Thermal Emission Spectrometer

TES-TSDR Standard Data Product Software Interface Specification

N. Gorelick
Arizona State University

Approved by:

____
P. Christensen, Principal Investigator

____
G. Mehall, Instrument Manager

October 29, 1999

CONTENTS

1. Introduction

1.1. Purpose and Scope of Document

This document describes the format and content of the Thermal Emission Spectrometer (TES) Time Sequential Data Records (TSDR) standard data products.

1.2. Applicable Documents

TES Software Specification Document 642-441, Vol. 5
TES Operation User's Guide, 642-444 Vol. 5
PDS Data Dictionary, July 15, 1996, JPL D-7116, Rev D
PDS Data Preparation Workbook, Feb. 1995, Version 3.1, JPL D-7669, Part 1
Planetary Data System Standards Reference, July 1995, Version 3.2, JPL D-7669, Part 2

2. Data Product Characteristics and Environment

2.1. Instrument Overview

The TES instrument uses a Michelson interferometer to make infrared spectrometric measurements, and uses two sets of broad-band bolometric detectors to cover the thermal and visible bands. Each of the three bands has a co-aligned array of 6 detectors arranged in a 3x2 configuration and each detector has a field of view of 8.3 mrad square.

In normal operation the TES completes a scan of the Michelson mirror every 2 seconds and each of the spectrometer detectors measures the spectral radiance of the target at 143 wavelengths with 10-wavenumber spacing. The visual and thermal bolometers integrate during the entire scan and produce one measurement per detector. This 2-second scan is called a "single length" scan.

The TES has a second operating mode in which the Michelson mirror is scanned twice as far over a 4-second period. This mode is referred to as a "double length" scan and produces 286 spectral points with 5-wavenumber spacing for each of the spectrometer detectors. During double scans the two bolometric channels integrate twice as long, but still produce only a single value per detector.

The instrument also contains software to optionally perform spectral, spatial, and temporal averaging of the spectrometer data. None of these post-processing steps are applied to the bolometric data.

The TES has a rotating pointing mirror that allows the instrument to take measurements ranging from the nadir position up to and past the planet's limb in both the fore and aft directions. Additionally, the pointing mirror can be positioned to take measurements of space and of the internal reference surfaces and lamps contained within the body of the TES instrument.

2.2. Data Product Overview

The TES Standard Data Product contains the raw and calibrated thermal IR radiance spectra, the visual and thermal bolometric radiance measurements, and several atmospheric and surface properties derived from this data. Also included are the parameters that describe each observation, some downlinked diagnostic information, and the derived pointing and positional information calculated from the project's SPICE kernels.
The TES data are divided into the following 10 tables:

- OBS - Observation Parameters
- RAD - Raw and Calibrated Radiance Data
- BOL - Bolometer Data
- GEO – Derived Positional & Geometric Values
- POS – Raw Positional & Geometric Data

TLM - Auxiliary Observation Parameters
IFG - Raw Interferogram Data
CMP - Raw Complex Data
SRF - Derived Properties - Surface Observations
LMB - Derived Properties - Atmospheric Limb Observations

Each table is stored in a separate file with a PDS TABLE structure (i.e., using fixed-length binary records with extensions to handle the variable length spectra). Every record is stored with the spacecraft time, and related records can be retrieved from each table using time as a common key. In some tables up to 6 records can be stored for a given time, one for each detector. In these cases these records also include a field named "detector", that with the time field uniquely identifies the record.
Each scan of the instrument always produces the following data records:
1 record in the OBS table, 6 records in the BOL table.Because the instrument is capable of spatially and temporally averaging the spectral data, the number of records in the RAD table can vary from 0 to 6 for each scan. There are 7 spatial averaging combinations that combine together the data from different detectors. This has the net effect of reducing the number of active detectors, and consequently fewer spectra are downlinked. One RAD record is produced for each spectrum downlinked. The spatial masks are described in the DETMASK.TXT document.
If temporal averaging is applied to the spectrometer data, then the averaged data are associated with the first scan. The other scans in the average contain no spectrometer data, but still have OBS and BOL records associated with them.. All other tables, with the exception of the OBS and BOL tables, also treat temporally averaged data as belonging to the first scan. Each scan (or set of scans if temporal averaging is applied) may generate the following records as well:

1 record in the IFG table,
1 record in the CMP table,
1 record in the TLM table.

The data contained in these tables are downlinked from the instrument only upon request.

If a scan targets the planet (as opposed to targeting space or an internal reference surface) then the following records are also generated:

6 records in the GEO table
0 to 6 records in the SRF table

The SRF records are only generated for those scans that actually observe the planet's surface.

2.3. Standards Used in Generating Data Products

2.3.1. Time Standards

The time value stored with each TES-TSDR data record is the value of the spacecraft clock at the start of the observation, truncated to an integer value. This number is equal to the number of seconds since 12:00 a.m. 1/1/1980 GMT.

2.3.2. Coordinate Systems

All of the derived geometry fields that relate to longitude and latitude on the surface of Mars are computed using an areocentric coordinate system with west longitudes.

2.3.3 Orbit Numbers

The attached PDS labels for TES data files include the fields START_ORBIT_NUMBER and STOP_ORBIT_NUMBER. These fields refer to the beginning and ending orbits during which the data were acquired, using the TES Team orbit numbering system, also known as the Orbit Counter Keeper (ock). During the Orbit Insertion Phase TES ock numbers and MGS Project orbit numbers were identical, except that the Project counted orbits from one periapsis to the next, while TES considered an orbit to begin at the spacecraft nameuver preceding periapsis, usually a difference of no more than twenty minutes. However, the MGS Project reset its orbit count to 1 at the beginning of the Mapping Phase. TES ock numbers were not reset, in order to preserve the unique orbit identifier. For TES data products acquired during mapping, the MGS Project mapping orbit number can be determined by subtracting 1683 from the TES ock number. During mapping, both TES and the MGS Project consider the beginning of an orbit to occur at the descending equator crossing.

2.3.4. Data Storage Conventions

All the TES-TSDR records are stored in binary form. Numerical fields are stored using the most significant byte first (MSB), and real numbers are stored using standard IEEE floating-point format. Character and string fields are space padded but not null terminated.

3. Detailed Data Product Specifications

Each table is stored with a PDS TABLE structure using fixed-length binary records sorted time-sequentially. Each table file is prefixed with an ASCII header that describes the contents and format of the table, and a pointer that indicates where the binary table data start. The description identifies each column in the table, detailing its name, starting position (in bytes), size (in bytes), data type, description, and scaling factors if applicable. In some cases the column being described is a fixed-length array of related, homogeneous values (such as temperatures or voltages). For that case, the column description also includes the number of items in the array and the size of each item. A typical column description follows:

```
OBJECT              = COLUMN
NAME                = PNT_ANGLE
DATA_TYPE           = MSB_INTEGER
START_BYTE          = 12
BYTES               = 2
SCALING_FACTOR      = .046875
DESCRIPTION         = “Scan mirror pointing angle,
                      degrees from nadir.”
END_OBJECT          = COLUMN
```

The RAD, SRF, CMP, and IFG tables store some variable-length data. These variable length records are stored in a file separate from the fixed-length records and are addressed from the fixed-length records with a “pointer” column. Pointer columns contain the position of the variable length data, in bytes, from the start of the file in which it is listed. A position value of -1 in a pointer column indicates that there are no variable length data for that record. Additional keywords in a column’s description are used to identify it as a pointer to a variable length column, and describe the data in the variable length records. These keywords are:

```
VAR_DATA_TYPE
VAR_ITEM_BYTES
VAR_RECORD_TYPE
```

The VAR_DATA_TYPE and VAR_ITEM_BYTES keywords are similar to the PDS keywords DATA_TYPE and ITEM_BYTES, but refer to the structure of the variable-length data. The VAR_RECORD_TYPE keyword identifies the overall format of the variable-length record. This keyword has two possible values:

```
VAR_RECORD_TYPE = VAX_VARIABLE_LENGTH
VAR_RECORD_TYPE = Q15
```

The value VAX_VARIABLE_LENGTH indicates that the variable-length record has the size of the record in bytes, as a 2-byte integer, both before and after the record. This corresponds to the VAX/VMS variable-length record format.

Figure 1 illustrates the use of variable-length records, and how they relate to the fixed-length records. In this example, the table contains 2 columns, one of which is a pointer to the variable-length records. The table shows 6 rows, but only 5 of the rows actually point to variable-length records. The fourth record contains –1 in the pointer column, indicating that there are no variable-length data for that row.

```
OBJECT              = COLUMN
  NAME              = KEY
  DATA_TYPE         = ASCII_INTEGER
```

```
   BYTES                      = 1
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
   NAME                       = VDATA
   DATA_TYPE                  = ASCII_INTEGER
   BYTES                      = 2
   VAR_ITEM_BYTES             = 1
   VAR_RECORD_TYPE            = CHARACTER
   VAR_DATA_TYPE              = VAX_VARIABLE_LENGTH
END_OBJECT                    = COLUMN
```

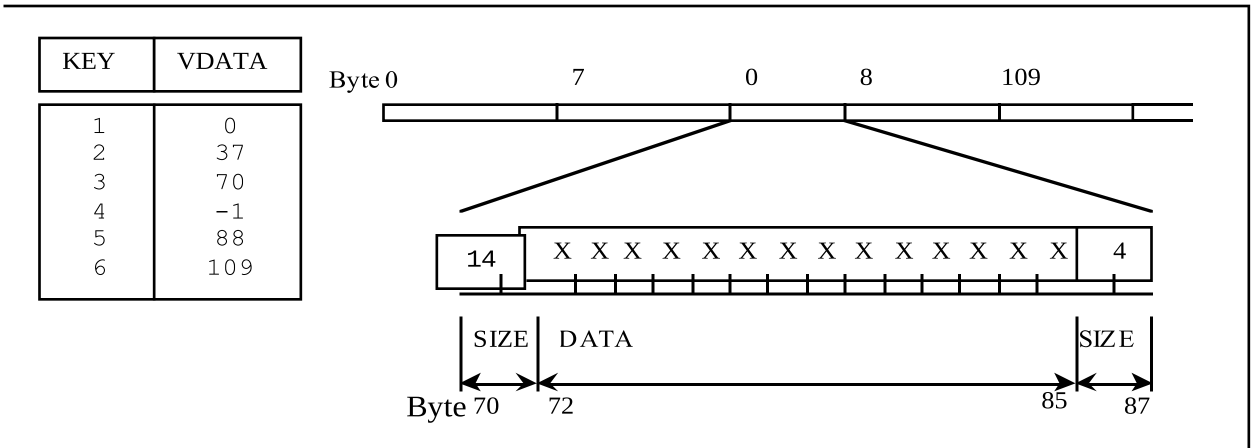

Figure 1. An example of a variable length

The Q15 format is very similar to the VAX_VARIABLE_LENGTH format; however it is only used to store floating point values in a compact representation. This format is an array of floating point mantissas stored as 2-byte signed integers. These mantissas share a scaling exponent that is stored as the first item in the record as another 2-byte signed integer. All the elements in the array must be scaled by the exponent, by multiplying them by 2 to the power (exp-15). Just like the VAX_VARIABLE_LENGTH records, the Q15 records are also stored with the size of the record in bytes, as a 2-byte integer, both before and after the record. A diagram of a complete Q15 variable length record is shown in figure 2.

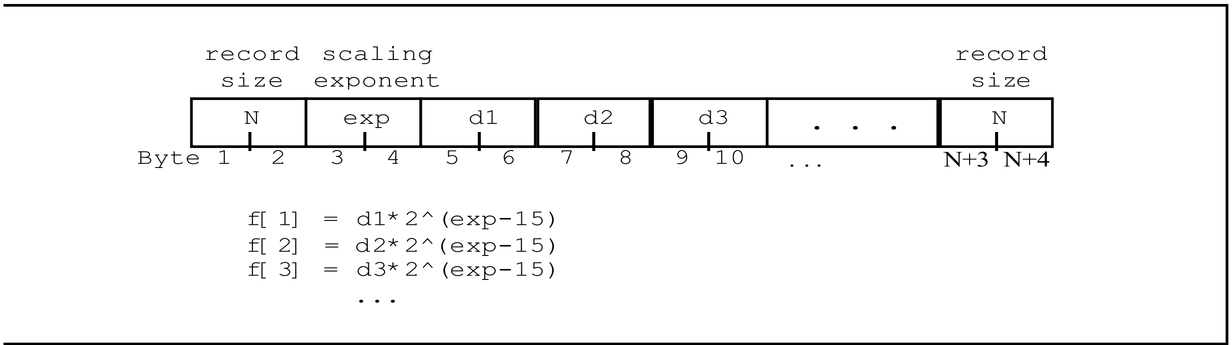

Figure 2. A Q15 record

The fixed-length records are stored in files with a .DAT extension. The variable length records that are referenced by an individual .DAT file can be found in a file with the same name, but with a .VAR extension.

3.1. Label and Header Descriptions

Each .DAT file is prefixed with an ASCII header in PDS 3.0 format. The format of this header consists of sets of keyword=value pairs, followed by the keyword END. A sample header is given below:

PDS_VERSION_ID	= PDS3
FILE_NAME	= "OBS04101.DAT"
RECORD_TYPE	= FIXED_LENGTH
RECORD_BYTES	= 39
FILE_RECORDS	= 1245
LABEL_RECORDS	= 35
^TABLE	= 36
SPACECRAFT_ID	= MGS
INSTRUMENT_ID	= TES
MISSION_PHASE_NAME	= "MAPPING"
TARGET_NAME	= MARS
PRODUCT_ID	= "TES04101"
PRODUCER_ID	= MGS_TES_TEAM
DATA_SET_ID	= "MGS-M-TES-3-TSDR-V1.0"
PRODUCT_RELEASE_DATE	= 1998-08-18
PRODUCT_CREATION_TIME	= 1998-08-18T17:30:00
START_TIME	= 1997-10-26T08:33:44.293
STOP_TIME	= 1997-10-29T06:43:30.274
SPACECRAFT_CLOCK_START_COUNT	= 562322042
SPACECRAFT_CLOCK_STOP_COUNT	= 562574628
START_ORBIT_NUMBER	= 28

```
   STOP_ORBIT_NUMBER                = 29

   OBJECT                           = TABLE
      NAME                          = OBS
      INTERCHANGE_FORMAT            = BINARY
      PRIMARY_KEY                   = ( "SPACECRAFT_CLOCK_START_COUNT",
                                    "DETECTOR_NUMBER" )
      START_PRIMARY_KEY             = ( 562322042, 1 )
      STOP_PRIMARY_KEY              = ( 562574628, 6 )
      ROWS                          = 1210
      STRUCTURE                     = "OBS.FMT"
   END_OBJECT                       = TABLE
END
```

The above header consists of three primary parts: a description of the whole file, a pointer to the binary table data, and a set of nested PDS objects that identify the contents and layout of the table.

The first few lines of the header describe the overall structure of the file and in this case indicate that the file consists of 1,245 fixed-length records, 39 bytes in length. These lines include the entire ASCII header which is padded with white space to occupy an integral number of records of this length.

The keyword TABLE is a pointer to the start of the binary data. The number given with this keyword is the record number of the start of the table data. In this case the record number is 36, which starts at byte 1404 counting from byte zero (35 records * 39 bytes/record).

The remainder of the header identifies the origin of the data and describes the table contained in the file. The data are identified by the time they were acquired, as shown in the SPACECRAFT_CLOCK_START_TIME and SPACECRAFT_CLOCK_STOP_TIME keywords which contain the time on the first and last record in the file, respectively. These times are also given as UTC time strings in the START_TIME and STOP_TIME fields

The columns within the table are specified as a collection of PDS COLUMN objects. A sample column definition follows:

```
        OBJECT                      = COLUMN
              NAME                  = POINTING_MIRROR_ANGLE
              ALIAS_NAME            = PNT_ANGLE
              DATA_TYPE             = MSB_INTEGER
              START_BYTE            = 10
              BYTES                 = 2
              SCALING_FACTOR        = .046875
              DESCRIPTION           = "Scan mirror pointing angle,
                                    degrees from nadir."
        END_OBJECT                  = COLUMN
```

The column definitions give the name, type, and size of every field in the table. In the case of this field, "pnt_angle", a scaling factor is also given to convert from the stored value to useful units. A scaling offset may also be included, but if not included, should be assumed to be zero. Scaling factors and offsets should be applied as follows:

scaled_value = (stored_value * scaling_factor) + scaling_offset

Descriptions are provided for every column as well. These descriptions are surrounded by quotes and may span several lines. In the case of a fixed-length array, the BYTES term indicates the size of the array, and the two fields ITEMS and ITEM_SIZE are included to describe the number and size of a single element in the array.

This following column description indicates the column "interferogram_maximum" and is a homogeneous array of 6, 2-byte integers.

```
        OBJECT                      = COLUMN
              NAME                  = INTERFEROGRAM_MAXIMUM
              DATA_TYPE             = MSB_INTEGER
```

```
        START_BYTE          = 29
        BYTES               = 12
        ITEMS               = 6
        ITEM_BYTES          = 2
        SCALING_FACTOR      = .000152587890625
        DESCRIPTION         = "Array of 6 interferogram maximum values"
    END_OBJECT              = COLUMN
```

4. Applicable Software

4.1. Utility Programs

The TES project has produced a software tool that not only reads the PDS table and the variable-length records, but is also capable of joining the related records among multiple tables. This piece of software is called 'vanilla' and is included on every volume. In addition the software is available via anonymous ftp from ftp://east.la.asu.edu/pub/software/vanilla/vanilla.tar.Z.

The vanilla program was developed for use on UNIX machines with integers in MSB_INTEGER format, and for PCs.

4.2. Applicable PDS Software Tools

The TES team uses no PDS software to view, manipulate or process the data. However, the tables are stored using the PDS TABLE standard structure and any tool that understands that structure should be able to read all of the data except the variable-length spectra.

A. Appendices

A.1 TLM Table

```
NAME                        = TLM
COLUMNS                     = 31
ROW_BYTES                   = 113
DESCRIPTION                 = "

  The TLM table stores the auxiliary observation parameters
  downlinked with the long packet format (see OBS Table, DATA_PACKET_TYPE).
  Records in the TLM table occur at a frequency less than or equal
  to the frequency of OBS records; that is, one (or none) per
  observation."

OBJECT                      = COLUMN
    NAME                    = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 1
    BYTES                   = 4
    ALIAS_NAME              = sclk_time
    DESCRIPTION             = "The value of the spacecraft clock at the
                            beginning of the observation"
END_OBJECT                  = COLUMN


OBJECT                      = COLUMN
    NAME                    = AUXILIARY_DIAGNOSTIC_TEMPS
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 5
    BYTES                   = 24
    ITEMS                   = 12
    ITEM_BYTES              = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = aux_temps
    DESCRIPTION             = "Array of 12 auxiliary temperatures,
                            Read from internal instrument thermistors.
                                    1: T5 - Black Body 1
                                    2: T6 - Black Body 2
                                    3: T7 - Black Body 3
                                    4: T8 - Bolometric Black Body Reference (spare)
                                    5: T9 - Electronics
                                    : T10 - Power Supply
                                    7: T11 - Telescope Field Stop
                                    8: T12 - Interferometer Fixed Mirror
                                    9: T13 - Interferometer Beamsplitter
                                    10: T14 - Interferometer Motor
                                    11: T15 - Primary Mirror
                                    12: T16 - Secondary Mirror"
    UNIT                    = "K"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
```

```
     NAME                  = INTERFEROGRAM_MAXIMUM
     DATA_TYPE             = MSB_INTEGER
     START_BYTE            = 29
     BYTES                 = 12
     ITEMS                 = 6
     ITEM_BYTES            = 2
     SCALING_FACTOR        = 0.000152587890625
     ALIAS_NAME            = ifgm_max
     DESCRIPTION           = "Array of 6 interferogram maximum values,
                             one for each spectrometer detector.
                             Scaling factor is 5.0/32768 V"
     UNIT                  = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
     NAME                  = INTERFEROGRAM_MINIMUM
     DATA_TYPE             = MSB_INTEGER
     START_BYTE            = 41
     BYTES                 = 12
     ITEMS                 = 6
     ITEM_BYTES            = 2
     SCALING_FACTOR        = 0.000152587890625
     ALIAS_NAME            = ifgm_min
     DESCRIPTION           = "Array of 6 interferogram minimum values,
                             one for each spectrometer detector.
                              Scaling factor is 5.0/32768 V"
     UNIT                  = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
     NAME                  = ONBOARD_PROCESSING_EVENT_LOG
     DATA_TYPE             = MSB_UNSIGNED_INTEGER
     START_BYTE            = 53
     BYTES                 = 12
     ITEMS                 = 6
     ITEM_BYTES            = 2
     ALIAS_NAME            = dsp_log
     DESCRIPTION           = "Array of digital signal processor event logs,
                             16-bit mask, one for each spectrometer detector.
                             See TES User's Guide for details"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
     NAME                  = DIAGNOSTIC_TELEMETRY_1
     DATA_TYPE             = MSB_INTEGER
     START_BYTE            = 65
     BYTES                 = 1
     SCALING_FACTOR        = 3.90625
     ALIAS_NAME            = V1
     DESCRIPTION           = "Electronic power supply load current"
     UNIT                  = "mA"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
     NAME                  = DIAGNOSTIC_TELEMETRY_2
     DATA_TYPE             = MSB_INTEGER
     START_BYTE            = 66
```

```
    BYTES                   = 1
    SCALING_FACTOR          = 1.95312
    ALIAS_NAME              = V2
    DESCRIPTION             = “Mechanic power supply load current”
    UNIT                    = “mA”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_3
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 67
    BYTES                   = 1
    SCALING_FACTOR          = 0.278906
    ALIAS_NAME              = V3
    DESCRIPTION             = “Diagnostic voltage P26V2.
                              +26v: Pointing mirror motor.”
    UNIT                    = “VOLTS”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_4
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 68
    BYTES                   = 1
    SCALING_FACTOR          = 0.278906
    ALIAS_NAME              = V4
    DESCRIPTION             = “Diagnostic voltage P28V2.
                              +28v: Interferometer motor.”
    UNIT                    = “VOLTS”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_5
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 69
    BYTES                   = 1
    SCALING_FACTOR          = 4.45312
    OFFSET                  = -17.00000
    ALIAS_NAME              = V5
    DESCRIPTION             = “Pointing mirror motor current”
    UNIT                    = “mA”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_6
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 70
    BYTES                   = 1
    SCALING_FACTOR          = 0.652344
    ALIAS_NAME              = V6
    DESCRIPTION             = “Interferometer motor current”
    UNIT                    = “mA”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_7
    DATA_TYPE               = MSB_INTEGER
```

```
    START_BYTE              = 71
    BYTES                   = 1
    SCALING_FACTOR          = 0.119457
    ALIAS_NAME              = V7
    DESCRIPTION             = "Diagnostic voltage P10V1.
                               +10v: Servo Electronics"
    UNIT                    = "VOLTS"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_8
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 72
    BYTES                   = 1
    SCALING_FACTOR          = -0.103067
    ALIAS_NAME              = V8
    DESCRIPTION             = "Diagnostic voltage N10V1.
                               -10v: Servo Electronics"
    UNIT                    = "VOLTS"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_9
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 73
    BYTES                   = 1
    SCALING_FACTOR          = 0.15576
    ALIAS_NAME              = V9
    DESCRIPTION             = "Diagnostic voltage P16V1.
                               +16v: Analog MUX and A/D"
    UNIT                    = "VOLTS"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_10
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 74
    BYTES                   = 1
    SCALING_FACTOR          = -0.15625
    ALIAS_NAME              = V10
    DESCRIPTION             = "Diagnostic voltage N16V1.
                               -16v: Analog MUX and A/D"
    UNIT                    = "VOLTS"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = DIAGNOSTIC_TELEMETRY_11
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 75
    BYTES                   = 1
    SCALING_FACTOR          = 0.0976055
    ALIAS_NAME              = V11
    DESCRIPTION             = "Diagnostic voltage P10V2.
                               +10v: Heaters"
    UNIT                    = "VOLTS"
END_OBJECT                  = COLUMN
```

```
OBJECT                    = COLUMN
   NAME                   = DIAGNOSTIC_TELEMETRY_12
   DATA_TYPE              = MSB_INTEGER
   START_BYTE             = 76
   BYTES                  = 1
   SCALING_FACTOR         = -0.0985813
   ALIAS_NAME             = V12
   DESCRIPTION            = “Diagnostic voltage N10V2.
                          -10v: Heaters”
   UNIT                   = “VOLTS”
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
   NAME                   = DIAGNOSTIC_TELEMETRY_13
   DATA_TYPE              = MSB_INTEGER
   START_BYTE             = 77
   BYTES                  = 1
   SCALING_FACTOR         = 0.976562
   ALIAS_NAME             = V13
   DESCRIPTION            = “Albedo Calibration Lamps current”
   UNIT                   = “mA”
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
   NAME                   = DIAGNOSTIC_TELEMETRY_14
   DATA_TYPE              = MSB_INTEGER
   START_BYTE             = 78
   BYTES                  = 1
   SCALING_FACTOR         = 0.0648437
   ALIAS_NAME             = V14
   DESCRIPTION            = “Neon lamps current”
   UNIT                   = “mA”
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
   NAME                   = DIAGNOSTIC_TELEMETRY_15
   DATA_TYPE              = MSB_INTEGER
   START_BYTE             = 79
   BYTES                  = 1
   SCALING_FACTOR         = 0.045727
   ALIAS_NAME             = V15
   DESCRIPTION            = “Diagnostic voltage P5V1.
                           +5v: Servo electronics and DSP”
   UNIT                   = “VOLTS”
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
   NAME                   = DIAGNOSTIC_TELEMETRY_16
   DATA_TYPE              = MSB_INTEGER
   START_BYTE             = 80
   BYTES                  = 1
   SCALING_FACTOR         = 0.0480992
   ALIAS_NAME             = V16
   DESCRIPTION            = “Diagnostic voltage P5V2.
                          Control processor and BIU.”
   UNIT                   = “VOLTS”
END_OBJECT                = COLUMN
```

```
OBJECT                     = COLUMN
    NAME                   = DIAGNOSTIC_TELEMETRY_17
    DATA_TYPE              = MSB_INTEGER
    START_BYTE             = 81
    BYTES                  = 1
    SCALING_FACTOR         = 0.0478277
    ALIAS_NAME             = V17
    DESCRIPTION            = "Diagnostic voltage P5V3.
                           +5v: Analog MUX, A/D, Timing sequencer"
    UNIT                   = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = DIAGNOSTIC_TELEMETRY_18
    DATA_TYPE              = MSB_INTEGER
    START_BYTE             = 82
    BYTES                  = 1
    SCALING_FACTOR         = 0.0488039
    ALIAS_NAME             = V18
    DESCRIPTION            = "Diagnostic voltage P5V4.
                            +5v: Fringe and ZPD circuit"
    UNIT                   = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = DIAGNOSTIC_TELEMETRY_19
    DATA_TYPE              = MSB_INTEGER
    START_BYTE             = 83
    BYTES                  = 1
    SCALING_FACTOR         = 0.141966
    ALIAS_NAME             = V19
    DESCRIPTION            = "Diagnostic voltage P15V1.
                           +15v Amplifiers"
    UNIT                   = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = DIAGNOSTIC_TELEMETRY_20
    DATA_TYPE              = MSB_INTEGER
    START_BYTE             = 84
    BYTES                  = 1
    SCALING_FACTOR         = -0.149688
    ALIAS_NAME             = V20
    DESCRIPTION            = "Diagnostic voltage N15V1.
                            -15v Amplifiers"
    UNIT                   = "VOLTS"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = NEON_LAMP
    DATA_TYPE              = MSB_UNSIGNED_INTEGER
    START_BYTE             = 85
    BYTES                  = 1
    ALIAS_NAME             = neon_lamp
    DESCRIPTION            = " Control interferometer neon lamp in use,
                            primary (1) or backup(2)"
```

```
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = NEON_GAIN
    DATA_TYPE                 = CHARACTER
    START_BYTE                = 86
    BYTES                     = 1
    ALIAS_NAME                = neon_gain
    DESCRIPTION               = “Control interferometer neon lamp gain,
                                      (L)ow or (H)igh”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = NEON_AMPLITUDE
    DATA_TYPE                 = MSB_INTEGER
    START_BYTE                = 87
    BYTES                     = 1
    ALIAS_NAME                = neon_amp
    DESCRIPTION               = “Control interferogram signal amplitude at zero
                              path difference (zpd)”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = NEON_ZPD
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 88
    BYTES                     = 2
    ALIAS_NAME                = neon_zpd
    DESCRIPTION               = “Control interferogram zero path difference (zpd)
                              location measured in counts from start of scan”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = INTERFEROGRAM_ZPD
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 90
    BYTES                     = 12
    ITEMS                     = 6
    ITEM_BYTES                = 2
    ALIAS_NAME                 = ifgm_zpd
    DESCRIPTION               = “IR interferogram zero path difference (zpd) location
                              measured from start of scan”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = INTERFEROGRAM_END
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 102
    BYTES                     = 12
    ITEMS                     = 6
    ITEM_BYTES                = 2
    ALIAS_NAME                = ifgm_end
    DESCRIPTION               = “Number of extra counts at end of each IR
                               interferogram”
END_OBJECT                    = COLUMN
```

A.2 BOL Table

```
NAME                         = BOL
COLUMNS                      = 10
ROW_BYTES                    = 28
DESCRIPTION                  = “

  The BOL table contains the raw and calibrated visual and thermal
  bolometer measurements, and several properties derived from these
  measurements.

  Six BOL records are generated for each instrument scan, one for
  each detector.  When spectrometer data are temporally averaged,
  there can be up to 4 scans of bolometer data.”

OBJECT                       = COLUMN
    NAME                     = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 1
    BYTES                    = 4
    ALIAS_NAME               = sclk_time
    DESCRIPTION              = “The value of the spacecraft clock at the
                                beginning of the observation”
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = DETECTOR_NUMBER
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 5
    BYTES                    = 1
    ALIAS_NAME               = detector
    DESCRIPTION              = “The number of the detector that made
                                the observation. Detectors are numbered
                                from 1 to 6"
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = TEMPORAL_INTEGRATION_SCAN_NUMBER
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 6
    BYTES                    = 1
    ALIAS_NAME               = tic_count
    DESCRIPTION              = “The number of the scan from the set of temporally
                               averaged scans”
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = RAW_VISUAL_BOLOMETER
    DATA_TYPE                = MSB_INTEGER
    START_BYTE               = 7
    BYTES                    = 2
    SCALING_FACTOR           = .000152587890625
    ALIAS_NAME               = vbol
    DESCRIPTION              = “Raw visual bolometer data, per detector.
```

```
                                   Scaling factor is 5.0/2^15."
    UNIT                           = "VOLTS"
END_OBJECT                         = COLUMN

OBJECT                             = COLUMN
    NAME                           = RAW_THERMAL_BOLOMETER
    DATA_TYPE                      = MSB_INTEGER
    START_BYTE                     = 9
    BYTES                          = 2
    SCALING_FACTOR                 = .000152587890625
    ALIAS_NAME                     = tbol
    DESCRIPTION                    = "Raw thermal bolometer data, per detector,
                                   Scaling factor is 5.0/2^15."
    UNIT                           = "VOLTS"
END_OBJECT                         = COLUMN

OBJECT                             = COLUMN
    NAME                           = CALIBRATED_VISUAL_BOLOMETER
    DATA_TYPE                      = IEEE_REAL
    START_BYTE                     = 11
    BYTES                          = 4
    ALIAS_NAME                     = cal_vbol
    DESCRIPTION                    = "Calibrated visual bolometric radiance."
    UNIT                           = "watt cm-2 stradian-1 micron-1"
END_OBJECT                         = COLUMN

OBJECT                             = COLUMN
    NAME                           = LAMBERT_ALBEDO
    DATA_TYPE                      = IEEE_REAL
    START_BYTE                     = 15
    BYTES                          = 4
    ALIAS_NAME                     = lambert_alb
    DESCRIPTION                    = "Lambertian albedo, derived from visual bolometer"
END_OBJECT                         = COLUMN

OBJECT                             = COLUMN
    NAME                           = BOLOMETRIC_THERMAL_INERTIA
    DATA_TYPE                      = IEEE_REAL
    START_BYTE                     = 19
    BYTES                          = 4
    ALIAS_NAME                     = ti_bol
    DESCRIPTION                    = "Thermal inertia, derived from thermal bolometer"
    UNIT                           = "J m-2 s-1/2 K-1"
END_OBJECT                         = COLUMN

OBJECT                             = COLUMN
    NAME                           = BOLOMETRIC_BRIGHTNESS_TEMP
    DATA_TYPE                      = MSB_UNSIGNED_INTEGER
    START_BYTE                     = 23
    BYTES                          = 2
    SCALING_FACTOR                 = 0.01
    ALIAS_NAME                     = brightness_temp_bol
    DESCRIPTION                    = "Temperature observed by the thermal bolometer,
                                    assuming the target is radiating as a black body"
    UNIT                           = "K"
END_OBJECT                         = COLUMN
```

```
OBJECT                    = COLUMN
    NAME                  = BOLOMETER_CALIBRATION_ID
    DATA_TYPE             = CHARACTER
    START_BYTE            = 25
    BYTES                 = 4
    ALIAS_NAME            = version_id
    DESCRIPTION           = “Calibration algorithm version ID for bolometer data”
END_OBJECT                = COLUMN
```

A.3 CMP Table

```
NAME                    = CMP
COLUMNS                 = 3
ROW_BYTES               = 9
DESCRIPTION             = "

   The CMP table contains the real and complex data from the FFT.
   The complex data is only downlinked when requested and can only
   be requested for a single detector per observation.

   The CMP array contains 286 points (143 real, 143 complex) for a
   short scan (OBS Table, SCAN_LENGTH = 1), and 572 points (286 real, 286
   complex) for a long scan (OBS Table, SCAN_LENGTH = 2)."

OBJECT                  = COLUMN
    NAME                = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 1
    BYTES               = 4
    ALIAS_NAME          = sclk_time
    DESCRIPTION         = "The value of the spacecraft clock at the
                        beginning of the observation"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = DETECTOR_NUMBER
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 5
    BYTES               = 1
    ALIAS_NAME          = detector
    DESCRIPTION         = "The number of the spectrometer detector that
                         made the observation. Detectors are numbered
                         from 1 to 6"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = FFT_COMPLEX_DATA
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 6
    BYTES               = 4
    VAR_DATA_TYPE       = MSB_INTEGER
    VAR_ITEM_BYTES      = 2
    VAR_RECORD_TYPE     = Q15
    ALIAS_NAME          = complex
    DESCRIPTION         = "The real and imaginary parts of the FFT. This
                         column is the pointer to the data."
    UNIT                = "Transformed Volts"
END_OBJECT              = COLUMN
```

A.4 GEO Table

```
NAME                    = GEO
COLUMNS                 = 20
ROW_BYTES               = 43
DESCRIPTION             = “

  The GEO table contains information about the sun/spacecraft/target
  geometry in a format that is easily searchable.  These values are
  computed for every scan other than those used to calibrate the
  instrument.  If a viewing vector does not intersect the target body
  (i.e., an atmospheric observation), then most of the geometry is calculated
  relative to the point on the viewing vector closest to the body (i.e., the
  tangent point).  If the closest point lies behind the spacecraft, fill
  values are used.”

OBJECT                  = COLUMN
    NAME                = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 1
    BYTES               = 4
    ALIAS_NAME          = sclk_time
    DESCRIPTION         = “The value of the spacecraft clock at the
                           beginning of the observation”
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = DETECTOR_NUMBER
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 5
    BYTES               = 1
    ALIAS_NAME          = detector
    DESCRIPTION         = “The number of the spectrometer detector that
                           made the observation. Detectors are numbered
                          from 1 to 6"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = LONGITUDE
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 6
    BYTES               = 2
    SCALING_FACTOR      = 0.01
    DESCRIPTION         = “Areocentric west longitude of target point”
    UNIT                = “DEGREE”
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = LATITUDE
    DATA_TYPE           = MSB_INTEGER
    START_BYTE          = 8
    BYTES               = 2
    SCALING_FACTOR      = 0.01
    DESCRIPTION         = “Areocentric latitude of target point”
```

```
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = PHASE_ANGLE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 10
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = phase
    DESCRIPTION             = “Angle between the spacecraft, the target point
                              and the sun”
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = EMISSION_ANGLE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 12
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = emission
    DESCRIPTION             = “Angle between the spacecraft, the target point and
                              the surface normal vector at the target”
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = INCIDENCE_ANGLE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 14
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = incidence
    DESCRIPTION             = “Angle between the sun, the target point and the
                              surface normal vector at the target”
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = PLANETARY_PHASE_ANGLE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 16
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = planetary_phase
    DESCRIPTION             = “Angle between the spacecraft, the center of the
                              target body and the sun”
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = SOLAR_LONGITUDE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 18
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
```

```
    DESCRIPTION          = "Planetocentric longitude of the sun"
    UNIT                 = "DEGREE"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = SUB_SPACECRAFT_LONGITUDE
    DATA_TYPE            = MSB_UNSIGNED_INTEGER
    START_BYTE           = 20
    BYTES                = 2
    SCALING_FACTOR       = 0.01
    ALIAS_NAME           = sub_sc_lon
    DESCRIPTION          = "Areocentric west longitude of sub-spacecraft point"
    UNIT                 = "DEGREE"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = SUB_SPACECRAFT_LATITUDE
    DATA_TYPE            = MSB_INTEGER
    START_BYTE           = 22
    BYTES                = 2
    SCALING_FACTOR       = 0.01
    ALIAS_NAME           = sub_sc_lat
    DESCRIPTION          = "Areocentric latitude of sub-spacecraft point"
    UNIT                 = "DEGREE"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = SUB_SOLAR_LONGITUDE
    DATA_TYPE            = MSB_UNSIGNED_INTEGER
    START_BYTE           = 24
    BYTES                = 2
    SCALING_FACTOR       = 0.01
    ALIAS_NAME           = sub_solar_lon
    DESCRIPTION          = "Areocentric west longitude of the sub-solar point"
    UNIT                 = "DEGREE"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = SUB_SOLAR_LATITUDE
    DATA_TYPE            = MSB_INTEGER
    START_BYTE           = 26
    BYTES                = 2
    SCALING_FACTOR       = 0.01
    ALIAS_NAME           = sub_solar_lat
    DESCRIPTION          = "Areocentric latitude of the sub-solar point"
    UNIT                 = "DEGREE"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = TARGET_DISTANCE
    DATA_TYPE            = MSB_UNSIGNED_INTEGER
    START_BYTE           = 28
    BYTES                = 2
    DESCRIPTION          = "Distance from the spacecraft to the target point"
    UNIT                 = "KM"
END_OBJECT               = COLUMN
```

```
OBJECT                        = COLUMN
    NAME                      = TARGET_ALTITUDE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 30
    BYTES                     = 2
    SCALING_FACTOR            = 0.01
    ALIAS_NAME                = height
    DESCRIPTION               = “Distance from the surface to the target point.
                              This value is non-zero only for atmospheric
                              targets”
    UNIT                      = “KM”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = SPACECRAFT_ALTITUDE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 32
    BYTES                     = 2
    ALIAS_NAME                = altitude
    DESCRIPTION               = “Distance from the spacecraft to the sub-spacecraft
                               point on the surface”
    UNIT                      = “KM”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = LOCAL_TIME
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 34
    BYTES                     = 2
    SCALING_FACTOR            = 0.001
    DESCRIPTION               = “Local time at target, in decimal Martian hours.
                              The Martian day is divided into 24 equal hours.”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = SOLAR_DISTANCE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 36
    BYTES                     = 2
    SCALING_FACTOR            = 10000
    DESCRIPTION               = “Distance from the center of the sun to the center
                               of the target body”
    UNIT                      = “KM”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = PLANETARY_ANGULAR_RADIUS
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 38
    BYTES                     = 2
    SCALING_FACTOR            = 0.01
    ALIAS_NAME                = angular_semidiameter
    DESCRIPTION               = “Smallest angular radius of Mars as viewed from
                              the spacecraft.”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
```

```
    NAME            = GEOMETRY_CALIBRATION_ID
    DATA_TYPE       = CHARACTER
    START_BYTE      = 40
    BYTES           = 4
    ALIAS_NAME      = version_id
    DESCRIPTION     = “Version ID of geometry algorithm used”
END_OBJECT          = COLUMN
```

A.5 IFG Table

```
NAME                          = IFG
COLUMNS                       = 3
ROW_BYTES                     = 9
DESCRIPTION                   = “

  The IFG table contains the raw interferogram data.  The
  interferogram data is only downlinked when requested and
  can only be requested for a single detector per observation.

  The IFG array contains 1600 points for a short scan
  (OBS Table, SCAN_LENGTH = 1), and 3200 points for a long scan
  (OBS Table, SCAN_LENGTH = 2).”

OBJECT                        = COLUMN
   NAME                       = SPACECRAFT_CLOCK_START_COUNT
   DATA_TYPE                  = MSB_UNSIGNED_INTEGER
   START_BYTE                 = 1
   BYTES                      = 4
   ALIAS_NAME                 = sclk_time
   DESCRIPTION                = “The value of the spacecraft clock at the
                              beginning of the observation”
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
   NAME                       = DETECTOR_NUMBER
   DATA_TYPE                  = MSB_UNSIGNED_INTEGER
   START_BYTE                 = 5
   BYTES                      = 1
   ALIAS_NAME                 = detector
   DESCRIPTION                = “The number of the spectrometer detector that
                               made the observation. Detectors are
                              numbered from 1 to 6"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
   NAME                       = INTERFEROGRAM_DATA
   DATA_TYPE                  = MSB_UNSIGNED_INTEGER
   START_BYTE                 = 6
   BYTES                      = 4
   VAR_DATA_TYPE              = MSB_INTEGER
   VAR_ITEM_BYTES             = 2
   VAR_RECORD_TYPE            = Q15
   ALIAS_NAME                 = ifgm
   DESCRIPTION                = “Raw interferogram data”
   UNIT                       = “VOLTS”
END_OBJECT                    = COLUMN
```

A.6 LMB Table

```
NAME                        = LMB
COLUMNS                     = 8
ROW_BYTES                   = 1592
DESCRIPTION                 = “
```

The LMB table contains values derived from spectra that look at the limb of Mars. It contains one record for each limb set - sequential observations that view the limb at different altitudes. See the limb parameters quality word for information on the validity of calculated variables. The aerosol information may include data from surface observations taken at other times of the same geographic location.

The uncertainty array provides error information for surface radiance spectrum values taken near the same time.”

```
OBJECT                      = COLUMN
    NAME                    = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 1
    BYTES                   = 4
    ALIAS_NAME              = sclk_time
    DESCRIPTION             = “The value of the spacecraft clock at the
                            beginning of the observation”
END_OBJECT                  = COLUMN


OBJECT                      = COLUMN
    NAME                    = AEROSOL_OPACITY_PROFILE_LIMB
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 5
    BYTES                   = 76
    ITEMS                   = 38
    ITEM_BYTES              = 2
    SCALING_FACTOR          = 0.001
    ALIAS_NAME              = opacity_profile
    DESCRIPTION             = “Aerosol integrated normal optical depth from
                            infinity to each of 38 pressures at TBD microns.”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = AEROSOL_OPACITY_SPECTRUM_LIMB
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 81
    BYTES                   = 572
    ITEMS                   = 286
    ITEM_BYTES              = 2
    SCALING_FACTOR          = 0.001
    ALIAS_NAME              = opacity_spectrum
    DESCRIPTION             = “Aerosol column optical depth spectrum
                             to surface”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = AEROSOL_SNG_SCAT_ALB_SPECTRUM
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
```

```
      START_BYTE               = 653
      BYTES                    = 572
      ITEMS                    = 286
      ITEM_BYTES               = 2
      SCALING_FACTOR           = 0.001
      ALIAS_NAME               = ss_albedo
      DESCRIPTION              = "Aerosol single scattering albedo spectrum at
                                  pressure level indicated in aerosol_sng_
                                  scat_pres_level_ind column."
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
      NAME                     = AEROSOL_SNG_SCAT_PRES_LEVEL_IND
      DATA_TYPE                = MSB_UNSIGNED_INTEGER
      START_BYTE               = 1225
      BYTES                    = 1
      ALIAS_NAME               = ss_pressure
      DESCRIPTION              = "Pressure Level index (1-38) of the pressure
                                  level to which the single scattering albedo
                                  spectrum pertains.
                                  Pressure level is chosen where the tangent
                                 optical depth is approximately unity."
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
      NAME                     = LIMB_TEMPERATURE_PROFILE
      DATA_TYPE                = MSB_UNSIGNED_INTEGER
      START_BYTE               = 1226
      BYTES                    = 76
      ITEMS                    = 38
      ITEM_BYTES               = 2
      SCALING_FACTOR           = 0.01
      ALIAS_NAME               = limb_pt
      DESCRIPTION              = "Atmospheric temperature profile at 38 pressures
                                  derived from limb set observation"
      UNIT                     = "K"
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
      NAME                     = SURFACE_RAD_SPECTRUM_UNCERTAINTY
      DATA_TYPE                = MSB_UNSIGNED_INTEGER
      START_BYTE               = 1302
      BYTES                    = 286
      ITEMS                    = 286
      ITEM_BYTES                = 1
      ALIAS_NAME               = srs_uncertainty
      DESCRIPTION              = "Percent uncertainty in surface radiance spectrum."
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
      NAME                     = LIMB_PARAMETERS_QUALITY
      DATA_TYPE                = MSB_UNSIGNED_INTEGER
      START_BYTE               = 1588
      BYTES                    = 4
      ALIAS_NAME               = lmb_quality
      DESCRIPTION              = "32-bit data quality word. Bits TBD"
END_OBJECT                     = COLUMN
```

A.7 OBS Table

```
NAME                    = OBS
COLUMNS                 = 20
ROW_BYTES               = 42
DESCRIPTION             = "

  The OBS table stores the state of the instrument at the start of each
  observation.  One OBS record is generated for each observation."

OBJECT                  = COLUMN
    NAME                = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 1
    BYTES               = 4
    ALIAS_NAME          = sclk_time
    DESCRIPTION         = "The value of the spacecraft clock at the
                        beginning of the observation"
END_OBJECT              = COLUMN


OBJECT                  = COLUMN
    NAME                = ORBIT_NUMBER
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 5
    BYTES               = 2
    ALIAS_NAME          = orbit
    DESCRIPTION         = "The project supplied orbit number."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = ORBIT_COUNTER_KEEPER
    DATA_TYPE           = MSB_UNSIGNED_INTERGER
    START_BYTE          = 7
    BYTES               = 2
    ALIAS_NAME          = ock
    DESCRIPTION         = "Sequential count of the number of orbital revolutions
                        since orbit insertion. This number is identical to the
                        project supplied orbit number up until the first time it is
                        reset to zero."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = INSTRUMENT_TIME_COUNT
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 9
    BYTES               = 4
    ALIAS_NAME          = ick
    DESCRIPTION         = "The number of two-second intervals that have elapsed
                        since the start of the orbit. The two-second
                        interval is the smallest time unit defined by
                        the instrument and equals the time to complete
                        a single length scan."
END_OBJECT              = COLUMN
```

```
OBJECT                      = COLUMN
    NAME                    = TEMPORAL_AVERAGE_COUNT
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 13
    BYTES                   = 1
    ALIAS_NAME              = tic
    DESCRIPTION             = “The number of two-second scans averaged into
                              this observation.  Valid values are 1, 2 and 4"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = MIRROR_POINTING_ANGLE
    DATA_TYPE               = MSB_INTEGER
    START_BYTE              = 14
    BYTES                   = 2
    SCALING_FACTOR          = .046875
    ALIAS_NAME              = pnt_angle
    DESCRIPTION             = “Scan mirror pointing angle, degrees from nadir
                              about the spacecraft’s +Y axis.”
    UNIT                    = “DEGREE”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = IMC_COUNT
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 16
    BYTES                   = 1
    ALIAS_NAME              = pnt_imc
    DESCRIPTION             = “The number of image motion compensation steps used.”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = OBSERVATION_TYPE
    DATA_TYPE               = CHARACTER
    START_BYTE              = 17
    BYTES                   = 1
    ALIAS_NAME              = pnt_view
    DESCRIPTION             = “The observation classification.  Coarsely identifies
                              the type of observation as one of the following:
                                    B=Internal black body reference surface,
                                    1=Visual Bolometer calibration lamp 1,
                                    2=Visual Bolometer calibration lamp 2,
                                    D=Planet, Day side,
                                    N=Planet, Night side,
                                    L=Planet, limb,
                                    S=Space”
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = SCAN_LENGTH
    DATA_TYPE               = CHARACTER
    START_BYTE              = 18
    BYTES                   = 1
    ALIAS_NAME              = scan_len
    DESCRIPTION             = “Length of scan
                                    1 = single length scans (~10 wavenumber spacing),
```

```
                              2 = double length scans (~5 wavenumber spacing)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = DATA_PACKET_TYPE
    DATA_TYPE           = CHARACTER
    START_BYTE          = 19
    BYTES               = 1
    ALIAS_NAME          = pckt_type
    DESCRIPTION         = "Downlink packet format
                              S = short packets (no auxiliary info)
                              L = long packets (auxiliary info included)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = SCHEDULE_TYPE
    DATA_TYPE           = CHARACTER
    START_BYTE          = 20
    BYTES               = 1
    ALIAS_NAME          = schedule_type
    DESCRIPTION         = "Schedule type being executed:
                              T = Real time plan,
                              C = Record plan,
                              O = Overlay"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = SPECTROMETER_GAIN
    DATA_TYPE           = CHARACTER
    START_BYTE          = 21
    BYTES               = 1
    ALIAS_NAME          = spc_gain
    DESCRIPTION         = "Spectrometer amplifier gain channel number,
                              1 = ~1
                              2 = ~2
                              3 = ~4
                              4 = ~8"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = VISUAL_BOLOMETER_GAIN
    DATA_TYPE           = CHARACTER
    START_BYTE          = 22
    BYTES               = 1
    ALIAS_NAME          = vbol_gain
    DESCRIPTION         = "Visual bolometer amplifier gain setting,
                              L = Low setting,
                              H = High setting"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = THERMAL_BOLOMETER_GAIN
    DATA_TYPE           = CHARACTER
    START_BYTE          = 23
    BYTES               = 1
    ALIAS_NAME          = tbol_gain
    DESCRIPTION         = "Thermal bolometer amplifier gain setting,
```

```
                                L = Low setting,
                                H = High setting"
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = PREPROCESSOR_DETECTOR_NUMBER
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 24
    BYTES                    = 1
    ALIAS_NAME               = comp_pp
    DESCRIPTION              = "Precompressor reference detector number. The
                             spectrum from each detector within a single ICK
                             is subtracted from the spectrum of this detector
                             prior to data compression to reduce signal entropy"
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = DETECTOR_MASK
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 25
    BYTES                    = 1
    ALIAS_NAME               = det_mask
    DESCRIPTION              = "Spatial detector mask number, one of eight possible
                             combinations in which the spectra from the six TES
                             detectors can be co-added prior to transmission to
                             Earth. Varies from no combination (all detectors
                             separate) to all detectors co-added into a single
                             spectrum.
                             See TES Software User's Guide for details"
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = OBSERVATION_CLASSIFICATION
    DATA_TYPE                = MSB_BIT_STRING
    START_BYTE               = 26
    BYTES                    = 4
    ALIAS_NAME               = class
    DESCRIPTION              = "32-bit observation classification word.  Bit
                                column descriptions and code definitions follow;
                                see class.txt for more information."

    OBJECT                       = BIT_COLUMN
        NAME                     = MISSION_PHASE
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 1
        BYTES                    = 3
        ALIAS_NAME               = phase
        DESCRIPTION              = "Identifies MGS Mission Phase:
                                    0 = Error
                                    1 = Aerobraking Phase 1 (AB-1)
                                    2 = Science Phasing Orbit 1 (SPO-1)
                                    3 = Science Phasing Orbit 2 (SPO-2)
                                    4 = Aerobraking Phase 2 (AB-2)
                                    5 = Mapping Phase
                                    >5 = Error "
    END_OBJECT                   = BIT_COLUMN
```

```
OBJECT                    = BIT_COLUMN
    NAME                  = INTENDED_TARGET
    DATA_TYPE             = MSB_UNSIGNED_INTEGER
    START_BYTE            = 4
    BYTES                 = 4
    ALIAS_NAME            = type
    DESCRIPTION           = "Description of observation type, including
                             various physical targets and various tests conducted
                              0 = No Target
                              1 = Surface Observation
                              2 = Atmospheric Observation
                              3 = Phobos Observation
                              4 = Deimos Observation
                              5 = Reference Observation
                              6 = Space and Global Mars Observations
                              7 = Test Data
                              8 = Less than Ick 15
                              9 = PROM Data"
END_OBJECT                = BIT_COLUMN

OBJECT                    = BIT_COLUMN
    NAME                  = TES_SEQUENCE
    DATA_TYPE             = MSB_UNSIGNED_INTEGER
    START_BYTE            = 8
    BYTES                 = 4
    ALIAS_NAME            = sequence
    DESCRIPTION           = "Description of observation sequence performed,
                             must be used in conjunction with OBSERVATION_TYPE;
                             see class.txt for bit codes and definitions"
END_OBJECT                = BIT_COLUMN

OBJECT                    = BIT_COLUMN
    NAME                  = NEON_LAMP_STATUS
    DATA_TYPE             = MSB_UNSIGNED_INTEGER
    START_BYTE            = 12
    BYTES                 = 2
    ALIAS_NAME            = lamp_status
    DESCRIPTION           = "Describes the status of the neon lamp, and by correlation,
                             defines when spectra are collected
                              0 = Neon lamp on, spectra collected
                              1 = Neon lamp off, spectra not collected"
END_OBJECT                = BIT_COLUMN

OBJECT                    = BIT_COLUMN
    NAME                  = TIMING_ACCURACY
    DATA_TYPE             = MSB_UNSIGNED_INTEGER
    START_BYTE            = 14
    BYTES                 = 1
    ALIAS_NAME            = timing
    DESCRIPTION           = "Describes the accuracy of observation timing,
                              based on availablity of equator crossing broadcasts
                              0 = most accurate timing, MGS-PDS equator crossing
                                   broadcast received
                              1 = timing drifts present, MGS-PDS equator crossing
                                   broadcast not recived"
END_OBJECT                = BIT_COLUMN
```

```
    OBJECT                        = BIT_COLUMN
      NAME                        = SPARE
      DATA_TYPE                   = MSB_UNSIGNED_INTEGER
      START_BYTE                  = 15
      BYTES                       = 2
      ALIAS_NAME                  = spare
      DESCRIPTION                 = "Reserved for future use."
    END_OBJECT                    = BIT_COLUMN

    OBJECT                        = BIT_COLUMN
      NAME                        = CLASSIFICATION_VALUE
      DATA_TYPE                   = MSB_INTEGER
      START_BYTE                  = 17
      BYTES                       = 16
      ALIAS_NAME                  = class_value
      DESCRIPTION                 = "One of the following signed numerical details:
                                        latitude coordinants
                                        timing before or after periapsis (seconds)
                                        ANS roll number relative to periapsis
                                     Must be used in conjunction with TES_SEQUENCE and
                                    OBSERVATION_TYPE"
    END_OBJECT                    = BIT_COLUMN

  END_OBJECT                      = COLUMN

  OBJECT                        = COLUMN
    NAME                        = OBSERVATION_QUALITY
    DATA_TYPE                   = MSB_BIT_STRING
    START_BYTE                  = 30
    BYTES                       = 4
    ALIAS_NAME                  = obs_quality
    DESCRIPTION                 = "32-bit observation quality word.   Bit column
                                   description and code definition follow;  see also
                                   quality.txt for more information."

    OBJECT                        = BIT_COLUMN
      NAME                        = HGA_MOTION
      DATA_TYPE                   = MSB_UNSIGNED_INTEGER
      START_BYTE                  = 1
      BYTES                       = 2
      ALIAS_NAME                  = hga_motion
      DESCRIPTION                 = "Identifies motion and rate of High Gain Antenna;
                                      0 = HGA motion unknown
                                      1 = HGA not moving
                                      2 = HGA moving at 0.05 deg/sec (autotrack)
                                      3 = HGA moving at 0.51 deg/sec (rewind)"
    END_OBJECT                    = BIT_COLUMN

    OBJECT                        = BIT_COLUMN
      NAME                        = SOLAR_PANEL_MOTION
      DATA_TYPE                   = MSB_UNSIGNED_INTEGER
      START_BYTE                  = 3
      BYTES                       = 3
      ALIAS_NAME                  = pnl_motion
      DESCRIPTION                 = "Identifies motion and rate of both Solar Panels;
                                      0 = panel motion unknown
                                      1 = panels not moving
```

```
                                  2 = panels moving at 0.051 deg/sec (autotrack)
                                  3 = panels moving at 0.120 deg/sec (prior to ock 3859)
                                  4 = panels moving at 0.240 deg/sec (starting at ock 3859)
                                  5 = panels moving at 0.400 deg/sec (aurobraking only)
                                  6 = panels moving & changing between rates
                                  7 = not assigned”
END_OBJECT                      = BIT_COLUMN

OBJECT                          = BIT_COLUMN
    NAME                        = ALGOR_PATCH
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 6
    BYTES                       = 1
    ALIAS_NAME                  = algor_patch
    DESCRIPTION                 = “Status of algor flight software patch;
                                  0 = Algor flight software patch not onboard TES
                                  1 = Algor flight software patch onboard TES”
END_OBJECT                      = BIT_COLUMN

OBJECT                          = BIT_COLUMN
    NAME                        = IMC_PATCH
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 7
    BYTES                       = 1
    ALIAS_NAME                  = imc_patch
    DESCRIPTION                 = “Status of IMC flight software patch;
                                  0 = IMC moving in forward direction
                                      (IMC patch not onboard)
                                  1 = IMC moving in reverse direction
                                      (IMC patch onboard)”
END_OBJECT                      = BIT_COLUMN

OBJECT                          = BIT_COLUMN
    NAME                        = MOMENTUM_DESATURATION
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 8
    BYTES                       = 1
    ALIAS_NAME                  = momentum
    DESCRIPTION                 = “Occurance of autonomous angular momentum
                                  desaturation;
                                  0 = angular momentum desaturation not
                                      occurring on spacecraft
                                  1 = angular momentum desaturation occurring
                                      on spacecraft”
END_OBJECT                      = BIT_COLUMN

OBJECT                          = BIT_COLUMN
    NAME                        = EQUALIZATION_TABLE
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 9
    BYTES                       = 1
    ALIAS_NAME                  = equal_tab
    DESCRIPTION                 = “Status of equalization tables;
                                  0 = equalization tables not onboard TES
                                  1 = equalization tables onboard TES”
END_OBJECT                      = BIT_COLUMN
```

```
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                 = PRIMARY_DIAGNOSTIC_TEMPERATURES
   DATA_TYPE            = MSB_UNSIGNED_INTEGER
   START_BYTE           = 34
   BYTES                = 8
   ITEMS                = 4
   ITEM_BYTES           = 2
   SCALING_FACTOR       = 0.01
   ALIAS_NAME           = temps
   DESCRIPTION          = "Primary diagnostic temperatures:
                              temps[1] = T1 = Visual Bolometer Detector Package
                              temps[2] = T2 = Thermal Bolometer Detector Package
                              temps[3] = T3 = Spectrometer Detector Package
                              temps[4] = T4 = Thermal Bolometer Black Body
                              Reference"
   UNIT                 = "K"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                 = FFT_START_INDEX
   DATA_TYPE            = MSB_UNSIGNED_INTEGER
   START_BYTE           = 42
   BYTES                = 1
   ALIAS_NAME           = ffti
   DESCRIPTION          = "This parameter specifies the starting wavenumber
                            of the spectra.  The wavenumber of the first data
                            channel is 10.58 times the index number.  This
                            value also defines how the spectral mask is applied
                            to the channels"
END_OBJECT              = COLUMN
```

A.8 POS Table

```
NAME                    = POS
COLUMNS                 = 7
ROW_BYTES               = 70
DESCRIPTION             = "

   The POS table stores the positions of the spacecraft and sun
   relative to the planet, the spacecraft's orientation quaternion,
   and the Mars body quaternion, all relative to the J2000 system.

   These data are initially derived from the project's SPICE kernels,
   but may be corrected from various other sources.  This table
   may also include interpolated values where SPICE data were unavailable."

OBJECT                  = COLUMN
      NAME              = SPACECRAFT_CLOCK_START_COUNT
      DATA_TYPE         = MSB_UNSIGNED_INTEGER
      START_BYTE        = 1
      BYTES             = 4
      ALIAS_NAME        = sclk_time
      DESCRIPTION       = "The value of the spacecraft clock at the
                          beginning of the observation"
END_OBJECT              = COLUMN


OBJECT                  = COLUMN
      NAME              = EPHEMERIS_TIME
      DATA_TYPE         = IEEE_REAL
      START_BYTE        = 5
      BYTES             = 8
      ALIAS_NAME        = et
      DESCRIPTION       = "Ephemeris time, seconds since 1/1/2000"
      UNIT              = "Seconds"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
      NAME              = SPACECRAFT_POSITION
      DATA_TYPE         = IEEE_REAL
      START_BYTE        = 13
      BYTES             = 12
      ITEMS             = 3
      ITEM_BYTES        = 4
      ALIAS_NAME        = pos
      DESCRIPTION       = "Spacecraft position vector relative to Mars
                           in the J2000 reference frame"
      UNIT              = "KM"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
      NAME              = SUN_POSITION
      DATA_TYPE         = IEEE_REAL
      START_BYTE        = 25
      BYTES             = 12
```

```
    ITEMS                  = 3
    ITEM_BYTES             = 4
    ALIAS_NAME             = sun
    DESCRIPTION            = “Sun position vector relative to Mars in the J2000
                              reference frame”
    UNIT                   = “KM”
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = SPACECRAFT_QUATERNION
    DATA_TYPE              = IEEE_REAL
    START_BYTE             = 37
    BYTES                  = 16
    ITEMS                  = 4
    ITEM_BYTES             = 4
    ALIAS_NAME             = quat
    DESCRIPTION            = “Spacecraft pointing quaternion in the J2000
                              reference frame”
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = MARS_QUATERNION
    DATA_TYPE              = IEEE_REAL
    START_BYTE             = 53
    BYTES                  = 16
    ITEMS                  = 4
    ITEM_BYTES             = 4
    ALIAS_NAME             = qbody
    DESCRIPTION            = “Mars body quaternion in the J2000 reference frame”
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = POSITION_SOURCE_ID
    DATA_TYPE              = CHARACTER
    START_BYTE             = 69
    BYTES                  = 2
    ITEMS                  = 2
    ITEM_BYTES             = 1
    ALIAS_NAME             = id
    DESCRIPTION            = “2-character source ID.
                             First character is source of positions.
                             Second character is source of pointing.
                             See ancillary table for details.”
END_OBJECT                 = COLUMN
```

A.9 RAD Table

```
NAME                    = RAD
COLUMNS                 = 10
ROW_BYTES               = 28
DESCRIPTION             = "

  The RAD table contains the raw and calibrated observed radiances.
  For each observation there can be up to 6 RAD records, one for each
  active spectrometer detector.  If the Temporal Integration Count
  (OBS Table, TEMPORAL_AVERAGE_COUNT) is greater than 1, then the data
  represent the average of the measurements from that many scans.

  The instrument can apply a programmable spectral mask to the raw
  data causing neighboring channels to be averaged; however, this
  feature is used only when downlink bandwidth is limited.  When
  spectrally masked data are received, the averaged-out channels are
  replaced with the averaged value to expand the spectra back to its
  original size.  The spectral-mask that was used to perform the
  averaging is kept in this table.

  The raw spectra are compressed for downlink.  The original
  bit-packed compression header, containing the size of the
  compressed data and the compression mode used, is kept in this
  table in order to be used to evaluate the performance of the compressor."

OBJECT                  = COLUMN
    NAME                = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 1
    BYTES               = 4
    ALIAS_NAME          = sclk_time
    DESCRIPTION         = "The value of the spacecraft clock at the
                          beginning of the observation"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = DETECTOR_NUMBER
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 5
    BYTES               = 1
    ALIAS_NAME          = detector
    DESCRIPTION         = "The number of the spectrometer detector that
                          made the observation. Detectors are numbered
                          from 1 to 6"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = SPECTRAL_MASK
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 6
    BYTES               = 1
    ALIAS_NAME          = spectral_mask
    DESCRIPTION         = "ID number of spectral mask applied.
```

```
                              See ancillary Masks table"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = COMPRESSION_MODE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 7
    BYTES                     = 2
    ALIAS_NAME                = cmode
    DESCRIPTION               = "16-bit compression header of original data
                              containing the size and compression mode of the
                              original compressed data.  See TES Users Guide."
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = RAW_RADIANCE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 9
    BYTES                     = 4
    VAR_DATA_TYPE             = MSB_INTEGER
    VAR_ITEM_BYTES            = 2
    VAR_RECORD_TYPE           = Q15
    ALIAS_NAME                = raw_rad
    DESCRIPTION               = "Raw spectral radiance"
    UNIT                      = "transformed volts"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = CALIBRATED_RADIANCE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 13
    BYTES                     = 4
    VAR_DATA_TYPE             = MSB_INTEGER
    VAR_ITEM_BYTES            = 2
    VAR_RECORD_TYPE           = Q15
    ALIAS_NAME                = cal_rad
    DESCRIPTION               = "Calibrated spectral radiance"
    UNIT                      = "watts cm-2 steradian-1 wavenumber-1"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = DETECTOR_TEMPERATURE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 17
    BYTES                     = 2
    ALIAS_NAME                = tdet
    DESCRIPTION               = "Derived temperature of the detector, used to
                               remove instrument radiance in calibration
                              algorithm"
    UNIT                      = "K"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = TARGET_TEMPERATURE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 19
```

```
    BYTES                  = 2
    ALIAS_NAME             = target_temp
    DESCRIPTION            = "Derived temperature of the observed target"
    UNIT                   = "K"
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = RADIANCE_CALIBRATION_ID
    DATA_TYPE              = CHARACTER
    START_BYTE             = 21
    BYTES                  = 4
    ALIAS_NAME             = version_id
    DESCRIPTION            = "Calibration algorithm version id for spectral data."
END_OBJECT                 = COLUMN

OBJECT                     = COLUMN
    NAME                   = DATA_QUALITY
    DATA_TYPE              = MSB_BIT_STRING
    START_BYTE             = 25
    BYTES                  = 4
    ALIAS_NAME             = data_quality
    DESCRIPTION            = "32-bit observation quality word.   Bit column
                              description and code definition follow;  see also
                              quality.txt for more information."

    OBJECT                     = BIT_COLUMN
        NAME                   = MAJOR_PHASE_INVERSION
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 1
        BYTES                  = 1
        ALIAS_NAME             = phase_inversion
        DESCRIPTION            = "Identifies data that contains major phase inversions;
                                    0 = data does not contain major phase inversions
                                    1 = data does contain major phase inversions"
    END_OBJECT                 = BIT_COLUMN

    OBJECT                     = BIT_COLUMN
        NAME                   = ALGOR_RISK
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 2
        BYTES                  = 1
        ALIAS_NAME             = algor_risk
        DESCRIPTION            = "Identifies whether data is at low or hgih risk for algor
                                   phase inversions;
                                    0 = data at low risk of algor phase inversions
                                    1 = data at high risk of algor phase inversions"
    END_OBJECT                 = BIT_COLUMN

    OBJECT                     = BIT_COLUMN
        NAME                   = CALIBRATION_QUALITY
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 3
        BYTES                  = 3
        ALIAS_NAME             = calib_quality
        DESCRIPTION            = "These bits are reserved for future use;
                                    value of these bits currently set to 0"
```

```
    END_OBJECT                  = BIT_COLUMN


    OBJECT                   = BIT_COLUMN
        NAME                    = SPECTROMETER_NOISE
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 6
        BYTES                   = 2
        ALIAS_NAME              = spect_noise
        DESCRIPTION             = “Identifies noise level in data based on space
                                  observations made at least once every 12 orbits;
                                   0 = instrument noise not calculated
                                   1 = instrument noise at nominal levels
                                   2 = instrument noise at anomalously high levels
                                   3 = not assigned”
    END_OBJECT                  = BIT_COLUMN
END_OBJECT                   = COLUMN
```

A.10 SRF Table

```
NAME                     = SRF
COLUMNS                  = 11
ROW_BYTES                = 109
DESCRIPTION              = "
```

The SRF table contains values derived from spectra that include Mars in the field of view. It contains one record for each valid calibrated radiance spectrum that includes the planet and for which any valid quantities could be derived. See the surface parameters quality word for ingormation on the validity of calculted variables.

The surface spectrum with the atmosphere removed is contained in a variable length array. See the SURFACE_RAD_SPECTRUM_UNCERTAINTY column in the LMB table at the time nearest the observation for a measure of the error in these values.

For observations that target a body other than Mars (e.g. Phobos and Deimos), there will be no data in this table."

```
OBJECT                   = COLUMN
    NAME                 = SPACECRAFT_CLOCK_START_COUNT
    DATA_TYPE            = MSB_UNSIGNED_INTEGER
    START_BYTE           = 1
    BYTES                = 4
    ALIAS_NAME           = sclk_time
    DESCRIPTION          = "The value of the spacecraft clock at the
                         beginning of the observation"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = DETECTOR_NUMBER
    DATA_TYPE            = MSB_UNSIGNED_INTEGER
    START_BYTE           = 5
    BYTES                = 1
    ALIAS_NAME           = detector
    DESCRIPTION          = "The number of the spectrometer detector that
                          made the observation. Detectors are
                         numbered from 1 to 6"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = SPECTRAL_THERMAL_INERTIA
    DATA_TYPE            = IEEE_REAL
    START_BYTE           = 6
    BYTES                = 4
    ALIAS_NAME           = ti_spc
    DESCRIPTION          = "Thermal inertia, derived from spectrometer data"
    UNIT                 = "J m-2 s-1/2 K-1"
END_OBJECT               = COLUMN

OBJECT                   = COLUMN
    NAME                 = DOWN_WELLING_FLUX
    DATA_TYPE            = IEEE_REAL
```

```
    START_BYTE              = 10
    BYTES                   = 4
    ALIAS_NAME              = dw_flux
    DESCRIPTION             = "Atmospheric down-welling flux"
    UNIT                    = "watts cm-2"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = SURFACE_PRESSURE
    DATA_TYPE               = IEEE_REAL
    START_BYTE              = 14
    BYTES                   = 4
    ALIAS_NAME              = srf_pressure
    DESCRIPTION             = "Surface pressure estimate from lookup table,
                               based on topography and seasonal pressure variation"
    UNIT                    = "mBar"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = SPECTRAL_SURFACE_TEMPERATURE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 18
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = srf_tmp_spc
    DESCRIPTION             = "Surface temperature, derived from spectrometer data.
                               See users guide (process.asc or process.pdf) for more
                               information."
    UNIT                    = "K"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = NADIR_TEMPERATURE_PROFILE
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 20
    BYTES                   = 76
    ITEMS                   = 38
    ITEM_BYTES              = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = nadir_pt
    DESCRIPTION             = "Atmospheric pressure/temperature profile from Nadir observation.
                               Array of temperatures at 38 given pressures"
    UNIT                    = "K"
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = AEROSOL_OPACITY_NADIR
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 96
    BYTES                   = 2
    SCALING_FACTOR          = 0.01
    ALIAS_NAME              = optical_depth
    DESCRIPTION             = "Aerosol normal optical depth to surface at TBD microns.
                               Use surface pressure to scale to surface"
END_OBJECT                  = COLUMN
```

```
OBJECT                        = COLUMN
    NAME                      = SURFACE_PARAMETERS_QUALITY
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 98
    BYTES                     = 4
    ALIAS_NAME                = srf_quality
    DESCRIPTION               = "32-bit data quality word, per detector.  Bits TBD"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = SURFACE_RADIANCE
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 102
    BYTES                     = 4
    VAR_DATA_TYPE             = MSB_INTEGER
    VAR_ITEM_BYTES            = 2
    VAR_RECORD_TPYE           = Q15
    ALIAS_NAME                = srf_radiance
    DESCRIPTION               = "Derived surface radiance"
    UNIT                      = "watts cm-2 steradian-1 wavenumber-1"
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = SURFACE_CALIBRATION_ID
    DATA_TYPE                 = CHARACTER
    START_BYTE                = 106
    BYTES                     = 4
    ALIAS_NAME                = version_id
    DESCRIPTION               = "Surface Atmosphere Separation Algorithm version ID"
END_OBJECT                    = COLUMN
```