NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Ames Research Center
Moffett Field, California
PIONEER VENUS PROJECT
SPECIFICATION PC-456.O4

PIONEER VENUS: DATA USER REQUIREMENTS FOR SUPPLEMENTARY EXPERIMENTER DATA RECORDS

May 15, 1976

l. SCOPE

This specification defines the requirements of each of the Pioneer Venus data users for the Supplementary Experimenter Data Records (SEDR).

2. APPLICABLE DOCUMENTS

2.1 NASA/ARC SPECIFICATIONS

PC-456.OO, Pioneer Venus: Data Records Processing System (DRPS) Description

PC-456.O1, Pioneer Venus: Input and Output Tape Description

PC-456.O2, Pioneer Venus: Data Records Processing System (DRPS) Detailed Processing Requirements

PC-456.O3, Pioneer Venus: Data User Requirements for Experimenter Data Records

PC-454.OO, Pioneer Venus: On-Line Ground Data System Software Specification

PC-455.OO, Pioneer Venus: Off-Line Telemetry Data Processing Specification

3. REQUIREMENTS

3.1 GENERAL REQUIREMENTS

The general requirements and content for the Supplementary Experimenter Data Records have been covered in PC-456.O1 Pioneer Venus: Input and Output Tape Requirements.

3.2 SPECIFIC REQUIREMENTS

The SEDR formats for all data users shall conform to the specification given below. In the case of the Orbiter Spacecraft, the SEDR shall be generated periodically from launch through mission completion. The Multiprobe Spacecraft SEDR shall be generated periodically from launch up until probe separation. A predicted model trajectory shall be generated for each of the probes after separation, from planet entry to impact in a format TBS.

Details on the use of the various tables defined in the SEDR format and the QLSEDR format are described in Section 6.3 of this specification. Coordinate System diagrams in the trajectory portion of the format are in Figures 3.2 Sheets 1 through 8.

3.2.1 Production SEDR. The SEDRs— for both spacecraft shall contain measured or true trajectory data as shown in Figure 3.2.1 sheets 1 through 1O. These data shall be in IBM 360 Double Precision Floating Point formats.

3.2.2 Quick Look SEDR (QLSEDR). The best available data at the time the and will not contain the resolution that the production SEDRs will contain. The Logistics file shall be identical to that described above. The data file shall contain only 24 of the variables that are in the normal production SEDR. Since the variables are predicted, these selected variables shall be in IBM 360 Single Precision Floating Point formats. The format and variables which shall be carried in the QLSEDR are shown in Figure 3.2.2 sheets 1 through 7.

3.3 SEDR TAPE DELIVERY

SEDR tapes shall be sent to each addressee shown in Figure 3.4 of Specification PC-456.O3.

6.3.1.2.1 Measured SRR Times. For some SRR pulses, one of the telemetered ATTM measurements will contain the time interval between the SRR pulse and the beginning of the major telemetry frame which immediately follows. For these SRR pulses, the time of the SRR pulse is calculated by:

TSRR = TMAJ - (telemetered time interval)

TMAJ is the Spacecraft Universal Time (SCUT) of the beginning of the major telemetry frame.

6.3.1.2.2 Estimated SRR Times. For about half of the SRR pulses, no time interval measurement will be made. For these pulses, the time of the SRR pulse is estimated by:

TSSR(est) = TSRR (last measured) + (n) (spin period)

TSRR (last measured) is the SCUT of the last SRR pulse for which a measured time interval was telemetered.

Spin period is the spacecraft spin period from Table 3. n is the integer number of spin periods which have elapsed since the last measured SRR pulse.

6.3.1.3 Smoothed Roll Reference Times (Fs). An Fs signal follows each SRR pulse. The time of the Fs signal is calculated by:

TFs = TSRR + delta

delta is the time delay from SRR to Fs from Table 3.

6.3.1.4 Roll Index Pulse Times (RIP). A RIP pulse follows each Fs signal.

The time of the RIP pulse is calculated by:

TRIP = TFS + (RIP time delay)

(RIP time delay) is the current value of the time from Fs to RIP as determined from the telemetered measurement ARIPAD. (RIP time delay) = (decimal value of ARIPAD) (Spin Period)/1024

Spin period is the spacecraft spin period from Table 3.

6.3.1.5 Ram Pulse Times (RAM). A RAM pulse follows each RIP pulse. The time of the RAM pulse is calculated by:

TRAM = TRIP + (RAM time delay)

(RAM time delay) is the value of the RAM time delay at the RIP time. The RAM time delay at the time of the beginning of each major telemetry frame is calculated from the telemetered measurement AVPDRD by:

RAM time delay= (decimal value of AVPDRD) x (spin period)/4096
The RAM time delay at the RIP time is interpolated to the RIP time from the telemetered measurements.

(spin period) is the spacecraft spin period from Table 3.

6.3.1.6 NADIR Pulse Times (NADIR). A NADIR pulse follows each RIP pulse. The time of the NADIR pulse is calculated by:

TNADIR = TRIP + (NADIR time delay)

(NADIR time delay) is the value of the NADIR time delay at the RIP time.

The NADIR time delay at the time of the beginning of each major telemetry frame is calculated from the telemetered measurement AVPDND by:

NADIR time delay = (decimal value at AVPDND) x (spin period)/4096

(spin period if the spacecraft spin period from Table 3).

The NADIR time delay at the RIP time is interpolated to the RIP time from the telemetered measurements.

6.3.2 Pulse Times - Table 1. The times of one complete set of roll reference signals shall be included in Table 1 of the SEDR tape and QL Tape. For the Orbiter spacecraft, one complete set of roll reference signals shall include an Fs signal, the RIP pulse which is based on that Fs signal and the RAM and NADIR pulses which are based on the RIP pulse. For the Bus spacecraft, one complete set of roll reference signals shall include an Fs signal and the RIP pulse which is based on that Fs signal. A separate data record shall be included in the tape for each set of roll reference signals which occur during the time span of the data.

The signal times shall be the SCUT of each signal which have been calculated from the telemetry record as described in section 6.3.1.

6.3.3 Spacecraft Attitude. Table 2 shall tabulate the celestial latitude and celestial longitude of the spacecraft spin axis. The entries in the table will be provided as input and will not be calculated. Interpolation for spin axis attitude at times between the tabulated times shall be by using the technique described in section 6.3.6.

6.3.4 Spacecraft Spin Period - Table 3. Table 3 shall tabulate the spacecraft spin period and associated time delay (section 6.3.1.3). The entries in this table will be provided as input and will not be calculated. Linear interpolation may be used to estimate spin period and time delay at times between the entries in the table.

6.3.5 SRR Epochs - Table 4. Table 4 shall tabulate the positions of roll reference celestial bodies. The entries in this table will be input and will not be calculated. If the telemetry measurement ASRRMS indicates that a star is being used for the roll reference, the star celestial latitude and celestial longitude will be included in Table 4. If the telemetry measurement ASRRMS indicates that the Simulated ROll Reference (SIM SRR) is being used, the error between the Sun and the Sim SRR will be tabulated. Table 4 will contain enough entries to model any Sim SRR drift and allow linear interpolation between entries.

The use of Table 4 to calculate spacecraft roll angle is described in section 6.4.

6.3.6 Vector Interpolation for Spacecraft Attitude.

6.3.6.1 Interpolation Requirement. If the spacecraft spin axis attitude is needed at a time which is between the times for which Table 2 contains tabulated values, the intermediate attitude must be interpolated as a vector: the attitude must be interpolated in the plane which contains the two tabulated vectors.

6.3.6.2 Vector Representation of Attitudes. Let T be the time at which the interpolated attitude is desired. Let Tl and T2 be the times at which the spin axis attitude is tabulated in Table 2.
[T1 < T < T2]

ATT1 = vector spin axis attitude at time T1

ATT2 = vector spin axis attitude at time T2

ATT = vector spin axis attitude at time T

ATT1X, ATT1Y, ATT1Z = X, Y, Z component of ATT1

ATTlX = cos (CLAT1) cos (CLON1)

ATT1Y = cos (CLAT1) sin (CLON1)

ATT1Z = sin (CLAT1)

ATT2X, ATT2Y, ATT2Z = X, Y, Z components of ATT2

ATT2X = cos (CLAT2) cos (CLON2)

ATT2Y = cos (CLAT2) sin (CLONZ)

ATT2Z = sin (CLAT2)

ATTX, ATTY, ATTZ = X, Y, Z components of the interpolated vector ATT

Figure 6.3.6.2 shows the vector relations.

6.3.6.3 Minimum Angle between Vectors. Check that the angle between ATT1 and ATT2 is large enough to avoid a zero divisor later.

MAGDIF = [(ATT2X - ATT1X)2 + (ATT2Y - ATT1Y)2 + (ATT2Z - ATT1Z)2112

If MAGDIF less than O.OOO17 set
ATTX = ATT1X
ATTY = ATT1Y
ATTZ = ATT1Z

6.3.6.4 Interpolation Equations.

BIGANG = 2 sin-1 (MAGDIF/2)
RATIO = (T-T1)/(T2 - T1)
LILANG = (BIGANG) (RATIO)
ATTX = (ATT2X - ATT1X cos (BIGANG)) RATIO + ATT1X cos (LILANG)
ATTY = (ATT2Y - ATT1Y cos (BIGANG)) RATIO + ATT1Y cos (LILANG)
ATTZ = (ATT2Z - ATT1Z cos (BIGANG)) RATIO + ATT1Z cos (LILANG)

6.3.6.5 Interpolated Attitude.
CLAT = interpolated celestial latitude
CLAT = sin-1 (ATTZ)

CLON = interpolated celestial longitude

CLON = tan-1 (ATTY)/ATTX

6.3.6.6 Attitude Data. When spacecraft attitude is interpolated to the epochs of the SEDR Ephemeris, include the components of ATT in the Ephemeris Data File.

Interpolated component	Ephemeris File Variable	Ephemeris File Words
ATTX	63	124 and 125
ATTY	64	126 and 127
ATTZ	65	128 and 129

When spacecraft attitude is interpolated to the epochs of the Quick Look Data Record, include the components of ATT in the Ephemeris Record, File 6.

Interpolated component	Ephemeris File Word
ATTX	18
ATTY	19
ATTZ	20

PRL LRL P/L FILE I.D.

FILE l

LOGISTICS RECORD
(EBCDIC)

EOF

PRL LRL P/L FILE I.D.

PT11 RECORD

FILE 2

EOF

PRL LRL P/L FILE I.D.

AT12 RECORD

FILE 3

AT12 RECORD

EOF

PRL LRL P/L FILE I.D.

FILE 4

SP13 RECORD

5P13 RECORD

EOF

PRL LRL P/L FILE I.D.

SR14 RECORD

SR14 RECORD

EOF

PRL LRL P/L FILE I.D.

EPHEMERIS RECORD
(ORBIT TODAY)

FILE 6

EPHEMERIS RECORD

EOF

EOF

PIONEER VENUS SEDR TAPE
FORMAT DEFINITION
REV.NO. 3 DATE 1/20/

```
                                                            For Definitions
                                                             Refer to Log
          WORD 0  WORD 1  WORD 2  WORD 3  WORD 4  WORD 5      File Table
         |-----------------------------------------------|  --------------
         | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|
         |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|
         |-----------------------------------------------|
RECORD 1 | *LH WD|                                       |
       2 |    * P I O N E E R     V E N U S   S E D R *  |
       3 |                                               |
       4 |    T A P E   S E Q U E N C E   N O . X X X X  |        7
       5 |                                               |
       6 |                                               |        1
       7 |    S / C   I D                           X X  |        7
       8 |    O R B I T   N O                   X X X X  |        7
       9 |                                               |
      10 |                                               |
      11 |                                               |
      12 |                                               |
      13 |                                               |
      14 |                                               |
      15 |                                               |
      16 |    G E N E R A T E D       M M M   D D , Y Y  |      2,7
      17 |    S T A R T   D A T E           D O Y , Y Y  |        7
      18 |    S T A R T   T I M E             H H : M M  |        7
      19 |    S T O P     D A T E           D O Y , Y Y  |        7
      20 |    S T O P     T I M E             H H : M M  |        7
      21 |                                               |
      22 |    D Q I      P  ( O R )   A                  |        8
         |-----------------------------------------------|

          WORD 0 OF RECORD 1 IS LOGICAL READER WORD


                  *LH WD =  LOGICAL HEADER WORD
                         DATA FORMAT:  EBCDIC
                  (LRL)  LOGICAL RECORD LENGTH:  6 WORDS
                         *LOGICAL RECORDS IN FILE:  22
                  (PRL)  PHYSICAL RECORD LENGTH:  132
                         LOGICAL RECORDS PER PHYSICAL RECORD: 22
```

```
PIONEER VENUS SEDR FILE DEFINITION            Fig 3.2.1
LOGISTIC FILE RECORD FORMAT
REV.NO.  3     DATE 1/20/78

     BIT
    |---------------------------------------------------------------|
    | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
 WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
    |---------------------------------------------------------------|  |
   0|        PRL          |      LRL (#words)   |  P/L              |  |
   1|                Number of       Logical Records in This File   |  |
   2|      (SPARE)                  |           S/C I.D.            |  |
   3|                            ORBIT NUMBER                       |  |
   4|      YEAR                     |      DOY                      |  =  HEADER
   5|      START TIME (DATA)  MS BINARY                             |  |  RECORD
   6|      YEAR                     |      DOY                      |  |
   7|      STOP TIME          MS BINARY                             |  |
   8|                          (SPARE)                              |  |
   9|                          (SPARE)                              |  |
  10|                          (SPARE)                              |  |
  11|                          (SPARE)                              |  |
    |---------------------------------------------------------------|  v
```

```
     BIT
   |---------------------------------------------------------------|
   | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
   |---------------------------------------------------------------|  |
  0|[       YEAR                   |         DOY                 ] |  |
  1|[     ms binary             (S/C UT of Fs Pulse              ] |  |
   |                                                               |  |
  2|[       YEAR                   |         DOY                 ] |  |
  3|[     ms binary             (S/C UT of RIP Pulse)            ] |  |
   |                                                               |  |
  4|[       YEAR                   |         DOY                 ] |  =  DATA
  5|[     ms binary             (S/C UT of RAM Pulse             ] |  |  RECORD
   |                                                               |  |
  6|[       YEAR                   |         DOY                 ] |  |
  7|[     ms binary             (S/C UT of NADIR Pulse           ] |  |
  8|                    DATA QUALITY FLAG 1 Delta - R*8            |  |
  9|                          (SPARE)                              |  |
 10| A |                       | B |   | C |   | D |               |  |
 11| UCLA Pulse time correction (EBCDIC)                           |  |
   |---------------------------------------------------------------|  v

         Logical Record Length  :   12 words             A: STRM
         Data format            :   Binary               B: CICK
         Physical Record Length :  120 words             C: SRRM
         No. Logical Records/Physical Record  : 10       D: Fire

         SRRM: 0 = unk       Fire:   0 = Norm
               1 = Star      (22,23) 1 = Fire
               2 = Sim
               3 = Sun
```

```
PIONEER VENUS SEDR TAPE FILE                   FIG 3.2.1
DEFINITION FILE 2
TABLE 1 - PULSE TIMES (Plll)
LOGICAL RECORD FORMAT
REV. NO. 3   DATE 1/20/78

     BIT
    |---------------------------------------------------------------|
    | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
 WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
    |---------------------------------------------------------------|  |
   0|        PRL          |      LRL (#words)   |  P/L    | FILE ID |  |
   1|               Number of logical Records in This File          |  = HEADER
   2|      (SPARE)                  |           S/C ID              |  | RECORD
   3|                            ORBIT NUMBER                       |  |
   4|                          (SPARE)                              |  |
    |---------------------------------------------------------------|  v


     BIT
    |---------------------------------------------------------------|
    | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
 WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
    |---------------------------------------------------------------|  |
   0|[ S/C UT      YEAR                           DOY            ]  |  |
   1|[                                     ms  binary             ] |  =  DATA
   2|                    CLAT (celestial latitude)(in deg. dec deg) |  |  RECORD
   3|                    CLON (celestial longitude)(in deg. dec deg)|  |
   4|                    (SPARE)                                    |  |
    |---------------------------------------------------------------|  v


          Logical Record Length :  5 words
          Data Format           :  Single Precision Flt. Pt. Binary
          Physical Record Length:  5O words
          Logical Records/Physical Record : 10
```

```
PIONEER VENUS SEDR TAPE FILE                   FIG 3.2.1
DEFINITION FILE 3
TABLE 2 - S/C ATTITUDE (ATl2)
REV. NO. 3    DATE 1/20/78

     BIT
    |---------------------------------------------------------------|
    | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
 WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
    |---------------------------------------------------------------|  |
   0|        PRL          |    LRL (# words)    |   P/L   |FILE I.D |  |
   1|               Number of        Logical Records in This File   |  |
   2|          (SPARE)              |            S/C I.D.           |  |
   3|                         ORBIT NUMBER                          |  = HEADER
   4|           YEAR                |            DOY                |  | RECORD
   5|      START DATA TIME          |         MS BINARY             |  |
   6|           YEAR                |            DOY                |  |
   7|      STOP DATA TIME           |         MS BINARY             |  |
   8|                             SPARE                             |  |
   9|                             SPARE                             |  |
    |---------------------------------------------------------------|  v
```

```
    BIT
   |---------------------------------------------------------------|
   | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
   |---------------------------------------------------------------|  |
  0|[ S/C  UT       YEAR           |             DOY              ]|  |
  1|[                                            ms binary        ]|  |
  2|                          SPIN PERI0D (in sec. dec secs)       |  |
  3|                          TIME DELAY  (in sec. dec secs)       |  = DATA
  4|                              (SPARE)                          |  | RECORD
  5|                              (SPARE)                          |  |
  6|                              (SPARE)                          |  |
  7|                              (SPARE)                          |  |
  8|                              (SPARE)                          |  |
  9|                              (SPARE)                          |  |
   |---------------------------------------------------------------|  v


         Time Delay =  delay from SRR Pulse to Fs Pulse.
         Logical Record Length: 10 words
         Data Format          :  Single Precision Flt. Pt., Binary
         Physical Record Length: 40 words
         # Logical Records/Physical Record:  4
```

```
PIONEER VENUS SEDR TAPE FILE
DEFINITION FILE 4
TABLE 3 - S/C SPIN RECORD (SPl3)
LOGICAL RECORD FORMAT
REV. NO. 3    DATE 1/20/78


     BIT
    |---------------------------------------------------------------|
    | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
 WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |

   0|        PRL          |    LRL (# words)    |   P/L   |FILE I.D |  |
   1|               Number of        Logical Records in This File   |  |
   2|          (SPARE)             |            S/C I.D.           |  |
   3|                         ORBIT NUMBER                          |  = HEADER
   4|           YEAR                |            DOY                |  | RECORD
   5|      START DATA TIME          |         MS BINARY             |  |
   6|           YEAR                |            DOY                |  |
   7|      STOP DATA TIME           |         MS BINARY             |  |
   8|                             SPARE                             |  |
   9|                             SPARE                             |  |
    |---------------------------------------------------------------|  v
```

```
    BIT
   |---------------------------------------------------------------|
   | | | | | | | | | | |1|1|1|1|1|1|1|1|1|1|2|2|2|2|2|2|2|2|2|2|3|3|  ^
WD |0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|2|3|4|5|6|7|8|9|0|1|  |
   |---------------------------------------------------------------|  |
  0|[ S/C  UT       YEAR           |             DOY              ]|  |
  1|[                                            ms binary        ]|  |
  2|                          SPIN PERI0D (in sec. dec secs)       |  |
  3|                          TIME DELAY  (in sec. dec secs)       |  = DATA
  4|                              (SPARE)                          |  | RECORD
  5|                              (SPARE)                          |  |
  6|                              (SPARE)                          |  |
  7|                              (SPARE)                          |  |
  8|                              (SPARE)                          |  |
  9|                              (SPARE)                          |  |
   |---------------------------------------------------------------|  v
```

Logical Record Length : 10 words
Data Format   : Single Precision, Flt. Pt. Binary
Physical Record Length : 100 words
#Logical Records/Physical Record :   10

PIONEER VENUS SEDR TAPE FILE
DEFINITIONS FILE 5
TABLE 4 - SRR EPOCHS (SR14)
LOGICAL RECORD FORMAT
REV. NO. 3   DATE 1/20/78

```
      EPHEMERIS HEADER RECORD

      BIT                  1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
      __________________________________________________________________
word 0|         PRL         |  LRL (# words)      |  P/L      |FILE ID|
      |_______________________________________________________________|
     1|        Number of Logical Records in This File                 |
      |_______________________________________________________________|
     2|       (spare)                 |            S/C I.D.           |
      |_______________________________________________________________|
     3|                           ORBIT NUMBER                        |
      |_______________________________________________________________|
     4|      S/C UT YEAR              |              DOY        S/C UT|
      |_______________________________________________________________|
     5|                    START TIME -  MILLISECONDS                 |
      |_______________________________________________________________|
     6|      S/C UT YEAR              |              DOY        S/C UT|
      |_______________________________________________________________|
     7|                     STOP TIME -  MILLISECONDS                 |
      |_______________________________________________________________|
     8|                            SPARE                              |
      |_______________________________________________________________|
     9|                            SPARE                              |
      |_______________________________________________________________|

                                     .
                                     .
                                     .
      __________________________________________________________________
   282|                            SPARE                              |
      |_______________________________________________________________|
   283|                            SPARE                              |
      |_______________________________________________________________|

       All data is in IBM 360 binary format, 2 and 4 byte integers
```

EPHEMERIS DATA RECORD

```
LOGICAL RECORD LENGTH:   284          1. ALL DATA IS IN IBM 360 format, DP
PHYSICAL RECORD LENGTH:  284          2. Except for integer variables, all
                                    variables are in double-precision
                                    floating point (data
                                    records). including
                                    calculated attitude, nadir
                                      and ram.
NO. OF LOGICAL RECORDS PER
PHYSICAL RECORD:         1             3. File order is in S/C UT
                                    ascending order.

     BIT                  1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
WORD ______________________________________________________________________________
  0  |     S/C   YEAR               |                  S/C DOY    | NAME  VAR
     |_______________________________________________________________|___________
  1  |     S/C   UT in binary                                     |SCUT      1
     |_______________________________________________________________|___________
  2-3|DP Julian Date, Days (elapsed days from                     |JULDAT
     |Noon, 1 Jan. 4713 B.C.                                      |          2
     |_______________________________________________________________|___________
  4-5|Gregorian Calendar Date (2 integer words which              |
     |represent the vigestimal date) based on number 20           | VIGDAT  3
     |_______________________________________________________________|___________
  6-7|ET - UTC, set (Universal Time Co-ordinated)                 |ETMUTC   4
     |_______________________________________________________________|___________
  8-9|Range rate of probe. km/sec                      +          |RANGRF   5
     |___________________________________________________|__________|___________
10-11|Magnitude of velocity vector, km/sec (speed of S/C)|Geocentric|MAGVEL   6
     |___________________________________________________|__________|___________
12-13|Earth.probe range, km (radius to S/C)            +          |REARPR   7
     |_______________________________________________________________|___________
14-15|Range to probe, km                               +          |MRANGE   8
     |___________________________________________________|__________|___________
16-17|Probe inertia velocity, km/sec                   |          |MMAGVF   9
     |___________________________________________________|__________|___________
16-19|Probe inertial path angle, deg                   |HELIO-    |HINFTP  10
     |___________________________________________________|CENTRIC __|___________
20-21|Celestial latitude of probe, deg                 |          |CELLTF  11
```

22-23	Celestial longitude of probe, deg		CELLNF	12
24-25	Celestial latitude of Earth, deg		CELLTE	13
26-27	Celestial longitude of Earth, deg		CELLNE	14
28-29	X component of S/C in Sun-Earth line, km	HELIO-CENTRIC	XSCSEL	15
30-31	Y component of S/C in Sun.Earth line, km		YSCSEL	16
32-33	Z component of S/C in Sun.Earth line, km		ZSCSEL	17
34-35	Sun-probe distance in Sun-Earth X-Y plane, km (projection of Sun-S/C vector onto the X-Y plane		SPSE	18
36-37	Longitude of S/C in Sun-Earth line system, deg	+	LNPSEL	19

Note: The term "probe" refers to the Multiprobe or Orbiter spacecraft and not to the separated Large or Small Probes.

Fig 3.2.1

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      EPHEMERIS DATA RECORD con't

     BIT                   1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 name  var
WORD  _________________________________________________________________________
38-39 |X component of geocentric r of S/C, km      +                |XPGSFF  20
      |____________________________________________|________________|__________
40-41 |Y component of geocentric r of S/C, km      |                |YPGSFF  21
      |____________________________________________|________________|__________
42-43 |Z component of geocentric r of S/C, km      |                |ZPGSFF  22
      |____________________________________________|________________|__________
44-45 |X component of geocentric r of S/C, km/sec  |                |DXPGSF  23
      |____________________________________________|________________|__________
46-47 |Y component of geocentric r of S/C, km/sec  |                |DYPGSF  24
      |____________________________________________|________________|__________
46-49 |Z component of geocentric r of S/C, km/sec  |                |DZPGSF  25
      |____________________________________________|________________|__________
50-51 |X component of heliocentric r of S/C, km    |                |XPHSFF  26
      |____________________________________________|________________|__________
52-53 |Y component of heliocentric r of S/C, km    | Space-fixed    |YPHSFF  27
      |____________________________________________| Coordinates ___|__________
54-55 |Z component of heliocentric r of S/C, km    | FERP           |ZPHSFF  28
      |____________________________________________| Earth Mean  ___|__________
56-57 |X component of heliocentric r of S/C, km/sec| Equinox &      |DXPHSF  29
      |____________________________________________| Ecliptic of ___|__________
56-55 |Y component of heliocentric r of S/C, km/sec| 1950.0         |DYPHSF  30
      |____________________________________________|________________|__________
60-61 |Z component of heliocentric r of S/C, km/sec|                |DZPHSF  31
      |____________________________________________|________________|__________
62-63 |X component of body 1 - S/C r, km           |+               |XP1SFF  32
      |____________________________________________||_______________|__________
64-65 |Y component of body 1 - S/C r, km           ||               |YP1SFF  33
      |____________________________________________||_______________|__________
66-67 |Z component of body 1 - S/C r, km           ||               |ZP1SFF  34
      |____________________________________________||_   Body     __|__________
68-69 |X component of body 1 - S/C r, km/sec       ||  1 = Venus    |DXP1SF  35
      |____________________________________________||_______________|__________
70-71 |Y component of body 1 - S/C r, km/sec       ||               |DYP1SF  36
      |____________________________________________||_______________|__________
72-73 |Z component of body 1 - S/C r, km/sec       ||               |DZP1SF  37
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74-75	Body 1 - S/C range, km		B1MAGR	38
76-77	Body l - S/C velocity magnitude, km/sec		B1MAGV	39
78-79	Latitude of probe, deg		EALATP	40
80-81	Longitude of probe, deg		EALOMP	41
82-83	Velocity magnitude of probe relative to body km/sec.	Body Fixed Earth (see EN/1)	EAVELP	42
84-85	Body fixed path angle of probe. deg		EAPTHP	43
86-87	Body fixed azimuth angle of probe. deg		EAAZIP	44

Note: The term "probe" refers to the Multiprobe or Orbiter spacecraft and not to the separated Large or Small Probes.

EN/1 -- Earth true equator of date and Greenwich Meridian

Fig 3.2.1

EPHEMERIS DATA RECORD con't

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      BIT                   1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 name  var
  WORD _________________________________________________________________________
  88-89| Latitude of probe. deg                    +                 |B1LATP  45
       |___________________________________________|_________________|__________
  90-91| Longitude of probe. deg                   |                 |B1LOMP  46
       |___________________________________________|Body Fixed      _|__________
  92-93| Velocity magnitude of probe relative to   |Body 1 = Venus   |B1VELP  47
       | body km/sec                               |(see EN/2)       |
       |___________________________________________|_________________|__________
  94-95| Body fixed path angle of probe. deg       |                 |B1PTHP  48
       |___________________________________________|_________________|__________
  96-97| Body fixed azimuth angle of probe. deg    +                 |B1AZIP  49
       |_____________________________________________________________|__________
       |___________________________________________|_________________|__________
100-101| Earth-probe-sun angle, deg                |                 |EPSUAN  51
       |___________________________________________| Angle Group   __|__________
102-103| Sun-Earth-probe angle, deg                | All angles in   |SEPANG  52
       |___________________________________________| degrees       __|__________
104-105| Earth-Sun-probe angle, deg                |                 |ESPANG  53
       |___________________________________________|_________________|__________
106-107| Sun-probe-body 1 angle, deg               |                 |SPB1AN  54
       |___________________________________________|_________________|__________
108-109| Body 1-Earth-probe angle, deg             +                 |B1EPAN  55
       |_____________________________________________________________|__________
110-111| Flag for periapsis (See EN/3)                               |PERIAP  56
       |_____________________________________________________________|__________
112-113|      X-coordinate of XROLL   +            +                 |XROLLX  57
       |______________________________|____________|_________________|__________
114-115|      Y-coordinate of XROLL   |            |                 |XROLLY  58
       |______________________________|____________|_________________|__________
116-117|      Z-coordinate of XROLL   |            |                 |XROLLZ  59
       |______________________________|____________|_________________|__________
118-119|      X-coordinate of YROLL   |            |                 |YROLLX  60
       |______________________________| Attitude   |Spacecraft - ____|__________
120-121|      Y-coordinate of YROLL   | Data       |Centered         |YROLLY  61
       |______________________________|____________|Non-Rotating ____|__________
122-123|      Z-coordinate of YROLL   |            |Coordinates      |YROLLZ  62
       |______________________________|____________|_________________|__________
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124-125|      X-coordinate of ATT     |            |                 |ATTX    63
       |______________________________|____________|_________________|__________
126-127|      Y-coordinate of ATT     |            |                 |ATTY    64
       |______________________________|____________|_________________|__________
128-129|      Z-coordinate of ATT     +            |                 |ATTZ    65
       |___________________________________________|_________________|__________
130-131| NADROL                                    |                 |NADROL  66
       |___________________________________________|_________________|__________
132-133| NADLOK                                    |                 |NADLOK  67
       |___________________________________________|_________________|__________
134-135| RAMROL                                    |                 |RAMROL  68
       |___________________________________________|_________________|__________
136-137| RAMLOK                                    +                 |RAMLOK  69
       ______________________________________________________________|__________
Note: The term "probe" refers to the Multiprobe or Orbiter spacecraft
      and not to the separated Large or Small Probes.

 EN/2 -- Venus true equator of date and Prime Meridian
 EN/3 -- PERIAP = 0. for no closest approach,
                = 1 for periapsis to PCB,
                = 2 for apoapsis to PCB

Fig  3.2.1
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  EPHEMERIS DATA RECORD con't

      BIT                 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 name  var
  WORD _________________________________________________________________________
138-153|                            SPARES                           |     70-77
       |_____________________________________________________________|__________
154-155|Celestial latitude of probe, deg           +                 | DECPI  78
       |___________________________________________|_________________|__________
156-157|Celestial longitude of probe, deg          |                 | RAP1   79
       |___________________________________________|_________________|__________
158-159|Flight-path angle of probe, deg            |                 | PTHP1  80
       |___________________________________________|_________________|__________
160-161|Azimuth angle of probe, deg                |                 | AZP1   81
       |___________________________________________|_________________|__________
162-163|Range rate of probe. km/sec                |                 | DR1    82
       |___________________________________________|_________________|__________
164-165|X-component of Earth position, km          |        (EC)     | XE1    83
       |___________________________________________|_________________|__________
166-167|Y-component of Earth position, km          |        (EC)     | YE1    84
       |___________________________________________|_________________|__________
168-169|Z-component of Earth position, km          |        (EC)     | ZE1    85
       |___________________________________________|_________________|__________
170-171|X-component of Earth velocity, km/sec      |        (EC)     | DXE1   86
       |___________________________________________|_________________|__________
172-173|Y-component of Earth velocity, km/sec      |        (EC)     | DYE1   87
       |___________________________________________|_________________|__________
174-175|Z-component of Earth velocity, km/sec      |        (EC)     | DZE1   88
       |___________________________________________|_________________|__________
176-177|Venus-to-Earth range, km                   | Venus Centered  | RE1    89
       |___________________________________________| Earth Mean     _|__________
178-179|Celestial latitude of Earth direction, deg | Equinox &       | DECE1  90
       |___________________________________________| Ecliptic of    _|__________
180-181|Celestial longitude of Earth direction, deg| 1950.0          | RAE1   91
       |___________________________________________|_________________|__________
182-183|X-component of Sun position. km            |        (EC)     | XS1    92
       |___________________________________________|_________________|__________
184-185|Y-component of Sun position, km            |        (EC)     | YS1    93
       |___________________________________________|_________________|__________
186-187|Z-component of Sun position, km            |        (EC)     | ZS1    94
       |___________________________________________|_________________|__________
188-189|X-component of Sun velocity, km/sec        |                 | DXS1   95
```

190-191	Y-component of Sun velocity, km/sec		DYS1	96
192-193	Z-component of Sun velocity, km./sec		DZS1	97
194-195	Venus-to-Sun range, km		RS1	98
196-197	Celestial latitude of Sun direction, deg		DESC1	99
198-199	Celestial longitude of Sun direction. deg +		RAS1	100

Note: The term "probe" refers to the Multiprobe or Orbiter spacecraft and not to the separated Large or Small Probes.

Fig 3.2.1

EPHEMERIS DATA RECORD con't

```
      BIT                 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 name  var
  WORD _________________________________________________________________________
200-201|Orbit semimajor axis, km                 +     +             | SMA   101
       |_________________________________________|_____|_____________|__________
202-203|Orbit eccentricity                       |     |             | ECC   102
       |_________________________________________|_____|_____________|__________
204-205|Time from periapsis, secs                |     |             | TFP   103
       |_________________________________________|_____|_____________|__________
206-207|Radius of closest approach, km           |     |             | RCA   104
       |_________________________________________|_____|_____________|__________
208-209|orbit period, day                        |     |             | PER   105
       |_________________________________________|Conic|_____________|__________
210-211|Spacecraft true anomaly, deg             |Group|             | TA    106
       |_________________________________________|_____|Venus        |__________
212-213|Orbit inclination, deg                   |     |Centered     | INCL  107
       |_________________________________________|_____|Earth Mean   |__________
214-215|Longitude of ascending node, deg         |     |Equinox &    | LANL  108
       |_________________________________________|_____|Ecliptic of  |__________
216-217|Argument of periapsis, deg               |     |1950.0       | APF1  109
       |_________________________________________|_____|_____________|__________
218-219|X-component of unit vector to periapsis  |     |             | PX1   110
       |_________________________________________|_____|_____________|__________
220-221|Y-component of unit vector to periapsis  |     |             | PY1   111
       |_________________________________________|_____|_____________|__________
222-223|Z-component of unit vector to periapsis  |     |             | PZ1   112
       |_________________________________________|_____|_____________|__________
224-225|X-component of unit normal to orbit plane|     |             | WX1   113
       |_________________________________________|_____|_____________|__________
228-227|Y.component of unit normal to orbit plane|     |             | WY1   114
       |_________________________________________|_____|_____________|__________
228-229|Z-component of unit normal to orbit plane+     |             | WZ1   115
       |_______________________________________________|_____________|__________
230-231|Sun-Venus-probe angle, deg               +     |             | S200P 116
       |_________________________________________|Angle|_____________|__________
232-233|Sun-Earth-Venus angle, deg               +Group|             | SE200 117
       |_______________________________________________|_____________|__________
234-235|X-component of probe position, km              |             | XP1   118
       |_______________________________________________|_____________|__________
236-237|Y-component of probe position, km              |             | YP1   119
```

238-239	Z-component of probe position, km		ZP1	120
240-241	X-component of probe velocity, km/sec		DXP1	121
242-243	Y-component of probe velocity. km/sec		DYP1	122
244-245	Z-component of probe velocity, km/sec	+	DZP1	123

Note: The term "probe" refers to the Multiprobe or Orbiter spacecraft and not to the separated Large or Small Probes.

Fig 3.2.1

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      EPHEMERIS DATA RECORD con't

      BIT                 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 name  var
  WORD _________________________________________________________________________
246-247|X-component of Earth position, km       (EQ)   +             | XE1   124
       |_______________________________________________|_____________|__________
248-249|Y-component of Earth position, km       (EQ)   |             | YE1   125
       |_______________________________________________|_____________|__________
250-251|Z-component of Earth position, km       (EQ)   |             | ZE1   126
       |_______________________________________________|_____________|__________
252-253|X-component of Sun position, km         (EQ)   |             | XS1   127
       |_______________________________________________|_____________|__________
254-255|Y-component of Sun position, km         (EQ)   |Venus        | YS1   128
       |_______________________________________________|Centered     |__________
256-257|Z-component of Sun position, km         (EQ)   |Earth Mean   | ZS1   129
       |_______________________________________________|Equinox &    |__________
258-259|X-component of probe position, km              |Ecliptic of  | XP2   130
       |_______________________________________________|1950.0       |__________
260-261|Y-component of probe position, km              |             | YP2   131
       |_______________________________________________|_____________|__________
262-263|Z-component of probe position, km              |             | ZP2   132
       |_______________________________________________|_____________|__________
264-265|X-component of probe velocity, km/sec          |             | DXP2  133
       |_______________________________________________|_____________|__________
266-267|Y-component of probe velocity, km/sec          |             | DYP2  134
       |_______________________________________________|_____________|__________
268-269|Z-component of probe velocity. km/sec+         +             | DZP2  135
       |_____________________________________________________________|__________
270-271|Celestial latitude of Earth-to-probe direction,deg (see EN/4)| DECP3 136
       |_____________________________________________________________|__________
272-273|Celestial longitude of Earth-to-probe direction,deg          | RAP3  137
       |_____________________________________________________________|__________
274-279|              (SPARES - Double Precision Zeros)              |   138-140
       |________________________________________________________________________
```

EN/4 Earth-centered, Earth mean Equinox & Ecliptic of 1950.0

Fig 3.2.1

The next nine pages contain graphics. Please see TIFF files.