NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Ames Research Center
Moffett Field, California
PIONEER VENUS PROJECT
SPECIFICATION PC-456.04

PIONEER VENUS: DATA USER REQUIREMENTS FOR SUPPLEMENTARY EXPERIMENTER DATA RECORDS

May 15, 1976

1. 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-456.00, Pioneer Venus: Data Records Processing System (DRPS) Description

PC-456.01, Pioneer Venus: Input and Output Tape Description

PC-456.02, Pioneer Venus: Data Records Processing System (DRPS) Detailed Processing Requirements

PC-456.03, Pioneer Venus: Data User Requirements for Experimenter Data Records

PC-454.00, Pioneer Venus: On-Line Ground Data System Software Specification

PC-455.00, 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 1 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

```
                                                                   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 (P111)
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: 50 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 PERIOD (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 (SP13)
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
PHYSICAL RECORD LENGTH: 284

NO. OF LOGICAL RECORDS PER PHYSICAL RECORD: 1

1. ALL DATA IS IN IBM 360 format, DP
2. Except for integer variables, all variables are in double-precision floating point (data records). including calculated attitude, nadir and ram.
3. File order is in S/C UT ascending order.

BIT 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

WORD				NAME	VAR
0	S/C YEAR	S/C DOY			
1	S/C UT in binary			SCUT	1
2-3	DP Julian Date, Days (elapsed days from Noon, 1 Jan. 4713 B.C.			JULDAT	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-CENTRIC	HINFTP	10
20-21	Celestial latitude of probe, deg			CELLTF	11

Bytes	Description		Name	Word
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

EPHEMERIS DATA RECORD con't

WORD	BIT 0–31		name	var
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 Coordinates	YPHSFF	27
54-55	Z component of heliocentric r of S/C, km	FERP Earth Mean	ZPHSFF	28
56-57	X component of heliocentric r of S/C, km/sec	Equinox & Ecliptic of	DXPHSF	29
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	Body	ZP1SFF	34
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

74-75	Body 1 - S/C range, km		B1MAGR	38
76-77	Body 1 - 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

EPHEMERIS DATA RECORD con't

WORD	BIT 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	23 24 25 26 27 28 29 30 31	name	var
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 Earth Mean	RE1	89
178-179	Celestial latitude of Earth direction, deg	Equinox & Ecliptic of	DECE1	90
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 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

WORD				name	var
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	Conic		PER	105
210-211	Spacecraft true anomaly, deg	Group		TA	106
212-213	Orbit inclination, deg		Venus Centered	INCL	107
214-215	Longitude of ascending node, deg		Earth Mean Equinox &	LANL	108
216-217	Argument of periapsis, deg		Ecliptic of 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	Angle		S200P	116
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

EPHEMERIS DATA RECORD con't

WORD	BIT 0–31		name	var
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 Centered Earth Mean Equinox & Ecliptic of 1950.0	YS1	128
256-257	Z-component of Sun position, km (EQ)		ZS1	129
258-259	X-component of probe position, km		XP2	130
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.