Technical Memorandum No. 33-199

SFPRO–Single Precision Cowell Trajectory Processor

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ABSTRACT

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SFPRO, a Single Precision Cowell Trajectory Processor, is a link under the JPL IBSYS-SFOF-JPTRAJ monitor. SFPRO is a digital computer program written in the FAP language for the IBM 7094 computer. Created because of core limitations imposed by the SFOF system, SFPRO, in combination with SPACE, a Single Precision Cowell Trajectory Program, preserves the full output capability of the older JPL Space Trajectories Program. Given a spacecraft ephemeris tape generated by SPACE, SFPRO can perform tracking station view period calculations, and at specified intervals of time it can generate tracking station printouts, and printouts of spacecraft position and velocity and other quantities relative to the Earth, the Sun, and the target body, referenced to any of several planes. SFPRO can generate a binary SAVE tape, containing a time history of the position and velocity of the spacecraft with reference to the bodies of the integration scheme of SPACE, the orientation of the spacecraft with reference to as many as five tracking stations, and various auxiliary quantities. The spacecraft ephemeris contains all physical constants and other data which define the trajectory of a spacecraft. Therefore the trajectory cannot be modified by SFPRO. The program has all the output capabilities of SPACE, and in addition, the tracking station and SAVE tape options.

Herein presented are the general logic flow of SFPRO, definitions of input and output, hardware and software configurations, and interfaces of the program with the systems.

I. INTRODUCTION

SFPRO, Single Precision Cowell Trajectory Processor, originated from a need to maintain capabilities previously available in the JPL Space Trajectories Program, described in Ref. 1 and 2 Section VIII, while producing a program which would operate under the IBSYS-SFOF-FPTRAJ monitor. The core storage requirements of such a program dictated that two separate links be written.

One link, SPACE, Single Precision Cowell Trajectory Program, would provide the trajectory integration and normal printing capability, and would generate a chronologically ordered collection of data on magnetic tape, consisting of the results of integrating the equations of motion in SPACE, and other quantities generated by the integrator in performing its task. This collection of data is known as a spacecraft (or probe) ephemeris.

The spacecraft ephemeris becomes input data to SFPRO, which then produces printing as requested, computes epochs of tracking station view periods, and generates a trajectory SAVE tape on input request. A SAVE tape consists of records of fixed format containing position and velocity information for the spacecraft and the bodies of the integration scheme, as well as tracking station-related data and other quantities of engineering interest.

The JPL Double Precision Ephemeris System is used by SFPRO to determine planetary and lunar position and velocity when these quantities are required for output purposes.

SFPRO produces printed output with respect to the centers of the Earth, the Sun and the target body specified when the spacecraft ephemeris was generated by SPACE. The coordinate frames in which positions, velocities and angular quantities may be expressed are mean Earth equator and equinox of 1950.0, mean ecliptic and equinox of 1950.0, mean Earth equator and equinox of date, mean ecliptic and equinox of date, or true ecliptic and equinox of date. When Mars is the target selected and aerocentric output is requested, position and velocity of the spacecraft and the angular orientation of the Earth and Sun will be computed based on a Mars equator and equinox system assumed not to precess or nutate from its 1950.0 orientation. This coordinate system and its generation are described in subroutine 27 (Section VI). With the Moon as target, spacecraft position, velocity, and certain angular quantities are computed and printed with respect to a true lunar equator (selenographic-spherical) coordinate system whose formation is indicated in Section VI in subroutine 28.2.

Conic output may be called for; this expresses the osculating two-body orbit of the spacecraft with respect to the Earth, Sun or target in many sets of orbital elements referred to any of the above mentioned standard frames of reference, and in addition, to the plane of the orbit of the target body about its "parent" body, i.e. Earth-Moon or Sun-planet.

Tracking stations of the Deep Space Instrumentation Facility (DSIF) may be simulated using a topocentric spherical coordinate system, the positions of 15 DSIF stations being defined in SFPRO. The times of spacecraft rise, extreme elevation and set with respect to the stations and the orientation of the spacecraft relative to the stations at these times can be computed and printed. This is the view period capability.

Simultaneously, these same quantities can be printed with the other blocks of output at the times specified for that output, during the duration of the spacecraft's visibility to a specific tracking station. This type of output is known as station prints.

Certain quantities computed relative to the stations are oriented toward the hardware configurations of the DSIF stations. In particular, equations for doppler frequency calculations are based on certain types of receiving and transmitting equipment. The antenna of a station may be mounted in the local horizontal plane, and is referred to as an azimuth-elevation (AZ-EL) station, or parallel to the Earth's equator, with the designation of hour angle-declination (HADEC). The DSIF stations are of both types, but the choice of computations may be made by input. The equations for tracking station quantities appear in subroutine 26 in Section VI.

Requests for type and density of printing are made to SFPRO by use of "phasing". In each phase, three printing intervals and two odd-time prints are available, and any of the standard output blocks described in Section VB may be printed at these times. View periods and station prints are also requested in the phasing portion of the input.

Phasing may also be utilized to print when the spacecraft reaches a given distance from a specified body or at the point of closest approach to an input body. A phase is terminated when the print end time of the last print interval of the phase is reached, or at the attainment of closest approach or the desired radius.

As many as eight phases may be used in processing a spacecraft ephemeris, the only constraint being that any SFPRO phase must request by input the same integration central body as used by SPACE in the generation of that portion of the spacecraft ephemeris.

Of significant importance is the generation of trajectory SAVE tapes. When requested by input, a binary tape is produced by SFPRO with records of fixed size, each containing position and velocity of the spacecraft relative to the seven bodies of SPACE, angles relating the spacecraft to the principle bodies, and to any of the DSIF tracking stations, up to five in number. Section VA contains a complete description of the format of a SAVE tape. A record is produced after passage of time equal to an input multiple of the integration step size used by SPACE, a quantity found on the spacecraft ephemeris tape.

The SAVE tapes generated by SFPRO are used as input to several programs at the Jet Propulsion Laboratory. These include a Plotting Program, a Spacecraft Attitude Reference Program, a Star Identification Program, and a Communications Prediction Program, all of which were used in connection with the Mariner 1964 mission.

Thc spacecraft ephemeris tape provided by SPACE has one basic format, with two options available. In either option, the first record contains identification information sufficient to specify a unique trajectory. The second through the last record each contains the integrated position and velocity of the spacecraft at the end of a series of integration steps, usually six, and the finite differences computed in the integration process. Section VI, subroutine 31, Ref. 10 describes the integration process and defines the above-mentioned finite differences. One option produces a spacecraft ephemeris which contains the integration of the variational equations, and the associated finite differences, as well as the position and velocity data. Section VI, subroutine 43 of Ref. 10 indicates the formulation of the variational equations used in SPACE. The other option is as above, but without the variational equations and the corresponding finite differences. The variational equations are mentioned here because they effect the contents of the spacecraft ephemeris, but they are not utilized by SFPRO.

Because the leading record of a spacecraft ephemeris contains the values of all physical constants, initial conditions and other related data used in the integration of a trajectory by SPACE, there is no way in which the trajectory may be altered by SFPRO.

A spacecraft ephemeris need not be processed by SFPRO immediately after its generation by SPACE. In addition, the spacecraft ephemerides for several trajectories may be placed on one physical tape due to a serialization feature which identifies spacecraft ephemerides. The value of the serialization assembled in SFPRO and the method of modification is described in Section VI, subroutine 33, and a detailed description of spacecraft ephemeris record format appears in Section IVF.

II. BASIC PROGRAM LOGIC

The operation of SFPRO can be separated into four logical segments. These are herein enumerated as initialization, phasing, end-of-step, and derivative box. Details of the latter three follow in Sections IIA, IIB, and IIC respectively.

In the initialization process, the identification record of the spacecraft ephemeris is read to obtain the data which defines the trajectory to be processed (see Section IVF for the spacecraft ephemeris tape identification record format). This data consists in part of the initial time and coordinates ot the spacecraft as they were originally input to SPACE, the body to which these are referenced, and the target body name. The values of the physical constants used in SPACE and other data either defining the trajectory or which are necessary for processing the spacecraft ephemeris tape are also part of this identification record. The initial conditions and physical constants are printed at the beginning of each processed trajectory in the format specified in Section VB. Should the generation of a trajectory SAVE tape be requested by input, this process is initialized by subroutine 30, PLTSET, in Section VI.

The phasing, described in detail in Section IIA, is now examined to determine the frequency of printing to be used in the first phase of the processing. On this basis, triggers are set up which inform the spacecraft ephemeris interpolation subroutine 38, SPASM, in Section VI, of the times at which it is to interrupt its processing to allow printing to occur. In similar fashion, triggers are set up for the station view period option, which like print times, is requested in each phase. Section IVB indicates the type of input required to request printing and view period computation. Subroutine 26, LOOP, Section VI, describes in detail the calculations used in determining view periods.

At this point the derivative box (Section IIC) is entered once to bring the first integrated data record from the spacecraft ephemeris into the portion of storage known as the HBANK, which is explained in subroutine 38, SPASM, Section VI. This is the final step of the initialization process and SPASM, the spacecraft ephemeris interpolator, is now prepared to begin processing.

A. PHASING

A method of segmenting a trajectory to provide a flexible output capability is utilized by SFPRO and is known as phasing. It is similar in many respects to that used by the program SPACE (Ref. 10), but not entirely the same. In SFPRO, phasing is used to control the times, frequencies, and types of printing desired. But unlike the phasing in SPACE, no means is available to control the integration of the trajectory in the phasing of SFPRO, as the integrated trajectory is indeed the primary input to SFPRO.

Internal to SFPRO, in subroutine 42. 1, TRAJ (Section VI), are nominal sets of phasing for three prevalent cases, i. e., when the target is the Moon, Venus, or Mars. These "canned" phases are identical to their counterparts in SPACE, and provide a minimal amount of output suitable for the particular target body, and terminate processing at impact on or closest approach to the target. The canned phasing may be modified or completely overridden by input. In the event that a body other than those mentioned above is the target, phasing must be input which reflects this fact. Section IVB contains definitions of these and all other input parameters to SFPRO. Should a spacecraft ephemeris cover a shorter duration than the processing period requested in SFPRO, notice of this is given and processing is terminated. Conversely, a spacecraft ephemeris need not be processed to its full length, such processing to be terminated by the appropriate phasing input.

A phase ends when one of three possible conditions is satisfied, on the basis of whichever occurs first. If the final print time for a phase is reached, this causes termination of the phase. When the spacecraft reaches a distance from a body, both the distance and the body being inputs to the phasing, or when the spacecraft reaches closest approach with the target body, the phase is terminated. One must specify for each phase whether it is to be the last phase of the trajectory.

It is possible that the position of the spacecraft may not be known precisely enough beforehand for the user to ascertain in which phase to start processing, i. e., whether to start geocentric or selenocentric. If desired, for phasing which is identical or similar to that canned, the program will determine from the initial position of the spacecraft and the planetary ephemerides the phase in which to begin processing. This is referred to as "automatic phasing" and this mode is assumed by the program but may be overridden by input (again, see Section IVB).

B. END-OF-STEP CALCULATIONS

The "end-of-step box" is that coding to which subroutine SPASM, the spacecraft ephemeris interpolator, transfers at the end of each integration step it processes. Subroutine 38 (Section VI) spells out the details of the linkage between SPASM and the end-of-step box, which is located in subroutine TRAJ, 42.1.

Upon completion of processing each step, certain quantities must be recomputed to reflect the changes in the position and velocity of the spacecraft over that step, and the change in time itself. The quantities involved are the positions and velocities of the n-bodies with respect to the integration central body, referenced to the mean Earth equator and equinox of 1950.0, and the magnitudes of the n-body--central body, and n-body--spacecraft position vectors. Also updated at this time are the current values of quantities which are dependent variables for the trigger logic of SPASM. Included in this group are topocentric quantities for view period triggers (see LOOP, subroutine 26) and quantities for shadow and back-up target impact triggers. Subroutine 30, PLLLT, Section VI, is called and will generate a trajectory SAVE tape record if one has been requested by input. The arc distance travelled by the spacecraft is updated by subroutine 29, PATH, Section VI, for use with the public information output described in Section VB. Control is always returned to SPASM.

C. DERIVATIVE BOX

The "derivative box" logic in subroutine TRAJ is used by SPASM, and provides the latter with integrated data read from the spacecraft ephemeris by the subroutine 33, READN. When SPASM has processed all the data in its HBANK from the previous spacecraft ephemeris record, the next record is then read into the HBANK by READN. After a new record is read by READN the flag words in this record are examined in the derivative box and if they reflect a discontinuity in the integration an appropriate comment is written on SYSOU1. The trajectory is terminated by calling subroutine 1, ABORT, Section VI, if the last data record is passed, as a backup precaution. Hence a user should terminate a trajectory through the phasing capability and not allow SFPRO to run out of data. Unless the run is aborted, the derivative box returns control to SPASM.

III. MACHINE AND SYSTEM CONFIGURATION

There are two computer systems in use at the Jet Propulsion Laboratory. One is the standard IBM 7094 IBSYS job-shop system. It is used for daily checkout and production. The other system is the JPL SFOF system, which is used to process spacecraft data and to allow input, output, and control at remote user areas.

SFPRO, under JPTRAJ, satisfies all the requirements of both systems and can therefore be used in any of the various modes of operation. Core storage is allocated as follows:

Octal Locations	Contents
0-3777	IBSYS
4000-21077	SFOF
21100-22277	JPTRAJ
22300-77777	SFPRO

IV. INPUT

A. INPUT CAPABILITY

Data in the SFPRO link of a JPTRAJ source deck is input by JPTRAJ just prior to the execution of SFPRO. JPTRAJ does this with the aid of SFPRO's symbol table. In addition, data can come from other links in the JPTRAJ source deck by proper use of the JPTRAJ "WANT" and "USE" control cards. Here again, JPTRAJ uses SFPRO's symbol table. SFPRO has no input subroutine so that when JPTRAJ transfers control to SFPRO all input is completed (i.e., there is no on-line input capability in SFPRO). This restriction is circumvented by using "WANT" control cards and a link named TRIO (Ref. 11, Section VIII).

The binary tape-read subroutines EPHSET and EPHEM have been included in SFPRO for reading the n-body ephemeris tape.

Sense switches 4 and 6 on the 7094 console may be used to input a request to SFPRO for on-line output. Section V describes the output one may request and the setting of the switches.

B. INPUT DEFINITION

```
SYMBOL       TYPE EXPLANATION                                  UNITS      NOM. VALUE

PAGBCD       BCD  TWO LINES (40 WORDS) OF PAGE HEADING                        BLANKS
FAZFLG       FIX  NON-ZERO=USE PHASING OF DOMINANT BODY                       1
RUNID        BCD  RUN I.D. USED WITH SCFORF=1                                 TRAJ01
                  SAVE TAPE OPTION
PLOTFQ       FIX  SAVE TAPE FLAG. INPUT N=SAVE EVERY NTH STEP                 0
PLOTFQ+1     FIX  PHYSICAL FILE NO.                                           1
PLOTFQ+2     FLO  TIME INCREMENT ADDED TO TIME PAST INJ.       SEC            0.0
PLOTFQ+3     OCT  STATIONS 59 11 12 41 51 14 13 15 42 61 08 91                0
PLOTFQ+4     OCT  STATIONS 75 76 02 00 00 00 00 00 00 00 00 00                0
                  (MAXIMUM OF FIVE STATIONS)
                  PUBLIC INFORMATION AND BOARD UNITS
PUBLIC       FLO  ROTATION ANGLE                               DEC            49.3
PUBLIC+1     FLO  SCALE FACTOR                                 BD UN/KM .45E-7
PUBLIC+2     FLO  HORIZONTAL LOCATION OF SUN                   BD UN          12.5
PUBLIC+3     FLO  VERTICAL LOCATION OF SUN                     BD UN          8.0
CAN50        FLO  1950.0 UNIT CARTESIAN BODY-CANOPUS X                        -.060340592
CAN50+1      FLO  1950.0 UNIT CARTESIAN BODY-CANOPUS Y                        .60342839
CAN50+2      FLO  1950.0 UNIT CARTESIAN BODY-CANOPUS Z                        -.79513092
LAUNCH       SEG  LAUNCH EPOCH                                                0.0
TARGAD       FLO  ALTITUDE ABOVE TARGET TO END RUN                            0.0
                  VIEW PERIOD PRINTS
VPGROP       OCT  GROUP PRINT FLAG AT VIEW PERIODS                            0
VPGROP+1     OCT  CONIC PRINT FLAG AT VIEW PERIODS                            0
FLAG42       FIX  NON-ZERO PUTS OUTPUT IN SC4020 MODE                         0
PRTSWX       FIX  PRINT SWITCH  NON-ZERO=PRINT EVERY CASE                     0
PRTSTP       FIX  NON-ZERO=PRINT EVERY END-OF-STEP                            0
PRTSTP+1     OCT  PRINT GROUP AT EACH END-OF-STEP                             0
PRTSTP+2     OCT  CONIC GROUP AT EACH END-OF-STEP                             0
DEPOPT       FIX  0=NO DEP. VAR.  1=PRINT  -1=END PHASE                       0
DEPOPT+1     OCT  LOCATION OF DEPENDENT VARIABLE                              0
DEPOPT+2     FLO  VALUE OF DEPENDENT VARIABLE                                 0.0
OPTSWT       FIX  ON-LINE OUTPUT CONTROL                                      0
                     0=NO REMOTE CONTROL. NO ON-LINE PRINT
                     -1=REMOTE CONTROL.HANG FOR S.S. SETTING
                     5=FINE PRINT ON-LINE
                     1=MINIMUM PRINT ON-LINE
```

THE 40 PHASE PARAMETERS MUST BE INPUT INTO THE PROPER BUFFERS AS FOLLOWS

WHERE XXXXXX IS REPLACED BY
MOOPH1 TO MOOPH8 FOR MOON
VENPH1 TO VENPH8 FOR VENUS
MARPH1 TO MARPH8 FOR MARS
MOOPH1 TO MOOPH8 FOR ALL OTHER TARGET BODIES

```
SYMBOL       TYPE EXPLANATION                                  UNITS      NOM. VALUE

XXXXXX+0     FIX  -=PRINT AT START OF PHASE
                  + = DO NOT PRINT AT START OF PHASE
                  SET TPRT=PHASE START        USE OLD TPRT
                  0          PRINT AT END              LAST PHASE  4
                  1          PRINT AT END          NOT LAST PHASE  5
                  2 DO NOT PRINT AT END                LAST PHASE  6
                  3 DO NOT PRINT AT END            NOT LAST PHASE  7
XXXXXX+1     BCD  BODY FROM WHICH TO COMPUTE R FOR R TEST
XXXXXX+2     FLO  VALUE OF R TO END PHASE
XXXXXX+3     BCD  BODY FROM WHICH TO COMPUTE R. FOR R.=0 TEST
XXXXXX+4     FLO  VALUE OF R TO TURN ON R.=0 TEST
                     + VALUE=TURN ON TEST WHEN (BODY-PROBE R) GR. THAN (+ VALUE)
                     - VALUE=TURN ON TEST WHEN (BODY-PROBE R) LESS THAN -(-VALUE)
XXXXXX+6     BCD  CENTRAL BODY FOR INTEGRATION
XXXXXX+7     SEG  STEPSIZE
XXXXXX+9     FIX  NO. OF STEPSIZE DOUBLES
XXXXXX+10    BCD  BODY USED IN LOOKUP FOR STEPSIZE
XXXXXX+11    SEG  PRINT END 1
XXXXXX+13    SEG  PRINT DELTA 1
XXXXXX+15    SEG  PRINT END 2
XXXXXX+17    SEG  PRINT DELTA 2
XXXXXX+19    SEG  PRINT END 3
XXXXXX+21    SEG  PRINT DELTA 3
XXXXXX+23    SEG  ODD PRINT 1
XXXXXX+25    SEG  ODD PRINT 2
XXXXXX+27    OCT  GROUP PRINT FLAGS WHERE THE FORMAT OF THE OCTAL WORD IS
                       G GC H HC 0 T TC R 0 0 0 U
                    WHERE G = GEOCENTRIC
                          GC= GEOCENTRIC CONIC (PLANE INDEPENDENT)
                          H = HELIOCENTRIC
                          HC= HELIOCENTRIC CONIC (PLANE INDEPENDENT)
                          T = TARGET
                          TC= TARGET CONIC (PLANE INDEPENDENT)
                          R = R DOT EQUAL ZERO
                          U = VARIATIONAL EQUATIONS
                    FLAG=1=EQUATORIAL
                         2=ECLIPTIC
                         4=ECLIPTIC AT START ONLY
                         5=EQUATORIAL AT START ONLY
                         6=ECLIPTIC AT END ONLY
                         7=EQUATORIAL AT END ONLY
XXXXXX+28    OCT  STATION PRINTS (15 STATIONS IN TWO WORDS. MAX OF 5 AT A TIME)
                    12 STATIONS ARE FLAGGED IN FIRST WORD, 3 IN SECOND AS FOLLOWS
                      59 11 12 41 51 14 13 15 42 61 08 91, 75 76 02
```

```
XXXXXX+38  OCT  CONIC PRINT FLAGS (PLANE DEPENDENT VARIABLES)
                  WHERE THE FORMAT OF THE OCTAL WORD IS
                    Q C O T Q C O T Q C O T
                    WHERE THE FIRST SET OF Q C O T IS USED IN THE GEO CONIC,
                    THE SECOND SET IS USED IN THE HELIO CONIC AND THE THIRD SET
                    IS USED IN THE TARGET CONIC AND WHERE
                      Q = EARTH EQUATORIAL PLANE
                      C = ECLIPTIC PLANE
                      O = ORBIT PLANE OF TARGET (X IS ALONG THE ASCENDING NODE
                            OF THE ORBIT PLANE OF THE TARGET ON THE TARGET
                            TRUE EQUATOR PLANE, IF THE TARGET TRUE EQUATOR
                            PLANE IS DEFINED. OTHERWISE, ON THE ECLIPTIC PLANE.
                      T = TRUE TARGET EQUATOR PLANE (DEFINED FOR MOON AND MARS)
                            X IS DEFINED THE SAME AS FOR THE ORBIT PLANE
XXXXXX+30  OCT  VIEW PERIODS ( 15 STATIONS IN TWO WORDS, MAX OF 5 AT A TIME )
                  12 STATIONS ARE FLAGGED IN FIRST WORD, 3 IN SECOND AS FOLLOWS
                  . 59 11 12 41 51 14 13 15 42 61 08 91, 75 76 02
XXXXXX+34  FIX  SHADOW PARAMETER FLAG  1=ON
XXXXXX+39  BCD  OUTPUT EQUINOX (      ) = TRUE-OF-DATE
                               (1950.0) = MEAN 1950.0


NOTE...THERE ARE NO INTEGRATION OR STEPSIZE CONTROL INPUTS TO SFPRO BUT
       STORAGE HAS BEEN ALLOCATED FOR THEM. THIS ALLOWS ONE SET OF PHASING TO
       SUFFICE FOR BOTH SPACE AND SFPRO VIA WANT CARDS, IF DESIRED


FRQ         FLO  A1I    STATION FREQUENCY COEFFICIENTS                 930.15E6
FRQ+1       FLO  A2I                                                   1.0
FRQ+2       FLO  A3I                                                   1.0
FRQ+3       FLO  A4I                                                   32.3595506
FRQ+4       FLO  A5I                                                   1E5
FRQ+5       FLO  A6I                                                   1.0
FRQ+6       FLO  A7I                                                   .455E6
FRQ+7       FLO  RF1                                                   960.05E6
FRQ+8       FLO  RF2,K3                                                29.668212E6
FRQ+9       FLO  K1                                                    32.4482
FRQ+10      FLO  K2                                                    20.
FRQ+11      FLO  RFB,B5                                                960.05E6
FRQ+12      FLO  B6                                                    1.0
FRQ+13      FLO  FA                                                    960.05E6
FRQ+14      FLO  FI                                                    30.434E6
FRQ+15      FLO  SLIT (SPEED OF LIGHT, KM/SEC)                         299792.5
FRQ+16      FLO  SK1                                                   23.5E6
FRQ+17      FLO  LSK1                                                  23.5E6
FRQ+18      FLO  LSFT                                                  2295.E6
FRQ+19      FLO  SFT                                                   2295.E6
FRQ+20      FLO  FRQ1)                                                 22.E6
HASPAN      FLO  HOUR ANGLE CONSTRAINT FOR HA-DEC STATIONS DEG         90.0
                 STATION COORDINATES, MAX. OF 15 STATIONS,
                 FIVE WORDS EACH
STACRD      FLO  STATION LATITUDE
STACRD+1    FLO  STATION LONGITUDE
STACRD+2    FLO  RADIUS TO STATION
STACRD+3    FIX  CODE WORD  0=AZ-EL,1=HA-DEC
STACRD+4         STATION TRANSMITTER TYPE  0=L BAND  1=L-S BAND  2=S BAND
STABCD,+3   BCD  STATION NAMES (MAX. OF 15 STATIONS, FOUR WORDS EACH)


       THERE ARE MANY MORE SYMBOLS IN THE SYMBOL
       TABLE. THE FOLLOWING TABLE GIVES THE ADDITIONAL SYMBOLS,
       WHERE I AND/OR O INDICATES WHETHER THE
       DATA IS INPUT TO SFPRO OR OUTPUT FROM SFPRO.


SYMBOL I/O TYPE EXPLANATION                                  UNITS


BTQ      O  FLO  B.T EARTH EQUATORIAL                         KM
BRQ      O  FLO  B.R EARTH EQUATORIAL                         KM
BTC      O  FLO  B.T ECLIPTIC                                 KM
BRC      O  FLO  B.R ECLIPTIC                                 KM
BTO      O  FLO  B.T, TARGET ORBITAL PLANE                    KM
BRO      O  FLO  B.R, TARGET ORBITAL PLANE                    KM
BTT      O  FLO  B.T, TARGET TRUE EQUATOR PLANE               KM
BRT      O  FLO  B.R, TARGET TRUE EQUATOR PLANE               KM
                   ALL B.T, B.R VALUES IN THE BUFFERS ARE
                   THE LAST ONES COMPUTED BY THE PROGRAM
C3       O  FLO  TARGET CONIC ENERGY CONSTANT                 KM2/SEC2
VH       O  FLO  TARGET CONIC HYPERBOLIC EXCESS VELOCITY      KM/SEC
TFD      O  FLO  TIME OF FLIGHT                               DAYS
TFH      O  FLO  TIME OF FLIGHT                               HOURS
TFM      O  FLO  TIME OF FLIGHT                               MIN
TFLIND   O  FLO  LINEARIZED TIME OF FLIGHT                    DAYS
TFLINH   O  FLO  LINEARIZED TIME OF FLIGHT                    HOURS
TFI      O  FLO  TIME PAST INJECTION EPOCH                    SEC
SELAT    O       SELENOGRAPHIC LATITUDE OF S/C                DEG
SELON    O       SELENOGRAPHIC LONGITUDE OF S/C               DEG
JULD     O  FLO  JULIAN DATE (2 WORDS)                        DAYS
                 1ST WORD INTEGER DAYS
                 2ND WORD FRACTIONAL PART OF A DAY
LATIT    O       GEOCENTRIC LATITUDE OF S/C                   DEG
LONGY    O       GEOCENTRIC LONGITUDE OF S/C                  DEG
TZERO    O  FLO  INJECTION EPOCH SEC PAST 0 HR JAN 1, 1950 SEC
XOP      O  FLO  42-WORD BUFFER CONTAINING 7                  KM,KM/SEC
                 RECTANGULAR POSITON VECTORS FOLLOWED
                 BY 7 RECTANGULAR VELOCITY VECTORS
                 THE ORDER OF THE VECTORS IS
                 EARTH TO S/C
                 MOON TO S/C
                 SUN TO S/C
                 VENUS TO S/C
                 MARS TO S/C
                 SATURN TO S/C
                 JUPITER TO S/C
                 THE COORDINATE SYSTEM IS EARTH CENTERED,
                 EARTH EQUATORIAL, SPACE FIXED, WHERE THE
                 EQUINOX IS DEFINED BY THE INPUT PARAMETER
                 DEFINING THE OUTPUT EQUINOX
STATE    I  FIX  CONTAINS FLAGS FROM THE SEARCH PROGRAM
TAPEX   I/O      EPHEMERIS TAPE INFORMATION (6 WORDS)
            FIX     WORD 1   PZE SYSUT8
                    WORD 2   EMPTY
            FLO     WORD 3-4 J.D. OF MIN DATE ON TAPE
            FLO     WORD 5-6 J.D. OF MAX DATE ON TAPE
T        O  FLO  CURRENT EPOCH SEC PAST 0 HR JAN 1, 1950   SEC
```

C. JPTRAJ RESTRICTIONS

SFPRO operates under the JPTRAJ monitor, which imposes three programming requirements. SFPRO satisfies these requirements by providing:

1. A four-word Program Control Block (PCB) located at entry "......".
2. A Symbol Table, which immediately follows the PCB.
3. A zero (normal return via JEXIT) or a one (error return via ABORT) in the accumulator upon return to JPTRAJ.

A detailed description of the JPTRAJ programming requirements is found in Ref. 4 (Section VIII).

1. Program Control Block

```
...... BCI     1,SFPRO                 *
       ZERO    1,,1                CLASS 1,,1 ERROR RETURN
       ZERO    LST                 LENGTH OF SYMBOL TABLE
       TRA     NS4
```

2. Symbol Table

```
ORG EQU     *               BEGINNING OF SYMBOL TABLE
    SYM     TZERO,I
    SYM     TZERO,I
    SYM     BTQ
    SYM     BTC
    SYM     BTO
    SYM     BTT
    SYM     BRQ
    SYM     BRC
    SYM     BRO
    SYM     BRT
    SYM     T,I
    SYM     C3,I
    SYM     VH,I
    SYM     TFD
    SYM     TFH
    SYM     TFM
    SYM     TFLIND
    SYM     TFLINH
    SYM     TFI,I
    SYM     SELON,I
    SYM     SELAT,I
    SYM     JULD
    SYM     LATIT,I
    SYM     LONGY,I
    SYM     TARGAD
    SYM     PAGBCD
    SYM     TARBCD
    SYM     INJBCD
    SYM     FAZFLG
    SYM     INJTYP
    SYM     INJT
    SYM     INJX
    SYM     INJY
    SYM     INJZ
    SYM     INJDX
    SYM     INJDY
    SYM     INJDZ
    SYM     RMAX
    SYM     PHL
    SYM     INJTDT
    SYM     INJEQX
    SYM     MOOPH1
    SYM     MOOPH2
    SYM     MOOPH3
    SYM     MOOPH4
    SYM     MOOPH5
    SYM     MOOPH6
    SYM     MOOPH7
    SYM     MOOPH8
    SYM     VENPH1
    SYM     VENPH2
    SYM     VENPH3

    SYM     VENPH4
    SYM     VENPH5
    SYM     VENPH6
    SYM     VENPH7
    SYM     VENPH8
    SYM     MARPH1
    SYM     MARPH2
    SYM     MARPH3
    SYM     MARPH4
    SYM     MARPH5
    SYM     MARPH6
    SYM     MARPH7
    SYM     MARPH8
    SYM     STABCD
    SYM     STACRD
    SYM     FRQ
    SYM     XOP,I
    SYM     XOP,I
    SYM     TARAD
    SYM     LUNGRV
    SYM     SCALE1
    SYM     GRAV
    SYM     BRNOPT
    SYM     RADOPT
    SYM     DEPOPT
    SYM     VPGROP
    SYM     FLAG42,I
    SYM     RUNID,I
    SYM     PRTSWX,I
    SYM     STATE,I
    SYM     ABORT,I
    SYM     NEWBOD
    SYM     PLOTFQ
    SYM     HASPAN
    SYM     TAPEX
    SYM     OPTSWT,I
    SYM     NUTEPH
    SYM     MNAET
    SYM     LAUNCH
    SYM     PUBLIC
    SYM     PRTSTP
    SYM     CAN50
LST EQU     *-ORG           LENGTH OF SYMBOL TABLE


WHERE SYM IS DEFINED AS FOLLOWS

    MACRO
Z   SYM     X,Y
    BCI     1,X
    RMT
    IFF     1,Y
    MZE     $X
    IFF     0,Y
    PZE     X
    RMT
    END
```

D. COMMON MAP AND LOAD MAP

```
77152          COMMON  199
77152   COMMON COMMON  1
77316    BFF23 SYN     COMMON+100
77152      COM SYN     COMMON                 COMMON BLOCK
77151   PRTSWT COMMON  1          PRINT SUPP. SWITCH, 0=SUPPRESS,NON ZERO=NORMAL
77150   INPSWT COMMON  1
77147    OMEGA COMMON  1
77145          COMMON  1
77143          COMMON  2                      BUFFER FOR ,TIME,
77143       TT COMMON  1                              .
77141          COMMON  1                      INJECTION EPOCH
77141     T(0) COMMON  1                             .
77136          COMMON  2
77136     TARG COMMON  1
77135   LOMEGA COMMON  1                      EARTH,S RATE IN RAD/SEC
77134   GHA(T) COMMON  1                      GREENWICH HOUR ANGLE
77133    NUTRA COMMON  1                      NUTATION IN RIGHT ASCENSION
77124          COMMON  6
77124     YEAR COMMON  1
77123     MODE COMMON  1
77122   TARGET COMMON  1
77120          COMMON  1
77120      GJH COMMON  1
77116          COMMON  1
77116      RKH COMMON  1
77115    PHASE COMMON  1
77114        Q COMMON  1
77112          COMMON  1
77111          COMMON  1
77111    TBURN COMMON  1
77110       GK COMMON  1
77077          COMMON  8
77077       AA COMMON  1                      EARTH,S MEAN EQUATOR TO 1950.0
77076       ET COMMON  1                      TRUE OBLIQUITY
77075   CENTER COMMON  1                      CENTRAL BODY MEMBER
77064          COMMON  8                              .
77064    (MNA) COMMON  1                      MOON,S TRUE EQUATOR MATRIX TO 1950.0
77053          COMMON  8                                      .
77053     (NA) COMMON  1                      EARTH,S TRUE EQUATOR TO 1950.0
77042          COMMON  8                                      .
77042       MM COMMON  1        MOON,S TRUE EQUATOR TO EARTH,S TRUE EQUATOR
77040          COMMON  1
77040      TOB COMMON  1                      OBSERVATION TIME
77036          COMMON  1
77036      TDR COMMON  1                      DRIVE TAPE TIME
77035     CODE COMMON  1
77034     MASS COMMON  1
77033    MASS. COMMON  1
77032     M(T) COMMON  1
77031      ACC COMMON  1
77030       RO COMMON  1
77027        R COMMON  1                      DISTANCE FROM CENTRAL BODY
77026     RB6P COMMON  1                      DISTANCE FROM NTH BODY TO PROBE
77025     RB5P COMMON  1                                  .
77024     RB4P COMMON  1                                  .
77023     RB3P COMMON  1                                  .


77022     RB2P COMMON  1                                  .
77021     RB1P COMMON  1                                  .
77020     RB0P COMMON  1                                  .
77017      RB6 COMMON  1                      DISTANCE FROM NTH BODY TO CENTRAL BODY
77016      RB5 COMMON  1                                  .
77015      RB4 COMMON  1                                  .
77014      RB3 COMMON  1                                  .
77013      RB2 COMMON  1                                  .
77012      RB1 COMMON  1                                  .
77011      RB0 COMMON  1                                  .
00007     BSEP SYN     RB0P-RB0               CARTESIAN VELOCITY COORDINATES
76764          COMMON  20                     OF THE N BODIES     1950.0
76764      XN. COMMON  1                      CARTESIAN POSITION COORDINATES
76737          COMMON  20                     OF THE N BODIES   1950.0
76737       XN COMMON  1
76736      KB6 COMMON  1                      GRAVITY COEFFICIENTS OF THE N BODIES
76735      KB5 COMMON  1                                  .
76734      KB4 COMMON  1                                  .
76733      KB3 COMMON  1                                  .
76732      KB2 COMMON  1                                  .
76731      KB1 COMMON  1                                  .
76730      KB0 COMMON  1                                  .
00014    NTAB1 SYN     XN.-XN-9               NUMBER OF COORDINATES
00044    NTAB2 SYN     3*NTAB1                ENTER CENTRAL DIFFERENCES
00330    NTAB3 SYN     6*NTAB2                ENTER TIME POINTS
01122    NTAB4 SYN     NTAB3+378
00052    SEPP1 SYN     2*XN.-2*XN
76727    JECAN COMMON  1                      BUFFERS FOR JEKYL, HYDE, ETAL
76726    MENAN COMMON  1                                  .
76725       NU COMMON  1                                  .
76724    ECCEN COMMON  1                                  .
76723     AVAL COMMON  1                                  .
76722     PVAL COMMON  1                                  .
76721     NORB COMMON  1                                  .
76717          COMMON  1                                  .
76717    IMINE COMMON  1                                  .
76716    FQFLG COMMON  1                      FREQUENCY FLAG, 0=OFF,  OTHERWISE ON
76715    VAFLG COMMON  1                      VARIATIONAL EQUATIONS FLAG
00007      AMM SYN     7
00064      AMN SYN     52                     6+6*6+5*2
00001      AME SYN     1
00011      BAM SYN     AMM+AME+1
        *                                     GENERAL BUFFER FOR MARK I
74524          COMMON  3*AMN+AMN*BAM+AMN*BAM+AMN*AME
74513          COMMON  9                      DERIVATIVES FOR
74513     FRQ. COMMON  1                      FREQUENCY
74447          COMMON  35                     DERIVATIVES FOR
74447     VAR. COMMON  1                      VARIATIONAL EQUATIONS,1950.0
74446     CZ.. COMMON  1                      COWELL BUFFER 1950.0
74445     CY.. COMMON  1                      COWELL BUFFER 1950.0
74444     CX.. COMMON  1                      COWELL BUFFER 1950.0
74440          COMMON  3                      DERIVATIVES FOR POSITIONS, 1950.0
74427          COMMON  9
74427      FRQ COMMON  1
74363          COMMON  35                     VARIATIONAL EQUATIONS, 1950.0
74363      VAR COMMON  1
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74362      CZ. COMMON  1                     COWELL BUFFER 1950.0
74361      CY. COMMON  1                     COWELL BUFFER 1950.0
74360      CX. COMMON  1                     COWELL BUFFER 1950.0
74357       CZ COMMON  1                     COWELL BUFFER 1950.0
74356       CY COMMON  1                     COWELL BUFFER 1950.0
74355       CX COMMON  1                     COWELL BUFFER 1950.0
74353          COMMON  1                     CURRENT EPOCH
74353        T COMMON  1                          *
74351          COMMON  1                     NUMBER OF EQUATIONS
74351    HBANK COMMON  1
74345          COMMON  3
74335          COMMON  8
74335   VARCFF COMMON  1
74271          COMMON  35
74271   VARTRU COMMON  1                     VARIATIONAL EQUATIONS, TRUE EQUATOR
74266          COMMON  2                     BUFFERS FOR THRUST
74266       CE COMMON  1                              *
74260          COMMON  5                     MOON - FIXED POSITION  1950.0
74260       CD COMMON  1                     LUNAR OBLATENESS PERTURBATION 1950.0
74256          COMMON  1                     EARTH OBLATENESS
74253          COMMON  3                     POSITION WITH RESPECT TO EARTH 1950.0
74251          COMMON  2           POSITION WITH RESPECT TO EARTH  MEAN OF DATE
74251       CC COMMON  1                          *                  *
74246          COMMON  2                     EARTH OBLATENESS PERTURBATION 1950.0
74246       CB COMMON  1                                *
74243          COMMON  2                     N-BODY PERTURBATION  1950.0
74243       CA COMMON  1                             *
74240          COMMON  2                     DIRECTION COSINES OF CANOPUS
74240    CANOP COMMON  1                     TRUE EQUATOR AND EQUINOX OF DATE
74235          COMMON  2                                 *
74235       S3 COMMON  1                                 *
74232          COMMON  2                                 *
74232       S2 COMMON  1                                 *
74227          COMMON  2                                 *
74227       S1 COMMON  1                                 *
74202          COMMON  20                    TRUE EQUATOR AND EQUINOX OF DATE
74202     XOP. COMMON  1           VELOCITY COORDINATES OF PROBE IN N BODY SYSTEMS
74155          COMMON  20                    TRUE EQUATOR AND EQUINOX OF DATE
74155      XOP COMMON  1           POSITION COORDINATES OF PROBE IN N BODY SYSTEMS
74130          COMMON  20                    TRUE EQUATOR AND EQUINOX OF DATE
74130     XN.1 COMMON  1           VELOCITY COORDINATES OF NTH BODY
74103          COMMON  20                    TRUE EQUATOR AND EQUINOX OF DATE
74103      XN1 COMMON  1           POSITION COORDINATES OF NTH BODY
74102      Z1. COMMON  1                     EARTH-FIXED CARTESIAN
74101      Y1. COMMON  1                     EARTH-FIXED CARTESIAN
74100      X1. COMMON  1                     EARTH-FIXED CARTESIAN
74077       Z1 COMMON  1                     EARTH-FIXED CARTESIAN
74076       Y1 COMMON  1                     EARTH-FIXED CARTESIAN
74075       X1 COMMON  1                     EARTH-FIXED CARTESIAN
74074   SIGMA1 COMMON  1                     EARTH-FIXED SPHERICAL
74073   GAMMA1 COMMON  1                     EARTH-FIXED SPHERICAL
74072       V1 COMMON  1                     EARTH-FIXED SPHERICAL
74071   THETA1 COMMON  1                     EARTH-FIXED SPHERICAL
74070     PHI1 COMMON  1                     EARTH-FIXED SPHERICAL
74067       R1 COMMON  1                     EARTH-FIXED SPHERICAL
74064          COMMON  2                     BUFFER
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74064     XEP. COMMON  1                     BUFFER
74061          COMMON  2                     FOR ,,SPACE,,
74061      XEP COMMON  1                     FOR ,,SPACE,,
74060       Z. COMMON  1                     OUTPUT BUFFER
74057       Y. COMMON  1                     REFERENCED TO
74056       X. COMMON  1                     TRUE EQUATOR
74055        Z COMMON  1                     AND EQUINOX OF DATE
74054        Y COMMON  1
74053        X COMMON  1
74050          COMMON  2                     1950.0 EQUATOR
74050      CS3 COMMON  1                     1950.0 EQUATOR
74045          COMMON  2                     1950.0 EQUATOR TO EARTH
74045      CS2 COMMON  1                     1950.0 EQUATOR TO EARTH
74042          COMMON  2                     1950.0 EQUATOR TO SUN
74042      CS1 COMMON  1                     1950.0 EQUATOR TO SUN
74041     QZO. COMMON  1                     ENCKE BUFFER
74040     QYO. COMMON  1                     1950.0
74037     QXO. COMMON  1
74036      QZO COMMON  1                     TWO-BODY SOLUTION, 1950.0
74035      QYO COMMON  1                     TWO-BODY SOLUTION, 1950.0
74034      QXO COMMON  1                     TWO-BODY SOLUTION, 1950.0
74033      QZ. COMMON  1                     TRUE SOLUTION, 1950.0
74032      QY. COMMON  1                     TRUE SOLUTION, 1950.0
74031      QX. COMMON  1                     TRUE SOLUTION, 1950.0
74030       QZ COMMON  1                     TRUE SOLUTION, 1950.0
74027       QY COMMON  1                     TRUE SOLUTION, 1950.0
74026       QX COMMON  1                     TRUE SOLUTION, 1950.0
74012          COMMON  11
74012    GROPS COMMON  1
74007          COMMON  2
74007      CR1 COMMON  1
74004          COMMON  2
74003          COMMON  1
74003      CPT COMMON  1
74002      CPC COMMON  1
74001      CPM COMMON  1
74000      CPS COMMON  1
73777      CPE COMMON  1
73774          COMMON  2
73774    EULER COMMON  1
73773      IAS COMMON  1
73772      INA COMMON  1
73771     ACCD COMMON  1
73770     DESS COMMON  1
73767     DEMS COMMON  1
73766      ALP COMMON  1
73765     EST4 COMMON  1
73764     STE4 COMMON  1
73763     SET4 COMMON 1
73762     STP4 COMMON  1
73761     TSP4 COMMON  1
73760     TPS4 COMMON  1
73757     TEP4 COMMON  1
73756     ETP4 COMMON  1
73755     EPT4 COMMON  1
73754     ESM4 COMMON  1
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73753	EMS4	COMMON	1
73752	SEM4	COMMON	1
73751	SMP4	COMMON	1
73750	MSP4	COMMON	1
73747	MPS4	COMMON	1
73746	MEP4	COMMON	1
73745	EMP4	COMMON	1
73744	EPM4	COMMON	1
73743	SEP4	COMMON	1
73742	ESP4	COMMON	1
73741	EPS4	COMMON	1
73740	TALT	COMMON	1
73737	RAO	COMMON	1
73736	RAA3	COMMON	1
73735	RAA2	COMMON	1
73734	RAA1	COMMON	1
73723		COMMON	8
73723	MVEC	COMMON	1
73720		COMMON	2
73720	B3UV	COMMON	1
73715		COMMON	2
73715	B2UV	COMMON	1
73712		COMMON	2
73712	B1UV	COMMON	1
73711	B3MAG	COMMON	1
73710	B2MAG	COMMON	1
73707	B1MAG	COMMON	1
73706	MTA3	COMMON	1
73705	MTA2	COMMON	1
73704	MTA1	COMMON	1
73703	DAO	COMMON	1
73702	DA3	COMMON	1
73701	DA2	COMMON	1
73700	DA1	COMMON	1
73677	SHATC	COMMON	1
73671		COMMON	5
73671	SARA	COMMON	1
73663		COMMON	5
73663	ERIF	COMMON	1
73660		COMMON	2
73660	JOSHT	COMMON	1
73654		COMMON	3
73654	SCUM	COMMON	1
73653	SHA	COMMON	1
73652	VT	COMMON	1
73651	RT	COMMON	1
73650	VM	COMMON	1
73647	RM	COMMON	1
73646	VS	COMMON	1
73645	RS	COMMON	1
73642		COMMON	2
73642	VOT	COMMON	1
73637		COMMON	2
73637	ROT	COMMON	1
73636	R.A.M	COMMON	1
73633		COMMON	2

73633	VO1	COMMON	1
73630		COMMON	2
73630	RO1	COMMON	1
73627	R.A.S	COMMON	1
73624		COMMON	2
73624	VO2	COMMON	1
73621		COMMON	2
73621	RO2	COMMON	1
73620	SIA	COMMON	1
73617	RAWXR	COMMON	1
73616	TSBP3	COMMON	1
73605		COMMON	8
73605	PEQW3	COMMON	1
73604	BAGE	COMMON	1
73603	GARB	COMMON	1
73564		COMMON	14
73564	GRUB8	COMMON	1
73545		COMMON	14
73545	GRUB6	COMMON	1
73533		COMMON	9
73533	GRUB5	COMMON	1
73523		COMMON	7
73523	GRAB6	COMMON	1
73515		COMMON	5
73515	GRAB5	COMMON	1
73513		COMMON	1
73513	MUSE3	COMMON	1
73505		COMMON	5
73505	TGSPH	COMMON	1
73477		COMMON	5
73477	ERSPH	COMMON	1
73476	MA3	COMMON	1
73475	EA3	COMMON	1
73474	TA3	COMMON	1
73473	SVL	COMMON	1
73472	HNG	COMMON	1
73471	HGE	COMMON	1
73470	ADS	COMMON	1
73467	DPT	COMMON	1
73463		COMMON	3
73463	SCRUG	COMMON	1
73462	DRT	COMMON	1
73461	MA2	COMMON	1
73460	EA2	COMMON	1
73457	TA2	COMMON	1
73456	TSBP2	COMMON	1
73455	CRUD	COMMON	1
73444		COMMON	8
73444	PEQW2	COMMON	1
73443	BOSH	COMMON	1
73424		COMMON	14
73424	GRUB4	COMMON	1
73412		COMMON	9
73412	GRUB3	COMMON	1
73402		COMMON	7
73402	GRAB4	COMMON	1

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73374          COMMON  5
73374   GRAB3  COMMON  1
73372          COMMON  1
73372   MUSE2  COMMON  1
73370          COMMON  1
73367          COMMON  1
73362          COMMON  5
73362   JUICE  COMMON  1
73350          COMMON  9
73350   SCMP.  COMMUN  1
73347   SCAMP  COMMON  1
73335          COMMON  9
73335     MA1  COMMON  1
73334     EA1  COMMON  1
73333     TA1  COMMON  1
73332      DR  COMMON  1
73331     ALT  COMMON  1
73330     GED  COMMON  1
73327   LONGS  COMMON  1
73326   LONGM  COMMON  1
73325   TSBP1  COMMON  1
73314          COMMON  8
73314    PEQW  COMMON  1
73313   CRUMY  COMMON  1
73312   CRUMB  COMMON  1
73273          COMMON  14
73273   GRUB2  COMMON  1
73261          COMMON  9
73261   GRUB1  COMMON  1
73251          COMMON  7
73251   GRAB2  COMMON  1
73243          COMMON  5
73243   GRAB1  COMMON  1
73241          COMMON  1
73241   MUSE1  COMMON  1
73235          COMMON  3
73235     LTS  COMMON  1
73234     ASD  COMMON  1
73233   T(F)L  COMMON  1
73232     SPN  COMMON  1
73231   PRFLG  COMMON  1
73227          COMMON  1
73227   37HED  COMMON  1
        *              SPECIAL PRINT ONLINE OR 3070  SS6
73226    SP1A  COMMON  1                      SINGLE SPACE
73225    SP2A  COMMON  1                      DOUBLE SPACE
73224    SP3A  COMMON  1                      SUPPRESS SPACE
73223   EJCTA  COMMON  1                      EJECT PAGE
        *              FINE PRINT OFF LINE
73222    SP1B  COMMON  1                      SINGLE SPACE
73221    SP2B  COMMON  1                      DOUBLE SPACE
73220    SP3B  COMMON  1                      SUPPRESS SPACE
73217   EJCTB  COMMON  1                      EJECT PAGE
        *              FINE PRINT ONLINE OR 3070  SS6,SS4
73216    SP1C  COMMON  1                      SINGLE SPACE
73215    SP2C  COMMON  1                      DOUBLE SPACE
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73214    SP3C  COMMON  1                      SUPPRESS SPACE
73213   EJCTC  COMMON  1                      EJECT PAGE
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ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.

REWIND	READB	SETHI	WRITEB	ENDFIL	BSREC	ENDOUT	UNLOAD	OUTUS	ACTIND
BFLG	RESTKA	REQIND	PRCON	CKIND	CKACT	WRITED			

THE NAME OF THIS PROGRAM IS 'SFPRO ' 4/17/65

ENTRY NAME	ENTRY ADD.	TRANSFER VECTORS	LOAD ADD.	OCTAL LENGTH	DECIMAL LENGTH	COMMON BREAK
TL	22302	'NONE'	22300	00012	00010	
DUMMY	22306					
DATCEL	22310					
CG	22303					
RGGSAV	22300					
RGGSTR	22301					
EXPORT	22307					
MARSMN	22322	SIN	22312	00240	00160	
MARSPC	22433	COS				
MARFIX	22446	CROSS				
PMAT	22533	UNIT				
PPMAT	22522	FIX				
MHA	22517	FLOAT				
		MATRIX				
CANCLK	23377	REWIND	22552	01010	00520	
PLOTFQ	23056	READB				
PLLLT	22726	STABCD				
PLTSET	22572	PAGBCD				
FILEND	23057	BLATZ				
RECNUM	23412	SAVEIT				
		ABORT				
		LAUNCH				
		FLOTT				
		ADD				
		CW1				
		CHANGE				
		SIN				
		COS				
		GCE				
LOG10	23562	'NONE'	23562	00074	00060	77151
LN	23566					
SQRT	23656	'NONE'	23656	00052	00042	77151
SIN	23730	'NONE'	23730	00237	00159	77151
COS	23733					
QSIN	23737					
QCOS	23741					
CROSS	24217	SQRT	24167	00103	00067	77151
PROD	24170					
UNIT	24251					
ARTAN	24272	'NONE'	24272	00071	00057	
DAYS	24366	FIX	24363	00031	00025	77151
		FLOAT				
		ADD				
ADD	24414	'NONE'	24414	00031	00025	77151
FIXT	24446	FLOAT	24445	00257	00175	
FLOT	24551					
FIX	24724	'NONE'	24724	00012	00010	
FLOAT	24730					
CHANGE	24742	GROP	24736	00035	00029	
		ORBETT				
		SPRAY				
		PRINTD				
ECLIP	24776	COS	24773	00056	00046	
		SIN				
		MATRIX				
RVIN	25060	COS	25051	00310	00200	
RVOUT	25203	SIN				
		MATRIX				
		PROD				
		ARTAN				
		UNIT				
		ARSIN				
GHA	25364	DAYS	25361	00105	00069	
		FIX				
		FLOAT				
GEDLAT	25470	SIN	25466	00056	00046	77151
		SQRT				
GETTER	25546	PROD	25544	00046	00038	
		ARCOS				
SPACE	25616	COS	25612	00226	00150	77133
EARTH	25716	SIN				
		RVOUT				
		RVIN				
CLUCK	26044	UNIT	26040	00113	00075	
		CROSS				
		PROD				
		ARTAN				
BCDNO	26156	PROUT	26153	00045	00037	
NEWBCD	26201	ERPRT				
		ABORT				
ARSIN	26224	'NONE'	26220	00140	00096	77151
ARCOS	26220					
WOLF	26366	OPRFLG	26360	00115	00077	
MACH	26473	PRSET				
TIM	26472	TIME1				
		PROUT				
		TIME				
		KERN1				
ROTEQ	26476	MNAET	26475	00154	00108	
DELTJD	26642					
DIST	26732	PROD	26651	00063	00051	
PATH	26652					
TIME1	26752	OPRFLG	26734	00446	00294	77123
TIME2	26755	EQUNX1				
TIME3	26760	TARBCD				
LAUNCH	27364	INJEQX				
		DAYS				
		FIXT				
		ADD				
		FIX				
		FLOAT				
		GRUPPE				
		PROUT				
		FLOT				
		TL				
READ1	27452	SETHI	27402	00343	00227	
READN	27521	READB				
SCDATE	27653	RUNID				
SPAM	27614	REWIND				
READC	27537	FLGWRO				
		VARFLG				
		PROUT				
		ERPRT				
		ABORT				
		SPASM				
		SCFORF				
		SPGBCD				
		TARBCD				
		INJBCD				
		INJTYP				
		INJT				

```
                              INJX
                              INJDX
                              RMAX
                              PHL
                              INJTOT
                              INJEQX
                              BRNOPT
                              RADOPT
                              GASOPT
                              NEWBOD
                              TARAD
                              GRAV
                              LUNGRV
                              OUT
                              EGM
                              HARMN2
                              SCTIME
                              DELTJD
                              MNAET
                              NUTEPH
                              SCBEGT
                              SCENDT
                              KERN1
                              JJ
SAVEIT         27750          WRITEB      27745        00157        00111
FILE           30062          ENDFIL
                              BSREC
SEITE          30126          DATCEL      30124        00201        00129
CASE           30200          PROUT
EJECT          30176
LINES          30201
EJECT1         30177
PAGBCD         30204
SPGBCO         30254
GRUPPE         30330          EJECT1      30325        00016        00014
                              LINES
                              SEITE
EFFECT         30344          GROP1       30343        00050        00040
SPRAY          30414          GROP        30413        00013        00011
PRSET          30657          PROUT       30426        01255        00685        73212
DPRSET         31677          ENDOUT
ERPRT          30566          OPRFLG
JEXIT          31003          EXPORT
ABORT          31002          READC
......         31143          GRUPPE
TIME           30752          INJT
PRTSWX         31660          INJTOT
FLAG42         31653          INJBCD
RUNID          31654          HBODY
                              PLOTFQ
                              FILE
                              FILENO
                              RECNUM
                              FLUSH
                              BTQ
                              BTC
                              BTD
                              BTT
                              BRQ
                              BRC
                              BRD
                              BRT
                              TFD
                              TFH
                              TFM
                              TFLIND
                              TFLINH
                              JULD
                              TARGAD
                              PAGBCD
                              TARBCD
                              FAZFLG
                              INJTYP
                              INJX
                              INJY
                              INJZ
                              INJDX
                              INJDY
                              INJDZ
                              RMAX
                              PHL
                              INJEQX
                              MOOPH1
                              MOOPH2
                              MOOPH3
                              MOOPH4
                              MOOPH5
                              MOOPH6
                              MOOPH7
                              MOOPH8
                              VENPH1
                              VENPH2
                              VENPH3
                              VENPH4
                              VENPH5
                              VENPH6
                              VENPH7
                              VENPH8
                              MARPH1
                              MARPH2
                              MARPH3
                              MARPH4
                              MARPH5
                              MARPH6
                              MARPH7
                              MARPH8
                              STABCD
                              STACRD
                              FRO
                              TARAD
                              LUNGRV
                              SCALE1
                              GRAV
                              BRNOPT
                              RADOPT
                              DEPOPT
                              VPGROP
                              NEWBOD
                              HASPAN
                              TAPEX
                              NUTEPH
                              MNAET
                              LAUNCH
                              PUBLIC
                              PRTSTP
                              CAN50
                              PROUTA
                              PROUTB
                              PROUTC
                              PROUTD
                              TMWD
                              FGDOUT
```

		LABEL				
		TRAJ				
PHL	33224	DAYS	31703	01330	00728	
RMAX	33225	E.T.				
ROT	33023	ROTEQ				
NUTATE	32761	MNA				
RESET	33202	GHA				
INTRAN	31730	GRUPPE				
CAN50	33221	EPHSET				
INJBCD	32357	GRAV				
INJTYP	32360	LUNGRV				
INJX	32361	RUNID				
INJY	32362	SCALE1				
INJZ	32363	PROUT				
INJDX	32364	RADOPT				
INJDY	32365	BRNOPT				
INJDZ	32366	TIME2				
INJEQX	32367	MNAET				
HARMN2	32370	NUTMAT				
GASCPT	32406	MATRIX				
CENTRS	32535	INTR1				
SCTIME	32440	UNIT				
		EQUNX1				
BTB	36200	PRSET	33233	03067	01591	73234
LOOP	33300	MATRIX				
CW1	33254	UNIT				
STABCD	35054	PROD				
STACRD	35154	SIN				
STA1	35671	COS				
PETE	35150	ARSIN				
FRQ	36101	ARTAN				
SLIT	36120	ARCUS				
BLATZ	35305	CROSS				
HASPAN	36025	CLUCK				
		GETTER				
		LOGIO				
		GRAV				
		PLOTFQ				
		GRUPPE				
		PROUT				
EPHSET	42431	NEWBCD	36322	04404	02308	
BNTR2	42431	FIX				
ANTR1	42513	TARAD				
INTR1	42513	CENTRS				
GRAV	42360	CENTES				
SCALE1	42354	DAYS				
OUT	42356	EPHEM				
E.T.	42722	GRUPPE				
EGM	42352	PROUT				
NEWBOD	42346	ERPRT				
NUTLOB	36562	ABORT				
BODTAB	42405	UNLOAD				
		TAPEX				
		EPTAPE				
EPHEM	42732	REWIND	42726	01456	00814	
TAPEX	44112	READB				
EPTAPE	44264	BSREC				
PROUT	44416	OUTUS	44404	02715	01485	
FGDOLT	45571	ACTIND				
PRCNV	44507	BFLG				
PROUT2	44474	RFSTKA				
PROUT3	44500	REQIND				
TSXA	46461	PRCON				
SPROUT	44416	CKIND				
LABEL	47251	CKACT				
TMWD	47252	WRITED				
FLUSH	47230					
PROUTA	46243					
PROUTB	46245					
PROUTC	47221					
PROUTD	47254					
MNA	47333	FIX	47321	01651	00937	77041
MNA1	47332	FLOAT				
MNAMD	47363	COS				
MNAMD1	47362	SIN				
MATRIX	50544	SQRT				
NUTMAT	51034	ARTAN				
LUNGRV	50624	BODTAB				
NUTLCN	51032	ANTR1				
NUTOBL	51033	NUTLOB				
NUTEPH	51167					
MNAET	51166					
SPASM	51172	*NONE*	51172	02527	01367	
HC	51364					
NI	51365					
TGLO	51372					
Y	51422					
YDOT	51423					
Y(2)	51424					
YO	51425					
YO(2)	51426					
BABTB	51566					
DELX	51472					
J	51366					
HD	51451					
ND	51433					
JJ	52472					
SET	52574					
CONIC	56601	SPRAY	53721	05404	02820	73212
USERV	57005	EFFECT				
PRINTD	54035	ROT				
TARAD	56215	PRSET				
CLAPP	60652	ORBETT				
SAC	56555	EQUNX1				
SAVA	56733	RESET				
IMPFLG	60653	TIME1				
PRNTD1	54034	DAYS				
GROP1	56155	ARTAN				
BTQ	56560	PROD				
BTC	56561	ARSIN				
BTD	56562	GETTER				
BTT	56563	SIN				
BRQ	56564	SPACE				
BRC	56565	RVOUT				
BRD	56566	GEDLAT				
BRT	56567	HC				
TFD	56571	CANCLK				
TFH	56572	CLUCK				
TFM	56573	ECLIP				
TFLIND	56574	GRUPPE				
TFLINH	56575	GRAV				
JULD	56576	PROUT				
CENTES	54025	LOOP				
PUBLIC	61250	UNIT				
GCE	56200	ARCOS				
		CROSS				
		MNA				
		MNAMD1				
		MATRIX				
		MARSMM				
		MARSPC				
		MARFIX				

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                          MHA
                          INJFLG
                          NUTATE
                          ERPKT
                          ABORT
                          GROP
                          COS
                          CAN50
                          JEKYL
                          CLASS
                          SPECL
                          ADD
                          TIME3
                          INJBCD
                          BCDNO
                          SQRT
                          LN
                          INJTYP
                          DIST
CLAS'     62760           SQRT       61325      02313      01227      76716
SPECI     63335           UNIT
JEKYI     61467           CROSS
                          LN
                          ARTAN
                          ARCOS
                          SIN
                          HARMN2
                          INJTYP
                          SAVA
                          RMAX
FLGWRD    67331           READ1      63640      03627      01943      73212
SCFORF    67451           CASL
SCHEGT    67452           IMPFLG
SCENDT    67454           CLAPP
MOOPH1    66576           BNTR2
MCOPH2    66646           BCDNO
MCOPH3    66716           PLTSET
MCCPH4    66766           EJECT
MCOPH5    67036           SEITE
MCCPH6    67106           FLOT
MCOPH7    67156           INJBCD
MOOPH8    67226           INTRAN
VENPH1    66716           INTR1
VENPH2    66766           PROD
VENPH3    67036           WOLF
VENPH4    67106           CW1
VENPH5    67156           BTB
VENPH6    67226           SPRAY
VENPH7    66576           STACRO
VENPH8    66646           ADD
MARPH1    67106           SET
MARPH2    67156           SPAM
MARPH3    67226           PRSET
MARPH4    66576           PROUT
MARPH5    66646           PRINTO
MARPH6    66716           ERPKT
MARPH7    66766           HC
MARPH8    67036           ABORT
INJTDT    67363           TIME1
TARBCD    67364           GRUPPE
RADOPT    67372           ROT
LAST      67401           LOOP
REND      67402           CHANGE
REND.     67404           TARAD
MODE1     67406           PATH
KERN1     67407           PLLLT
GJHO      67410           PRNTD1
RKHO      67412           PLOTFQ
HBODY     67413           BSREC
PRTO      67414           RECNUM
DPRTO     67416           GETTER
OPRT      67430           ARSIN
GROP      67434           READN
CODE1     67435           JJ
VIEW      67437           FLOAT
PASH      67443           GRAV
ORBETT    67447
EQUNX1    67450
OPRFLG    67365
BRNOPT    67341
DEPOPT    67333
VPGROP    65205
INJFLG    67330
TRAJ      63722
TARN      67332
TARGAD    67323
FAZFLG    67370
INJT      67366
FLOTT     65026
VARFLG    67400
DOT       66301
PRTSTP    67336
READD     67470           (IOU)      67467      00365      00245
READB     67472
WRITED    67475
WRITEB    67477
BSREC     67706
BSFILE    67711
REWIND    67714
UNLOAD    67717
ENDFIL    67722
SETLOW    67700
SETHI     67703
(UNIT)    70051
TAPEIO    70051
(IOU)     70057           'NONE'     70054      00030      00024
OUTUS     70106           RGGSAV     70104      02320      01232
BFLG      70742           RGGSTR
ENDOUT    70473
CKIND     72335
CKACT     72400
REQIND    72334
ACTIND    72333
RESTKA    72331
PL1CON    72414
PL2CON    72415
PL3CON    72416
PRCON     72417

'SFPRO ' JUST LOADED.

 UNUSED CORE LIES FROM   72424   THROUGH   73212,  LEAVING   00567  OCTAL OR   00375  DECIMAL LOCATIONS.
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E. INPUT FORMS

JPL SFPRØ SPECIAL ØUTPUT, CØNTRØL

NAME ______ DATE 12-1-64

12 NAME	VALUE		TYPE	NOMINAL VALUE	EXPLANATION
PAGBCD√√√=	( )	$	BCD	√√√√√√	PAGE HEADING
PAGBCD+3√=	( )	$	BCD	√√√√√√	
PAGBCD+6√=	( )	$	BCD	√√√√√√	(A SECØND LINE ØF PAGE HEADING IS
PAGBCD+9√=	( )	$	BCD	√√√√√√	AVAILABLE BY INPUT INTØ
PAGBCD+12=	( )	$	BCD	√√√√√√	PAGBCD+20 THRØUGH PAGBCD+39)
PAGBCD+15=	( )	$	BCD	√√√√√√	
PAGBCD+18=	( )	$	BCD	√√√√√√	
		$			
FAZFLG=		$	FIX	1	NØN-ZERØ = AUTØMATIC PHASING
		$			
RUNID =	( )	$	BCD	(TRAJ01)	RUN I.D.
		$			
PLØTFQ =		$	FIX	0	SAVE TAPE FLAG AND FREQ. BY STEP
PLØTFQ+1=		$	FIX	1	PHYSICAL FILE NØ.
PLØTFQ+2=		$	FLØ	0.0	TIME INCREMENT ADDED TØ TIME PAST INJ. SEC
PLØTFQ+3=	/8, 0,0,0,0,0,0,0,0,0/8	$	ØCT	0,0	STATIØNS (MAXIMUM ØF FIVE)
	5 9 1 1 1 4 2 5 1 1 4 3 5 5 2 6 1 8 8 1 / 7 5 7 6 2	$			
PUBLIC =		$	FLØ	49.3	Ω RØTATIØN ANGLE DEG
PUBLIC+1=		$	FLØ	.45E-7	S SCALE FACTØR BØARD UNITS/KM
PUBLIC+2=		$	FLØ	12.5	US LØC. SUN-HØRIZØNTAL BØARD UNITS
PUBLIC+3=		$	FLØ	8.0	VS LØC. SUN-VERTICAL BØARD UNITS
CAN50=		$	FLØ		BØDY-CANØPUS UNIT 1950.0 PØSITIØN {-.060340592
LAUNCH=		$	SEG	0,0	LAUNCH EPØCH .60342839
	Y Y M M D D D H H M M S S F F F	$			-.79513092
TARGAD=		$	FLØ	0.0	ALT. ABØVE TARGET TØ END RUN KM
		$			
VPGRØP=	0, 0, 0,0/8, /8	$	ØCT	0,0	PRINT GRØUP, CØNIC FLAGS USED AT VIEW PERIØDS
	N'C GEØ, N'C HEL, N'C TARG, R, PI; Q'C Ø'T GEØ, Q'C Ø'T HELIØ, Q'C Ø'T TARG	$			
FLAG42=		$	FIX	0	NØN-ZERØ PUTS ØUTPUT IN SC4020 MØDE
		$			
PRTSWX=		$	FIX	0	NØN-ZERØ = PRINT EVERY CASE
PRTSTP =		$	FIX	0	NØN-ZERØ = PRINT EVERY END ØF STEP
PRTSTP+1=	0, 0, 0,0/8, /8	$	ØCT	0,0	PRINT GRØUP, CØNIC FLAGS USED AT END ØF STEP
	N'C GEØ, N'C HEL, N'C TARG, R, PI; Q'C Ø'T GEØ, Q'C Ø'T HELIØ, Q'C Ø'T TARG	$			
DEPØPT =		$	FIX	0	0=NØ. DEP VAR. 1=PRINT -1=END PHASE
DEPØPT+1=	/8	$	ØCT	0	LØCATIØN ØF DEPENDENT VARIABLE
DEPØPT+2=		$	FLØ	0.0	VALUE ØF DEPENDENT VARIABLE
		$			
ØPTSWT =		$	FIX	0	ØN-LINE ØUTPUT CØNTRØL -1=EXTERNAL SET
		$			0=NØ ØN-LINE PRINT 5=FINE 1=MINIMUM

JPL SPACE, SFPRØ PHASING

Name ______ Date 12-1-64

12 Name	Value		Type	Nominal Value	Explanation
++++++=		$	FIX		USE MØØPHi VENPHi MARPHi
		$			FØR MØØN, VENUS, MARS AND 1≤i≤8
		$			ALSØ USE MØØPHi FØR EARTH, SUN,
		$			SATURN, JUPITER.
		$			− = PRINT AT START ØF PHASE
		$			RESET TPRT TØ TSTART ▼ USE ØLD TPRT
		$			±0 PRINT AT END, LAST PHASE ±4
		$			±1 PRINT AT END, NØT LAST PHASE ±5
		$			±2 DØNT PRINT AT END, LAST PHASE ±6
		$			±3 DØNT PRINT AT END, NØT LAST PHASE ±7
"	+1=( )	$	BCD		BØDY FRØM WHICH TØ CØMPUTE R FØR R TEST
"	+2=	$	FLØ		VALUE ØF R TØ END PHASE
"	+3=( )	$	BCD		BØDY FRØM WHICH TØ CØMPUTE Ṙ FØR Ṙ TEST
"	+4=	$	FLØ		VALUE ØF R TØ TURN ØN R TEST +=>, −=<
"	+6=( )	$	BCD		INTEGRATIØN CENTRAL BØDY
"	+7=	$	SEG		STEPSIZE
	DDDHHMMSSFFF	$			
"	+9=	$	FIX		NØ. ØF DØUBLES
"	+10=( )	$	BCD		BØDY FRØM WHICH TØ CØMPUTE STEPSIZE
"	+11=	$	SEG		PRINT END 1
"	+13=	$	SEG		PRINT DELTA 1
"	+15=	$	SEG		2
"	+17=	$	SEG		2
	YYMMDDDDHHMMSSFFF	$			
"	+19=	$	SEG		3 { 1 = EQUATØRIAL
"	+21=	$	SEG		3 2 = ECLIPTIC
"	+23=	$	SEG		ØDD PRINT 1 4 = ECL. AT START ØNLY
"	+25=	$	SEG		2 5 = EQU AT START ØNLY
		$			6 = ECL. AT END ØNLY
"	+27= 0 0 0 /8	$	ØCT		GRØUP PRINT { 7 = EQU. AT END ØNLY
	N C GEØ, N C HELIØ, N C TARG, R, PI, U	$			{ 1 = GRØUP B (ALL)
"	+38= /8	$	ØCT		CØNIC PRINT { 2 = GRØUP C (ALL BUT R, V)
	Q C Ø T GEØ, Q C Ø T HELIØ, Q C Ø T TARG	$			3 = GRØUP D (B.T, B.R LINE ØNLY)
"	+28= /8	$	ØCT		STATIØN PRINTS (MAXIMUM ØF 5)
	5 9 1 1 1 2 4 1 5 1 1 4 1 3 1 5 4 2 6 1 0 8 9 1	$			
"	+30= /8	$	ØCT		VIEW PERIØDS (MAXIMUM ØF 5)
		$			
"	+34=	$	FIX		SHADØW PARAMETER FLAG 1 = ØN
"	+39=( )	$	BCD		EQUINØX (✓✓✓✓✓✓) = TRUE ØF DATE
		$			(1950.0) = MEAN 1950.0

JPL SFPRØ STATIØN CØNSTANTS

NAME ______ DATE 12-1-64

12 NAME	VALUE		TYPE	NOMINAL VALUE	EXPLANATION
FRQ//√=		$	FLØ	930.15E6	A1I
FRQ+1√=		$	FLØ	1.0	A2I
FRQ+2√=		$	FLØ	1.0	A3I
FRQ+3√=		$	FLØ	32.3595506	A4I
FRQ+4√=		$	FLØ	1E5	A5I
FRQ+5√=		$	FLØ	1.0	A6I
FRQ+6√=		$	FLØ	.455E6	A7I
FRQ+7√=		$	FLØ	960.05E6	RF1
FRQ+8√=		$	FLØ	[illegible]	RF2, K3
FRQ+9√=		$	FLØ	32.4402	K1
FRQ+10=		$	FLØ	20.	K2
FRQ+11=		$	FLØ	960.05E6	RFB, B5
FRQ+12=		$	FLØ	1.0	B6
FRQ+13=		$	FLØ	960.05E6	FA
FRQ+14=		$	FLØ	30.434E6	FI
FRQ+15=		$	FLØ	299792.5	SLIT
FRQ+16=		$	FLØ	23.5E6	SK1
FRQ+17=		$	FLØ	23.5E6	LSK1
FRQ+18=		$	FLØ	2295.E6	LSFT
FRQ+19=		$	FLØ	2295.E6	SFT
FRQ+20=		$	FLØ	22.E6	FRQ))
		$			
HASPAN=		$	FLØ	90.	HØUR ANGLE CONSTRAINT FØR HA-DEC STATIØNS, DEG
		$			
STACRD-4=		$	FLØ	-10.0	ELEV. ANGLE TØ START STATIØN PRINTS
STACRD-3=		$	FLØ	5E-4	ELEV. TØLERANCE FØR VIEW PERIØDS
STACRD-2=		$	FLØ	5E-6	ELEV. RATE TØLERANCE FOR VIEW PERIØDS
STACRD-1=		$	FLØ	5.0	ELEV. ANGLE TØ START, END VIEW PERIØDS
		$			
STABCD+0	=( )	$	BCD		STATIØN A NAME: FØUR BCD WØRDS
STACRD+0	=	$	FLØ		STATIØN A CØØRD: LAT., LØNG., R., CØDE, DUMMY
		$			CØDE=0=AZ-EL; =1=HA-DEC
STABCD+0	=( )	$	BCD		STATIØN B NAME
STACRD+0	=	$	FLØ		STATIØN B CØØRD.
		$			
STABCD+0	=( )	$	BCD		STATIØN C NAME
STACRD+0	=	$	FLØ		STATIØN C CØØRD.
		$			
STABCD+0	=( )	$	BCD		STATIØN D NAME
STACRD+0	=	$	FLØ		STATIØN D CØØRD.

F. SPACECRAFT EPHEMERIS TAPE FORMAT

TAPE ID RECORD

BUFFER NAME	NUMBER OF PARAMETERS	DESCRIPTION
RUNID	1	BCD S/C EPHEMERIS IDENTIFICATION
FLGWRD	1	CURRENT STATUS FLAG WORD
SCFORF	1	DATA RECORD FORMAT FLAG
PAGBCD	40	SPACE PAGE HEADING
TARBCD	1	BCD TARGET NAME
INJBCD	1	BCD INJECTION CENTRAL BODY NAME
INJTYP	1	TYPE OF INJECTION CONDITIONS
INJT	2	SEXAGESIMAL INJECTION EPOCH
INJX	3	INJECTION CONDITIONS
INJDX	3	
RMAX	1	
PHL	1	
INJTDT	1	DELTA TIME ADDED TO INJT
INJEQX	1	INJECTION EQUINOX
BRNOPT	18	MOTOR BURN INPUT PARAMETERS
RADOPT	6	RADIATION PRESSURE INPUT PARAMETERS
GASOPT	17	GAS JETS INPUT PARAMETERS
NEWBOD	4	BODY TO REPLACE SATURN OPTION
TARAD	7	TABLE OF BODY RADII
GRAV	7	N-BODY GM'S
LUNGRV	4	LUNAR POTENTIAL CONSTANTS
OMEGAO	1	ROTATION RATE OF THE EARTH
DUT	1	DIFFERENCE=ET-UT
EGM	4	GM'S USED FOR EPHEMERIS
HARMN2	14	OBLATENESS CONSTANTS FOR EARTH AND MARS
VARFLG	1	VARIATIONAL EQUATIONS FLAG
TIM	1	TIME OF DAY OF S/C EPHEMERIS GENERATION
MACH	1	MACHINE USED IN S/C EPHEMERIS GENERATION
SYSDAT	1	DATE OF S/C EPHEMERIS GENERATION
DELTJD	2	JD 1950.0 - JD 0 HR JAN 1, 1950
MNAET	1	FLAG TO DESIGNATE FREQ OF COMPUTATION OF MATRICES
NUTEPH	1	FLAG TO DESIGNATE WHERE TO GET NUTATIONS
SCBEGT	2	EPOCH TO START WRITING S/C EPHEMERIS
SCENDT	2	EPOCH TO STOP WRITING S/C EPHEMERIS
CX	6	INJECTION CONDITIONS MEAN 1950.0 EARTH EQ.

TAPE DATA RECORD

BUFFER NAME	NUMBER OF PARAMETERS	DESCRIPTION
RUNID	1	BCD S/C EPHEMERIS IDENTIFICATION
FLGWRD	1	CURRENT STATUS FLAG WORD
KERN1	1	BCD CENTRAL BODY NAME
JJJJJ	1	DIFFERENCE COUNT
HC	1	STEP SIZE FOR RECORD
TTTTT	2	END TIME FOR RECORD
JJ	1	NUMBER OF INTEGRATION STEPS TAKEN
DISTIM	2	DISCONTINUITY TIME IN RECORD
HBANK+4	6/42	POSITION
HBANK+108	6/42	VELOCITY
HBANK+264	6/42	DELTA 0
HBANK+316	6/42	DELTA 1
HBANK+368	6/42	DELTA 2
HBANK+420	6/42	DELTA 3
HBANK+472	6/42	DELTA 4
HBANK+524	6/42	DELTA 5
HBANK+576	6/42	DELTA 6

V. OUTPUT

A. SAVE TAPE FORMAT

VARIABLES STORED ON THE TRAJECTORY SAVE TAPE ARE
REFERENCED TO A S/C,GEO,HELIO,OR TARGETCENTRIC COORDINATE SYSTEM.
ALL UNITS ARE MADE UP OF KM,SEC,DEGREES UNLESS STATED

VAR.NO.	DESCRIPTION
1-2	DOUBLE PRECISION TIME IN SECONDS PAST 1950.0
3	TIME IN SECONDS PAST INJECTION
4	CENTRAL BODY NUMBER
5	TARGET BODY NUMBER
6-8	GEOCENTRIC EARTH-PROBE POSITION VECTOR
9-11	GEOCENTRIC EARTH-PROBE VELOCITY VECTOR
12	GEOCENTRIC LATITUDE OF THE PROBE
13	GEOCENTRIC LONGITUDE OF THE PROBE
14	GEOCENTRIC EARTH-PROBE POSITION VECTOR MAGNITUDE
15	DECLINATION OF THE PROBE
16	RIGHT ASCENSION OF THE PROBE
17	GEOCENTRIC EARTH-PROBE VELOCITY VECTOR MAGNITUDE
18	INERTIAL PATH ANGLE
19	INERTIAL AZIMUTH ANGLE
20	ALTITUDE OF PROBE ABOVE EARTH
21	RT. ASCENSION OF THE EARTH IN THE S/C COORDINATE SYSTEM
22	DECLINATION OF THE TARGET IN THE S/C COORDINATE SYSTEM
23	RT. ASCENSION OF THE TARGET IN THE S/C COORDINATE SYSTEM
24	HELIOCENTRIC SUN-PROBE POSITION VECTOR MAGNITUDE
25	HELIOCENTRIC LATITUDE OF THE PROBE
26	HELIOCENTRIC LONGITUDE OF PROBE
27	ALTITUDE OF PROBE ABOVE ECLIPTIC PLANE
28	(HELIO. SUN-PROBE R MAG.)(SIN (HELIO. LONG. OF PROBE))
29	(HELIO. SUN-PROBE R MAG.)(COS (HELIO. LONG. OF PROBE))
30	EARTH-PROBE-SUN ANGLE
31	EARTH-PROBE-TARGET ANGLE
32	EARTH-PROBE-NEAR LIMB OF TARGET ANGLE
33	SUN-EARTH-PROBE ANGLE
34	SUN-PROBE-NEAR LIMB OF EARTH ANGLE
35	SUN-TARGET-PROBE ANGLE
36	MOON-EARTH-PROBE ANGLE
37	MOON-PROBE-SUN ANGLE
38	EARTH-PROBE-MOON ANGLE
39	TARGET-PROBE-SUN ANGLE
40	CANOPUS CLOCK ANGLE EARTH CENTER
41	MOON CLOCK ANGLE EARTH CENTER
42	TARGET CLOCK ANGLE EARTH CENTER
43	TARGETCENTRIC TARGET-PROBE POSITION VECTOR MAGNITUDE
44	TARGETCENTRIC TARGET-PROBE VELOCITY VECTOR MAGNITUDE
45	ALTITUDE OF PROBE ABOVE TARGET
46	ANGULAR SEMI DIAMETER OF TARGET
47-49	SELENOCENTRIC MOON-PROBE POSITION VECTOR
50-52	HELIOCENTRIC SUN-PROBE POSITION VECTOR
53-55	APHRODIOCENTRIC VENUS-PROBE POSITION VECTOR
56-58	AREOCENTRIC MARS-PROBE POSITION VECTOR
59-61	CRONOCENTRIC SATURN-PROBE POSITION VECTOR
62-64	ZEOCENTRIC JUPITER-PROBE POSITION VECTOR
65	TIME PAST LAUNCH (ZERO IF NO LAUNCH EPOCH IS GIVEN)
66	DAYS PAST MIDNIGHT OF LAUNCH (ZERO IF NO LAUNCH EPOCH IS GIVEN)
67	EARTH CLOCK ANGLE
68	CANOPUS-PROBE-EARTH ANGLE
69	CANOPUS-PROBE-SUN ANGLE
70-72	ZERO

VARIABLES STORED ON THE TRAJECTORY SAVE TAPE
REFERENCED TO A TOPOCENTRIC COORDINATE SYSTEM
AT A VIEWING STATION
(MAXIMUM OF FIVE STATIONS)

STAT. 1	STAT. 2	STAT. 3	STAT. 4	STAT. 5		VARIABLE	
73-76	109-112	145-148	181-184	217-220	1-4	STATION NAME, BCD	
77	113	149	185	221	5	AZIMUTH ANGLE	
78	114	150	186	222	6	ELEVATION ANGLE	
79	115	151	187	223	7	HOUR ANGLE	
80	116	152	188	224	8	DECLINATION	
81	117	153	189	225	9	SLANT RANGE	
82	118	154	190	226	10	AZIMUTH RATE	
83	119	155	191	227	11	ELEVATION RATE	
84	120	156	192	228	12	HOUR ANGLE RATE	
85	121	157	193	229	13	DECLINATION RATE	
86	122	158	194	230	14	SLANT RANGE RATE	
87	123	159	195	231	15	SLANT RANGE ACCEL.	
88	124	160	196	232	16	PROBE RIGHT ASCENSION	
89	125	161	197	233	17	F1	CPS
90	126	162	198	234	18	F2	CPS
91	127	163	199	235	19	1-WAY DOPPLER RATE	CPS**2
92	128	164	200	236	20	2-WAY DOPPLER RATE	CPS**2
93	129	165	201	237	21	BEACON FREQUENCY	CPS
94	130	166	202	238	22		
95	131	167	203	239	23		
96	132	168	204	240	24		
97	133	169	205	241	25		
98	134	170	206	242	26		
99	135	171	207	243	27	TRANSMITTER REF.	CPS
100	136	172	208	244	28	DOPPLER RATE	CPS**2
101	137	173	209	245	29	SPACE LOSS	DB
102	138	174	210	246	30	POLARIZATION ANGLE	
103	139	175	211	247	31	PROBE-STATION-SUN ANGLE	
104	140	176	212	248	32	PROBE-STATION-MOON ANGLE	
105	141	177	213	249	33	STATION-PROBE-SUN ANGLE	
106	142	178	214	250	34	CANOPUS CLOCK ANGLE	
107	143	179	215	251	35	MOON CLOCK ANGLE	
108	144	180	216	252	36	TARGET CLOCK ANGLE	

B. PRINTED OUTPUT FORMAT AND DEFINITIONS

CONSTANTS

```
LINE A
CASE (NO.)               IBSYS-JPTRAJ-SFPRO (DATE)                    (PAGE NO.)
LINE B
 (FIRST LINE OF PAGE HEADING FROM SPACE                          )
LINE C
 (SECOND LINE OF PAGE HEADING FROM SPACE                         )
LINE D
 (THIRD LINE OF PAGE HEADING FROM SFPRO                          )
LINE E
 (FOURTH LINE OF PAGE HEADING FROM SFPRO                         )
LINE F
 DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1
LINE G
 S/C EPHEMERIS WRITTEN (TIME) (DATE) RUNID=(       )
LINE H
      GME GRAVITATIONAL COEFFICIENT FOR THE EARTH IN KM*3/SEC*2
        J COEFFICIENT OF THE SECOND HARMONIC IN EARTHS OBLATENESS
        H COEFFICIENT OF THE THIRD HARMONIC IN EARTHS OBLATENESS
        D COEFFICIENT OF THE FOURTH HARMONIC IN EARTHS OBLATENESS
       RE EARTH RADIUS TO BE USED IN THE EARTHS OBLATE POTENTIAL, KM
      REM EARTH RADIUS TO CONVERT LUNAR EPHEMERIS TO KM
LINE I
        G UNIVERSAL GRAVITATIONAL CONSTANT FOR LUNAR OBLATENESS, KM*3/SEC*2-KG
        A MOMENTS OF INERTIA OF MOON FOR LUNAR OBLATE POTENTIAL,KG-KM*2
        B
        C
      OME ROTATION RATE OF THE EARTH IN DEG/SEC
       AU ASTRONOMICAL UNIT TO CONVERT PLANETARY EPHEMERIDES TO KM
LINE J
      GMM GRAVITATIONAL COEFFICIENT FOR THE MOON IN KM*3/SEC*2
      GMS GRAVITATIONAL COEFFICIENT FOR THE SUN IN KM*3/SEC*2
      GMV GRAVITATIONAL COEFFICIENT FOR VENUS IN KM*3/SEC*2
      GMA GRAVITATIONAL COEFFICIENT FOR MARS IN KM*3/SEC*2
      GMC GRAVITATIONAL COEFFICIENT FOR SATURN IN KM*3/SEC*2
      GMJ GRAVITATIONAL COEFFICIENT FOR JUPITER IN KM*3/SEC*2
LINE K
      EGM EARTHS GM, USED WITH EPHEMERIDES, NOT PERTURBATIONS, KM*3/SEC*2
      MGM  MOONS GM, USED WITH EPHEMERIDES, NOT PERTURBATIONS, KM*3/SEC*2
       JA COEFFICIENT OF THE SECOND HARMONIC IN MARS OBLATENESS
       HA COEFFICIENT OF THE THIRD HARMONIC IN MARS OBLATENESS
       DA COEFFICIENT OF THE FOURTH HARMONIC IN MARS OBLATENESS
       RA MARS RADIUS TO BE USED IN THE MARS OBLATE POTENTIAL, KM
```

ACCELERATIONS

```
LINE I (IF SOLAR RADIATION PRESSURE IS REQUESTED)
      RADIATION PRESSURE INPUT
LINE J (IF SOLAR RADIATION PRESSURE IS REQUESTED)
      ARA AREA OF SPACECRAFT, SQUARE METERS
      GB  MULTIPLE OF PERCENT OF REFLECTED RADIANT ENERGY
      MAS MASS OF SPACECRAFT,KG
      GB1 CONSTANT COEFFICIENT OF POLYNOMIAL, RADIANS-SQUARE METERS
      GB2 LINEAR COEFFICIENT OF POLYNOMIAL,RADIANS-SQUARE METERS/DEG
      SC  SOLAR RADIATION CONSTANT, (KG-KM/SQUARE SEC)E-6
LINE K (IF GAS JETS ARE REQUESTED)
      ATTITUDE CONTROL INPUT
LINE L (IF GAS JETS ARE REQUESTED)
      GAS FLAG
      GRB REFERENCE BODY
      GS1 START TIME SEG. YYMMDDDHH
      GS2                 MMSSFFF
      GDT DELTA T ADDED TO START TIME,SEC
LINE M (IF GAS JETS ARE REQUESTED)
      GE1 END TIME SEG. YYMMDDDHH
      GE2               MMSSFFF
      GMS MASS,KG
      GA0 FA POLYNOMIAL QUADRATIC TERM
      GA1               LINEAR TERM
      GA2               CONSTANT TERM
LINE N (IF GAS JETS ARE REQUESTED)
      GB0 FB POLYNOMIAL QUADRATIC TERM
      GB1               LINEAR TERM
      GB2               CONSTANT TERM
      GC0 FC POLYNOMIAL QUADRATIC TERM
      GC1               LINEAR TERM
      GC2               CONSTANT TERM
LINE O (IF MOTOR BURN IS REQUESTED)
      MOTOR BURN INPUT
LINE P (IF MOTOR BURN IS REQUESTED)
      BRN FLAG FOR BURN IF ZERO NO BURN
      BT1 START TIME IN SEG. YYMMDDDHH
      BT2                    MMSSFFF
      BDT DURATION OF BURN,SEC
      BC3 VALUE OF ENERGY FOR SHUT OFF, KM2/SEC2
      BMU BIAS ANGLE,DEG
LINE Q (IF MOTOR BURN IS REQUESTED)
      BCF GUIDANCE FLAG
      BOD BODY FROM WHICH TO MEASURE ALTITUDE TO START BURN
      BAL ALTITUDE ABOVE BODY TO START BURN,KM
      BWT WEIGHT OF VECHILE,POUNDS
      BW. FLOW RATE,POUNDS/SEC
      BTH THRUST,POUNDS FORCE
LINE R (IF MOTOR BURN IS REQUESTED)
      BPG PRINT GROUPS DURING BURN
      BPC CONIC GROUPS DURING BURN
      BCX X COMPONENT OF C VECTOR,KM
      BCY Y
      BCZ Z
```

INJECTION CONDITIONS

```
LINE A
INJECTION CONDITIONS (EQUINOX) (TARGET) (DP SEC PAST 1950) (JD) (CALENDAR DATE)

LINE B    (INCLUDES ONE OF THE * LINES BELOW)
    (CENTRAL BODY)

*IF COORDINATES ARE INERTIAL CARTESIAN
      XO VERNAL EQUINOX CARTESIAN POSITION, KM
      YO
      ZO
     DXO VERNAL EQUINOX CARTESIAN VELOCITY, KM/SEC
     DYO
     DZO

*IF COORDINATES ARE SPHERICAL INERTIAL
     RAD RADIUS, KM
     DEC DECLINATION, DEG
      RA RIGHT ASCENSION, DEG
       V VELOCITY, KM/SEC
     PTI PATH ANGLE, DEG
     AZI AZIMUTH ANGLE, DEG

*IF COORDINATES ARE EARTH-FIXED OR SELENOGRAPHIC
     RAD RADIUS, KM
     LAT LATITUDE, DEG
     LON LONGITUDE, DEG
      VE VELOCITY RELATIVE TO ROTATING COORDINATE SYSTEM, KM/SEC
     PTR PATH ANGLE RELATIVE TO ROTATING COORDINATE SYSTEM, DEG
     AZR AZIMUTH ANGLE RELATIVE TO ROTATING COORDINATE SYSTEM, DEG

*IF COORDINATES ARE ENERGY-ASYMPTOTE
     AZL AZIMUTH AT LAUNCH SITE, DEG
     RAD RADIUS, KM
     PTH PATH ANGLE, DEG
      C3 ENERGY CONSTANT FROM VIS VIVA INTEGRAL, KM*2/SEC
     DAO DECLINATION OF OUTGOING ASYMPTOTE, DEG
     RAD RIGHT ASCENSION OF OUTGOING ASYMPTOTE, DEG

LINE C
    (TYPE)      (CARTESIAN,SPHERICAL,EARTH FIXED,SELENOGRAPHIC,ENERGY-
                 ASYMPTOTE,PSEUDO-ASYMPTOTE)
      TO SECONDS PAST MIDNIGHT OF INJECTION TIME, SEC
     GHA GREENWICH HOUR ANGLE OF VERNAL EQUINOX AT INJECTION EPOCH, DEG
     GHO GREENWICH HOUR ANGLE OF VERNAL EQUINOX AT PREVIOUS MIDNIGHT, DEG
       ((ECLIPTIC) IS PRINTED IF APPLICABLE)

LINE D
     (DATE AND TIME OF RUN)    (CENTRAL BODY)    (EQUATIONS OF MOTION)
```

GEOCENTRIC

```
(TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)

GEOCENTRIC                                                (COORDINATE PLANE)

LINE A
        X VERNAL EQUINOX CARTESIAN POSITION, KM
        Y
        Z
       DX VERNAL EQUINOX CARTESIAN VELOCITY, KM/SEC
       DY
       DZ
LINE B
        R RADIUS, KM
      DEC DECLINATION, DEG
       RA RIGHT ASCENSION, DEG
        V INERTIAL SPEED, KM/SEC
      PTH INERTIAL PATH ANGLE, DEG
       AZ INERTIAL AZIMUTH ANGLE, DEG
LINE C
        R RADIUS, KM
      LAT GEOCENTRIC LATITUDE, DEG
      LON EARTH-FIXED LONGITUDE, DEG
       VE EARTH-FIXED SPEED, KM/SEC
      PTE EARTH-FIXED PATH ANGLE, DEG
      AZE EARTH-FIXED AZIMUTH ANGLE, DEG
LINE D
       XS THE GEOCENTRIC POSITION OF THE SUN, KM
       YS
       ZS
      DXS THE GEOCENTRIC VELOCITY OF THE SUN, KM/SEC
      DYS
      DZS
LINE E
       XM THE GEOCENTRIC POSITION OF THE MOON, KM
       YM
       ZM
      DXM THE GEOCENTRIC VELOCITY OF THE MOON, KM/SEC
      DYM
      DZM
LINE F
       XT THE GEOCENTRIC POSITION OF THE TARGET BODY, KM
       YT
       ZT
      DXT THE GEOCENTRIC VELOCITY OF THE TARGET BODY, KM/SEC
      DYT
      DZT
LINE G
       RS EARTH-SUN DISTANCE, KM
       VS GEOCENTRIC SPEED OF SUN, KM/SEC
       RM EARTH-MOON DISTANCE, KM
       VM GEOCENTRIC SPEED OF MOON, KM/SEC
       RT EARTH-TARGET DISTANCE, KM
       VT GEOCENTRIC SPEED OF TARGET, KM/SEC
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CONTINUED ON NEXT PAGE

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LINE H
      GED GEODETIC LATITUDE, DEG
      ALT ALTITUDE ABOVE THE EARTHS SURFACE, KM
      LOS LONGITUDE OF SUN, DEG
      RAS RIGHT ASCENSION OF SUN, DEG
      RAM RIGHT ASCENSION OF MOON, DEG
      LOM LONGITUDE OF MOON, DEG
LINE I
      DUT EPHEMERIS TIME MINUS UNIVERSAL TIME, SEC
       DT ADAMS-MOULTON STEP SIZE, SEC
       DR GEOCENTRIC RADIAL SPEED OF PROBE, KM/SEC
      SHA SUN SHADOW PARAMETER, KM
      DES DECLINATION OF THE SUN, DEG
      DEM DECLINATION OF THE MOON, DEG
LINE J
      CCL CANOPUS CLOCK ANGLE, DEG
      MCL MOON CLOCK ANGLE, DEG
      TCL TARGET CLOCK ANGLE, DEG
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HELIOCENTRIC

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HELIOCENTRIC                                              (COORDINATE PLANE)

LINE A
        X VERNAL EQUINOX CARTESIAN POSITION, KM
        Y
        Z
       DX VERNAL EQUINOX CARTESIAN VELOCITY, KM/SEC
       DY
       DZ
LINE B
        R SUN-PROBE RADIUS, KM
      LAT CELESTIAL LATITUDE - OR DECLINATION - OF THE PROBE, DEG
      LON CELESTIAL LONGITUDE - OR RIGHT ASCENSION - OF THE PROBE, DEG
        V INERTIAL SPEED, KM/SEC
      PTH PATH ANGLE, DEG
       AZ AZIMUTH ANGLE, DEG
LINE C
       XE HELIOCENTRIC POSITION OF THE EARTH, KM
       YE
       ZE
      DXE HELIOCENTRIC VELOCITY OF THE EARTH, KM/SEC
      DYE
      DZE
LINE D
       XT HELIOCENTRIC POSITION OF THE TARGET, KM
       YT
       ZT
      DXT HELIOCENTRIC VELOCITY OF THE TARGET, KM/SEC
      DYT
      DZT
LINE E
      LTE CELESTIAL LATITUDE - OR DECLINATION - OF THE EARTH, DEG
      LOE CELESTIAL LONGITUDE - OR RIGHT ASCENSION - OF THE EARTH, DEG
      LTT CELESTIAL LATITUDE - OR DECLINATION - OF THE TARGET, DEG
      LOT CELESTIAL LONGITUDE - OR RIGHT ASCENSION - OF THE TARGET, DEG
      RST DISTANCE OF THE TARGET FROM THE SUN, KM
      VST SPEED OF THE TARGET WITH RESPECT TO THE SUN, KM/SEC
LINE F
      EPS EARTH-PROBE-SUN ANGLE, DEG
      ESP EARTH-SUN-PROBE ANGLE, DEG
      SEP SUN-EARTH-PROBE ANGLE, DEG
      EPM EARTH-PROBE-MOON ANGLE, DEG
      EMP EARTH-MOON-PROBE ANGLE, DEG
      MEP MOON-EARTH-PROBE ANGLE, DEG
LINE G
      MPS MOON-PROBE-SUN ANGLE, DEG
      MSP MOON-SUN-PROBE ANGLE, DEG
      SMP SUN-MOON-PROBE ANGLE, DEG
      SEM SUN-EARTH-MOON ANGLE, DEG
      EMS EARTH-MOON-SUN ANGLE, DEG
      ESM EARTH-SUN-MOON ANGLE, DEG


LINE H  (NOT PRINTED IF TARGET=MOON)
      EPT EARTH-PROBE-TARGET ANGLE, DEG
      ETP EARTH-TARGET-PROBE ANGLE, DEG
      TEP TARGET-EARTH-PROBE ANGLE, DEG
      TPS TARGET-PROBE-SUN ANGLE, DEG
      TSP TARGET-SUN-PROBE ANGLE, DEG
      STP SUN-TARGET-PROBE ANGLE, DEG
LINE I  (ONLY RPM AND SPN ARE PRINTED IF TARGET=MOON)
      SET SUN-EARTH-TARGET ANGLE, DEG
      STE SUN-TARGET-EARTH ANGLE, DEG
      EST EARTH-SUN-TARGET ANGLE, DEG
      RPM PROBE-MOON DISTANCE, KM
      RPT PROBE-TARGET DISTANCE, KM
      SPN SUN-PROBE-NEAR LIMB OF EARTH ANGLE, DEG
LINE J
      GCE CLOCK ANGLE OF EARTH, DEG
      GCT CLOCK ANGLE OF TARGET, DEG
      SIP SUN-PROBE-NEAR LIMB OF TARGET ANGLE, DEG
      CPT CANOPUS-PROBE-TARGET ANGLE, DEG
      SIN CANOPUS-PROBE-NEAR LIMB OF TARGET ANGLE, DEG
LINE K
      REP EARTH PROBE DISTANCE, KM
      VEP VELOCITY OF THE PROBE WITH RESPECT TO EARTH, KM/SEC
      CPE CANOPUS-PROBE-EARTH ANGLE, DEG
      CPS CANOPUS-PROBE-SUN ANGLE, DEG
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                        (TARGET)CENTRIC


(TARGET)CENTRIC                                         (COORDINATE PLANE)

LINE A
        X TARGET-CENTERED VERNAL EQUINOX POSITION, KM
        Y
        Z
       DX TARGET-CENTERED VERNAL EQUINOX VELOCITY, KM/SEC
       DY
       DZ
LINE B
        R RADIUS FROM TARGET CENTER, KM
      DEC DECLINATION - OR CELESTIAL LATITUDE, DEG
       RA RIGHT ASCENSION - OR CELESTIAL LONGITUDE, DEG
        V SPEED RELATIVE TO THE TARGET, KM/SEC
      PTH TARGET-BODY PATH ANGLE, DEG
       AZ TARGET-BODY AZIMUTH ANGLE, DEG
LINE C  (PRINTED ONLY IF TARGET=MOON)
        R RADIUS FROM TARGET CENTER, KM
      LAT TARGET-CENTERED LATITUDE, DEG
      LON TARGET-CENTERED LONGITUDE, DEG
       VP SPEED RELATIVE TO THE ROTATING TARGET, KM/SEC
      PTP ROTATING TARGET-BODY PATH ANGLE, DEG
      AZP ROTATING TARGET-BODY AZIMUTH ANGLE, DEG
LINE D  (PRINTED ONLY IF TARGET=MOON)
      LTS SELENOGRAPHIC LATITUDE OF THE SUN, DEG
      LNS SELENOGRAPHIC LONGITUDE OF THE SUN, DEG
      LTE SELENOGRAPHIC LATITUDE OF THE EARTH, DEG
      LNE SELENOGRAPHIC LONGITUDE OF THE EARTH, DEG
LINE E
      ALT ALTITUDE ABOVE THE TARGET BODYS SURFACE, KM
      SHA SUNS SHADOW PARAMETER, KM
          SHA = -ABS(RTP X 1RTS)*SGN(RTP DOT RTS)
      ALP ILLUMINATED CRESCENT ORIENTATION VIEWING ANGLE, DEG
          ALP = ARCOS(A DOT V) WHERE -S3 = 1RTP   W = 1(S3 XS4)   V = WXS3
                                      S4 = 1RTS   U = (0,0,1)     A = 1(UXS3)
       DR RADIAL RATE, KM/SEC
       DP TRANSVERSE ANGULAR VELOCITY, DEG/SEC
      ASD ANGULAR SEMIDIAMETER OF TARGET AS SEEN FROM S/C, DEG
LINE F
      HGE RIGHT ASCENSION OF EARTH IN SPACECRAFT COORDINATE SYSTEM, DEG
      SVL DECLINATION OF TARGET IN SPACECRAFT COORDINATE SYSTEM, DEG
      HNG RIGHT ASCENSION OF TARGET IN SPACECRAFT COORDINATE SYSTEM, DEG
      SIA EARTH-PROBE-NEAR LIMB OF TARGET ANGLE, DEG




      THE FOLLOWING ADDITIONAL LINES ARE PRINTED
      IF MARS IS THE TARGET. ALL VARIABLES ARE
      REFERENCED TO A MARS EQUATORIAL INERTIAL COORDINATE
      SYSTEM OR TO A MARS FIXED COORDINATE SYSTEM

LINE H
                                     AREOCENTRIC EQUATORIAL COORDINATES
LINE I
        X MARS EQUATORIAL, MARS-PROBE POSITION, KM
        Y
        Z
       DX MARS EQUATORIAL, MARS-PROBE VELOCITY, KM/SEC
       DY
       DZ
LINE J
        R RADIUS FROM MARS CENTER, KM
      DEC DECLINATION, DEG
       RA RIGHT ASCENSION, DEG
        V SPEED RELATIVE TO MARS, KM/SEC
      PTH PATH ANGLE, DEG
       AZ AZIMUTH ANGLE, DEG
LINE K
        R RADIUS FROM MARS CENTER, KM
      LAT MARS-CENTERED LATITUDE, DEG
      LON MARS-FIXED LONGITUDE, DEG
       VP SPEED RELATIVE TO ROTATING MARS, KM/SEC
      PTP PATH ANGLE RELATIVE TO ROTATING MARS, DEG
      AZP AZIMUTH ANGLE RELATIVE TO ROTATING MARS, DEG
LINE L
      RAE RIGHT ASCENSION OF THE EARTH, DEG
      DEE DECLINATION OF THE EARTH, DEG
      RAS RIGHT ASCENSION OF THE SUN, DEG
      DES DECLINATION OF THE SUN, DEG
      LOE LONGITUDE OF THE EARTH, DEG
      LOS LONGTITUDE OF THE SUN, DEG
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```
                    GEO OR HELIO OR TARGET CONIC


GROUP A

                                 (BODY) CONIC

EPOCH OF PERICENTER PASSAGE (OP SEC PAST 1950) (JD) (CALENDAR DATE)
LINE A
         SMA SEMIMAJOR AXIS,KM
         ECC ECCENTRICITY,UNITLESS
         B   MAGNITUDE OF B VECTOR,KM
         SLR SEMILATUS RECTUM,KM
         APO APOCENTER DISTANCE,KM
         RCA CLOSEST APPROACH DISTANCE,KM
LINE B
         VH  HYPERBOLIC EXCESS SPEED,VELOCITY AT APOGEE FOR ELLIPSE,KM/SEC
         C3  TWICE TOTAL ENERGY PER UNIT MASS OR VIS VIVA INTEGRAL,KM*2/SEC*2
         C1  ANGULAR MOMENTUM,KM*2/SEC
         TFP TIME FROM PERICENTER PASSAGE,SEC
         TF  TIME FROM INJ TO PERICENTER PASSAGE IN HRS FOR EARTH-MOON TRAJ,
                  IN DAYS OTHERWISE

         PER PERIOD, MIN EXCEPT DAYS IF HELIO, PRINTED ONLY IF C3 IS -
         LTF LINEARIZED TIME-OF-FLIGHT IN HRS FOR EARTH-MOON TRAJ, IN DAYS
                  OTHERWISE   PRINTED ONLY IF C3 IS + IN PLACE OF PER
LINE C
         TA  TRUE ANOMALY,DEG
         MTA MAXIMUM TRUE ANOMALY,DEG
         EA  ECCENTRIC ANOMALY,DEG
         MA  MEAN ANOMALY,DEG
         C3J JACOBI CONSTANT, KM*2/SEC*2, PRINTED IN GEO AND SELENO CONICS ONLY
         TFI TIME FROM INJECTION IN HRS FOR EARTH-MOON TRAJ, IN DAYS OTHERWISE
LINE D     (PRINTED ONLY IF C3 IS + AND IF CONIC IS TARGET CONIC)
         ZAE ANGLE BETWEEN IN. ASYMPTOTE AT TARG AND TARG-EARTH VECTOR,DEG
         ZAP ANGLE BETWEEN IN. ASYMPTOTE AT TARG AND TARG-SUN VECTOR,DEG
         ZAC ANGLE BETWEEN IN. ASYMPTOTE AT TARG AND TARG-CANOPUS VECTOR,DEG
         DEF ANGLE BETWEEN INCOMING AND OUTGOING ASYMPTOTES,DEG
         IR  IMPACT RADIUS,KM
         GP  ANGLE BETWEEN IN. ASYMPTOTE AND ITS PROJ. ON ORB. PLANE OF TARG,DEG


GROUPS B,C,D

                                 ALL VECTORS REFERENCED TO (        ) PLANE

LINE A
         X    BODY-PROBE POSITION VECTOR IN COORD. SYSTEM GIVEN ABOVE,KM
         Y
         Z
         DX   BODY-PROBE VELOCITY VECTOR IN COORD. SYSTEM GIVEN ABOVE, KM/SEC
         DY
         DZ
LINE B
         INC INCLINATION OF PROBE ORBIT PLANE TO PLANE GIVEN ABOVE,DEG
         LAN LONGITUDE OR RIGHT ASCENSION OF ASCENDING NODE,DEG
         APF ARGUMENT OF PERICENTER,DEG
         MX  UNIT M VECTOR       M = W X IRO
         MY
         MZ
LINE C
         WX  UNIT W VECTOR
         WY
         WZ
         PX  UNIT P VECTOR
         PY
         PZ
LINE D
         QX  UNIT Q VECTOR
         QY
         QZ
         RX  UNIT R VECTOR
         RY
         RZ
LINE E
         BX  UNIT B VECTOR
         BY
         BZ
         TX  UNIT T VECTOR    T = R X S
         TY
         TZ
LINE F     (PRINTED ONLY IF C3 IS +)
         SXI UNIT INCOMING ASYMPTOTE VECTOR
         SYI
         SZI
         DAI DECLINATION OR LATITUDE OF INCOMING ASYMPTOTE,DEG
         RAI RIGHT ASCENSION OR LONGITUDE OF INCOMING ASYMPTOTE,DEG


LINE G     (PRINTED ONLY IF C3 IS +)
         SXO UNIT OUTGOINT ASYMPTOTE VECTOR
         SYO
         SZO
         DAO DECLINATION OR LATITUDE OF OUTGOING ASYMPTOTE,DEG
         RAO RIGHT ASCENSION OR LONGITUDE OF OUTGOING ASYMPTOTE,DEG
LINE H     (PRINTED ONLY IF C3 IS + AND IF CONIC IS TARGET CONIC)
         ETE ANGLE BETWEEN T AND PROJ. OF EARTH-TARG VECTOR ON R-T PLANE,DEG
         ETS ANGLE BETWEEN T AND PROJ. OF SUN-TARG VECTOR ON R-T PLANE,DEG
         ETC ANGLE BETWEEN T AND PROJ. OF CANOPUS-TARG VECTOR ON R-T PLANE,DEG
LINE I     (PRINTED ONLY IF C3 IS -)
         DAP DECLINATION OF ASYMPTOTE,DEG
         RAP RT. ASCENSION OF ASYMPTOTE,DEG
LINE J
         BTX T COMPONENT OF B,KM  WHERE X=Q FOR EARTH EQU., X=C FOR ECLIPTIC
         BRX B COMPONENT OF B,KM        X=O FOR TARG ORBIT, X=T FOR TARG EQU
         B   MAGNITUDE OF B,KM
         THA DIRECTION ANGLE OF IMPACT PARAMETER IN R-T PLANE MEASURED + FROM T
         T VECTOR IN (      ) PLANE
```

OUTPUT DESIGNATING BEGINNING OF TRAJECTORY BURN

```
LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  START BURN
```

OUTPUT DESIGNATING END OF TRAJECTORY BURN

```
LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  END BURN
```

OUTPUT DESIGNATING BEGINNING OF GAS JET COMPUTATION

```
LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  START GAS JETS
```

OUTPUT DESIGNATING END OF GAS JET COMPUTATION

```
LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  END GAS JETS
```

SHADOW PARAMETERS

```
* WHEN PROBE ENTERS, LEAVES,IS IN, OR OUT OF A BODYS SHADOW
  ONE OF THE FOLLOWING SET OF TWO LINES WILL BE OUTPUT


LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  PROBE IS ENTERING (BODY) SHADOW

LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  PROBE IS LEAVING (BODY) SHADOW

LINE A
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  PROBE IS IN (BODY) SHADOW

LINE A *
  (TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)
LINE B
  PROBE IS OUT OF (BODY) SHADOW
```

```
IF PUBLIC INFORMATION IS REQUESTED THE FOLLOWING FIVE LINES ARE PRINTED

LINE A
      PUBLIC INFORMATION
LINE B
      EAL ALTITUDE OF PROBE ABOVE EARTH                        ST. MILES
      TAL ALTITUDE OF PROBE ABOVE TARGET                       ST. MILES
      RPE EARTH PROBE DISTANCE                                 ST. MILES
      RPT TARGET PROBE DISTANCE                                ST. MILES
      RPS SUN PROBE DISTANCE                                   ST. MILES
      ARC DISTANCE ALONG PATH OF THE TRAJECTORY                ST. MILES
LINE C
      VGC GEOCENTRIC INERTIAL SPEED OF PROBE               ST. MILES/HR.
      VTC TARGETCENTRIC INERTIAL SPEED OF PROBE            ST. MILES/HR.
      VSC HELIOCENTRIC INERTIAL SPEED OF PROBE             ST. MILES/HR.
      LAT GEOCENTRIC LATITUDE OF PROBE                              DEG.
      LON GEOCENTRIC LONGITUDE OF PROBE                             DEG.
LINE D
      BOARD UNITS
LINE E
       UP HORIZONTAL POSITION OF PROBE                       BOARD UNITS
       VP VERTICAL POSITION OF PROBE                         BOARD UNITS
       UE HORIZONTAL POSITION OF EARTH                       BOARD UNITS
       VE VERTICAL POSITION OF EARTH                         BOARD UNITS
       UT HORIZONTAL POSITION OF TARGET                      BOARD UNITS
       VT VERTICAL POSITION OF TARGET                        BOARD UNITS
```

```
                                 STATION PRINTS

(TIME PAST INJECTION) (EQUINOX)  (DP SEC PAST 1950)  (JD)  (CALENDAR DATE)


(STATION NAME) (AZEL OR HADEC)
LINE A
      R   GEO. RADIUS MAG. OF PROBE, KM
      LAT GEO. LATITUDE, DEG.
      LON GEO. LONGITUDE, DEG.
LINE B
      MIN MINUTES FROM INJECTION
      HA  LOCAL HOUR ANGLE OF PROBE, DEG
      DEC LOCAL DECLINATION OF PROBE, DEG
      ELE ELEVATION ANGLE OF PROBE, DEG
      AZI NORTH AZIMUTH OF PROBE, DEG
LINE C
      CKC CLOCK ANGLE OF CANOPUS, DEG.
      CKM CLOCK ANGLE OF MOON, DEG.
      CKT CLOCK ANGLE OF TARGET, DEG.
      PSS PROBE-STATION-SUN ANGLE, DEG
      PSM PROBE-STATION-MOON ANGLE, DEG.
LINE D
      UT  TIME CORRECTION FOR FREQUENCIES,HOURS
      DHA HOUR-ANGLE RATE, DEG/SEC
      DDE DECLINATION RATE, DEG/SEC
      DEL ELEVATION RATE, DEG/SEC
      DAZ AZIMUTH RATE, DEG/SEC
LINE E
      ET  EPHEMERIS TIME CORRECTOR, HOURS
      RGE SLANT RANGE OF PROBE, KM
      DRG SLANT-RANGE RATE, KM/SEC
      DDR RATE OF THE SLANT-RANGE RATE, KM/SEC2 (ZERO IF CENTER NOT EARTH)
      SLS SPACE LOSS, DB
LINE F
      RDI RADIUS OF THE STATION, KM
      PHI NORTH GEOCENTRIC LATITUDE OF THE STATION, DEG
      THI EAST LONGITUDE OF THE STATION, DEG
      SPS STATION-PROBE-SUN ANGLE, DEG
      POL POLARIZATION ANGLE, DEG.
LINE G
      DT  TIME FOR LIGHT TO TRAVEL FROM STATION TO PROBE (SEC.)
      RFB REFERENCE BEACON FREQUENCY, CPS
      RF1 ONE WAY REFERENCE FREQUENCY, CPS
      RF2 TWO WAY REFERENCE FREQUENCY, CPS
      FA  TRANSPONDER RECEIVER FREQUENCY, CPS
LINE H
      BF1 BEACON FREQUENCY, CPS
      F1  ONE WAY DOPPLER FREQUENCY, CPS
      F2  TWO WAY DOPPLER FREQUENCY, CPS
      XA  GROUND TRANSMITTER FREQUENCY, CPS
      PRA PROBE RIGHT ASCENSION, DEG.
LINE I
      D1  ONE WAY DOPPLER DETECTOR FREQUENCY, CPS
      D2  TWO WAY DOPPLER DETECTOR FREQUENCY, CPS
      DOP DOPPLER RATE, SQUARE CPS
      DF1 ONE WAY DOPPLER FREQUENCY RATE, SQUARE CPS (ONLY IF CENTER = EARTH)
      DF2 TWO WAY DOPPLER FREQUENCY RATE, SQUARE CPS (ONLY IF CENTER = EARTH)
```

C. JOB-SHOP OUTPUT CAPABILITY

1. In the job-shop mode of operation, printed output is put on tape SYSOU1. Or, by proper use of input parameter FLAG42, the output is put on low density tape SYSPL1. The latter tape can be processed by the S-C 4020 High-Speed Microfilm Recorder. Subroutine PROUT is utilized to produce the line images for SYSOU1 or SYSPL1.

2. Output also appears on the 7094 on-line printer. The progress of the trajectory and the occurrence of errors are noted. Subroutine ERPRT is utilized to produce the on-line print. Additional on-line print capability is available by proper use of the 7094 console sense switches or by input. A minimum on-line print (defined as on-line printing of injection conditions, phase changes and encounter conditions) is obtained by depressing sense switch 6. A detailed or fine on-line print (defined as the duplication, on-line, of all output on SYSOU1 or SYSPL1) is obtained by depressing sense switches 4 and 6. The sense switches, hence the on-line print request, may be changed at will during the computation of the trajectory. If desired, input parameter OPTSWT may be used to preset the on-line print request in the source deck.

3. The trajectory SAVE tape may be put on high density binary tape SYSCK2. Input parameters located at PLOTFQ control the generation of the SAVE tape.

4. Debugging output (SNAP) may be used (Ref. 4, Section VIII). SFPRO's FILE control card must have the following format:

	Column	
1	8	16
$	FILE	147

D. SFOF OUTPUT CAPABILITY

The SFOF output capability is similar to the job-shop output capability. The normal output is put on SYSOU1. The on-line output control and printing are done at remote user area 5, instead of at the 7094 console and printer. The progress of the trajectory and the occurrence of errors are printed on the remote administrative printer. The minimum or fine print of the trajectory is printed on the remote SC-3070 printer. This minimum or fine on-line SC-3070 print is controlled by the remote console option switches 33 and 35 (corresponding to sense switches 4 and 6). If desired, input parameter OPTSWT may be used to preset the on-line print request in the source deck.

The spacecraft ephemerides are treated the same as in the job-shop mode but the debugging output capability (SNAP) does not exist.

VI. SUBROUTINES

SFPRO is made up of 43 closed subroutines, some of which have more than one entry and perform more than one function. Many subroutines have not changed in function from Ref. 1 (Section VIII) but the documentation was repeated in this Technical Memorandum (TM 33-199) for completeness. All subroutines were documented according to the following specifications:

IDENTIFICATION

Entry name(s)
Programmer(s)
Coding language
Date

PURPOSE

Defines the task performed by this subroutine.

RESTRICTIONS

Cites the error conditions, external buffers used, COMMON used, subroutines used, etc., (COMMON names and subroutine names are capitalized).

METHOD

Gives a detailed description of how the subroutine accomplishes its task. Includes a flow chart when applicable.

USE

Defines all calling sequences, including the definition and use of input and output parameters.

CODING INFORMATION

Gives the decimal and octal sizes of the subroutine excluding COMMON storage or external buffer storage.

REFERENCES

Gives Requests for Programming (RFP) number, Inter-Office Memoranda (IOM' s) and technical references if applicable.

IDENTIFICATION

ABORT/ERPRT/JEXIT/PRSET/....../TIME

Nicholas S. Newhall, JPL

IBM 7094 Fap

December 2, 1964

PURPOSE

To handle communication between SFPRO and the various systems, I/O devices, switches, flags and subroutines.

RESTRICTIONS

a. Entries RUNID, PRTSWX, FLAG42, COMTRJ, COMTRK and COMFLG are provided for those input parameters.
b. The on-line printer is sensed to obtain the date and time-of-day if the parameter EXPORT is zero.
c. The print flags are in COMMON locations SP1A, · · · , SP3C, EJCTA, EJCTB, EJCTC, 37HED, PRFLG and PRTSWT.
d. Subroutines TYPWRT and PROUT are used for on-line printing.

METHOD

a. PRSET examines the input flags, the 7094 sense-switches, the SFOF mode cell SFMODE,and user area option switches in order to set the appropriate COMMON print flags for PROUT.
b. ERPRT prints the on-line messages. The 7094 on-line printer or the remote user area administrative printer will print the message, depending on the contents of parameter SFMODE.
c. TIME provides the user with the BCD time-of-day in the AC and the computer code letter A, B or C left adjusted in the MQ and followed by blanks.
d. JEXIT prints "END TRAJECTORY (SFPRO)", closes the output files used by PROUT and returns control to JPTRAJ with a zero in the accumulator, designating a normal return.
e. ABORT prints "END TRAJECTORY (SFPRO)", closes the output files used by PROUT and returns control to JPTRAJ with a one in the accumulator, designating the error return.
f. ...... is the location of the Program Control Block (PCB) and contains the information JPTRAJ needs to set up for and transfer control to SFPRO.

USE

Calling sequences:

a. CALL PRSET
   return

b. TSX $ERPRT, 4, N
   PZE A, , B
   return
   where

A, · · · , A+(B-1)	contain BCD text
B	is the number of words of text, $B \leq 12$
N = 0	means message not printed off-line
= 2	means message printed off-line after a double space
= 3	means message printed off-line after a page eject.

c. CALL TIME
   return

d. CALL JEXIT
   (transfers control to JPTRAJ)

e. CALL ABORT
   (transfers control to JPTRAJ)

CODING INFORMATION

Length of subroutine is 757(10) or 1365(8) words.

IDENTIFICATION 2

ADD
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To perform double precision addition of two double precision floating point numbers.

RESTRICTIONS

a. If the numbers involved are sufficiently large so as to cause overflow, erroneous results will be obtained.
b. Uses COMMON to COMMON + 3.

METHOD

The contents of the AC-MQ registers and/or the contents of specified cells in core storage (see USE) are added using the DFAD machine instruction. The high order part of the result is placed in the AC and the low order part in the MQ.

USE

Calling sequences:

a. CALL ADD
return

Enter with one of the double precision numbers in the AC-MQ and the other number in COMMON and COMMON + 1. Exit with the result in the AC-MQ.

b.

```
CALL   ADD        or      CALL   ADD,YI,0
TSX    YI,0
TSX    0,0
return
```

Enter with one of the double precision numbers in the AC-MQ and the other number in YI and YI + 1. Exit with the result in the AC-MQ.

c.

```
CALL   ADD        or      CALL   ADD,YI,ZI
TSX    YI,0
TSX    ZI,0
return
```

Enter with one of the double precision numbers in YI and YI + 1 and the other number in ZI and ZI + 1. Exit with the result in the AC-MQ.

CODING INFORMATION

Length of the subroutine is 25(10) or 31(8) words.

IDENTIFICATION 3

ARCOS/ARSIN
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute arcsine x or arccosine x for a floating point, single precision x, in degrees.

RESTRICTIONS

If $|x| > 1.0$ the result will be ±90.0 for the arcsine, taking the same sign as the argument, and will be 180.0 for the arccosine for a negative argument and 0.0 for the arccosine for a positive argument.

METHOD

$$\mathrm{Sin}^{-1}\, x = \pi/2 - \sqrt{1-x}\ F(x), \quad \cos^{-1} x = \sqrt{1-x}\ F(x)$$

where $F(x) = \sum_{i=o}^{7} C_i x^i$, and

C_0	= 1.570796327	C_4	= 0.0308918810
C_1	= -0.2145988016	C_5	= -0.0170881256
C_2	= 0.0889789874	C_6	= 0.0066700901
C_3	= -0.0501743046	C_7	= -0.0012624911

Accuracy: 7 significant decimal digits.

USE

Enter with the argument in the accumulator. Exit with the result in the accumulator in degrees.

Calling sequences:

for arccosine:		for arcsine:	
CLA	X	CLA	X
CALL	ARCOS	CALL	ARSIN
return		return	

CODING INFORMATION

Length of subroutine is 96(10) or 140(8) words.

IDENTIFICATION 4

ARTAN
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute arctangent (y/x) in degrees for floating point, single precision x and y.

RESTRICTIONS

Uses COMMON to COMMON + 4.

METHOD

The following Rand approximating polynomial is used:

$$\text{Arctan }(y/x) = \text{Arctan } D = \pi/4 + \sum_{i=o}^{7} C_{2i+1}\left(\frac{D-1}{D+1}\right)^{2i+1}$$

where:

C_1 =	0.9999993329	C_9 =	0.0964200441
C_3 =	-0.3332985605	C_{11} =	-0.0559098861
C_5 =	0.1994653599	C_{13} =	0.0218612288
C_7 =	-0.1390853351	C_{15} =	-0.0040540580

Accuracy: 7 significant figures.

USE

Enter with y in the accumulator and x in the MQ. Exit with Arctan (y/x) in the accumulator in degrees normalized to lie in the range 0 to 360.

Calling sequence:

```
CLA     Y
LDQ     X
CALL    ARTAN
return
```

CODING INFORMATION

Length of subroutine is 57(10) or 71(8) words.

IDENTIFICATION 5

BCDNO/NEWBCD
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To replace a BCD word (the name of a celestial body) in the accumulator with a fixed point number scaled 35. This number will be used as a reference number in locating data pertinent to that body.

RESTRICTIONS

a. An error is possible if the BCD word is not recognized (see USE), in which case a comment to this effect is printed and control is given to ABORT.
b. ERPRT, PROUT and ABORT may be called.
c. NEWBCD is provided so that SATURN may be replaced by some other body name.

METHOD

The accumulator is compared with each of seven BCD words until equality occurs. Each comparison is counted and, at equality, this count, in fixed point scaled 35, replaces the accumulator.

USE

Calling sequence:

```
CAL     L(BCD word)
CALL    BCDNO
return
```

If (BCD word) =	EARTH	return with accumulator	= 0
	MOON		= 1
	SUN		= 2
	VENUS		= 3
	MARS		= 4
	SATURN		= 5
	JUPITE		= 6

CODING INFORMATION

Length of subroutine is 36(10) or 44(8) words.

IDENTIFICATION 6

CHANGE
Peter S. Fisher, JPL
IBM 7094 Fap
December 2, 1964

PURPOSE

To call PRINTD with special group and conic print flags.

RESTRICTIONS

The subroutines SPRAY and PRINTD are called, and GROP and ORBETT are referenced indirectly.

METHOD

The current group and conic print flags are saved and the desired replacements are substituted. SPRAY is called to prepare the GROPS flags for PRINTD and then PRINTD is called. Then the group and conic flags are reset and SPRAY is again called to restore the GROPS flags.

USE

Calling sequence:

```
CALL    CHANGE
OCT     A
OCT     B
return
```

where A is one word of twelve octal digits (designating the desired group options) and B is one word of twelve octal digits (designating the desired conic options).

CODING INFORMATION

Length of subroutine is 28(10) or 34(8) words.

IDENTIFICATION

CLASS
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

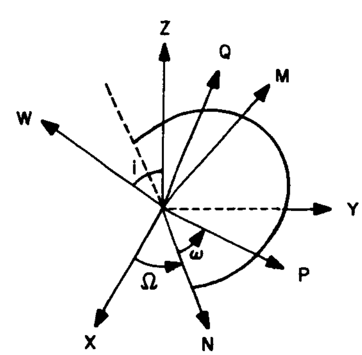
To calculate conic orbital elements.

RESTRICTIONS

a. CLASS is a subset of a rectangular-to-orbital elements package and uses other subroutines in the package.
b. COMMON through COMMON+3 are used.
c. An error can occur if the input value of c_3 is zero.
d. Subroutines SQRT, ARCOS and SIN are called.
e. Location HARMN is referenced indirectly to obtain the Earth's oblateness constants.

METHOD

The following sketch illustrates the relationship between the orbital elements and the reference $\hat{P}$, $\hat{Q}$, $\hat{W}$ and $\overline{X}$, $\overline{Y}$, $\overline{Z}$ frames:



Hence, $i = \cos^{-1} W_z$, where $0 \leqq i \leqq 180$ deg for the inclination

$$\left\{ \begin{aligned} \sin \Omega &= \frac{W_x}{\sin i} \\ \cos \Omega &= \frac{-W_y}{\sin i} \end{aligned} \right.$$

where $0 \leqq \Omega < 360$ deg for the right ascension of the ascending node

7.1-2 of 4

$$\begin{cases} \sin\omega = \dfrac{P_z}{\sin i} \\ \cos\omega = \dfrac{Q_z}{\sin i} \end{cases}$$

where $0 \leqq \omega < 360$ deg for the argument of the pericenter.

The formulas for Ω may be derived by constructing the unit vector $\hat{N}$ at the ascending node:

$$\hat{N} = \frac{\hat{U} \times \hat{W}}{|\hat{U} \times \hat{W}|}$$

where $\hat{U} = (0, 0, 1)$ and $\sin i = |\hat{U} \times \hat{W}|$. $\hat{N}$ is then projected onto the X and Y axes to give the formulas for the cosine and the sine.

Next, the auxiliary unit vector $\hat{M} = \hat{W} \times \hat{N}$ is constructed so that ω is given by:

$$\begin{cases} \sin\omega = \hat{P} \cdot \hat{M} = \hat{P} \cdot (\hat{W} \times \hat{N}) = -\hat{N} \cdot (\hat{W} \times \hat{P}) = -\hat{N} \cdot \hat{Q} \\ \cos\omega = \hat{P} \cdot \hat{N} \end{cases}$$

The conic parameters are given by the standard formulas for $c_1 \neq 0$:

$q = \dfrac{p}{1 + \epsilon}$	the closest approach distance
$V_p = \dfrac{\mu(1 + \epsilon)}{c_1}$	the velocity at closest approach
$V_a = \dfrac{\mu(1 - \epsilon)}{c_1}$	velocity at farthest departure($c_3 < 0$)
$V_h = \sqrt{c_3}$	hyperbolic excess velocity ($c_3 > 0$)
$q_2 = a(1 + \epsilon)$	farthest departure distance ($c_3 < 0$)
$P = \dfrac{2\pi}{n}$	the period

For an Earth satellite, the quantities $\dot{\omega}$ and $\dot{\Omega}$ are also computed:

$$\dot{\omega} = \frac{nJa_{\oplus}^2}{p^2}\left(2 - \frac{5}{2}\sin^2 i\right)$$

$$\dot{\Omega} = \frac{-nJa_{\oplus}^2}{p^2}\cos i$$

where

- J is the coefficient of the second harmonic in the Earth's oblateness expression
- $a_{\oplus}$ is the Earth radius, km
- n is the mean motion, rad/sec
- p is the semilatus rectum, km

so that $\dot{\omega}$ and $\dot{\Omega}$ may be converted to deg/day for output.

USE

Calling sequence:

```
CALL    CLASS
PZE     A,,B
PZE     C
NOP
error return
normal return
```

where

A, $\cdots$, A+8 contain the input vectors $\hat{P}$, $\hat{Q}$, $\hat{W}$.

B, $\cdots$, B+7 contain the input parameters c_1, c_3, μ, ϵ, $1 - \epsilon$, a, p and n, respectively, as computed by JEKYL.

C, $\cdots$, C+9 contain the output parameters:

- i, inclination, radians
- Ω, right ascension of the ascending node, radians
- ω, argument of pericenter, radians
- q, closest approach distance, km
- V_p, velocity at closest approach, km/sec
- V_a, (or V_h if $c_3 > 0$), velocity at farthest departure (or hyperbolic excess velocity), km/sec
- q_2, (or zero if $c_3 > 0$), farthest departure distance, km
- P period, sec
- $\dot{\omega}$ derivative of ω, deg/day
- $\dot{\Omega}$ derivative of Ω, deg/day

The error exit will be taken if the input c_3 is zero.

CODING INFORMATION

Length of subroutine (includes CLASS as a subset) is 1226 (10) or 2312 (8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION

JEKYL
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute the $\hat{P}$, $\hat{Q}$ and $\hat{W}$ vectors, the epoch of closest approach, and c_1 and c_3 from cartesian position and velocity vectors.

RESTRICTIONS

a. COMMON through COMMON+14 are used.
b. An error can occur if the logarithm or square root of a negative number is attempted.
c. Subroutines SQRT, UNIT, CROSS and LN are called.
d. JEKYL is a subset of a rectangular-to-orbital-elements package and uses several other subroutines in the package.
e. COMMON locations ECCEN, IMINE, AVAL, PVAL, NORB, NU, JECAN and MENAN are used.

METHOD

Given the cartesian position and velocity vectors $\overline{R}$ and $\overline{V}$ compute:

$$p = \frac{R^2V^2 - (R\dot{R})^2}{\mu}$$ the semilatus rectum

where

$$R\dot{R} = \overline{R} \cdot \overline{V}$$

$$c_1 = \sqrt{R^2V^2 - (R\dot{R})^2}$$ the angular momentum

$$\frac{1}{a} = \frac{2\mu - RV^2}{R\mu}$$

$$c_3 = -\frac{\mu}{a}$$ the "energy" or vis viva integral

At this point a test is made with the help of the I. D. input to determine whether or not a is an acceptable parameter. a* is defined by

$$a^* = \begin{cases} 10^{10} \text{ km for the planets} \\ 10^{9} \text{ km for the Sun} \\ 10^{12} \text{ km for the Moon} \end{cases}$$

The motion is considered parabolic and c_3 is set to zero whenever $|a| > a^*$.

$$1 - \epsilon^2 = \frac{p}{a}$$

$$\epsilon = \sqrt{1 - (1 - \epsilon^2)} \qquad \text{the eccentricity}$$

$$\begin{cases} \cos \nu = \dfrac{p - R}{\epsilon R} \\ \sin \nu = \dfrac{\dot{R}}{\epsilon}\sqrt{\dfrac{p}{\mu}} \end{cases} \qquad \text{true anomaly}$$

$$q = \frac{p}{1 + \epsilon} \qquad \text{closest approach distance}$$

$$\hat{W} = \frac{\overline{R} \times \overline{V}}{c_1} \qquad \text{unit angular momentum vector}$$

$$\hat{U}_1 = \frac{\overline{R}}{R}$$

$$\hat{V}_1 = \frac{R}{c_1}\overline{V} - \frac{\dot{R}}{c_1}\overline{R}$$

$$\hat{P} = \cos \nu \overline{U}_1 - \sin \nu \overline{V}_1$$

$$\hat{Q} = \sin \nu \overline{U}_1 + \cos \nu \overline{V}_1$$

If $c_3 \neq 0$, $T - T_p$ is computed from Kepler's equation according to the sign of a:

If $a > 0$:

$$\begin{cases} \cos E = \dfrac{R}{p}(\cos \nu + \epsilon) \\ \sin E = \dfrac{R}{p}\sqrt{1 - \epsilon^2} \sin \nu \end{cases}$$

$$M = E - \epsilon \sin E$$

if $1 - \epsilon > 0.1$ or if $1 - \epsilon \leqq 0.1$ and $|\sin E| > 0.1$

$$M = (1 - \epsilon) \sin E + \left(\frac{\sin^3 E}{6} + \frac{3 \sin^5 E}{40}\right)$$

if $1 - \epsilon \leqq 0.1$ and $\cos E > 0$, $|\sin E| \leqq 0.1$

$$M = n(T - T_p)$$

where

$$n = \sqrt{\mu} a^{-3/2}$$

if $a < 0$:

$$\sinh F = \frac{R\dot{R}}{\epsilon \sqrt{\mu |a|}}$$

$$M = \epsilon \sinh F - F$$

if $\epsilon - 1 > 0.1$ or if $\epsilon - 1 \leqq 0.1$ and $|\sinh F| > 0.1$

$$M = (\epsilon - 1) \sinh F - \left(\frac{3 \sinh^5 F}{40} - \frac{\sinh^3 F}{6}\right)$$

if $\epsilon - 1 \leqq 0.1$ and $|\sinh F| \leqq 0.1$

$$M = n(T - T_p)$$

where

$$n = \sqrt{\mu} |a|^{-3/2}$$

If $c_3 = 0$, the formula for the parabola is used:

$$M = \sqrt{\mu}(T - T_p) = qD + \frac{1}{6} D^3$$

where

$$D = R\dot{R}/\sqrt{\mu} = \sqrt{2q} \tan \nu/2$$

USE

Calling sequence:

```
CALL   JEKYL
PZE    0,,A
PZE    B,,C
```

```
PZE   D
PZE   E,,F
PZE   G
error return
normal return
```

where

A	contains the μ (gravitational coefficient) of the body from which the input position and velocity vectors are measured.
A+1	contains an integer I.D. used in the parabola test: 0 = planets 1 = Moon 2 = Sun
B, B+1, B+2	contain the input cartesian position vector, $\overline{R}$.
C, C+1, C+2	contain the input cartesian velocity vector, $\overline{V}$.
D, ⋯, D+8	contain the output unit vectors $\hat{P}$, $\hat{Q}$, $\hat{W}$.
E	contains the input epoch T.
F	contains the output epoch of closest approach, T_p.
G, G+1, G+2	contain the output $\Delta T = T - T_p$, the angular momentum, c_1, and the energy or vis viva integral, c_3.

In addition, the following quantities are computed and stored in the COMMON locations given:

Location	Symbol	Description
ECCEN	ϵ	eccentricity
1MINE	$1-\epsilon$	1 minus eccentricity
AVAL	a	semimajor axis
PVAL	p	semilatus rectum
NORB	n	mean motion
NU	ν	true anomaly
JECAN	E(or F)	eccentric anomaly
MENAN	M	mean anomaly

The error exit is taken if a negative square root is attempted or if the logarithm of a negative number is attempted.

CODING INFORMATION

Length of subroutine (includes JEKYL as a subset) is 714(10) or 2312(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION

SPECL
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute the reference unit vectors $\hat{R}$, $\hat{S}$, $\hat{T}$, and $\overline{B}$ and the impact parameters $B \cdot T$, $B \cdot R$.

RESTRICTIONS

a. COMMON through COMMON+3 are used.
b. Subroutines SQRT, ARCOS and SIN are called.
c. COMMON location PVAL and ECCEN are used.
d. SPECL is a subset of a rectangular-to-orbital-elements package and uses several other subroutines in the package.
e. External locations SAVA, INJTYP and RMAX are referenced indirectly.
f. An error will occur if a negative square root is attempted.

METHOD

The computation of the $\hat{S}$ and $\overline{B}$ vectors depends on the value of the eccentricity, ϵ:

a. $\epsilon \geq 1$, the hyperbolic case with $a < 0$:

$$\hat{S} = \begin{cases} \dfrac{1}{\epsilon}\hat{P} + \dfrac{\sqrt{\epsilon^2 - 1}}{\epsilon}\hat{Q} & \text{for the incoming asymptote} \\ \dfrac{-1}{\epsilon}\hat{P} + \dfrac{\sqrt{\epsilon^2 - 1}}{\epsilon}\hat{Q} & \text{for the outgoing asymptote} \end{cases}$$

$$\overline{B} = \begin{cases} \dfrac{|a|(\epsilon^2 - 1)}{\epsilon}\hat{P} - \dfrac{|a|\sqrt{\epsilon^2 - 1}}{\epsilon}\hat{Q} & \text{for the incoming asymptote} \\ \dfrac{|a|(\epsilon^2 - 1)}{\epsilon}\hat{P} + \dfrac{|a|\sqrt{\epsilon^2 - 1}}{\epsilon}\hat{Q} & \text{for the outgoing asymptote} \end{cases}$$

b. $\epsilon < 1$, the elliptic case with $a > 0$

$$\left.\begin{aligned} \hat{S} &= \hat{P} \\ \bar{B} &= a\sqrt{|\epsilon^2 - 1|}\,\hat{Q} \end{aligned}\right\}$$

for both the incoming and outgoing asymptote options

The remaining two reference vectors $\hat{T}$ and $\hat{R}$ are given in either the hyperbolic or elliptic case by

$$\hat{T} = \left(\frac{S_y}{\sqrt{S_x^2 + S_y^2}}, \frac{-S_x}{\sqrt{S_x^2 + S_y^2}}, 0 \right)$$

$$\hat{R} = \hat{S} \times \hat{T}$$

USE

Calling sequence:

```
CALL   SPECL
PZE    A, , B
PZE    C
error return
normal return
```

Enter with the semimajor axis, a, in the AC and the eccentricity, ϵ, in the MQ.

Where

A, · · · , A+8	contain the input vectors $\hat{P}$, $\hat{Q}$, $\hat{W}$.
B	contains zero for reference to an incoming asymptote and 1 for reference to an outgoing asymptote.
C, · · · , C+14	contain the output B · T, B · R and vectors $\hat{S}$, $\bar{B}$, $\hat{T}$ and $\hat{R}$, respectively.

The error return is taken if a negative square root is attempted.

CODING INFORMATION

Length of subroutine (includes SPECL as a subset) is 714(10) or 2312(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION 8

CLUCK

Peter S. Fisher, JPL

IBM 7094 Fap

December 2, 1964

PURPOSE

To compute the Canopus clock angle, Moon clock angle, and target clock angle.

RESTRICTIONS

The subroutines UNIT, CROSS, PROD, and ARTAN are called.

METHOD

$$\text{Clock} \measuredangle \triangleq \text{Tan}^{-1}\left(\frac{-\overline{A}\cdot\overline{C}}{\overline{B}\cdot\overline{C}}\right)$$

where:

$$\overline{A} = \frac{\overline{R}_{sp} \times \overline{R}_{ip}}{|\overline{R}_{sp} \times \overline{R}_{ip}|}$$

$$\overline{B} = \frac{\overline{A} \times \overline{R}_{sp}}{|\overline{A} \times \overline{R}_{sp}|}$$

$$\overline{C} = \frac{(\overline{N} \times \overline{R}_{sp}) \times \overline{R}_{sp}}{|(\overline{N} \times \overline{R}_{sp}) \times \overline{R}_{sp}|}$$

$\overline{R}_{sp} \triangleq$ True of-date Sun-probe position vector

$\overline{R}_{ip} \triangleq$ True of-date observation point-probe position vector

$\overline{N}$ $\triangleq$ True of-date probe-Canopus position vector for the Canopus clock angle

$\triangleq$ True of-date Moon-probe position vector for the Moon clock angle

$\triangleq$ True of-date target-probe position vector for the target clock angle

USE

Calling sequence:

```
Call CLUCK
PZE A, , B
return
```

where A is the location of the input $\overline{R}_{ip}$ vector and where B is the location where the three output clock angles will be stored.

CODING INFORMATION

Length of subroutine is 72(10) or 110(8) words

IDENTIFICATION 9

COS/SIN/QCOS/QSIN
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute sin x or cos x for a floating point, single precision x (x in radians or degrees).

RESTRICTIONS

a. Loops for large argument or small unnormalized argument.
b. Uses COMMOM to COMMON +2.

METHOD

The argument is reduced to a first quadrant equivalent and then a thirteenth order polynomial approximation, employing fixed point arithmetic, is used.
The cosine is computed by first adding $\pi/2$ to the argument.

USE

Enter with the argument in the accumulator.
Exit with the result in the accumulator.
Calling sequences:

for COS X				for SIN X			
X in radians		X in degrees		X in radians		X in degrees	
CLA	X	CLA	X	CLA	X	CLA	X
CALL	QCOS	CALL	COS	CALL	QSIN	CALL	SIN
return		return		return		return	

CODING INFORMATION

Length of subroutine is 159(10) or 237(8) words.

IDENTIFICATION

CROSS/PROD/UNIT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute: (1) the cross product of two vectors; or (2) the dot product of two vectors, or the magnitude and magnitude squared of one vector; or (3) a unit vector.

RESTRICTIONS

a. All vectors must be stored BES 3.
b. In the calling sequences to the CROSS and UNIT option the location given for the output vector may be the same as the location given for an input vector.

METHOD

The vector operations of vector product and scalar product and the multiplication of a vector by a scalar ($1/|v|$ to obtain a unit vector) are performed in a manner indicated by their definitions.

USE

Calling sequences:

a. To compute the vector product of two vectors $\overline{C} = \overline{A} \times \overline{B}$:

```
CALL    CROSS
PZE     A,,B
PZE     C
return
```

b. To compute the scalar product of two vectors $\overline{A} \cdot \overline{B}$:

```
CALL    PROD
MZE     A,,B
return
```

Exit with the result in the accumulator.

c. To compute the magnitude and magnitude squared of a vector $\overline{A}$:

```
CALL    PROD
PZE     A
return
```

Exit with the magnitude in the AC and the magnitude squared in the MQ.

d. To obtain a unit vector $\overline{B} = \overline{A}/|\overline{A}|$;

```
CALL    UNIT
PZE     A,,B
return
```

CODING INFORMATION

Length of subroutine is 66(10) or 102(8) words.

IDENTIFICATION 11

DAYS

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

To convert the double precision floating point seconds located in the AC and MQ to single precision integer days and residual seconds.

RESTRICTIONS

a. A double precision number is assumed to be two floating point words.
b. Subroutines FIX, FLOAT, and ADD are called.
c. Uses COMMON to COMMON +5.

METHOD

The double precision seconds are divided by 86, 400 and the integral part of the result in single precision replaces the MQ. The residual seconds replace the AC.

USE

Enter with the seconds in the AC and MQ in double precision floating point. Exit with the residual seconds in floating point in the AC and the integral days in floating point in the MQ.

Calling sequence:

```
CLA     L(SECONDS A)
LDQ     L(SECONDS B)
CALL    DAYS
return
```

CODING INFORMATION

Length of subroutine is 25(10) or 31(8) words.

IDENTIFICATION 12

DUMMY/EOS/CANCLK/DATCEL/RGGSAV/RGGSTR/EXPORT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To allow certain parameters to be defined at program load time, and to provide storage and definition of miscellaneous quantities.

METHOD

EOS, RGGSAV and RGGSTR are defined. CANCLK is a three-word buffer for clock angles. DUMMY is provided for name only. DATCEL contains the BCD date of loading of the program in a format as follows: YYMMDD. EXPORT is a flag which controls the sensing of the 7094 on-line printer to read the JPL printer board and clock. If EXPORT is non-zero, no sensing of the on-line printer is made by the program. This is to allow non-JPL installations to use the program even if their printer board or clock hardware is different.

USE

This subroutine is always left symbolic and is the first physical subroutine in the deck. This allows for the word DATCEL and other parameters to be updated at load time, if necessary.

CODING INFORMATION

Length of subroutine is 9(10) or 11(8) words.

IDENTIFICATION

EARTH/SPACE
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

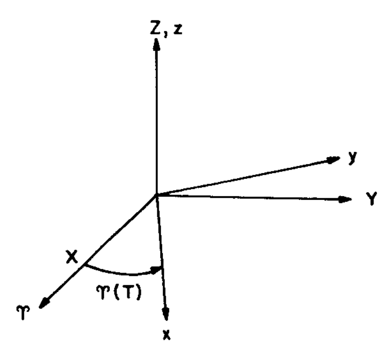
To rotate from space-fixed cartesian coordinates to Earth-fixed sphericals, and vice versa.

RESTRICTIONS

a. Subroutines COS, SIN, RVIN, RVOUT and MATRIX are called.
b. COMMON through COMMON+11 are used.
c. The COMMON locations GHA(T) and LOMEGA are assumed to contain the Greenwich hour angle in degrees and the Earth's rotation rate in radians/sec, respectively.

METHOD

At the epoch T a "space-fixed" cartesian coordinate system is defined, centered at the Earth with the X - Y plane the equator, the X axis the direction of the vernal equinox, and the Z axis the spin axis of the Earth. The "Earth-fixed" frame is obtained from the space-fixed by rotating about the Z axis by an angle ♈(T), the Greenwich hour angle of the vernal equinox, to bring the x axis in coincidence with the Greenwich meridian as shown in the following sketch:



The coordinates are then related by

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \cos \Upsilon(T) & \sin \Upsilon(T) \\ -\sin \Upsilon(T) & \cos \Upsilon(T) \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix}$$

$$z = Z,$$

and

$$\begin{pmatrix} \dot{x} \\ \dot{y} \end{pmatrix} = \begin{pmatrix} \cos\Upsilon(T) & \sin\ (T) \\ -\sin\Upsilon(T) & \cos\ (T) \end{pmatrix} \begin{pmatrix} \dot{X} \\ \dot{Y} \end{pmatrix} + \omega \begin{pmatrix} -\sin\Upsilon(T) & \cos\Upsilon(T) \\ -\cos\Upsilon(T) & -\sin\Upsilon(T) \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix}$$

$$\dot{z} = \dot{Z},$$

where ω is the rotation rate of the Earth.

The inverse transformation is

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \begin{pmatrix} \cos\Upsilon(T) & -\sin\Upsilon(T) \\ \sin\Upsilon(T) & \cos\Upsilon(T) \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$Z = z$$

and

$$\begin{pmatrix} \dot{X} \\ \dot{Y} \end{pmatrix} = \begin{pmatrix} \cos\Upsilon(T) & -\sin\Upsilon(T) \\ \sin\Upsilon(T) & \cos\Upsilon(T) \end{pmatrix} \begin{pmatrix} \dot{x} \\ \dot{y} \end{pmatrix} + \omega \begin{pmatrix} -\sin\Upsilon(T) & -\cos\Upsilon(T) \\ \cos\Upsilon(T) & -\sin\Upsilon(T) \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

$$\dot{Z} = \dot{z}$$

SPACE performs the rotation from space-fixed cartesian to Earth-fixed cartesian and then calls subroutine RVOUT to obtain the Earth-fixed spherical set.

EARTH calls subroutine RVIN to make the transformation from Earth-fixed spherical to Earth-fixed cartesian and then performs the rotation from Earth-fixed cartesian to space-fixed cartesian.

USE

Calling sequences:

a. To rotate from space-fixed cartesian coordinates to Earth-fixed sphericals:

```
CALL   SPACE
PZE    A,,B
PZE    C,,D
```

where A, A+1, A+2 contain the input space-fixed cartesian position.
B, B+1, B+2 contain the input space-fixed cartesian velocity.
C, ..., C+5 contain the output Earth-fixed spherical set r, ϕ, θ, v, γ, σ.
D, ..., D+5 contain the output Earth-fixed cartesian set x, y, z, $\dot{x}$, $\dot{y}$, $\dot{z}$.

b. To rotate from Earth-fixed sphericals to space-fixed cartesian coordinates:

```
CALL    EARTH
PZE     A
PZE     B,,C
```

where A, ···, A+5 contain the input Earth-fixed spherical set r, ϕ, θ, v, γ, σ.

B, B+1, B+2 contain the output space-fixed cartesian position coordinates X, Y, Z.

C, C+1, C+2 contain the output space-fixed cartesian velocity coordinates $\dot{X}$, $\dot{Y}$, $\dot{Z}$.

and where both entries assume that COMMON location GHA(T) and LOMEGA contain the Greenwich hour angle in degrees and the Earth's rotation rate in radians/sec, respectively.

CODING INFORMATION

Length of subroutine is 112(10) or 160(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION

ECLIP

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

To rotate Earth equatorial coordinates to ecliptic and vice versa.

RESTRICTIONS

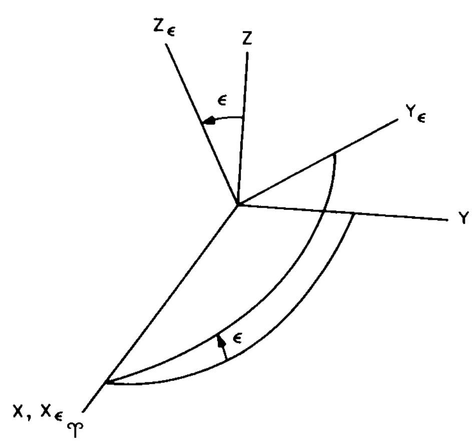
a. Subroutines SIN, COS and MATRIX are called.

b. COMMON+10 through COMMON+12 are used.

c. The cell ET in COMMON is assumed to contain the mean or true obliquity of the ecliptic.

METHOD

The ecliptic plane is characterized by its inclination to the Earth's equator, ϵ, the obliquity of the ecliptic, and its ascending node on the Earth's equator, the vernal equinox, as shown in the following sketch:



where X, Y, Z is the Earth equatorial frame and X_ϵ, Y_ϵ, Z_ϵ is the ecliptic. The coordinates are related by

$$\begin{pmatrix} X_\epsilon \\ Y_\epsilon \\ Z_\epsilon \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\epsilon & \sin\epsilon \\ 0 & -\sin\epsilon & \cos\epsilon \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

where ϵ can be the mean or true obliquity.

USE

Calling sequence:

```
CALL  ECLIP
PFX   X,,Y
return
```

where

X-3, X-2, X-1 contain the input vector.

Y-3, Y-2, Y-1 contain the output vector.

PFX = PZE assumes equatorial input and rotates to ecliptic.

PFX = MZE assumes ecliptic input and rotates to equatorial.

X = Y is permitted.

And where the COMMON location ET contains the input true of-date obliquity or the mean 1950.0 obliquity.

CODING INFORMATION

Length of subroutine is 45(10) or 55(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION 15

EFFECT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To replace each of the output flags GROPS to GROPS +11 with a 0, 2, or 4 for the suppression, ecliptic, or equatorial output option, respectively.

RESTRICTIONS

a. It is assumed that subroutine SPRAY has previously been called so that GROPS to GROPS +11 contain the group output flags.
b. PHASE, GROPS and CODE, in COMMON, are used and GROP1 is referenced indirectly.

METHOD

The value of PHASE is found to be 0, 1 or >1 according as the start-of-phase, normal, or end-of-phase print condition has been met at the print epoch. At the same time each flag will be a one digit octal integer. Each of the resulting 24 possible combinations is considered and each branch replaces the flag with 0, 2, or 4 scaled 35.

The following table summarizes the combinations and results:

Initial value of octal flag	Resulting value of octal flag
0	0 for all values of PHASE
1	4 for all values of PHASE
2	2 for all values of PHASE
3	0 for all values of PHASE
4	2 for PHASE = 0, 0 otherwise
5	4 for PHASE = 0, 0 otherwise
6	2 for PHASE > 1, 0 otherwise
7	4 for PHASE > 1, 0 otherwise

USE

Calling sequence:

CALL EFFECT
return

CODING INFORMATION

Length of subroutine is 40(10) or 50(8) words.

IDENTIFICATION

EPHEM
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

The ephemeris interpolation routine EPHEM is designed to read a JPL Ephemeris Tape and to interpolate for the position and/or velocity of any subset of the planets and Moon at any Julian date within the time interval spanned by the tape.

The ephemeris data carried on tape are in heliocentric coordinates for the planets and geocentric coordinates for the Moon. EPHEM, however, may be used to obtain coordinates referenced to any of the bodies as center. In particular, data are furnished for the Earth-Moon barycenter rather than for the Earth, and EPHEM performs the necessary calculations for obtaining geocentric coordinates of the planets and Sun.

The data on the ephemeris tape and the results of the interpolation are expressed in the coordinate system of the mean Earth equator and equinox of 1950. 0.

RESTRICTIONS

a. Subroutines READB, BSREC, REWIND are called.
b. A buffer of 1862 cells must be provided by the user for storage of the raw ephemeris from the tape. Buffers of 36, 13, and 150 cells are also required by EPHEM, as described in USE.
c. EPHEM makes extensive use of 7094 double precision instructions, hence all tables must start in even core locations.
d. The ephemeris tape must be in the format described in Appendix A of Ref. 1.

METHOD

Everett's formula

$$x(T_j) = ux_0 + tx_1 + \frac{u(u^2-1)}{3!}\Delta_m^2 x_0 + \frac{t(t^2-1)}{3!}\Delta_m^2 x_1$$

$$+ \frac{u(u^2-1)(u^2-4)}{5!}\Delta_m^4 x_1 + \frac{t(t^2-1)(t^2-4)}{5!}\Delta_m^4 x_1$$

is used for interpolation, where

T_j = the desired Julian date, $T \leq T_j < T + h$

h = step size of data

T = point in time at which data are tabulated

$t = (T_j - T)/h, 0 \leq t \leq 1$

$u = 1 - t$

$x_0 = x(T)$

$x_1 = x(T + h)$

$\Delta_m^n = n^{th}$ modified difference

It is assumed that the Julian date specified by the user as the epoch for which data are requested is in Universal Time. Since the ephemerides are tabulated in Ephemeris Time, the specified epoch is modified by

$$ET = UT + \Delta t$$

to convert to Ephemeris Time.

Planetary coordinates for centers other than the Sun are obtained by the vector subtraction

$$\overline{P} = \overline{P}_0 - \overline{C}$$

where

$\overline{P}$ = planetary coordinates referred to the desired center

$\overline{P}_0$ = planetary coordinates referred to the Sun

$\overline{C}$ = heliocentric coordinates of the desired center

A similar vector subtraction is performed for velocity vectors.

Calculation of the heliocentric coordinates of the Earth and/or Moon or the geocentric or selenocentric coordinates of the Sun and planets requires additional manipulations. Heliocentric lunar and Earth coordinates are obtained as

$$\overline{M} = \overline{B} + \mu_m \overline{L}$$

$$\overline{E} = \overline{B} - \mu_e \overline{L}$$

where

$\overline{M}$ = heliocentric coordinates of the Moon

$\overline{E}$ = heliocentric coordinates of the Earth

$\overline{B}$ = heliocentric coordinates of the Earth-Moon barycenter

$\overline{L}$ = geocentric coordinates of the Moon

$$\mu_m = \frac{\mu_E}{\mu_E + \mu_M}$$

$$\mu_e = \frac{\mu_M}{\mu_E + \mu_M}$$

μ_E = the GM of the Earth

μ_M = the GM of the Moon

Both μ_E and μ_M are obtained from TAB1, as described in the next section.

USE

The subroutine EPHEM may be used by either the FORTRAN II or the FAP programs. The calling sequence for a FORTRAN II program is

CALL EPHEM (JD, CENT, TAB1, TAB2, TAB3, TAB4, NTAPE)

and for the FAP program is

CALL EPHEM, JD, CENT, TAB1, TAB2, TAB3, TAB4, NTAPE

The arguments in the calling sequence are interpreted as follows:

JD = double-precision floating point Julian date T_j, assumed to be in Universal Time, at which data are required.

CENT = control-word floating point integer identifying the desired center of the coordinate system according to the scheme given in Table 1.

TAB1 = 36-word table of physical constants with the structure given in Table 2.

TAB2 = 13 floating point integers that control the data output for each body according to the scheme given in Table 3. The control-word sequence is given in Table 4.

TAB3 = 1862-word buffer used by EPHEM to store a record of ephemeris data as it is read from the ephemeris tape.

TAB4 = 150-word block of storage containing the output information listed in Table 5. The control-word integer in TAB4 is interpreted as shown in Table 6.

NTAPE = location of word containing a fixed-point number designating the logical tape unit on which the JPL Ephemeris Tape is mounted.

The nutations and nutation rates are always in units of radians and radians/day. The units of the planetary and lunar data are determined by the value of the output control word found in location TAB1 +34. If this single precision word is zero the output will be in kilometers and kilometers/sec; if this word is 1.0 the planetary data will be in AU and AU/day and the lunar data will be in "Earth-radii" and "Earth-radii"/day.

The output is always cartesian, referenced to the mean Earth equator and equinox of 1950.0.

CODING INFORMATION

a. When the routine is part of a new core load it will automatically rewind the ephemeris tape the first time called to allow it to retrieve the data in the identification records. This data defines the time span of data on the tape. The criterion for this rewind is comparison of the current tape unit designation with that of the previous call. Only if they are the same will a rewind not be issued. To prevent rewinds when chain type jobs are run, the entry TAPEX is provided. The six quantities starting at TAPEX may be "wanted" (see Ref. 2) from link to link in any compatible fashion to prevent rewinding. To deliberately cause a rewind, the entry EPTAPE is provided. If a zero is stored in this cell, the ephemeris tape will rewind the next time EPHEM is called.

b. Length of subroutine is 813(10) or 1455(8) words.

Table 1. Central body identification

Body	Control integer	Body	Control integer
Mercury	1.0	Neptune	8.0
Venus	2.0	Pluto	9.0
Earth	3.0	Sun	10.0
Mars	4.0	Moon	11.0
Jupiter	5.0	Earth-Moon barycenter	12.0
Saturn	6.0		
Uranus	7.0		

Table 2. TAB1 structure

Word in record	Physical constant and unit	Word format
TAB1	k = universal gravitational constant, $AU^{3/2}$/day	Double-precision floating point
TAB1+2	GM of Mercury, km^3/sec^2	↓
+4	GM of Venus, km^3/sec^2	↓
+6	GM of Earth, km^3/sec^2	↓
+8	GM of Mars, km^3/sec^2	↓
+10	GM of Jupiter, km^3/sec^2	↓
+12	GM of Saturn, km^3/sec^2	↓
+14	GM of Uranus, km^3/sec^2	↓
+16	GM of Neptune, km^3/sec^2	↓
+18	GM of Pluto, km^3/sec^2	↓
+20	GM of Sun, km^3/sec^2	↓
+22	GM of Moon, km^3/sec^2	↓
+24	Astronomical unit, km	↓
+26	Earth radius for lunar ephemeris conversion, km	↓
+28	Speed of light, km/sec	↓

Table 2 (Cont'd)

Word in record	Physical constant and unit	Word format
TAB1 +30	Solar-flux constant, lb-force/m^2	Double-precision floating point
+32	Seconds per mean solar day	Double-precision floating point
+34	Output-unit control word	Single-precision floating point
+35	Δt = ET - UT, sec	Single-precision floating point

Table 3. TAB2 output control interpretation

Control word	Meaning
0.0	No data, this body
1.0	Position data only, this body
2.0	Velocity data only, this body
3.0	Both position and velocity data, this body

Table 4. TAB2 structure

Word position	Body controlled	Word position	Body controlled
TAB2	Mercury	TAB2+7	Neptune
TAB2+1	Venus	+8	Pluto
+2	Earth	+9	Sun
+3	Mars	+10	Moon
+4	Jupiter	+11	Earth-Moon barycenter
+5	Saturn		
+6	Uranus	+12	Nutations

Table 5. TAB4 structure

Word position	Contents
TAB4	Floating point control-word integer indicating type of error, if any
TAB4+1	Zero cell for double-precision compatibility
+2	Mercury position and velocity in double-precision floating point
+14	11 more sub-blocks of position and velocity data for each of the other bodies in double-precision floating point, each sub-block consisting of 12 words, in the same order as given in TAB2
+146	Nutation in longitude and nutation in latitude in single-precision floating point
+148	Nutation rates in single-precision floating point

Table 6. TAB4 error code interpretation

Control word	Meaning
0.0	Successful return
1.0	Specified date T_j smaller than starting date of data available
2.0	T_j greater than final date of data available
3.0	Reading error (redundancy)
4.0	A TAB2 control word is negative or greater than 3
5.0	CENTER control word is in error

REFERENCES

1. Peabody, P. R., Scott, J. F., Orozco, E. G., User's Description of JPL Ephemeris Tapes, Technical Report No. 32-580, Jet Propulsion Laboratory, Pasadena, California, March 2, 1964.

2. Newhall, N. S., User's Guide for JPTRAJ (JPL Trajectory Monitor), Engineering Document No. 199, Jet Propulsion Laboratory, Pasadena, Californi.., January 4, 1964.

IDENTIFICATION

EPHSET/E. T. /INTR1
Alan D. Rosenberg, JPL
IBM 7094 Fap
December 2, 1964

PURPOSE

a. EPHSET performs initialization of the calling sequence to the subroutine EPHEM.
b. INTR1 obtains positions and velocities of the Moon, Sun, and planets at a given epoch from the double precision JPL Ephemeris Tape and arranges this information in a manner compatible with the program SPACE. Results are referenced to the mean Earth equator and equinox of 1950. 0.
c. E. T. converts a given universal time epoch to the corresponding ephemeris time epoch.

RESTRICTIONS

a. FIX, DAYS, EPHEM, GRUPPE, PROUT, ERPRT, ABORT and UNLOAD are called.
b. NEWBCD, TARAD, CENTR5, CENTE5, TAPEX and EPTAPE are external cells which are referenced.
c. Subroutine INTR1 has the following error conditions:
   1. Unknown central body reference for EPHEM: (CENTER).
   2. Unknown control word for EPHEM: (CONTRL).
   3. Redundancy reading ephemeris tape: (REDUN).
   4. Input epoch earlier than data on ephemeris tape: (EARLY).
   5. Input epoch later than data on ephemeris tape: (LATE).

The word in parenthesis above is printed in the error message: PLANETARY EPHEMERIS ERROR = (error word) on a device appropriate to the mode of SFOF operation and always on the off-line output.

Conditions 1. and 2. cause CALL ABORT in SFOF mode 4 and non-SFOF mode of operation, and TSX ENDSYS, 4 in SFOF mode 2. Conditions 3., 4., and 5. allow one re-try in mode 4 and non-SFOF mode by pressing START, then CALL ABORT in case of a second failure. In SFOF mode 2, TSX ENDSYS, 4 occurs and a comment TURN ON-----AFTER OPERATOR ACTION is printed, where the name of the program currently operating is inserted above.

d. The ephemeris tape is assumed to be mounted on SYSUT8, which corresponds to FORTRAN logical tape 12 and physical unit B6.
e. The COMMON cells T, KB0, XN, XN., CENTER, TARG, PRFLG, 37HED, SP1A, SP2A, SP3A, EJCTA, SP1B, SP2B, SP3B, EJCTB, SP1C, SP2C, EJCTC are referenced.

f. The system low-core cells (PAUSE, ENDSYS, SFMODE and JPTRAJ) are referenced.

g. The buffer NEWBOD through NEWBOD +3 and entry BODTAB are provided to allow substitution of any of the normally unused planets, i.e. Mercury, Neptune, Uranus and Pluto, in place of Saturn.

h. The buffers EGM, SCALE1, DUT and GRAV contain physical constants which may be modified by input. Entry NUTLOB has been provided so the computed nutations are accessible.

METHOD

a. INTR1 takes the double precision seconds past 0^h January 1, 1950 U. T. which it assumes to be in T and T+1, converts it to double precision Julian date and calls EPHEM; upon return, the double precision positions and velocities of the bodies are rounded off and stored in the XN and XN. buffers in COMMON. The nutation in longitude and obliquity and their rates in radians and radians/day are placed in NUTOBL through NUTOBL +3.

b. E. T. adds T, the double precision seconds past 0^h January 1, 1950 U. T. to ΔT, the difference between Universal and Ephemeris time, and returns with the results in the AC-MQ.

USE

a. CALL EPHSET
   return

b. CALL INTR1
   return

Assumption is that T and T+1 contain the double precision seconds past 0^h January 1, 1950 U. T., and CENTER contains a fixed point integer scaled 35, of value 0 through 6, corresponding to the names EARTH, MOON, SUN, VENUS, MARS, SATURN, JUPITE, respectively.

c. CALL E. T.
   return

Assumption is as above for cells T and T+1. Results are double precision seconds past 0^h January 1, 1950 E. T. in the AC-MQ.

CODING INFORMATION

Length of subroutine is 2308(10) or 4404(8) words.

REFERENCE

Cary, C.; Inter-Office Memorandum 312.3-176, Physical Constants and Other Parameters to be used in MA-C Computations-Updated Version, October 30, 1964.

IDENTIFICATION 18

FIX/FLOAT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To convert a single precision floating point number to a fixed point integer scaled 35 or vice versa.

RESTRICTIONS

Conversion will be made mod 2^{27}.

METHOD

The unnormalized add and floating point add instructions are used with masks.

USE

Enter with the number to be converted in the accumulator. Exit with the result in the accumulator.

Calling sequences:

To float a fixed point integer:		To fix a floating point number:	
CLA	L(INTEGER)	CLA	L(NUMBER)
CALL	FLOAT	CALL	FIX
return		return	

CODING INFORMATION

Length of subroutine is 9(10) or 11(8) words.

IDENTIFICATION

FIXT/FLOT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute the number of seconds that have elapsed since 0^h January 1, 1950, given a Greenwich Mean Time (GMT) between the years 1950 and 2000 or vice versa.

RESTRICTIONS

a. The locations YEAR to YEAR +6, in COMMON, are used in the FIXT option.
b. A double precision number is considered to be two floating point words.

METHOD

The double precision floating point number is decoded into the various lengths of time and vice versa, taking into account leap years and leap centuries.

USE

a. GMT to seconds: on entrance the AC must contain YYMM0DDHH and the MQ must contain NNSSFFF, where

    YY = last two digits of the year
    MM = month of the year, January being 1
    0 = zero
    DD = days
    HH = hours
    NN = minutes
    SS = seconds
    FFF = milliseconds

   Exit with the double precision floating point seconds past 0^h, January 1, 1950, in the AC and MQ. If YY = MM = 0, then (AC - MQ) is converted to an interval in double precision seconds.

   Calling sequence:

```
CLA     L(YYMM0DDHH)
LDQ     L(NNSSFFF)
CALL    FLOT
return
```

b. Seconds to GMT: on entrance the AC and MQ must contain the double precision floating point seconds past 0^h, January 1, 1950. Exit with the GMT in location YEAR to YEAR +6, where

YEAR = YY = last two digits of year
+1 = MM = month, January being 1
+2 = DD = days
+3 = HH = hours
+4 = NN = minutes
+5 = SS = seconds
+6 = FFF = milliseconds

YEAR through YEAR +5 are fixed point integers scaled 35. YEAR +6 is fixed point scaled 0.

Calling sequence:

```
CLA     L(SECONDS A)
LDQ     L(SECONDS B)
CALL    FIXT
return
```

CODING INFORMATION

Length of subroutine is 175(10) or 257(8) words.

IDENTIFICATION

GEDLAT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute ϕ', the geodetic latitude of the probe, and ρ', the distance from the geocenter to the point on the surface of the Earth lying on the Earth-probe line.

RESTRICTIONS

a. Subroutines SIN and SQRT are called.
b. COMMOM through COMMON+9 are used.

METHOD

a. ϕ' is given by:

$$\phi' = \phi + b_1 \sin 2\phi + b_2 \sin 4\phi + b_3 \sin 6\phi$$

where ϕ is the input geocentric latitude of the probe,

$$b_1 = 0.19456624 \text{ deg}$$

$$b_2 = 0.00033036 \text{ deg}$$

$$b_3 = 0.00000075 \text{ deg.}$$

b. ρ' is given by:

$$\rho' = a\sqrt{1 - \epsilon^2 \sin^2 \phi}$$

where ϕ is the input geocentric latitude of the probe,

ϵ^2 = 0.006768657997, eccentricity squared,

a = 6378.2064, equatorial radius, kilometers.

USE

Calling sequence:

CALL GEDLAT

Enter with the geocentric latitude of the probe, ϕ, in the accumulator in degrees.
Exit with the geodetic latitude of the probe, ϕ', in the AC in degrees and the radius, ρ', in the MQ in kilometers.

CODING INFORMATION

Length of subroutine is 46(10) or 56(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report 32-223, Revision 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION 21

GETTER
JPL Staff
IBM 7094 Fap

PURPOSE

To compute, in floating point, the angle, in degrees, between two vectors, where each vector is the difference of two other vectors.

RESTRICTIONS

a. All vectors must be stored BES 3.
b. Subroutines ARCOS and PROD are called.
c. The formula used to compute the angle does not hold, in general, for unit vectors since

$$\frac{\overline{A} - \overline{B}}{|\overline{A} - \overline{B}|} \neq \frac{\hat{A} - \hat{B}}{|\hat{A} - \hat{B}|}$$

for all $\overline{A}$, $\overline{B}$ where $\hat{}$ signifies a unit vector.

METHOD

The desired angle is computed using the following formula:

$$\text{ANGLE} = \text{ARCOS}\left[\frac{(\overline{A} - \overline{B})\cdot(\overline{C} - \overline{B})}{|\overline{A} - \overline{B}||\overline{C} - \overline{B}|}\right]$$

Note: For $\overline{B} = \overline{0}$, either $\overline{A}$ or $\overline{C}$ may be unit vectors and give a correct result.

USE

Calling sequence:

```
CALL   GETTER
PZE    A,,C
PZE    B,,D
return
```

The angle between the vectors $\overline{A} - \overline{B}$ and $\overline{C} - \overline{B}$ is computed in degrees and stored in D.

CODING INFORMATION

Length of subroutine is 37(10) or 45(8) words.

IDENTIFICATION

GHA

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

To compute the Earth's rotation rate and the Greenwich hour angle of the vernal equinox.

RESTRICTIONS

a. COMMON locations T, T+1, NUTRA, LOMEGA, OMEGA and GHA(T) contain input and output quantities.
b. COMMON through COMMON+6 are used.
c. Subroutines DAYS, FIX and FLOAT are called.

METHOD

The mean value of the Greenwich hour angle is computed as follows:

$$\Upsilon_m(T) = 100°07554260 + 0°9856473460\ d + (2°9015)\ 10^{-13} d^2 + \omega t \ (\text{mod } 360 \text{ deg})$$

$$0 \leq \Upsilon_m(T) < 360 \text{ deg}$$

where

T is the epoch under consideration in U. T.

d is integer days past 0 hr January 1, 1950

t is seconds past 0 hr of epoch T

ω is the Earth's rotation rate and is given by:

$$\omega = \frac{0.00417807417}{1 + (5.21)\ 10^{-13} d} \text{ deg/sec.}$$

Given the nutation in right ascension, $\delta\alpha$, the true value of the hour angle is:

$$\Upsilon(T) = \Upsilon_m(T) + \delta\alpha$$

USE

Calling sequence:

CALL GHA

return

where

T, T+1	contain the input double precision seconds past 0 hr January 1, 1950 U. T.
NUTRA	contains $\delta\alpha$, the input nutation in right ascension in degrees.
OMEGA	contains the output Earth's rotation rate in deg/sec.

LOMEGA contains the output Earth's rotation rate in rad/sec.

GHA(T) contains the output true Greenwich hour angle in degrees.

CODING INFORMATION

Length of subroutine is 68(10) or 104(8) words.

IDENTIFICATION 23

GRUPPE
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To maintain a count of the number of lines of output made on a page and to use this count to control page ejects.

RESTRICTIONS

Subroutine SEITE is called to give the page eject and page heading.

METHOD

If the print suppress flag indicates no printing, the subroutine exits. N, the number of lines of output that are going to be printed in the following group, is added to the current line count C. If $N + C > 63$ subroutine SEITE is called to get a page eject and page heading. If $N + C \leq 63$, $N + C$ becomes the new line count C.

USE

Calling sequence:

```
CALL    GRUPPE
PZE     N
```

where N is the number of lines of output that will be requested before the next CALL GRUPPE.

CODING INFORMATION

Length of subroutine is 14(10) or 16(8) words.

IDENTIFICATION 24.1

INTRAN
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To print the initial conditions found in the identification record of the spacecraft ephemeris tape as the heading information for the trajectory to be processed.

RESTRICTIONS

a. Subroutines DAYS, E. T., ROTEQ, MNA, GHA, GRUPPE, TIME2 and PROUT are used.
b. Entries PHL, RMAX, INJBCD, INJTYP, INJX, INJY, INJZ, INJDX, INJDY, INJDZ, INJEQX, HARMN2, GASOPT and CENTR5 are provided for storage of data from the spacecraft ephemeris identification record.
c. GRAV, LUNGRV, SCALE1, RADOPT, BRNOPT, RUNID and EPHSET are referenced indirectly to locate quantities for printing.

METHOD

INTRAN prints the physical constants, injection conditions and other quantities which determine the trajectory integrated by SPACE. This information comes to SFPRO in the identification record of the spacecraft ephemeris.

USE

Calling sequence:

```
CALL    INTRAN
return
```

CODING INFORMATION

Length of subroutine (includes INTRAN as a subset) is 728(10) or 1330(8) words.

IDENTIFICATION 24.2

NUTATE
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To update the precession A and nutation N matrices and apply the product matrix NA to the Earth-probe vector.

RESTRICTIONS

a. NUTATE is a subset of a rotation package and uses other parameters in the package.
b. MNAET is tested to determine if the .1 day delta-time option is to be used in computing the N matrix. A zero MNAET forces recomputation of N.
c. Locations XEP, CC, (NA), AA and TARG (epoch in days past 0 hr January 1 1950), in COMMON, are referenced.
d. Subroutines ROTEQ, MNA and MATRIX are called.
e. COMMON through COMMON+2 are used.
f. NUTMAT, the location of the nutation matrix, is referenced indirectly.

METHOD

Subroutine ROTEQ is called to update the A matrix. The N matrix is updated if MNAET = 0 or if MNAET is non-zero and time has increased by .1 day since the last computation. N is updated by calling subroutine MNA. Then subroutine MATRIX is called to form the product NA. The CC+3 vector is then multiplied by NA to give the Earth-probe position vector in the space fixed Earth true equator and equinox of date coordinate system (XEP).

USE

Calling sequence:

```
CALL   NUTATE
return
```

CODING INFORMATION

Length of subroutine (includes NUTATE as a subset) is 728(10) or 1330(8) words.

IDENTIFICATION 24.3

RESET
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To set the obliquity of the ecliptic to the 1950.0 value and to set the NA matrix to unity.

RESTRICTIONS

a. RESET is a subset of a rotation package and uses other parameters in the package.
b. COMMON locations ET and (NA) are used.

METHOD

The mean obliquity of 1950.0 is put into ET and the (NA) matrix is set to unity so any use of these quantities will cause the results to be in the mean 1950.0 coordinate system.

USE

Calling sequence:

```
CALL    RESET
return
```

CODING INFORMATION

Length of subroutine (includes RESET as a subset) is 728(10) or 1330(8) words.

IDENTIFICATION 24.4

ROT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To update the planetary ephemerides, the Greenwich hour angle and the (n-body)-probe vector and to rotate several sets of vectors to the output coordinate system.

RESTRICTIONS

a. ROT is a subset of a rotation package and uses other subroutines in the package.
b. Subroutines INTR1, GHA, UNIT, MATRIX, RESET and NUTATE are called.
c. Location EQUNX1 is referenced indirectly.
d. CX, CX., QX, QX., XN, XN., CS2, (NA), XEP, XEP., X, X., S2, CANOP, XN1, XN.1, X0P, X0P. and VAFLG, in COMMON, are used.

METHOD

a. The planetary ephemerides are updated by calling subroutine INTR1.
b. Subroutine NUTATE is called (which calls MNA to update the nutation in rt. ascension and the M and N matrices) and then GHA is called to compute the current value of the true Greenwich hour angle.
c. The true of-date Earth-probe position and velocity vector are computed and stored in XEP and XEP. .
d. RESET is called if the output equinox is 1950.0.
e. The X, X., S1, S2, CANOP, and the variational coefficients are rotated to the desired output reference system, determined by the contents of location EQUNX1.
f. The Earth-(n-body) position and velocity vectors are formed.
g. The N and A matrices are recomputed, if RESET was called earlier.

USE

Calling sequence:

```
CALL    ROT
return
```

CODING INFORMATION

Length of subroutine (includes ROT as a subset) is 728(10) or 1330(8) words.

IDENTIFICATION

LN/LOG10
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute $\log_{10} x$ or $\log_e x$ for a floating point, single precision x.

RESTRICTIONS

a. An error will occur if $x \leq 0$.
b. Uses COMMON to COMMON +3.

METHOD

Represent x as $2^k F$ where $1/2 \leq F < 1$.

Therefore, $\log_e x = \log_e (2^k F) = k \log_e 2 + \log_e F$.

The following continued fraction is used to compute $\log_e F$:

$$\log_e F = \log_e 0.725 + \cfrac{r}{0.725 + \cfrac{r}{2 + \cfrac{r}{2.175 + \cfrac{r}{1 + \cfrac{r}{3.625 + \cfrac{r}{\frac{2}{3} + \cfrac{r}{5.075 + \cfrac{r}{0.5}}}}}}}}$$

where $r = (F - 0.725)$.

$\text{Log}_{10}\, x$ is computed by obtaining $\log_e x$, using the above approximation, and then using the relation:

$$\log_{10} x = (\log_e x)(\log_{10} e)$$

Accuracy: This method gives 26 significant binary digits except near $x = 1$, where the result is accurate to 26 binary places.

USE

Enter with a floating point argument in the accumulator, exit with the floating point logarithm in the accumulator.

Calling sequences:

For $\log_e x$:	CLA	X	For $\log_{10} x$:	CLA	X
	CALL	LN		CALL	LOG10
	error return			error return	
	normal return			normal return	

CODING INFORMATION

Length of subroutine is 59(10) or 73(8) words.

IDENTIFICATION

LOOP
Alan D. Rosenberg, JPL
IBM 7094 Fap
December 2, 1964

PURPOSE

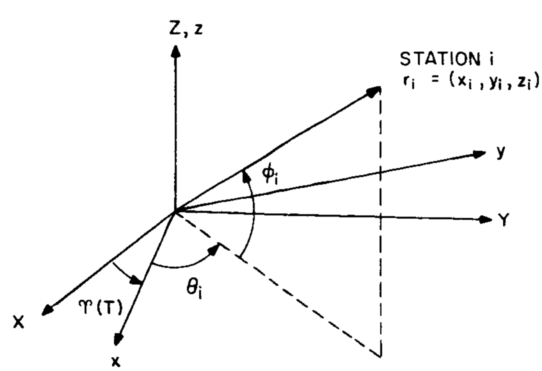
To make calculations for view periods and station prints for designated stations, and to print the results of these calculations.

RESTRICTIONS

a. Subroutines called are PRSET, MATRIX, UNIT, PROD, CROSS, SIN, COS, ARSIN, ARCOS, CLUCK, GETTER, LOG10, GRUPPE, PROUT.
b. Cells referred to indirectly are GRAV and PLOTFQ.
c. The COMMON region is used including cells from COM through COM+199, and X0P, CX.., SP1B, SP1C, SP2B, SP2C, SP3B, SP3C, T(0), OMEGA, PRFLG, CENTER, GHA(T), and LOMEGA.

METHOD

Let the space-fixed geocentric cartesian coordinates of the probe referenced to the true equator and equinox of date be given as (X, Y, Z), and the corresponding velocity vector as $(\dot{X}, \dot{Y}, \dot{Z})$. For a station with coordinates (r_i, ϕ_i, θ_i) the program computes the topocentric quantities to be described herein. Sketch 1 illustrates the basic coordinate systems.



Sketch 1. Earth - fixed station coordinates

$\Upsilon(T)$ is the right ascension of the Greenwich meridian at epoch T. r_i is the distance from the geocenter to the station, ϕ_i is the geocentric north latitude, and θ_i is the east longitude.

The subroutine LOOP, in its arithmetic calculations, first sets up the matrix shown below:

$$\begin{bmatrix} \cos \Upsilon(T) & \sin \Upsilon(T) & 0 \\ -\sin \Upsilon(T) & \cos \Upsilon(T) & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

This matrix is stored in locations SIMLAR +40, through SIMLAR +48, where $\Upsilon(T)$ is the right ascension of the Greenwich meridian at epoch T. The Earth-fixed cartesian coordinates of the probe (x, y, z) are found below:

$$\begin{Bmatrix} x \\ y \\ z \end{Bmatrix} = \begin{bmatrix} \cos \Upsilon(T) & \sin \Upsilon(T) & 0 \\ -\sin \Upsilon(T) & \cos \Upsilon(T) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} X \\ Y \\ Z \end{Bmatrix}$$

(X, Y, Z) are the geocentric true-of-date space fixed cartesian coordinates of the probe and are located in locations CAPX, CAPY, CAPZ, respectively.

The corresponding Earth-fixed velocity components $(\dot{x}, \dot{y}, \dot{z})$ are computed by the following operations:

$$\begin{Bmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \end{Bmatrix} = \begin{bmatrix} \cos \Upsilon(T) & \sin \Upsilon(T) & 0 \\ -\sin \Upsilon(T) & \cos \Upsilon(T) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} \omega Y + \dot{X} \\ -\omega X + \dot{Y} \\ \dot{Z} \end{Bmatrix}$$

where ω is the rotation rate of the Earth.

The coordinates are stored in X) through X)+2. The velocities are stored in X). through X). +2

The Earth-fixed cartesian coordinates of the station are:

$$x_i = r_i \cos \phi_i \cos \theta_i$$

$$y_i = r_i \cos \phi_i \sin \theta_i$$

$$z_i = r_i \sin \phi_i$$

The storage is arranged as follows:

SIMLAR+3 ϕ_i
SIMLAR+4 θ_i
SIMLAR+5 r_i
SIMLAR+11 $\sin\phi_i$
SIMLAR+12 $\cos\phi_i$
SIMLAR+13 $\sin\theta_i$
SIMLAR+14 $\cos\theta_i$

where the sines and cosines of ϕ_i and θ_i are computed in LOOP.

The values of (x_i, y_i, z_i) are placed in SIMLAR+18 $\rightarrow x_i$
+19 $\rightarrow y_i$
+20 $\rightarrow z_i$

The topocentric coordinates of the probe are (x_{ip}, y_{ip}, z_{ip}) where

$$x_{ip} = x - x_i \rightarrow \text{SIMLAR+15}$$

$$y_{ip} = y - y_i \rightarrow \text{SIMLAR+16}$$

$$z_{ip} = z - z_i \rightarrow \text{SIMLAR+17}$$

The magnitude of the slant range vector $\vec{r}_{ip}$ is found by

$$\rho = \sqrt{\left[x_{ip}^2 + y_{ip}^2 + z_{ip}^2\right]}$$

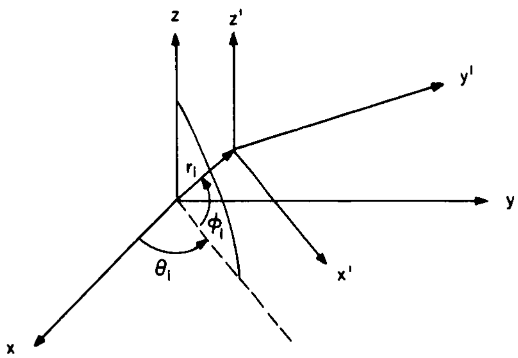
and is stored in RAD.

The slant range rate is stored in RDT and computed by the following equation:

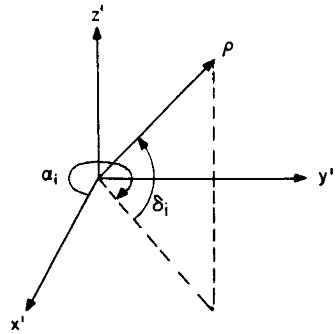
$$\dot{\rho} = \frac{x_{ip}\dot{x} + y_{ip}\dot{y} + z_{ip}\dot{z}}{\rho}$$

The topocentric hour angle-declination system is described in Sketches 2 and 3. In this system the x - y plane has been translated to the station and rotated through the angle θ_i so that x' lies along the meridian, the z' axis remaining parallel to the z axis.

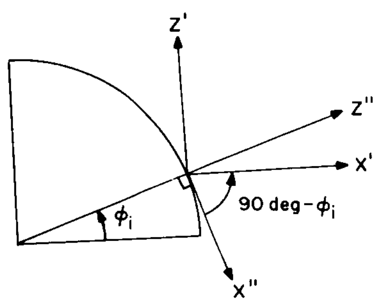
The azimuth-elevation topocentric coordinate system is constructed by rotating the x' and z' axis about the y' axis, causing the resultant x" - y" plane to be perpendicular to r_i, with the z" axis pointing to the zenith. This system is illustrated in Sketches 4 and 5 following.



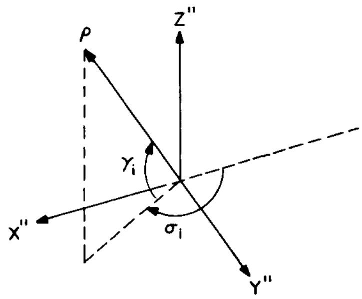
Sketch 2. Rotation to station meridian



Sketch 3. Local hour angle declination coordinate system



Sketch 4. Rotation to station latitude



Sketch 5. Azimuth-elevation coordinate system

The elevation angle and its sine and cosine are found as below:

$$\sin \gamma_i = \frac{\vec{r}_i \cdot \vec{r}_{ip}}{|r_i| \rho}$$

This expands to

$$\sin \gamma_i = \frac{x_i x_{ip} + y_i y_{ip} + z_i z_{ip}}{|r_i| \rho}$$

The angle γ_i and its cosine are then found. These quantities are stored as follows:

γ_i	ELEV
$\sin \gamma_i$	SIMLAR+23
$\cos \gamma_i$	SIMLAR+24

The elevation rate, $\dot{\gamma}_i$ is stored in location ELEVD and is computed as shown below:

$$\dot{\gamma}_i = \frac{(x_i\dot{x} + y_i\dot{y} + z_i\dot{z}) - r_i \sin\gamma_i}{r_i \rho \cos\gamma_i}$$

The local hour angle α_i is computed as follows and stored in HA:

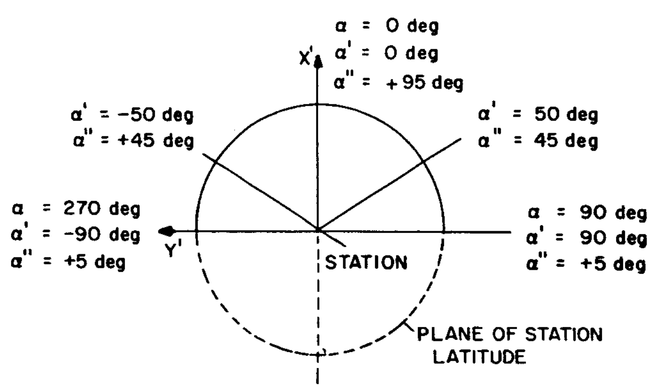
$$\alpha_i = \theta_i - \arctan\frac{y_{ip}}{x_{ip}} \text{ when } \arctan\frac{y_{ip}}{x_{ip}} \geq 0$$

$$\alpha_i = \theta_i - \arctan\frac{y_{ip}}{x_{ip}} + 360 \text{ deg when } \arctan\frac{y_{ip}}{x_{ip}} < 0$$

The local hour angle rate $\dot{\alpha}_i$ is found as shown below and stored in location HART:

$$\dot{\alpha}_i = \frac{-x_{ip}\dot{y} + y_{ip}\dot{x}}{x_{ip}^2 + y_{ip}^2}$$

In order to determine whether the probe is in view of a given station, the hour angle α is used to form a function which will be evaluated to determine visibility.



Sketch 6. Determination of viewability of probe from an hour angle-declination station

The functions α' and α'' illustrated in Sketch 6 have these properties:

$$0 \text{ deg} \leq \alpha < 360 \text{ deg}$$

$$+180 \leq \alpha' \leq -180 \text{ deg}$$

$$-85 \text{ deg} < \alpha'' \leq +95 \text{ deg}$$

When the station is an azimuth-elevation type, the above relationships are not used and the probe is assumed to be in view of a given station if the probe's elevation angle γ_i is greater than 5 deg above the local horizon. For hour angle-declination stations if the absolute value of the function α' is less than 50 deg, the elevation is assumed to be such that the probe will still be in view at the next iteration. If the value $|\alpha'|$ is greater than 50 deg the function α'' is computed. As indicated on the above diagram, if 50 deg $\leq |\alpha'| \leq$ 90 deg, then correspondingly, 45 deg $\geq \alpha'' \geq$ 5 deg. If the relation min $[\alpha'', \gamma_i \geq 5 \text{ deg}]$ is satisfied, the station is able to view the probe.

The value of either γ_i or α', depending on the above conditions, and the value of $\dot{\gamma}_i$, and a code word are stored in a block of three locations, the location of the block being determined by the station from which the probe is being viewed.

If a view period event or a station print is to occur, further calculations must be made. The declination of the probe, δ_i, is given as:

$$\delta_i = \arcsin \frac{z_{ip}}{\rho}$$

where

$$-90 \text{ deg} \leq \delta_i \leq 90 \text{ deg}$$

This is measured positive North.

δ_i is stored in location DCL,
sin δ_i in SIMLAR+21 and
cos δ_i in SIMLAR+22

The angular rate of declination, $\dot{\delta}_i$, is

$$\dot{\delta}_i = \frac{\dot{z} - \dot{\rho} \sin \delta_i}{\rho \cos \delta_i}$$

and is stored in DCD.

The quantities σ_i, $\dot{\sigma}_i$ are computed in the following manner:

$$\cos \sigma_i = \frac{z_{ip} \cos \phi_i - x_{ip} \sin \phi_i \cos \theta_i - y_{ip} \sin \phi_i \sin \theta_i}{\rho \cos \gamma_i}$$

and is stored in SIMLAR+25. The expression in the numerator above is equivalent to $-x''_{ip}$. σ_i is then computed from the value of cos σ_i and stored in SIG.

If the quantity $y''_{ip} = y_{ip} \cos \theta_i - x_{ip} \sin \theta_i$ is negative, the value of σ_i is between 180 and 360 deg and is formed by taking 360 deg - arcos $(\cos \sigma_i)$. The value of sin $\dot{\sigma}_i$ is calculated by the following:

$$\dot{\sigma}_i = \frac{x''_{ip} + \cos\sigma_i(\rho\cos\gamma_i - \rho\dot{\gamma}_i \sin r_i)}{\rho\cos\gamma_i \sin\sigma_i}$$ 26-7 of 12

and is stored in SIGD.

The vector $\vec{R}_{ip}$ is determined by rotating the components of the topocentric coordinate system $\vec{r}_{ip}(x_{ip}, y_{ip}, z_{ip})$ through the angle $\Upsilon(T)$ such that the resulting coordinate system is parallel to the true of date coordinate system which is input to LOOP (X, Y, Z).

$$\bar{R}_{ip} = \begin{Bmatrix} X_{ip} \\ Y_{ip} \\ Z_{ip} \end{Bmatrix} = \begin{bmatrix} \cos\Upsilon(T) & -\sin\Upsilon(T) & 0 \\ \sin\Upsilon(T) & \cos\Upsilon(T) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} x_{ip} \\ y_{ip} \\ z_{ip} \end{Bmatrix}$$

The station-probe-Sun angle SPS is found by:

$$SPS = \arccos \frac{\vec{C} \cdot \vec{R}_{ip}}{|\bar{R}_{ip}|}$$

and is stored in cell SPS.

A four quadrant polarization angle is computed from the following formula and stored in a cell named POL:

$$POL = \frac{(\vec{C} \times \vec{R}_{ip})^1 \cdot \left[\vec{R}_{ip} \times (\vec{R}_{ip} \times \vec{R})\right]^1}{(\vec{C} \times \vec{R}_{ip})^1 \cdot (\vec{R}_{ip} \times \vec{R})^1}$$

The notations $(\vec{R})^1$ or $\vec{R}^1$ indicate that unitization of the vector $\bar{R}$ has taken place.

Herein follow the calculations of the Canopus, Moon, and target clock angles, which are accomplished using the following formula:

$$\text{N-clock angle} = \arctan \frac{-\left[\left(\vec{N} \times \vec{R}^1_{sp}\right) \times \vec{R}^1_{sp}\right]^1 \cdot \left(\vec{R}^1_{sp} \times \vec{R}^1_{ip}\right)^1}{\left[\left(\vec{N} \times \vec{R}^1_{sp}\right) \times \vec{R}^1_{sp}\right]^1 \cdot \left[\left(\vec{R}^1_{sp} \times \vec{R}^1_{ip}\right) \times \vec{R}^1_{sp}\right]^1}$$

The vector $\vec{N}$ denotes the vector from the station to the body to which the clock angle is referenced,

i. e. $\vec{N} = \vec{R}_{ec}$ for the Canopus clock angle CKC

$\vec{N} = \vec{R}_{em}$ for the Moon clock angle CKM

$\vec{N} = \vec{R}_{et}$ for the target clock angle CKT. 26-8 of 12

$\overline{R}_{sp}$ in this formula denotes the true-of-date sun-probe position vector.

The probe-station-Sun angle (PSS) and the probe-station-Moon angle (PSM) are the angles between the probe-station vector and the Sun-station or Moon-station vectors, respectively. They are computed by:

$$PSS = \left[(\vec{R}_{sp} - \vec{R}_{ip})^1 \cdot (-\vec{R}_{ip})^1\right]$$

$$PSM = \left[(\vec{R}_{mp} - \vec{R}_{ip})^1 \cdot (-\vec{R}_{ip})^1\right]$$

where $\vec{R}_{mp}$ is the true-of-date Moon-probe position vector.

The light time correction (DELT) is the time in seconds which is required for light to travel the station-probe distance and is given by

$$DELT = \frac{\rho}{c}$$

where c is the finite speed of light.

The probe right ascension (PRA) is found by PRA = arctan (Y_{ip}/X_{ip}) where X_{ip} and Y_{ip} are components of $\vec{R}_{ip}$.

The method of calculation of various quantities associated with frequencies of spacecraft and tracking station transmitting and receiving equipment is indicated in the equations which follow.

The frequency calculations for L-band stations are as follows:

$$XA = \frac{f_a}{A_{4i}}(1 + \rho/c), \text{ cps}$$

$$F1 = A_{6i}\left[A_{1i} + A_{2i}f_i - A_{7i} - A_{3i}f_t(1 - \dot{\rho}/c)\right], \text{ cps}$$

$$F2 = A_{6i}\left[A_{4i}f_{ri}(2\dot{\rho}/c) + A_{5i}\right], \text{ cps}$$

$$D1 = F1/30, \text{ cps}$$

$$D2 = F2/30, \text{ cps}$$

$$DF1 = A_{6i}A_{3i}f_t(\ddot{\rho}/c), \text{ cps}^2$$

$$DF2 = A_{6i}A_{4i}f_r(2\ddot{\rho}/c), \text{ cps}^2$$

The calculations for L-S band stations are:

$$XA = f_{rq}(1 + \dot{\rho}/c), \text{ cps}$$

$$D1 = \left[LSK1 + \frac{30}{96} \times 10^6 - \frac{LSFT}{96}(1 - \dot{\rho}/c)\right], \text{ cps}$$

$$D2 = \left[LSK1 + \frac{30}{96} \times 10^6 - \frac{240}{221} f_{rq}(1 - 2\dot{\rho}/c)\right], \text{ cps}$$

$$F1 = 30\ D1, \text{ cps}$$

$$F2 = 30\ D2, \text{ cps}$$

$$DF1 = 30\left[\frac{LSFT}{96}(\ddot{\rho}/c)\right], \text{ cps}^2$$

$$DF2 = 30\left[\frac{240}{221} f_{rq}(2\ddot{\rho}/c)\right], \text{ cps}^2$$

For S-band equipped stations, the equations are:

$$XA = \text{same as for L-S band}$$

$$D1 = \left[\frac{240}{221} \times 96 \times SK1 - SFT(1 - \dot{\rho}/c) + 1 \times 10^6\right], \text{ cps}$$

$$D2 = \left[\left(\frac{240}{221} \times 96 \times f_{rq}\right)(2\dot{\rho}/c) + 1 \times 10^6\right], \text{ cps}$$

$$F1 = 30D1, \text{ cps}$$

$$F2 = 30D2, \text{ cps}$$

$$DF1 = 30 \times SFT(\ddot{\rho}/c), \text{ cps}^2$$

$$DF2 = 30 \times 96 \times \frac{240}{221} \times f_{rq}(2\ddot{\rho}/c), \text{ cps}^2$$

The parameter which determines a station's type is the fifth cell of the station coordinate information for a given station. If this is zero the L-band equations will be used. If it is a fixed point 1 scaled 35, the L-S equations are used, and if it is a fixed point 2 scaled 35, the S-band equations are used. All stations have zero (L-band) as the canned value. This may be modified by input.

The quantity $\ddot{\rho}$, slant range acceleration of the probe with respect to the station will be computed only if the Earth was the central body for integration. Otherwise $\ddot{\rho}$ will appear as zero and the equations which contain $\ddot{\rho}$ will not be used. $\ddot{\rho}$ is obtained as follows:

First compute $\ddot{\bar{r}}$, the Earth-fixed probe acceleration vector

$$\ddot{\bar{r}} = \begin{Bmatrix} \ddot{x} \\ \ddot{y} \\ \ddot{z} \end{Bmatrix} = \begin{bmatrix} \cos \Upsilon(T) & \sin \Upsilon(T) & 0 \\ -\sin \Upsilon(T) & \cos \Upsilon(T) & 0 \\ 0 & 0 & 1 \end{bmatrix} \left(\begin{Bmatrix} \ddot{X} \\ \ddot{Y} \\ \ddot{Z} \end{Bmatrix} + 2\omega \begin{Bmatrix} \dot{Y} \\ -\dot{X} \\ 0 \end{Bmatrix} - \omega^2 \begin{Bmatrix} X \\ Y \\ 0 \end{Bmatrix} \right)$$

Now

$$\rho\dot{\rho} = \bar{r}_{ip} \cdot \dot{\bar{r}}_{ip} = \bar{r}_{ip} \cdot \dot{\bar{r}}$$

differentiating and noting that $\dot{\bar{r}} = \dot{\bar{r}}_{ip}$ yields

$$\rho\ddot{\rho} + \dot{\rho}^2 = \bar{r}_{ip} \cdot \ddot{\bar{r}} + \dot{\bar{r}} \cdot \dot{\bar{r}}$$

then

$$\ddot{\rho} = \frac{\bar{r}_{ip} \cdot \ddot{\bar{r}} + \dot{\bar{r}}^2 - \dot{\rho}^2}{\rho}$$

$\ddot{\rho}$ is then stored in RDDT.

The remaining frequency equations are

$$BF1 = B_5 B_6 (1 + \dot{\rho}/c) - 960 \times 10^6, \text{ cps}$$

$$DOPRAT = (2\ddot{\rho}/c) \times 960 \times 10^6, \text{ cps}^2$$

$$SLOSS = K_1 + K_2 \log_{10}(K_3 \rho)$$

USE

Calling sequence

```
CALL    LOOP
PZE     X,,Y
OP      B,,C
```

where X is the location of the Earth-centered space fixed of date equatorial cartesian position vector of the probe. Y is the corresponding coordinate of the velocity vector.

B contains binary code word which is used to determine which stations are to be considered. Each bit corresponds to a station in the station tables contained in LOOP. Each bit from right to left corresponds to the table entries from beginning to end of the tables.

C contains the unit probe-Sun vector in the same coordinate system as X (defined above). X, Y, and C are BSS 3.

OP is PZE for station prints, MZE for view periods, where appropriate buffering is performed.

The station coordinates and BCD identification are built into the subroutine with the values listed below:

59 JOBURG - MTS AZEL
-25.73521, 27.70403, 6375.6952, 0, 0

11 GOLDSTONE HADEC
35.208070, 243.15802, 6372.0341, 1, 0

12 GOLDSTONE ECHO HADEC
35.117400, 243.19428, 6371.8770, 1, 0

41 WOOMERA HADEC
-31.211865, 136.88727, 6372.6040, 1, 0

51 JOBURG - 85 HADEC
-25.739277, 27.685181, 6375.4980, 1, 0

14 GOLDSTONE - 210 AZEL
35.243770, 243.12129, 6372.1341, 0, 0

13 GOLDSTONE - 85 AZEL
35.066620, 243.20507, 6372.2599, 0, 0

15 GOLDSTONE - 30 AZEL
35.06615, 243.20853, 6372.2478, 0, 0

42 CANBERRA HADEC
-35.21963, 148.98028, 6371.6686, 1, 0

61 MADRID HADEC
40.238000, 355.75050, 6370.0868, 1, 0

08 CARNARVON AZEL
-24.75336, 113.71605, 6374.05, 0, 0

91 ANTIGUA AZEL
17.0355, 298.2072, 6376.3091, 0, 0

75 ASCENSION AZEL
-7.8991, 345.58760, 6377.8013, 0, 0

76 PRETORIA AZEL
-25.79040, 28.3580, 6375.6810, 0, 0

02 BERMUDA AZEL
32.1709, 295.3465, 6372.050, 0, 0

These are the values given in reference 2 with typographical errors corrected.

CODING INFORMATION

Length of subroutine in 1590 (10) or 3066 (8) words.

REFERENCES

1. Holdridge, D. B., TR 32-223, Revision 1, Space Trajectories Program for the IBM 7090 Computer, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.
2. Scott, J. F., Interoffice Memorandum 372.21/318, Station Coordinates, September 1, 1964.

IDENTIFICATION

MARSMM/MARSPC/MARFIX/MHA/PMAT/PPMAT

Alan D. Rosenberg, JPL

IBM 7094 Fap

December 2, 1964

PURPOSE

a. To compute the Mars hour angle and the matrices PMAT and PPMAT which rotate from a space-fixed mean Earth equator and equinox of 1950.0 coordinate system to a space-fixed Mars equatorial coordinate system, and from the latter system to a Mars-fixed Mars equatorial coordinate system, respectively.

b. To apply the PMAT matrix to an input vector.

c. To apply the PPMAT matrix to input position and velocity vectors.

RESTRICTIONS

a. Subroutines SIN, COS, CROSS, UNIT, FIX, FLOAT and MATRIX are called.

b. COMMON locations XN, XN., T and T+1 are assumed to contain the planetary positions and velocities and double precision seconds past 0 hr January 1, 1950, respectively.

c. MARSMM must be called before MARSPC or MARFIX may be called.

d. COMMON+4, COMMON+5 and cells 77764_8 through 77777_8 are used.

e. Entries MHA, PMAT and PPMAT are provided so the computed Mars hour angle and two rotation matrices are accessible.

METHOD

a. The orientation of the Mars spin axis is defined relative to the mean Earth equator and equinox of 1950.0 by the angles:

$$\alpha_0 = 317.7934 \text{ deg}$$

$$\delta_0 = 54.6575 \text{ deg}$$

which correspond to the direction cosines:

$$\hat{P} = \cos\delta_0 \cos\alpha_0, \cos\delta_0 \sin\alpha_0, \sin\delta_0$$

A unit vector normal to the Mars-orbital plane is computed by:

$$\hat{N} = \frac{\overline{R}_{\odot♂} \times \overline{V}_{\odot♂}}{\left| \overline{R}_{\odot♂} \times \overline{V}_{\odot♂} \right|}$$

where $\overline{R}_{\odot♂}$ and $\overline{V}_{\odot♂}$ are the Sun-Mars position and velocity vectors referenced to the Earth equator and equinox of 1950.0 coordinate system. Next, define

$$\hat{I} = \frac{\hat{P} \times \hat{N}}{|\hat{P} \times \hat{N}|}$$

$$\hat{K} = \hat{P}$$

$$\hat{J} = \hat{K} \times \hat{I}$$

where $\hat{I}$, $\hat{J}$, $\hat{K}$ are the unit vectors defining the X, Y, Z axes, respectively, of the space-fixed Mars equator and equinox of 1950.0 coordinate system. Hence the matrix to rotate from the space-fixed Earth mean equator and equinox of 1950.0 frame to the space-fixed Mars equatorial frame is as follows:

$$\text{PMAT} = \begin{pmatrix} I_x & I_y & I_z \\ J_x & J_y & J_z \\ K_x & K_y & K_z \end{pmatrix}.$$

Since no precession or nutation of the Mars equator has been defined, the above matrix is sufficient to express the relationship between the Earth and Mars equators as stated.

b. The rotation from a space-fixed Mars equatorial coordinate system to a Mars-fixed Mars equatorial coordinate system involves only a rotation about the Z-axis by the Mars hour angle, MHA:

$$\text{MHA} = \text{MHA}_{ref} + \omega_M T_D \qquad 0 \text{ deg} \leq \text{MHA} < 360 \text{ deg}$$

where

MHA_{ref} = 145.042501 deg

ω_M = angular rotation rate

= 350.891962 deg/day

= $0.7088217655 \times 10^{-4}$ rad/sec

T_D = days past 0 hr January 1, 1950, U. T.

The rotation matrix is therefore:

$$PPMAT = \begin{pmatrix} \cos MHA & \sin MHA & 0 \\ -\sin MHA & \cos MHA & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

and position and velocity vectors may be expressed in the Mars-fixed Mars equatorial co-ordinate system as follows:

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} PPMAT \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

$$\begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \end{pmatrix} = \begin{pmatrix} PPMAT \end{pmatrix} \begin{pmatrix} \dot{X} + \omega_M Y \\ \dot{Y} - \omega_M X \\ \dot{Z} \end{pmatrix}$$

MARSMM computes the Mars hour angle MHA and the two matrices PMAT and PPMAT.

MARSPC rotates an input vector from space-fixed Earth mean equator and equinox of 1950.0 coordinates to space-fixed Mars equatorial coordinates.

MARFIX rotates an input position and velocity vector from space-fixed Mars equatorial coordinates to Mars-fixed Mars equatorial coordinates.

USE

Calling sequences:

a. CALL MARSMM
   return

Exit with the Mars hour angle computed and stored in MHA, the Earth-equatorial to Mars-equatorial rotation matrix stored row-wise in PMAT through PMAT+8 and the space-fixed Mars equatorial to Mars-fixed Mars equatorial rotation matrix stored row-wise in PPMAT through PPMAT+8.

b. CALL MARSPC
   PZE A,, B
   return

where A, A+1, A+2 contain the input vector referenced to the space-fixed mean Earth equator and equinox of 1950.0 coordinate system.

B, B+1, B+2 contain the output vector referenced to the space-fixed Mars equatorial coordinate system

and where the matrix used is assumed to have been previously computed and stored internally in PMAT through PMAT+8.

c. CALL MARFIX

PZE A,, B

return

where A, ..., A+5 contain the input position and velocity vectors referenced to the space-fixed Mars equatorial coordinate system.

B, ..., B+5 contain the output position and velocity vectors referenced to the Mars-fixed Mars equatorial coordinate system

and where the matrix used is assumed to have been previously computed and stored internally in PPMAT through PPMAT+8.

CODING INFORMATION

Length of subroutine is 160(10) or 240(8) words.

REFERENCE

JPL Section 312 RFP 141, July 4, 1963.

IDENTIFICATION 28.1

MATRIX
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To perform the matrix multiplication C = (A)(B).

RESTRICTIONS

a. The matrix A must be m x 3 and B must be 3 x n.
b. MATRIX is a subset of a package of several subroutines.

METHOD

The multiplication is performed in the manner indicated by the mathematical definition of matrix multiplication.

USE

Calling sequence:

```
CALL   MATRIX
PZE    M,,A
PZE    N,,B
PZE    ,,C
```

where

M	contains the fixed point m dimension of matrix A.
A, ···, A+8	contain the A matrix, stored row-wise with A_{11} the first element.
N	contains the fixed point n dimension of matrix B.
B, ···, B+8	contain the B matrix, stored row-wise with B_{11} the first element.
C, ···, C+8	contain the matrix product C = (A)(B), stored row-wise with C,, the first element.

CODING INFORMATION

Length of subroutine (includes MATRIX as a subset) is 1046(10) or 2026(8) words.

IDENTIFICATION

MNA/MNA1/MNAMD/MNAMD1/NUTEPH/NUTLON/NUTOBL
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To rotate true Earth equator of-date coordinates to true lunar equator of-date coordinates and vice versa via the M and $\dot{M}$ matrices, and to form the matrix N, which rotates mean Earth equator of-date coordinates to true Earth equator of-date coordinates.

RESTRICTIONS

a. MNA, et. al., is a subset of the lunar model package and uses other subroutines in the package.

b. The input parameter NUTEPH is an internal cell and is accessible via an entry. If NUTEPH is non-zero then the nutation in longitude and nutation in obliquity are computed. If NUTEPH is zero, then the nutations are obtained by interpolation of the nutation data on the double precision JPL Ephemeris Tapes obtained by calling subroutine ANTR1.

c. Entries NUTLON and NUTOBL have been provided so that the output parameters, nutation in longitude and nutation in obliquity, respectively, are accessible.

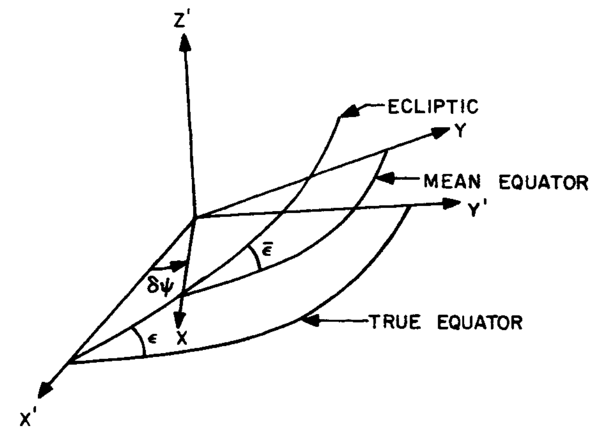
d. It is assumed that the matrix A, which rotates mean Earth equator of 1950.0 coordinates to mean Earth equator of-date coordinates, has been updated and is in COMMON locations AA through AA+8.

e. The output N matrix is stored in NUTMAT through NUTMAT+8 and is accessible via the entry NUTMAT, the output product matrix MNA is stored in COMMON locations (MNA) through (MNA)+8 and the output matrix M is stored in COMMON locations MM through MM+8.

f. $\delta\alpha$, the nutation in right ascension used in the calculation of the true value of the Greenwich hour angle, is computed and stored in COMMON location NUTRA.

METHOD

a. The nutation matrix N: To describe the nutation of the Earth about its precessing mean equator, it is convenient to construct the nutation matrix N which relates the cartesian coordinates expressed in the true equator and equinox to those in the mean equator and equinox as shown in the following sketch:



where:

1. $\bar{\epsilon}$ is the mean obliquity and is given by:

$$\bar{\epsilon} = 23^\circ.4457587 - 0^\circ.01309404T - 0^\circ.0088 \times 10^{-4}T^2 + 0^\circ.0050 \times 10^{-4}T^3$$

where T is the number of Julian centuries of 36,525 days past the epoch 0 hr January 1, 1950, E. T.

The nutations $\delta\epsilon$ and $\delta\psi$ may be obtained by interpolation of the nutation data on the double precision JPL Ephemeris Tapes or they may be computed as follows:

$$\Omega = 12^\circ.1127902 - 0^\circ.0529539222d + 20^\circ.795 \times 10^{-4}T + 20^\circ.81 \times 10^{-4}T^2 + 0^\circ.02 \times 10^{-4}T^3$$

$$☾ = 64^\circ.37545167 + 13^\circ.1763965268d - 11^\circ.31575 \times 10^{-4}T - 11^\circ.3015 \times 10^{-4}T^2 + 0^\circ.019 \times 10^{-4}T^3$$

$$\Gamma' = 208^\circ.8439877 + 0^\circ.1114040803d - 0^\circ.010334T - 0^\circ.010343T^2 - 0^\circ.12 \times 10^{-4}T^3$$

$$L = 280^\circ.08121009 + 0^\circ.9856473354d + 3^\circ.03 \times 10^{-4}T + 3^\circ.03 \times 10^{-4}T^2$$

$$\Gamma = 282^\circ.08053028 + 0^\circ.470684 \times 10^{-4}d + 4^\circ.5525 \times 10^{-4}T + 4^\circ.575 \times 10^{-4}T^2 + 0^\circ.03 \times 10^{-4}T^3$$

where T is the number of Julian centuries of 36,525 days past the epoch 0 hr January 1, 1950, E.T., and d is the number of days past the same epoch. The program uses d in double precision.

2. $\delta\psi$ is the nutation in longitude measured from the true vernal equinox at the X' axis to the mean vernal equinox at the X axis.

$\delta\psi = \Delta\psi + d\psi$, where $\Delta\psi$ denotes the long period terms and $d\psi$ denotes the short period terms. They are given by:

$$\Delta\psi = -(47°8927 + 0°0482T) \times 10^{-4}\sin\Omega + 0°5800 \times 10^{-4}\sin 2\Omega - 3°5361 \times 10^{-4}\sin 2L - 0°1378 \times 10^{-4}\sin(3L - \Gamma) + 0°0594 \times 10^{-4} \times \sin(L + \Gamma) + 0.0344 \times 10^{-4}\sin(2L - \Omega) + 0.0125 \times 10^{-4}\sin(2\Gamma' - \Omega) + 0°3500 \times 10^{-4}\sin(L - \Gamma) + 0°0125 \times 10^{-4}\sin(2L - 2\Gamma')$$

$$d\psi = -0°5658 \times 10^{-4}\sin 2☾ - 0°0950 \times 10^{-4}\sin(2☾ - \Omega) - 0°0725 \times 10^{-4} \times \sin(3☾ - \Gamma') + 0°0317 \times 10^{-4}\sin(☾ + \Gamma') + 0°0161 \times 10^{-4} \times \sin(☾ - \Gamma' + \Omega) + 0°0158 \times 10^{-4}\sin(☾ - \Gamma' - \Omega) - 0°0144 \times 10^{-4} \times \sin(3☾ + \Gamma' - 2L) - 0°0122 \times 10^{-4}\sin(3☾ - \Gamma' - \Omega) + 0°1875 \times 10^{-4} \times \sin(☾ - \Gamma') + 0°0078 \times 10^{-4}\sin(2☾ - 2\Gamma') + 0°0414 \times 10^{-4} \times \sin(☾ + \Gamma' - 2L) + 0°0167 \times 10^{-4}\sin(2☾ - 2L) - 0°0089 \times 10^{-4} \times \sin(4☾ - 2L)$$

3. $\delta\epsilon$ = is the nutation in obliquity. $\delta\epsilon = \Delta\epsilon + d\epsilon$, where $\Delta\epsilon$ denotes the long-period terms and $d\epsilon$ the short-period terms. They are given by:

$$\Delta\epsilon = 25°5844 \times 10^{-4}\cos\Omega - 0°2511 \times 10^{-4}\cos 2\Omega + 1°5336 \times 10^{-4} \times \cos 2L + 0°0666 \times 10^{-4}\cos(3L - \Gamma) - 0°0258 \times 10^{-4}\cos(L + \Gamma) - 0°0183 \times 10^{-4}\cos(2L - \Omega) - 0°0067 \times 10^{-4}\cos(2\Gamma' - \Omega)$$

$$d\epsilon = 0°2456 \times 10^{-4}\cos 2☾ + 0°0508 \times 10^{-4}\cos(2☾ - \Omega) + 0°0369 \times 10^{-4} \times \cos(3☾ - \Gamma') - 0°0139 \times 10^{-4}\cos(☾ + \Gamma') - 0°0086 \times 10^{-4} \times \cos(☾ - \Gamma' + \Omega) + 0°0083 \times 10^{-4}\cos(☾ - \Gamma' - \Omega) + 0°0061 \times 10^{-4} \times \cos(3☾ + \Gamma' - 2L) + 0°0064 \times 10^{-4}\cos(3☾ - \Gamma' - \Omega)$$

4. The true obliquity is computed as follows:

$$\epsilon = \bar{\epsilon} + \delta\epsilon$$

5. $\delta\alpha$ is the nutation in right ascension used in the calculation of the true value of the Greenwich hour angle of the vernal equinox and is given by:

$$\delta\alpha = \delta\psi \cos\bar{\epsilon}$$

If N is defined in the sense

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = N \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

where the primed system is the true equator and equinox and the unprimed is the mean equator and equinox, then the N_{ij} are given by

$N_{11} = \cos\delta\psi$

$N_{12} = -\sin\delta\psi \cos\bar{\epsilon}$

$N_{13} = -\sin\delta\psi \sin\bar{\epsilon}$

$N_{21} = \sin\delta\psi \cos\epsilon$

$N_{22} = \cos\delta\psi \cos\epsilon \cos\bar{\epsilon} + \sin\epsilon \sin\bar{\epsilon}$

$N_{23} = \cos\delta\psi \cos\epsilon \sin\bar{\epsilon} - \sin\epsilon \cos\bar{\epsilon}$

$N_{31} = \sin\delta\psi \sin\epsilon$

$N_{32} = \cos\delta\psi \sin\epsilon \cos\bar{\epsilon} - \cos\epsilon \sin\bar{\epsilon}$

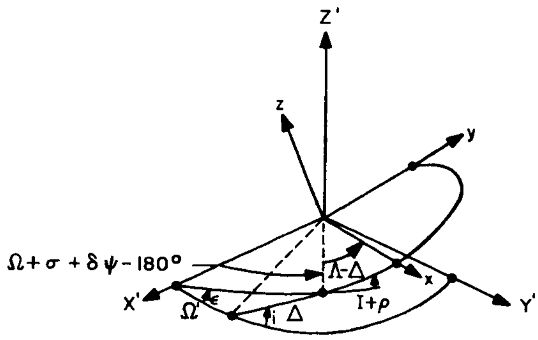
$N_{33} = \cos\delta\psi \sin\epsilon \sin\bar{\epsilon} + \cos\epsilon \cos\bar{\epsilon}$

Since $|\delta\psi| < 10^{-4}$ and $|\delta\epsilon| < 10^{-4}$, the N_{ij} are expanded to first order in $\delta\psi$ and $\delta\epsilon$ to obtain a form which is better behaved for numerical calculation:

$$N = \begin{pmatrix} 1 & -\delta\psi \cos\bar{\epsilon} & -\delta\psi \sin\bar{\epsilon} \\ \delta\psi \cos\bar{\epsilon} & 1 & -\delta\epsilon \\ \delta\psi \sin\bar{\epsilon} & \delta\epsilon & 1 \end{pmatrix}$$

b. The true Earth equator of-date to true lunar equator of-date matrix, M:

The relationship between the two planes is shown in the following sketch:



where the X', Y', Z' frame is the Earth's true equator and equinox; the x - y plane lies in Moon's true equator with z completing the right-hand system by lying along the Moon's spin axis. i is the inclination of the Moon's true equator to the Earth's true equator. Ω' is the right ascension of the ascending node of the Moon's true equator; Λ is the anomaly from the node to the x axis; Δ is the anomaly from the node to the ascending node of the Moon's true equator on the ecliptic; ϵ is the true obliquity of the ecliptic; $\delta\psi$ is the nutation in longitude; Ω is the mean longitude of the descending node of the Moon's mean equator on the ecliptic; ☾ is the mean longitude of the Moon; I is the inclination of the Moon's mean equator to the ecliptic; σ is the libration in the node; τ is the libration in the mean longitude; and ρ is the libration in the inclination. The anomalies are related by $\Lambda - \Delta = (\text{☾} + \tau) - (\Omega + \sigma)$.

The librations are given by

$$\sigma \sin I = -0^\circ\!.0302777 \sin g + 0^\circ\!.0102777 \sin(g + 2\omega) - 0^\circ\!.00305555 \sin(2g + 2\omega)$$

$$\tau = -0^\circ\!.003333 \sin g + 0^\circ\!.0163888 \sin g' + 0^\circ\!.005 \sin 2\omega$$

$$\rho = -0^\circ\!.0297222 \cos g + 0^\circ\!.0102777 \cos(g + 2\omega) - 0^\circ\!.00305555 \cos(2g + 2\omega)$$

$$I = 1^\circ\!.535$$

The following expressions have been programmed for g, g', and ω:

$$g = 215^\circ\!.54013 + 13^\circ\!.064992\,d$$

$$g' = 358^\circ\!.009067 + 0^\circ\!.9856005\,d$$

$$\omega = 196^\circ\!.745632 + 0^\circ\!.1643586\,d$$

Evidently $g = \text{☾} - \Gamma'$, the mean anomaly of the Moon; $g' = L - \Gamma$, the mean anomaly of the Sun; and $\omega = \Gamma' - \Omega$, the argument of the perigee of the Moon. All quantities relate to mean motions of the Sun and the Moon.

$$\cos i = \cos(\Omega + \sigma + \delta\psi) \sin\epsilon \sin(I + \rho) + \cos\epsilon \cos(I + \rho), \qquad 0 < i < 90^\circ$$

$$\sin\Omega' = -\sin(\Omega + \sigma + \delta\psi) \sin(I + \rho) \csc i, \qquad -90^\circ < \Omega' < 90^\circ$$

$$\sin\Delta = -\sin(\Omega + \sigma + \delta\psi) \sin\epsilon \csc i$$

$$\cos\Delta = -\sin(\Omega + \sigma + \delta\psi) \sin\Omega' \cos\epsilon - \cos(\Omega + \sigma + \delta\psi) \cos\Omega', \qquad 0 \leqq \Delta < 360^\circ$$

$$\Lambda = \Delta + (\text{☾} + \tau) - (\Omega + \sigma)$$

The two rectangular systems are related through Λ, Ω', and i by the rotation:

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{pmatrix} \begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix}$$

where

$$m_{11} = \cos \ \cos\Omega' - \sin\Lambda \sin\Omega' \cos i$$

$$m_{12} = \cos\Lambda \sin\Omega' + \sin\Lambda \cos\Omega' \cos i$$

$m_{13} = \sin\Lambda \sin i$

$m_{21} = -\sin\Lambda \cos\Omega' - \cos\Lambda \sin\Omega' \cos i$

$m_{22} = -\sin\Lambda \sin\Omega' + \cos\Lambda \cos\Omega' \cos i$

$m_{23} = \cos\Lambda \sin i$

$m_{31} = \sin\Omega' \sin i$

$m_{32} = -\cos\Omega' \sin i$

$m_{33} = \cos i$

Combining the above m_{ij} (M) rotation matrix with the N and A matrices gives the MNA matrix used to rotate a position vector from Earth mean equator of 1950.0 coordinates, (X, Y, Z), to true lunar equator of-date coordinater, (x, y, z):

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = MNA \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

and inversely,

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = (MNA)' \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

for the position transformation in the other direction.

c. The derivative of M, $\dot{M}$: In computing $\dot{M}$ the rates for the slowly varying angles Ω' and i are taken to be zero.

Thus

$\dot{M}_{11} = (-\sin\Lambda \cos\Omega' - \cos\Lambda \sin\Omega' \cos i)\dot{\Lambda}$

$\dot{M}_{12} = (-\sin\Lambda \sin\Omega' + \cos\Lambda \cos\Omega' \cos i)\dot{\Lambda}$

$\dot{M}_{13} = (\cos\Lambda \sin i)\dot{\Lambda}$

$\dot{M}_{21} = (-\cos\Lambda \cos\Omega' + \sin\Lambda \sin\Omega' \cos i)\dot{\Lambda}$

$\dot{M}_{22} = (-\cos\Lambda \sin\Omega' - \sin\Lambda \cos\Omega' \cos i)\dot{\Lambda}$

$\dot{M}_{23} = (-\sin\Lambda \sin i)\dot{\Lambda}$

$$\dot{M}_{31} = 0$$
$$\dot{M}_{32} = 0$$
$$\dot{M}_{33} = 0$$

From the formula

$$\Lambda = \Delta + (☾ + \tau) - (\Omega + \sigma)$$

obtain

$$\dot{\Lambda} = \dot{\Delta} + \dot{☾} + \dot{\tau} - \dot{\Omega} - \dot{\sigma}$$

The adopted numerical expressions for the rates are

$$\dot{\Delta} = \frac{-\cos(\Omega + \sigma + \delta\psi)\ \sin\epsilon\ (\dot{\Omega} + \dot{\sigma})}{\sin i \cos \Delta}$$

$$\dot{☾} = 0.266170762 \times 10^{-5} - 0.12499171 \times 10^{-13}\, T \text{ rad/sec}$$

$$\dot{\Omega} = -0.1069698435 \times 10^{-7} + 0.23015329 \times 10^{-13}\, T \text{ rad/sec}$$

$$\dot{\tau} = -0.1535272946 \times 10^{-9} \cos g + 0.569494067 \times 10^{-10} \cos g' + 0.579473484 \times 10^{-11} \cos 2\omega \text{ rad/sec}$$

$$\dot{\sigma} = -0.520642191 \times 10^{-7} \cos g + 0.1811774451 \times 10^{-7} \cos(g + 2\omega) - 0.1064057858 \times 10^{-7} \cos(2\omega + 2g) \text{rad/sec}$$

To obtain velocity transformations the approximation is made that

$$\dot{N} = \dot{A} = 0$$

thus

$$\begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \end{pmatrix} = MNA \begin{pmatrix} \dot{X} \\ \dot{Y} \\ \dot{Z} \end{pmatrix} + \dot{M}NA \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

and for the inverse transformation

$$\begin{pmatrix} \dot{X} \\ \dot{Y} \\ \dot{Z} \end{pmatrix} = (MNA)' \begin{pmatrix} \dot{x} \\ \dot{y} \\ \dot{z} \end{pmatrix} + (MNA)' \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

A definition of the A matrix can be found in subroutine ROTEQ.

USE

Calling sequences:

a. Position vector transformation:

```
CALL   MNA or MNA1
PZE    1,,A
PZE    n,,B
```

where A, A+1, A+2 contain the input vector
B, B+1, B+2 contain the output vector

n = 0 rotates true lunar equator of-date to mean Earth equator of 1950.0

= 1 rotates mean Earth equator of 1950.0 to true lunar equator of-date.

Enter with the fractional part of the day past 0 hr of the epoch, E. T., in the AC and the integer days past 0 hr January 1, 1950, E. T., of the epoch T, in the MQ.

It is assumed that the A matrix has been previously computed and stored in COMMON locations AA through AA+8.

The N matrix is computed and stored in locations NUTMAT through NUTMAT+8. The M matrix is computed and stored in COMMON locations MM through MM+8. The product matrices NA and MNA are formed and stored in COMMON locations (NA) through (NA) +8 and (MNA) through (MNA) + 8, respectively. The nutation in right ascension is computed and stored in COMMON location NUTRA. The nutations in longitude and obliquity are stored in locations NUTLON and NUTOBL, respectively.

If CALL MNA1 is used, the contents of MNAET are used to determine whether or not the .01 day test is to be used as criteria for recomputing the matrices M and N, MNAET = 0 forces recomputation.

b. Velocity vector transformation:

```
CALL   MNAMD
PZE    1,,A
PZE    1,,B
PZE    n,,C
```

where A, A+1, A+2 contain the input position vector
B, B+1, B+2 contain the input velocity vector
C, C+1, C+2 contain the output velocity vector
n = 0 rotates true lunar equator of-date to mean Earth equator of 1950.0
= 1 rotates mean Earth equator of 1950.0 to true lunar equator of-date.

Enter with the fractional part of the day past 0 hr of the epoch, E. T., in the AC and the integer days past 0 hr January 1, 1950, E. T. of the epoch T, in the MQ.

It is assumed that the A matrix has been previously computed and stored in COMMON locations AA through AA+8.

The N matrix is computed and stored in locations NUTMAT through NUTMAT+8. The M matrix is computed and stored in COMMON locations MM through MM+8. The product matrices NA and MNA are formed and stored in COMMON locations (NA) through (NA)+8 and (MNA) through (MNA)+8, respectively. The nutation in right ascension is computed and stored in COMMON location NUTRA. The nutations in longitude and obliquity are stored in locations NUTLON and NUTOBL, respectively.

If CALL MNAMD1 is used then the contents of MNAET are used to determine whether or not the .01 day test is to be used as criteria for recomputing the matrices M and N. MNAET = 0 forces recomputation.

CODING INFORMATION

Length of subroutine (includes MNA, et. al., as a subset) is 1046 (10) or 2026 (8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION 29

PATH/DIST

Peter S. Fisher, JPL

IBM 7094 Fap

December 2, 1964

PURPOSE

To compute the path (arc) length of a trajectory.

RESTRICTIONS

a. PATH should be called every end of step.
b. The subroutine PROD is called.
c. The current values of time and inertial velocity are expected in T, T + 1 and CX. to CX. + 2 respectively.
d. The arc length will be computed geocentrically when either the Earth or the Moon is the target, and heliocentrically for all other target bodies.

METHOD

$$S = \int_{t_{inj}}^{t_{end}} v\,dt \qquad \text{is approximated by} \sum \bar{v}\,\Delta t$$

Where Δt is the stepsize and $\bar{v}$ is the average velocity over a step $\bar{v} = \frac{v_i + v_{i+1}}{2}$

USE

Calling sequence:

```
CALL    PATH
return
```

The path length in km is stored in DIST.

CODING INFORMATION

Length of subroutine is 51(10) or 63(8) words.

IDENTIFICATION

PLLLT/PLTSET/PLOTFQ/FILENO/RECNUM/CANCLK

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

To control the SAVE tape option.

RESTRICTIONS

a. Subroutines REWIND and READB are used to position the tape.
b. Subroutine SAVEIT is used to write the SAVE tape.
c. Subroutines FLOTT, ADD, CW1, CHANGE, SIN and COS are used to compute the SAVE tape parameters.
d. STABCD, PAGBCD, BLATZ, LAUNCH and GCE are referenced indirectly.
e. ABORT is called if there is an error return from SAVEIT.
f. Entry CANCLK is provided so three clock angles can be stored internally in this subroutine.
g. Entries FILENO and RECNUM are provided so the file number and record number are available for output.
h. Entry PLOTFQ is provided for the five input parameters needed to define the request to use the SAVE tape option.

METHOD

This subroutine is the driver subroutine that effects the generation of the SAVE tape.

The initialization entry PLTSET does the following:

a. Checks PLOTFQ to see if the SAVE tape option is requested. If zero, the subroutine gives an exit.
b. Positions the SAVE tape on the basis of the file number.
c. Fetches the station subtable names and puts them in an internal buffer.
d. Sets up the initialization calling sequence to SAVEIT.
e. Calls SAVEIT.
f. Initializes the record number to 0 and converts launch epoch to seconds past 1950 if it is input non-zero.

The execution entry PLLLT does the following:

a. Checks PLOTFQ to see if the SAVE tape option is requested. If zero, the subroutine gives an exit.
b. Checks PLOTFQ for the frequency of writing the SAVE tape. If PLOTFQ = N and this entry to PLLLT is not the first one or is not a multiple of N, or if the current epoch is the same as it was on the previous entry, then the subroutine gives an exit.
c. Computes time past injection (TTT).

d. Computes time from launch (TFL) and days past 0 hr of launch day (DM) if launch epoch was input non-zero.

e. Sets flags for LOOP and PRINTD.

f. Calls CHANGE, which eventually calls LOOP and PRINTD.

g. Resets flags used by LOOP and PRINTD.

h. Computes two angles not computed by LOOP or PRINTD: SI) and CO).

i. Moves the data to the data buffer, increments the record number and calls SAVEIT.

USE

Calling sequences:

a. Initialization entry: CALL PLTSET

b. Execution entry: CALL PLLLT

The control (input) parameters must be in PLOTFQ to PLOTFQ + 4 as follows:

PLOTFQ	frequency of writing tape	0 = none
PLOTFQ+1	physical file number	
PLOTFQ+2	time added to seconds past injection	
PLOTFQ+3	stations to put on save tape (maximum of 5)	
PLOTFQ+4	stations to put on save tape	

The format and definition of the I. D. and data records on the SAVE tape are found in Section VA.

CODING INFORMATION

Length of subroutine is 515(10) or 1003(8) words.

IDENTIFICATION

PRINTD/PRNTD1/CONIC

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

a. PRINTD sets up and prints groups of output quantities whenever certain output control words are set.

b. PRNTD1 sets flags that override the output control words and then goes to PRINTD. The effect is to force computation and printing of the output quantities.

c. CONIC sets up and prints conic parameters.

RESTRICTIONS

a. It is assumed that the subroutine SPRAY has previously been called.

b. COMMON through COMMON +100 are used for temporary storage.

c. The following subroutines are called: SPRAY, EFFECT, ROT, PRSET, RESET, TIME1, DAYS, ARTAN, PROD, ARSIN, GETTER, SIN, SPACE, RVOUT, GEDLAT, ECLIP, GRUPPE, PROUT, UNIT, ARCOS, CROSS, MNA, MNAMD1, MATRIX, MARSMM, MARSPC, MARFIX, NUTATE, ERPRT, ABORT, COS, JERYL, CLASS, SPECL, ADD, TIME3, BCDNO, SQRT, LN, and LOOP.

d. The following entries are referenced indirectly: HC, CANCLK, CLUCK, GRAV, CG, MHA, INJFLG, GROP, CAN50, CASE, INJBCD and INJTYP.

METHOD

Each FLAG at GROPS to GROPS +3 and GROPS +5 to GROPS +6 is examined; if any cell is zero the corresponding group is not printed. If the cell has the value of two, the output is in ecliptic coordinates; a value of four gives equatorial coordinates. The following groups may be printed:

Geocentric
Geocentric Conic
Heliocentric
Heliocentric Conic
Target Centered
Target Centered Conic

The conic output quantities are in two groups: those independent of the reference coordinate system and those dependent on the reference coordinate system. The possible coordinate systems are earth equatorial, ecliptic, orbit plane of target and target true equator.

USE

Calling sequences:

a. CALL PRINTD
   return

b. CALL PRNTD1
   return

c. CLA I
   CALL CONIC
   return

where I = 0 for geocentric conic
      I = 1 for heliocentric conic
      I = 2 for targetcentric conic

CODING INFORMATION

Length of subroutine is 2820(10) or 5404(8) words.

IDENTIFICATION

PROUT/FLUSH
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To convert to specific output format from 1 to N lines of single or double precision information, convert the output data on one or several of the following output devices:

a. User Area Printer (SC 3070)
b. Peripheral Output Tape (SYSOU1)
   1. 1401 off-line printer or punch
   2. SC 4020 off-line microfilm recorder.

RESTRICTIONS

a. Care must be exercised if single and double precision numbers are intermixed within a repeated line format, to ensure that the address modifier ΔL will give the correct location for data in lines subsequent to the first.
b. Requires the SFOF subroutine OUTUS, an output coordinator of SFOF subroutines that require disk write operations. OUTUS includes the necessary buffers to be shared.
c. Requires the SFOF subroutine TAPEIO for off-line output requests.

USE

a. Calling sequence:

```
        CALL    PROUT
         BCI    1,XXXX
           P    FLAG, T, PROGID
         ZZZ                        }
          .                         }
          .                         }
          .                         }  Conversion control pseudo instructions
          .                         }  (see Conversion Parameters below)
          .                         }
         FVE    CODE, T, 1000A+B    }
         ZZZ                        }
          .                         }
          .                         }
          .                         }  Conversion control psuedo instructions
          .                         }
          .                         }
         FVE    CODE, T, 1000A+B    }
```

```
ZZZ
 .
 .
 .                                  As many conversion control groups as desired
 .
 .
 .
FVE     CODE, T, 1000A+B
FVE     0, 0, 0
```

where,

XXXX	4 BCD characters of identification (symbols may not start with Z)
P = PZE	specifies SC 3070 output with or without peripheral output
= MZE	peripheral output only
FLAG, T	is the location of the flag word where the status of the request will be placed
PROGID	is the beginning location of 12 BCD characters of program identification to be used as part of the SC 3070 page headings; if PROGID = 0, page headings, page numbers, and page ejects (upon 53-line count) will be omitted. The provision for page headings, page numbers, and blocked output is the responsibility of the user program

For User Area Printing (SC 3070),

CODE = 0	indicates user area printing
T = 0	indicates user area printing
A = 0	indicates no post-print control
B = 1	indicates 15 line pre-print paper advance
= 10	indicates single space
= 20	indicates double space

For Peripheral Output Tape (1401-Printing or Punching),

CODE	is the location of the system tape address or logical tape number for printing or punching
T = 0	indicates printing,
= 7	indicates punching
A or B = 0	indicates suppress post-print spacing, pre-print spacing, respectively
= I	where $1 \leq I \leq 9$, indicates skip to Channel I.
= 10K	indicates K spaces (K < 100)

For Peripheral Output Tape (SC 4020),

CODE	is the location of a control word that has the following format: PZE L(system tape address or logical tape number), 0, Line Count
T = 1	indicates SC 4020 printing

A or B =	0	indicates suppress post-print spacing, pre-print spacing, respectively
=	I	where $1 \leq I \leq 9$, indicates skip to Channel I.
=	10K	indicates K spaces ($K < 100$)

The calling sequence must be terminated by the "end" instructions:

FVE 0, 0, 0

b. Conversion parameters:

Function	Code
FLOATING TO FIXED	SVN L, T, 1000D+PP
FLOATING TO FLOATING	SIX L, T, 1000D+PP
FIXED TO FIXED	FOR L, T, 1000D+PP
BCD TO HOLLERITH	PTH L, T, 1000N+PP
FULL WORD OCTAL	PTW L, T, PP
ADDRESS TO OCTAL	PTW L, T, 1000+PP
DECREMENT TO OCTAL	PTW L, T, 2000+PP
REPEAT LINE FORMAT	PTW ΔL, 0, 3000+K
TTY BINARY CODE	PTW L, T, 4000+N
SET BINARY POINT	PZE BP, 0, 1
NO-OPERATION	PZE 0, 0, 0
REPEAT FIELD FORMAT	PZE ΔL, 0, 1000N+ΔP
INDIRECT ADDRESS	PON L, T, E
END	FVE 0, 0, 0

In these pseudo-instructions, PP represents the rightmost print position which will be used. PP may not exceed 132 for the off-line printer, 128 for the SC 4020, 120 for the SC 3070, and 72 for the off-line punch and teletypewriter. Characters before print position 2 will be lost, except for a teletypewriter line. Characters after limiting print position will result in an error indication. If fields should overlap, the later word will take precedence.

A tag (T) can be used for address modification in any pseudo-instruction except those with a prefix of FVE or PZE. A tag entry in the FVE code is interpreted as a flag only. The tag may be any number of the set 0, 1, 2, 3, 5, 6, 7. Index register 4 may not be used for address modification.

c. Parameter specifications:

Floating to Fixed   SVN L, T, 1000D+PP

The floating binary word in L, T will be rounded to D decimal places and converted to fixed decimal. If D is zero, there will be no decimal point. If the absolute value of the number is greater than $2^{35} - 1$, it will be printed in floating decimal as described below. D must be less than or equal to 8. An error indication occurs when $D > 8$ unless $n > 2^{35} - 1$ (floating point) or n = integer.

Floating to Floating SIX L, T, 1000D+PP 32-4 of 8

The floating binary word at L, T will be rounded to D decimal digits and converted to floating decimal. If D is less than or equal to 8, the number is taken as a single-precision number. If D is greater than 8 and less than or equal to 16, the number is considered to be in double-precision, floating-point form: the high-order part in L, T and the low order part in L+1, T. Any number less than 10^{-32} in absolute value will print as a single-precision zero. D must not be zero.

Fixed to Fixed FOR L, T, 1000D+PP

The fixed-point word used in L, T will be rounded to D decimal places and converted to fixed decimal. The location of the binary point is set by the last prior pseudo-instruction "SET BINARY POINT" (see below). If D is zero, there will be no decimal point. D must not exceed 8.

BCD to Hollerith PTH L, T, 1000N+PP

The N BCD words starting in L, T will be set for printing such that the last character will be in print position PP. N must be in the range permissible for the output device to be used.

Full Word Logical Octal PTW L, T, PP

The word in L, T will be converted to 12 logical octal digits.

Address in Octal PTW L, T, 1000+PP

The address portion of the word in L, T will be converted to octal.

Decrement in Octal PTW L, T, 2000+PP

The decrement portion of the word in L, T will be converted to octal.

Repeat Line Format PTW ΔL, 0, 3000+K

The string of data pseudo-instructions immediately following this instruction, defining a line image and terminating with one or more FVE code instructions, will produce K lines of output. After each line is formed the address fields of each data pseudo-instruction will be effectively incremented by ΔL for the next memory references.

Teletype Binary Code PTW L, T, 4000+N

The N six-bit characters starting in L, T will be placed on disk without conversion. This instruction cannot be indirectly addressed. Neither repeat command can be used in conjunction with this instruction. N must not exceed 999. No FVE code is used with this instruction since no line image is set up.

Set Binary Point PZE BP, 0, 1

The binary point for the following "FIXED TO FIXED" pseudo-instructions will be set at BP. Entry to the subroutine automatically performs PZE 35, , 1.

No-Operation PZE 0, 0, 0

This instruction is provided to facilitate modifying the calling sequence.

Repeat Field Format PZE ΔL, 0, 1000N+ΔP

If the immediately preceding effective pseudo-instruction is "SET BINARY POINT" or either "REPEAT" instruction, error action is taken. Otherwise, the immediately preceding effective pseudo-instruction will be repeated with L + n (ΔL) and PP + n (ΔP) for n = 1, 2, . . . , N. In the case of indirect addressing, the word repeated is the effective pseudo-instruction. FVE codes will not be repeated. N must not be zero.

Indirect Addressing PON L, T, E

The word at L, T will be used at this point in the calling sequence as a pseudo-instruction. If E is not equal to zero, it will be used as the decrement in place of the decrement in L, T.

End FVE 0, 0, 0

This pseudo-instruction signals the end of the calling sequence. Control is returned to the user program at the next instruction.

d. Coding information:

1. The user area printer (SC 3070) output is formatted as follows: a 15 line skip; a page header containing the 12 BCD characters of program identification beginning at PROGID, the 4 BCD characters of identification, date and page number; 2 blank lines; 50 lines, including spacing, specified by the user program. Each line image will be formatted, 5 BCD characters per word, with all necessary control indicators for the 7288 output subchannel.
2. Line images for peripheral output devices will be formed in standard format for off-line processing.
3. The BCD name specified in the calling sequence identifies a print output file which is to be placed on the disk. The user area is notified of the availability of the print output file when the file is closed. The size of the file should be arranged so that the print output is made available to the user area at frequent intervals, but not so frequent that the user area would have to make a request through the message composer for every few lines of output; this should be controlled by the frequency of closing the print output file. When the BCD name changes, the previous output file is closed and made available at the user area. When the user program has operated its minimum time and OFFSYS initiates a program interchange, all print output files are closed.

   When ENDSYS or FINSYS are called, the print output files are also closed. If it is desired to close a print output file at a specific time other than those above, it may be accomplished by giving the following instruction:

```
CALL   ENDOUT
PZE    N
```

where,

N = 1 means to close print files
= 2 means to close plot files
= 3 means to close print and plot files
= 4 means to close teletype files
= 5 means to close teletype and print files
= 6 means to close teletype and plot files
= 7 means to close teletype, print, and plot files

4. Before the subroutine FLUSH (described later) has been called, the completion flag of the last PROUT request must be checked to ensure that the file remains open until the output has been completed.
5. A page eject occurs and a new heading is printed (unless PROGID = 0) when any one of the following occurs:
   (a) Change of data name.
   (b) Change of ID heading (page numbers are not reset).
   (c) Calling ENDOUT.
6. When an MZE prefix, denoting off-line output only, is used, FVE codes specifying 3070 output cannot be contained in the calling sequence.
7. All off-line output is to be labeled. The label will consist of the 4-character user program name.
8. In MODE IV all PROUT 3070 output will be printed on the on-line printer under sense switch control:

   SSW No. 6 UP = no 3070 output

   DOWN = 3070 output printed on the on-line printer
9. User areas for which PROUT output is intended are not specified in the PROUT calling sequence. When data has been placed on disk, a message is sent to the appropriate used area(s) that this specific type of data is available. The user area can request the data when it is desirable. User areas receive only those data availability messages they designate at 7094 initialization.
10. All peripheral output processed by PROUT will be placed on the same output tape (SYSOU1). The BCD data name normally designated in the PROUT calling sequence is ignored.
11. FGDOUT option: Three types of floating to floating output are available in PROUT depending upon the contents of location FGDOUT:
    (a) c(FGDOUT) = 0 indicates no leading +, and no + in the exponent field.
    = 1 indicates leading +, and + in the exponent field.
    > 1 indicates leading +, and E+ in the exponent field.
    (b) c(FGDOUT) is initially > 1.

e. Suggestions for output efficiency:

1. Use buffering techniques wherever possible.
2. Organize and group output so that the number of output requests is minimized.
3. Organize output formats to print full lines or as full as possible under format requirements.
4. Arrange user program to continue computations during output processing if it becomes necessary to wait for a free output buffer within OUTUS.
5. Care should be taken not to modify a calling sequence or loop through a calling sequence until the flag word has been tested to determine the status of the previous request.

f. Operational description:

The type of request is determined and processed in one of the following ways:

1. User Area Printer Request

   The request is queued, and control is given to an output coordinating routine (OUTUS) which coordinates printing, plotting, and teletype requests, and their usage of output buffers, the calling of conversion routines, and making the necessary disk write requests. When OUTUS obtains a print (or plot or teletype) request from the queue, if an output buffer is available, OUTUS calls the proper conversion routine, and the converted output is placed in the output buffer. When the buffer is filled, or the data completed, a disk write request is then made by OUTUS to the disk control program (DCP), and control is returned to the user program. When the data has been written on disk, an interrupt occurs and control is routed to OUTUS to continue output of the request or initiate a new request. Then control is returned to the point of interruption. In this way, the print output (or plot output or teletype output) to be converted and placed on disk can be processed to make optimum usage of buffers and efficient requests of disk write operations. During the operation, if a buffer is filled or the queue is emptied or OUTUS has processed output requests as far as possible, control is returned to the user program.

2. IBM 1401 Off-Line Printer or Punch Request

   The proper conversion routine is initiated and output is written on the 1401 output tape. The tape operation will be asynchronous under the supervision of IOEX. When the request has been initiated, control is returned to the user program.

3. SC 4020 Off-Line Microfilm Recorder Request

   The proper conversion routine is initiated and output is written on the 4020 output tape. The tape operation will be asynchronous under the supervision of IOEX. When the request has been initiated, control is returned to the user program.

   In each option listed above, the results of the output request can be found in the flag word specified by the calling sequence.

g. Output:

1. Output Data:
   (a) 1401 - Print:
   Print lines may contain up to 132 characters.
   (b) 1401 - Punch:
   Card images may contain up to 72 characters.
   (c) SC 4020:
   Line images may contain up to 128 characters.
   (d) SC 3070:
   An integral number of lines of up to 120 characters each will be packed in each 128 word disk output buffer. The printed output is then available to the actual printer in the user area upon request.
2. Flags:
   (a) Upon entry, PROUT sets the user program flag word to zero. The user program can determine if the request has been completed by testing the flag word for zero or non-zero.
   (b) Upon completion of the request, the user program flag word is set with the results of the output operation as follows:

(1)	Sign Bit	= 0:	No unusual conditions occurred.
		= 1:	At least one unusual condition occurred. The address will indicate the condition.
	Bit 32	= 1:	A pseudo-instruction specifies too many (> 132) characters for one line of output.
	Bit 31	= 1:	There is an error in the repeat data pseudo-instruction.
	Bit 30	= 1:	The binary point exceeds bit position 35.
(2)	Decrement	= 1:	Processing has been successfully completed.

   (3) When the address contains a flag bit; the decrement will contain the complement of the address of the pseudo-instruction in question.
3. The Entry Point FLUSH:
   PROUT, being a buffered output routine, must have some means of emptying its buffer when desired, even though it may be only partially filled. For this purpose an entry to PROUT has been provided whose calling sequence is simply

```
CALL    FLUSH
return
```

   If the buffer in use by PROUT is empty, return is immediate to the next sequential instruction. If there are any words waiting to be written, the buffer is emptied. At the completion of the I/O, return is made to the location after the call.

CODING INFORMATION

Length of subroutine is 1484(10) or 2714(8) words

IDENTIFICATION 33

READN/READ1/READC/SPAM
Peter S. Fisher, JPL
IBM 7094, Fap
December 2, 1964

PURPOSE

To allow appropriate data communication between the spacecraft ephemeris tape and SPASM's HBANK. To help SPASM find discontinuity points in the ephemeris.

RESTRICTIONS

a. S/C ephemeris data is sprayed into cells with certain names expected to be entry points elsewhere in core.
b. TAPIO and PROUT are used for input-output.

METHOD

a. SPAM sets up an independent variable trigger using the two cells following the calling sequence in order to find discontinuity points in the S/C ephemeris.
b. READ1 finds the correct ID record corresponding to the (RUNID) given and reads said record. This record contains the injection conditions, constants, and option flags used in the corresponding SPACE run.
c. READN reads the data record of the tape. This record has two formats depending on whether or not the variational equations were integrated in SPACE. This condition is relayed to READN through the ID record.
d. READC repositions the S/C ephemeris tape after the processor has finished using it. It is important that this is done so that there is no possibility of SPACE writing over the unused portion.

USE

Calling sequences:

CALL READ1	CALL READN	CALL READC
return	return	return

CODING INFORMATION

Length of subroutine is 224 (10) or 340 (8) words.

IDENTIFICATION

ROTEQ/DELTJD
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To rotate mean Earth equator and equinox of-date coordinates to mean Earth equator and equinox of 1950.0 and vice versa.

RESTRICTIONS

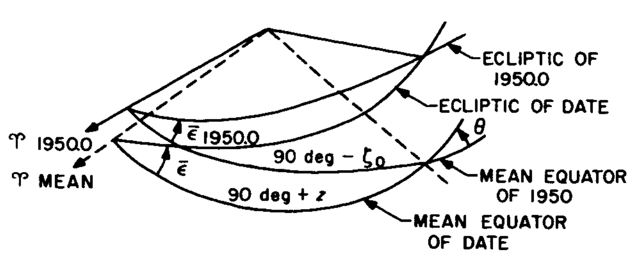
a. The matrix is stored in the COMMON locations AA through AA+8.
b. The subroutine uses COMMON through COMMON+2.
c. The option of recomputing the matrix only if time has changed by at least 1/64 day is controlled by the contents of the external quantity MNAET. Nominally MNAET is zero which turns off the 1/64 day test which forces a recomputation of the matrix.
d. An entry has been provided for access to DELTJD, the difference between the J.D. of 1950.0 and the J.D. of 0 hr January 1, 1950, in days.

METHOD

The general precession of the Earth's equator and the consequent retrograde motion of the equinox on the ecliptic may be represented by the rotation matrix:

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

where X, Y, and Z are expressed in the mean equator and equinox of 1950.0 and X', Y', Z' are the coordinates in the mean equator and equinox of date. The geometry of the precession has been represented by the three small parameters ζ_0, z, and θ in the following sketch.



where $\Upsilon_{1950.0}$ is the mean equinox of 1950.0; $\bar{\epsilon}_{1950.0}$ is the mean obliquity of 1950.0; Υ_{mean} is the mean equinox of date; $\bar{\epsilon}$ is the mean obliquity of date. Measured in the mean equator of 1950.0 from the mean equinox of 1950.0, 90 deg - ζ_0 is the right ascension of the ascending node of the mean equator of date on the mean equator of 1950.0. 90 deg + z is the right ascension of the node measured in the mean equator of date from the mean equinox of date. θ is the inclination of the mean equator of date to the mean equator of 1950.0.

In terms of ζ_0, z, and θ, (a_{ij}) is given by

$$a_{11} = -\sin\zeta_0 \sin z + \cos\zeta_0 \cos z \cos\theta$$
$$a_{12} = -\cos\zeta_0 \sin z - \sin\zeta_0 \cos z \cos\theta$$
$$a_{13} = -\cos z \sin\theta$$
$$a_{21} = \sin\zeta_0 \cos z + \cos\zeta_0 \sin z \cos\theta$$
$$a_{22} = \cos\zeta_0 \cos z - \sin\zeta_0 \sin z \cos\theta$$
$$a_{23} = -\sin z \sin\theta$$
$$a_{31} = \cos\zeta_0 \sin\theta$$
$$a_{32} = -\sin\zeta_0 \sin\theta$$
$$a_{33} = \cos\theta$$

$$\zeta_0 = 2304''.997T + 0''.302T^2 + 0''.0179T^3$$
$$z = 2304''.997T + 1''.093T^2 + 0''.0192T^3$$
$$\theta = 2004''.298T - 0''.426T^2 - 0''.0416T^3$$

with T the number of Julian centuries of 36,525 days past the epoch 1950.0.

The actual computational form of (a_{ij}) is obtained by expanding the a_{ij} in power series in ζ_0, z, θ and replacing the arguments by the above time series. The results are

$$a_{11} = 1 - 0.00029697T^2 - 0.00000013T^3$$
$$a_{12} = -a_{21} = -0.02234988T - 0.00000676T^2 + 0.00000221T^3$$
$$a_{13} = -a_{31} = -0.00971711T + 0.00000207T^2 + 0.00000096T^3$$
$$a_{22} = 1 - 0.00024976T^2 - 0.00000015T^3$$
$$a_{23} = a_{32} = -0.00010859T^2 - 0.00000003T^3$$
$$a_{33} = 1 - 0.00004721T^2 + 0.00000002T^3$$

USE

Calling sequence:

Enter with days past 0 hr January 1, 1950 E.T. in the AC-MQ.

```
CALL    ROTEQ
PFX     X,,Y
return
```

where

X-3, X-2, X-1 contain the input vector.

Y-3, Y-2, Y-1 contain the output vector.

PFX = PZE assumes mean 1950.0 input and rotates to mean of-date.

PFX = MZE assumes mean of-date input and rotates to mean 1950.0.

X = Y is permitted.

CODING INFORMATION

Length of subroutine is 107(10) or 153(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 Computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION

RVIN/RVOUT

JPL Staff

IBM 7094 Fap

December 2, 1964

PURPOSE

a. RVIN transforms a set of input spherical coordinates R, Φ, Θ, V, Γ, Σ, to a set of cartesian coordinates X, Y, Z, $\dot{X}$, $\dot{Y}$, $\dot{Z}$.

b. RVOUT transforms a set of input cartesian coordinates X, Y, Z, $\dot{X}$, $\dot{Y}$, $\dot{Z}$, to a set of spherical coordinates R, Φ, Θ, V, Γ, Σ.

RESTRICTIONS

a. Subroutines called are SIN, COS, MATRIX, PROD, ARTAN, UNIT, and ARSIN.

b. All angles are assumed to be in degrees.

METHOD

a. RVIN computes the cartesian components of the vector $\overline{R}$ by

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} R\cos\Phi\ \cos\Theta \\ R\cos\Phi\ \sin\Theta \\ R\sin\Phi \end{pmatrix}$$

where Θ is the longitude measured clockwise in the X - Y plane from the X-axis and Φ is the latitude measured positive above the X - Y plane. The quantities Γ, the path angle, and Σ, the azimuth angle determine the orientation of the velocity vector with respect to the plane of the local horizontal, that is, perpendicular to the $\overline{R}$ vector. $\overline{V}$ is expressed in the local horizontal system as

$$\overline{V} = \begin{pmatrix} \dot{X}' \\ \dot{Y}' \\ \dot{Z}' \end{pmatrix} = \begin{pmatrix} V\sin\Gamma \\ V\cos\Gamma\ \sin\Sigma \\ V\cos\Gamma\ \cos\Sigma \end{pmatrix}$$

and finally the results in the original system are

$$\bar{V} = \begin{pmatrix} \dot{X} \\ \dot{Y} \\ \dot{Z} \end{pmatrix} = \begin{pmatrix} \cos\Theta & -\sin\Theta & 0 \\ \sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos\Phi & 0 & -\sin\Phi \\ 0 & 1 & 0 \\ \sin\Phi & 0 & \cos\Phi \end{pmatrix} \begin{pmatrix} \dot{X}' \\ \dot{Y}' \\ \dot{Z}' \end{pmatrix}$$

b. RVOUT performs the computations which follow:

$$R = \sqrt{X^2 + Y^2 + Z^2}$$

$$\Phi = \arcsin \frac{Z}{R}, \qquad -90 \text{ deg} \leq \Phi \leq 90 \text{ deg}$$

$$\Theta = \arctan \frac{Y}{X}, \qquad 0 \text{ deg} \leq \Theta < 360 \text{ deg}$$

which gives R, the magnitude of $\bar{R}$, the latitude Φ and longitude Θ. The cartesian velocity components $(\dot{X}, \dot{Y}, \dot{Z})$ are rotated to the local horizontal system where the components are called $(\dot{X}', \dot{Y}', \dot{Z}')$ by

$$\begin{pmatrix} \dot{X}' \\ \dot{Y}' \\ \dot{Z}' \end{pmatrix} = \begin{pmatrix} \cos\Phi & 0 & \sin\Phi \\ 0 & 1 & 0 \\ -\sin\Phi & 0 & \cos\Phi \end{pmatrix} \begin{pmatrix} \cos\Theta & \sin\Theta & 0 \\ -\sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \dot{X} \\ \dot{Y} \\ \dot{Z} \end{pmatrix}$$

the spherical set may then be obtained as follows:

$$V = \sqrt{\dot{X}^2 + \dot{Y}^2 + \dot{Z}^2}$$

$$\Gamma = \arcsin \frac{\dot{X}'}{V}, \qquad -90 \text{ deg} \leq \Gamma \leq 90 \text{ deg}$$

$$\Sigma = \arctan \frac{\dot{Y}'}{\dot{Z}'}, \qquad 0 \text{ deg} \leq \Sigma < 360 \text{ deg}$$

USE

Calling sequences:

a. Spherical to cartesian:

```
CALL   RVIN
PZE    ,,A
PZE    ,,B
PZE    ,,C
```

where A, ···, A + 5 contain the input R, Φ, Θ, V, Γ, Σ; the output variables X, Y, Z are placed in B, B + 1, B + 2 and $\dot{X}$, $\dot{Y}$, $\dot{Z}$ are placed in C, C + 1, C + 2.

b. Cartesian to spherical:

```
CALL   RVOUT
PZE    1,,A
PZE    1,,B
PZE    1,,C
```

where A, A + 1, A + 2 contain the input X, Y, Z and B, B + 1, B + 2 contain the input $\dot{X}$, $\dot{Y}$, $\dot{Z}$. The output variables R, Φ, Θ, V, Γ, Σ are placed in C, ···, C + 5.

CODING INFORMATION

Length of subroutine is 200(10) or 310(8) words.

REFERENCE

Holdridge, D. B., Space Trajectories Program for the IBM 7090 computer, Technical Report No. 32-223, Revision No. 1, Jet Propulsion Laboratory, Pasadena, California, September 1, 1962.

IDENTIFICATION

SAVEIT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To write labeled binary tapes with information for reading contained in the label. These tapes will be used by the subroutine READIT.

RESTRICTIONS

Subroutines WRITEB, ENDFIL, BSREC are called.

METHOD

This subroutine is designed to be a companion to the subroutine READIT. It is designed to write "SAVE" tapes which normally contain trajectory information only at discrete time points along the S/C path. These tapes will be used for input to plotting programs or other programs requiring trajectory information only at discrete time points. It is felt that by correct usage of this program, other needs for retaining the information on magnetic tapes can be serviced. TAPIO is used by this subroutine to obtain asynchronous operation. The burden of supplying a buffer area is left to the user. The tape written is labeled with BCD information supplied by the user via tables. Data record lengths are always equal within one file. The length of the data records is defined by initializing information. A binary record is the first record made for each file of information and is of a fixed length. Following this is a BCD record containing labeling information for the file and for each of the data words in the data records. These two records are written on the tape upon successful execution of the initialization calling sequence. Data records are written on the tape by successful execution of the execution calling sequence.

USE

Initialization calling sequence:

```
CALL SAVEIT
PZE FLC
PZE L(F)
PZE L(HEAD)
PZE L(N2)
PZE L(MAIN)
PZE L(N3)
PZE L(NAME)
```

```
PZE L(N4)
PZE L(TABLE)
PZE L(N5)
PZE L(TABLE1)
PZE L(TABLE2)
TSX L(ERROR)
RETURN
```

FLC — is the logical tape number or unit control block communication cell.

F — is the file number (fixed point) for identification.

HEAD — is the name of a BCD table of labeling information for the file.

N2 — is the number of words in the table HEAD (fixed point).

MAIN — is the name of a BCD table containing one word labels in the main data table in each data record.

N3 — is the number of words in the table MAIN and therefore the number of words in each main table in the data records (fixed point).

NAME — is the name of a BCD table containing the names of each subtable within a data record. (Each data record contains the same number of subtables and all corresponding subtables in each data record have the same name.) The names are placed in the table name in the same order that their subtable appears in the data record. Each subtable name entry consists of 4 BCD words.

N4 — is the number of subtables found in each data record. The length of the table name is therefore (N4· 4).

TABLE — is a BCD table containing the labels of the entries in a subtable, one word for each data word in a subtable (it is assumed that the names of corresponding data words in two or more subtables are the same).

N5 — is the number of words in the table TABLE and therefore the number of words in each subtable (fixed point).

TABLE1 — is the name of a binary table containing N3 words of main table data words (This table is filled some time prior to the execution of each execution entry).

TABLE2 — is the name of a binary table containing N4·N5 words of subtable data words, the first N5 words representing the first subtable, the next N5 words, the second subtable, etc. (This table is filled some time prior to the execution of each execution entry.)

1. The length of the BCD record which is the second record written on the tape is N1 words where

$$N1 = N2 + N3 + (N4 \cdot 4) + N5 + 1$$

2. The first record written is always 8 words long and contains in order:

   F
   N1
   N2
   N3
   N4
   N5
   Format type 0 = FAP
   Check sum

3. The third record written and all succeeding records written in the file are $N3 + (N4 \cdot N5) + 1$.

K Upon return an integer will be placed in the accumulator, as follows:

1 = normal return.
2 = physical end of tape has been encountered while attempting to write.

The subroutine assumes all tables in the user's FAP program have been defined as blocks starting with symbols (BSS).

Execution calling sequence:

```
CALL SAVEIT
TSX L(ERROR)
RETURN
```

where ERROR is the name of an error return subroutine supplied by the user.

End-of-file calling sequence:

```
CALL FILE
TSX L(ERROR)
RETURN
```

Return indicators are the same as those for the execution entry.

1 = normal return. All buffers will have been dumped to tape and an end of file placed after the last recorded data record. An eight word trailer record will have been written identical to the binary record initially recorded on tape with one exception: F will have the value -377777777777. A subsequent entry into SAVEIT initialization routine for another file will replace the dummy record with the binary identification record of the next. When searching for a specific file, READIT will distinguish the logical files by the tape marks and the end of recorded data by the dummy record placed on tape by the last Call File entry.

This routine assumes that each file to be written will always contain the complete tabular structure; i. e., HEADING, MAIN items and SUBTABLE items.

CODING INFORMATION

Length of subroutine is 110 (10) or 156 (8) words.

IDENTIFICATION 37

SEITE/CASE/EJECT/EJECT1/LINES/PAGBCD
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To eject the page, set up and print the first three lines (heading) of each page.

RESTRICTIONS

a. Subroutine PROUT is called. DATCEL is referenced indirectly and contains the BCD date of loading of the program.

b. Entries are provided for locations CASE, EJECT, EJECT1, LINES and PAGBCD, where

C(CASE) = case number
C(EJECT) = page count
C(EJECT1) = line count
C(LINES) = 63: number of lines to be put on a page
C(PAGBCD through PAGBCD+39) = page heading.

METHOD

a. The page number, N, is incremented by 1.
b. The case number, C, is computed.
c. A page eject is given.
d. "Case C IBSYS-JPTRAJ-SFPRO C(DATCEL) N" is printed.
e. The 40 BCD words at PAGBCD are printed on two lines.
f. The line count is set to 3.

USE

Calling sequence:

```
CALL    SEITE
return
```

CODING INFORMATION

Length of subroutine is 129(10) or 201(8) words.

IDENTIFICATION

SPASM
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

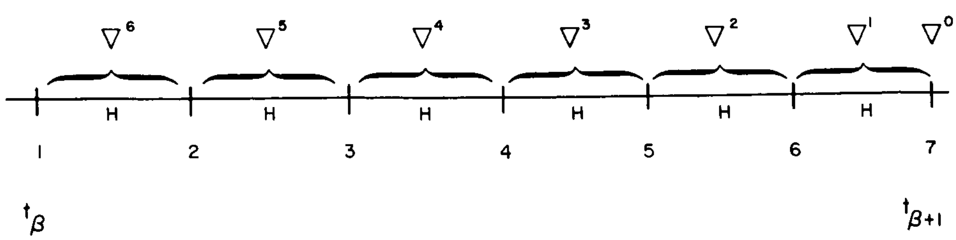
To sum sixth-order backward differences to obtain the values of the n-dependent variable of the differential equations and their derivatives, and then to interpolate for some epoch in the range of the difference array.

RESTRICTIONS

a. An external buffer, HBANK, is required.
b. The error exit is taken whenever an independent variable trigger epoch is equal to a time earlier than the left end of the step being taken.
c. Entries HC, NI, TGLO, Y, YDOT, Y(2), Y0, Y0(2), BABTB, DELX, J, HD, ND, SET, and JJ are provided for communication with other subroutines.

METHOD

This subroutine is a modification of the subroutine MARK (see Reference). Nominally the order of differences is 6, t_β is the epoch at the left end of the interval and $t_{\beta+1}$ is the epoch at the right end of the interval. ∇^i, i = 1, · · ·, 6 designates the i^{th} backward differences. ∇^0 designates the n derivatives at $t_{\beta+1}$. The following sketch relates these parameters:



SPASM sums the equally spaced backward differences to obtain the values of the n-dependent variables of the differential equations from t_β to $t_{\beta+1}$ at each stepsize interval, H. By differentiation, an interpolation formula may be derived for obtaining derivatives as well. Thus, given the $\nabla^0, \cdots, \nabla^6$ and the values of the n-dependent variables of the differential equations at $t_{\beta+1}$, both the dependent variables and their derivatives may be obtained by interpolation for any epoch between t_β and $t_{\beta+1}$.

USE

Same as for MARK (see Reference, page 6.31).

CODING INFORMATION

Length of subroutine is 1366(10) or 2526(8) words.

REFERENCE

White, R. J. et al., SPACE--Single Precision Cowell Trajectory Program, Technical Memorandum 33-198, Jet Propulsion Laboratory, Pasadena, California, January 15, 1965.

IDENTIFICATION 39

SPRAY
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To decode the input quantity GROP into twelve flags and to store the flags into GROPS to GROPS +11 before and after transformation by EFFECT.

RESTRICTIONS

a. It is assumed that parameter GROP contains 12 octal group output option flags, each octal digit being a flag.
b. GROPS to GROPS +11, in COMMON, are used. GROP is referenced indirectly.

METHOD

Each of the twelve octal digits in GROP is placed in bits 33 - 35 in an otherwise zero accumulator. These twelve words are stored sequentially into GROPS to GROPS +11.

USE

Calling sequence:

```
CALL    SPRAY
return
```

CODING INFORMATION

Length of subroutine is 10(10) or 12(8) words.

IDENTIFICATION 40

SQRT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute $\sqrt{x}$ for a normalized floating point, single precision x.

RESTRICTIONS

a. An error return will occur if the argument is negative, in which case the accumulator will contain $\sqrt{|x|}$.
b. Uses COMMON to COMMON +3.

METHOD

The Newton Raphson method is used to compute the square root of x where

$$0 \leq x \leq 2^{128}.$$

Accuracy: The result is accurate to 8 decimal digits.

USE

Enter with the argument in the accumulator. Exit with the result in the accumulator.
Calling sequence:

```
CLA        X
CALL       SQRT
error return
normal return
```

CODING INFORMATION

Length of subroutine is 41(10) or 51(8) words.

IDENTIFICATION

TIME1/TIME2/TIME3/LAUNCH
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To compute and print the calendar date, the Julian date and the trajectory time, given the double precision seconds past 0^h January 1, 1950.

RESTRICTIONS

a. DAYS, FIXT, ADD, FIX, FLOAT, GRUPPE and PROUT are called.
b. OPRFLG, EQUNX1, TARBCD and INJEQX are used.
c. A double precision number is assumed to be two floating point words.
d. The entry LAUNCH is provided to allow access to the launch epoch if it is input.

METHOD

a. Subroutine DAYS is used to obtain the integral days and residual seconds past 0^h January 1, 1950. The Julian date (JD) is then computed as a one word floating point integer and a one word floating point fraction using the following relations:

integral JD = integral days from 0^h January 1, 1950, to date +2433282, the Julian date of 12^h January 0, 1950 +I

fractional JD = residual days -0.5 + (1-I)

where I = 0 if residual days $<$ 0.5
= 1 if residual days $\geq$ 0.5

b. The calendar date is computed by calling subroutine FIXT.
c. The trajectory time is computed using the following relation:
trajectory time = current epoch minus injection epoch.
d. If LAUNCH is non-zero, then an additional line is printed in the TIME1 entry, giving TFL the trajectory time from launch using the following relation:
TFL = current epoch minus launch epoch.

USE

Enter with the time in double precision seconds past 0^h January 1, 1950, in the AC and MQ.

The three entries provide for three output formats as follows:

TIME1: X DAYS X HRS. X MIN. X.XXX SEC., C(EQUNX1), Octal sec past 50, JD, calendar date

TIME2: INJECTION CONDITIONS, C(INJEQX), C(TARBCD), Octal sec past 50, JD, calendar date

TIME3: EPOCH OF PERICENTER PASSAGE, Octal sec past 50, JD, calendar date

Calling sequence:

```
CLA     L(SECONDS A)
LDQ     L(SECONDS B)
CALL    TIME1 (or TIME2 or TIME3)
return
```

CODING INFORMATION

Length of subroutine is 235(10) or 353(8) words.

IDENTIFICATION 42.1

TRAJ
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To provide the control and closed subroutines needed to drive the subroutine SPASM.

RESTRICTIONS

Since TRAJ is the driver subroutine for SFPRO, numerous entries and transfer vectors are used for communication and control.

METHOD

TRAJ performs the following tasks:

a. Initializes triggers on the basis of input parameters.
b. Converts BCD input to integers via subroutine BCDNO.
c. Converts sexagesimal input to seconds past 0 hr January 1, 1950 via subroutines FLOT or FLOTT.
d. Obtains injection conditions, physical constants and other data defining the trajectory from the identification record of the spacecraft ephemeris tape.
e. Initializes the n-body ephemerides by calling EPHSET and INTR1.
f. Sets control flags and branches on the basis of input parameters.
g. Obtains the proper set of phase parameters and initializes triggers on the basis of those parameters.
h. Calls SPASM.
i. Supplies SPASM with derivative, end-of-step, step-size control and trigger subroutines as required.
j. Terminates a phase (and repeats starting at g above) or terminates the run and returns to JPTRAJ via JEXIT or ABORT.

USE

Calling sequence:

```
CALL   TRAJ
return
```

CODING INFORMATION

Length of subroutine is 1943(10) or 3627(8) words.

IDENTIFICATION 42.2

FLOTT
JPL Staff
IBM 7094 Fap
December 2, 1964

PURPOSE

To convert a sexagesimal date or an interval past the initial epoch, to seconds past 0 hr January 1, 1950.

RESTRICTIONS

a. FLOTT is a subset of the driver, TRAJ.
b. Subroutine FLOT is called to make the time conversion.
c. T(0) in COMMON is used.

METHOD

Subroutine FLOT is called to get the time in seconds past 0 hr January 1, 1950. However, if this number is less than 1×10^8 then the assumption is made that the input time was a time interval past the initial epoch. In this case the input interval, converted to seconds, is added to T(0), the initial epoch.

USE

Calling sequence:

```
CALL   FLOTT
PPP    A, N, B
```

where

A, N and A+1, N — contain the input time
B, PPP and B+1, PPP — contain the output seconds past 0 hr January 1, 1950

and PPP is the FAP code for 0, 1, · · · , 7 designating the index register to use to locate the output storage cell.

CODING INFORMATION

Length of subroutine (includes FLOTT as a subset) is 1943(10) or 3627(8) words.

IDENTIFICATION 43

WOLF/TIM/MACH
Peter S. Fisher, JPL
IBM 7094 Fap
December 2, 1964

PURPOSE

To print an explanatory comment at injection and at each phase change.

RESTRICTIONS

a. Subroutines PRSET, TIME1, PROUT, GRUPPE and TIME are called.
b. OPRFLG is set non-zero to signify that if on-line print has been requested then the line generated by this subroutine is also to be printed on-line. KERN1 is referenced to obtain the BCD name of the central body for integration.
c. Entries TIM and MACH have been provided to allow access to the time of day and computer I. D. character.
d. It is assumed that the date has been provided by the system at SYSDAT, octal location 101.

METHOD

A test is made to see if the current epoch, T, is injection epoch. If so, then subroutine TIME is called to obtain the time of day and computer I. D. character. Then the following comments are printed on one line:

DATE OF RUN MMDDYYC TTTRRS BBBBBB IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

Where MM is the month, DD is the day, YY is the year, C is the computer I. D. character, TTT is the hour of day, RR is minutes, and S is the tens of seconds. BBBBBB is the name of the body currently used as the central body for integration.

If the current epoch is not injection epoch then TIME1 is called to print the time line and then the following comments are printed on one line:

CHANGE OF PHASE OCCURS AT THIS POINT BBBBBB IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

Where BBBBBB is the name of the body currently used as the central body for integration.

USE

```
Calling sequence:  CALL    WOLF
                   return
```

CODING INFORMATION

Length of subroutine is 77(10) or 115(8) words.

VII. CHECK CASES

Four check cases have been used for several years by JPL trajectory engineers to confirm that the version of the trajectory program being released for use is computationally correct. In addition, other trajectories are run which check the options not used by the four standard cases.

```
      SOURCE PROGRAM LISTING                                  4/17/65     PAGE 1

*       SPACE    Z
            REWSC=1
            RUNID=(TRAJ01)                                                     C
            SCFORF=1
            PAGBCD=(EARTH-MOON FINE PRINT CHECK 1)                             C
            TARBCD=(MOON) INJBCD =(EARTH)                                      C
            FAZFLG=1 INJTYP=0 INJEQX=(1950.0)                                  C
            INJT=630101316,4201297                                             C
            INJX=215563036320/8,214523646526/8,612554325025/8                  C
            INJDX=603416475431/8,204420666560/8,603534774303/8                 C
*C1                                                                            C
            MOOPH1+11=2,0,0,3000000,200,0,4,0,400,0,400,0                      C
            MOOPH1+27=110000000000/8                                           C
            MOOPH1+38=101000000000/8                                           C
            MOOPH2+11=400,0,0,3000000                                          C
            MOOPH2+11=400,0,4,0                                                C
            MOOPH2+27=1100000/8                                                C
            MOOPH2+38=1011/8                                                   C
            MOOPH2+38=1111/8                                                   C
            MOOPH2+27=111101100000/8                                           C
*C2                                                                            C
*       SPACE    Z
            RUNID=(TRAJ02)
            SCFORF=1
            PAGBCD+8=(   CHECK 2   )       .
        PAGBCD=(EARTH-VENUS, RADIATION PRES. ON)
        INJBCD=(EARTH) TARBCD=(VENUS) INJTYP=0
        INJT=620900500,2332000
        INJX=625535030676/8,625730425255/8,621606475633/8
        INJDX=601700261755/8,602465443457/8,575673744666/8
        INJEQX=(1950.0)
        RADCPT=.102E9,0,0,3.83,.383,198.22
*C3
        VENPH1+11=4000,0,1000,0,20000,0,20000,0
        VENPH1+27=152400000000/8  VENPH1+38=100001000000/8
        VENPH2+0=5,(VENUS),2.5E6,(VENUS),0
        VENPH2+11=6000,0,1000,0,20000,0,20000,0
        VENPH2+27=152400000000/8  VENPH2+38=100001000000/8
        VENPH3+11=20000,0,200,0
        VENPH3+27=152402200000/8  VENPH3+38=100001000100/8
*C4
*       SPACE    Z
            RUNID=(TRAJ03)
            SCFORF=1
            PAGBCD = (    EARTH - MARS                  CHECK 3   )
            TARBCD=(MARS)   INJBCD=(EARTH)   FAZFLG =1    INJTYP=0
            INJT=641101116,3923043
            INJX=215522623366/8,213675042633/8,614630127306/8
            INJDX=602532206172/8,204542657366/8,200624303772/8
            INJEQX=(1950.0)
*C5
            MARPH1+27=110000000000/8  MARPH1+38=101000000000/8
            MARPH2+27=002100000000/8   MARPH2+38=01100000/8
            MARPH3+27=102002100000/8    MARPH3+38=0100/8
            MARPH3+27=102002100000/8    MARPH3+38=1011/8
*C6
* X     SPACE    Z
            RUNID=(TRAJ04)


      SOURCE PROGRAM LISTING                                  4/17/65     PAGE 2

            SCFORF=1
        PAGBCD=(EARTH-MOON)
        TARBCD=(MOON) INJBCD=(EARTH) INJTYP=0
        INJT=630800617,0455707
       INJX=615576114061/8,614444767212/8,612420651171/8
        INJDX=202703617723/8,604431537501/8,603535320551/8
        INJEQX=(1950.0)
        PAGBCD+7=(CHECK 4)
*C7
    MOOPH1+27=111000000000/8  MOOPH1+38=103000000000/8
        MOOPH2+27=151001100000/8  MOOPH2+38=100000001031/8
*C8
*       SFPRO    Z
            RUNID=(TRAJ01)
*       USE       C1,C2
            MOOPH1+11=2,0,0,3000000,200,0,4,0,400,0,400,0                      C.001
            MOOPH1+27=110000000000/8                                           C.001
            MOOPH1+38=101000000000/8                                           C.001
            MOOPH2+11=400,0,0,3000000                                          C.001
            MOOPH2+11=400,0,4,0                                                C.001
            MOOPH2+27=1100000/8                                                C.001
            MOOPH2+38=1011/8                                                   C.001
            MOOPH2+38=1111/8                                                   C.001
            MOOPH2+27=111101100000/8                                           C.001
*       SFPRO    Z
            RUNID=(TRAJ02)
*       USE       C3,C4
        VENPH1+11=4000,0,1000,0,20000,0,20000,0                                 .001
        VENPH1+27=152400000000/8  VENPH1+38=100001000000/8                      .001
        VENPH2+0=5,(VENUS),2.5E6,(VENUS),0                                      .001
        VENPH2+11=6000,0,1000,0,20000,0,20000,0                                 .001
        VENPH2+27-152400000000/8  VENPH2+38=100001000000/8                      .001
        VENPH3+11=20000,0,200,0                                                 .001
        VENPH3+27=152402200000/8  VENPH3+38=100001000100/8                      .001
VENPH1+30=010000000000/8 VENPH3+30=010000000000/8  VENPH2+4=-120E6
*       SFPRO    Z
            RUNID=(TRAJ03)
*       USE       C5,C6
            MARPH1+27=110000000000/8  MARPH1+38=101000000000/8                  .001
            MARPH2+27=002100000000/8   MARPH2+38=01100000/8                     .001
            MARPH3+27=102002100000/8    MARPH3+38=0100/8                        .001
            MARPH3+27=102002100000/8    MARPH3+38=1011/8                        .001
MARPH1+30=010100000000/8 MARPH3+30=010100000000/8
*       SFPRO    Z
            RUNID=(TRAJ04)
*       USE       C7,C8
    MOOPH1+27=111000000000/8  MOOPH1+38=103000000000/8                          .001
        MOOPH2+27=151001100000/8  MOOPH2+38=100000001031/8                      .001
*Z
*       END

                 THERE WERE NO GLARING SOURCE DECK ERRORS.

                 THE OBJECT STRING HAS 00623 OCTAL OR  403 DECIMAL WORDS.
```

A. Check case 1 is an Earth-Moon trajectory with a fine print. The spacecraft injects near the Earth on January 13, 1963 and impacts the Moon after a 66.08-hour flight time.

```
        START TRAJECTORY (SFPRO)       016390      G


CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                         1


EARTH-MOON FINE PRINT CHECK 1

DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1
S/C EPHEMERIS WRITTEN  016265G       041765 RUNID=(TRAJ01)

  GME  .39860063 06      J  .16234500-02      H -.57499999-05      D  .78749999-05     RE  .63781650 04     REM  .63783112 04
    G  .66709998-19      A  .88781796 29      B  .88800194 29      C  .88836976 29    OME  .41780741-02      AU  .14959850 09
  GMM  .49026293 04    GMS  .13271411 12    GMV  .32476627 06    GMA  .42977367 05    GMC  .37918700 08     GMJ  .12670935 09
  EGM  .39860320 06    MGM  .49027779 04     JA  .29200000-02     HA  .00000000 00     DA  .00000000 00      RA  .34170000 04

INJECTION CONDITIONS   1950.0    MOON        235610215276202246010000 J.D.= 2438043.27918167  JAN. 13,1963 18 42 01.297

GEOCENTRIC        XO .59369501 04  YO .27186042 04  ZO-.72683219 03 DXO-.42284408 01 DYO .85267773 01 DZO-.54530145 01
CARTESIAN         TO .67321297 05 GHA .33026725 02 GHD .11175336 03
DATE OF RUN 041765G 016394                 EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   0 DAYS   0 HRS.   0 MIN.   0.000 SEC.       235610215276202246010000 J.D.= 2438043.27918167  JAN. 13,1963 18 42 01.297

       GEOCENTRIC                                                                                   EQUATORIAL COORDINATES

    X  .59300736 04      Y  .27355045 04      Z -.72154209 03     DX -.42459721 01     DY  .85145659 01      DZ -.54584695 01
    R  .65703410 04    DEC -.63048288 01     RA  .24763570 02      V  .10969093 02    PTH  .16309296 01      AZ  .11984846 03
    R  .65703408 04    LAT -.63048288 01    LON  .35173684 03     VE  .10558881 02    PTE  .16943087 01     AZE  .12113527 03
   XS  .57180681 08     YS -.12437799 09     ZS -.53932928 08    DXS  .27926580 02    DYS  .10710362 02     DZS  .46452519 01
   XM -.36756323 06     YM  .12677916 06     ZM  .79800081 05    DXM -.40581204 00    DYM -.85550278 00     DZM -.29049915 00
   XT -.36756323 06     YT  .12677916 06     ZT  .79800081 05    DXT -.40581204 00    DYT -.85550278 00     DZT -.29049915 00
   RS  .14713360 09     VS  .30270378 02     RM  .39691779 06     VM  .99043331 00     RT  .39691779 06      VT  .99043331 00
  GED -.63474453 01    ALT  .19239502 03    LOS  .26166316 03    RAS  .29468988 03    RAM  .16096976 03     LOM  .12794304 03
  DUT  .35000000 02     DT  .75000000 01     DR  .31219413 00    SHA -.65653256 04    DES -.21503466 02     DEM  .11598331 02
  CCL  .10757921 03    MCL  .19058408 03    TCL  .19058408 03

                                                      GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    235610215265202567120360 J.D.= 2438043.27878392  JAN. 13,1963 18 41 26.931
  SMA  .39375093 06    ECC  .96332708 00      B  .71601901 05    SLR  .13020490 05    APO  .78093687 06     RCA  .65649734 04
   VH  .92250068-01     C3 -.10123167 01     C1  .72041483 05    TFP  .34366082 02     TF -.95461337-02     PER  .40981892 05
   TA  .32895214 01    MTA  .18000000 03     EA  .30168731 00     MA  .50314046-02    C3J -.12654848 01     TFI  .00000000 00

                                                           ALL VECTORS REFFERENCED TO EARTH EQUATOR PLANE
    X  .59300736 04      Y  .27355045 04      Z -.72154209 03     DX -.42459721 01     DY  .85145659 01      DZ -.54584695 01
  INC  .30446937 02    LAN  .19392943 03    APF  .18922662 03     MX -.41294011 00     MY  .76469264 00      MZ -.49469753 00
   WX -.12198597 00     WY  .49183847 00     WZ  .86209882 00     PX  .92475982 00     PY  .37177615 00      PZ -.81250652-01
   QX -.36046998 00     QY  .78732290 00     QZ -.50018393 00     RX -.75386592-01     RY -.30307261-01      RZ -.99669364 00
   BX  .36046999 00     BY -.78732293 00     BZ  .50018395 00     TX  .37300945 00     TY -.92782754 00      TZ  .00000000 00
  DAP -.46604574 01    RAP  .21901339 02

  BTQ  .61332682 05    BRQ -.35932925 05      B  .71601901 05    THA  .32987798 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                           ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.97660076 03      Y -.63914189 04      Z -.11668206 04     DX  .70016068 01     DY  .14831275 00      DZ -.84425396 01
  INC  .51745310 02    LAN  .73114849 02    APF  .18978106 03     MX  .64280274 00     MY  .41223896-01      MZ -.76492172 00
   WX  .75141259 00     WY -.22808386 00     WZ  .61915821 00     PX -.18558176 00     PY -.97353108 00      PZ -.13340412 00
   QX  .63319708 00     QY -.14662936-01     QZ -.77385170 00     RX  .24980654-01     RY  .13104436 00      RZ -.99106173 00
   BX -.63319708 00     BY  .14662936-01     BZ  .77385170 00     TX -.98231125 00     TY  .18725550 00      TZ  .00000000 00
  DAP -.76663494 01    RAP  .25920733 03

  BTO  .44731560 05    BRO -.55907510 05      B  .71600014 05    THA  .30866328 03     T VECTOR IN  ORBIT PLANE OF TARGET


CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                         2


EARTH-MOON FINE PRINT CHECK 1

   0 DAYS   0 HRS.  30 MIN.   0.000 SEC.       235610216200202246010000 J.D.= 2438043.30001501  JAN. 13,1963 19 12 01.297

       GEOCENTRIC                                                                                   EQUATORIAL COORDINATES

    X -.64378004 04      Y  .10748353 05      Z -.70365115 04     DX -.68642236 01     DY  .18130742 01      DZ -.20008014 01
    R  .14369581 05    DEC -.29319621 02     RA  .12091979 03      V  .73761785 01    PTH  .47189491 02      AZ  .81460855 02
    R  .14369581 05    LAT -.29319621 02    LON  .80372532 02     VE  .67959470 01    PTE  .52772510 02     AZE  .79570004 02
   XS  .57231149 08     YS -.12435870 09     ZS -.53924563 08    DXS  .27924342 02    DYS  .10719672 02     DZS  .46492855 01
   XM -.36828984 06     YM  .12523797 06     ZM  .79276364 05    DXM -.40153671 00    DYM -.85692245 00     DZM -.29140573 00
   XT -.36828984 06     YT  .12523797 06     ZT  .79276364 05    DXT -.40153671 00    DYT -.85692245 00     DZT -.29140573 00
   RS  .14713378 09     VS  .30270383 02     RM  .39699710 06     VM  .99018437 00     RT  .39699710 06      VT  .99018437 00
  GED -.29486055 02    ALT  .79965527 04    LOS  .25416511 03    RAS  .29471237 03    RAM  .16121925 03     LOM  .12067200 03
  DUT  .35000000 02     DT  .59999999 02     DR  .54112033 01    SHA  .11194083 05    DES -.21499938 02     DEM  .11518834 02
  CCL  .19864886 03    MCL  .27964880 03    TCL  .27964880 03

                                                      GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    235610215265202616021000 J.D.= 2438043.27878598  JAN. 13,1963 18 41 27.110
  SMA  .37239032 06    ECC  .98236781 00      B  .69621550 05    SLR  .13016341 05    APO  .73821458 06     RCA  .65660576 04
   VH  .97573257-01     C3 -.10703840 01     C1  .72030006 05    TFP  .18341874 04     TF -.94964876-02     PER  .37692696 05
   TA  .95501059 02    MTA  .18000000 03     EA  .11855552 02     MA  .29196966 00    C3J -.13245463 01     TFI  .50000000 00

                                                           ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.64378004 04      Y  .10748353 05      Z -.70365115 04     DX -.68642236 01     DY  .18130742 01      DZ -.20008014 01
  INC  .30431388 02    LAN  .19387282 03    APF  .18930823 03     MX -.88573875 00     MY -.44576431 00      MZ  .12946433 00
   WX -.12144386 00     WY  .49173155 00     WZ  .86223631 00     PX  .92460809 00     PY  .37200548 00      PZ -.81925175-01
   QX -.36104164 00     QY  .78728136 00     QZ -.49983677 00     RX -.76004171-01     RY -.30579408-01      RZ -.99663844 00
   BX  .36104185 00     BY -.78728138 00     BZ  .49983678 00     TX  .37326021 00     TY -.92772669 00      TZ  .00000000 00
  DAP -.46992333 01    RAP  .21916826 02

  BTQ  .60232702 05    BRQ -.34916783 05      B  .69621550 05    THA  .32989921 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                           ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .93177677 04      Y  .11378919 04      Z -.10879762 05     DX  .41303026 01     DY  .52923522 01      DZ -.30560760 01
  INC  .51730000 02    LAN  .73077271 02    APF  .18983655 03     MX  .12398145 00     MY  .97031129 00      MZ  .20766445 00
   WX  .75110449 00     WY -.22852845 00     WZ  .61936802 00     PX -.18557264 00     PY -.97343368 00      PZ -.13412519 00
   QX  .63356514 00     QY -.14195721-01     QZ -.77355907 00     RX  .25116913-01     RY  .13175244 00      RZ -.99096434 00
   BX -.63356517 00     BY  .14195722-01     BZ  .77355909 00     TX -.98230949 00     TY  .18726470 00      TZ  .00000000 00
  DAP -.77080383 01    RAP  .25920679 03

  BTO  .43514059 05    BRO -.54346838 05      B  .69620777 05    THA  .30868332 03     T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS   1 HRS.   0 MIN.   0.000 SEC.       235610217102202246010000 J.D.= 2438043.32084834  JAN. 13,1963 19 42 01.297
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                      3

EARTH-MOON FINE PRINT CHECK 1

      GEOCENTRIC                                                                   EQUATORIAL COORDINATES

    X -.17560347 05     Y  .12524493 05     Z -.96155400 04    DX -.56012699 01    DY  .45820013 00    DZ -.10498419 01
    R  .23615404 05   DEC -.24027331 02    RA  .14450255 03     V  .57171968 01   PTH  .57756951 02    AZ  .70737336 02
    R  .23615404 05   LAT -.24027331 02   LON  .96434764 02    VE  .51090483 01   PTE  .71168201 02   AZE  .52398568 02
   XS  .57281411 08    YS -.12433940 09    ZS -.53916191 08   DXS  .27920100 02   DYS  .10728981 02   DZS  .46533184 01
   XM -.36900876 06    YM  .12369424 06    ZM  .78751022 05   DXM -.39725542 00   DYM -.85832345 00   DZM -.29230572 00
   XT -.36900876 06    YT  .12369424 06    ZT  .78751022 05   DXT -.39725542 00   DYT -.85832345 00   DZT -.29230572 00
   RS  .14713396 09    VS  .30270388 02    RM  .39707613 06    VM  .98993617 00    RT  .39707613 06    VT  .98993617 00
  GED -.24172374 02   ALT  .17240778 05   LOS  .24666707 03   RAS  .29473486 03   RAM  .16146849 03   LOM  .11340070 03
  DUT  .35000000 02    DT  .12000000 03    DR  .48355625 01   SHA  .19093397 05   DES -.21496406 02   DEM  .11439160 02
  CCL  .22582774 03   MCL  .30592996 03   TCL  .30592996 03

                                                 GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23561021526520260763200O J.D.= 2438043.27878542  JAN. 13,1963 18 41 27.061
  SMA  .37205792 06   ECC  .98235115 00     B  .69591952 05   SLR  .13016892 05   APO  .73754945 06   RCA  .65663906 04
   VH  .97663317-01    C3 -.10713402 01    C1  .72031531 05   TFP  .36342360 04    TF -.95100104-02   PER  .37642240 05
   TA  .11718464 03   MTA  .18000000 03    EA  .17569177 02    MA  .57928050 00   C3J -.13239474 01   TFI  .10000000 01

                                                           ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.17560347 05     Y  .12524493 05     Z -.96155400 04    DX -.56012699 01    DY  .45820013 00    DZ -.10498419 01
  INC  .30433413 02   LAN  .19386406 03   APF  .18931736 03    MX -.65751894 00    MY -.69056407 00    MZ  .30131392 00
   WX -.12137595 00    WY  .49177971 00    WZ  .86221840 00    PX  .92460810 00    PY  .37198683 00    PZ -.82009821-01
   QX -.36106468 00    QY  .78726012 00    QZ -.49985377 00    RX -.76083232-01    RY -.30609682-01    RZ -.99663148 00
   BX  .36106468 00    BY -.78726012 00    BZ  .49985377 00    TX  .37324410 00    TY -.92773318 00    TZ  .00000000 00
  DAP -.47040997 01   RAP  .21915830 02

  BTQ  .60206265 05   BRQ -.34903369 05     B  .69591952 05   THA  .32989785 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                           ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .15311712 05     Y  .10204333 05     Z -.14802373 05    DX  .27560775 01    DY  .47503466 01    DZ -.15888903 01
  INC  .51732033 02   LAN  .73070762 02   APF  .18984160 03    MX -.12431851 00    MY  .87236354 00    MZ  .47278626 00
   WX  .75109962 00    WY -.22862019 00    WZ  .61934015 00    PX -.18563194 00    PY -.97341250 00    PZ -.13419712 00
   QX  .63355362 00    QY -.14173943-01    QZ -.77356897 00    RX  .25138660-01    RY  .13182153 00    RZ -.99095464 00
   BX -.63355361 00    BY  .14173943-01    BZ  .77356896 00    TX -.98229773 00    TY  .18732638 00    TZ  .00000000 00
  DAP -.77121970 01   RAP  .25920320 03

  BTQ  .43494155 05   BRQ -.54325119 05     B  .69591379 05   THA  .30868170 03    T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS  1 HRS. 30 MIN.  0.000 SEC.     23561022000420224601000O J.D.= 2438043.34168167  JAN. 13,1963 20 12 01.297

      GEOCENTRIC                                                                   EQUATORIAL COORDINATES

    X -.26909438 05     Y  .12891467 05     Z -.11140858 05    DX -.48458458 01    DY  .13495155-01    DZ -.68978221 00
    R  .31850063 05   DEC -.20474518 02    RA  .15440238 03     V  .48947118 01   PTH  .62480507 02    AZ  .66977448 02
    R  .31850063 05   LAT -.20474518 02   LON  .98814059 02    VE  .44310939 01   PTE  .78419512 02   AZE  .35391096 03
   XS  .57331665 08    YS -.12432007 09    ZS -.53907612 08   DXS  .27915854 02   DYS  .10738289 02   DZS  .46573509 01
   XM -.36971996 06    YM  .12214801 06    ZM  .78224065 05   DXM -.39296826 00   DYM -.85970578 00   DZM -.29319913 00
   XT -.36971996 06    YT  .12214801 06    ZT  .78224065 05   DXT -.39296826 00   DYT -.85970578 00   DZT -.29319913 00
   RS  .14713413 09    VS  .30270393 02    RM  .39715486 06    VM  .98968873 00    RT  .39715486 06    VT  .98968873 00
  GED -.20602362 02   ALT  .25474498 05   LOS  .23916902 03   RAS  .29475734 03   RAM  .16171748 03   LOM  .10612916 03
  DUT  .35000000 02    DT  .24000000 03    DR  .43408934 01   SHA  .26744537 05   DES -.21492873 02   DEM  .11359310 02
  CCL  .23711064 03   MCL  .31662791 03   TCL  .31662791 03


                                     IBSYS-JPTRAJ-SFPRO 041765                                      4

EARTH-MOON FINE PRINT CHECK 1

                                                 GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23561021526520260200400O J.D.= 2438043.27878490  JAN. 13,1963 18 41 27.016
  SMA  .37196284 06   ECC  .98234627 00     B  .69583701 05   SLR  .13017132 05   APO  .73735914 06   RCA  .65665280 04
   VH  .97689426-01    C3 -.10716141 01    C1  .72032195 05   TFP  .54342813 04    TF -.95225721-02   PER  .37627811 05
   TA  .12700795 03   MTA  .18000000 03    EA  .21439325 02    MA  .66653158 00   C3J -.13233752 01   TFI  .15000000 01

                                                           ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.26909438 05     Y  .12891467 05     Z -.11140858 05    DX -.48458458 01    DY  .13495155-01    DZ -.68978221 00
  INC  .30434307 02   LAN  .19386203 03   APF  .18931955 03    MX -.52100999 00    MY -.77091448 00    MZ  .36638715 00
   WX -.12136180 00    WY  .49179718 00    WZ  .86221050 00    PX  .92460784 00    PY  .37198286 00    PZ -.82031064-01
   QX -.36107014 00    QY  .78725114 00    QZ -.49986402 00    RX -.76103050-01    RY -.30617338-01    RZ -.99662977 00
   BX  .36107013 00    BY -.78725113 00    BZ  .49986401 00    TX  .37324077 00    TY -.92773452 00    TZ  .00000000 00
  DAP -.47053206 01   RAP  .21915625 02

  BTQ  .60198679 05   BRQ -.34900009 05     B  .69583701 05   THA  .32989711 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                           ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .19672663 05     Y  .18301019 05     Z -.17101970 05    DX  .21540860 01    DY  .42715453 01    DZ -.10353782 01
  INC  .51732910 02   LAN  .73068587 02   APF  .18984280 03    MX -.23309050 00    MY  .78584616 00    MZ  .57281283 00
   WX  .75109991 00    WY -.22865144 00    WZ  .61932815 00    PX -.18565762 00    PY -.97340515 00    PZ -.13421490 00
   QX  .63354565 00    QY -.14174141-01    QZ -.77357542 00    RX  .25145530-01    RY  .13183832 00    RZ -.99095224 00
   BX -.63354567 00    BY  .14174141-01    BZ  .77357545 00    TX -.98229270 00    TY  .18735275 00    TZ  .00000000 00
  DAP -.77132250 01   RAP  .25920166 03

  BTQ  .43488317 05   BRQ -.54319335 05     B  .69583216 05   THA  .30868093 03    T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS  2 HRS.  0 MIN.  0.000 SEC.     23561022070620224601000O J.D.= 2438043.36251501  JAN. 13,1963 20 42 01.297

      GEOCENTRIC                                                                   EQUATORIAL COORDINATES

    X -.35157458 05     Y  .12708409 05     Z -.12197376 05    DX -.43488279 01    DY -.19455837 00    DZ -.50112047 00
    R  .39323358 05   DEC -.18070164 02    RA  .16012653 03     V  .43819264 01   PTH  .65289371 02    AZ  .65085562 02
    R  .39323357 05   LAT -.18070165 02   LON  .97017682 02    VE  .41922472 01   PTE  .71719590 02   AZE  .30593275 03
   XS  .57381912 08    YS -.12430074 09    ZS -.53899425 08   DXS  .27911605 02   DYS  .10747595 02   DZS  .46613828 01
   XM -.37042345 06    YM  .12059931 06    ZM  .77695507 05   DXM -.38867531 00   DYM -.86106942 00   DZM -.29408592 00
   XT -.37042345 06    YT  .12059931 06    ZT  .77695507 05   DXT -.38867531 00   DYT -.86106942 00   DZT -.29408592 00
   RS  .14713431 09    VS  .30270397 02    RM  .39723332 06    VM  .98944204 00    RT  .39723332 06    VT  .98944204 00
  GED -.18185229 02   ALT  .32947228 05   LOS  .23167097 03   RAS  .29477983 03   RAM  .16196623 03   LOM  .98857371 02
  DUT  .35000000 02    DT  .24000000 03    DR  .39806762 01   SHA  .33869684 05   DES -.21489336 02   DEM  .11279286 02
  CCL  .24347642 03   MCL  .32255119 03   TCL  .32255119 03

                                                 GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23561021526520257774400O J.D.= 2438043.27878471  JAN. 13,1963 18 41 26.000
  SMA  .37193564 06   ECC  .98234480 00     B  .69581531 05   SLR  .13017264 05   APO  .73730508 06   RCA  .65665992 04
   VH  .97697084-01    C3 -.10716919 01    C1  .72032559 05   TFP  .72342974 04    TF -.95270573-02   PER  .37623715 05
   TA  .13292118 03   MTA  .18000000 03    EA  .24446771 02    MA  .11536815 01   C3J -.13229201 01   TFI  .20000000 01
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CASE  1                               IBSYS-JPTRAJ-SFPRO 041765                                  5

EARTH-MOON FINE PRINT CHECK 1

                                                                     ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.35157458 05     Y  .12708409 05     Z -.12197376 05    DX -.43488279 01    DY -.19455837 00    DZ -.50112047 00
  INC  .30434887 02   LAN  .19386105 03   APF  .18932061 03    MX -.43119465 00    MY -.80850590 00    MZ  .40048648 00
   WX -.12135547 00    WY  .49180769 00    WZ  .86220537 00    PX  .92460773 00    PY  .37198076 00    PZ -.82041699-01
   QX -.36107253 00    QY  .78724552 00    QZ -.49987109 00    RX -.76112974-01    RY -.30621161-01    RZ -.99662888 00
   BX  .36107253 00    BY -.78724552 00    BZ  .49987109 00    TX  .37323899 00    TY -.92773523 00    TZ  .00000000 00
  DAP -.47053320 01   RAP  .21915515 02

  BTQ  .60196496 05   BRQ -.34899444 05     B  .69581531 05   THA  .32989661 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                                     ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .23215760 05     Y  .25658274 05     Z -.18681743 05    DX  .18088820 01    DY  .39207859 01    DZ -.74609460 00
  INC  .51733463 02   LAN  .73067059 02   APF  .18984340 03    MX -.29546519 00    MY  .72246756 00    MZ  .62509272 00
   WX  .75109959 00    WY -.22867323 00    WZ  .61932056 00    PX -.18567820 00    PY -.97339996 00    PZ -.13422402 00
   QX  .63354002 00    QY -.14178708-01    QZ -.77357991 00    RX  .25150057-01    RY  .13184673 00    RZ -.99095099 00
   BX -.63354006 00    BY  .14178709-01    BZ  .77357996 00    TX -.98228870 00    TY  .18737375 00    TZ  .00000000 00
  DAP -.77137526 01   RAP  .25920043 03

  BTO  .43486596 05   BRO -.54318169 05     B  .69581231 05   THA  .30868042 03     T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS  6 HRS.  0 MIN.  0.000 SEC.        23561022772620224601000O J.D.= 2438043.52918168  JAN. 14,1963 00 42 01.297

       GEOCENTRIC                                                                                 EQUATORIAL COORDINATES

    X -.84114400 05     Y  .65059352 04     Z -.15548877 05    DX -.28179711 01    DY -.52034270 00    DZ -.99636187-01
    R  .85786519 05   DEC -.10442625 02    RA  .17557719 03     V  .28673411 01   PTH  .72971953 02    AZ  .61241663 02
    R  .85786518 05   LAT -.10442626 02   LON  .52304021 02    VE  .60837608 01   PTE  .26785336 02   AZE  .27426584 03
   XS  .57783604 08    YS -.12414543 09    ZS -.53832072 08   DXS  .27877475 02   DYS  .10822000 02   DZS  .46936178 01
   XM -.37577210 06    YM  .10812474 06    ZM  .73410790 05   DXM -.35413399 00   DYM -.87130586 00   DZM -.30094165 00
   XT -.37577210 06    YT  .10812474 06    ZT  .73410790 05   DXT -.35413399 00   DYT -.87130586 00   DZT -.30094165 00
   RS  .14713573 09    VS  .30270437 02    RM  .39785018 06    VM  .98749717 00    RT  .39785018 06    VT  .98749717 00
  GED -.10512209 02   ALT  .79409021 05   LOS  .17168650 03   RAS  .29495966 03   RAM  .16394734 03   LOM  .40674176 02
  DUT  .35000000 02    DT  .48000000 03    DR  .27416413 01   SHA  .79254281 05   DES -.21460932 02   DEM  .10633072 02
  CCL  .25991151 03   MCL  .33699600 03   TCL  .33699600 03

                                                    GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23561021526520264571OOOO J.D.= 2438043.27878814  JAN. 13,1963 18 41 27.296
  SMA  .37210408 06   ECC  .98235293 00     B  .69597264 05   SLR  .13017238 05   APO  .73764320 06   RCA  .65665591 04
   VH  .97652204-01    C3 -.10712050 01    C1  .72032487 05   TFP  .21634001 05    TF -.94447134-02   PER  .37649367 05
   TA  .14971167 03   MTA  .18000000 03    EA  .38438245 02    MA  .34477074 01   C3J -.13210443 01   TFI  .59999999 01

                                                                     ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.84114400 05     Y  .65059352 04     Z -.15548877 05    DX -.28179711 01    DY -.52034270 00    DZ -.99636187-01
  INC  .30442654 02   LAN  .19365364 03   APF  .18932776 03    MX -.15454728 00    MY -.86732156 00    MZ  .47314763 00
   WX -.12131985 00    WY  .49193702 00    WZ  .86213670 00    PX  .92461349 00    PY  .37194855 00    PZ -.82123046-01
   QX -.36106977 00    QY  .78718004 00    QZ -.49997633 00    RX -.76189428-01    RY -.30649074-01    RZ -.99662220 00
   BX  .36106974 00    BY -.78717999 00    BZ  .49997630 00    TX  .37320917 00    TY -.92774723 00    TZ  .00000000 00
  DAP -.47106069 01   RAP  .21913674 02

  BTQ  .60205711 05   BRQ -.34914917 05     B  .69597264 05   THA  .32988939 03     T VECTOR IN  EARTH EQUATOR PLANE


CASE  1                               IBSYS-JPTRAJ-SFPRO 041765                                  6

EARTH-MOON FINE PRINT CHECK 1

                                                                     ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .41175304 05     Y  .71487404 05     Z -.23525935 05    DX  .93534122 00    DY  .27071772 01    DZ -.13405399 00
  INC  .51741021 02   LAN  .73054934 02   APF  .18984685 03    MX -.45324335 00    MY  .50319649 00    MZ  .73577425 00
   WX  .75112934 00    WY -.22885599 00    WZ  .61921698 00    PX -.18586293 00    PY -.97335636 00    PZ -.13428465 00
   QX  .63345061 00    QY -.14224354-01    QZ -.77365234 00    RX  .25186659-01    RY  .13190147 00    RZ -.99094279 00
   BX -.63345062 00    BY  .14224354-01    BZ  .77365236 00    TX -.98225282 00    TY  .18756172 00    TZ  .00000000 00
  DAP -.77172582 01   RAP  .25918947 03

  BTO  .43489594 05   BRO -.54336085 05     B  .69597091 05   THA  .30867313 03     T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS 10 HRS.  0 MIN.  0.000 SEC.        23561023674620224601000O J.D.= 2438043.69584834  JAN. 14,1963 04 42 01.297

       GEOCENTRIC                                                                                 EQUATORIAL COORDINATES

    X -.12038556 06     Y -.11858322 04     Z -.16261956 05    DX -.22807968 01    DY -.53816650 00    DZ -.13566510-01
    R  .12148473 06   DEC -.76927096 01    RA  .18056436 03     V  .23434676 01   PTH  .75345235 02    AZ  .60432451 02
    R  .12148473 06   LAT -.76927105 01   LON  .35712693 03    VE  .85737836 01   PTE  .15333528 02   AZE  .27202766 03
   XS  .58184603 08    YS -.12398905 09    ZS -.53764255 08   DXS  .27843110 02   DYS  .10896324 02   DZS  .47258164 01
   XM -.38062099 06    YM  .95511378 05    ZM  .69030420 05   DXM -.31927256 00   DYM -.88034611 00   DZM -.30737028 00
   XT -.38062099 06    YT  .95511378 05    ZT  .69030420 05   DXT -.31927256 00   DYT -.88034611 00   DZT -.30737028 00
   RS  .14713719 09    VS  .30270480 02    RM  .39844693 06    VM  .98560677 00    RT  .39844693 06    VT  .98560677 00
  GED -.77445006 01   ALT  .11510691 06   LOS  .11170200 03   RAS  .29513943 03   RAM  .16591331 03   LOM  .34247588 03
  DUT  .35000000 02    DT  .95999999 03    DR  .22672296 01   SHA  .11447679 06   DES -.21432338 02   DEM  .99767607 01
  CCL  .26498468 03   MCL  .34093882 03   TCL  .34093882 03

                                                    GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23561021526620220441OOOO J.D.= 2438043.27880827  JAN. 13,1963 18 41 29.035
  SMA  .37241584 06   ECC  .98237085 00     B  .69620343 05   SLR  .13015004 05   APO  .73826632 06   RCA  .65653729 04
   VH  .97561411-01    C3 -.10703106 01    C1  .72026306 05   TFP  .36032262 05    TF -.89615583-02   PER  .37696572 05
   TA  .15535241 03   MTA  .18000000 03    EA  .46694800 02    MA  .57350989 01   C3J -.13200759 01   TFI  .10000000 02

                                                                     ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.12038556 06     Y -.11858322 04     Z -.16261956 05    DX -.22807968 01    DY -.53816650 00    DZ -.13566510-01
  INC  .30464137 02   LAN  .19384033 03   APF  .18933858 03    MX -.57482837-01    MY -.87038283 00    MZ  .48900833 00
   WX -.12128280 00    WY  .49227853 00    WZ  .86194666 00    PX  .92463905 00    PY  .37185250 00    PZ -.82269809-01
   QX -.36101673 00    QY  .78701159 00    QZ -.50027925 00    RX -.76328626-01    RY -.30696292-01    RZ -.99661008 00
   BX  .36101680 00    BY -.78701174 00    BZ  .50027934 00    TX  .37311734 00    TY -.92778416 00    TZ  .00000000 00
  DAP -.47190468 01   RAP  .21908003 02

  BTQ  .60213148 05   BRQ -.34948090 05     B  .69620343 05   THA  .32986885 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                                     ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .52632178 05     Y  .10674526 06     Z -.24368619 05    DX  .68707836 00    DY  .22404781 01    DZ -.45491792-02
  INC  .51762303 02   LAN  .73038647 02   APF  .18985119 03    MX -.49786965 00    MY  .41884523 00    MZ  .75940403 00
   WX  .75128417 00    WY -.22913658 00    WZ  .61892529 00    PX -.18613935 00    PY -.97329003 00    PZ -.13438261 00
   QX  .63318576 00    QY -.14246840-01    QZ -.77386869 00    RX  .25242856-01    RY  .13199047 00    RZ -.99092952 00
   BX -.63318579 00    BY  .14246841-01    BZ  .77386872 00    TX -.98219904 00    TY  .18784318 00    TZ  .00000000 00
  DAP -.77229221 01   RAP  .25917305 03

  BTO  .43484158 05   BRO -.54370099 05     B  .69620254 05   THA  .30865215 03     T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS 14 HRS.  0 MIN.  0.000 SEC.        23561024576620224601000O J.D.= 2438043.86251501  JAN. 14,1963 08 42 01.297
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CASE  1                                   IBSYS-JPTRAJ-SFPRO C41765                                        7

EARTH-MOON FINE PRINT CHECK 1

      GEOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.15085768 06     Y -.88699365 04     Z -.16157990 05    DX -.19742425 01    DY -.52734149 00    DZ  .23835855-01
    R  .15197959 06   DEC -.61030421 01    RA  .18336493 03     V  .20435975 01   PTH  .76593858 02    AZ  .60053228 02
    R  .15197959 06   LAT -.61030421 01   LON  .29976323 03    VE  .10796389 02   PTE  .10610265 02   AZE  .27127716 03
   XS  .58585506 08    YS -.12383160 09    ZS -.53695974 08   DXS  .27808509 02   DYS  .10970566 02   DZS  .47579785 01
   XM -.38496583 06    YM  .82776450 05    ZM  .64560577 05   DXM -.28413486 00   DYM -.88819066 00   DZM -.31336824 00
   XT -.38496583 06    YT  .82776450 05    ZT  .64560577 05   DXT -.28413486 00   DYT -.88819066 00   DZT -.31336824 00
   RS  .14713866 09    VS  .30270527 02    RM  .39902218 06    VM  .98377584 00    RT  .39902218 06    VT  .98377584 00
  GED -.61443159 01   ALT  .14560163 06   LOS  .51717424 02   RAS  .29531912 03   RAM  .16786486 03   LOM  .28426317 03
  DUT  .35000000 02    DT  .95999999 03    DR  .19879115 01   SHA  .14462524 06   DES -.21403552 02   DEM  .93112143 01
  CCL  .26780095 03   MCL  .34292233 03   TCL  .34292233 03

                                                     GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    23561021526720231575000O J.D.= 2438043.27886120  JAN. 13,1963 18 41 33.609
  SMA  .37281702 06   ECC  .98239812 00     B  .69641901 05   SLR  .13009046 05   APO  .73907177 06   RCA  .65622774 04
   VH  .97432780-01    C3 -.10691589 01    C1  .72009819 05   TFP  .50427688 05    TF -.76910257-02   PER  .37757500 05
   TA  .15655770 03   MTA  .18000000 03    EA  .52917723 02    MA  .80134045 01   C3J -.13193548 01   TFI  .14000000 02

                                                                  ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.15085768 06     Y -.88699365 04     Z -.16157990 05    DX -.19742425 01    DY -.52734149 00    DZ  .23835855-01
  INC  .30505725 02   LAN  .19382076 03   APF  .18935274 03    MX -.21224571-02    MY -.86811068 00    MZ  .49636590 00
   WX -.12126403 00    WY  .49292740 00    WZ  .86157843 00    PX  .92469112 00    PY  .37167308 00    PZ -.82495185-01
   QX -.36088967 00    QY  .78669020 00    QZ -.50087616 00    RX -.76543465-01    RY -.30766107-01    RZ -.99659146 00
   BX  .36088972 00    BY -.78669029 00    BZ  .50087622 00    TX  .37294428 00    TY -.92785375 00    TZ  .00000000 00
  DAP -.47320045 01   RAP  .21897315 02

  BTQ  .60207184 05   BRQ -.35001275 05     B  .69641901 05   THA  .32982854 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                  ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .61536196 05     Y  .13687808 06     Z -.23989056 05    DX  .55819511 00    DY  .19652243 01    DZ  .51000346-01
  INC  .51803762 02   LAN  .73018046 02   APF  .18985587 03    MX -.52068252 00    MY  .36901151 00    MZ  .76988296 00
   WX  .75162963 00    WY -.22953736 00    WZ  .61835676 00    PX -.18653071 00    PY -.97319575 00    PZ -.13452231 00
   QX  .63266011 00    QY -.14231440-01    QZ -.77429854 00    RX  .25322711-01    RY  .13211741 00    RZ -.99091052 00
   BX -.63266025 00    BY  .14231443-01    BZ  .77429871 00    TX -.98212273 00    TY  .18824173 00    TZ  .00000000 00
  DAP -.77309968 01   RAP  .25914980 03

  BTO  .43458500 05   BRO -.54418184 05     B  .69641799 05   THA  .30861095 03    T VECTOR IN  ORBIT PLANE OF TARGET

  O DAYS 18 HRS.  O MIN.  0.000 SEC.           235610255006202246010000 J.D.= 2438044.02918167  JAN. 14,1963 12 42 01.297

      GEOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.17770549 06     Y -.16349802 05     Z -.15653149 05    DX -.17660922 01    DY -.51121891 00    DZ  .44518640-01
    R  .17914122 06   DEC -.50128303 01    RA  .18525670 03     V  .18391325 01   PTH  .77380777 02    AZ  .59800106 02
    R  .17914122 06   LAT -.50128311 01   LON  .24149074 03    VE  .12794071 02   PTE  .80638382 01   AZE  .27091419 03
   XS  .58985707 08    YS -.12367309 09    ZS -.53627230 08   DXS  .27773671 02   DYS  .11044726 02   DZS  .47901038 01
   XM -.38880297 06    YM  .69937162 05    ZM  .60007481 05   DXM -.24876397 00   DYM -.89484113 00   DZM -.31893244 00
   XT -.38880297 06    YT  .69937162 05    ZT  .60007481 05   DXT -.24876397 00   DYT -.89484113 00   DZT -.31893244 00
   RS  .14714016 09    VS  .30270577 02    RM  .39957459 06    VM  .98200919 00    RT  .39957459 06    VT  .98200919 00
  GED -.50468166 01   ALT  .17276318 06   LOS  .35173278 03   RAS  .29549874 03   RAM  .16980278 03   LOM  .22603682 03
  DUT  .35000000 02    DT  .95999999 03    DR  .17947056 01   SHA  .17149115 06   DES -.21374574 02   DEM  .86372676 01
  CCL  .26969944 03   MCL  .34415151 03   TCL  .34415151 03


CASE  1                                   IBSYS-JPTRAJ-SFPRO C41765                                        -

EARTH-MOON FINE PRINT CHECK 1

                                                     GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    235610215271202635310000 J.D.= 2438043.27897256  JAN. 13,1963 18 41 43.230
  SMA  .37331979 06   ECC  .98243756 00     B  .69658332 05   SLR  .12997666 05   APO  .74008317 06   RCA  .65564062 04
   VH  .97257058-01    C3 -.10677190 01    C1  .71978314 05   TFP  .64818067 05    TF -.50187110-02   PER  .37833904 05
   TA  .16073869 03   MTA  .18000000 03    EA  .58032496 02    MA  .10279362 02   C3J -.13187499 01   TFI  .18000000 02

                                                                  ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.17770549 06     Y -.16349802 05     Z -.15653149 05    DX -.17660922 01    DY -.51121891 00    DZ  .44518640-01
  INC  .30574359 02   LAN  .19379468 03   APF  .18936975 03    MX  .35414986-01    MY -.86466739 00    MZ  .50109422 00
   WX -.12128732 00    WY  .49398366 00    WZ  .86096973 00    PX  .92477547 00    PY  .37139268 00    PZ -.82811715-01
   QX -.36066566 00    QY  .78615962 00    QZ -.50186919 00    RX -.76846193-01    RY -.30861668-01    RZ -.99656519 00
   BX  .36066577 00    BY -.78615988 00    BZ  .50186935 00    TX  .37267274 00    TY -.92796284 00    TZ  .00000000 00
  DAP -.47502019 01   RAP  .21880548 02

  BTQ  .60180443 05   BRQ -.35079874 05     B  .69658332 05   THA  .32976159 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                  ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .68968952 05     Y  .16372239 06     Z -.23018075 05    DX  .47611210 00    DY  .17745784 01    DZ  .81218655-01
  INC  .51872269 02   LAN  .72993168 02   APF  .18986032 03    MX -.53471193 00    MY  .33435978 00    MZ  .77607103 00
   WX  .75223636 00    WY -.23007977 00    WZ  .61741666 00    PX -.18705802 00    PY -.97306873 00    PZ -.13470900 00
   QX  .63178269 00    QY -.14159631-01    QZ -.77501594 00    RX  .25430191-01    RY  .13228689 00    RZ -.99088518 00
   BX -.63178284 00    BY  .14159634-01    BZ  .77501611 00    TX -.98201966 00    TY  .18877870 00    TZ  .00000000 00
  DAP -.77417948 01   RAP  .25911847 03

  BTO  .43403805 05   BRO -.54482885 05     B  .69658274 05   THA  .30854259 03    T VECTOR IN  ORBIT PLANE OF TARGET

  O DAYS 22 HRS.  O MIN.  0.000 SEC.           235610264026202246010000 J.D.= 2438044.19584834  JAN. 14,1963 16 42 01.297

      GEOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.20197367 06     Y -.23590486 05     Z -.14912014 05    DX -.16112623 01    DY -.49446968 00    DZ  .57519812-01
    R  .20389272 06   DEC -.41941613 01    RA  .18666195 03     V  .16864089 01   PTH  .77925660 02    AZ  .59581681 02
    R  .20389272 06   LAT -.41941613 01   LON  .18273172 03    VE  .14618480 02   PTE  .64772868 01   AZE  .27070455 03
   XS  .59385405 08    YS -.12351350 09    ZS -.53558024 08   DXS  .27738596 02   DYS  .11118803 02   DZS  .48221919 01
   XM -.39212934 06    YM  .57010689 05    ZM  .55377399 05   DXM -.21320225 00   DYM -.90030021 00   DZM -.32406026 00
   XT -.39212934 06    YT  .57010689 05    ZT  .55377399 05   DXT -.21320225 00   DYT -.90030021 00   DZT -.32406026 00
   RS  .14714168 09    VS  .30270629 02    RM  .40010285 06    VM  .98031154 00    RT  .40010285 06    VT  .98031154 00
  GED -.42226405 01   ALT  .19751463 06   LOS  .29174806 03   RAS  .29567829 03   RAM  .17172787 03   LOM  .16779764 03
  DUT  .35000000 02    DT  .95999999 03    DR  .16491006 01   SHA  .19596997 06   DES -.21345405 02   DEM  .79557309 01
  CCL  .27111373 03   MCL  .34500428 03   TCL  .34500428 03

                                                     GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    235610215276202166010000 J.D.= 2438043.27917733  JAN. 13,1963 18 42 00.922
  SMA  .37394621 06   ECC  .98249295 00     B  .69666085 05   SLR  .12978771 05   APO  .74134573 06   RCA  .65466920 04
   VH  .97020826-01    C3 -.10659304 01    C1  .71925978 05   TFP  .79200374 05    TF -.10395050-03   PER  .37929169 05
   TA  .16236954 03   MTA  .18000000 03    EA  .62428375 02    MA  .12528675 02   C3J -.13182134 01   TFI  .22000000 02
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CASE  1                          IBSYS-JPTRAJ-SFPRO 041765                                     9

EARTH-MOON FINE PRINT CHECK 1

                                                                 ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.20197367 06     Y -.23590486 05    Z -.14912014 05    DX -.16112623 01    DY -.49446968 00    DZ  .57519812-01
INC  .30678652 02   LAN  .19376253 03  APF  .18938914 03    MX  .63262731-01    MY -.86082503 00    MZ  .50495360 00
 WX -.12138116 00    WY  .49557412 00   WZ  .86004242 00    PX  .92489906 00    PY  .37098963 00    PZ -.83237212-01
 QX -.36031698 00    QY  .78534898 00   QZ -.50338718 00    RX -.77254108-01    RY -.30987677-01    RZ -.99652977 00
 BX  .36031698 00    BY -.78534898 00   BZ  .50338718 00    TX  .37228153 00    TY -.92811985 00    TZ  .00000000 00
DAP -.47746651 01   RAP  .21856396 02

BTQ  .60124433 05   BRQ -.35191135 05    B  .69666085 05   THA  .32965935 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                 ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .75414606 05     Y  .18818541 06    Z -.21705243 05    DX  .41806925 00    DY  .16307159 01    DZ  .99789828-01
INC  .51976518 02   LAN  .72963995 02  APF  .18986397 03    MX -.54396204 00    MY  .30801712 00    MZ  .78053240 00
 WX  .75319225 00    WY -.23079157 00   WZ  .61598437 00    PX -.18774776 00    PY -.97290240 00    PZ -.13495069 00
 QX  .63043616 00    QY -.14005840-01   QZ -.77611315 00    RX  .25570602-01    RY  .13250598 00    RZ -.99085231 00
 BX -.63043615 00    BY  .14005839-01   BZ  .77611313 00    TX -.98188438 00    TY  .18948108 00    TZ  .00000000 00
DAP -.77557702 01   RAP  .25907749 03

BTO  .43309357 05   BRO -.54567880 05    B  .69666017 05   THA  .30843828 03    T VECTOR IN  ORBIT PLANE OF TARGET

 1 DAYS  2 HRS.  0 MIN.  0.000 SEC.       235610273046202246010000 J.D.= 2438044.36251501  JAN. 14,1963 20 42 01.297

     GEOCENTRIC                                                                                  EQUATORIAL COORDINATES

  X -.22426698 06     Y -.30593316 05    Z -.14016070 05    DX -.14894586 01    DY -.47827064 00    DZ  .66408229-01
  R  .22677759 06   DEC -.35434440 01   RA  .18776804 03     V  .15657713 01   PTH  .78326461 02    AZ  .59353992 02
  R  .22677759 06   LAT -.35434440 01  LON  .12367354 03    VE  .16305768 02   PTE  .53960380 01   AZE  .27056998 03
 XS  .59784595 06    YS -.12335286 09   ZS -.53488356 08   DXS  .27703285 02   DYS  .11192795 02   DZS  .48542428 01
 XM -.39494248 06    YM  .44014164 05   ZM  .50676633 05   DXM -.17749132 00   DYM -.90457156 00   DZM -.32874950 00
 XT -.39494248 06    YT  .44014164 05   ZT  .50676633 05   DXT -.17749132 00   DYT -.90457156 00   DZT -.32874950 00
 RS  .14714323 09    VS  .30270684 02   RM  .40060570 06    VM  .97868743 00    RT  .40060570 06    VT  .97868743 00
GED -.35675297 01   ALT  .22039947 06  LOS  .23176327 03   RAS  .29585776 03   RAM  .17364094 03   LOM  .10954645 03
DUT  .35000000 02    DT  .95999999 03   DR  .15333855 01   SHA  .21859221 06   DES -.21316048 02   DEM  .72673895 01
CCL  .27223368 03   MCL  .34564152 03  TCL  .34564152 03

                                               GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               235610215305202630310000 J.D.= 2438043.27952766  JAN. 13,1963 18 42 31.191
SMA  .37472680 06   ECC  .98256930 00    B  .69660839 05   SLR  .12949718 05   APO  .74292581 06   RCA  .65317859 04
 VH  .96706058-01    C3 -.10637043 01   C1  .71845430 05   TFP  .93570106 05    TF  .83038806-02   PER  .38048298 05
 TA  .16366297 03   MTA  .18000000 03   EA  .66307598 02    MA  .14755473 02   C3J -.13177218 01   TFI  .26000000 02

                                                                 ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.22426698 06     Y -.30593316 05    Z -.14016070 05    DX -.14894586 01    DY -.47827064 00    DZ  .66408229-01
INC  .30830375 02   LAN  .19372335 03  APF  .18941050 03    MX  .85070010-01    MY -.85669632 00    MZ  .50875798 00
 WX -.12158215 00    WY  .49786782 00   WZ  .85868830 00    PX  .92507084 00    PY  .37043490 00    PZ -.83797006-01
 QX -.35980784 00    QY  .78415929 00   QZ -.50560126 00    RX -.77791771-01    RY -.31150898-01    RZ -.99648283 00
 BX  .35980783 00    BY -.78415926 00   BZ  .50560124 00    TX  .37174238 00    TY -.92833593 00    TZ  .00000000 00
DAP -.48068514 01   RAP  .21823116 02

BTQ  .60028069 05   BRQ -.35344919 05    B  .69660839 05   THA  .32951014 03    T VECTOR IN  EARTH EQUATOR PLANE


CASE  1                          IBSYS-JPTRAJ-SFPRO 041765                                    10

EARTH-MOON FINE PRINT CHECK 1

                                                                 ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .81140989 05     Y  .21080132 06    Z -.20174349 05    DX  .37438849 00    DY  .15162157 01    DZ  .11208100 00
INC  .52128210 02   LAN  .72930370 02  APF  .18986624 03    MX -.55003496 00    MY  .28678324 00    MZ  .78435768 00
 WX  .75461303 00    WY -.23171147 00   WZ  .61389659 00    PX -.18863579 00    PY -.97268761 00    PZ -.13526032 00
 QX  .62847095 00    QY -.13733659-01   QZ -.77771181 00    RX  .25751592-01    RY  .13278633 00    RZ -.99081009 00
 BX -.62847095 00    BY  .13733659-01   BZ  .77771181 00    TX -.98170943 00    TY  .19038541 00    TZ  .00000000 00
DAP -.77736747 01   RAP  .25902471 03

BTO  .43161171 05   BRO -.54678515 05    B  .69660798 05   THA  .30828624 03    T VECTOR IN  ORBIT PLANE OF TARGET

 1 DAYS  6 HRS.  0 MIN.  0.000 SEC.       235610302066202246010000 J.D.= 2438044.52918168  JAN. 15,1963 00 42 01.297

     GEOCENTRIC                                                                                  EQUATORIAL COORDINATES

  X -.24497662 06     Y -.37368612 05    Z -.13010890 05    DX -.13899911 01    DY -.46287676 00    DZ  .72894213-01
  R  .24815164 06   DEC -.30054642 01   RA  .18867301 03     V  .14668482 01   PTH  .78635463 02    AZ  .59085315 02
  R  .24815164 06   LAT -.30054642 01  LON  .64414211 02    VE  .17881174 02   PTE  .46129782 01   AZE  .27047738 03
 XS  .60183277 08    YS -.12319114 09   ZS -.53418227 08   DXS  .27667737 02   DYS  .11266703 02   DZS  .48862561 01
 XM -.39724057 06    YM  .30964657 05   ZM  .45911510 05   DXM -.14167205 00   DYM -.90765972 00   DZM -.33299838 00
 XT -.39724057 06    YT  .30964657 05   ZT  .45911510 05   DXT -.14167205 00   DYT -.90765972 00   DZT -.33299838 00
 RS  .14714479 09    VS  .30270740 02   RM  .40108196 06    VM  .97714125 00    RT  .40108196 06    VT  .97714125 00
GED -.30259078 01   ALT  .24177350 06  LOS  .17177636 03   RAS  .29603716 03   RAM  .17554284 03   LOM  .51284040 02
DUT  .35000000 02    DT  .95999999 03   DR  .14380882 01   SHA  .23970624 06   DES -.21286500 02   DEM  .65730077 01
CCL  .27315668 03   MCL  .34614435 03  TCL  .34614435 03

                                               GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               235610215322202110310000 J.D.= 2438043.28009913  JAN. 13,1963 18 43 20.566
SMA  .37571466 06   ECC  .98267342 00    B  .69636995 05   SLR  .12906903 05   APO  .74491946 06   RCA  .65098484 04
 VH  .96287670-01    C3 -.10609132 01   C1  .71726563 05   TFP  .10792073 06    TF  .22019148-01   PER  .38198547 05
 TA  .16473160 03   MTA  .18000000 03   EA  .69787217 02    MA  .16951545 02   C3J -.13172613 01   TFI  .30000000 02

                                                                 ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.24497662 06     Y -.37368612 05    Z -.13010890 05    DX -.13899911 01    DY -.46287676 00    DZ  .72894213-01
INC  .31046062 02   LAN  .19367679 03  APF  .18943334 03    MX  .10274311 00    MY -.85218454 00    MZ  .51305435 00
 WX -.12194079 00    WY  .50110303 00   WZ  .85675295 00    PX  .92530329 00    PY  .36968754 00    PZ -.84527670-01
 QX -.35908603 00    QY  .78244892 00   QZ -.50875226 00    RX -.78494652-01    RY -.31361064-01    RZ -.99642111 00
 BX  .35908815 00    BY -.78244916 00   BZ  .50875242 00    TX  .37101536 00    TY -.92862677 00    TZ  .00000000 00
DAP -.48468639 01   RAP  .21778253 02

BTQ  .59876006 05   BRQ -.35555236 05    B  .69636995 05   THA  .32929755 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                 ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .86316262 05     Y  .23191945 06    Z -.18495561 05    DX  .34020546 00    DY  .14217424 01    DZ  .12063117 00
INC  .52343658 02   LAN  .72892010 02  APF  .18986630 03    MX -.55360104 00    MY  .26889734 00    MZ  .78817511 00
 WX  .75666063 00    WY -.23289466 00   WZ  .61092118 00    PX -.18977354 00    PY -.97241115 00    PZ -.13565612 00
 QX  .62566011 00    QY -.13291064-01   QZ -.77998245 00    RX  .25984140-01    RY  .13314431 00    RZ -.99075599 00
 BX -.62566015 00    BY  .13291066-01   BZ  .77998251 00    TX -.98148400 00    TY  .19154418 00    TZ  .00000000 00
DAP -.77965626 01   RAP  .25895708 03

BTO  .42939624 05   BRO -.54622382 05    B  .69636951 05   THA  .30806982 03    T VECTOR IN  ORBIT PLANE OF TARGET

 1 DAYS 10 HRS.  0 MIN.  0.000 SEC.       235610311106202246010000 J.D.= 2438044.69584834  JAN. 15,1963 04 42 01.297
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   11

EARTH-MOON FINE PRINT CHECK 1

       GEOCENTRIC                                                                    EQUATORIAL COORDINATES

   X -.26437573 06    Y -.43927890 05    Z -.11923683 05   DX -.13066445 01   DY -.44824937 00   DZ  .77920893-01
   R  .26826547 06  DEC -.25474829 01   RA  .18943391 03    V  .13835891 01  PTH  .78884791 02   AZ  .58743026 02
   R  .26826546 06  LAT -.25474829 01  LON  .50108444 01   VE  .19363027 02  PTE  .40205823 01  AZE  .27041055 03
  XS  .60581443 08   YS -.12302836 09   ZS -.53347636 08  DXS  .27631951 02  DYS  .11340526 02  DZS  .49182315 01
  XM -.39902232 06   YM  .17879167 05   ZM  .41088381 05  DXM -.10578462 00  DYM -.90957011 00  DZM -.33680550 00
  XT -.39902232 06   YT  .17879167 05   ZT  .41088381 05  DXT -.10578462 00  DYT -.90957011 00  DZT -.33680550 00
  RS  .14714639 09   VS  .30270798 02   RM  .40153048 06   VM  .97567725 00   RT  .40153048 06   VT  .97567725 00
 GED -.25648203 01  ALT  .26188730 06  LOS  .11179342 03  RAS  .29621649 03  RAM  .17743443 03  LOM  .35301137 03
 DUT  .35000000 02   DT  .95999999 03   DR  .13576351 01  SHA  .25955771 06  DES -.21256762 02  DEM  .58733265 01
 CCL  .27394551 03  MCL  .34655822 03  TCL  .34655822 03

                                                  GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                   235610215345202643010000 J.D.= 2438043.28101011  JAN. 13,1963 18 44 39.274
 SMA  .37697399 06  ECC  .98281512 00    B  .69586635 05  SLR  .12845176 05  APO  .74746973 06  RCA  .64782519 04
  VH  .95729411-01   C3 -.10573690 01   CI  .71554840 05  TFP  .12224202 06   TF  .43882846-01  PER  .38390761 05
  TA  .16564213 03  MTA  .18000000 03   EA  .72937569 02   MA  .19104912 02  C3J -.13168218 01  TFI  .34000000 02

                                                               ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
   X -.26437573 06    Y -.43927890 05    Z -.11923683 05   DX -.13066445 01   DY -.44824937 00   DZ  .77920893-01
 INC  .31350122 02  LAN  .19362201 03  APF  .18945700 03   MX  .11736732 00   MY -.84706748 00   MZ  .51836459 00
  WX -.12253097 00   WY  .50563186 00   WZ  .85400401 00   PX  .92561465 00   PY  .36868698 00   PZ -.85483703-01
  QX -.35808332 00   QY  .78000422 00   QZ -.51319582 00   RX -.79415662-01   RY -.31632516-01   RZ -.99633958 00
  BX  .35808329 00   BY -.78000415 00   BZ  .51319577 00   TX  .37004149 00   TY -.92901523 00   TZ  .00000000 00
 DAP -.49038401 01  RAP  .21718177 02

 BTQ  .59645586 05  BRQ -.35842766 05    B  .69586635 05  THA  .32899712 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                               ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
   X  .91055950 05    Y  .25178535 06    Z -.16711966 05   DX  .31282303 00   DY  .13417828 01   DZ  .12680315 00
 INC  .52647988 02  LAN  .72848472 02  APF  .18986310 03   MX -.55483514 00   MY  .25325107 00   MZ  .79247826 00
  WX  .75957138 00   WY -.23442258 00   WZ  .60671023 00   PX -.19123658 00   PY -.97205318 00   PZ -.13616612 00
  QX  .62167501 00   QY -.12597343-01   QZ -.78317392 00   RX  .26284758-01   RY  .13360510 00   RZ -.99068603 00
  BX -.62167504 00   BY  .12597344-01   BZ  .78317397 00   TX -.98119198 00   TY  .19303450 00   TZ  .00000000 00
 DAP -.78260571 01  RAP  .25687007 03

 BTQ  .42615809 05  BRQ -.55010759 05    B  .69586570 05  THA  .30776428 03    T VECTOR IN  ORBIT PLANE OF TARGET

  1 DAYS 14 HRS.  0 MIN.  0.000 SEC.          235610320126202246010000 J.D.= 2438044.86251501  JAN. 15,1963 08 42 01.297

       GEOCENTRIC                                                                    EQUATORIAL COORDINATES

   X -.28266672 06    Y -.50281177 05    Z -.10770919 05   DX -.12355633 01   DY -.43423497 00   DZ  .82081237-01
   R  .28730590 06  DEC -.21484846 01   RA  .19008636 03    V  .13122360 01  PTH  .79097325 02   AZ  .58284026 02
   R  .28730590 06  LAT -.21484846 01  LON  .30549903 03   VE  .20765244 02  PTE  .35576730 01  AZE  .27036072 03
  XS  .60979093 08   YS -.12286453 09   ZS -.53276585 08  DXS  .27595929 02  DYS  .11414262 02  DZS  .49501688 01
  XM -.40028703 06   YM  .47746130 04   ZM  .36213617 05  DXM -.69868463-01  DYM -.91030888 00  DZM -.34016981 00
  XT -.40028703 06   YT  .47746130 04   ZT  .36213617 05  DXT -.69868463-01  DYT -.91030888 00  DZT -.34016981 00
  RS  .14714801 09   VS  .30270858 02   RM  .40195016 06   VM  .97429941 00   RT  .40195016 06   VT  .97429941 00
 GED -.21631122 01  ALT  .28092772 06  LOS  .51808410 02  RAS  .29639574 03  RAM  .17931661 03  LOM  .29472928 03
 DUT  .35000000 02   DT  .95999999 03   DR  .12685500 01  SHA  .27832947 06  DES -.21226835 02  DEM  .51690606 01
 CCL  .27463043 03  MCL  .34691034 03  TCL  .34691034 03
```

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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   12

EARTH-MOON FINE PRINT CHECK 1

                                                  GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                   235610215404202760610000 J.D.= 2438043.28245232  JAN. 13,1963 18 46 43.881
 SMA  .37861564 06  ECC  .98300879 00    B  .69498163 05  SLR  .12756975 05  APO  .75079853 06  RCA  .64331408 04
  VH  .94977210-01   C3 -.10527838 01   CI  .71308753 05  TFP  .13651741 06   TF  .78495979-01  PER  .38641839 05
  TA  .16643766 03  MTA  .18000000 03   EA  .75798285 02   MA  .21197347 02  C3J -.13163941 01  TFI  .38000000 02

                                                               ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
   X -.28266672 06    Y -.50281177 05    Z -.10770919 05   DX -.12355833 01   DY -.43423497 00   DZ  .82081237-01
 INC  .31781062 02  LAN  .19355781 03  APF  .18948050 03   MX  .12957496 00   MY -.84096911 00   MZ  .52533931 00
  WX -.12346662 00   WY  .51199887 00   WZ  .85006662 00   PX  .92603266 00   PY  .36733906 00   PZ -.86749742-01
  QX -.35667641 00   QY  .77647875 00   QZ -.51948179 00   RX -.80637086-01   RY -.31987156-01   RZ -.99623013 00
  BX  .35667640 00   BY -.77647673 00   BZ  .51948177 00   TX  .36872912 00   TY -.92953689 00   TZ  .00000000 00
 DAP -.49766499 01  RAP  .21637262 02

 BTQ  .59301625 05  BRQ -.36239647 05    B  .69498163 05  THA  .32857060 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                               ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
   X  .95445647 05    Y  .27058126 06    Z -.14851533 05   DX  .29068467 00   DY  .12728703 01   DZ  .13140203 00
 INC  .53078989 02  LAN  .72799048 02  APF  .18985507 03   MX -.55352363 00   MY  .23904040 00   MZ  .79779178 00
  WX  .76370744 00   WY -.23642079 00   WZ  .60071342 00   PX -.19314268 00   PY -.97158245 00   PZ -.13683361 00
  QX  .61599291 00   QY -.11522565-01   QZ -.78766767 00   RX  .26679355-01   RY  .13420749 00   RZ -.99059404 00
  BX -.61599279 00   BY  .11522563-01   BZ  .78766752 00   TX -.98080789 00   TY  .19497662 00   TZ  .00000000 00
 DAP -.78646630 01  RAP  .25875663 03

 BTQ  .42144654 05  BRQ -.55261191 05    B  .69498115 05  THA  .30733089 03    T VECTOR IN  ORBIT PLANE OF TARGET

  1 DAYS 18 HRS.  0 MIN.  0.000 SEC.          235610327146202246010000 J.D.= 2438045.02918167  JAN. 15,1963 12 42 01.297

       GEOCENTRIC                                                                    EQUATORIAL COORDINATES

   X -.30000779 06    Y -.56435753 05    Z -.95618061 04   DX -.11744021 01   DY -.42060585 00   DZ  .85814440-01
   R  .30541954 06  DEC -.17940585 01   RA  .19065365 03    V  .12503974 01  PTH  .79292513 02   AZ  .57641404 02
   R  .30541953 06  LAT -.17940585 01  LON  .24590205 03   VE  .22098914 02  PTE  .31870969 01  AZE  .27032287 03
  XS  .61376221 08   YS -.12269963 09   ZS -.53205074 08  DXS  .27559669 02  DYS  .11487912 02  DZS  .49820676 01
  XM -.40103458 06   YM -.83321843 04   ZM  .31293600 05  DXM -.33962371-01  DYM -.90988291 00  DZM -.34309058 00
  XT -.40103458 06   YT -.83321843 04   ZT  .31293600 05  DXT -.33962371-01  DYT -.90988291 00  DZT -.34309058 00
  RS  .14714964 09   VS  .30270918 02   RM  .40233996 06   VM  .97301155 00   RT  .40233996 06   VT  .97301155 00
 GED -.18062765 01  ALT  .29904135 06  LOS  .35182332 03  RAS  .29657492 03  RAM  .18119024 03  LOM  .23643865 03
 DUT  .35000000 02   DT  .95999999 03   DR  .12286261 01  SHA  .29616432 06  DES -.21196720 02  DEM  .44609135 01
 CCL  .27523752 03  MCL  .34721735 03  TCL  .34721735 03

                                                  GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                   235610215466202252610000 J.D.= 2438043.28473766  JAN. 13,1963 18 50 01.334
 SMA  .38081990 06  ECC  .98327692 00    B  .69353690 05  SLR  .12630457 05  APO  .75527131 06  RCA  .63684789 04
  VH  .93945401-01   C3 -.10466906 01   CI  .70954268 05  TFP  .15071996 06   TF  .13334370 00  PER  .38979752 05
  TA  .16714646 03  MTA  .18000000 03   EA  .78383379 02   MA  .23199731 02  C3J -.13159679 01  TFI  .42000000 02
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   13

EARTH-MOON FINE PRINT CHECK 1

                                                                    ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.30000779 06    Y -.56435753 05    Z -.95618061 04    DX -.11744021 01    DY -.42060585 00    DZ  .85814440-01
INC  .32402870 02  LAN  .19348238 03  APF  .18950222 03    MX  .13969666 00    MY -.83325221 00    MZ  .53495429 00
 WX -.12493616 00   WY  .52110191 00   WZ  .84430106 00    PX  .92660240 00    PY  .36548874 00    PZ -.88464571-01
 QX -.35468141 00   QY  .77127899 00   QZ -.52851702 00    RX -.82294132-01    RY -.32460070-01    RZ -.99607932 00
 BX  .35468134 00   BY -.77127884 00   BZ  .52851691 00    TX  .36692734 00    TY -.93024960 00    TZ  .00000000 00
DAP -.50752813 01  RAP  .21526244 02

BTQ  .58785859 05  BRQ -.36798873 05    B  .69353690 05   THA  .32795419 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                    ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .99553975 05    Y  .28844897 06    Z -.12932931 05    DX  .27294258 00    DY  .12127590 01    DZ  .13494879 00
INC  .53700903 02  LAN  .72742661 02  APF  .18983976 03    MX -.54898183 00    MY  .22555830 00    MZ  .80482420 00
 WX  .76965569 00   WY -.23909248 00   WZ  .59200045 00    PX -.19568529 00    PY -.97094692 00    PZ -.13772932 00
 QX  .60773101 00   QY -.98416972-02   QZ -.79408167 00    RX  .27210923-01    RY  .13501456 00    RZ -.99046992 00
 BX -.60773115 00   BY  .98416995-02   BZ  .79408186 00    TX -.98028916 00    TY  .19756813 00    TZ  .00000000 00
DAP -.79164734 01  RAP  .25860521 03

BTO  .41452436 05  BRO -.55602358 05    B  .69353634 05   THA  .30670511 03    T VECTOR IN  ORBIT PLANE OF TARGET

 1 DAYS 22 HRS.  0 MIN.  0.000 SEC.       2356103361662022460100000 J.D.= 2438045.19584834  JAN. 15,1963 16 42 01.297

      GEOCENTRIC                                                                               EQUATORIAL COORDINATES

  X -.31653008 06    Y -.62394955 05    Z -.82995664 04    DX -.11217080 01    DY -.40703204 00    DZ  .89533161-01
  R  .32272791 06  DEC -.14736312 01   RA  .19115127 03     V  .11966286 01   PTH  .79491225 02    AZ  .56697807 02
  R  .32272790 06  LAT -.14736312 01  LON  .18623541 03    VE  .23373436 02   PTE  .28853382 01   AZE  .27029411 03
 XS  .61772626 08   YS -.12253366 09   ZS -.53133104 08   DXS  .27523172 02   DYS  .11561474 02   DZS  .50139278 01
 XM -.40126538 06   YM -.21424506 05   ZM  .26334720 05   DXM  .18955440-02   DYM -.90829977 00   DZM -.34556741 00
 XT -.40126538 06   YT -.21424506 05   ZT  .26334720 05   DXT  .18955440-02   DYT -.90829977 00   DZT -.34556741 00
 RS  .14715131 09   VS  .30270978 02   RM  .40269893 06    VM  .97181731 00    RT  .40269893 06    VT  .97181731 00
GED -.14836692 01  ALT  .31634971 06  LOS  .29183815 03   RAS  .29675401 03   RAM  .18305625 03   LOM  .17814039 03
OUT  .35000000 02   DT  .95999999 03   DR  .11765576 01   SHA  .31317932 06   DES -.21166414 02   DEM  .37495646 01
CCL  .27578364 03  MCL  .34748894 03  TCL  .34748894 03

                                                  GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               2356102156062021202100000 J.D.= 2438043.28843318  JAN. 13,1963 18 55 20.627
SMA  .38390618 06  ECC  .98365649 00    B  .69124322 05   SLR  .12446199 05   APO  .76153797 06   RCA  .62743723 04
 VH  .92490215-01   C3 -.10382761 01   C1  .70434812 05   TFP  .16480067 06    TF  .22203636 00   PER  .39454566 05
 TA  .16779803 03  MTA  .18000000 03   EA  .80676696 02    MA  .25061839 02   C3J -.13155282 01   TFI  .46000000 02

                                                                    ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.31653008 06    Y -.62394955 05    Z -.82995664 04    DX -.11217080 01    DY -.40703204 00    DZ  .89533161-01
INC  .33331057 02  LAN  .19339308 03  APF  .18951938 03    MX  .14778767 00    MY -.82273719 00    MZ  .54887301 00
 WX -.12727523 00   WY  .53453153 00   WZ  .83550962 00    PX  .92740189 00    PY  .36286063 00    PZ -.90872875-01
 QX -.35174802 00   QY  .76328729 00   QZ -.54190670 00    RX -.84625815-01    RY -.33111186-01    RZ -.99586249 00
 BX  .35174817 00   BY -.76328760 00   BZ  .54190692 00    TX  .36436821 00    TY -.93125497 00    TZ  .00000000 00
DAP -.52138257 01  RAP  .21368708 02

BTQ  .57994008 05  BRQ -.37614718 05    B  .69124322 05   THA  .32703269 03    T VECTOR IN  EARTH EQUATOR PLANE


CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   14

EARTH-MOON FINE PRINT CHECK 1

                                                                    ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .10344153 06    Y  .30550418 06    Z -.10968566 05    DX  .25931991 00    DY  .11600335 01    DZ  .13782209 00
INC  .54629141 02  LAN  .72677591 02  APF  .18981315 03    MX -.53972122 00    MY  .21199654 00    MZ  .81471371 00
 WX  .77843838 00   WY -.24279053 00   WZ  .57886649 00    PX -.19920705 00    PY -.97005254 00    PZ -.13897705 00
 QX  .59527320 00   QY -.71292128-02   QZ -.80349170 00    RX  .27956510-01    RY  .13613616 00    RZ -.99029559 00
 BX -.59527323 00   BY  .71292131-02   BZ  .80349173 00    TX -.97955856 00    TY  .20115918 00    TZ  .00000000 00
DAP -.79886574 01  RAP  .25839524 03

BTO  .40405835 05  BRO -.56085046 05    B  .69124265 05   THA  .30577043 03    T VECTOR IN  ORBIT PLANE OF TARGET

 2 DAYS  0 HRS.  0 MIN.  0.000 SEC.       2356103415762022460100000 J.D.= 2438045.27918167  JAN. 15,1963 18 42 01.297

      GEOCENTRIC                                                                               EQUATORIAL COORDINATES

  X -.32452114 06    Y -.65300771 05    Z -.76477978 04    DX -.10983640 01    DY -.40011004 00    DZ  .91542422-01
  R  .33111425 06  DEC -.13234866 01   RA  .19137723 03     V  .11725491 01   PTH  .79600767 02    AZ  .56048426 02
  R  .33111424 06  LAT -.13234866 01  LON  .15637924 03    VE  .23991241 02   PTE  .27553358 01   AZE  .27028264 03
 XS  .61970931 08   YS -.12245029 09   ZS -.53096948 08   DXS  .27504634 02   DYS  .11598222 02   DZS  .50298434 01
 XM -.40118728 06   YM -.27960045 05   ZM  .23842704 05   DXM  .19794696-01   DYM -.90707679 00   DZM -.34663930 00
 XT -.40118728 06   YT -.27960045 05   ZT  .23842704 05   DXT  .19794696-01   DYT -.90707679 00   DZT -.34663930 00
 RS  .14715215 09   VS  .30271009 02   RM  .40286656 06    VM  .97125636 00    RT  .40286656 06    VT  .97125636 00
GED -.13325026 01  ALT  .32473605 06  LOS  .26184554 03   RAS  .29684354 03   RAM  .18398668 03   LOM  .14898868 03
OUT  .35000000 02   DT  .95999999 03   DR  .11532869 01   SHA  .32141168 06   DES -.21151193 02   DEM  .33928972 01
CCL  .27603786 03  MCL  .34761284 03  TCL  .34761284 03

                                                  GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               2356102157002020316100000 J.D.= 2438043.29111344  JAN. 13,1963 18 59 12.201
SMA  .38595647 06  ECC  .98390672 00    B  .68963812 05   SLR  .12322652 05   APO  .76570162 06   RCA  .62113059 04
 VH  .91529582-01   C3 -.10327606 01   C1  .70084353 05   TFP  .17176910 06    TF  .28636265 00   PER  .39771055 05
 TA  .16810641 03  MTA  .18000000 03   EA  .81696404 02    MA  .25913684 02   C3J -.13152964 01   TFI  .46000000 02

                                                                    ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.32452114 06    Y -.65300771 05    Z -.76477978 04    DX -.10983640 01    DY -.40011004 00    DZ  .91542422-01
INC  .33974277 02  LAN  .19334201 03  APF  .18952475 03    MX  .15098952 00    MY -.81575430 00    MZ  .55834295 00
 WX -.12895533 00   WY  .54373785 00   WZ  .82928852 00    PX  .92792951 00    PY  .36110393 00    PZ -.92470128-01
 QX -.34973903 00   QY  .75759675 00   QZ -.55111668 00    RX -.86174984-01    RY -.33535010-01    RZ -.99571542 00
 BX  .34973906 00   BY -.75759681 00   BZ  .55111673 00    TX  .36265777 00    TY -.93192239 00    TZ  .00000000 00
DAP -.53057284 01  RAP  .21263510 02

BTQ  .57436994 05  BRQ -.38170654 05    B  .68963812 05   THA  .32639335 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                    ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
  X  .10532131 06    Y  .31375881 06    Z -.99715801 04    DX  .25414384 00    DY  .11361910 01    DZ  .13911048 00
INC  .55272449 02  LAN  .72640962 02  APF  .18979365 03    MX -.53243060 00    MY  .20482654 00    MZ  .82131851 00
 WX  .78443744 00   WY -.24521199 00   WZ  .56967476 00    PX -.20152205 00    PY -.96945588 00    PZ -.13980041 00
 QX  .58655526 00   QY -.51373503-02   QZ -.80989311 00    RX  .28452274-01    RY  .13687447 00    RZ -.99017970 00
 BX -.58655517 00   BY  .51373495-02   BZ  .80989299 00    TX -.97907065 00    TY  .20352069 00    TZ  .00000000 00
DAP -.80362980 01  RAP  .25825708 03

BTO  .39676542 05  BRO -.56407202 05    B  .68963762 05   THA  .30512236 03    T VECTOR IN  ORBIT PLANE OF TARGET

 2 DAYS 10 HRS. 46 MIN. 13.045 SEC.       235610364533202453700262 J.D.= 2438045.72794378  JAN. 16,1963 05 28 14.343
 CHANGE OF PHASE OCCURS AT THIS POINT     MOON     IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

 2 DAYS 10 HRS. 46 MIN. 13.045 SEC.       235610364533202453700262 J.D.= 2438045.72794378  JAN. 16,1963 05 28 14.343
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                  15


EARTH-MOON FINE PRINT CHECK 1

      GEOCENTRIC                                                                    EQUATORIAL COORDINATES

    X -.36523823 06     Y -.79984803 05     Z -.37911595 04    DX -.10184934 01    DY -.35201941 00    DZ  .11197415 00
    R  .37391297 06   DEC -.58094002 00    RA  .19235240 03     V  .10834134 01   PTH  .80653600 02    AZ  .45730101 02
    R  .37391296 06   LAT -.58094002 00   LON  .35535771 03    VE  .27160095 02   PTE  .22557630 01   AZE  .27025929 03
   XS  .63035470 08    YS -.12199675 09    ZS -.52900268 08   DXS  .27405060 02   DYS  .11795732 02   DZS  .51153816 01
   XM -.39855843 06    YM -.62934252 05    ZM  .10317100 05   DXM  .11562157 00   DYM -.89559930 00   DZM -.35050410 00
   XT -.39855843 06    YT -.62934252 05    ZT  .10317100 05   DXT  .11562157 00   DYT -.89559930 00   DZT -.35050410 00
   RS  .14715677 09    VS  .30271171 02    RM  .40362852 06    VM  .96866896 00    RT  .40362852 06    VT  .96866896 00
  GEO -.58489673 00   ALT  .36753476 06   LOS  .10033062 03   RAS  .29732531 03   RAM  .18897318 03   LOM  .35197849 03
  DUT  .35000000 02    DT  .95999999 03    DR  .10690306 01   SHA  .36322043 06   DES -.21068411 02   DEM  .14646888 01
  CCL  .27724801 03   MCL  .34808360 03   TCL  .34808360 03

                                                   GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGL                  23561021757020267l100262 J.D.= 2438043.33522507  JAN. 13,1963 20 02 43.446
  SMA  .41596048 06   ECC  .98686110 00     B  .67207113 05   SLR  .10858714 05   APO  .82645569 06   RCA  .54652607 04
   VH  .79604680-01    C3 -.95826562 00    C1  .65789743 05   TFP  .20673089 06    TF  .13450417 01   PER  .44497717 05
   TA  .16970044 03   MTA  .18000000 03    EA  .84120820 02    MA  .27875258 02   C3J -.13134935 01   TFI  .58770290 02

     HELIOCENTRIC                                                                   EQUATORIAL COORDINATES

    X -.63400707 08     Y  .12191676 09     Z  .52896477 08    DX -.28423554 02    DY -.12147752 02    DZ -.50034074 01
    R  .14724600 09   LAT  .21053455 02   LON  .11747590 03     V  .31312943 02   PTH  .70083631 00    AZ  .10013326 03
   XE -.63035470 08    YE  .12199675 09    ZE  .52900268 08   DXE -.27405060 02   DYE -.11795732 02   DZE -.51153816 01
   XT -.63434028 08    YT  .12193381 09    ZT  .52910585 08   DXT -.27289439 02   DYT -.12691332 02   DZT -.54658857 01
  LTE  .21068411 02   LOE  .11732530 03   LTT  .21054316 02   LOT  .11748495 03   RST  .14727953 09   VST  .30588548 02
  EPS  .76123524 02   ESP  .14127420 00   SEP  .10373514 03   EPM  .13596538 03   EMP  .40084703 02   MEP  .39499116 01
  MPS  .14696276 03   MSP  .27453512-18   SMP  .33028755 02   SEM  .10763194 03   EMS  .72218416 02   ESM  .14968061 00
  RPM  .40000002 05   SPN  .75146158 02
  GCE  .82751986 02   GCT  .25083559 03   SIP  .14447234 03   CPT  .88422180 02   SIN  .85931766 02
  REP  .37391297 06   VEP  .10834134 01   CPE  .86484485 02   CPS  .10389195 03

                                                   HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23560763327320205l700262 J.D.= 2438037.54273527   JAN. 8,1963 01 01 32.327
  SMA  .16142967 09   ECC  .88703716-01     B  .16079327 09   SLR  .16015949 09   APO  .17574908 09   RCA  .14711026 09
   VH  .26232628 02    C3 -.82211717 03    C1  .46103605 10   TFP  .70720201 06    TF -.13767471 03   PER  .40943280 03
   TA  .86267625 01   MTA  .18000000 03    EA  .78950769 01    MA  .71969685 01                       TFI  .58770290 02

     SELENOCENTRIC                                                                  EQUATORIAL COORDINATES

    X  .33320203 05     Y -.17050551 05     Z -.14108259 05    DX -.11341150 01    DY  .54357989 00    DZ  .46247825 00
    R  .40000002 05   DEC -.20652943 02    RA  .33290035 03     V  .13399933 01   PTH -.88527735 02    AZ  .25193471 03
    R  .39999995 05   LAT -.95993432 01   LON  .32067773 03    VP  .13467491 01   PTP -.84073395 02   AZP  .27107525 03
  LTS  .91549292-01   LNS  .28895195 03   LTE -.63668248 01   LNE  .10455312 01
  ALT  .36201912 05   SHA  .21802296 05   ALP  .13446896 02    DR -.13395509 01    DP  .49314433-04   ASD  .24904133 01
  HGE  .28387647 03   SVL -.64635958 01   HNG  .14753069 03   SIA  .13347496 03

                                                   SELENOCENTRIC CONIC


CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                  16


EARTH-MOON FINE PRINT CHECK 1


EPOCH OF PERICENTER PASSAGE                  23561040141520240230026 2 J.D.= 2438046.03247707  JAN. 16,1963 12 46 46.019
  SMA -.31620675 04   ECC  .10594037 01     B  .11059679 04   SLR  .38683569 03   APO  .00000000 00   RCA  .18783868 03
   VH  .12451709 01    C3  .15504505 01    C1  .13771391 04   TFP -.26311675 05    TF  .66079089 02   LTF  .66038382 02
   TA -.15919563 03   MTA  .16072189 03    EA -.18607764 03    MA -.59364792 03   C3J -.13134935 01   TFI  .58770290 02
  ZAE  .14143332 03   ZAP  .14547150 03   ZAC  .88754508 02   DEF  .14144374 03    IR  .37433771 04    GP  .63179035 01

                                                         ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .33320203 05     Y -.17050551 05     Z -.14108259 05    DX -.11341150 01    DY  .54357989 00    DZ  .46247825 00
  INC  .15282212 03   LAN  .20013795 03   APF  .29751894 02    MX -.53044219 00    MY -.79649527 00    MZ -.29016748 00
   WX -.15724122 00    WY  .42880140 00    WZ -.88959280 00    PX -.96709348 00    PY  .11557282 00    PZ  .22664830 00
   QX  .19999131 00    QY  .89596242 00    QZ  .39652180 00    RX -.31111934 00    RY  .14875512 00    RZ -.93865681 00
   BX -.50807406 00    BY -.80757818 00    BZ -.29946327 00    TX  .43135853 00    TY  .90218059 00    TZ  .00000000 00
  SXI -.84683796 00   SYI  .40489763 00   SZI  .34485263 00   DAI  .20172799 02   RAI  .15444619 03
  SXO  .97889370 00   SYO  .18671297 00   SZO -.83026355-01   DAO -.47625423 01   RAO  .10798815 02
  ETE  .15534899 03   ETS  .35188020 03   ETC  .23880145 03

  BTQ -.10481738 04   BRQ  .35284082 03     B  .11059679 04   THA  .16139551 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                         ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .33320203 05     Y -.21255886 05     Z -.61604863 04    DX -.11341150 01    DY  .68270049 00    DZ  .20805108 00
  INC  .17067038 03   LAN  .25589908 03   APF  .67402341 02    MX -.53045122 00    MY -.84620354 00    MZ  .50655583-01
   WX -.15724388 00    WY  .39499588-01    WZ -.98677205 00    PX -.96709555 00    PY  .19620176 00    PZ  .16196217 00
   QX  .20000530 00    QY  .97976927 00    QZ  .73480111-02    RX -.13313504 00    RY  .79970211-01    RZ -.98786629 00
   BX -.50807497 00    BY -.86005482 00    BZ  .46535492-01    TX  .51491794 00    TY  .85723948 00    TZ  .00000000 00
  SXI -.84683798 00   SYI  .50867008 00   SZI  .15530671 00   DAI  .89345865 01   RAI  .14900803 03
  SXO  .97890096 00   SYO  .13826904 00   SZO -.15045484 00   DAO -.86532869 01   RAO  .80398014 01
  ETE  .17665351 03   ETS  .13184719 02   ETC  .26010596 03

  BTC -.11047399 04   BRC -.52098851 02     B  .11059677 04   THA  .18270003 03     T VECTOR IN  ECLIPTIC PLANE

                                                         ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.34936237 05     Y -.18967891 05     Z -.44359931 04    DX  .11536559 01    DY  .66550951 00    DZ  .14750169 00
  INC  .17339225 03   LAN  .10296412 03   APF  .53759360 02    MX -.47390971 00    MY  .88003799 00    MZ -.30622778-01
   WX  .11211730 00    WY  .25810384-01    WZ -.99335722 00    PX  .64813837 00    PY  .75584742 00    PZ  .92792662-01
   QX  .75322326 00    QY -.65423562 00    QZ  .68015082-01    RX  .95269299-01    RY  .55078411-01    RZ -.99392658 00
   BX -.49700623 00    BY  .86709756 00    BZ -.33565826-01    TX  .50050873 00    TY -.86573149 00    TZ  .00000000 00
  SXI  .86047355 00   SYI  .49746893 00   SZI  .11004486 00   DAI  .63179018 01   RAI  .30033660 02
  SXO -.36311845 00   SYO -.92946225 00   SZO -.65134337-01   DAO -.37345664 01   RAO  .24866061 03
  ETE  .17201818 03   ETS  .85493964 01   ETC  .25547064 03

  BTO -.11053411 04   BRO  .37349652 02     B  .11059719 04   THA  .17806470 03     T VECTOR IN  ORBIT PLANE OF TARGET

                                                         ALL VECTORS REFERENCED TO TRUE TARGET EQU. PLANE
    X -.34936237 05     Y -.18302078 05     Z -.66702965 04    DX  .11536559 01    DY  .64312123 00    DZ  .22595300 00
  INC  .16946995 03   LAN  .14215389 03   APF  .93335740 02    MX -.47390972 00    MY  .87739360 00    MZ  .74733752-01
   WX  .11211732 00    WY  .14430088 00    WZ -.98315922 00    PX  .64813837 00    PY  .73934828 00    PZ  .18242840 00
   QX  .75322326 00    QY -.65767596 00    QZ -.10632943-01    RX  .14726263 00    RY  .82277774-01    RZ -.98566932 00
   BX -.49700608 00    BY  .86489750 00    BZ  .70265847-01    TX  .48774886 00    TY -.87298399 00    TZ  .00000000 00
  SXI  .86047355 00   SYI  .48075910 00   SZI  .16868881 00   DAI  .97115931 01   RAI  .29192725 02
  SXO -.36311845 00   SYO -.91502409 00   SZO -.17570977 00   DAO -.10119965 02   RAO  .24835482 03
  ETE  .17804142 03   ETS  .14572628 02   ETC  .26149387 03

  BTT -.11031585 04   BRT -.78841964 02     B  .11059723 04   THA  .18408793 03     T VECTOR IN  TRUE TARGET EQU. PLANE

   2 DAYS 10 HRS. 46 MIN. 13.046 SEC.        23561036453320245371 2157 J.D.= 2438045.72794378  JAN. 16,1963 05 28 14.343
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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                        17

EARTH-MOON FINE PRINT CHECK 1

***** S/C DISCONTINUITY=R STOP

  2 DAYS 14 HRS. 46 MIN. 13.045 SEC.      23561037355320245370026? J.D.= 2438045.89461044  JAN. 16,1963 09 28 14.343

      GEOCENTRIC                                                                            EQUATORIAL COORDINATES

   X -.38002094 06    Y -.84781086 05    Z -.20042063 04   DX -.10510077 01   DY -.30554540 00   DZ  .14315054 00
   R  .38936841 06  DEC -.29492244 00   RA  .19257649 03    V  .11038421 01  PTH  .81448086 02   AZ  .24997337 02
   R  .38936840 06  LAT -.29492244 00  LON  .29541755 03   VE  .28344867 02  PTE  .22070219 01  AZE  .27030094 03
  XS  .63429640 08   YS -.12182636 09   ZS -.52826378 08  DXS  .27367567 02  DYS  .11868919 02  DZS  .51470765 01
  XM -.39663938 06   YM -.75786597 05   ZM  .52648548 04  DXM  .15087609 00  DYM -.88926003 00  DZM -.35112140 00
  XT -.39663938 06   YT -.75786597 05   ZT  .52648548 04  DXT  .15087609 00  DYT -.88926003 00  DZT -.35112140 00
  RS  .14715653 09   VS  .30271230 02   RM  .40384914 06   VM  .96790145 00   RT  .40384914 06   VT  .96790145 00
 GED -.29693224 00  ALT  .38299020 06  LOS  .40345138 02  RAS  .29750409 03  RAM  .19081722 03  LOM  .29365827 03
 DUT  .35000000 02   DT  .24000000 03   DR  .10915691 01  SHA  .37812480 06  DES -.21037321 02  DEM  .74696826 00
 CCL  .27765387 03  MCL  .34791781 03  TCL  .34791781 03

                                                GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23561022271020275710026? J.D.= 2438043.41004477  JAN. 13,1963 21 50 27.868
 SMA  .48084759 06  ECC  .98928614 00    B  .70198728 05  SLR  .10248266 05  APO  .95654345 06  RCA  .51517305 04
  VH  .66817385-01   C3 -.82895419 00   C1  .63913734 05  TFP  .21466647 06   TF  .31407142 01  PER  .55305814 05
  TA  .16980938 03  MTA  .18000000 03   EA  .78912623 02   MA  .23288669 02  C3J -.13116060 01  TFI  .62770290 02

     HELIOCENTRIC                                                                           EQUATORIAL COORDINATES

   X -.63809861 08    Y  .12174157 09    Z  .52824374 08   DX -.28418574 02   DY -.12174465 02   DZ -.50039259 01
   R  .14725191 09  LAT  .21022512 02  LON  .11766091 03    V  .31318880 02  PTH  .83140136 00   AZ  .10018118 03
  XE -.63429640 08   YE  .12182636 09   ZE  .52826378 08  DXE -.27367567 02  DYE -.11868919 02  DZE -.51470765 01
  XT -.63826480 08   YT  .12175057 09   ZT  .52831643 08  DXT -.27216691 02  DYT -.12758179 02  DZT -.54981980 01
 LTE  .21037321 02  LOE  .11750409 03  LTT  .21022962 02  LOT  .11766531 03  RST  .14726915 09  VST  .30557316 02
 EPS  .76050275 02  FSP  .14720910 00  SEP  .10380259 03  EPM  .13463025 03  EMP  .43325136 02  MEP  .20445681 01
 MPS  .14840544 03  MSP  .27453512-18  SMP  .31590432 02  SEM  .10582256 03  EMS  .74026270 02  ESM  .15130585 00
 RPM  .20246302 05  SPN  .75111707 02
 GCE  .82346128 02  GCT  .25026394 03  SIP  .14348069 03  CPT  .88131122 02  SIN  .83206373 02
 REP  .38936841 06  VEP  .11038421 01  CPE  .86121167 02  CPS  .10388202 03

                                               HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23560754513420203270026? J.D.= 2438036.25833576   JAN. 6,1963 18 12 00.210
 SMA  .16151695 09  ECC  .89494149-01    B  .16086853 09  SLR  .16022333 09  APO  .17597177 09  RCA  .14706212 09
  VH  .26204653 02   C3 -.82167296 03   C1  .46112792 10  TFP  .83257413 06   TF -.16850030 03  PER  .40976487 03
  TA  .10162288 02  MTA  .18000000 03   EA  .92940971 01   MA  .84659742 01                     TFI  .62770290 02


CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                        18

EARTH-MOON FINE PRINT CHECK 1

     SELENOCENTRIC                                                                          EQUATORIAL COORDINATES

   X  .16618444 05    Y -.89944889 04    Z -.72690611 04   DX -.12018839 01   DY  .58371463 00   DZ  .49427194 00
   R  .20246302 05  DEC -.21040731 02   RA  .33157618 03    V  .14246235 01  PTH -.87529320 02   AZ  .25302177 03
   R  .20246300 05  LAT -.94878634 01  LON  .31717110 03   VP  .14278818 01  PTP -.85408334 02  AZP  .27278094 03
 LTS  .88137612-01  LNS  .28692690 03  LTF -.64515772 01  LNE  .83822898 00
 ALT  .18508212 05  SHA -.10605897 05  ALP  .14520479 02   DR -.14232992 01   DP  .17379452-03  ASD  .49247490 01
 HGE  .28394972 03  SVL -.62957729 01  HNG  .14897526 03  STA  .12970550 03

                                              SELENOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE               23561040141520232026026? J.D.= 2438046.03247254  JAN. 16,1963 12 46 45.628
 SMA -.31727021 04  ECC  .10485194 01    B  .10002417 04  SLR  .31534426 03  APO  .00000000 00  RCA  .15393765 03
  VH  .12430623 01   C3  .15452535 01   C1  .12433889 04  TFP -.11911285 05   TF  .66078980 02  LTF  .66045389 02
  TA -.15986283 03  MTA  .16250168 03   EA -.15124076 03   MA -.26739410 03  C3J -.13116060 01  TFI  .62770290 02
 ZAE  .13929939 03  ZAP  .14581398 03  ZAC  .88732473 02  DEF  .14500336 03   IR  .37483117 04   GP  .63427407 01

                                                      ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
   X  .16618444 05    Y -.89944889 04    Z -.72690611 04   DX -.12018839 01   DY  .58371463 00   DZ  .49427194 00
 INC  .15320724 03  LAN  .20119881 03  APF  .32661050 02   MX -.54744332 00   MY -.79121388 00   MZ -.27253750 00
  WX -.16299502 00   WY  .42025195 00   WZ -.89264283 00   PX -.95910610 00   PY  .14470649 00   PZ  .24325823 00
  QX  .23139844 00   QY  .89579032 00   QZ  .37948080 00   RX -.31177721 00   RY  .15027412 00   RZ -.93819647 00
  BX -.50907499 00   BY -.81083225 00   BZ -.28877969 00   TX  .43418892 00   TY  .90082183 00   TZ  .00000000 00
 SXI -.84514787 00  SYI  .40735452 00  SZI  .34610308 00  DAI  .20249146 02  RAI  .15426630 03
 SXO  .98430058 00  SYO  .13133390 00  SZO -.11790022 00  DAO -.67709355 01  RAO  .76000107 01
 ETE  .15594766 03  ETS  .35210166 03  ETC  .23886763 03

 BTQ -.95168004 03  BRQ  .30787735 03    B  .10002417 04  THA  .16207312 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                      ALL VECTORS REFERENCED TO ECLIPTIC PLANE
   X  .16618444 05    Y -.11143933 05    Z -.30907656 04   DX -.12018839 01   DY  .73217098 00   DZ  .22125359 00
 INC  .17045289 03  LAN  .25942100 03  APF  .92840074 02   MX -.54744185 00   MY -.83432765 00   MZ  .64728207-01
  WX -.16299462 00   WY  .30441734-01   WZ -.98614959 00   PX -.95910566 00   PY  .22953790 00   PZ  .16561035 00
  QX  .23139581 00   QY  .97281819 00   QZ -.82158124-02   RX -.13301820 00   RY  .80492879-01   RZ -.98783953 00
  BX -.50907436 00   BY -.85879096 00   BZ  .57631531-01   TX  .51771731 00   TY  .85555174 00   TZ  .00000000 00
 SXI -.84514785 00  SYI  .51142164 00  SZI  .15547651 00  DAI  .89444348 01  RAI  .14882074 03
 SXO  .98429932 00  SYO  .73589302-01  SZO -.16041714 00  DAO -.92311107 01  RAO  .42756565 01
 ETE  .17721913 03  ETS  .13373134 02  ETC  .26013909 03

 BTC -.99853791 03  BRC -.58355204 02    B  .10002416 04  THA  .18334460 03    T VECTOR IN  ECLIPTIC PLANE

                                                      ALL VECTORS REFFRENCED TO ORBIT PLANE OF TARGET
   X -.17898265 05    Y -.91911945 04    Z -.22553648 04   DX  .12302910 01   DY  .70081077 00   DZ  .15747996 00
 INC  .17352715 03  LAN  .10823258 03  APF  .60970128 02   MX -.45500501 00   MY  .89032078 00   MZ -.17430032-01
  WX  .10709121 00   WY  .35277303-01   WZ -.99362541 00   PX  .67334498 00   PY  .73272645 00   PZ  .98586406-01
  QX  .73153175 00   QY -.67961122 00   QZ  .54714546-01   RX  .95832279-01   RY  .54964310-01   RZ -.99387883 00
  BX -.49522171 00   BY  .86847419 00   BZ -.22540140-01   TX  .49752356 00   TY -.86745047 00   TZ  .00000000 00
 SXI  .86214066 00  SYI  .49447814 00  SZI  .11047579 00  DAI  .63427449 01  RAI  .29836292 02
 SXO -.42223324 00  SYO -.90316310 00  SZO -.77573140-01  DAO -.44490835 01  RAO  .24494367 03
 ETE  .17257501 03  ETS  .87290175 01  ETC  .25549498 03

 BTO -.99998402 03  BRO  .22664500 02    B  .10002413 04  THA  .17870047 03    T VECTOR IN  ORBIT PLANE OF TARGET
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                19


EARTH-MOON FINE PRINT CHECK 1

                                                                      ALL VECTORS REFERENCED TO TRUE TARGET EQU. PLANE
   X -.17896265 05    Y -.88558833 04    Z -.33373731 04   DX  .12302910 01   DY  .67697488 00   DZ  .24008477 00
 INC  .16920170 03  LAN  .14514047 03  APF  .98247516 02   MX -.45500505 00   MY  .88602568 00   MZ  .89070395-01
  WX  .10709124 00   WY  .15374302 00   WZ -.98229283 00   PX  .67334490 00   PY  .71569852 00   PZ  .18542637 00
  QX  .73153197 00   QY -.68128015 00   QZ -.26877340-01   RX  .14761624 00   RY  .81798305-01   RZ -.98565638 00
  BX -.49522192 00   BY  .86494594 00   BZ  .81386615-01   TX  .48468854 00   TY -.87468681 00   TZ  .00000000 00
 SXI  .86214064 00  SYI  .47773635 00  SZI  .16876468 00  DAI  .97160038 01  RAI  .28992065 02
 SXO -.42223309 00  SYO -.88742492 00  SZO -.18492740 00  DAO -.10656900 02  RAO  .24455508 03
 ETE  .17861089 03  ETS  .14764895 02  ETC  .26153086 03

 BTT -.99682568 03  BRT -.82590847 02    B  .10002413 04  THA  .18473635 03    T VECTOR IN  TRUE TARGET EQU. PLANE

  2 DAYS 17 HRS. 56 MIN. 20.068 SEC.         2356104012172022565651б4 J.D.= 2438046.02663616  JAN. 16,1963 12 38 21.365

      GEOCENTRIC                                                                                EQUATORIAL COORDINATES

   X -.39370375 06    Y -.87062974 05    Z  .51784053 03   DX -.19409183 01   DY  .41802673 00   DZ  .64834569 00
   R  .40321566 06  DEC  .73565041-01   RA  .19246961 03    V  .20886029 01  PTH  .59831455 02   AZ  .30798739 03
   R  .40321564 06  LAT  .73585041-01  LON  .24765127 03   VE  .30290947 02  PTE  .34175406 01  AZE  .27122424 03
  XS  .63741659 08   YS -.12169063 09   ZS -.52767523 08  DXS  .27337696 02  DYS  .11926830 02  DZS  .51721553 01
  XM -.39475985 06   YM -.85897950 05   ZM  .12583334 04  DXM  .17863677 00  DYM -.88345073 00  DZM -.35129676 00
  XT -.39475985 06   YT -.85897950 05   ZT  .12583334 04  DXT  .17863677 00  DYT -.88345073 00  DZT -.35129676 00
  RS  .14715993 09   VS  .30271275 02   RM  .40399923 06   VM  .96737050 00   RT  .40399923 06   VT  .96737050 00
 GED  .74086506-01  ALT  .39683745 06  LOS  .35282732 03  RAS  .29764565 03  RAM  .19227594 03  LOM  .24745760 03
 DUT  .35000000 02   CT  .30000000 02   DR  .18057034 01  SHA  .39094342 06  DES -.21012561 02  DEM  .17846004 00
 CCL  .27800318 03  MCL  .33402653 03  TCL  .33402653 03

                                              GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  2356102523352026347651б4 J.D.= 2438043.96804659  JAN. 14,1963 11 13 59.226
 SMA -.16711740 06  ECC  .19206555 01    B  .27403774 06  SLR  .44936490 06  APO  .00000000 00  RCA  .15385755 06
  VH  .15443942 01   C3  .23851533 01   C1  .42322232 06  TFP  .17786214 06   TF  .16532758 02  LTF -.30851336 01
  TA  .86583683 02  MTA  .12137624 03   EA  .67455208 02   MA  .94176516 02  C3J -.12929574 01  TFI  .65938907 02

     HELIOCENTRIC                                                                               EQUATORIAL COORDINATES

   X -.64135562 08    Y  .12160357 09    Z  .52768041 08   DX -.29278615 02   DY -.11508803 02   DZ -.45238096 01
   R  .14725917 09  LAT  .20997946 02  LON  .11780784 03    V  .31782930 02  PTH  .29341340 01   AZ  .99923428 02
  XE -.63741659 08   YE  .12169063 09   ZE  .52767523 08  DXE -.27337696 02  DYE -.11926830 02  DZE -.51721553 01
  XT -.64136618 08   YT  .12160474 09   ZT  .52768782 08  DXT -.27159060 02  DYT -.12810280 02  DZT -.55234521 01
 LTE  .21012561 02  LOE  .11764566 03  LTT  .20998002 02  LOT  .11780800 03  RST  .14726086 09  VST  .30532382 02
 EPS  .75675643 02  ESP  .15211196 00  SEP  .10417224 03  EPM  .11668619 03  EMP  .63093561 02  MEP  .22017590 00
 MPS  .16612275 03  MSP  .00000000 00  SMP  .13877082 02  SEM  .10439096 03  EMS  .75456784 02  ESM  .15211196 00
 RPM  .17380899 04  SPN  .74769311 02
 GCE  .81996811 02  GCT  .23602335 03  SIP  .76122749 02  CPT  .84107641 02  SIN -.58923587 01
 REP  .40321566 06  VEP  .20886029 01  CPE  .85891898 02  CPS  .10387388 03

                                             HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  235606420414202544565164 J.D.= 2438022.11540262  DEC. 23,1962 14 46 10.787


CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                20


EARTH-MOON FINE PRINT CHECK 1

 SMA  .16750454 09  ECC  .13111141 00    B  .16605843 09  SLR  .16462511 09  APO  .18946630 09  RCA  .14554278 09
  VH  .24670310 02   C3 -.79230154 03   C1  .46741923 10  TFP  .20659306 07   TF -.50793069 03  PER  .43276035 03
  TA  .25914514 02  MTA  .18000000 03   EA  .22802370 02   MA  .19891018 02                     TFI  .65938907 02

    SELENOCENTRIC                                                                               EQUATORIAL COORDINATES

   X  .10560991 04    Y -.11650243 04    Z -.74049290 03   DX -.21195550 01   DY  .13014775 01   DZ  .99964245 00
   R  .17380699 04  DEC -.25216403 02   RA  .31219243 03    V  .26806048 01  PTH -.74743889 02   AZ  .26078864 03
   R  .17380697 04  LAT -.73609024 01  LON  .29706478 03   VP  .26818005 01  PTP -.74650484 02  AZP  .27793066 03
 LTS  .85465302-01  LNS  .26532264 03  LTE -.65132043 01  LNE  .67274375 00
 ALT -.45776367-04  SHA -.41686305 03  ALP  .30377679 02   DR -.25861384 01   DP  .23251989-01  ASD  .90000000 02
 HGE  .28432435 03  SVL -.60294826 01  HNG  .16747784 03  SIA  .26686194 02

                                            SELENOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  2356104C14152021553277б4 J.D.= 2438046.03246359  JAN. 16,1963 12 46 44.855
 SMA -.31747777 04  ECC  .10471702 01    B  .98656127 03  SLR  .30657376 03  APO  .00000000 00  RCA  .14975489 03
  VH  .12426759 01   C3  .15442433 01   C1  .12259761 04  TFP -.50348978 03   TF  .66078766 02  LTF  .66046055 02
  TA -.14186097 03  MTA  .16273738 03   EA -.53987633 02   MA -.11291661 02  C3J -.12929574 01  TFI  .65938907 02
 ZAE  .13770351 03  ZAP  .14599427 03  ZAC  .88726667 02  DEF  .14547475 03   IR  .37492740 04   GP  .63501737 01

                                                                      ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
   X  .10560991 04    Y -.11650243 04    Z -.74049290 03   DX -.21195550 01   DY  .13014775 01   DZ  .99964245 00
 INC  .15325757 03  LAN  .20135351 03  APF  .33086642 02   MX -.77714300 00   MY -.61243373 00   MZ -.14482228 00
  WX -.16384731 00   WY  .41908968 00   WZ -.89303848 00   PX -.95784397 00   PY  .14897102 00   PZ  .24564717 00
  QX  .23598499 00   QY  .89564019 00   QZ  .37701405 00   RX -.31196709 00   RY  .15070544 00   RZ -.93806417 00
  BX -.50959702 00   BY -.81108836 00   BZ -.28713506 00   TX  .43496463 00   TY  .90043788 00   TZ  .00000000 00
 SXI -.84466851 00  SYI  .40804349 00  SZI  .34646153 00  DAI  .20271038 02  RAI  .15421568 03
 SXO  .98472650 00  SYO  .12352237 00  SZO -.12270225 00  DAO -.70480841 01  RAO  .71497390 01
 ETE  .15635654 03  ETS  .35220839 03  ETC  .23888631 03

 BTQ -.93920787 03  BRQ  .30197967 03    B  .98656127 03  THA  .16217605 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                      ALL VECTORS REFERENCED TO ECLIPTIC PLANE
   X  .10560991 04    Y -.13634529 04    Z -.21588749 03   DX -.21195550 01   DY  .15917410 01   DZ  .39936096 00
 INC  .17041953 03  LAN  .25988900 03  APF  .93589395 02   MX -.77714299 00   MY -.61949734 00   MZ  .11077731 00
  WX -.16384732 00   WY  .29218065-01   WZ -.98605283 00   PX -.95784399 00   PY  .23440102 00   PZ  .16610562 00
  QX  .23598504 00   QY  .97170070 00   QZ -.10419622-01   RX -.13299074 00   RY  .80643914-01   RZ -.98783097 00
  BX -.50959710 00   BY -.85837121 00   BZ  .59242432-01   TX  .51850609 00   TY  .85507394 00   TZ  .00000000 00
 SXI -.84466852 00  SYI  .51219637 00  SZI  .15553128 00  DAI  .89476109 01  RAI  .14876790 03
 SXO  .98472653 00  SYO  .64511701-01  SZO -.16171536 00  DAO -.93064775 01  RAO  .37482217 01
 ETE  .17762070 03  ETS  .13470561 02  ETC  .26014847 03

 BTC -.98478553 03  BRC -.59166277 02    B  .98656128 03  THA  .18343822 03    T VECTOR IN  ECLIPTIC PLANE

                                                                      ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
   X -.17072027 04    Y -.26328510 03    Z -.19260247 03   DX  .24311512 01   DY  .10884874 01   DZ  .30056464 00
 INC  .17353626 03  LAN  .10897661 03  APF  .62006959 02   MX -.15457317 00   MY  .98778217 00   MZ  .19830499-01
  WX  .10645493 00   WY  .36606773-01   WZ -.99364332 00   PX  .67707782 00   PY  .72916713 00   PZ  .99402598-01
  QX  .72817092 00   QY -.68335567 00   QZ  .52837809-01   RX  .96003769-01   RY  .54924237-01   RZ -.99386447 00
  BX -.49444642 00   BY  .86895537 00   BZ -.20959839-01   TX  .49658148 00   TY -.86799011 00   TZ  .00000000 00
 SXI  .86266453 00  SYI  .49353469 00  SZI  .11060468 00  DAI  .63501754 01  RAI  .29774086 02
 SXO -.43049277 00  SYO -.89910845 00  SZO -.79245274-01  DAO -.45451852 01  RAO  .24441491 03
```

```
CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                    21

EARTH-MOON FINE PRINT CHECK 1

 ETE  .17297407 03   ETS  .88239332 01   ETC  .25550184 03

 BTO -.98634243 03   BRC  .20805829 02     B  .98656184 03   THA  .17879158 03    T VECTOR IN  ORBIT PLANE OF TARGET

                                                                 ALL VECTORS REFERENCED TO TRUE TARGET EQU. PLANE
   X -.17072027 04     Y -.23838514 03     Z -.22268204 03   DX  .24311512 01    DY  .10447752 01    DZ  .42847257 00
 INC  .16915818 03   LAN  .14553108 03   APF  .98928698 02   MX -.15457314 00    MY  .97833566 00    MZ  .13771661 00
  WX  .10645491 00    WY  .15507303 00    WZ -.98215024 00   PX  .67707777 00    PY  .71206567 00    PZ  .18581723 00
  QX  .72817097 00    QY -.68477315 00    QZ -.29193567-01   RX  .14772316 00    RY  .81644573-01    RZ -.98565308 00
  BX -.49444650 00    BY  .86523426 00    BZ  .83020126-01   TX  .48372284 00    TY -.87522124 00    TZ  .00000000 00
 SXI  .86266451 00   SYI  .47678290 00   SZI  .16878379 00  DAI  .97171146 01   RAI  .28928827 02
 SXO -.43049266 00   SYO -.88319800 00   SZO -.18611027 00  DAO -.10725871 02   RAO  .24401424 03
 ETE  .17901415 03   ETS  .14864007 02   ETC  .26154192 03

 BTT -.98305602 03   BRT -.83096680 02     B  .98656181 03   THA  .18483166 03    T VECTOR IN  TRUE TARGET EQU. PLANE

 215563036320   214523646526   612554325025   603416475431   204420666560   603534774303                     EARTH
                   630101318                       4201297                  000000000000                    INITIAL

 213406755133   613444001540   612562723572   602416525766   201516557516   201400455161                      MOON
                                                             235610401217   202256565164                      END



    END TRAJECTORY (SFPRO)        016405       G
```

B. Check case 2 is an Earth-Venus trajectory made during the Mariner II mission. The spacecraft injects near Earth-Sun phase change on September 5, 1962 and encounters Venus 100.81 days later with a miss of 41, 000 km. Radiation pressure was included as a perturbation on the spacecraft.

```
START TRAJECTORY (SFPRO)        016405        G


CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                     1


EARTH-VENUS, RADIATICN PRES. ON                    CHECK 2

DOUBLE PRECISICN EPHEMERIS TAPE - EPHEM1
S/C EPHEMERIS WRITTEN  016311G       041765 RUNID=(TRAJC2)

  GME  .39860063 06     J  .16234500-02     H -.57499999-05     D  .78749999-05    RE  .63781650 04   REM  .63783112 04
    G  .66709998-19     A  .88781796 29     B  .88800194 29     C  .88836976 29   OME  .41780741-02    AU  .14959850 09
  GMM  .49026293 04   GMS  .13271411 12   GMV  .32476627 06   GMA  .42977367 05   GMC  .37918700 08   GMJ  .12670935 09
  EGM  .39860320 06   MGM  .49027779 04    JA  .29200000-02    HA  .00000000 00    DA  .00000000 00    RA  .34170000 04
RADIATION PRESSURE INPUT
  ARA  .38300000 01    GB  .38300000 00   MAS  .19822000 03   GB1  .00000000 00   GB2  .00000000 00    SC  .10200000 09

INJECTION CCNDITICNS   1950.0     VENUS        23557540064120200000000 J.D.= 2437912.51634260  SEPT. 5,1962 00 23 32.000

GEOCENTRIC        X0-.14297030 07  Y0-.19355307 07  Z0-.99998901 05 DX0-.17513577 01 DY0-.24185118 01 DZ0-.10838549 00
CARTESIAN         T0 .14120000 04 GHA .34951873 03 GHO .34361929 03
DATE OF RUN 041765G 016411                   EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   0 DAYS  0 HRS.  0 MIN.  0.000 SEC.        23557540064120200000000 J.D.= 2437912.51634260  SEPT. 5,1962 00 23 32.000

       GEOCENTRIC                                                                                   EQUATORIAL COORDINATES

    X -.14242090 07     Y -.19394898 07     Z -.10167162 06    DX -.17445130 01    DY -.24233611 01    DZ -.11043330 00
    R  .24083872 07   DEC -.24194955 01    RA  .23370936 03     V  .29880094 01   PTH  .89380513 02    AZ  .60890359 02
    R  .24083872 07   LAT -.24194955 01   LON  .24419063 03    VE  .17546301 03   PTE  .97569593 00   AZE  .27000513 03
   XS -.14343227 09    YS  .42810504 08    ZS  .18564279 08   DXS -.87218609 01   DYS -.25899198 02   DZS -.11230749 02
   XM -.27632510 06    YM -.27943325 06    ZM -.81923071 05   DXM  .72901663 00   DYM -.58854660 00   DZM -.27195625 00
   XT -.88139502 08    YT -.41412272 08    ZT -.22861356 08   DXT  .21205738 02   DYT -.90988719 01   DZT -.55559089 01
   RS  .15083166 09    VS  .29546049 02    RM  .40143479 06    VM  .97560880 00    RT  .10003094 09    VT  .23734804 02
  GED -.24359640 01   ALT  .24020091 07   LOS  .17386238 03   RAS  .16338111 03   RAM  .22532043 03   LOM  .23580169 03
  DUT  .35000000 02    DT  .38400000 04   'DR  .29878348 01   SHA -.22746660 07   DES  .70698621 01   DEM -.11775395 02
  CCL  .60726652 02   MCL  .18216895 03   TCL  .33871826 03

                                                     GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23557461301520224000000 J.D.= 2437903.65617187  AUG. 27,1962 03 44 53.250
  SMA -.46364060 05   ECC  .11521704 01     B  .26532655 05   SLR  .15184072 05  APO  .00000000 00   RCA  .70552370 04
   VH  .29320965 01    C3  .85971898 01    C1  .77797048 05   TFP  .76551875 06    TF -.88601705 01   LTF -.88860944 01
   TA  .14959338 03   MTA  .15021865 03    EA  .25901344 03    MA  .27738007 04                       TFI  .00000000 00

                                                              ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.14242090 07     Y -.19394898 07     Z -.10167162 06    DX -.17445130 01    DY -.24233611 01    DZ -.11043330 00
  INC  .29204827 02   LAN  .23804503 03   APF  .20544248 03    MX  .69203649 00    MY -.53365594 00    MZ  .48603182 00
   WX -.41393320 00    WY  .25820200 00    WZ  .87288096 00    PX  .15975404 00    PY  .96464240 00    PZ -.20958780 00
   QX -.89615328 00    QY  .52662815-01    QZ -.44054734 00    RX  .21561010-01    RY  .29956756-01    RZ -.99931861 00
   BX -.69847200 00    BY  .52485563 00    BZ -.48648066 00    TX -.81163524 00    TY  .58416457 00    TZ  .00000000 00
  SXI -.30645677 00   SYI  .86339653 00   SZI -.40072304 00   DAI -.23623387 02   RAI  .10954197 03
  SXO -.58376653 00   SYO -.81108220 00   SZO -.36909137-01   DAO -.21152174 01   RAO  .23425600 03

  BTQ  .25279185 05   BRQ -.80586099 04     B  .26532655 05   THA  .34231852 03    T VECTOR IN  EARTH EQUATOR PLANE


CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                     2


EARTH-VENUS, RADIATICN PRES. ON                    CHECK 2

       HELIOCENTRIC                                                                                   ECLIPTIC COORDINATES

    X  .14200807 09     Y -.48482164 08     Z  .67773075 06    DX  .69773480 01    DY  .25962118 02    DZ  .86299610 00
    R  .15005755 09   LAT  .25877623 00   LON  .34114987 03     V  .26897207 02   PTH -.37969414 01    AZ  .88140099 02
   XE  .14343227 09    YE -.46662315 06    ZE -.58024999 03   DXE  .87218609 01   DYE  .28229385 02   DZE  .22423267-03
   XT  .55292774 08    YT -.93751323 06    ZT -.44998112 07   DXT  .29927599 02   DYT  .17671232 02   DZT -.14772718 01
  LTE -.22041709-03   LOE  .34197892 03   LTT -.23674050 01   LOT  .30053131 03   RST  .10893507 09   VST  .34786721 02
  EPS  .10831392 03   ESP  .86857472 00   SEP  .70817518 02   EPM  .24705000 01   EMP  .16501275 03   MEP  .12516769 02
  MPS  .10696074 03   MSP  .73425371 00   SMP  .72305031 02   SEM  .64412562 02   EMS  .11544974 03   ESM  .13759044 00
  EPT  .14907056 03   ETP  .70903655 00   TEP  .30220393 02   TPS  .46474513 02   TSP  .40692629 02   STP  .92832855 02
  SET  .46190403 02   STE  .92306648 02   EST  .41502947 02   RPM  .20183694 07   RPT  .97957366 08   SPN  .10816219 03
  GCE  .29927335 03   GCT  .97991616 02   SIP  .46470888 02   CPT  .90244641 02   SIN  .90241014 02
  REP  .24083872 07   VEP  .29880094 01   CPE  .65410268 02   CPS  .82023973 02

                                                    HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23560757030720204000000 J.D.= 2438036.71366030   JAN. 7,1963 05 07 40.250
  SMA  .12695262 09   ECC  .19329432 00     B  .12455836 09   SLR  .12220933 09   APO  .15149183 09   RCA  .10241340 09
   VH  .26584071 02    C3 -.10453830 04    C1  .40272697 10   TFP -.10730648 08    TF  .12419732 03   PER  .28554204 03
   TA -.16376221 03   MTA  .18000000 03    EA -.16031381 03    MA -.15658301 03                       TFI  .00000000 00

                                                              ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .14200807 09     Y -.48482164 08     Z  .67773075 06    DX  .69773480 01    DY  .25962118 02    DZ  .86299610 00
  INC  .18778048 01   LAN  .33323168 03   APF  .17168459 03    MX  .32278481 00    MY  .94591575 00    MZ  .32455293-01
   WX -.14758198-01    WY -.29256456-01    WZ  .99946298 00    PX -.81834786 00    PY  .57470330 00    PZ  .47389873-02
   QX -.57453331 00    QY -.81783845 00    QZ -.32423542-01    RX -.38781845-02    RY  .27235427-02    RZ -.99998854 00
   BX  .57453345 00    BY  .81783864 00    BZ  .32423550-01    TX  .57470988 00    TY  .81835723 00    TZ  .00000000 00
  DAP  .27152563 00   RAP  .14492068 03

  BTC  .12449287 09   BRC -.40386688 07     B  .12455836 09   THA  .35814192 03    T VECTOR IN  ECLIPTIC PLANE

   0 DAYS  0 HRS.  4 MIN. 10.114 SEC.        23557540073720241643001б J.D.= 2437912.51923743  SEPT. 5,1962 00 27 42.114

                                                    EXTREME ELEVATION


11 GOLDSTONE       HAGEC
    R .24091345 07    LAT-.24194033 01    LON .24314580 03
  MIN .41685607 01     HA .50277709-02    DEC-.25121188 01    ELE .52279807 02    AZI .18002709 03
  CKC .60822521 02    CKM .18226568 03    CKT .33881390 03    PSS .70830197 02    PSM .13006480 02
   UT .69476011-01    DHA .41864582-02    DDE .48975676-06    DEL-.13432677-10    DAZ .20703512-02
   ET .59753790-01    RGE .24040910 07    DRG .29877987 01    DDR .27545438-04    SLS .21971309 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .10830272 03    POL .26163253 03
   DT .80191831 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .59568071 05     F1 .88568071 05     F2 .11913614 06     XA .29668507 08    PRA .23370951 03
   D1 .29522690 04     D2 .39712047 04    DOP .17641282 00    DF1 .88211004-01    DF2 .17642201 00

   0 DAYS  5 HRS. 31 MIN. 11.877 SEC.        23557541241020276021777б J.D.= 2437912.74634117  SEPT. 5,1962 05 54 43.877

                                                    END OF VIEW PERIOD
```

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CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                      3


EARTH-VENUS, RADIATION PRES. ON                      CHECK 2


11 GOLDSTONE        HADEC
     R .24677288 07    LAT-.24121658 01    LON .16117712 03
   MIN .33119795 03     HA .82093542 02    DEC-.24981126 01    ELE .50000006 01    AZI .26337999 03
   CKC .60774648 02    CKM .18229802 03    CKT .33874847 03    PSS .70510814 02    PSM .12305560 02
    UT .55199657 01    DHA .41785403-02    DDE .84879161-06    DEL-.33908751-02    DAZ .24442539-02
    ET .55102435 01    RGE .24671653 07    DRG .33601948 01    DDR .36428088-05    SLS .21993803 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .10860089 03    POL .31601992 03
    DT .82295764 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .60760625 05     F1 .89760625 05     F2 .12152125 06     XA .29668544 08    PRA .23360218 03
    D1 .29920208 04     D2 .40507083 04    DOP .23330112-01    DF1 .11665664-01    DF2 .23331328-01

  0 DAYS  8 HRS. 31 MIN. 27.578 SEC.       2355754176302027120l7425 J.D.= 2437912.87152289  SEPT. 5,1962 08 54 59.578

      GEOCENTRIC                                                                               EQUATORIAL COORDINATES

    X -.14777297 07     Y -.20137724 07     Z -.10504899 06    DX -.17436422 01     DY -.24178359 01    DZ -.10967355 00
    R  .24999999 07   DEC -.24082530 01    RA  .23372834 03     V  .29829929 01   PTH  .89438460 02    AZ  .57558176 02
    R  .24999998 07   LAT -.24082530 01   LON  .11599464 03    VE  .18214160 03   PTE  .93834846 00   AZE  .27000494 03
   XS -.14369731 09    YS  .42014936 08    ZS  .18219292 08   DXS -.65508244 01   DYS -.25948871 02   DZS -.11252379 02
   XM -.25316542 06    YM -.29664618 06    ZM -.90016714 05   DXM  .77970859 00   DYM -.53263596 00   DZM -.25524645 00
   XT -.87488807 08    YT -.41688206 08    ZT -.23030191 08   DXT  .21201135 02   DYT -.88840181 01   DZT -.54473050 01
   RS  .15081815 09    VS  .29547868 02    RM  .40024329 06    VM  .97816016 00    RT  .99612185 08    VT  .23623866 02
  GED -.24246451 01   ALT  .24936217 07   LOS  .45968165 02   RAS  .16370187 03   RAM  .22952170 03   LOM  .11178800 03
  DUT  .35000000 02    DT  .38400000 04    DR  .29828497 01   SHA -.23566905 07   DES  .69384518 01   DEM -.12997290 02
  CCL  .60634217 02   MCL  .18219923 03   TCL  .33859821 03

     HELIOCENTRIC                                                                               ECLIPTIC COORDINATES

    X  .14221958 09     Y -.47684513 06     Z  .70419224 06    DX  .68071821 01    DY  .26021667 02    DZ  .86157906 00
    R  .15000239 09   LAT  .26897968 00   LON  .34146431 03     V  .26911098 02   PTH -.38651443 01    AZ  .88142928 02
   XE  .14369731 09    YE -.45795169 08    ZE -.57224999 03   DXE  .65508244 01   DYE  .28283563 02   DZE  .30839443-03
   XT  .56208505 08    YT -.93204504 08    ZT -.45449275 07   DXT  .29751959 02   DYT  .17965735 02   DZT -.14630241 01
  LTE -.21739763-03   LOE  .34232334 03   LTT -.23911262 01   LOT  .30109276 03   RST  .10893636 09   VST  .34786307 02
  EPS  .10859382 03   ESP  .90013292 00   SEP  .70505962 02   EPM  .21454634 01   EMP  .16647676 03   MEP  .11377748 02
  MPS  .10809808 03   MSP  .76239607 00   SMP  .71139539 02   SEM  .68344733 02   EMS  .11151381 03   ESM  .14127420 00
  EPT  .14925942 03   ETP  .73501950 00   TEP  .30005538 02   TPS  .46484706 02   TSP  .40448233 02   STP  .93067058 02
  SET  .46186826 02   STE  .92525719 02   EST  .41287451 02   RPM  .21091007 07   RPT  .97455262 08   SPN  .10844765 03
  GCE  .29336578 03   GCT  .97964005 02   SIP  .46481061 02   CPT  .90265339 02   SIN  .90261693 02
  REP  .24999999 07   VEP  .29829929 01   CPE  .65391742 02   CPS  .82079078 02

  0 DAYS  8 HRS. 31 MIN. 27.578 SEC.       23557541763020271201 7425 J.D.= 2437912.87152289  SEPT. 5,1962 08 54 59.578
  CHANGE OF PHASE OCCURS AT THIS POINT    SUN      IS THE CENTRAL BODY FOR INTEGRATION    COWELL EQUATIONS OF MOTION

  0 DAYS  8 HRS. 31 MIN. 27.578 SEC.       23557541763020271201 7425 J.D.= 2437912.87152289  SEPT. 5,1962 08 54 59.578
***** S/C DISCONTINUITY=R STOP

 10 DAYS  0 HRS.  0 MIN.  0.000 SEC.       2355762465412020000000000 J.D.= 2437922.51634260 SEPT. 15,1962 00 23 32.000



CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                      4


EARTH-VENUS, RADIATION PRES. ON                      CHECK 2

      GEOCENTRIC                                                                               EQUATORIAL COORDINATES

    X -.29459900 07     Y -.39596962 07     Z -.18561650 06    DX -.18101584 01    DY -.22479060 01    DZ -.83382725-01
    R  .49388769 07   DEC -.21538386 01    RA  .23335097 03     V  .28873356 01   PTH  .87750912 02    AZ  .28278027 03
    R  .49388766 07   LAT -.21538386 01   LON  .23397583 03    VE  .36001617 03   PTE  .45916459 00   AZE  .27000399 03
   XS -.14886089 09    YS  .19932581 08    ZS  .86430340 07   DXS -.38169667 01   DYS -.26933975 02   DZS -.11680032 02
   XM  .35565800 06    YM  .31766000 05    ZM -.15071250 05   DXM -.67912161-01   DYM  .10293403 01   DZM  .38498199 00
   XT -.70143962 08    YT -.46752834 08    ZT -.26364873 08   DXT  .20130531 02   DYT -.33992767 01   DZT -.25942826 01
   RS  .15043795 09    VS  .29604584 02    RM  .35739170 06    VM  .11010743 01    RT  .88323888 08    VT  .20579691 02
  GED -.21685026 01   ALT  .49324987 07   LOS  .17299827 03   RAS  .17237341 03   RAM  .51038925 01   LOM  .57287521 01
  DUT  .35000000 02    DT  .86399999 05    DR  .28851114 01   SHA -.43277107 07   DES  .32935974 01   DEM -.24168855 01
  CCL  .58092839 02   MCL  .18001176 03   TCL  .33497854 03

                                              GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 2355745640712026l4000000 J.D.= 2437903.11304506  AUG. 26,1962 14 42 47.094
  SMA -.48756736 05   ECC  .41369376 01     B  .19572228 06   SLR  .78567839 06   APO  .00000000 00   RCA  .15294684 06
   VH  .28592470 01    C3  .81752934 01    C1  .55961764 06   TFP  .16764449 07    TF -.94032974 01   LTF -.96835464 01
   TA  .10172830 03   MTA  .10398835 03    EA  .22349110 03    MA  .56328600 04                       TFI  .10000000 02

                                                         ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.29459900 07     Y -.39596962 07     Z -.18561650 06    DX -.18101584 01    DY -.22479060 01    DZ -.83382725-01
  INC  .16704291 03   LAN  .22394338 03   APF  .24862286 03    MX -.78739428 00    MY  .57545421 00    MZ  .22105679 00
   WX -.15560298 00    WY  .16145056 00    WZ -.97453827 00    PX  .89220446 00    PY -.40046986 00    PZ -.20880220 00
   QX -.42398222 00    QY -.90197513 00    QZ -.81732545-01    RX  .18089977-01    RY  .22456040-01    RZ -.99958414 00
   BX  .76325770 00    BY -.60662247 00    BZ -.22236653 00    TX -.77874733 00    TY  .62733772 00    TZ  .00000000 00
  SXI -.19574112 00   SYI -.97203039 00   SZI -.12978141 00   DAI -.74569622 01   RAI  .25861442 03
  SXO -.62707683 00   SYO -.77842347 00   SZO -.28836106-01   DAO -.16524148 01   RAO  .23114602 03

  BTQ -.19236543 06   BRQ  .36093665 05     B  .19572228 06   THA  .16937310 03    T VECTOR IN  EARTH EQUATOR PLANE

     HELIOCENTRIC                                                                               ECLIPTIC COORDINATES

    X  .14591490 09     Y -.25432486 06     Z  .14052120 07    DX  .20068083 01    DY  .27261957 02    DZ  .81851411 00
    R  .14812139 09   LAT  .54356693 00   LON  .35011285 03     V  .27347971 02   PTH -.56579202 01    AZ  .88222545 02
   XE  .14886089 09    YE -.21725787 08    ZE  .21093750 03   DXE  .38169667 01   DYE  .29357489 02   DZE  .72395800-03
   XT  .78716934 08    YT -.75108355 08    ZT -.55886490 07   DXT  .23947498 02   DYT  .25206705 02   DZT -.10270783 01
  LTE  .80337629-04   LOE  .35169648 03   LTT -.29404613 01   LOT  .31634385 03   RST  .10894427 09   VST  .34783839 02
  EPS  .11713199 03   ESP  .16742844 01   SEP  .61193739 02   EPM  .29580944 01   EMP  .45491967 02   MEP  .13154992 03
  MPS  .12009008 03   MSP  .17042457 01   SMP  .58205692 02   SEM  .16725533 03   EMS  .12714714 02   ESM  .27976454-01
  EPT  .15400725 03   ETP  .14042330 01   TEP  .24588489 02   TPS  .46490702 02   TSP  .33935479 02   STP  .99573822 02
  SET  .45688628 02   STE  .98852535 02   EST  .35458836 02   RPM  .51828308 07   RPT  .83858056 08   SPN  .11705800 03
  GCE  .30190716 03   GCT  .96885707 02   STP  .46486466 02   CPT  .90610493 02   SIN  .90606257 02
  REP  .49388769 07   VEP  .28873356 01   CPE  .65333435 02   CPS  .83681660 02

                                              HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 2356076010072024200000000 J.D.= 2438036.91812644   JAN. 7,1963 10 02 06.125
  SMA  .12711439 09   ECC  .19174311 00     B  .12475574 09   SLR  .12244098 09   APO  .15148770 09   RCA  .10274108 09
   VH  .26609980 02    C3 -.10440525 04    C1  .40310850 10   TFP -.98843141 07    TF  .12440178 03   PER  .28608802 03
   TA -.15471579 03   MTA  .18000000 03    EA -.14952899 03    MA -.14395794 03                       TFI  .10000000 02
```

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EARTH-VENUS, RADIATION PRES. ON CHECK 2

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X .14591490 09	Y -.25432486 08	Z .14052120 07	DX .20068083 01	DY .27261957 02	DZ .81851411 00
INC .18587005 01	LAN .33311393 03	APF .17172312 03	MX .17133551 00	MY .98472437 00	MZ .31016013-01
WX -.14667435-01	WY -.28928543-01	WZ .99947385 00	PX -.81755167 00	PY .57583563 00	PZ .46691569-02
QX -.57566773 00	QY -.81705306 00	QZ -.32096611-01	RX -.38173202-02	RY .26886973-02	RZ -.99998870 00
BX .57566795 00	BY .81705337 00	BZ .32096624-01	TX .57584214 00	TY .81756091 00	TZ .00000000 00
DAP .26752399 00	RAP .14484137 03				
BTC .12469147 09	BRC -.40042806 07	B .12475575 09	THA .35816066 03	T VECTOR IN ECLIPTIC PLANE	

20 DAYS 0 HRS. 0 MIN. 0.000 SEC. 23557711444120200000000 J.D.= 2437932.51634260 SEPT. 25,1962 00 23 32.000

GEOCENTRIC EQUATORIAL COORDINATES

X -.45979200 07	Y -.58249575 07	Z -.25234741 06	DX -.20370898 01	DY -.20667679 01	DZ -.75129389-01
R .74252728 07	DEC -.19475678 01	RA .23171426 03	V .29029138 01	PTH .83685803 02	AZ .27412054 03
R .74252724 07	LAT -.19475678 01	LON .22248273 03	VE .54147273 03	PTE .30530860 00	AZE .27000243 03
XS -.14998374 09	YS -.35242666 07	ZS -.15280271 07	DXS .12410339 01	DYS -.27232440 02	DZS -.11807567 02
XM -.30698800 06	YM .23379312 06	ZM .10962314 06	DXM -.65192327 00	DYM -.70124340 00	DZM -.21031082 00
XT -.53836485 08	YT -.47594874 08	ZT -.27452569 08	DXT .17380964 02	DYT .12471921 01	DZT -.13377666-02
RS .15003292 09	VS .29707989 02	RM .40114597 06	VM .98029428 00	RT .76923876 08	VT .17425654 02
GED -.19608297 01	ALT .74188946 07	LOS .17211453 03	RAS .18134607 03	RAM .14270815 03	LOM .13347661 03
DUT .35000000 02	DT .86399999 05	DR .28853040 01	SHA .57189834 07	DES -.58354574 00	DEM .15859237 02
CCL .54908527 02	MCL .17902846 03	TCL .32988437 03			

HELIOCENTRIC ECLIPTIC COORDINATES

X .14538582 09	Y -.16032803 07	Z .20856724 07	DX -.32781237 01	DY .27755994 02	DZ .75229430 00
R .14540962 09	LAT .82184592 00	LON .35936818 03	V .27959028 02	PTH -.73417984 01	AZ .88339303 02
XE .14998374 09	YE .38412656 07	ZE -.16750000 03	DXE -.12410339 01	DYE .29682056 02	DZE -.10052919-02
XT .96147259 08	YT -.50746559 08	ZT -.62519542 07	DXT .16139931 02	DYT .30825770 02	DZT -.49840641 00
LTE -.63966244-04	LOE .14670947 01	LTT -.32912470 01	LOT .33217489 03	RST .10889718 09	VST .34799049 02
EPS .12737365 03	ESP .22540303 01	SEP .50372317 02	EPM .30935140 01	EMP .87329832 02	MEP .89576652 02
MPS .12438191 03	MSP .23480519 01	SMP .53270038 02	SEM .41534791 02	EMS .13836342 03	ESM .10159538 00
EPT .15635381 03	ETP .22187835 01	TEP .21427371 02	TPS .45843535 02	TSP .27490426 02	STP .10666604 03
SET .44126349 02	STE .10641343 03	EST .29460212 02	RPM .74331404 07	RPT .70064357 08	SPN .12732443 03
GCE .30509147 03	GCT .94975840 02	SIP .45838464 02	CPT .90458623 02	SIN .90453552 02	
REP .74252728 07	VEP .29029138 01	CPE .65895949 02	CPS .85551184 02		

30 DAYS 0 HRS. 0 MIN. 0.000 SEC. 23557776234120200000000 J.D.= 2437942.51634260 OCT. 5,1962 00 23 32.000

GEOCENTRIC EQUATORIAL COORDINATES

X -.65251300 07	Y -.75245950 07	Z -.32267187 06	DX -.24711199 01	DY -.18707223 01	DZ -.94630717-01
R .99649870 07	DEC -.18555933 01	RA .22906903 03	V .31008048 01	PTH .78063383 02	AZ .27032214 03
R .99649879 07	LAT -.18555933 01	LON .20998124 03	VE .72692496 03	PTE .23911980 00	AZE .27000028 03
XS -.14670615 09	YS -.26886199 08	ZS -.11658137 08	DXS .63318504 01	DYS -.26704604 02	DZS -.11580656 02
XM -.68798000 05	YM -.36469675 06	ZM -.13060500 06	DXM .98580337 00	DYM -.89724778-01	DZM -.10839426 00
XT -.40459242 08	YT -.44982924 08	ZT -.26523195 08	DXT .13416545 02	DYT .45558889 01	DZT .20502792 01
RS .14960440 09	VS .29788250 02	RM .39343938 06	VM .99579522 00	RT .66059772 08	VT .14316545 02
GED -.18682299 01	ALT .99586087 07	LOS .17129732 03	RAS .19038511 03	RAM .25931701 03	LOM .24022922 03
DUT .35000000 02	DT .86399999 05	DR .30337561 01	SHA -.62315690 07	DES -.44693872 01	DEM -.19387606 02
CCL .50252467 02	MCL .18124768 03	TCL .32224025 03			

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EARTH-VENUS, RADIATION PRES. ON CHECK 2

HELIOCENTRIC ECLIPTIC COORDINATES

X .14018102 09	Y .22273076 08	Z .26971427 07	DX -.88029703 01	DY .27353559 02	DZ .65822661 00
R .14196508 09	LAT .10886058 01	LON .90281427 01	V .28742699 02	PTH -.87820086 01	AZ .88503715 02
XE .14670615 09	YE .29304946 08	ZE -.34662500 03	DXE -.63318504 01	DYE .29107516 02	DZE .81241129-03
XT .10624691 09	YT -.22516788 08	ZT -.64386654 07	DXT .70846950 01	DYT .34103020 02	DZT .69377898-01
LTE -.13275111-03	LOE .11296306 02	LTT -.33927342 01	LOT .34803441 03	RST .10879737 09	VST .34831217 02
EPS .13877656 03	ESP .25157991 01	SEP .38707620 02	EPM .13205653 01	EMP .14428713 03	MEP .34392275 02
MPS .13981677 03	MSP .23858315 01	SMP .37797382 02	SEM .68658255 02	EMS .11120126 03	ESM .14040588 00
EPT .15442676 03	ETP .37334930 01	TEP .21839737 02	TPS .44352715 02	TSP .21457243 02	STP .11419003 03
SET .41039022 02	STE .11546660 03	EST .23494375 02	RPM .96428862 07	RPT .56930815 08	SPN .13873989 03
GCE .30974753 03	GCT .91987786 02	SIP .44346476 02	CPT .89687298 02	SIN .89681058 02	
REP .99649870 07	VEP .31008048 01	CPE .67059296 02	CPS .87620699 02		

40 DAYS 0 HRS. 0 MIN. 0.000 SEC. 23560063024120200000000 J.D.= 2437952.51634260 OCT. 15,1962 00 23 32.000

GEOCENTRIC EQUATORIAL COORDINATES

X -.89645690 07	Y -.90925694 07	Z -.43980175 06	DX -.32316775 01	DY -.18013380 01	DZ -.19977844 00
R .12776218 08	DEC -.19727080 01	RA .22540614 03	V .37051949 01	PTH .73707002 02	AZ .26572977 03
R .12776217 08	LAT -.19727072 01	LON .19646200 03	VE .93214765 03	PTE .21860020 00	AZE .26999523 03
XS -.13909721 09	YS -.49439307 08	ZS -.21438519 08	DXS .11238484 02	DYS -.25377741 02	DZS -.11004352 02
XM .26497600 06	YM .23467350 06	ZM .67616500 05	DXM -.70543373 00	DYM .76178503 00	DZM .33864570 00
XT -.30873043 08	YT -.40179650 08	ZT -.24108129 08	DXT .86948352 01	DYT .62786870 01	DZT .34134386 01
RS .14917067 09	VS .29856808 02	RM .36035674 06	VM .10920779 01	RT .56113733 08	VT .11254938 02
GED -.19861400 01	ALT .12769839 08	LOS .17062259 03	RAS .19956673 03	RAM .41529191 02	LOM .12585053 02
DUT .35000000 02	DT .86399999 05	DR .35563928 01	SHA -.56965965 07	DES -.82630526 01	DEM .10814954 02
CCL .41557154 02	MCL .17956780 03	TCL .30900056 03			

HELIOCENTRIC ECLIPTIC COORDINATES

X .13013264 09	Y .45370412 08	Z .32141952 07	DX -.14470161 02	DY .25928771 02	DZ .53328121 00
R .13785249 09	LAT .13360396 01	LON .19220979 02	V .29697999 02	PTH -.99150500 01	AZ .88721579 02
XE .13909721 09	YE .53887430 08	ZE .37475000 03	DXE -.11238484 02	DYE .27660902 02	DZE -.61392783-04
XT .10822417 09	YT .74332876 07	ZT -.61330476 07	DXT -.25436489 01	DYT .34779311 02	DZT .63375914 00
LTE .14393977-03	LOE .21176789 02	LTT -.32358661 01	LOT .39291406 01	RST .10865237 09	VST .34877962 02
EPS .15115231 03	ESP .23683655 01	SEP .26479337 02	EPM .26318715 00	EMP .93801988 01	MEP .17035640 03
MPS .15131390 03	MSP .24163492 01	SMP .26269723 02	SEM .15819700 03	EMS .21751701 02	ESM .51396029-01
EPT .14878612 03	ETP .67759441 01	TEP .24435940 02	TPS .41815304 02	TSP .15954735 02	STP .12222996 03
SET .35698980 02	STE .12676150 03	EST .17539519 02	RPM .13131621 08	RPT .44794839 08	SPN .15112370 03
GCE .31844284 03	GCT .87443398 02	SIP .41807374 02	CPT .88201058 02	SIN .88193128 02	
REP .12776218 08	VEP .37051949 01	CPE .68955252 02	CPS .89872999 02		

50 DAYS 0 HRS. 0 MIN. 0.000 SEC. 23560147614120200000000 J.D.= 2437962.51634260 OCT. 25,1962 00 23 32.000

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EARTH-VENUS, RADIATION PRES. ON CHECK 2

GEOCENTRIC EQUATORIAL COORDINATES

X	-.12182598 08	Y	-.10732624 08	Z	-.71985549 06	DX	-.42535830 01	DY	-.20558822 01	DZ	-.48200560 00
R	.16251865 08	DEC	-.25386720 01	RA	.22137940 03	V	.47488892 01	PTH	.74116566 02	AZ	.25756036 03
R	.16251864 08	LAT	-.25386720 01	LON	.18257882 03	VE	.11852195 04	PTE	.22080635 00	AZE	.26998646 03
XS	-.12735948 09	YS	-.70529325 08	ZS	-.30582920 08	DXS	.15878383 02	DYS	-.23311213 02	DZS	-.10107572 02
XM	-.40167300 06	YM	.36811000 05	ZM	.44580750 05	DXM	-.13040566 00	DYM	-.90233684 00	DZM	-.32850051 00
XT	-.25464137 08	YT	-.34625345 08	ZT	-.20852825 08	DXT	.38591230 01	DYT	.63074894 01	DZT	.39913621 01
RS	.14876201 09	VS	.29961620 02	RM	.40581238 06	VM	.96908718 00	RT	.47772137 08	VT	.84028699 01
GED	-.25559496 01	ALT	.16245486 08	LOS	.17017628 03	RAS	.20897687 03	RAM	.17476380 03	LOM	.13596321 03
DUT	.35000000 02	DT	.86399999 05	DR	.45675790 01	SHA	-.43232354 07	DES	-.11863622 02	DEM	.63069898 01
CCL	.19765542 02	MCL	.17739505 03	TCL	.28021402 03						

HELIOCENTRIC ECLIPTIC COORDINATES

X	.11517683 09	Y	.66741462 08	Z	.36090505 07	DX	-.20131966 02	DY	.23330238 02	DZ	.37499619 00
R	.13316592 09	LAT	.15530142 01	LON	.30090971 02	V	.30817797 02	PTH	-.10676357 02	AZ	.88997368 02
XE	.12735948 09	YE	.76874577 08	ZE	-.29725000 03	DXE	-.15878383 02	DYE	.25408181 02	DZE	-.68032741-03
XT	.10189534 09	YT	.36811345 08	ZT	-.53568093 07	DXT	-.12019260 02	DYT	.32782931 02	DZT	.11519040 01
LTE	-.11448601-03	LOE	.31115308 02	LTT	-.28306284 01	LOT	.19863077 02	RST	.10847318 09	VST	.34935799 02
EPS	.16271230 03	ESP	.18604239 01	SEP	.15427257 02	EPM	.10706862 01	EMP	.13155425 03	MEP	.47375064 02
MPS	.16198915 03	MSP	.19073919 01	SMP	.16103431 02	SEM	.38573790 02	EMS	.14132854 03	ESM	.97165341-01
EPT	.14165444 03	ETP	.12184368 02	TEP	.26161183 02	TPS	.38059895 02	TSP	.11124842 02	STP	.13081526 03
SET	.27162146 02	STE	.14123952 03	EST	.11598330 02	RPM	.15979840 08	RPT	.33949931 08	SPN	.16268981 03
GCE	.34023445 03	GCT	.80448475 02	SIP	.38049432 02	CPT	.85932632 02	SIN	.85922168 02		
REP	.16251865 08	VEP	.47488892 01	CPE	.71495394 02	CPS	.92277241 02				

60 DAYS 0 HRS. 0 MIN. 0.000 SEC. 235602344041202000000000 J.D.= 2437972.51634260 NOV. 4,1962 00 23 32.000

GEOCENTRIC EQUATORIAL COORDINATES

X	-.16374399 08	Y	-.12775431 08	Z	-.13410055 07	DX	-.54786102 01	DY	-.27682579 01	DZ	-.10034055 01
R	.20811796 08	DEC	-.36944057 01	RA	.21796162 03	V	.62197462 01	PTH	.77591237 02	AZ	.24268670 03
R	.20811795 08	LAT	-.36944057 01	LON	.16930462 03	VE	.15156661 04	PTE	.22963010 00	AZE	.26997681 03
XS	-.11178401 09	YS	-.89502878 08	ZS	-.38810484 08	DXS	.20083005 02	DYS	-.20488341 02	DZS	-.88854039 01
XM	.16354000 06	YM	-.31999500 06	ZM	-.13356550 06	DXM	.89676070 00	DYM	.47770262 00	DZM	.10968220 00
XT	-.24075564 08	YT	-.29725462 08	ZT	-.17432042 08	DXT	-.53176308 00	DYT	.47914758 01	DZT	.38026623 01
RS	.14836672 09	VS	.30034140 02	RM	.38338215 06	VM	.10219637 01	RT	.42037031 08	VT	.61401345 01
GED	-.37195119 01	ALT	.20805418 08	LOS	.17002645 03	RAS	.21868345 03	RAM	.29707023 03	LOM	.24841323 03
DUT	.35000000 02	DT	.86399999 05	DR	.60744496 01	SHA	-.41462561 07	DES	-.15164120 02	DEM	-.20388711 02
CCL	.32567589 03	MCL	.18399321 03	TCL	.21489162 03						

CASE 1 IBSYS-JPTRAJ-SFPRO 041765 8

EARTH-VENUS, RADIATION PRES. ON CHECK 2

HELIOCENTRIC ECLIPTIC COORDINATES

X	.95409609 08	Y	.85300785 08	Z	.38521260 07	DX	-.25561615 02	DY	.19393148 02	DZ	.18180579 00
R	.12803928 09	LAT	.17240311 01	LON	.41798249 02	V	.32086187 02	PTH	-.10999625 02	AZ	.89333904 02
XE	.11178401 09	YE	.97555208 08	ZE	-.21500000 02	DXE	-.20083005 02	DYE	.22332096 02	DZE	.10894537-02
XT	.87708444 08	YT	.63348316 08	ZT	-.41674630 07	DXT	-.20614768 02	DYT	.28240895 02	DZT	.15836764 01
LTE	-.83028001-05	LOE	.41111584 02	LTT	-.22058770 01	LOT	.35839082 02	RST	.10827349 09	VST	.35000354 02
EPS	.16665256 03	ESP	.18557237 01	SEP	.11491716 02	EPM	.10379981 01	EMP	.10045162 03	MEP	.78510362 02
MPS	.16620530 03	MSP	.19113637 01	SMP	.11683337 02	SEM	.74141950 02	EMS	.10571553 03	ESM	.14213722 00
EPT	.13533242 03	ETP	.20367426 02	TEP	.24300146 02	TPS	.33140288 02	TSP	.71373136 01	STP	.13972239 03
SET	.14859359 02	STE	.15942650 03	EST	.57141354 01	RPM	.20738833 08	RPT	.24607579 08	SPN	.16663500 03
GCE	.34324107 02	GCT	.69215731 02	SIP	.33125852 02	CPT	.82900689 02	SIN	.82886251 02		
REP	.20811796 08	VEP	.62197462 01	CPE	.74275088 02	CPS	.94776907 02				

95 DAYS 14 HRS. 20 MIN. 28.240 SEC. 2356053016542020365557427 J.D.= 2438008.11389166 DEC. 9,1962 14 44 00.240

GEOCENTRIC EQUATORIAL COORDINATES

X	-.38114915 08	Y	-.32470177 08	Z	-.10737317 08	DX	-.69861472 01	DY	-.11839936 02	DZ	-.59359686 01
R	.51208877 08	DEC	-.12103416 02	RA	.22042775 03	V	.14974180 02	PTH	.68705464 02	AZ	.12448577 03
R	.51208876 08	LAT	-.12103416 02	LON	.28156642 03	VE	.36467469 04	PTE	.21920553 00	AZE	.26995161 03
XS	-.33001654 08	YS	-.13173211 09	ZS	-.57122265 08	DXS	.29507772 02	DYS	-.60166952 01	DZS	-.26084711 01
XM	.21883625 06	YM	.27911400 06	ZM	.88068499 05	DXM	-.85077953 00	DYM	.59187478 00	DZM	.29572740 00
XT	-.38807242 08	YT	-.33876662 08	ZT	-.12684747 08	DXT	-.55834930 01	DYT	-.87147206 01	DZT	-.16056959 01
RS	.14732756 09	VS	.30227691 02	RM	.36544492 06	VM	.10777737 01	RT	.53052172 08	VT	.10473777 02
GED	-.12183442 02	ALT	.51202499 08	LOS	.31707434 03	RAS	.25593566 03	RAM	.51902168 02	LOM	.11304084 03
DUT	.35000000 02	DT	.86399999 05	DR	.13951831 02	SHA	-.29675361 08	DES	-.22812884 02	DEM	.13944966 02
CCL	.27278204 03	MCL	.17997888 03	TCL	.61752705 02						

HELIOCENTRIC ECLIPTIC COORDINATES

X	-.51132606 07	Y	.10952209 09	Z	.30669430 07	DX	-.36493919 02	DY	-.66663640 01	DZ	-.73618439 00
R	.10968427 09	LAT	.16022872 01	LON	.92673030 02	V	.37105101 02	PTH	-.77066202 01	AZ	.90930744 02
XE	.33001654 08	YE	.14358377 09	ZE	.38800000 03	DXE	-.29507772 02	DYE	.65578001 01	DZE	-.45493245-03
XT	-.58055881 07	YT	.10745695 09	ZT	.18397960 07	DXT	-.35091265 02	DYT	-.20763944 01	DZT	.19933603 01
LTE	.15089344-03	LOE	.77055806 02	LTT	.97944912 00	LOT	.93092518 02	RST	.10762939 09	VST	.35209114 02
EPS	.12888771 03	ESP	.15697150 02	SEP	.35415132 02	EPM	.79129368-01	EMP	.11248624 02	MEP	.16867161 03
MPS	.12896576 03	MSP	.15755508 02	SMP	.35278724 02	SEM	.15557318 03	EMS	.24368171 02	ESM	.58516955-01
EPT	.13656698 03	ETP	.41576446 02	TEP	.18565540 01	TPS	.34345667 02	TSP	.75079015 00	STP	.14490346 03
SET	.34155269 02	STE	.12977892 03	EST	.16065797 02	RPM	.51567252 08	RPT	.24999996 07	SPN	.12888057 03
GCE	.87217959 02	GCT	.32897067 03	SIP	.34203573 02	CPT	.72723123 02	SIN	.72581027 02		
REP	.51208877 08	VEP	.14974180 02	CPE	.80194516 02	CPS	.10226701 03				

95 DAYS 14 HRS. 20 MIN. 28.240 SEC. 2356053016542020365557427 J.D.= 2438008.11389166 DEC. 9,1962 14 44 00.240
CHANGE OF PHASE OCCURS AT THIS POINT VENUS IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

95 DAYS 14 HRS. 20 MIN. 28.240 SEC. 2356053016542020365557423 J.D.= 2438008.11389166 DEC. 9,1962 14 44 00.240
***** S/C DISCONTINUITY=R STOP

95 DAYS 16 HRS. 53 MIN. 43.705 SEC. 2356053062462027321377777 J.D.= 2438008.22032065 DEC. 9,1962 17 17 15.705

EXTREME ELEVATION

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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                  9


EARTH-VENUS, RADIATICN PRES. ON                  CHECK 2


11 GOLDSTONE        HADEC
      R .51337278 08    LAT-.12135106 02    LON .24319437 03
    MIN .13781373 06     HA .35995644 03    DEC-.12140337 02    ELE .42651574 02    AZI .17994024 03
    CKC .27278288 03    CKM .17997188 03    CKT .61460581 02    PSS .35467366 02    PSM .16745569 03
     UT .22968954 04    DHA .41733529-02    DDE-.34460419-05    DEL .35270805-09    DAZ .53753114-02
     ET .22968657 04    RGE .51332960 08    DRG .13975647 02    DDR .00000000 00    SLS .24630199 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12876903 03    POL .67495580 02
     DT .17122830 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .94755354 05     F1 .12375535 06     F2 .18951071 06     XA .29669594 08    PRA .22047504 03
     D1 .41251785 04     D2 .63170235 04

  95 DAYS 21 HRS. 52 MIN. 44.727 SEC.      23560531705420213500007 6 J.D.= 2438008.42797137   DEC. 9,1962 22 16 16.727

                                                 END OF VIEW PERIOD


11 GOLDSTCNE        HADEC
      R .51588432 08    LAT-.12196989 02    LON .16832835 03
    MIN .13811274 06     HA .74828172 02    DEC-.12201297 02    ELE .49999998 01    AZI .25125303 03
    CKC .27279575 03    CKM .17996884 03    CKT .60901067 02    PSS .35572730 02    PSM .16367384 03
     UT .23018790 04    DHA .41729830-02    DDE-.33640906-05    DEL-.32307599-02    DAZ .24991200-02
     ET .23018693 04    RGE .51587877 08    DRG .14380041 02    DDR .00000000 00    SLS .24634502 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12852815 03    POL .11054749 03
     DT .17207861 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .96050377 05     F1 .12505038 06     F2 .19210075 06     XA .29669634 08    PRA .22056223 03
     D1 .41683459 04     D2 .64033584 04

  96 DAYS 11 HRS. 53 MIN. 28.702 SEC.      235605347557202131637777 J.D.= 2438009.01181367  DEC. 10,1962 12 17 00.702

                                                START OF VIEW PERIOD


11 GOLDSTONE        HADEC
      R .52299049 08    LAT-.12371365 02    LON .31783551 03
    MIN .13895348 06     HA .28530967 03    DEC-.12375620 02    ELE .49999981 01    AZI .10896810 03
    CKC .27284703 03    CKM .17997103 03    CKT .59330653 02    PSS .35849109 02    PSM .15700028 03
     UT .23158913 04    DHA .41728503-02    DDE-.35470234-05    DEL .32221787-02    DAZ .25056196-02
     ET .23158815 04    RGE .52298493 08    DRG .13795244 02    DDR .00000000 00    SLS .24646385 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12787748 03    POL .33034434 02
     DT .17444897 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .94177634 05     F1 .12317763 06     F2 .18835527 06     XA .29669577 08    PRA .22083945 03
     D1 .41059211 04     D2 .62785089 04

  96 DAYS 16 HRS. 51 MIN. 36.500 SEC.      235605360347202100000000 J.D.= 2438009.21884838  DEC. 10,1962 17 15 08.500

                                                 EXTREME ELEVATION




CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                  10


EARTH-VENUS, RADIATICN PRES. ON                  CHECK 2


11 GOLDSTONE        HADEC
      R .52552614 08    LAT-.12433335 02    LON .24319487 03
    MIN .13925161 06     HA .35995594 03    DEC-.12438469 02    ELE .42353440 02    AZI .17993862 03
    CKC .27286141 03    CKM .17996652 03    CKT .58762363 02    PSS .35952588 02    PSM .15370370 03
     UT .23208601 04    DHA .41731118-02    DDE-.34651272-05    DEL-.30526236-10    DAZ .52312657-02
     ET .23208504 04    RGE .52548321 08    DRG .14198296 02    DDR .00000000 00    SLS .24650524 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12763865 03    POL .67921023 02
     DT .17528231 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .95468363 05     F1 .12446836 06     F2 .19093673 06     XA .29669616 08    PRA .22092974 03
     D1 .41489454 04     D2 .63645574 04

  96 DAYS 21 HRS. 49 MIN. 42.096 SEC.      235605371136202414200015 J.D.= 2438009.42585739  DEC. 10,1962 22 13 14.096

                                                 END OF VIEW PERIOD


11 GOLDSTONE        HADEC
      R .52806970 08    LAT-.12495367 02    LON .16856428 03
    MIN .13954970 06     HA .74592113 02    DEC-.12499584 02    ELE .49999998 01    AZI .25087456 03
    CKC .27287887 03    CKM .17996432 03    CKT .58191034 02    PSS .36054075 02    PSM .14988854 03
     UT .23258283 04    DHA .41727512-02    DDE-.33831196-05    DEL-.32232876-02    DAZ .25008325-02
     ET .23258186 04    RGE .52806415 08    DRG .14601377 02    DDR .00000000 00    SLS .24654780 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12739937 03    POL .10950829 03
     DT .17614322 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .96759181 05     F1 .12575918 06     F2 .19351836 06     XA .29669656 08    PRA .22102092 03
     D1 .41919727 04     D2 .64506120 04

  97 DAYS 11 HRS. 52 MIN. 22.345 SEC.      235605421676202454100003 J.D.= 2438010.01104565  DEC. 11,1962 12 15 54.345

                                                START OF VIEW PERIOD


11 GOLDSTONE        HADEC
      R .53530446 08    LAT-.12671106 02    LON .31759792 03
    MIN .14039237 06     HA .28554739 03    DEC-.12675269 02    ELE .50000015 01    AZI .10934855 03
    CKC .27294229 03    CKM .17996816 03    CKT .56539357 02    PSS .36321583 02    PSM .14309546 03
     UT .23398728 04    DHA .41726186-02    DDE-.35658786-05    DEL .32145546-02    DAZ .25073634-02
     ET .23398631 04    RGE .53529891 08    DRG .14017982 02    DDR .00000000 00    SLS .24666600 03
    RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12674910 03    POL .39044234 02
     DT .17855647 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
    BF1 .94890928 05     F1 .12389093 06     F2 .18978185 06     XA .29669598 08    PRA .22131016 03
     D1 .41296976 04     D2 .63260618 04

  97 DAYS 14 HRS. 20 MIN. 28.240 SEC.      235605426154202036557427 J.D.= 2438010.11389166  DEC. 11,1962 14 44 00.240
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CASE  1                                 IBSYS-JPTRAJ-SFPRO 041765                                        11

EARTH-VENUS, RADIATICN PRES. CN                CHECK 2

      GEOCENTRIC                                                                        EQUATORIAL COORDINATES

    X -.39292249 08     Y -.34585063 08     Z -.11798440 08    DX -.66286401 01    DY -.12640377 02    DZ -.63478138 01
    R  .53658276 08   DEC -.12702049 02    RA  .22135425 03     V  .15620907 02   PTH  .67168155 02    AZ  .12255903 03
    R  .53658275 08   LAT -.12702050 02   LON  .28052158 03    VE  .38119831 04   PTE  .21639405 00   AZE  .26995096 03
   XS -.27883219 08    YS -.13269048 09    ZS -.57537650 08   DXS  .29723859 02   DYS -.50734308 01   DZS -.21989640 01
   XM  .51533499 05    YM  .34426450 06    ZM  .12676725 06   DXM -.10446186 01   DYM  .14998627 00   DZM  .14414167 00
   XT -.39740388 08    YT -.35456520 08    ZT -.12997606 08   DXT -.52048402 01   DYT -.95668209 01   DZT -.20150284 01
   RS  .14729161 09    VS  .30233804 02    RM  .37046414 06    VM  .10653256 01    RT  .54821537 08    VT  .11075864 02
  GED -.12785775 02   ALT  .53651898 06   LOS  .31730000 03   RAS  .25813268 03   RAM  .81486513 02   LOM  .14065384 03
  DUT  .35000000 02    DT  .76800000 04    DR  .14396972 02   SHA -.31822035 08   DES -.22994183 02   DEM  .20010047 02
  CCL  .27295560 03   MCL  .17997039 03   TCL  .56240365 02

                                              GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                2356024142652027765557427 J.D.= 2437973.47138876   NOV. 4,1962 23 18 47.990
  SMA -.16336234 04   ECC  .12745619 05     B  .20821539 08   SLR  .26538343 12   APO  .00000000 00   RCA  .20819907 08
   VH  .15620431 02    C3  .24399787 03    C1  .32524145 09   TFP  .31659122 07    TF  .60955045 02   LTF  .60943603 02
   TA  .67172293 02   MTA  .90004494 02    EA  .91665283 02    MA  .17344531 07                       TFI  .97597547 02

                                                       ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.39292249 08     Y -.34585063 08     Z -.11798440 08    DX -.66286401 01    DY -.12640377 02    DZ -.63478138 01
  INC  .34693325 02   LAN  .22352560 02   APF  .13555276 03    MX  .64569876 00    MY -.55448230 00    MZ -.52499744 00
   WX  .21646322 00    WY -.52641588 00    WZ  .82221034 00    PX -.87921651 00    PY  .26099517 00    PZ  .39857203 00
   QX -.42440770 00    QY -.80917719 00    QZ -.40633771 00    RX  .18872320 00    RY  .35988791 00    RZ -.91370904 00
   BX -.87924989 00    BY  .26093171 00    BZ  .39854019 00    TX -.88561855 00    TY  .46441339 00    TZ  .00000000 00
  SXI -.42447668 00   SYI -.80915671 00   SZI -.40630644 00   DAI -.23973022 02   RAI  .24231888 03
  SXO -.42433871 00   SYO -.80919766 00   SZO -.40636898 00   DAO -.23976943 02   RAO  .24232773 03

  BTQ  .18735903 06   BRQ -.90830831 07     B  .20821539 08   THA  .33413609 03    T VECTOR IN  EARTH EQUATOR PLANE

     HELIOCENTRIC                                                                         ECLIPTIC COORDINATES

    X -.11409030 08     Y  .10820414 09     Z  .29346385 07    DX -.36352499 02    DY -.85929000 01    DZ -.79604676 00
    R  .10884352 09   LAT  .15449947 01   LON  .96019018 02     V  .37362760 02   PTH -.73091441 01    AZ  .91033023 02
   XE  .27683219 08    YE  .14462829 09    ZE  .26950000 03   DXE -.29723859 02   DYE  .55294794 01   DZE -.90044736-03
   XT -.11857169 08    YT  .10692755 09    ZT  .21811440 07   DXT -.34928699 02   DYT -.40493277 01   DZT  .19563566 01
  LTE  .10483430-03   LOE  .79087698 02   LTT  .11614574 01   LOT  .96327662 02   RST  .10760506 09   VST  .35217018 02
  EPS  .12662666 03   ESP  .16999598 02   SEP  .36373740 02   EPM  .24787221 00   EMP  .38850398 02   MEP  .14090146 03
  MPS  .12687366 03   MSP  .16993096 02   SMP  .36133232 02   SEM  .17568276 03   EMS  .43063947 01   ESM  .00000000 00
  EPT  .13814754 03   ETP  .40772486 02   TEP  .10799443 01   TPS  .36651964 02   TSP  .49218042 00   STP  .14285578 03
  SET  .35659721 02   STE  .12706242 03   EST  .17277850 02   RPM  .53946285 08   RPT  .15486327 07   SPN  .12661984 03
  GCE  .87044397 02   GCT  .32328476 03   SIP  .36422580 02   CPT  .72903288 02   SIN  .72673901 02
  REP  .53658276 08   VEP  .15620907 02   CPE  .80256417 02   CPS  .10247121 03

                                             HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                2356076045712023165557427 J.D.= 2438037.00636128   JAN. 7,1963 12 09 09.615
  SMA  .12728584 09   ECC  .19193415 00     B  .12491931 09   SLR  .12259680 09   APO  .15171634 09   RCA  .10285535 09
   VH  .26586760 02    C3 -.10426462 04    C1  .40336490 10   TFP -.23235094 07    TF  .12449002 03   PER  .28666702 03
   TA -.48826488 02   MTA  .18000000 03    EA -.40984314 02    MA -.33771896 02                       TFI  .97597547 02


CASE  1                                 IBSYS-JPTRAJ-SFPRO 041765                                        12

EARTH-VENUS, RADIATICN PRES. ON                CHECK 2

                                                       ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X -.11409030 08     Y  .10820414 09     Z  .79346385 07    DX -.36352499 02    DY -.85929000 01    DZ -.79604676 00
  INC  .18584504 01   LAN  .33224521 03   APF  .17258636 03    MX -.99437648 00    MY -.10435814 00    MZ -.18022150-01
   WX -.15102577-01    WY -.28699463-01    WZ  .99947400 00    PX -.81749394 00    PY  .57592164 00    PZ  .41845776-02
   QX -.57573879 00    QY -.81700073 00    QZ -.32159537-01    RX -.34208974-02    RY  .24100104-02    RZ -.99999103 00
   BX  .57573890 00    BY  .81700090 00    BZ  .32159544-01    TX  .57592680 00    TY  .81750127 00    TZ  .00000000 00
  DAP  .23975927 00   RAP  .14483543 03

  BTC  .12485467 09   BRC -.40173818 07     B  .12491929 09   THA  .35815706 03    T VECTOR IN  ECLIPTIC PLANE

    APHRODIOCENTRIC                                                                        ECLIPTIC COORDINATES

    X  .44813947 06     Y  .12765891 07     Z  .75349489 06    DX -.14238000 01    DY -.45435722 01    DZ -.27524033 01
    R  .15486327 07   DEC  .29114400 02    RA  .70656657 02     V  .54997253 01   PTH -.88076883 02    AZ  .24107256 03
  ALT  .15424327 07   SHA  .93510054 06   ALP  .44169141 02    DR -.54966278 01    DP  .68282368-05   ASD  .22938678 00
  HGE  .23337333 03   SVL  .29755004 02   HNG  .22464570 02   SIA  .13791816 03

                                            APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                2356056354632020171157427 J.D.= 2438013.32310322  DEC. 14,1962 19 45 16.119
  SMA -.10868129 05   ECC  .49093327 01     B  .52332792 05   SLR  .25153263 06   APO  .00000000 00   RCA  .42565318 05
   VH  .54614609 01    C3  .29827556 02    C1  .28581342 06   TFP -.27727588 06    TF  .10080676 03   LTF  .10077004 03
   TA -.99823254 02   MTA  .10175304 03    EA -.23297472 03    MA -.79687521 04                       TFI  .97597547 02
  ZAE  .13737671 03   ZAP  .36622976 02   ZAC  .72228841 02   DEF  .23506073 02    IR  .13170148 05    GP -.30196549 02

                                                       ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .44813947 06     Y  .12765891 07     Z  .75349489 06    DX -.14238000 01    DY -.45435722 01    DZ -.27524033 01
  INC  .13987522 03   LAN  .20929608 03   APF  .23079818 03    MX  .90377507 00    MY -.67839262-01    MZ -.42258339 00
   WX -.31534191 00    WY  .56202240 00    WZ -.76464279 00    PX  .64115457 00    PY -.20748265 00    PZ -.49939815 00
   QX -.43932598 00    QY -.80067352 00    QZ -.40732552 00    RX  .14960904 00    RY  .47762633 00    RZ -.86573101 00
   BX  .91301253 00    BY -.40041880-01    BZ -.40596154 00    TX -.95428022 00    TY  .29891348 00    TZ  .00000000 00
  SXI -.25877867 00   SYI -.82614998 00   SZI -.50050952 00   DAI -.30033716 02   RAI  .25260764 03
  SXO -.60145228 00   SYO -.74162469 00   SZO -.29706229 00   DAO -.17281242 02   RAO  .23095819 03
  ETE  .31588812 03   ETS  .47608824 02   ETC  .26220584 03

  BTC -.46222361 05   BRC  .24540072 05     B  .52332798 05   THA  .15203557 03    T VECTOR IN  ECLIPTIC PLANE

  97 DAYS 16 HRS. 49 MIN. 34.068 SEC.      2356054324502024105777774 J.D.= 2438010.21743134  DEC. 11,1962 17 13 06.068

                                             EXTREME ELEVATION

11 GOLDSTONE       HADEC
     R .53787170 08     LAT-.12733219 02     LON .24319538 03
   MIN .14068956 06      HA .35995543 03     DEC-.12738260 02     ELE .42053649 02     AZI .17993823 03
   CKC .27296101 03     CKM .17996448 03     CKT .55926993 02     PSS .36421226 02     PSM .14006545 03
    UT .23448261 04     DHA .41728723-02     DDE-.34841772-05     DEL .59478588-10     DAZ .51955657-02
    ET .23448163 04     RGE .53782901 08     DRG .14419971 02     DDR .00000000 00     SLS .24670695 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .12651186 03     POL .69777658 02
    DT .17940042 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .96178251 05      F1 .12517825 06      F2 .19235650 06      XA .29669638 08     PRA .22140440 03
    D1 .41726083 04      D2 .64118833 04
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                        13

EARTH-VENUS, RADIATION PRES. ON               CHECK 2

 97 DAYS 21 HRS. 46 MIN. 43.673 SEC.      23560544322120272610000 J.D.= 2438010.42379250  DEC. 11,1962 22 10 15.673

                                              END OF VIEW PERIOD

11 GOLDSTONE       HADEC
    R .54044684 08    LAT-.12795400 02    LON .16880253 03
  MIN .14098673 06     HA .74353744 02    DEC-.12799528 02    ELE .49999981 01    AZI .25049356 03
  CKC .27298267 03    CKM .17996305 03    CKT .55297931 02    PSS .36518864 02    PSM .13631710 03
   UT .23497787 04    DHA .41725204-02    DDE-.34024723-05    DEL-.32156265-02    DAZ .25025536-02
   ET .23497690 04    RGE .54044127 08    DRG .14822158 02    DDR .00000000 00    SLS .24674904 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12627420 03    POL .10844218 03
   DT .18027178 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .97466207 05     F1 .12646621 06     F2 .19493241 06     XA .29669678 08    PRA .22149951 03
   D1 .42155402 04     D2 .64977470 04

 98 DAYS 11 HRS. 51 MIN. 21.325 SEC.      23560547401720225144000 J.D.= 2438011.01033940  DEC. 12,1962 12 14 53.325

                                              START OF VIEW PERIOD

11 GOLDSTONE       HADEC
    R .54781106 08    LAT-.12972554 02    LON .31735794 03
  MIN .14183135 06     HA .28578749 03    DEC-.12976631 02    ELE .50000006 01    AZI .10973161 03
  CKC .27305733 03    CKM .17996836 03    CKT .53360464 02    PSS .36777444 02    PSM .12942838 03
   UT .23638559 04    DHA .41723878-02    DDE-.35865708-05    DEL .32067363-02    DAZ .25091171-02
   ET .23638461 04    RGE .54780550 08    DRG .14242186 02    DDR .00000000 00    SLS .24686660 03
  RDI .63720340 04    PHI .35208070 02    THI .24315062 03    SPS .12562437 03    POL .47720675 02
   DT .16272622 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .95608915 05     F1 .12460891 06     F2 .19121783 06     XA .29669620 08    PRA .22180080 03
   D1 .41536305 04     D2 .63739276 04

 98 DAYS 16 HRS. 47 MIN. 36.383 SEC.      23560550455320206100004 J.D.= 2438011.21606924  DEC. 12,1962 17 11 08.383

                                              EXTREME ELEVATION

11 GOLDSTONE       HADEC
    R .55040991 08    LAT-.13034851 02    LON .24319593 03
  MIN .14212761 06     HA .35995489 03    DEC-.13039798 02    ELE .41752110 02    AZI .17993783 03
  CKC .27307996 03    CKM .17996541 03    CKT .52590690 02    PSS .36873261 02    PSM .12668496 03
   UT .23687934 04    DHA .41726334-02    DDE-.35059628-05    DEL-.38922904-10    DAZ .51640097-02
   ET .23687837 04    RGE .55036747 08    DRG .14644325 02    DDR .00000000 00    SLS .24690712 03
  RDI .63720340 04    PHI .35208070 02    THI .24315062 03    SPS .12538876 03    POL .71151220 02
   DT .18358281 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .96896718 05     F1 .12589672 06     F2 .19379343 06     XA .29669660 08    PRA .22189893 03
   D1 .41965572 04     D2 .64597811 04

 98 DAYS 21 HRS. 43 MIN. 49.406 SEC.      23560551530620226377774 J.D.= 2438011.42177553  DEC. 12,1962 22 07 21.406

                                              END OF VIEW PERIOD
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                        14

EARTH-VENUS, RADIATION PRES. ON               CHECK 2

11 GOLDSTONE       HADEC
    R .55301687 08    LAT-.13097232 02    LON .16904324 03
  MIN .14242382 06     HA .74112901 02    DEC-.13101273 02    ELE .50000006 01    AZI .25010981 03
  CKC .27310541 03    CKM .17996465 03    CKT .51754115 02    PSS .36967043 02    PSM .12307660 03
   UT .23737303 04    DHA .41722898-02    DDE-.34257759-05    DEL-.32077712-02    DAZ .25042806-02
   ET .23737206 04    RGE .55301131 08    DRG .15047159 02    DDR .00000000 00    SLS .24694875 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12515273 03    POL .10734222 03
   DT .18446469 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .98186745 05     F1 .12718674 06     F2 .19637349 06     XA .29669701 08    PRA .22199793 03
   D1 .42395581 04     D2 .65457829 04

 99 DAYS 11 HRS. 50 MIN. 25.742 SEC.      23560554614120233700000 J.D.= 2438012.00969609  DEC. 13,1962 12 13 57.742

                                              START OF VIEW PERIOD

11 GOLDSTONE       HADEC
    R .56051542 08    LAT-.13276151 02    LON .31711519 03
  MIN .14327643 06     HA .28603037 03    DEC-.13280143 02    ELE .50000006 01    AZI .11011788 03
  CKC .27319006 03    CKM .17997115 03    CKT .48700013 02    PSS .37216475 02    PSM .11609826 03
   UT .23878404 04    DHA .41721550-02    DDE-.36177725-05    DEL .31987020-02    DAZ .25108887-02
   ET .23878307 04    RGE .56050986 08    DRG .14480073 02    DDR .00000000 00    SLS .24706573 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .12450346 03    POL .63096492 02
   DT .18696594 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .96370720 05     F1 .12537072 06     F2 .19274144 06     XA .29669644 08    PRA .22231138 03
   D1 .41790240 04     D2 .64247146 04

 99 DAYS 14 HRS. 20 MIN. 28.240 SEC.      23560555245420203655742 7 J.D.= 2438012.11389166  DEC. 13,1962 14 44 00.240

      GEOCENTRIC                                                                          EQUATORIAL COORDINATES

  X -.40401515 08     Y -.36840644 08     Z -.12933012 08    DX -.62034062 01    DY -.13476355 02    DZ -.67974975 01
  R  .56185213 08   DEC -.13307983 02    RA  .22236052 03     V  .16318712 02   PTH  .65605731 02    AZ  .12098424 03
  R  .56185212 08   LAT -.13307983 02   LON  .27955649 03    VE  .39813214 04   PTE  .21388054 00   AZE  .26995005 03
 XS -.22730310 08    YS -.13348523 09    ZS -.57882082 08   DXS  .29906197 02   DYS -.41233146 01   DZS -.17867313 01
 XM -.12793600 06    YM  .33046900 06    ZM  .13650800 06   DXM -.99311659 00   DYM -.30104887 00   DZM -.31415671-01
 XT -.40601382 08    YT -.37181991 08    ZT -.13381116 08   DXT -.47487228 01   DYT -.10398957 02   DZT -.24227590 01
 RS  .14725933 09    VS  .30241937 02    RM  .37975230 06    VM  .10382186 01    RT  .56657099 08    VT  .11685821 02
GED -.13395416 02   ALT  .56178835 08   LOS  .31753213 03   RAS  .26033617 03   RAM  .11116315 03   LOM  .16835911 03
DUT  .35000000 02    PT  .19200000 04    DR  .14861858 02   SHA -.34020608 08   DES -.23145176 02   DEM  .21067397 02
CCL  .27320710 03   MCL  .17997388 03   TCL  .47981663 02
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CASE  1                                            IBSYS-JPTRAJ-SFPRO 041765                                                  15

EARTH-VENUS, RADIATION PRES. ON                          CHECK 2

     HELIOCENTRIC
                                                                                                          ECLIPTIC COORDINATES
   X -.17671205 08     Y  .10654955 09     Z  .27908750 07    DX -.36109603 02    DY -.10574465 02    DZ -.87625891 00
   R  .10804104 09   LAT  .14802061 01   LON  .99416771 02     V  .37636293 02   PTH -.69360767 01    AZ  .91164229 02
  XE  .22730310 08    YE  .14549448 09    ZE  .92500000 02   DXE -.29906197 02   DYE  .44937880 01   DZE -.11228770-02
  XT -.17871072 08    YT  .10605811 09    ZT  .25155560 07   DXT -.34654920 02   DYT -.60106769 01   DZT  .19131060 01
 LTE  .35989975-04   LOE  .81120568 02   LTT  .13398415 01   LOT  .99564643 02   RST  .10758265 09   VST  .35224305 02
 EPS  .12438064 03   ESP  .18353928 02   SEP  .37265422 02   EPM  .35200672 00   EMP  .65374236 02   MEP  .11427372 03
 MPS  .12473202 03   MSP  .18283875 02   SMP  .36984094 02   SEM  .15141594 03   EMS  .28513518 02   ESM  .69941139-01
 EPT  .14195066 03   ETP  .37676784 02   TEP  .37266289 00   TPS  .39820246 02   TSP  .20367177 00   STP  .13997590 03
 SET  .37029535 02   STE  .12447948 03   EST  .18490979 02   RPM  .56342391 08   RPT  .59771421 06   SPN  .12437414 03
 GCE  .86792896 02   GCT  .31477456 03   SIP  .39225915 02   CPT  .74211037 02   SIN  .73616706 02
 REP  .56185213 08   VEP  .16318712 02   CPE  .80294715 02   CPS  .10263574 03

   APHRODIOCENTRIC
                                                                                                          ECLIPTIC COORDINATES
   X  .19966693 06     Y  .49144134 06     Z  .27531963 06    DX -.14546834 01    DY -.45637881 01    DZ -.27893649 01
   R  .59771421 06   DEC  .27427178 02    RA  .67868647 02     V  .55429975 01   PTH -.85207301 02    AZ  .23340268 03
 ALT  .59151421 06   SHA  .38439586 06   ALP  .35237906 02    DR -.55236167 01    DP  .44393975-04   ASD  .59433147 00
 HGE  .23561935 03   SVL  .28408768 02   HNG  .29165777 02   SIA  .14135633 03

                                               APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                   23560563570320217665 7427 J.D.= 2438013.32977998  DEC. 14,1962 19 54 52.991
 SMA -.10957719 05   ECC  .47467960 01     B  .50846750 05   SLR  .23594240 06   APO  .00000000 00   RCA  .41056337 05
  VH  .54440910 01    C3  .29638127 02    CI  .27681426 06   TFP -.10505275 06    TF  .10081344 03   LTF  .10077715 03
  TA -.97325680 02   MTA  .10216152 03    EA -.18054369 03    MA -.29904414 04                       TFI  .99597547 02
 ZAE  .13758618 03   ZAP  .38744028 02   ZAC  .71997601 02   DEF  .24323049 02    IR  .13202868 05    GP -.30414800 02

                                                              ALL VECTORS REFERENCED TO ECLIPTIC PLANE
   X  .19966693 06     Y  .49144134 06     Z  .27531963 06    DX -.14546834 01    DY -.45637881 01    DZ -.27893649 01
 INC  .13544712 03   LAN  .21605784 03   APF  .23628763 03    MX  .84715059 00    MY -.48073606-01    MZ -.52917415 00
  WX -.41294392 00    WY  .56716335 00    WZ -.71260336 00    PX  .79759858 00    PY -.15251911 00    PZ -.58358786 00
  QX -.43967525 00    QY -.80936009 00    QZ -.38938659 00    RX  .15259087 00    RY  .47991693 00    RZ -.86394195 00
  BX  .87232404 00    BY  .21410391-01    BZ -.48845918 00    TX -.95298885 00    TY  .30300536 00    TZ  .00000000 00
 SXI -.26177904 00   SYI -.82332705 00   SZI -.50359134 00   DAI -.30237887 02   RAI  .25236179 03
 SXO -.59783670 00   SYO -.75906513 00   SZO -.25770428 00   DAO -.14933885 02   RAO  .23177616 03
 ETE  .31441521 03   ETS  .43093203 02   ETC  .26214139 03

 BTC -.41939799 05   BRC  .28747949 05     B  .50846745 05   THA  .14557102 03    T VECTOR IN  ECLIPTIC PLANE

 99 DAYS 16 HRS. 45 MIN. 43.425 SEC.          23560555665620266627 7777 J.D.= 2438012.21476186  DEC. 13,1962 17 09 15.425

                                                 EXTREME ELEVATION
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CASE  1                                            IBSYS-JPTRAJ-SFPRO 041765                                                  16

EARTH-VENUS, RADIATION PRES. ON                          CHECK 2

11 GOLDSTONE          HADEC
      R .56314655 08     LAT-.13338846 02     LON .24319668 03
    MIN .14356572 06      HA .35995413 03     DEC-.13343706 02     ELE .41448203 02     AZI .17993744 03
    CKC .27321600 03     CKM .17996881 03     CKT .47192466 02     PSS .37308352 02     PSM .11364111 03
     UT .23927620 04     DHA .41723913-02     DDE-.35428809-05     DEL .85089164-10     DAZ .51551705-02
     ET .23927523 04     RGE .56310637 06     DRG .14889348 02     DUR .00000000 00     SLS .24710588 03
    RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .12426952 03     POL .72443400 02
     DT .18783204 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
    BF1 .97681373 05      F1 .12668137 06      F2 .19536275 06      XA .29669685 08     PRA .22241341 03
     D1 .42227124 04      D2 .65120915 04

  99 DAYS 21 HRS. 40 MIN. 59.154 SEC.         23560556737320262360 0003 J.D.= 2438012.41980502  DEC. 13,1962 22 04 31.154

                                                 END OF VIEW PERIOD

11 GOLDSTONE          HADEC
      R .56579154 08     LAT-.13401751 02     LON .16928718 03
    MIN .14386098 06      HA .73868842 02     DEC-.13405710 02     ELE .49999998 01     AZI .24972218 03
    CKC .27324451 03     CKM .17996858 03     CKT .45227621 02     PSS .37398106 02     PSM .11022675 03
     UT .23976630 04     DHA .41720535-02     DDE-.34715348-05     DEL-.31997026-02     DAZ .25060007-02
     ET .23976733 04     RGE .56578597 08     DRG .15304175 02     DDR .00000000 00     SLS .24714711 03
    RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .12403520 03     POL .10620616 03
     DT .18872566 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
    BF1 .99009607 05      F1 .12800981 06      F2 .19801962 06      XA .29669726 08     PRA .22251635 03
     D1 .42669935 04      D2 .66006538 04

 100 DAYS 11 HRS. 49 MIN. 36.368 SEC.         23560562026520206157 7761 J.D.= 2438013.00912486  DEC. 14,1962 12 13 08.389

                                                 START OF VIEW PERIOD

11 GOLDSTONE          HADEC
      R .57346540 08     LAT-.13584950 02     LON .31686715 03
    MIN .14470960 06      HA .28627852 03     DEC-.13588860 02     ELE .49999998 01     AZI .11051125 03
    CKC .27333547 03     CKM .17997595 03     CKT .30617401 02     PSS .37636859 02     PSM .10316422 03
     UT .24118267 04     DHA .41718964-02     DDE-.37506941-05     DEL .31902922-02     DAZ .25127548-02
     ET .24118170 04     RGE .57345984 06     DRG .14901448 02     DDR .00000000 00     SLS .24726413 03
    RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .12338666 03     POL .25613208-05
     DT .19128559 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
    BF1 .97720124 05      F1 .12672012 06      F2 .19544025 06      XA .29669686 08     PRA .22284269 03
     D1 .42240041 04      D2 .65146749 04

 100 DAYS 16 HRS. 43 MIN. 54.897 SEC.         23560563076320256263 7777 J.D.= 2438013.21350574  DEC. 14,1962 17 07 26.897

                                                 EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                          17


EARTH-VENUS, RADIATION PRES. ON                    CHECK 2


11 GOLDSTONE        HADEC
    R .57619118 08    LAT-.13650689 02    LON .24320013 03
  MIN .14500391 06     HA .35995068 03    DEC-.13655460 02    ELE .41136446 02    AZI .17993513 03
  CKC .27336137 03    CKM .17997409 03    CKT .79897165 01    PSS .37723421 02    PSM .10097619 03
   UT .24167319 04    DHA .41721331-02    DDE-.37863361-05    DEL .24364495-09    DAZ .52816880-02
   ET .24167221 04    RGE .57614926 06    DRG .15746835 02    DDR .00000000 00    SLS .24730477 03
  RDI .63720340 04    PHI .35208070 02    THI .24315062 03    SPS .12315359 03    PUL .73683747 02
   DT .19218268 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .10042737 06     F1 .12942737 06     F2 .20085475 06     XA .29669769 08    PRA .22294910 03
   D1 .43142458 04     D2 .66951583 04

100 DAYS 19 HRS. 31 MIN. 50.356 SEC.        235605635712202455507536 J.D.= 2438013.33011986  DEC. 14,1962 19 55 22.357

    GEOCENTRIC                                                                              EQUATORIAL COORDINATES

   X -.41051522 08      Y -.38296840 08      Z -.13673227 08     DX -.74023300 01     DY -.14859380 02     DZ -.72436947 01
   R  .57782631 08    DEC -.13687849 02     RA  .22301170 03      V  .18112613 02    PTH  .68235511 02     AZ  .12000563 03
   R  .57782630 08    LAT -.13687850 02    LON  .20116672 03     VE  .40881274 04    PTE  .23575764 00    AZE  .26995292 03
  XS -.19582444 08     YS -.13388803 09     ZS -.58056638 08    DXS  .30000255 02    DYS -.35421508 01    DZS -.15347133 01
  XM -.22577100 06     YM  .28624600 06     ZM  .12788162 06    DXM -.85772726 00    DYM -.53310871 00    DZM -.13084948 00
  XT -.41084044 08     YT -.38300817 08     ZT -.13648677 08    DXT -.44341001 01    DYT -.10892720 02    DZT -.26687897 01
  RS  .14724146 09     VS  .30247603 02     RM  .38634573 06     VM  .10183430 01     RT  .57802575 08     VT  .12059645 02
 GED -.13777587 02    ALT  .57776254 08    LOS  .23983393 03    RAS  .26167892 03    RAM  .12826393 03    LOM  .10641894 03
 DUT  .35000000 02     DT  .24000000 03     DR  .16821471 02    SHA -.35392949 08    DES -.23222040 02    DEM  .19329668 02
 CCL  .27338419 03    MCL  .17998013 03    TCL  .32630208 03

   HELIOCENTRIC                                                                               ECLIPTIC COORDINATES

   X -.21469078 08      Y  .10535806 09      Z  .26909640 07     DX -.37402585 02     DY -.12654299 02     DZ -.73542869 00
   R  .10755688 09    LAT  .14336311 01    LON  .10151762 03      V  .39492093 02    PTH -.71978411 01     AZ  .90894727 02
  XE  .19582444 08     YE  .14593346 09     ZE -.26000000 02    DXE -.30000255 02    DYE  .38603336 01    DZE -.11356622-02
  XT -.21501601 08     YT  .10536418 09     ZT  .27150700 07    DXT -.34434355 02    DYT -.71950176 01    DZT  .18838057 01
 LTE -.10117328-04    LDF  .82357275 02    LTT  .14463002 01    LOT  .10153394 03    RST  .10756998 09    VST  .35228423 02
 EPS  .12301625 03    ESP  .19211890 02    SEP  .37771855 02    EPM  .37813586 00    EMP  .80750818 02    MEP  .98871069 02
 MPS  .12339400 03    MSP  .19108989 02    SMP  .37497010 02    SEM  .13659433 03    EMS  .43302559 02    ESM  .10326686 00
 EPT  .11913395 03    ETP  .60830594 02    TEP  .35663121-01    TPS  .10864178 03    TSP  .19782341-01    STP  .71337549 02
 SET  .37800169 02    STL  .12297074 03    EST  .19229084 02    RPM  .57843469 08    RPT  .40941986 05    SPN  .12300993 03
 GCE  .86615805 02    GCT  .23291788 03    SIP  .99931756 02    CPT  .11913896 03    SIN  .11042893 03
 REP  .57782631 08    VEP  .18112613 02    CPF  .80314032 02    CPS  .10271886 03

  APHRODIOCENTRIC                                                                             ECLIPTIC COORDINATES

   X  .32522779 05      Y -.61173124 04      Z -.24105883 05     DX -.29682299 01     DY -.54592814 01     DZ -.26192343 01
   R  .40941986 05    DEC -.36070585 02     RA  .34934751 03      V  .67434806 01    PTH  .12660726-06     AZ  .24127988 03
 ALT  .34741986 05    SHA -.38789263 05    ALP  .12302172 02     DR  .47704695-07     DP  .94370840-02    ASD  .87100270 01
 HGE  .23698374 03    SVL -.31715798 02    HNG  .11207159 03    SIA  .11042393 03

                                                 APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 235605635712202455501147 J.D.= 2438013.33011986  DEC. 14,1962 19 55 22.356




CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                          18


EARTH-VENUS, RADIATION PRES. ON                    CHECK 2

 SMA -.10968193 05    ECC  .47327923 01      B  .50738202 05    SLR  .23471190 06    APD  .00000000 00    RCA  .40941986 05
  VH  .54414910 01     C3  .29609825 02     C1  .27609149 06    TFP  .98943083-04     TF  .10081377 03    LTF  .10077751 03
  TA  .25613208-05    MTA  .10219806 03     EA  .00000000 00     MA  .28124896-05                         TFI  .10081377 03
 ZAE  .13776095 03    ZAP  .39980848 02    ZAC  .71962126 02    DEF  .24396129 02     IR  .13207785 05     GP -.30447669 02

                                                                 ALL VECTORS REFERENCED TO ECLIPTIC PLANE
   X  .32522779 05      Y -.61173124 04      Z -.24105863 05     DX -.29682299 01     DY -.54592814 01     DZ -.26192343 01
 INC  .13514175 03    LAN  .21640519 03    APF  .23658779 03     MX -.44016288 00     MY -.80956431 00     MZ -.38840984 00
  WX -.41862255 00     WY  .56769796 00     WZ -.70885411 00     PX  .79436250 00     PY -.14941416 00     PZ -.58878147 00
  QX -.44016288 00     QY -.80956431 00     QZ -.38840984 00     RX  .15312781 00     RY  .48022248 00     RZ -.86367711 00
  BX  .86943101 00     BY  .25013427-01     BZ -.49342078 00     TX -.95273657 00     TY  .30379766 00     TZ  .00000000 00
 SXI -.26238309 00    SYI -.82285679 00    SZI -.50404540 00    DAI -.30266004 02    RAI  .25231415 03
 SXO -.59806759 00    SYO -.75971682 00    SZO -.25523606 00    DAO -.14787573 02    RAO  .23178931 03
 ETE  .31364342 03    ETS  .40579462 02    ETC  .26212929 03

 BTC -.41642657 05    BRC  .28986852 05      B  .50738202 05    THA  .14515891 03     T VECTOR IN  ECLIPTIC PLANE

 625535030676    625730425255    621606475633    601700261755    602465443457    575673744666                       EARTH
                    620900500                         2332000                    000000000000                       INITIAL

 217773675412    214745625452    617600155411    602576054657    602772507364    603444441742                        VENUS
                                                                 235605635712    202455507536                        END



         END TRAJECTORY (SFPRO)        016441        G
```

C. Check case 3 is an Earth-Mars trajectory made during the design phase of the Mariner C mission. The spacecraft injects near the Earth on November 11, 1964 and encounters Mars 258.97 days later with a miss of 236,205 km. A minimum print was requested. Earth and Mars oblateness perturbations were included.

```
   START TRAJECTORY (SFPRO)      000000       G

CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                          1


   EARTH - MARS               CHECK 3

DOUBLE PRECISICN EPHEMERIS TAPE - EPHEM1
S/C EPHEMERIS WRITTEN  016324G      041765 RUNID=(TRAJ03)

  GME  .39860063 06     J  .16234500-02     H -.57499999-05     D  .78749999-05    RE  .63781650 04    REM  .63783112 04
    G  .66709998-19     A  .88781796 29     B  .88800194 29     C  .88836976 29   OME  .41780741-02     AU  .14959850 09
  GMM  .49026293 04   GMS  .13271411 12   GMV  .32476627 06   GMA  .42977367 05   GMC  .37918700 08    GMJ  .12670935 09
  EGM  .39860320 06   MGM  .49027779 04    JA  .29200000-02    HA  .00000000 00    DA  .00000000 00     RA  .34170000 04

INJECTION CONDITICNS   1950.0    MARS         23567723701620260540200O J.D.= 2438711.19401670  NOV. 11,1964 16 39 23.043

GEOCENTRIC          XO .54206087 04  YO .17802719 04  ZO-.32653654 04 DXO-.27051733 01 DYO .11088835 02 DZO .78981014 00
CARTESIAN           TC .59963042 05 GHA .30069470 03 GHO .50164659 02
DATE OF RUN 041765G 016450                    EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   0 DAYS  0 HRS.  0 MIN.  0.000 SEC.         235677237016202605402000 J.D.= 2438711.19401670  NOV. 11,1964 16 39 23.043

       GEOCENTRIC                                                                                EQUATORIAL COORDINATES

    X  .54194063 04     Y  .17978477 04     Z -.32577224 04    DX -.27422009 01    DY  .11080006 02     DZ  .78601700 00
    R  .65738098 04   DEC -.29706737 02    RA  .18352879 02     V  .11441330 02   PTH  .19036053 01     AZ  .84370138 02
    R  .65738096 04   LAT -.29706739 02   LON  .77658181 02    VE  .11027283 02   PTE  .19751097 01    AZE  .84157781 02
   XS -.96461613 08    YS -.10304310 09    ZS -.44685264 08   DXS  .23091572 02   DYS -.17704550 02    DZS -.76783641 01
   XM  .25334946 06    YM -.26971397 06    ZM -.14600498 06   DXM  .71534795 00   DYM  .62824798 00    DZM  .20905980 00
   XT -.20584371 09    YT  .93772019 08    ZT  .48581444 08   DXT  .23841340 01   DYT -.25932608 02    DZT -.10896690 02
   RS  .14806538 09    VS  .30093671 02    RM  .40100812 06    VM  .97474315 00    RT  .23135467 09     VT  .28229808 02
  GED -.29874523 02   ALT  .20090686 03   LOS  .28618882 03   RAS  .22688352 03   RAM  .31376712 03    LOM  .13072418 02
  DUT  .35000000 02    DT  .75000000 01    DR  .38005918 00   SHA  .53646702 04   DES -.17565394 02    DEM -.21351886 02
  CCL  .12196123 03   MCL  .40309905 02   TCL  .22181517 03

                                                GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                   235677237005202701106200 J.D.= 2438711.19360542  NOV. 11,1964 16 38 47.509
  SMA -.41371209 05   ECC  .11587348 01     B  .24217761 05   SLR  .14176526 05   APO  .00000000 00    RCA  .65670528 04
   VH  .31039869 01    C3  .96347346 01    C1  .75171617 05   TFP  .35534115 02    TF -.41127447-03    LTF -.23138793-01
   TA  .35463618 01   MTA  .14965626 03    EA  .96198518 00    MA  .15275302 00                        TFI  .00000000 00

                                                              ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .54194063 04     Y  .17978477 04     Z -.32577224 04    DX -.27422009 01    DY  .11080006 02     BZ  .78601700 00
  INC  .30187602 02   LAN  .97102443 02   APF  .27620986 03    MX -.26720726 00    MY  .95986447 00     MZ  .85208402-01
   WX  .49897454 00    WY  .62172189-01    WZ  .86438362 00    PX  .83934327 00    PY  .21358915 00     PZ -.49988249 00
   QX -.21570175 00    QY  .97494321 00    QZ  .54391739-01    RX -.43039015 00    RY  .15917508 00     RZ -.88849737 00
   BX  .23787206 00    BY  .94928832 00    BZ -.20559325 00    TX  .34687610 00    TY  .93791097 00     TZ  .00000000 00
  SXI  .61539222 00   SYI  .67685773 00   SZI -.40392572 00   DAI -.23823625 02   RAI  .47723203 02
  SXO -.83333143 00   SYO  .30819850 00   SZO  .45888167 00   DAO  .27314968 02   RAO  .15970363 03

  BTQ  .22883279 05   BRQ  .79281447 04     B  .24217761 05   THA  .19109164 02    T VECTOR IN  EARTH EQUATOR PLANE

                                                              ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.43043933 03     Y  .54986291 04     Z -.35769763 04    DX -.10319328 02    DY -.29379116 01     DZ -.39729283 01
  INC  .39497020 02   LAN  .22258649 03   APF  .23526778 03    MX -.90025614 00    MY -.28472285 00     MZ -.32935052 00
   WX -.43040654 00    WY  .46828726 00    WZ  .77165765 00    PX -.96661145-02    PY  .85245492 00     PZ -.52271127 00
   QX -.90258240 00    QY -.23243833 00    QZ -.36237736 00    RX -.12453859 00    RY -.23734787 00     RZ -.96340854 00
   BX -.78382110 00    BY  .23005198 00    BZ -.57680204 00    TX -.68550390 00    TY  .46463196 00     TZ  .00000000 00
  SXI -.46431430 00   SYI  .61825264 00   SZI -.63417330 00   DAI -.39358695 02   RAI  .12690694 03
  SXO -.44763039 00   SYO -.85310201 00   SZO  .26803707 00   DAO  .15547494 02   RAO  .24231359 03


CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                          2


   EARTH - MARS               CHECK 3

  BTO  .24169739 05   BRO -.15243946 04     B  .24217764 05   THA  .35639111 03    T VECTOR IN  ORBIT PLANE OF TARGET

   0 DAYS  0 HRS.  5 MIN. 50.668 SEC.         235677237146202333032710 J.D.= 2438711.19807535  NOV. 11,1964 16 45 13.711

                                            START OF VIEW PERIOD


41 WCOMERA          HADEC
     R .73104551 04      LAT-.21913748 02      LON .11117700 03
   MIN .58444723 01       HA .77346002 02      DEC .10776721 02      ELF .49999998 01      AZI .28581141 03
   CKC .65038662 02      CKM .34355178 03      CKT .16489163 03      PSS .13576659 03      PSM .57192600 02
    UT .97407872-01      GHA-.17765033 00      DDE .53562399-01      DEL .11693349 00      DAZ .14072010 00
    ET .87685650-01      RGE .30696641 04      DRG-.37157797 01      DDR .28824451-01      SLS .16183589 03
   RDI .63726033 04      PHI-.31211875 02      THI .13688727 03      SPS .44232583 02      POL .47279629 02
    DT .10239296-01      RFB .96004999 09      RF1 .96004999 09      RF2 .29668212 08       FA .96004999 09
   BF1 .38100655 05       F1 .67100654 05       F2 .76201310 05       XA .29667844 08      PRA .17010850 01
    D1 .22366865 04       D2 .25400437 04      DOP .18460417 03      DF1 .92306893 02      DF2 .18461379 03

   0 DAYS  0 HRS. 13 MIN. 25.629 SEC.         235677237330202126047771 J.D.= 2438711.20334111  NOV. 11,1964 16 52 48.672

                                            EXTREME ELEVATION


41 WCOMERA          HADEC
     R .94747954 04      LAT-.94725852 01      LON .13634373 03
   MIN .13427158 02       HA .13039093 01      DEC .24102865 02      ELE .34671153 02      AZI .35855267 03
   CKC .26022479 03      CKM .17883042 03      CKT .76638563-01      PSS .14877800 03      PSM .13064526 03
    UT .22376596 00      GHA-.93410073-01      DDE .20182813-02      DEL .12506687-08      DAZ .10369751 00
    ET .21406374 00      RGE .42680964 04      DRG .66632083 01      DDR .66476813-02      SLS .16469875 03
   RDI .63726039 04      PHI-.31211875 02      THI .13688727 03      SPS .31221147 02      POL .27439606 03
    DT .14236835-01      RFB .96004999 09      RF1 .96004999 09      RF2 .29668212 08       FA .96004999 09
   BF1 .71338135 05       F1 .10033814 06       F2 .14267627 06       XA .29668871 08      PRA .79644035 02
    D1 .33446045 04       D2 .47558757 04      DOP .42574607 02      DF1 .21288412 02      DF2 .42576825 02

   0 DAYS  0 HRS. 58 MIN. 23.541 SEC.         235677240572202512631072 J.D.= 2438711.23456694  NOV. 11,1964 17 37 46.584

                                            START OF VIEW PERIOD


11 GOLDSTCNE         HADEC
     R .25527495 05      LAT .14045439 02      LON .16718489 03
   MIN .58392355 02       HA .88095318 02      DEC .59881711 01      ELE .49999998 01      AZI .27380915 03
   CKC .24029951 03      CKM .15869310 03      CKT .34014576 03      PSS .11707154 03      PSM .15153309 03
    UT .77320592 00      GHA-.44994237-02      DDE .50953728-02      DEL .65865580-02      DAZ .16200294-02
    ET .96348370 00      RGE .24170307 05      DRG .51428878 01      DDR .14793496-03      SLS .17975971 03
   RDI .63720340 04      PHI .35208070 02      THI .24315082 03      SPS .62920126 02      POL .12835445 03
    DT .80623455-01      RFB .96004999 09      RF1 .96004999 09      RF2 .29668212 08       FA .96004999 09
   BF1 .66469489 05       F1 .95469489 05       F2 .13293698 06       XA .29668720 08      PRA .11038826 03
    D1 .31823163 04       D2 .44312992 04      DOP .94743906 00      DF1 .47374420 00      DF2 .94748840 00

   0 DAYS  1 HRS.  7 MIN. 51.639 SEC.         235677241010202527173207 J.D.= 2438711.24114214  NOV. 11,1964 17 47 14.682

                                            EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                        3

  EARTH - MARS               CHECK 3

41 WOOMERA         HADEC
     R .28707454 05   LAT .15541228 02   LON .16789739 03
   MIN .67860642 02    HA .32202550 03   DEC .25395915 02   ELE .22755152 02   AZI .37068277 02
   CKC .26584786 03   CKM .18416428 03   CKT .56930040 01   PSS .10124796 03   PSM .17504134 03
    UT .11310107 01   DHA .68746103-03   DDE .43157301-03   DEL .00000000 00   DAZ-.82009333-03
    ET .11212885 01   RGE .25634643 05   DRG .56449693 01   DDR-.37371986-03   SLS .18027062 03
   RDI .63726039 04   PHI-.31211875 02   THI .13688727 03   SPS .78742311 02   POL .29053117 03
    DT .85507955-01   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .68077345 05    F1 .97077345 05    F2 .13615469 06    XA .29668770 08   PRA .13256807 03
    D1 .32359115 04    D2 .45384897 04   DOP-.23934626 01   DF1-.11967936 01   DF2-.23935872 01

  0 DAYS  1 HRS. 51 MIN. 34.505 SEC.     235677242230202306063004 J.D.= 2438711.27149938  NOV. 11,1964 18 30 57.548

                                          EXTREME ELEVATION

11 GOLDSTONE       HADEC
     R .42487724 05   LAT .19425995 02   LON .16569189 03
   MIN .11157508 03    HA .84894975 02   DEC .14911680 02   ELE .12627887 02   AZI .27947768 03
   CKC .25409903 03   CKM .17205290 03   CKT .35393920 03   PSS .10379106 03   PSM .16946661 03
    UT .18595846 01   DHA .10307962-02   DDE .15055734-02   DEL-.11071971-09   DAZ .18500019-02
    ET .18498624 01   RGE .40637238 05   DRG .50797076 01   DDR-.73492546-04   SLS .18427255 03
   RDI .63720340 04   PHI .35208070 02   THI .24315082 03   SPS .76193669 02   POL .13164146 03
    DT .13555121 00   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .66267162 05    F1 .95267162 05    F2 .13253432 06    XA .29668714 08   PRA .12692068 03
    D1 .31755720 04    D2 .44178108 04   DOP-.47067785 00   DF1-.23535118 00   DF2-.47070237 00

  0 DAYS  2 HRS. 38 MIN. 51.168 SEC.     235677243535202433042177 J.D.= 2438711.30433114  NOV. 11,1964 19 18 14.211

                                          END OF VIEW PERIOD

11 GOLDSTONE       HADEC
     R .56233558 05   LAT .21395650 02   LON .15885759 03
   MIN .15885280 03    HA .90000000 02   DEC .17913106 02   ELE .10214350 02   AZI .28479461 03
   CKC .25879639 03   CKM .17637449 03   CKT .35863128 03   PSS .98374648 02   PSM .17578290 03
    UT .26475468 01   DHA .23622032-02   DDE .74183679-03   DEL-.14525590-02   DAZ .18989237-02
    ET .26378245 01   RGE .54752837 05   DRG .48764806 01   DDR-.66289583-04   SLS .18686220 03
   RDI .63720340 04   PHI .35208070 02   THI .24315082 03   SPS .81604387 02   POL .13024477 03
    DT .18263578 00   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .65616351 05    F1 .94616351 05    F2 .13123270 06    XA .29668694 08   PRA .13366745 03
    D1 .31538783 04    D2 .43744234 04   DOP-.42454698 00   DF1-.21228454 00   DF2-.42456909 00

  0 DAYS  4 HRS. 29 MIN. 10.329 SEC.     235677246724202257454010 J.D.= 2438711.38094179  NOV. 11,1964 21 08 33.372

                                          EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                        4

  EARTH - MARS               CHECK 3

41 WOOMERA         HADEC
     R .85687236 05   LAT .23475263 02   LON .13715056 03
   MIN .26917214 03    HA .35971709 03   DEC .27103681 02   ELE .31683818 02   AZI .29615789 00
   CKC .27083620 03   CKM .18762835 03   CKT .10658689 02   PSS .90910393 02   PSM .16914906 03
    UT .44862023 01   DHA .38428194-02   DDE .16976693-04   DEL .00000000 00   DAZ-.40172515-02
    ET .44764801 01   RGE .82168376 05   DRG .42691754 01   DDR-.26138638-04   SLS .19038816 03
   RDI .63726039 04   PHI-.31211875 02   THI .13688727 03   SPS .69057611 02   POL .25090216 03
    DT .27408416 00   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .63671529 05    F1 .92671528 05    F2 .12734306 06    XA .29668634 08   PRA .14534215 03
    D1 .30890509 04    D2 .42447685 04   DOP-.16740307 00   DF1-.83705892-01   DF2-.16741179 00

  0 DAYS  9 HRS.  4 MIN. 44.114 SEC.     235677256771202624036402 J.D.= 2438711.57230505  NOV. 12,1964 01 44 07.157

                                          END OF VIEW PERIOD

41 WOOMERA         HADEC
     R .15188983 06   LAT .25186489 02   LON .73711471 02
   MIN .54473522 03    HA .65239299 02   DEC .26701548 02   ELE .49999998 01   AZI .30547913 03
   CKC .27158268 03   CKM .18681885 03   CKT .11375078 02   PSS .87980697 02   PSM .16881881 03
    UT .90789203 01   DHA .39964068-02   DDE-.40932680-04   DEL-.27576970-02   DAZ-.22765480-02
    ET .90691981 01   RGE .15120170 06   DRG .41318458 01   DDR-.51204038-05   SLS .19568520 03
   RDI .63726039 04   PHI-.31211875 02   THI .13688727 03   SPS .91960818 02   POL .19781903 03
    DT .50435451 00   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .63231746 05    F1 .92231746 05    F2 .12646349 06    XA .29668620 08   PRA .14889937 03
    D1 .30743915 04    D2 .42154498 04   DOP-.32793267-01   DF1-.16397487-01   DF2-.32794974-01

  0 DAYS 16 HRS.  3 MIN. 35.643 SEC.     235677273204202527632767 J.D.= 2438711.86317923  NOV. 12,1964 08 42 58.686

                                          START OF VIEW PERIOD

11 GOLDSTONE       HADEC
     R .24440763 06   LAT .26013783 02   LON .33179259 03
   MIN .96359403 03    HA .27000000 03   DEC .25240923 02   ELE .14232336 02   AZI .68933612 02
   CKC .27250371 03   CKM .18602131 03   CKT .12250009 02   PSS .82303859 02   PSM .16597682 03
    UT .16059900 02   DHA .41205723-02   DDE .68856901-04   DEL .31787964-02   DAZ .20088750-02
    ET .16050178 02   RGE .24276298 06   DRG .32367789 01   DDR-.61114379-05   SLS .19979772 03
   RDI .63720340 04   PHI .35208070 02   THI .24315082 03   SPS .97603013 02   POL .87337137 01
    DT .80977002 00   RFB .96004999 09   RF1 .96004999 09   RF2 .29668212 08    FA .96004999 09
   BF1 .60365400 05    F1 .89365400 05    F2 .12073080 06    XA .29668532 08   PRA .15540360 03
    D1 .29788467 04    D2 .40243600 04   DOP-.39140274-01   DF1-.19571156-01   DF2-.39142312-01

  0 DAYS 22 HRS.  2 MIN. 24.581 SEC.     235677305612202717777775 J.D.= 2438712.11235677  NOV. 12,1964 14 41 47.625

                                          EXTREME ELEVATION
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   5

   EARTH - MARS              CHECK 3


11 GOLDSTONE        HADEC
    R .32018308 06    LAT .26332138 02    LON .24311272 03
  MIN .13224097 04     HA .38803100-01    DEC .26152673 02    ELE .80944529 02    AZI .18024147 03
  CKC .27334355 03    CKM .18574581 03    CKT .13050181 02    PSS .82989944 02    PSM .16826951 03
   UT .22040161 02    DHA .42092378-02    DDE .13282553-04    DEL .35548373-09    DAZ .21997915-01
   ET .22030439 02    RGE .31388890 06    DRG .34723908 01    DDR .21062289-04    SLS .20202959 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96889440 02    PUL .66385220 02
   DT .10470205 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .61119920 05     F1 .90119919 05     F2 .12223984 06     XA .29668555 08    PRA .15531430 03
   D1 .30039973 04     D2 .40746613 04    DOP .13489195 00    DF1 .67449487-01    DF2 .13489898 00

  1 DAYS  0 HRS. 52 MIN. 28.433 SEC.       23567731260120267467777 J.D.= 2438712.23045689  NOV. 12,1964 17 31 51.476

                                          START OF VIEW PERIOD


41 WOOMERA          HADEC
    R .35543450 06    LAT .26433460 02    LON .20089603 03
  MIN .14924738 04     HA .29510273 03    DEC .27079932 02    ELE .49999998 01    AZI .54032984 02
  CKC .27469251 03    CKM .18664314 03    CKT .14380262 02    PSS .82417746 02    PSM .16635982 03
   UT .24874564 02    DHA .41802313-02    DDE .28889848-04    DEL .28754132-02    DAZ-.23724653-02
   ET .24864642 02    RGE .35482239 06    DRG .31206772 01    DDR .78910615-05    SLS .20309429 03
  RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .97446075 02    POL .29649058 03
   DT .11835599 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .59993599 05     F1 .88993599 05     F2 .11998720 06     XA .29668520 08    PRA .15661926 03
   D1 .29664532 04     D2 .39995733 04    DOP .50537749-01    DF1 .25270190-01    DF2 .50540381-01

  1 DAYS  4 HRS.  1 MIN.  3.330 SEC.       23567732021620245760000 2 J.D.= 2438712.36141635  NOV. 12,1964 20 40 26.373

                                          END OF VIEW PERIOD


11 GOLDSTONE        HADEC
    R .39415704 06    LAT .26523594 02    LON .15399668 03
  MIN .16810555 04     HA .90000001 02    DEC .26046246 02    ELE .14664581 02    AZI .29176807 03
  CKC .27325794 03    CKM .18475267 03    CKT .12924697 02    PSS .63232003 02    PSM .17032008 03
   UT .28017591 02    DHA .41408869-02    DDE-.12825492-04    DEL-.31489765-02    DAZ .20478790-02
   ET .28007669 02    RGE .39249569 06    DRG .37451721 01    DDR-.24048908-05    SLS .20397077 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96617079 02    PUL .12391140 03
   DT .13092245 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .61993470 05     F1 .90993469 05     F2 .12398694 06     XA .29668582 08    PRA .15526003 03
   D1 .30331156 04     D2 .41328980 04    DOP-.15401954-01    DF1-.77013780-02    DF2-.15402756-01

  1 DAYS  5 HRS.  9 MIN. 45.876 SEC.       23567732222520216550000 4 J.D.= 2438712.40913101  NOV. 12,1964 21 49 08.919

                                          EXTREME ELEVATION
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   6

   EARTH - MARS              CHECK 3


41 WOOMERA          HADEC
    R .40618349 06    LAT .26551961 02    LON .13689154 03
  MIN .17497646 04     HA .35999566 03    DEC .27314896 02    ELE .31473229 02    AZI .13986227-01
  CKC .27478429 03    CKM .18612316 03    CKT .14443382 02    PSS .83007551 02    PSM .16757163 03
   UT .29162743 02    DHA .42130407-02    DDE .28465302-06    DEL-.66754852-10    DAZ-.14198915-02
   ET .29153020 02    RGE .40462016 06    DRG .33978217 01    DDR .23483918-04    SLS .20423931 03
  RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96836862 02    POL .24569043 03
   DT .13503345 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .60881121 05     F1 .89881121 05     F2 .12176224 06     XA .29668548 08    PRA .15622513 03
   D1 .29960373 04     D2 .40587414 04    DOP .15040110 00    DF1 .75204466-01    DF2 .15040894 00

  1 DAYS  9 HRS. 27 MIN. 13.599 SEC.       23567733165320212217000 3 J.D.= 2438712.58792410  NOV. 13,1964 02 06 36.642

                                          END OF VIEW PERIOD


41 WOOMERA          HADEC
    R .46041387 06    LAT .26642141 02    LON .72732435 02
  MIN .20072266 04     HA .64841681 02    DEC .27141061 02    ELE .49999998 01    AZI .30604596 03
  CKC .27453583 03    CKM .18533242 03    CKT .14166138 02    PSS .83354659 02    PSM .16852825 03
   UT .33453777 02    DHA .41746027-02    DDE-.18834210-04    DEL-.26749412-02    DAZ-.23617951-02
   ET .33444055 02    RGE .45981469 06    DRG .36844154 01    DDR .91408363-05    SLS .20534573 03
  RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96468474 02    POL .19491262 03
   DT .15337765 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .61798903 05     F1 .90798903 05     F2 .12359761 06     XA .29668576 08    PRA .15592088 03
   D1 .30266301 04     D2 .41199269 04    DOP .58541843-01    DF1 .29272446-01    DF2 .58544892-01

  1 DAYS 16 HRS.  8 MIN. 43.704 SEC.       23567734546120253747272 5 J.D.= 2438712.86674475  NOV. 13,1964 08 48 06.747

                                          START OF VIEW PERIOD


11 GOLDSTONE        HADEC
    R .54102641 06    LAT .26746519 02    LON .33253338 03
  MIN .24587284 04     HA .27000000 03    DEC .26399349 02    ELE .14853435 02    AZI .67923391 02
  CKC .27454434 03    CKM .18460343 03    CKT .14129508 02    PSS .81891759 02    PSM .16919265 03
   UT .40149472 02    DHA .41658876-02    DDE .23677451-04    DEL .31668868-02    DAZ .20418418-02
   ET .40135750 02    RGE .53935789 06    DRG .29894372 01    DDR-.12455483-05    SLS .20673161 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .97901433 02    POL .74912276 01
   DT .17991040 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .59573318 05     F1 .88573318 05     F2 .11914664 06     XA .29668507 08    PRA .15767635 03
   D1 .29524439 04     D2 .39715545 04    DOP-.79770265-02    DF1-.39887210-02    DF2-.79774418-02

  1 DAYS 22 HRS.  6 MIN. 31.686 SEC.       23567736005020253527776 0 J.D.= 2438713.11521677  NOV. 13,1964 14 45 54.729

                                          EXTREME ELEVATION
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CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                    7

   EARTH - MARS              CHECK 3

11 GOLDSTONE        HADEC
     R .61220466 06    LAT .26815268 02    LON .24314178 03
   MIN .27665281 04     HA .91304778-02    DEC .26727319 02    ELE .81519237 02    AZI .18009867 03
   CKC .27475741 03    CKM .18424525 03    CKT .14302104 02    PSS .82526114 02    PSM .16828738 03
    UT .46108601 02    DHA .42056489-02    DDE .33135784-05    DEL .17197100-09    DAZ .14261885-01
    ET .46099079 02    RGE .60590158 06    DRG .33035058 01    DDR .23779668-04    SLS .20774211 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .97241184 02    POL .65432769 02
    DT .20210698 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .60579085 05     F1 .89579085 05     F2 .12115817 06     XA .29668538 08    PRA .15736204 03
    D1 .29859695 04     D2 .40386057 04    DOP .15229521 00    DF1 .76151572-01    DF2 .15230315 00

   2 DAYS  0 HRS. 54 MIN. 22.017 SEC.       23567136477620220747775 7 J.D.= 2438713.23177151  NOV. 13,1964 17 33 45.060

                                        START OF VIEW PERIOD

41 WOOMERA          HADEC
     R .64542124 06    LAT .26841987 02    LON .20118667 03
   MIN .29343669 04     HA .29520998 03    DEC .27197779 02    ELE .49999998 01    AZI .53880752 02
   CKC .27543256 03    CKM .18467486 03    CKT .14958194 02    PSS .82339999 02    PSM .16644544 03
    UT .46906115 02    DHA .41861815-02    DDE .15260463-04    DEL .28824943-02    DAZ-.23658362-02
    ET .48896393 02    RGE .64483460 06    DRG .29746462 01    DDR .10079948-04    SLS .20828304 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .97412441 02    POL .29601863 03
    DT .21509364 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .59525952 05     F1 .88525952 05     F2 .11905190 06     XA .29668505 08    PRA .15797221 03
    D1 .29508650 04     D2 .39683968 04    DOP .64556316-01    DF1 .32279839-01    DF2 .64559678-01

   2 DAYS  4 HRS.  4 MIN. 31.028 SEC.       235677372442202411100007 J.D.= 2438713.36382026  NOV. 13,1964 20 43 54.071

                                        END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .68293925 06    LAT .26868908 02    LON .15364048 03
   MIN .31245171 04     HA .90000001 02    DEC .26594136 02    ELE .14957446 02    AZI .29224703 03
   CKC .27457440 03    CKM .18355329 03    CKT .14078366 02    PSS .82911585 02    PSM .16690853 03
    UT .52075285 02    DHA .41656561-02    DDE-.10705148-04    DEL-.31559547-02    DAZ .20480711-02
    ET .52065562 02    RGE .68126687 06    DRG .36219128 01    DDR-.80499001-06    SLS .20876041 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96826515 02    POL .12333810 03
    DT .22724614 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .61598746 05     F1 .90598746 05     F2 .12319749 06     XA .29668570 08    PRA .15711345 03
    D1 .30199582 04     D2 .41065831 04    DOP-.51555020-02    DF1-.25778852-02    DF2-.51557705-02

   2 DAYS  5 HRS. 11 MIN. 30.249 SEC.       235677374417202245277777 J.D.= 2438713.41033903  NOV. 13,1964 21 50 53.292

                                        EXTREME ELEVATION
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CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                    8

   EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .69612972 06    LAT .26877650 02    LON .13688761 03
   MIN .31915041 04     HA .35999965 03    DEC .27325044 02    ELE .31463082 02    AZI .98911702-02
   CKC .27544756 03    CKM .18433708 03    CKT .14943884 02    PSS .82832090 02    PSM .16507589 03
    UT .53191735 02    DHA .42052850-02    DDE .22687142-07    DEL .13744012-09    DAZ-.16097312-03
    ET .53182013 02    RGE .69278233 06    DRG .32803041 01    DDR .25048085-04    SLS .20890600 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96901625 02    POL .24525889 03
    DT .23108727 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .60504785 05     F1 .89504785 05     F2 .12100957 06     XA .29668536 08    PRA .15764285 03
    D1 .29834928 04     D2 .40336524 04    DOP .16041870 00    DF1 .80213527-01    DF2 .16042705 00

   2 DAYS  9 HRS. 28 MIN. 45.473 SEC.       235677404042202102034011 J.D.= 2438713.58898745  NOV. 14,1964 02 08 08.516

                                        END OF VIEW PERIOD

41 WOOMERA          HADEC
     R .74666870 06    LAT .26908131 02    LON .72537816 02
   MIN .34487579 04     HA .64773729 02    DEC .27215641 02    ELE .49999998 01    AZI .30614233 03
   CKC .27526443 03    CKM .18382572 03    CKT .14731305 02    PSS .83187426 02    PSM .16358040 03
    UT .57479297 02    DHA .41823622-02    DDE-.12114746-04    DEL-.28809655-02    DAZ-.23613363-02
    ET .57469575 02    RGE .74608631 06    DRG .35876784 01    DDR .10303963-04    SLS .20954985 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96525558 02    POL .19451012 03
    DT .24866757 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .61489115 05     F1 .90489115 05     F2 .12297823 06     XA .29668566 08    PRA .15735832 03
    D1 .30163038 04     D2 .40992743 04    DOP .65991006-01    DF1 .32997221-01    DF2 .65994443-01

   2 DAYS 16 HRS.  7 MIN. 34.266 SEC.       235677417600202247463471 J.D.= 2438713.86594108  NOV. 14,1964 08 46 57.309

                                        START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .82469330 06    LAT .26947403 02    LON .33274504 03
   MIN .38475711 04     HA .27000000 03    DEC .26719997 02    ELE .15024580 02    AZI .67642751 02
   CKC .27522743 03    CKM .18332088 03    CKT .14648416 02    PSS .82427984 02    PSM .16352204 03
    UT .64126184 02    DHA .41727100-02    DDE .14238938-04    DEL .31606802-02    DAZ .20452045-02
    ET .64116462 02    RGE .82301849 06    DRG .29145792 01    DDR-.53405270-06    SLS .21040226 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .97255899 02    POL .73158019 01
    DT .27452938 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .59333594 05     F1 .88333594 05     F2 .11866719 06     XA .29668500 08    PRA .15837187 03
    D1 .29444531 04     D2 .39555730 04    DOP-.34203030-02    DF1-.17102406-02    DF2-.34204811-02

   2 DAYS 22 HRS.  5 MIN. 32.164 SEC.       235677432171202632437763 J.D.= 2438714.11452786  NOV. 14,1964 14 44 55.207

                                        EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   9

   EARTH - MARS               CHECK 3

11 GOLDSTONE        HADEC
     R .89444021 06    LAT .26976256 02    LON .24314693 03
   MIN .42055360 04     HA .39176941-02    DEC .26917398 02    ELE .81709312 02    AZI .18011787 03
   CKC .27533934 03    CKM .18304828 03    CKT .14718894 02    PSS .82969162 02    PSM .16034027 03
    UT .70092266 02    DHA .41995586-02    DDE .14488960-05    DEL .20570073-09    DAZ .53296082-02
    ET .70082543 02    RGE .88813430 06    DRG .32417615 01    DDR .24279745-04    SLS .21106364 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96689264 02    PUL .65298115 02
    DT .29624967 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .60381357 05     F1 .89381357 05     F2 .12076271 06     XA .29668532 08    PRA .15810419 03
    D1 .29793786 04     D2 .40254238 04    DOP .15549792 00    DF1 .77753010-01    DF2 .15550602 00

   3 DAYS  0 HRS. 52 MIN. 41.624 SEC.       23567743710520212527757 J.D.= 2438714.23060957  NOV. 14,1964 17 32 04.667

                                          START OF VIEW PERIOD

41 WOOMERA          HADEC
     R .92692685 06    LAT .26988064 02    LON .20130071 03
   MIN .43726936 04     HA .29524460 03    DEC .27235729 02    ELE .49999998 01    AZI .53831702 02
   CKC .27579596 03    CKM .18333511 03    CKT .15156079 02    PSS .82889736 02    PSM .15861467 03
    UT .72878227 02    DHA .41854944-02    DDE .10429267-04    DEL .28832519-02    DAZ-.23618971-02
    ET .72868504 02    RGE .92635169 06    DRG .29177366 01    DDR .10560242-04    SLS .21142959 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96754037 02    POL .29602014 03
    DT .30899762 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .59343705 05     F1 .88343704 05     F2 .11868741 06     XA .29668500 08    PRA .15850378 03
    D1 .29447901 04     D2 .39562470 04    DOP .67632326-01    DF1 .33817924-01    DF2 .67635848-01

   3 DAYS  4 HRS.  3 MIN. 37.572 SEC.       23567744456520211660000 J.D.= 2438714.36320156  NOV. 14,1964 20 43 00.615

                                          END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .96398117 06    LAT .27000445 02    LON .15349812 03
   MIN .45636261 04     HA .90000001 02    DEC .26805975 02    ELE .15070415 02    AZI .29243257 03
   CKC .27518521 03    CKM .18253723 03    CKT .14523080 02    PSS .83346239 02    PSM .15714345 03
    UT .76060435 02    DHA .41717661-02    DDE-.84921185-05    DEL-.31551930-02    DAZ .20475417-02
    ET .76050712 02    RGE .96230477 06    DRG .35701049 01    DDR-.40885746-06    SLS .21176032 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96283332 02    POL .12326842 03
    DT .32099027 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .61432838 05     F1 .90432838 05     F2 .12286568 06     XA .29668565 08    PRA .15787574 03
    D1 .30144279 04     D2 .40955225 04    DOP-.26184988-02    DF1-.13093176-02    DF2-.26186352-02

   3 DAYS  5 HRS.  9 MIN. 58.328 SEC.       23567744653020225740000 5 J.D.= 2438714.40927512  NOV. 14,1964 21 49 21.371

                                          EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   10

   EARTH - MARS               CHECK 3

41 WOOMERA          HADEC
     R .97684275 06    LAT .27004495 02    LON .13688646 03
   MIN .46299720 04     HA .81634521-03    DEC .27323316 02    ELE .31464810 02    AZI .35998601 03
   CKC .27580179 03    CKM .18309037 03    CKT .15131911 02    PSS .83309580 02    PSM .15612227 03
    UT .77166200 02    DHA .41993533-02    DDE-.52880588-07    DEL-.91200913-10    DAZ-.26416352-03
    ET .77156477 02    RGE .97350128 06    DRG .32301408 01    DDR .25425385-04    SLS .21186080 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .96315704 02    PUL .24524955 03
    DT .32472502 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .60344143 05     F1 .89344143 05     F2 .12068829 06     XA .29668531 08    PRA .15824327 03
    D1 .29781381 C4     D2 .40229429 04    DOP .16283509 00    DF1 .81421787-01    DF2 .16284357 00

   3 DAYS  9 HRS. 27 MIN. 19.246 SEC.       23567745615420244501400 2 J.D.= 2438714.58798946  NOV. 15,1964 02 06 42.289

                                          END OF VIEW PERIOD

41 WOOMERA          HADEC
     R .10266695 07    LAT .27019067 02    LON .72447009 02
   MIN .48873207 04     HA .64749066 02    DEC .27242672 02    ELE .49999998 01    AZI .30617727 03
   CKC .27566471 03    CKM .18271435 03    CKT .14964693 02    PSS .83636687 02    PSM .15358703 03
    UT .81455345 02    DHA .41831765-02    DDE-.89877241-05    DEL-.28822286-02    DAZ-.23595091-02
    ET .81445622 02    RGE .10260944 07    DRG .35430975 01    DDR .10632036-04    SLS .21231782 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .95968071 02    POL .19448753 03
    DT .34226821 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .61346350 05     F1 .90346349 05     F2 .12269270 06     XA .29668562 08    PRA .15800836 03
    D1 .30115450 04     D2 .40897566 04    DOP .68092126-01    DF1 .34047836-01    DF2 .68095672-01

   3 DAYS 16 HRS.  5 MIN.  2.258 SEC.       23567747167220224641043 5 J.D.= 2438714.86418172  NOV. 15,1964 08 44 25.301

                                          START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .11034953 07    LAT .27038592 02    LON .33284732 03
   MIN .52850375 04     HA .27000000 03    DEC .26868758 02    ELE .15103862 02    AZI .67512398 02
   CKC .27562786 03    CKM .18232844 03    CKT .14881046 02    PSS .83170108 02    PSM .15277855 03
    UT .88083959 02    DHA .41749724-02    DDL .10160559-04    DEL .31572498-02    DAZ .20460240-02
    ET .88074236 02    RGE .11018178 07    DRG .28767906 01    DDR-.30665202-06    SLS .21293626 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .96405841 02    POL .73800364 01
    DT .36752679 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .59212580 05     F1 .88212581 05     F2 .11842516 06     XA .29668496 08    PRA .15872239 03
    D1 .29404193 04     D2 .39475054 04    DOP-.19639313-02    DF1-.98201679-03    DF2-.19640336-02

   3 DAYS 22 HRS.  3 MIN. 10.498 SEC.       23567750426620230523776 4 J.D.= 2438715.11288820  NOV. 15,1964 14 42 33.541

                                          EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                      11

   EARTH - MARS                 CHECK 3


11 GOLDSTONE          HADEC
     R .11725092 07      LAT .27053517 02     LON .24314876 03
   MIN .56431749 04       HA .20637512-02     DEC .27009111 02     ELE .81801029 02     AZI .18010445 03
   CKC .27570684 03      CKM .18211132 03     CKT .14917629 02     PSS .83650535 02     PSM .14917093 03
    UT .94052915 02      DHA .41954327-02     DDE .76892019-06     DEL .19799240-09     DAZ .32243126-02
    ET .94043192 02      RGE .11662020 07     DRG .32083073 01     DDR .24440798-04     SLS .21342954 03
   RDI .63720340 04      PHI .35208070 02     THI .24315082 03     SPS .95900162 02     POL .65371784 02
    DT .38900304 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60274224 05       F1 .89274223 05      F2 .12054845 06      XA .29668529 08     PRA .15849979 03
    D1 .29758074 04       D2 .40182815 04     DOP .15652937 00     DF1 .78268762-01     DF2 .15653753 00

   4 DAYS  0 HRS. 49 MIN. 59.273 SEC.        235677511174202450337774 J.D.= 2438715.22873051  NOV. 15,1964 17 29 22.316

                                            START OF VIEW PERIOD


41 WOOMERA            HADEC
     R .12046053 07      LAT .27059740 02     LON .20136612 03
   MIN .58099878 04       HA .29525787 03     DEC .27250272 02     ELE .49999998 01     AZI .53812901 02
   CKC .27605468 03      CKM .18232648 03     CKT .15245643 02     PSS .83619936 02     PSM .14740866 03
    UT .96833129 02      DHA .41844575-02     DDE .79196735-05     DEL .28834233-02     DAZ-.23594401-02
    ET .96823407 02      RGE .12040332 07     DRG .28860205 01     DDR .10732553-04     SLS .21370684 03
   RDI .63726039 04      PHI-.31211875 02     THI .13688727 03     SPS .95916197 02     POL .29616003 03
    DT .40162218 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59242138 05       F1 .88242138 05      F2 .11848428 06      XA .29668497 08     PRA .15879782 03
    D1 .29414046 04       D2 .39494759 04     DOP .68735882-01     DF1 .34369731-01     DF2 .68739461-01

   4 DAYS  4 HRS.  1 MIN. 23.821 SEC.        235677516663202556500003 J.D.= 2438715.36165351  NOV. 15,1964 20 40 46.864

                                            END OF VIEW PERIOD


11 GOLDSTONE          HADEC
     R .12413979 07      LAT .27066371 02     LON .15342067 03
   MIN .60013969 04       HA .90000001 02     DEC .26915433 02     ELE .15128727 02     AZI .29252852 03
   CKC .27558286 03      CKM .18170615 03     CKT .14751010 02     PSS .84009684 02     PSM .14531381 03
    UT .10002328 03      DHA .41741730-02     DDE-.69903057-05     DEL-.31540240-02     DAZ .20471923-02
    ET .10001356 03      RGE .12397196 07     DRG .35402285 01     DDR-.25897748-06     SLS .21396054 03
   RDI .63720340 04      PHI .35208070 02     THI .24315082 03     SPS .95512328 02     POL .12335923 03
    DT .41352589 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61337163 05       F1 .90337162 05      F2 .12267433 06      XA .29668562 08     PRA .15830255 03
    D1 .30112387 04       D2 .40891441 04     DOP-.16586030-02     DF1-.82934471-03     DF2-.16586894-02

   4 DAYS  5 HRS.  7 MIN. 24.359 SEC.        235677520621202663377770 J.D.= 2438715.40749308  NOV. 15,1964 21 46 47.402

                                            EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                      12

   EARTH - MARS                 CHECK 3


41 WOOMERA            HADEC
     R .12540775 07      LAT .27068539 02     LON .13688563 03
   MIN .60674059 04       HA .14438629-02     DEC .27316861 02     ELE .31471263 02     AZI .35998601 03
   CKC .27606114 03      CKM .18213410 03     CKT .15221409 02     PSS .83992654 02     PSM .14467994 03
    UT .10112343 03      DHA .41954022-02     DDE-.93932381-07     DEL .79221064-10     DAZ-.46811805-03
    ET .10111371 03      RGE .12507388 07     DRG .32009670 01     DDR .25562354-04     SLS .21403740 03
   RDI .63726039 04      PHI-.31211875 02     THI .13688727 03     SPS .95525117 02     POL .24537490 03
    DT .41720148 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60250717 05       F1 .89250717 05      F2 .12050143 06      XA .29668528 08     PRA .15858497 03
    D1 .29750239 04       D2 .40167145 04     DOP .16371230 00     DF1 .81860413-01     DF2 .16372083 00

   4 DAYS  9 HRS. 24 MIN. 52.200 SEC.        235677530247202637124003 J.D.= 2438715.58628754  NOV. 16,1964 02 04 15.243

                                            END OF VIEW PERIOD


41 WOOMERA            HADEC
     R .13034930 07      LAT .27076465 02     LON .72390531 02
   MIN .63248699 04       HA .64740068 02     DEC .27252530 02     ELE .49999998 01     AZI .30619002 03
   CKC .27595513 03      CKM .18183584 03     CKT .15084579 02     PSS .84295748 02     PSM .14174575 03
    UT .10541450 03      DHA .41829236-02     DDE-.71772316-05     DEL-.28827246-02     DAZ-.23580114-02
    ET .10540477 03      RGE .13029221 07     DRG .35161334 01     DDR .10760885-04     SLS .21439244 03
   RDI .63726039 04      PHI-.31211875 02     THI .13688727 03     SPS .95201606 02     POL .19459653 03
    DT .43460796 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61260001 05       F1 .90260001 05      F2 .12252000 06      XA .29668559 08     PRA .15838861 03
    D1 .30086667 04       D2 .40840000 04     DOP .68917328-01     DF1 .34460459-01     DF2 .68920917-01

   4 DAYS 16 HRS.  1 MIN. 58.759 SEC.        235677543754202346520031 J.D.= 2438715.86205789  NOV. 16,1964 08 41 21.802

                                            START OF VIEW PERIOD


11 GOLDSTONE          HADEC
     R .13795911 07      LAT .27087178 02     LON .33290795 03
   MIN .67219792 04       HA .27000000 03     DEC .26951381 02     ELE .15147867 02     AZI .67439958 02
   CKC .27592510 03      CKM .18152108 03     CKT .15006794 02     PSS .83989894 02     PSM .14035385 03
    UT .11203299 03      DHA .41759780-02     DDE .78807291-05     DEL .31551399-02     DAZ .20463603-02
    ET .11202326 03      RGE .13779123 07     DRG .28526666 01     DDR-.21236046-06     SLS .21487850 03
   RDI .63720340 04      PHI .35208070 02     THI .24315082 03     SPS .95478781 02     POL .75366782 01
    DT .45962201 01      RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59135327 05       F1 .88135327 05      F2 .11827065 06      XA .29668494 08     PRA .15894135 03
    D1 .29378442 04       D2 .39423551 04     DOP-.13600477-02     DF1-.68005925-03     DF2-.13601185-02

   4 DAYS 22 HRS.  0 MIN. 15.042 SEC.        235677556352202413000023 J.D.= 2438716.11085747  NOV. 16,1964 14 39 38.086

                                            EXTREME ELEVATION
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                    13

  EARTH - MARS               CHECK 3


11 GOLDSTONE          HADEC
    R .14481305 07    LAT .27095481 02    LON .24314965 03
  MIN .70802506 04     HA .11768341-02    DEC .27059747 02    ELE .81851663 02    AZI .18010561 03
  CKC .27599038 03    CKM .18134050 03    CKT .15028734 02    PSS .84428895 02    PSM .13673057 03
   UT .11800418 03    DHA .41925622-02    DDE .43947608-06    DEL-.75195075-10    DAZ .18337964-02
   ET .11799445 03    RGE .14418225 07    DRG .31859891 01    DDR .24502991-04    SLS .21527231 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .95014668 02    POL .65529145 02
   DT .48094016 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29666212 08     FA .96004999 09
  BF1 .60202753 05     F1 .89202753 05     F2 .12040551 06     XA .29668527 08    PRA .15875324 03
   D1 .29734251 04     D2 .40135168 04    DOP .15692768 00    DF1 .78467929-01    DF2 .15693586 00

  5 DAYS  0 HRS. 46 MIN. 50.558 SEC.      23567756325520231467773 3 J.D.= 2438716.22654629  NOV. 16,1964 17 26 13.601

                                         START OF VIEW PERIOD


41 WOOMERA            HADEC
    R .14799651 07    LAT .27098950 02    LON .20141163 03
  MIN .72468425 04     HA .29526128 03    DEC .27254002 02    ELE .49999998 01    AZI .53808080 02
  CKC .27627319 03    CKM .18151226 03    CKT .15291316 02    PSS .84425990 02    PSM .13481875 03
   UT .12078071 03    DHA .41835653-02    DDE .63735747-05    DEL .28836038-02    DAZ-.23577544-02
   ET .12077098 03    RGE .14793961 07    DRG .28644431 01    DDR .10805352-04    SLS .21549576 03
  RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .95003058 02    POL .29635915 03
   DT .49347334 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .59173039 05     F1 .88173040 05     F2 .11834608 06     XA .29668495 08    PRA .15899158 03
   D1 .29391013 04     D2 .39448693 04    DOP .69202114-01    DF1 .34602860-01    DF2 .69205719-01

  5 DAYS  3 HRS. 58 MIN. 34.994 SEC.      23567757075120240462364 0 J.D.= 2438716.35969950  NOV. 16,1964 20 37 58.037

                                          END OF VIEW PERIOD


11 GOLDSTONE          HADEC
    R .15165787 07    LAT .27102664 02    LON .15337178 03
  MIN .74385832 04     HA .90000000 02    DEC .26979147 02    ELE .15162651 02    AZI .29258439 03
  CKC .27589079 03    CKM .16100446 03    CKT .14885581 02    PSS .84772073 02    PSM .13252556 03
   UT .12397639 03    DHA .41753512-02    DDE-.59400459-05    DEL-.31530765-02    DAZ .20470279-02
   ET .12396666 03    RGE .15148996 07    DRG .35194556 01    DDR-.19280866-06    SLS .21570175 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .94642920 02    POL .12352103 03
   DT .50531603 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .61270640 05     F1 .90270639 05     F2 .12254128 06     XA .29668560 08    PRA .15858780 03
   D1 .30090213 04     D2 .40847093 04    DOP-.12348295-02    DF1-.61744691-03    DF2-.12348938-02

  5 DAYS  5 HRS.  4 MIN. 23.040 SEC.      23567757270420241250026 3 J.D.= 2438716.40539447  NOV. 16,1964 21 43 46.083

                                          EXTREME ELEVATION
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                    14

  EARTH - MARS               CHECK 3


41 WOOMERA            HADEC
    R .15291372 07    LAT .27103874 02    LON .13688541 03
  MIN .75043839 04     HA .18711090-02    DEC .27307508 02    ELE .31480617 02    AZI .35999011 03
  CKC .27628241 03    CKM .18135361 03    CKT .15269168 02    PSS .84766078 02    PSM .13209075 03
   UT .12507306 03    DHA .41926319-02    DDE-.12168300-06    DEL-.50607362-11    DAZ-.85845263-03
   ET .12506334 03    RGE .15257997 07    DRG .31605404 01    DDR .25619655-04    SLS .21576402 03
  RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .94644705 02    POL .24555973 03
   DT .50895192 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .60185304 05     F1 .89185303 05     F2 .12037061 06     XA .29668526 08    PRA .15881261 03
   D1 .29728434 04     D2 .40123536 04    DOP .16407928 00    DF1 .82043911-01    DF2 .16408782 00

  5 DAYS  9 HRS. 21 MIN. 57.444 SEC.      23567760233420207633401 1 J.D.= 2438716.58426490  NOV. 17,1964 02 01 20.488

                                          END OF VIEW PERIOD


41 WOOMERA            HADEC
    R .15762657 07    LAT .27108307 02    LON .72349284 02
  MIN .77619573 04     HA .64739008 02    DEC .27253690 02    ELE .49999998 01    AZI .30619152 03
  CKC .27619665 03    CKM .16110635 03    CKT .15153925 02    PSS .85050619 02    PSM .12896577 03
   UT .12936595 03    DHA .41824782-02    DDE-.59948608-05    DEL-.28831068-02    DAZ-.23568459-02
   ET .12935623 03    RGE .15776975 07    DRG .34967278 01    DDR .10816942-04    SLS .21605455 03
  RDI .63726033 04    PHI-.31211875 02    THI .13688727 03    SPS .94339828 02    POL .19476564 03
   DT .52626318 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .61197657 05     F1 .90197856 05     F2 .12239571 06     XA .29668557 08    PRA .15864516 03
   D1 .30065952 04     D2 .40798571 04    DOP .69276344-01    DF1 .34639976-01    DF2 .69279952-01

  5 DAYS 15 HRS. 58 MIN. 40.185 SEC.      23567761603220263512240 3 J.D.= 2438716.85975958  NOV. 17,1964 08 38 03.228

                                         START OF VIEW PERIOD


11 GOLDSTONE          HADEC
    R .16536399 07    LAT .27114269 02    LON .33294817 03
  MIN .81586696 04     HA .27000000 03    DEC .27001012 02    ELE .15174287 02    AZI .67396431 02
  CKC .27617623 03    CKM .18084008 03    CKT .15082771 02    PSS .84846303 02    PSM .12701428 03
   UT .13597783 03    DHA .41764997-02    DDE .64229264-05    DEL .31537608-02    DAZ .20465967-02
   ET .13596810 03    RGE .16521605 07    DRG .28345617 01    DDR-.17071868-06    SLS .21645511 03
  RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .94515540 02    POL .77381206 01
   DT .55110134 01    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
  BF1 .59077348 05     F1 .88077347 05     F2 .11815470 06     XA .29668492 08    PRA .15909732 03
   D1 .29359115 04     D2 .39384899 04    DOP-.10933558-02    DF1-.54670636-03    DF2-.10934127-02

  5 DAYS 21 HRS. 57 MIN.  2.654 SEC.      23567763043220233127776 7 J.D.= 2438717.10863075  NOV. 17,1964 14 36 25.698

                                          EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   15

   EARTH - MARS              CHECK 3


11 GOLDSTONE        HADEC
     R .17220173 07     LAT .27118853 02     LON .24315014 03
   MIN .85170442 04      HA .67710876-03     DEC .27088910 02     ELE .81880829 02     AZI .18009742 03
   CKC .27623528 03     CKM .18068667 03     CKT .15097570 02     PSS .85255432 02     PSM .12349773 03
    UT .14195073 03     DHA .41904661-02     DDE .25305560-06     DEL .43485809-09     DAZ .11463110-02
    ET .14194101 03     RGE .17157089 07     DRG .31686733 01     DDR .24525589-04     SLS .21678294 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .94081424 02     POL .65728611 02
    DT .57229879 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60147300 05      F1 .89147300 05      F2 .12029460 06      XA .29668525 08     PRA .15893556 03
    D1 .29715767 04      D2 .40096200 04     DOP .15707241 00     DF1 .78540296-01     DF2 .15708059 00

   6 DAYS  0 HRS. 43 MIN. 28.364 SEC.       23567763533220266403777 4 J.D.= 2438717.22420609  NOV. 17,1964 17 22 51.407

                                          START OF VIEW PERIOD


41 WOOMERA          HADEC
     R .17536496 07     LAT .27120748 02     LON .20144727 03
   MIN .86834726 04      HA .29525906 03     DEC .27251577 02     ELE .49999989 01     AZI .53811216 02
   CKC .27647499 03     CKM .18083008 03     CKT .15316646 02     PSS .85270263 02     PSM .12138887 03
    UT .14472454 03     DHA .41828413-02     DDE .53237285-05     DEL .28838815-02     DAZ-.23565152-02
    ET .14471482 03     RGE .17530827 07     DRG .26474344 01     DDR .10835699-04     SLS .21697012 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .94052119 02     POL .29658800 03
    DT .58476534 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59118571 05      F1 .88118571 05      F2 .11823714 06      XA .29668493 08     PRA .15913464 03
    D1 .29372857 04      D2 .39412380 04     DOP .69396474-01     DF1 .34700044-01     DF2 .69400088-01

   6 DAYS  3 HRS. 55 MIN. 27.913 SEC.       23567764303220257230000 1 J.D.= 2438717.35753421  NOV. 17,1964 20 34 50.956

                                          END OF VIEW PERIOD


11 GOLDSTONE        HADEC
     R .17901182 07     LAT .27122765 02     LON .15333804 03
   MIN .88754650 04      HA .90000004 02     DEC .27018136 02     ELE .15163403 02     AZI .29261858 03
   CKC .27615520 03     CKM .18040103 03     CKT .14973005 02     PSS .85585525 02     PSM .11909069 03
    UT .14792442 03     DHA .41760067-02     DDE-.51697794-05     DEL-.31523776-02     DAZ .20470050-02
    ET .14791469 03     RGE .17884387 07     DRG .35028172 01     DDR-.16365443-06     SLS .21714355 03
   RDI .63720340 04     PHI .35208070 02     THI .24315062 03     SPS .93722870 02     POL .12371961 03
    DT .59655887 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61217356 05      F1 .90217356 05      F2 .12243471 06      XA .29668558 08     PRA .15878680 03
    D1 .30072452 04      D2 .40817571 04     DOP-.10493941-02     DF1-.52472441-03     DF2-.10494488-02

   6 DAYS  5 HRS.  1 MIN.  7.466 SEC.       23567764476320250110000 4 J.D.= 2438717.40313088  NOV. 17,1964 21 40 30.509

                                          EXTREME ELEVATION
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   16

   EARTH - MARS              CHECK 3


41 WOOMERA          HADEC
     R .18025646 07     LAT .27123415 02     LON .13688511 03
   MIN .89411242 04      HA .21705627-02     DEC .27296136 02     ELE .31491988 02     AZI .35998286 03
   CKC .27648742 03     CKM .18069632 03     CKT .15297051 02     PSS .85586524 02     PSM .11875383 03
    UT .14901874 03     DHA .41905914-02     DDE-.14103703-06     DEL-.12304112-09     DAZ-.57501280-03
    ET .14900901 03     RGE .17992475 07     DRG .31640777 01     DDR .25642685-04     SLS .21719589 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .93717686 02     POL .24577532 03
    DT .60316426 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60132584 05      F1 .89132584 05      F2 .12026517 06      XA .29668524 08     PRA .15898082 03
    D1 .29710861 04      D2 .40088389 04     DOP .16422677 00     DF1 .62117663-01     DF2 .16423533 00

   6 DAYS  9 HRS. 18 MIN. 47.968 SEC.       23567765441420260133777 6 J.D.= 2438717.58207189  NOV. 18,1964 01 58 11.011

                                          END OF VIEW PERIOD


41 WOOMERA          HADEC
     R .18514814 07     LAT .27125778 02     LON .72315997 02
   MIN .91987993 04      HA .64742662 02     DEC .27249686 02     ELE .50000006 01     AZI .30618634 03
   CKC .27642049 03     CKM .18048654 03     CKT .15197968 02     PSS .85856675 02     PSM .11554925 03
    UT .15331332 03     DHA .41820315-02     DDE-.51600804-05     DEL-.28835157-02     DAZ-.23559215-02
    ET .15330360 03     RGE .18509151 07     DRG .34807476 01     DDR .10838967-04     SLS .21744180 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .93427282 02     POL .19496676 03
    DT .61739874 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61146682 05      F1 .90146681 05      F2 .12229336 06      XA .29668556 08     PRA .15883549 03
    D1 .30048893 04      D2 .40764454 04     DOP .69417401-01     DF1 .34710509-01     DF2 .69421017-01

   6 DAYS 15 HRS. 55 MIN. 13.409 SEC.       23567767010720207165420 0 J.D.= 2438717.85736634  NOV. 18,1964 08 34 36.452

                                          START OF VIEW PERIOD


11 GOLDSTONE        HADEC
     R .19266259 07     LAT .27128880 02     LON .33297685 03
   MIN .95952234 04      HA .27000000 03     DEC .27031668 02     ELE .15190601 02     AZI .67369535 02
   CKC .27640525 03     CKM .18025791 03     CKT .15133047 02     PSS .85722325 02     PSM .11301786 03
    UT .15992039 03     DHA .41767990-02     DDE .54114368-05     DEL .31528315-02     DAZ .20468277-02
    ET .15991066 03     RGE .19249464 07     DRG .28191335 01     DDR-.15435407-06     SLS .21778244 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .93533092 02     POL .79642848 01
    DT .64209291 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59027941 05      F1 .88027941 05      F2 .11805588 06      XA .29668490 08     PRA .15921904 03
    D1 .29342647 04      D2 .39351961 04     DOP-.98854978-03     DF1-.49430063-03     DF2-.98860127-03

   6 DAYS 21 HRS. 53 MIN. 40.722 SEC.       23567770250720274174000 1 J.D.= 2438718.10629357  NOV. 18,1964 14 33 03.765

                                          EXTREME ELEVATION
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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                17

   EARTH - MARS               CHECK 3

11 GOLDSTONE        HADEC
     R .19944894 07     LAT .27131180 02     LON .24315045 03
   MIN .99536785 04      HA .37384033-03     DEC .27105380 02     ELE .81897302 02     AZI .18008187 03
   CKC .27646159 03     CKM .18012772 03     CKT .15144228 02     PSS .86108977 02     PSM .10966609 03
    UT .16589464 03     DHA .41888743-02     DDE .13811370-06     DEL-.30551660-09     DAZ .74887425-03
    ET .16588492 03     RGE .19881808 07     DRG .31535412 01     DDR .24529727-04     SLS .21806319 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .93121585 02     POL .65951595 02
    DT .66318563 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60098842 05      F1 .89098842 05      F2 .12019768 06      XA .29668523 08     PRA .15907782 03
    D1 .29699614 04      D2 .40065894 04     DOP .15709892 00     DF1 .78553547-01     DF2 .15710710 00

   7 DAYS  0 HRS. 39 MIN. 58.492 SEC.        23567770740620230434OOO6 J.D.= 2438718.22177701  NOV. 18,1964 17 19 21.535

                                        START OF VIEW PERIOD

41 WOOMERA          HADEC
     R .20259463 07     LAT .27132100 02     LON .20147726 03
   MIN .10119975 05      HA .29525336 03     DEC .27245323 02     ELE .50000006 01     AZI .53819299 02
   CKC .27667076 03     CKM .18025237 03     CKT .15332376 02     PSS .86136118 02     PSM .10735308 03
    UT .16866624 03     DHA .41822563-02     DDE .45654779-05     DEL .28842536-02     DAZ-.23555598-02
    ET .16865652 03     RGE .20253809 07     DRG .28323837 01     DDR .10844226-04     SLS .21822420 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .93080013 02     POL .29683417 03
    DT .67559426 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59070372 05      F1 .88070372 05      F2 .11814074 06      XA .29668492 08     PRA .15924913 03
    D1 .29356790 04      D2 .39380248 04     DOP .69451083-01     DF1 .34727351-01     DF2 .69454701-01

   7 DAYS  3 HRS. 52 MIN. 10.237 SEC.        2356777151112022436227 53 J.D.= 2438718.35524628  NOV. 18,1964 20 31 33.280

                                         END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .20622615 07     LAT .27133055 02     LON .15331335 03
   MIN .10312170 05      HA .90000000 02     DEC .27042239 02     ELE .15196232 02     AZI .29263973 03
   CKC .27639738 03     CKM .17988288 03     CKT .15034645 02     PSS .86428477 02     PSM .10517403 03
    UT .17186951 03     DHA .41764056-02     DDE-.45805434-05     DEL-.31518799-02     DAZ .20470861-02
    ET .17185978 03     RGE .20606020 07     DRG .34879243 01     DDR-.15454133-06     SLS .21837395 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .92773746 02     POL .12393944 03
    DT .68734275 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61169664 05      F1 .90169664 05      F2 .12233933 06      XA .29668557 08     PRA .15894653 03
    D1 .30056554 04      D2 .40779776 04     DOP-.98974909-03     DF1-.49490032-03     DF2-.98980063-03

   7 DAYS  4 HRS. 57 MIN. 43.627 SEC.        23567771704020252560000 0 J.D.= 2438718.40077164  NOV. 18,1964 21 37 06.670

                                         EXTREME ELEVATION
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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                18

   EARTH - MARS               CHECK 3

41 WOOMERA          HADEC
     R .20746700 07     LAT .27133355 02     LON .13688492 03
   MIN .10377727 05      HA .23555755-02     DEC .27283404 02     ELE .31504720 02     AZI .35998601 03
   CKC .27668641 03     CKM .18013950 03     CKT .15315345 02     PSS .86434288 02     PSM .10486251 03
    UT .17296212 03     DHA .41890306-02     DDE-.15319623-06     DEL-.11807980-09     DAZ-.76516017-03
    ET .17295239 03     RGE .20713328 07     DRG .31492621 01     DDR .25648383-04     SLS .21841907 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .92763773 02     POL .24600884 03
    DT .69092214 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60085139 05      F1 .89085139 05      F2 .12017028 06      XA .29668523 08     PRA .15911463 03
    D1 .29695046 04      D2 .40056759 04     DOP .16426327 00     DF1 .82135910-01     DF2 .16427182 00

   7 DAYS  9 HRS. 15 MIN. 29.816 SEC.        23567772647320215602400 7 J.D.= 2438718.57977847  NOV. 19,1964 01 54 52.860

                                         END OF VIEW PERIOD

41 WOOMERA          HADEC
     R .21233569 07     LAT .27134417 02     LON .72287455 02
   MIN .10635497 05      HA .64749279 02     DEC .27242439 02     ELE .49999998 01     AZI .30617697 03
   CKC .27663273 03     CKM .17996030 03     CKT .15228876 02     PSS .86693101 02     PSM .10166801 03
    UT .17725828 03     DHA .41816311-02     DDE-.45366699-05     DEL-.28839776-02     DAZ-.23551692-02
    ET .17724855 03     RGE .21227920 07     DRG .34661338 01     DDR .10843219-04     SLS .21863222 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .92484802 02     POL .19518656 03
    DT .70808708 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61099882 05      F1 .90099882 05      F2 .12219976 06      XA .29668554 08     PRA .15898663 03
    D1 .30033294 04      D2 .40733255 04     DOP .69444634-01     DF1 .34724125-01     DF2 .69448251-01

   7 DAYS 15 HRS. 51 MIN. 41.750 SEC.        235677742162202145377624 J.D.= 2438718.85491658  NOV. 19,1964 08 31 04.793

                                        START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .21981118 07     LAT .27135709 02     LON .33299832 03
   MIN .11031696 05      HA .27000000 03     DEC .27050507 02     ELE .15200625 02     AZI .67353007 02
   CKC .27662407 03     CKM .17976446 03     CKT .15169596 02     PSS .86609951 02     PSM .98542518 02
    UT .18386159 03     DHA .41769853-02     DDE .46710593-05     DEL .31521988-02     DAZ .20470748-02
    ET .18385187 03     RGE .21964325 07     DRG .28046553 01     DDR-.15233668-06     SLS .21892843 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .92539486 02     POL .82051343 01
    DT .73265091 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .58981576 05      F1 .87981576 05      F2 .11796315 06      XA .29668489 08     PRA .15932036 03
    D1 .29327191 04      D2 .39321050 04     DOP-.97562954-03     DF1-.48784018-03     DF2-.97568036-03

   7 DAYS 21 HRS. 50 MIN. 12.919 SEC.        235677754563202773200010 J.D.= 2438719.10388845  NOV. 19,1964 14 29 35.963

                                         EXTREME ELEVATION
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CASE  1                                      IBSYS-JPTRAJ-SFPRO 041765                                    19

   EARTH - MARS                CHECK 3

11 GOLDSTONE          HADEC
     R .22656760 07     LAT .27136557 02     LON .24315064 03
   MIN .11390215 05      HA .17929077-03     DEC .27113869 02     ELE .81905787 02     AZI .18010136 03
   CKC .27667954 03     CKM .17965651 03     CKT .15179027 02     PSS .86979190 02     PSM .95387049 02
    UT .18983692 03     DHA .41876294-02     DDE .64847653-07     DEL-.10351005-09     DAZ .28407902-03
    ET .18982719 03     RGE .22593672 07     DRG .31390873 01     DDR .24523613-04     SLS .21917381 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .92145549 02     POL .66189221 02
    DT .75364367 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60052555 05      F1 .89052554 05      F2 .12010511 06      XA .29668522 08     PRA .15919545 03
    D1 .29684185 04      D2 .40035037 04     DOP .15705976 00     DF1 .78533969-01     DF2 .15706794 00

   8 DAYS  0 HRS. 36 MIN. 23.896 SEC.     23567776146020257017775 J.D.= 2438719.21929327  NOV. 19,1964 17 15 46.939

                                    START OF VIEW PERIOD

41 WOOMERA            HADEC
     R .22969674 07     LAT .27136857 02     LON .20150360 03
   MIN .11556398 05      HA .29524548 03     DEC .27236702 02     ELE .49999998 01     AZI .53830444 02
   CKC .27686606 03     CKM .17976919 03     CKT .15344140 02     PSS .87015392 02     PSM .92894017 02
    UT .19260663 03     DHA .41817816-02     DDE .39948818-05     DEL .28846964-02     DAZ-.23547991-02
    ET .19259691 03     RGE .22964037 07     DRG .28178836 01     DDR .10840326-04     SLS .21931503 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .92094965 02     POL .29709064 03
    DT .76599754 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .59023938 05      F1 .88023938 05      F2 .11804788 06      XA .29668490 08     PRA .15934607 03
    D1 .29341312 04      D2 .39349292 04     DOP .69426107-01     DF1 .34714861-01     DF2 .69429722-01

   8 DAYS  3 HRS. 48 MIN. 45.876 SEC.     23567776716620216550003 J.D.= 2438719.35288100  NOV. 19,1964 20 28 08.919

                                     END OF VIEW PERIOD

11 GOLDSTONE          HADEC
     R .23331682 07     LAT .27137135 02     LON .15329449 03
   MIN .11748765 05      HA .90000001 02     DEC .27056865 02     ELE .15204013 02     AZI .29265256 03
   CKC .27662855 03     CKM .17944771 03     CKT .15081764 02     PSS .87290124 02     PSM .90926720 02
    UT .19581274 03     DHA .41766660-02     DDE-.41131604-05     DEL-.31515346-02     DAZ .20472416-02
    ET .19580302 03     RGE .23314890 07     DRG .34734682 01     DDR-.15604168-06     SLS .21944674 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .91806421 02     POL .12417268 03
    DT .77770090 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61123370 05      F1 .90123370 05      F2 .12224674 06      XA .29668555 08     PRA .15907836 03
    D1 .30041123 04      D2 .40748913 04     DOP-.99935797-03     DF1-.49970501-03     DF2-.99941002-03

   8 DAYS  4 HRS. 54 MIN. 14.575 SEC.     23567777111420231707777 J.D.= 2438719.39835206  NOV. 19,1964 21 33 37.618

                                     EXTREME ELEVATION
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CASE  1                                      IBSYS-JPTRAJ-SFPRO 041765                                    20

   EARTH - MARS                CHECK 3

41 WOOMERA            HADEC
     R .23454852 07     LAT .27137215 02     LON .13688484 03
   MIN .11814243 05      HA .24299621-02     DEC .27269920 02     ELE .31518204 02     AZI .35998286 03
   CKC .27688480 03     CKM .17967574 03     CKT .15329562 02     PSS .87299450 02     PSM .90578669 02
    UT .19690404 03     DHA .41878039-02     DDE-.15831487-06     DEL .19129320-09     DAZ-.64444699-03
    ET .19689432 03     RGE .23421475 07     DRG .31348238 01     DDR .25644941-04     SLS .21948635 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .91792957 02     POL .24625335 03
    DT .78125622 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .60038901 05      F1 .89038901 05      F2 .12007780 06      XA .29668522 08     PRA .15922678 03
    D1 .29679634 04      D2 .40025934 04     DOP .16424122 00     DF1 .82124887-01     DF2 .16424977 00

   8 DAYS  9 HRS. 12 MIN.  6.066 SEC.     23570000550202215773777 J.D.= 2438719.57742024  NOV. 20,1964 01 51 29.109

                                     END OF VIEW PERIOD

41 WOOMERA            HADEC
     R .23939653 07     LAT .27137453 02     LON .72262183 02
   MIN .12072101 05      HA .64757668 02     DEC .27233245 02     ELE .50000015 01     AZI .30616509 03
   CKC .27684192 03     CKM .17952359 03     CKT .15253265 02     PSS .87549217 02     PSM .87477823 02
    UT .20120168 03     DHA .41812866-02     DDE-.40502518-05     DEL-.28844844-02     DAZ-.23545443-02
    ET .20119196 03     RGE .23934015 07     DRG .34517393 01     DDR .10836800-04     SLS .21967438 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .91523142 02     POL .19541823 03
    DT .79835269 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .61053786 05      F1 .90053786 05      F2 .12210757 06      XA .29668553 08     PRA .15911262 03
    D1 .30017928 04      D2 .40702524 04     DOP .69403525-01     DF1 .34703570-01     DF2 .69407140-01

   8 DAYS 15 HRS. 48 MIN.  6.917 SEC.     23570001423420237273645 J.D.= 2438719.85243009  NOV. 20,1964 08 27 29.960

                                    START OF VIEW PERIOD

11 GOLDSTONE          HADEC
     R .24683412 07     LAT .27137607 02     LON .33301502 03
   MIN .12468115 05      HA .27000000 03     DEC .27061732 02     ELE .15206599 02     AZI .67343161 02
   CKC .27683927 03     CKM .17935873 03     CKT .15199060 02     PSS .87505281 02     PSM .83777677 02
    UT .20780192 03     DHA .41771128-02     DDE .41091324-05     DEL .31517699-02     DAZ .20473360-02
    ET .20779219 03     RGE .24666621 07     DRG .27901535 01     DDR-.15857773-06     SLS .21993626 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .91538713 02     POL .84555372 01
    DT .82278980 01     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .58935136 05      F1 .87935136 05      F2 .11787027 06      XA .29668487 08     PRA .15940844 03
    D1 .29311712 04      D2 .39290090 04     DOP-.10155999-02     DF1-.50782641-03     DF2-.10156528-02

   8 DAYS 18 HRS. 36 MIN. 50.283 SEC.     23570002117720225164463 J.D.= 2438719.96959869  NOV. 20,1964 11 16 13.327
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CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                      21


  EARTH - MARS              CHECK 3

     GEOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.20809419 07     Y  .78698492 06     Z  .11403225 07    DX -.26177298 01    DY  .94365922 00    DZ  .14259753 01
    R  .25000000 07   DEC  .27137601 02    RA  .15928403 03     V  .31267247 01   PTH  .89205767 02    AZ  .90115152 02
    R  .24999999 07   LAT  .27137601 02   LON  .29073023 03    VE  .16222060 03   PTE  .11043101 01   AZE  .26999996 03
   XS -.77915722 08    YS -.11520235 09    ZS -.49957800 08   DXS  .25786643 02   DYS -.14308895 02   DZS -.62037552 01
   XM  .12583806 06    YM  .31244563 06    ZM  .12704644 06   DXM -.10238458 01   DYM  .30328885 00   DZM  .23776494 00
   XT -.20267688 09    YT  .74862852 08    ZT  .40625872 08   DXT  .58881486 01   DYT -.23873869 02   DZT -.10057389 02
   RS  .14777761 09    VS  .30136058 02    RM  .35999762 06    VM  .10939728 01    RT  .21984912 09    VT  .26566576 02
  GED  .27295870 02   ALT  .24936262 07   LOS  .73742065 01   RAS  .23592802 03   RAM  .68062793 02   LOM  .19950898 03
  DUT  .35000000 02    DT  .15360000 05    DR  .31264243 01   SHA -.24980716 07   DES -.19758764 02   DEM  .20665352 02
  CCL  .27668530 03   MCL  .17933773 03   TCL  .15223058 02

                                                    GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                     23567723400620245564463 3 J.D.= 2438711.12252729  NOV. 11,1964 14 56 26.358
  SMA -.42146391 05   ECC  .13033514 01     B  .35230037 05   SLR  .29448734 05   APO  .00000000 00   RCA  .12785168 05
   VH  .30753092 01    C3  .94575266 01    C1  .10834336 06   TFP  .76438697 06    TF -.71489413-01   LTF -.11351401 00
   TA  .13930707 03   MTA  .14010763 03    EA  .25941846 03    MA  .31956874 04                       TFI  .87755818 01

                                                              ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.20809419 07     Y  .78698492 06     Z  .11403225 07    DX -.26177298 01    DY  .94365922 00    DZ  .14259753 01
  INC  .27140339 02   LAN  .69031556 02   APF  .31091752 03    MX -.35458424 00    MY -.93499826 00    MZ -.17886665-02
   WX  .42591672 00    WY -.16322498 00    WZ  .88989185 00    PX  .86231199 00    PY  .37094129 00    PZ -.34467795 00
   QX -.27386140 00    QY  .91417625 00    QZ  .29875404 00    RX -.42905386 00    RY  .15460601 00    RZ -.88994929 00
   BX  .34292617 00    BY  .93932690 00    BZ  .81626506-02    TX  .33900407 00    TY  .94078491 00    TZ  .00000000 00
  SXI  .48597169 00   SYI  .87090792 00   SZI -.72850767-01   DAI -.41777423 01   RAI  .60838228 02
  SXO -.83725687 00   SYO  .30169643 00   SZO  .45605947 00   DAO  .27133124 02   RAO  .16018379 03

  BTQ  .31435160 05   BRQ  .15905195 05     B  .35230037 05   THA  .26837963 02    T VECTOR IN  EARTH EQUATOR PLANE

                                                              ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.11312736 07     Y -.21303847 07     Z  .65702387 06    DX -.13774467 01    DY -.26789233 01    DZ  .83810340 00
  INC  .27492597 02   LAN  .21047333 03   APF  .25538925 03    MX  .86049492 00    MY -.33987433 00    MZ  .37957846 00
   WX -.23413705 00    WY  .39790916 00    WZ  .88707048 00    PX -.21792566 00    PY  .86772248 00    PZ -.44675051 00
   QX -.94748307 00    QY -.29789062 00    QZ -.11645919 00    RX -.12256340 00    RY -.23843148 00    RZ -.96339431 00
   BX -.86671441 00    BY  .32792556 00    BZ -.37586029 00    TX -.88937654 00    TY  .45717543 00    TZ  .00000000 00
  SXI -.77485449 00   SYI  .47472915 00   SZI -.41746541 00   DAI -.24674672 02   RAI  .14850550 03
  SXO -.44044021 00   SYO -.85682030 00   SZO  .26808834 00   DAO  .15550542 02   RAO  .24279500 03

  BTO  .34389301 05   BRO  .76437425 04     B  .35228514 05   THA  .12531466 02    T VECTOR IN  ORBIT PLANE OF TARGET

   8 DAYS 18 HRS. 36 MIN. 50.283 SEC.          23570002117720225164463 3 J.D.= 2438719.96959869  NOV. 20,1964 11 16 13.327
   CHANGE OF PHASE OCCURS AT THIS POINT    SUN      IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   8 DAYS 18 HRS. 36 MIN. 50.283 SEC.          23570002117720225164463 3 J.D.= 2438719.96959869  NOV. 20,1964 11 16 13.327
***** S/C DISCONTINUITY=R STOP

   8 DAYS 18 HRS. 36 MIN. 50.283 SEC.          23570002117720225164463 3 J.D.= 2438719.96959869  NOV. 20,1964 11 16 13.327




CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                      22


  EARTH - MARS              CHECK 3

     HELIOCENTRIC                                                                          ECLIPTIC COORDINATES

    X  .75834779 08     Y  .12674386 09     Z  .73327900 06    DX -.28404373 02    DY  .17028954 02    DZ  .93162262 00
    R  .14770056 09   LAT  .28445432 00   LON  .59106609 02     V  .33130976 02   PTH  .58065999-01    AZ  .88388930 02
   XE  .77915722 08    YE  .12556816 09    ZE  .19450000 03   DXE -.25786643 02   DYE  .15595867 02   DZE -.12002587-02
   XT -.12476316 09    YT  .21041414 09    ZT  .74879929 07   DXT -.19898495 02   DYT -.10308557 02   DZT  .26993591 00
  LTE  .75410606-04   LOE  .58180174 02   LTT  .17533010 01   LOT  .12066543 03   RST  .24473665 09   VST  .22411812 02
  EPS  .91281439 02   ESP  .96909388 00   SEP  .87749463 02   EPM  .82792833 01   EMP  .89955339 02   MEP  .81765380 02
  MPS  .99534470 02   MSP  .94382735 00   SMP  .79521691 02   SEM  .16857908 03   EMS  .11393339 02   ESM  .27088086-01
  EPT  .16331898 03   ETP  .18701907 00   TEP  .16493999 02   TPS  .81760679 02   TSP  .61563839 02   STP  .36675276 02
  SET  .80900794 02   STE  .36599970 02   EST  .62499229 02   RPM  .24742260 07   RPT  .21745316 09   SPN  .91135265 02
  GCE  .83114691 02   GCT  .27833776 03   SIP  .81759989 02   CPT  .83250368 02   SIN  .83249477 02
  REP  .25000006 07   VEP  .31267244 01   CPE  .82997981 02   CPS  .99625016 02

                                                    HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                     23570000505520220454463 3 J.D.= 2438719.68135459  NOV. 20,1964 04 21 09.037
  SMA  .18975202 09   ECC  .22161495 00     B  .18503364 09   SLR  .18043270 09   APO  .23180391 09   RCA  .14770014 09
   VH  .21110348 02    C3 -.69940812 03    C1  .48934615 10   TFP  .24904290 05    TF  .84873377 01   PER  .52177972 03
   TA  .32007375 00   MTA  .18000000 03    EA  .25549432 00    MA  .19887295 00                       TFI  .87755818 01

                                                              ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .75834779 08     Y  .12674386 09     Z  .73327900 06    DX -.28404373 02    DY  .17028954 02    DZ  .93162262 00
  INC  .16360055 01   LAN  .49096154 02   APF  .96943779 01    MX -.85785656 00    MY  .51311951 00    MZ  .28114365-01
   WX  .21577869-01    WY -.18693868-01    WZ  .99959237 00    PX  .51821992 00    PY  .85523332 00    PZ  .48074970-02
   QX -.85497458 00    QY  .51790494 00    QZ  .28141647-01    RX  .24913707-02    RY  .41115811-02    RZ -.99998794 00
   BX  .85497501 00    BY -.51790521 00    BZ -.28141661-01    TX  .85524362 00    TY -.51822615 00    TZ  .00000000 00
  DAP  .27545128 00   RAP  .58786660 02

  BTC  .18496032 09   BRC  .52072106 07     B  .18503360 09   THA  .16126311 01    T VECTOR IN  ECLIPTIC PLANE

                                                              ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.12881938 09     Y  .72256614 08     Z -.80709250 05    DX -.16237118 02    DY -.28879102 02    DZ -.12250912 00
  INC  .21409312 00   LAN  .32230397 03   APF  .18808731 03    MX -.48920510 00    MY -.87216093 00    MZ -.36971695-02
   WX -.22852750-02    WY -.29572244-02    WZ  .99999302 00    PX -.86941883 00    PY  .49407454 00    PZ -.52577550-03
   QX -.49406954 00    QY -.86941397 00    QZ -.37001628-02    RX  .45711940-03    RY -.25977245-03    RZ -.99999937 00
   BX  .49406978 00    BY  .86941439 00    BZ  .37001646-02    TX  .49407485 00    TY  .86941937 00    TZ  .00000000 00
  DAP -.30126256-01   RAP  .15039123 03

  BTO  .18503232 09   BRO -.68465451 06     B  .18503359 09   THA  .35978799 03    T VECTOR IN  ORBIT PLANE OF TARGET

 252 DAYS 17 HRS. 35 MIN. 56.663 SEC.         23572410515520273231032 4 J.D.= 2438963.92731141  JULY 22,1965 10 15 19.706
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   23

  EARTH - MARS              CHECK 3

    HELIOCENTRIC                                                                          ECLIPTIC COORDINATES

    X -.14180703 09    Y -.18080550 09    Z -.35318550 06    DX  .16289199 02    DY -.13676693 02    DZ -.60002750 00
    R  .22978248 09  LAT -.88067603-01  LON  .23189265 03     V  .21277922 02   PTH  .19117819 01    AZ  .91613891 02
   XE  .74579964 08   YE -.13242883 09   ZE  .20050000 03   DXE  .25477438 02   DYE  .14502661 02   DZE -.89901685-03
   XT -.14380243 09   YT -.18092580 09   ZT -.29060300 06   DXT  .19907202 02   DYT -.13014897 02   DZT -.76160681 00
  LTE  .75584905-04  LOE  .29938691 03  LTT -.72045688-01   LOT  .23152181 03   RST  .23111333 09   VST  .23796308 02
  EPS  .39290480 02  ESP  .67494281 02  SEP  .73215237 02   EPM  .41964682-01   EMP  .25186631 02   MEP  .15476932 03
  MPS  .39248762 02  MSP  .67636768 02  SMP  .73114467 02   SEM  .81740242 02   EMS  .98117059 02   ESM  .14230920 00
  EPT  .17065762 03  ETP  .92592157 01  TEP  .82755473-01   TPS  .13152909 03   TSP  .37121615 00   STP  .48099716 02
  SET  .73133797 02  STE  .39001090 02  EST  .67865112 02   RPM  .22207495 09   RPT  .20000010 07   SPN  .39288832 02
  GCE  .25662492 03  GCT  .81135149 02  SIP  .13143232 03   CPT  .69055774 02   SIN  .88959000 02
  REP  .22172902 09  VEP  .29645552 02  CPE  .90548312 02   CPS  .81532245 02

                                                  HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23570000665620237231O324 J.D.= 2438719.72289301  NOV. 20,1964 05 20 57.956
  SMA  .18894964 09  ECC  .21854539 00    B  .18438207 09   SLR  .17992501 09   APO  .23024371 09   RCA  .14765556 09
   VH  .21223477 02   C3 -.70237821 03   C1  .48865721 10   TFP  .21099262 08    TF  .85288772 01   PER  .51847363 03
   TA  .17313131 03  MTA  .18000000 03   EA  .17142858 03    MA  .16956232 03                       TFI  .25273329 03

                                                            ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X -.14180703 09    Y -.18080550 09    Z -.35318550 06    DX  .16289199 02    DY -.13676693 02    DZ -.60002750 00
  INC  .16162992 01  LAN  .48770085 02  APF  .99924950 01    MX  .78657053 00    MY -.61685783 00    MZ -.28163934-01
   WX  .21212796-01   WY -.18589970-01   WZ  .99960213 00    PX  .51863737 00    PY  .85498018 00    PZ  .48942541-02
   QX -.85473099 00   QY  .51832719 00   QZ  .27777973-01    RX  .25383737-02    RY  .41845408-02    RZ -.99998790 00
   BX  .85473110 00   BY -.51832726 00   BZ -.27777977-01    TX  .85499051 00    TY -.51864363 00    TZ  .00000000 00
  DAP  .28042110 00  RAP  .58758687 02

  BTC  .18431093 09  BRC  .51218220 07    B  .18438208 09   THA  .15917862 01    T VECTOR IN  ECLIPTIC PLANE

                                                            ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .18467587 09    Y -.13672896 09    Z -.16276000 05    DX  .13224495 02    DY  .16668987 02    DZ  .86889505-01
  INC  .23438124 00  LAN  .32447736 03  APF  .18587607 03    MX  .59503176 00    MY  .80369177 00    MZ  .40881908-02
   WX -.23756955-02   WY -.33278210-02   WZ  .99999163 00    PX -.86909271 00    PY  .49464883 00    PZ -.41860045-03
   QX -.49464329 00   QY -.86908642 00   QZ -.40673197-02    RX  .36380267-03    RY -.20706026-03    RZ -.99999980 00
   BX  .49464335 00   BY  .86908654 00   BZ  .40673203-02    TX  .49464893 00    TY  .86909289 00    TZ  .00000000 00
  DAP -.23985062-01  RAP  .15035340 03

  BTD  .18438054 09  BRD -.74994092 06    B  .18438207 09   THA  .35976695 03    T VECTOR IN  ORBIT PLANE OF TARGET

 252 DAYS 17 HRS. 35 MIN. 56.663 SEC.        23572410515520273231O324 J.D.= 2438963.92731141  JULY 22,1965 10 15 19.706
   CHANGE OF PHASE OCCURS AT THIS POINT    MARS      IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

 252 DAYS 17 HRS. 35 MIN. 56.562 SEC.        23572410515520271540O605 J.D.= 2438963.92731024  JULY 22,1965 10 15 19.605
***** S/C DISCONTINUITY=R STOP

 252 DAYS 20 HRS. 48 MIN.  8.447 SEC.        2357241126602026766377777 J.D.= 2438964.06078114  JULY 22,1965 13 27 31.491

                                                  END OF VIEW PERIOD
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CASE  1                                   IBSYS-JPTRAJ-SFPRO 041765                                   24

  EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .22190329 09    LAT-.50951153 01    LON .49656887 02
   MIN .36412814 06     HA .87231794 02    DEC-.50942717 01    ELE .50000015 01    AZI .26706465 03
   CKC .10136622 03    CKM .18000759 03    CKT .24824382 01    PSS .73163041 02    PSM .15232307 03
    UT .60688022 04    DHA .41720441-02    DDE-.26955391-05    DEL-.35621011-02    DAZ-.21483052-02
    ET .60687924 04    RGE .22190273 09    DRG .15503473 02    DOR .00000000 00    SLS .25901732 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39277244 02    POL .73453400 02
    DT .74018774 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99648038 05     F1 .12864804 06     F2 .19929608 06     XA .29669746 08    PRA .19162357 03
    D1 .42882679 04     D2 .66432025 04

 253 DAYS  2 HRS. 33 MIN.  2.735 SEC.        23572412474620234347 7774 J.D.= 2438964.30029836  JULY 22,1965 19 12 25.778

                                                  START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22221582 09    LAT-.51510810 01    LON .32331955 03
   MIN .36447304 06     HA .27982994 03    DEC-.51520449 01    ELE .49999998 01    AZI .99907570 02
   CKC .10135190 03    CKM .18000785 03    CKT .24315460 01    PSS .73072565 02    PSM .15092180 03
    UT .60745505 04    DHA .41720528-02    DDE-.27125325-05    DEL .33563979-02    DAZ .24589006-02
    ET .60745408 04    RGE .22221527 09    DRG .14723647 02    DOR .00000000 00    SLS .25902954 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39247306 02    PUL .25988379 03
    DT .74123025 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97150736 05     F1 .12615074 06     F2 .19430147 06     XA .29669669 08    PRA .19175124 03
    D1 .42050245 04     D2 .64767157 04

 253 DAYS  7 HRS. 53 MIN. 11.378 SEC.        23572413625020246571O775 J.D.= 2438964.52262061  JULY 23,1965 00 32 34.421

                                                  EXTREME ELEVATION

11 GOLDSTONE        HADEC
     R .22250566 09    LAT-.52030169 01    LON .24318039 03
   MIN .36479319 06     HA .35997042 03    DEC-.52040806 01    ELE .49587638 02    AZI .17995005 03
   CKC .10133864 03    CKM .18000815 03    CKT .23811683 01    PSS .72987776 02    PSM .14781557 03
    UT .60798864 04    DHA .41721307-02    DDE-.27033431-05    DEL .22889545-10    DAZ .58297472-02
    ET .60798766 04    RGE .22250081 09    DRG .15083386 02    DOR .00000000 00    SLS .25904070 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39223628 02    POL .26956085 03
    DT .74218272 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98302758 05     F1 .12730276 06     F2 .19660552 06     XA .29669704 08    PRA .19186593 03
    D1 .42434253 04     D2 .65535172 04

 253 DAYS  9 HRS.  9 MIN.  3.198 SEC.        23572414043220243665 7776 J.D.= 2438964.57530371  JULY 23,1965 01 48 26.241

                                                  START OF VIEW PERIOD
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CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                      25

   EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .22257431 09    LAT-.52153224 01    LON .22419005 03
   MIN .36486904 06     HA .27269581 03    DEC-.52144831 01    ELE .49999998 01    AZI .93076060 02
   CKC .10133162 03    CKM .16000436 03    CKT .23648736 01    PSS .72966246 02    PSM .14715206 03
    UT .60811507 04    DHA .41720369-02    DDE-.27125488-05    DEL .35644173-02    DAZ-.21428804-02
    ET .60811409 04    RGE .22257376 09    DRG .14685578 02    DDR .00000000 00    SLS .25904354 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39217182 02    POL .91733430 02
    DT .74242604 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97028825 05     F1 .12602882 06     F2 .19405765 06     XA .29669665 08    PRA .19189484 03
    D1 .42009608 04     D2 .64685883 04

 253 DAYS 13 HRS. 13 MIN. 16.001 SEC.        235724147551202605600012 J.D.= 2438964.74489635  JULY 23,1965 05 52 39.045

                                        END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22279522 09    LAT-.52549323 01    LON .16305810 03
   MIN .36511326 06     HA .80094039 02    DEC-.52558945 01    ELE .49999998 01    AZI .25996342 03
   CKC .10132503 03    CKM .18000814 03    CKT .23270621 01    PSS .72899894 02    PSM .14400504 03
    UT .60852210 04    DHA .41720462-02    DDE-.26939007-05    DEL-.33582485-02    DAZ .24551727-02
    ET .60852113 04    RGE .22279466 09    DRG .15443135 02    DDR .00000000 00    SLS .25905216 03
   RDI .63720340 04    PHI .35206070 02    THI .24315062 03    SPS .39199973 02    POL .27142240 03
    DT .74316291 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99454611 05     F1 .12845481 06     F2 .19890962 06     XA .29669740 08    PRA .19198067 03
    D1 .42818270 04     D2 .66303207 04

 253 DAYS 14 HRS. 57 MIN. 53.500 SEC.        235724152613202105357776 J.D.= 2438964.81755257  JULY 23,1965 07 37 16.543

                                        EXTREME ELEVATION

41 WOOMERA          HADEC
     R .22288981 09    LAT-.52718965 01    LON .13686820 03
   MIN .36521788 06     HA .19067764-01    DEC-.52711830 01    ELE .64059294 02    AZI .35993943 03
   CKC .10131710 03    CKM .18000466 03    CKT .23050893 01    PSS .72874101 02    PSM .14386849 03
    UT .60869647 04    DHA .41721309-02    DDE-.27026796-05    DEL .20001197-09    DAZ-.68033495-02
    ET .60869549 04    RGE .22288408 09    DRG .15066858 02    DDR .00000000 00    SLS .25905565 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39191260 02    POL .89493473 02
    DT .74346117 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98249830 05     F1 .12724983 06     F2 .19649966 06     XA .29669702 08    PRA .19201994 03
    D1 .42416609 04     D2 .65499886 04

 253 DAYS 20 HRS. 46 MIN. 51.018 SEC.        235724164775202407640005 J.D.= 2438965.05988497  JULY 23,1965 13 26 14.061

                                        END OF VIEW PERIOD
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CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                      26

   EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .22320515 09    LAT-.53284824 01    LON .49516322 02
   MIN .36556685 06     HA .87372351 02    DEC-.53276431 01    ELE .49999998 01    AZI .26679148 03
   CKC .10130216 03    CKM .16000458 03    CKT .22402073 01    PSS .72778185 02    PSM .13964886 03
    UT .60927808 04    DHA .41720295-02    DDE-.26925118-05    DEL-.35611789-02    DAZ-.21468091-02
    ET .60927710 04    RGE .22320459 09    DRG .15448209 02    DDR .00000000 00    SLS .25906813 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39165357 02    POL .73681145 02
    DT .74453027 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99471058 05     F1 .12847106 06     F2 .19894212 06     XA .29669740 08    PRA .19214517 03
    D1 .42823686 04     D2 .66314039 04

 254 DAYS  2 HRS. 31 MIN. 52.648 SEC.        235724177064202730377762 J.D.= 2438965.29948715  JULY 23,1965 19 11 15.691

                                        START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22351664 09    LAT-.53844130 01    LON .32314865 03
   MIN .36591187 06     HA .28000084 03    DEC-.53853718 01    ELE .49999998 01    AZI .10019747 03
   CKC .10128760 03    CKM .18000477 03    CKT .21710913 01    PSS .72687777 02    PSM .13792965 03
    UT .60985312 04    DHA .41720385-02    DDE-.27101580-05    DEL .33533756-02    DAZ .24603748-02
    ET .60985214 04    RGE .22351608 09    DRG .14668745 02    DDR .00000000 00    SLS .25908024 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39135161 02    POL .26007100 03
    DT .74556931 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96974918 05     F1 .12597492 06     F2 .19394984 06     XA .29669663 08    PRA .19227316 03
    D1 .41391639 04     D2 .64649945 04

 254 DAYS  7 HRS. 51 MIN. 20.365 SEC.        235724210354202664217003 J.D.= 2438965.52133574  JULY 24,1965 00 30 43.408

                                        EXTREME ELEVATION

11 GOLDSTONE        HADEC
     R .22380481 09    LAT-.54361876 01    LON .24318051 03
   MIN .36623133 06     HA .35997031 03    DEC-.54372505 01    ELE .49354668 02    AZI .17995054 03
   CKC .10127415 03    CKM .18000501 03    CKT .21019275 01    PSS .72603317 02    PSM .13492730 03
    UT .61038555 04    DHA .41721157-02    DDE-.27006008-05    DEL-.98184116-11    DAZ .58515787-02
    ET .61038458 04    RGE .22379997 09    DRG .15027692 02    DDR .00000000 00    SLS .25909127 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39111279 02    POL .26952741 03
    DT .74651626 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96125046 05     F1 .12712505 06     F2 .19625009 06     XA .29669698 08    PRA .19238790 03
    D1 .42375015 04     D2 .65416697 04

 254 DAYS  9 HRS.  6 MIN. 38.584 SEC.        235724212526202320203767 J.D.= 2438965.57362994  JULY 24,1965 01 46 01.627

                                        START OF VIEW PERIOD
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                              27

   EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .22387270 09    LAT-.54483905 01    LON .22433043 03
   MIN .36630664 06     HA .27255543 03    DEC-.54475556 01    ELE .49999998 01    AZI .93348863 02
   CKC .10126712 03    CKM .18000120 03    CKT .20809614 01    PSS .72581971 02    PSM .13402082 03
    UT .61051106 04    DHA .41720220-02    DDE-.27101585-05    DEL .35634509-02    DAZ-.21413905-02
    ET .61051009 04    RGE .22387214 09    DRG .14630046 02    DDR .00000000 00    SLS .25909407 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39104820 02    POL .91716475 02
    DT .74675698 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96850992 05     F1 .12585099 06     F2 .19370198 06     XA .29669659 08    PRA .19241666 03
    D1 .41950330 04     D2 .64567327 04

 254 DAYS 13 HRS. 10 MIN. 44.147 SEC.       23572422164320263030001 J.D.= 2438965.74313878  JULY 24,1965 05 50 07.190

                                          END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22409268 09    LAT-.54879406 01    LON .16322890 03
   MIN .36655073 06     HA .79923233 02    DEC-.54888988 01    ELE .49999998 01    AZI .25967385 03
   CKC .10126036 03    CKM .18000493 03    CKT .20267591 01    PSS .72515782 02    PSM .13099599 03
    UT .61091788 04    DHA .41720318-02    DDE-.26907913-05    DEL-.33551914-02    DAZ .24566514-02
    ET .61091691 04    RGE .22409213 09    DRG .15387134 02    DDR .00000000 00    SLS .25910260 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39067423 02    POL .27140619 03
    DT .74749077 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99275475 05     F1 .12827547 06     F2 .19655095 06     XA .29669734 08    PRA .19250268 03
    D1 .42758492 04     D2 .66183650 04

 254 DAYS 14 HRS. 56 MIN.  2.565 SEC.       23572422471720231570000 J.D.= 2438965.81626862  JULY 24,1965 07 35 25.608

                                          EXTREME ELEVATION

41 WOOMERA          HADEC
     R .22418754 09    LAT-.55050018 01    LON .13686837 03
   MIN .36665604 06     HA .18896103-01    DEC-.55042957 01    ELE .64292408 02    AZI .35993943 03
   CKC .10125234 03    CKM .18000145 03    CKT .19971409 01    PSS .72489845 02    PSM .13086637 03
    UT .61109339 04    DHA .41721157-02    DDE-.26998805-05    DEL-.13091981-09    DAZ-.68518993-02
    ET .61109242 04    RGE .22418179 09    DRG .15011286 02    DDR .00000000 00    SLS .25910607 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39078574 02    POL .89526518 02
    DT .74778987 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98071868 05     F1 .12707187 06     F2 .19614373 06     XA .29669697 08    PRA .19254228 03
    D1 .42357289 04     D2 .65381244 04

 254 DAYS 20 HRS. 45 MIN. 33.855 SEC.       235724237112202163040006 J.D.= 2438966.05899188  JULY 24,1965 13 24 56.899

                                          END OF VIEW PERIOD
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                              28

   EARTH - MARS              CHECK 3

41 WOOMERA          HADEC
     R .22450220 09    LAT-.55616181 01    LON .49375904 02
   MIN .36700556 06     HA .87512761 02    DEC-.55607848 01    ELE .49999998 01    AZI .26651861 03
   CKC .10123713 03    CKM .18000131 03    CKT .19048104 01    PSS .72393953 02    PSM .12651462 03
    UT .61167593 04    DHA .41720146-02    DDE-.26893160-05    DEL-.35601767-02    DAZ-.21453148-02
    ET .61167496 04    RGE .22450164 09    DRG .15392162 02    DDR .00000000 00    SLS .25911846 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .39052349 02    POL .73912042 02
    DT .74885677 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99291578 05     F1 .12829158 06     F2 .19858315 06     XA .29669734 08    PRA .19266803 03
    D1 .42763859 04     D2 .66194385 04

 255 DAYS  2 HRS. 30 MIN. 42.900 SEC.       235724251203202370577774 J.D.= 2438966.29867990  JULY 24,1965 19 10 05.943

                                          START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22481265 09    LAT-.56175112 01    LON .32297761 03
   MIN .36735071 06     HA .28017189 03    DEC-.56184666 01    ELE .49999998 01    AZI .10048723 03
   CKC .10122234 03    CKM .18000146 03    CKT .18047165 01    PSS .72303607 02    PSM .12437647 03
    UT .61225118 04    DHA .41720239-02    DDE-.27076060-05    DEL .33502689-02    DAZ .24618467-02
    ET .61225020 04    RGE .22481210 09    DRG .14612896 02    DDR .00000000 00    SLS .25913046 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .39021894 02    POL .26024150 03
    DT .74969234 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96796069 05     F1 .12579607 06     F2 .19359214 06     XA .29669657 08    PRA .19279636 03
    D1 .41932023 04     D2 .64530712 04

 255 DAYS  7 HRS. 49 MIN. 29.659 SEC.       235724262461202131662746 J.D.= 2438966.52005442  JULY 25,1965 00 28 52.702

                                          EXTREME ELEVATION

11 GOLDSTONE        HADEC
     R .22509912 09    LAT-.56691218 01    LON .24318063 03
   MIN .36766949 06     HA .35997019 03    DEC-.56701830 01    ELE .49121735 02    AZI .17994908 03
   CKC .10120872 03    CKM .18000167 03    CKT .17029284 01    PSS .72219482 02    PSM .12149973 03
    UT .61278247 04    DHA .41721004-02    DDE-.26976829-05    DEL .13411688-10    DAZ .56486290-02
    ET .61276149 04    RGE .22509430 09    DRG .14971395 02    DDR .00000000 00    SLS .25914136 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38997811 02    POL .26948589 03
    DT .75083368 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97944120 05     F1 .12694412 06     F2 .19588624 06     XA .29669693 08    PRA .19291114 03
    D1 .42314706 04     D2 .65296079 04

 255 DAYS  9 HRS.  4 MIN. 14.308 SEC.       235724264622202254740001 J.D.= 2438966.57196008  JULY 25,1965 01 43 37.351

                                          START OF VIEW PERIOD
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                  29

  EARTH - MARS               CHECK 3


41 WOOMERA          HADEC
     R .22516625 09    LAT-.56812215 01    LON .22447066 03
   MIN .36774423 06     HA .27241521 03    DEC-.56803907 01    ELE .50000006 01    AZI .93621360 02
   CKC .10120167 03    CKM .17999787 03    CKT .16737451 01    PSS .72198318 02    PSM .12038231 03
    UT .61290705 04    DHA .41720070-02    DDE-.27075786-05    DEL .35624047-02    DAZ-.21399029-02
    ET .61290608 04    RGE .22516570 09    DRG .14573867 02    DDR .00000000 00    SLS .25914411 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38991341 02    POL .91700554 02
    DT .75107182 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96671083 05     F1 .12567108 06     F2 .19334216 06     XA .29669654 08    PRA .19293977 03
    D1 .41690360 04     D2 .64447388 04

 255 DAYS 13 HRS.  8 MIN. 12.560 SEC.       235724273735202715200004 J.D.= 2438966.74138430  JULY 25,1965 05 47 35.604

                                             END OF VIEW PERIOD


11 GOLDSTONE        HADEC
     R .22538530 09    LAT-.57207093 01    LON .16339985 03
   MIN .36798821 06     HA .79752273 02    DEC-.57216614 01    ELE .49999998 01    AZI .25938443 03
   CKC .10119473 03    CKM .18000157 03    CKT .15903113 01    PSS .72132295 02    PSM .11750772 03
    UT .61331367 04    DHA .41720172-02    DDE-.26875000-05    DEL-.33520501-02    DAZ .24581280-02
    ET .61331270 04    RGE .22538475 09    DRG .15330363 02    DDR .00000000 00    SLS .25915255 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38973755 02    POL .27139048 03
    DT .75180249 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99093670 05     F1 .12809367 06     F2 .19818734 06     XA .29669729 08    PRA .19302597 03
    D1 .42697890 04     D2 .66062447 04

 255 DAYS 14 HRS. 54 MIN. 11.935 SEC.       235724277023202575200003 J.D.= 2438966.81498817  JULY 25,1965 07 33 34.979

                                             EXTREME ELEVATION


41 WOOMERA          HADEC
     R .22548042 09    LAT-.57378617 01    LON .13686655 03
   MIN .36809419 06     HA .18724441-01    DEC-.57371650 01    ELE .64525279 02    AZI .35994148 03
   CKC .10118664 03    CKM .17999810 03    CKT .15467979 01    PSS .72106214 02    PSM .11736926 03
    UT .61349031 04    DHA .41721002-02    DDE-.26968983-05    DEL-.36576903-10    DAZ-.71421107-02
    ET .61348934 04    RGE .22547466 09    DRG .14954714 02    DDR .00000000 00    SLS .25915602 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38964770 02    POL .89478590 02
    DT .75210241 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97890700 05     F1 .12689070 06     F2 .19578140 06     XA .29669691 08    PRA .19306591 03
    D1 .42296900 04     D2 .65260466 04

 255 DAYS 20 HRS. 44 MIN. 16.963 SEC.       235724311227202000640006 J.D.= 2438967.05810192  JULY 25,1965 13 23 40.006

                                             END OF VIEW PERIOD
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CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                  30

  EARTH - MARS               CHECK 3


41 WOOMERA          HADEC
     R .22579439 09    LAT-.57945079 01    LON .49235635 02
   MIN .36844428 06     HA .87653023 02    DEC-.57936797 01    ELE .49999998 01    AZI .26624606 03
   CKC .10117116 03    CKM .17999794 03    CKT .14037477 01    PSS .72010344 02    PSM .11295041 03
    UT .61407379 04    DHA .41719994-02    DDE-.26859302-05    DEL-.35590949-02    DAZ-.21438223-02
    ET .61407281 04    RGE .22579383 09    DRG .15335276 02    DDR .00000000 00    SLS .25916831 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38938225 02    POL .74149100 02
    DT .75316706 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .99109407 05     F1 .12810941 06     F2 .19821881 06     XA .29669729 08    PRA .19319218 03
    D1 .42703135 04     D2 .66072937 04

 256 DAYS  2 HRS. 29 MIN. 33.494 SEC.       235724323322202104600004 J.D.= 2438967.29787658  JULY 25,1965 19 08 56.537

                                             START OF VIEW PERIOD


11 GOLDSTONE        HADEC
     R .22610377 09    LAT-.58503592 01    LON .32280641 03
   MIN .36878955 06     HA .28034310 03    DEC-.58513094 01    ELE .50000024 01    AZI .10077684 03
   CKC .10115614 03    CKM .17999810 03    CKT .12445347 01    PSS .71920073 02    PSM .11031216 03
    UT .61464924 04    DHA .41720092-02    DDE-.27048434-05    DEL .33470781-02    DAZ .24633162-02
    ET .61464827 04    RGE .22610322 09    DRG .14556335 02    DDR .00000000 00    SLS .25918020 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38907508 02    POL .26041654 03
    DT .75419906 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96614939 05     F1 .12561494 06     F2 .19322988 06     XA .29669652 08    PRA .19332086 03
    D1 .41871646 04     D2 .64409959 04

 256 DAYS  7 HRS. 47 MIN. 39.258 SEC.       235724334565202446445001 J.D.= 2438967.51877663  JULY 26,1965 00 27 02.301

                                             EXTREME ELEVATION


11 GOLDSTONE        HADEC
     R .22638855 09    LAT-.59018007 01    LON .24318075 03
   MIN .36910765 06     HA .35997006 03    DEC-.59028611 01    ELE .48889057 02    AZI .17994908 03
   CKC .10114234 03    CKM .17999834 03    CKT .10783801 01    PSS .71836273 02    PSM .10757185 03
    UT .61517941 04    DHA .41720849-02    DDE-.26945318-05    DEL-.41294189-10    DAZ .56133654-02
    ET .61517644 04    RGE .22638375 09    DRG .14914852 02    DDR .00000000 00    SLS .25919097 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38883219 02    POL .26943663 03
    DT .75513461 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97763048 05     F1 .12676305 06     F2 .19552610 06     XA .29669688 08    PRA .19343569 03
    D1 .42254349 04     D2 .65175365 04

 256 DAYS  9 HRS.  1 MIN. 50.376 SEC.       235724336716202265537775 J.D.= 2438967.57029421  JULY 26,1965 01 41 13.419

                                             START OF VIEW PERIOD
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CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                  31

   EARTH - MARS                CHECK 3

41 WOOMERA            HADEC
     R .22645494 09     LAT-.59137963 01     LON .22461074 03
   MIN .36918183 06      HA .27227514 03     DEC-.59129698 01     ELE .49999981 01     AZI .93893530 02
   CKC .10113527 03     CKM .17999455 03     CKT .10326734 01     PSS .71815287 02     PSM .10627989 03
    UT .61530305 04     DHA .41719918-02     DDE-.27047700-05     DEL .35612792-02     DAZ-.21384176-02
    ET .61530208 04     RGE .22645438 09     DRG .14517195 02     DDR .00000000 00     SLS .25919368 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .38876736 02     POL .91684270 02
    DT .75537039 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .96489597 05      F1 .12548960 06      F2 .19297919 06      XA .29669648 08     PRA .19346416 03
    D1 .41829865 04      D2 .64326398 04

 256 DAYS 13 HRS.  5 MIN. 41.247 SEC.      23572434603020204512004 J.D.= 2438967.73963299  JULY 26,1965 05 45 04.290

                                         END OF VIEW PERIOD

11 GOLDSTONE          HADEC
     R .22667304 09     LAT-.59532184 01     LON .16357095 03
   MIN .36942568 06      HA .79581171 02     DEC-.59541661 01     ELE .49999998 01     AZI .25909518 03
   CKC .10112817 03     CKM .17999826 03     CKT .88914591 00     PSS .71749432 02     PSM .10359304 03
    UT .61570945 04     DHA .41720025-02     DDE-.26839704-05     DEL-.33488249-02     DAZ .24596025-02
    ET .61570848 04     RGE .22667248 09     DRG .15273411 02     DDR .00000000 00     SLS .25920204 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .38858962 02     POL .27137481 03
    DT .75609791 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .98911291 05      F1 .12791129 06      F2 .19782258 06      XA .29669723 08     PRA .19355056 03
    D1 .42637096 04      D2 .65940860 04

 256 DAYS 14 HRS. 52 MIN. 21.613 SEC.      23572435113020212401777 J.D.= 2438967.81371130  JULY 26,1965 07 31 44.656

                                         EXTREME ELEVATION

41 WOOMERA            HADEC
     R .22676641 09     LAT-.59704612 01     LON .13686872 03
   MIN .36953235 06      HA .18548965-01     DEC-.59697739 01     ELE .64757886 02     AZI .35993705 03
   CKC .10111999 03     CKM .17999482 03     CKT .81630664 00     PSS .71723207 02     PSM .10341586 03
    UT .61588725 04     DHA .41720849-02     DDE-.26936668-05     DEL .16343477-10     DAZ-.66853434-02
    ET .61588628 04     RGE .22676264 09     DRG .14898024 02     DDR .00000000 00     SLS .25920549 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .38849640 02     POL .89425796 02
    DT .75639866 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .97709156 05      F1 .12670916 06      F2 .19541831 06      XA .29669686 08     PRA .19359083 03
    D1 .42236385 04      D2 .65139437 04

 256 DAYS 20 HRS. 43 MIN.  0.341 SEC.      23572436334320266120003 J.D.= 2438968.05721509  JULY 26,1965 13 22 23.385

                                         END OF VIEW PERIOD


CASE  1                                IBSYS-JPTRAJ-SFPRO 041765                                  32

   EARTH - MARS                CHECK 3

41 WOOMERA            HADEC
     R .22708170 09     LAT-.60271267 01     LON .49095526 02
   MIN .36988300 06      HA .87793124 02     DEC-.60263065 01     ELE .49999998 01     AZI .26597385 03
   CKC .10110425 03     CKM .17999469 03     CKT .56300309 00     PSS .71627355 02     PSM .99010180 02
    UT .61647166 04     DHA .41719842-02     DDE-.26822633-05     DEL-.35579342-02     DAZ-.21423318-02
    ET .61647069 04     RGE .22708114 09     DRG .15278861 02     DDR .00000000 00     SLS .25921769 03
   RDI .63726039 04     PHI-.31211875 02     THI .13688727 03     SPS .38822967 02     POL .74406202 02
    DT .75746106 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .98928744 05      F1 .12792874 06      F2 .19785749 06      XA .29669723 08     PRA .19371764 03
    D1 .42642914 04      D2 .65952495 04

 257 DAYS  2 HRS. 28 MIN. 24.431 SEC.      23572437544020267447776 J.D.= 2438968.29707722  JULY 26,1965 19 07 47.474

                                         START OF VIEW PERIOD

11 GOLDSTONE          HADEC
     R .22739004 09     LAT-.60829331 01     LON .32263508 03
   MIN .37022840 06      HA .28051444 03     DEC-.60838782 01     ELE .49999998 01     AZI .10106625 03
   CKC .10108900 03     CKM .17999491 03     CKT .26823988 00     PSS .71537145 02     PSM .95817155 02
    UT .61704733 04     DHA .41719946-02     DDE-.27017472-05     DEL .33436043-02     DAZ .24647831-02
    ET .61704636 04     RGE .22736948 09     DRG .14500871 02     DDR .00000000 00     SLS .25922947 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .38791985 02     POL .26059010 03
    DT .75848956 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .96437322 05      F1 .12543732 06      F2 .19287464 06      XA .29669647 08     PRA .19384665 03
    D1 .41812440 04      D2 .64291547 04

 257 DAYS  7 HRS. 45 MIN. 49.168 SEC.      23572440667220203300174 J.D.= 2438968.51750244  JULY 27,1965 00 25 12.211

                                         EXTREME ELEVATION

11 GOLDSTONE          HADEC
     R .22767314 09     LAT-.61341979 01     LON .24318086 03
   MIN .37054582 06      HA .35996995 03     DEC-.61352575 01     ELE .48656662 02     AZI .17995104 03
   CKC .10107503 03     CKM .17999521 03     CKT .35994583 03     PSS .71453669 02     PSM .93220413 02
    UT .61757635 04     DHA .41720697-02     DDE-.26910134-05     DEL .14947315-10     DAZ .58009946-02
    ET .61757538 04     RGE .22766835 09     DRG .14859462 02     DDR .00000000 00     SLS .25924012 03
   RDI .63720340 04     PHI .35208070 02     THI .24315082 03     SPS .38767490 02     POL .26939843 03
    DT .75941978 03     RFB .96004999 09     RF1 .96004999 09     RF2 .29668212 08      FA .96004999 09
   BF1 .97585731 05      F1 .12658573 06      F2 .19517146 06      XA .29669682 08     PRA .19396152 03
    D1 .42195243 04      D2 .65057153 04

 257 DAYS  8 HRS. 59 MIN. 26.791 SEC.      23572441101220235255400 J.D.= 2438968.56863233  JULY 27,1965 01 38 49.834

                                         START OF VIEW PERIOD
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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                      33

  EARTH - MARS               CHECK 3

41 WOOMERA          HADEC
     R .22773877 09    LAT-.61460876 01    LON .22475066 03
   MIN .37061944 06     HA .27213523 03    DEC-.61452671 01    ELE .50000015 01    AZI .94165340 02
   CKC .10106795 03    CKM .17999145 03    CKT .35985860 03    PSS .71432870 02    PSM .91809677 02
    UT .61769907 04    DHA .41719769-02    DDE-.27015633-05    DEL .35600750-02    DAZ-.21369352-02
    ET .61769809 04    RGE .22773822 09    DRG .14462334 02    DDR .00000000 00    SLS .25924278 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38761001 02    POL .91669417 02
    DT .75965282 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96313914 05     F1 .12531391 06     F2 .19262783 06     XA .29669642 08    PRA .19398985 03
    D1 .41771304 04     D2 .64209275 04

 257 DAYS 13 HRS.  3 MIN. 10.208 SEC.       235724420122202240120004 J.D.= 2438968.73788485  JULY 27,1965 05 42 33.251

                                           END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22795597 09    LAT-.61854380 01    LON .16374217 03
   MIN .37086316 06     HA .79409941 02    DEC-.61863806 01    ELE .49999998 01    AZI .25880613 03
   CKC .10106068 03    CKM .17999520 03    CKT .35955821 03    PSS .71367167 02    PSM .89337630 02
    UT .61810527 04    DHA .41719883-02    DDE-.26800011-05    DEL-.33455168-02    DAZ .24610751-02
    ET .61810429 04    RGE .22795541 09    DRG .15218574 02    DDR .00000000 00    SLS .25925106 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38743028 02    POL .27135987 03
    DT .76037731 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98735680 05     F1 .12773568 06     F2 .19747136 06     XA .29669717 08    PRA .19407642 03
    D1 .42578560 04     D2 .65823786 04

 257 DAYS 14 HRS. 50 MIN. 31.595 SEC.       235724423234202521600002 J.D.= 2438968.81243794  JULY 27,1965 07 29 54.639

                                           EXTREME ELEVATION

41 WOOMERA          HADEC
     R .22805160 09    LAT-.62027670 01    LON .13686890 03
   MIN .37097052 06     HA .18373489-01    DEC-.62020900 01    ELE .64990204 02    AZI .35994148 03
   CKC .10105243 03    CKM .17999181 03    CKT .35940538 03    PSS .71340796 02    PSM .89086203 02
    UT .61828420 04    DHA .41720700-02    DDE-.26899514-05    DEL-.24406805-10    DAZ-.72411993-02
    ET .61828323 04    RGE .22804582 09    DRG .14844082 02    DDR .00000000 00    SLS .25925451 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38733765 02    POL .89385862 02
    DT .76067888 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97536416 05     F1 .12653642 06     F2 .19507283 06     XA .29669680 08    PRA .19411704 03
    D1 .42178805 04     D2 .65024277 04

 257 DAYS 20 HRS. 41 MIN. 43.979 SEC.       235724435460202602777777 J.D.= 2438969.05633128  JULY 27,1965 13 21 07.023

                                           END OF VIEW PERIOD
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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                      34

  EARTH - MARS               CHECK 3

41 WOOMERA          HADEC
     R .22836427 09    LAT-.62594465 01    LON .48955591 02
   MIN .37132172 06     HA .87933054 02    DEC-.62586278 01    ELE .50000015 01    AZI .26570202 03
   CKC .10103642 03    CKM .17999176 03    CKT .35883286 03    PSS .71244948 02    PSM .84787424 02
    UT .61886954 04    DHA .41719700-02    DDE-.26779876-05    DEL-.35566959-02    DAZ-.21408440-02
    ET .61886856 04    RGE .22836371 09    DRG .15226125 02    DDR .00000000 00    SLS .25926661 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38706555 02    POL .74651913 02
    DT .76173924 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98759861 05     F1 .12775986 06     F2 .19751972 06     XA .29669718 08    PRA .19424435 03
    D1 .42586620 04     D2 .65839907 04

 258 DAYS  2 HRS. 27 MIN. 15.688 SEC.       235724447557202535477767 J.D.= 2438969.29628160  JULY 27,1965 19 06 38.731

                                           START OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22867164 09    LAT-.63151851 01    LON .32246364 03
   MIN .37166725 06     HA .28068589 03    DEC-.63161260 01    ELE .49999998 01    AZI .10135544 03
   CKC .10102096 03    CKM .17999209 03    CKT .35810162 03    PSS .71154778 02    PSM .81037152 02
    UT .61944543 04    DHA .41719814-02    DDE-.26978192-05    DEL .33404494-02    DAZ .24662474-02
    ET .61944444 04    RGE .22867109 09    DRG .14450695 02    DDR .00000000 00    SLS .25927829 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38675299 02    POL .26075745 03
    DT .76276454 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96276639 05     F1 .12527664 06     F2 .19255328 06     XA .29669641 08    PRA .19437368 03
    D1 .41758679 04     D2 .64184426 04

 258 DAYS  7 HRS. 43 MIN. 59.367 SEC.       235724460776202464372773 J.D.= 2438969.51623160  JULY 28,1965 00 23 22.410

                                           EXTREME ELEVATION

11 GOLDSTONE        HADEC
     R .22895319 09    LAT-.63662562 01    LON .24318096 03
   MIN .37178398 06     HA .35996985 03    DEC-.63673148 01    ELE .48424605 02    AZI .17995054 03
   CKC .10100683 03    CKM .17999250 03    CKT .35721029 03    PSS .71071588 02    PSM .78579586 02
    UT .61997330 04    DHA .41720570-02    DDE-.26863629-05    DEL .93513614-10    DAZ .57040999-02
    ET .61997233 04    RGE .22894842 09    DRG .14811037 02    DDR .00000000 00    SLS .25928882 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38650588 02    POL .26935263 03
    DT .76368962 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97430594 05     F1 .12643059 06     F2 .19486119 06     XA .29669677 08    PRA .19448854 03
    D1 .42143531 04     D2 .64953728 04

 258 DAYS  8 HRS. 57 MIN.  3.536 SEC.       235724463106202512044003 J.D.= 2438969.56697429  JULY 28,1965 01 36 26.579

                                           START OF VIEW PERIOD
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CASE  1                                        IBSYS-JPTRAJ-SFPRO 041765                                           35

   EARTH - MARS                CHECK 3

41 WOOMERA          HADEC
     R .22901813 09    LAT-.63780340 01    LON .22489038 03
   MIN .37205705 06     HA .27199552 03    DEC-.63772187 01    ELE .50000015 01    AZI .94436723 02
   CKC .10099973 03    CKM .17998877 03    CKT .35695931 03    PSS .71050949 02    PSM .77111682 02
    UT .62009508 04    DHA .41719646-02    DDE-.26971364-05    DEL .35587945-02    DAZ-.21354581-02
    ET .62009411 04    RGE .22901757 09    DRG .14414524 02    DDR .00000000 00    SLS .25929144 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38644083 02    POL .91653873 02
    DT .76392028 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .96160807 05     F1 .12516081 06     F2 .19232161 06     XA .29669638 08    PRA .19451672 03
    D1 .41720269 04     D2 .64107204 04

 258 DAYS 13 HRS.  0 MIN. 39.423 SEC.      235724472214202473560011 J.D.= 2438969.73613966  JULY 28,1965 05 40 02.467

                                           END OF VIEW PERIOD

11 GOLDSTONE        HADEC
     R .22923452 09    LAT-.64172905 01    LON .16391347 03
   MIN .37230065 06     HA .79238632 02    DEC-.64182296 01    ELE .49999998 01    AZI .25851737 03
   CKC .10099232 03    CKM .17999260 03    CKT .35598391 03    PSS .70985358 02    PSM .74874780 02
    UT .62050109 04    DHA .41719776-02    DDE-.26744588-05    DEL-.33421293-02    DAZ .24625483-02
    ET .62050010 C4    RGE .22923397 09    DRG .15171573 02    DDR .00000000 00    SLS .25929964 03
   RDI .63720340 04    PHI .35208070 02    THI .24315082 03    SPS .38625912 02    POL .27134472 03
    DT .76464210 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98585165 05     F1 .12758517 06     F2 .19717033 06     XA .29669712 08    PRA .19460342 03
    D1 .42528389 04     D2 .65723443 04

 258 DAYS 14 HRS. 48 MIN. 41.842 SEC.      235724475341202161220001 J.D.= 2438969.81116765  JULY 28,1965 07 28 04.885

                                           EXTREME ELEVATION

41 WOOMERA          HADEC
     R .22933046 09    LAT-.64346955 01    LON .13686908 03
   MIN .37240669 06     HA .18184662-01    DEC-.64340279 01    ELE .65222141 02    AZI .35994065 03
   CKC .10098398 03    CKM .17998926 03    CKT .35544931 03    PSS .70958611 02    PSM .74514401 02
    UT .62068115 04    DHA .41720594-02    DDE-.26844723-05    DEL-.68334116-10    DAZ-.71845382-02
    ET .62068018 04    RGE .22932467 09    DRG .14797611 02    DDR .00000000 00    SLS .25930308 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38616503 02    POL .89344693 02
    DT .76494466 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .97388238 05     F1 .12638824 06     F2 .19477648 06     XA .29669676 08    PRA .19464435 03
    D1 .42129412 04     D2 .64925492 04

 258 DAYS 20 HRS. 40 MIN. 27.799 SEC.      235724507575202553700001 J.D.= 2438970.05544957  JULY 28,1965 13 19 50.843

                                           END OF VIEW PERIOD
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CASE  1                                        IBSYS-JPTRAJ-SFPRO 041765                                           36

   EARTH - MARS                CHECK 3

41 WOOMERA          HADEC
     R .22964264 09    LAT-.64913383 01    LON .48815893 02
   MIN .37276046 06     HA .88072745 02    DEC-.64905263 01    ELE .49999998 01    AZI .26543071 03
   CKC .10096774 03    CKM .17998935 03    CKT .35306893 03    PSS .70862842 02    PSM .70414719 02
    UT .62126743 04    DHA .41719626-02    DDE-.26712658-05    DEL-.35553872-02    DAZ-.21393608-02
    ET .62126645 04    RGE .22964209 09    DRG .15178249 02    DDR .00000000 00    SLS .25931510 03
   RDI .63726039 04    PHI-.31211875 02    THI .13688727 03    SPS .38588959 02    POL .74892898 02
    DT .76600344 03    RFB .96004999 09    RF1 .96004999 09    RF2 .29668212 08     FA .96004999 09
   BF1 .98606545 05     F1 .12760655 06     F2 .19721309 06     XA .29669713 08    PRA .19477205 03
    D1 .42535515 04     D2 .65737697 04

 258 DAYS 23 HRS. 17 MIN. 28.762 SEC.      235724514260202747055042 J.D.= 2438970.16448848  JULY 28,1965 15 56 51.805

       GEOCENTRIC                                                                               EQUATORIAL COORDINATES

     X -.22069152 09     Y -.58437119 08     Z -.26078223 08    DX -.67759749 01    DY -.26997936 02    DZ -.12361472 02
     R  .22978189 09   DEC -.65166083 01    RA  .19483103 03     V  .30456663 02   PTH  .29023969 02    AZ  .11381592 03
     R  .22978189 09   LAT -.65166083 01   LON  .95120270 01    VE  .16623345 05   PTE  .50932720-01   AZE  .26996292 03
    XS -.87878015 08    YS  .11366779 09    ZS  .49293696 08   DXS -.23821953 02   DYS -.15721360 02   DZS -.68170658 01
    XM -.21864600 06    YM  .24773650 06    ZM  .13595025 06   DXM -.87000689 00   DYM -.64006138 00   DZM -.21641982 00
    XT -.22073127 09    YT -.58214939 08    ZT -.26008592 08   DXT -.31068879 01   DYT -.26372385 02   DZT -.12262985 02
    RS  .15189727 09    VS  .29344829 02    RM  .35729807 06    VM  .11015571 01    RT  .22975578 09    VT  .29249551 02
   GED -.65606317 01   ALT  .22977551 09   LOS  .30238905 03   RAS  .12770806 03   RAM  .13143081 03   LOM  .30611180 03
   DUT  .35000000 02    DT  .95999999 03    DR  .14776826 02   SHA -.21702920 09   DES  .18936493 02   DEM  .22364368 02
   CEL  .10096057 03   MCL  .17998949 03   TCL  .35149954 03

      HELIOCENTRIC                                                                                ECLIPTIC COORDINATES

     X -.13281351 09     Y -.18788445 09     Z -.67584800 06    DX  .17045978 02    DY -.12551548 02    DZ -.60018480 00
     R  .23008792 09   LAT -.16829842 00   LON  .23474391 03     V  .21177038 02   PTH  .11137503 01    AZ  .91621096 02
    XE  .87878015 08    YE -.12389606 09    ZE -.33300000 03   DXE  .23821953 02   DYE  .17135739 02   DZE -.62513351-03
    XT -.13285326 09    YT -.18765291 09    ZT -.70036300 06   DXT  .20715065 02   DYT -.11938455 02   DZT -.75871021 00
   LTE -.12560788-03   LOE  .30534763 03   LTT -.17452641 00   LOT  .23470252 03   RST  .22992193 09   VST  .23921042 02
   EPS  .36574496 02   ESP  .70603794 02   SEP  .70821708 02   EPM  .83050504-01   EMP  .11152291 03   M    .68394209 02
   MPS  .38491877 02   MSP  .70597944 02   SMP  .70910179 02   SEM  .46866878 01   EMS  .17510180 03   ESM  .98911702-02
   EPT  .83624309 02   ETP  .96317149 02   TEP  .58097472-01   TPS  .45330583 02   TSP  .41964682-01   STP  .13462755 03
   SET  .70763497 02   STE  .38591306 02   EST  .70645197 02   RPM  .22965057 09   RPT  .23620497 06   SPN  .38572905 02
   GCE  .25903942 03   GCT  .70538979 02   SIP  .44511159 02   CPT  .69922116 02   SIN  .69102693 02
   REP  .22978189 09   VEP  .30456663 02   CPE  .89749999 02   CPS  .81061030 02

       AREOCENTRIC                                                                                ECLIPTIC COORDINATES

     X  .39749151 05     Y -.23154230 06     Z  .24514323 05    DX -.36690870 01    DY -.61309294 00    DZ  .15852540 00
     R  .23620496 06   DEC  .59571193 01    RA  .27974108 03     V  .37233336 01   PTH  .14331472-07    AZ  .27245343 03
   ALT  .23282697 06   SHA  .16810431 06   ALP  .17384013 03    DR  .16537543-07    DP  .90316174-03   ASD  .81942291 00
   HGE  .32142550 03   SVL -.60343030 01   HNG  .45014140 02   SIA  .82804886 02
```

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CASE  1                                  IBSYS-JPTRAJ-SFPRO 041765                                          37

   EARTH - MARS            CHECK 3

                                                                        AREOCENTRIC EQUATORIAL COORDINATES

    X  .22979118 06     Y  .29207460 05     Z  .46213904 05    DX  .71223004 00    DY -.33713025 01    DZ -.14107658 01
    R  .23620497 06   DEC  .11282797 02    RA  .72437015 01     V  .37233335 01   PTH  .28662945-06    AZ  .24727144 03
    R  .23620497 06   LAT  .11282797 02   LON  .30645975 03    VP  .19905394 02   PTP  .71843381-06   AZP  .26585560 03
  RAE  .10944998 03   DEE  .23958425 02   RAS  .14864074 03   DES  .13037049 02   LOE  .48666033 02   LOS  .87856794 02

                                             AREOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 235724514260202747020726 J.D.= 2438970.16448848  JULY 28,1965 15 56 51.805
  SMA -.31836705 04   ECC  .75192653 02     B  .23936746 06   SLR  .17997083 08   APO  .00000000 00   RCA  .23620497 06
   VH  .36741412 01    C3  .13499314 02    C1  .87946988 06   TFP  .42952848-03    TF  .25897047 03   LTF  .25892714 03
   TA  .25613208-05   MTA  .90762007 02    EA  .00000000 00    MA  .28401568-04                       TFI  .25897047 03
  ZAE  .17354659 03   ZAP  .13547478 03   ZAC  .91406690 02   DEF  .15241199 01    IR  .57375745 04    GP  .13530178 01

                                                        ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .39749151 05     Y -.22218080 06     Z -.69631051 05    DX -.36690870 01    DY -.62555059 00    DZ -.98487204-01
  INC  .16278397 03   LAN  .18477665 03   APF  .26487261 03    MX -.98543065 00    MY -.16800820 00    MZ -.26451349-01
   WX -.24646413-01    WY  .29494718 00    WZ -.95519564 00    PX  .16828246 00    PY -.94062713 00    PZ -.29479079 00
   QX -.98543064 00    QY -.16800820 00    QZ -.26451351-01    RX  .29670185-01    RY  .54843099-02    RZ -.99953872 00
   BX  .18137299 00    BY -.93830958 00    BZ -.29441294 00    TX -.18058620 00    TY  .98355917 00    TZ  .00000000 00
  SXI -.96310547 00   SYI -.18050290 00   SZI -.30369485-01   DAI -.17403100 01   RAI  .19040390 03
  SXO -.98758150 00   SYO -.15548378 00   SZO -.22528538-01   DAO -.12908989 01   RAO  .18894714 03
  ETE  .13235197 03   ETS  .15412666 03   ETC  .23280338 03

  BTQ -.22874827 06   BRQ  .70505397 05     B  .23936746 06   THA  .16286951 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                        ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .22979118 06     Y  .45471979 05     Z  .30349612 05    DX  .71222989 00    DY -.36536678 01    DZ  .81561729-01
  INC  .17251061 03   LAN  .91436507 02   APF  .80324851 02    MX  .19128822 00    MY -.98128942 00    MZ  .21905565-01
   WX  .13030142 00    WY  .32675759-02    WZ -.99146904 00    PX  .97284652 00    PY  .19251069 00    PZ  .12848846 00
   QX  .19128823 00    QY -.98128942 00    QZ  .21905566-01    RX  .48232219-02    RY -.23114559-01    RZ -.99972117 00
   BX  .97021651 00    BY  .20554400 00    BZ  .12818577 00    TX -.97891536 00    TY -.20426632 00    TZ  .00000000 00
  SXI  .20420937 00   SYI -.97864240 00   SZI  .23612419-01   DAI  .13530169 01   RAI  .28178655 03
  SXO  .17833326 00   SYO -.98376287 00   SZO  .20194839-01   DAO  .11571570 01   RAO  .28027481 03
  ETE  .15684928 03   ETS  .17862398 03   ETC  .25730070 03

  BTO -.23739161 06   BRO -.30692058 05     B  .23936746 06   THA  .16736683 03     T VECTOR IN  ORBIT PLANE OF TARGET

                                                     ALL VECTORS REFERENCED TO AREOCENTRIC EQUATOR PLANE
    X  .22979118 06     Y  .29207449 05     Z  .46213904 05    DX  .71222989 00    DY -.33713025 01    DZ -.14107658 01
  INC  .15475869 03   LAN  .16220799 03   APF  .15268954 03    MX  .19128822 00    MY -.90545272 00    MZ -.37889858 00
   WX  .13030142 00    WY  .40603604 00    WZ -.90451990 00    PX  .97284651 00    PY  .12365298 00    PZ  .19565170 00
   QX  .19128823 00    QY -.90545272 00    QZ -.37889858 00    RX -.82930786-01    RY  .36701005 00    RZ -.92651284 00
   BX  .97021651 00    BY  .13568382 00    BZ  .20067343 00    TX -.97540813 00    TY -.22040640 00    TZ  .00000000 00
  SXI  .20420936 00   SYI -.90372816 00   SZI -.37626306 00   DAI -.22102400 02   RAI  .28273290 03
  SXO  .17833325 00   SYO -.90701412 00   SZO -.38146707 00   DAO -.22424586 02   RAO  .28112333 03
  ETE  .16199127 03   ETS  .18376597 03   ETC  .26244269 03

  BTT -.23368551 06   BRT -.51844599 05     B  .23936746 06   THA  .19250882 03     T VECTOR IN  TRUE TARGET EQU. PLANE

215522623366     213675042633     614630127306     602532206172     204542657366     200624303772                    EARTH
                    641101116                           3923043                       000000000000                  INITIAL

220457633260     622662154022     621420154524     602725735144     600471673266     575575031600                     MARS
                                                                     235724514260     202747055042                      END


    END TRAJECTORY (SFPRC)        016542        G
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D. Check case 4 is an Earth-Moon trajectory with a minimum print requested. The spacecraft injects near the Earth on August 6, 1963 and impacts the Moon after a 66.37-hour flight time.

```
START TRAJECTORY (SFPRO)      016543      G

CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   1

EARTH-MCON                                CHECK 4

DOUBLE PRECISICN EPHEMERIS TAPE - EPHEM1
S/C EPHEMERIS WRITTEN  016353G      041765 RUNID=(TRAJ04)

  GME  .39860063 06    J  .16234500-02    H -.57499999-05    D  .78749999-05    RE  .63781650 04   REM  .63783112 04
    G  .66709998-19    A  .88781796 29    B  .88800194 29    C  .88836976 29   OME  .41780741-07    AU  .14959850 09
  GMM  .49026293 04  GMS  .13271411 12  GMV  .32476627 06  GMA  .42977367 05   GMC  .37918700 08   GMJ  .12670935 09
  EGM  .39860320 06  MGM  .49027779 04   JA  .29200000-02   HA  .00000000 00    DA  .00000000 00    RA  .34170000 04

INJECTION CONDITICNS   1950.0    MOON       235631122755202732375600 J.D.= 2438248.21175586   AUG. 6,1963 17 04 55.707

GEOCENTRIC      X0-.61143780 04  Y0-.23438636 04  Z0-.54566108 03 DX0 .35295397 01 DY0-.88027116 01 DZ0-.54594941 01
CARTESIAN       T0 .61495706 05 GHA .21074440 03 GH0 .31381078 03
DATE OF RUN 041765G 016553                  EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

  0 DAYS  0 HRS.  0 MIN.  0.000 SEC.        235631122755202732375600 J.D.= 2438248.21175586   AUG. 6,1963 17 04 55.707
                                                                                          EQUATORIAL COORDINATES
     GEOCENTRIC

    X -.61066757 04     Y -.23620296 04     Z -.55352168 03   DX  .35627327 01   DY -.87922516 01    DZ -.54547870 01
    R  .65709252 04   DEC -.48322111 01    RA  .20114620 03    V  .10943100 02  PTH  .16181000 01    AZ  .11987157 03
    R  .65709251 04   LAT -.48322111 01   LON  .35040180 03   VE  .10531934 02  PTE  .16812886 01   AZE  .12116592 03
   XS -.10447122 09    YS  .10094874 09    ZS  .43774450 08  DXS -.21109203 02  DYS -.18709376 02   DZS -.81139760 01
   XM  .32552845 06    YM -.16238938 06    ZM -.94397182 05  DXM  .48530280 00  DYM  .87985646 00   DZM  .30392424 00
   XT  .32552845 06    YT -.16238938 06    ZT -.94397182 05  DXT  .48530280 00  DYT  .87985646 00   DZT  .30392424 00
   RS  .15172701 09    VS  .29350908 02    RM  .37583228 06   VM  .10497791 01   RT  .37583228 06    VT  .10497791 01
  GED -.48649840 01   ALT  .19287213 03   LOS  .28523799 03  RAS  .13598239 03  RAM  .33348775 03   LOM  .12274335 03
  DUT  .35000000 02    DT  .75000000 01    DR  .30900500 00  SHA -.60875954 04  DES  .16768649 02   DEM -.14546660 02
  CCL  .78939548 02   MCL  .18709179 03   TCL  .18709179 03

                                              GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 235631122745202256470160 J.D.= 2438248.21135838   AUG. 6,1963 17 04 21.364
  SMA  .25371170 06   ECC  .97412174 00     B  .57344925 05  SLR  .12961326 05  APO  .50085777 06   RCA  .65656162 04
   VH  .14350904 00    C3 -.15710770 01    C1  .71877622 05  TFP  .34342858 02   TF -.95396826-02   PER  .21196803 05
   TA  .32791989 01   MTA  .18000000 03    EA  .37554599 00   MA  .97211426-02  C3J -.19874077 01   TFI  .00000000 00

                                                           ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.61066757 04     Y -.23620296 04     Z -.55352188 03   DX  .35627327 01   DY -.87922516 01    DZ -.54547870 01
  INC  .30224249 02   LAN  .12802531 02   APF  .18635416 03   MX  .35195159 00   MY -.79361762 00    MZ -.49628737 00
   WX  .11154605 00    WY -.49087135 00    WZ  .86406182 00   PX -.94795842 00   PY -.31348205 00    PZ -.55711693-01
   QX  .29821515 00    QY -.81288025 00    QZ -.50029331 00   RX  .52894520-01   RY  .17491783-01    RZ -.99844687 00
   BX -.29821515 00    BY  .81288026 00    BZ  .50029332 00   TX -.31396969 00   TY  .94943301 00    TZ  .00000000 00
  DAP -.31936974 01   RAP  .19829862 03

  BTQ  .49626634 05   BRQ -.28733908 05     B  .57344925 05  THA  .32992908 03    T VECTOR IN  EARTH EQUATOR PLANE

  BTO  .56783066 05   BRO -.80009963 04     B  .57343984 05  THA  .35197955 03    T VECTOR IN  ORBIT PLANE OF TARGET


CASE  1                              IBSYS-JPTRAJ-SFPRO 041765                                   2

EARTH-MOON                                CHECK 4
                                                                                          EQUATORIAL COORDINATES
     HELIOCENTRIC

    X  .10446511 09     Y -.10095110 09     Z -.43775003 08   DX  .24671935 02   DY  .99171245 01    DZ  .26591889 01
    R  .15172454 09   LAT -.16769149 02   LON  .31598005 03    V  .26723118 02  PTH  .21102723 02    AZ  .76838918 02
   XE  .10447122 09    YE -.10094874 09    ZE -.43774450 08  DXE  .21109203 02  DYE  .18709376 02   DZE  .81139760 01
   XT  .10479674 09    YT -.10111112 09    ZT -.43868847 08  DXT  .21594505 02  DYT  .19589232 02   DZT  .84179002 01
  LTE -.16768649 02   LOE  .31598239 03   LTT -.16764987 02  LOT  .31602545 03  RST  .15208646 09   VST  .30346692 02
  EPS  .11211055 03   ESP  .98911702-02   SEP  .67887145 02  EPM  .50291134 02  EMP  .77056544 00   MEP  .12893820 03
  MPS  .16224048 03   MSP  .44234658-01   SMP  .17715845 02  SEM  .16300448 03  EMS  .16954125 02   ESM  .40178123-01
  RPM  .37999636 06   SPN  .36028888 02
  GCE  .28106045 03   GCT  .28815224 03   SIP  .16197841 03  CPT  .96371983 02  SIN  .96109912 02
  REP  .65709252 04   VEP  .10943100 02   CPE  .84659921 02  CPS  .77642693 02

  2 DAYS 10 HRS. 26 MIN. 41.238 SEC.        235631271546202170747003 J.D.= 2438250.64695538   AUG. 9,1963 03 31 36.945
  CHANGE OF PHASE CCCURS AT THIS POINT    MOON     IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

  2 DAYS 10 HRS. 26 MIN. 41.238 SEC.        235631271546202170747003 J.D.= 2438250.64695538   AUG. 9,1963 03 31 36.945
***** S/C DISCONTINUITY=R STOP

  2 DAYS 10 HRS. 26 MIN. 41.238 SEC.        235631271546202170747003 J.D.= 2438250.64695538   AUG. 9,1963 03 31 36.945
                                                                                          EQUATORIAL COORDINATES
     GEOCENTRIC

    X  .33731393 06     Y  .62030703 05     Z -.75559509 04   DX  .83209578 00   DY  .28275367 00    DZ  .66862292-01
    R  .34305333 06   DEC -.12620747 01    RA  .10420049 02    V  .88136461 00  PTH  .79945668 02    AZ  .56020466 02
    R  .34305333 06   LAT -.12620747 01   LON  .60359662 00   VE  .24897456 02  PTE  .19975127 01   AZE  .27019802 03
   XS -.10882430 09    YS  .96928550 08    ZS  .42031089 08  DXS -.20263164 02  DYS -.19499616 02   DZS -.84560510 01
   XM  .36799422 06    YM  .38832118 05    ZM -.18535277 05  DXM -.97790682-01  DYM  .97846287 00   DZM  .39709176 00
   XT  .36799422 06    YT  .38832118 05    ZT -.18535277 05  DXT -.97790682-01  DYT  .97846287 00   DZT  .39709176 00
   RS  .15167229 09    VS  .29365551 02    RM  .37050132 06   VM  .10604878 01   RT  .37050132 06    VT  .10604878 01
  GED -.12706726 01   ALT  .33667513 06   LOS  .12849246 03  RAS  .13830891 03  RAM  .60237696 01   LOM  .35620731 03
  DUT  .35000000 02    DT  .12000000 03    DR  .86782920 00  SHA  .27545618 06  DES  .16088259 02   DEM -.28675644 01
  CCL  .25589520 03   MCL  .95146835 01   TCL  .95146835 01

                                              GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 235631126074202141547003 J.D.= 2438248.28649031   AUG. 6,1963 18 52 32.763
  SMA  .25765422 06   ECC  .98634146 00     B  .42439093 05  SLR  .69902918 04  APO  .51178926 06   RCA  .35191793 04
   VH  .10313960 00    C3 -.15470370 01    C1  .52785743 05  TFP  .20394418 06   TF  .17936268 01   PER  .21692795 05
   TA  .17330692 03   MTA  .18000000 03    EA  .10963569 03   MA  .56408823 02  C3J -.20625021 01   TFI  .58444788 02

                                                           ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .33731393 06     Y  .62030703 05     Z -.75559509 04   DX  .83209578 00   DY  .28275367 00    DZ  .66862292-01
  INC  .34000192 02   LAN  .12291775 02   APF  .18443371 03   MX -.13787150 00   MY  .81778769 00    MZ  .55876084 00
   WX  .11904706 00    WY -.54637588 00    WZ  .82903568 00   PX -.96050819 00   PY -.27487319 00    PZ -.43229019-01
   QX  .25149897 00    QY -.79114927 00    QZ -.55752134 00   RX  .41560678-01   RY  .11893616-01    RZ -.99906518 00
   BX -.25149911 00    BY  .79114966 00    BZ  .55752163 00   TX -.27513038 00   TY  .96140692 00    TZ  .00000000 00
  DAP -.24776118 01   RAP  .19596978 03

  BTQ  .35216462 05   BRQ -.23682852 05     B  .42439093 05  THA  .32607941 03    T VECTOR IN  EARTH EQUATOR PLANE
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CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765                                        3

EARTH-MOON                                 CHECK 4

    HELIOCENTRIC                                                                                   EQUATORIAL COORDINATES

  X  .10916161 09     Y -.96866519 08     Z -.42038645 08    DX  .21095260 02    DY  .19782370 02     DZ  .85229133 01
  R  .15187702 09   LAT -.16068951 02   LON  .31841518 03     V  .30149497 02   PTH  .35350583 00     AZ  .72784577 02
 XE  .10882430 09    YE -.96928550 08    ZE -.42031089 08   DXE  .20263164 02   DYE  .19499616 02    DZE  .84560510 01
 XT  .10919230 09    YT -.96889718 08    ZT -.42049624 08   DXT  .20165373 02   DYT  .20478079 02    DZT  .88531429 01
LTE -.16088259 02   LOE  .31830891 03   LTT -.16068927 02   LOT  .31841635 03   RST  .15191690 09    VST  .30072780 02
EPS  .53309240 02   ESP  .10397499 00   SEP  .12658684 03   EPM  .13094632 03   EMP  .44376237 02    MEP  .46774429 01
MPS  .17568139 03   MSP  .27453512-18   SMP  .43174719 01   SEM  .13126360 03   EMS  .48631356 02    ESM  .10514460 00
RPM  .39999998 05   SPN  .52243945 02
GCE  .10410479 03   GCT  .29361948 03   SIP  .17319097 03   CPT  .10027956 03   SIN  .97789149 02
REP  .34305333 06   VEP  .88136461 00   CPE  .93813447 02   CPS  .77962564 02

   SELENOCENTRIC                                                                                   EQUATORIAL COORDINATES

  X -.30680285 05     Y  .23198585 05     Z  .10979326 05    DX  .92988647 00    DY -.69570920 00     DZ -.33022947 00
  R  .39999998 05   DEC  .15931216 02    RA  .14290562 03     V  .12073739 01   PTH -.89713068 02     AZ  .28162652 03
  R  .39999992 05   LAT  .19721915 01   LON  .31342552 03    VP  .12126119 01   PTP -.84664754 02    AZP  .26956365 03
LTS  .68027659 00   LNS  .30930468 03   LTE  .64762768 01   LNE  .35771092 03
ALT  .38261908 05   SHA -.30113121 04   ALP  .16060174 02    DR -.12073587 01    DP  .86493654-05    ASD  .24904141 01
HGE  .30669076 03   SVL  .71320920 00   HNG  .17574058 03   SIA  .12845590 03

                                              SELENOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  23563130750120270314700З J.D.= 2438250.97712412   AUG. 9,1963 11 27 03.525
SMA -.40430650 04   ECC  .10014713 01     B  .21933919 03   SLR  .11905448 02   APO  .00000000 00    RCA  .59483483 01
 VH  .11011903 01    C3  .12126201 01    C1  .24159470 03   TFP -.28526580 05    TF  .66368837 02    LTF  .66367338 02
 TA -.17659408 03   MTA  .17689390 03    EA -.17634126 03    MA -.44517467 03   C3J -.20625021 01    TFI  .58444788 02
ZAE  .13592348 03   ZAP  .17538636 03   ZAC  .10020075 03   DEF  .17378768 03    IR  .41322112 04     GP  .13820333 01

                                                            ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.30660285 05     Y  .23198585 05     Z  .10979326 05    DX  .92988647 00    DY -.69570920 00     DZ -.33022947 00
INC  .16032753 03   LAN  .19605032 03   APF  .23137774 03    MX  .63472325 00    MY  .74773151 00     MZ  .19374390 00
 WX -.92875261-01    WY  .32282394 00    WZ -.94163243 00    PX  .80336104 00    PY -.53451788 00     PZ -.26248813 00
 QX -.58803500 00    QY -.78086592 00    QZ -.20970842 00    RX -.21900350 00    RY  .16377081 00     RZ -.96188179 00
 BX  .63085499 00    BY  .75093887 00    BZ  .19522498 00    TX -.59887180 00    TY -.80084492 00     TZ  .00000000 00
SXI  .77031614 00   SYI -.57604387 00   SZI -.27346556 00   DAI -.15870591 02   RAI  .32321085 03
SXO -.83404353 00   SYO  .49142138 00   SZO  .25073945 00   DAO  .14521272 02   RAO  .14949326 03
ETE  .19264150 03   ETS  .31222767 01   ETC  .29697975 03

BTQ -.21477405 03   BRQ -.44517288 02     B  .21933919 03   THA  .19171016 03    T VECTOR IN  EARTH EQUATOR PLANE

BTO -.21915344 03   BRO  .90285067 01     B  .21933933 03   THA  .17764090 03    T VECTOR IN  ORBIT PLANE OF TARGET

                                                            ALL VECTORS REFERENCED TO TRUE TARGET EQU. PLANE
  X  .34622685 05     Y  .19963999 05     Z  .13765780 04    DX -.10420426 01    DY -.60835829 00     DZ -.42408749-01
INC  .17160407 03   LAN  .19652162 03   APF  .34298295 03    MX  .49907035 00    MY -.85486463 00     MZ -.14212150 00
 WX -.41584238-01    WY  .14019165 00    WZ -.98928273 00    PX -.83440279 00    PY -.54949130 00     PZ -.42794766-01
 QX -.54959927 00    QY  .82368209 00    QZ  .13982661 00    RX  .30357878-01    RY  .17732608-01     RZ -.99938177 00
 BX  .50357635 00    BY -.85221201 00    BZ -.14193504 00    TX -.50437699 00    TY  .86348356 00     TZ  .00000000 00
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CASE  1                                    IBSYS-JPTRAJ-SFPRO 041765

EARTH-MOON                                 CHECK 4

SXI -.86294973 00   SYI -.50406518 00   SZI -.35157448-01   DAI -.20147871 01   RAI  .21029000 03
SXO  .80340555 00   SYO  .59330378 00   SZO  .50306413-01   DAO  .28835607 01   RAO  .36445351 02
ETE  .17276643 03   ETS  .34324716 03   ETC  .27710467 03

BTT -.21711745 03   BRT  .31151411 02     B  .21934083 03   THA  .17183508 03    T VECTOR IN  TRUE TARGET EQU. PLANE

 2 DAYS 18 HRS. 14 MIN. 47.467 SEC.          23563130732320262621731l J.D.= 2438250.97202747   AUG. 9,1963 11 19 43.174

    GEOCENTRIC                                                                                     EQUATORIAL COORDINATES

  X  .36277700 06     Y  .67175656 05     Z -.68605143 04    DX  .18221274 01    DY -.55879889 00     DZ -.31984808 00
  R  .36900784 06   DEC -.10652918 01    RA  .10490673 02     V  .19325390 01   PTH  .61328497 02     AZ  .25187967 03
  R  .36900783 06   LAT -.10652918 01   LON  .24332788 03    VE  .27838229 02   PTE  .34919521 01    AZE  .26940535 03
 XS -.10939180 09    YS  .96379418 08    ZS  .41792963 08   DXS -.20147588 02   DYS -.19603023 02    DZS -.85007954 01
 XM  .36410058 06    YM  .66155687 05    ZM -.73387963 04   DXM -.17937539 00   DYM  .96620799 00    DZM  .39978709 00
 XT  .36410058 06    YT  .66155687 05    ZT -.73387963 04   DXT -.17937539 00   DYT  .96620799 00    DZT  .39978709 00
 RS  .15166480 09    VS  .29367794 02    RM  .37013466 06    VM  .10609256 01    RT  .37013466 06     VT  .10609256 01
GED -.10725498 01   ALT  .36262964 06   LOS  .11455612 02   RAS  .13861840 03   RAM  .10298081 02    LOM  .24313529 03
DUT  .35000000 02    DT  .30000000 02    DR  .16955806 01   SHA  .29561149 06   DES  .15995471 02    DEM -.11360978 01
CCL  .25600418 03   MCL  .11460551 02   TCL  .11460551 02

    HELIOCENTRIC                                                                                   EQUATORIAL COORDINATES

  X  .10975458 09     Y -.96312243 08     Z -.41799823 08    DX  .21969716 02    DY  .19044225 02     DZ  .81809474 01
  R  .15188595 09   LAT -.15974251 02   LON  .31873228 03     V  .30203953 02   PTH  .29378265 01     AZ  .72734647 02
 XE  .10939180 09    YE -.96379418 08    ZE -.41792963 08   DXE  .20147588 02   DYE  .19603023 02    DZE  .85007954 01
 XT  .10975590 09    YT -.96313263 08    ZT -.41800302 08   DXT  .19968213 02   DYT  .20569232 02    DZT  .89005826 01
LTE -.15995471 02   LOE  .31861840 03   LTT -.15974251 02   LOT  .31873232 03   RST  .15188768 09    VST  .30017382 02
EPS  .53123580 02   ESP  .11168705 00   SEP  .12676490 03   EPM  .13031147 03   EMP  .49483367 02    MEP  .20522700 00
MPS  .17649157 03   MSP  .27453512-16   SMP  .35083802 01   SEM  .12697004 03   EMS  .52918404 02    ESM  .11146784 00
RPM  .17380899 04   SPN  .52133219 02
GCE  .10399562 03   GCT  .29545637 03   SIP  .86491569 02   CPT  .10046924 03   SIN  .10469241 02
REP  .36900784 06   VEP  .19325390 01   CPE  .93699617 02   CPS  .78005014 02

   SELENOCENTRIC                                                                                   EQUATORIAL COORDINATES

  X -.13235605 04     Y  .10199694 04     Z  .47628197 03    DX  .20015028 01    DY -.15250069 01     DZ -.71963517 00
  R  .17380899 04   DEC  .15972547 02    RA  .14238165 03     V  .26171614 01   PTH -.89698277 02     AZ  .27232310 03
  R  .17380898 04   LAT  .18427696 01   LON  .30865416 03    VP  .26171886 01   PTP -.89600169 02    AZP  .25699724 03
LTS  .68990118 00   LNS  .30533973 03   LTE  .66009133 01   LNE  .35806582 03
ALT -.45776367-04   SHA -.10636159 03   ALP  .17841798 02    DR -.26171252 01    DP  .45415473-03    ASD  .90000000 02
HGE  .30687642 03   SVL  .69668271 00   HNG  .17656135 03   SIA  .40311468 02

                                              SELENOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  235631307506202557040111 J.D.= 2438250.97734800   AUG. 9,1963 11 27 22.868
SMA -.40580137 04   ECC  .10000144 01     B  .21782637 02   SLR  .11697804 00   APO  .00000000 00    RCA  .58488602-01
 VH  .10991520 01    C3  .12081352 01    C1  .23947860 02   TFP -.45969361 03    TF  .66374210 02    LTF  .66374195 02
 TA -.17926753 03   MTA  .17969241 03    EA -.51297603 02    MA -.71340369 01   C3J -.20830222 01    TFI  .66246518 02
ZAE  .13093467 03   ZAP  .17606694 03   ZAC  .10029423 03   DEF  .17936447 03    IR  .41385194 04     GP  .13916920 01
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CASE  1                          IBSYS-JPTRAJ-SFPRO 041765                                  5

EARTH-MOON                       CHECK 4

                                                          ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
  X -.13235805 04    Y  .10199694 04    Z  .47828197 03   DX  .20015028 01   DY -.15250069 01   DZ -.71963517 00
INC  .16384507 03  LAN  .22399531 03  APF  .26120797 03   MX  .61867379 00   MY  .78456081 00   MZ  .38965625-01
 WX -.19302659 00   WY  .19991755 00   WZ -.96051286 00   PX  .76936109 00   PY -.57675598 00   PZ -.27465616 00
 QX -.60888781 00   QY -.79199797 00   QZ -.42479812-01   RX -.21901752 00   RY  .16610380 00   RZ -.96147844 00
 BX  .61306750 00   BY  .78896549 00   BZ  .41008683-01   TX -.60427698 00   TY -.79677433 00   TZ  .00000000 00
SXI  .76608134 00  SYI -.58099930 00  SZI -.27488024 00  DAI -.15954877 02  RAI  .32282316 03
SXO -.77261865 00  SYO  .57249603 00  SZO  .27442416 00  DAO  .15927699 02  RAO  .14346224 03
ETE  .19274747 03  ETS  .84490378 00  ETC  .29680645 03

BTQ -.21762816 02  BRQ -.92905826 00    B  .21782637 02  THA  .18244448 03    T VECTOR IN  EARTH EQUATOR PLANE

BTO -.21339909 02  BRO  .43456509 01    B  .21777688 02  THA  .16848969 03    T VECTOR IN  ORBIT PLANE OF TARGET

                                                          ALL VECTORS REFERENCED TO TRUE TARGET EQU. PLANE
  X  .15113746 04    Y  .85649227 03    Z  .55891532 02   DX -.22691506 01   DY -.13010370 01   DZ -.88264561-01
INC  .16257850 03  LAN  .20366310 03  APF  .35311024 03   MX  .47900334 00   MY -.82580294 00   MZ -.29807107 00
 WX -.12032760 00   WY  .27459414 00   WZ -.95412808 00   PX -.86336763 00   PY -.50329218 00   PZ -.35963861-01
 QX -.49007664 00   QY  .81943721 00   QZ  .29763575 00   RX  .29776356-01   RY  .17155122-01   RZ -.99940932 00
 BX  .48537910 00   BY -.82202738 00   BZ -.29778877 00   TX -.49916313 00   TY  .86649651 00   TZ  .00000000 00
SXI -.86598469 00  SYI -.49888828 00  SZI -.34366389-01  DAI -.19694364 01  RAI  .20994596 03
SXO  .86072571 00  SYO  .50768159 00  SZO  .37560297-01  DAO  .21525520 01  RAO  .30533364 02
ETE  .17296761 03  ETS  .34106506 03  ETC  .27702658 03

BTT -.20786950 02  BRT  .64885049 01    B  .21776088 02  THA  .16266460 03    T VECTOR IN  TRUE TARGET EQU. PLANE

615576114061   614444767212   612420651171   202703617723   604431537501   603535320551            EARTH
                  630800617                        455707                  000000000000            INITIAL

613511766202   212777744203   211740002016   201776767451   601607727077   600561622465             MOON
                                                            235631307323   202626217311             END


    END TRAJECTCRY (SFPRC)        016562        G
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