARCDR ADF footprints used in computing the estimates of scattering properties for the pixel and estimates (and variances) of radius, rms surface tilt, and Fresnel reflectivity from the ARCDR.

(4) Stanford ALT Data Table
This table contains results from the Stanford analysis of altimetry data. Results include the number of SCVDR footprints used in computing the estimates of surface properties for this pixel, the centroid of the Doppler spectrum, the derived scattering function and the angles over which it is valid, variance of the individual points in the derived scattering function, and results of fitting analytic functions to the derived scattering function.

Ancillary Data
==============

Ancillary data for most processing at both MIT and Stanford was obtained from the data tapes and files received from the Magellan Project. These included trajectory and pointing information for the spacecraft, clock conversion tables, spacecraft engineering data, and SAR processing parameters. For calibration of the radar instrument itself, Magellan Project reports (including some received from Hughes Aircraft Co.[BARRY1987; CUEVAS1989; SE011]) were used. Documentation on handling of data at the Jet Propulsion Laboratory was also used [BRILL&MEISL1990; SCIEDR; SDPS101].

Coordinate System
=================

The data are presented in gridded formats, tiled to ensure that closely spaced points on the surface occupy nearby storage locations on the data storage medium. Four separate projections are used: sinusoidal equal area and Mercator for points within 89 degrees of the equator, and polar stereographic for points near the north and south poles. The projections are described by [SNYDER1987]; IAU conventions described by [DAVIESETAL1989] and Magellan Project assumptions [LYONS1988] have been adopted.

Software
========

A special library and several example programs are provided in source code form for reading the GVDR data files. The general-purpose example program will serve the needs of the casual user by accessing a given GVDR quantity over a specified region of GVDR pixels. More advanced users may want to write their own programs that use the GVDR library as a toolkit. The library, written in ANSI C, provides concise access methods for reading every quantity stored in the GVDR. It conveniently handles all geometric and tiling transformations and converts any compressed qualities to a standard native format. The general purpose program mentioned above provides an example of how to use this library.

Media/Format
============

The GVDR will be delivered to the Magellan Project (or its successor) using compact disc write once (CD-WO) media. Formats will be based on standards for such products established by the Planetary Data System (PDS) [PDSSR1992]."

CONFIDENCE_LEVEL_NOTE = "

Confidence Level Overview
=========================

The GVDR is intended to be the most systematic and comprehensive representation of the electromagnetic properties of the Venus surface that can be derived from Magellan data at this resolution. Nevertheless, there are limitations to what can be done with the data.

Review
======

The GVDR will be reviewed internally by the Magellan Project prior to release to the planetary community. The GVDR will also be reviewed by PDS.

Data Coverage and Quality
=========================

Because the orbit of Magellan was elliptical during most of its mapping operations, parts of the orbital coverage have higher resolution and higher signal-to-noise than others.

Cycle 1 Mapping

During Mapping Cycle 1, periapsis was near 10 degrees N latitude at altitudes of approximately 300 km over the surface. The altitude near the poles, on the other hand, was on the order of 3000 km. For all data types this means lower confidence in the results obtained at the poles than near the equator.

Further, the spacecraft attitude was adjusted so that the SAR antenna was pointed at about 45 degrees from nadir near periapsis; this was reduced to near 15 degrees at the poles.The objective was to compensate somewhat for the changing elevation and to provide scattering at higher incidence angles when the echo signal was expected to be strongest. The ALT antenna, at a constant 25 degree offset from the SAR antenna, followed in tandem but at angles which were not optimized for obtaining the best altimetry echo.

During Mapping Cycle 1 almost half the orbits provided SAR images of the north pole; because of the orbit inclination, ALT data never extended beyond about 85N latitude in the north and 85S in the south. No SAR images of the south pole were acquired during Mapping Cycle 1 because the SAR antenna was always pointed to the left of the ground track; the Cycle 1SAR image strip near the south pole was at a latitude equator ward of 85S.

Cycle 2 Mapping

During much of Mapping Cycle 2, the spacecraft was flown ‘backwards’ so as to provide SAR images of the same terrain but with ‘opposite side’ illumination. This adjustment also meant that the SAR could image near the Venus south pole (but not near the north pole). The ALT data continued to be limited to latitudes equator ward of 85N and 85S.

Cycle 3 Mapping

During Mapping Cycle 3 the emphasis was on obtaining SAR data from the same side as in Cycle 1 but at different incidence angles (for radar stereo). In fact, most data were acquired at an incidence angle of about 25 degrees, which meant that the ALT antenna was usually aimed directly at nadir instead of drifting from side to side, as had been the case in Cycle 1.These Cycle 3 data, therefore, may be among the best from the altimeter. Dynamic range in SAR data was larger than in Cycle1 because the incidence angle was fixed rather than varying to compensate for the changing spacecraft height.

All Cycles

It is important to remember that, since the SAR and ALT antennas were aimed at different parts of the planet during each orbit, building up a collection of composite scattering data for any single surface region requires that results from several orbits be integrated.

```
      In the case of data from polar regions, where only the SAR was able to probe, there will be
      no ALT data. When scheduling or other factors interrupted the systematic collection of
      data, there may be ALT data for some regions but no comparable SAR or radiometry data (or
      viceversa).

      Note that for all Cycles outages played an important role in determining coverage. For
      example, although a goal of Cycle 3 radar mapping was radar stereo, early orbits were used
      to collect data at nominal incidence angles that had been missed during Cycle 1 because of
      thermal problems with the spacecraft. A transmitter failure during Cycle 3 caused a loss of
      further data. It is not within the scope of this description to provide detailed
      information on data coverage.


  Limitations
  ===========
    Both the template fitting approach and the inversion approach will have their limitations in
    estimating overall surface properties for a region on Venus. The template calculation assumes
    that scattering is well-behaved at all incidence angles from 0 to 90 degrees and that a
    template representing that behavior can be constructed. The Hagfors function
    [HAGFORS1964]used by MIT, however, fails to give a finite rms surface tilt if used over this
    range of angles, so approximations based on a change in the scattering mechanism must be
    applied[HAGFORS&EVANS1968]. The inversion method [TYLER1992] is susceptible to noise at the
    higher incidence angles and this will corrupt solutions if not handled properly. Users of
    this data set should be aware that radar echoes are statistically variable and that each
    result has an uncertainty.

    A nominal nadir footprint can be assigned to altimetry results, but this footprint is biased
    near periapsis because the ALT antenna is rotated about 20 degrees from nadir (during Cycle
    1).Over polar regions in Cycle 1, the ALT antenna is rotated about 10 degrees to the opposite
    side of nadir. A more important consideration in polar regions is that the area illuminated
    by the ALT antenna is approximately 100 times as large as near periapsis because of the
    higher spacecraft altitude. The region contributing to echoes in polar regions -- and
    therefore the region over which estimates of Fresnel reflectivity and rms surface tilts apply
    -- is much larger than at periapsis."

  END_OBJECT                         = DATA_SET_INFORMATION

OBJECT                               = DATA_SET_MISSION
    MISSION_NAME                     = MAGELLAN
  END_OBJECT                         = DATA_SET_MISSION

  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.2 DATA_SET_COLL_ASSOC_DATA_SETS

The DATA_SET_COLL_ASSOC_DATA_SETS catalog object, a sub-object of the DATA_SET_COLLECTION object, is repeated for each data set associated with a DATA_SET_COLLECTION. For example, if there are three distinct data sets comprising a collection, this object will be repeated three different times – once for each data set.

B.2.1 Required Keywords

1. DATA_SET_ID

B.2.2 Optional Keywords

None

B.2.3 Required Objects

None

B.2.4 Optional Objects

None

B.2.5 Example

See the example of the DATA_SET_COLLECTION object in Section B.4.5.

B.3 DATA_SET_COLLECTION_REF_INFO

The DATA_SET_COLLECTION_REF_INFO catalog object, a sub-object of DATA_SET_COLLECTION object, associates a reference with a data set collection. It is repeated once for each reference identified in the DATA_SET_COLLECTION catalog object.

A separate REFERENCE catalog object must be completed to provide the associated citation for each reference.

B.3.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of “N/A”.

B.3.2 Optional Keywords

None

B.3.3 Required Objects

None

B.3.4 Optional Objects

None

B.3.5 Example

See the example for the DATA_SET_COLLECTION object in Section B.4.5.

B.4 DATA_SET_COLLECTION

The DATA_SET_COLLECTION catalog object is used to link several data sets as a collection to be used and distributed together.

B.4.1 Required Keywords

1. DATA_SET_COLLECTION_ID

B.4.2 Optional Keywords

None

B.4.3 Required Objects

1. DATA_SET_COLL_ASSOC_DATA_SETS
2. DATA_SET_COLLECTION_INFO
3. DATA_SET_COLLECTION_REF_INFO

B.4.4 Optional Objects

None

B.4.5 Usage Notes

One DATA_SET_COLLECTION_INFORMATION catalog object must be completed for each data set collection. One DATA_SET_COLLECTION_ASSOC_DATA_SETS catalog object must be completed for each data set associated with the data set collection. That is, if there is more than one data set, this object is repeated. Similarly, one DATA_SET_COLLECTION_REF_INFO catalog object is required for each individual reference associated with the data set collection. All references should be included that are relevant to providing more detailed / specific data set collection information; such as, description of the data set collection. These references may include published articles, books, papers, electronic publications, etc.

B.4.6 Example:

```
/* Template: Data Set Collection Template                   Rev: 1993-09-24      */

/* Note: Complete one template for each data set collection. Identify           */
/*       individual data sets that are included in the collection by            */
/*       repeating the 3 lines for the DATA_SET_COLL_ASSOC_DATA_SETS            */
/*       object. Identify each data set collection reference by                 */
/*       repeating the 3 lines for the DATA_SET_COLLECTION_REF_INFO object.     */
/*       Also complete a separate REFERENCE template for each new               */
/*       reference submitted to PDS.                                            */

/* Hierarchy:   DATA_SET_COLLECTION                                             */
/*              DATA_SET_COLLECTION_INFO                                        */
/*              DATA_SET_COLL_ASSOC_DATA_SETS                                   */
/*              DATA_SET_COLLECTION_REF_INFO                                    */

OBJECT                                  = DATA_SET_COLLECTION
  DATA_SET_COLLECTION_ID                = "PREMGN-E/L/H/M/V-4/5-RAD/GRAV-V1.0"

  OBJECT                                = DATA_SET_COLLECTION_INFO
    DATA_SET_COLLECTION_NAME            = "PRE-MGN E/L/H/M/V 4/5 RADAR/GRAVITY DATA V1.0"
    DATA_SETS                           = 15
    START_TIME                          = 1968-11-09T00:00:00
    STOP_TIME                           = 1988-07-27T00:00:00
    DATA_SET_COLLECTION_RELEASE_DT      = 1990-06-15
    PRODUCER_FULL_NAME                  = "RAYMOND E. ARVIDSON"
    DATA_SET_COLLECTION_DESC            = "


  Data Set Collection Overview
  ============================
    This entity is a collection of selected Earth-based radar data of Venus, the Moon, Mercury,
    and Mars, Pioneer Venus radar data, airborne radar images of Earth, and line of sight
    acceleration data derived from tracking the Pioneer Venus Orbiter and Viking Orbiter 2.
    Included are 12.6 centimeter wavelength Arecibo Venus radar images, 12.6 to 12.9cm Goldstone
    Venus radar images and altimetry data, together with altimetry, brightness temperature,
    Fresnel reflectivity and rms slopes derived from the Pioneer Venus Radar Mapper. For the
    Moon, Haystack 3.8 centimeter radar images and Arecibo 12.6 and 70 centimeter radar images
    are included. Mars data include Goldstone altimetry data acquired between 1971 and 1982 and
    araster data set containing radar units that model Goldstone and Arecibo backscatter
    observations. Mercury data consist of Goldstone altimetry files. The terrestrial data were
    acquired over the Pisgah lava flows and the Kelso dune field in the Mojave Desert,
    California, and consist of multiple frequency, multiple incidence angle views of the same
    regions. Data set documentation is provided, with references that allow the reader to
    reconstruct processing histories. The entire data set collection and documentation are
    available on a CD-ROM entitled Pre-Magellan Radar and Gravity Data."

  DATA_SET_COLLECTION_USAGE_DESC =                                  "


  Data Set Collection Usage Overview
  ==================================
    The intent of the data set collection is to provide the planetary science community with
    radar and gravity data similar to the kinds of data that Magellan will begin collecting in
    the summer of 1990. The data set collection will be used for pre- Magellan analyses of Venus
    and for comparisons to actual Magellan data. The entire data set collection and documentation
    are available on a CD-ROM entitled Pre-Magellan Radar and Gravity Data. A list of the
    hardware and software that may be used to read this CD-ROM can be obtained from the PDS
    Geosciences Discipline Node."

  END_OBJECT                            = DATA_SET_COLLECTION_INFO

  OBJECT                                = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                         = "NDC8-E-ASAR-4-RADAR-V1.0"
  END_OBJECT                            = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                         = "ARCB-L-RTLS-5-12.6CM-V1.0"
  END_OBJECT                            = DATA_SET_COLL_ASSOC_DATA_SETS
```

```
  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "ARCB-L-RTLS-4-70CM-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "ARCB-V-RTLS-4-12.6CM-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "ARCB-L-RTLS-3-70CM-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "GSSR-M-RTLS-5-ALT-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "GSSR-H-RTLS-4-ALT-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "GSSR-V-RTLS-5-12.6-9CM-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "HSTK-L-RTLS-4-3.8CM-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "ARCB/GSSR-M-RTLS-5-MODEL-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "P12-V-RSS-4-LOS-GRAVITY-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "P12-V-ORAD-4-ALT/RAD-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "P12-V-ORAD-5-RADAR-IMAGE-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "P12-V-ORAD-5-BACKSCATTER-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLL_ASSOC_DATA_SETS
    DATA_SET_ID                           = "VO2-M-RSS-4-LOS-GRAVITY-V1.0"
  END_OBJECT                              = DATA_SET_COLL_ASSOC_DATA_SETS

  OBJECT                                  = DATA_SET_COLLECTION_REF_INFO
    REFERENCE_KEY_ID                      = ARVIDSONETAL1990A
  END_OBJECT                              = DATA_SET_COLLECTION_REF_INFO

END_OBJECT                                = DATA_SET_COLLECTION
END
```

B.5 DATA_SET_COLLECTION_INFO

The DATA_SET_COLLECTION_INFO catalog object, a sub-object of DATA_SET_COLLECTION, provides an overview of content and usage, as well as other information specific to the data set collection. This object includes a free-form text description, DATA_SET_COLLECTION_DESC.

B.5.1 Required Keywords

1. DATA_SET_COLLECTION_DESC
2. DATA_SET_COLLECTION_NAME
3. DATA_SET_COLLECTION_RELEASE_DT
4. DATA_SET_COLLECTION_USAGE_DESC
5. DATA_SETS
6. PRODUCER_FULL_NAME
7. START_TIME
8. STOP_TIME

B.5.2 Optional Keywords

None

B.5.3 Required Objects

None

B.5.4 Optional Objects

None

B.5.5 Usage Notes

NOTE: The following paragraph headings and subheadings are recommended as the minimum set of headings needed to describe a data set collection adequately. Additional headings and sub-headings may be added as desired. Should any of the more common headings *not* appear within a text description, it will be considered not applicable to the data set collection.

B.5.5.1 DATA_SET_COLLECTION_INFO Headings

Data Set Collection Overview
A high-level description of the characteristics and properties of a data set collection

Data Set Collection Usage Overview
A high-level description of the intended use of a data set collection

B.5.6 Example

See the example of the DATA_SET_COLLECTION object in Section B.4.5.

B.6 DATA_SET_HOST

The DATA_SET_HOST catalog object, a sub-object of the DATA_SET catalog object, identifies one host/instrument pair associated with a data set.

B.6.1 Required Keywords

1. INSTRUMENT_HOST_ID
2. INSTRUMENT_ID

B.6.2 Optional Keywords

None

B.6.3 Required Objects

None

B.6.4 Optional Objects

None

B.6.5 Example

See the example for the DATA_SET object in Section B.1.6

B.7 DATA_SET_INFORMATION

The DATA_SET_INFORMATION catalog object, a sub-object of the DATA_SET catalog object, provides a high-level description of a single PDS data set.

B.7.1 Required Keywords

1. ABSTRACT_DESC
2. CITATION_DESC
3. CONFIDENCE_LEVEL_NOTE
4. DATA_OBJECT_TYPE
5. DATA_SET_COLLECTION_MEMBER_FLG
6. DATA_SET_DESC
7. DATA_SET_NAME
8. DATA_SET_RELEASE_DATE
9. DATA_SET_TERSE_DESC
10. DETAILED_CATALOG_FLAG
11. PRODUCER_FULL_NAME
12. START_TIME
13. STOP_TIME

B.7.2 Optional keywords

None

B.7.3 Required Objects

None

B.7.4 Optional Objects

None

B.7.5 Usage Notes

The DATA_SET_INFORMATION catalog object includes two free-form text description fields: DATA_SET_DESC and CONFIDENCE_LEVEL_NOTE. Following are recommended headings and subheadings for use in these fields, with brief descriptions of suggested contents.

Note: These headings and subheadings are recommended as the minimum set of headings needed to describe a data set adequately. Additional headings and sub-headings may be added as desired. Should any of the more common headings *not* appear within the description, they will be assumed to be not applicable to the data set.

B.7.5.1 DATA_SET_DESC Headings

Data Set Overview

A high level description of the characteristics and properties of a data set

Parameters

The primary parameters (measured or derived quantities) included in the data set, with units and sampling intervals

Processing

The overall processing used to produce the data set, including a description of the input data (and source), processing methods or software, and primary parameters or assumptions used to produce the data set

Data

Detailed description of each data type identified in the "Data Set Overview", (e.g., image data, table data, etc.)

Ancillary Data

Description of the ancillary information needed to interpret the data set. The ancillary information may or may not be provided along with the data set. If not, this description should include sources or references for locating the ancillary data.

Coordinate System

Description of the coordinate system(s) or frame(s) of reference to be used for proper interpretation of the data set

Software

Description of software relevant to the data, including software supplied with the data set as well as external software or systems that may be accessed independently to assist in visualization or analysis of the data

Media/Format

Description of the media on which the data set is delivered to PDS for distribution, including format information that may limit use of the data set on specific hardware platforms (e.g., binary/ASCII, IBM EBCDIC format)

B.7.5.2 CONFIDENCE_LEVEL_NOTE Headings

Confidence Level Overview

A high level description of the level of confidence (e.g., reliability, accuracy, or certainty) in the data

Review

Brief description of the review process that took place prior to release of the data set to insure the accuracy and completeness of the data and associated documentation

Data Coverage and Quality

Description of overall data coverage and quality. This section should include information about gaps in the data (both for times or regions) and details regarding how missing or poor data are flagged or filled, if applicable.

Limitations

Description of any limitations on the use of the data set. For example, discuss other data required to interpret the data properly, or any assumptions regarding special processing systems used to further reduce or analyze the data. If the data have been calibrated or otherwise corrected or derived, describe any known anomalies or uncertainties in the results.

B.7.5.3 CITATION_DESC Formation Rule

The CITATION_DESC keyword is subject to a formation rule described in detail in the CITATION_DESC element definition in the PDS Data Dictionary. A brief description is:

{ <author_name>, <author_name>, ... }, <data_set_name>, DATA_SET_ID,
NASA Planetary Data System, <year_of_peer_review>.

If a citation description is not defined, nor is applicable to the data set, the value "N/A" should be used.

B.7.5.4 OTHER - Data Supplier provided

Any other important information in addition to the headings above, as desired (e.g., data compression, time-tagging, etc.)

B.7.6 Example

See the example for the DATA_SET object in Section B.1.6.

B.8 DATA_SET_MAP_PROJECTION

The DATA_SET_MAP_PROJECTION catalog object is one of two distinct objects that together define the map projection used in creating the digital images in a PDS data set. The associated object that completes the definition is the IMAGE_MAP_PROJECTION, which is fully described in Appendix B.13 of this document.

The map projection information resides in these two objects essentially to reduce data redundancy and at the same time allow the inclusion of elements needed to process the data at the image level. Static information that is applicable to the complete data set resides in the DATA_SET_MAP_PROJECTION object while dynamic information that is applicable to the individual images resides in the IMAGE_MAP_PROJECTION object.

B.8.1 Required Keywords

1. DATA_SET_ID

B.8.2 Optional Keywords

None

B.8.3 Required Objects

1. DATA_SET_MAP_PROJECTION_INFO

B.8.4 Optional Objects

None

B.8.5 Example

```
PDS_VERSION_ID                          = PDS3
LABEL_REVISION_NOTE                     = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                             = FIXED_LENGTH
RECORD_BYTES                            = 80

SPACECRAFT_NAME                         = MAGELLAN
TARGET_NAME                             = VENUS

OBJECT                                  = DATA_SET_MAP_PROJECTION
  DATA_SET_ID                           = "MGN-V-RDRS-5-DIM-V1.0"

  OBJECT                                = DATA_SET_MAP_PROJECTION_INFO
    MAP_PROJECTION_TYPE                 = "SINUSOIDAL"
```

```
  MAP_PROJECTION_DESC                 = "

 Map Projection Overview
 =======================
  The FMAP (Magellan Full Resolution Radar Mosaic) is presented in a Sinusoidal Equal-Area map
  projection. In this projection, parallels of latitude are straight lines, with constant
  distances between equal latitude intervals. Lines of constant longitude on either side of the
  projection meridian are curved since longitude intervals decrease with the cosine of latitude
  to account for their convergence toward the poles. This projection offers a number of
  advantages for storing and managing global digital data; in particular, it is computationally
  simple, and data are stored in a compact form.

  The Sinusoidal Equal-Area projection is characterized by a projection longitude, which is the
  center meridian of the projection, and a scale, which is given in units of pixels/degree. The
  center latitude for all FMAP's is the equator. Each FMAP contains its own central meridian.
  The tiles that make up an FMAP all have the same central meridian as the FMAP.

  Lat/Lon, Line/Sample Transformations
  ------------------------------------
    The transformation from latitude and longitude to line and sample is given by the following
    equations:

    line = INT(LINE_PROJECTION_OFFSET - lat*MAP_RESOLUTION + 1.0)

    sample = INT(SAMPLE_PROJECTION_OFFSET - (lon -
             CENTER_LONGITUDE)*MAP_RESOLUTION*cos(lat) + 1.0)

    Note that integral values of line and sample correspond to center of a pixel. Lat and lon
    are the latitude and longitude of a given spot on the surface.

  Line Projection Offset
  ----------------------
    LINE_PROJECTION_OFFSET is the line number minus one on which the map projection origin
    occurs. The map projection origin is the intersection of the equator and the projection
    longitude. The value of LINE_PROJECTION_OFFSET is positive for images starting north of the
    equator and is negative for images starting south of the equator.

  Sample Projection Offset
  ------------------------
    SAMPLE_PROJECTION_OFFSET is the nearest sample number to the left of the projection
    longitude. The value of SAMPLE_PROJECTION_OFFSET is positive for images starting to the
    west of the projection longitude and is negative for images starting to the east of the
    projection longitude.

  Center Longitude
  ----------------
    CENTER_LONGITUDE is the value of the projection longitude,which is the longitude that
    passes through the center of the projection.

  The values for FMAP products will be 1408, 235, and 35.

  There are four PDS parameters that specify the latitude and longitude boundaries of an image.
  MAXIMUM_LATITUDE and MINIMUM_LATITUDE specify the latitude boundaries of the image,and
  EASTERNMOST_LONGITUDE and WESTERNMOST_LONGITUDE specify the longitudinal boundaries of the
  map.

  Definitions of other mapping parameters can be found in the Planetary Science Data
  Dictionary."

  ROTATIONAL_ELEMENT_DESC              = "See DAVIESETAL1989."

  OBJECT                              = DS_MAP_PROJECTION_REF_INFO
    REFERENCE_KEY_ID                  = "DAVIESETAL1989"
  END_OBJECT                          = DS_MAP_PROJECTION_REF_INFO

  OBJECT                              = DS_MAP_PROJECTION_REF_INFO
    REFERENCE_KEY_ID                  = "BATSON1987"
  END_OBJECT                          = DS_MAP_PROJECTION_REF_INFO

  OBJECT                              = DS_MAP_PROJECTION_REF_INFO
    REFERENCE_KEY_ID                  = "EDWARDS1987"
  END_OBJECT                          = DS_MAP_PROJECTION_REF_INFO
```

```
  END_OBJECT                                = DATA_SET_MAP_PROJECTION_INFO
END_OBJECT                                  = DATA_SET_MAP_PROJECTION

END
```

B.9 DATA_SET_MAP_PROJECTION_INFO

The DATA_SET_MAP_PROJECTION catalog object, a sub-object of DATA_SET_MAP_PROJECTION, defines the specific map projection of an image data set.

B.9.1 Required Keywords

1. MAP_PROJECTION_DESC
2. MAP_PROJECTION_TYPE
3. ROTATIONAL_ELEMENT_DESC

B.9.2 Optional Keywords

None

B.9.3 Required Objects

1. DS_MAP_PROJECTION_REF_INFO

B.9.4 Optional Objects

None

B.9.5 Usage notes

The MAP_PROJECTION_DESC text should contain at least one heading, "Map Projection Overview". This section should provide a description of the map projection of the data set, indicating mathematical expressions used for latitude/longitude or line/sample transformations, line and sample projection offsets, center longitudes, etc., as well as any assumptions made in processing. Subheadings may be used for each of these descriptions, if desired.

The ROTATIONAL_ELEMENT_DESC text should contain at least one heading, "Rotational Element Overview". This section should provide a description of the standard used for the definition of a planet's pole orientation and prime meridian, right ascension and declination, spin angle, etc. (Please see the *Planetary Science Data Dictionary* for complete description.) The value in this field may also be a bibliographic citation of a published work containing the rotation element description. In this case the "Rotational Element Overview" heading may be omitted.

An example of a DATA_SET_MAP_PROJECTION_INFO object may be found in the previous section detailing the DATA_SET_MAP_PROJECTION object.

B.9.6 Example

See the example for the DATA_SET_MAP_PROJECTION object in Section B.8.5.

B.10 DATA_SET_MISSION

The DATA_SET_MISSION object, a sub-object of DATA_SET catalog object, identifies an associated mission.

B.10.1 Required Keywords

1. MISSION_NAME

B.10.2 Optional Keywords

None

B.10.3 Required Objects

None

B.10.4 Optional Objects

None

B.10.5 Example

See the example for the DATA_SET object in Section B.1.6.

B.11 DATA_SET_REFERENCE_INFORMATION

The DATA_SET_REFERENCE_INFORMATION object, a sub-object of DATA_SET catalog object, is used to identify references relevant to a particular data set. . A separate object must be completed for each reference cited within the DATA_SET catalog object.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.11.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.11.2 Optional Keywords

None

B.11.3 Required Objects

None

B.11.4 Optional Objects

None

B.11.5 Example

See the example for the DATA_SET object in Section B.1.6.

B.12 DATA_SET_TARGET

The DATA_SET_TARGET object, a sub-object of DATA_SET catalog object, identifies an observed target.

B.12.1 Required Keywords

2. TARGET_NAME

B.12.2 Optional Keywords

None

B.12.3 Required Objects

None

B.12.4 Optional Objects

None

B.12.5 Example

See the example for the DATA_SET object in Section B.1.6.

B.13 DS_MAP_PROJECTION_REF_INFO

The DS_MAP_PROJECTION_REF_INFO object, a sub-object of DATA_SET_MAP_PROJECTION_INFO catalog object, is used to identify references relevant to a map projection. A separate object must be completed for each reference cited within the DATA_SET_MAP_PROJECTION_INFO catalog object.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.13.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.13.2 Optional Keywords

None

B.13.3 Required Objects

None

B.13.4 Optional Objects

None

B.13.5 Example

See the example for the DATA_SET_MAP_PROJECTION object in Section B.8.5.

B.14 IMAGE_MAP_PROJECTION

The IMAGE_MAP_PROJECTION object is one of two distinct objects that define the map projection used in creating cartographically registered digital images in a PDS data set. The other associated object that completes the definition is DATA_SET_MAP_PROJECTION (see Appendix B.8).

The map projection information resides in these two objects to reduce redundancy and at the same time to allow the inclusion of elements needed to process the data at the image level. Basically, static information that is applicable to the complete data set resides in the DATA_SET_MAP_PROJECTION object, while dynamic information that is applicable to the individual images resides in the IMAGE_MAP_PROJECTION object.

The LINE_FIRST_PIXEL, LINE_LAST_PIXEL, SAMPLE_FIRST_PIXEL, and SAMPLE_LAST_PIXEL keywords are used to indicate spatial orientation of a stored image. An image may have been shifted or flipped prior to being physically recorded. These keywords are used in calculating the mapping of pixels between the original image and the stored image.

The following equations give the byte offsets needed to determine the mapping of a pixel (X,Y) from the original image to a pixel in the stored image:

The sample offset from the first pixel is:

$$\frac{\text{SAMPLE\_BITS} * (\text{Y} - \text{SAMPLE\_FIRST\_PIXEL}) * \text{LINE\_SAMPLES}}{8 * (\text{SAMPLE\_LAST\_PIXEL} - \text{SAMPLE\_FIRST\_PIXEL} + 1)}$$

The line offset from the first image line is:

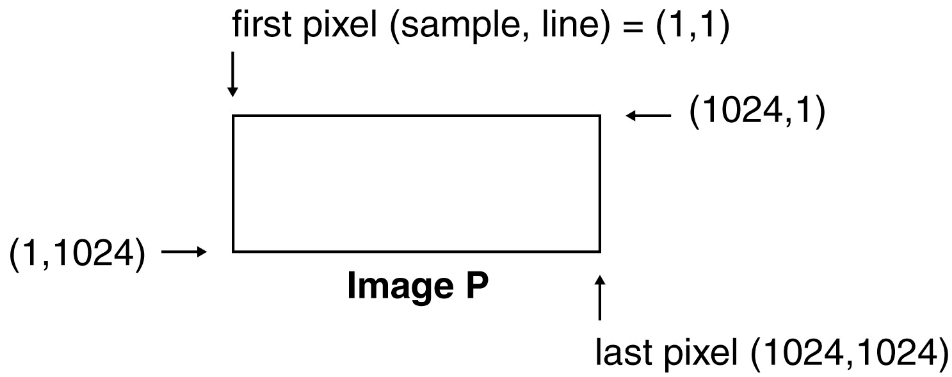
$$\frac{(\text{X} - \text{LINE\_FIRST\_PIXEL}) * \text{LINES}}{(\text{LINE\_LAST\_PIXEL} - \text{LINE\_FIRST\_PIXEL} + 1)}$$

Additionally, in any image, ABS (SAMPLE_LAST_PIXEL – SAMPLE_FIRST_PIXEL + 1) is always equal to LINE_SAMPLES, and ABS (LINE_LAST_PIXEL – LINE_FIRST_PIXEL + 1) is always equal to LINES.

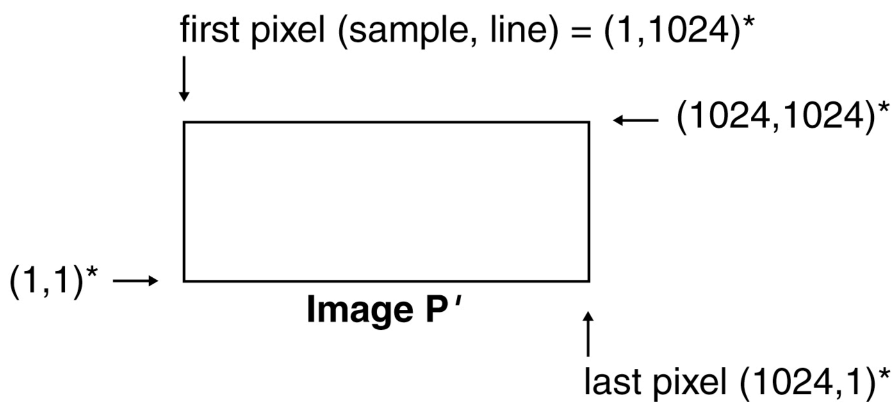
B.14.1 Example

Take a 1K by 1K 8-bit image which is rotated about the x-axis 180 degrees prior to being physically recorded.

Original Image: Positive direction is to the right and down



Stored Image: Positive direction is to the right and up



These pixel location values (*) are the positions from the original image. For example, the first pixel in the stored image (normally referred to as (1,1)) came from the position (1,1024) in the original image. These original values are used for the following IMAGE_MAP_PROJECTION keywords in the PDS label for the stored image:

```
SAMPLE_FIRST_PIXEL = 1
SAMPLE_LAST_PIXEL  = 1024
LINE_FIRST_PIXEL   = 1024
LINE_LAST_PIXEL    = 1
```

Now, given a pixel on the original image, P(X,Y) = (2,2), determine its location (P') in the stored image.

sample offset = (8 * (2 - 1) * 1024) / (8 * (1024 - 1 + 1)) = 1
line offset = ((2 - 1024) * 1024) / (1 - 1024 + 1) = (-1022)

Therefore, P' is located at (2, 1023) which is 1 byte from the first sample, and 1022 bytes (in the negative direction) from the first line in the stored image. See diagram above.

B.14.2 Required Keywords

1. MAP_PROJECTION_TYPE
2. A_AXIS_RADIUS
3. B_AXIS_RADIUS
4. C_AXIS_RADIUS
5. FIRST_STANDARD_PARALLEL
6. SECOND_STANDARD_PARALLEL
7. POSITIVE_LONGITUDE_DIRECTION
8. CENTER_LATITUDE
9. CENTER_LONGITUDE
10. REFERENCE_LATITUDE
11. REFERENCE_LONGITUDE
12. LINE_FIRST_PIXEL
13. LINE_LAST_PIXEL
14. SAMPLE_FIRST_PIXEL
15. SAMPLE_LAST_PIXEL
16. MAP_PROJECTION_ROTATION
17. MAP_RESOLUTION
18. MAP_SCALE
19. MAXIMUM_LATITUDE
20. MINIMUM_LATITUDE
21. EASTERNMOST_LONGITUDE
22. WESTERNMOST_LONGITUDE
23. LINE_PROJECTION_OFFSET
24. SAMPLE_PROJECTION_OFFSET
25. COORDINATE_SYSTEM_TYPE
26. COORDINATE_SYSTEM_NAME

B.14.3 Optional Keywords

1. DATA_SET_ID
2. IMAGE_ID
3. HORIZONTAL_FRAMELET_OFFSET
4. VERTICAL_FRAMELET_OFFSET
5. KEYWORD_LATITUDE_TYPE
6. OBLIQUE_PROJ_POLE_LATITUDE
7. OBLIQUE_PROJ_POLE_LONGITUDE
8. OBLIQUE_PROJ_POLE_ROTATION
9. OBLIQUE_PROJ_X_AXIS_VECTOR
10. OBLIQUE_PROJ_Y_AXIS_VECTOR
11. OBLIQUE_PROJ_Z_AXIS_VECTOR

B.14.4 Required Objects

1. DATA_SET_MAP_PROJECTION – This object is describe in Appendix B.

B.14.5 Optional Objects

None

B.14.6 Example

```
PDS_VERSION_ID                = PDS3

/* File characteristics */
RECORD_TYPE                   = STREAM

/* Identification data elements */
DATA_SET_ID                   = "MGN-V-RDRS-5-GVDR-V1.0"
DATA_SET_NAME                 = "MAGELLAN VENUS RADAR SYSTEM GLOBAL
       DATA RECORD V1.0"
PRODUCT_ID                    = "IMP-NORTH.100"

MISSION_NAME                  = "MAGELLAN"
SPACECRAFT_NAME               = "MAGELLAN"
INSTRUMENT_NAME               = "VENUS"

ORBIT_START_NUMBER            = 376
ORBIT_STOP_NUMBER             = 4367
START_TIME                    = "N/A"
STOP_TIME                     = "N/A"
SPACECRAFT_CLOCK_START_COUNT  = "N/A"
SPACECRAFT_CLOCK_STOP_COUNT   = "N/A"

PRODUCT_CREATION_TIME         = 1994-05-07T22:09:27.000
PRODUCT_RELEASE_DATE          = 1994-05-13
PRODUCT_SEQUENCE_NUMBER       = 00000
PRODUCT_VERSION_TYPE          = "PRELIMINARY"

SOURCE_DATA_SET_ID            = {"MGN-V-RDRS-5-SCVDR-V1.0",
                                "MGN-V-RDRS-CDR-ALT/RAD-V1.0"}
SOURCE_PRODUCT_ID             =
 {"SCVDR.00376-00399.1","SCVDR.00400-00499.1",
  "SCVDR.01100-01199.1","SCVDR.01200-01299.1","SCVDR.01300-01399.1",
  "SCVDR.01400-01499.1","SCVDR.01500-01599.1","SCVDR.01600-01699.1",
  "SCVDR.01700-01799.1","SCVDR.01800-01899.1","SCVDR.01900-01999.1",
  "ARCDRCD.001;2","ARCDRCD.002;1","ARCDRCD.003;1","ARCDRCD.004;1",
  "ARCDRCD.005;1","ARCDRCD.006;1","ARCDRCD.007;1","ARCDRCD.008;1",
  "ARCDRCD.017;1","ARCDRCD.018;1","ARCDRCD.019;1"}

SOFTWARE_FLAG                 = "Y"
```

```
PRODUCER_FULL_NAME               = "MICHAEL J. MAURER"
PRODUCER_INSTITUTION_NAME        = "STANFORD CENTER FOR RADAR ASTRONOMY"
PRODUCER_ID                      = "SCRA"
DESCRIPTION                      = "This file contains a single
  IMAGE_MAP_PROJECTION data object with an attached PDS label."

/* Data object definitions */
OBJECT                           = IMAGE_MAP_PROJECTION
  ^DATA_SET_MAP_PROJECTION       = "DSMAP.CAT"
  COORDINATE_SYSTEM_TYPE         = "BODY-FIXED ROTATING"
  COORDINATE_SYSTEM_NAME         = "PLANETOCENTRIC"
  MAP_PROJECTION_TYPE            = "STEREOGRAPHIC"
  A_AXIS_RADIUS                  = 6051.0 <KM>
  B_AXIS_RADIUS                  = 6051.0 <KM>
  C_AXIS_RADIUS                  = 6051.0 <KM>
  FIRST_STANDARD_PARALLEL        = "N/A"
  SECOND_STANDARD_PARALLEL       = "N/A"
  POSITIVE_LONGITUDE_DIRECTION   = "EAST"
  CENTER_LATITUDE                = 90
  CENTER_LONGITUDE               = 0
  REFERENCE_LATITUDE             = "N/A"
  REFERENCE_LONGITUDE            = "N/A"
  LINE_FIRST_PIXEL               = 1
  LINE_LAST_PIXEL                = 357
  SAMPLE_FIRST_PIXEL             = 1
  SAMPLE_LAST_PIXEL              = 357
  MAP_PROJECTION_ROTATION        = 0
  MAP_RESOLUTION                 = 5.79478 <PIXEL/DEGREE>
  MAP_SCALE                      = 18.225 <KM/PIXEL>
  MAXIMUM_LATITUDE               = 90.00
  MINIMUM_LATITUDE               = 60.00
  EASTERNMOST_LONGITUDE          = 360.00
  WESTERNMOST_LONGITUDE          = 0.00
  LINE_PROJECTION_OFFSET         = 178
  SAMPLE_PROJECTION_OFFSET       = 178
END_OBJECT
```

B.15 INSTRUMENT

The INSTRUMENT catalog object is used to submit information about an instrument to PDS. Instruments are typically associated with a particular spacecraft or earth-based host, so the INSTRUMENT_HOST_ID keyword may identify either a valid SPACECRAFT_ID or EARTH_BASE_ID. (In those cases where a specific instrument was mounted on multiple earth-based hosts, the INSTRUMENT_HOST_ID may be multi-valued.) The catalog object includes a text description of the instrument and a sub-object for identifying reference information.

B.15.1 Required Keywords

1. INSTRUMENT_HOST_ID
2. INSTRUMENT_ID

B.15.2 Optional Keywords

None

B.15.3 Required Objects

1. INSTRUMENT_INFORMATION
2. INSTRUMENT_REFERENCE_INFO

B.15.4 Optional Objects

None

B.15.5 Usage Notes

One INSTRUMENT_INFORMATION catalog object must be completed for each instrument. An INSTRUMENT_REFERENCE_INFO catalog object is required for each individual reference associated with the instrument. All references should be included that are relevant to providing more detailed / specific instrument information; such as, description of the instrument, instrument documentation, review results, etc. These references may include published articles, books, papers, electronic publications, etc.

B.15.6 Example

```
/* Template: Instrument Template                          Rev: 1993-09-24      */

/* Note:Complete one template for each instrument. Identify each               */
/*      instrument reference by repeating the 3 lines for the                  */
/*      INSTRUMENT_REFERENCE_INFO object. Also complete a separate             */
/*      REFERENCE template for each new reference submitted to PDS.            */

/* Hierarchy:   INSTRUMENT                                                     */
/*              INSTRUMENT_INFORMATION                                         */
/*              INSTRUMENT_REFERENCE_INFO                                      */

PDS_VERSION_ID                        = PDS3
LABEL_REVISION_NOTE                   = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                           = STREAM

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

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


  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.

    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 for50 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.

    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

    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.

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

Scientific 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 20minutes 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

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

Operational Modes

The Magellan radar system consisted of the following sections, each of which operated in the following modes:

Section	Mode
SAR (SAR)	Synthetic Aperture Radar
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, simple dat 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 degree sat 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 beam width
      (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 radio thermale
    mission 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
    2K; the long-term absolute accuracy after calibration was about20 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
```

B.16 INSTRUMENT_HOST

The INSTRUMENT_HOST catalog object is used to describe a variety of instrument hosts, such as a spacecraft or an earth-based observatory.

B.16.1 Required Keywords

1. INSTRUMENT_HOST_ID

B.16.2 Optional Keywords

None

B.16.3 Required Objects

1. INSTRUMENT_HOST_INFORMATION
2. INSTRUMENT_HOST_REFERENCE_INFO

B.16.4 Optional Objects

None

B.16.5 Usage Notes

One INSTRUMENT_HOST_INFORMATION catalog object must be completed for each instrument host. An INSTRUMENT_HOST_REFERENCE_INFO catalog object is required for each individual reference associated with the instrument host. All references should be included that are relevant to providing more detailed / specific instrument host information; such as, description of the instrument host, instrument host documentation, review results, etc. These references may include published articles, books, papers, electronic publications, etc.

B.16.6 Example

```
/* Template: Instrument Host Template                           Rev: 1993-09-24       */

/* Note: Complete one template for each instrument host. Identify each              */
/*       instrument host reference by repeating the 3 lines for the                 */
/*       INSTRUMENT_HOST_REFERENCE_INFO object. Also complete a separate            */
/*       REFERENCE template for each new reference submitted to PDS.                */

/* Hierarchy:   INSTRUMENT_HOST                                                      */
```

```
/*              INSTRUMENT_HOST_INFORMATION                                                 */
/*              INSTRUMENT_HOST_REFERENCE_INFO                                              */

PDS_VERSION_ID                         = PDS3
LABEL_REVISION_NOTE                    = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                            = "STREAM"

OBJECT                                 = INSTRUMENT_HOST
  INSTRUMENT_HOST_ID                   = "MGN"

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

  Instrument Host 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.

    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 down
    link 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.17 INSTRUMENT_HOST_INFORMATION

The INSTRUMENT_HOST_INFORMATION object, a sub-object of the INSTRUMENT_HOST catalog object, provides a description of an instrument host. For spacecraft, this typically includes paragraphs on the various subsystems. Earth-based instrument host descriptions generally focus on geographic and facility elements.

B.17.1 Required Keywords

1. INSTRUMENT_HOST_DESC
2. INSTRUMENT_HOST_NAME
3. INSTRUMENT_HOST_TYPE

B.17.2 Optional Keywords

None

B.17.3 Required Objects

None

B.17.4 Optional Objects

None

B.17.5 Usage Notes

The INSTRUMENT_HOST_DESC keyword contains a text description of the spacecraft or ground observatory. It should contain at least one heading, “Instrument Host Overview”. This section should provide a high-level description of the characteristics and properties of the host. Other headings and sub-headings may be added as needed.

B.17.6 Example

See the example for the INSTRUMENT_HOST object in Section B.15.5.

B.18 INSTRUMENT_HOST_REFERENCE_INFO

The INSTRUMENT_HOST_REFERENCE_INFO object, a sub-object of the INSTRUMENT_HOST catalog object, associates a reference with an instrument host. A separate object must be completed for each reference cited within the INSTRUMENT_HOST catalog object.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.18.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.18.2 Optional Keywords

None

B.18.3 Required Objects

None

B.18.4 Optional Objects

None

B.18.5 Example

See the example for the INSTRUMENT_HOST object in Section B.15.5.

B.19 INSTRUMENT_INFORMATION

The INSTRUMENT_INFORMATION catalog object provides a description of the instrument.

B.19.1 Required Keywords

1. INSTRUMENT_DESC
2. INSTRUMENT_NAME
3. INSTRUMENT_TYPE

B.19.2 Optional Keywords

None

B.19.3 Required Objects

None

B.19.4 Optional Objects

None

B.19.5 Usage Notes

The following paragraph headings and suggested contents for the INSTRUMENT_DESC text are strongly recommended as the minimal set of information necessary to adequately describe an instrument. Additional headings may be appropriate for specific instruments and these also may be added here. Should any of the recommended headings *not* appear within the description, they will be considered not applicable to the data set.

Instrument Overview
    A high-level description of the characteristics and properties of an instrument

Scientific Objectives
    The scientific objectives of data obtained from this instrument

Calibration
    Methods/procedures/schedules of instrument calibration (calibration stability, parameters, etc.)

Operational Considerations

Special circumstances or events that affect the instrument's ability to acquire high quality data , and which are reflected in the archive product. For example: spacecraft charging; thruster firings; contamination from other instruments; air quality; temperatures, etc.

Detectors

General description of the detector(s), including things like type of detector used, sensitivity and noise levels, detector fields of view, geometric factors, instrument/detector mounting descriptions (offset angles, pointing positions, etc.)

Electronics

Description of the instrument electronics and internal data processing (A-D converter)

Filters

Description of instrument filters and filter calibrations (filter type, center wavelength, min/max wavelength), as applicable

Optics

Description of instrument optics (focal lengths, transmittance, diameter, resolution, t_number, etc.), as applicable

Location

Latitude and longitude location, for earth-based instruments

Operational Modes

Description of instrument configurations for data acquisitions. Description of "modes" (scan, gain, etc.) of data acquisition and of measured parameter(s) and/or data sampling rates or schemes used in each mode

Subsystems

Logical subsystems of the instrument, including descriptions of each subsystem, how it's used, which "modes" make use of which subsystem, etc.

Measured Parameters

Description of what the instrument measures directly (particle counts, magnetic field components, radiance, current/voltage ratios, etc.), plus descriptions and definitions of these measurements (min/max, noise levels, units, time interval between measurements, etc.)

OTHER - Data Supplier provided: Any other important information in additional headings as desired (e.g., data reduction, data compression, time-tagging, diagnostics, etc.)

B.19.6 Example

See the example for the INSTRUMENT object in Section B.14.5.

B.20 INSTRUMENT_REFERENCE_INFO

The INSTRUMENT_REFERENCE_INFO catalog object associates a reference with an instrument description. A separate object must be completed for each reference cited within the INSTRUMENT catalog object. Include any important references such as instrument description and calibration documents. These can be published articles, internal documents or informal memoranda.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.20.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.20.2 Optional Keywords

None

B.20.3 Required Objects

None

B.20.4 Optional Objects

None

B.20.5 Example

See the example for the INSTRUMENT object in Section B.14.5.

B.21 INVENTORY

One INVENTORY catalog object is completed for each node responsible for orderable data sets from the PDS catalog. This object provides the inventory information necessary to facilitate the ordering of these data sets.

B.21.1 Required Keywords

1. NODE_ID

B.21.2 Optional Keywords

None

B.21.3 Required Objects

1. INVENTORY_DATA_SET_INFO

B.21.4 Optional Objects

None

B.21.5 Example

```
/* Template: InventoryTemplate                             Rev: 1990-03-20                    */

/* Note: The INVENTORY template shall be completed once for each node that is responsible     */
/*  for orderable data sets from the PDS catalog. The following hierarchy of templates provide */
/*  the necessary inventory information which will facilitate the ordering of these data sets. */

/* Hierarchy:   INVENTORY                                                               */
/*              INVENTORY_DATA_SET_INFO                                                 */
/*              INVENTORY_NODE_MEDIA_INFO                                               */

OBJECT                                  = INVENTORY
  NODE_ID                               = "IMAGING"

  OBJECT                                = INVENTORY_DATA_SET_INFO
    PRODUCT_DATA_SET_ID                 = "VG2-N-ISS-2-EDR-V1.0"

    OBJECT                              = INVENTORY_NODE_MEDIA_INFO
      MEDIUM_TYPE                       = "MAG TAPE"
      MEDIUM_DESC                       = "INDUSTRY STD 1/2IN;1600 OR 6250 BPI"
      COPIES                            = 1
      INVENTORY_SPECIAL_ORDER_NOTE      = "Not applicable."
    END_OBJECT                          = INVENTORY_NODE_MEDIA_INFO

    OBJECT                              = INVENTORY_NODE_MEDIA_INFO
```

```
      MEDIUM_TYPE                         = "CD-ROM"
      MEDIUM_DESC                         = "Compact Disk"
      COPIES                              = 1
      INVENTORY_SPECIAL_ORDER_NOTE        = "Not applicable."
    END_OBJECT                            = INVENTORY_NODE_MEDIA_INFO

  END_OBJECT                              = INVENTORY_DATA_SET_INFO
END_OBJECT                                = INVENTORY


OBJECT                                    = INVENTORY
  NODE_ID                                 = "NSSDC"

  OBJECT                                  = INVENTORY_DATA_SET_INFO
    PRODUCT_DATA_SET_ID                   = "VG2-N-ISS-2-EDR-V1.0"

    OBJECT                                = INVENTORY_NODE_MEDIA_INFO
      MEDIUM_TYPE                         = "CD-ROM"
      MEDIUM_DESC                         = "Compact Disk"
      COPIES                              = 1
      INVENTORY_SPECIAL_ORDER_NOTE        = "Not applicable."
    END_OBJECT                            = INVENTORY_NODE_MEDIA_INFO

  END_OBJECT                              = INVENTORY_DATA_SET_INFO
END_OBJECT                                = INVENTORY
END
```

B.22 INVENTORY_DATA_SET_INFO

The INVENTORY_DATA_SET_INFO object, sub-object of the INVENTORY catalog object, identifies a data set through the DATA_SET_ID. This object is repeated once for each orderable and cataloged PDS data set.

B.22.1 Required Keywords

1. PRODUCT_DATA_SET_ID

B.22.2 Optional Keywords

None

B.22.3 Required Objects

1. INVENTORY_NODE_MEDIA_INFO

B.22.4 Optional Objects

None

B.22.5 Example

See the example for the INVENTORY object in Section B.20.5.

B.23 INVENTORY_NODE_MEDIA_INFO

The INVENTORY_NODE_MEDIA_INFO object, a sub-object of the INVENTORY_DATA_SET_INFO object, provides information about a data set's distribution medium. This object is repeated for each type of distribution medium.

B.23.1 Required Keywords

1. COPIES
2. INVENTORY_SPECIAL_ORDER_NOTE
3. MEDIUM_DESC
4. MEDIUM_TYPE

B.23.2 Optional Keywords

None

B.23.3 Required Objects

None

B.23.4 Optional Objects

None

B.23.5 Example

See the example for the INVENTORY object in Section B.20.5.

B.24 MISSION

The MISSION catalog object is used to submit information about a mission or observing campaign to PDS. Sub-objects are included for identifying associated instrument hosts, targets, and references.

B.24.1 Required Keywords

1. MISSION_NAME

B.24.2 Optional Keywords

None

B.24.3 Required Objects

1. MISSION_HOST
2. MISSION_INFORMATION
3. MISSION_REFERENCE_INFORMATION

B.24.4 Optional Objects

None

B.24.5 Usage Notes

One MISSION_INFORMATION catalog object must be completed for each mission. A MISSION_HOST catalog object must be completed for each mission host associated with the mission, and one MISSION_REFERENCE_INFORMATION catalog object is required for each individual reference associated with the mission (e.g., articles, papers, memoranda, published data, etc.). All references should be included that are relevant to providing more detailed / specific mission information; such as, description of the mission, phases of the mission, mission objectives, mission documentation, review results, etc. These references may include published articles, books, papers, electronic publications, etc.

B.24.6 Example

```
/* Template: Mission Template                         Rev: 1993-09-24          */

/* Note:Complete one template for each mission or campaign. Identify            */
/*      multiple hosts associated with the mission by repeating the             */
/*      lines beginning and ending with the MISSION_HOST values. For            */
/*      each instrument_host identified, repeat the 3 lines for the             */
/*      MISSION_TARGET object for each target associated with the host.         */
/*      Also complete a separate REFERENCE template for each new                */
/*      reference submitted to PDS.                                             */

/* Hierarchy: MISSION                                                           */
/*            MISSION_INFORMATION                                               */
/*            MISSION_HOST                                                      */
/*            MISSION_TARGET                                                    */
/*            MISSION_REFERENCE_INFORMATION                                     */

PDS_VERSION_ID                        = PDS3
LABEL_REVISION_NOTE                   = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                           = STREAM

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)", "SP-18" }
    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].

    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 orbit5747.
```

```
    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 5752to
    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      = "


Mission Objectives Overview
===========================

  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 land forms 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....

    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.

    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 (dunefields), 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.

    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.

    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

OBJECT                                  = MISSION_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                      = "ARVIDSONETAL1992"
END_OBJECT                              = MISSION_REFERENCE_INFORMATION

OBJECT                                  = MISSION_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                      = "CAMPBELLETAL1992"
END_OBJECT                              = MISSION_REFERENCE_INFORMATION

...

OBJECT                                  = MISSION_REFERENCE_INFORMATION
  REFERENCE_KEY_ID                      = "TYLER1992"
```

```
  END_OBJECT                                = MISSION_REFERENCE_INFORMATION

  OBJECT                                    = MISSION_REFERENCE_INFORMATION
    REFERENCE_KEY_ID                        = "VRMPP1983"
  END_OBJECT                                = MISSION_REFERENCE_INFORMATION

END_OBJECT                                  = MISSION
END
```

B.25 MISSION_HOST

The MISSION_HOST object, a sub-object of the MISSION catalog object, is completed for each instrument host associated with a mission or observing campaign. If there is more than one instrument host involved in the mission, this object is repeated.

B.25.1 Required Keywords

1. INSTRUMENT_HOST_ID

B.25.2 Optional Keywords

None

B.25.3 Required Objects

1. MISSION_TARGET

B.25.4 Optional Objects

None

B.25.5 Example

See the example for the MISSION object in Section B.23.5.

B.26 MISSION_INFORMATION

The MISSION_INFORMATION object, a sub-object of the MISSION catalog object, provides start and stop times and text descriptions of a mission (or observing campaign) and its objectives. Suggested content includes agency involvement, spacecraft/observatory utilized, mission scenario including phases, technology and scientific objectives.

B.26.1 Required Keywords

1. MISSION_ALIAS_NAME
2. MISSION_DESC
3. MISSION_OBJECTIVES_SUMMARY
4. MISSION_START_DATE
5. MISSION_STOP_DATE

B.26.2 Optional Keywords

None

B.26.3 Required Objects

None

B.26.4 Optional Objects

None

B.26.5 Usage notes

The following paragraph headings and suggested contents for the MISSION_DESC and MISSION_OBJECTIVES_SUMMARY text are strongly recommended as the minimal set of information necessary to adequately describe a mission or observing campaign. Additional headings may be added as needed.

B.26.5.1 MISSION_DESC Headings

Mission Overview
A high-level description of a mission

Mission Phases
A description of each phase of a mission, starting with the pre-launch phase and continuing through end-of-mission, including: start and stop times of each phase; intended operations; targets; and mission phase objectives

B.26.5.2 MISSION_OBJECTIVES_SUMMARY Headings

Mission Objectives Overview
A high-level description of the objectives of the mission

B.26.6 Example

See the example for the MISSION object in Section B.23.5.

B.27 MISSION_REFERENCE_INFORMATION

The MISSION_REFERENCE_INFORMATION object, a sub-object of the MISSION catalog object, associates a reference with a mission. A separate object must be completed for each reference cited within the MISSION catalog object.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.27.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.27.2 Optional Keywords

None

B.27.3 Required Objects

None

B.27.4 Optional Objects

None

B.27.5 Example

See the example for the MISSION object in Section B.23.5.

B.28 MISSION_TARGET

The MISSION_TARGET object, a sub-object of the MISSION_HOST catalog object, associates a target with a mission host. One MISSION_TARGET catalog object is completed for each target associated with a mission host.

B.28.1 Required Keywords

1. TARGET_NAME

B.28.2 Optional Keywords

None

B.28.3 Required Objects

None

B.28.4 Optional Objects

None

B.28.5 Example

See the example for the MISSION object in Section B.23.5.

B.29 PERSONNEL

The PERSONNEL catalog object is used to provide new or updated information for personnel associated with PDS in some capacity. Associated personnel include data suppliers and producers for data sets or volumes archived with PDS, as well as PDS node personnel and contacts within other agencies and institutions.

B.29.1 Required Keywords

1. PDS_USER_ID

Note: With respect to new submissions, contact a PDS Data Engineer to obtain a valid and unique PDS_USER_ID. The value is constructed using the initial of the first name and the last name (e.g., John Smith would become PDS_USER_ID = “JSMITH”). The Data Engineer will ensure that the newly constructed value does not conflict with a previous entry in the catalog.

B.29.2 Optional Keywords

None

B.29.3 Required Objects

1. PERSONNEL_ELECTRONIC_MAIL
2. PERSONNEL_INFORMATION

B.29.4 Optional Objects

None

B.29.5 Usage Notes

One PERSONNEL_INFORMATION catalog object must be completed for each person. One PERSONNEL_ELECTRONIC_MAIL catalog object must be completed for each email address associated with the person. That is, if there is more than one email address, this object is repeated.

B.29.6 Example

```
/* Template: Personnel Template                          Rev: 1993-09-24       */

/* Note:Complete one for each new PDS user, data supplier, or data             */
/*producer. If more than one electronic mail address is available              */
/*repeat the lines for the PERSONNEL_ELECTRONIC_MAIL object.                   */

/* Hierarchy:   PERSONNEL                                                      */
/*              PERSONNEL_INFORMATION                                          */
/*              PERSONNEL_ELECTRONIC_MAIL                                      */

PDS_VERSION_ID                        = PDS3
LABEL_REVISION_NOTE                   = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                           = STREAM

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"
    PDS_ADDRESS_BOOK_FLAG             = Y
    REGISTRATION_DATE                 = 1990-02-06
    ADDRESS_TEXT                      = "Massachusetts Institute of Technology
                                         Center for Space Research Building 37-601
                                         Cambridge, MA 02139"
  END_OBJECT                          = PERSONNEL_INFORMATION

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

  OBJECT                              = PERSONNEL_ELECTRONIC_MAIL
    ELECTRONIC_MAIL_ID                = "PFORD"
    ELECTRONIC_MAIL_TYPE              = "NASAMAIL"
    PREFERENCE_ID                     = 2
  END_OBJECT                          = PERSONNEL_ELECTRONIC_MAIL

  OBJECT                              = PERSONNEL_ELECTRONIC_MAIL
    ELECTRONIC_MAIL_ID                = "JPLPDS::PFORD"
    ELECTRONIC_MAIL_TYPE              = "NSI/DECNET"
    PREFERENCE_ID                     = 3
 END_OBJECT                           = PERSONNEL_ELECTRONIC_MAIL

END_OBJECT                             = PERSONNEL
END
```

B.30 PERSONNEL_ELECTRONIC_MAIL

The PERSONNEL_ELECTRONIC_MAIL object, a sub-object of the PERSONNEL catalog object, provides electronic mail information for an individual. This object may be repeated if more than one electronic mail address is applicable.

B.30.1 Required Keywords

1. ELECTRONIC_MAIL_ID
2. ELECTRONIC_MAIL_TYPE
3. PREFERENCE_ID

B.30.2 Optional Keywords

None

B.30.3 Required Objects

None

B.30.4 Optional Objects

None

B.30.5 Example

See the example for the PERSONNEL object in Section B.28.5.

B.31 PERSONNEL_INFORMATION

The PERSONNEL_INFORMATION object, a sub-object of the PERSONNEL catalog object, provides name, address, telephone, and related information for an individual.

B.31.1 Required Keywords

1. ADDRESS_TEXT
2. ALTERNATE_TELEPHONE_NUMBER
3. FAX_NUMBER
4. FULL_NAME
5. INSTITUTION_NAME
6. LAST_NAME
7. NODE_ID
8. PDS_AFFILIATION
9. REGISTRATION_DATE
10. TELEPHONE_NUMBER

B.31.2 Optional Keywords

1. PDS_ADDRESS_BOOK_FLAG

B.31.3 Required Objects

None

B.31.4 Optional Objects

None

B.31.5 Example

See the example for the PERSONNEL object in Section B.28.5.

B.32 REFERENCE

The REFERENCE catalog object provides a citation and a unique identifier for every journal article, book, chapter, or other reference mentioned in a CATALOG object or one of its components (MISSION, INSTRUMENT HOST, INSTRUMENT, DATA SET, etc.).

One REFERENCE catalog object should be completed for each reference associated with a CATALOG (or component) object. Since the goal in generating REFERENCE catalog objects is to provide additional external long-term documentation, care should be exercised in selecting candidate references. Internal documents, informal memoranda, and other unpublished material should be avoided. A REFERENCE should cite published data, such as other PDS archives. Multiple REFERENCE catalog objects are often assembled into a single REF.CAT file to accompany an archive.

B.32.1 Required Keywords

1. REFERENCE_KEY_ID
2. REFERENCE_DESC

B.32.2 Optional Keywords

None

B.32.3 Required Objects

None

B.32.4 Optional Objects

None

B.32.5 Usage Notes

The following examples show how to cite various types of information in REFERENCE catalog objects for PDS archive products. PDS has elected to use the American Geophysical Union (AGU) reference citation formats. The information presented within this section was derived from and complies with AGU's formats for publication (see www.agu.org/pubs/references.html for more information). For assistance in determining the proper format for a citation that does not fit within one of the categories described here, contact a PDS Data Engineer.

B.32.5.1 Materials Appropriate for Inclusion in a REFERENCE Catalog Object

Each article, book, report, electronic collection (CD-ROM or electronic publication), thesis, or similar publication used in documenting a PDS archival product should be defined by a REFERENCE catalog object.

B.32.5.2 Materials Inappropriate for Inclusion in a REFERENCE Catalog Object

Unpublished materials such as personal communications, unpublished reports, papers presented at meetings, and manuscripts in preparation or submitted for publication but not yet formally accepted are not allowed in REFERENCE catalog objects; PDS does not consider them to be part of the literature. Likewise, internal memoranda and documents should be avoided unless they can be accessed by outside users. Papers accepted but without final publication data (volume, page numbers, dates, etc.) are discouraged since the information in the REFERENCE catalog object would be incomplete and need to be updated later.

In cases where it would be desirable to credit another author or group for contributions or prior work, an in-line text acknowledgement or citation is acceptable, even when the material is not readily accessible. If such material is required for understanding the archive, the normal constraints apply, however.

B.32.5.3 Reference List Citations

The most widely accessible source of a particular piece of material should be cited. For example, if an article exists as an internal publication and in a professional journal, the latter should be used in the REFERENCE catalog object.

B.32.5.4 Construction of REFERENCE_KEY_ID

1. For a single author, the REFERENCE_KEY_ID comprises the author's surname followed by the year of the publication (e.g., "SMITH1990").

2. For two authors, the REFERENCE_KEY_ID comprises the author's surname followed by "&" followed by the co-author's surname followed by the year of the publication (e.g., "LAUREL&HARDY1990").

3. For more than two authors, the REFERENCE_KEY_ID comprises the first author's surname followed by "ETAL" followed by the year of the publication (e.g., "SMITHETAL1990").

4. If the same author(s) published more than one paper in the same year, the following applies:

    a. The initial publication will have a REFERENCE_KEY_ID as formulated above (e.g., "SMITH1990"). Note that the reference uses an implicit "A".

b. Subsequent publications will use the next sequential letter to uniquely identify the reference:

   - the 2nd publication will be "SMITH1990B",
   - the 3rd publication will be "SMITH1990C".

5. The REFERENCE_KEY_ID value should be enclosed within double quotes.

6. For additional information on formulating a REFERENCE_KEY_ID, check the PDS Data Dictionary (http://pdsproto.jpl.nasa.gov/onlinecatalog/top.cfm).

B.32.5.5 Construction of REFERENCE_DESC

The information included in a REFERENCE catalog object will vary somewhat depending on the source. The following subsections describe the most common types; contact a PDS Data Engineer for assistance when encountering a type not described here. Details on constructing the components of a REFERENCE_DESC value are described in the next section.

B.32.5.5.1 Papers in Professional Journals and Other Articles

Citations of articles should include the following information in the order listed:

1. Name(s) of author or authors
2. Title of article
3. Name of periodical
4. Volume and/or issue number
5. First and last pages occupied by article
6. Year of publication

Example:

```
OBJECT                      = REFERENCE
 REFERENCE_KEY_ID           = "SCARF&GURNETT1977"
 REFERENCE_DESC             = "
    Scarf, F.L., and D.A. Gurnett, A plasma wave investigation for the
    Voyager mission, Space Sci. Rev., Vol. 21, No. 1, pp. 289-331, 1977."
 END_OBJECT                 = REFERENCE
```

B.32.5.5.2 Books and Reports

Citations of books and reports should include the following information, in the order listed:

1. Name(s) of author or authors
2. Title of article or chapter (if only part of book or report is being cited)
3. Title of book or report
4. Volume number (if part of a multivolume series)
5. Edition (if not original)
6. Editor(s) (if any)

7. Report number(s)
8. Page numbers (if only part of book or report is being cited)
9. Publisher's name
10. City of publication
11. Year of publication

Examples:

```
OBJECT                          = REFERENCE
 REFERENCE_KEY_ID               = "FIELDETAL1989B"
 REFERENCE_DESC                 = "
    Field, S.W., S.E. Haggerty, and A.J. Erlank, Subcontinental
    Metasomatism in the Region of Jagersfontein, Springer-Verlag,
    New York, 1989."
END_OBJECT                      = REFERENCE

OBJECT                          = REFERENCE
 REFERENCE_KEY_ID               = "THOMPSON1985"
 REFERENCE_DESC                 = "
    Thompson, W.B., Preliminary investigation of the electrodynamic
    of a conducting tether, in Spacecraft Environmental Technology
    1983, edited by C. K. Purvis and C. P. Pike, NASA Conf. Publ.,
    Vol. 2359, pp. 649-662, National Aeronautics and Space Administration,
    Washington, DC, 1985."
END_OBJECT                      = REFERENCE
```

B.32.5.5.3 Electronic Publications

Certain types of electronic publications may be given as REFERENCE catalog objects. These include publications on electronic media such as CD-ROM and regularly issued, dated electronic journals. Data deposited at PDS and National Data Centers (e.g., NSSDC) may also be included. Because of the ephemeral nature of some electronic media, authors should consult a Data Engineer if the specific reference (e.g., a website) does not seem to have a traditional hardcopy analog.

B.32.5.5.3.1 Data Sets

REFERENCE catalog objects for data sets that are on deposit at PDS or National Data Centers (e.g., NSSDC) should include the following information, in the order listed:

1. Name of author or authors (e.g., Principal Investigator and/or Data Producer)
2. Name of the data set (e.g., DATA_SET_NAME)
3. Unique identifier of the data set (e.g., DATA_SET_ID)
4. Volume and/or issue number (e.g., VOLUME_SET_ID or VOLUME_ID) (optional)
5. Name of publisher or producer (e.g., NASA Planetary Data System)
6. Year of publication

Example:

```
OBJECT                          = REFERENCE
 REFERENCE_KEY_ID               = "LEVINETAL2000"
 REFERENCE_DESC                 = "
     Levin, G.V., P.A. Straat, E.A. Guinness, P.G. Valko, J.H. King,
     and D.R. Williams, Viking Lander Labeled Release Data Archive,
     VL1/VL2-M-LCS-2-EDR-V1.0, USA_NASA_JPL_VL_9010, NASA
     Planetary Data System, 2000."
END_OBJECT                      = REFERENCE
```

B.32.5.5.3.2 Physical Media (CD-ROM / DVD-R)

REFERENCE catalog objects for physical media (e.g., CDs or DVDs) should include the following information, in the order listed:

1. Name of author or authors (e.g., Principal Investigator and/or Data Producer)
2. Name of the volume or volume set (e.g., VOLUME_NAME or VOLUME_SET_NAME)
3. Unique identifier of the volume or volume set (e.g., VOLUME_ID or VOLUME_SET_ID)
4. Name of publisher or producer (e.g., NASA Planetary Data System)
5. Year of publication

Example:

```
OBJECT                          = REFERENCE
 REFERENCE_KEY_ID               = "LEVINETAL2000B"
 REFERENCE_DESC                 = "
Levin, G.V., P.A. Straat, E.A. Guinness, P.G. Valko, J.H. King,
and D.R. Williams, Viking Lander 1 Experiment Data Records (EDR)
Image Products, USA_NASA_JPL_VL_00xx, NASA Planetary Data
System, 2000."
END_OBJECT                      = REFERENCE
```

B.32.5.5.3.3 Electronic Journal Articles

Material published in regularly issued, dated electronic journals should be referenced similarly to printed papers (see Papers in Professional Journals and Other Articles, above). Because this aspect of the Internet is evolving rapidly, PDS does not offer specific recommendations; authors should contact a Data Engineer for current guidelines. Because the Internet is a dynamic environment and sites may change or move, PDS cautions that such electronic sources should have established a record of stability before being considered acceptable for use in REFERENCE catalog objects.

B.32.5.6 REFERENCE_DESC Components

B.32.5.6.1 Author Names

For the first author only, the surname is given first, followed by initials. Names of any co-authors appear in regular order: initials precede the co-author's surname. The word “and” precedes the last author’s name. Do not include white space between authors' initials (e.g., Kurth, W.S.) When the number of authors exceeds five, the author list may consist of the first five authors’ names and initials as usual, followed by “and N others”, where “N”, an arabic numeral, is the number of remaining authors.

Example:

```
OBJECT                          = REFERENCE
 REFERENCE_KEY_ID               = "KURTHETAL1982"
 REFERENCE_DESC                 = "
Kurth, W.S., F.L. Scarf, J.D. Sullivan, and D.A. Gurnett,
Detection of nonthermal continuum radiation in Saturn's
magnetosphere, Geophys. Res. Lett., Vol. 9, p. 889, 1982."
END_OBJECT                      = REFERENCE
```

B.32.5.6.2 Journal Titles

PDS uses the same guidelines as the AGU which were established by the ***Chemical Abstracts Service Source Index*** in abbreviating the names of serial publications and reports. One word titles (e.g., Science, Icarus, Nature) are not abbreviated. Articles, conjunctions, prepositions, hyphens, parentheses, commas, and accents are omitted in abbreviated titles. Apostrophes in transliterated titles are retained.

Examples of common journal titles in planetary science include:

- Adv. Space Res.
- Geophys. Res. Lett.
- J. Geophys. Res.
- Rev. Geophys.
- Radio Sci.
- Space Sci. Rev.

Other examples include:

- AAPG Bull.
- Anal. Chem.
- Ann. Geophys.
- Ann. Glaciol.
- Appl. Opt.
- Appl. Spectrosc.
- Astrophys. J.
- Bull. Int. Assoc. Eng. Geol.
- Bull. Mar. Sci.

- Can. J. Phys.
- Chem. Geol.
- Contrib. Mineral. Petrol.
- Earth Planet. Sci. Lett.
- Geochim. Cosmochim. Acta
- Geol. Soc. Am. Bull.
- IEEE Trans. Geosci. Remote Sens.
- IEEE Trans. Nucl. Sci.
- Int. J. Rock Mech. Min. Sci. Geomech. Abstr.
- J. Atmos. Chem.
- J. Atmos. Oceanic Technol.
- J. Atmos. Sci.
- J. Atmos. Terr. Phys.
- J. Fluid Mech.
- J. Geomagn. Geoelectr.
- J. High Resolut. Chromatogr.
- J. Petrol.
- J. Phys. Oceanogr.
- Mon. Weather Rev.
- Phys. Fluids
- Philos. Trans. R. Soc. London Ser. A
- Planet. Space Sci.
- Q. J. R. Meteorol. Soc.
- Remote Sens. Environ.
- Science

B.33 SOFTWARE

The SOFTWARE catalog object provides general information about a software tool including description, availability information, and dependencies.

The SOFTWARE catalog object is completed for each software program registered in the PDS Software Inventory. This Inventory includes software available within the planetary science community, including software on PDS archive volumes. Of interest are any applications, tools, or libraries that have proven useful for the display, analysis, formatting, transformation, or preparation of either science data or meta-data for the PDS archives.

B.33.1 Required Keywords

1. SOFTWARE_ID
2. SOFTWARE_VERSION_ID

B.33.2 Optional Keywords

None

B.33.3 Required Objects

1. SOFTWARE_INFORMATION
2. SOFTWARE_ONLINE
3. SOFTWARE_PURPOSE

B.33.4 Optional Objects

None

B.33.5 Example

```
/* Template: Software Template                      Rev: 1998-12-01              */

/* Note: This template should be completed to register software in the           */
/*       PDS Software Inventory.                                                 */

PDS_VERSION_ID                       = PDS3
LABEL_REVISION_NOTE                  = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                          = STREAM

OBJECT                               = SOFTWARE
  SOFTWARE_ID                        = NASAVIEW
```

```
  SOFTWARE_VERSION_ID                = "V1R2B"

  OBJECT                             = SOFTWARE_INFORMATION
    SOFTWARE_NAME                    = "NASAVIEW - PDS DATA PRODUCT ACCESS TOOL
                                        V1.2B"
    DATA_FORMAT                      = PDS
    SOFTWARE_LICENSE_TYPE            = PUBLIC_DOMAIN
    TECHNICAL_SUPPORT_TYPE           = FULL
    REQUIRED_STORAGE_BYTES           = "1.8MB"
    PDS_USER_ID                      = SHUGHES
    NODE_ID                          = CN
    SOFTWARE_DESC                    = "


  Software Overview
  =================
    NasaView Version 1.2b is a PDS Image display program developed for the following platforms:
    (a) PC / Win32
    (b) Unix / Sun OS

    NasaView is capable of accessing and displaying all images, tables, cubes, and histograms in
    the PDS archive. This release has been tested using Galileo, Magellan, Viking, MDIM, Voyager,
    IHW LSPN, and Clementine uncompressed images.

    NasaView is planned as a PDS data product object display utility that will run on SUN, MAC,
    and PC platforms in a GUI environment.

    This application was built using the Label Library Light (L3), Object Access Library (OAL),
    and the XVT Development Solution for C package. Label Library Light parses PDS ODL labels and
    creates an in-memory representation of the label information. The Object Access Library uses
    the parse-tree and accesses the actual PDS object. The XVT Development Solution supplies the
    cross platform GUI and an Object-oriented environment. XVT allows the definition of visual
    objects such as Windows and Menus and associates events and code with them.


  Available Support Material
  ==========================
       BINARIES


  Programming Language
  ====================
       SUN_C


  Platforms Supported
  ===================
       PC / Microsoft Win95, Win98, NT4.0


  Support Software Required / Used
  ================================
       X_WINDOWS

  END_OBJECT                         = SOFTWARE_INFORMATION

  OBJECT                             = SOFTWARE_ONLINE
    ON_LINE_IDENTIFICATION           = "http://pds.jpl.nasa.gov/license.html"
    ON_LINE_NAME                     = "NASAVIEW REVISION 2 BETA"
    NODE_ID                          = CN
    PROTOCOL_TYPE                    = URL
    PLATFORM                         = "PC/WIN32"
  END_OBJECT                         = SOFTWARE_ONLINE

  OBJECT                             = SOFTWARE_PURPOSE
    SOFTWARE_PURPOSE                 = DISPLAY
  END_OBJECT                         = SOFTWARE_PURPOSE

END_OBJECT                           = SOFTWARE
END
```

B.34 SOFTWARE_INFORMATION

The SOFTWARE_INFORMATION object, a sub-object of SOFTWARE catalog object, provides basic identification and operating system information associated with a specific SOFTWARE object.

B.34.1 Required Keywords

1. DATA_FORMAT
2. NODE_ID
3. PDS_USER_ID
4. REQUIRED_STORAGE_BYTES
5. SOFTWARE_DESC
6. SOFTWARE_LICENSE_TYPE
7. SOFTWARE_NAME
8. TECHNICAL_SUPPORT_TYPE

B.34.2 Optional Keywords

None

B.34.3 Required Objects

None

B.34.4 Optional Objects

None

B.34.5 Example

See the example for the SOFTWARE object in Section B.32.5.

B.35 SOFTWARE_ONLINE

The SOFTWARE_ONLINE object, a sub-object of SOFTWARE catalog object, provides identifying information for each PDS node providing access to a particular SOFTWARE object.

B.35.1 Required Keywords

1. NODE_ID
2. ON_LINE_IDENTIFICATION
3. ON_LINE_NAME
4. PLATFORM
5. PROTOCOL_TYPE

B.35.2 Optional Keywords

None

B.35.3 Required Objects

None

B.35.4 Optional Objects

None

B.35.5 Example

See the example for the SOFTWARE object in Section B.32.5.

B.36 SOFTWARE_PURPOSE

The SOFTWARE_PURPOSE object, a sub-object of SOFTWARE catalog object, describes the functionality provided by a specific SOFTWARE object.

B.36.1 Required Keywords

1. SOFTWARE_PURPOSE

B.36.2 Optional Keywords

None

B.36.3 Required Objects

None

B.36.4 Optional Objects

None

B.36.5 Example

See the example for the SOFTWARE object in Section B.32.5.

B.37 TARGET

The TARGET catalog object provides basic descriptive information for a single observational target.

B.37.1 Required Keywords

1. TARGET_NAME

B.37.2 Optional Keywords

None

B.37.3 Required Objects

1. TARGET_INFORMATION

B.37.4 Optional Objects

1. TARGET_REFERENCE_INFORMATION

B.37.5 Usage Notes

One TARGET_INFORMATION catalog object must be completed for each target. A TARGET_REFERENCE_INFORMATION catalog object is required for each individual reference associated with the target. All references should be included that are relevant to providing more detailed / specific target information; such as, type of target, orbit direction, description of the target, etc. These references may include published articles, books, papers, electronic publications, etc.

B.37.6 Example

```
/* Template: Target Template                    Rev: 1995-01-01    */

/* Note:  The following template is used for the                   */
/*        submission of a target to the PDS                        */

PDS_VERSION_ID                        = PDS3
LABEL_REVISION_NOTE                   = "1998-07-01, Richard Simpson (STANFORD), initial;"
RECORD_TYPE                           = STREAM
```

```
OBJECT                              = TARGET
  TARGET_NAME                       = JUPITER

  OBJECT                            = TARGET_INFORMATION
    TARGET_TYPE                     = PLANET
    PRIMARY_BODY_NAME               = SUN
    ORBIT_DIRECTION                 = PROGRADE
    ROTATION_DIRECTION              = PROGRADE
    TARGET_DESC                     = "

  A_AXIS_RADIUS              : 71492.000000
  B_AXIS_RADIUS              : 71492.000000
  BOND_ALBEDO                : UNK
  C_AXIS_RADIUS              : 66854.000000
  FLATTENING                 : 0.006500
  MAGNETIC_MOMENT            : 1550000000000000000000.000000
  MASS                       : 1898799999999999953652202602496.000000
  MASS_DENSITY               : 1.330000
  MINIMUM_SURFACE_TEMPERATURE : UNK
  MAXIMUM_SURFACE_TEMPERATURE : UNK
  MEAN_SURFACE_TEMPERATURE   : UNK
  EQUATORIAL_RADIUS          : 71492.000000
  MEAN_RADIUS                : 69911.000000
  SURFACE_GRAVITY            : 25.900000
  REVOLUTION_PERIOD          : 4333.000000
  POLE_RIGHT_ASCENSION       : 268.000000
  POLE_DECLINATION           : 64.500000
  SIDEREAL_ROTATION_PERIOD   : 0.410000
  MEAN_SOLAR_DAY             : 0.410000
  OBLIQUITY                  : 3.100000
  ORBITAL_ECCENTRICITY       : 0.048000
  ORBITAL_INCLINATION        : 1.300000
  ORBITAL_SEMIMAJOR_AXIS     : 778376719.000000
  ASCENDING_NODE_LONGITUDE   : 100.500000
  PERIAPSIS_ARGUMENT_ANGLE   : 275.200000"

  END_OBJECT                        = TARGET_INFORMATION

  OBJECT                            = TARGET_REFERENCE_INFORMATION
    REFERENCE_KEY_ID                = "XYZ95"
  END_OBJECT                        = TARGET_REFERENCE_INFORMATION

END_OBJECT                          = TARGET
END
```

B.38 TARGET_INFORMATION

The TARGET_INFORMATION object, a sub-object of the TARGET catalog object, provides physical and dynamic parameters of the target.

B.38.1 Required Keywords

1. ORBIT_DIRECTION
2. PRIMARY_BODY_NAME
3. ROTATION_DIRECTION
4. TARGET_DESC
5. TARGET_TYPE

B.38.2 Optional Keywords

None

B.38.3 Required Objects

None

B.38.4 Optional Objects

None

B.38.5 Example

See the example for the TARGET object in Section B.36.5.

B.39 TARGET_REFERENCE_INFORMATION

The TARGET_REFERENCE_INFORMATION object, a sub-object of the TARGET catalog object, associates a reference with a target. A separate object must be completed for each reference cited within the TARGET catalog object.

A separate REFERENCE catalog object is completed to provide the associated citation for each reference.

B.39.1 Required Keywords

1. REFERENCE_KEY_ID

Note: If there are no relevant references to cite, the REFERENCE_KEY_ID should have a value of "N/A".

B.39.2 Optional Keywords

None

B.39.3 Required Objects

None

B.39.4 Optional Objects

None

B.39.5 Usage Notes

NOTE: The following are recommended as the minimum set of information needed to describe a target adequately. Additional information may be added as desired. If any of the information not be available or is not known then, consult Chapter 17, Usage of N/A, UNK, and NULL.

```
A_AXIS_RADIUS
B_AXIS_RADIUS
BOND_ALBEDO
C_AXIS_RADIUS
FLATTENING
MAGNETIC_MOMENT
```

```
MASS
MASS_DENSITY
MINIMUM_SURFACE_TEMPERATURE
MAXIMUM_SURFACE_TEMPERATURE
MEAN_SURFACE_TEMPERATURE
EQUATORIAL_RADIUS
MEAN_RADIUS
SURFACE_GRAVITY
REVOLUTION_PERIOD
POLE_RIGHT_ASCENSION
POLE_DECLINATION
SIDEREAL_ROTATION_PERIOD
MEAN_SOLAR_DAY
OBLIQUITY
ORBITAL_ECCENTRICITY
ORBITAL_INCLINATION
ORBITAL_SEMIMAJOR_AXIS
ASCENDING_NODE_LONGITUDE
PERIAPSIS_ARGUMENT_ANGLE
```

B.39.6 Example

See the example for the TARGET object in Section B.36.5.