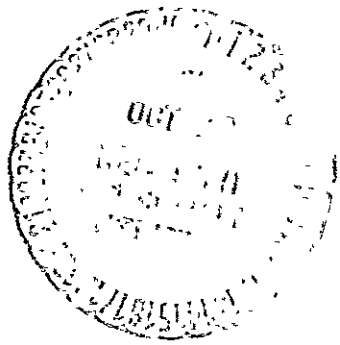
Technical Memorandum No. 33-204

SPODP – Single Precision Orbit Determination Program

Michael R. Warner
Melba W. Nead



JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

February 15, 1965

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February 15, 1965

Prepared Under Contract No. NAS 7-100
National Aeronautics & Space Administration

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ABSTRACT

This Technical Memorandum describes the Single Precision Orbit Determination Program which was developed for operation under the data processing system of the Space Flight Operations Facility. Included are sections containing flow diagrams, load maps, the common storage map, input and output descriptions, subroutine writeups, operating instructions, and check cases. The computational methods employed by the program are described in the subroutine documentation.

I. INTRODUCTION

The Single Precision Orbit Determination Program (SPODP; more commonly expressed as ODP) for the IBM 7094 computer was written to meet the specifications of the Jet Propulsion Laboratory for a reliable and accurate method of tracking and predicting the motion of lunar and interplanetary spacecraft. The uses of the ODP may conveniently be separated into real-time and nonreal-time applications.

Real-time applications:

1. To establish a reliable set of orbital elements for the spacecraft.
2. To provide an acquisition ephemeris for the world-wide network of tracking stations.
3. To assist JPL engineers in evaluating the performance of tracking stations and the quality of tracking data.

Nonreal-time applications:

1. To provide a high-speed computing method necessary for orbit determination and tracking data accuracy studies (premission).
2. To provide a high-speed computing method necessary for a sophisticated orbital analysis based on large numbers of observations (post-mission).

In addition to solving for the six initial conditions of the spacecraft's motion, the ODP has the capability of solving for 14 physical constants and the Earth radius, latitude, and longitude of 15 tracking stations. From this set of 66 parameters, a subset containing from one to twenty is extracted by the user. The ODP obtains solutions for the parameters in this subset.

The ODP, since it must have initial estimates of the parameters, is an orbit improvement program. It differentially connects the estimates by means of an over-determined system of equations, employing a modified least-squares method. This procedure may be briefly outlined as follows:

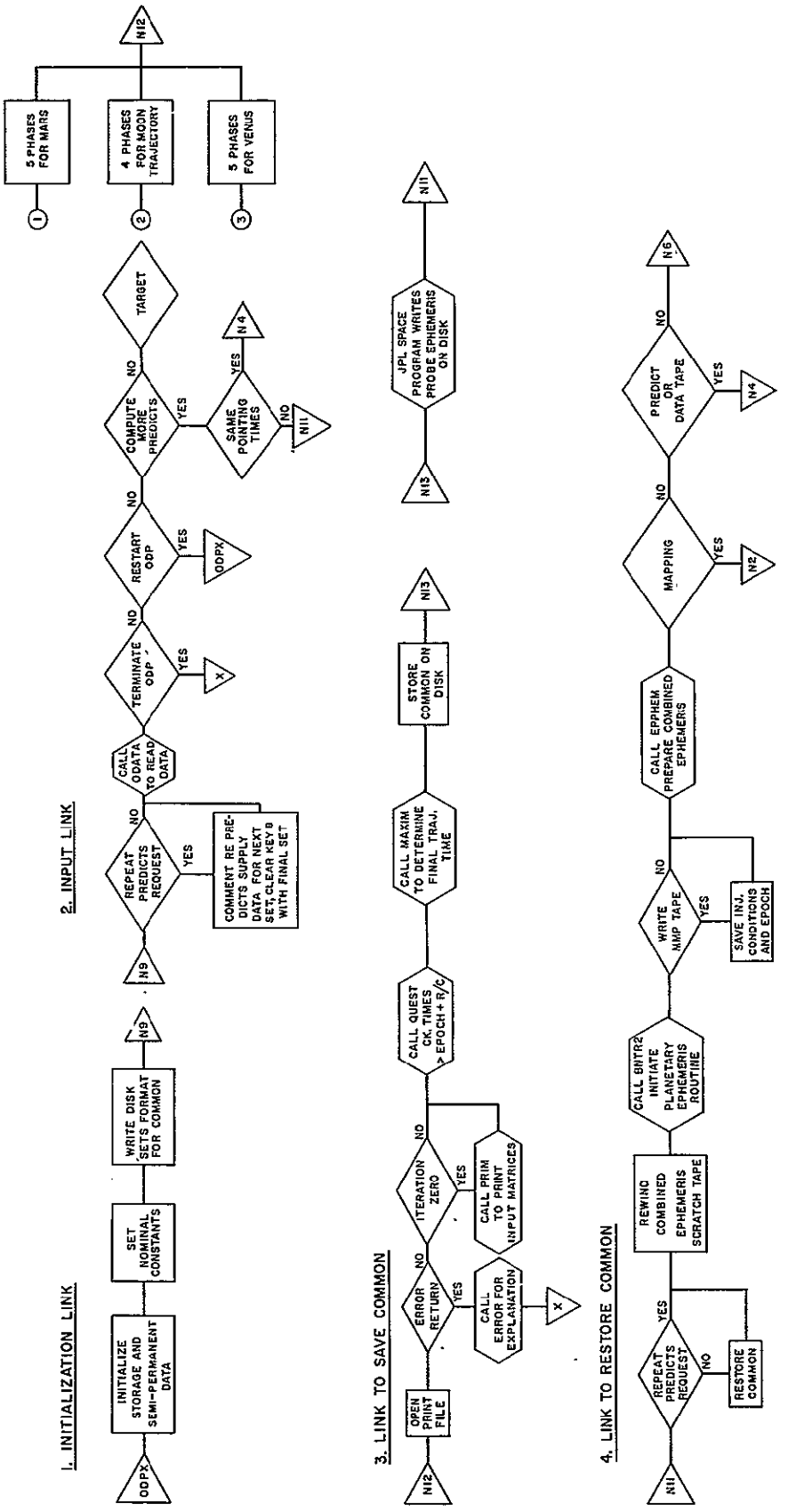
1. Input parameter estimates.
2. Write probe ephemeris file on disk based on orbit estimate.
3. Read i^{th} observation from data file, G_i. This observation may be slant range, range rate, one of four angle types, one of four doppler types, or DSIF ranging.
4. Using probe ephemeris, determine the value of the observation based on orbit estimate, F_i.
5. Obtain the residual $\Delta F_i = G_i - F_i$.
6. Calculate the partials of the observations with respect to the n parameters to be estimated, $\partial F_i/\partial Q_i, \cdots, \partial F_i/\partial Q_n$.
7. Multiply the column matrix of partials by itself to form a matrix J_i^*.
8. Add J_i^* to the accumulated matrix $J^* = J_1^* + J_2^* + \cdots, + J_{i-1}^*$.
9. Multiply the column matrix of partials by the residual to form a column matrix R_i.
10. Add R_i to the accumulated column matrix $R = R_1 + R_2 + \cdots, + R_{i-1}$.
11. Repeat steps 3 through 10 until all observations are processed.
12. Obtain the final J matrix by adding in the <u>a priori</u> uncertainties. $J = J^* + \tilde{\Gamma}^{-1}$.
13. Solve the normal equations $J\Delta Q = R$ for the column matrix of changes to the parameter estimates, ΔQ.
14. Repeat steps 2 through 13 until the procedure converges.

The ODP is written on disk in thirteen links. Each link constitutes a logical section of the overall orbit determination. The linking is accomplished by use of the JPTRAJ source program, which is also used to pass certain information between links.

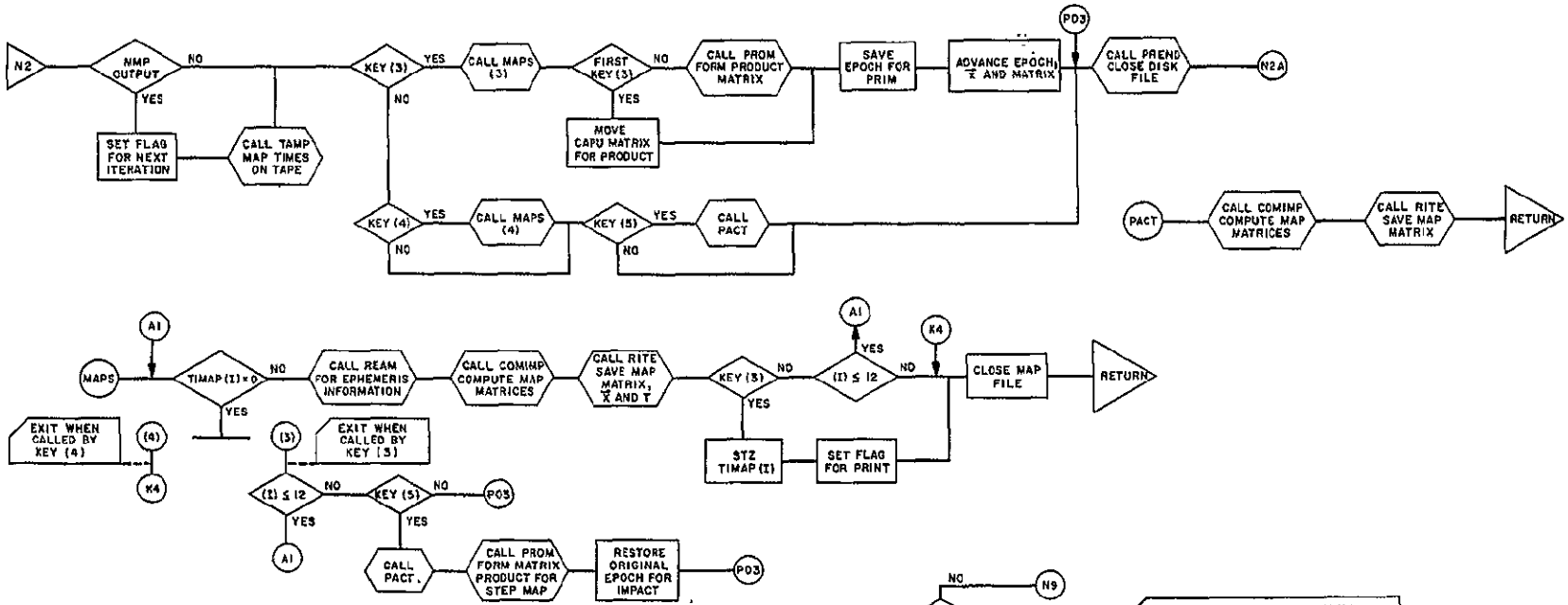
II. FLOW CHARTS

A. LINKS

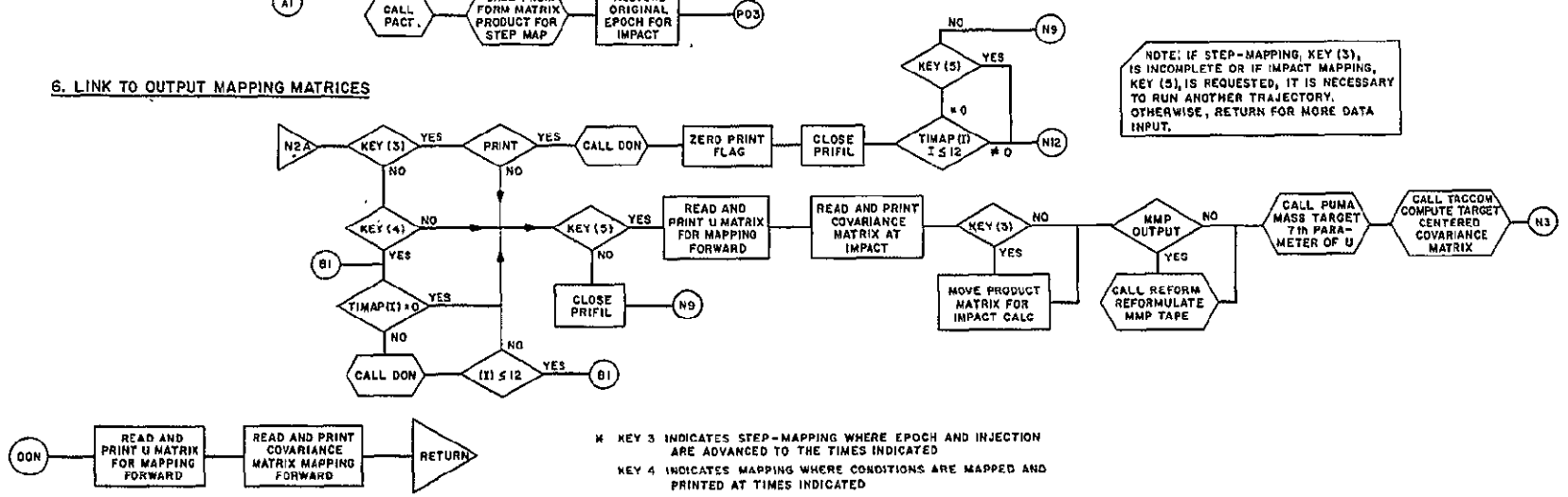
1. Initialization Link
2. Input Link
3. Link to Save COMMON
4. Link to Restore COMMON
5. Link to Compute Mapping Matrices
6. Link to Output Mapping Matrices
7. Link to Compute Closest Approach Parameters
8. Predictions or Data Simulation Link
9. Link to Sort Predictions
10. Data Fitting Link
11. Link to Output Solution
12. Link to Output Residuals and Statistics
13. Link to Output Auxiliary Quantities


1. INITIALIZATION LINK
ODPX
INITIALIZE STORAGE AND SEMI-PERMANENT DATA
SET NOMINAL CONSTANTS
WRITE DISK SETS FORMAT FOR COMMON
N9
2. INPUT LINK
N9
REPEAT PREDICTS REQUEST
YES
COMMENT RE PREDICTS SUPPLY DATA FOR NEXT SET, CLEAR KEY 8 WITH FINAL SET
NO
CALL ODATA TO READ DATA
TERMINATE ODP
YES
X
NO
RESTART ODP
YES
ODPX
NO
COMPUTE MORE PREDICTS
YES
SAME POINTING TIMES
YES
N4
NO
N11
NO
TARGET
5 PHASES FOR MARS
4 PHASES FOR MOON TRAJECTORY
5 PHASES FOR VENUS
N12
1
2
3
3. LINK TO SAVE COMMON
N12
OPEN PRINT FILE
ERROR RETURN
YES
CALL ERROR FOR EXPLANATION
X
NO
ITERATION ZERO
YES
CALL PRIM TO PRINT INPUT MATRICES
NO
CALL QUEST CK. TIMES > EPOCH + R/C
CALL MAXIM TO DETERMINE FINAL TRAJ. TIME
STORE COMMON ON DISK
N13
JPL SPACE PROGRAM WRITES PROBE EPHEMERIS ON DISK
N13
N11
4. LINK TO RESTORE COMMON
N11
REPEAT PREDICTS REQUEST
YES
RESTORE COMMON
NO
REWIND COMBINED EPHEMERIS SCRATCH TAPE
CALL BNTR2 INITIATE PLANETARY EPHEMERIS ROUTINE
WRITE NMP TAPE
YES
SAVE INJ. CONDITIONS AND EPOCH
NO
CALL EPHEM PREPARE COMBINED EPHEMERIS
MAPPING
YES
N2
NO
PREDICT OR DATA TAPE
YES
N4
NO
N6

5. LINK TO COMPUTE MAPPING MATRICES



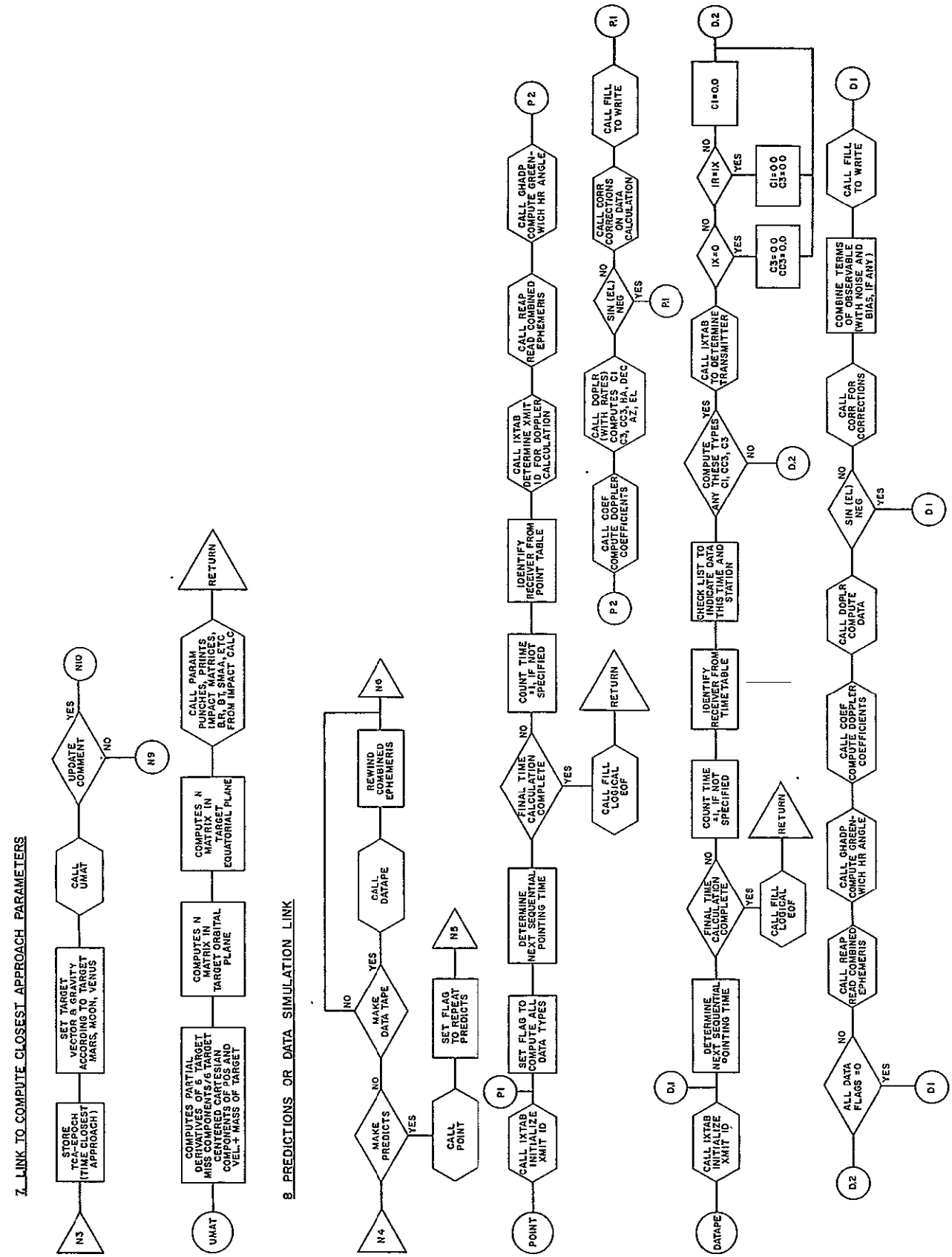
6. LINK TO OUTPUT MAPPING MATRICES



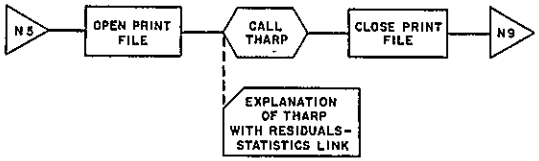
M KEY 3 INDICATES STEP-MAPPING WHERE EPOCH AND INJECTION ARE ADVANCED TO THE TIMES INDICATED

KEY 4 INDICATES MAPPING WHERE CONDITIONS ARE MAPPED AND PRINTED AT TIMES INDICATED

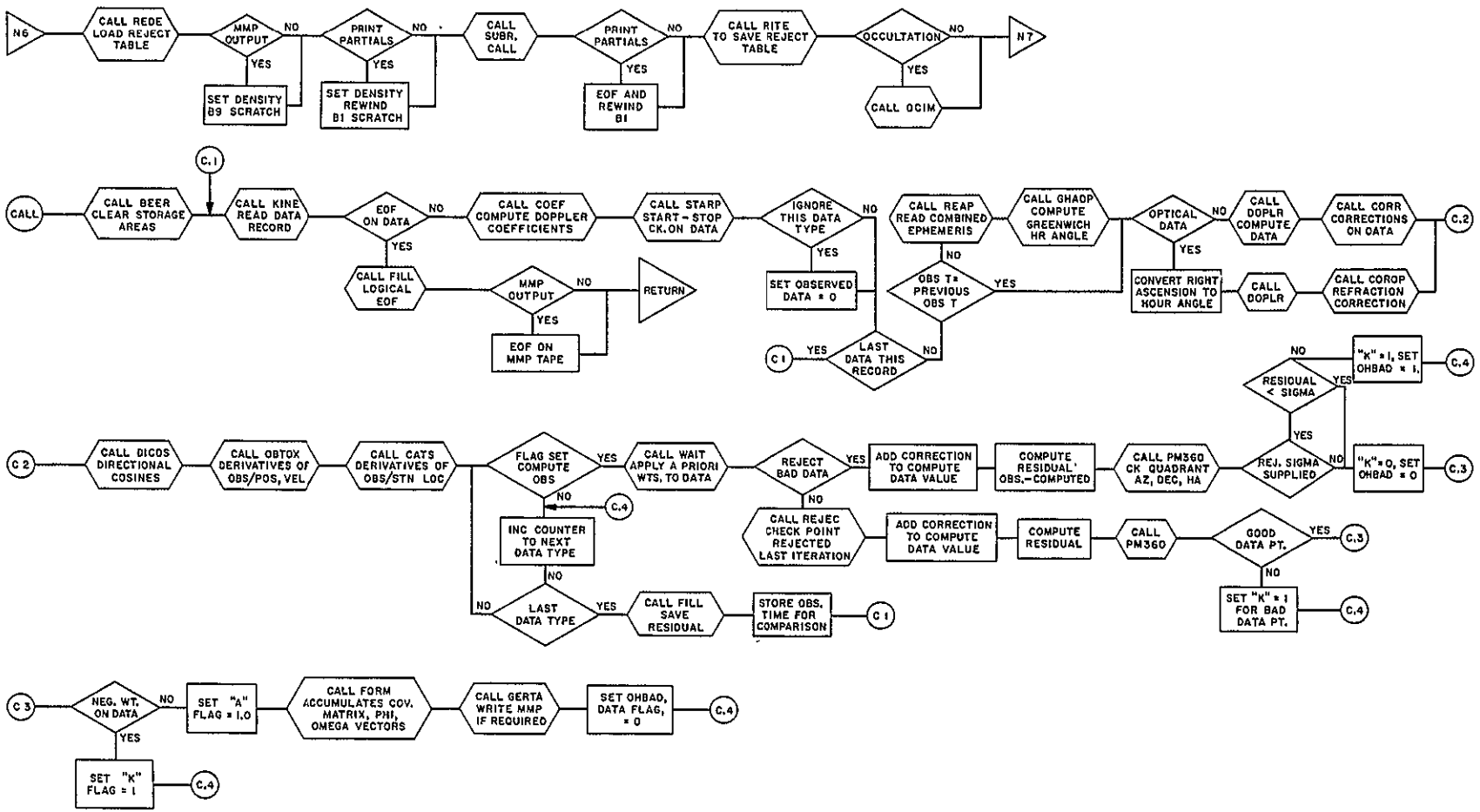
KEY 5 INDICATES IMPACT MAPPING, CLOSEST APPROACH PARAMETERS ARE COMPUTED.

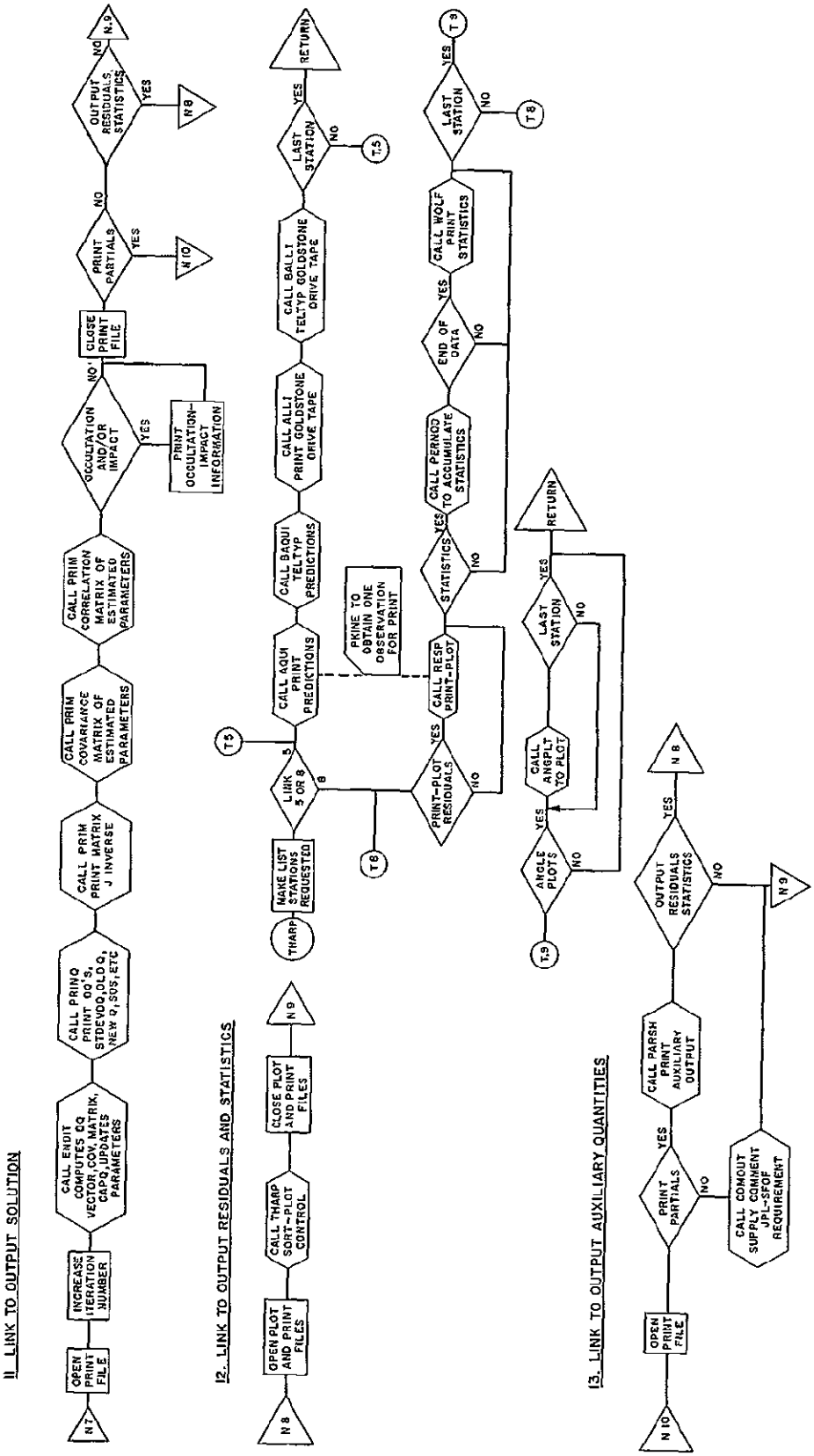

7. LINK TO COMPUTE CLOSEST APPROACH PARAMETERS
N3
STORE TCA-EPOCH (TIME CLOSEST APPROACH)
SET TARGET VECTOR & GRAVITY ACCORDING TO TARGET MARS, MOON, VENUS
CALL UMAT
UPDATE COMMENT
YES
NO
N10
N9
UMAT
COMPUTES PARTIAL DERIVATIVES OF 6 TARGET MISS COMPONENTS/6 TARGET CONTROLLED OPTICS AND VEL.+ MASS OF TARGET
COMPUTES N MATRIX IN TARGET ORBITAL PLANE
COMPUTES N MATRIX IN TARGET EQUATORIAL PLANE
CALL PARAM PUNCHES, PRINTS IMPACT MATRICES, BR, BT, SMAA, ETC FROM IMPACT CALC
RETURN
8. PREDICTIONS OR DATA SIMULATION LINK
N4
MAKE PREDICTS
NO
YES
MAKE DATA TAPE
NO
YES
CALL DATAPE
REWIND COMBINED EPHEMERIS
N6
CALL POINT
SET FLAG TO REPEAT PREDICTS
N5
POINT
CALL IXTAB INITIALIZE XMIT ID
P1
SET FLAG TO COMPUTE ALL DATA TYPES
DETERMINE NEXT SEQUENTIAL POINTING TIME
FINAL TIME CALCULATION COMPLETE
NO
YES
COUNT TIME IF NOT SPECIFIED
IDENTIFY RECEIVER FROM POINT TABLE
CALL IXTAB DETERMINE XMIT ID FOR DOPPLER CALCULATION
CALL REAP READ COMBINED EPHEMERIS
CALL GHADP COMPUTE GREENWICH HR ANGLE
P2
CALL FILL LOGICAL EOF
RETURN
P2
CALL COEF. COMPUTE DOPPLER COEFFICIENTS
CALL DOPLER (WITH RATES) COMPUTES C1 C3, CC3, HA, DEC AZ, EL
SIN (EL) NEG
NO
YES
P1
CALL CORR CORRECTIONS ON DATA CALCULATION
CALL FILL TO WRITE
P1
DATAPE
CALL IXTAB INITIALIZE XMIT ID
D1
DETERMINE NEXT SEQUENTIAL POINTING TIME
FINAL TIME CALCULATION COMPLETE
NO
YES
CALL FILL LOGICAL EOF
RETURN
COUNT TIME IF NOT SPECIFIED
IDENTIFY RECEIVER FROM TIME TABLE
CHECK LIST TO INDICATE DATA THIS TIME AND STATION
COMPUTE ANY TYPE TYPES C1, CC3, C3
YES
NO
D2
CALL IXTAB TO DETERMINE TRANSMITTER
IX=0
YES
NO
C3=0.0 CC3=0.0
IR=IX
YES
NO
C1=0.0 C3=0.0
C1=0.0
D2
ALL DATA FLAGS =0
NO
YES
D2
D1
CALL REAP READ COMBINED EPHEMERIS
CALL GHADP COMPUTE GREENWICH HR ANGLE
CALL COEF. COMPUTE DOPPLER COEFFICIENTS
CALL DOPLR COMPUTE DATA
SIN (EL) NEG
NO
YES
D1
CALL CORR FOR CORRECTIONS
COMBINE TERMS OF OBSERVABLE (WITH NOISE AND BIAS, IF ANY)
CALL FILL TO WRITE
D1

9. LINK TO SORT PREDICTIONS



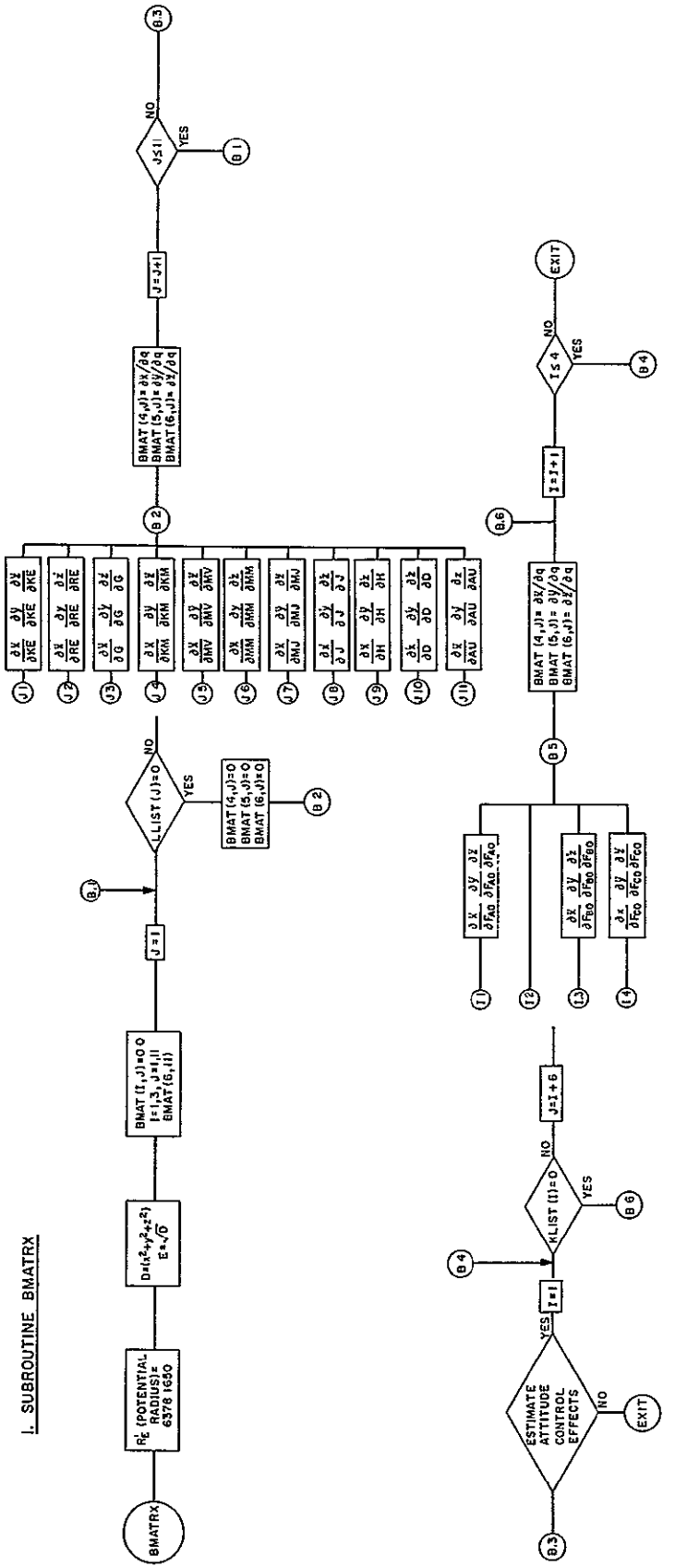
10. DATA FITTING LINK

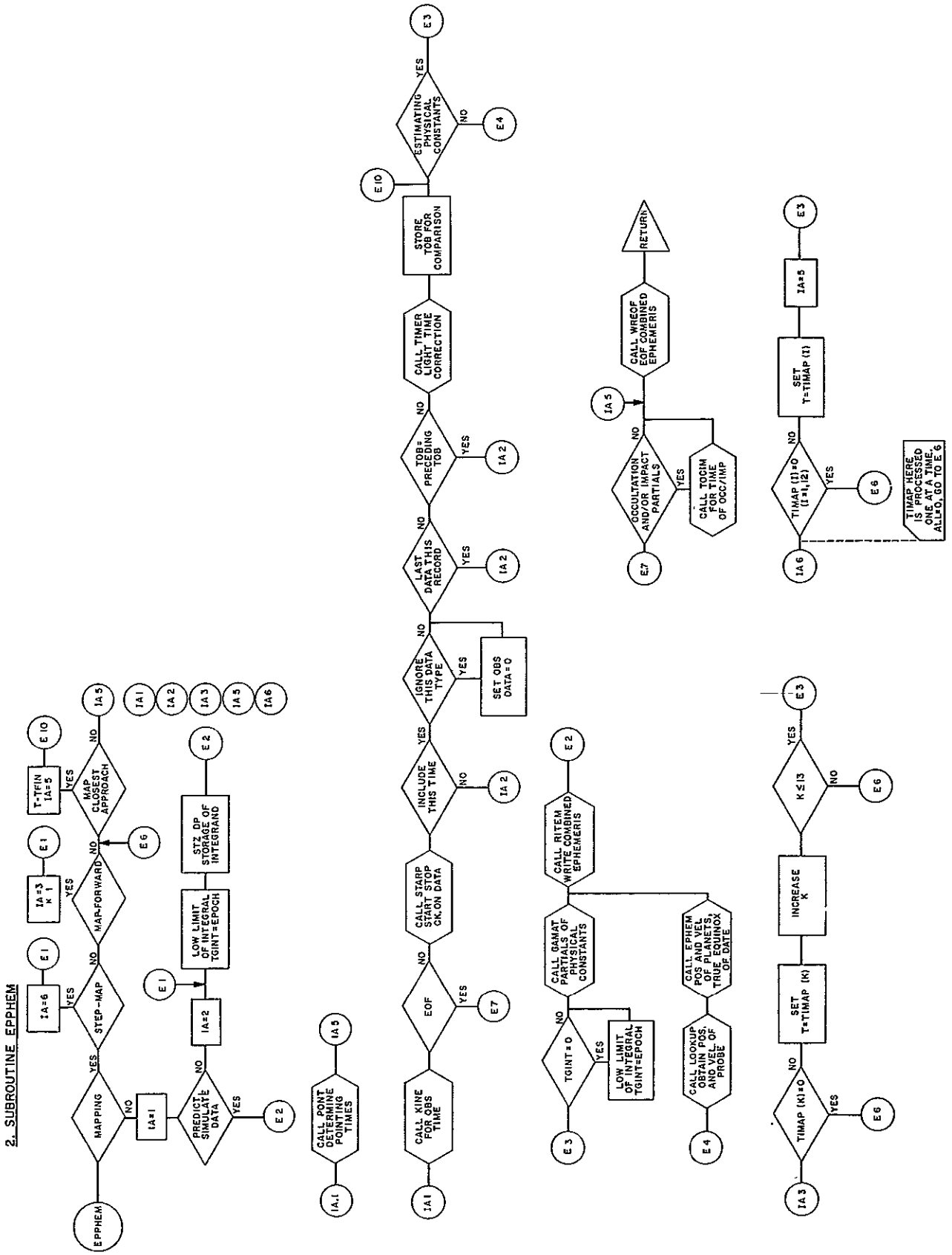



11. LINK TO OUTPUT SOLUTION
N7
OPEN PRINT FILE
INCREASE ITERATION NUMBER
CALL ENDIT COMPUTES GQ VECTOR, COV. MATRIX, CAPQ, UPDATES PARAMETERS
CALL PRINQ PRINT QQ'S, STDEVQQ, OLDQ Q, NEW Q, SOS, ETC
CALL PRIM PRINT MATRIX J INVERSE
CALL PRIM COVARIANCE MATRIX OF ESTIMATED PARAMETERS
CALL PRIM CORRELATION MATRIX OF ESTIMATED PARAMETERS
OCCULTATION AND/OR IMPACT
NO
YES
PRINT OCCULTATION-IMPACT INFORMATION
CLOSE PRINT FILE
PRINT PARTIALS
NO
YES
N 10
OUTPUT RESIDUALS, STATISTICS
NO
YES
N 8
N 9
12. LINK TO OUTPUT RESIDUALS AND STATISTICS
N 8
OPEN PLOT AND PRINT FILES
CALL THARP SORT-PLOT CONTROL
CLOSE PLOT AND PRINT FILES
N 9
THARP
MAKE LIST STATIONS REQUESTED
LINK 5 OR 8
5
8
T5
T8
CALL AQUI PRINT PREDICTIONS
CALL BAQUI TELTYP PREDICTIONS
CALL ALLI PRINT GOLDSTONE DRIVE TAPE
CALL BALLI TELTYP GOLDSTONE DRIVE TAPE
LAST STATION
YES
NO
T5
RETURN
PRINT-PLOT RESIDUALS
YES
NO
CALL RESP PRINT-PLOT
PKINE TO OBTAIN ONE OBSERVATION FOR PRINT
STATISTICS
YES
NO
CALL PERNOD TO ACCUMULATE STATISTICS
END OF DATA
YES
NO
CALL WOLF PRINT STATISTICS
LAST STATION
YES
NO
T8
T9
13. LINK TO OUTPUT AUXILIARY QUANTITIES
T9
ANGLE PLOTS
YES
NO
CALL ANGPLT TO PLOT
LAST STATION
YES
NO
RETURN
N 10
OPEN PRINT FILE
PRINT PARTIALS
YES
NO
CALL PARSH PRINT AUXILIARY OUTPUT
CALL COMOUT SUPPLY COMMENT JPL-SFOF REQUIREMENT
OUTPUT RESIDUALS STATISTICS
YES
NO
N 8
N 9

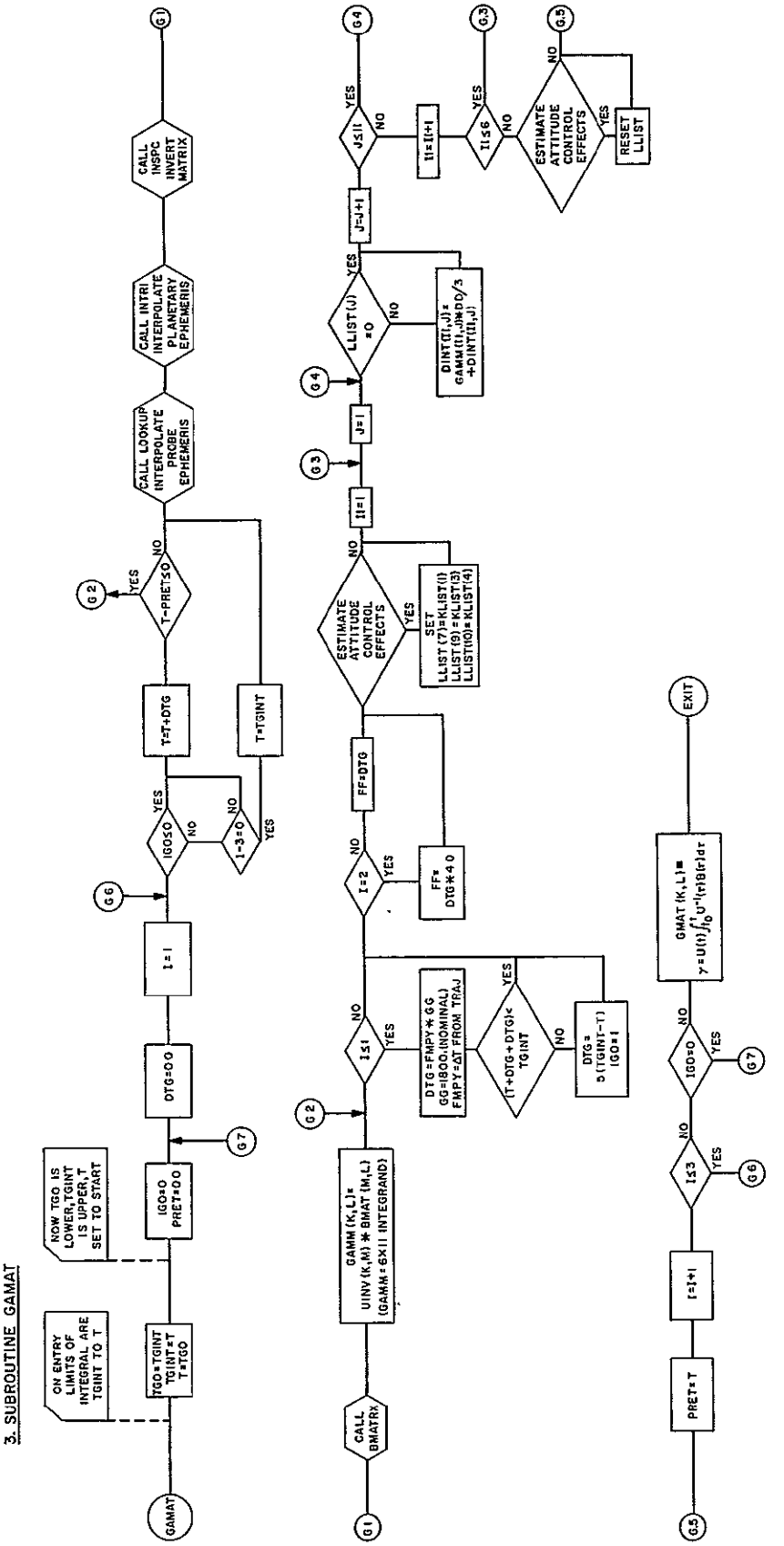
B. SUBROUTINES

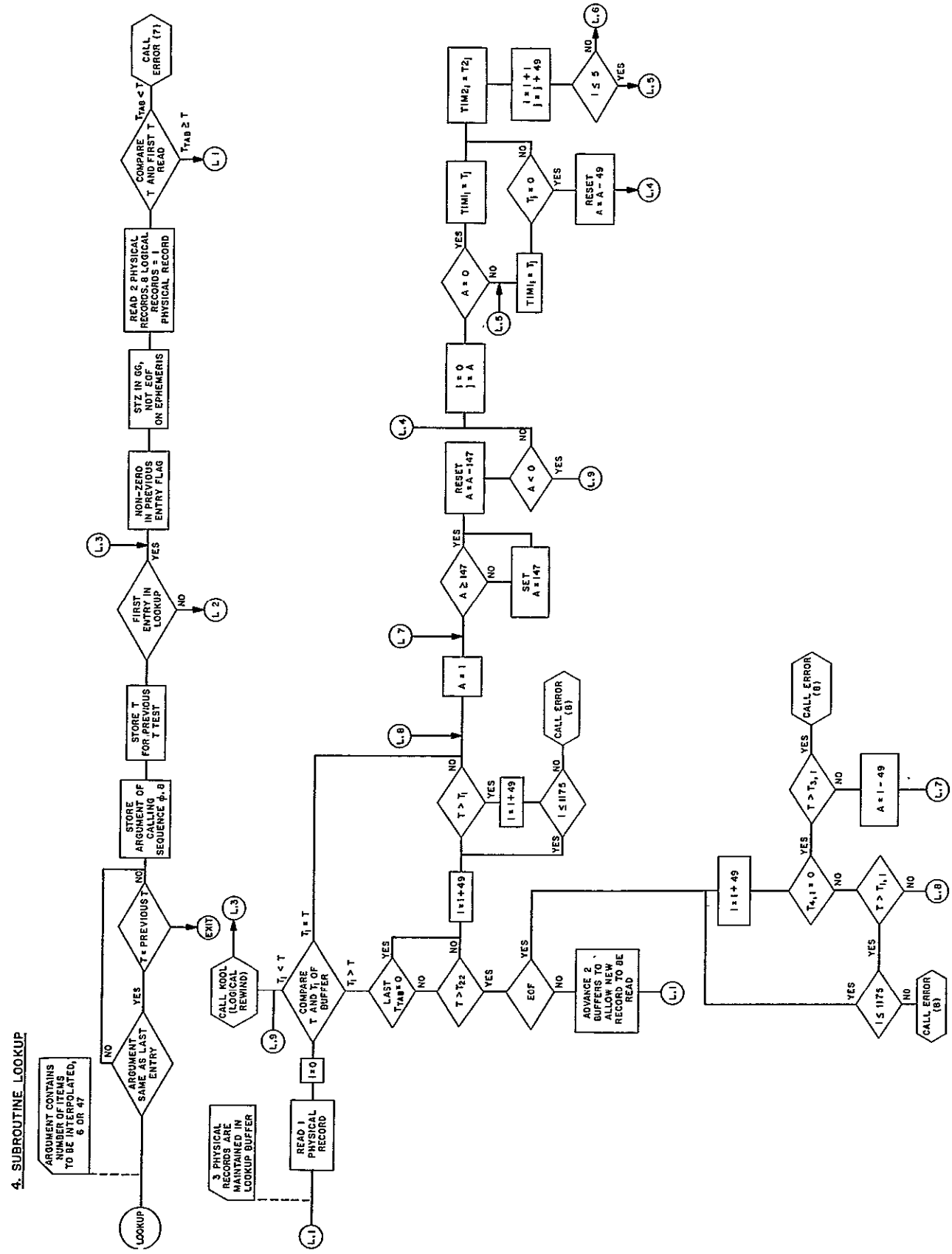
1. BMATRX
2. EPPHEM
3. GAMAT
4. LOOKUP
5. MAXIM


I. SUBROUTINE BMATRX
BMATRX
R_E^1 (POTENTIAL RADIUS) = 6378.1660
D=(x²+y²+z²)
E=√D
BMAT (I, J)=0.0 I=1,3, J=1,11 BMAT(6,11)
I=1
L LIST (J)=0
NO
YES
BMAT (4,J)=0 BMAT (5,J)=0 BMAT (6,J)=0
B2
B3
J=J+1
J≤11
B1
BMAT (4,J)= ∂X/∂q BMAT (5,J)= ∂Y/∂q BMAT (6,J)= ∂Z/∂q
B2
J1 J2 J3 J4 J5 J6 J7 J8 J9 J10 J11
B5
I=I+1
I≤4
EXIT
B4
B6
BMAT (4,J)= ∂X/∂q BMAT (5,J)= ∂Y/∂q BMAT (6,J)= ∂Z/∂q
I1 I2 I3 I4
J=I+6
K LIST (I)=0
B4
B6
I=1
ESTIMATE ATTITUDE CONTROL EFFECTS
YES
NO
EXIT
B3

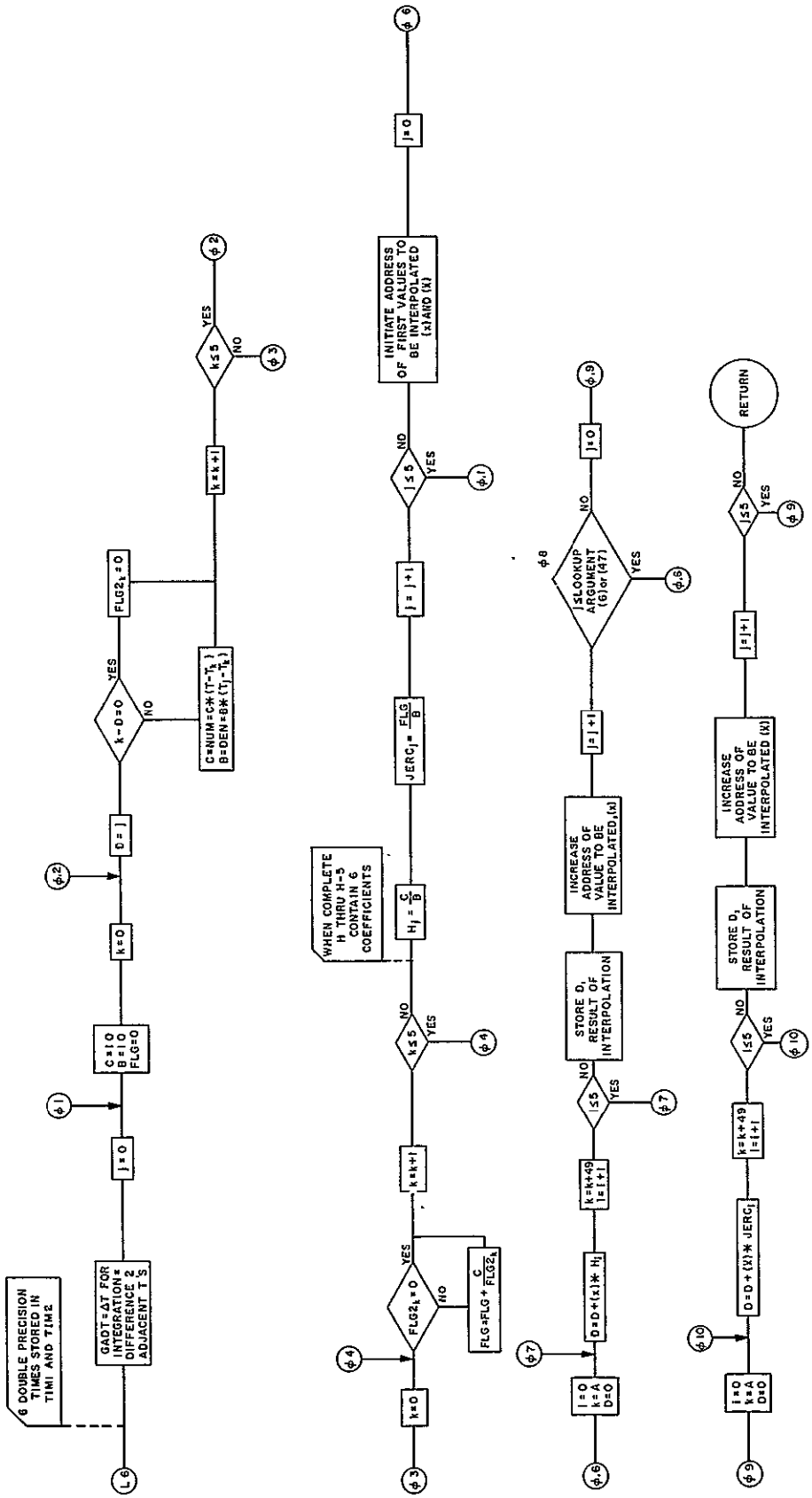

2. SUBROUTINE EPPHEM
EPPHEM
MAPPING
IA=1
PREDICT SIMULATE DATA
YES
NO
E2
IA=2
LOW LIMIT OF INTEGRAL TGINT=EPOCH
E1
STZ DP STORAGE OF INTEGRAND
E2
STEP-MAP
YES
NO
E1
IA=6
MAP-FORWARD
YES
NO
E1
IA=3 K=1
MAP CLOSEST APPROACH
YES
NO
IA5
E6
T-TFIN IA=5
YES
E10
IA1
IA2
IA3
IA5
IA6
CALL POINT DETERMINE POINTING TIMES
IA1
CALL KINE FOR OBS TIME
IA1
EOF
YES
NO
E7
CALL STARP START STOP CK,ON DATA
INCLUDE THIS TIME
YES
NO
IA2
IGNORE THIS DATA TYPE
YES
SET OBS DATA=0
LAST DATA THIS RECORD
YES
NO
IA2
TOB= PRECEDING TOB
YES
NO
IA2
CALL TIMER LIGHT TIME CORRECTION
STORE TOB FOR COMPARISON
ESTIMATING PHYSICAL CONSTANTS
YES
NO
E4
E10
E3
CALL RITEM WRITE COMBINED EPHEMERIS
E2
CALL GAMAT PARTIALS OF PHYSICAL CONSTANTS
TGINT=0
YES
NO
LOW LIMIT OF INTEGRAL TGINT=EPOCH
E3
CALL EPHEM POS AND VEL OF PLANETS, TRUE EQUINOX OF DATE
CALL LOOKUP OBTAIN POS, AND VEL, OF PROBE
E4
CALL WREOF EOF COMBINED EPHEMERIS
RETURN
IA5
OCCULTATION AND/OR IMPACT PARTIALS
YES
NO
CALL TOCIM FOR TIME OF OCC/IMP
E7
SET T=TIMAP (I)
IA=5
E3
TIMAP (I)=0 (I=1,12)
YES
NO
E6
IA6
TIMAP HERE, IS PROCESSED ONE AT A TIME, ALL=0, GO TO E6
K≤13
YES
NO
E6
E3
INCREASE K
SET T=TIMAP (K)
TIMAP (K)=0
NO
YES
E6
IA3

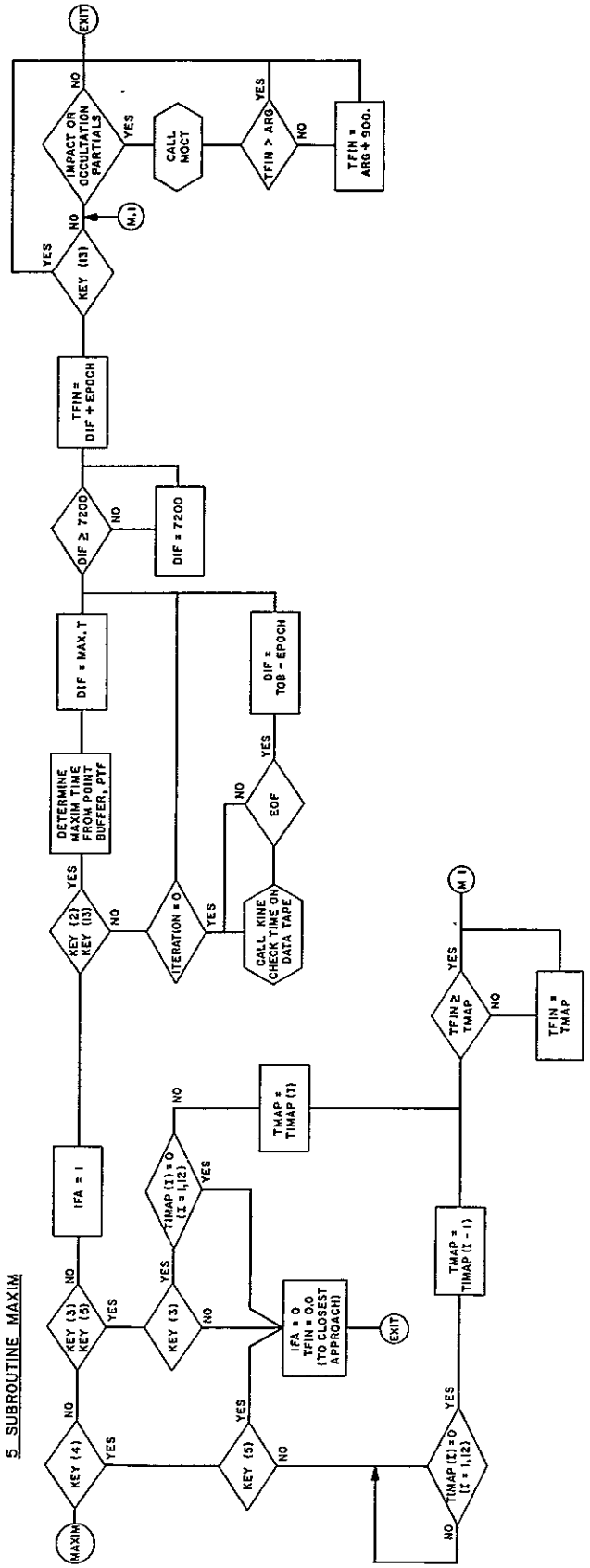
3. SUBROUTINE GAMAT




4. SUBROUTINE LOOKUP
LOOKUP
ARGUMENT CONTAINS NUMBER OF ITEMS TO BE INTERPOLATED, 6 OR 47
3 PHYSICAL RECORDS ARE MAINTAINED IN LOOKUP BUFFER
STORE ARGUMENT OF CALLING SEQUENCE ϕ.8
STORE T FOR PREVIOUS T TEST
FIRST ENTRY IN LOOKUP
NON-ZERO IN PREVIOUS ENTRY FLAG
STZ IN GG, NOT EOF ON EPHEMERIS
READ 2 PHYSICAL RECORDS, 8 LOGICAL RECORDS = 1 PHYSICAL RECORD
COMPARE T AND FIRST T READ
CALL ERROR (7)
T = PREVIOUS T
ARGUMENT SAME AS LAST ENTRY
CALL KOOL (LOGICAL REWIND)
READ 1 PHYSICAL RECORD
COMPARE T AND Ti OF BUFFER
LAST
EOF
ADVANCE 2 BUFFERS TO ALLOW NEW RECORD TO BE READ
RESET A = A - 147
SET A = 147
RESET A = A - 49
CALL ERROR (8)
EXIT
L.1
L.2
L.3
L.4
L.5
L.6
L.7
L.8
L.9

4. SUBROUTINE LOOKUP p 2




5 SUBROUTINE MAXIM
EXIT
IMPACT OR OCCULTATION PARTIALS
NO
YES
CALL MOCT
TFIN > ARG
YES
NO
TFIN = ARG + 900.
(M.)
KEY (13)
YES
NO
TFIN = DIF + EPOCH
DIF ≥ 7200
NO
DIF = 7200
DIF = MAX. T
DIF = TOB - EPOCH
DETERMINE MAXIM TIME FROM POINT BUFFER, PTF
EOF
YES
NO
KEY (2) KEY (13)
YES
NO
ITERATION = 0
YES
CALL KINE CHECK TIME ON DATA TAPE
(M 1)
TFIN ≥ TMAP
YES
NO
TFIN = TMAP
IFA = 1
TMAP = TIMAP (I)
NO
TIMAP (I) = 0 (I = 1,12)
YES
TMAP = TIMAP (I - 1)
KEY (3) KEY (5)
NO
YES
KEY (5)
YES
NO
IFA = 0 TFIN = 0.0 (TO CLOSEST APPROACH)
EXIT
KEY (4)
NO
YES
KEY (5)
YES
NO
TIMAP (I) = 0 (I = 1,12)
YES
NO
MAXIM

III. PHYSICAL LIMITATIONS

A. DISK AND TAPE USAGE UNDER SFOF

The ODP uses tape unit B6 for the planetary ephemeris (EPHEM) tape and tape unit A4 for the combined ephemeris scratch tape. Disk allocation is restricted to the 2800 record block named JPLODP.

B. DEBUGGING FACILITIES

Snaps may be inserted in links ODPX, LA2A, LA3, LA5, LA7, LA8, LA10, and LA12, as these links contain subroutine PROUT.

Octal correctors may be inserted in any link through the JPTRAJ source deck.

IV. INPUT AND STORAGE ALLOCATION

Primary input to the ODP is a deck of control and data cards, which are described in detail in Section IV. A. These cards contain the parameter estimates, the desired options, and all variables which are not a function of each observation. Subroutine CARDS is used for card input.

Also input to the ODP is a file on disk containing the tracking data, and a planetary ephemeris tape. The data file is written on disk by the Orbit Data Generator Program, ODG, while the ephemeris tape is the standard JPL EPHEM system tape. The system routine DCP is used for disk reading and subroutine TAPIO is used for reading the planetary ephemeris tape.

A. CARD INPUT

```
      EPOCH                                                          E01

*           EPOCH ASSOCIATED WITH THE TRAJECTORY, WHERE
M           YY=  LAST TWO DIGITS OF THE YEAR
*           MM=  MONTH OF THE YEAR
*            0=  ZERO
*           DD=  DAYS
*           HH=  HOURS
*           NN=  MINUTES
*           SS=  SECONDS
*           FFF= MILLISECONDS

YYMM0DDHH,MMSSFFF


      GEOCENTRIC POSITION AND VELOCITY AT EPOCH                      E02

*     SYMBOLS ALLOWED
X,Y,Z,DX,DY,DZ


      INPUT OTHER OPTIONS AND CONSTANTS                              E03

* SYMBOL ALLOWED          EXPLANATION AND/OR NOMINAL

XE                        K(EARTH) (398603.2KM3/SEC2)
RE                        EARTH RADIUS (6378.3149KM)
XM                        K(MOON)
MV                        MASS RATIO VENUS (2.4471118E-6)
MM                        MASS RATIO MARS (3.2383420E-7)
MJ                        MASS RATIO JUPITER (9.5475420E-4)
J                         COEF. SECOND HARMONIC (1.62345E-3)
H                         COEF. THIRD HARMONIC (-.575E-5)
O                         COEF. FOURTH HARMONIC (.7875E-5)
AU                        ASTRONOMICAL UNIT (1.49599E8KM)
C                         VELOCITY OF LIGHT (299792.5KM/SEC)
RI(I)                     STATION RANGE
LA(I)                     STATION LATITUDE (GEOCENTRIC)
LO(I)                     STATION LONGITUDE
*           RI(1)=6372.2599   LA(1)=-35.066620   LO(1)=243.20507
*           RI(2)=6372.0341   LA(2)=35.20807     LO(2)=243.15082
*           RI(3)=6371.6686   LA(3)=-35.219630   LO(3)=148.98028
*           RI(4)=6372.6040   LA(4)=-31.211875   LO(4)=136.88727
*           RI(5)=6375.4980   LA(5)=-25.739277   LO(5)=27.685181
*           RI(6)=6376.3091   LA(6)=17.0355      LO(6)=298.2072
*           RI(7)=6377.8013   LA(7)=-7.8991      LO(7)=345.5876
*           RI(8)=6376.1150   LA(8)=18.064939    LO(8)=292.91122
*           RI(9)=6375.6810   LA(9)=-25.7904     LO(9)=28.3580
*           RI(10)=6374.05    LA(10)=-24.75336   LO(10)=113.71605
*           RI(11)=6372.05    LA(11)=32.1709     LO(11)=295.3465
*           RI(12)=6371.6686  LA(12)=-35.21963   LO(12)=148.98028
*           RI(13)=6370.0868  LA(13)=40.23800    LO(13)=355.7505
*           RI(14)=6375.9450  LA(14)=18.823066   LO(14)=204.31472
*           RI(15)=6180.1990  LA(15)=10.668      LO(15)=0.0



NSDISP(I)                 NORTH-SOUTH DISPLACEMENT, DEG
EWDISP(I)                 EAST-WEST DISPLACEMENT, DEG
INDEX(I)                  INDEX OF REFRACTION (340.0)
DRIFT                     TRANSPONDER DRIFT, CPS/SEC
STEP                      INITIAL TRAJECTORY STEP SIZE, SEC
ENERGY                    POWERED FLIGHT ENERGY
DTBURN                    POWERED FLIGHT DURATION
MJTOR                     MJTOR COUNT
JETON                     JETON FOR A.C.
JETOFF                    JETOFF FOR A.C.
PREDID                    IDENTIFICATION FOR PREDICTS
READ ORBIT FROM DISK      ORBIT STORED ON DISK IN LINK 6
READ MATRIX FROM DISK     MATRIX STORED ON DISK IN LINK 6
SOLAR PRESSURE OFF
LIGHT TIME OFF
REFRACTION AND VERTICAL OFF
MAP OUTPUT
PHI VECTOR OUTPUT
UPDATE CONENT             TO WRITE DISK FOR M/C AND SPACE
DJT                       E.T.-U.T., SEC (35.)
FJELWT                    WEIGHT OF FUEL, LB.
RTFUEL                    FLOW RATE, LB/SEC
THRUST                    THRUST, LB
BRNMU                     BIAS ANGLE, DEG
RSTOP                     TARGET RADIUS, KM (MARS,3400.0)
*                                           (MOON,1738.09)
*                                           (VENUS,6200.0)
RAND                      INPUT FOR RANDOM NUMBER, OCTAL (1)
RMAX                      MAXIMUM SLANT RANGE FOR DATA, DEG
ELMIN                     MINIMUM ELEVATION ANGLE FOR DATA, DEG
DATA SIGMA OUTPUT         RESIDUAL PRINT WITH PLACED BY
*                         STANDARD DEVIATIONS
REM CONSTRAINT            RE IS DETERMINED BY THE RELATION
*                         RSM= CUBE ROOT (86.315745(KE*KM))
*                         KE AND KM PARTIALS ARE CONSISTENT
*                         WITH THE CONSTRAINT
RADOPT                    RADIATION PRESSURE OPTION  (1.031E8)

FLRES                     NON-ZERO, RESIDUALS IN FLOATING PT.

PUNMAT                    PUNCH MATRIX, N
                     1 INPUT J MATRIX OF ESTIMATED PARAMETERS
                     2 INPUT COVARIANCE MATRIX OF CONSIDERED PARAMETERS
                     3 J INVERSE
                     4 COVARIANCE MATRIX OF ESTIMATED PARAMETERS
                     5 CORRELATION MATRIX OF ESTIMATED PARAMETERS
                     6 COVARIANCE MATRIX AT IMPACT
                     7 (ALREADY PUNCHED)
                     8 J MATRIX
                     9 INPUT COVARIANCE MATRIX OF ESTIMATED PARAMETERS
                    10 CORRELATIONS BASED ON J MATRIX
                    11 U PRODUCT MATRIX

*           TO CHANGE AREA, MASS, GAMMA B OF SPACECRAFT
ARMARS                    (11.12)
MSMARS                    (259.00)
GBMARS                    (.096)
ARMOON                    (2.789)
MSMOON                    (340.20)
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G8KOON                  (3.0)
ARVEN                   (3.83)
HSVEN                   (198.22)
G8VEN                   (.383)

*           THE FOLLOWING ARE DOPPLER COEFFICIENTS AND
*           FREQUENCIES WHICH ARE A FUNCTION OF THE
*           BAND. NOMINALLY, STATIONS 1,2, AND 3 ARE
*           S BAND, 4 AND 5 ARE L-S BAND.

*                           L-BAND        L-S BAND      S BAND

TFREQ  TRANSPONDER FREQ     960.0E6       20.00E6       20.00E6
XFREQ  TRANSMITTER FREQ     29.66E6       2290.0E6      2290.0E6

D3P1(1)         (C1)        930.15E6      9.375E6       1.0E6
D3P1(2)         (C1)        .96875        .3125         1.0
D3P1(3)         (CC3)       .1E6          9.375E6       1.0E6
D3P1(4)         (CC3)       32.359559561  32.57918552   104.25339367
D3P1(5)         (C3)        930.15        9.375E6       1.0E6
D3P1(6)         (C3)        31.348314605  32.57918552   104.25339367

D3P2(I)         SAME AS ABOVE FOR STATION 2
D3P3(I)         SAME AS ABOVE FOR STATION 3
D3P4(I)         SAME AS ABOVE FOR STATION 4
D3P5(I)         SAME AS ABOVE FOR STATION 5

INFRQ  GROUND STATION INJECTION FREQUENCY, CPS (23.6279142E6)
SYNFRQ GROUND STATION SYNTHESIZER FREQUENCY, CPS (22.04209265E6)

L       FOLLOWED BY STATION ID TO ALTER STATION BAND
S       FOLLOWED BY STATION ID TO ALTER STATION BAND
LS      FOLLOWED BY STATION ID TO ALTER STATION BAND

        ESTIMATE THESE PARAMETERS                                   (04

        CONSIDER THESE PARAMETERS                                   (05

*           THESE CARDS ARE FOLLOWED BY LISTS OF PARAMETER NAMES
            WHICH TELL THE DDP TO ESTIMATE (CONSIDER) THE
*           CORRESPONDING PARAMETER.  NO NUMERIC DATA REQUIRED.
*           LIST OF PARAMETER NAMES WHICH CAN BE ESTIMATED
*           (CONSIDERED).
*       SYMBOLS ALLOWED

X,Y,Z,DX,DY,DZ,KE,RE,G,KM,MV,MM,MJ,J,H,D,AU,C,RI(I),LA(I),LO(I)
*                   OR
X,Y,Z,DX,DY,DZ,KE,RE,G,KM,MV,MM,FA,J,FB,FC,AU,C,RI(I),LA(I),LO(I)

        REJECTION SIGNAS                                            (06

*           THE ABOVE CARD IS FOLLOWED BY DATA INDICATING WHICH OF
*           THE OBSERVABLES ARE TO BE CHECKED FOR POSSIBLE REJECTION
*           OF BAD POINTS.  IF A SYMBOL IS ACCOMPANIED BY A NUMERICAL
*           VALUE THE OBSERVATION WILL BE REJECTED IF THE ABSOLUTE
*           VALUE OF THE RESIDUAL EXCEEDS THE INPUT VALUE.
*       SYMBOLS ALLOWED

                R(I),DR(I),EL(I),AZ(I),DEC(I),HA(I),C1(I),CC3(I),
                C3(I),DI(I),RU(I)

                INVERSE COVARIANCE MATRIX OF ESTIMATED PARAMETERS    (07
                COVARIANCE MATRIX OF ESTIMATED PARAMETERS            (10
                COVARIANCE MATRIX OF CONSIDERED PARAMETERS           (11

*               PROVISION IS MADE TO ENTER ONE OF THREE
*               MATRICES IN ONE OF THREE WAYS

*               TO ENTER THE DIAGONAL TERM OF THE MATRIX
DIAG=

*               TO ENTER THE MATRIX BY ROW
R01=
*              (CONTINUE ON FOLLOWING CARD, IF NECESSARY)
R02=
R33=

*               TO ENTER WITH NO SYMBOLS SUPPLY A
*               FORTRAN TYPE ARRAY FOR A 20X20 MATRIX

        DELETE THESE DATA TYPES                                     (13

*               SYMBOLS ALLOWED AS IN (06 ABOVE

        STATISTICS AND RESIDUALS FOR THESE DATA TYPES               (14

*               DESIGNATION OF AT LEAST ONE DATA TYPE PER
*               STATION IS NECESSARY FOR THE CALCULATION OF
*               STATISTICS. INCLUDE ALL DATA TYPES FOR WHICH
*               STATISTICS AND RESIDUALS ARE DESIRED. THE
*               VERTICAL PLOTTING SCALE CAN BE DEFINED AS
*               RI(I)*10., THE HORIZONTAL SCALE CAN BE DEFINED
*               AS NHR*1.5. THIS LATTER IS NOMINALLY 1. HOUR
*               A MAXIMUM OF 8 DATA TYPES PER STATION MAY BE
*               REQUESTED.
*               SYMBOLS ALLOWED AS FOLLOWS

                R(I),DR(I),EL(I),AZ(I),DEC(I),HA(I),C1(I),CC3(I)
                C3(I),DI(I),RU(I),NHR

        NOMINAL VALUES CORRESPONDING TO COVARIANCE MATRIX           (15

*               IF A COVARIANCE MATRIX FOR THE ESTIMATED PARAMETERS
*               OR ITS INVERSE IS ENTERED THE VALUES OF THE
*               ESTIMATED PARAMETERS ASSOCIATED WITH MATRIX MAY
*               ALSO BE ENTERED. THESE VALUES FOLLOW THIS CONTROL
*               CARD AND MUST BE IN THE SAME ORDER AS THE
*               PARAMETERS IN THE MATRIX.
*               IF NOMINAL VALUES FOR THE PARAMETERS ARE NOT
*               ENTERED THE PROGRAM WILL SET THE NOMINAL
*               VALUES TO THE INITIAL ESTIMATE OF THE PARAMETERS.
*               NO SYMBOLS ARE ALLOWED.
```

```
      WEIGHTS BY DATA TYPE AND STATION                                  (16

*           NORMALLY THE ODP COMPUTES THE WEIGHT FOR EACH DATA
*           TYPE FROM INFORMATION THE ODG  PUTS ON THE TRACKING
*           DATA FILE.  THE OPERATOR CAN OVERRIDE THIS FEATURE BY
*           FOLLOWING THE ABOVE CARD WITH WEIGHTS (SIGMA RATHER
*           THAN SIGMA SQUARED) FOR ANY OR ALL OF THE DATA TYPES.
*           WEIGHTS MUST BE SPECIFIED IN THIS MANNER WHEN FITTING
*           AN ODP-SIMULATED DATA FILE.
*           THE USER MAY ALSO INPUT OCTAL WEIGHT CODES, E.G.,
*           CC3(2)=314333/8
*           SYMBOLS ALLOWED

            R(I),DR(I),EL(I),AZ(I),DEC(I),HA(I),C1(I),CC3(I)
            C3(I),DI(I),RU(I)


      POINTING TIMES, SAMPLE RATE, COUNT TIMES                          (17

*           AS THE NAME SUGGESTS, DATA FOLLOWING THIS CONTROL
*           CARD DEFINES THE AMOUNT OF OUTPUT OBTAINED WHEN THE
*           PROGRAM IS PREPARING A DATA FILE OR COMPUTING POINT-
*           ING PREDICTIONS.  A SYMBOLIC NAME IS ASSOCIATED WITH
*           EACH OF THE 15 POSSIBLE TRACKING STATIONS, AND EACH
*           NAME MAY BE FOLLOWED BY ONE, TWO, OR THREE GROUPS OF
*           DATA.  THE FORMAT OF EACH GROUP IS AS FOLLOWS, FIRST
*           TIME, LAST TIME, SAMPLE RATE, COUNT TIME.  POINTING
*           PREDICTIONS (OR A DATA FILE) WILL BE GENERATED FOR
*           THE INDICATED STATION IF THE PROBE IS ABOVE STATION'S
*           HORIZON ANYTIME BETWEEN THE FIRST TIME AND THE LAST
*           TIME.  THE INTERVAL BETWEEN PREDICTIONS IS DEFINED BY
*           THE SAMPLE RATE AND ANY REQUESTED DOPPLER CAL-
*           CULATIONS WILL BE BASED ON THE INDICATED COUNT TIME.
*           THE TWO TIMES ARE GREENWICH TIME AND ARE COMPOSED OF
*           TWO WORDS EACH, AS DEFINED ELSEWHERE.  THE SAMPLE
*           RATE AND THE COUNT TIME ARE GIVEN AS FLOATING POINT
*           SECONDS.  AS AN EXAMPLE,
JETMTS=620702103,0,620702104,0,10.,5.,620702107,0,620702109,0,30.,30.
*           INSTRUCTS THE PROGRAM TO GENERATE POINTING PREDICTS FOR
*           THE MTS EVERY 10 SEC BETWEEN 0300002 AND 0400002 ON JULY
*           21, 1962 WITH A DOPPLER AVERAGING TIME OF 5 SEC.
*           POINTING PREDICTIONS WILL ALSO BE GENERATED FOR
*           0700002 TO 0900002 ON THE SAME DAY BUT WITH A 30-SEC
*           SAMPLE RATE AND 30-SEC DOPPLER AVERAGING TIME.
*           SYMBOLS ALLOWED

            JETGLV,JETGL2,CANJET,DONJET,JOBJET,ANTGUA,ASCENS,PUERTO,
            PRETOR,JODREL,T3CAPE,BAHAMA,SANSAL,HAWAII,TRINID


      DATA FILE SIGMA                                                   (21

*           IF A DATA FILE IS BEING PREPARED THE DATA TYPES
*           FOLLOWING THIS CARD WILL BE ENTERED ON THE ODP DATA
*           FILE.  IF NUMERIC FIELD APPEARS WITH A SYMBOL THE
*           PROGRAM WILL PUT A NORMALLY DISTRIBUTED RANDOM NUMBER
*           WITH MEAN ZERO ON THE CALCULATED VALUE OF THE DATA


-------------------------------------------------------------------------

*           TYPE.  THE ONE-SIGMA VALUE OF THE DISTRIBUTION IS SET
*           TO THE VALUE FOLLOWING THE SYMBOLIC NAME OF THE DATA
*           TYPE.  IF NO NUMERIC FIELD FOLLOWS A SYMBOL THE
*           ONE-SIGMA VALUE OF THE DISTRIBUTION IS SET TO ZERO.
*           SYMBOLS ALLOWED

            R(I),DR(I),EL(I),AZ(I),DEC(I),HA(I),C1(I),CC3(I)
            C3(I),DI(I),RU(I)


      DATA FILE BIAS                                                    (22

*           SAME AS THE ABOVE EXCEPT THAT THE NUMERIC FIELD
*           INDICATES THE CONSTANT THE ODP WILL ADD TO THE
*           CALCULATED VALUE OF EACH DATA TYPE.


      PAGE HEADING                                                      (23

*           UP TO 11 BCD WORDS MAY FOLLOW THIS CONTROL CARD.
*           THE COMMENT MUST BE INITIATED WITH A LEFT PARENT-
*           THESIS AND CLOSED WITH RIGHT PARENTHESIS.  THE
*           COMMENT WILL BE PRINTED ABOVE VARIOUS OUTPUT GROUPS.


      MAP COVARIANCE MATRIX TO                                          (24

*           THIS CARD IS FOLLOWED BY UP TO 12 MONOTONICALLY IN-
*           CREASING GREENWICH TIMES.  THE COVARIANCE MATRIX
*           FROM THE PREVIOUS ITERATION WILL BE MAPPED FORWARD TO
*           THESE TIMES.
*           SYMBOLS ALLOWED, NONE


      TRANSMITTER ID TABLE                                              (26

*           THE DATA FOLLOWING THIS CONTROL CARD DEFINES THE
*           TRANSMITTING STATION AS A FUNCTION OF TIME.  THIS
*           DATA IS REQUIRED ONLY WHEN GENERATING DATA FILES OR
*           POINTING PREDICTIONS SINCE THE ODG  IDENTIFIES THE
*           TRANSMITTER FOR EACH TIME POINT APPEARING ON THE ODP
*           DATA FILE.  THE FORMAT OF THE TRANSMITTER TABLE IS,
*           IX(1),FREQ(1),TIME(1),IX(2),FREQ(2),....IX IS A FIXED
*           NUMBER, FREQ IS A FLOATING POINT NUMBER.
*           THE INTERPRETATION OF THE TABLE IS AS FOLLOWS,
*           STATION IX(I) IS TRANSMITTING WITH A FREQ(I) UNTIL
*           TIME(I), THEN STATION IX(I+1) IS TRANSMITTING WITH A
*           FREQ(I+1) UNTIL TIME(I+1),ETC.  IX(I)=0 IS INTERPRETED
*           AS  THE TRANSPONDER AND TIME(I)=0 IS INTERPRETED AS
*           INFINITY.  WHEN GENERATING A DATA FILE ONLY ONE TYPE
*           OF DOPPLER WILL BE ALLOWED PER TIME POINT.  IF ALL
*           THREE DOPPLER TYPES ARE REQUESTED FOR A RECEIVING
*           STATION (SEE DATA FILE SIGMA CONTROL CARDS), THE
*           FOLLOWING RULES DETERMINE THE DOPPLER TYPE THAT WILL
*           APPEAR.

*           1. IF ELEVATION AT STATION IX IS NEGATIVE SET IX=0
*           2. IF IX=0 OMIT CC3 AND C3
*           3. IF IX≠IR≠0 OMIT C1 AND CC3 WHERE IR IS THE RECEIVER
```

```
*             4. IF IX=IR OMIT C1 AND C3
*             SYMBOLS ALLOWED, NONE

*             RESTRICTIONS
*             A MAXIMUM OF 134 IX-TIME PAIRS IS ALLOWED


      OFFLINE CONTROL                                                  (27

*             WHEN ANY OPTION OTHER THAN A DATA FITTING
*             ITERATION IS DESIRED KEY CONTROL IS NECESSARY
*             THIS CONTROL CARD MUST BE PRESENT EACH ITERATION TO SET
*             THE KEYS FOR THAT ITERATION.  THE CARDS FOR EACH
*             ITERATION MUST BE FOLLOWED BY AN END DATA CARD.
* SYMBOL ALLOWED          OPTION                  NEED CONTROL CARDS
KEY(2)          SIMULATE DDG  DATA FILE         1,2,17,21
KEY(3)          STEP-MAP, FORWARDS EPOCH        1,2,24
KEY(4)          MAP FORWARD TO INPUT TIME       1,2,24
KEY(5)          MAP TO ENCOUNTER                1,2
KEY(6)          REJECT BAD POINTS               1,2,6
KEY(8)          REPEAT PREDICTS
KEY(12)         PREDICTS PREPARED FOR TELETYPE  1,2,17,KEY(13)
                TRANSMISSION
KEY(13)         POINTING PREDICTIONS            1,2,17
KEY(14)         STATISTICS                      1,2,14
KEY(15)         ANGLE PLOTS                     1,2
KEY(16)         RESIDUALS                       1,2,14
KEY(17)         TIME PLOTS                      1,2,14
TERMINATE JOB   MUST BE INCLUDED TO END JOB
RESTART DDP     TO INITIALIZE DDP FROM BEGINNING


      BURN START TIME                                                  (30

*             THIS TIME, IN THE USUAL GREENWICH FORMAT, DENOTES THE
*             BEGINNING OF THE POWERED FLIGHT.


      SPHERICAL INJECTION CONDITIONS                                   (31

*             IN PLACE OF CARTESIAN INJECTION CONDITIONS, THE USER
*             MAY INPUT SPHERICAL CONDITIONS UNDER THIS CONTROL
*             CARD.  THE SPHERICAL CONDITIONS ARE TRANSFORMED TO
*             CARTESIAN CONDITIONS AT INPUT TIME.
*             SYMBOLS ALLOWED

              RAD,LAT,LONG,VE,ELE,AZE


      OCCULTATION TIMES                                                (32

*             THIS DATA TYPE IS INPUT BY CARD, RATHER THAN THROUGH
*             THE DDS.  TWO OCCULTATION TIMES APPEAR ON EACH CARD.
*             THE FORMAT IS OCCX=T1,T2,WEIGHT,REJECTION SIGMA, WHERE
*             T1 AND T2 ARE GREENWICH TIMES IN THE USUAL FORMAT.
*             RESTRICTIONS
*             ONLY STATIONS 1 THROUGH 5 PERMITTED.  IF ONLY ONE
*             TIME IS TO BE USED THEN T2 MUST BE 0,0.
*             SYMBOLS ALLOWED

              OCC1,OCC2,OCC3,OCC4,OCC5


      IMPACT TIMES                                                     (33

*             SAME AS OCCULTATION TIME, EXCEPT THAT ONLY ONE TIME
*             PER STATION IS INPUT.  THE FORMAT IS IMPX=T,WEIGHT,
*             REJECTION SIGMA.
*             RESTRICTIONS
*             ONLY STATIONS 1 THROUGH 5 PERMITTED
*             SYMBOLS ALLOWED

              IMP1,IMP2,IMP3,IMP4,IMP5


      START AND STOP TIMES                                             (34

*             THIS INPUT PERMITS THE FITTING OF DATA ONLY DURING THE
*             INTERVAL BETWEEN T-START AND T-STOP.  UP TO THREE PAIRS
*             MAY BE INPUT IN THE USUAL GMT FORMAT.


      END DATA                                                         (00

*             THIS CARD MUST TERMINATE EACH SET OF CONTROL DATA
*             READ BY THE DDP.
```

B. LOAD MAPS AND COMMON STORAGE MAP

```
ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
     (DFMP)      (DFAD)      (DFSB)      READB       WRITEB

     THE NAME OF THIS PROGRAM IS *LA2          2/22/65

  ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.    OCTAL LENGTH    DECIMAL LENGTH    COMMON BREAK
  - **PCB        22302          EPDX           22300          00011           00009
                                COMAP
  COMAP          22322          OFFSYS         22311          00273           00187
                                TYPRYT
                                TAMP
                                PROM
                                FLOT
                                REAM
                                COMIMP
                                OCP
                                FLAK
  PRAMS          22606          OCP            22604          00043           00035
                                FLAK
  COMIMP         22660          PRAMS          22647          01357           00751          47055
                                (DFMP)
                                (DFAD)
                                MAMUL
                                (DFSB)
  ADD            24226          *NONE*         24226          00050           00040
  ARSIN          24306          *NONE*         24276          00144           00100          77152
  ARCOS          24302
  QARSIN         24300
  QARCOS         24276
  ERRARS         24427
  ERRARC         24433
  ARTAN          24442          *NONE*         24442          00103           00067          77152
  DAYS           24550          FIX            24545          00041           00033
                                FLOAT
                                ADD
  ERROR          24606          *NONE*         24606          00011           00009
  FIXT           24620          FIXTT          24617          00007           00007
  FIXTT          24626          *NONE*         24626          00312           00202          50031
  FLOT           24734
  FIX            25115
  FLOAT          25121
  DAYE           25131
  FLAT           25142          ERROR          25140          00102           00066
  FLAPR          25170          TYPRYT
  FLAK           25177
  INSPC          25246          *NONE*         25242          00310           00200          50031
  MAMUL          25556          *NONE*         25552          00130           00088          77461
  PNUT           25710          SIN            25702          00336           00222          50001
                                COS
  PROM           26244          *NONE*         26240          00156           00110          77461
  QUIZ           26416          *NONE*         26416          00003           00003
  REAP           26424          READB          26421          02543           01379
  REAM           26424          FLAT
                                ERROR
  ROT            31170          *NONE*         31164          00266           00182          50031
  OFFSYS         31452          *NONE*         31452          00010           00008
  ENDSYS         31453
  FINSYS         31454
  SCHAIN         31455
  PGSTRT         31456
  PGSTOP         31457
  OCP            31460
  TYPRYT         31461
  SIN            31462          *NONE*         31462          00242           00162
  COS            31465
  QSIN           31471
  QCOS           31473
  TAMP           31736          WRITEB         31724          00126           00086
  EPDX           32032          FLAT
  (DFAD)         32052          *NONE*         32052          00121           00081          77776
  (DFSB)         32072
  (DFMP)         32112
  (DFDP)         32140
  READO          32174          (IOU)          32173          00365           00245
  READB          32176
  WRITED         32201
  WRITEB         32203
  BSREC          32412
  BSFILE         32415
  REWIND         32420
  UNLOAD         32423
  ENDFIL         32426
  SETLOW         32404
  SETHI          32407
  (UNIT)         32555
  TAPEIO         32555
  (IOU)          32563          *NONE*         32560          00030           00024

 *LA2   * JUST LOADED.

   UNUSED CORE LIES FROM   32610   THROUGH   47055.  LEAVING   14246  OCTAL OR   06310  DECIMAL LOCATIONS.
```

```
ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
     DEFINE      ATTACH      OPEN        CLOSE       (DFMP)      (DFAD)      SQRT        FGDOUT      PRQUT       WRITED
     ENDFIL      REWIND      READB       (DFSB)

     THE NAME OF THIS PROGRAM IS *LAZA  *      2/22/65

  ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.     OCTAL LENGTH     DECIMAL LENGTH     COMMON BREAK
    **PCB        22302          MAPOUT          22301          00007            00007
    MAPOUT       22324          DEFINE          22310          01564            00884
                                ATTACH
                                OPEN
                                TYPRYT
                                OFFSYS
                                CLOSE
                                DCP
                                FLAK
                                PRAN
                                PRIN
                                REFORM
                                TACCOM
    AAT          24102          (DFMP)          24074          00116            00078           77461
                                (DFAD)
    BIBCD        24237          *NONE*          24212          00055            00045
    DIAGO        24274          SQRT            24267          00105            00069           50031
    ERROR        24374          *NONE*          24374          00011            00009
    FIXT         24406          FIXTI           24405          00007            00007
    FIXTI        24414          *NONE*          24414          00312            00202           50031
    FLOT         24522
    FIX          24703
    FLOAT        24707
    DAYE         24717
    FLAT         24730          ERROR           24726          00101            00065
    FLAPR        24756          TYPRYT
    FLAK         24765
    NORMAY       25034          SQRT            25027          00251            00169           77461
    PRIN         25321          FGDOUT          25300          01423            00787           50001
    PRAN         25310          PRQUT
                                BIBCD
                                FLAPR
                                PRIME
                                NORMAY
                                PRIT
                                DIAGO
    PRIME        26730          WRITEB          26723          00177            00127
    REFORM       26751          FLAT
                                ENDFIL
                                REWIND
                                READB
    PRIT         27124          FIXT            27122          00036            00030
                                BIBCD
    QUIZ         27160          *NONE*          27160          00002            00002
    OFFSYS       27162          *NONE*          27162          00010            00008
    ENDSYS       27163
    FINSYS       27164
    SCHAIN       27165
    PGSTRT       27166
    PGSTOP       27167
    DCP          27170
    TYPRYT       27171
    TAPR         27172          *NONE*          27172          00002            00002
    SCALE        27200          *NONE*          27174          00043            00035           77461
    TACCOM       27250          SCALE           27237          01617            00911           47055
                                (DFMP)
                                (DFAD)
                                AAT
                                (DFSB)
    (DFAD)       31056          *NONE*          31056          00120            00080           77776
    (DFSB)       31076
    (DFMP)       31116
    (DFDP)       31144
    SQRT         31176          *NONE*          31176          00054            00044           77773
    PRQUT        31266          OUTUS           31252          03031            01561
    FGDOUT       32532          ACTIND
    PACNV        31633          BFLG
    PRQUT2       31604          RESTKA
    PRQUT3       31417          REQIND
    TSXA         33441          WRITE
    TSXB         34231          PRCON
                                RGGSAV
                                RGGSTR
                                CKIND
                                CKACT
    READD        34304          (IOU)           34303          00365            00245
    READB        34306
    WRITED       34311
    WRITEB       34313
    BSREC        34522
    BSFILE       34525
    REWIND       34530
    UNLOAD       34533
    ENDFIL       34536
    SETLOW       34514
    SEYMI        34517
    (UNIT)       34665
    TAPEIO       34665
    (IOU)        34673          *NONE*          34670          00030            00024
    OUTUS        34722          RGGSAV          34720          02320            01232
    BFLG         35556          RGGSTR
    ENDOUT       35307
    CKIND        37151
    CKACT        37214
    REQIND       37150
    ACTIND       37147
    RESTKA       37145
    PL1CON       37230
    PL2CON       37231
    PL3CON       37232
    PRCON        37233
    RGGSAV       37240          *NONE*          37240          00133            00091
    RGGSTR       37322
    IOCS         37374          CLOCK           37373          04335            02269
    DEFINE       37375
    JOIN         37400
    ATTACH       37403
    CLOSE        37406
    OPEN         37411
    READ         37414
    WRITE        37417
    COPY         37422
    REW          37425
    WEF          37430
    BSR          37433
    BSF          37436
```

```
STASH       37441
CLOCK       43733          'NONE'      43730          00106          00070
MINUTE      43730
XMIN        43730

'LA2A  ' JUST LOADED.

 UNUSED CORE LIES FROM   44036   THROUGH   47055,  LEAVING   03020  OCTAL OR   01552   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
   DEFINE      ATTACH      OPEN        CLOSE       WRITEB      ENDFIL      FGDOUT      SQRT        PROUT       LOG

   THE NAME OF THIS PROGRAM IS 'LA3   '     2/22/65

 ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
   **PCB       22302          OZ              22301          00006          00006
   OZ          22316          DEFINE          22307          01367          00759
                              ATTACH
                              OPEN
                              TYPRYT
                              OFFSYS
                              UMAT
                              CLOSE
   ARTAN       23676          'NONE'          23676          00103          00067          77152
   FIXT        24002          FIXTT           24001          00007          00007
   FIXTT       24010          'NONE'          24010          00312          00202          50031
   FLOT        24116
   FIX         24277
   FLOAT       24303
   DAYE        24313
   ERROR       24322          'NONE'          24322          00012          00010
   FLAT        24336          ERROR           24334          00101          00065
   FLAPR       24364          TYPRYT
   FLAK        24373
   GERPU       24440          WRITEB          24435          00100          00064
                              FLAT
                              ENDFIL
   ORBEQ       24544          ARTAN           24535          00167          00119          77461
                              COS
                              SIN
   PARAM       24732          FGDOUT          24724          01320          00720
                              SQRT
                              FIXT
                              PROUT
                              INORM
                              ORBEQ
   QUIZ        26244          'NONE'          26244          00002          00002
   OFFSYS      26246          'NONE'          26246          00010          00008
   ENDSYS      26247
   FINSYS      26250
   SCHAIN      26251
   PGSTRT      26252
   PGSTOP      26253
   DCP         26254
   TYPRYT      26255
   SIN         26256          'NONE'          26256          00243          00163
   COS         26261
   QSIN        26265
   QCOS        26267
   INORM       26526          SQRT            26521          00252          00170          77461
   UMAT        27004          SQRT            26773          03221          01681          77461
                              LOG
                              GERPU
                              ARTAN
                              PARAM
   LOG         32222          'NONE'          32214          00066          00054          77774
   LOG10       32214
   SQRT        32302          'NONE'          32302          00054          00044          77773
   PROUT       32272          OUTUS           32356          03031          01561
   FGDOUT      33636          ACTIND
   PRCNV       32537          BFLG
   PROUT2      32510          RESTKA
   PROUT3      32523          REQIND
   TSXA        34545          WRITE
   TSXB        35335          PRCON
                              RGGSAV
                              RGGSTR
                              CKIND
                              CKACT
   READD       35410          (IOU)           35407          00365          00245
   READB       35412
   WRITED      35415
   WRITEB      35417
   BSREC       35626
   BSFILE      35631
   REWIND      35634
   UNLOAD      35637
   ENDFIL      35642
   SETLOW      35620
   SETHI       35623
   (UNIT)      35771
   TAPEIO      35771
   (IOU)       35777          'NONE'          35774          00030          00024
   OUTUS       36026          RGGSAV          36024          02320          01232
   BFLG        36662          RGGSTR
   ENDOUT      36613
   CKIND       40255
   CKACT       40320
   REQIND      40254
   ACTIND      40253
   RESTKA      40251
   PL1CON      40334
   PL2CON      40335
   PL3CON      40336
   PRCON       40337
   RGGSAV      40344          'NONE'          40344          00133          00091
   RGGSTR      40426
   IOCS        40500          CLOCK           40477          04335          02269
   DEFINE      40501
   JOIN        40504
   ATTACH      40507
```

```
CLOSE       40512
OPEN        40515
READ        40520
WRITE       40523
COPY        40526
REW         40531
WEF         40534
BSR         40537
BSF         40542
STASH       40545
CLOCK       45037          *NONE*        45034          00106          00070
MINUTE      45034
XMIN        45034

*LA3    * JUST LOADED.

  UNUSED CORE LIES FROM   45142   THROUGH   50031.  LEAVING   02670  OCTAL OR   01464   DECIMAL LOCATIONS.
```

```
ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
    REWIND      (DFAD)      (DFMP)      (DFSB)      SQRT       DMOD       (DFDP)      EXP(3      READB

  THE NAME OF THIS PROGRAM IS *LA4   *      2/22/65

ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  **PCB        22302          PREDA          22301          00007          00007
  PREDA        22314          TYPRYT         22310          00050          00040
                              POINT
                              DATAPE
                              REWIND
  ABDD         22360          *NOVE*         22360          00030          00024
  ADD          22410          *NOVE*         22410          00050          00040
  ARSIN        22470          *NOVE*         22460          00144          00100          77152
  ARCOS        22464
  QARSIN       22462
  QARCOS       22460
  ERRARS       22611
  ERRARC       22615
  ARTAN        22624          *NOVE*         22624          00102          00066          77152
  COEF         22736          (DFAD)         22726          00770          00504          50031
                              (DFMP)
                              (DFSB)
                              QUIZ
  CORR         23724          SQRT           23716          00274          00188          47675
                              SIN
  DATAPE       24230          IXTAB          24212          00447          00295          50031
                              OFFSYS
                              (DFAD)
                              REAP
                              GHADP
                              COEF
                              DOPLR
                              CORR
                              NO2F
                              FILT
  DAYS         24664          FIX            24661          00041          00033
                              FLOAT
                              ADD
  DNAME        24735          *NOVE*         24722          00014          00012
  SIPREG       24736          *NOVE*         24736          00003          00003
  ODOFF        24737
  SPHX         24740
  DOPLR        24756          RATES          24741          01313          00715          50031
                              DMOD
                              VEC
                              ABDD
                              (DFMP)
                              (DFAD)
                              SQRT
                              ARTAN
                              ARSIN
  ERROR        26254          *NONE*         26254          00012          00010
  FILL         26270          RITE           26266          00277          00191          50001
  FILT         26552          PISA
  FIXT         26566          FIXTT          26565          00007          00007
  FIXTT        26574          *NOVE*         26574          00312          00202          50031
  FLOT         26702
  FIX          27063
  FLOAT        27067
  DAYE         27077
  FLAT         27110          ERROR          27106          00102          00066
  FLAPR        27136          TYPRYT
  FLAK         27145
  GHADP        27222          (DFDP)         27210          00320          00208          50031
                              (DFSB)
                              (DFMP)
                              (DFAD)
                              DMOD
                              COS
  IXTAB        27530          *NONE*         27530          00066          00054
  NO2F         27616          *NOVE*         27616          00050          00040
  PNUT         27674          SIN            27666          00337          00223          50001
                              COS
  POINT        30242          IXTAB          30225          00305          00197          50031
                              COEF
                              OFFSYS
                              (DFAD)
                              REAP
                              GHADP
                              DOPLR
                              CORR
                              FILL
  QUIZ         30532          *NOVE*         30532          00003          00003
  RATES        30546          COS            30535          00662          00434          50031
                              SIN
                              SQRT
                              ARSIN
                              EXP(3
  REAP         31422          READB          31417          02543          01379
  REAM         31422          FLAT
                              ERROR
  RDT          34166          *NOVE*         34162          00266          00182          50031
  OFFSYS       34450          *NOVE*         34450          00010          00008
  ENDSYS       34451
  FINSYS       34452
  SCHAIN       34453
```

```
PGSTRT      34454
PGSTOP      34455
DCP         34456
TYPRYT      34457
SIN         34460          'NONE'      34460          00242          00162
COS         34463
QSIN        34467
QCOS        34471
VEC         34722          'NONE'      34722          00017          00015          50031
REDE        34742          DCP         34741          00421          00273
RITE        34745
PISA        35171
EXP(3       35362          'NONE'      35362          00136          00094          77773
(DFAD)      35520          'NONE'      35520          00120          00080          77776
(DFSB)      35540
(DFMP)      35560
(DFDP)      35606
DMOD        35640          'NONE'      35640          00060          00048          77776
SQRT        35720          'NONE'      35720          00055          00045          77773
READD       35776          (IOU)       35775          00365          00245
READB       36000
WRITED      36003
WRITEB      36005
BSREC       36214
BSFILE      36217
REWIND      36222
UNLOAD      36225
ENDFIL      36230
SETLOW      36206
SETHI       36211
(UNIT)      36357
TAPEIO      36357
(IOU)       36365          'NONE'      36362          00030          00024

'LA4    * JUST LOADED.

  UNUSED CORE LIES FROM   36412   THROUGH   47675,  LEAVING   11264  OCTAL OR   04788  DECIMAL LOCATIONS.
```

```
ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
    DEFINE      ATTACH      OPEN        CLOSE       PROUT       FGDOUT      TELTYP      ENDOUT

    THE NAME OF THIS PROGRAM IS 'LA5    *      2/22/65

ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  **PCB      22302        SQRT               22301       00006          00006
  SQRT       22316        TYPRYT             22307       02055          01069
                          DEFINE
                          ATTACH
                          OPEN
                          THARP
                          CLOSE
                          FLAK
  BIBCD      24411        'NONE'             24364       00054          00044
  DNAME      24453        'NONE'             24440       00014          00012
  AQUI       24512        PROUT              24454       00741          00481          50031
  ALLI       24472        FGDOUT
  BALLI      24467        PKINE
  BAQUI      24464        FIXT
                          DAYE
                          TELTYP
                          ENDOUT
                          BIBCD
  PERNOD     25421        KINE               25415       00007          00007
  WOLF       25420
  RESP       25416
  ANGPLT     25417
  MONKED     25424        'NONE'             25424       00002          00002
  ERROR      25426        'NONE'             25426       00012          00010
  FILL       25442        RITE               25440       00277          00191          50001
  FILT       25724        PISA
  FIXT       25740        FIXTT              25737       00007          00007
  FIXTT      25746        'NONE'             25746       00312          00202          50031
  FLOT       26054
  FIX        26235
  FLOAT      26241
  DAYE       26251
  FLAT       26262        ERROR              26260       00102          00066
  FLAPR      26310        TYPRYT
  FLAK       26317
  KINE       26364        REDE               26362       00216          00142          50001
                          ERROR
  QUIZ       26600        'NONE'             26600       00002          00002
  OFFSYS     26602        'NONE'             26602       00010          00008
  ENDSYS     26603
  FINSYS     26604
  SCHAIN     26605
  PGSTRT     26606
  PGSTOP     26607
  DCP        26610
  TYPRYT     26611
  THARP      26626        OFFSYS             26612       00573          00379
  PKINE      26733        KINE
                          AQUI
                          ALLI
                          BAQUI
                          BALLI
                          PERNOD
                          RESP
                          WOLF
```

```
                                ANGPLT
                                BIBCD
                                TYPRYT
REDE            27406           DCP             27405           00422           00274
RITE            27411
PISA            27635
TELTYP          30036           PROUT2          30027           01101           00577
SCCTTY          30253           ACTIND
                                PROUT3
                                TSXA
                                RGGSAV
                                RGGSTR
                                TSXB
PROUT           31144           OUTUS           31130           03032           01562
FGDOUT          32410           ACTIND
PRCNV           31311           &FLG
PROUT2          31262           RESTKA
PROUT3          31275           REQIND
TSXA            33317           WRITE
TSXB            34107           PRCON
                                RGGSAV
                                RGGSTR
                                CKIND
                                CKACT
OUTUS           34164           RGGSAV          34162           02320           01232
&FLG            35020           RGGSTR
ENDOUT          34551
CKIND           36413
CKACT           36456
REQIND          36412
ACTIND          36411
RESTKA          36407
PL1CON          36472
PL2CON          36473
PL3CON          36474
PRCON           36475
RGGSAV          36502           'NOVE'          36502           00133           00091
RGGSTR          36564
IOCS            36636           CLOCK           36635           04335           02269
DEFINE          36637
JDIN            36642
ATTACH          36645
CLOSE           36650
OPEN            36653
READ            36656
WRITE           36661
COPY            36664
REW             36667
WEF             36672
BSR             36675
BSF             36700
STASH           36703
CLOCK           43175           'NOVE'          43172           00106           00070
MINUTE          43172
XMIN            43172

'LA5    ' JUST LOADED.

  UNUSED CORE LIES FROM   43300   THROUGH   50001,  LEAVING   04502  OCTAL OR   02370   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
    SETHI       REWIND      ENDFIL      (DFSB)      (DFAD)      (DFMP)      SQRT        EXP(3       DMOD        (DFDP)
    WRITEB      READB

  THE NAME OF THIS PROGRAM IS 'LA6    '      2/22/65

 ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
   **PCB        22302           FIT             22301           00006           00006
   FIT          22320           REDE            22307           00735           00477
                                TYPRYT
                                SETHI
                                REWIND
                                CALL
                                ENDFIL
                                RITE
                                OCIM
                                FLAK
   ABDD         23244           'NOVE'          23244           00030           00024
   ADD          23274           'NOVE'          23274           00050           00040
   ARSIN        23354           'NOVE'          23344           00144           00100           77152
   ARCOS        23350
   QARSIN       23346
   QARCOS       23344
   ERRARS       23475
   ERRARC       23501
   ARTAN        23510           'NOVE'          23510           00103           00067           77152
   BEER         23614           REJEC           23613           00071           00057           47675
   CALL         23736           BEER            23704           00523           00339           51235
                                KINE
                                COEF
                                STARP
                                (DFSB)
                                REAP
                                GHADP
                                DOPLR
                                COROP
                                CORR
                                DICOS
                                OBTOX
                                CATS
                                OFFSYS
                                WAIT
                                QUIZ
                                REJEC
                                PM360
                                FORM
                                GERTA
                                FILL
                                GREOF
   CATS         24436           VEC             24427           00645           00421           47675
                                ABDD
                                COS
   COEF         25304           (DFAD)          25274           00770           00504           50031
                                (DFMP)
                                (DFSB)
                                QUIZ
   COL          26272           COS             26264           00406           00262           50031
                                SQRT
   COROP        26702           SQRT            26672           00170           00120           50031
                                EXP(3
                                ARTAN
```

		SIN				
CORR	27070	SQRT	27062	00275	00189	47675
		SIN				
DAYS	27362	FIX	27357	00041	00033	
		FLOAT				
		ADD				
DECOD	27420	*NONE*	27420	00040	00032	50031
DICOS	27466	SIN	27460	00173	00123	50031
		COS				
DOPLR	27670	RATES	27653	01313	00715	50031
		DMOD				
		VEC				
		ADDD				
		(DFMP)				
		(DFAD)				
		SQRT				
		ARTAN				
		ARSIN				
ERROR	31166	*NONE*	31166	00012	00010	
FILL	31202	RITE	31200	00277	00191	50001
FILT	31464	PISA				
FIXT	31500	FIXTT	31477	00007	00007	
FIXTT	31506	*NONE*	31506	00312	00202	50031
FLOT	31614					
FIX	31775					
FLOAT	32001					
DAYE	32011					
FLAT	32022	ERROR	32020	00101	00065	
FLAPR	32050	TYPRYT				
FLAK	32057					
FORM	32132	PARLEY	32121	01066	00566	50031
		(DFMP)				
		(DFAD)				
		(DFDP)				
		SQRT				
GERTA	33212	WRITEB	33207	00215	00141	
GREOF	33332	FLAT				
		ENDFIL				
GHADP	33436	(DFDP)	33424	00321	00209	50031
		(DFSB)				
		(DFMP)				
		(DFAD)				
		DMOD				
		COS				
INPAR	33752	FORM	33745	00177	00127	50031
INSPC	34150	*NONE*	34144	00310	00200	50031
KINE	34456	READE	34454	00216	00142	50001
		ERROR				
OBTOX	34676	*NONE*	34672	00275	00189	50031
OCIM	35174	INPAR	35167	00222	00146	
		OCPAR				
		READB				
		FLAT				
		ERROR				
OCPAR	35416	FORM	35411	00515	00333	50031
PARLEY	36130	WRITEB	36126	00044	00036	
		FLAT				
PM360	36176	*NONE*	36172	00050	00040	50001
PNUT	36250	SIN	36242	00336	00222	50001
		COS				
QUIZ	36600	*NONE*	36600	00003	00003	
RATES	36614	COS	36603	00662	00434	50031
		SIN				
		SQRT				
		ARSIN				
		EXP(3				
READ	37470	READB	37465	02543	01379	
REAM	37470	FLAT				
		ERROR				
REJEC	42230	*NONE*	42230	00056	00046	46711
RECO	42302					
ROT	42312	*NONE*	42306	00266	00182	50031
OFFSYS	42574	*NONE*	42574	00010	00008	
ENDSYS	42575					
FINSYS	42576					
SCHAIN	42577					
PGSTRT	42600					
PGSTOP	42601					
OCP	42602					
TYPRYT	42603					
SIN	42604	*NONE*	42604	00242	00162	
COS	42607					
QSIN	42613					
OCOS	42615					
STARP	43046	*NONE*	43046	00030	00024	
VEC	43076	*NONE*	43076	00020	00016	50031
WAIT	43130	COL	43116	00346	00230	50031
		DECOD				
		SQRT				
		WOCT				
		COS				
		ERROR				
WOCT	43464	*NONE*	43464	00013	00011	
REDE	43500	OCP	43477	00421	00273	
RITE	43503					
PISA	43727					
EXP(3	44120	*NONE*	44120	00136	00094	77773
(DFAD)	44256	*NONE*	44256	00120	00080	77776
(DFSB)	44276					
(DFMP)	44316					
(DFDP)	44344					
DMOD	44376	*NONE*	44376	00060	00048	77776
SQRT	44456	*NONE*	44456	00055	00045	77773
READO	44534	(IOU)	44533	00365	00245	
READB	44536					
WRITED	44541					
WRITEB	44543					
BSREC	44752					
BSFILE	44755					
REWIND	44760					
UNLOAD	44763					
ENDFIL	44766					
SETLOW	44744					
SETHI	44747					
(UNIT)	45115					
TAPEIO	45115					
(IOU)	45123	*NONE*	45120	00030	00024	

*LA6 * JUST LOADED.

UNUSED CORE LIES FROM 45150 THROUGH 46711. LEAVING 01542 OCTAL OR 00866 DECIMAL LOCATIONS.

```
ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
    DEFINE      ATTACH      OPEN        CLOSE       FGDOUT      PROUT       SQRT        (DFSB)      (DFMP)      (DFAD)
    CLOCK       (DFDP)

   THE NAME OF THIS PROGRAM IS 'LAT   '     2/22/65

 ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  **PCB        22302        APRIOR             22300        00012          00010
                            PRINT
  PRINT        22330        DEFINE             22312        02514          01356
                            ATTACH
                            OPEN
                            ENDIT
                            RITE
                            OFFSYS
                            PRINQ
                            PRIN
                            CLOSE
                            REDE
                            FGDOUT
                            FIXT
                            PROUT
                            FLAK
  BIBCD        25053        'NONE'             25026        00055          00045
  DIAG         25110        SQRT               25103        00106          00070        50031
  DIAGO        25216        SQRT               25211        00105          00069        50031
  ONAME        25331        'NONE'             25316        00014          00012
  ENDIT        25346        (DFSB)             25332        01474          00828        50031
                            (DFMP)
                            (DFAD)
                            PRIN
                            SQRT
                            STPREG
                            REVRT
                            NOUT
  ERRUR        27026        'NONE'             27026        00011          00009
  FIXT         27040        FIXTT              27037        00007          00007
  FIXTT        27046        'NONE'             27046        00312          00202        50031
  FLOT         27154
  FIX          27335
  FLOAT        27341
  DAYE         27351
  FLAT         27362        ERROR              27360        00101          00065
  FLAPR        27410        TYPRYT
  FLAK         27417
  NORMAY       27466        SQRT               27461        00251          00169        77461
  NOUT         27734        PROUT              27732        00100          00064
  BLEW         27776        TYPRYT
  BUKEY        30032        'NONE'             30032        00040          00032
  OPKEY        30036
  COKEY        30053
  AFKEY        30060
  PRIM         30113        FGDOUT             30072        01424          00788        50001
  PRAM         30102        PROUT
                            BIBCD
                            FLAPR
                            PRIME
                            NORMAY
                            PRIT
                            DIAGO
  TAMP         31517        'NONE'             31516        00005          00005
  PRIME        31520
  TAPR         31521
  DIAGO        ******
  PRINQ        31532        FGDOUT             31523        00435          00285        50031
  PRIT         31763        DIAG
  APRIOR       32154        CLOCK
                            PROUT
                            FLAPR
                            FIXT
                            BIBCD
  QUIZ         32160        'NONE'             32160        00002          00002
  REVRT        32170        COKEY              32162        00206          00134        50031
                            BLEW
  OFFSYS       32370        'NONE'             32370        00010          00008
  ENDSYS       32371
  FINSYS       32372
  SCHAIN       32373
  PGSTRT       32374
  PGSTOP       32375
  OCP          32376
  TYPRYT       32377
  STPREG       32410        (DFAD)             32400        02055          01069        71757
                            (DFDP)
                            DSQRT
                            (DFMP)
  DSQRT        34456        ERROR              34455        00106          00070        77776
  REDE         34564        OCP                34563        00421          00273
  RITE         34567
  PISA         35013
  (DFAD)       35204        'NONE'             35204        00120          00080        77776
  (DFSB)       35224
  (DFMP)       35244
  (DFDP)       35272
  SQRT         35324        'NONE'             35324        00056          00044        77773
  CLOCK        35403        'NONE'             35400        00106          00070
  MINUTE       35480
  XMIN         35500
  PROUT        35522        OUTUS              35506        03032          01562
  FGDOUT       36766        ACTIND
  PRCNV        35667        BFLG
  PROUT2       35640        RESTKA
  PROUT3       35653        REQIND
  TSXA         37675        WAITE
  TSXB         40465        PRCON
                            RGGSAV
                            RGGSTR
                            CKIND
                            CKACT
  OUTUS        40542        RGGSAV             40540        02320          01232
  BFLG         41376        RGGSTR
  ENDOUT       41127
  CKIND        42771
  CKACT        43034
  REQIND       42770
  ACTIND       42767
  RESTKA       42765
  PL1CON       43050
  PL2CON       43051
  PL3CON       43052
  PRCON        43053
  RGGSAV       43060        'NONE'             43060        00133          00091
  RGGSTR       43142
  IOCS         43214        CLOCK              43213        04335          02269
  DEFINE       43215
  JOIN         43220
  ATTACH       43223
```

```
CLOSE       43226
OPEN        43231
READ        43234
WRITE       43237
COPY        43242
REW         43245
WEF         43250
BSR         43253
BSF         43256
STASH       43261

*LA7   * JUST LOADED.

  UNUSED CORE LIES FROM   47550   THROUGH   50001,  LEAVING   00232  OCTAL OR   00154   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
   DEFINE     ATTACH     OPEN       CLOSE       WEF        WRITE      FGDOUT     PROUT      SQRT

    THE NAME OF THIS PROGRAM IS *LAB   *      2/22/65

ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  **PCB        22302          RESID          22301         00007          00007
  CLOCK        22310          *NONE*         22310         00002          00002
  RESID        22320          DEFINE         22312         01301          00705
                              ATTACH
                              OPEN
                              TYPRYT
                              THARP
                              CLOSE
  ANGPLT       23620          PKINE          23613         00577          00383          51235
                              FIXT
                              BIBCD
                              CXPLOT
                              DIFD
  BIBCD        24437          *NONE*         24412         00054          00044
  CXPLOT       24470          WEF            24466         03320          01744
  XXXFSR       25327          WRITE
  CDC          25675
  PLTONE       24521
  SET          24472
  DIFD         30006          *NONE*         30006         00026          00022
  ONAME        30047          *NONE*         30034         00015          00013
  BALLI        30056          KINE           30051         00007          00007
  BAQUI        30057
  ALLI         30052
  AQUI         30053
  JUDY         30054
  ERROR        30060          *NONE*         30060         00011          00009
  FIXT         30072          FIXTT          30071         00007          00007
  FIXTT        30100          *NONE*         30100         00312          00202          50031
  FLOT         30206
  FIX          30367
  FLOAT        30373
  DAYE         30403
  FLAT         30414          ERROR          30412         00102          00066
  FLAPR        30442          TYPRYT
  FLAK         30451
  KINE         30516          REDE           30514         00215          00141          50001
                              ERROR
  PERNOD       30736          FIXT           30731         00503          00323          51235
  WOLF         31067          FGDOUT
                              PROUT
                              SQRT
                              COLA
  QUIZ         31434          *NONE*         31434         00002          00002
  RESP         31450          CDC            31436         01564          00884          50001
  COLA         32736          FGDOUT
                              CXPLOT
                              PKINE
                              PERNOD
                              FIXT
                              PROUT
                              FLAPR
                              BIBCD
                              ERROR
  OFFSYS       33222          *NONE*         33222         00010          00008
  ENDSYS       33223
  FINSYS       33224
  SCHAIN       33225
  POSTRT       33226
  POSTOP       33227
  DCP          33230
  TYPRYT       33231
  STATID       33232          *NONE*         33232         00020          00016
  THARP        33266          OFFSYS         33252         00573          00379
  PKINE        33373          KINE
                              AQUI
                              ALLI
                              BAQUI
                              BALLI
                              PERNOD
                              RESP
                              WOLF
                              ANGPLT
                              BIBCD
                              TYPRYT
  REDE         34046          DCP            34045         00421          00273
  RITE         34051
  PISA         34275
  SQRT         34466          *NONE*         34466         00054          00044          77773
  PROUT        34556          OUTUS          34542         03032          01562
  FGDOUT       36022          ACTIND
  PRCNV        34723          BFLG
  PROUT2       34674          RESTKA
  PROUT3       34707          REQIND
  TSXA         36731          WRITE
  TSXB         37521          PRCON
                              RGGSAV
                              RGGSTR
                              CKIND
                              CKACT
  OUTUS        37576          RGGSAV         37574         02320          01232
  BFLG         40432          RGGSTR
  ENDOUT       40163
  CKIND        42025
  CKACT        42070
  REQIND       42024
  ACTIND       42023
```

```
RESTKA      42021
PL1CON      42104
PL2CON      42105
PL3CON      42106
PRCON       42107
RGGSAV      42114          *MOVE*      42114          00133          00091
RGGSTR      42176
IOCS        42250          CLOCK       42247          04335          02269
DEFINE      42251
JOIN        42254
ATTACH      42257
CLOSE       42262
OPEN        42265
READ        42270
WRITE       42273
COPY        42276
REW         42301
WEF         42304
BSR         42307
BSF         42312
STASH       42315

*LAB   * JUST LOADED.

  UNUSED CORE LIES FROM   46604   THROUGH   50001,  LEAVING   01176  OCTAL OR   00638   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
    REWIND      ENDFIL      SQRT        (DFDP)      (DFSB)      (DFMP)      (DFAD)      DMOD        DEFINE      ATTACH
    OPEN        CLOSE       EXP(3       RGGSAV      RGGSTR      CLOCK       READ

  THE NAME OF THIS PROGRAM IS *LA9   *      2/22/65

 ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  MOOPH1      22460         TYPRYT            22300       01322          00722
  OOOFF       22414         ODATA
  READS       22306         REWIND
                            OFFSYS
                            ENDFIL
                            ERROR
  TELTP1      23624         *MOVE*            23622       00003          00003
  TELTYP      23623
  (UNIT)      23622
  FIXT        23526         FIXTT             23625       00010          00008
  DIAG        23642         SQRT              23635       00105          00069          50031
  ERROR       23744         TYPRYT            23742       00442          00290
                            ONLIN
  FIXTT       24404         *MOVE*            24404       00312          00202          50031
  FLOT        24512
  FIX         24673
  FLOAT       24677
  DAYE        24707
  GHADP       24730         (DFDP)            24716       00320          00208          50031
                            (DFSB)
                            (DFMP)
                            (DFAD)
                            DMOD
                            COS
  QUIZ        25236         *MOVE*            25236       00002          00002
  OFFSYS      25240         *MOVE*            25240       00010          00008
  ENDSYS      25241
  FINSYS      25242
  SCHAIN      25243
  PGSTRT      25244
  PGSTOP      25245
  DCP         25246
  TYPRYT      25247
  SIN         25250         *MOVE*            25250       00243          00163
  COS         25253
  QSIN        25257
  QCOS        25261
  SPHX        25522         COS               25513       00323          00211          50031
                            SIN
                            GHADP
  STPREG      26046         (DFAD)            26036       02055          01069          71757
                            (DFDP)
                            DSQRT
                            (DFMP)
  DSQRT       30114         ERROR             30113       00106          00070          77776
  REDE        30222         DCP               30221       00422          00274
  RITE        30225
  PISA        30451
  ODATA       30566         TYPRYT            30643       03305          01733          50001
  ONLIN       30770         DEFINE
  ******      31136         ATTACH
                            OPEN
                            CARDS
                            OFFSYS
                            ERROR
                            FINSYS
                            CLOSE
                            OOOFF
                            READS
                            MOOPH1
                            FLOT
                            SPHX
                            STPREG
                            DIAG
                            REDE
                            DCP
                            EXP(3
  CARDS       34154         RGGSAV            34150       02266          01206
  CRDCON      34430         RGGSTR
  CRDCNV      34450         CLOCK
                            READ
  EXP(3       36436         *MOVE*            36436       00136          00094          77773
  (DFAD)      36574         *MOVE*            36574       00120          00080          77776
  (DFSB)      36614
  (DFMP)      36634
  (DFDP)      36662
  DMOD        36714         *MOVE*            36714       00060          00048          77776
  SQRT        36774         *MOVE*            36774       00054          00044          77773
  CLOCK       37053         *MOVE*            37050       00107          00071
  MINUTE      37050
  XMIN        37050
  READD       37160         (IOU)             37157       00365          00245
  READB       37162
  WRITEO      37165
```

```
WRITEB      37167
BSREC       37376
BSFILE      37401
REWIND      37404
UNLOAD      37407
ENDFIL      37412
SETLOW      37370
SETHI       37373
(UNIT)      ******
TAPEIO      37541
(IOU)       37547          'NOVE'      37544          00030          00024
RGGSAV      37574          'NOVE'      37574          00133          00091
RGGSTR      37656
IOCS        37730          CLOCK       37727          04335          02269
DEFINE      37731
JOIN        37734
ATTACH      37737
CLOSE       37742
OPEN        37745
READ        37750
WRITE       37753
COPY        37756
REW         37761
WEF         37764
BSR         37767
BSF         37772
STASH       37775

'LA9   ' JUST LOADED.

  UNUSED CORE LIES FROM   44264   THROUGH   50001,  LEAVING   03516  OCTAL OR   01870   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,
    FGDOUT      DEFINE      ATTACH      OPEN        CLOSE       COMENT      READB       PROUT

    THE NAME OF THIS PROGRAM IS 'LA1D  '      2/22/65

 ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.     OCTAL LENGTH     DECIMAL LENGTH     COMMON BREAK
   **PCB       22302                          22301          00006            00006
   PARSH       22316          PARSH           22307          01226            00662
                              FGDOUT
                              DEFINE
                              ATTACH
                              OPEN
                              CONDUT
                              WASH
                              CLOSE
   CONOUT      23536          COMENT          23535          00016            00014
   FIXT        23554          FIXTT           23553          00007            00007
   FIXTT       23562          'NOVE'          23562          00312            00202          50031
   FLOT        23670
   FIX         24051
   FLOAT       24055
   DAYE        24065
   FLAT        24076          ERROR           24074          00102            00066
   FLAPR       24124          TYPRYT
   FLAK        24133
   ERROR       24176          'NOVE'          24176          00011            00009
   WASH        24214          READB           24207          00623            00403
                              FLAT
                              FIXT
                              PROUT
                              FLAPR
   OFFSYS      25032          'NOVE'          25032          00010            00008
   ENDSYS      25033
   FINSYS      25034
   SCHAIN      25035
   PGSTRT      25036
   PGSTOP      25037
   DCP         25040
   TYPRYT      25041
   PROUT       25056          OUTUS           25042          03031            01561
   FGDOUT      26322          ACTIND
   PRCNV       25223          BFLG
   PROUT2      25174          RESTKA
   PROUT3      25207          REQIND
   TSXA        27231          WRITE
   TSXR        30021          PRCON
                              RGGSAV
                              RGGSTR
                              CKIND
                              CKACT
   READD       30074          (IOU)           30073          00365            00245
   READB       30076
   WRITED      30101
   WRITEB      30103
   BSREC       30312
   BSFILE      30315
   REWIND      30320
   UNLOAD      30323
   ENDFIL      30326
   SETLOW      30304
   SETHI       30307
   (UNIT)      30455
   TAPEIO      30455
   (IOU)       30461          'NOVE'          30460          00030            00024
   OUTUS       30512          RGGSAV          30510          02320            01232
   BFLG        31146          RGGSTR
   ENDOUT      31377
   CKIND       32741
   CKACT       33004
   REQIND      32740
   ACTIND      32737
   RESTKA      32735
   PL1CON      33020
   PL2CON      33021
   PL3CON      33022
   PRCON       33023
   RGGSAV      33030          'NOVE'          33030          00133            00091
   RGGSTR      33112
   IOCS        33164          CLOCK           33163          04336            02270
   DEFINE      33165
   JOIN        33170
   ATTACH      33173
   CLOSE       33176
   OPEN        33201
   READ        33204
   WRITE       33207
```

```
COPY        33212
REW         33215
WEF         33220
BSR         33223
BSF         33226
STASH       33231
COMENT      37522          CLOCK       37521          03177          01663
CLOCK       42723          *NONE*      42720          00106          00070
MINUTE      42720
XMIN        42720

*LA10  * JUST LOADED.

  UNUSED CORE LIES FROM   43026   THROUGH   50031,  LEAVING   05004  OCTAL OR   02564   DECIMAL LOCATIONS.


ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
    REWIND      SQRT        (DFSB)      READB       BSREC       (DFAD)      (DFMP)      (DFDP)      DKOD        WRITEB
    ENDFIL

  THE NAME OF THIS PROGRAM IS *LA11  *      2/22/65

ENTRY NAME   ENTRY ADD.   TRANSFER VECTORS   LOAD ADD.   OCTAL LENGTH   DECIMAL LENGTH   COMMON BREAK
  **PCB        22304          EPOX           22300          00022          00018
                              TRADE
                              TAPEX
                              LOCO
  LOCO         22332          REDE           22322          00165          00117
  TRADE        22455          REWIND
  EPOX         22466          KOOL
                              BNTR2
                              ENTR1
                              TYPRYT
                              EPPHEM
                              FLAK
  ACE          22514          SQRT           22507          00067          00055          47675
  BMATRX       22610          SQRT           22576          01432          00794          47675
                              G1G2
                              RCAL
                              RCOM
                              RSIG
                              ACE
  ERROR        24230          *NONE*         24230          00012          00010
  ADD          24242          *NONE*         24242          00050          00040
  ARSIN        24322          *NONE*         24312          00144          00100          77152
  ARCOS        24316
  QARSIN       24314
  QARCOS       24312
  ERRARS       24443
  ERRARC       24447
  ARTAN        24456          *NONE*         24456          00103          00067          77152
  DAYS         24564          FIX            24561          00042          00034
                              FLOAT
                              ADD
  EPPHEM       24644          QUIZ           24623          00604          00388          47675
                              PONT
                              KINE
                              STARP
                              (DFSB)
                              TIMER
                              LOOKUP
                              INTR1
                              KOOL
                              GAMAT
                              RITEM
                              TOCIN
                              WREOF
  FIXT         25430          FIXTT          25427          00007          00007
  FIXTT        25436          *NONE*         25436          00312          00202          50031
  FLOT         25544
  FIX          25725
  FLOAT        25731
  DAYE         25741
  FLAT         25752          ERROR          25750          00102          00066
  FLAPR        26000          TYPRYT
  FLAK         26007
  G1G2         26056          *NONE*         26052          00266          00182          50001
  EPHEM        26344          REWIND         26340          01452          00810
  TAPEX        27524          READB
                              BSREC
  PNUT         30020          SIN            30012          00336          00222          50001
                              COS
  ROT          30354          *NONE*         30350          00266          00182          50031
  GAMAT        30652          (DFAD)         30636          00614          00396          47675
                              (DFSB)
                              LOOKUP
                              INTR1
                              INSPC
                              BMATRX
                              (DFMP)
                              (DFDP)
  GHADP        31464          (DFDP)         31452          00320          00208          50031
                              (DFSB)
                              (DFMP)
                              (DFAD)
                              DKOD
                              COS
  INSPC        31776          *NONE*         31772          00310          00200          50031
  BNTR2        36365          EPHEM          32302          04214          02188
  INTR1        36406          PNUT
                              ROT
                              ERROR
  KINE         36520          REDE           36516          00200          00128          50001
                              ERROR
  LOOKUP       36720          ERROR          36716          00463          00307          47777
  KOOL         37250          REDE
  PONT         37414          OFFSYS         37401          00311          00201          51235
                              (DFAD)
                              TIMER
                              LOOKUP
                              INTR1
                              GAMAT
                              RITEM
```

QUIZ	37712	*NOVE*	37712	00003	00003	
RCAL	37722	SQRT	37715	00240	00160	50031
RCOM	40162	SQRT	40155	00133	00091	50031
WREOF	40431	FLAT	40310	02520	01360	
RITEH	40314	WRITEB				
		ENDFIL				
		REWIND				
RSIG	43034	*NOVE*	43030	00064	00052	47675
OFFSYS	43114	*NOVE*	43114	00010	00008	
ENDSYS	43115					
FINSYS	43116					
SCHAIN	43117					
PGSTRT	43120					
PGSTOP	43121					
DCP	43122					
TYPRYT	43123					
SIN	43124	*NOVE*	43124	00242	00162	
COS	43127					
QSIN	43133					
QCOS	43135					
STARP	43366	*NOVE*	43366	00031	00025	
TIMER	43426	(DFSB)	43417	00142	00098	50031
		LOOKUP				
		SQRT				
TOCIN	43600	OFFSYS	43561	01126	00598	
		TIMER				
		LOOKUP				
		INTRI				
		SQRT				
		KOOL				
		GAMAT				
		CHADP				
		COS				
		SIN				
		ARSIN				
		ARCOS				
		WRITEB				
		FLAT				
		RITE				
REDE	44710	DCP	44707	00421	00273	
RITE	44713					
PISA	45137					
(DFAD)	45330	*NOVE*	45330	00120	00080	77776
(DFSB)	45350					
(DFMP)	45370					
(DFDP)	45416					
DMOD	45450	*NOVE*	45450	00060	00048	77776
SQRT	45530	*NOVE*	45530	00055	00045	77773
READD	45606	(IOU)	45605	00365	00245	
READB	45610					
WRITED	45613					
WRITEB	45615					
BSREC	46024					
BSFILE	46027					
REWIND	46032					
UNLOAD	46035					
ENDFIL	46040					
SETLOW	46016					
SETHI	46021					
(UNIT)	46167					
TAPEID	46167					
(IOU)	46175	*NOVE*	46172	00030	00024	

'LA11 ' JUST LOADED.

UNUSED CORE LIES FROM 46222 THROUGH 47675, LEAVING 01454 OCTAL OR 00812 DECIMAL LOCATIONS.

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.

DEFINE ATTACH OPEN CLOSE SQRT PROUT (DFSB) (DFAD) FGOOUT EXIT

THE NAME OF THIS PROGRAM IS 'LA12 ' 2/22/65

ENTRY NAME	ENTRY ADD.	TRANSFER VECTORS	LOAD ADD.	OCTAL LENGTH	DECIMAL LENGTH	COMMON BREAK
**PCB	22302	SAVCOM	22301	00123	00083	
SAVCOM	22440	DEFINE	22424	02154	01132	
		ATTACH				
		OPEN				
		PRIM				
		OUFST				
		MAXIM				
		OFFSYS				
		TYPRYT				
		RITE				
		CLOSE				
		ERROR				
		FLAK				
BIBCD	24625	*NOVE*	24600	00055	00045	
DIAGO	24662	SQRT	24655	00105	00069	50031
ERROR	24766	TYPRYT	24762	00544	00356	
		PROUT				
		ENDSYS				
		RECOV				
FLAT	25530	ERROR	25526	00102	00066	
FLAPR	25556	TYPRYT				
FLAK	25565					
KINE	25632	REDE	25630	00215	00141	50001
		ERROR				
MAXIM	26056	QUIZ	26045	00473	00315	50001
		KINE				
		(DFSB)				
		(DFAD)				
		MOCT				
MOCT	26544	*NOVE*	26540	00107	00071	
NORMAY	26654	SQRT	26647	00252	00170	77461
APRED	27204	FIXT	27121	00143	00099	
UPREJ	27231					
OPERA	27122					
BUKEY	27264	*NOVE*	27264	00040	00032	
OPKEY	27270					
COKEY	27305					
AFKEY	27312					
PRIM	27345	FGOOUT	27324	01424	00788	50001
PRAM	27334	PROUT				
		BIBCD				
		FLAPR				
		PRIME				
		NORMAY				
		PRIT				
		DIAGO				
TAMP	30751	*NOVE*	30750	00004	00004	
PRIME	30752					
TAPR	30753					
DIAGO	******					

PRIT	30756	FIXT	30754	00035	00029	
		BIOCO				
QUEST	31020	SQRT	31031	00165	00117	47675
		ERROR				
		EXIT				
QUIZ	31176	*NONE*	31176	00002	00002	
RECOV	31200	*NONE*	31200	00002	00002	
SETUP	31204	RITE	31202	00105	00069	50031
		ENDSYS				
FIXT	31310	FIXTT	31307	00007	00007	
FIXTT	31316	*NONE*	31316	00312	00202	50031
FLOT	31424					
FIX	31605					
FLOAT	31611					
DAYE	31621					
OFFSYS	31630	*NONE*	31630	00011	00009	
ENDSYS	31631					
FINSYS	31632					
SCHAIN	31633					
PGSTRT	31634					
PGSTOP	31635					
DCP	31636					
TYPRYT	31637					
REDE	31642	DCP	31641	00421	00273	
RITE	31645					
PISA	32071					
EXIT	32263	*NONE*	32262	00210	00136	
EXSEL	32366					
EXITFN	32274					
ERRDMP	32262					
(DFAD)	32472	*NONE*	32472	00120	00080	77776
(DFSB)	32512					
(DFMP)	32532					
(DFDP)	32560					
SQRT	32612	*NONE*	32612	00054	00044	77773
PROUT	32702	OUTUS	32666	03032	01562	
FGDOUT	34146	ACTIND				
PRCNV	33047	BFLG				
PROUT2	33020	RESTKA				
PROUT3	33033	REQIND				
TSXA	35055	WRITE				
TSXB	35645	PRCON				
		RGGSAV				
		RGGSTR				
		CKIND				
		CKACT				
OUTUS	35722	RGGSAV	35720	02320	01232	
BFLG	36556	RGGSTR				
ENDOUT	36307					
CKIND	40151					
CKACT	40214					
REQIND	40150					
ACTIND	40147					
RESTKA	40145					
PL1CON	40230					
PL2CON	40231					
PL3CON	40232					
PRCON	40233					
RGGSAV	40240	*NONE*	40240	00133	00091	
RGGSTR	40322					
IOCS	40374	CLOCK	40373	04335	02269	
DEFINE	40375					
JOIN	40400					
ATTACH	40403					
CLOSE	40406					
OPEN	40411					
READ	40414					
WRITE	40417					
COPY	40422					
REW	40425					
WEF	40430					
BSR	40433					
BSF	40436					
STASH	40441					
CLOCK	44733	*NONE*	44730	00106	00070	
MINUTE	44730					
XMIN	44730					

*LA12 * JUST LOADED.

UNUSED CORE LIES FROM 45036 THROUGH 47675, LEAVING 02640 OCTAL OR 01440 DECIMAL LOCATIONS.

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY.
DEFINE ATTACH OPEN PROUT CLOSE (DFDP) (DFSB) (DFMP) (DFAD) DMOD
SQRT

THE NAME OF THIS PROGRAM IS *ODPX * 2/22/65

ENTRY NAME	ENTRY ADD.	TRANSFER VECTORS	LOAD ADD.	OCTAL LENGTH	DECIMAL LENGTH	COMMON BREAK
FIRST	22312	FDATA	22301	02070	01080	
		DEFINE				
		ATTACH				
		OPEN				
		PROUT				
		NOMNL				
		RITE				
		CLOSE				
		FLAK				
**PCB	24372	FIRST	24371	00007	00007	
ERROR	24400	*NONE*	24400	00012	00010	
FDATA	24412	*NONE*	24412	01117	00591	
FIXT	25532	FIXTT	25531	00007	00007	
FIXTT	25540	*NONE*	25540	00312	00202	50031
FLOT	25646					
FIX	26027					
FLOAT	26033					
DAYE	26043					
CHADP	26064	(DFDP)	26052	00320	00208	50031
		(DFSB)				
		(DFMP)				
		(DFAD)				
		DMOD				
		COS				
NOMNL	26376	*NONE*	26372	00763	00499	47777
NORMAY	27362	SQRT	27355	00251	00169	77461
QUIZ	27626	*NONE*	27626	00002	00002	
OFFSYS	27630	*NONE*	27630	00010	00008	
ENDSYS	27631					
FINSYS	27632					

```
SCHAIN      27633
PGSTRT      27634
PGSTOP      27635
OCP         27636
TYPRYT      27637
SIN         27640          'NOVE'      27640       00243       00163
COS         27643
QSIN        27647
QCOS        27651
REDE        30104          OCP         30103       00421       00273
RITE        30107
PISA        30333
FLAT        30526          ERROR       30524       00102       00066
FLAPR       30554          TYPRYT
FLAK        30563
(DFAD)      30626          'NOVE'      30626       00120       00080       77776
(DFSB)      30646
(DFMP)      30666
(DFDP)      30714
DKBB        30746          'NOVE'      30746       00060       00048       77776
SQRT        31026          'NOVE'      31026       00054       00044       77773
PROUT       31116          OUTUS       31102       03032       01562
FGDOUT      32362          ACTIND
PRCNV       31263          BFLG
PROUT2      31234          RESTKA
PROUT3      31247          REQIND
TSXA        33271          WRITE
TSXB        34061          PRCON
                           RGGSAV
                           RGGSTR
                           CKIND
                           CKACT
OUTUS       34136          RGGSAV      34134       02320       01232
BFLG        34772          RGGSTR
ENDOUT      34523
CKIND       36365
CKACT       36430
REQIND      36364
ACTIND      36363
RESTKA      36361
PL1CON      36444
PL2CON      36445
PL3CON      36446
PRCON       36447
RGGSAV      36454          'NOVE'      36454       00133       00091
RGGSTR      36536
IOCS        36610          CLOCK       36607       04335       02269
DEFINE      36611
JOIN        36614
ATTACH      36617
CLOSE       36622
OPEN        36625
READ        36630
WRITE       36633
COPY        36636
REW         36641
WFF         36644
BSR         36647
BSF         36652
STASH       36655
CLOCK       43147          'NOVE'      43144       00106       00070
MINUTE      43144
XMIN        43144

'OOPX  * JUST LOADED.

  UNUSED CORE LIES FROM   43252   THROUGH   47777,  LEAVING   04526  OCTAL OR   02390   DECIMAL LOCATIONS.
```

OJP COMMON MAP, JANUARY 4, 1965.

```
 77461      T COMMON  2                 RUNNING TIME
 77457  EPOCH COMMON  2                 EPOCH
 77455   TFIN COMMON  2                 FINAL TRAJECTORY TIME
 77453    TOB COMMON  2                 OBSERVATION TIME
 77451   DELT COMMON  2                 LIGHT TIME CORRECTION
 77447  TGINT COMMON  2                 LOWER LIMIT OF GINI INTEGRATION
 77445  DELT2 COMMON  2                 SECOND LIGHT TIME CORRECTION
        *             FORTRAN CARD 02
 77443    GHA COMMON  1                 GREENWICH HOUR ANGLE
 77442  GHAVJ COMMON  1                 INJECTION GHA
 77441  RUTMX COMMON  3*3               PRED. OF PRECESSION AND NUTATION MX.
 77430   DXDR COMMON  36
 77430        EQU     DXDR
 77427        EQU     DXDR+1           NOT ZERO FOR GEOCENTRIC INTEGRATION
 77426        EQU     DXDR+2           NOT ZERO TO UPDATE COMET
 77425        EQU     DXDR+3           BCD TARGET NAME
 77424        EQU     DXDR+4           TRANSPONDER DRIFT
 77423        EQU     DXDR+5
 77422        EQU     DXDR+6           TARGET (1=MARS 2=MOON 3=VENUS)
 77421        EQU     DXDR+7           PHYSICAL CONSTANTS STEP MULTIPLIER
 77420        EQU     DXDR+8           NOT ZERO FOR FLOATING RESIDUALS
 77417        EQU     DXDR+9           NOT ZERO INDICATES OPTICAL DATA
 77416        EQU     DXDR+10          NOT ZERO TO PUNCH J MATRIX
 77415        EQU     DXDR+11
 77414        EQU     DXDR+12          INITIAL TRAJ STEP SIZE
 77413        EQU     DXDR+13          NOT ZERO FOR MMP OUTPUT
 77412        EQU     DXDR+14          UP LEG SLANT RANGE
 77411        EQU     DXDR+15          DOWN LEG SLANT RANGE
 77410        EQU     DXDR+16          UP LEG REFRACTION CORRECTION
 77407        EQU     DXDR+17          DOWN LEG REFRACTION CORRECTION
 77406        EQU     DXDR+18          TFIN-EPOCH
 77405        EQU     DXDR+19          DP
 77404        EQU     DXDR+20          B.T FROM SPACE
 77403        EQU     DXDR+21          B.R FROM SPACE
 77402        EQU     DXDR+22
 77401        EQU     DXDR+23
 77400        EQU     DXDR+24
 77377        EQU     DXDR+25
 77376        EQU     DXDR+26
 77375        EQU     DXDR+27          NOT ZERO, OCCULTATION-IMPACT DATA
 77374        EQU     DXDR+28
 77373        EQU     DXDR+29
 77372        EQU     DXDR+30          RANDOM NUMBER STARTER
 77371        EQU     DXDR+31          SUBR. ERROR 1+4
 77370        EQU     DXDR+32          SUBR. ERROR 2+4
 77367        EQU     DXDR+33          SUBR. ERROR 3+4
 77366        EQU     DXDR+34          EPOCH YYMMDDHH
 77365        EQU     DXDR+35          EPOCH MMSSHF
        *             FORTRAN CARD 03
 77364   RVEC COMMON  1                 SLANT RANGE
 77363   RDOT COMMON  1                 SLANT RANGE RATE
 77362     EL COMMON  1                 ELEVATION ANGLE
 77361    AZI COMMON  1                 AZIMUTH ANGLE
```

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77360      DEC COMMON  1                   LOCAL DECLINATION ANGLE
77357       HA COMMON  1                   LOCAL HOUR ANGLE
77356       C1 COMMON  1                   1 WAY DOPPLER
77355      C13 COMMON  1                   COHERENT 3 WAY DOPPLER
77354       C3 COMMON  1                   3 WAY DOPPLER
77353      CD1 COMMON  1                   DIFFERENCED 1 WAY DOPPLER
77352      CD3 COMMON  1                   DSIF RANGING
77351      XXX COMMON  1                   EXTRA DATA TYPE
     *                 FORTRAN CARD 04
77350    DRVEC COMMON  1                   CORRECTIONS
77347    DRDOT COMMON  1
77346      DEL COMMON  1
77345      DAZ COMMON  1
77344     DDEC COMMON  1
77343      DHA COMMON  1
77342      DC1 COMMON  1
77341     DCC3 COMMON  1
77340      DC3 COMMON  1
77337     DCD1 COMMON  1
77336     DCD3 COMMON  1
77335     DXXX COMMON  1
     *                 FORTRAN CARD 05
77334    RVECO COMMON  1                   OBSERVED VALUES
77333    RDOTO COMMON  1
77332      ELO COMMON  1
77331      AZIO COMMON 1
77330     DECO COMMON  1
77327      HAO COMMON  1
77326      C1O COMMON  1
77325 *   CC3O COMMON  1
77324      C3O COMMON  1
77323     CD1O COMMON  1
77322     CD3O COMMON  1
77321     XXXO COMMON  1
     *                 FORTRAN CARD 06
77320    RVECD COMMON  1                   RESIDUALS (OBSERVED-CALCULATED)
77317    RDOTD COMMON  1
77316      ELD COMMON  1
77315      AZID COMMON 1
77314     DECD COMMON  1
77313      HAD COMMON  1
77312      C1D COMMON  1
77311     CC3D COMMON  1
77310      C3D COMMON  1
77307     CD1D COMMON  1
77306     CD3D COMMON  1
77305     XXXD COMMON  1
     *                 FORTRAN CARD 07
77304    RVECW COMMON  1                   WEIGHTS
77303    RDOTW COMMON  1
77302      ELW COMMON  1
77301      AZIW COMMON 1
77300     DECW COMMON  1
77277      HAW COMMON  1
77276      C1W COMMON  1
77275     CC3W COMMON  1
77274      C3W COMMON  1
77273     CD1W COMMON  1
77272     CD3W COMMON  1
77271     XXXW COMMON  1
     *                 FORTRAN CARD 08
77270       IR COMMON  1                   RECEIVER I.D.
77267       IX COMMON  1                   XMITTER I.D.
77266       ID COMMON  1                   CURRENT DATA TYPE
77265     PASS COMMON  1                   PASS IDENTIFICATION
77246     XJUP COMMON  6                   JUPITER VECTOR
77240     XSRN COMMON  6                   SATURN VECTOR
77232     XMAR COMMON  6                   MARS VECTOR
77224     XVEN COMMON  6                   VENUS VECTOR
77216     XSUN COMMON  6                   SUN VECTOR
77210     XMOO COMMON  6                   MOON VECTOR
     *                 FORTRAN CARD 09
77202       X COMMON  1                   PROBE VECTOR
77201       Y COMMON  1
77200       Z COMMON  1
77177    XDOT COMMON  1
77176    YDOT COMMON  1
77175    ZDOT COMMON  1
77174       U COMMON  36                  VARIATIONAL EQUATIONS
77130     DLO COMMON  1                   NUTATION IN LONGITUDE
77127     DOB COMMON  1                   NUTATION IN OBLIQUITY
     *                 FORTRAN CARD 10
77126     XAC COMMON  1                   PROBE ACCELERATION
77125     YAC COMMON  1
77124     ZAC COMMON  1
77123   XJERK COMMON  1                   PROBE JERK (THIRD DERIVATIVE)
77122   YJERK COMMON  1
77121   ZJERK COMMON  1
77120    UINV COMMON  36                  INVERSE OF VARIATIONAL EQUATIONS
77054    POBX COMMON  6*12                PARTIALS(OBSERVABLES/CARTESIAN)
76744    BMAT COMMON  6*11                B MATRIX OF PARTIALS
     *                 FORTRAN CARD 11
76642     ELX COMMON  1                   DIRECTION COSINES
76641     ELY COMMON  1
76640     ELZ COMMON  1
76637      AX COMMON  1                   DIRECTION COSINES
76636      AY COMMON  1
76635      AZ COMMON  1
76634      DX COMMON  1                   DIRECTION COSINES
76633      DY COMMON  1
76632      DZ COMMON  1
76631     TAX COMMON  1                   DIRECTION COSINES
76630     TAY COMMON  1
76627     TAZ COMMON  1
76626     TDX COMMON  1                   DIRECTION COSINES
76625     TDY COMMON  1
76624     TDZ COMMON  1
     *                 FORTRAN CARD 12
76623     TAU COMMON  1                   DOPPLER AVERAGING TIME
76622   ILIST COMMON  6                   POSITION AND VELOCITY FLAGS
76614   LLIST COMMON  11                  PHYSICAL CONSTANTS PARTIALS FLAGS
76601   MLIST COMMON  1                   VELOCITY OF LIGHT FLAG
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76600   NLIST COMMON  3*15              STATION LOCATION FLAGS
76523    NEST COMMON  1                 NO. ESTIMATED PARAMETERS
76522    NCON COMMON  1                 NO. CONSIDERED PARAMETERS
76521      EP COMMON  100
76521         EQU     EP                E.T.-U.T.
76520         EQU     EP+1
76513         EQU     EP+6              BAND(-1017=LS 0=L 1017=S)
76512         EQU     EP+7              K1 FREQUENCY
76511         EQU     EP+8              K5 FREQUENCY
76510         EQU     EP+9              BAND DESIGNATION (15 WORDS)
76471         EQU     EP+24             START TIME, ATTITUDE CONTROL
76470         EQU     EP+25             DP
76467         EQU     EP+26             STOP TIME, ATTITUDE CONTROL
76466         EQU     EP+27             DP
76465         EQU     EP+28
76457         EQU     EP+34             MCIM COMENT BUFFER (30 WORDS)
76421         EQU     EP+64             NOT ZERO TO READ CARDS FROM A2
76420         EQU     EP+65             ID FOR PREDICTS
76417         EQU     EP+66             POWERED FLIGHT PARAMETERS (10 WORDS)
76375         EQU     EP+84             STEP MAP FLAG-U PRODUCT
76374         EQU     EP+85             START TIME, STEP MAP PRINTOUT
76373         EQU     EP+86             DP
76372         EQU     EP+87             FLAG TO REPEAT TRAJ FOR STEP MAP
76371         EQU     EP+88             SPACE COMENT BUFFER (17 WORDS)
76350         EQU     EP+105            MAPPED FORWARD EPOCH
76347         EQU     EP+106            DP
76346         EQU     EP+107            FLAG FOR PUNCHING MATRICES
76345         EQU     EP+108            NOT ZERO TO BYPASS LAIL
76344         EQU     EP+109
76235   SIGX3 COMMON  12*15             REJECTION SIGMAS
*                     FORTRAN CARD 13.
75751       A COMMON  1                 COMMON
75750       B COMMON  1                 STORAGE
75747       C COMMON  1                 AVAILABLE
75746       D COMMON  1                 FOR
75745       E COMMON  1                 FAP
75744       F COMMON  1                 OR
75743       G COMMON  1                 FORTRAN
75742       H COMMON  1                 USAGE
75741       O COMMON  1
75740       P COMMON  1
75737       Q COMMON  1
75736       R COMMON  1
75735       S COMMON  1
*                     FORTRAN CARD 14
75734     RNJ COMMON  2                 SPHERICAL INJECTION CONDITIONS
75732   PHINJ COMMON  2
75730   THINJ COMMON  2
75726     VNJ COMMON  2
75724    ELNJ COMMON  2
75722    AZNJ COMMON  2
75720     XNJ COMMON  6                 CARTESIAN INJECTION CONDITIONS
75712    XNDP COMMON  6
*                     FORTRAN CARD 15
75704   GRAVE COMMON  1                 K(EARTH)
75703      RE COMMON  1                 EARTH RADIUS
75702     GMB COMMON  1                 RADIATION PRESSURE CONSTANT
75701   GRAVP COMMON  1                 K(MOON)
75700    RVEN COMMON  1                 MASS RATIO VENUS
75677    RMAR COMMON  1                 MASS RATIO MARS
75676    RJUP COMMON  1                 MASS RATIO JUPITER
75675      QJ COMMON  1                 COEFFICIENT SECOND HARMONIC
75674      QR COMMON  1                 COEFFICIENT THIRD HARMONIC
75673      QO COMMON  1                 COEFFICIENT FOURTH HARMONIC
75672      AU COMMON  1                 ASTRONOMICAL UNIT
75671     VELC COMMON  1                VELOCITY OF LIGHT
*                     FORTRAN CARD 16
75670       RI COMMON  15               STATION RANGE
75651     PHII COMMON  15               STATION LATITUDE (GEOCENTRIC)
75632   THETAI COMMON  15               STATION LONGITUDE
*                     FORTRAN CARD 17
75613    GRAVS COMMON  1                K(SUN)
75612    GRAVV COMMON  1                K(VENUS)
75611    GRAVM COMMON  1                K(MARS)
75610    GRAVJ COMMON  1                K(JUPITER)
75607    OMEGA COMMON  1                ANGULAR ROTATION RATE OF EARTH
75606       XI COMMON  1                STATION X(I)
75605       YI COMMON  1                STATION Y(I)
75604       ZI COMMON  1                STATION Z(I)
75603      RAI COMMON  1                STATION RIGHT ASCENSION
*                     FORTRAN CARD 18
75602       UI COMMON  15               NORTH SOUTH DISPLACEMENT (GEOD-GEOC)
75563       VI COMMON  15               EAST WEST DISPLACEMENT
75544      FNI COMMON  15               LOCAL INDEX OF REFRACTION
75525      TAB COMMON  1000
75525         EQU     TAB              DATA FILE INPUT BUFFER (400 WORDS)
74705         EQU     TAB+400          DATA FILE OUTPUT BUFFER (400 WORDS)
74065         EQU     TAB+800          SCRATCH AREA, LAB (200 WORDS)
73555       YI COMMON  49*24           PROBE EPHEMERIS INTERPOLATION BUFFER
71325     RESR COMMON  8*15            SCALE FACTORS
71135     IRES COMMON  8*15            PLOT FLAGS
70745      NHR COMMON  1               PLOT STEP
*                     FORTRAN CARD 19
70744     DRDC COMMON  12              VELOCITY OF LIGHT PARTIALS
70730     DIM3 COMMON  12*3*15         STATION PARTIALS BY DATA TYPE
67674   CPPHI COMMON  20               CAP PHI MATRIX OF PARTIALS
67650   CPPH2 COMMON  20               DP
67624   CPTHI COMMON  20               CAP THETA MATRIX OF PARTIALS
67600   CPTH2 COMMON  20               DP
67554       XJ COMMON  20*20           J MATRIX
66734      XJ2 COMMON  20*20           DP
66114       XK COMMON  400             SCRATCH 20*20 MATRIX
65274      XK2 COMMON  400             SCRATCH 20*20 MATRIX
64454    RIGHT COMMON  20              RESIDUAL*CPPHI ACCUMULATED
64430    RITE2 COMMON  20              DP
*                     FORTRAN CARD 20
64404    CPGAM COMMON  20*20           COVARIANCE MATRIX
63564   CPGM2 COMMON  20*20            DP
62744    GFLIP COMMON  400             INPUT COVARIANCE MATRIX (INVERSE)
62124    GFLP2 COMMON  400             DP
61304    GAMIN COMMON  20*20           COV MX OF UNADJUSTED PARAMETERS
60464     DINT COMMON  60              V MATRIX INTEGRAND
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60362    DIN2 COMMON  66                 DP
60260     DIG COMMON  48
60260         EQU     DIG
60231  PLOFIL EQU     DIG-23             IOCS PLOT  CONTROL (12 WORDS FORWARD)
60215  PUNFIL EQU     DIG-35             IOCS PUNCH CONTROL (12 WORDS FORWARD)
60201  PRIFIL EQU     DIG-47             IOCS PRINT CONTROL (12 WORDS FORWARD)
                      FORTRAN CARD 21
60200    YEAR COMMON  1                  7-WORD TIME BLOCK
60177   MONTH COMMON  1                  INTEGERS IN ADDRESS PART
60176     DAY COMMON  1                  FAP USE ONLY
60175    HOUR COMMON  1
60174     MIN COMMON  1
60173     SEC COMMON  1
60172    FRAC COMMON  1
                      FORTRAN CARD 22
60171     IF1 COMMON  1
60170     IF2 COMMON  1
60167     IF3 COMMON  1                  CONTENTS OF KEYS 10-17
60166     IF4 COMMON  1
60165     IF5 COMMON  1                  ZERO TO CLOSE DATA FILE/PREDICT OUTPUT
60164     IF6 COMMON  1                  DATA FILE READ  1B17=EOF  2B17=NORMAL
60163     IF7 COMMON  1
60162     IF8 COMMON  1                  NOT ZERO TO CHECK RESIDUAL REJECTION
60161     IF9 COMMON  1
60160    IF10 COMMON  1                  NOT ZERO TO PRINT PHI VECTORS
                      FORTRAN CARD 23
60157   KLIST COMMON  4                  FLAGS FOR ATTITUDE CONTROL ESTIMATION
60153    FABC COMMON  9                  ATTITUDE CONTROL COEFFICIENTS
60142   ELMIN COMMON  1                  MINIMUM ELEVATION ANGLE
60141    RMAX COMMON  1                  MAXIMUM SLANT RANGE
60140     RUN COMMON  1                  DATA FILE OUTPUT COUNTER
60137   BEFOR COMMON  1
60136      QA COMMON  11                 PARTIALS DF/DQ
60123      QB COMMON  6                  PARTIALS DF/DXO
60115    TOBL COMMON  2                  PREVIOUS TOB
60113     XMU COMMON  20                 SCRATCH COLUMN VECTOR
60067      XX COMMON  400                SCRATCH 20*20 MATRIX
57247      XC COMMON  400                SCRATCH 20*20 MATRIX
                      FORTRAN CARD 24
56427   IGNAZ COMMON  12*15              NOT ZERO TO IGNORE DATA POINT
56143    SDUR COMMON  2                  SUM OF SQUARED RESIDUALS
56141   BU225 COMMON  15*15              INPUT BUFFER
55600   BU12 COMMON   12                 DP INPUT BUFFER
                      FORTRAN CARD 25
55564      XN COMMON  3                  CORRECTED PROBE COORDINATES
55561     DXN COMMON  3
55556    DDXN COMMON  3
55553   DDDXN COMMON  3
55550      TS COMMON  1                  DATA SAMPLE INTERVAL
55547     SSQ COMMON  12*6*4             S**2 WEIGHTING TABLE
55107      TL COMMON  12*6*4             T WEIGHTING TABLE
54447     GSQ COMMON  6                  G WEIGHTING TABLE
54441   OHBAD COMMON  12                 NOT ZERO IF DATA TYPE REJECTED LAST
                      FORTRAN CARD 26
54425   QTILD COMMON  20                 A PRIORI ESTIMATE
54401     QTP COMMON  20                 DP
54355      QP COMMON  20                 ESTIMATED CONDITIONS AND CONSTANTS
54331    QPDP COMMON  20
54305     CZ1 COMMON  1                  DOPPLER COEFFICIENTS
54304     CZ2 COMMON  1
54303     CZ3 COMMON  1
54302     CZ4 COMMON  1
54301     CZ5 COMMON  1
54300     CZ6 COMMON  1
54277      PI COMMON  45                 INITIAL POINTING TIMES
54222     PID COMMON  45                 POINTING COUNT INTERVALS
54145     PIF COMMON  45                 FINAL POINTING TIMES
54070    PIFD COMMON  45
54070         EQU     PIFD               OCCULTATION-IMPACT TIMES (30 WORDS)
54032         EQU     PIFD-30            START-STOP TIMES (12 WORDS)
54016         EQU     PIFD-42
54013    PINI COMMON  45                 POINTING SAMPLE INTERVAL
53736   PINTD COMMON  45                 CURRENT POINTING TIME
53661   BALNC COMMON  12*15              INPUT WEIGHTS
                      FORTRAN CARD 27
53375  COSRAI COMMON  1                  COS(RAI)
53374  SINRAI COMMON  1                  SIN(RAI)
53373  COSPHI COMMON  1                  COS(PHII)
53372  SINPHI COMMON  1                  SIN(PHII)
53371   SINEL COMMON  1                  SIN(EL)
53370    C137 COMMON  1                  NOT ZERO TO BYPASS LAI3
53367    GADT COMMON  1                  PHYSICAL CONSTANTS INTEGRATION STEP
53366    CAPU COMMON  1                  U SUM OF SQUARES
53365   CAPQL COMMON  1
53364     DCQ COMMON  1
                      FORTRAN CARD 28
53363    NTOT COMMON  1                  NUMBER OF POINTS IN SOUR
53362     QNU COMMON  20                 NEW Q-S (QP+RIGHT)
53336    QNUD COMMON  20                 DP
53312     ITNU COMMON  1                 ITERATION NUMBER
53311   COSEL COMMON  1                  COS(EL)
53310   SINAZ COMMON  1                  SIN(AZ)
53307   COSAZ COMMON  1                  COS(AZ)
                      FORTRAN CARD 29
53306    CORR COMMON  400                SCRATCH 20*20 MATRIX
52466    GMP COMMON   400                SCRATCH 20*20 MATRIX
51666    GMAT COMMON  66                 V MATRIX OF PARTIALS
51544     IFA COMMON  10
51544         EQU     IFA                ZERO TO INTEGRATE TO ENCOUNTER
51543         EQU     IFA-1
51542         EQU     IFA-2
51541         EQU     IFA-3              NOT ZERO FOR DATA SIGMA OUTPUT
51540         EQU     IFA-4              RADIUS OF TARGET
51537         EQU     IFA-5
51536         EQU     IFA-6
51535         EQU     IFA-7              NOT ZERO TO TURN OFF SOLAR PRESSURE
51534         EQU     IFA-8              NOT ZERO TO TURN OFF LIGHT TIME
51533         EQU     IFA-9              NOT ZERO TO TURN OFF REFRACTION
51532   XFREQ COMMON  1                  XMITTER FREQUENCY
51531   TFREQ COMMON  1                  XPONDER FREQUENCY
51530    KEYS COMMON  1                  CONTENTS OF KEYS
51527   XPDBX COMMON  6                  XMITTER BOOT PARTIALS
51521   TXCON COMMON  6*15               FREQUENCY COEFFICIENTS
51367   TXCNZ COMMON  6*15               DP
                      FORTRAN CARD 30
51235   CONTS COMMON  11                 PAGE HEADING
51222   SIGMA COMMON  12*15              DATA FILE SIGMA
50736    BIAS COMMON  12*15              DATA FILE BIAS
50452    TMAP COMMON  2                  CURRENT MAPPING TIME
50450  ITERAT COMMON  1
50447     YYI COMMON  6*45               TRANSMITTER ID TABLE
50031    TIMAP COMMON  24                MAPPING TIMES
50001    AREA COMMON  1                  S/C AREA
50000   FMASS COMMON  1                  S/C MASS
47777    GAMM COMMON  66                 PHYSICAL CONSTANTS INTEGRATION MATRIX
47675    CAPU COMMON  400                MAPPING MATRIX TO ENCOUNTER
             END
```

V. OUTPUT

Primary output from the ODP is in the form of a BCD tape which may be listed on the IBM 1401. This listing contains the following items:

1. List of card input
2. A priori covariance matrix
3. Inverse of a priori covariance matrix
4. Trajectory information
5. J matrix
6. J matrix correlations
7. Parameter estimates and statistics
8. Inverse of J matrix
9. Covariance matrix
10. Covariance matrix correlations

The following items are output on option:

1. Residuals, computed observables, weights, and frequencies
2. Residual statistics
3. Pointing ephemeris
4. Mapping matrix
5. Mapped covariance matrix
6. Position and velocity of probe at mapping times
7. Encounter parameters and statistics
8. Supplementary printout at data times--vectors and partials

All items, with the exception of the supplementary partials printout, may be printed on the SC-3070 in SFOF Mode II operation.

Any matrix which is printed by the ODP may also be punched on option. In this case the card images are written on the same BCD output tape for punching by the 1401.

The ODP also writes a plotting tape for the SC-4020 plotter, containing plots of residuals versus time, and angle residuals versus angles.

A binary tape for the Matrix Manipulation Program, containing data partials and mapping matrices, is generated on option. This capability does not exist in Mode II operation.

Error comments and status-of-program messages are printed on the administrative printer in Mode II and the on-line printer in Mode IV. Refer to Subroutine 28, ERROR, for a listing of these comments.

A. DISK AND TAPE FORMATS

The Planetary Ephemeris format is presented in Ref. 4, and the Matrix Manipulation Program tape format in Ref. 11 (Section IX). The other formats are covered in Section VI; the Prediction File is presented in Subroutine 30, FILL; the Data File in Subroutine 43, KINE; the Probe Ephemeris in Subroutine 45, LOOKUP; and the Combined Ephemeris in Subroutine 86, RITEM.

B. OUTPUT SYMBOLS AND DEFINITIONS

The following symbols appear on the output listings. The corresponding symbols used in this report and the definitions are given:

Output symbol	Report symbol	Definition
X	x	position of probe, geocentric equatorial true of date, km
Y	y	
Z	z	
DX	$\dot{x}$	velocity of probe, geocentric equatorial true of date, km/sec
DY	$\dot{y}$	
DZ	$\dot{z}$	
KE	GM_e	gravitational constant of Earth, km^3/sec^2
RE	R_e	equatorial radius of Earth, km
G	γB	solar pressure constant
KM	GM_m	gravitational constant of Moon, km^3/sec^2
MV	M_v	mass of Venus, solar masses
MM	M_r	mass of Mars, solar masses

Output symbol	Report symbol	Definition
MJ	M_j	mass of Jupiter, solar masses
J	J	second harmonic coefficient
H	H	third harmonic coefficient
D	D	fourth harmonic coefficient
AU	a_e	astronomical unit, km
FA	F_{ao}	attitude control coefficients
FB	F_{bo}	
FC	F_{co}	
C	c	speed of light, km/sec
RI(I)	R_i	radius of Earth at station i, km
LA(I)	ϕ_i	geocentric latitude of station i, deg
LO(I)	λ_i	longitude of station i, deg
R	ρ	slant range, km
DR	$\dot{\rho}$	slant range rate, km/sec
EL	γ	elevation angle, deg
AZ	σ	azimuth angle, deg
DEC	δ	declination, deg
HA	α	hour angle, deg
C1	f_1	one-way integrated doppler frequency, cps
CC3	f_{c3}	coherent three-way integrated doppler frequency, cps
C3	f_3	three-way integrated doppler frequency, cps
D1	f_{d1}	differenced one-way integrated doppler frequency, cps

Output symbol	Report symbol	Definition
RU	ρDSIF	DSIF ranging
B	$\lvert B \rvert$	vector from target center of mass perpendicular to probe asymptote, km
B·RO	$\underline{B}\cdot\underline{R}_0$	dot products, target orbital plane, km
B·TO	$B\cdot T_0$	
B·RT	$\underline{B}\cdot\underline{R}_T$	dot products, target equatorial plane, km
B·TT	$B\cdot\underline{T}_T$	
TL	t_L	linearized time of flight, hours (lunar missions) or days
TF	t_f	true time of flight, hours (lunar missions) or days
SMAA	a	semi-major axis of dispersion ellipse at target, km
SMIA	b	semi-minor axis, km
THETA	θ	inclination of dispersion ellipse to target orbital plane, deg
DEL T	σ_t	standard deviation of linearized time of flight, sec
DEL B	σ_B	standard deviation of $\underline{B}$ vector, km
DEL S	σ_S	standard deviation of asymptote unit vector, km
DEL BR	$\sigma_{\underline{B}\cdot\underline{R}}$	standard deviation of $\underline{B}\cdot\underline{R}$, km
DEL BT	$\sigma_{\underline{B}\cdot\underline{T}}$	standard deviation of $\underline{B}\cdot\underline{T}$, km
C3	c_3	vis viva energy, km^2/sec^2
TC	τ	doppler count time, sec
Q	q	transmitter index
FRQ	f_q	if $q \neq 0$, station frequency less 29.66×10^6 cps
	f_T	if $q = 0$, probe frequency less 960×10^6 cps

VI. SUBROUTINES

Section VI contains the documentation for the 104 Subroutines which were written primarily for use by the SPODP. Documentation is not included for JPL general-purpose routines and SFOF routines.

IDENTIFICATION

AAT
Melba Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

This subroutine forms the matrix product of two vectors.

RESTRICTIONS

Standard Fortran II arrays.

USE

CALL	AAT (X, Y, PRO)
X (1, 6)	P
Y (6, 1)	P^T
PRO (6, 6)	Product matrix

CODING INFORMATION

Length of subroutine is 77 (10) or 115 (8) words.

IDENTIFICATION

ABDD
Charles Coltharp, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

ABDD computes the function.

$$S = \frac{Z_i(ax + by) - cz}{d},$$

the form of which has frequent application in ODP station location partial expressions.

RESTRICTIONS

COMMON break: 47675

USE

CALL ABDD
PZE D d
PZE R x, y, z (1 x 3)
COMMON input:
O a
B b
C c
Z_i Z - component of geocentric station vector, km.
COMMON output:
S s

CODING INFORMATION

Length of subroutine is 24 (10) or 30 (8) words.

IDENTIFICATION 3

ACE
Melba Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To compute the unit vector as needed in calculation of the attitude control effects partials in BMATRX.

RESTRICTIONS

a. COMMON from ODP
b. Subroutines used:
SQRT

USE

CALL ACE (DDX)
Computes R, X/R etc, and stores the result in DDX(I).

CODING INFORMATION

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

IDENTIFICATION 4

ANGPLT
Alfred Schoepke, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

ANGPLT plots hour angle residuals versus hour angle, and declination residuals versus declination. A tape containing the plotting information is written for the SC-4020.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutine used:
   PKINE
   FIXT
   BIBCD
   CXPLOT

USE

CALL ANGPLT
COMMON input:

IR	station identification
RVECD	residual array
RVEC	data type array

CODING INFORMATION

Length of subroutine is 383 (10) or 577 (8) words.

IDENTIFICATION 5

AQUI/ALLI/BAQUI/BALLI
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To format, list, and send, via TELTYP, predictions needed by the tracking stations.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   PROUT
   FGDOUT
   PKINE
   FIXT
   TELTYP
   ENDOUT
   BIBCD

In MODE 2, the predictions are transmitted in real time by TELTYP. In MODE 4, a magnetic tape (A9) is written by TELTYP. This tape is then processed to punch paper tape acceptable to the teleprinters.

USE

CALL	AQUI	to list predictions
CALL	BAQUI	to prepare for transmission
CALL	ALLI	to list drive tape for Goldstone
CALL	BALLI	to prepare drive tape for transmission

CODING INFORMATION

Length of subroutine is 460 (10) or 714 (8) words.

REFERENCE

Heller, J., IOM to F. Curl, Nominal Predict Format, June 10, 1963.

IDENTIFICATION 6

BEER
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

BEER stores zeroes in certain ODP common locations prior to the data fit. It also executes the reset entry of REJEC.

RESTRICTIONS

a. COMMON break: 46711
b. Subroutine called:
REJEC

USE

CALL BEER
COMMON output: zeroes in DINT, DIN2, QA, QB, TOBL, TOBL-1, TGINT, TGINT-1, XMU, RIGHT, RITE2, XX, XC, XJ, XJ2, XK, XK2, IF2, IF4. BIGNO in IF1 and IF5.

CODING INFORMATION

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

IDENTIFICATION

7

BIBCD
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To convert the binary equivalent of 2 digit decimal numbers to BCD for print-out.

RESTRICTION

Range of numbers: $1 \leq n \leq 99$

USE

With argument in the accumulator
CALL BIBCD
The BCD equivalent is in the accumulator on return.

CODING INFORMATION

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

IDENTIFICATION

BMATRX
Melba Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

BMATRX is written to compute the analytic partials of the physical constants when these parameters are being estimated or considered in the ODP.

RESTRICTIONS

a. COMMON break: 47675
b. When computing partials of the attitude control effects, partials of MJ, H, and D are inhibited, thus a maximum of 11 of the possible 14 can be computed at one time.
c. Subroutines used:
   ACE
   GIG2
   RCAL
   RCOM
   RSIG
   SQRT

METHOD

Formulas for the partial derivatives of acceleration with respect to physical constants, $\partial\ddot{r}/\partial q$, are derived from the equations of motion. These are integrated to obtain $\partial r/\partial q$.

The equations for these partials follow:

$$\frac{\partial \ddot{x}}{\partial GM_e} = \frac{-xg_1}{r^3}$$

$$\frac{\partial \ddot{y}}{\partial GM_e} = \frac{-yg_1}{r^3}$$

$$\frac{\partial \ddot{z}}{\partial GM_e} = \frac{-zg_2}{r^3}$$

$$\frac{\partial \ddot{x}}{\partial R_e} = \frac{-GM_m}{R_e}\left\{2x_m\left[\frac{1}{|\underline{r}_m - \underline{r}|^3} - \frac{1}{r_m^3}\right] - 3\frac{\left(\underline{r}\cdot\underline{r}_m - r^2\right)\left(x - x_m\right)}{|\underline{r}_m - \underline{r}|^5} - \frac{3\dot{x}}{|\underline{r}_m - \underline{r}|^3}\right\} \qquad x \to y, z$$

$$\frac{\partial \ddot{x}}{\partial \gamma B} = \frac{c_1 A_p (x - x_s)}{M_p \left| \underline{r} - \underline{r}_s \right|^3} \qquad x \rightarrow y, z$$

where

$c_1 = 1.031 \times 10^8$

A_p = surface area of probe, m^2

M_p = mass of probe, kg

$$\frac{\partial \ddot{x}}{\partial GM_m} = -\left[\frac{x_m}{r_m^3} + \frac{(x - x_m)}{\left| \underline{r}_m - \underline{r} \right|^3} \right] \qquad x \rightarrow y, z$$

$$\frac{\partial \ddot{x}}{\partial M_v} = -GM_s \left[\frac{x_v}{r_v^3} + \frac{(x - x_v)}{\left| \underline{r}_v - \underline{r} \right|^3} \right] \qquad x \rightarrow y, z$$

$$\frac{\partial \ddot{x}}{\partial M_r} = -GM_s \left[\frac{x_r}{r_r^3} + \frac{(x - x_r)}{\left| \underline{r}_r - \underline{r} \right|^3} \right] \qquad x \rightarrow y, z$$

$$\frac{\partial \ddot{x}}{\partial M_j} = -GM_s \left[\frac{x_j}{r_j^3} + \frac{(x - x_j)}{\left| \underline{r}_j - \underline{r} \right|^3} \right] \qquad x \rightarrow y, z$$

$$\frac{\partial \ddot{x}}{\partial J} = -x \left[1 - 5\left(\frac{z}{r}\right)^2 \right] \frac{GM_e}{r^2} \frac{R_e^2}{r^3} \qquad x \rightarrow y$$

$$\frac{\partial \ddot{z}}{\partial J} = -z \left[3 - 5\left(\frac{z}{r}\right)^2 \right] \frac{GM_e}{r^2} \frac{R_e^2}{r^3}$$

$$\frac{\partial \ddot{x}}{\partial H} = x \left[7\left(\frac{z}{r}\right)^2 - 3 \right] \frac{z}{r} \frac{GM_e}{r^3} \frac{R_e^3}{r^3} \qquad x \rightarrow y$$

$$\frac{\partial \ddot{z}}{\partial H} = \left[1 - 10\left(\frac{z}{r}\right)^2 + \frac{35}{3}\left(\frac{z}{r}\right)^4 \right] \frac{3r}{5} \frac{GM_e}{r^3} \frac{R_e^3}{r^3}$$

$$\frac{\partial \ddot{x}}{\partial D} = -x \left[3 - 42\left(\frac{z}{r}\right)^2 + 63\left(\frac{z}{r}\right)^4 \right] \frac{GM_e}{7r^3} \frac{R_e^4}{r^4} \qquad x \rightarrow y$$

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$$\frac{\partial \ddot{z}}{\partial D} = -z\left[15 - 70\left(\frac{z}{r}\right)^2 + 63\left(\frac{z}{r}\right)^4\right]\frac{GM_e}{7r^3}\frac{R_e^4}{r^4}$$

$$\frac{\partial \ddot{x}}{\partial a_e} = \frac{1}{a_e}\sum_{k=1}^{4} GM_k\left[x_k\left(\frac{1}{|\underline{r}_k - \underline{r}|^3} - \frac{1}{r_k^3}\right) - \frac{3\left(r^2 - \underline{r}\cdot\underline{r}_k\right)\left(x - x_k\right)}{|\underline{r}_k - \underline{r}|^5}\right] \qquad x \rightarrow y, z$$

where

k = 1 = Sun
k = 2 = Venus
k = 3 = Mars
k = 4 = Jupiter

The partial derivatives of acceleration with respect to the attitude control effects are given by

$$\begin{bmatrix} \frac{\partial \ddot{x}}{\partial F_{AO}} & \frac{\partial \ddot{x}}{\partial F_{BO}} & \frac{\partial \ddot{x}}{\partial F_{CO}} \\ \frac{\partial \ddot{y}}{\partial F_{AO}} & & \vdots \\ \frac{\partial \ddot{z}}{\partial F_{AO}} & \cdots & \frac{\partial \ddot{z}}{\partial F_{CO}} \end{bmatrix} = \frac{10^{-8}}{m}\begin{bmatrix} A_x & B_x & C_x \\ A_y & B_y & C_y \\ A_z & B_z & C_z \end{bmatrix}$$

where the unit vectors along the three body fixed axes are defined by

$$\overline{A} = \frac{-\overline{H}(\overline{E}\cdot\overline{H}) + \overline{E}}{|\overline{H}(\overline{E}\cdot\overline{H}) - \overline{E}|} = A_x, A_y, A_z$$

$$\overline{B} = \frac{\overline{E} \times \overline{H}}{|\overline{E} \times \overline{H}|} = B_x, B_y, B_z$$

$$\overline{C} = -\overline{H} = C_x, C_y, C_z$$

and

$\overline{E} = E_x, E_y, E_z$ = Unit vector directed from the probe toward Canopus

$\overline{H} = H_x, H_y, H_z$ = Unit vector directed from the probe toward the Sun

USE 8-4 of 4

CALL BMATRX

The subroutine checks lists in the COMMON area to determine what is required.

CODING INFORMATION

Length of subroutine is 794(10) or 1432(8) words.

REFERENCES

a. Anderson, John D., RFP 312-37, August 29, 1961.

b. Null, George W., RFP 312-179, Addendum 3, December 11, 1963.

IDENTIFICATION

CALL
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

CALL serves as the logical control routine for the data fitting link, LA6. All steps from reading the ODG data file through computation of partials and residuals to writing the residual file are initiated by this routine.

RESTRICTIONS

a. COMMON break: 46711
b. Subroutines called:
   BEER
   KINE
   COEF
   STARP
   (DFSB)
   REAP
   CHADP
   DOPLR
   COROP
   CORR
   DICOS
   OBTOX
   CATS
   OFFSYS
   WAIT
   QUIZ
   REJEC
   PM360
   FORM
   GERTA/GREOF
   FILL

USE

CALL CALL

COMMON input:

IGNAZ	data type delete flags (12 × 15)
PTFD-30	data start and stop times
LLIST	physical constants solve flags (11)
EPOCH	ODP epoch, d.p. sec past 1950.0
THETAI	station longitude, deg
SIGX3	rejection sigmas (12 × 15)
DXDR-27	occultation-impact data flag

COMMON output:

HAO	observed hour angle from observed optical right ascension
RVECD	residual array
TOBL	previous observation time

CODING INFORMATION

Length of subroutine is 339 (10) or 528 (8) words.

IDENTIFICATION

CATS
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

CATS computes the partials of the ODP data types with respect to the station locations. Such a partial may be non-zero only if the tracking datum is from the same station as the specified station location.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines called:
   VEC
   ABDD
   COS

METHOD

$$\left.\begin{aligned} X_i &= R_i \cos(\alpha_G + \lambda_i)\cos\phi_i \\ Y_i &= R_i \sin(\alpha_G + \lambda_i)\cos\phi_i \\ Z_i &= R_i \sin\phi_i \end{aligned}\right\} \text{(station coordinates)}$$

$$\left.\begin{aligned} \frac{\partial \rho_i}{\partial R_i} &= \frac{1}{R_i}(\underline{R}_i \cdot \underline{L}) \\ \frac{\partial \rho_i}{\partial \phi_i} &= Z_i\left\{\left[L_x \cos(\alpha_G + \lambda_i) + L_y \sin(\alpha_G + \lambda_i)\right] - L_z R_i \cos\phi_i\right\} \\ \frac{\partial \rho_i}{\partial \lambda_i} &= Y_i L_x - X_i L_y \end{aligned}\right\} \text{(slant range partials)}$$

where

$$\underline{L} = \frac{\underline{\rho} + \underline{r}_s}{\rho}$$

λ_i = station longitude

ϕ_i = station geocentric latitude

R_i = station Earth radius

$$\left.\begin{aligned} \frac{\partial \dot{\rho}_i}{\partial R_i} &= \frac{1}{\underline{R}_i}\,(\underline{R}_i \cdot \underline{L}') \\ \frac{\partial \dot{\rho}_i}{\partial \phi_i} &= -Z_i\left\{\left[L_x' \cos(a_G + \lambda_i) + L_y' \sin(a_G + \lambda_i)\right] + L_z' R_i \cos\phi_i\right\} \\ \frac{\partial \dot{\rho}_i}{\partial \lambda_i} &= -Y_i L_x' + X_i L_y' \end{aligned}\right\} \text{(range rate partials)}$$

where

$$L_x' = \frac{1}{\rho_i}\,(-\dot{x} - 2\omega Y_i + \dot{\rho}_i L_x + \omega y)$$

$$L_y' = \frac{1}{\rho_i}\,(-\dot{y} + 2\omega X_i + \dot{\rho}_i L_y - \omega x)$$

$$L_z' = \frac{1}{\rho_i}\,(-\dot{z} + \rho_i L_z)$$

$$\left.\begin{aligned} \frac{\partial \gamma_i}{\partial R_i} &= \frac{-1}{R_i \rho_i}\,(\underline{R}_i \cdot \underline{\tilde{D}}) \\ \frac{\partial \gamma_i}{\partial \phi_i} &= \frac{1}{\rho_i}\left\{Z_i\left[\tilde{D}_x \cos(a_G + \lambda_i) + \tilde{D}_y \sin(a_G + \lambda_i)\right] - \tilde{D}_z R_i \cos\phi_i\right\} \\ \frac{\partial \gamma_i}{\partial \lambda_i} &= \frac{1}{\rho_i}\,(Y_i \tilde{D}_x - X_i \tilde{D}_y) \end{aligned}\right\} \text{(elevation angle partials)}$$

$$\frac{\partial \sigma_i}{\partial R_i} = \frac{-1}{R_i \rho_i} (\underline{R}_i \cdot \underline{\tilde{A}})$$

$$\frac{\partial \sigma_i}{\partial \phi_i} = \frac{1}{\rho_i} \left\{ Z_i \left[\tilde{A}_x \cos(\alpha_G + \lambda_i) + \tilde{A}_y \sin(\alpha_G + \lambda_i) \right] - \tilde{A}_z R_i \cos \phi_i \right\}$$

$$\frac{\partial \sigma_i}{\partial \lambda_i} = \frac{1}{\rho_i} (Y_i \tilde{A}_x - X_i \tilde{A}_y)$$

10-3 of 5

(azimuth angle partials)

$$\frac{\partial \gamma_i}{\partial S_i} (\underline{\tilde{D}}) \rightarrow \frac{\partial \delta_i}{\partial S_i} (\underline{D}) \quad \text{(declination partials)}$$

$$\frac{\partial \sigma_i}{\partial S_i} (\underline{\tilde{A}}) \rightarrow \frac{\partial \alpha_i}{\partial S_i} (\underline{A}) \quad \text{(hour angle partials)}$$

where

$$D_x = - \sin \delta_i \cos(\alpha_G + \lambda_i)$$

$$D_y = - \sin \delta_i \sin(\alpha_G + \lambda_i)$$

$$D_z = \cos \delta_i$$

$$A_x = - \sin(\alpha_G + \lambda_i)$$

$$A_y = \cos(\alpha_G + \lambda_i)$$

$$A_z = 0$$

$$\tilde{D}_x = \sin \gamma_i \left[\sin \sigma_i \sin(\alpha_G + \lambda_i) + \cos \sigma_i \sin \phi_i \cos(\alpha_G + \lambda_i) \right] + \cos \phi_i \cos(\alpha_G + \lambda_i) \cos \gamma_i$$

$$\tilde{D}_y = - \sin \gamma_i \left[\sin \sigma_i \cos(\alpha_G + \lambda_i) - \cos \sigma_i \sin \phi_i \sin(\alpha_G + \lambda_i) \right] + \cos \phi_i \sin(\alpha_G + \lambda_i) \cos \gamma_i$$

$$\tilde{D}_z = - \cos \sigma_i \cos \phi_i \sin \gamma_i + \sin \phi_i \cos \gamma_i$$

$$\tilde{A}_x = - \cos \sigma_i \sin(\alpha_G + \lambda_i) + \sin \sigma_i \sin \phi_i \cos(\alpha_G + \lambda_i)$$

$$\tilde{A}_y = \cos \sigma_i \cos(\alpha_G + \lambda_i) + \sin \sigma_i \sin \phi_i \sin(\alpha_G + \lambda_i)$$

$$\tilde{A}_z = - \sin \sigma_i \cos \phi_i$$

The vectors $\underline{A}$, $\underline{D}$, $\tilde{\underline{A}}$, and $\tilde{\underline{D}}$, defined above, are computed by subroutine DICOS.

$$\frac{\partial f_{1i}}{\partial S_i} = \frac{\Omega_2}{c} \frac{\partial \dot{\rho}_i}{\partial S_i}$$ (one-way doppler partials)

$$\frac{\partial f_{c3i,q}}{\partial S_i} = \frac{\Omega_4}{c} \frac{\partial \dot{\rho}_i}{\partial S_i}$$ (two-way doppler receiver partials)

$$\frac{\partial f_{3i,q}}{\partial S_i} = \frac{\Omega_6}{c} \frac{\partial \dot{\rho}_i}{\partial S_i}$$ (three-way doppler receiver partials)

$$\frac{\partial f_{dli,j}}{\partial S_i} = \frac{\Omega_2}{c} \frac{\partial \dot{\rho}_i}{\partial S_i}$$ (differenced one-way doppler receiver i partials)

$$\frac{\partial f_{c3i,q}}{\partial S_q} = \frac{\Omega_4}{c} \frac{\partial \dot{\rho}_q}{\partial S_q}$$ (two-way doppler transmitter partials)

$$\frac{\partial f_{3i,q}}{\partial S_q} = \frac{\Omega_6}{c} \frac{\partial \dot{\rho}_q}{\partial S_q}$$ (three-way doppler transmitter partials

$$\frac{\partial f_{dli,j}}{\partial S_j} = \frac{\Omega_2}{c} \frac{\partial \dot{\rho}_j}{\partial S_j}$$ (differenced one-way doppler receiver j partials)

where

Ω_2 = one-way multiplier

Ω_4 = two-way multiplier

Ω_6 = three-way multiplier

USE

CALL CATS

COMMON inputs:

RI	R_i, km
PHII	ϕ_i, deg
THETAI	λ_i, deg
GHA	α_G, deg
ELX	$\underline{L}$
AX	$\underline{A}$
DX	$\underline{D}$
TAX	$\underline{\tilde{A}}$
TDX	$\underline{\tilde{D}}$
RVEC	ρ_i, km
OMEGA	ω, deg/sec
X	$\underline{r}$, km
XDOT	$\dot{\underline{r}}$, km/sec
CZ2	Ω_2
CZ4	Ω_4
CZ6	Ω_6

COMMON output:

DIM3 partials $\frac{\partial F}{\partial S_i}$ $(12 \times 3 \times 15)$

CODING INFORMATION

Length of subroutine is 421 (10) or 645 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM33-168, March 18, 1964.

b. Anderson, John D., RFP 312-37, August 29, 1961.

IDENTIFICATION

COEF
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

COEF calculates the coefficients used by the ODP in doppler calculations. The subroutine is cognizant of band differences. All intermediate calculations are in double precision.

RESTRICTIONS

COMMON break: 47675
Subroutines used:
(DFAD)
(DFMP)
(DFSB)
QUIZ

METHOD

$$f_T = f_{T\,base} + \Delta f_T \quad \text{(transponder frequency)}$$

$$f_q = f_{q\,base} + \Delta f_q \quad \text{(transmitter frequency)}$$

$$\Omega_2 = \omega_2 [f_T + D(t_{ob} - t_0)]$$

$$\Omega_1 = \omega_1 + \Delta\omega_1 - \Omega_2$$

$$\Omega_4 = \omega_4 f_q$$

$$\Omega_3 = \omega_3 + \Delta\omega_3 \text{ for predicts} \quad \Omega_3 = 0 \text{ for data fitting}$$

$$\Omega_6 = \omega_6 f_q$$

$$\Omega_5 = \omega_5 + \Delta\omega_5 - \Omega_6 \text{ for predicts} \quad \Omega_5 = 0 \text{ for data fitting}$$

where for L to S band,

$$f_{T\ base} = 2290.0 \times 10^6 \text{ cps}$$

$$f_{q\ base} = 20.00 \times 10^6 \text{ cps}$$

$$k_1 = f_{q\ base} + \Delta k_1$$

$$\omega_2 = 0.3125$$

$$\omega_1 = 9.375 \times 10^6 \text{ cps}$$

$$\omega_4 = 32.579185520$$

$$\omega_3 = 9.375 \times 10^6 \text{ cps}$$

$$\omega_6 = 32.579185520$$

$$\omega_5 = 9.375 \times 10^6 \text{ cps}$$

$$\Delta\omega_1 = 30\ k_1$$

$$\Delta\omega_3 = 30\ k_1$$

$$\Delta\omega_5 = 30\ k_1$$

for L band,

$$f_{T\ base} = 960.0 \times 10^6 \text{ cps}$$

$$f_{q\ base} = 29.66 \times 10^6 \text{ cps}$$

$$\omega_2 = 0.96875$$

$$\omega_1 = 930.15 \times 10^6 \text{ cps}$$

$$\omega_4 = 32.359550561$$

$$\omega_3 = 100000. \text{ cps}$$

$$\omega_6 = 31.348314605$$

$$\omega_5 = 930.15 \times 10^6 \text{ cps}$$

$$\Delta\omega_1 = \Delta\omega_3 = \Delta\omega_5 = 0$$

for S band,

$$f_{T \text{ base}} = 2290.0 \times 10^6 \text{ cps}$$

$$f_{q \text{ base}} = 20.00 \times 10^6 \text{ cps}$$

$$k_s = f_{q \text{ base}} + \Delta k_s$$

$$\omega_2 = 1.0$$

$$\omega_1 = 1000000.$$

$$\omega_4 = 104.25339367$$

$$\omega_3 = 1000000.$$

$$\omega_6 = 104.25339367$$

$$\omega_5 = 1000000.$$

$$\Delta\omega_1 = \omega_6 k_s$$

$$\Delta\omega_3 = 0$$

$$\Delta\omega_5 =$$

also

D = transponder (beacon) drift

t_{ob} = observation time

t_0 = ODP epoch

USE

CALL COEF

COMMON input:

EP-6	band indication
EP-7	Δk_1, cps
EP-8	Δk_s, cps
TXCON	6 × 15 array of ω_1, ω_2, ..., ω_6 coefficients for each station, d.p.
TFREQ	Δf_T, cps
XFREQ	Δf_q, cps
DXDR-4	D, cps/sec
TOB	observation time, d.p. sec past 1950.0
EPOCH	ODP epoch, d.p. sec past 1950.0
C1O	observed one-way doppler (flag)
CD1O	observed differenced one-way doppler (flag)
CC3O	observed two-way doppler (flag)
C3O	observed three-way doppler (flag)
CD3O	observed DSIF ranging (flag)

COMMON output:

CZ1	Ω_1
CZ2	Ω_2
CZ3	Ω_3
CZ4	Ω_4
CZ5	Ω_5
CZ6	Ω_6
RNJ	Ω_5, d.p.
PHINJ	Ω_6, d.p.

CODING INFORMATION

Length of subroutine is 503 (10) or 767 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.
b. Wollenhaupt, Wilber R., RFP 312-268, April 16, 1964.
c. Wollenhaupt, Wilber R., RFP 312-319, September 3, 1964.

IDENTIFICATION

COL

Michael R. Warner, JPL

Fortran II, Version 3

January 4, 1965

PURPOSE

COL calculates the G^2 terms in the weighting function

$$\sigma_j^2 = \sum_{p=1}^{6} S_{pjk}^2 G_{pj}^2 \max\left(\frac{t_{pjk}}{\tau}, 1\right)$$

RESTRICTIONS

a. COMMON break: 47675

b. Subroutines used:

COS

SQRT

METHOD

The computation of the g value depends on the value of the weight code group (p) and the data type (j). The following table indicates the g term for each of the p, j combinations:

Group index p		1	2	3	4	5	6
Data type index	j						
ρ_i	1	1	1	$\dot{\rho}_i$	ρ_i	$\Delta_r \rho_i$	1
$\dot{\rho}_i$	2	1	ρ_i	ρ_i	$\Delta_r \dot{\rho}_i$	1	
γ_i	3	1	1	1	$\Delta_r \gamma_i$		
σ_i	4	$\frac{1}{\cos \gamma_i}$	1	1			
δ_i	5	1	1	1	$\Delta_r \delta_i$		
a_i	6	$\frac{1}{\cos \delta_i}$	1	1	$\Delta_r a_i$		
f_{1i}	7	Ω_2	Ω_2	$\frac{1}{\tau}$	$\frac{\Omega_2}{c}$		
f_{c3i}	8	$\frac{\Omega_4}{c}$	$\frac{1}{\tau}$	$\frac{\Omega_4}{c} \frac{(\rho_i + \rho_q)}{2}$	$\frac{1}{\sqrt{3}\tau}$	$\frac{\Omega_4}{\tau c}(\lvert \Delta_r \dot{\rho}_i \rvert + \lvert \Delta_r \dot{\rho}_q \rvert)$	$\frac{\Omega_4}{c}$
f_{3i}	9	$\frac{\Omega_6}{c}$	$\frac{1}{\tau}$	Ω_6	$\frac{\Omega_6}{c}(\lvert \Delta_r \dot{\rho}_i \rvert + \lvert \Delta_r \dot{\rho}_q \rvert)$	$\frac{\Omega_6}{c}$	
f_{d1i}	10	$\frac{\Omega_2}{c} \rho_i \rho_j$	$\frac{\Omega_2}{c}(\rho_i - \rho_j)$	$\frac{1}{\tau}$	$\frac{\Omega_2}{c}(\lvert \Delta_r \dot{\rho}_i \rvert + \lvert \Delta_r \dot{\rho}_j \rvert)$	$\frac{\Omega_2}{c}$	
ρ_{DSIF}	11	1	1	$\dot{\rho}$	ρ	$\Delta_r \rho$	1

where

ρ = slant range
$\dot{\rho}$ = range rate
γ = elevation angle
δ = declination
$\Delta_r\rho$ = refraction correction to slant range
$\Delta_r\dot{\rho}$ = refraction correction to range rate
$\Delta_r\delta$ = refraction correction to declination
$\Delta_r\alpha$ = refraction correction to hour angle
Ω_2 = one-way doppler multiplier
Ω_4 = two-way doppler multiplier
Ω_6 = three-way doppler multiplier
τ = doppler averaging time
c = velocity of light

USE

CALL COL

COMMON input:

RVEC	ρ, km
RDOT	$\dot{\rho}$, km/sec
EL	γ, deg
DEC	δ, deg
DRVEC	$\Delta_r\rho$, km
DRDOT	$\Delta_r\dot{\rho}$, km/sec
DRDEC	$\Delta_r\delta$, deg
DRHA	$\Delta_r\alpha$, deg
CZ2	Ω_2
CZ4	Ω_4
CZ6	Ω_6
TAU	τ, sec
VELC	c, km/sec

COMMON output:

GSQ	g^2 (1 × 6)

CODING INFORMATION

Length of subroutine is 262 (10) or 406 (8) words

IDENTIFICATION 13

COMAP
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

COMAP checks the mapping requests which are made of the ODP. When step-mapping the product of the U matrices for mapping is computed, thus the U matrix which is used in the calculation of the closest approach parameters is:

$$U = U_{IMP} * U_{T_N} * \ldots * U_{T2} * U_{TI}$$

where U_{TN} are the matrices computed for each step-map time and U_{IMP} is evaluated at time of closest approach. Results of the mapping matrix calculations are stored on disk to be printed in a subsequent link.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCF
b. COMMON break: 47055
c. Subroutines used:
   TAMP
   PROM
   REAM
   COMIMP
   FLAK
   FLOT
   DCP
   OFFSYS
   TYPRYT

USE

This link is called under control of the JPTRAJ Source Deck.

CODING INFORMATION

Length of subroutine is 186(10) or 272(8) words.

IDENTIFICATION

COMIMP
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To project the statistical information contained in the covariance matrix $\Gamma(t_0)$ to any later time.

RESTRICTIONS

a. COMMON break: 47055
b. Subroutines used:
   MAMUL
   PRAMS
   (DFAD)
   (DFSB)
   (DFMP)

METHOD

The procedure employs a mapping matrix

$$Ut_0, t = \frac{\partial Q_t}{\partial Q_{t_0}}$$

which is an extended matrix of variational partials representing all estimated parameters Q_{t_0}. If the parameter set Q_{t_0} consists only of the six initial conditions, then this matrix is identical to the familiar U matrix. A similar mapping matrix is employed for including the effect of the considered parameter set $\tilde{Q}_{t_0}$:

$$Vt_0, t = \frac{\partial Q_t}{\partial \tilde{Q}_{t_0}}$$

The mapping operation is then accomplished by

$$\Gamma_t = U\Gamma_{t_0}U^T - V\Gamma_{\tilde{Q}}{}^{\upsilon T}J^{-1}U^T - UJ^{-1}{}_{\upsilon}\Gamma_{\tilde{Q}}V^T + V\Gamma_{\tilde{Q}}V^T$$

If no parameters are being considered, this reduces to

$$\Gamma_t = U\Gamma_{t_0}U^T$$

The covariance matrix of estimated parameters is defined as

$$\Gamma = J^{-1} + J^{-1}KJ^{-1}$$

where

$$J^{-1} = (J^* + \tilde{\Gamma}^{-1})^{-1}$$

and

$$K = v\Gamma_{\tilde{Q}}v^T$$

where

$\Gamma_{\tilde{Q}}$ = a priori covariance matrix of the m considered parameters

$$v = \sum_{i=1}^{N} \phi_i w^{-1} \theta_i^T$$ (θ_i is the analogous vector of partials of considered parameters)

USE

CALL COMIMP

The matrix thus generated is used in the calculation of the target centered covariance matrix (TACCOM) and the closest approach parameters.

CODING INFORMATION

Length of subroutine is 750(10) or 1356(8) words.

REFERENCE

Anderson, John D., RFP 312-37, August 29, 1961.

IDENTIFICATION 15

COMOUT
Michael R. Warner, JPL
IMB 7094 Fap
January 4, 1965

PURPOSE

COMOUT writes the midcourse and trajectory information on the COMENT region of disk.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
COMENT

USE

CALL COMOUT
COMMON input:

EP-63	midcourse COMENT buffer (29 words forward)
EP-104	trajectory COMENT buffer (17 words forward)

CODING INFORMATION

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

IDENTIFICATION 16-1 of 2

COROP
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

COROP computes the refraction corrections to optically obtained hour angle and declination.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
SQRT
EXP(3)
ARTAN
SIN

METHOD

$$\Delta_r\gamma = \tan^{-1}\left(\frac{A}{\rho - B}\right) \quad \text{(correction to elevation angle)}$$

where

$$A = \frac{0.00211}{(\gamma/57.2957795 + 0.0598)^{2.42}}$$

$$B = \sqrt{C^2 - R_e^2 + R_e^2 \sin^2\gamma} - R_e \sin\gamma$$

$$C = R_e + 51.2064$$

ρ = slant range

R_e = earth equatorial radius

The program then uses $\Delta_r\gamma$ to obtain $\Delta_r\alpha$ and $\Delta_r\delta$ in the same manner as subroutine CORR (q.v.).

USE

CALL COROP

COMMON input:

RVEC ρ, km

EL γ, deg

RE R_e, km

COMMON output:

DHA $\Delta_r\alpha$, deg

DDEC $\Delta_r\delta$, deg

CODING INFORMATION

Length of subroutine is 120(10) or 170(8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

b. Cain, Dan L., TM 312-275, February 14, 1963.

IDENTIFICATION

CORR
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

CORR calculates the refraction corrections and the vertical displacements for angular tracking data.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines called:
SIN
SQRT

METHOD

$$\Delta_r\gamma = 57.2957795 \frac{n}{340.0} b_1 b_2 \qquad \gamma < 0.3 \text{ radians}$$

$$\Delta_r\gamma = 57.2957795\ n \times 10^{-6} \frac{\cos\gamma}{\sin\gamma} \qquad \gamma \geq 0.3 \text{ radians}$$

$$\Delta_r\alpha = \frac{\Delta_r\gamma \cos\phi \sin^2\alpha}{\cos^2\gamma \sin\sigma} \qquad \delta < 87°$$

$$\Delta_r\delta = \frac{(\sin\phi \cos\gamma - \sin\gamma \cos\phi \cos\sigma)\Delta_r\gamma}{\cos\delta} \qquad \delta < 87°$$

$$\Delta_r\alpha = \Delta_r\delta = 0 \qquad \delta \geq 87°$$

$$b_1 = 1.0 - (1.216 \times 10^5 b_3 \gamma_{rad}) - (51.0 - 300.0\ \gamma_{rad}) \sqrt{b_3}$$

$$b_2 = \left[7.0 \times 10^{-4}/(0.0589 + \gamma_{rad})\right] - 1.26 \times 10^{-3}$$

$$b_3 = \frac{1}{10^3(r - R_i)}$$

$$\Delta_v \alpha = \frac{v}{\cos \phi}$$

$$\Delta_v \gamma = u \cos \sigma$$

$$\Delta_v \sigma = u \sin \sigma \frac{\sin \gamma}{\cos \gamma}$$

$$\Delta_v \delta = 0$$

where

γ = elevation angle (γ_{rad} = γ in radians)
σ = azimuth angle
α = hour angle
δ = declination
Δ_r = refraction correction
Δ_v = vertical correction
n = index of refraction (nominally 340.0)
ϕ = geocentric latitude of station
r = geocentric probe distance
R_i = Earth radius at station i
u = north-south displacement of vertical
v = east-west displacement of vertical

USE

CALL CORR

COMMON input:

SINEL	sin γ
IFA-9	$\neq$ 0 to bypass Δ_r and Δ_v calculation
EL	γ
ELZ	sin δ
X, Y, Z	geocentric probe vector
RI(i)	Earth radius at station i
FNI(i)	index of refraction at station i
COSEL	cos γ
HA	α
COSPHI	cos ϕ
SINAZ	sin σ

COSAZ	cos σ
UI(i)	north-south displacement, station i
VI(i)	east-west displacement, station i

COMMON output:

DEL	$\Delta_r\gamma + \Delta_v\gamma$
DHA	$\Delta_r a + \Delta_v a$
DAZ	$\Delta_v\sigma$
DDEC	$\Delta_r\delta$

CODING INFORMATION

Length of subroutine is 188(10) or 274(8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.
b. Cain, Dan L., IOM to W. Hoover, July 6, 1960.
c. Cain, Dan L., IOM to W. Hoover, October 4, 1960.

IDENTIFICATION

CXPLOT/XXXFSR/CDC
John R. Schoeni, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To generate on the computer plotting tapes to be displayed on the SC-4020 microfilm recorder. Controlled by a set of pseudo-operations, the routine will scale data, generate and label grid lines, and annotate the plotted information.

RESTRICTIONS

a. ERROR return when incorrect calling sequence is given.
b. Subroutine used:
   IOCS

USE

CXPLOT uses IOCS to control I/O buffering and the user before calling CXPLOT must open a reserve file for the subroutine's use. In defining the buffer pool to be attached to the plotting file, it is recommended that at least two buffers of up to 200 words in length be assigned. The entry into CXPLOT is from a FAP calling sequence and consists of a call CXPLOT followed by pseudo-operations which specify the operations to be performed. The calling sequence is terminated by an error exit of the form, PZE A, where A is the location of the users error routine. Normal return is to the location following the error return. The following pseudo-operations are recognized.

FVE N, T, D FVE O, O, O	Selection of tape unit and indication of film advance
SIX SX, L, SY SIX F, SIZE, D	Printing horizontal titles
SVN SX, L, Sy SVN F, SIZE, D	Printing vertical titles
PON $Rx_{0'}$, Rx_n PON $Ry_{0'}$, Ry_n PON n, e, p PON m, e, q PON Fx, , Fy PON $X_{0'}$, X_n PON $Y_{0'}$, Y_n	Generation and labelling of grid

PTW Lx_0, EX, Ly_0 PTW N, A, CHAR	Generation of graph
PTH X, t, Y	Generation of special grid line or form flash
MZE O, t, N	Termination of plot
PZE A,	Error return

CONTROL PSEUDO-OPERATIONS

FVE N, T, D

An FVE pseudo-operation must be the first pseudo-operation encountered in the first calling sequence to CXPLOT in a program because it causes various addresses throughout the subroutine to be initialized.

N In the FVE pseudo-operation, N indicates that every Nth point will be plotted.
N = 0 = 1

T T = 1 will cause a film advance command to be generated.
T = 0 indicates no frame advance.

D is the symbolic location of the File Control Block that has been opened for this file.

FVE O, O, O

A second FVE pseudo-operation is used when the output is to be written on the IBM 7094 using a packed format and high density tape mode. The plot tape generated by the use of this option requires processing on the 1401 before being plotted on the SC-4020. The Standard SFOF mode of operation is high density and packed.

MZE O, T, N

The MZE pseudo-operation gives information required to terminate a particular plot or set of plots.

If N is zero, the instruction is treated as a skip, and control will pass to the next pseudo-operation.

If N is non-zero, STOP PRINT and ADVANCE FRAME commands will be generated and written on the tape previously specified.

T not used.

PZE A

The PZE pseudo-operation indicates the end of the calling sequence. Normal exit is to the instruction following this pseudo-operation. "A" is the address of a user supplied error routine.

SIX SX, L, SY
SIX F, SIZE, D

The SIX pseudo-operations give information required for printing horizontal titles. The first operation in the pair describes where the title is to be located. The second operation tells the location of the format statement and the letter size. Six pseudo-operations must always occur in pairs.

L = 1 SX and SY designate the X and Y coordinates locating the center of the title.

L = 0 SX and SY designate the X and Y coordinates locating the position at which the first character of the title is to be centered.

F designates the location of the format statement to be used for the title. The format statement starting at location F must be of the form

(xHyz ----------).

x an integer indicating the number of hollerith characters which follow the H.

y if blank the current frame will be used. This is the normal case.

y if equal to 1, a film advance command is generated before printing this title.

z is always a blank character.

SIZE designates the letter size and may have the values 0, 1, 2, 3 specifying that letters of 1, 2, 4, or 8 times normal size are to be used. (Caution: a character 8 times normal size is 64 by 128 units in size.)

D When printing normal size letters, SIZE is zero, D indicates whether the letters will be generated by the vector generator or by the plotting matrix.

D = 0: plotting matrix.

D = 1: vector generator.

VERTICAL TITLES

SVN SX, L, SY
SVN F, SIZE, D

The SVN pseudo-operations give information required for printing titles vertically. They are analogous to the SIX pseudo-operations in format.

GRIDS & LABELS

PON

The PON pseudo-operations specify the grid lines to be drawn, the exposure to be used in drawing them, the formats to control their labelling and the scaling to be used in the plot.

The first five PON pseudo-operations must be used as a group. 18-4 of 6

PON Rx_0, , Rx_n
PON Ry_0, , Ry_n
PON n, e, p
PON m, e, q
PON FX, , Fy

PON Rx_0, , Rx_n

Rx_0 is the location of the lower end of the range of x values.
Rx_n is the location of the upper end of the range of x values.

The limits for the range will be in floating point form.

PON Ry_0, , Ry_n

is analogous to the PON Rx_0, , Rx_n for the range of y.

PON n, e, p

contains an integer n specifying the number of uniform intervals in the x-direction (vertical grids) to be bounded by grid lines, and an integer p indicating that the first grid line and every p^{th} grid line following will be labelled. If e = 1, the labelled grid lines will be drawn heavy; otherwise they will be light (vertical grids).

PON m, e, q

This is analogous to the third PON but refers to the y-direction (horizontal grids).

PON Fx, , Fy

contains the locations of format statements to be used in labelling the horizontal and vertical grid lines, respectively. These should be of the form:

FX BCI , (F c.d),

where

F indicates that a conversion from a floating point number to fixed point number should be performed, and that the fixed point number should be printed.

c designates the "column width." ($c \leq 9$)

d designates the number of digits to be retained to the right of the decimal point. $d < (c-1)$

PON X_0, , X_n
PON Y_0, , Y_n

The sixth and seventh PON pseudo-operations specify the area of the character on surface (1023 × 1023) to be used for plotting. These two PON pseudo-operations may be omitted, and if so the standard case of

```
PON   96,,992
PON    0,,896
```

will be assumed by the subroutine.

PON X_0,, X_n

is the range of the horizontal positions to be used

$$(0 \leqslant X_0 < X_n \leqslant 1023).$$

PON Y_0,, Y_n

contains the range of vertical positions to be used for the graph

$$(0 \leqslant Y_0 < Y_n \leqslant 1023).$$

GENERATION OF GRAPH

PTW Lx_0, EX, Ly_0

PTW N, A, CHAR

The PTW pseudo-operations specify the character and the exposure to be used in plotting, the memory area containing the sets of (x, y) values to be plotted, and the scaling factors to be used.

Lx_0 designates the starting memory location for the sequence of values of x to be plotted.

Ly_0 designates the starting location for the corresponding values of y.

N designates the number of pairs of values of x and y to be plotted.

Thus, locations Lx_0 to Lx_0+N-1 contain the values of x corresponding to the values of y found in locations Ly_0 to Ly_0+N-1.

Note the special case where the data are in x, y pairs. N is the number of c and y values, and the address of the FVE pseudo-operation is set to 2. The same type of logic applies to triplets, etc.

EX designates the exposure to be used in plotting. If EX = 0, the exposure will be heavy; otherwise, the light mode will be used.

A=0 The scaling factors computed from the previous set of PON pseudo-operations will be used.

A≠0 The four locations following the pair of PTW instructions should contain the location of floating point values of a, b, c, and d in that order.

For each pair of values, x, y, a corresponding pair of coordinates (X, Y) is computed by the subroutine as follows:

$$X = ax + b$$

$$Y = cy + d$$

where 18-6 of 6

a, b, c and d are the scaling parameters. They depend upon the range of coordinates to be used when plotting the range of values specified.

If, in scaling, a point is either $0 > X > 1024$ or $0 > Y > 1024$, the point is discarded.

CHAR The Hollerith character to be used for the plot is given in the six bit positions 30 to 35 of location CHAR.

JOINING POINTS BY VECTORS

If the character specified is the space the vector generator will be used for the plot, and successive points will be connected using straight line segments.

PTH X, t, Y

The PTH pseudo-operation allows the programmer two options: one to draw grid lines directly in either the x or y direction, and one to control usage of the form flash.

t = 0 A horizontal grid line will be drawn beginning at X, Y and extending to the right edge of the frame.

t = 1 A vertical grid line will be drawn from X, Y to the upper edge of the frame.

t = 4 A form flash command will be generated. Care must be taken not to generate more than one form flash on the same plot.

CODING INFORMATION

Length of subroutine is 1744(10) or 3320(8) words.

IDENTIFICATION

DATAPE
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To generate a simulated data file for checking and for study programs.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   IXTAB
   OFFSYS
   (DFAD)
   TIMER
   LOOKUP
   INTR1
   GHADP
   COEF
   DOPLR
   CORR
   ND2F
   FILT

Types of doppler are limited as follows:
If IX (transmitter) = 0, C3 and CC3 are zero.
If IX $\neq$ 0, IR (receiver) $\neq$ IX, C1 and CC3 are zero.
If IX $\neq$ 0, IR = IX, C1 and C3 are zero.

METHOD

Data identified under the control card DATA TAPE SIGMA will be included on the file. Weights for each data type must be included under WEIGHTS BY DATA TYPE AND STATION. The equation for the computation of the data value in the file is:

$$R(I) = Rc(I) + \Delta R(I) + F(I, IR) * A + B(I, IR)$$

where

R(I) = the array of data where I references the data type
Rc(I) = calculated value of the data point

$\Delta R(I)$ = correction on calculated value

F(I, IR) = noise factor on data by type and station. This provided by setting the data type under DATA TAPE SIGMA to a floating point number.

A = random number

B(I, IR) = bias. Obtained by value under DATA TAPE BIAS according type.

Data is calculated by the same routines employed in the fitting of data.

USE

CALL DATAPE

CODING INFORMATION

Length of subroutine is 301(10) or 455(8) words.

IDENTIFICATION 20

DECOD
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

DECOD determines the group value for the given group number of the weight code word. This word consists of six 3-bit groups from bit S through bit 17. Each group may have a value from 0 through 7. DECOD also floats the data sample rate, which occupies the address portion of the weight code word.

RESTRICTION

COMMON break: 47675

USE

CALL	DECOD	
PZE	J	group number
PZE	K	group value
COMMON input:		
	RVECW	weight code array (1 × 11)
	ID	data type identification
COMMON output:		
	TS	sample rate, sec.

CODING INFORMATION

Length of subroutine is 32 (10) or 40 (8) words.

IDENTIFICATION 21

DIAG/DIAGO
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To compute standard deviation of the mapped forward covariance matrix or standard deviation of input covariance matrix.

RESTRICTIONS

a. COMMON break: 47675
b. Each subroutine computes the square root of the diagonal of a specific matrix.
c. Subroutines used:
SQRT

USE

CALL	DIAG	Standard deviation of input covariance matrix
CALL	DIAGO	Standard deviation of mapped forward covariance matrix

CODING INFORMATION

Length of each subroutine is 105 (10) or 151 (8) words.

IDENTIFICATION 22

DICOS
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

DICOS computes the direction cosine vectors $\underline{A}$, $\underline{D}$, $\underline{\tilde{A}}$, and $\underline{\tilde{D}}$, which are defined in the documentation of subroutine CATS.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
SIN/COS

USE

CALL DICOS
COMMON input:

DEC	δ, deg
GHA	α_G, deg
THETAI	λ_i, deg
EL	γ, deg
AZI	σ, deg
PHII	ϕ_i, deg

COMMON output:

AX	$\underline{A}$
DX	$\underline{D}$
TAX	$\underline{\tilde{A}}$
TDX	$\underline{\tilde{D}}$

CODING INFORMATION

Length of subroutine is 123 (10) or 173 (8) words.

IDENTIFICATION

(DISCBU) REDE/RITE/PISA
Charles Coltharp, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

DISCBU provides elementary buffering for reading and writing scratch information on disk.

RESTRICTIONS

Subroutines used:
DCP

METHOD

DISCBU uses DCP for reading and writing the disk. All physical records are 200 words in length. Each logical record is preceded on the disk by a control word,

```
PZE O,,L
```

where L is the number of words in the logical record. L may be zero, but L will never be greater than 200.

A control word of

```
MZE O,,O
```

denotes a logical end of file.

USE

```
To write   CALL   RITE
           PZE    FILE,,   ERREOF
           IOXY   A,,      N
```

```
To read  CALL   REDE
         PZE    FILE,,   ERREOF
         IOXY   A,,      N
         .
         .
         .
```

A is the location into which information is read, or from which it is written.

TCH, transfer in channel, will be recognized by both read and write operations.

The tag portion of all IO commands is ignored.

The address and decrement portions of IOCD commands are ignored.

Closed or unopened files are opened automatically by the first read or write operation requested.

Read Operation

- IOCD Rewind file; close file. When IOCD is used it must be the only command in the command list.
- IOCP Read N words, ignoring logical record marks, and proceed to next command. If this command precisely finishes a record, the logical end of record may be recognized by the next command.
- IOCT Read N words, ignoring logical record marks, and terminate IO. Unread words in a partially read record will be lost.
- IORP Read to logical record mark (read one whole record, or finish a record already started), and proceed to next command. Put number of words read into the decrement portion of the IORP command. N is not interpreted.
- IORT Same as IORP, but terminate IO.
- IOSP Same as IORP if the number of words in the record is less than or equal to N. Otherwise, transmission is stopped after N words have been read. Unread words in this record will be lost. Control proceeds to the next command.
- IOST Same as IOSP, but terminate IO.

Write Operation

- IOCD Write logical EOF, rewind file; close file. When IOCD is used it must be the only command in the command list.
- IOCP Write N words, and proceed to next command.
- IOCT Write N words followed by a logical record mark, and terminate IO
- IORP Write N words followed by a logical record mark, and proceed to next command.

IORT Same as IOCT.

IOSP Same as IORP.

IOST Same as IORT.

If at any time in writing, a record reaches a length of 200 words before a logical record mark is indicated by the user, DISCBU will insert a logical record mark before continuing the transmission.

File Block

```
FILE   BCI   1,   XXXXXX
  +1   PZE   J   (decrement = P)
  +2   PZE   K   (decrement = Q)
  +3   PZE   BUFFER   (decrement = R)
  +4   PZE   200
```

XXXXXX an entry in the disk directory, defined as scratch

J that record in XXXXXX with which this file begins

K that record in XXXXXX with which this file ends

BUFFER the location of a 400 word block of core storage

The decrements of FILE +1 through FILE +3 (the items in parentheses, above) will be used by DISCBU for bookkeeping. These items will be zero when the file is not open, and they should be set zero initially by the user.

P last disk record transmitted

Q buffer designation

0 = next disk transmission will be from (or into) BUFFER + 0

1 = next disk transmission will be from (or into) BUFFER + 200

R location of next word in BUFFER to be read or written.

FILE +4 is the location given to DCP for the flag word. Initially this must be a positive, non-zero number.

Error - End of File Return

Control is returned to ERREOF under the conditions described below.

If an error is indicated by DCP, that indication will be in the AC on return. The error codes are described in the design specifications for DCP.

If the user tries to exceed the self-imposed file bounds (K is the largest usable disk record in XXXXXX), the AC on return will be MZE 0,0,-1.

No provision is made for continuing if the condition occurs on a read operation. Before the file may be used again, the user must issue the sequence

```
CALL   REDE
PZE    FILE,,   ERREOF
IOCD
```

to close and rewind the file.

If the condition occurs on a write operation, the user may continue, provided all seven index registers are preserved, by executing

TRA $PISA.

However, K should be increased if the user wishes to read the material back at a later time.

If a logical EOF is encountered by a read operation, the AC will be plus zero.

CODING INFORMATION

Length of subroutine is 273 (10) or 421 (8) words.

IDENTIFICATION 24

DNAME
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

DNAME contains a list of the BCD names of the eleven ODP data types.

USE

The BCD names, one per word, are stored backward. The entry point, DNAME, is assigned to the first logical location (last physical location).

CODING INFORMATION

Length of subroutine is 12 (10) or 14 (8) words.

IDENTIFICATION

DOPLR
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

DOPLR obtains the calculated values of the ODP data types.

RESTRICTIONS

COMMON break: 47675
Subroutines called:
ABDD
ARSIN
ARTAN
DMOD
RATES
SQRT
VEC
(DFAD)
(DFMP)

METHOD

DOPLR first obtains the fine light-time correction in a two-iteration procedure:

$$\epsilon = 0$$

$$\underline{r}_t = \underline{r}'_t + \epsilon \dot{\underline{r}}'_t$$

$$\dot{\underline{r}}_t = \dot{\underline{r}}'_t + \epsilon \ddot{\underline{r}}'_t$$

$$\ddot{\underline{r}}_t = \ddot{\underline{r}}'_t + \epsilon \dddot{\underline{r}}'_t$$

$$\dddot{\underline{r}}_t = \dddot{\underline{r}}'_t$$

$$\Delta t = \frac{\rho + \Delta t' \dot{\rho}}{C + \dot{\rho}}$$

$\epsilon = \Delta t' - \Delta t$; the procedure is then repeated.

where

$\Delta t'$ = coarse correction from subroutine TIMER

$t' = t_{ob} - \Delta t'$

ρ = slant range at t'

$\dot{\rho}$ = range rate at t'

c = speed of light

The eleven ODP data types are then obtained. DOPLR calls subroutine RATES to obtain slant range and its derivatives and all other leg-dependent quantities:

$$\rho = \left| \underline{r}_t - \underline{R}_{it_{ob}} \right| \qquad \text{(slant range)}$$

where

$\underline{r}$ = geocentric position vector of probe

$\underline{R}_i$ = geocentric position vector of station i

$$\dot{\rho} = \frac{\underline{\rho} \cdot \underline{\dot{\rho}}}{\rho} \qquad \text{(range rate)}$$

where

$\underline{\rho}$ = topocentric position vector of probe

$\underline{\dot{\rho}}$ = topocentric velocity vector of probe

$$\gamma = \sin^{-1} \frac{\underline{R}_i \cdot \underline{L}}{R_i} \qquad \text{(elevation angle)}$$

where

$$\underline{L} = \frac{\underline{\rho} + \underline{r}_s}{\rho}$$

R_i = Earth radius at station i

$\underline{r}_s$ = geocentric position vector of Sun

$$\sigma = \tan^{-1} \frac{\sin \sigma}{\cos \sigma} \qquad \text{(azimuth angle).}$$

where

$$\sin\sigma = \frac{L_y \cos(a_G + \lambda_i) - L_x \sin(a_G + \lambda_i)}{\cos\lambda_i}$$

$$\cos\sigma = \frac{-L_x \sin\phi_i \cos(a_G + \lambda_i) - L_y \sin(a_G + \lambda_i)\sin\phi_i + L_z \cos\phi_i}{\cos\gamma_i}$$

a_G = Greenwich hour angle

λ_i = longitude of station i

ϕ_i = geocentric latitude of station i

$$a = a_G + \lambda_i - \tan^{-1}\left(\frac{\rho_y}{\rho_x}\right) \qquad \text{(hour angle)}$$

$$\delta = \sin^{-1} L_z \qquad \text{(declination)}$$

$$f_1 = \Omega_1 + \Omega_2\phi_1 \qquad \text{(one-way integrated doppler frequency)}$$

$$f_{c3} = \Omega_3 + \Omega_4\phi_3 \qquad \text{(coherent three-way integrated doppler frequency)}$$

$$f_3 = \Omega_5 + \Omega_6\phi_3 \qquad \text{(three-way integrated doppler frequency)}$$

where

$\Omega_1, \Omega_2, \cdots \Omega_6$ are defined in COEF writeup.

$$\phi_1 = \frac{\dot\rho_i}{c} - \frac{1}{c^2} h_1 - \frac{\ddot\rho_i}{c}\frac{\tau^2}{24}$$

$$\phi_3 = \frac{1}{c}(\dot\rho_i + \dot\rho_q) - \frac{1}{c^2} h_3 - \frac{1}{c}(\ddot\rho_i + \ddot\rho_q)\frac{\tau^2}{24}$$

τ = doppler counting interval

q = transmitter index

i = receiver index

$$h_1 = \frac{\dot{\rho}}{\rho}\,\underline{\rho}\cdot(\underline{r}-\underline{r}_s) + \frac{1}{2}\left(\dot{R}_{it_{ob}} - \dot{r}_t^2\right)$$

$$h_3 = \dot{\rho}_i^2 + \dot{\rho}_q\dot{\rho}_i + \frac{\dot{\rho}_i}{\rho_i}\,\underline{\rho}_i\cdot\left(\underline{\dot{R}}_{it_{ob}} - \underline{\dot{r}}_{st}\right)$$

$$- \frac{\dot{\rho}_q}{\rho_q}\,\underline{\rho}_q\cdot\left(\underline{\dot{R}}_{qt_{tr}} - \underline{\dot{r}}_{st}\right) + \frac{1}{2}\left(\dot{R}^2_{it_{ob}} - \dot{R}^2_{qt_{tr}}\right)$$

$f_{dl} = f_{li} - f_{lj}$ (differenced one-way doppler from stations i and j)

where f_{li} and f_{lj} are one-way doppler values which must be taken simultaneously at stations i and j

$$\rho_{DSIF} = \frac{\Omega_6(\rho_q + \rho_i)}{16\,c} + \epsilon \qquad \text{(DSIF ranging)}$$

where

ϵ = ranging system bias

USE

CALL DOPLR

COMMON input:

DELT	$\Delta t'$, d.p. sec past 1950.0
X	$\underline{r}(1 \times 3)$, km
XDOT	$\underline{\dot{r}}(1 \times 3)$, km/sec
XAC	$\underline{\ddot{r}}(1 \times 3)$, km/sec^2
XJERK	$\underline{\dddot{r}}(1 \times 3)$, km/sec^3
VELC	c, km/sec
CZ1, · · · CZ6	$\Omega_1, \cdots \Omega_6$
RVECO	observed values of ODP data types (1 × 11)
OMEGA	Earth rotation rate, deg/sec

COMMON output:

RVEC	calculated values of ODP data types (1 × 11)
DELT2	Δt, d.p. sec past 1950.0

CODING INFORMATION 25-5 of 5

Length of subroutine is 715 (10) or 1313 (8) words.

REFERENCE

Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

IDENTIFICATION

ENDIT
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

ENDIT sets up and solves the normal equations. The covariance matrix

$$\Gamma = J^{-1} + J^{-1} KJ^{-1}$$

is obtained from the matrices accumulated by subroutine FORM. The ΔQ vector is retained for subsequent output.

RESTRICTIONS

COMMON break: 47675
Subroutines used:
(DFSB)/(DFMP)/(DFAD)
PRIM
SQRT
STPREG
REVRT
NOUT

METHOD

The matrix inversion is accomplished by subroutine STPREG (q. v.).

USE

CALL ENDIT
COMMON input:
KLIST attitude control estimate flags
FABC attitude control coefficients

ILIST	initial conditions estimate flags
XNJ	initial conditions
LLIST	physical constants estimate flags
GRAVE	physical constants
MLIST	velocity of light estimate flag
VELC	velocity of light
NLIST	station locations estimate flags
RI	station locations
GFLIP	a priori Γ^{-1}
QTILD	nominal values corresponding to QTILD
NEST	number of estimated parameters
NCON	number of considered parameters
RIGHT	accumulated right-hand side
XJ	accumulated normal matrix
SOUR	sum of squares
NTOT	number of data points
XX	accumulated consider matrix
XMU	accumulated consider vector

COMMON output:

QNU	updated parameter list
RIGHT	ΔQ vector
XJ	J inverse
CPGAM	covariance matrix
XNJ, GRAVE, RI, FABC	updated parameters
CAPQ	Q sum of squares

CODING INFORMATION

Length of subroutine is 828 (10) or 1474 (8) words.

IDENTIFICATION

EPPHEM
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To prepare an ephemeris tape with complete information required from the planetary ephemeris and the probe ephemeris for each time point of the ODP. This program checks the requirements of each iteration and interpolates and if necessary integrates the partials of the physical constants. The information is written on tape A-4.

RESTRICTIONS

a. COMMON break: 47055
b. Subroutines used:
   GAMAT
   LOOKUP
   RITEM
   TOCIM
   INTR1
   PONT
   STARP
   WREOF
   KINE
   QUIZ
   TIMER
   (DFSB)

METHOD

EPPHEM is primarily a logical decision box, which accomplishes its task through the use of subroutines. A flow chart is given to supply further clarification.

USE

CALL EPPHEM

CODING INFORMATION

Length of subroutine is 361 (10) or 551 (8) words.

IDENTIFICATION

ERROR
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

ERROR prints ODP error condition messages. There are three versions of this subroutine in the ODP; the version in link LA9 prints recoverable error condition messages, the version in link LA12 prints unrecoverable error messages, and the version in the other links stores the calling sequence for subsequent action by LA12.

RESTRICTIONS

COMMON break: 47675
Subroutines used: (LA9)
TYPRYT
ONLIN
Subroutines used: (LA12)
TYPRYT
PROUT
ENDSYS
RECOV

USE

```
CALL   ERROR
PZE    I  }
PZE    J  }   Decrement integers
PZE    K  }
```

I	Error message	Version
1	INCORRECT RECORD NUMBER IN DISK CALLING SEQUENCE	LA12
2	WEIGHT (J = ID) FOR STATION (K = IR) = 0	LA12
3	DISK STORAGE NOT ALLOCATED FOR THIS JOB	LA9

4	ESTIMATE OR CONSIDER LIST EXCEEDS 20 PARAMETERS	LA9
5	NO INPUT RECEIVED WITHIN TIME LIMIT	LA9
6	PROGRAM UNABLE TO READ/WRITE PROBE EPHEMERIS	LA12
7	FIRST PROBE EPHEMERIS TIME GREATER THAN LOOKUP ARGUMENT	LA12
8	LAST PROBE EPHEMERIS TIME LESS THAN LOOKUP ARGUMENT	LA12
9	INJECTION CONDITION = 0	LA9
10	INPUT J MATRIX NOT N*N	LA9
11	INADMISSIBLE SYMBOL OR DATA FIELD	LA9
12	INPUT CONSIDER MATRIX NOT M*M	LA9
13	POINTING TIME LESS THAN EPOCH + R/C	LA9
14	MAPPING TIME LESS THAN EPOCH	LA9
15	DISK TRANSMISSION ERROR	LA12, LA9
16	DISK BUFFER ALLOCATION INSUFFICIENT	LA12
17	PLANETARY EPHEMERIS ERROR	LA12
18	DATA POINT OUT OF TIME SORT	LA12
19	ERROR IN CXPLOT CALLING SEQUENCE	LA12
20	ERROR IN DP SQRT SUBROUTINE	LA12, LA9
21	LOOKUP TIME FAILS TO MATCH TIME ON EPHEMERIS TAPE	LA12

The second line of messages 1, 2, 3, 6, 7, 8, 15, 16, 17, 18, 19, 20, 21, is

RECOVERY IMPOSSIBLE. JOB ABORTED.

The second line of messages 4, 5, 9, 11, 13, 14, is

USER MUST CORRECT AND RELOAD INPUT DECK WITHIN 3 MINUTES.

The second line of messages 10, 12, is

CONDITION IGNORED. JOB WILL CONTINUE.

CODING INFORMATION

Length of the LA9 version is 286 (10) or 436 (8) words.

Length of the LA12 version is 326 (10) or 506 (8) words.

Length of the dummy version is 9 (10) or 11 (8) words.

IDENTIFICATION

29

FDATA
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

FDATA stores the nominal values of the S and T weighting tables in COMMON arrays SSQ and TL, respectively. The S values are squared prior to their storage in SSQ.

RESTRICTIONS

COMMON break: 47675

USE

CALL FDATA

CODING INFORMATION

Length of subroutine is 591 (10) or 1117 (8) words.

REFERENCE

Hamilton, Thomas W., Inter-Office Memorandum to M. Warner, June 1962.

IDENTIFICATION

FILL/FILT
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

FILL writes the ODP residual file on disk in the same physical format as the ODG-generated data file. It is also used to write the tracking predictions on disk for subsequent output. FILT writes a simulated ODG data file on disk. Both entries use the RITE entry of the buffered disk routine DISCBU.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   RITE
   PISA

USE

```
CALL   FILL
PZE

CALL   FILT
PZE
```

COMMON input:

TOB	time of observation, d.p. sec past 1950.0
RVEC	array of computed data types (1 × 11)
RVECD	array of residuals (1 × 11)
RVECW	array of weights (1 × 11)
IF5	≠ 0 normal entry, = 0 end-of-file entry
EP-6	band designation
XFREQ	transmitter frequency
TFREQ	transponder frequency
IR	receiver ID, B17
IX	transmitter ID, B17
TAU	doppler averaging time, sec

COMMON output:

TAB-799 400 word output buffer for DISCBU

The disk logical record format is as follows:

Word	0	word count (2N + 5, B17) or - 0 for EOF
	1	TOB
	2	TOB-1
	3	XFREQ if IX ≠ 0
		TFREQ if IX = 0
	4	0
	5	bit S 1 if L - S band
		0 if L or S band
		1 1 if RVEC ≠ 0
		2 1 if RVEC - 1 ≠ 0
		3 1 if RVEC - 2 ≠ 0
		. .
		. .
		. .
		11 1 if RVEC - 10 ≠ 0
		12-15 not used
		16 1 if L - S or S band
		0 if L band
		17 not used
		18-21 IX
		22-25 IR
		26-35 TAU
	6	first member of RVEC which is non-zero
	7	bits S-17 RVECD corresponding to word 6
		18-35 RVECW corresponding to word 6
	8	second member of RVEC which is non-zero
	9	second RVECD - RVECW word
	.	
	.	
	.	
2N + 4		Nth member of RVEC which is non-zero
2N + 5		Nth RVECD - RVECW word

CODING INFORMATION

Length of subroutine is 191 (10) or 277 (8) words.

IDENTIFICATION 31

FIRST
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Main program for link 1 of SFOF-JPTRAJ version of the JPL Orbit Determination Program. FIRST clears COMMON and formats the rejection table on the disk.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP
b. COMMON break: 46711
c. Subroutines used:
   FDATA
   NOMNL
   FLAK
   DISCBU

USE

Initiates ODP by clearing COMMON and calling subroutines to store the permanent or semi-permanent information. This link is called only once per "run" of the ODP.

CODING INFORMATION

Length of subroutine is 427 (10) or 653 (8) words.

IDENTIFICATION

32

FIT
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Main program for link 6. The purpose of the routine is to control calculation of the observables and the linkage.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP
b. COMMON break: 46711
c. Subroutines used:
   CALL
   OCIM
   FLAK
   DISCBU
   TAPIO

USE

When fitting data, this link is called by the JPTRAJ monitor.

CODING INFORMATION

Length of subroutine is 476 (10) or 734 (8) words.

IDENTIFICATION

33

FLAT/FLAPR/FLAK
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Subroutine to check the I/O activity flags.

RESTRICTIONS

a. ERROR exit to indicate disk I/O error
b. Subroutines used:
   ERROR
   TYPRYT

USE

CALL	FLAT	To check TAPIO flag
CALL	FLAPR	To check PROUT flag
CALL	FLAK	To identify disk error return

CODING INFORMATION

Length of subroutine is 64 (10) or 100 (8) words.

REFERENCE

EPD - 125, Rev. 1, April 1, 1964

IDENTIFICATION

FORM
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

FORM sets up the column matrix of partials $\partial F/\partial Q$ and accumulates the normal matrix J.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   PARLEY
   (DFMP)/(DFAD)/(DFSB)
   SQRT

METHOD

The partials $\partial F/\partial Q$ are obtained by the chain rule when Q is an initial condition or physical constant:

$$\frac{\partial F}{\partial Q} = \frac{\partial F}{\partial \underline{r}} \frac{\partial \underline{r}}{\partial Q}$$

If Q is the velocity of light or a station parameter, $\partial F/\partial Q$ are computed analytically and input to FORM.

USE

A = 1.0	to execute entire routine
CALL FORM	
A = -1.0	to bypass chain rule section (occultation or impact time partials)
CALL FORM	

COMMON input:

RVECW	weight for data type ID
ID	data type identification
POBX	partials $\partial F/\partial \underline{r}$ (6 × 12)
GMAT	partials $\partial \underline{r}/\partial q$ (6 × 11)
U	partials $\partial \underline{r}/\partial r_0$ (6 × 6)
ILIST	initial conditions flags (6)
LLIST	physical constants flags (11)

MLIST	velocity of light flag (1)
NLIST	station locations flags (3 × 15)
QA	partials $\partial F/\partial q$ from occultation-impact
QB	partials $\partial F/\partial r_0$ from occultation-impact
DRDC	partials $\partial F/\partial \overline{c}$
DIM3	partials $\partial F/\partial S_i$
NEST	number of estimated parameters
NCON	number of considered parameters
RVECD	residual, data type ID
IF10	phi vector output flag
DXDR-13	MMP output flag

COMMON output:

CPPHI	ordered partials $\partial F/\partial Q$
CPTHT	ordered partials $\partial F/\partial \tilde{Q}$ (considered)
XJ	J matrix
RIGHT	right-hand side of normal equations
XX	J matrix for considered parameters
NTOT	number of data points
SOUR	sum of squares

CODING INFORMATION

Length of subroutine is 566 (10) or 1066 (8) words.

IDENTIFICATION

G1G2
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

G1G2 computes the gravity equations g_1 and g_2.

RESTRICTION

COMMON break: 47675

METHOD

$$g_1 = 1 + \left[3 - 42\left(\frac{z}{r}\right)^2 + 63\left(\frac{z}{r}\right)^4\right]\left[\frac{D}{7}\left(\frac{R_e}{r}\right)^4\right] + \left[H\left(\frac{R_e}{r}\right)^3\right]\left[3 - 7\left(\frac{z}{r}\right)^2\right]\frac{z}{r}$$

$$+ \left[J\left(\frac{R_e}{r}\right)^2\right]\left[1 - 5\left(\frac{z}{r}\right)^2\right]$$

$$g_2 = 1 + \left[15 - 70\left(\frac{z}{r}\right)^2 + 63\left(\frac{z}{r}\right)^4\right]\left[\frac{D}{7}\left(\frac{R_e}{r}\right)^4\right] - \left[H\left(\frac{R_e^3}{r}\right)\right]\left[1 - 10\left(\frac{z}{r}\right)^2\right.$$

$$\left. + \frac{35}{3}\left(\frac{z}{r}\right)^4\right]\frac{3}{5}\frac{r}{z} + \left[J\left(\frac{R_e}{r}\right)^2\right]\left[3 - 5\left(\frac{z}{r}\right)^2\right]$$

USE

CALL G1G2 (G1, G2) Results are stored in G1 and G2.

CODING INFORMATION

Length of subroutine is 182 (10) or 266 (8) words.

REFERENCE

Anderson, John D., TM 312-131, August 23, 1961.

IDENTIFICATION

GAMAT
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To obtain the partials $\partial r/\partial q$ from the following integral using Simpson's rule:

$$\Upsilon(t) = U(t) \int_{t_0}^{t_U - 1} (t^*)B(t^*)\, dt^*$$

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   BMATRX
   INSPC
   INTR1
   LOOKUP
   (DFAD)
   (DFDP)
   (DFMP)
   (DFSB)

METHOD

The partials of acceleration with respect to physical constants $\partial \ddot{r}/\partial q$ are evaluated in BMATRX. These partials are then numerically integrated to obtain $\partial r/\partial q$.

Using the acceleration partials as evaluated in BMATRX, if

$$B = \begin{Bmatrix} 0 & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 \\ \frac{\partial \ddot{x}}{\partial q_1} & \frac{\partial \ddot{x}}{\partial q_2} & \cdots & \frac{\partial \ddot{x}}{\partial q_n} \\ \frac{\partial \ddot{y}}{\partial q_1} & \frac{\partial \ddot{y}}{\partial q_2} & \cdots & \frac{\partial \ddot{y}}{\partial q_n} \\ \frac{\partial \ddot{z}}{\partial q_1} & \frac{\partial \ddot{z}}{\partial q_2} & \cdots & \frac{\partial \dot{z}}{\partial q_n} \end{Bmatrix}$$

$$U = \begin{Bmatrix} \frac{\partial x}{\partial x_0} & \cdots & \frac{\partial x}{\partial \dot{z}_0} \\ \frac{\partial y}{\partial x_0} & \cdots & \frac{\partial y}{\partial \dot{z}_0} \\ \frac{\partial z}{\partial x_0} & \cdots & \frac{\partial z}{\partial \dot{z}_0} \\ \frac{\partial \dot{x}}{\partial x_0} & \cdots & \frac{\partial \dot{x}}{\partial \dot{z}_0} \\ \frac{\partial \dot{y}}{\partial x_0} & \cdots & \frac{\partial \dot{y}}{\partial \dot{z}_0} \\ \frac{\partial \dot{z}}{\partial x_0} & \cdots & \frac{\partial \dot{z}}{\partial \dot{z}_0} \end{Bmatrix}$$

and

$$\Upsilon = \begin{Bmatrix} \frac{\partial x}{\partial q_1} & \cdots & \frac{\partial x}{\partial q_n} \\ \frac{\partial y}{\partial q_1} & \cdots & \frac{\partial y}{\partial q_n} \\ \frac{\partial z}{\partial q_1} & \cdots & \frac{\partial z}{\partial q_n} \\ \frac{\partial \dot{x}}{\partial q_1} & \cdots & \frac{\partial \dot{x}}{\partial q_n} \\ \frac{\partial \dot{y}}{\partial q_1} & \cdots & \frac{\partial \dot{y}}{\partial q_n} \\ \frac{\partial \dot{z}}{\partial q_1} & \cdots & \frac{\partial \dot{z}}{\partial q_n} \end{Bmatrix}$$

then the partials $\partial r/\partial q$ are obtained from the following integral using Simpson's method:

$$\Upsilon(t) = U(t) \int_{t_0}^{t} U^{-1}(t^*) B(t^*)\, dt^*$$

The Simpson procedure uses an integration step based on the data times; if no data times exist in the interval, the time steps employed in the trajectory integration are used. The inverse of the U matrix is obtained not by the usual numerical methods but by an inspection method as defined in the subroutine INSPC.

USE

CALL GAMAT Result of the integration is placed on the combined ephemeris tape for use as needed.

CODING INFORMATION

Length of subroutine is 369 (10) or 561 (8) words.

REFERENCE

Anderson, John D., RFP 312-37, August 29, 1961.

IDENTIFICATION 37

GERTA/GREOF
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

GERTA writes the partials $\partial F/\partial Q$ (the "phi vector") on the MMP output tape, B7-SYSUT9. Each set of partials is tagged by time, receiver, transmitter, and data type.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
WRITEB/ENDFIL
FLAT

USE

CALL GERTA

CALL GREOF for end-of-file

COMMON input:

CPPHI	partials $\partial F/\partial Q$ (1×20)
TOB	time, d.p. sec past 1950.0
IR	receiver ID
IX	transmitter ID
ID	data type ID

CODING INFORMATION

Length of subroutine is 141 (10) or 215 (8) words.

IDENTIFICATION

GHADP
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

GHADP calculates the Greenwich hour angle for the time given in COMMON location TOB. Intermediate calculations are in double precision. Output is in COMMON location GHA.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
(DFDP)
(DFAD)
(DFMP)
(DFSB)
DMOD
COS

METHOD

$$\alpha_G = 100°.0755426 + 0°.985647346d + 2°.9015 \times 10^{-13} d^2 + \omega s + \Delta\lambda \cos\bar{\epsilon} \pmod{360°}$$

where α_G = Greenwich hour angle
d = integer days past 1950.0
s = sec past 0^h of d th day
ω = Earth rotation rate
$\bar{\epsilon}$ = mean obliquity
$\Delta\lambda$ = nutation in longitude

The mean obliquity is given by

$$\bar{\epsilon} = 23°.445759 - 0°.1309404T - 0°.88 \times 10^{-6} T^2 + 0°.5 \times 10^{-6} T^3$$

where T = Julian centuries past 1950.0

USE

CALL GHADP

COMMON input:

TOB	observation time, d.p. sec past 1950.0
OMEGA	Earth rotation rate, deg/sec
DLO	nutation in longitude, deg

COMMON output:

GHA	Greenwich hour angle, deg

CODING INFORMATION

Length of subroutine is 208 (10) or 320 (8) words.

REFERENCE

Holdridge, D. B., TR 32-223, March 2, 1962.

IDENTIFICATION

IMPAR
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

IMPAR computes the partials of impact time with respect to the estimated and considered parameters.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
FORM

METHOD

$$\frac{\partial T_I}{\partial Q} = \frac{-1}{\underline{\rho} \cdot \underline{\dot{\rho}}} \left(\underline{\rho} \cdot \frac{\partial \underline{\rho}}{\partial Q} \right)$$

where

T_I = impact time
Q = parameter
$\underline{\rho}$ = target centered probe position
$\underline{\dot{\rho}}$ = target centered probe velocity

USE

CALL IMPAR

PZE	XTAR	geocentric target position and velocity

COMMON input:

X	geocentric probe position and velocity (1×6)
U	partials $\partial \underline{\rho} / \partial r_0$ (6×6)
GMAT	partials $\partial \underline{\rho} / \partial q$ (6×11)
LLIST	physical constants flags (11)

COMMON output:

QA	partials $\partial T_I / \partial q$ (1×11)
QB	partials $\partial T_I / \partial r_0$ (1×6)

CODING INFORMATION

Length of subroutine is 127 (10) or 177 (8) words.

IDENTIFICATION

40

INSPC
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

INSPC inverts the U matrix of variational partials by inspection.

RESTRICTIONS

COMMON break: 47675

METHOD

If the U matrix is partitioned

$$U = \left[\begin{array}{c|c} U_{11} & U_{12} \\ \hline U_{21} & U_{22} \end{array}\right]$$

then its inverse may be written as

$$U^{-1} = \left[\begin{array}{c|c} U_{22}^T & -U_{12}^T \\ \hline -U_{21}^T & U_{11}^T \end{array}\right]$$

USE

CALL INSPC

COMMON input:

U	U matrix of variational partials (6 x 6)

COMMON output:

UINV	U^{-1}

CODING INFORMATION

Length of subroutine is 200 (10) or 310 (8) words.

REFERENCE

Anderson, John D., TM 312-409, March 24, 1964.

IDENTIFICATION

41

INTR1/BNTR2
Alan D. Rosenberg and Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This version of INTR1 uses the latest version of the JPL Ephemeris routines, EPHEM, to obtain the necessary planetary information. INTR1 adjusts this output so it matches output from the original INTR1 rotated to true of date for the ODP.

RESTRICTIONS

a. Portions of the ODP COMMON storage must be made available to the routine. ERROR return for planetary ephemeris tape error.
b. Subroutines used:
   EPHEM
   PNUT
   ROT
   ERROR

USE

CALL	BNTR2	Enter one time to set up blocks of storage necessary to EPHEM
CALL	INTR1	Time is used from COMMON

CODING INFORMATION

Length of subroutine is 2188 (10) or 4214 (8) words.

REFERENCES

a. Holdridge, D. B., TR 32-223, Space Trajectories Program for the IBM 7090 Computer, March 2, 1962.
b. Peabody, P. R., Scott, J. F., Orozco, E. G., TR 32-580, User's Description of JPL Ephemeris Tapes, March 2, 1964.

IDENTIFICATION 42

IXTAB
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

IXTAB does a lookup in the table of transmitter ID's and frequencies by means of a time argument.

RESTRICTION

COMMON break: 47675

USE

```
CALL   IXTAB
PZE    N
```

N is the location of a flag which is zero for the initialization entry and non-zero for the normal entry. The initialization entry returns the lookup pointer to the first point in the table.

COMMON input:

TOB	lookup time, d.p. sec past 1950.0
EPOCH	ODP epoch, d.p. sec past 1950.0
YY1	table of times, sec past epoch (1 × 90)
YY1-90	table of transmitter ID's (1 × 90)
YY1-180	table of frequencies (1 × 90)

COMMON output:

IX	transmitter ID
XFREQ	transmitter frequency if IX ≠ 0
TFREQ	transponder frequency if IX ≠ 0

CODING INFORMATION

Length of subroutine is 54 (10) or 66 (8) words.

IDENTIFICATION

KINE
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

KINE reads the ODG data file or the ODP residual file from disk. Each entry loads COMMON with the contents of the next sequential logical record. KINE uses the REDE entry of the buffered disk routine DISCBU.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   REDE
   ERROR
c. Error conditions:
   Disk parity error
   Attempted read outside of file limits

USE

```
CALL   KINE
PZE    RVECO  \
PZE    RVECW   } for ODG data reading
PZE    = 1001  |
PZE    = 2000 /
PZE    IF6        1B17 = EOF, 2B17 = normal

PZE    RVEC   \
PZE    RVECD   } for ODP residual reading
PZE    = 1     |
PZE    = 1000 /
```

COMMON output:

TOB	observation time, d.p. sec past 1950.0
RVEC	array of computed data types
RVECO	array of observed data types
RVECW	array of weight code-words
RVECD	array of residual-weight words
PASS	pass identification
XFREQ	transmitter frequency, cps
TFREQ	transponder frequency, cps
IR	receiver identification
IX	transmitter identification
TAU	doppler averaging time, sec

The ODG logical record format is as follows:

Word			
	0	word count (2N + 5, B17) or -0 for EOF	
	1	TOB	
	2	TOB - 1	
	3	XFREQ if IX $\neq$ 0	
		TFREQ if IX $\neq$ 0	
	4	PASS	
	5	bit S	1 if L - S band
			0 if L or S band
		1	1 if RVECO $\neq$ 0
		2	1 if RVECO - 1 $\neq$ 0
		3	1 if RVECO - 2 $\neq$ 0
		.	
		.	
		.	
		11	1
		12-15	not used
		16	1 if L - S or S band
			0 if L band
		17	1 if optical data
		18-21	IX
		22-25	IR
		26-35	TAU
	6	first member of RVECO which is non-zero	
	7	bits S-17	weight codeword corresponding to word 6
		18-35	data sample rate, sec
	8	second member of RVECO which is non-zero	
	9	second weight-sample rate word	
	2N + 4	Nth member of RVECO which is non-zero	
	2N + 5	Nth weight-sample rate word	

The corresponding residual record format is found in the documentation of subroutine FILL.

CODING INFORMATION

Length of subroutine is 142 (10) or 216 (8) words.

IDENTIFICATION 44

LOCO
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This is the control routine for the link which restores the ODP COMMON from disk following computation of the trajectory. In addition it controls preparation of the combined ephemeris on tape A4.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP
b. COMMON break: 47675
c. Subroutines used:

KOOL
TAPIO
INTR1
EPPHEM
FLAK
TYPRYT

USE

This is one of the basic links of the ODP in that it restores COMMON and prepares the ephemeris. It is called under control of the JPTRAJ monitor.

CODING INFORMATION

Length of subroutine is 116 (10) or 164 (8) words.

IDENTIFICATION

LOOKUP/KOOL
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To perform look-up on the probe ephemeris generated by SPACE.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   ERROR Called when time incompatible with the ephemeris which has been generated.
   REDE

METHOD

The subroutine computes the coefficients for a 5th degree Lagrangian interpolation and provides values for the position, velocity, acceleration and jerk (3rd derivative) of the probe, variational equations, nutation in longitude and nutation in obliquity. (Flow chart is included)

$$y(x) = \sum_{k=0}^{w} l_k(x) f(x_k)$$

where

$$l_i(x) = \frac{\pi(x)}{(x - x_i)\pi'(x_i)}$$

$$= \frac{(x - x_0) \cdots (x - x_{i-1})(x - x_{i+1}) \cdots (x - x_n)}{(x_i - x_0) \cdots (x_i - x_{i-1})(x_i - x_{i+1}) \cdots (x_i - x_n)}$$

For each time that LOOKUP is called the following information is stored in COMMON

X, Y, Z, XDOT, YDOT, ZDOT		Probe vector
U	(36)	Variational equations

$$\partial x/\partial x_0,\ \partial x/\partial y_0,\ \partial x/\partial z_0,\ \partial x/\partial \dot{x}_0 \cdots \partial \dot{z}/\partial x_0 \cdots \partial \dot{z}/\partial \dot{z}_0$$

DLO	Nutation in longitude
DOB	Nutation in obliquity
XAC, YAC, ZAC	Probe acceleration
XJERK, YJERK, ZJERK	Probe jerk (3rd derivative)

USE

CALL	LOOKUP (n)	n = number of items to be interpolated, 6 or 49. When 6, the probe vector only is given.
CALL	KOOL	to provide a logical reset on the probe ephemeris file and to set flag for LOOKUP to read 3 physical records needed on first entry to the subroutine.

CODING INFORMATION

Length of subroutine is 314 (10) or 472 (8) words.

REFERENCE

Hildebrand, F. B., Introduction to Numerical Analysis, McGraw-Hill, New York, 1956.

IDENTIFICATION 46

MAMUL

Melba W. Nead, JPL

Fortran II, Version 3

January 4, 1965

PURPOSE

To multiply two matrices and store in a third array.

RESTRICTION

Maximum array: 20 x 20

USE

```
CALL   MAMUL   (A, B, C, M, N, L)
                A(M, L)  *  B(L, N)  =  C (M, N)
```

CODING INFORMATION

Length of subroutine is 87 (10) or 127 (8) words.

IDENTIFICATION

47

MAPOUT
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

MAPOUT reads all matrices which were computed and stored on disk in Link 2. Here they are printed and in some cases punched. Also, the mapping information is saved for the MMP (MATRIX MANIPULATOR PROGRAM) input tape.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP

b. COMMON break: 47055

c. Subroutines used:
   PRIM
   FLAK
   REFORM
   PUMA
   PRAM
   DCP
   IOCS
   TYPRYT
   OFFSYS
   TACCOM

USE

This link is called under control of the JPTRAJ Source Deck.

CODING INFORMATION

Length of subroutine is 866 (10) or 1542 (8) words.

IDENTIFICATION

48

MAXIM
Melba Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

Checks data tape, mapping times, predictions, pointing times, etc. so that the trajectory can be run a minimum length of time and still satisfy all demands on the probe ephemeris.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

KINE
MOCT
QUIZ
(DFAD)
(DFSB)

METHOD

Flow chart is included.

USE

CALL MAXIM

CODING INFORMATION

Length of subroutine is 315 (10) or 473 (8) words.

IDENTIFICATION 49

MOCT
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

MOCT obtains the latest occultation or impact time for determining the trajectory link time stop.

RESTRICTION

COMMON break: 47675

USE

CALL MOCT
PZE LAST latest occultation/impact time, d.p. sec past 1950.0
COMMON input:
PTFD occultation/impact input area
DXDR-27 occultation/impact flag

CODING INFORMATION

Length of subroutine is 71 (10) or 107 (8) words.

IDENTIFICATION 50

ND2F
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This is a SHARE routine which has been modified so that it is possible to start at a predetermined portion of the random number generator.

RESTRICTION

COMMON break: 47675

METHOD

RANO, an octal number, can be input into the ODP data.
This number is chosen from a pre-calculated set.

USE

To provide noise on a simulated data tape.

CODING INFORMATION

Length of subroutine is 39 (10) or 47 (8) words.

IDENTIFICATION

51

NOMNL
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

NOMNL stores the nominal values of all constants, other than the weighting tables and the target-dependent solar pressure constants.

RESTRICTION

COMMON break: 47675

USE

CALL NOMNL

This subroutine outputs into approximately 150 COMMON locations.

CODING INFORMATION

Length of subroutine is 499 (10) or 1051 (8) words.

REFERENCES

a. Clarke, Victor C., TR 32-604, March 6, 1964.
b. Scott, James F., IOM 317.21/318, September 1, 1964.

IDENTIFICATION 52

NORMAY
Melba Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To normalize a matrix on its diagonal terms.

RESTRICTIONS

a. Maximum matrix: 20×20
b. Subroutines used:

SQRT

USE

CALL NORMAY (XMAT, YMAT, N)
XMAT = matrix A be normalized
YMAT = location to store normalized matrix
N = order of matrix

CODING INFORMATION

Length of subroutine is 169 (10) or 251 (8) words.

IDENTIFICATION

NOUT
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

NOUT prints comments indicating the rows and columns of the normal matrix which were deleted by subroutine STPREG during inversion:

VARIABLE NO. XX REJECTED BY DIAGONAL TEST.

RESTRICTION

Subroutines used:

PROUT

USE

```
CALL   NOUT
PZE    INOUT
```

INOUT is a 1 × 20 array in which STPREG has indicated the status of each variable.
COMMON input:

PRIFIL PROUT file control block for printing.

CODING INFORMATION

Length of subroutine is 64 (10) or 100 (8) words.

IDENTIFICATION

OBTOX
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

OBTOX computes the partials of the ODP data types with respect to the probe position and velocity at the observation time.

RESTRICTION

COMMON break: 47675

METHOD

$$\frac{\partial \rho_i}{\partial \underline{r}} = \underline{L}$$

$$\frac{\partial \rho_i}{\partial \underline{\dot{r}}} = 0$$

(slant range partials)

$$\frac{\partial \dot{\rho}_i}{\partial x} = \frac{1}{\rho_i}\left(\dot{x} + \omega \overline{y_1} - \dot{\rho}_i L_x\right)$$

$$\frac{\partial \dot{\rho}_i}{\partial y} = \frac{1}{\rho_i}\left(\dot{y} - \omega x_i - \dot{\rho}_i L_y\right)$$

$$\frac{\partial \dot{\rho}_i}{\partial z} = \frac{1}{\rho_i}\left(\dot{z} - \dot{\rho}_i L_z\right)$$

$$\frac{\partial \dot{\rho}_i}{\partial \underline{\dot{r}}} = \underline{L}$$

(range rate partials)

$$\frac{\partial \gamma_i}{\partial \underline{r}} = \frac{\underline{\tilde{D}}}{\rho_i}$$

$$\frac{\partial \gamma_i}{\partial \underline{\dot{r}}} = 0$$

(elevation angle partials)

$$\frac{\partial \sigma_i}{\partial \underline{r}} = \frac{\widetilde{\underline{A}}}{\rho_i}$$

$$\frac{\partial \sigma_i}{\partial \dot{\underline{r}}} = 0$$

(azimuth angle partials)

$$\frac{\partial \delta_i}{\partial x} = \frac{-\cos \alpha_{ri} \sin \delta_i}{\rho_i}$$

$$\frac{\partial \delta_i}{\partial y} = \frac{-\sin \alpha_{ri} \sin \delta_i}{\rho_i}$$

$$\frac{\partial \delta_i}{\partial z} = \frac{\cos \delta_i}{\rho_i}$$

$$\frac{\partial \delta_i}{\partial \dot{r}} = 0$$

(declination partials)

$$\frac{\partial a_i}{\partial x} = \frac{\sin \alpha_{ri}}{\rho_i \cos \delta_i}$$

$$\frac{\partial a_i}{\partial y} = \frac{-\cos \alpha_{ri}}{\rho_i \cos \delta_i}$$

$$\frac{\partial a_i}{\partial z} = 0$$

$$\frac{\partial a_i}{\partial \dot{\underline{r}}} = 0$$

(hour angle partials)

$$\frac{\partial f_{1i}}{\partial \underline{r}} = \frac{\Omega_2}{c} \frac{\partial \dot{\rho}_i}{\partial \underline{r}} \qquad \underline{r} \rightarrow \dot{\underline{r}}$$

(one-way doppler partials)

$$\frac{\partial f_{c3i,q}}{\partial \underline{r}} = \frac{\Omega_4}{c} \left(\frac{\partial \dot{\rho}_i}{\partial \underline{r}} + \frac{\partial \dot{\rho}_q}{\partial \underline{r}} \right) \qquad \underline{r} \rightarrow \dot{\underline{r}}$$

(two-way doppler partials)

$$\frac{\partial f_{3i,q}}{\partial \underline{r}} = \frac{\Omega_6}{c}\left(\frac{\partial \dot{\rho}_i}{\partial \underline{r}} + \frac{\partial \dot{\rho}_q}{\partial \underline{r}}\right) \quad \underline{r} \rightarrow \dot{\underline{r}} \qquad \text{(three-way doppler partials)}$$

$$\frac{\partial f_{dli,j}}{\partial \underline{r}} = \frac{\Omega_2}{c}\left(\frac{\partial \dot{\rho}_i}{\partial \underline{r}} - \frac{\partial \dot{\rho}_j}{\partial \underline{r}}\right) \quad \underline{r} \rightarrow \dot{\underline{r}} \qquad \text{(differenced one-way partials)}$$

(all symbols used here are defined in the subroutine CATS documentation)

USE

CALL OBTOX

COMMON input:

ELX	$\underline{L}$
TAX	$\underline{\tilde{A}}$
TDX	$\underline{\tilde{D}}$
RVEC	ODP computed data type array
X	$\underline{r}$, $\dot{\underline{r}}$
OMEGA	ω, deg/sec
RAI	α_{ri}, deg
CZ2	Ω_2
CZ4	Ω_4
CZ6	Ω_6
VELC	c, km/sec

COMMON output:

POBX	$\partial F/\partial \underline{r}$, $\partial F/\partial \dot{\underline{r}}$

CODING INFORMATION

Length of subroutine is 189 (10) or 275 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

b. Anderson, John D., TM 312-409, March 24, 1964.

IDENTIFICATION

55

OCIM
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

OCIM reads the ODP combined ephemeris tape, extracting occultation and impact time parameters necessary for partials calculation.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines called:

IMPAR
OCPAR
READB
FLAT
ERROR

c. Error conditions:

Ephemeris tape permanent redundancy

USE

CALL OCIM

COMMON input:

DXDR-6	target (1 = Mars 2 = Moon 3 = Venus)
DXDR-27	1B17 = occultation time 2B17 = impact time
XMOO	geocentric Moon vector
XVEN	geocentric Venus vector
XMAR	geocentric Mars vector
PTFD	occultation-impact times input array
X	geocentric probe vector
XAC	geocentric probe accelerations
XJERK	geocentric probe jerks
RVECD	residual
RVECW	weight
DINT	physical constants partials
T	corrected occultation/impact time

IDENTIFICATION

OCPAR
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

OCPAR computes the partials of occultation time with respect to the estimated and considered parameters.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
FORM

METHOD

$$\frac{\partial T_0}{\partial Q} = \frac{\underline{\rho} \cdot \underline{\rho}_m \left(\frac{\underline{\rho}_m \cdot \frac{\partial \underline{\rho}_m}{\partial Q}}{\rho_m^2} + \frac{\underline{\rho} \cdot \frac{\partial \underline{\rho}}{\partial Q}}{\rho^2} \right) - \underline{\rho} \cdot \frac{\partial \underline{\rho}_m}{\partial Q} - \underline{\rho}_m \cdot \frac{\partial \underline{\rho}}{\partial Q} + \frac{|\underline{\rho}| \, |\underline{\rho}_m| \sin \phi_p R_m}{\rho_m^2 \sqrt{\rho_m^2 - R_m^2}} \underline{\rho}_m \cdot \frac{\partial \underline{\rho}_m}{\partial Q}}{\underline{\rho} \cdot \underline{\rho}_m \left(\frac{\underline{\rho}_m \cdot \dot{\underline{\rho}}_m}{\rho_m^2} + \frac{\underline{\rho} \cdot \dot{\underline{\rho}}}{\rho^2} \right) - \underline{\rho} \cdot \underline{\rho}_m - \underline{\rho}_m \cdot \underline{\rho} + \frac{|\underline{\rho}| \, |\underline{\rho}_m| \sin \phi_p R_m}{\rho_m^2 \sqrt{\rho_m^2 - R_m^2}} (\underline{\rho}_m \cdot \underline{\rho}_m)}$$

where

$\underline{\rho}_m = \underline{r}_m - \underline{R}_i$

R_m = radius of target

$\underline{r}_m$ = geocentric target vector

$$\phi_p = \cos^{-1} \frac{\underline{\rho} \cdot \underline{\rho}_m}{|\underline{\rho}| \, |\underline{\rho}_m|}$$

$\underline{\rho}$ = topocentric probe vector

$\underline{R}_i$ = geocentric station vector

USE

CALL	OCPAR	
PZE	XTAR	$\underline{r}_m$, km
PZE	AA	$A = \underline{\Gamma} \cdot \dot{\underline{\Gamma}}$
PZE	AB	$B = \underline{\beta} \cdot \dot{\underline{\beta}}$
PZE	AC	$C = \sqrt{\Gamma^2 \beta^2 - (\underline{\Gamma} \cdot \underline{\beta})^2}$
PZE	AK	$K = \underline{\Gamma} \cdot \dot{\underline{\beta}} + \underline{\beta} \cdot \dot{\underline{\Gamma}}$
PZE	AM	$M = R_m C / \beta^2 \sqrt{\beta^2 - R_m^2}$
PZE	GDB	$\underline{\Gamma} \cdot \underline{\beta}$
PZE	BETA	$\lvert\underline{\beta}\rvert$ $(\underline{\beta} = \underline{\rho}_m)$
PZE	GAMMA	$\lvert\underline{\Gamma}\rvert$ $(\underline{\Gamma} = \underline{r} - \underline{R}_i)$
PZE	XMX	$\underline{\rho}_m \cdot \underline{r}$
PZE	XXI	$\underline{r} \cdot \underline{R}_i$
PZE	SI	$\underline{R}_i$

COMMON input:

U	partials $\partial\rho/\partial\underline{r}_0$ (6×6)
GMAT	partials $\partial\underline{\rho}/\partial q$ (6×11)
LLIST	physical constants flags (11)
RI	$\lvert\underline{R}_i\rvert$, km
NLIST	station locations flags (3×15)
COSRAI	cos α_{ri}
SINRAI	sin. α_{ri}
COSPHI	sin ϕ_i

COMMON output:

QA	partials $\partial T_0/\partial q$
QB	partials $\partial T_0/\partial \underline{r}_0$
DIM3	partials $\partial T_0/\partial s_i$

CODING INFORMATION

Length of subroutine is 333 (10) or 515 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

b. Liu, Anthony, RFP 312-136, May 20, 1963.

IDENTIFICATION

ODATA/ONLIN/.....
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

ODATA performs the following functions:

a. In conjunction with the conversion subroutine CARDS, reads ODP control cards and the symbolic and/or numeric data cards. The cards may be read from the on-line reader or input tape A2 (mode 4) or the user area reader (mode 2).
b. Manipulates the symbolic and numeric data and stores them in the appropriate COMMON locations for subsequent ODP use.
c. Under sense switch (or console key) control, terminates ODP execution.
d. Prints the trajectory target on the administrative (or on-line) printer.
e. Stores the target-dependent solar pressure constants.
f. On option, reads the previously computed injection conditions, constants, and covariance matrix from disk.
g. Applies Gauss' constraint to the planetary masses:

$$GM_s = 3.9640160 \times 10^{-14} a_e^3$$

$$GM_v = \frac{M_v}{M_s} GM_s$$

$$GM_r = \frac{M_r}{M_s} GM_s$$

$$GM_j = \frac{M_j}{M_s} GM_s$$

where

a_e = astronomical unit
s, v, r, j = subscripts denoting the Sun, Venus, Mars, Jupiter.

h. On option, applies the scaling constraint to the Earth radius:

$$R_{em} = 86.315745 (GM_e + GM_m)^{1/3}$$

where 57-2 of 2

R_{em} = earth radius for scaling the lunar ephemeris.

RESTRICTIONS

a. If any of the following error conditions are detected, ODATA calls subroutine ERROR for the appropriate comment printout and subsequent action:
   1. Error in symbolic or numeric input.
   2. Checksum or redundancy error.
   3. Cards not received within time limit (mode 2).
   4. Illegal card in deck (mode 2)
   5. End-of-file indication (mode 4)
   6. Data on input card inconsistent with ODP requirements.
   7. Error in reading disk.

b. COMMON break: 47675

c. Subroutines called:

TYPRYT
IOCS - DEFINE/ATTACH/OPEN/CLOSE
CARDS
OFFSYS
ERROR
FINSYS
READS/MOOPH1/ODOFF
FLOT
SPHX
STPREG
DIAG
DISCBU - REDE
EXP(3

USE

CALL ODATA

ODATA uses most of the ODP COMMON map. Section IVB has the COMMON listing. The input descriptions are in Section IVA.

ONLIN is used for returning to ODATA after a corrected card input error (TTR $ONLIN).

..... represents the entry point for the JPTRAJ program control block of LA9.

CODING INFORMATION

Length of subroutine is 1723 (10) or 3273 (8) words.

IDENTIFICATION

ORBEQ
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

ORBEQ rotates the encounter noise moment matrix from the ODP $\underline{R}$, $\underline{T}$ plane to the midcourse program $\underline{R}$, $\underline{T}$ plane.

RESTRICTIONS

a. COMMON break: 47055
b. Subroutines used
   ARTAN
   COS
   SIN

METHOD

$$\theta = \tan^{-1} \frac{\underline{B} \cdot \underline{R}_{m/c}}{\underline{B} \cdot \underline{T}_{m/c}} - \tan^{-1} \frac{\underline{B} \cdot \underline{R}_{odp}}{\underline{B} \cdot \underline{T}_{odp}}$$

$$R = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

USE

CALL	ORBEQ	
PZE	BRO	ODP $\underline{B} \cdot \underline{R}$, km
PZE	BTO	ODP $\underline{B} \cdot \underline{T}$, km
PZE	BRM	M/C $\underline{B} \cdot \underline{T}$, km
PZE	BTM	M/C $\underline{B} \cdot \underline{T}$, km
PZE	CNO	ODP noise moment matrix (6 × 6)
PZE	CNM	M/C noise moment matrix (3 × 3)

CODING INFORMATION

Length of subroutine is 119 (10) or 167 (8) words.

IDENTIFICATION 59

OZ
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

OZ is the control program for the calculation of the closest approach parameters.

RESTRICTIONS

a. COMMON break: 47055
b. Subroutines used:

UMAT
TYPRYT
IOCS
OFFSYS

USE

When impact or closest approach parameters are requested, this link is called under control of the JPTRAJ Source Deck.

CODING INFORMATION

Length of subroutine is 766 (10) or 1376 (8) words.

IDENTIFICATION 60-1 of 2

PARAM

Michael R. Warner, JPL

IBM 7094 Fap

January 4, 1965

PURPOSE

PARAM outputs the encounter parameters page of the ODP printout. It also loads the buffers for COMENT output.

RESTRICTIONS

a. COMMON break: 47055

b. Subroutines called:

SQRT
FIXT
PROUT
TNORM
ORBEQ

USE

CALL	PARAM	
PZE	CNO	noise moment matrix of encounter parameters (6 × 6)
PZE	BRO	$\underline{B} \cdot \underline{R}$, km (ODP plane)
PZE	BTO	$\underline{B} \cdot \underline{T}$, km (ODP plane)
PZE	ELPS	miss ellipse configuration (1 × 3 - semi-major axis, semi-minor axis, orientation angle)
PZE	A	semi-major axis of encounter conic
PZE	UNJ	$\partial M/\partial Q_0$ matrix of encounter partials
PZE	TL	linearized time of flight, days
PZE	UT	$\partial M/\partial Q$ matrix of encounter partials

COMMON input:

DXDR-6	target identification
DXDR-21	$\underline{B} \cdot \underline{R}$ (midcourse plane)
DXDR-20	$\underline{B} \cdot \underline{T}$ (midcourse plane)
DXDR-2	COMENT update flag
GRAVE	GM_{Earth}, km^3/sec^2
GRAVR	GM_{Mars}
GRAVV	GM_{Venus}

GRAVM	GM_{Moon}	60-2 of 2
GRAVS	GM_{Sun}	
TFIN	time of impact/closest approach, d.p. seconds past 1950.0	
COMTS	ODP page heading, BCD	
PRIFIL	PROUT file control block	
XNJ	ODP initial conditions (1 × 6), d.p.	
EPOCH	ODP epoch, d.p. sec past 1950.0	
XDOT	probe velocity at encounter, km/sec (1 × 3)	

COMMON output:

COMBU	midcourse program COMENT parameters
COMBW	trajectory program COMENT parameters

CODING INFORMATION

Length of subroutine is 720 (10) or 1320 (8) words.

IDENTIFICATION

PARLEY
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To write time, partials, position and velocity of probe and planets, etc., on tape for each data point while the data is being processed.

RESTRICTIONS

a. COMMON break: 47675
b. Cannot be used in SFOF MODE 2 (real-time mode).
c. Subroutines used:

FLAT
TAPIO

USE

CALL PARLEY

The following items are written on a scratch tape to be read and printed in a subsequent link:

TOB		Observation time
GHA		Greenwich Hour Angle
X		Probe vector
Y		
Z		
XDOT		
YDOT		
ZDOT		
U	(36)	Variational equations
DLO		Nutation in longitude
DOB		Nutation in obliquity
XAC		Probe Acceleration
YAC		
ZAC		
XJERK		Probe jerk (3rd derivative)
YJERK		
ZJERK		
XSUN	(6)	Sun vector

XVEN	(6)	Venus vector	XTARG vector only	61-2 of 2
XMOO	(6)	Moon vector		
XMAR	(6)	Mars vector		
CPPHI	(20)	CAP PHI matrix of partials		
CPTHT	(20)	CAP THETA matrix of partials		
DELT		Light time correction		
DELT2		Second light time correction		
DHA		Refraction corrections		
DDEC				
DAZ				
DEL				
DRDOT				
DRVEC				

CODING INFORMATION

Length of subroutine is 30 (10) or 36 (8) words.

REFERENCE

Null, George, W., RFP 312-179, August 15, 1963.

IDENTIFICATION

62

PARSH
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This link is called only when the COMENT region is to be updated, or when in MODE 4, the printing of the partials is requested. The program is called under control of the JPTRAJ monitor.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutine used:

COMOUT
WASH
FGDOUT
DISCBU

USE

Control program for writing COMENT on disk or printing partials.

CODING INFORMATION

Length of subroutine is 662 (10) or 1226 (8) words.

IDENTIFICATION

63

PERNOD/WOLF
Charles Coltharp/Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

PERNOD accumulates statistics on data residuals. It is called during the processing of each residual. WOLF is called at the end-of-file for each station's residuals. It obtains the standard deviation, root-mean-square, mean, and second moment for each data type and each pass identification.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

FIXT
PROUT/FGDOUT
SQRT
COLA

USE

CALL PERNOD after each residual is read

CALL WOLF after each station is completed

COMMON input:

TOB	observation time, d.p. seconds past 1950.0
RVECD	residual array (1 × 11)
ITNO	iteration number
PASS	pass identification
IR	receives identification
PRIFIL	IOCS printing file control block

CODING INFORMATION

Length of subroutine is 323 (10) or 503 (8) words.

IDENTIFICATION 64

PM360
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

PM360 adjusts angle residuals by 360 deg if they are greater than 180 deg or less than -180 deg.

RESTRICTIONS

COMMON break: 47675

USE

CALL PM360

COMMON input:

DECD	declination residual
HAD	hour angle residual
AZID	azimuth residual

COMMON output:

DECD, HAD, AZID	residuals adjusted by 360 deg if necessary

CODING INFORMATION

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

IDENTIFICATION

PNUT
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

PNUT calculates the rotation matrix for nutation-precession.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
SIN
COS

METHOD

$$N = \begin{bmatrix} 1 & -\Delta\lambda \cos \bar{\epsilon} & -\Delta\lambda \sin \bar{\epsilon} \\ \Delta\lambda \cos \bar{\epsilon} & 1 & -\Delta\epsilon \\ \Delta\lambda \sin \bar{\epsilon} & \Delta\epsilon & 1 \end{bmatrix}$$

$$a_{11} = 1 - 0.29697 \times 10^{-3} T^2 - 0.13 \times 10^{-6} T^3$$

$$a_{12} = -0.02234988T - 0.676 \times 10^{-5} T^2 + 0.221 \times 10^{-5} T^3$$

$$a_{13} = -0.00971711T + 0.207 \times 10^{-5} T^2 + 0.96 \times 10^{-6} T^3$$

$$a_{21} = -a_{12}$$

$$a_{22} = 1 - 0.24976 \times 10^{-3} T^2 - 0.15 \times 10^{-6} T^3$$

$$a_{23} = -0.10859 \times 10^{-3} T^2 - 0.3 \times 10^{-7} T^3$$

$$a_{31} = -a_{13}$$

$$a_{32} = a_{23}$$

$$a_{33} = 1 - 0.4721 \times 10^{-4} T^2 + 0.2 \times 10^{-7} T^3$$

where

$\Delta\lambda$ = nutation in longitude
$\Delta\epsilon$ = nutation in obliquity
$\bar{\epsilon}$ = mean obliquity (see writeup for GHADP)
T = Julian centuries past 1950.0

USE

CALL PNUT
COMMON input:
T time, d.p. sec past 1950.0
DOB nutation in obliquity, deg
DLO nutation in longitude, deg
COMMON output:
ROTMX nutation-precession matrix (NA)

CODING INFORMATION

Length of subroutine is 222 (10) or 336 (9) words.

REFERENCE

Holdridge, D. B., TR 32-223, March 2, 1962.

IDENTIFICATION 66

POINT
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To generate the pointing predictions for the tracking stations.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

COEF
FILL
OFFSYS
CORR
GHADP
REAP
DOPLR
IXTAB
(DFAD)

USE

CALL POINT

CODING INFORMATION

Length of subroutine is 196 (10) or 304 (8) words.

REFERENCE

Trask, D.W., RFP 312-37, Addendum 6, April 4, 1962.

IDENTIFICATION 67

PONT
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To compute the times at which the combined ephemeris shall be written for a simulated data tape or predictions.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

GAMAT
INTR1
LOOKUP
OFFSYS
RITEM
TIMER
(DFAD)

Flow chart included

USE

CALL PONT

CODING INFORMATION

Length of subroutine is 201 (10) or 311 (8) words.

IDENTIFICATION

68

PRAMS
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To save the U matrix when it is calculated by COMIMP. Core space forces the calculation and the print-out of these matrices to be done in separate links.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP
b. Subroutines used:

FLAK
DCP

USE

CALL PRAMS

CODING INFORMATION

Length of subroutine is 18 (10) or 22 (8) words.

IDENTIFICATION 69

PREDA
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This is the main program of the link which computes predictions for the DSIF stations or prepares a simulated data tape.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

POINT
DATAPE
TYPRYT
TAPIO

USE

This link is called under control of the JPTRAJ Source Deck when predictions or a data tape are requested.

CODING INFORMATION

Length of subroutine is 39 (10) or 47 (8) words.

IDENTIFICATION 70-1 of 2

PRIM/PRAM
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To print any matrix up to 20 × 20 from a possible list of 63. Included is the capability of punching the array in a format acceptable as input back into the ODP. When step-mapping, probe position and velocity and the mapping matrix are automatically punched.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

BIBCD
FLAPR
PRIME
NORMAY
PRIT
DIAGO
FGDOUT
PROUT

USE

```
CALL   PRIM
PZE    ,,N
```

where N is as follows:

1. Input J matrix of estimated parameters
2. Input covariance matrix of considered parameters
3. J inverse
4. Covariance matrix of estimated parameters
5. Correlation matrix of estimated parameters
6. Covariance matrix at impact
7. Covariance matrix mapped forward
8. J matrix
9. Input covariance matrix of estimated parameters
10. Correlations based on J matrix
11. U product matrix in step-mapping

CALL PRAM 70-2 of 2
TSX CAPU

Prints U matrix for mapping forward

To punch a matrix PUNCH=n under OTHER PARAMETER VALUES in the data input. This will punch the matrix only one time.

CODING INFORMATION

Length of subroutine is 787 (10) or 1423 (8) words.

REFERENCE

Trask, D.W., REP 312-37, Addendum 6, April 4, 1962.

IDENTIFICATION 71

PRIME/REFORM
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To write impact times, probe and target vectors and the mapping matrices on the MATRIX MANIPULATOR PROGRAM input tape.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

TAPIO
FLAT

USE

CALL	REFORM	To read mapping times from preliminary storage tape. TFIN is added to those originally saved and all are written on the final MMP tape.
CALL	PRIME	To write the mapping matrices on the MMP tape.

CODING INFORMATION

Length of subroutine is 98 (10) or 142 (8) words.

REFERENCE

Peterson, G. E., ED 218, May 15, 1964.

IDENTIFICATION 72

PRINQ/PRIT/APRIOR
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To print DQ's, new Q's, old Q's, standard deviation of covariance matrix of estimated parameters, etc.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

FGDOUT
DIAG
CLOCK
PROUT
FLAPR
FIXT
BIBCD

USE

CALL PRINQ	Prints DQ's etc. of estimated parameter.
CALL PRIT	Entered with double precision time in seconds in ACC and MQ. These are converted to year, month, day, hour, minute, second, and stored in COMMON.
APRIOR	Buffer in which the standard deviation of the aprior covariance matrix is stored through the "WANT" capability of the JPTRAJ monitor.

CODING INFORMATION

Length of subroutine is 259 (10) or 403 (8) words.

REFERENCE

Trask, D.W., RFP 312-37, Addendum 6, April 4, 1962.

IDENTIFICATION 73

PRINT
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

PRINT controls the printing of the DQ's and the matrices which have been computed in the preceding link. Also, when occultation calculations are requested it reads this information from disk and prepares it for printing.

RESTRICTIONS

a. ERROR condition: disk error indicated by DCP
b. COMMON break: 47675
c. Subroutines used:

PRINQ
PRIM
FIXT
PROUT
FGDOUT
FLAK
DISCBU
IOCS
ENDIT
OFFSYS

USE

Upon completion of the calculation of the data fitting link, the print link is called under control of the JPTRAJ MONITOR.

CODING INFORMATION

Length of subroutine is 1352 (10) or 2510 (8) words.

IDENTIFICATION 74

PROM

Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To multiply two square matrices and store in a third array.

RESTRICTION

Maximum array: 20 × 20

USE

```
CALL   PROM (A, B, C, N)
       A (N, N) * B(N, N) = C (N, N)
```

CODING INFORMATION

Length of subroutine is 110 (10) or 156 (8) words.

IDENTIFICATION

75

QUEST
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

Checks to ascertain that the times specified are greater than EPOCH plus light time correction. Exits with an error return if time is not compatible.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   ERROR
   SQRT
   EXIT

USE

CALL QUEST

CODING INFORMATION

Length of subroutine is 117 (10) or 165 (8) words.

IDENTIFICATION 76

QUIZ
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

QUIZ allows a Fortran program to interrogate the COMMON location KEYS, which contains the "key settings" specified by the input deck.

RESTRICTION

COMMON break: 47675

USE

In Fortran,

B A = (octal representation of desired key setting)
IF (QUIZF (A)) S_1, S_2, S_1

where

S_1 is the normal return indicating that the key is set
S_2 is the normal return indicating that the key is not set

COMMON input:

KEYS key setting word

CODING INFORMATION

Length of subroutine is 2 (10) or 2 (8) words.

IDENTIFICATION

RATES
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

RATES obtains the topocentric slant range and its first three derivatives. Both the up-leg and down-leg are calculated using the light-time correction supplied by subroutine DOPLR. Four other range-dependent quantities are also obtained.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines called:
   COS
   SIN
   SQRT
   ARSIN
   EXP(3

METHOD

$$\alpha_{r_i} = \lambda_i + \alpha_G - 2\omega\Delta t \qquad \text{(station right ascension)}$$

$$X_i = R_i \cos\phi_i \cos\alpha_{ri}$$

$$Y_i = R_i \cos\phi_i \sin\alpha_{ri}$$

$$Z_i = R_i \sin\phi_i$$

$$\dot{X}_i = -\omega Y_i$$

$$\dot{Y}_i = \omega X_i$$

$$\ddot{X}_i = -\omega Y_i$$

$$\ddot{Y}_i = \omega X_i$$

(station coordinates and derivatives)

$$\ddot{X}_i = -\omega \dot{Y}_i$$

$$\ddot{Y}_i = \omega \dot{X}_i$$

(station coordinates and derivatives)

$$\underline{\rho}_i = \underline{r} - \underline{R}_i$$

$$\dot{\underline{\rho}}_i = \dot{\underline{r}} - \dot{\underline{R}}_i$$

$$\ddot{\underline{\rho}}_i = \ddot{\underline{r}} - \ddot{\underline{R}}_i$$

$$\dddot{\underline{\rho}}_i = \dddot{\underline{r}} - \dddot{\underline{R}}_i$$

(topocentric coordinates)

$$A = \underline{\rho}_i \cdot \dot{\underline{r}}$$

$$B = \dot{\underline{R}}_i \cdot \dot{\underline{r}}_s$$

$$C = \dot{X}_i^2 + \dot{Y}_i^2$$

$$D = \underline{\rho}_i \cdot (\dot{\underline{R}}_i - \dot{\underline{r}}_s)$$

$$a = |\underline{\rho}|$$

$$b = \underline{\rho} \cdot \dot{\underline{\rho}}$$

$$c = \underline{\rho} \cdot \ddot{\underline{\rho}} + \dot{\underline{\rho}} \cdot \dot{\underline{\rho}}$$

$$d = \underline{\rho} \cdot \dddot{\underline{\rho}} + 3\dot{\underline{\rho}} \cdot \ddot{\underline{\rho}}$$

(four output quantities)

$$\rho = a$$

$$\dot{\rho} = \frac{b}{a}$$

$$\ddot{\rho} = \frac{c - \dot{\rho}^2}{a}$$

$$\dddot{\rho} = \frac{d - 3\dot{\rho}\ddot{\rho}}{a}$$

(slant range)

77-3 of 4

$$\Delta_r \rho = \frac{0.0018958}{(\sin \gamma + 0.06483)^{1.4}} \frac{n_i}{340.0}$$

$$\Delta_r \rho = \frac{0.0018958}{\tau} \left[\frac{1}{(\sin F + 0.06483)^{1.4}} - \frac{1}{(\sin G + 0.06483)^{1.4}} \right] \frac{n}{340.0}$$

(slant range)

where

λ_i = longitude station i

α_G = Greenwich hour angle

ω = Earth rotation rate

Δt = light time correction

ϕ_i = geocentric latitude, station i

R_i = Earth radius at station i

$\underline{r}$ = geocentric probe coordinates

$\underline{r}_s$ = geocentric sun coordinates

γ = elevation angle

n_i = index of refraction, station i

τ = doppler averaging time

$F = \gamma + \frac{\tau \dot{\gamma}}{2}$

$G = \gamma - \frac{\tau \dot{\gamma}}{2}$

USE

CALL	RATES	
PZE	RHO	ρ, km
PZE	DRHO	$\dot{\rho}$, km/sec
PZE	DDRHO	$\ddot{\rho}$, km/sec^2
PZE	DDDRHO	$\dddot{\rho}$, km/sec^3
PZE	A	A
PZE	B	B
PZE	C	C
PZE	D	D
PZE	DT	Δt, sec
PZE	I	station index (IX for up-leg, IR for down-leg)

COMMON input:

THETAI	θ_i, deg	
GHA	α_G, deg	
OMEGA	ω, deg/sec	
PHII	ϕ_i, deg	
RI	R_i, km	
XN	$\underline{r}$, km	light time corrected
DXN	$\dot{\underline{r}}$, km/sec	light time corrected
DDXN	$\ddot{\underline{r}}$, km/sec^2	light time corrected
DDDXN	$\dddot{\underline{r}}$, km/sec^3	light time corrected
XSUN	$\underline{r}_s$, $\dot{\underline{r}}_s$	
EL	γ, deg	
FNI	n_i	
TAU	τ, sec	

COMMON output:

RVEC	ρ, km
RDOT	$\dot{\rho}$, km/sec
DRVEC	$\Delta_r \rho$, km
DRDOT	$\Delta_r \rho$, km/sec

CODING INFORMATION

Length of subroutine is 435 (10) or 663 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

b. Anderson, John D., TM 312-409, March 24, 1964.

IDENTIFICATION 78

RCAL
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

RCAL is to be used to compute the coefficients as required in BMATRX:

$$A = \left(\frac{1}{||\overrightarrow{RV} - \vec{R}||^3} - \frac{1}{RV^3} \right)$$

$$B = \left(\frac{3(\overrightarrow{RV} \cdot \vec{R} - R^2)}{||\overrightarrow{RV} - \vec{R}||^5} \right)$$

$$C = \left(\frac{3}{||\overrightarrow{RV} - \vec{R}||^3} \right)$$

RESTRICTIONS

a. COMMON break: 47675
b. Subroutine used:
SQRT

USE

CALL RCAL(RV) RV, location of the body vector. Results are stored in COMMON locations A, B, and C.

CODING INFORMATION

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

IDENTIFICATION 79

RCOM
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

RCOM computes the coefficients as defined in BMATRX:

$$A = \left(\frac{1}{\left| \left| \overrightarrow{RV} - \vec{R} \right| \right|^3} \right)$$

$$B = \left(\frac{1}{RV^3} \right)$$

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
SQRT

USE

CALL RCOM(RV) RV, location of the body vector. Results are stored in COMMON locations A and B.

CODING INFORMATION

Length of subroutine is 91 (10) or 133 (8) words.

IDENTIFICATION

80

READS/ODOFF/MOOPH1
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

READS is the main program of the link of the ODP which reads data. The routine also includes phasing for all three possible targets, Moon, Mars, and Venus. The target is checked and the phasing is moved so as to be available to the trajectory through the WANT capability of the JPTRAJ monitor.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   ODATA
   TAPIO
   OFFSYS
   ERROR

USE

Upon the completion of each iteration, the logic of the program causes it to cycle back through READS, all under control of the Source Deck and the JPTRAJ monitor.

CALL ODOFF	To end ODP and return to system as called from ODATA.
MOOPH1	Entry to allow JPTRAJ "WANT" feature to save information from this area of READS, namely, the phasing for SPACE.

CODING INFORMATION

Length of subroutine is 704 (10) or 1300 (8) words.

IDENTIFICATION 81

REAP/REAM
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To read the combined ephemeris tape as it is written by the subroutine RITEM.

RESTRICTIONS

a. ERROR indication received by encountering EOF on tape
b. Subroutines used:
   TAPIO
   FLAT
   ERROR

METHOD

REAP-REAM read the combined ephemeris tape which has been written by RITEM. The subroutine uses two buffers for efficiency of operation.

USE

CALL REAP Compares TOB with that saved on tape
CALL REAM Compares T with that saved on tape

CODING INFORMATION

Length of subroutine is 1375(10) or 2537(8) words.

IDENTIFICATION

82

REJEC
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

REJEC keeps a record of those residuals which were rejected by the 3-sigma test. Each bit in the rejection table represents a residual. The table is ordered sequentially.

RESTRICTION

COMMON break: 46711

USE

```
CALL   REJEC
PZE    I
PZE    J
PZE    K
```

where

I = 0 to initialize (set pointer at first bit)
= 1 for normal entry

J = 0 to determine rejection status of current point
= 1 to update rejection status of current point

K = 0 point not rejected
= 1 point rejected

} input if J = 1, output if J = 0

COMMON input and output:

CAPU 500 word rejection table, with recording capability for 18,000 residuals

CODING INFORMATION

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

IDENTIFICATION

83

RESID
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Control program for the link which prints and plots residuals and prints statistics.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   THARP
   TYPRYT
   IOCS

USE

Upon request for residuals and statistics, this link is called by the JPTRAJ monitor.

CODING INFORMATION

Length of subroutine is 704 (10) or 1300 (8) words.

IDENTIFICATION

RESP/COLA
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

This subroutine is designed to provide both listings and plots of information from the receiving stations. The plots are the residuals, observed minus calculated values, for one, two, or three types versus time. Date, station number, time at start of frame, and pass number are included on each frame. In addition to the above, the listings contain count time, sample time, computed values for the data, and weights. Rejected data points are starred. It is possible to list the residual in fixed (nominal) or floating point (FLRES = 1.0).

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   FGDOUT
   CXPLOT
   PKINE
   PERNOD
   STATID
   FIXT
   PROUT
   FLAPR
   BIBCD
   ERROR
   CDC

A maximum of 8 data residuals can be plotted or listed on one iteration.

USE

CALL RESP — With each call to RESP a maximum of 3 residuals is plotted or listed. The routine must be called again for more; the maximum number is 8.

CODING INFORMATION

Length of subroutine is 883 (10) or 1563 (8) words.

REFERENCE

Trask, D.W., RFP 312-37, Addendum 6, April 4, 1962.

IDENTIFICATION

RITEM/WREOF
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

To write the combined ephemeris tape.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
FLAT
TAPIO

METHOD

RITEM uses TAPIO to write the combined ephemeris tape. The subroutine uses two buffers alternately to provide efficient timing. Each buffer contains four logical records of 156 words each.

USE

CALL RITEM Writes logical record on tape A4. Each record contains the following information:

T (2)	Time of data point
TOB (2)	Observation time
XJUP (6)	Jupiter vector
XERM (6)	
XMAR (6)	Mars vector
XVEN (6)	Venus vector
XSUN (6)	Sun vector
XMOO (6)	Moon vector
X, Y, Z, XDOT, YDOT, ZDOT	Probe vector
U (36)	Variational equations
DLO	Nutation in longitude
DOB	Nutation in obliquity

XAC, YAC, ZAC	Probe acceleration
XJERK, YJERK, ZJERK	Probe jerk (3rd derivative)
GMAT (66)	Gamma matrix

CALL WREOF To write end of file and rewind tape A4 when ephemeris is complete.

CODING INFORMATION

Length of subroutine is 1350(10) or 2506(8) words.

IDENTIFICATION 86

ROT
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

ROT rotates the planetary ephemerides from the mean equator and equinox of 1950.0 to the true equator of equinox of date.

RESTRICTION

COMMON break: 47675

METHOD

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix}_{\text{of date}} = NA \begin{pmatrix} x \\ y \\ z \end{pmatrix}_{1950.0}$$

where
NA = nutation-precession matrix obtained by subroutine PNUT

USE

CALL ROT
COMMON input:

ROTMX	NA
XSUN	geocentric position and velocity of Sun, 1950.0
XVEN	geocentric position and velocity of Venus
XMAR	geocentric position and velocity of Mars
XJUP	geocentric position and velocity of Jupiter
XMOO	geocentric position and velocity of Moon

COMMON output:
XSUN, XVEN, XMAR, XJUP, XMOO rotated to true-of-date

CODING INFORMATION

Length of subroutine is 182 (10) or 266 (8) words.

IDENTIFICATION

87

RSIG
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

The partial of AU is expressed as a sum of terms evaluated for SUN, VENUS, MARS, and JUPITER. RSIG evaluates and sums these terms as they are needed in BMATRX.

$$\sum_{k=1}^{4} GM_k \left[x_k \left(\frac{1}{\left| \underline{r}_k - \underline{r} \right|^3} - \frac{1}{r_k^3} \right) - \frac{3\left(r^2 - \underline{r} \cdot \underline{r}_k \right)(x - x_k)}{\left| \underline{r}_k - \underline{r} \right|^5} \right]$$

where

k = 1 = Sun
k = 2 = Venus
k = 3 = Mars
k = 4 = Jupiter

RESTRICTION

COMMON break: 47675

USE

CALL RSIG(GRA, XPL, SIGX) where GRA is gravity of the body, XPL position of body, and SIGX is the sum. The routine is called for the four bodies and SIGX is accumulated.

CODING INFORMATION

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

IDENTIFICATION

88

SAVCOM
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Control for the program to save COMMON. This routine also prints the input matrices when the ODP is initiated and checks the times supplied so the trajectory can be run only for the required period.

RESTRICTIONS

a. ERROR condition; disk error indicated by DCP
b. COMMON break: 47675
c. Subroutines used:
   PRIM
   TYPRYT
   QUEST
   MAXIM
   ERROR
   FLAK
   DISCBU
   OFFSYS

USE

To save COMMON during the trajectory link, this routine is under control of the JPTRAJ monitor.

CODING INFORMATION

Length of subroutine is 1118 (10) or 2136 (8) words.

IDENTIFICATION 89

SCALE
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

When the target is Mars or Venus, the target vector is divided by AU as required in calculation of the target centered covariance matrix.

USE

CALL SCALE (XPOS, P) XPOS is the target vector, the quotient is stored in P.

CODING INFORMATION

Length of subroutine is 34 (10) or 42 (8) words.

IDENTIFICATION

90

SORT
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Time sorted predictions are prepared in Link 4. This is the main program in which these predicts are station sorted and prepared for transmission to the tracking stations.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   THARP
   FLAK
   TYPRYT
   IOCS

USE

Link 5 is called under control of the JPTRAJ Source Deck.

CODING INFORMATION

Length of subroutine is 1069 (10) or 2055 (8) words.

IDENTIFICATION

SPHX
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

SPHX converts Earth-fixed spherical coordinates to geocentric equatorial cartesian coordinates. No provision is made for nutations; thus, the output is in the mean equator and equinox of date.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   SIN
   COS
   GHADP

METHOD

$$x_0 = r_0 \cos \phi_0 \cos(\alpha_G + \lambda_0)$$

$$y_0 = r_0 \cos \phi_0 \sin(\alpha_G + \lambda_0)$$

$$z_0 = W$$

$$\dot{x}_0 = (\dot{U} - \omega V)\cos \alpha_G - (\dot{V} + \omega U)\sin \alpha_G$$

$$\dot{y}_0 = (\dot{U} - \omega V)\sin \alpha_G + (\dot{V} + \omega U)\cos \alpha_G$$

$$\dot{z}_0 = \dot{W}$$

$$U = r_0 \cos \phi_0 \cos \lambda_0$$

$$V = r_0 \cos \phi_0 \sin \lambda_0$$

$$W = r_0 \sin \phi_0$$

$$\dot{U} = v_0(\sin\gamma_0 \cos\phi_0 \cos\lambda_0 - \cos\gamma_0 \sin\gamma_0 \sin\sigma_0 - \cos\gamma_0 \sin\phi_0 \cos\lambda_0 \cos\sigma_0)$$

$$\dot{V} = v_0(\sin\gamma_0 \cos\phi_0 \sin\lambda_0 + \cos\gamma_0 \cos\gamma_0 \sin\sigma_0 - \cos\gamma_0 \sin\phi_0 \sin\lambda_0 \cos\sigma_0)$$

$$\dot{W} = v_0(\sin\gamma_0 \sin\phi_0 + \cos\gamma_0 \cos\phi_0 \cos\sigma_0)$$

where

$x_0, y_0, z_0, \dot{x}_0, \dot{y}_0, \dot{z}_0$ = geocentric equatorial position and velocity

$r_0, \phi_0, \lambda_0, v_0, \gamma_0, \sigma_0$ = Earth-fixed spherical coordinates

α_G = Greenwich hour angle

ω = Earth rotation rate

USE

CALL SPHX

COMMON input:

RNJ	r_0, km
PHINJ	ϕ_0, deg
THTNJ	λ_0, deg
VNJ	v_0, km/sec
ELNJ	γ_0, deg
AZNJ	σ_0, deg
EPOCH	epoch of state vector, d.p. sec past 1950.0
OMEGA	ω, deg/sec

COMMON output:

XNJ	$x_0, y_0, z_0, \dot{x}_0, \dot{y}_0, \dot{z}_0$ (1 × 6)

CODING INFORMATION

Length of subroutine is 211 (10) or 323 (8) words.

IDENTIFICATION

STARP
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

STARP determines whether an observed time point should be deleted or retained on the basis of input data start and stop times.

RESTRICTION

COMMON break: 47675

USE

```
CALL   STARP
PZE    I        I = 0 for point outside allowed range
                  = 1 for point within allowed range
```

COMMON input:

TOB	observation time, d.p. sec past 1950.0
PTFD-30	start-stop times

CODING INFORMATION

Length of subroutine is 24 (10) or 30 (8) words.

IDENTIFICATION

STPREG
Charles L. Lawson/Terry Kinney, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

Double precision solution of the normal equations of a linear least squares regression problem using the stepwise procedure of M. A. Efroymson.

This subroutine is particularly intended for use in least-squares problems in which the user is aware of a large number of basic functions which might bear a linear relationship to the object function but expects that only some of these basic functions make a significant contribution to the determination of the object function.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   (DFAD)/(DFMP)/(DFDP)
   DSQRT

METHOD

In an n-parameter problem this subroutine provides successively a 1-parameter fit, a 2-parameter fit, . . . , a k-parameter fit, where the new parameter introduced at each step is the one which will make the greatest reduction in the sum of squares of residuals. This criterion is equivalent to the requirement that the new parameter be selected as the one which will have the highest statistical significance in the sense that the ratio of its magnitude to its standard deviation will be largest or equivalently its "F" value will be largest (see Ref. c). The termination level k, which will be $\leq$ n, is determined by the subroutine on the basis of tolerance parameters SDIN, SDOUT, and CD provided by the user.

For an exposition of this procedure, see Ref. a of this subroutine. For a complete single precision regression package which incorporates this procedure in its system solving subroutine, see Ref. b. For a discussion of this procedure including details of its implementation in this program see Ref. c.

USE

Let the overdetermined system of linear equations which expresses the linear regression problem be denoted by

$$Gc = f$$

where G is an m by n matrix (m > n), c is an n-vector, f is an m-vector. The elements of G and f are known and the coefficient vector c is to be computed as a weighted least squares solution.

The normal equations Ac = b are formed from the overdetermined system by pre-multiplication by G*W, (*denotes transposition) where W is an m by m non-negative definite weighting matrix (W may be the identity matrix).

This computation, as well as the computation of the scalar quantity s = f*Wf, is to be done by the user's program. STPREG may then be called as follows:

```
D   DIMENSION A (20, 20), B (20), S (1)
    DIMENSION INOUT (20)
    CALL STPREG (A, B, S, N, M, SDIN, SDOUT,
    CD, NIN, INOUT)
```

The parameters are defined as follows:

A(I, J), I = 1, N; J = 1, N

On entry: The matrix A, computed by the user as A = G*WG.
A is normalized by STPREG before inversion.
On return: A^{-1} if NIN = N. If NIN < N then only an NIN by NIN submatrix of A will have been inverted and the elements of this inverse will be in the locations A (I, J) corresponding to those values of I and J for which both INOUT (I) = + 1 and INOUT (J) = + 1. The other A (I, J) locations for $I \leq N$, $J \leq N$ will contain zero. A^{-1} is unnormalized before the return.

B(I), I = 1, N

On entry: The vector b, computed by the user as b = G*Wf.
On return: The solution vector c if NIN = N. If NIN < N then only NIN components of c will have been computed and they will be those in the locations B (I) for which INOUT (I) = + 1. The other B (I) locations for $I \leq N$ will contain zero.

S

On entry: The scalar s, computed by the user as s = f*Wf.
On return: The weighted sum of squares of residuals:

$$(f - Gc)*W(f - Gc) = (f - Gc)*Wf$$
$$= f*Wf - (Gc)*Wf = f*Wf - c*b$$

N The dimension, n, of the normal system.

M The dimension, m, of the f vector.

SDIN, SDOUT

If DSIN > 0., these two numbers will be used by the "significance" logic of the program. A coefficient will be permitted to enter the solution if the ratio of its

magnitude to its standard deviation will exceed SDIN. If this ratio subsequently drops below SDOUT this coefficient will be removed from the solution. To avoid looping, SDIN should exceed SDOUT.

Typical values for SDIN and SDOUT might be SDIN = 1.96, SDOUT = 1.64, which could be interpreted as meaning that a coefficient will be permitted to enter the solution if there is a 95% probability that it is different from zero and will later be removed from the solution if this probability falls below 90%.

If SDIN ≤ 0 all significance tests will be skipped. This permits use of the program with meaningless data in B and S, as may be the case when only matrix inversion is desired.

CD Tolerance for relative reduction in magnitude of diagonal elements. The i^{th} coefficient will not be entered into the solution if the i^{th} diagonal element becomes smaller than CD times the original i^{th} diagonal element of the matrix A. For example if CD = 10.**(-12) then a potential pivot element will not be used if it has lost more than its first 12 significant decimal places.

NIN On return: The number of coefficients in the final solution. INOUT (I), I = 1, N
On return: Flags to indicate final status of each coefficient.

- +1 Included in solution.
- -1 Rejected by diagonal test.
- -2 Rejected by significance tests.

CODING INFORMATION

Length of subroutine is 1069 (10) or 2055 (8) words.

REFERENCES

a. Efroymson, M. A., Multiple Regression Analysis, Mathematical Methods for Digital Computers, ed. Ralston and Wilf, Wiley, 1960, pp. 191-203.
b. Efroymson, M. A., Stepwise Multiple Regression with Variable Transformations, SHARE Distribution No. 1194, October, 1961.
c. Lawson, C. L., Computation of the Most Significant Coefficients in Least-Squares Estimation, JPL Section Report No. 372-5, August, 1962.

IDENTIFICATION 94-1 of 2

TACCOM
Melba W. Nead, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

To evaluate the target-centered cartesian Covariance Matrix.

RESTRICTIONS

a. COMMON break: 47055
b. Subroutines used:
   AAT
   SCALE
   (DFAD)
   (DFMP)
   (DFSB)

METHOD

In the following, A will represent the ephemeris scaling factor. Thus, A = REM when target = MOON, and A = AU when target = MARS or VENUS.

a. When A is among the estimated parameters, compute the target centered covariance matrix as

$$\Gamma_E = \Gamma_X + PP^T\sigma_A^2 - \Gamma_{XA}P^T - P\Gamma_{XA}^T$$

where

Γ_X = upper left hand 6×6 sub-matrix of the geocentric covariance matrix Γ

P = 6-vector giving the geocentric position and velocity of the target in units of A and A/sec, referred to the Earth equatorial system

σ_A^2 = diagonal element of Γ corresponding to A

Γ_{XA} = first 6 elements of the column of Γ corresponding to A

b. When A is not among the estimated parameters

$$\Gamma_E = \Gamma_X$$

USE

CALL TACCOM (GAME, ITAR)

GAME contains Γ_E as calculated in TACCOM

ITAR contains the target reference

ITAR = 1 MARS

ITAR = 2 MOON

ITAR = 3 VENUS

CODING INFORMATION

Length of subroutine is 938 (10) or 1652 (8) words.

REFERENCE

Carey, C., RFP 312-252, March 5, 1964.

IDENTIFICATION 95

TAMP/EPOX
Melba W. Nead, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

Writes mapping times on scratch tape A7 to be saved for matrix manipulation program input tape.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:

TAPIO
FLAT

USE

CALL TAMP

EPOX	provides space for storage of injection conditions which are saved through the WANT cards feature of JPTRAJ

CODING INFORMATION

Length of subroutine is 87 (10) or 127 (8) words.

IDENTIFICATION

THARP/PKINE
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

THARP serves as the logical control routine for the predictions and residuals output links, LA5 and LA8. It sets up lists of desired stations and calls the output subroutines AQUI, PERNOD, RESP, and ANGPLT. PKINE is called by these output routines in order to obtain a meaningful logical record from the disk read routine KINE.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   OFFSYS
   KINE
   AQUI/ALLI/BAQUI/BALLI
   PERNOD/WOLF
   RESP
   ANGPLT
   BIBCD
   TYPRYT

USE

```
CALL   THARP
CALL   PKINE
PZE    SUBR    = 1 if called from ANGPLT
               = 2 if called from AQUI
               = 3 if called from PERNOD
               = 4 if called from RESP
```

COMMON input:

IF3	ODP option flags
IRES	residual output flags (8 × 15)
RESR	plotting scale factors (8 × 15)
ITNO	iteration number
PT	pointing times (used as flags)

CODING INFORMATION

Length of subroutine is 379 (10) or 573 (8) words.

IDENTIFICATION

TIMER
Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

TIMER obtains the primary light time correction which adjusts the observation time for ephemeris lookup purposes.

RESTRICTIONS

a. COMMON break: 47675
b. Subroutines used:
   (DFSB)
   LOOKUP
   SQRT

METHOD

$$\Delta t = 0$$

$$t = t_{ob} - \Delta t$$

$$r = \sqrt{x^2 + y^2 + z^2}$$

$$\Delta t = \frac{r - R_e}{C}$$

The procedure is then repeated with the new Δt.

USE

CALL TIMER
COMMON input:

TOB	t_{ob}, d. p. sec past 1950.0
RE	R_e, km
VELC	c, km/sec

COMMON output:

T	t, d. p. sec past 1950.0
DELT	Δt, d. p. sec

CODING INFORMATION

Length of subroutine is 98 (10) or 142 (8) words.

IDENTIFICATION

98

TNORM
Melba W. Nead/Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

TNORM normalizes an N x N matrix on its diagonal terms. N may be 2, 3, 4, 5, or 6 but the matrix must be stored in a 6 × 6 array.

RESTRICTION

Subroutine called:

SQRT

USE

CALL	TNORM	
PZE	YMAT	input matrix
PZE	XMAT	output normalized matrix
PZE	N	N

CODING INFORMATION

Length of subroutine is 170 (10) or 252 (8) words.

IDENTIFICATION

TOCIM

Michael R. Warner, JPL

IBM 7094, Fap

January 4, 1965

PURPOSE

TOCIM computes occultation time and impact time, and obtains the residual. It writes a record on the combined ephemeris tape for each observable, and outputs on disk for subsequent printing.

RESTRICTIONS

a. COMMON break: 47675

b. Subroutines used:

OFFSYS
TIMER
LOOKUP/KOOL
INTRI
SQRT
COS/SIN
GAMAT
GHADP
ARCOS/ARSIN
FLAT
RITE
WRITEB

METHOD

TOCIM uses a Newton-Raphson formula for both data types:

For occultation time,

$$\left[T_0^{(r)} - T_0^{(r-1)}\right]\left.\frac{d(\phi_p - \phi_m)}{dt}\right|_{T_0^{(r-1)}} = \phi_m - \phi_p$$

where

$$\phi_m = \sin^{-1}\frac{R_m}{|\rho_m|}$$

$$\phi_p = \cos^{-1} \frac{\underline{\rho} \cdot \underline{\rho}_m}{|\underline{\rho}| |\underline{\rho}_m|}$$

$$\frac{d(\phi_p - \phi_m)}{dt} = \frac{\underline{\rho} \cdot \underline{\rho}_m}{a_1} \left[\left(\frac{a_2}{\rho^2} + \frac{a_3}{\rho_m^2} \right) - a_4 \right] + \frac{a_3 R_m}{\rho_m^2 \sqrt{\rho_m^2 - R_m^2}}$$

$$a_1 = |\underline{\rho}| |\underline{\rho}_m| \sin \phi_p$$

$$a_2 = \underline{\rho} \cdot \dot{\underline{\rho}}_m$$

$$a_3 = \underline{\rho}_m \cdot \dot{\underline{\rho}}_m$$

$$a_4 = \underline{\rho} \cdot \dot{\underline{\rho}}_m + \underline{\rho}_m \cdot \dot{\underline{\rho}}$$

For impact time,

$$\left[T_I^{(r)} - T_I^{(r-1)} \right] \left| \dot{\underline{r}} - \dot{\underline{r}}_m \right| = \left| \underline{r} - \underline{r}_m \right| - R_m$$

(all quantities are defined in the subroutine OCPAR documentation)

USE

CALL TOCIM

COMMON input:

DXDK-6	target identification
IFA-4	R_m, km
PTFD	occultation-impact data buffer
DXDR-27	occultation-impact buffer
LLIST	physical constants estimate flags
RI	station Earth radius, km
PHII	station geocentric latitude, deg
THETAI	station longitude, deg
EPOCH	ODP epoch, d. p. sec past 1950.0
OMEGA	Earth rotation rate, deg/sec

CODING INFORMATION

Length of subroutine is 998 (10) or 1746 (8) words.

REFERENCE

Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.

IDENTIFICATION

UMAT
Kenneth Oslund/Michael R. Warner, JPL
Fortran II, Version 3
January 4, 1965

PURPOSE

UMAT computes the encounter conic, rotating from the geocentric equatorial system to the target-centered $\underline{R}$, $\underline{T}$ system. All encounter parameters and statistics are obtained by this routine.

RESTRICTIONS

Subroutines called:

SQRT
LOG
GERPU
ARTAN
PARAM

METHOD

The following inputs are in the UMAT calling sequence:

$\underline{r}'_{tp}$, $\underline{\dot{r}}'_{tp}$	target centered probe position and velocity at time of encounter
$\underline{r}_{ct}$, $\underline{\dot{r}}_{ct}$	position and velocity of target, centered at that body's primary, at time of encounter
Γ_e	covariance matrix at encounter (7×7)
U_e	mapping matrix to encounter (7×7)
μ	GM_{target}
t_f	time of flight

First, the rotation matrix is obtained:

$$r'^2 = \underline{r}_{ct} \cdot \underline{r}_{ct}$$

$$\dot{s}'^2 = \underline{\dot{r}}_{ct} \cdot \underline{\dot{r}}_{ct}$$

$$r'\dot{r}' = \underline{r}_{ct} \cdot \underline{\dot{r}}_{ct}$$

$$\underline{u}_p = \frac{\underline{r}_{ct}}{r'}$$

$$\underline{v}_p = \frac{r'\underline{\dot{r}}_{ct} - \dot{r}'\underline{r}_{ct}}{r'\sqrt{\dot{s}'^2 - \dot{r}'^2}}$$

$$a_{33} = \sqrt{\left(u_{pr} + v_{py}\right)^2 + \left(u_{py} - v_{px}\right)^2} - 1$$

$$a_{23} = \sqrt{u_{pz}^2 + v_{pz}^2}$$

$$a_{11} = \frac{\frac{1}{1 + a_{33}}\left[v_{pz}\left(u_{px} + v_{py}\right) + u_{pz}\left(u_{py} - v_{px}\right)\right]}{a_{23}}$$

$$a_{12} = \frac{\frac{1}{1 + a_{33}}\left[v_{pz}\left(u_{py} - v_{px}\right) - u_{pz}\left(u_{px} + v_{py}\right)\right]}{a_{23}}$$

$$a_{21} = -a_{12}a_{33}$$

$$a_{22} = a_{11}a_{33}$$

$$a_{31} = a_{12}a_{23}$$

$$a_{32} = -a_{11}a_{23}$$

The target-centered probe vector is then rotated:

$$\underline{r}_{tp} = A\underline{r}'_{tp}$$

$$\underline{\dot{r}}_{tp} = A\underline{\dot{r}}'_{tp}$$

and the following column vectors are formed:

$$\underline{X}_p = \begin{pmatrix} \underline{r}_{tp} \\ 0 \end{pmatrix} \qquad \dot{\underline{X}}_p = \begin{pmatrix} \dot{\underline{r}}_{tp} \\ 0 \end{pmatrix}$$

$$\underline{X}_v = \begin{pmatrix} 0 \\ \underline{r}_{tp} \end{pmatrix} \qquad \dot{\underline{X}}_v = \begin{pmatrix} 0 \\ \dot{\underline{r}}_{tp} \end{pmatrix}$$

(the seventh member of these vectors is in each case zero)

The encounter conic is then obtained:

$$r^2 = \underline{X}_p \cdot \underline{X}_p$$

$$\dot{\underline{s}}^2 = \dot{\underline{X}}_p \cdot \dot{\underline{X}}_p$$

$$r\dot{r} = \underline{X}_p \cdot \dot{\underline{X}}_p$$

$$a = \frac{1}{\frac{2}{r} - \frac{\dot{s}^2}{\mu}} \quad \text{(semi-major axis)}$$

$$e^2 = 1 - \frac{r^2\dot{s}^2 - (r\dot{r})^2}{\mu/a} \quad (\text{eccentricity})^2$$

$$e \sinh F = \frac{r\dot{r}}{\sqrt{-\mu/a}}$$

$$e \cosh F = 1 - \frac{r}{a}$$

$$e \exp F = e \sinh F + e \cos F$$

$$F = \log (\exp F) \quad \text{(hyperbolic anomaly)}$$

$$e\, p_z = X_{pz} \frac{e \cosh F}{r} - \dot{X}_{pz}\, e \sinh F \sqrt{-\frac{a}{\mu}}$$

$$e \sin \Phi_s = \left(\frac{X_{pz}}{r} - X_{pz}\sqrt{-\frac{a}{\mu}} \right) \exp F + \dot{X}_p\, e\sqrt{-\frac{a}{\mu}}$$

$$\underline{B} \cdot \underline{T} \cos \Phi_s = \sqrt{-\frac{a}{\mu}}(X_{pz}\dot{X}_{py} - X_{py}\dot{X}_{px})$$

$$\underline{B} \cdot \underline{R} \cos \Phi_s = a(\sin \Phi_s - e\, p_z)$$

$$T_a = \frac{3}{2}\sqrt{-\frac{a}{\mu}}(e \sinh F - F + \log e)$$

$$T_e = \left(\frac{e \sinh F + 1}{e}\right)a\sqrt{-\frac{a}{\mu}}$$

$$T_F = -r\sqrt{-\frac{a}{\mu}}$$

$$v_\infty = \frac{1}{\sqrt{-\frac{a}{\mu}}}$$

$$n = \frac{-v_\infty}{a}$$

$$t_L = t_f + \frac{(F - e \sinh F - \log e)}{n} \qquad \text{(linearized time of flight)}$$

The next step is to obtain the encounter partials. The encounter parameter set (M) is

$\underline{B} \cdot \underline{R}$	as defined above
$\underline{B} \cdot \underline{T}$	as defined above
t_L	linearized time of flight
$\underline{S} \cdot \underline{R}_s$	dot products of incoming asymptote unit vector $\underline{S}$ with standard $\underline{R}$ and $\underline{T}$ vectors
$\underline{S} \cdot \underline{T}_s$	
C_3	vis-viva energy

These parameters are related to the position and velocity of the probe at encounter and the target gravitational constant. This set is called Q.

$$F_{az} = \frac{\exp F}{r}$$

$$F_{a\dot{z}} = -\sqrt{-\frac{a}{\mu}}\,(\exp F - e)$$

$$F_{bz} = \frac{e \cosh F}{r}$$

$$F_{b\dot{z}} = -\sqrt{-\frac{a}{\mu}}\; e \sinh F$$

$$F_{cx} = -\dot{X}_{py}$$

$$F_{cy} = \dot{X}_{px}$$

$$F_{c\dot{x}} = X_{py}$$

$$F_{c\dot{y}} = -X_{px}$$

$$S_x = \left[\left(\frac{X_{px}}{r} - \sqrt{-\frac{a}{\mu}}\,\dot{X}_{px}\right)\exp F + e\sqrt{-\frac{a}{\mu}}\,\dot{X}_{px}\right]\frac{1}{e} \quad x \rightarrow y$$

$$S_z = \sin \Phi_s$$

$$T_{sx} = \frac{S_y}{\cos \Phi_s}$$

$$T_{sy} = -\frac{S_x}{\cos \Phi_s}$$

$$R_{sx} = T_{sy} S_z$$

$$R_{sy} = -T_{sx} S_z$$

$$R_{sz} = \cos \Phi_s$$

$$\underline{\delta a} = 2a^2\left(\frac{X_p}{r^3} + \frac{\dot{X}_n}{\mu}\right)$$

$$\delta a_\mu = - \frac{a^2(1 + e \cosh F)}{r\mu}$$

$$\left[\underline{\delta e} \vdots \delta' e_\mu\right] = \frac{1}{e}\left[- \frac{\frac{e}{a} \cosh F \, \underline{X}_p}{r} - \frac{e \sinh F(\underline{\dot{X}}_p + \underline{X}_v)}{\sqrt{-\frac{\mu}{a}}} + \underline{\delta a}\left(\frac{\frac{1}{2} e^2 \sinh^2 F}{a} + \frac{r e \cosh F}{a^2}\right)\right]$$

$$\delta e_\mu = \delta' e_\mu + \frac{1}{e}\left[- \frac{1}{\mu}\left(\frac{1}{2} e^2 \sinh^2 F + \frac{r}{a} e \cosh F\right) + \frac{r^2}{2a^2} + \frac{r^2 \delta a_\mu}{2a^3}\right]$$

$$\left[\underline{\delta F} \vdots \delta' F_\mu\right] = \frac{1}{e^2}\left[\frac{\frac{e}{a} \sinh F \, X_p}{r} + \frac{e \cosh F(\underline{\dot{X}}_p + \underline{X}_v)}{\sqrt{-\frac{\mu}{a}}} - \underline{\delta a}\left(\frac{\frac{1}{2} e^2 \cosh^2 F}{a} + \frac{r e \sinh F}{a^2}\right)\right]$$

$$\delta F_\mu = \delta' F_\mu + \frac{1}{e^2}\left(- \frac{e \sinh F}{2\mu e \cosh F} - \frac{r^2 e \sinh F \, \delta a_\mu}{2 e \cosh F \, a^3}\right)$$

$$\left[\delta \Phi_s \vdots \delta' \Phi_{s\mu}\right] = \left[- \frac{X_{pz} \underline{X}_p \exp F}{r^3} - \frac{\frac{1}{2} \dot{X}_{pz}(e - \exp F)_{\partial a}}{\sqrt{-\frac{\mu}{a}}}\left(- \frac{\dot{X}_{pz} a}{\sqrt{-\frac{\mu}{a}}} + \sin \Phi_s\right)\underline{\delta e}\right.$$

$$\left. - \left(\dot{X}_{pz}\sqrt{-\frac{a}{\mu}} - \frac{X_{pz}}{r}\right)\underline{\delta F} \exp F + \underline{F_a}\right] \frac{1}{e \cos \Phi_s}$$

$$\left[\underline{\delta S_x} \vdots \delta' S_{x\mu}\right] = \frac{1}{e}\left[- \frac{X_{px} \exp F \, \underline{X}_p}{r^3} + \frac{\dot{X}_{px}(\exp F - e)}{2\sqrt{-\frac{\mu}{a}}} \underline{\delta a}\right.$$

$$\left. + \left(\sqrt{-\frac{a}{\mu}} \dot{X}_{px} - S_x\right)\underline{\delta e} - \left(\frac{\sqrt{-\frac{a}{\mu}} \dot{X}_{px} - X_{px}}{r}\right) \exp F \, \underline{\delta F} + \underline{F_a}\right]$$

$$\left[\underline{\delta S_y} \vdots \delta' S_{y\mu}\right] = \left[\underline{\delta S_x} \vdots \delta' S_{x\mu}\right] \quad x \rightarrow y$$

$$\left[\delta S_z \vdots \delta' S_{z\mu}\right] = \cos \Phi_s \underline{\delta \Phi_s}$$

$$\underline{E_p} = -\frac{e \sinh F \sqrt{-\frac{a}{\mu}}\, \underline{\dot{X}_p}}{2\mu}$$

$$\underline{\delta S_\mu} = \underline{\delta' S_\mu} + \left[\underline{E_p} - (e \cosh F - e^2) \frac{\underline{\dot{X}_p} \sqrt{-\frac{a}{\mu}}}{2\mu}\right] \frac{1}{e \cos \Phi_s}$$

$$\dot{\delta \Phi}_{s\mu} = \delta' \Phi_{s\mu} + \delta' S_{z\mu}$$

$$\left[\underline{e\, \delta P_z} \vdots \left(e\, \delta P_{z\mu}\right)'\right] = -\frac{X_{pz}\, e \cosh F\, \underline{X_p}}{r^3} + \frac{X_{pz}\, e \sinh F\, \underline{\delta a}}{2\sqrt{-\frac{\mu}{a}}}$$

$$\left(-\dot{X}_{pz}\, e \cosh F \sqrt{-\frac{a}{\mu}} - \frac{e \sinh F}{r}\right) \underline{\delta F} + \underline{F_b}$$

$$e\, \delta P_{z\mu} = (e\, \delta P_{z\mu}) + E_{pz}$$

The program now computes the variational matrix $V = \left(\frac{\partial M}{\partial Q}\right)$:

$$\left[\underline{v_1} \vdots v'_{1\mu}\right] = \left[\left(e \sin \Phi_p - e^2 P_z\right)\underline{\delta a} - a\, e\, P_z \underline{\delta e}\right.$$

$$\left. - (\underline{B} \cdot \underline{R}\, e \sin \Phi_p a\, e \cos \Phi_p)\underline{\delta \Phi_s} - a\, e^2\, \underline{\delta P_z}\right] \frac{1}{e \cos \Phi_p}$$

$$\left[\underline{v_2} \vdots v'_{2\mu}\right] = \left(\frac{e \cos \Phi_p\, \underline{B} \cdot \underline{T}}{2a} \underline{\delta a} + \underline{B} \cdot \underline{T}\, e \sin \Phi_p \underline{\delta \Phi_s} - e \sqrt{-\frac{a}{\mu}}\, \underline{F_c}\right) \frac{1}{e \cos \Phi_p}$$

$$\left[\underline{v_3} \vdots v'_{3\mu}\right] = T_a\, \underline{\delta a} + T_e\, \underline{\delta e} + T_F\, \underline{\delta F}$$

$$\left[\underline{v_4} \vdots v'_{4\mu}\right] = \frac{\mu}{a^2}\, \underline{\delta a}$$

$$\left[\underline{v_5} \vdots v'_{5\mu}\right] = T_{sx}\, \underline{\delta S_x} + T_{sy}\, \underline{\delta S_y}$$

$$\left[v_6 \vdots v'_{6\mu}\right] = R_{sx}\underline{\delta S_x} + R_{sy}\underline{\delta S_y} + R_{sz}\underline{\delta S_z}$$

$$v_{1\mu} = v'_{1\mu}$$

$$v_{2\mu} = v'_{2\mu} + \frac{\underline{\underline{B}} \cdot \underline{T}}{2\mu}$$

$$v_{3\mu} = v'_{3\mu} - \frac{\sqrt{-\frac{a^3}{\mu}}(F - e \sinh F - \log e)}{2\mu}$$

$$v_{4\mu} = v'_{4\mu} - \frac{1}{a}$$

$$v_{5\mu} = v'_{5\mu}$$

$$v_{6\mu} = v'_{6\mu}$$

The following matrix manipulations are then performed:

$$N = V^T A \Gamma_e A^T V \qquad \text{(noise moment matrix)}$$

$$V_0 = VAU_e \qquad \left(V_0 = \frac{\partial M}{\partial \Omega_0} \text{ matrix}\right)$$

Finally, the configuration of the miss ellipse is obtained:

$$r = \sqrt{\left(\frac{n_{11} - n_{22}}{2}\right)^2 + n_{12}^2}$$

$$s = \frac{n_{11} + n_{22}}{2}$$

$$a_m = \sqrt{s + r} \qquad \text{(semi-major axis)}$$

$$b_m = \sqrt{s - r} \qquad \text{(semi-minor axis)}$$

$$\theta = \frac{1}{2}\tan^{-1}\left(\frac{2n_{12}}{n_{22} - n_{11}}\right) \qquad \text{(inclination)}$$

USE

CALL	UMAT		
PZE	XT	$\underline{r}'_{tp}$, $\dot{\underline{r}}'_{tp}$	(1 × 6)
PZE	XH	$\underline{r}_{ct}$, $\dot{\underline{r}}_{ct}$	(1 × 6)
PZE	G	Γ_e	(7 × 7)
PZE	U	U_e	(7 × 7) in (20 × 20) array
PZE	TMU	μ of target	
PZE	TF	t_f, sec	

CODING INFORMATION

Length of subroutine is 1681 (10) or 3221 (8) words.

REFERENCES

a. Warner, M. R., Nead, M. W., Hudson, R. H., TM 33-168, March 18, 1964.
b. Anderson, John D., RFP 312-83, October 1962.
c. Null, George W., RFP 312-179, Addendum 2, September 19, 1963.

IDENTIFICATION

101

VEC
Charles Coltharp, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

VEC computes the standard dot product of two 1 × 3 vectors, $A = \underline{X} \cdot \underline{Y}$.

RESTRICTION

COMMON break: 47675

USE

```
CALL   VEC
PZE    X
PZE    Y
```

COMMON output:

A	dot product

CODING INFORMATION

Length of subroutine is 15 (10) or 17 (8) words.

IDENTIFICATION

WAIT

Michael R. Warner, JPL

Fortran II, Version 3

January 4, 1965

PURPOSE

WAIT obtains the a priori weight for each data point used in the normal equations.

RESTRICTIONS

a. COMMON break: 47675

b. Subroutines used:

COL

DECOD

SQRT

WOCT

COS

ERROR

Error condition:

If the weight obtained is less than 10^{-20}, the program will abort.

METHOD

Method a1.

If a priori coefficients $\sqrt{\varpi_j}$ are input to the program, the calculated weight is

$$\sqrt{\omega_j} = \sqrt{\varpi_j}\ \beta_1\ \beta_2 \sqrt{\frac{60}{\tau_s}}$$

where

β_1 = 1 when not weighting azimuth or hour angle

$= \frac{1}{\cos \gamma}$ when weighting azimuth angle

$= \frac{1}{\cos \delta}$ when weighting hour angle

β_2 = 1 when weighting azimuth angle

$= 1 + \frac{18}{(\gamma + 1)^2}$ when not weighting azimuth angle

τ_s = data sample rate

δ = declination

γ = elevation angle

Method a2.

If octal weight codes are input to the ODP a priori coefficient table, the program uses Method b.

Method b.

If octal weight codes are input by the ODG data file, and if no input was made to the ODP coefficient array, the calculated sigma is

$$\omega_j = \sum_{i=1}^{6} S^2_{pjk}\, g^2_{pj}\, \max\left(\frac{T_{pjk}}{\tau},\ 1\right)$$

(see documentation for subroutines DECOD and COL).

USE

CALL WAIT

COMMON input:

BALNC	$\sqrt{\tilde{\omega}_j}$ (12 × 15)
ID	data type identification
IR	receiver identification
SSQ	S^2_{pjk} (12 × 6 × 4)
TL	T_{pjk} (12 × 6 × 4)
GSQ	g^2_{pjk} (6)
TAU	τ (doppler averaging time, sec)
IF10	phi vector output flag
DEC	δ, deg
EL	γ, deg
TS	τ_s, sec

COMMON output:

RVECW	array of weights

CODING INFORMATION

Length of subroutine is 230 (10) or 346 (8) words.

REFERENCE

Hamilton, Thomas W., TM 312-182, April 12, 1962.

IDENTIFICATION

WASH
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

WASH prints certain time-dependent quantities which are calculated by the ODP (see list below). The subroutine is operative only in Mode-IV or the JPTRAJ production mode.

RESTRICTIONS

a. COMMON break: 47675

b. Subroutines used:

READB
FLAT/FLAPR
FIXT
PROUT

USE

CALL WASH
COMMON input:

TOB	observation time, d.p. sec past 1950.0
GHA	Greenwich hour angle, deg
X	geocentric probe vector
XSUN	geocentric Sun vector
XMOO	geocentric Moon vector
XVEN	geocentric Venus vector
XMAR	geocentric Mars vector
CPPHI	partials $\partial F/\partial Q$
CPTHT	partials $\partial F/\partial \tilde{Q}$
U	partials $\partial \underline{r}/\partial \underline{r}_0$
GMAT	partials $\partial \underline{r}/\partial q$
DRVEC	refraction corrections

CODING INFORMATION

Length of subroutine is 401 (10) or 621 (8) words.

IDENTIFICATION

104

WOCT
Michael R. Warner, JPL
IBM 7094 Fap
January 4, 1965

PURPOSE

WOCT determines whether an input a priori weight represents a floating point quantity or an octal weight code.

USE

CALL	WOCT	
PZE	WT	a priori weight word
PZE	CODE	output if octal code
PZE	TEST	= 0 if floating point
		≠ 0 if octal code

CODING INFORMATION

Length of subroutine is 11 (10) or 13 (8) words.

VII. OPERATING INSTRUCTIONS

The ODP may be operated in three modes: SFOF Mode II, SFOF Mode IV, and the JPTRAJ Production Mode. Mode II requires the full SFOF hardware configuration, namely, the 7094-disk-7040, with associated user-area equipment. Mode IV requires the 7094 and disk, properly initialized for SFOF operation. The JPTRAJ Production Mode is independent of the SFOF system, requiring only the 7094 and disk.

A. MODE II OPERATION

1. After the system has been initialized and the user programs loaded on disk, ask the operator to mount the following tapes:

   A3 scratch for 1401 output
   A4 scratch for combined ephemerides
   B6 EPHEM system tape
   B9 scratch for 4020 plot output (optional)

2. Type PS1X$ at the user area 7 console.

3. Depress the TURN ON button, then the TRANSMIT MESSAGE button.

4. When requested by the administrative printer, enter the ODPX source deck via the user area card reader.

5. At the conclusion of PS1X, type ODPX$ at the user-area 5 console.

6. Depress the TURN ON button, then the TRANSMIT MESSAGE button.

7. At the beginning of ODPX execution, the message ENTER SWITCHES. 22 = TERMINATE, 23 = DELAY, NONE = PROCEED will be printed by the administrative printer. To proceed, clear the switches and type ODPX$ at the user area console.

8. Depress the OPTION SWITCH ENTRY button, then the TRANSMIT MESSAGE button.

9. When requested by the administrative printer, enter the input deck, as described in Section IV A, via the user area card reader. The program will then execute the options requested by the input deck.

10. To obtain the full SC-3070 printout, type 1$ at the console, depress the AUTO ON button, then the TRANSMIT MESSAGE button.

11. The message described in step 7 will be printed between iterations. The user has the opportunity to read a new deck for the next iteration, or terminate ODP execution.

B. MODE IV OPERATION

1. After the system has been initialized and the user programs loaded on disk, mount the following tapes:

A3 scratch for 1401 output
A4 scratch for combined ephemeris
B6 EPHEM system tape
B7 scratch for MMP output (optional)
B1 scratch for supplementary partials output (optional)
B9 scratch for 4020 plot output (optional)

2. While the system is at the idle stop, depress sense switch 1 and depress START at the 7094 console.

3. At the card reader select, enter the card TURN ON, PS1X$.

4. Raise sense switch 1.

5. At the card reader select, enter the ODPX source deck.

6. At the conclusion of PS1X (idle stop), depress sense switch 1 and depress START.

7. At the card reader select, enter the card TURN ON, ODPX$.

8. Raise sense switch 1.

9. At the card reader select, enter the input deck, as described. The program will then execute the options requested by the input deck.

10. To obtain on-line printout, depress sense switch 6.

11. The card reader will select between iterations for additional input. If console key 22 is depressed at the end of an iteration, the execution will be terminated.

C. JPTRAJ PRODUCTION MODE OPERATION

1. Mount the following tapes:

   A1 JPTRAJ system tape
   A2 input tape (see below)
   A3 scratch for 1401 output
   A4 scratch for combined ephemeris
   A5 JPTRAJ program tape
   B1 scratch for system operation
   B6 EPHEM system tape
   B7 scratch for MMP output (optional)
   B9 scratch for 4020 plot output (optional)

2. The input tape should contain the following card images:

   $JOB MRW, 2116000, 542-70285-1-3170, FC (example of JPL job card)
   * JPTRAJ
   $RESTORE
   * DATA
   [ODPX source deck]
   [ODPX input deck for iteration 1]
   .
   .
   .
   .
   .
   .
   [ODPX input deck for iteration n]
   EOF card
   $PAUSE

3. To start the system, depress the LOAD TAPE button at the 7094 console.

4. Once the program has been restored on disk, the $RESTORE card and the A5 tape need not be used.

D. SOURCE DECK LISTING

```
      ANALYSIS OF THE JPTRAJ SOURCE PROGRAM FOR THE ODP PROVIDES
      THE BASIC LOGIC OF THE PROGRAM. IN THE FOLLOWING THE STARRED
      ITEMS ARE DIRECTLY FROM THE SOURCE PROGRAM WHICH IS GIVEN
      IN COMPLETE FORM IN THE APPENDIX.   NON-STANDARD EXITS FOR
      EACH LINK ARE EXPLAINED. THE STANDARD EXIT IS IN SEQUENCE.


*N1   ODPX    N9
      N9

*N9   LA9     X,N11,N1,N4
      X       TERMINATE JOB
      N11     USE SAME PROBE EPHEMERIS,SKIP TRAJ THIS PASS
      N1      RESTART FEATURE, TO RESET TO NOMINAL INPUT
      N4      USE SAME COMBINED EPHEMERIS, SKIP TO LINK 4
              THE CARD     SW5=1    WILL CAUSE THE ODP TO READ THE INPUT
              DECK FROM TAPE A2. NORMAL INPUT IS BY ONLINE READER.

*N12  LA12    X
      X       TERMINATE JOB

*N13  SPACE   X
      X       TERMINATE JOB

*N11  LA11    N4,N6,N12
      N4      EXIT TO PREDICT-DATA TAPE LINK
      N6      EXIT TO DATA FITTING LINK
      N12     EXIT TO LINK 12 FOR ERROR, THEN TO X

*N2   LA2     N12, X
      N12     EXIT TO LINK 12 FOR ERROR COMMENT, THEN TO X
      X       TERMINATE JOB

*N2A  LA2A    N9,N12
      N9      STEP MAP COMPLETED, CHECK FOR MORE INPUT
      N12     EXIT TO LINK 12 FOR ERROR, THEN TO X

*N3   LA3     N9,N10
              (NO EXIT TO LINK 4)
      N9      IMPACT MAPPING COMPLETE, CHECK FOR MORE INPUT
      N10     COMMENT OUTPUT REQUESTED

*N4   LA4     N6,N12
      N6      NO SORTING NECESSARY, GO TO DATA FITTING LINK
      N12     EXIT TO LINK 12 FOR ERROR

*N5   LA5     N9,N12
              (NO EXIT TO LINK 6)
      N9      PREDICTS SORTED CHECK FOR MORE INPUT
      N12     EXIT TO LINK 12 FOR ERROR

*N6   LA6     N12
      N12     EXIT TO LINK 12 FOR ERROR

*N7   LA7     N9,N10,N12


      N9      RETURN FOR MORE INPUT, NO RESIDUALS, STATISTICS REQUESTED
      N10     EXIT HERE TO PRINT PARTIALS
      N12     ERROR EXIT

*N8   LA8     N9,N12
              (NO EXIT TO LINK 10)
      N9      RETURN FOR MORE INPUT
      N12     ERROR EXIT

*N10  LA10    N8,N9
              (NO EXIT TO LINK X)
      N8      AFTER PARTIALS PRINT RETURN TO LINK 8 FOR RESIDUALS
              AND STATISTICS
      N9      NO OTHER REQUESTS, RETURN TO INPUT LINK

*X    END
```

VIII. CHECK CASES

```
      SOURCE PROGRAM LISTING

*N1    DDPX    N9
*N9    LA9     X,N11,N1,N4
55164/*1.0E16
*N12   LA12    K
*N13   SPACE   K
               SCFORF=2
*      WANT    N9,(MOSPH11,200,(MOTOR,BRKOPT),18
*      WANT    N11,(TAPEX),6
*      WANT    N12,(XNJ,1NJX),1,(XNJ-1,1NJY),1
*      ETC     (XNJ-2,1NJZ),1,(XNJ-3,1NJDX),1
*      ETC     (XNJ-4,1NJDY),1,(XNJ-5,1NJDZ),1
*      ETC     (EPOCH,1NJT),1,(EPOCH-1,1NJT+1),1
*      ETC     (OUT,GRAV-2),1,(AU,SCALE1+1),1
*      ETC     (RE,SCALE1),1,(PORE,HARMN+5),1
*      ETC     (QD,HARMN+4),1,(QH,HARMN+3),1
*      ETC     (QJ,HARMN+2),1,(GRAVE,GRAV),1
*      ETC     (GRAVM,GRAV+1),1,(GRAVS,GRAV+2),1
*      ETC     (GRAVV,GRAV+3),1,(GRAVR,GRAV+4),1
*      ETC     (GRAVJ,GRAV+6),1,(STEP,H),1
*      ETC     (TARGET,TARBCD),1,(AREA,RADOPT+3),1
*      ETC     (GM8,RADOPT+4),1,(FMASS,RADOPT+5),1
*      ETC     (FAD,GASOPT+9),1,(FBO,GASOPT+12)
*      ETC     (FCO,GASOPT+15),1,(FA1,GASOPT+8)
*      ETC     (FB1,GASOPT+11),1,(FC1,GASOPT+14)
*      ETC     (FA2,GASOPT+7),1,(FB2,GASOPT+10)
*      ETC     (FC2,GASOPT+13),1,(JETON,GASOPT),1
*      ETC     (JETON,GASOPT+2),1,(JETON-1,GASOPT+3),1
*      ETC     (JETOFF,GASOPT+5),1,(JETOFF-1,GASOPT+6),1
*      ETC     (TFIN,SCCPSO),1,(TFIN-1,SCCPSO+1),1
*      ETC     (FMASS,GASOPT+16),1
GASOPT+1=(CANOPU)
(NJBCO=(EARTH)
RADOPT=.1031E9
*N11   LA11    N4,N6,N12
*      WANT    N9,(C137),1
*      WANT    N13,(CLPT,TRADE+1),1,(CLPT+1,TRADE),1
*      ETC     (CLPBTC,TRADE+2),1,(CLPBRC,TRADE+3),1
*      ETC     (CLPBTT,TRADE+4),1,(CLPBRT,TRADE+5),1
*      ETC     (TAPEX),6
*N2    LA2     N12,X
*      WANT    N11,(EPOX),14
*N2A   LA2A    N9,N12
*N3    LA3     N9,N10
*N4    LA4     N6,N12
*N5    LA5     N9,N12
*N6    LA6     N12
*N7    LA7     N9,N10,N12
*      WANT    N9,(APRIOR-19,APRIOR-19),20
*N8    LA8     N9,N12
*N10   LA10    N8,N9
*X     END                                                              (0

               THERE WERE NO GLARING SOURCE DECK ERRORS.

               THE OBJECT STRING HAS 00516 OCTAL OR  334 DECIMAL WORDS.
```

```
0000 13450I    PAGE HEADING                                             (23
0000 13450     (MARS CHECK CASE - FIT SIMULATED DATA, THEN MAP)
0000 13450     EPOCH                                                    (01
0000 13450     64110Z815,0757000
0000 13450     GEOCENTRIC POSITION AND VELOCITY AT EPOCH                (02
0000 13450     X=.56662222E4 Y=.21966726E4 Z=-.32403740E4
0000 13450     DX=-.1883947?E1 DY=-.10978654E2 DZ=-.12280548E1
0000 13450     OTHER OPTIONS AND CONSTANTS                              (03
0000 13450     TARGET=(MARS)
0000 13450     (NFRQ=3624200.
0000 13450     ESTIMATE THESE PARAMETERS                                (04
0000 13450     X Y Z DX DY DZ RM AU
0000 13450     COVARIANCE MATRIX OF ESTIMATED PARAMTERS                 (10
0000 13450     DIAG=10.,10.,10.,.01,.01,.01,1E-17,25.
0000 13450     POINTING TIMES, SAMPLE RATE, COUNT TIME                  (17
0000 13450     00HJET=64110Z816,0,64110301G,0,3600.,60.
0000 13450     JDBJET=64110Z816,0,64110301G,0,3600.,60.
0000 13450     DATA FILE SIGMA                                          (21
0000 13450     HA(4)=.001 DEC(4)=.002 CC3(4)=.001
0000 13450     HA(5)=.002 DEC(5)=.001 CC3(5)=.002
0000 13450     STATISTICS AND RESIDUALS FOR THESE DATA TYPES            (14
0000 13450     HA(4)=.01 DEC(4)=.01 CC3(4)=.01
0000 13450     HA(5)=.01 DEC(5)=.01 CC3(5)=.01
0000 13450     WEIGHTS BY DATA TYPE AND STATION                         (16
0000 13450     HA(4)=.5 DEC(4)=.5 CC3(4)=.1
0000 13450     HA(5)=.5 DEC(5)=.5 CC3(5)=.1
0000 13450     TRANSMITTER ID TABLE                                     (26
0000 13450     4,2038516.,641102916,D,5,2038516.
0000 13450     OFFLINE CONTROL                                          (27
0000 13450     KEY(2) KEY(14) KEY(16)
0000 13450     END DATA                                                  (0
```

INPUT COVARIANCE MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MM	AU
X	.10000000 02	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Y	.00000000 00	.10000000 02	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Z	.00000000 00	.00000000 00	.10000000 02	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
DX	.00000000 00	.00000000 00	.00000000 00	.99999998-02	.00000000 00	.00000000 00	.00000000 00	.00000000 00
DY	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999998-02	.00000000 00	.00000000 00	.00000000 00
DZ	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999998-02	.00000000 00	.00000000 00
MM	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999998-18	.00000000 00
AU	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.25000000 02

INPUT J MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MM	AU
X	.99999999-01	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Y	.00000000 00	.99999999-01	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
Z	.00000000 00	-.00000000 00	.99999999-01	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
DX	.00000000 00	-.00000000 00	-.00000000 00	.10000000 03	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
DY	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.10000000 03	-.00000000 00	-.00000000 00	-.00000000 00
DZ	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.10000000 03	-.00000000 00	-.00000000 00
MM	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.99999998 18	-.00000000 00
AU	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.39999999-01

CASE 1 IBSYS-JPTRAJ-SPACE 022265

DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1

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	ONE	.41780741-02	AU	.14959850 09
GMM	.49026293 04	GMS	.13271411 12	GMV	.32476627 06	GMA	.42977368 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	.11120000 02	GB	.95999999-01	MAS	.25900000 03	GB1	.00000000 00	GB2	.00000000 00	SC	.10310000 09

INJECTION CONDITIONS MARS 2357005514232022000000000 J.D.= 2438728.13052083 NOV. 28,1964 15 07 57.000

GEOCENTRIC	XO	.56682222 04	YO	.21466726 04	ZO	-.32403748 04	DXO	-.18839477 01	DYO	.10978654 02	DZO	-.12280548 01
CARTESIAN	TO	.54476999 05	GHA	.29452970 03	GHO	-.66920765 02						

DATE OF RUN 022265A 13460 EARTH IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

PROBE IS IN EARTH'S SHADOW

0 DAYS 0 HRS. 0 MIN. 0.000 SEC. 2357005514232022000000000 J.D.= 2438728.13052083 NOV. 28,1964 15 07 57.000

GEOCENTRIC EQUATORIAL COORDINATES

X	.56682219 04	Y	.21466724 04	Z	-.32403747 04	DX	-.18839476 01	DY	.10978653 02	DZ	-.12280547 01
R	.68729157 04	DEC	-.28129771 02	RA	.20742711 02	V	.11206614 02	PTH	.12650650 02	AZ	.90421379 02
R	.68729154 04	LAT	-.28129772 02	LON	.86213015 02	VE	.10775808 02	PTE	.13165318 02	AZE	.90439129 02
XS	-.58995549.08	YS	-.12408705 09	ZS	-.53810146 08	DXS	.27792202 02	DYS	-.10840364 02	DZS	-.47011071 01
XM	-.38523466 06	YM	-.44736395 05	ZM	.18645579 05	DXM	.37058146-01	DYM	-.92038371 00	DZM	-.41497853 00
XT	-.19750066 09	YT	.58811766 08	ZT	.33854926 08	DXT	.87298950 01	DYT	-.21590059 02	DZT	-.91209471 01
RS	.14755881 09	VS	.30199675 02	RM	.38827148 06	VM	.10102904 01	RT	.20883364 09	VT	.25010665 02
GED	-.28291871 02	ALT	.49950940 03	LOS	.31004216 03	RAS	.24457186 03	RAM	.18662395 03	LOM	.25209425 03
DUT	.35000000 02	DT	.37500000 01	DR	.24543145 01	SHA	.62358861 04	DES	-.21387223 02	DEM	.27525167 01
CCL	.11901304 03	MCL	.21144471 03	ICL	.21574659 03						

GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2357005513262023546642400 J.D.= 2438728.12770659 NOV. 28,1964 15 03 53.850

SMA	-.41536075 05	ECC	.11580720 01	B	.24259727 05	SLR	.14169237 05	APO	.00000000 00	RCA	.65656922 04
VH	.30978206 01	C3	.95964924 01	CI	.75152290 05	TFP	.24314986 03	TF	-.28142345-02	LTF	-.25588951-01
TA	.23551647 02	MTA	.14971233 03	EA	.64722201 01	MA	.10390285 01			TFI	.00000000 00

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.56682219 04	Y	.21466724 04	Z	-.32403747 04	DX	-.18839476 01	DY	.10978653 02	DZ	-.12280547 01
INC	.28132666 02	LAN	.11163641 03	APF	.24566020 03	MX	-.35740510 00	MY	.93392694 00	MZ	-.64857359-02
WX	.43829295 00	WY	.17385475 00	WZ	.88185818 00	PX	.89883014 00	PY	-.86854062-01	PZ	-.42960527 00
QX	-.19040406-02	QY	.98093365 00	QZ	-.19433341 00	RX	-.21994247 00	RY	.16164777 00	RZ	-.96202662 00
BX	.45496172 00	BY	.80323618 00	BZ	-.38447559 00	TX	.59221295 00	TY	.80578151 00	TZ	.00000000 00
SXI	.77710383 00	SYI	.41972693 00	SZI	-.46897637 00	DAI	-.27967872 02	RAI	.28374231 02		
SXO	-.77518326 00	SYO	.56972462 00	SZO	.27295548 00	DAO	.15840210 02	RAO	.14368579 03		

BTQ	.24222576 05	BRQ	.13420740 04	B	.24259727 05	THA	.31712828 01

T VECTOR IN EARTH EQUATOR PLANE

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	.56682219 04	Y	.60027003 03	Z	-.38269391 04	DX	-.18839476 01	DY	.95837711 01	DZ	-.54945680 01
INC	.42277832 02	LAN	.13936388 03	APF	.21231137 03	MX	-.35740509 00	MY	.85425011 00	MZ	-.37751597 00
WX	.43829294 00	WY	.51035282 00	WZ	.73989141 00	PX	.89883011 00	PY	-.25060393 00	PZ	-.35958584 00
QX	.19040406-02	QY	.82264062 00	QZ	-.56855842 00	RX	-.18420546-01	RY	.15001224-01	RZ	-.99971770 00
BX	.45496171 00	BY	.58396360 00	BZ	-.67230674 00	TX	.63146777 00	TY	.77540212 00	TZ	.00000000 00

CASE 1 IBSYS-JPTRAJ-SPACE 022265

SXI	.77710380 00	SYI	.19849447 00	SZI	-.59725159 00	DAI	-.36673309 02	RAI	.14328600 02		
SXO	-.77518323 00	SYO	.63128952 00	SZO	-.23756120-01	DAO	.13612515 01	RAO	.14084150 03		
BTC	.22379497 05	BRC	-.93644235 04	B	.24259727 05	THA	.33729373 03	T VECTOR IN ECLIPTIC PLANE			

HELIOCENTRIC ECLIPTIC COORDINATES

X	.59001217 08	Y	.13525276 09	Z	-.41570000 04	DX	-.29676149 02	DY	.21399603 02	DZ	-.54944124 01
R	.14756169 09	LAT	-.16140947-02	LON	.66431758 02	V	.36997370 02	PTH	.12089898 02	AZ	.98735356 02
XE	.58995549 08	YE	.13525209 09	ZE	-.33000000 03	DXE	-.27792202 02	DYE	.11815832 02	DZE	.15556812-03
XT	-.13850512 09	YT	.20267817 09	ZT	.76614060 07	DXT	-.19062307 02	DYT	-.11620746 02	DZT	.22182012 00
LTE	-.12813608-03	LOE	.66433669 02	LTT	.17675885 01	LOT	.12434771 03	RST	.24560294 09	VST	.22326273 02
EPS	.65134214 02	ESP	.13988227-01	SEP	.11486336 03	EPM	.28249721 02	EMP	.48000350 00	MEP	.15127023 03
MPS	.61567036 02	MSP	.13507880 00	SMP	.11829015 03	SEM	.61571418 02	EMS	.11829583 03	ESM	.13270400 00
EPT	.39785299 02	ETP	.27453512-18	TEP	.14021349 03	TPS	.85283946 02	TSP	.57933486 02	STP	.36782563 02
SET	.85286588 02	STE	.36781888 02	EST	.57931519 02	RPM	.39431215 06	RPT	.20883893 09	SPN	-.29894790 01
SAC	.22280601-09										
GCE	.24098695 03	GCT	.27673355 03	SIP	.85283019 02	CPT	.84329569 02	SIN	.84328642 02		
REP	.68729157 04	VFP	.11206614 02	CPE	.12085570 03	CPS	.10111911 03				

0 DAYS 0 HRS. 9 MIN. 49.244 SEC. 2357005516462024371643?4 J.D.= 2438728.13734078 NOV. 28,1964 15 17 46.244
PROBE IS LEAVING EARTH'S SHADOW

2 DAYS 0 HRS. 52 MIN. 3.000 SEC. 2357006773402020000000000 J.D.= 2438730.16666666 NOV. 30,1964 16 00 00.000

2 DAYS 0 HRS. 52 MIN. 18.000 SEC. 2357006773432026000000000 J.D.= 2438730.16684028 NOV. 30,1964 16 00 15.000

215542322602	214412016141 21169808915	614626031437	601731456722 17481859072	204537405524	601471557132 000000000000		EARTH INITIAL
623733473151	223571732535	222507660544	602504407717	201741457741 235700677343	200715435157 202600000000		EARTH END

J MATRIX ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	.86586481 07	.34045452 07	-.50691355 07	-.21792881 10	.13770335 11	-.15816493 10	.23125263 07	-.77185333-04
Y	.34045452 07	.13396596 07	-.19929949 07	-.85587537 09	.54135596 10	-.62224241 09	.91247442 06	-.30475400-04
Z	-.50691355 07	-.19929949 07	.29680390 07	.12758964 10	-.80622930 10	.92586914 09	-.13499765 07	.45040778-04
DX	-.21792881 10	-.85587537 09	.12758964 10	.54958336 12	-.34665872 13	.39774309 12	-.58092013 09	.19371962-01
DY	.13770335 11	.54135596 10	-.80622930 10	-.34665872 13	.21901237 14	-.25151332 13	.36716555 10	-.12253934 00
DZ	-.15816493 10	-.62224241 09	.92586914 09	.39774309 12	-.25151332 13	.28909286 12	-.42327558 09	.14149069-01
MM	.23125263 07	.91247442 06	-.13499765 07	-.58092013 09	.36716555 10	-.42327558 09	.99999998 18	-.29593198-04
AU	-.77185333-04	-.30475400-04	.45040778-04	.19371962-01	-.12253934 00	.14149069-01	-.29593198-04	.39999999-01

CORRELATIONS BASED ON J MATRIX ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	-.10000000 01	-.99962436 00	.99994028 00	.99901687 00	-.99996582 00	.99969255 00	-.78588977-06	.13115346-06
Y	-.99962436 00	-.10000000 01	.99948009 00	.99746235 00	-.99942768 00	.99987035 00	-.78835797-06	.13165040-06
Z	.99994028 00	.99948009 00	-.99999999 00	-.99899622 00	.99997574 00	-.99953067 00	.78359453-06	-.13071971-06
DX	.99901687 00	.99746235 00	-.99899622 00	-.10000000 01	.99919678 00	-.99785440 00	.78360940-06	-.13065524-06
DY	-.99996582 00	-.99942768 00	.99997574 00	.99919678 00	-.10000000 01	.99955799 00	-.78456262-06	.13092157-06
DZ	.99969255 00	.99987035 00	-.99953067 00	-.99785440 00	.99955799 00	-.10000000 01	.78723525-06	-.13157676-06
MM	-.78588977-06	-.78835797-06	.78359453-06	.78360940-06	-.78456262-06	.78723525-06	-.10000000 01	.14796599-12
AU	.13115346-06	.13165040-06	-.13071971-06	-.13065524-06	.13092157-06	-.13157676-06	.14796599-12	-.10000000 01

MARS CHECK CASE - FIT SIMULATED DATA, THEN MAP

ITERATION NUMBER 1 EPOCH 64/11/28 150757.000 CLOCK 135150 SOS .20501 00 QSOS .20501 00

Q	DQ	STDEVDQ	APRIORI STDEVDQ	OLD Q	NEW Q	NOMINAL Q	DQ(NOM)
X	-.11623599-01	.75099736 00	.31622776 01	.56682222 04	.56682105 04	.56682222 04	-.11596680-01
Y	.13752168-01	.25575302 00	.31622776 01	.21466726 04	.21466863 04	.21466726 04	.13763428-01
Z	-.57554049-02	.77465767 00	.31622776 01	-.32403748 04	-.32403805 04	-.32403748 04	-.57678223-02
DX	-.15225409-04	.57259488-03	.99999999-01	-.18839477 01	-.18839629 01	-.18839477 01	-.15228987-04
DY	-.74521106-06	.18780906-03	.99999999-01	.10978654 02	.10978653 02	.10978654 02	-.71525574-06
DZ	-.12002572-05	.75434680-03	.99999999-01	-.12280548 01	-.12280560 01	-.12280548 01	-.12069941-05
MM	-.34015613-17	.99999997-09	.99999997-09	.32383419-06	.32383419-06	.32383419-06	-.35527136-14
AU	.28060658-08	.50000000 01	.50000000 01	.14959850 09	.14959850 09	.14959850 09	.00000000 00

J INVERSE ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	.62999675-01	-.59524518-01	.11556153 00	.11487003-03	.47341748-04	.10028577-03	-.12224223-16	.16363926-07
Y	-.59524518-01	.65409607-01	-.67366365-01	-.88619571-04	-.22914837-04	-.46559043-04	-.28395455-16	.18269573-07
Z	.11556153 00	-.67366365-01	.60009450 00	.42117713-03	.29749136-03	.57407415-03	-.27951063-15	.26668629-06
DX	.11487003-03	-.88619571-04	.42117713-03	.32786490-06	.20192139-06	.39447369-06	-.14904260-18	.14775477-09
DY	.47341748-04	-.22914837-04	.29749136-03	.20192139-06	.15039588-06	.28756925-06	-.14411435-18	.13669769-09
DZ	.10028577-03	-.46559043-04	.57407415-03	.39447369-06	.28756925-06	.56903910-06	-.28010333-18	.25951601-09
MM	-.12224223-16	-.28395455-16	-.27951063-15	-.14904260-18	-.14411435-18	-.28010333-18	.99999998-18	.21195486-22
AU	.16363926-07	.18269573-07	.26668629-06	.14775477-09	.13669769-09	.25951601-09	.21195486-22	.25000000 02

COVARIANCE MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	.62999675-01	-.59524518-01	.11556153 00	.11487003-03	.47341748-04	.10028577-03	-.12224223-16	.16363926-07
Y	-.59524518-01	.65409607-01	-.67366365-01	-.88619571-04	-.22914837-04	-.46559043-04	-.28395455-16	.18269573-07
Z	.11556153 00	-.67366365-01	.60009450 00	.42117713-03	.29749136-03	.57407415-03	-.27951063-15	.26668629-06
DX	.11487003-03	-.88619571-04	.42117713-03	.32786490-06	.20192139-06	.39447369-06	-.14904260-18	.14775477-09
DY	.47341748-04	-.22914837-04	.29749136-03	.20192139-06	.15039588-06	.28756925-06	-.14411435-18	.13669769-09
DZ	.10028577-03	-.46559043-04	.57407415-03	.39447369-06	.28756925-06	.56903910-06	-.28010333-18	.25951601-09
MM	-.12224223-16	-.28395455-16	-.27951063-15	-.14904260-18	-.14411435-18	-.28010333-18	.99999998-18	.21195486-22
AU	.16363926-07	.18269573-07	.26668629-06	.14775477-09	.13669769-09	.25951601-09	.21195486-22	.25000000 02

CORRELATION MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	.99999999 00	-.92726948 00	.59433910 00	.79926371 00	.48635924 00	.52966234 00	-.48702594-07	.13039122-07
Y	-.92726948 00	.10000000 01	-.34002631 00	-.60514773 00	-.23103514 00	-.24133051 00	-.11102686-06	.14286888-07
Z	.59433910 00	-.34002631 00	.10000000 01	.94952738 00	.99025392 00	.98239720 00	-.36081826-06	.68852682-07
DX	.79926371 00	-.60514773 00	.94952738 00	.10000000 01	.90932032 00	.91327070 00	-.26029327-06	.51608834-07
DY	.48635924 00	-.23103514 00	.99025392 00	.90932032 00	.10000000 01	.98299978 00	-.37161160-06	.70497417-07
DZ	.52966234 00	-.24133051 00	.98239720 00	.91327070 00	.98299978 00	.10000000 01	-.37131904-06	.68805492-07
MM	-.48702594-07	-.11102686-06	-.36081826-06	-.26029327-06	-.37161160-06	-.37131904-06	.99999999 00	.42390971-14
AU	.13039122-07	.14286888-07	.68852682-07	.51608834-07	.70497417-07	.68805492-07	.42390971-14	.99999999 00

STATION NUMBER 41 64/11/28 ITERATION NUMBER 1 PASS NUMBER 000000 PAGE 1

FREQUENCY2038516.0

TIME	TC	Q	DEC		HA		CC3	
160000	60	41	.78431416 01	.652-01	-.0009	.32882011 03 .659-01	.0012	.28456650 05 .130-01 .0007
170000	60	41	.10831269 02	.652-01	-.0016	.33477567 03 .664-01	.0007	.23700862 05 .130-01 -.0010
180000	60	41	.12099763 02	.652-01	.0016	.34646760 03 .667-01	.0015	.21835252 05 .130-01 .0005
190000	60	41	.12798196 02	.652-01	-.0012	.35971234 03 .667-01	-.0025	.20948827 05 .130-01 .0000
200000	60	41	.13218797 02	.652-01	.0010	.13594732 02 .669-01	.0000	.20512531 05 .130-01 .0002
210000	60	41	.13479367 02	.654-01	.0007	.27772787 02 .671-01	-.0011	.20302005 05 .131-01 -.0007
220000	60	41	.13639556 02	.657-01	.0013	.42085743 02 .676-01	-.0001	.20195638 05 .132-01 .0007
230000	60	41	.13732021 02	.674-01	-.0003	.56446052 02 .693-01	.0006	.20116875 05 .135-01 -.0005
						64/11/29		
000000	60	41	.13762374 02	.774-01	-.0016	.70780797 02 .796-01	.0010	.20016164 05 .155-01 .0005
150000	60	41	.14855866 02	.784-01	.0005	.28953924 03 .813-01	-.0007	.14764306 05 .157-01 .0005
160000	60	41	.14977514 02	.674-01	.0024	.30453431 03 .696-01	.0001	.14926591 05 .135-01 .0005
			FREQUENCY	.0				
170000	60	0	.15058219 02	.657-01	.0033	.31962313 03 .681-01	-.0019	
180000	60	0	.15117300 02	.654-01	-.0001	.33475542 03 .676-01	-.0007	
190000	60	0	.15157664 02	.652-01	-.0009	.34990900 03 .676-01	.0006	
200000	60	0	.15180486 02	.652-01	.0009	.50660299 01 .674-01	.0013	
210000	60	0	.15187077 02	.652-01	.0027	.20210603 02 .676-01	.0010	
			FREQUENCY2038516.0					
220000	60	51	.15178905 02	.657-01	-.0023	.35328527 02 .679-01	-.0004	
230000	60	51	.15156356 02	.667-01	.0012	.50405889 02 .691-01	.0006	
						64/11/30		
000000	60	51	.15119074 02	.715-01	.0000	.65427979 02 .740-01	-.0003	
010000	60	51	.14819789 02	.111 01	.0010	.79978701 02 .115 01	-.0003	
			FREQUENCY	.0				
150000	60	0	.15275558 02	.798-01	-.0010	.28933294 03 .828-01	-.0008	
160000	60	0	.15356074 02	.674-01	.0035	.30433643 03 .698-01	-.0008	

MARINER STATISTICS STATION 41 ITERATION 1

PASS	DATA TYPE	BEGINNING TIME	END TIME	NUMBER OF POINTS	STD DEV	RMS	FIRST MOMENT	SECOND MOMENT
000000	CC3	11/28-160000	11/29-160000	11	.574-03	.589-03	.133-03	.347-06
	HA	11/28-160000	11/30-160000	22	.101-02	.101-02	-.461-04	.103-05
	DEC	11/28-160000	11/30-160000	22	.158-02	.165-02	.459-03	.271-05

STATION NUMBER 51 64/11/28 ITERATION NUMBER 1 PASS NUMBER 000000 PAGE 2

FREQUENCY2038516.0

TIME	TC	Q	DEC		HA		CC3	
220000	60	41	.13129207 02	.735-01	.0017	-.28861228 03 .754-01	.0004	
230000	60	41	.13532427 02	.667-01	.0005	-.30329097 03 .686-01	.0046	
						64/11/29		
000000	60	41	.13838208 02	.654-01	-.0009	-.31818084 03 .674-01	-.0044	

FREQUENCY .0

010000	60	0	.14068252 02	.652-01	.0010	.33319524 03 .671-01	.0026			
020000	60	0	.14235436 02	.649-01	-.0008	.34827475 03 .671-01	.0005			
030000	60	0	.14349870 02	.649-01	.0002	.33738108 01 .671-01	.0035			
040000	60	0	.14420789 02	.652-01	.0005	.18457121 02 .671-01	-.0048			
050000	60	0	.14456847 02	.652-01	.0009	.33498143 02 .674-01	.0005			
060000	60	0	.14465484 02	.659-01	-.0010	.48477208 02 .681-01	.0005			
070000	60	0	.14461425 02	.684-01	.0015	.63393088 02 .706-01	.0007			
080000	60	0	.14359558 02	.112 00	-.0004	.78067596 02 .116 00	.0057			

FREQUENCY2038516.0

220000	60	51	.14953242 02	.857-01	-.0002	.28509123 03 .886-01	-.0014	.14302250 05	.172-01	.0009
230000	60	51	.15068582 02	.676-01	.0000	.30005508 03 .698-01	.0017	-.14459947 05	.135-01	.0001
						64/11/30				
000000	60	51	.15137918 02	.657-01	.0019	.31513791 03 .681-01	.0009	.14735132 05	.132-01	-.0002
010000	60	51	.15189322 02	.652-01	-.0002	.33026529 03 .676-01	-.0031	.15106839 05	.131-01	.0021
020000	60	51	.15225421 02	.649-01	.0009	.34541624 03 .674-01	.0017	.15546990 05	.130-01	-.0020
030000	60	51	.15246821 02	.649-01	.0002	.57495905 00 .674-01	.0012	.16022491 05	.130-01	.0007
040000	60	51	.15254266 02	.652-01	.0004	.15727202 02 .674-01	.0012	.16497762 05	.130-01	-.0017
050000	60	51	.15248872 02	.652-01	.0009	.30859974 02 .676-01	-.0003	.16937468 05	.131-01	.0029
060000	60	51	.15231617 02	.659-01	.0003	.45960994 02 .681-01	.0005	.17309181 05	.132-01	.0002
070000	60	51	.15200640 02	.679-01	-.0001	.61013895 02 .703-01	-.0045	.17585710 05	.135-01	-.0012
080000	60	51	.15120052 02	.925-01	-.0006	.75933573 02 .959-01	-.0002	.17746981 05	.185-01	.0010

MARINER STATISTICS STATION 51 ITERATION 1

PASS	DATA TYPE	BEGINNING TIME	END TIME	NUMBER OF POINTS	STD DEV	RMS	FIRST MOMENT	SECOND MOMENT
000000	CC3	11/29-220000	11/30-080000	11	.144-02	.146-02	.255-03	.213-05
	HA	11/28-220000	11/30-080000	22	.267-02	.269-02	.334-03	.722-05
	DEC	11/28-220000	11/30-080000	22	.794-03	.850-03	.303-03	.723-06

```
0000 135231     OFFLINE CONTROL                                  I27
0000 13523      KEY(5)
0000 13523      END DATA                                         I0
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CASE  1                                IBSYS-JPTRAJ-SPACE 022265


DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1

  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    DME  .41780741-02     AU  .14959850 09
  GMM  .49026293 04    GMS  .13271411 12    GMV  .32476627 06    GMA  .42977367 05    GME  .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  .11120000 02     GB  .95999999-01    MAS  .25900000 03    GB1  .00000000 00    GB2  .00000000 00     SC  .10310000 09

INJECTION CONDITIONS                MARS       2357005514232022000000000 J.D.= 2438728.13052083  NOV. 28,1964 15 07 57.000

GEOCENTRIC        XO .56682105 04   YO .21466863 04   ZO-.32403805 04 DXO-.18839629 01 DYO .10978653 02 DZO-.12280560 01
CARTESIAN         TO .54476999 05 GHA .29452970 03 GHO .66920765 02
DATE OF RUN 022265A  13525                    EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

      PROBE IS IN EARTH'S    SHADOW

   0 DAYS  0 HRS.  0 MIN.  0.000 SEC.       2357005514232022000000000 J.D.= 2438728.13052083  NOV. 28,1964 15 07 57.000

      GEOCENTRIC                                                                                  EQUATORIAL COORDINATES

    X  .56682103 04      Y  .21466862 04      Z -.32403804 04     DX -.18839629 01     DY  .10978653 02     DZ -.12280559 01
    R  .68729131 04    DEC -.28129837 02     RA  .20742872 02      V  .11206616 02    PTH  .12650726 02     AZ  .90421329 02
    R  .68729129 04    LAT -.28129838 02    LON  .86213175 02     VE  .10775811 02    PTE  .13165397 02    AZE  .90439077 02
   XS -.58995549 08     YS -.12408705 09     ZS -.53810146 08    DXS  .27792202 02    DYS -.10840364 02    DZS -.47011071 01
   XM -.38523466 06     YM -.44736395 05     ZM  .18645579 05    DXM  .37058146-01    DYM -.92038371 00    DZM -.41497853 00
   XT -.19750066 09     YT  .58811766 08     ZT  .33854926 08    DXT  .87298950 01    DYT -.21590059 02    DZT -.91209471 01
   RS  .14755881 09     VS  .30199675 02     RM  .38827148 06     VM  .10102904 01     RT  .20883364 09     VT  .25010665 02
  GED -.28291938 02    ALT  .49950689 03    LOS  .31004216 03    RAS  .24457186 03    RAM  .18662395 03    LOM  .25209425 03
  DUT  .35000000 02     DT  .37500000 01     DR  .24543294 01    SHA  .62358811 04    DES -.21387223 02    DEM  .27525167 01
  CCL  .11901320 03    MCL  .21144487 03    TCL  .21574675 03

                                                GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                    2357005513262023545325OO J.D.= 2438728.12770658  NOV. 28,1964 15 03 53.849
  SMA -.41536060 05    ECC  .11580719 01      B  .24259711 05     SLR  .14169223 05     APO  .00000000 00     RCA  .65656862 04
   VH  .30978211 01     C3  .95964959 01     C1  .75152253 05     TFP  .24315096 03      TF -.28142471-02     LTF -.25588937-01
   TA  .23551788 02    MTA  .14971234 03     EA  .64722590 01      MA  .10390338 01                          TF1  .00000000 00

                                                                  ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .56682103 04      Y  .21466862 04      Z -.32403804 04     DX -.18839629 01     DY  .10978653 02     DZ -.12280559 01
  INC  .28132733 02    LAN  .11163647 03    APF  .24566016 03     MX -.35740735 00     MY  .93392608 00     MZ -.64849760-02
   WX  .43829371 00     WY  .17385554 00     WZ  .88185763 00     PX  .89882977 00     PY -.86854203-01     PZ -.42960603 00
   QX  .19036494-02     QY  .98093352 00     QZ -.19433418 00     RX -.21994273 00     RY  .16164795 00     RZ -.96202654 00
   BX  .45496110 00     BY  .80323605 00     BZ -.38447660 00     TX  .59221295 00     TY  .80578150 00     TZ  .00000000 00
  SXI  .77710339 00    SYI  .61972664 00    SZI -.46897743 00    DAI -.27967940 02    RAI  .28374228 02
  SXO -.77518320 00    SYO  .56972458 00    SZO  .27295579 00    DAO  .15840229 02    RAO  .14368579 03

  BTQ  .24222561 05    BRQ  .13420647 04      B  .24259711 05    THA  .31712632 01    T VECTOR IN  EARTH EQUATOR PLANE

                                                                  ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .56682103 04      Y  .68028036 03      Z -.38269499 04     DX -.18839629 01     DY  .95837699 01     DZ -.54965689 01
  INC  .42277902 02    LAN  .13934386 03    APF  .21231139 03     MX -.35740735 00     MY  .85424963 00     MZ -.37751494 00
   WX  .43829370 00     WY  .51035333 00     WZ  .73989060 00     PX  .89882980 00     PY -.25060437 00     PZ -.35958650 00
   QX  .19036569-02     QY  .82264020 00     QZ -.56855910 00     RX -.18420855-01     RY  .15001476-01     RZ -.99971775 00
   BX  .45496101 00     BY  .58396315 00     BZ -.67230762 00     TX  .63146777 00     TY  .77540213 00     TZ  .00000000 00
```



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  SXI  .77710346 00    SYI  .19849367 00    SZI -.59725243 00    DAI -.36673369 02    RAI  .14328550 02
  SXO -.77518328 00    SYO  .63128954 00    SZO  .23756519-01    DAO  .13612746 01    RAO  .14084150 03

  BTC  .22379481 05    BRC -.93644400 04      B  .24259718 05    THA  .33729368 03    T VECTOR IN  ECLIPTIC PLANE

      HELIOCENTRIC                                                                                ECLIPTIC COORDINATES

    X  .59001217 08      Y  .13525276 09      Z -.41570000 04     DX -.29676165 02     DY  .21399602 02     DZ -.54944132 01
    R  .14756169 09    LAT -.16140947-02    LON  .66431758 02      V  .36997382 02    PTH  .12089884 02     AZ  .98735355 02
   XE  .58995549 08     YE  .13525209 09     ZE -.33000000 03     DXE -.27792202 02     DYE  .11815832 02    DZE  .15556812-03
   XT -.13850512 09     YT  .20267817 09     ZT  .76614060 07     DXT -.19062307 02     DYT -.11620746 02     DZT  .22182012 00
  LTE -.12813608-03    LDE  .66433669 02    LTI  .17875885 01     LOI  .12434771 03     RST  .24560294 09     VST -.22326273 02
  EPS  .65134159 02    ESP -.13988227-01    SEP -.11486342 03     EPM  .28249846 02     EMP  .47990158 00     MEP  .15127010 03
  MPS  .61567035 02    MSP  .13507880 00    SMP  .11829816 03     SEM  .61571418 02     EMS  .11829583 03     ESM  .13270400 00
  EPT  .39785456 02    ETP  .27453512-18    TEP  .14021333 03     TPS  .85283946 02     TSP  .57933486 02     STP  .36782563 02
  SET  .85286588 02    STE  .36781888 02    EST  .57931519 02     RPM  .39431214 06     RPT  .20883893 09     SPN -.29895868 01
  SAC  .22280601-09
  GCE  .24098679 03    GCI  .27673355 03    SIP  .85283019 02     CPT  .84329569 02     SIN  .84328642 02
  REP  .68729131 04    VEP  .11206616 02    CPE  .12085585 03     CPS  .10111911 03

   0 DAYS  0 HRS.  9 MIN. 49.241 SEC.       2357005516462024366447O5 J.D.= 2438728.13734075  NOV. 28,1964 15 17 46.241
  PROBE IS LEAVING EARTH'S    SHADOW

   8 DAYS 19 HRS. 24 MIN.  2.979 SEC.       2357013351072027753525l4 J.D.= 2438736.93888865  DEC. 7,1964 10 31 59.980

   8 DAYS 19 HRS. 24 MIN.  2.979 SEC.       2357013351072027753525l4 J.D.= 2438736.93888865  DEC. 7,1964 10 31 59.980
  CHANGE OF PHASE OCCURS AT THIS POINT    SUN      IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

225 DAYS  2 HRS. 44 MIN. 31.060 SEC.       2357232024272020075275l2 J.D.= 2438953.24476920  JULY 11,1965 17 52 28.060

      GEOCENTRIC                                                                                  EQUATORIAL COORDINATES

    X -.20952635 09      Y -.22337826 08      Z -.94661789 07     DX -.13367881 02     DY -.23273616 02     DZ -.10141585 02
    R  .21092624 09    DEC -.25722458 01     RA  .18608537 03      V  .28691692 02    PTH  .34373873 02     AZ  .11345038 03
    R  .21092624 09    LAT -.25722458 01    LON  .34854236 03     VE  .15343772 05    PTE  .60490716-01    AZE  .26996480 03
   XS -.50004426 08     YS  .13176278 09     ZS  .57140097 08    DXS -.27634650 02    DYS -.88887630 01    DZS -.38558931 01
   XM -.16125000 05     YM -.36611200 06     ZM -.16854550 06    DXM  .97207475 00    DYM -.20357370-01    DZM -.10283720 00
   XT -.21150188 09     YT -.22632994 08     ZT -.93652949 07    DXT -.92234842 01    DYT -.22096207 02    DZT -.10412922 02
   RS  .15207519 09     VS  .29283987 02     RM  .40336781 06     VM  .97771122 00     RT  .21291549 09     VT  .26110227 02
  GED -.25897513 01    ALT  .21091986 09    LOS  .27323891 03    RAS  .11078193 03    RAM  .26747809 03    LOM  .69935081 02
  DUT  .35000000 02     DT  .86399999 05     DR  .16199062 02    SHA -.20585269 09    DES  .22069798 02    DEM -.24698652 02
  CCL  .10205468 03    MCL  .18000385 03    TCL  .92811081 01
```

CASE 1 IBSYS-JPTRAJ-SPACE 022265 3

HELIOCENTRIC ECLIPTIC COORDINATES

X	-.15952193 09	Y	-.16787898 09	Z	.20262100 06	DX	.14266770 02	DY	-.15698153 02	DZ	-.43642342-01
R	.23158289 09	LAT	.50131026-01	LON	.22646218 03	V	.21212605 02	PTH	.41969292 01	AZ	.90121874 02
XE	.50004426 08	YE	-.14361901 09	ZE	.28500000 02	DXE	.27634650 02	DYE	.96890669 01	DZE	.11010766-02
XT	-.16149745 09	YT	-.16810964 09	ZT	.41261150 06	DXT	.18411166 02	DYT	-.14725897 02	DZT	-.76102304 00
LTE	.10737647-04	LDE	.28919679 03	LTT	.10141465 00	LOT	.22614924 03	RST	.23311467 09	VST	.23588180 02
EPS	.39857595 02	ESP	.62734623 02	SEP	.77407780 02	EPM	.10835236 00	EMP	.98784596 02	MEP	.81107116 02
MPS	.39965850 02	MSP	.62679107 02	SMP	.77355039 02	SEM	.15847546 03	EMS	.21468911 02	ESM	.55952909-01
EPT	.17402787 03	ETP	.59161291 01	TEP	.54625775-01	TPS	.13982710 03	TSP	.31713545 00	STP	.39855781 02
SET	.77408314 02	STE	.39544090 02	EST	.63047593 02	RPM	.21086426 09	RPT	.19999992 07	SPN	.39855862 02
SAC	.90460970-10										
GCE	.25793531 03	GCT	.87216419 02	SIP	.13973033 03	CPT	.93937702 02	SIN	.93840928 02		
REP	.21092624 09	VEP	.28691692 02	CPE	.91869014 02	CPS	.82500247 02				

HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 23570024066020254752 7522 J.D.= 2438723.37336585 NOV. 23,1964 20 57 38.810

SMA	.19063377 09	ECC	.22638500 00	B	.18568449 09	SLR	.18086375 09	APO	.23379039 09	RCA	.14747714 09
VH	.20955964 02	C3	-.69617315 03	C1	.48993033 10	TFP	.19860889 08	TF	-.47571538 01	PER	.52562087 03
TA	.16533578 03	MTA	.18000000 03	EA	.16159514 03	MA	.15749984 03			TFI	.22511424 03

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	-.15952193 09	Y	-.15410060 09	Z	-.66606276 08	DX	.14266770 02	DY	-.14384853 02	DZ	-.62856916 01
INC	.23492319 02	LAN	.30826009 00	APF	.60843575 02	MX	.72491694 00	MY	-.63112116 00	MZ	-.27600995 00
WX	.21446739-02	WY	-.39862036 00	WZ	.91711352 00	PX	.48287950 00	PY	.80351821 00	PZ	.34811732 00
QX	-.87568406 00	QY	.44210871 00	QZ	.19420888 00	RX	.17931470 00	RY	.29838215 00	RZ	-.93745086 00
BX	.87568416 00	BY	-.44210876 00	BZ	-.19420890 00	TX	.85713101 00	TY	-.51509847 00	TZ	.00000000 00
DAP	.20372204 02	RAP	.58995964 02								
BTQ	.18165617 09	BRQ	.38467694 08	B	.18568449 09	THA	.11956381 02	T VECTOR IN EARTH EQUATOR PLANE			

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	-.15952193 09	Y	-.16787898 09	Z	.20262100 06	DX	.14266770 02	DY	-.15698153 02	DZ	-.43642342-01
INC	.13177922 00	LAN	.68820811 02	APF	.35230551 03	MX	.72491693 00	MY	-.68883299 00	MZ	-.21271140-02
WX	.21446737-02	WY	-.83096782-03	WZ	.99999736 00	PX	.48287949 00	PY	.87568647 00	PZ	-.30795250-03
QX	-.87568391 00	QY	.48287887 00	QZ	.22793191-02	RX	-.14870399-03	RY	-.26966991-03	RZ	-.99999969 00
BX	.87568413 00	BY	-.48287899 00	BZ	-.22793196-02	TX	.87568673 00	TY	-.48287963 00	TZ	.00000000 00
DAP	-.17645793-01	RAP	.61126355 02								
BTC	.18568398 09	BRC	.42323416 06	B	.18568446 09	THA	.13059492 00	T VECTOR IN ECLIPTIC PLANE			

ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET

X	.17224305 09	Y	-.15479968 09	Z	-.16642050 06	DX	.15289946 02	DY	.14689711 02	DZ	.63605690 00
INC	.17264500 01	LAN	.31941926 03	APF	.19329738 03	MX	.66815475 00	MY	.74341242 00	MZ	-.30118211-01
WX	-.19598038-01	WY	-.22880996-01	WZ	.99954606 00	PX	-.88868259 00	PY	.45847028 00	PZ	-.69293238-02
QX	-.45810362 00	QY	-.88841500 00	QZ	-.29319061-01	RX	.61581179-02	RY	-.31769557-02	RZ	-.99997587 00
BX	.45810368 00	BY	.88841512 00	BZ	.29319065-01	TX	.45848135 00	TY	.88870403 00	TZ	.00000000 00
DAP	-.39702438 00	RAP	.15271084 03								
BTO	.18560465 09	BRO	-.54442254 07	B	.18568448 09	THA	.35831986 03	T VECTOR IN ORBIT PLANE OF TARGET			

225 DAYS 2 HRS. 44 MIN. 31.060 SEC. 23572320242720200 7527522 J.D.= 2438953.24476920 JULY 11,1965 17 52 28.060
CHANGE OF PHASE OCCURS AT THIS POINT MARS IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

CASE 1 IBSYS-JPTRAJ-SPACE 022265 4

225 DAYS 2 HRS. 44 MIN. 31.060 SEC. 23572320242720200 7527522 J.D.= 2438953.24476920 JULY 11,1965 17 52 28.060

GEOCENTRIC EQUATORIAL COORDINATES

X	-.20952635 09	Y	-.22337827 08	Z	-.94661791 07	DX	-.13367881 02	DY	-.23273616 02	DZ	-.10141585 02
R	.21092624 09	DEC	-.25722458 01	RA	.18608537 03	V	.28691692 02	PTH	.34373873 02	AZ	.11345038 03
R	.21092624 09	LAT	-.25722458 01	LON	.34854236 03	VE	.15343772 05	PTE	.60490716-01	AZE	.26996480 03
XS	-.50004427 08	YS	.13176278 09	ZS	.57140097 08	DXS	-.27634650 02	DYS	-.88887629 01	DZS	-.38558930 01
XM	-.16126000 05	YM	-.36611200 06	ZM	-.16854537 06	DXM	.97207451 00	DYM	-.20357370-01	DZM	-.10283720 00
XT	-.21150188 09	YT	-.22632995 08	ZT	-.93652949 07	DXT	-.92234842 01	DYT	-.22096207 02	DZT	-.10412922 02
RS	.15207519 09	VS	.29283987 02	RM	.40336780 06	VM	.97771098 00	RT	.21291549 09	VT	.26110227 02
GED	-.25897513 01	ALT	.21091986 09	LOS	.27323891 03	RAS	.11078193 03	RAM	.26747793 03	LDM	.69934925 02
DUT	.35000000 02	DT	.38400000 04	DR	.16199062 02	SHA	-.20585269 09	DES	.22069798 02	DEM	-.24698632 02
CCL	.10206468 03	MCL	.18000385 03	ICL	.92811038 01						

HELIOCENTRIC ECLIPTIC COORDINATES

X	-.15952193 09	Y	-.16787898 09	Z	.20262100 06	DX	.14266770 02	DY	-.15698153 02	DZ	-.43642342-01
R	.23158289 09	LAT	.50131026-01	LON	.22646218 03	V	.21212605 02	PTH	.41969292 01	AZ	.90121874 02
XE	.50004427 08	YE	-.14361901 09	ZE	.27500000 02	DXE	.27634650 02	DYE	.96890667 01	DZE	.11010766-02
XT	-.16149745 09	YT	-.16810964 09	ZT	.41261150 06	DXT	.18411166 02	DYT	-.14725897 02	DZT	-.76102304 00
LTE	.10360887-04	LDE	.28919679 03	LTT	.10141465 00	LOT	.22614924 03	RST	.23311467 09	VST	.23588180 02
EPS	.39857594 02	ESP	.62734623 02	SEP	.77407780 02	EPM	.10812639 00	EMP	.98784597 02	MEP	.81107116 02
MPS	.39965851 02	MSP	.62679107 02	SMP	.77355038 02	SEM	.15847546 03	EMS	.21468911 02	ESM	.55952909-01
EPT	.17402788 03	ETP	.59161291 01	TEP	.54625775-01	TPS	.13982710 03	TSP	.31721256 00	STP	.39855791 02
SET	.77408312 02	STE	.39544090 02	EST	.63047594 02	RPM	.21088426 09	RPT	.20000000 07	SPN	.39855861 02
SAC	.90460971-10										
GCE	.25793531 03	GCT	.87216416 02	SIP	.13973032 03	CPT	.93937700 02	SIN	.93840926 02		
REP	.21092624 09	VEP	.28691692 02	CPE	.91869014 02	CPS	.82500245 02				

AREOCENTRIC ECLIPTIC COORDINATES

X	.19755248 07	Y	.23066303 06	Z	-.20999099 06	DX	-.41443964 01	DY	-.97225593 00	DZ	.71738064 00
R	.20000000 07	DEC	-.60269085 01	RA	.66597225 01	V	.43169362 01	PTH	-.82615601 02	AZ	.29904489 03
ALT	.19966220 07	SHA	-.12817149 07	ALP	.17289476 03	DR	-.42811324 01	DP	.15894875-04	ASD	.96773534-01
HGE	.32014240 03	SVL	.59718631 01	HNG	.14019883 03	SIA	.17393110 03				
SAC	.90460971-10										

AREOCENTRIC EQUATORIAL COORDINATES

X	-.28159035 06	Y	.18703261 07	Z	.65006682 06	DX	.10731629 01	DY	-.40344328 01	DZ	-.10989137 01
R	.19999999 07	DEC	.18967598 02	RA	.98561966 02	V	.43169362 01	PTH	-.82615601 02	AZ	.30389252 03
R	.20000000 07	LAT	.18967598 02	LON	.21477832 03	VP	.13459592 03	PTP	-.18227299 01	AZP	.27013177 03
RAE	.99052002 02	DEE	.24866261 02	RAS	.14029968 03	DES	.15866048 02	LDE	.21526835 03	LOS	.25651603 03

AREOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 23572354253720240352 7522 J.D.= 2438958.55775496 JULY 17,1965 01 23 10.029

SMA	-.23114860 04	ECC	.11133878 03	B	.25734764 06	SLR	.28651617 08	APO	.00000000 00	RCA	.25504654 06
VH	.43119555 01	C3	.18592960 02	C1	.11096716 07	TFP	-.45904197 06	TF	.23042723 03	LTF	.23039799 03
TA	-.83125959 02	MTA	.90514614 02	EA	-.15702370 03	MA	-.49063444 05			TFI	.22511424 03
ZAE	.16848501 03	ZAP	.14587674 03	ZAC	.98962530 02	DEF	.10293611 01	IR	.51987771 04	GP	.84749242 01

CASE 1 I8SYS-JPTRAJ-SPACE 022265 5

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.19755248 07	Y	.29516781 06	Z	-.10088414 06	DX	-.41443964 01	DY	-.11774092 01	DZ	.27133758 00
INC	.17357811 03	LAN	.34183582 03	APF	.56319054 02	MX	.15201859 00	MY	-.98332328 00	MZ	.99828441-01
WX	-.34867790-01	WY	-.10627491 00	WZ	-.99372528 00	PX	.26914820 00	PY	-.95859092 00	PZ	.93073576-01
QX	-.96246738 00	QY	-.26421408 00	QZ	.62027644-01	RX	-.60466938-01	RY	-.17183313-01	RZ	-.99802227 00
BX	.27778184 00	BY	-.95617919 00	BZ	.92512715-01	TX	-.27335371 00	TY	.96191359 00	TZ	.00000000 00
SXI	-.96001118 00	SYI	-.27281309 00	SZI	.62861092-01	DAI	.36040509 01	RAI	.19586392 03		
SXO	-.96484594 00	SYO	-.25559374 00	SZO	.61189193-01	DAO	.35080731 01	RAO	.19483720 03		
ETE	.32002128 02	ETS	.14294957 03	ETC	.23281654 03						
BTQ	-.25623962 06	BRQ	-.23855108 05	B	.25734764 06	THA	.18531872 03	T VECTOR IN EARTH EQUATOR PLANE			

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	.19755248 07	Y	.23066303 06	Z	-.20999099 06	DX	-.41443964 01	DY	-.97225593 00	DZ	.71738064 00
INC	.15038975 03	LAN	.35595333 03	APF	.70857026 02	MX	.15201845 00	MY	-.86242815 00	MZ	.48281090 00
WX	-.34867758-01	WY	-.49206372 00	WZ	-.86940663 00	PX	.26914808 00	PY	-.84242503 00	PZ	.46677369 00
QX	-.96246739 00	QY	-.21772405 00	QZ	.16202702 00	RX	-.16181709 00	RY	-.37972899-01	RZ	-.98608989 00
BX	.27778195 00	BY	-.84043626 00	BZ	.46530000 00	TX	-.22845947 00	TY	.97355343 00	TZ	.00000000 00
SXI	-.96001119 00	SYI	-.22528158 00	SZI	.16621285 00	DAI	-.95676999 01	RAI	.19320638 03		
SXO	-.96484594 00	SYO	-.21014895 00	SZO	.15782811 00	DAO	.90808550 01	RAO	.19228744 03		
ETE	.54838743 02	ETS	.16578618 03	ETC	.25565315 03						
BTC	-.22689608 06	BRC	-.12143301 06	B	.25734764 06	THA	.20815534 03	T VECTOR IN ECLIPTIC PLANE			

ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET

X	-.28159081 06	Y	.19730736 07	Z	-.16639353 06	DX	.10731639 01	DY	-.41327579 01	DZ	.63605730 00
INC	.14925252 03	LAN	.90054571 02	APF	.73760504 02	MX	.84781782 00	MY	.16353827 00	MZ	.50443871 00
WX	.51125324 00	WY	.48695213-03	WZ	-.85942896 00	PX	.82487204 00	PY	.28043826 00	PZ	.49085507 00
QX	.24125624 00	QY	-.95987187 00	QZ	.14297356 00	RX	.37050490-01	RY	-.14264319 00	RZ	-.98908047 00
BX	.82267265 00	BY	.28904839 00	BZ	.48955159 00	TX	-.96788319 00	TY	-.25140034 00	TZ	.00000000 00
SXI	.24865517 00	SYI	-.95731436 00	SZI	.14737645 00	DAI	.84749191 01	RAI	.28456039 03		
SXO	.23383784 00	SYO	-.96235193 00	SZO	.13855914 00	DAO	.79644786 01	RAO	.28365738 03		
ETE	.56350271 02	ETS	.16729771 03	ETC	.25716468 03						
BTO	-.22361396 06	BRO	-.12737582 06	B	.25734764 06	THA	.20966686 03	T VECTOR IN ORBIT PLANE OF TARGET			

ALL VECTORS REFERENCED TO AREOCENTRIC EQUATOR PLANE

X	-.28159081 06	Y	.18703260 07	Z	.65006682 06	DX	.10731639 01	DY	-.40344325 01	DZ	-.10989137 01
INC	.14172193 03	LAN	.12438140 03	APF	.11477325 03	MX	.84781858 00	MY	-.55648232-01	MZ	.52735849 00
WX	.51125371 00	WY	.34981902 00	WZ	-.78501359 00	PX	.82487278 00	PY	.56678651-01	PZ	.56246990 00
QX	.24125622 00	QY	-.93510115 00	QZ	-.25957899 00	RX	-.65441985-01	RY	.24595948 00	RZ	-.96708837 00
BX	.82267267 00	BY	.65075067-01	BZ	.56477866 00	TX	-.96637878 00	TY	-.25712262 00	TZ	.00000000 00
SXI	.24865516 00	SYI	-.93455437 00	SZI	-.25451664 00	DAI	-.14744945 02	RAI	.28489939 03		
SXO	.23383781 00	SYO	-.93557250 00	SZO	-.26462040 00	DAO	-.15344397 02	RAO	.28403305 03		
ETE	.62416562 02	ETS	.17336400 03	ETC	.26323097 03						
BTT	-.20890083 06	BRT	-.15029387 06	B	.25734764 06	THA	.21573316 03	T VECTOR IN TRUE TARGET EQU. PLANE			

230 DAYS 10 HRS. 21 MIN. 2.322 SEC. 2357235426662026511473 25 J.D.= 2438958.56179771 JULY 17,1965 01 28 59.322

GEOCENTRIC EQUATORIAL COORDINATES

X	-.21527995 09	Y	-.33370439 08	Z	-.14273386 08	DX	-.11678219 02	DY	-.24713026 02	DZ	-.10779755 02
R	.21831805 09	DEC	-.37486067 01	RA	.18881126 03	V	.29382266 02	PTH	.32988816 02	AZ	.11331624 03
R	.21831805 09	LAT	-.37486067 01	LON	.23189716 03	VE	.15863321 05	PTE	.57782545-01	AZE	.26996476 03
XS	-.62405360 08	YS	.12716259 09	ZS	.55144967 08	DXS	-.26664940 02	DYS	-.11125287 02	DZS	-.48248740 01
XM	.35175000 06	YM	-.16575950 06	ZM	-.11054600 06	DXM	.45401406 00	DYM	.79613352 00	DZM	.32725155 00
XT	-.21534786 09	YT	-.33127602 08	ZT	-.14298221 08	DXT	-.74922993 01	DYT	-.23570404 02	DZT	-.11052582 02
RS	.15203851 09	VS	.29292839 02	RM	.40425820 06	VM	.97316541 00	RT	.21834967 09	VT	.27089815 02
GED	-.37740790 01	ALT	.21831167 09	LDS	.15925455 03	RAS	.11616865 03	RAM	.33476820 03	LDM	.17854099 02
DUT	.35000000 02	DT	.95999999 03	DR	.15997919 02	SHA	-.21117487 09	DES	.21266347 02	DEM	-.15869899 02
CCL	.10175299 03	NCL	.18001457 03	TCL	.32801724 03						

HELIOCENTRIC ECLIPTIC COORDINATES

X	-.15279459 09	Y	-.17489919 09	Z	.18206950 06	DX	.14986720 02	DY	-.14835227 02	DZ	-.57264804-01
R	.23224114 09	LAT	.44918739-01	LON	.22885904 03	V	.21087651 02	PTH	.35678491 01	AZ	.90158692 02
XE	.62485360 08	YE	-.13860480 09	ZE	.36950000 03	DXE	.26664940 02	DYE	.12126476 02	DZE	.25510788-03
XT	-.15286250 09	YT	-.17468628 09	ZT	.62669500 05	DXT	.19172641 02	DYT	-.13895480 02	DZT	-.76217288 00
LTE	.13924623-03	LOE	.29426664 03	LTT	.15469524-01	LOT	.22881184 03	RST	.23212549 09	VST	.23690830 02
EPS	.39289430 02	ESP	.65407611 02	SEP	.75302954 02	EPM	.66719594-01	EMP	.38905585 02	MEP	.14102778 03
MPS	.39355420 02	MSP	.65497911 02	SMP	.75146666 02	SEM	.14310437 03	EMS	.36804360 02	ESM	.91192092-01
EPT	.97133889 02	ETP	.82800138 02	TEP	.65610602-01	TPS	.62814820 02	TSP	.55071707-01	STP	.11712955 03
SEI	.75244898 02	STE	.39300298 02	EST	.65454801 02	RPM	.21863250 09	RPT	.25337335 06	SPM	.39287756 02
SAC	.89948905-10										
GCE	.25824700 03	GCT	.46264244 02	SIP	.62050924 02	CPT	.47739595 02	SIN	.46975699 02		
REP	.21831805 09	VFP	.29382266 02	CPE	.91154633 02	CPS	.82009783 02				

AREOCENTRIC ECLIPTIC COORDINATES

X	.67905585 05	Y	-.21290933 06	Z	.11940061 06	DX	-.41859201 01	DY	-.93974701 00	DZ	.70490804 00
R	.25337335 06	DEC	.28115064 02	RA	.28768963 03	V	.43476369 01	PTH	.00000000 00	AZ	.28059274 03
ALT	.24999535 06	SHA	.22549665 06	ALP	.16413254 03	DR	.46250916-07	DP	.98313903-03	ASD	.76389518 00
HGE	.32071056 03	SVL	-.28109262 02	HNG	.58804424 02	SIA	.96369993 02				
SAC	.89948905-10										

AREOCENTRIC EQUATORIAL COORDINATES

X	.20844761 06	Y	.13603512 05	Z	.14339664 06	DX	.10420695 01	DY	-.40671214 01	DZ	-.11289647 01
R	.25337335 06	DEC	.34468284 02	RA	.37338876 01	V	.43476368 01	PTH	.29456472-06	AZ	.25164103 03
R	.25337335 06	LAT	.34468285 02	LON	.54251868 02	VP	.18982457 02	PTP	-.44976981-07	AZP	.26586315 03
RAE	.10224721 03	DEE	.24671811 02	RAS	.14291916 03	DES	.15017378 02	LOE	.15276519 03	LOS	.19343714 03

AREOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2357235426662026510746 00 J.D.= 2438958.56179770 JULY 17,1965 01 28 59.321

SMA	-.23152535 04	ECC	.11043655 03	P	.25567811 06	SLR	.28235053 08	APO	.00000000 00	RCA	.25337335 06
VH	.43084458 01	C3	.18562705 02	C1	.11015753 07	TFP	.65103445-03	TF	.23043127 03	LTF	.23040201 03
TA	.25613208-05	MTA	.90518817 02	EA	.00000000 00	MA	.69414259-04			TFI	.23043127 03
ZAE	.16978730 03	ZAP	.14321075 03	ZAC	.98950581 02	DEF	.10376917 01	IR	.52012245 04	GP	.84832144 01

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ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.67905585 05	Y	-.24283757 06	Z	.24835528 05	DX	-.41859201 01	DY	-.11426220 01	DZ	.27282742 00
INC	.17331640 03	LAN	.34281734 03	APF	.57372230 02	MX	-.96280351 00	MY	-.26281448 00	MZ	.62753035-01
WX	-.34382693-01	WY	-.11119170 00	WZ	-.99320403 00	PX	.26800603 00	PY	-.95841794 00	PZ	.98019490-01
QX	-.96280351 00	QY	-.26281449 00	QZ	.62753035-01	RX	-.61238094-01	RY	-.17311678-01	RZ	-.99797304 00
BX	.27671320 00	BY	-.95599888 00	BZ	.97447246-01	TX	-.27203356 00	TY	.96228777 00	TZ	.00000000 00
SXI	-.96033725 00	SYI	-.27148216 00	SZI	.63638026-01	DAI	.36486594 01	RAI	.19578531 03		
SXO	-.96519082 00	SYO	-.25412526 00	SZO	.61862898-01	DAO	.35467473 01	RAO	.19475065 03		
ETE	.46388492 02	ETS	.14413840 03	ETC	.23280735 03						

BTQ -.25445631 06 BRQ -.24965733 05 B .25567811 06 THA .18560358 03 T VECTOR IN EARTH EQUATOR PLANE

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	.67905585 05	Y	-.21290933 06	Z	.11940061 06	DX	-.41859201 01	DY	-.93974701 00	DZ	.70490804 00
INC	.15010870 03	LAN	.35604388 03	APF	.71013729 02	MX	-.96280351 00	MY	-.21615121 00	MZ	.16213590 00
WX	-.34382693-01	WY	-.49716855 00	WZ	-.86697247 00	PX	.26800602 00	PY	-.84029880 00	PZ	.47124377 00
QX	-.96280351 00	QY	-.21615121 00	QZ	.16213590 00	RX	-.16205584 00	RY	-.37757772-01	RZ	-.98605894 00
BX	.27671319 00	BY	-.83830711 00	BZ	.46975632 00	TX	-.22691466 00	TY	.97391465 00	TZ	.00000000 00
SXI	-.96033725 00	SYI	-.22375123 00	SZI	.16639635 00	DAI	.95783617 01	RAI	.19311549 03		
SXO	-.96519082 00	SYO	-.20853347 00	SZO	.15786215 00	DAO	.90828306 01	RAO	.19219159 03		
ETE	.69235305 02	ETS	.16698522 03	ETC	.25565417 03						

BTC -.22479983 06 BRC -.12180449 06 B .25567811 06 THA .20845039 03 T VECTOR IN ECLIPTIC PLANE

ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET

X	.20844761 06	Y	.70722138 05	Z	.12548319 06	DX	.10420693 01	DY	-.41748402 01	DZ	.62189034 00
INC	.14896956 03	LAN	.90114076 02	APF	.73889917 02	MX	.23968636 00	MY	-.96025503 00	MZ	.14304100 00
WX	.51549237 00	WY	-.10263728-02	WZ	-.85689357 00	PX	.82268951 00	PY	.27912224 00	PZ	.49525014 00
QX	.23968636 00	QY	-.96025502 00	QZ	.14304100 00	RX	.36859198-01	RY	-.14284059 00	RZ	-.98905911 00
BX	.82048545 00	BY	.28780589 00	BZ	.49393461 00	TX	-.96828207 00	TY	-.24985965 00	TZ	.00000000 00
SXI	.24712597 00	SYI	-.95768820 00	SZI	.14751961 00	DAI	.84832127 01	RAI	.28446920 03		
SXO	.23222710 00	SYO	-.96274309 00	SZO	.13855065 00	DAO	.79639885 01	RAO	.28356148 03		
ETE	.70745116 02	ETS	.16849503 03	ETC	.25716398 03						

BTO -.22151246 06 BRO -.12768525 06 B .25567811 06 THA .20996021 03 T VECTOR IN ORBIT PLANE OF TARGET

ALL VECTORS REFERENCED TO AREOCENTRIC EQUATOR PLANE

X	.20844761 06	Y	.13603502 05	Z	.14139664 06	DX	.10420693 01	DY	-.40671214 01	DZ	-.11289647 01
INC	.14148794 03	LAN	.12412029 03	APF	.11464694 03	MX	.23968636 00	MY	-.93547864 00	MZ	-.25967318 00
WX	.51549236 00	WY	.34928090 00	WZ	-.78247716 00	PX	.82268953 00	PY	.53689554-01	PZ	.56594997 00
QX	.23968636 00	QY	-.93547863 00	QZ	-.25967317 00	RX	-.65045327-01	RY	.24608663 00	RZ	-.96706279 00
BX	.82048545 00	BY	.62158088-01	BZ	.56827810 00	TX	-.96679774 00	TY	-.25554284 00	TZ	.00000000 00
SXI	.24712597 00	SYI	-.93495411 00	SZI	-.25453787 00	DAI	-.14746201 02	RAI	.28480575 03		
SXO	.23222710 00	SYO	-.93592642 00	SZO	-.24478719 00	DAO	-.15354307 02	RAO	.28393511 03		
ETE	.76774132 02	ETS	.17452404 03	ETC	.26319299 03						

BTT -.20687620 06 BRT -.15024492 06 B .25567811 06 THA .21598922 03 T VECTOR IN TRUE TARGET EQU. PLANE

230 DAYS 10 HRS. 28 MIN. 31.060 SEC. 2357235430472020075275ZZ J.D.= 2438958.56699143 JULY 17,1965 01 36 28.060

CASE 1 I8SYS-JPTRAJ-SPACE 022265 8

GEOCENTRIC EQUATORIAL COORDINATES

X	-.21528519 09	Y	-.33381530 08	Z	-.14278223 08	DX	-.11676525 02	DY	-.24714124 02	DZ	-.10780385 02
R	.21832523 09	DEC	-.37497550 01	RA	.18881394 03	V	.29382748 02	PTH	.32987712 02	AZ	.11331638 03
R	.21832523 09	LAT	-.37497550 01	LON	.23002497 03	VE	.15863822 05	PTE	.57779984-01	AZE	.26996476 03
XS	-.62497325 08	YS	.12715759 09	ZS	.55142802 08	DXS	-.26663893 02	DYS	-.11127437 02	DZS	-.48258048 01
XM	.35195200 06	YM	-.16540250 06	ZM	-.11039887 06	DXM	.45305043 00	DYM	.79657650 00	DZM	.32755005 00
XT	-.21535122 09	YT	-.33138180 08	ZT	-.14303181 08	DXT	-.74905242 01	DYT	-.23571790 02	DZT	-.11053182 02
RS	.15203847 09	VS	.29292856 02	RH	.40424757 06	VH	.97317924 00	RT	.21835491 09	VT	.27090775 02
GED	-.37752351 01	ALT	.21831886 09	LOS	.15738492 03	RAS	.11617388 03	RAM	.33482846 03	LOM	.16039501 02
DUT	.35000000 02	DT	.95999999 03	DR	.15997706 02	SHA	-.21117983 09	DES	.21265476 02	DEM	-.15848649 02
CCL	.10175268 03	MCL	.18001457 03	TCL	.32779482 03						

HELIOCENTRIC ECLIPTIC COORDINATES

X	-.15278787 09	Y	-.17490584 09	Z	.18204450 06	DX	.14987368 02	DY	-.14834143 02	DZ	-.57407438-01
R	.23224173 09	LAT	.44913615-01	LON	.228861137 03	V	.21087349 02	PTH	.35668485 01	AZ	.90159081 02
XE	.62497325 08	YE	-.13859936 09	ZE	.36950000 03	DXE	.26663893 02	DYE	.12128819 02	DZE	.25391578-03
XT	-.15285389 09	YT	-.17469252 09	ZT	.62328000 05	DXT	.19173369 02	DYT	-.13894648 02	DZT	-.76217318 00
LTE	.13924627-03	LDE	.79477160 01	LTT	-.15145855-01	LOT	.22881445 03	RST	.23212452 09	VST	.23690931 02
EPS	.39288859 02	ESP	.65410233 02	SEP	.75300904 02	EPM	.66351990-01	EMP	.38847295 02	MEP	.14108616 03
MPS	.39354758 02	MSP	.65500652 02	SMP	.75144586 02	SEM	.14304783 03	EMS	.36860782 02	ESM	.91192092-01
EPT	.96693188 02	ETP	.83240775 02	TEP	.66351990-01	TPS	.62418076 02	TSP	.55514057-01	STP	.11752649 03
SET	.75242820 02	STE	.39300033 02	EST	.65457144 02	RPM	.21863992 09	RPT	.25338079 06	SPN	.39287185 02
SAC	.89948448-10										
GCE	.25824731 03	GCT	.46042143 02	SIP	.61654202 02	CPT	.47651963 02	SIN	.46888088 02		
REP	.21832523 09	VEP	.29382748 02	CPE	.91153933 02	CPS	.82009314 02				

AREOCENTRIC ECLIPTIC COORDINATES

X	.66027186 05	Y	-.21333097 06	Z	.11971690 06	DX	-.41860009 01	DY	-.93949461 00	DZ	.70476573 00
R	.25338079 06	DEC	.28195282 02	RA	.28719760 03	V	.43476370 01	PTH	.43719955 00	AZ	.28036057 03
ALT	.25000279 06	SHA	.22469740 06	ALP	.16379697 03	DR	.33174608-01	DP	.98308158-03	ASD	.76387384 00
HGE	.32071114 03	SVL	-.28189059 02	HNG	.58310008 02	SIA	.95929314 02				
SAC	.89948448-10										

AREOCENTRIC EQUATORIAL COORDINATES

X	.20891517 06	Y	.11778436 05	Z	.14289000 06	DX	.10418224 01	DY	-.40671375 01	DZ	-.11291355 01
R	.25338080 06	DEC	.34328284 02	RA	.32268656 01	V	.43476371 01	PTH	.43719955 00	AZ	.25135458 03
R	.25338079 06	LAT	.34328285 02	LON	.51903004 02	VP	.19002142 02	PTP	.10002983 00	AZP	.26580524 03
RAE	.10225037 03	DEE	.24671581 02	RAS	.14292172 03	DES	.15016530 02	LOE	.15092650 03	LOS	.19159786 03

AREOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2357235426662026517057ZZ J.D.= 2438958.56179777 JULY 17,1965 01 28 59.327

SMA	-.23152520 04	ECC	.11043662 03	B	.25567811 06	SLR	.28235069 08	APD	.00000000 00	RCA	.25337335 06
VH	.43084471 01	C3	.18562716 02	C1	-.11015757 07	TFP	.44873269 03	TF	.23043127 03	LTF	.23040201 03
TA	.44115593 00	MTA	.90518817 02	EA	.43718589 00	MA	.47844590 02			TFI	.23043647 03
ZAE	.16978823 03	ZAP	.14320822 03	ZAC	.98950570 02	DEF	.10378332 01	IR	.52012236 04	GP	.84832033 01

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.66027186 05	Y	-.24335024 06	Z	.24957948 05	DX	-.41860009 01	DY	-.11423338 01	DZ	.27279727 00
INC	.17331641 03	LAN	.34281740 03	APF	.57372299 02	MX	-.96483854 00	MY	-.25542721 00	MZ	.61996301-01
WX	-.34382542-01	WY	-.11119166 00	WZ	-.99320404 00	PX	.26800593 00	PY	-.95841796 00	PZ	.98019493-01
QX	-.96280352 00	QY	-.26281441 00	QZ	.62752869-01	RX	-.61237934-01	RY	-.17311628-01	RZ	-.99797302 00
BX	.27671310 00	BY	-.95599890 00	BZ	.97447249-01	TX	-.27203348 00	TY	.96228779 00	TZ	.00000000 00
SXI	-.96033726 00	SYI	-.27148208 00	SZI	.63637859-01	DAI	.36486460 01	RAI	.19578530 03		
SXD	-.96519083 00	SYD	-.25412519 00	SZD	.61862732-01	DAD	.35467370 01	RAD	.19475064 03		
ETE	.46403853 02	ETS	.14413949 03	ETC	.23280735 03						

BTQ	-.25445630 06	BRQ	-.24965732 05	B	.25567811 06	THA	.18560358 03

T VECTOR IN EARTH EQUATOR PLANE

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	.66027186 05	Y	-.21333097 06	Z	-.11971690 06	DX	-.41860009 01	DY	-.93949461 00	DZ	-.70476573 00
INC	.15010870 03	LAN	.35604390 03	APF	.71013749 02	MX	-.96483853 00	MY	-.20967486 00	MZ	.15850256 00
WX	-.34382543-01	WY	-.49716853 00	WZ	-.86697250 00	PX	.26800593 00	PY	-.84029881 00	PZ	.47124378 00
QX	-.96280353 00	QY	-.21615121 00	QZ	.16213572 00	RX	-.16205567 00	RY	-.37757728-01	RZ	-.98605895 00
BX	.27671310 00	BY	-.83830713 00	BZ	.46975634 00	TX	-.22691465 00	TY	.97391465 00	TZ	.00000000 00
SXI	-.96033727 00	SYI	-.22375123.00	SZI	.16639617 00	DAI	.95783515 01	RAI	.19311549 03		
SXD	-.96519084 00	SYD	-.20853347 00	SZD	.15786198 00	DAD	.90828213 01	RAD	.19219159 03		
ETE	.69250666 02	ETS	.16698631 03	ETC	.25565417 03						

BTC	-.22479982 06	BRC	-.12180449 06	B	.25567811 06	THA	.20845039 03

T VECTOR IN ECLIPTIC PLANE

ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET

X	.20891516 06	Y	.68848766 05	Z	.12576220 06	DX	.10418234 01	DY	-.41749240 01	DZ	.62174067 00
INC	.14896956 03	LAN	.90114108 02	APF	.73889938 02	MX	.23334517 00	MY	-.96237565 00	MZ	.13922333 00
WX	.51549223 00	WY	.10266641-02	WZ	-.85689366 00	PX	.82268954 00	PY	.27912237 00	PZ	.49525006 00
QX	.23968664 00	QY	-.96025498 00	QZ	.14304079 00	RX	.36859183-01	RY	-.14284037 00	RZ	-.98905915 00
BX	.82048546 00	BY	.28780600 00	BZ	.49393454 00	TX	-.96828200 00	TY	-.24985992 00	TZ	.00000000 00
SXI	.24712624 00	SYI	-.95768817 00	SZI	.14751939 00	DAI	.84831998 01	RAI	.28446922 03		
SXD	.23222739 00	SYD	-.96274305 00	SZD	.13855045 00	DAD	.79639766 01	RAD	.28356149 03		
ETE	.70760472 02	ETS	.16849611 03	ETC	.25716397 03						

BTD	-.22151248 06	BRD	-.12768523 06	B	.25567811 06	THA	.20996020 03

T VECTOR IN ORBIT PLANE OF TARGET

ALL VECTORS REFERENCED TO AREOCENTRIC EQUATOR PLANE

X	.20891516 06	Y	-.11778488 05	Z	.14289000 06	DX	.10418234 01	DY	-.40671372 01	DZ	-.11291355 01
INC	.14148793 03	LAN	.12412032 03	APF	.11464695 03	MX	.23334517 00	MY	-.93586417 00	MZ	-.26402324 00
WX	.51549222 00	WY	.34928120 00	WZ	-.78247710 00	PX	.82268953 00	PY	.53689705-01	PZ	.56594993 00
QX	.23968664 00	QY	-.93547851 00	QZ	-.25967335 00	RX	-.65045446-01	RY	.24608678 00	RZ	-.96706273 00
BX	.82048546 00	BY	.62158233-01	BZ	.56827807 00	TX	-.96679766 00	TY	-.25554313 00	TZ	.00000000 00
SXI	.24712624 00	SYI	-.93495399 00	SZI	-.25453804 00	DAI	-.14746214 02	RAI	.28480576 03		
SXD	.23222738 00	SYD	-.93592631 00	SZD	-.26478736 00	DAD	-.15354317 02	RAD	.28393513 03		
ETE	.76789494 02	ETS	.17452513 03	ETC	.26319299 03						

BTT	-.20687620 06	BRT	-.15024491 06	B	.25567811 06	THA	.21598922 03

T VECTOR IN TRUE TARGET EQU. PLANE

215542322304	214412017045 21189808915	614626031734	601731460721 17481859072	204537405516	601471557251 000000000000	EARTH INITIAL
220775513340	622733565354	217604377240	603414100141	601440622006 235723543047	177435553167 202007527522	MARS END

U MATRIX FOR MAPPING FORWARD ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	-.14240628 06	.32833775 05	.12743440 05	-.32201795-01	.18749275-01	-.67970214-02	.00000000 00	.00000000 00
Y	-.55073909 05	.15447656 05	.55744004 04	-.12770882-01	.73212989-02	-.26537464-02	.00000000 00	.00000000 00
Z	.82201993 05	-.21762468 05	-.91111089 04	.18877931-01	-.10989078-01	.43940406-02	.00000000 00	.00000000 00
DX	.37202730 08	-.51210248 07	-.23455938 07	.80190345 01	-.47951245 01	.16743353 01	.00000000 00	.00000000 00
DY	-.22529723 09	.54473221 08	.21533065 08	-.51212858 02	.29795080 02	-.11093539 02	.00000000 00	.00000000 00
DZ	.25683868 08	-.66539341 07	-.19962635 07	.59071261 01	-.33589278 01	.10381906 01	.00000000 00	.00000000 00
MM	.21474836 11	-.18468359 12	.74625055 11	-.14336000 06	.82944000 05	-.17536000 05	.10000000 01	.00000000 00
AU	-.46875000 00	.71875000 00	-.29687500 00	.13411045-06	-.29429793-06	.58207661-08	.00000000 00	.10000000 01

COVARIANCE MATRIX AT IMPACT ITERATION NUMBER 1

	X	Y	Z	DX	DY	DZ	MM	AU
X	.10637680 05	.22420325 05	.12501384 05	-.29614010-02	.15642850-02	-.28561890-02	.21474894-07	-.11718800 02
Y	.22420325 05	.88347057 05	.47340614 05	-.28379472-01	.16219363-01	-.11518833-01	.18468361-06	-.17968771 02
Z	.12501384 05	.47340614 05	.34772597 05	-.11713876-01	.75178238-02	-.98098615-02	.74625093-07	-.74219149 01
DX	-.29614010-02	-.28379472-01	-.11713876-01	.20777808-07	-.12004298-07	.27655606-08	-.14335999-12	.33527526-05
DY	.15642850-02	.16219363-01	.75178238-02	-.12004298-07	.70263182-08	-.19162602-08	.82943994-13	-.73574456-05
DZ	-.28561890-02	-.11518833-01	-.98098615-02	.27655606-08	-.19162602-08	.29285971-08	-.17536011-13	.14550667-06
MM	.21474894-07	.18468361-06	.74625093-07	-.14335999-12	.82943994-13	-.17536011-13	.99999998-18	.21195486-22
AU	-.11718800 02	-.17968771 02	-.74219149 01	.33527526-05	-.73574456-05	.14550667-06	.21195486-22	.25000000 02

ENCOUNTER PARAMETERS AND STATISTICS 65/07/17 012859.322

B	.25568130 06	SMAA	.32174637 03
B.RD	-.12768892 06	SMIA	.83507688 02
B.TD	-.22151403 06	DEL T	.37226349 02
B.RC	-.12180449 06	DEL B	.33240677 03
B.TC	-.22479983 06	DEL S	.16038767 03
TL	.23040207 03	DEL BR	.10149567 03
THETA	.10699438 02	DEL BT	.31653260 03

N MATRIX

	B.RD	B.TD	TL	C3	S.TS	S.RS
B.RD	.10301371 05	-.17613031 05	-.17042226 04	.14831570-01	.10897963-02	.74349552-03
B.TD	-.17613032 05	.10019289 06	.10369679 05	.95422841-01	-.69411049-02	-.30035637-02
TL	-.17042227 04	.10369679 05	.13858011 04	.51374437-02	-.62122480-03	-.24740746-03
C3	.14831570-01	.95422841-01	.51374439-02	.66149723-06	-.11622786-07	-.69983611-08
S.TS	.10897963-02	-.69411049-02	-.62122480-03	-.11622786-07	.53718767-09	.25609643-09
S.RS	.74349549-03	-.30035638-02	-.24740745-03	-.69983607-08	.25609644-09	.15636082-09

NORMALIZED N MATRIX

	B.RD	B.TD	TL	C3	S.TS	S.RS
B.RD	.99999999 00	-.54823672 00	-.45105381 00	.17967000 00	.46327063 00	.58582360 00
B.TD	-.54823674 00	.10000000 01	.88002785 00	.37065500 00	-.94612197 00	-.75884733 00
TL	-.45105381 00	.88002785 00	.10000000 01	.16968076 00	-.72000467 00	-.53149401 00
C3	.17967001 00	.37065500 00	.16968077 00	.99999998 00	-.61657117 00	-.68812661 00
S.TS	.46327065 00	-.94612197 00	-.72000467 00	-.61657117 00	.99999999 00	.88364239 00
S.RS	.58582357 00	-.75884738 00	-.53149399 00	-.68812657 00	.88364241 00	.99999999 00

DH/DQQ MATRIX

	B.RD	B.TD	TL	C3	S.TS	S.RS
X	.24330516 05	.64995540 05	-.29677574 05	.13145920 00	-.11157073-01	.56606676-03
Y	.98666986 04	.27841637 05	-.11310281 05	.49878439-01	-.44800132-02	.25911632-03
Z	-.13503961 05	-.40737256 05	.16973777 05	-.74298253-01	.66583250-02	-.28822134-03
DX	-.59392066 07	-.13507410 08	.79610852 07	-.35645702 02	.26993601 01	-.10983036 00
DY	.38196933 08	.10563821 09	-.46808109 08	.20666396 03	-.17838378 02	.87565422 00
DZ	-.49480323 07	-.12244892 08	.53021018 07	-.23715798 02	.20346128 01	-.14765713 00
MU	.24638750 01	-.72774732 01	.14250550 00	.43780724-03	.10143746-04	-.60035930-05

DH/DQ MATRIX

	B.RD	B.TD	TL	C3	S.TS	S.RS
X	-.14297395 00	-.16182701 00	.22580654 00	.28314228-06	.43595943-07	-.25130324-07
Y	-.28136354-01	.98867121 00	-.40707545-01	-.11281551-05	-.47139432-07	.27172928-07
Z	-.99584158 00	.32882216-02	-.35173765-01	.66306711-06	.55314040-07	-.26137118-07
DX	-.63716973 04	-.16846420 04	.91028766 04	-.84913467 01	-.36826590-03	.21228334-03
DY	-.85946945 04	.40525272 04	-.13368759 05	.13992037 01	.15366673-02	-.88579189-03
DZ	.10419841 05	-.11039756 03	-.84511326 04	-.12437810 01	.18654026 00	.26722055 00
MU	.24778832 01	-.87136382 01	.23160733-01	.43191793-03	.10281612-04	-.59267003-05

N MATRIX FOR MANEUVER CALCULATIONS

	B.RC	B.TC	TL
B.RC	.11291969 05	-.19957052 05	-.22881360-01
B.TC	-.19957053 05	.99202292 05	.11945784 00
TL	-.22881360-01	.11945784 00	.18564079-06

0000 140311 OFFLINE CONTROL (27
0000 14031 TERMINATE JOB
0000 14031 END DATA (0

```
0000 141001     PAGE HEADING                                                    (23
0000 14100      (VENUS CHECK CASE - STEP MAP1
0000 14100      EPOCH                                                           (01
0000 14100      620900500,2332000
0000 14100      GEOCENTRIC POSITION AND VELOCITY AT EPOCH                       (02
0000 14100      X=-.14245297E7 Y=-.19398640E7 Z=-.10071723E6
0000 14100      DX=-.17446099E1 DY=-.24232877E1 DZ=-.11048412E0
0000 14100      OTHER OPTIONS AND CONSTANTS                                     (03
0000 14100      TARGET=(VENUS)
0000 14100      ESTIMATE THESE PARAMETERS                                       (04
0000 14100      X Y Z DX DY DZ MV AU
0000 14100      COVARIANCE MATRIX OF ESTIMATED PARAMETERS                       (10
0000 14100      DIAG=.1,.1,.1,.0001,.0001,.0001,-1E-17,25.
0000 14100      MAP COVARIANCE MATRIX TO                                        (24
0000 14100      621200700,0
0000 14100      OFFLINE CONTROL                                                 (27
0000 14100      KEY(3) KEY(5)
0000 14100      END DATA                                                        (0
```

INPUT COVARIANCE MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MV	AU
X	.99999999-01	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Y	.00000000 00	.99999999-01	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Z	.00000000 00	.00000000 00	.99999999-01	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
DX	.00000000 00	.00000000 00	.00000000 00	.99999999-04	.00000000 00	.00000000 00	.00000000 00	.00000000 00
DY	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999999-04	.00000000 00	.00000000 00	.00000000 00
DZ	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999999-04	.00000000 00	.00000000 00
MV	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.99999998-18	.00000000 00
AU	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.25000000 02

INPUT J MATRIX OF ESTIMATED PARAMETERS ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MV	AU
X	.10000000 02	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00	.00000000 00
Y	.00000000 00	.10000000 02	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
Z	.00000000 00	-.00000000 00	.10000000 02	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
DX	.00000000 00	-.00000000 00	-.00000000 00	.10000000 05	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00
DY	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.10000000 05	-.00000000 00	-.00000000 00	-.00000000 00
DZ	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.10000000 05	-.00000000 00	-.00000000 00
MV	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.99999998 18	-.00000000 00
AU	.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	-.00000000 00	.39999999-01

```
CASE  1                          IBSYS-JPIRAJ-SPACE 022265                      1


DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1

  GME  .39860063 06      J  .16234500-02      H -.57499999-05      D  .78769999-05      RE  .63781650 04     REM  .63783112 04
    C  .66709998-19      A  .48781796 29      B  .88800194 29      C  .88836976 29     OME  .41780741-02      AU  .14959850 09
  GMM  .49026293 04    GMS  .13271411 12    GMV  .32476627 06    GMA  .42977368 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  .10310000 09

INJECTION CONDITIONS              VENUS       2355754006412020000000000 J.D.= 2437912.51634260  SEPT. 5,1962 00 23 32.000

GEOCENTRIC        X0=-.14245297 07  Y0=-.19398640 07  Z0=-.10071723 06 DX0=-.17446099 01 DY0=-.24232877 01 DZ0=-.11048412 00
CARTESIAN         ID -.14120000 04 GHA .34951873 03 GHD .34361929 03
DATE OF RUN 022265A  14103                  EARTH    IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   PROBE IS OUT OF EARTH'S    SHADOW

   0 DAYS  0 HRS.  0 MIN.  0.000 SEC.       2355754006412020000000000 J.D.= 2437912.51634260  SEPT. 5,1962 00 23 32.000

      GEOCENTRIC                                                                                  EQUATORIAL COORDINATES

    X -.14245296 07      Y -.19398639 07      Z -.10071723 06     DX -.17446098 01     DY -.24232875 01     DZ -.11048412 00
    R  .24088380 07    DEC -.23963223 01     RA  .23370847 03      V  .29880081 01    PTH  .89393198 02     AZ  .62816414 02
    R  .24088380 07    LAT -.23963223 01    LON  .24418974 03     VE  .17549891 03    PTE  .97549786 00    AZE  .27000472 03
   XS -.14343227 09     YS  .42810504 08     ZS  .18564279 08    DXS -.87218607 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 -.41612272 08     ZT -.22861356 08    DXT  .21205738 02    DYT -.90988722 01    DZT -.55559090 01
   RS  .15083166 09     VS  .29546049 02     RM  .40143479 06     VM  .97560880 00     RT  .10003094 09     VT  .23734804 02
  GED -.26126335 01    ALT  .24024598 07    LOS  .17386238 03    RAS  .16338111 03    RAM  .22532043 03    LOM  .23580169 03
  DUT  .35000000 02     DT  .19200000 04     DR  .29878406 01    SHA -.22750333 07    DES  .70698621 01    DEM -.11775395 02
  CCL  .60702505 02    MCL  .18217293 03    TCL  .33869367 03

                                                GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                  2355746127732023300000000 J.D.= 2437903.65534361  AUG. 27,1962 03 43 41.688
  SMA -.46363768 05    ECC  .11464198 01      B  .25992350 05    SLR  .14571132 05     APD  .00000000 00     RCA  .67885751 04
   VH  .29321057 01     C3  .85972439 01     C1  .76210645 05    TFP  .76559031 06      TF -.88609980 01     LTF -.88860057 01
   TA  .15011236 03    MTA -.15072477 03     EA  .25931107 03     MA  .27740861 04                          TFI  .00000000 00

                                                                  ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.14245296 07      Y -.19398639 07      Z -.10071723 06     DX -.17446098 01     DY -.24232875 01     DZ -.11048412 00
  INC  .27271914 02    LAN -.23836288 03    APF  .20465420 03     MX  .70574093 00     MY -.54195777 00     MZ  .45648056 00
   WX -.39026894 00     WY  .24044364 00     WZ  .88884194 00     PX  .16105420 00     PY  .96826562 00     PZ -.19121377 00
   QX -.90656441 00     QY -.68592011-01     QZ -.41660539 00     RX -.21574512-01     RY  .29972926-01     RZ -.99931781 00
   BX -.71196419 00     BY -.53327496 00     BZ -.45686411 00     TX -.81161130 00     TY  .58419782 00     TZ  .00000000 00
  SXI -.30283033 00    SYI  .87814137 00    SZI -.37051435 00    DAI -.21747342 02    RAI  .10902694 03
  SXD -.58379930 00    SYD -.81105764 00    SZD -.36930149-01    DAD -.21164212 01    RAD  .23425365 03

  BTQ  .24871152 05    BRQ -.75521459 04      B  .25992350 05    THA  .34310904 03     T VECTOR IN  EARTH EQUATOR PLANE

                                                                  ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X -.14245296 07      Y -.18198130 07      Z  .67933540 06     DX -.17446098 01     DY -.22672196 01     DZ  .86269591 00
  INC  .43960422 02    LAN  .21420263 03    APF  .23385448 03     MX  .70574097 00     MY -.31562129 00     MZ  .63441003 00
   WX -.39026905 00     WY  .57420661 00     WZ  .71981946 00     PX  .16105420 00     PY  .81227206 00     PZ -.56063743 00
   QX -.90656441 00     QY -.10280938 00     QZ -.40950625 00     RX -.17609356 00     RY -.22888077 00     RZ -.95739468 00
   BX -.71196439 00     BY  .30750167 00     BZ -.63130772 00     TX -.79257140 00     TY  .60977912 00     TZ  .00000000 00
```

```
CASE  1                              IBSYS-JPTRAJ-SPACE 022265                              2

  SXI -.30283033 00    SYI  .65825499 00    SZI -.68928400 00    DAI -.43573456 02    RAI  .11470480 03
  SXD -.58379930 00    SYD -.75880365 00    SZD  .28878253 00    DAD  .16785081 02    RAD  .23242646 03

  BTC  .25821250 05    BRC -.29777056 04      B  .25992357 05    THA  .35342171 03    T VECTOR IN  ECLIPTIC PLANE

                                                                ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X -.21047606 07      Y  .49300253 06      Z  .62163449 06    DX -.26151033 01    DY  .12088622 01    DZ  .79251463 00
  INC  .46529416 02    LAN  .14007295 03    APF  .23072292 03    MX -.14000245 00    MY -.72132412 00    MZ  .67822014 00
   WX  .46573257 00     WY  .55647604 00     WZ  .68798206 00    PX  .82730393 00    PY  .20775199-02    PZ -.56172740 00
   QX -.31406365 00     QY  .83080683 00     QZ -.45939320 00    RX -.24082291 00    RY  .11130159 00    RZ -.96416608 00
   BX  .13066194 00     BY -.72572865 00     BZ -.67545940 00     TX  .41953216 00    TY  .90774047 00    TZ  .00000000 00
  SXI  .56802335 00    SYI  .40812293 00    SZI -.71463701 00    DAI -.45613458 02    RAI  .35697122 02
  SXD -.87521258 00    SYD  .40449869 00    SZD  .26529930 00    DAD  .15384736 02    RAD  .15519494 03

  BTD  .25569498 05    BRD -.46834718 04      B  .25994920 05    THA  .34962039 03    T VECTOR IN  ORBIT PLANE OF TARGET

  0 DAYS  8 HRS. 28 MIN. 56.404 SEC.       2355754175632020630552055 J.D.= 2437912.86977319  SEPT. 5,1962 08 52 28.404

  0 DAYS  8 HRS. 28 MIN. 56.404 SEC.       2355754175632020630552055 J.D.= 2437912.86977319  SEPT. 5,1962 08 52 28.404
  CHANGE OF PHASE OCCURS AT THIS POINT   SUN      IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

  95 DAYS 14 HRS. 14 MIN. 19.059 SEC.      2356053015172026074046l1 J.D.= 2438008.10961873   DEC. 9,1962 14 37 51.059

     HELIOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.51022567 07      Y  .99263157 08      Z  .46385104 08    DX -.36494257 02    DY -.58201960 01    DZ -.33262712 01
    R  .10968494 09    LAT  .25017435 02    LON  .92942489 02     V  .37104845 02    PTH -.77073126 01    AZ  .92101531 02
   AE  .33012548 08     YE  .13172989 09     ZE  .57121301 08    DXE -.29507274 02    DYE  .60187032 01    DZE  .26093430 01
   XT -.57926326 07     YT  .97856442 08     ZT  .44437148 08    DXT -.35091492 02    DYT -.26941798 01    DZT  .10045215 01
  LTE  .22812463 02    LOE  .75930981 02    LTT  .24385356 02    LOT  .93387681 02    RST  .10762945 09    VST  .35209096 02
  EPS  .12889057 03    ESP  .15695707 02    SEP  .35413715 02    EPM  .78819662-01    EMP  .11190031 02    MEP  .16873061 03
  MPS  .12896821 03    MSP  .15754195 02    SMP  .35277586 02    SEM  .15551557 03    EMS  .24425661 02    ESM  .57674939-01
  EPT  .13652545 03    ETP  .41616422 02    TEP  .18581345 01    TPS  .34321186 02    TSP  .75043170 00    STP  .14492821 03
  SET  .34151903 02    STE  .12978488 03    EST  .16063212 02    RPM  .51564817 08    RPT  .25000001 07    SPN  .12888343 03
  SAC  .22900140-09
  GCE  .87219501 02    GCT  .32905271 03    SIP  .34179292 02    CPT  .72719283 02    SIN  .72577188 02
  REP  .51206375 08    VEP  .14973609 02    CPE  .80195375 02    CPS  .10226691 03

                                                  HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                      2356076050232024274046l1 J.D.= 2438037.01349749   JAN. 7,1963 12 19 26.184
  SMA  .12722493 09    ECC  .19144548 00      B  .12487168 09    SLR  .12256196 09    APO  .15158156 09    RCA  .10288829 09
   VH  .28606638 02     C3 -.10431455 04     C1  .40330759 10    TFP -.24972951 07     TF  .12449715 03    PER  .28646125 03
   TA -.52176583 02    MTA  .18000000 03     EA -.43934634 02    MA -.36323921 02                          IFI  .95593274 02

                                                                ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.51022567 07      Y  .99263157 08      Z  .46385104 08    DX -.36494257 02    DY -.58201960 01    DZ -.33262712 01
  INC  .25099883 02    LAN  .35798326 03    APF  .14666950 03    MX -.99880593 00    MY -.35811769-01    MZ -.33229952-01
   WX -.14928005-01     WY -.42393483 00     WZ  .90556966 00    PX -.81748708 00    PY  .52667570 00    PZ  .23308281 00
   QX -.57575346 00     QY -.73681204 00     QZ -.35442367 00    RX -.19593895 00    RY  .12623598 00    RZ -.92245689 00
   BX  .57575345 00     BY  .73681203 00     BZ  .35442346 00     TX  .54159204 00    TY  .84064094 00    TZ  .00000000 00
  DAP  .13478637 02    RAP  .14720786 03

  BTQ  .11628279 09    BRQ -.45510967 08      B  .12487168 09    THA  .33862552 03    T VECTOR IN  EARTH EQUATOR PLANE
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CASE  1                              IBSYS-JPTRAJ-SPACE 022265                              3

                                                                ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X -.51022567 07      Y  .10952328 09      Z  .30665980 07    DX -.36494257 02    DY -.66630823 01    DZ -.73627064 00
  INC  .18528344 01    LAN  .33250316 03    APF  .17232764 03    MX -.99880594 00    MY -.46875205-01    MZ -.16240136-01
   WX -.14928005-01     WY -.28680307-01     WZ  .99947717 00    PX -.81748705 00    PY  .57593065 00    PZ  .43166742-02
   QX -.57575334 00     QY -.81699520 00     QZ -.32043274-01    RX -.35288584-02    RY  .24861283-02    RZ -.99999059 00
   BX  .57575339 00     BY  .81699527 00     BZ -.32043277-01     TX  .57593606 00    TY  .81749474 00    TZ  .00000000 00
  DAP  .24732883 00    RAP  .14483478 03

  BTC  .12480754 09    BRC -.40013342 07      B  .12487166 09    THA  .35816372 03    T VECTOR IN  ECLIPTIC PLANE

                                                                ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .10522015 09      Y  .30951192 08      Z  .12362223 07    DX -.15093336 02    DY  .33785281 02    DZ -.27614238 01
  INC  .42377940 01    LAN  .20514100 03    APF  .22340356 03    MX -.28065725 00    MY  .95702555 00    MZ -.73031397-01
   WX -.31394514-01     WY  .66895422-01     WZ  .99726595 00    PX  .36652532 00    PY  .92900173 00    PZ -.50776334-01
   QX -.92985851 00     QY -.36347699 00     QZ -.53687768-01    RX -.18637393-01    RY -.47232232-01    RZ -.99871001 00
   BX  .92985854 00     BY -.36397900 00     BZ -.53687770-01     TX  .93020169 00    TY -.36704881 00    TZ  .00000000 00
  DAP -.29105203 01    RAP  .68466271 02

  BTD  .12469110 09    BRD -.67127396 07      B  .12487166 09    THA  .35691845 03    T VECTOR IN  ORBIT PLANE OF TARGET

  95 DAYS 14 HRS. 14 MIN. 19.059 SEC.      2356053015172026074046l1 J.D.= 2438008.10961873   DEC. 9,1962 14 37 51.059
  CHANGE OF PHASE OCCURS AT THIS POINT   VENUS     IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

  95 DAYS 14 HRS. 14 MIN. 19.059 SEC.      2356053015172026074046l1 J.D.= 2438008.10961873   DEC. 9,1962 14 37 51.059

     GEOCENTRIC                                                                            EQUATORIAL COORDINATES

    X -.38114804 08      Y -.32466730 08      Z -.10736197 08    DX -.69869830 01    DY -.11838899 02    DZ -.59356140 01
    R  .51206374 08    DEC -.12102736 02     RA  .22042483 03     V  .14973609 02    PTH  .68707168 02    AZ  .12448867 03
    R  .51206373 08    LAT -.12102736 02    LON  .28310597 03    VE  .36465785 04    PTE  .21920980 00    AZE  .26995161 03
   XS -.33012548 08     YS -.13172989 09     ZS -.57121301 08    DXS  .29507273 02    DYS -.60187031 01    DZS -.26093429 01
   XM  .21915150 06     YM  .27889500 06     ZM  .87959625 05    DXM -.85011053 00    DYM  .59271705 00    DZM  .29599153 00
   XT -.38805180 08     YT -.33873445 08     ZT -.12684154 08    DXT -.55842184 01    DYT -.87128830 01    DZT -.16048215 01
   RS  .14732764 09     VS  .30227680 02     RH  .36544041 06    VH -.10777812 01     RT  .53048469 08     VI  .10472501 02
  GEO -.12182757 02    ALT  .51199996 08    LOS -.31861212 03    RAS  .25593098 03    RAH  .51840267 02    LOM  .11452140 03
  DUT  .35000000 02     DT  .38400000 04     OR -.13951461 02    SHA -.29672879 08    DES -.22812463 02    DEM  .13927554 02
  CCL  .27278050 03    MCL  .17997891 03    TCL -.61833203 02

     HELIOCENTRIC                                                                          EQUATORIAL COORDINATES

    X -.51022566 07      Y  .99263156 08      Z  .46385104 08    DX -.36494256 02    DY -.58201960 01    DZ -.33262711 01
    R  .10968493 09    LAT  .25017435 02    LON  .92942489 02     V  .37104844 02    PTH -.77073143 01    AZ  .92101531 02
   XE  .33012548 08     YE  .13172989 09     ZE  .57121301 08    DXE -.29507273 02    DYE  .60187031 01    DZE  .26093429 01
   XT -.57926326 07     YT  .97856442 08     ZT  .44437148 08    DXT -.35091492 02    DYT -.26941798 01    DZT  .10045215 01
  LTE  .22812463 02    LOE  .75930981 02    LTT  .24385356 02    LOT  .93387681 02    RST  .10762945 09    VST  .35209096 02
  EPS  .12889057 03    ESP  .15695704 02    SEP  .35413715 02    EPM  .78819662-01    EMP  .11190073 02    MEP  .16873057 03
  MPS  .12896821 03    MSP  .15754195 02    SMP  .35277587 02    SEM  .15551562 03    EMS  .24425606 02    ESM  .58516955-01
  EPT  .13652545 03    ETP  .41616422 02    TEP  .18580818 01    TPS  .34321389 02    TSP  .75039911 00    STP  .14492820 03
  SET  .34151904 02    STE  .12978488 03    EST  .16063212 02    RPM  .51564818 08    RPT  .25000000 07    SPN  .12888343 03
  SAC  .22900140-09
  GCE  .87219499 02    GCT  .32905271 03    SIP  .34179296 02    CPT  .72719279 02    SIN  .72577184 02
  REP  .51206374 08    VEP  .14973609 02    CPE  .80195375 02    CPS  .10226691 03
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CASE  1                          IBSYS-JPTRAJ-SPACE 022265                          4


  APHRODIOCENTRIC                                                    EQUATORIAL COORDINATES

    X  .69037591 06     Y  .14067148 07     Z  .19479566 07     DX -.14027647 01     DY -.31260163 01     DZ -.43307926 01
    R  .25000000 07   DEC  .51185796 02    RA  .63859499 02      V  .55222722 01    PTH -.88684816 02     AZ  .24853760 03
  ALT  .24938001 07   SNA  .14365062 07   ALP  .50235695 02     DR -.55208174 01     DP  .29047796-05    ASD  .14209440 00
  HGE  .23110942 03   SVL  .29805915 02   HNG  .17862165 02    SIA  .13638335 03
  SAC  .22900140-09

                                    APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE          2356056342322027574046l1 J.D.= 2438013.29235961  DEC. 14,1962 19 00 59.871
  SMA -.10741161 05   ECC  .54573169 01     B  .57624974 05    SLR  .30915540 06    APO  .00000000 00    RCA  .47876758 05
   VH  .54986978 01    C3  .30235677 02    C1  .31686472 06    IFP -.44778881 06     TF  .10077602 03    LTF  .10073765 03
   TA -.99240591 02   HTA  .10055855 03    EA -.25498362 03     MA -.13134227 05                        TFI  .95593274 02
  ZAE  .13728729 03   ZAP  .34431163 02   ZAC  .72681574 02    DEF  .21117187 02     IR  .13100778 05     GP -.29764390 02

                                    ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .69037591 06     Y  .14067148 07     Z  .19479566 07     DX -.14027647 01     DY -.31260163 01     DZ -.43307926 01
  INC  .12568504 03   LAN  .18063363 03   APF  .20564144 03     MX  .96106519 00     MY -.15408769 00     MZ -.22933716 00
   WX -.89823426-02    WY  .81217684 00    WZ -.58332922 00     PX  .90424851 00     PY -.24244515 00     PZ -.35148387 00
   QX -.42689480 00    QY -.53064020 00    QZ -.73224367 00     RX  .32102521 00     RY  .71553693 00     RZ -.62044313 00
   BX  .96716951 00    BY -.14110654 00    BZ -.21135770 00     TX -.91238207 00     TY  .40933966 00     TZ  .00000000 00
  SXI -.25397198 00   SYI -.56608119 00   SZI -.78425141 00    DAI -.51651496 02    RAI  .24583663 03
  SXD -.58536138 00   SYD -.47722978 00   SZD -.65543945 00    DAD -.40952978 02    RAD  .21918946 03
  ETE  .30676850 03   ETS  .41834750 02   ETC  .25151733 03

  BTQ -.54178344 05   BRQ  .19630194 05     B  .57624974 05    THA  .16008325 03     T VECTOR IN  EARTH EQUATOR PLANE

                                    ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X  .69037591 06     Y  .20655587 07     Z  .12275376 07     DX -.14027647 01     DY -.45909108 01     DZ -.27297031 01
  INC  .14912599 03   LAN  .18100294 03   APF  .20613286 03     MX  .96107515 00     MY -.23260884 00     MZ -.14910819 00
   WX -.89822391-02    WY -.51307865 00    WZ -.85829785 00     PX  .90425774 00     PY -.36226754 00     PZ -.22602173 00
   QX -.42689838 00    QY -.77814811 00    QZ -.46069866 00     RX  .14442028 00     RY  .47274711 00     RZ -.86928300 00
   BX  .96716970 00    BY -.21354349 00    BZ -.13777493 00     TX -.95636865 00     TY  .29216260 00     TZ  .00000000 00
  SXI -.25397199 00   SYI -.83135503 00   SZI -.49431472 00    DAI -.29624573 02    RAI  .25301252 03
  SXD -.58536812 00   SYD -.69858971 00   SZD -.41148134 00    DAD -.24297925 02    RAD  .23003940 03
  ETE  .31756582 03   ETS  .52632071 02   ETC  .26231466 03

  BTC -.56896602 05   BRC  .91331112 04     B  .57624970 05    THA  .17088060 03     T VECTOR IN  ECLIPTIC PLANE

                                    ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .21701731 07     Y -.11002964 06     Z  .12362209 07     DX -.47923321 01     DY  .11675437 00     DZ -.27414251 01
  INC  .14982375 03   LAN  .99025410 02   APF  .19958971 03     MX  .94519880-03     MY -.99591691 00     MZ -.90300711-01
   WX  .49644364 00    WY -.78854661-01    WZ -.86448325 00     PX -.13846385 00     PY -.97592482 00     PZ -.16853506 00
   QX -.85695557 00    QY  .20336746 00    QZ -.47357037 00     RX  .49628792 00     RY -.12062964-01     RZ -.86807415 00
   BX  .20910910-01    BY -.99666294 00    BZ -.78903148-01     TX  .24299205-01     TY  .99970473 00     TZ  .00000000 00
  SXI -.86781784 00   SYI  .21093512-01   SZI -.49643450 00    DAI -.29764388 02    RAI  .17860762 03
  SXD -.81707303 00   SYD  .37875450 00   SZD -.43466907 00    DAD -.25764239 02    RAD  .15512990 03
  ETE  .31229757 03   ETS  .71005011 02   ETC  .27321265 03

  BTO -.57386433 05   BRO  .52377827 04     B  .57624970 05    THA  .17478494 03     T VECTOR IN  ORBIT PLANE OF TARGET

 100 DAYS 19 HRS. 23 MIN. 26.074 SEC.       2356056355142024114341S6 J.D.= 2438013.32428326  DEC. 14,1962 19 46 58.075


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      GEOCENTRIC                                                     EQUATORIAL COORDINATES

    X -.41051080 08     Y -.38291325 08     Z -.13671191 08     DX -.74626395 01     DY -.14910036 02     DZ -.72400016 0
    R  .57778180 08   DEC -.13686847 02    RA  .22300789 03      V  .18177398 02    PTH  .68362926 02     AZ  .11985724 0
    R  .57778180 08   LAT -.13686847 02   LON  .20326984 03     VE  .40878328 04    PTE  .23682742 00    AZE  .26995322 0
   XS -.19597573 08    YS -.13388624 09    ZS -.58055864 08    DXS  .29999834 02    DYS -.35449458 01    DZS -.15359250 01
   XM -.22533850 06    YM  .28651450 06    ZM  .12794737 06    DXM -.85853022 00    DYM -.53210795 00    DZM -.13040236 00
   XT -.41081809 08    YT -.38295325 08    ZT -.13647331 08    DXT -.44356764 01    DYT -.10890376 02    DZT -.26676137 01
   RS  .14724155 09    VS  .30247574 02    RM  .38631403 06    VM  .10184389 01    RT  .57797029 08     VT  .12057847 02
  GEO -.13776577 02   ALT  .57771403 08   LOS  .24193441 03    RAS  .26167247 03    RAM  .12818441 03    LDM  .10844636 03
  DUT  .35000000 02    DT  .24000000 03    DR  .16896584 02    SMA -.35388548 08    DES -.23221698 02    DEM  .19341652 02
  CCL  .27338213 03   MCL  .17998010 03   TCL  .32543668 03

      HELIOCENTRIC                                                   EQUATORIAL COORDINATES

    X -.21453506 08     Y  .99594916 08     Z  .44384672 08     DX -.37462473 02     DY -.11365090 02     DZ -.57040765 01
    R  .10755761 09   LAT  .24372012 02   LON  .10264880 03      V  .39561833 02    PTH -.72353166 01     AZ  .95856804 02
   XE  .19597573 08    YE  .13388624 09    ZE  .58055864 08    DXE -.29999834 02    DYE  .35449458 01    DZE  .15359250 01
   XT -.21484235 08    YT  .95590916 08    ZT  .44408532 08    DXT -.34435511 02    DYT -.73454299 01    DZT -.11316886 01
  LTE  .23221698 02   LOE  .81672475 02   LTI  .24382966 02    LOI  .10266685 03    RST  .10757004 09    VST  .35228403 02
  EPS  .12302097 03   ESP  .19209271 02   SEP  .37769753 02    EPM  .37800648 00    EMP  .80678812 02    MEP  .98943153 02
  MPS  .12339864 03   MSP  .19106508 02   SMP  .37496848 02    SEM  .13666413 03    EMS  .43232903 02    ESM  .10231507 00
  EPI  .11879526 03   ETP  .61170761 02   IEP  .33542591-01    IPS  .10851589 03    ISP  .18504685-01    STP  .71464353 02
  SET  .37796579 02   STE  .12297788 03   EST  .19225541 02    RPM  .57839493 08    RPT  .39109093 05    SPN  .12301465 03
  SAC  .23814957-09
  GCE  .86617870 02   GCT  .23205454 03   SIP  .99394255 02    CPI  .11992423 03    SIN  .11080259 03
  REP  .57778180 08   VEP  .18177398 02   CPE  .80314971 02    CPS  .10271893 03

  APHRODIOCENTRIC                                                    EQUATORIAL COORDINATES

    X  .30728787 05     Y  .40000217 04     Z -.23859226 05     DX -.30269631 01     DY -.40196605 01     DZ -.45723879 01
    R  .39109093 05   DEC -.37594455 02    RA  .74165933 01      V  .67990372 01    PTH  .75343634-06     AZ  .21192412 03
  ALT  .32909093 05   SNA -.37080350 05   ALP  .12618129 02     DR  .74910647-07     DP  .99607556-02    ASD  .91216356 01
  HGE  .23697902 03   SVL -.32544186 02   HNG  .11213077 03    SIA  .10967362 03
  SAC  .23814957-09

                                    APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE          2356056355142024114259S0 J.D.= 2438013.32428326  DEC. 14,1962 19 46 58.075
  SMA -.10964912 05   ECC  .45667493 01     B  .48858741 05    SLR  .21771052 06    APO  .00000000 00    RCA  .39109093 05
   VH  .54423050 01    C3  .29618684 02    C1  .26590418 06    IFP  .98913489-04     TF  .10080794 03    LTF  .10077252 03
   TA  .25613208-05   HTA  .10264878 03    EA  .00000000 00     MA  .28129103-05                        TFI  .10080794 03
  ZAE  .13776038 03   ZAP  .39971175 02   ZAC  .71965344 02    DEF  .25297576 02     IR  .13206245 05     GP -.30444610 02

                                    ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X  .30728787 05     Y  .40000217 04     Z -.23859226 05     DX -.30269631 01     DY -.40196605 01     DZ -.45723879 01
  INC  .11477088 03   LAN  .20822792 03   APF  .22221299 03     MX -.44520467 00     MY -.59121025 00     MZ -.67250520 00
   WX -.42946162 00    WY  .80000596 00    WZ -.41899068 00     PX  .78571975 00     PY  .10227857 00     PZ -.61006849 00
   QX -.44520466 00    QY -.59121024 00    QZ -.67250520 00     RX  .33778184 00     RY  .71389431 00     RZ -.61339898 00
   BX  .86413916 00    BY  .22925609 00    BZ -.44800129 00     TX -.90392323 00     TY  .42769475 00     TZ  .00000000 00
  SXI -.26236753 00   SYI -.55446560 00   SZI -.78977317 00    DAI -.52164318 02    RAI  .24467864 03
  SXD -.60645214 00   SYD -.59925832 00   SZD -.52259473 00    DAD -.31506462 02    RAD  .22465815 03
  ETE  .30229105 03   ETS  .29230400 02   ETC  .25076851 03
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CASE 1 I8SYS-JPTRAJ-SPACE 022265 6

BTQ -.33373639 05	BRQ .35684405 05	B .48858741 05	THA .13308353 03	T VECTOR IN EARTH EQUATOR PLANE			
			ALL VECTORS REFERENCED TO ECLIPTIC PLANE				
X .30728787 05	Y -.58220504 04	Z -.23481196 05	DX -.30269631 01	DY -.55069064 01	DZ -.25958396 01		
INC .13464185 03	LAN .21712739 03	APF .23754776 03	MX -.44520466 00	MY -.80995385 00	MZ -.38179517 00		
WX -.42946161 00	WY .56728598 00	WZ -.70267300 00	PX .78571975 00	PY -.14886692 00	PZ -.60040245 00		
QX -.44520467 00	QY -.80995385 00	QZ -.38179519 00	RX .15308934 00	RY .48018908 00	RZ -.86370255 00		
BX .86413918 00	BY .32104934-01	BZ -.50222781 00	TX -.95275255 00	TY .30374755 00	TZ .00000000 00		
SXI -.26234753 00	SYI -.82289482 00	SZI -.50400189 00	DAI -.30265119 02	RAI .25231716 03			
SXD -.60645215 00	SYD -.75769880 00	SZD -.24105666 00	DAD -.13948913 02	RAD .23132667 03			
ETE .31365265 03	ETS .40592002 02	ETC .26213010 03					
BTC -.39749469 05	BRC .28410497 05	B .48858742 05	THA .14444512 03	T VECTOR IN ECLIPTIC PLANE			
			ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET				
X .15995859 04	Y -.32570000 05	Z -.21590682 05	DX -.60659888 01	DY .14842515 01	DZ -.26884349 01		
INC .13722957 03	LAN .13851610 03	APF .23438793 03	MX -.89218352 00	MY .21830320 00	MZ -.39541406 00		
WX .44981742 00	WY .50871417 00	WZ -.73408052 00	PX .40900621-01	PY -.83279864 00	PZ -.55206295 00		
QX -.89218351 00	QY .21830318 00	QZ -.39541406 00	RX .50638494 00	RY -.18010652-01	RZ -.86211938 00		
BX .23527313 00	BY -.86038996 00	BZ -.45207930 00	TX .35544639-01	TY .99936808 00	TZ .00000000 00		
SXI -.86157462 00	SYI .30643724-01	SZI -.50670514 00	DAI -.30444610 02	RAI .17796301 03			
SXD -.87948699 00	SYD .39536650 00	SZD -.26493010 00	DAD -.15362798 02	RAD .15579407 03			
ETE .30926123 03	ETS .61084647 02	ETC .27339349 03					
BTO -.41602414 05	BRO .25620809 05	B .48858741 05	THA .14837340 03	T VECTOR IN ORBIT PLANE OF TARGET			

100 DAYS 19 HRS. 26 MIN. 19.059 SEC. 2356056355672026074046ll J.D.= 2438013.32628540 DEC. 14,1962 19 49 51.059

GEOCENTRIC — EQUATORIAL COORDINATES

X -.41052372 08	Y -.38293904 08	Z -.13672441 08	DX -.74907017 01	DY -.14914270 02	DZ -.72176348 01		
R .57781104 08	DEC -.13687417 02	RA .22300891 03	V .18183518 02	PTH .68464816 02	AZ .11972255 03		
R .57781103 08	LAT -.13687417 02	LON .20254812 03	VE .40880465 04	PTE .23706050 00	AZE .26995361 05		
XS -.19592383 08	YS -.13388685 09	ZS -.58056129 08	DXS .29999978 02	DYS -.35439873 01	DZS -.15355094 01		
XM -.22548650 06	YM .28642300 06	ZM .12792500 06	DXM -.85825494 00	DYM -.53245151 00	DZM -.13055575 00		
XT -.41082576 08	YT -.38297208 08	ZT -.13647793 08	DXT -.44351359 01	DYT -.10891180 02	DZT -.26680171 01		
RS .14724152 09	VS .30247584 02	RM .38632512 06	VM .10184061 01	RT .57798931 08	VT .12058464 02		
GEO -.13777151 02	ALT .57774727 08	LOS .24121388 03	RAS .26167468 03	RAM .12821159 03	LON .10775079 03		
OUT .35000000 02	DT .24000000 03	DR .16914169 02	SHA -.35391055 08	DES -.23221815 02	DEM .19337558 02		
CCL .27338252 03	MCL .17998012 03	TCL .32423100 03					

HELIOCENTRIC — EQUATORIAL COORDINATES

X -.21459989 08	Y .95592949 08	Z .44383688 08	DX -.37490680 02	DY -.11370283 02	DZ -.56021254 01		
R .10755675 09	LAT .24371643 02	LON .10265275 03	V .39586879 02	PTH -.72124065 01	AZ .95825815 02		
XE .19592383 08	YE .13388685 09	ZE .58056129 08	DXE -.29999978 02	DYE .35439873 01	DZE .15355094 01		
XT -.21490192 08	YT .95588645 08	ZT .44408336 08	DXT -.34435114 02	DYT -.73471930 01	DZT -.11325077 01		
LTE .23221815 02	LOE .81674687 02	LTT .24382856 02	LOT .10267041 03	RST .10757002 09	VST .35228410 02		
EPS .12301850 03	ESP .19210847 02	SEP .37770653 02	EPM .37800648 00	EMP .80703614 02	MEP .98918331 02		
MPS .12339619 03	MSP .19108037 02	SMP .37495776 02	SEM .13664028 03	EMS .43256699 02	ESM .10326686 00		
EPT .11708922 03	ETP .62876250 02	TEP .33542591-01	TPS .10981217 03	TSP .15639313-01	STP .70168220 02		
SET .37797812 02	STE .12297543 03	EST .19226755 02	RPM .57842254 08	RPT .39123598 05	SPN .12301217 03		
SAC .23815338-09							
GCE .86617480 02	GCT .23084848 03	SIP .10069395 03	CPT .12031818 03	SIN .11119995 03			
REP .57781104 08	VEP .18183518 02	CPE .80314979 02	CPS .10271903 03				

CASE 1 I8SYS-JPTRAJ-SPACE 022265 7

APHRODIOCENTRIC — EQUATORIAL COORDINATES

X .30202689 05	Y .33043787 04	Z -.24648217 05	DX -.30555658 01	DY -.40230900 01	DZ -.45496177 01		
R .39123598 05	DEC -.39050781 02	RA .62437123 01	V .67985849 01	PTH .14131968 01	AZ .21265149 03		
ALT .32923599 05	SHA -.36803285 05	ALP .14175582 02	DR .16766977 00	DP .99533717-02	ASD .91182247 01		
HGE .23698150 03	SVL -.33361545 02	HNG .11394177 03	SIA .10797099 03				
SAC .23815338-09							

APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356056355142024ll466611 J.D.= 2438013.32428326 DEC. 14,1962 19 46 58.075

SMA -.10964909 05	ECC .45667502 01	B .48858736 05	SLR .21771055 06	APO .00000000 00	RCA .39109092 05		
VH .54423057 01	C3 .29618692 02	C1 .26590420 06	FFP .17298361 03	TF .10080794 03	LTF .10077252 03		
TA .17226236 01	MTA .10264878 03	EA .13790468 01	MA .49193246 01		TFI .10080994 03		
ZAE .13776068 03	ZAP .39973169 02	ZAC .71965352 02	DEF .25297576 02	IR .13206244 05	GP -.30444603 02		

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X .30202689 05	Y .33043787 04	Z -.24648217 05	DX -.30555658 01	DY -.40230900 01	DZ -.45496177 01		
INC .11477088 03	LAN .20822792 03	APF .22221299 03	MX -.46862293 00	MY -.59401770 00	MZ -.65386199 00		
WX -.42946165 00	WY .80000593 00	WZ -.41899072 00	PX .78571969 00	PY .10227852 00	PZ -.61006803 00		
QX -.44520469 00	QY -.59121028 00	QZ -.67250511 00	RX .33778185 00	RY .71389419 00	RZ -.61339908 00		
BX .86413912 00	BY .22925603 00	BZ -.44800140 00	TX -.90792319 00	TY .42769483 00	TZ .00000000 00		
SXI -.26234762 00	SYI -.55445566 00	SZI -.78927307 00	DAI -.52116430? 02	RAI .24467864 03			
SXD -.60645213 00	SYD -.59925835 00	SZD -.52259466 00	DAD -.31506458 02	RAD .22465815 03			
ETE .30228987 03	ETS .29226401 02	ETC .25076850 03					
BTQ -.33373633 05	BRQ .35684404 05	B .48858736 05	THA .13308352 03	T VECTOR IN EARTH EQUATOR PLANE			
			ALL VECTORS REFERENCED TO ECLIPTIC PLANE				
X .30202689 05	Y -.67741585 04	Z -.23928315 05	DX -.30555658 01	DY -.55009941 01	DZ -.25735845 01		
INC .13464185 03	LAN .21712739 03	APF .23754777 03	MX -.44862293 00	MY -.80511276 00	MZ -.36357392 00		
WX -.42946164 00	WY .56728595 00	WZ -.70267301 00	PX .78571969 00	PY -.14886698 00	PZ -.60040247 00		
QX -.44520470 00	QY -.80995385 00	QZ -.38179508 00	RX .15308934 00	RY .48018896 00	RZ -.86370259 00		
BX .86413913 00	BY .32104841-01	BZ -.50222789 00	TX -.95275253 00	TY .30374763 00	TZ .00000000 00		
SXI -.26234761 00	SYI -.82289483 00	SZI -.50400177 00	DAI -.30265111 02	RAI .25231716 03			
SXD -.60645214 00	SYD -.75769880 00	SZD -.24105658 00	DAD -.13948908 02	RAD .23132667 03			
ETE .31365147 03	ETS .40588005 02	ETC .26213010 03					
BTC -.39749463 05	BRC .28410495 05	B .48858736 05	THA .14444512 03	T VECTOR IN ECLIPTIC PLANE			
			ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET				
X .55016583 03	Y -.32310610 05	Z -.22053972 05	DX -.60669988 01	DY .15147077 01	DZ -.26679470 01		
INC .13722957 03	LAN .13851610 03	APF .23438794 03	MX -.89300985 00	MY .24323921 00	MZ -.37863977 00		
WX .44981735 00	WY .50871418 00	WZ -.73408053 00	PX .40900556-01	PY -.83279862 00	PZ -.55206300 00		
QX -.89218354 00	QY .21830321 00	QZ -.39541396 00	RX .50638483 00	RY -.18010689-01	RZ -.86211945 00		
BX .23527304 00	BY -.86038993 00	BZ -.45207940 00	TX .35544721-01	TY .99936808 00	TZ .00000000 00		
SXI -.86157468 00	SYI .30643796-01	SZI -.50670503 00	DAI -.30444602 02	RAI .17796300 03			
SXJ -.87948700 00	SYD .39536648 00	SZD -.26493001 00	DAD -.15362793 02	RAD .15579407 03			
ETE .30926022 03	ETS .61081146 02	ETC .27339349 03					
BTO -.41602410 05	BRO .25620611 05	B .48858738 05	THA .14837339 03	T VECTOR IN ORBIT PLANE OF TARGET			

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CASE  1                                  IBSYS-JPTRAJ-SPACE 022265                                    8


  625535100735   625730503775   621602710213   601700276504   602465436600   575674117131                    EARTH
                  21172191649                    17448304640                  000000000000                    INITIAL

  217727454543   214522350406   617601552025   602611220703   603400724620   603442741665                    VENUS
                                                                235605635567   202607404611                    END



          U MATRIX FOR MAPPING FORWARD                          ITERATION  NUMBER       0

          X             Y             Z             DX            DY            DZ            MV            AU

 X    .39773183 01  .21087921 01  .10280934 01  .40090036-06  .12381001-05  .60017031-06  .00000000 00  .00000000 00
 Y    .42917053 00  .30646667 00  .21520492 00  .14571548-06 -.55214985-08  .10965675-06  .00000000 00  .00000000 00
 Z    .15201560 00  .16583731 00 -.13895442 00  .55276687-07  .73585203-07 -.18714900-06  .00000000 00  .00000000 00
DX    .13987192 08  .68392637 07  .33544449 07  .16401137 01  .40547289 01  .19595172 01  .00000000 00  .00000000 00
DY    .36532307 07  .79637667 07  .19422097 07  .14248229 01  .25076387 01  .14931677 01  .00000000 00  .00000000 00
 ODPX+14130


6212007OO,0000000
 X=   -.36497317E+08  Y=   -.29912202E+08  Z=   -.94567338E+07  $      0 0 0   1
DX=   -.73404306E+01 DY=   -.10826458E+02 DZ=   -.54166483E+01  $      0 0 0   2
R01 2434742613722106260011457/8      2425763152052070143632127/8 $      0 0 0   3
    2415664720732066222720127/8      2145574750241616721103207/8 $      0 0 0   4
    2156566163401626035256747/8      2146356567351612653114337/8 $      0 0 0   5
    5434036716215103600077417/8      1775737365171445200000007/8 $      0 0 0   6
R02 2425763152052070143632127/8      2425236352652074306122427/8 $      0 0 0   7
    2414354260122065502015337/8      2144530201701615071545047/8 $      0 0 0   8
    2154743607711624366766727/8      2144773431361617310644357/8 $      0 0 0   9
    5445025337765111642140127/8      2005070130201455600000007/8 $      0 0 0  10
 ODPX+14130



R03 2415664720732066222720117/8      2414354260122065502015347/8 $      0 0 0  11
    2407142435072055601275357/8      2134430507671604130547067/8 $      0 0 0  12
    2145017707321615540513197/8      2127722130251571726364277/8 $      0 0 0  13
    5445506524675110635312227/8      2004060754741454400000007/8 $      0 0 0  14
R04 2145574750241616721103227/8      2144530201701615071545047/8 $      0 0 0  15
    2134430507671604130547067/8      1664206136041331253311047/8 $      0 0 0  16
    1674472426641341046550567/8      1664367346351335254623147/8 $      0 0 0  17
    5175513627344646442334107/8      5507746126405157000000007/8 $      0 0 0  18
R05 2156566163401626035256747/8      2154743607711624366766737/8 $      0 0 0  19
    2145017707321615540513157/8      1674472426641341046550567/8 $      0 0 0  20
 ODPX+14130



    1705073270071353604062047/8      1674675601041347255521267/8 $      0 0 0  21
    5207241311334650154370247/8      1545130722661211400000007/8 $      0 0 0  22
R06 2146356567351612653114337/8      2144773431361617310644357/8 $      0 0 0  23
    2127722130251571726364277/8      1664347346351335254623147/8 $      0 0 0  24
    1674675601041347255521267/8      1664771144431323056552577/8 $      0 0 0  25
    5214235514054666115426057/8      1535661672421207400000007/8 $      0 0 0  26
R07 5434036716215103600077417/8      5445025337765111642140127/8 $      0 0 0  27
    5445506524675110635312227/8      5175513627344646442334107/8 $      0 0 0  28
    5207241311334650154370247/8      5214235514054666115426057/8 $      0 0 0  29
    1054471135640523511035307/8      0000000000000000000000007/8 $      0 0 0  30
DZ    .18190670 07  .19553291 07  .48569469 07  .69472166 00  .15003603 01  .13430120 00  .00000000 00  .00000000 00
MV   -.94537556 09 -.23478037 10 -.26254072 10 -.12541165 04 -.32486109 04 -.38261904 04  .10000000 01  .00000000 00
AU    .14841206-01  .25548558-01 -.20478152-01 -.23691501-08  .24669914-07  .16027430-07  .00000000 00  .10000000 01



                    CONDITIONS AFTER FORWARD MAPPING          62/09/05  002332.000  TO  62/12/07  000000.000

  X= -.36497317 08    Y= -.29912202 08    Z= -.94567338 07   DX= -.73404306 01   DY= -.10826458 02   DZ= -.54166483 01

                    STANDARD  DEVIATIONS


  X=  .14570403 06    Y=  .10678034 06    Z=  .62140492 05   DX=  .22809497-01   DY=  .49980155-01   DZ=  .24672443-01


          COVARIANCE  MATRIX  AFTER  MAPPING                  ITERATION  NUMBER       0

          X             Y             Z             DX            DY            DZ            MV            AU

 X    .21229665 11  .12831745 11  .62849716 10  .29409537 04  .68604511 04  .33107333 04 -.94537555-09  .37103015 00
 Y    .12831245 11  .11402042 11  .47906166 10  .23922537 04  .50635308 04  .25555497 04 -.23478037-08  .63871396 00
 Z    .62849716 10  .47906166 10  .38614407 10  .11663202 04  .25758895 04  .10125431 04 -.26254072-08  .51195380 00
DX    .29409537 04  .23922537 04  .11663202 04  .52027313-03  .11265490-02  .54346325-03 -.12541165-14 -.59228753-07
DY    .68604511 04  .50635308 04  .25758895 04  .11265490-02  .24980159-02  .11891137-02 -.32486109-14  .61674783-06
DZ    .33107333 04  .25555497 04  .10125431 04  .54346325-03  .11891137-02  .60872945-03 -.38261903-14  .40068574-06
MV   -.94537555-09 -.23478037-08 -.26254072-08 -.12541165-14 -.32486109-14 -.38261903-14  .99999998-18  .00000000 00
AU    .37103015 00  .63871396 00 -.51195380 00 -.59228753-07  .61674783-06  .40068574-06  .00000000 00  .25000000 02
```

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CASE  1                                  IBSYS-JPTRAJ-SPACE 022265

DOUBLE PRECISION EPHEMERIS TAPE - EPHE41

  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  .42977368 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   HAS  .19022000 03   GB1  .00000000 00   SU2  .00000000 00     SC  .10310000 09

INJECTION CONDITIONS              VENUS      2356051234402020000000000 J.D.= 2438005.50000000   DEC. 7,1962 00 00 00.000

GEOCENTRIC        XO-.36497317 08  YO-.29912202 08  ZO-.94567338 07 DXO-.73404306 01 DYO-.10826458 02 DZO-.54166483 01
CARTESIAN         IO .00000000 00 GHA .75283983 02 GHO .75283983 02
DATE OF RUN 022265A  14135                  SUN       IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION

   2 DAYS 14 HRS. 37 MIN. 51.431 SEC.      2356053015172026671177775 J.D.= 2438008.10962304   DEC. 9,1962 14 37 51.431

      HELIOCENTRIC                                                                                  EQUATORIAL COORDINATES

    X -.51022667 07     Y  .99263156 08     Z  .46385103 08    DX -.36494255 02    DY -.58201981 01    DZ -.33262720 01
    R  .10968493 09   LAT  .25017435 02   LON  .92942495 02     V  .37104844 02   PTH -.77073117 01    AZ  .92101534 02
   XE  .33012537 08    YE  .13172989 09    ZE  .57121303 08   DXE -.29507275 02   DYE  .60187012 01   DZE  .26093421 01
   XT -.57926456 07    YT  .97856441 08    ZT  .44437148 08   DXT -.35091491 02   DYT -.26941837 01   DZT  .10045197 01
  LTE  .22812464 02   LOE  .75930985 02   LTT  .24385356 02   LOT  .93387689 02   RST  .10762945 09   VST  .35209096 02
  EPS  .12889057 03   ESP  .15695705 02   SEP  .35413715 02   EPM  .79129368-01   EMP  .11190247 02   MEP  .16873040 03
  MPS  .12896821 03   MSP  .15754194 02   SMP  .35277588 02   SEM  .15551576 03   EMS  .24425467 02   ESM  .57674939-01
  EPI  .13652552 03   EIP  .41616356 02   TEP  .18581082 01   TPS  .34321412 02   TSP  .75039911 00   STP  .14492818 03
  SET  .34151907 02   STE  .12978487 03   EST  .16063214 02   RPM  .51564819 08   RPT  .25000001 07   SPN  .12888343 03
  SAC  .22900140-09
  GCE  .87219499 02   GCT  .32905257 03   SIP  .34179318 02   CPT  .72719297 02   SIN  .72577202 02
  REP  .51206376 08   VEP  .14973608 02   CPE  .80195375 02   CPS  .10226691 03

                                        HELIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE                 2356076050232026071177775 J.D.= 2438037.01350758   JAN. 7,1963 12 19 27.056
  SMA  .12722491 09   ECC  .19144538 00     B  .12487167 09   SLR  .12256195 09   APD  .15158153 09   RCA  .10286829 09
   VH  .26606642 02    C3 -.10431457 04    C1  .40330757 10   TFP -.24972956 07    TF  .31513507 02   PER  .28646119 03
   TA -.52176596 02   MTA  .18000000 03    EA -.43934648 02    MA -.36323937 02                       TFI  .26096230 01

                                                                ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE
    X -.51022667 07     Y  .99263156 08     Z  .46385103 08    DX -.36494255 02    DY -.58201981 01    DZ -.33262720 01
  INC  .25099881 02   LAN  .35798326 03   APF  .14666952 03    HX -.99880594 00    MY -.35811855-01    MZ -.33229988-01
   WX -.14928002-01    WY -.42393484 00    WZ  .90556967 00    PX -.81748733 00    PY  .52667545 00    PZ  .23308269 00
   QX -.57575317 00    QY -.73681227 00    QZ -.35442357 00   RX  .19593890 00    RY  .12623585 00    RZ -.97245697 00
   BX  .57575314 00    BY  .73681223 00    BZ  .35442355 00    TX  .54159255 00    TY  .84064113 00    TZ  .00000000 00
  DAP  .13478631 02   RAP  .14720788 03

  BTO  .11628278 09   BRO -.45510973 08     B  .12487167 09   THA  .33862552 03    T VECTOR IN  EARTH EQUATOR PLANE

                                                                ALL VECTORS REFERENCED TO ECLIPTIC PLANE
    X -.51022667 07     Y  .10952327 09     Z  .30665980 07    DX -.36494255 02    DY -.66630846 01    DZ -.73627058 00
  INC  .18528344 01   LAN  .33250317 03   APF  .17232766 03    HX -.99880594 00    MY -.46075798-01    MZ -.16240136-01
   WX -.14928002-01    WY -.28680308-01    WZ  .99947717 00    PX -.81748730 00    PY  .57593041 00    PZ  .43166667-02
   QX -.57575309 00    QY -.81699546 00    QZ -.32043277-01   RX -.35288531-02    RY  .24861228-02    RZ -.99999066 00
   BX  .57575310 00    BY  .81699547 00    BZ  .32043278-01    TX  .57593579 00    TY  .81749494 00    TZ  .00000000 00
```

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CASE  1                                  IBSYS-JPTRAJ-SPACE 022265

  DAP  .24732883 00   RAP  .14483480 03

  BTC  .12480753 09   BRC -.40013344 07     B  .12487165 09   THA  .35816372 03    T VECTOR IN  ECLIPTIC PLANE

                                                                ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET
    X  .10522014 09     Y  .30951206 08     Z  .12362214 07    DX -.15093340 02    DY  .33785279 02    DZ -.27414236 01
  INC  .42377882 01   LAN  .20514101 03   APF  .22340358 03    HX -.28065739 00    MY  .95702552 00    MZ -.73031394-01
   WX -.31394514-01    WY  .66895417-01    WZ  .99726596 00    PX  .36657501 00    PY  .92900175 00    PZ -.50776340-01
   QX -.92985853 00    QY  .36397868 00    QZ -.53687747-01   RX -.18637381-01    RY -.47232243-01    RZ -.99870991 00
   BX  .92985865 00    BY -.36397873 00    BZ  .53687754-01    TX  .93020180 00    TY -.36704854 00    TZ  .00000000 00
  DAP -.29105203 01   RAP  .68466288 02

  BTO  .12469108 09   BRO -.67127359 07     B  .12487163 09   THA  .35691845 03    T VECTOR IN  ORBIT PLANE OF TARGET

   2 DAYS 14 HRS. 37 MIN. 51.431 SEC.      2356053015172026671177775 J.D.= 2438008.10962304   DEC. 9,1962 14 37 51.431
   CHANGE OF PHASE OCCURS AT THIS POINT    VENUS     IS THE CENTRAL BODY FOR INTEGRATION   COWELL EQUATIONS OF MOTION
  PROBE IS LEAVING VENUS'      SHADOW

   2 DAYS 14 HRS. 37 MIN. 51.431 SEC.      2356053015172026671177775 J.D.= 2438008.10962304   DEC. 9,1962 14 37 51.431

      GEOCENTRIC                                                                                    EQUATORIAL COORDINATES

    X -.38114804 08     Y -.32466733 08     Z -.10736199 08    DX -.69869809 01    DY -.11838899 02    DZ -.59356140 01
    R  .51206376 08   DEC -.12102737 02    RA  .22042483 03     V  .14973609 02   PTH  .68707164 02    AZ  .12448867 03
    R  .51206376 08   LAT -.12102737 02   LON  .28310441 03    VE  .36665785 04   PTE  .21920980 00   AZE  .26995161 03
   XS -.33012537 08    YS -.13172989 09    ZS -.57121302 08   DXS  .29507274 02   DYS -.60187012 01   DZS -.26093421 01
   XM  .21915100 06    YM  .27889500 06    ZM  .87959750 05   DXM -.85011119 00   DYM  .59271622 00   DZM  .29599127 00
   YT -.38805183 08    YT -.33873448 08    ZT -.12684155 08   DXT -.55842176 01   DYT -.87128849 01   DZT -.16048224 01
   RS  .14732764 09    VS  .30227679 02    RM  .36544014 06    VM  .10777812 01    RT  .53048472 08    VT  .10472502 02
  GED -.12182759 02   ALT  .51199998 08   LOS  .31861057 03   RAS  .25593098 03   RAM  .51840329 02   LOM  .11451991 03
  DUT  .35000000 02    DT  .38400000 04    DR  .13951460 02   SHA -.29672880 08   DES -.22812463 02   DEM  .13927585 02
  CCL  .27278050 03   MCL  .17997891 03   TCL  .61833078 02

      HELIOCENTRIC                                                                                  EQUATORIAL COORDINATES

    X -.51022667 07     Y  .99263155 08     Z  .46385103 08    DX -.36494254 02    DY -.58201981 01    DZ -.33262720 01
    R  .10968493 09   LAT  .25017435 02   LON  .92942495 02     V  .37104843 02   PTH -.77073126 01    AZ  .92101534 02
   XE  .33012537 08    YE  .13172989 09    ZE  .57121302 08   DXE -.29507274 02   DYE  .60187012 01   DZE  .26093421 01
   XT -.57926456 07    YT  .97856441 08    ZT  .44437148 08   DXT -.35091491 02   DYT -.26941837 01   DZT  .10045197 01
  LTE  .22812463 02   LOE  .75930985 02   LTT  .24385356 02   LOT  .93387689 02   RST  .10762945 09   VST  .35209096 02
  EPS  .12889057 03   ESP  .15695707 02   SEP  .35413716 02   EPM  .79129368-01   EMP  .11190135 02   MEP  .16873051 03
  MPS  .12896821 03   MSP  .15754197 02   SMP  .35277589 02   SEM  .15551569 03   EMS  .24425541 02   ESM  .58516955-01
  EPI  .13652552 03   EIP  .41616357 02   TEP  .18581082 01   TPS  .34321416 02   TSP  .75039911 00   STP  .14492818 03
  SET  .34151907 02   STE  .12978487 03   EST  .16063214 02   RPM  .51564819 08   RPT  .25000001 07   SPN  .12888343 03
  SAC  .22900140-09
  GCE  .87219499 02   GCT  .32905258 03   SIP  .34179322 02   CPT  .72719294 02   SIN  .72577199 02
  REP  .51206376 08   VEP  .14973609 02   CPE  .80195375 02   CPS  .10226691 03
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APHRODIOCENTRIC EQUATORIAL COORDINATES

X	.69037884 06	Y	-.14067148 07	Z	.19479556 07	DX	-.14027633 01	DY	-.31260145 01	DZ	-.43307917 01
R	.25000001 07	DEC	.51185758 02	RA	.63859482 02	V	.55222701 01	PTH	-.86686723 02	AZ	.24853656 03
ALT	.24938001 07	SHA	.14365071 07	ALP	.50235550 02	DR	-.55208152 01	DP	.29049545-05	ASD	.14209440 00
NGE	.23110942 03	SVL	.29805898 02	HNG	.17862250 02	SIA	.13638342 03				
SAC	.22980140-09										

APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356056342332020771177775 J.D.= 2438013.27236082 DEC. 14,1962 19 01 00.493

SMA	-.10741169 05	ECC	.54575904 01	B	.57628458 05	SLR	.30918769 06	APO	.00000000 00	RCA	.47879731 05
VH	.54986957 01	C3	.30235654 02	C1	.31688127 06	TFP	-.44778906 06	TF	.77923667 01	LTF	.77539993 01
TA	-.99239987 02	MTA	.10055802 03	EA	-.25498070 03	MA	-.13134219 05			TFI	.26096230 01
ZAE	.13728728 03	ZAP	.34431171 02	ZAC	.72681565 02	DEF	.21116094 02	IR	.13100782 05	GP	-.29764401 02

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.69037884 06	Y	-.14067148 07	Z	.19479556 07	DX	-.14027633 01	DY	-.31260145 01	DZ	-.43307917 01
INC	.12568510 03	LAN	.18063479 03	APF	.20564165 03	HX	.96107241 00	HY	-.15407576 00	HZ	-.22934989 00
WX	-.89988358-02	WY	.81218591 00	WZ	-.58333008 00	PX	.90426000 00	PY	-.24242755 00	PZ	-.35148785 00
QX	-.42688758 00	QY	-.53066471 00	QZ	-.73224507 00	RX	.32102514 00	RY	.71553710 00	RZ	-.62044296 00
BX	.96716951 00	BY	-.14109259 00	BZ	-.21136701 00	TX	-.91238214 00	TY	.40933950 00	TZ	.00000000 00
SXI	-.25397181 00	SYI	-.56608108 00	SZI	-.78425155 00	DAI	-.51651508 02	RAI	.24583664 03		
SXD	-.58534882 00	SYD	-.47724057 00	SZD	-.65544458 00	DAD	-.40953367 02	RAD	.21919069 03		
ETE	.30676850 03	ETS	.41834766 02	ETC	.25151734 03						

BTQ -.54181293 05 BRQ .19632282 05 B .57628458 05 THA .16008230 03 T VECTOR IN EARTH EQUATOR PLANE

ALL VECTORS REFERENCED TO ECLIPTIC PLANE

X	.69037884 06	Y	.20655583 07	Z	.12275367 07	DX	-.14027633 01	DY	-.45909088 01	DZ	-.27297030 01
INC	.14912548 03	LAN	.18100483 03	APF	.20613378 03	HX	.96107233 00	HY	-.23260024 00	HZ	-.14912356 00
WX	-.89992301-02	WY	.51308132 00	WZ	-.85829328 00	PX	.90426026 00	PY	-.36224872 00	PZ	-.22603090 00
QX	-.42688763 00	QY	-.77815399 00	QZ	-.46069870 00	RX	.14442024 00	RY	.47274729 00	RZ	-.86928288 00
BX	.96716973 00	BY	-.21353375 00	BZ	-.13778981 00	TX	-.95636871 00	TY	.29218244 00	TZ	.00000000 00
SXI	-.25397181 00	SYI	-.83135495 00	SZI	-.49431489 00	DAI	-.29624584 02	RAI	-.25301253 03		
SXD	-.58534893 00	SYD	-.69860452 00	SZD	-.41168313 00	DAD	-.24298037 02	RAD	-.23004092 03		
ETE	.31756582 03	ETS	.52632085 02	ETC	.26231466 03						

BTC -.56899888 05 BRC .91346706 04 B .57628461 05 THA .17087959 03 T VECTOR IN ECLIPTIC PLANE

ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET

X	.21701734 07	Y	-.11003277 06	Z	.12362202 07	DX	-.47923297 01	DY	.11675377 00	DZ	-.27414250 01
INC	.14982230 03	LAN	.99027389 02	APF	.19959053 03	HX	.95282354-03	HY	-.99590256 00	HZ	-.90315392-01
WX	.49643698 00	WY	.78871185-01	WZ	-.86447056 00	PX	-.13844413 00	PY	-.97591341 00	PZ	-.16854260 00
QX	-.85695887 00	QY	.20335195 00	QZ	-.47357019 00	RX	.49628808 00	RY	-.12062912-01	RZ	-.86807405 00
BX	.20919794-01	BY	-.99666157 00	BZ	-.78918122-01	TX	.24299092-01	TY	.99970473 00	TZ	.00000000 00
SXI	-.86781774 00	SYI	.21093411-01	SZI	-.49643467 00	DAI	-.29764399 02	RAI	.17860762 03		
SXD	-.81708372 00	SYD	.37872508 00	SZD	-.43467002 00	DAD	-.25764349 02	RAD	.15513188 03		
ETE	.31229757 03	ETS	.71005016 02	ETC	.27321265 03						

BTQ -.57389813 05 BRQ .52390984 04 B .57628455 05 THA .17478394 03 T VECTOR IN ORBIT PLANE OF TARGET

7 DAYS 19 HRS. 46 MIN. 58.744 SEC. 2356056355142025372671?3 J.D.= 2438013.32429101 DEC. 14,1962 19 46 58.745

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GEOCENTRIC EQUATORIAL COORDINATES

X	-.41051080 08	Y	-.38291332 08	Z	-.13671194 08	DX	-.74625149 01	DY	-.14909948 02	DZ	-.72400025 01
R	.57778186 08	DEC	-.13686849 02	RA	.22300790 03	V	.18177275 02	PTH	.68362656.02	AZ	.11985742 03
R	.57778186 08	LAT	-.13686849 02	LON	.20326704 03	VE	.40878331 04	PTE	.23682486 00	AZE	.26995322 03
XS	-.19597553 08	YS	-.13388624 09	ZS	-.58055864 08	DXS	.29999834 02	DYS	-.35449421 01	DZS	-.15359235 0.
XM	-.22533900 06	YM	.28651450 06	ZM	.12794737 06	DXM	-.85852918 00	DYM	-.53210926 00	DZM	-.13040295 00
XT	-.41001011 08	YT	-.38295332 08	ZT	-.13647333 08	DXT	-.44356744 01	DYT	-.10890379 02	DZT	-.26676153 01
RS	.14724155 09	VS	.30247574 02	RM	.38631431 06	VM	.10184388 01	RT	.57797036 08	VT	.12057849 02
GEO	-.13776580 02	ALT	.57771808 08	LOS	.26193162 03	RAS	.26167248 03	RAM	.12818447 03	LOM	.10844362 03
DUT	.35000000 02	DT	.24000000 03	DR	.16896438 02	SHA	-.35388552 08	DES	-.23221698 02	DEM	.19341637 02
CCL	.27338213 03	MCL	.17998010 03	TCL	.32543787 03						

HELIOCENTRIC EQUATORIAL COORDINATES

X	-.21453526 08	Y	.95594911 08	Z	.44384671 08	DX	-.37462349 02	DY	-.11365006 02	DZ	-.57040790 01
R	.10755761 09	LAT	.24372011 02	LON	.10264881 03	V	.39561692 02	PTH	-.72352603 01	AZ	.95856866 02
RE	.19597553 08	VE	.13388624 09	ZE	.58055864 08	DXE	-.29999834 02	DYE	.35449421 01	DZE	.15359235 01
RT	-.21484259 08	VT	.95590911 08	ZT	.44408511 08	DXT	-.34435508 02	DYT	-.73656367 01	DZT	-.11316918 01
LTE	.23221698 02	LBE	.81672483 02	LTT	.24382966 02	LOT	.10266686 03	RST	.10757004 09	VST	.35228403 02
EPS	.12302097 03	ESP	.19209272 02	SEP	.37769755 02	EPM	.37807118 00	SMP	.80678866 02	MEP	.98943098 02
MPS	.12339863 03	MSP	.19106513 02	SPP	.37494852 02	SEN	.13664407 03	EMS	.43232956 02	ESM	.10279207 00
EPT	.11879603 03	ETP	.61169990 02	TEP	.33542591-01	TPS	.10851572 03	TSP	.18506685-01	STP	.71466527 02
SET	.37796585 02	STE	.12297786 03	EST	.19225546 02	RPM	.57839699 08	RPT	.39112531 05	SPN	.12301464 03
SAC	.23814957-09										
GCE	.86617867 02	GCT	.23205574 03	SIP	.99394888 02	CPT	.11992330 03	SIN	.11080247 03		
REP	.57778186 08	VEP	.18177275 02	CPE	.80314970 02	CPS	.10271893 03				

APHRODIOCENTRIC EQUATORIAL COORDINATES

X	.30731973 05	Y	.40003297 04	Z	-.23860705 05	DX	-.30268405 01	DY	-.40195693 01	DZ	-.45723873 01
R	.39112531 05	DEC	-.37593313 02	RA	.74163977 01	V	.67989284 01	PTH	.50229894-06	AZ	.21192407 03
ALT	.32912531 05	SHA	-.37083647 05	ALP	.12617437 02	DR	.74904063-07	DP	.99597208-02	ASD	.91208270 01
NGE	.23697903 03	SVL	-.32543115 02	HNG	.11213028 03	SIA	.10967520 03				
SAC	.23814957-09										

APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356056355142025372604?2 J.D.= 2438013.32429101 DEC. 14,1962 19 46 58.745

SMA	-.10964920 05	ECC	.45670602 01	B	.48862267 05	SLR	.21774181 06	APO	.00000000 00	RCA	.39112530 05
VH	.54423031 01	C3	.29618663 02	C1	.26592329 06	TFP	.10186252-03	TF	.78242908 01	LTF	.77888724 01
TA	.34150945-05	MTA	.19264791 03	EA	.85377364-06	MA	.28967721-05			TFI	.78242910 01
ZAE	.13776036 03	ZAP	.39971185 02	ZAC	.71965335 02	DEF	.25295833 02	IR	.13206249 05	GP	-.30444619 02

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.30731973 05	Y	.40003297 04	Z	-.23860705 05	DX	-.30268405 01	DY	-.40195693 01	DZ	-.45723873 01
INC	.11477124 03	LAN	.20822719 03	APF	.22221180 03	HX	-.44519378 00	HY	-.59120630 00	HZ	-.67251588 00
WX	-.42945022 00	WY	.80000903 00	WZ	-.41899652 00	PX	.78573214 00	PY	.10227745 00	PZ	-.61005268 00
QX	-.44519376 00	QY	-.59120628 00	QZ	-.67251587 00	RX	.31778178 00	RY	.71389443 00	RZ	-.61339881 00
BX	.86414488 00	BY	.22924567 00	BZ	-.44799561 00	TX	-.98392327 00	TY	.42769463 00	TZ	.00000000 00
SXI	-.26234739 00	SYI	-.55466547 00	SZI	-.78977326 00	DAI	-.52166327 02	RAI	.24467865 03		
SXD	-.60643400 00	SYD	-.59925466 00	SZD	-.52261993 00	DAD	-.31508156 02	RAD	.22465883 03		
ETE	.30229105 03	ETS	.29230405 02	ETC	.25076051 03						

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BTQ	-.33376521 05	BRQ	.35686536 05	B	.48862267 05	THA	-.13308429 03	T VECTOR IN EARTH EQUATOR PLANE			
						ALL VECTORS REFERENCED TO ECLIPTIC PLANE					
X	.30731973 05	Y	-.58223563 04	Z	-.23682676 05	DX	-.30268405 01	DY	-.55068224 01	DZ	-.25958754 01
INC	.13664238 03	LAN	.21712663 03	APF	.23754634 03	MX	-.44519377 00	MY	-.80995448 00	MZ	-.38180656 00
WX	-.42945021 00	WY	.56728648 00	WZ	-.70267956 00	PX	.78573216 00	PY	-.14886166 00	PZ	-.60038753 00
QX	-.44519377 00	QY	-.80995446 00	QZ	-.38180655 00	RX	.15308931 00	RY	.48018924 00	RZ	-.86370243 00
BX	.86414488 00	BY	.32097629-01	BZ	-.50221846 00	TX	-.95275260 00	TY	.30374742 00	TZ	.00000000 00
SXI	-.26234738 00	SYI	-.82289474 00	SZI	-.50400203 00	DAI	-.30266128 02	RAI	.25231717 03		
SXO	-.60643401 00	SYO	-.75770547 00	SZO	-.24108124 00	DAO	-.13950363 02	RAD	.23132775 03		
ETE	.31365265 03	ETS	.40592005 02	ETC	.26213010 03						
BTC	-.39752716 05	BRC	.28412022 05	B	.48862270 05	THA	.14444588 03	T VECTOR IN ECLIPTIC PLANE			
						ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET					
X	.16000420 04	Y	-.32573250 05	Z	-.21591972 05	DX	-.60658784 01	DY	.14841501 01	DZ	-.26884647 01
INC	.13723007 03	LAN	.13851527 03	APF	.23438643 03	MX	-.89218155 00	MY	.21829178 00	MZ	-.39542477 00
WX	.44982056 00	WY	.50870284 00	WZ	-.73408642 00	PX	.40908683-01	PY	-.83280857 00	PZ	-.55204743 00
QX	-.89218155 00	QY	.21829177 00	QZ	-.39542477 00	RX	.50638509 00	RY	-.18010562-01	RZ	-.86211930 00
BX	.23526740 00	BY	-.86039665 00	BZ	-.45206955 00	TX	.35544453-01	TY	.99936809 00	TZ	.00000000 00
SXI	-.86157454 00	SYI	.30643560-01	SZI	-.50670528 00	DAI	-.30444619 02	RAI	.17796302 03		
SXO	-.87948921 00	SYO	.39534584 00	SZO	-.26495350 00	DAO	-.15364189 02	RAD	.15579524 03		
ETE	.30926123 03	ETS	.61084645 02	ETC	.27339349 03						
BTO	-.41605758 05	BRO	.25621909 05	B	.48862269 05	THA	.14837416 03	T VECTOR IN ORBIT PLANE OF TARGET			

7 DAYS 19 HRS. 49 MIN. 51.431 SEC. 2356056355672026671177 75 J.D.= 2438013.32628971 DEC. 14,1962 19 49 51.431

GEOCENTRIC EQUATORIAL COORDINATES

X	-.41052371 08	Y	-.38293907 08	Z	-.13672442 08	DX	-.74905246 01	DY	-.14914115 02	DZ	-.72176794 01
R	.57781104 08	DEC	-.13687418 02	RA	.22300892 03	V	.18183384 02	PTH	.68464354 02	AZ	.11972300 03
R	.57781103 08	LAT	-.13687418 02	LON	.20254657 03	VE	.40880464 04	PTE	.23705879 00	AZE	.26995361 03
XS	-.19592373 08	YS	-.13388685 09	ZS	-.58056130 08	DXS	.29999978 02	DYS	-.35439852 01	DZS	-.15355085 01
XM	-.22548700 06	YM	.28642250 06	ZM	-.12792687 06	DXM	-.85825437 00	DYM	-.53245234 00	DZM	-.13055608 00
XT	-.41082577 08	YT	-.38297212 08	ZT	-.13647794 08	DXT	-.44351348 01	DYT	-.10891182 02	DZT	-.26680179 01
RS	.14724152 09	VS	.30247584 02	RM	.38632500 06	VM	.10184061 01	RT	.57798935 08	VT	.12058465 02
GEO	-.13777152 02	ALT	.57774727 08	LOS	.24121233 03	RAS	.26167468 03	RAM	.12821170 03	LOM	.10774934 03
DUT	.35000000 02	DT	.24000000 03	DR	.16913991 02	SHA	-.35391056 08	DES	-.23221815 02	DEM	.19337545 02
CCL	.27338252 03	MCL	.17998012 03	TCL	.32423443 03						

HELIOCENTRIC EQUATORIAL COORDINATES

X	-.21459998 08	Y	.95592947 08	Z	.44383687 08	DX	-.37490503 02	DY	-.11370190 02	DZ	-.56821710 01
R	.10755675 09	LAT	.24371643 02	LON	.10265276 03	V	.39586691 02	PTH	-.72123937 01	AZ	.95825938 02
XE	.19592373 08	YE	.13388685 09	ZE	.58056130 08	DXE	-.29999978 02	DYE	.35439852 01	DZE	.15355085 01
XT	-.21490205 08	YT	.95589642 08	ZT	.44408336 08	DXT	-.34435113 02	DYT	-.73471968 01	DZT	-.11325095 01
LTE	.23221815 02	LOE	.81674692 02	LIT	.24382856 02	LOI	.10267042 03	RST	.10757082 09	VST	.35228410 02
EPS	.12301850 03	ESP	.19210845 02	SEP	.37770653 02	EPM	.37807118 00	EMP	.80703716 02	MEP	.98918229 02
MPS	.12339618 03	MSP	.19108037 02	SMP	.37495777 02	SEM	.13664018 03	EMS	.43256800 02	ESM	.10231507 00
EPT	.11709311 03	ETP	.62872362 02	TEP	.34970568-01	TPS	.10980964 03	TSP	.18504685-01	SIP	.70170748 02
SET	.37797815 02	STE	.12297542 03	EST	.19226759 02	RPM	.57842254 08	RPT	.39126984 05	SPM	.12301217 03
SAC	.23815338-09										
GCE	.86617479 02	GCT	.23085190 03	SIP	.10069221 03	CPT	.12031658 03	SIN	.11119915 03		
REP	.57781104 08	VEP	.18183384 02	CPE	.80314978 02	CPS	.10271903 03				

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APHRODIOCENTRIC EQUATORIAL COORDINATES

X	.30206808 05	Y	.33059017 04	Z	-.24648340 05	DX	-.30553899 01	DY	-.40229929 01	DZ	-.45496615 01
R	.39126984 05	DEC	-.39046991 02	RA	.62457221 01	V	.67984777 01	PTH	.14106330 01	AZ	.21265003 03
ALT	.32926984 05	SHA	-.36807055 05	ALP	.14171916 02	DR	.16736299 00	DP	.99523646-02	ASD	.91174290 01
HGE	.23698150 03	SVL	-.33359017 02	HNG	.11393792 03	SIA	.10797568 03				
SAC	.23815338-09										

APHRODIOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356056355142025375325475 J.D.= 2438013.32429103 DEC. 14,1962 19 46 58.745

SMA	-.10964917 05	ECC	.45670611 01	B	.48862266 05	SLR	.21774185 06	APQ	.00000000 00	RCA	.39112531 05
VH	.54423037 01	C3	.29618670 02	C1	.26592331 06	TFP	.17268546 03	TF	.78242908 01	LTF	.77888724 01
TA	.17194770 01	MTA	.10264791 03	EA	.13765490 01	MA	.49108403 01			TFI	.78262896 01
ZAE	.13776057 03	ZAP	.39973174 02	ZAC	.71965343 02	DEF	.25295826 02	IR	.13206248 05	GP	-.30444612 02

						ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE					
X	.30206808 05	Y	.33059017 04	Z	-.24648340 05	DX	-.30553899 01	DY	-.40229929 01	DZ	-.45496615 01
INC	.11477125 03	LAN	.20822719 03	APF	.22221180 03	MX	-.46857002 00	MY	-.59600908 00	MZ	-.66390773 00
WX	-.42945024 00	WY	.80000898 00	WZ	-.61899656 00	PX	.78573211 00	PY	.10227740 00	PZ	-.61005274 00
QX	-.44519381 00	QY	-.59120634 00	QZ	-.67251579 00	RX	.33778181 00	RY	.71389434 00	RZ	-.61339893 00
BX	.86414484 00	BY	.22924561 00	BZ	-.44739571 00	TX	-.90392326 00	TY	.42769471 00	TZ	.00000000 00
SXI	-.26234747 00	SYI	-.55446555 00	SZI	-.78977318 00	DAI	-.52164319 02	RAI	.24467864 03		
SXO	-.60643400 00	SYO	-.59925471 00	SZO	-.52261987 00	DAO	-.31508153 02	RAD	.22465883 03		
ETE	.30228987 03	ETS	.29226412 02	ETC	.25076851 03						
BTQ	-.33376518 05	BRQ	.35686538 05	B	.48862266 05	THA	.13308428 03	T VECTOR IN EARTH EQUATOR PLANE			
						ALL VECTORS REFERENCED TO ECLIPTIC PLANE					
X	.30206808 05	Y	-.67728103 04	Z	-.23929034 05	DX	-.30553899 01	DY	-.55009224 01	DZ	-.25736633 01
INC	.13464238 03	LAN	.21712664 03	APF	.23754635 03	MX	-.46857002 00	MY	-.80512304 00	MZ	-.36361931 00
WX	-.42945024 00	WY	.56728643 00	WZ	-.70267960 00	PX	.78573209 00	PY	-.14886173 00	PZ	-.60038754 00
QX	-.44519382 00	QY	-.80995450 00	QZ	-.38180645 00	RX	.15308932 00	RY	.48018912 00	RZ	-.86370252 00
BX	.86414484 00	BY	.32097534-01	BZ	-.50221853 00	TX	-.95275257 00	TY	.30374750 00	TZ	.00000000 00
SXI	-.26234749 00	SYI	-.82289480 00	SZI	-.50400192 00	DAI	-.30265120 02	RAI	.25231716 03		
SXO	-.60643402 00	SYO	-.75770550 00	SZO	-.24108117 00	DAO	-.13950360 02	RAD	.23132775 03		
ETE	.31365147 03	ETS	.40588012 02	ETC	.26213010 03						
BTC	-.39752710 05	BRC	.28412022 05	B	.48862266 05	THA	.14444588 03	T VECTOR IN ECLIPTIC PLANE			
						ALL VECTORS REFERENCED TO ORBIT PLANE OF TARGET					
X	.55244946 03	Y	-.32314327 05	Z	-.22054476 05	DX	-.60668877 01	DY	.15145495 01	DZ	-.26680164 01
INC	.13723007 03	LAN	.13851527 03	APF	.23438645 03	MX	-.89300736 00	MY	.24318280 00	MZ	-.37868185 00
WX	.44982048 00	WY	.50870296 00	WZ	-.73408640 00	PX	.40908606-01	PY	-.83280846 00	PZ	-.55204755 00
QX	-.89218161 00	QY	.21829185 00	QZ	-.39542466 00	RX	.50638496 00	RY	-.18010642-01	RZ	-.86211938 00
BX	.23526730 00	BY	-.86039658 00	BZ	-.45206972 00	TX	.35544620-01	TY	.99936808 00	TZ	.00000000 00
SXI	-.86157462 00	SYI	.30643707-01	SZI	-.50670516 00	DAI	-.30444610 02	RAI	.17796301 03		
SXO	-.87948925 00	SYO	.39534587 00	SZO	-.26495338 00	DAO	-.15364182 02	RAD	.15579524 03		
ETE	.30926021 03	ETS	.61081140 02	ETC	.27339348 03						
BTO	-.41605749 05	BRO	.25621916 05	B	.48862266 05	THA	.14837414 03	T VECTOR IN ORBIT PLANE OF TARGET			

CASE 1 I85YS-JPIRAJ-SPACE 022265 7

632427135666	631706661666 21174200096	630437201056	603730124337 17448304640	604531616254	603532066024 000000000000	EARTH INITIAL
217727515530	214622511174	617601553043	602611205256	603400721472 235605635567	603442743230 202667117775	VENUS END

U MATRIX FOR MAPPING FORWARD ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MV	AU
X	.10966738 01	.22628337 00	.95824143-01	.38971570-04	.29859219-04	-.13719305-04	.00000000 00	.00000000 00
Y	.26646167 00	.10270700 01	.15926470 00	.38408640-04	-.12657212-04	-.40772528-05	.00000000 00	.00000000 00
Z	.14890519 00	.18058750 00	.92539933 00	-.46092930-07	.31993660-05	-.22687172-04	.00000000 00	.00000000 00
DX	.75527639 06	.15126123 06	.61127321 05	.27719612 02	.20412752 02	-.94570649 01	.00000000 00	.00000000 00
DY	.18940998 06	.67661268 06	.87107397 05	.25112386 02	-.75215715 01	-.23777418 01	.00000000 00	.00000000 00
DZ	.90707747 05	.10145706 06	.62498159 06	-.10337408 01	.21220986 01	-.14140570 02	.00000000 00	.00000000 00
MV	-.11663469 11	-.12298928 11	-.11436336 11	-.11459470 07	-.46888873 06	.27653503 06	.10000000 01	.00000000 00
AU	.10846571 00	.76123472-01	.54280288-01	.20273964-04	.53912774-05	-.67916350-05	.00000000 00	.10000000 01

COVARIANCE MATRIX AT IMPACT ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MV	AU
X	.47175286 11	.38625947 11	.20113070 11	.24072435 07	.73161593 06	-.88647863 06	-.15561391-07	.34610615 01
Y	.38625947 11	.34565694 11	.17722058 11	.20495190 07	.54127742 06	-.74744181 06	-.18174269-07	.31844926 01
Z	.20113070 11	.17722058 11	.10110164 11	.10488527 07	.28992393 06	-.41058659 06	-.17080953-07	.22685311 01
DX	.24072435 07	.20495190 07	.10488527 07	.12505391 03	.35761035 02	-.45555512 02	-.13852334-11	.55924926-03
DY	.73161593 06	.54127742 06	.28992393 06	.35761035 02	.12487717 02	-.13385001 02	-.48508475-12	.13441655-03
DZ	-.88647863 06	-.74744181 06	-.41058659 06	-.45555512 02	-.13385001 02	.17369259 02	.43232970-12	-.19567239-03
MV	-.15561391-07	-.18174269-07	-.17080953-07	-.13852334-11	-.48508475-12	.43232970-12	.99999998-18	.00000000 00
AU	.34610615 01	.31844926 01	.22685311 01	.55924926-03	.13441655-03	-.19567239-03	.00000000 00	.25000000 02

U PRODUCT MATRIX OF STEP MAPPING ITERATION NUMBER 0

	X	Y	Z	DX	DY	DZ	MV	AU
X	.56437986 01	.42107851 01	.21757652 01	.27753481-03	.95502075-04	-.10171062-03	.00000000 00	.00000000 00
Y	.70343361 00	.48017091 00	.36603342 00	.32273659-04	.12672889-04	-.14935375-04	.00000000 00	.00000000 00
Z	.22739587 00	.21658458 00	.19479862 00	.15866207-04	.21757187-05	.23492609-05	.00000000 00	.00000000 00
DX	.19764677 08	.13985615 08	.72116839 07	.95289662 03	.34895230 03	-.36874327 03	.00000000 00	.00000000 00
DY	.80540421 07	.11420462 08	.46543167 07	.54908483 03	.27889194 02	-.16720472 03	.00000000 00	.00000000 00
DZ	.40302329 07	.44308611 07	.52374215 07	.20256576 03	.48287167 02	-.15515567 03	.00000000 00	.00000000 00
MV	-.15561391 11	-.18174269 11	-.17080953 11	-.13852334 07	-.48508476 06	.43232971 06	.10000000 01	.00000000 00
AU	.13844246 00	.12737971 00	.90741242-01	.22369971-04	.53766621-05	-.78268958-05	.00000000 00	.10000000 01

ENCOUNTER PARAMETERS AND STATISTICS 62/12/14 194658.745

B	.48863381 05	SMAA	.13827722 06
B.RD	.25623516 05	SMIA	.46249093 05
B.TO	-.41606075 05	DEL T	.31379607 05
B.RC	.28412022 05	DEL B	.14581931 06
B.TC	-.39752716 05	DEL S	.17077879 06
TL	.10077253 03	DEL BR	.91950071 05
THETA	.37570843 02	DEL BT	.11317444 06

N MATRIX

	B.RD	B.TO	TL	C3	S.TS	S.RS
B.RD	.84548154 10	-.82051087 10	.26191344 10	-.59891937 05	.22538312 06	.11646524 06
B.TO	-.82051090 10	.12808455 11	-.30171756 10	.64743844 05	-.28456252 06	-.14590043 06
TL	.26191345 10	-.30171755 10	.98467973 09	-.20929726 05	.80506390 05	.41782426 05
C3	-.59891386 05	.64743775 05	-.20929769 05	.45701790 00	-.17441461 01	-.90371404 00
S.TS	.22538313 06	-.28456251 06	.80506391 05	-.17441487 01	.70437215 01	.36340356 01
S.RS	.11646524 06	-.14590043 06	.41782426 05	-.90371227 00	.36340358 01	.18758385 01

NORMALIZED N MATRIX

	B.RD	B.TO	TL	C3	S.TS	S.RS
B.RD	.10000000 01	-.78846768 00	.90773319 00	-.96349549 00	.92356662 00	.92479722 00
B.TO	-.78846771 00	.99999999 00	-.84958083 00	.84622042 00	-.94738878 00	-.94126186 00
TL	.90773323 00	-.84958081 00	.10000000 01	-.98661894 00	.96667782 00	.97218390 00
C3	-.96348663 00	.84621952 00	-.98662093 00	.10000000 01	-.97210949 00	-.97603794 00
S.TS	.92356665 00	-.94738875 00	.96667784 00	-.97211093 00	.10000000 01	.99974760 00
S.RS	.92479726 00	-.94126187 00	.97218390 00	-.97603603 00	.99974765 00	.99999999 00

```
DM/DDO MATRIX

              B.RO            B.TO            TL              C3              S.TS            S.RS

X       .19432538 01    -.30687803 01   .71810839 00    -.15502912-04   .67876250-04    .34794829-04

Y       .12661832 00    -.37872949 00   .99066247-01    -.15491778-05   .79940872-05    .41622495-05

Z       .34317390 00    -.17255082 00   -.66687256-02   .86614341-06    .37648641-05    .17358850-05

DX      .64180771 07    -.11189817 08   .23966677 07    -.51176269 02   .23588366 03    .12053721 03

DY      .65818714 07    -.15729188 07   .16748565 07    -.41520920 02   .11365567 03    .60119785 02

DZ      -.18816308 06   -.63123703 05   .11391386 07    -.15014267 02   .43341703 02    .24794701 02

MU      -.56560455-01   -.96096551-01   -.26623533-01   .14224868-03    .50777522-06    .40648822-06


DM/DQ MATRIX

              B.RO            B.TO            TL              C3              S.TS            S.RS

X       .21496986 00    -.71465895 00   .55341266-01    .33640446-03    .10118067-04    .62313123-05

Y       .60157931 00    .64188397 00    .14796535 00    -.11025433-03   .20658079-05    .12722483-05

Z       -.91472661 00   -.98744307-01   .97671857-01    -.23437026-03   -.56003876-05   -.51622475-06

DX      -.11462816 04   -.42096133 04   -.67860414 03   -.71121789 01   -.20354937-01   -.12535791-01

DY      .42021899 04    -.25239673 04   .46801974 03    -.10266800 02   .17521200-01    .10790601-01

DZ      .82683492 04    -.68900916 03   .67421384 03    -.53769287 01   -.52946112-01   -.42589657-01

MU      -.33843363-01   -.14002395 00   .17583676-02    .91201498-04    .18249393-05    .11239068-05


N MATRIX FOR MANEUVER CALCULATIONS

              B.RC            B.TC            TL

B.AC    .95964167 10    -.84255963 10   .32634384 05

B.TC    -.84255966 10   .11666853 11    -.32763030 05

TL      .32634384 05    -.32763030 05   .13190690 00
0000 141631     OFFLINE CONTROL                                                 127
0000 14163      TERMINATE JOB
0000 14163      END DATA                                                        10
```

```
        SOURCE PROGRAM LISTING

    *N1     OOPX    N9
    *N9     LA9     X,N11,N1,N4
    55164/=1.0E14
    *N12    LA12    X
    *N13    SPACE   X
                    SCFORF=2
    *       WANT    N9,(MOOPM1),20D,(MJTOR,BRNOPT),18
    *       WANT    N11,(TAPEX),6
    *       WANT    N12,(XNJ,INJX),1,(XNJ-1,INJY),1
    *       ETC     (XNJ-2,INJZ),1,(XNJ-3,INJDX),1
    *       ETC     (XNJ-4,INJDY),1,(XNJ-5,INJDZ),1
    *       ETC     (EPOCH,INJT),1,(EPOCH-1,INJT+11),1
    *       ETC     (DUT,GRAV-2),1,(AU,SCALE1+1),1
    *       ETC     (RE,SCALE1),1,(PORE,HARMN+5),1
    *       ETC     (QQ,HARMN+4),1,(QM,HARMN+3),1
    *       ETC     (QJ,HARMN+2),1,(GRAVE,GRAV),1
    *       ETC     (GRAVM,GRAV+1),1,(GRAVS,GRAV+2),1
    *       ETC     (GHAVV,GRAV+3),1,(GHAVM,GRAV+4),1
    *       ETC     (GHAVJ,GRAV+6),1,(STEP,HI),1
    *       ETC     (TANGET,TARBCO),1,(AREA,RADJPT+3),1
    *       ETC     (GM0,RADOPT+6),1,(EMASS,RADJPT+5),1
    *       ETC     (FA0,GASOPT+9),1,(FB0,GASOPT+12)
    *       ETC     (FC0,GASOPT+15),1,(FA1,GASOPT+8)
    *       ETC     (FB1,GASOPT+11),1,(FC1,GASOPT+14)
    *       ETC     (FA2,GASOPT+7),1,(FB2,GASOPT+10)
    *       ETC     (FC2,GASOPT+13),1,(JETON,GASOPT),1
    *       ETC     (JETON,GASOPT+2),1,(JETON-1,GASOPT+3),1
    *       ETC     (JETOFF,GASOPT+5),1,(JETOFF-1,GASOPT+6),1
    *       ETC     (IFIN,SECP50),1,(IFIN-1,SECP50+1),1
    *       ETC     (EMASS,GASOPT+16),1
    GASOPT+1=(CANOPU)
    INJBCO=(EARTH)
    *N11    LA11    N4,N6,N12
    *       WANT    N9,(C1371),1
    *       WANT    N13,(CLPT,TRADE+1),1,(CLPT+1,TRADE),1
    *       ETC     (CLPBTC,TRADE+2),1,(CLPARC,TRADE+3),1
    *       ETC     (CLPBTT,TRADE+4),1,(CLPBRT,TRADE+5),1
    *       ETC     (TAPEX),6
    *N2     LA2     N12,X
    *       WANT    N11,(EPOX),14
    *N2A    LA2A    N9,N12
    *N3     LA3     N9,N10
    *N4     LA4     N6,N12
    *N5     LA5     N9,N12
    *N6     LA6     N12
    *N7     LA7     N9,N10,N12
    *       WANT    N9,(APRIOR-19,APRIOR-19),20
    *N8     LA8     N9,N12
    *N10    LA10    N8,N9
    *X      END                                                             10

                    THERE WERE NO CLARIFYING SOURCE DECK ERRORS.

                    THE OBJECT STRING HAS 00514 OCTAL OR  332 DECIMAL WORDS.
```

```
0000 141751     PAGE HEADING                                                    (23
0000 14175      (MOON CHECK CASE - PREDICTIONS)
0000 14175      EPOCH                                                           (01
0000 14175      640702910,2758000
0000 14175      GEOCENTRIC POSITION AND VELOCITY AT EPOCH                       (02
0000 14175      X=.15667453E6 Y=.6304161585 Z=.80777204E4
0000 14175      DX=.14342616E1 DY=.97256996E0 DZ=.28116199E0
0000 14175      OTHER OPTIONS AND CONSTANTS                                     (03
0000 14175      SYNFRQ=2038516.
0000 14175      TFREQ=7590830.
0000 14175      POINTING TIMES, SAMPLE RATE, COUNT TIMES                        (17
0000 14175      JETGL2=640702911,0,640703011,0,1800.,60.
0000 14175      TRANSMITTER ID TABLE                                            (26
0000 14175      2,2038516.
0000 14175      OFFLINE CONTROL                                                 (27
0000 14175      KEY(8) KEY(13)
0000 14175      END DATA                                                        (0
```

CASE 1 IBSYS-JPTRAJ-SPACE 022265 1

DOUBLE PRECISION EPHEMERIS TAPE - EPHEM1

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	DME	.41780741-02	AU	.14959850 09
GMM	.49026293 04	GMS	.13271411 12	GMV	.32476627 06	GMA	.42977368 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 MOON 2356665063532024000000000 J.D.= 2438605.93608796 JULY 29,1964 10 27 58.000

GEOCENTRIC XO .15667453 06 YO .63041615 05 ZO .80777203 04 DXO .14342616 01 DYO .97256996 00 DZO .28116199 00
CARTESIAN ID .37678000 05 GHA .10409373 03 GHO .30667227 03
DATE OF RUN 022265A 14185 EARTH IS THE CENTRAL BODY FOR INTEGRATION COWELL EQUATIONS OF MOTION

0 DAYS 0 HRS. 0 MIN. 0.000 SEC. 2356665063532024000000000 J.D.= 2438605.93608796 JULY 29,1964 10 27 58.000

GEOCENTRIC EQUATORIAL COORDINATES

X	.15667452 06	Y	.63041612 05	Z	.80777202 04	DX	.14342615 01	DY	.97256992 00	DZ	.28116198 00
R	.16907513 06	DEC	.27384004 01	RA	.21918529 02	V	.17555769 01	PTH	.76231923 02	AZ	.61412202 02
R	.16907512 06	LAT	.27384004 01	LON	.27782479 03	VE	.12070910 02	PTE	.81207508 01	AZE	.27095862 03
XS	-.89949372 08	YS	.11227336 09	ZS	.48686598 08	DXS	-.23515989 02	DYS	-.16077681 02	DZS	-.69719988 01
XM	.38246410 06	YM	.27456507 05	ZM	-.26012551 05	DXM	-.83439888-01	DYM	.93230192 00	DZM	.40985490 00
XT	.38246410 06	YT	.27456507 05	ZT	-.26012551 05	DXT	-.83439888-01	DYT	.93230192 00	DZT	.40985490 00
RS	.15187686 09	VS	.29327501 02	RM	.38432968 06	VM	.10218268 01	RT	.38432968 06	VT	.10218268 01
GED	.27570333 01	ALT	.16269697 06	LOS	.24606715 02	RAS	.12870045 03	RAM	.41061295 01	LOM	.26001239 03
DUT	.35000000 02	DT	.12000000 03	DR	.17051340 01	SHA	.16335718 06	DES	.18697172 02	DEM	-.38809109 01
CCL	.25840724 03	MCL	.11052996 00	TCL	.11052996 00						

GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356664500622026213000000 J.D.= 2438605.21642518 JULY 28,1964 17 11 39.136

SMA	.24408791 06	ECC	.97401695 00	B	.55279828 05	SLR	.12519505 05	APO	.48183367 06	RCA	.63621468 04
VH	.14661061 00	C3	-.16330208 01	C1	.70641933 05	TFP	.62178864 05	TF	-.17271907 02	PER	.20002258 05
TA	.16192549 03	MTA	.18000000 03	EA	.71607988 02	MA	.18651553 02	C3J	-.20370820 01	TFI	.00000000 00

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.15667452 06	Y	.63041612 05	Z	.80777202 04	DX	.14342615 01	DY	.97256992 00	DZ	.28116198 00
INC	.28707658 02	LAN	.16908121 02	APF	.20378273 03	MX	-.34898680 00	MY	.80607909 00	MZ	.47795833 00
WX	.13970111 00	WY	-.45957623 00	WZ	.87708195 00	PX	-.77265498 00	PY	-.60455107 00	PZ	-.19370658 00
QX	.61926389 00	QY	-.65062065 00	QZ	-.43955031 00	RX	.15255788 00	RY	.11936638 00	RZ	-.98105948 00
BX	-.61926406 00	BY	.65062083 00	BZ	.43955042 00	TX	-.61622264 00	TY	.78757200 00	TZ	.00000000 00
DAP	-.11169176 02	RAP	.21804081 03								

BTQ	.49421011 05	BRQ	-.24767379 05	B	.55279828 05	THA	.33338222 03

T VECTOR IN EARTH EQUATOR PLANE

CASE 1 IBSYS-JPTRAJ-SPACE 022265 2

HELIOCENTRIC EQUATORIAL COORDINATES

X	-.90106046 08	Y	-.11221032 09	Z	-.48678520 08	DX	.24950250 02	DY	-.17050251 02	DZ	.72531608 01
R	.15192055 09	LAT	-.18688381 02	LON	.30976483 03	V	.31077876 02	PTH	-.21988086 00	AZ	.75813410 02
XE	.89949372 08	YE	-.11227336 09	ZE	-.48686598 08	DXE	.23515989 02	DYE	.16077681 02	DZE	.69719988 01
XT	.90331836 08	YT	-.11224590 09	ZT	-.48712610 08	DXT	.23432549 02	DYT	.17009983 02	DZT	.73818538 01
LTE	-.18697172 02	LOE	.30870045 03	LTT	-.18640121 02	LOT	.30882598 03	RST	.15209175 09	VST	.29881694 02
EPS	.74994993 02	ESP	.61373100-01	SEP	.10494339 03	EPM	.14723361 03	EMP	.13773981 02	MEP	.18992403 02
MPS	.13777126 03	MSP	.58933450-01	SMP	.42170224 02	SEM	.12393574 03	EMS	.55944139 02	ESM	.12012787 00
RPM	.23110470 06	SPV	.72833120 02								
GCE	.10159276 03	GCT	.28170329 03	SIP	.13734034 03	CPT	.92025110 02	SIN	.91594195 02		
REP	.16907513 06	VEP	.17555769 01	CPE	.97484351 02	CPS	.76877815 02				

1 DAYS 0 HRS. 32 MIN. 2.000 SEC. 2356665614542020000000000 J.D.= 2438606.95833333 JULY 30,1964 11 00 00.000

GEOCENTRIC EQUATORIAL COORDINATES

X	.25084050 06	Y	.13402614 06	Z	.30322890 05	DX	.81614400 00	DY	.67379618 00	DZ	.22454298 00
R	.28601301 06	DEC	.60858957 01	RA	.28115954 02	V	.10819020 01	PTH	.77274393 02	AZ	.61615284 02
R	.28601300 06	LAT	.60858957 01	LON	.27500634 03	VE	.20556600 02	PTE	.29427204 01	AZE	.27031620 03
XS	-.92013117 08	YS	.11083678 09	ZS	.48063660 08	DXS	-.23214413 02	DYS	-.16451548 02	DZS	-.71338363 01
XM	.36449540 06	YM	.10819357 06	ZM	.10548403 05	DXM	-.32284243 00	DYM	.88717703 00	DZM	.41420339 00
XT	.36449540 06	YT	.10819357 06	ZT	.10548403 05	DXT	-.32284243 00	DYT	.88717703 00	DZT	.41420339 00
RS	.15185954 09	VS	.29333497 02	RM	.38036037 06	VM	.10309582 01	RT	.38036037 06	VT	.10309582 01
GED	.61270553 01	ALT	.27963504 06	LOS	.16588743 02	RAS	.12969836 03	RAM	.16532524 02	LOM	.26342290 03
DUT	.35000000 02	DT	.48000000 03	DR	.10553263 01	SHA	.28251917 06	DES	.18451435 02	DEM	.15891664 01
CCL	.25920166 03	MCL	.11192516 01	TCL	.11192516 01						

GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356664503332025444000000 J.D.= 2438605.22424520 JULY 28,1964 17 22 54.785

SMA	.24654005 06	ECC	.97607359 00	B	.53607772 05	SLR	.11656495 05	APO	.48718128 06	RCA	.58988163 04
VH	.13991439 00	C3	-.16167784 01	C1	.68163673 05	TFP	.14982521 06	TF	-.17084226 02	PER	.20304432 05
TA	.16934513 03	MTA	.18000000 03	EA	.99461039 02	MA	.44273647 02	C3J	-.20471674 01	TFI	.24533889 02

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.25084050 06	Y	.13402614 06	Z	.30322890 05	DX	.81614400 00	DY	.67379618 00	DZ	.22454298 00
INC	.28976671 02	LAN	.17015325 02	APF	.20329595 03	MX	-.45905374 00	MY	.75220646 00	MZ	.47271026 00
WX	.14176438 00	WY	-.46324717 00	WZ	.87481701 00	PX	-.77702823 00	PY	-.59959958 00	PZ	-.19159193 00
QX	.61329434 00	QY	-.65259660 00	QZ	-.44495799 00	RX	.15168230 00	RY	.11704677 00	RZ	-.98147467 00
BX	-.61329438 00	BY	.65259664 00	BZ	.44495801 00	TX	-.61091702 00	TY	.79169463 00	TZ	.00000000 00
DAP	-.11045703 02	RAP	.21765584 03								

BTQ	.47782174 05	BRQ	-.24303436 05	B	.53607772 05	THA	.33304076 03

T VECTOR IN EARTH EQUATOR PLANE

CASE 1 18SYS-JPTRAJ-SPACE 022265 3

HELIOCENTRIC EQUATORIAL COORDINATES

X	.92263957 08	Y	-.11070276 09	Z	-.48033337 08	DX	.24030557 02	DY	.17125344 02	DZ	.73583793 01
R	.15190437 09	LAT	-.18433738 02	LON	.30980913 03	V	.30412018 02	PTH	-.39832041 00	AZ	.75360793 02
XE	.92013117 08	YE	-.11083678 09	ZE	-.48063660 08	DXE	.23214413 02	DYE	.16451548 02	DZE	.71338363 01
XT	.92377612 08	YT	-.11072859 09	ZT	-.48053111 08	DXT	.22891571 02	DYT	.17338725 02	DZT	.75480396 01
LTE	-.18451435 02	LOE	.30969836 03	LTT	-.18429768 02	LOT	.30983725 03	RST	.15199850 09	VST	.29692226 02
EPS	.80928671 02	ESP	.10653118 00	SEP	.98964764 02	EPM	.13630553 03	EMP	.31295930 02	MEP	.12398535 02
MPS	.14275634 03	MSP	.25217635-01	SMP	.37216890 02	SEM	.11136139 03	EMS	.68505077 02	ESM	.13343921 00
RPM	.11821924 06	SPM	.79650888 02								
GCE	.10079833 03	GCT	.28191758 03	SIP	.14191393 03	CPT	.93302061 02	SIN	.92459653 02		
REP	.28601301 06	VEP	.10819020 01	CPE	.98321564 02	CPS	.76978757 02				

1 DAYS 0 HRS. 36 MIN. 2.000 SEC. 2356665615502020000000000 J.D.= 2438606.96111111 JULY 30,1964 11 04 00.000

GEOCENTRIC EQUATORIAL COORDINATES

X	.25103626 06	Y	.13418778 06	Z	.30376764 05	DX	.81519112 00	DY	.67322571 00	DZ	.22440404 00
R	.28626616 06	DEC	.60913377 01	RA	.28126092 02	V	.10807990 01	PTH	.77275751 02	AZ	.61614519 02
R	.28626615 06	LAT	.60913377 01	LON	.27401373 03	VE	.20574902 02	PTE	.29371153 01	AZE	.27031557 03
XS	-.92018688 08	YS	.11083283 09	ZS	.48061947 08	DXS	-.23213584 02	DYS	-.16452559 02	DZS	-.71342736 01
XM	.36441784 06	YM	.10840647 06	ZM	.10647809 05	DXM	-.32348484 00	DYM	.88698269 00	DZM	.41418345 00
XT	.36441784 06	YT	.10840647 06	ZT	.10647809 05	DXT	-.32348484 00	DYT	.88698269 00	DZT	.41418345 00
RS	.15185950 09	VS	.29333513 02	RM	.38034944 06	VM	.10309843 01	RT	.38034944 06	VT	.10309843 01
GEO	.61325336 01	ALT	.27988819 06	LOS	.15588715 02	RAS	.12970107 03	RAM	.16566608 02	LOM	.26245425 03
DUT	.35000000 02	DT	.48000000 03	DR	.10542562 01	SHA	.28277598 06	DES	.18450759 02	DEM	.16041929 01
CCL	.25920271 03	MCL	.11199342 01	TCL	.11199342 01						

GEOCENTRIC CONIC

EPOCH OF PERICENTER PASSAGE 2356664503352020060000000 J.D.= 2438605.22430609 JULY 28,1964 17 23 00.047

SMA	.24655219 06	ECC	.97608645 00	B	.53596202 05	SLR	.11650884 05	APO	.48720843 06	REA	.58959386 04
VH	.13987292 00	C3	-.16166988 01	C1	.68147266 05	TFP	.15005995 06	TF	-.17082765 02	PER	.20305931 05
TA	.16935879 03	HTA	.18000000 03	EA	.99498608 02	MA	.44339739 02	C3J	-.20471971 01	TFI	.24600555 02

ALL VECTORS REFERENCED TO EARTH EQUATOR PLANE

X	.25103626 06	Y	.13418778 06	Z	.30376764 05	DX	.81519112 00	DY	.67322571 00	DZ	.22440404 00
INC	.28978429 02	LAN	.17016156 02	APF	.20329300 03	HX	-.45922455 00	HY	.75209822 00	HZ	.47271731 00
WX	.14177917 00	WY	-.46327146 00	WZ	.87480215 00	PX	-.77705276 00	PY	-.59957162 00	PZ	-.19157992 00
QX	.61325999 00	QY	-.65260538 00	QZ	-.44499313 00	RX	.15167722 00	RY	.11703370 00	RZ	-.98147700 00
BX	-.61325984 00	BY	.65260523 00	BZ	.44499303 00	TX	-.61088707 00	TY	.79171775 00	TZ	.00000000 00
OAP	-.11045001 02	RAP	.21765367 03								

BTQ	.47770919 05	BRQ	-.24300045 05	B	.53596202 05	THA	.33303853 03	T VECTOR IN	EARTH EQUATOR PLANE

CASE 1 18SYS-JPTRAJ-SPACE 022265

HELIOCENTRIC EQUATORIAL COORDINATES

X	.92269724 08	Y	-.11069865 09	Z	-.48031570 08	DX	.24028775 02	DY	.17125784 02	DZ	.73586777 01
R	.15190432 09	LAT	-.18433041 02	LON	.30981194 03	V	.30410929 02	PTH	-.39840322 00	AZ	.75359724 02
XE	.92018688 08	YE	-.11083283 09	ZE	-.48061947 08	DXE	.23213584 02	DYE	.16452559 02	DZE	.71342736 01
XT	.92383105 08	YT	-.11072443 09	ZT	-.48051299 08	DXT	.22890099 02	DYT	.17339541 02	DZT	.75484571 01
LTE	-.18450759 02	LOE	.30970107 03	LTT	-.18429081 02	LOT	.30983999 03	RST	.15199824 09	VST	.29691674 02
EPS	.80937248 02	ESP	.10653118 00	SEP	.98956090 02	EPM	.13628907 03	EMP	.31338248 02	MEP	.12372678 02
MPS	.14276421 03	MSP	.25217635-01	SMP	.37208888 02	SEM	.11132686 03	EMS	.68539587 02	ESM	.13343921 00
RPM	.11793766 06	SPM	.79640594 02								
GCE	.10079728 03	GCT	.28191721 03	SIP	.14191979 03	CPT	.93304393 02	SIN	.92459974 02		
REP	.28626616 06	VEP	.10807990 01	CPE	.98322790 02	CPS	.76979031 02				

222462325467	220750470430	215753222173	201560037436	200757472061	177435677052	EARTH
	21187169515		17515413504		000000000000	INITIAL
222753160271	222404413161	217725145467	200642503745	200527270151	176711206656	EARTH
				235666561550	202000000000	END

STATION NUMBER 2 64/07/29 PAGE 1

TIME	R	DR	EL	AZ	DEC	HA	C1	CC3	C3	RU
110000	.16755796 06	.15050596 01	47.636	136.455	1.705	332.326	1010789.13	1023069.11	1023069.11	001144252115
113000	.17028671 06	.15274765 01	51.590	146.367	1.846	339.850	1010960.92	1023412.66	1023412.66	001156233643
120000	.17305866 06	.15529082 01	54.596	157.866	1.982	347.384	1011155.81	1023802.44	1023802.44	001170336233
123000	.17587845 06	.15804852 01	56.389	170.809	2.113	354.924	1011367.16	1024225.10	1024225.10	001202572225
130000	.17874913 06	.16093108 01	56.767	184.499	2.238	2.466	1011588.06	1024666.91	1024666.91	001215145375
133000	.18167214 06	.16384802 01	55.686	197.936	2.358	10.006	1011811.61	1025114.00	1025114.00	001227722501
140000	.18464729 06	.16670989 01	53.281	210.238	2.473	17.540	1012030.93	1025552.64	1025552.64	001242621237
143000	.18767281 06	.16943014 01	49.800	220.972	2.584	25.066	1012239.39	1025969.58	1025969.58	001255656163
150000	.19074539 06	.17192679 01	45.509	230.131	2.690	32.580	1012430.72	1026352.23	1026352.23	001271043153
153000	.19386032 06	.17412398 01	40.635	237.930	2.791	40.079	1012599.08	1026688.97	1026688.97	001304347341
160000	.19701158 06	.17595327 01	35.353	244.648	2.890	47.561	1012739.23	1026969.29	1026969.29	001317757503
163000	.20019198 06	.17735484 01	29.790	250.542	2.985	55.024	1012846.56	1027183.99	1027183.99	001333456273
170000	.20339335 06	.17827840 01	24.042	255.830	3.078	62.466	1012917.20	1027325.29	1027325.29	001347224263
173000	.20660669 06	.17868442 01	18.179	260.685	3.171	69.884	1012948.01	1027386.95	1027386.95	001363020561
180000	.20982235 06	.17854687 01	12.248	265.250	3.261	77.281	1012936.66	1027364.27	1027364.27	001376621343
183000	.21303024 06	.17787053 01	6.368	269.642	3.392	84.596	1012881.63	1027254.27	1027254.27	001412403511
190000	.21622002 06	.17707772 01	.803	273.967	3.697	91.643	1012782.75	1027056.52	1027056.52	001426123757

64/07/30

070000	.27016468 06	.74415302 00	1.327	84.522	5.232	267.906	1004988.50	1011468.10	1011468.10	001733233605
073000	.27150337 06	.73977832 00	7.101	88.762	5.109	275.090	1004928.05	1011347.15	1011347.15	001740144427
080000	.27283360 06	.73864767 00	13.138	93.055	5.125	282.487	1004916.70	1011324.41	1011324.41	001745035411
083000	.27416693 06	.74363618 00	19.237	97.503	5.181	289.962	1004954.21	1011399.38	1011399.38	001751734177
090000	.27551468 06	.75475478 00	25.283	102.228	5.234	297.453	1005039.15	1011569.20	1011569.20	001756665755
093000	.27688772 06	.77173927 00	31.236	107.375	5.289	304.964	1005169.18	1011829.23	1011829.23	001763676773
100000	.27829630 06	.79419018 00	37.030	113.131	5.344	312.493	1005341.17	1012173.16	1012173.16	001771012373
103000	.27974982 06	.82159878 00	42.574	119.735	5.398	320.037	1005551.19	1012593.16	1012593.16	001776252055
110000	.28125670 06	.85336002 00	47.745	127.498	5.450	327.594	1005794.57	1013079.91	1013079.91	002003655402

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 0000 142041      POINTING TIMES                                          (17
 0000 14204       JETGLV=640702911,0,640703011,0,1800,,60,
 0000 14204       TRANSMITTER ID TABLE                                    (26
 0000 14204       1,2038516,
 0000 14204       OFFLINE CONTROL                                         (27
 0000 14204       KEY(13)
 0000 14204       END DATA                                                (0
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STATION NUMBER 1 64/07/29 PAGE 1

TIME	R	DR	EL	AZ	DEC	HA	C1	CC3	C3	RU
110000	.16754786 06	.15050839 01	47.774	136.409	1.709	332.381	1010789.32	1023069.48	1023069.48	001144272111
113000	.17027675 06	.15276002 01	51.738	146.322	1.851	339.905	1010961.87	1023414.55	1023414.55	001156211137
120000	.17304902 06	.15531298 01	54.750	157.878	1.986	347.439	1011157.52	1023805.83	1023805.83	001170314205
123000	.17586929 06	.15808013 01	56.542	170.873	2.117	354.980	1011369.58	1024229.95	1024229.95	001202551115
130000	.17874062 06	.16097161 01	56.911	184.619	2.242	2.522	1011591.17	1024673.13	1024673.13	001215145445
133000	.18166443 06	.16389676 01	55.813	198.099	2.362	10.062	1011815.34	1025121.47	1025121.47	001227704147
140000	.18464053 06	.16676600 01	53.386	210.424	2.477	17.597	1012035.23	1025561.24	1025561.24	001242604517
143000	.18766711 06	.16949262 01	49.881	221.162	2.587	25.123	1012244.18	1025979.16	1025979.16	001255643443
150000	.19074087 06	.17199454 01	45.568	230.310	2.693	32.637	1012435.91	1026362.62	1026362.62	001271032575
153000	.19365706 06	.17419581 01	40.674	238.093	2.795	40.136	1012604.59	1026699.98	1026699.98	001304341251
160000	.19700963 06	.17602795 01	35.374	244.791	2.893	47.618	1012744.95	1026980.73	1026980.73	001317753775
163000	.20019140 06	.17743108 01	29.796	250.665	2.988	55.082	1012852.41	1027195.68	1027195.68	001333455217
170000	.20339415 06	.17835493 01	24.034	255.933	3.081	62.524	1012923.06	1027337.02	1027337.02	001347225653
173000	.20660885 06	.17875998 01	18.158	260.770	3.174	69.941	1012953.80	1027398.52	1027398.52	001363024613
180000	.20982585 06	.17862029 01	12.216	265.317	3.266	77.338	1012942.27	1027375.51	1027375.51	001376627777
183000	.21303504 06	.17794119 01	6.325	269.694	3.396	84.652	1012886.99	1027264.98	1027264.98	001412416471
190000	.21622604 06	.17716328 01	.759	274.003	3.705	91.691	1012787.78	1027066.60	1027066.60	001426137161

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070000	.27016126 06	.74354145 00	1.353	84.548	5.231	267.956	1004983.37	1011457.84	1011457.84	001733225267
073000	.27149878 06	.73915859 00	7.141	88.773	5.111	275.141	1004923.27	1011337.59	1011337.59	001740133761
080000	.27282795 06	.73808231 00	13.190	93.050	5.128	282.540	1004912.35	1011315.72	1011315.72	001745022735
083000	.27416031 06	.74313785 00	19.300	97.484	5.184	290.015	1004950.39	1011391.74	1011391.74	001751717675
090000	.27550123 06	.75433312 00	25.358	102.194	5.237	297.506	1005035.91	1011562.73	1011562.73	001756650015
093000	.27687959 06	.77140234 00	31.322	107.328	5.292	305.017	1005166.59	1011824.06	1011824.06	001763857613
100000	.27828764 06	.79394451 00	37.128	113.072	5.347	312.547	1005339.29	1012169.40	1012169.40	001770772225
103000	.27974081 06	.82144929 00	42.686	119.669	5.400	320.091	1005550.04	1012590.87	1012590.87	001776231171
110000	.28124751 06	.85330990 00	47.870	127.430	5.453	327.648	1005794.19	1013079.13	1013079.13	002003634236

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 0000 142111      OFFLINE CONTROL                                         (27
 0000 14211       TERMINATE JOB
 0000 14211       END DATA                                                (0
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IX. REFERENCES

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ACKNOWLEDGEMENT

The authors gratefully acknowledge the support of personnel at JPL in both analysis and programming. Significant contributions were made by J. D. Anderson, C. Cary, D. L. Cain, C. D. Coltharp, D. B. Holdridge, R. E. Holzman, A. L. Laxdal, N. S. Newhall, G. W. Null, K. Oslund, A. D. Rosenberg, J. R. Schoeni, A. D. Schoepke, W. L. Sjogren, and R. J. White. Historically, the plan for the SPODP was developed by R. H. Hudson from his experience with the Ranger III ODP. The authors regret that the above list is incomplete and extend their appreciation to all other contributors.