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## Technical Note

1969-21

Haystack Pointing System:  
Moon with Offsets

H. E. Frachtman

P. P. Crowther, Editor

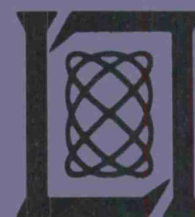
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
LINCOLN LABORATORY

HAYSTACK POINTING SYSTEM: MOON WITH OFFSETS

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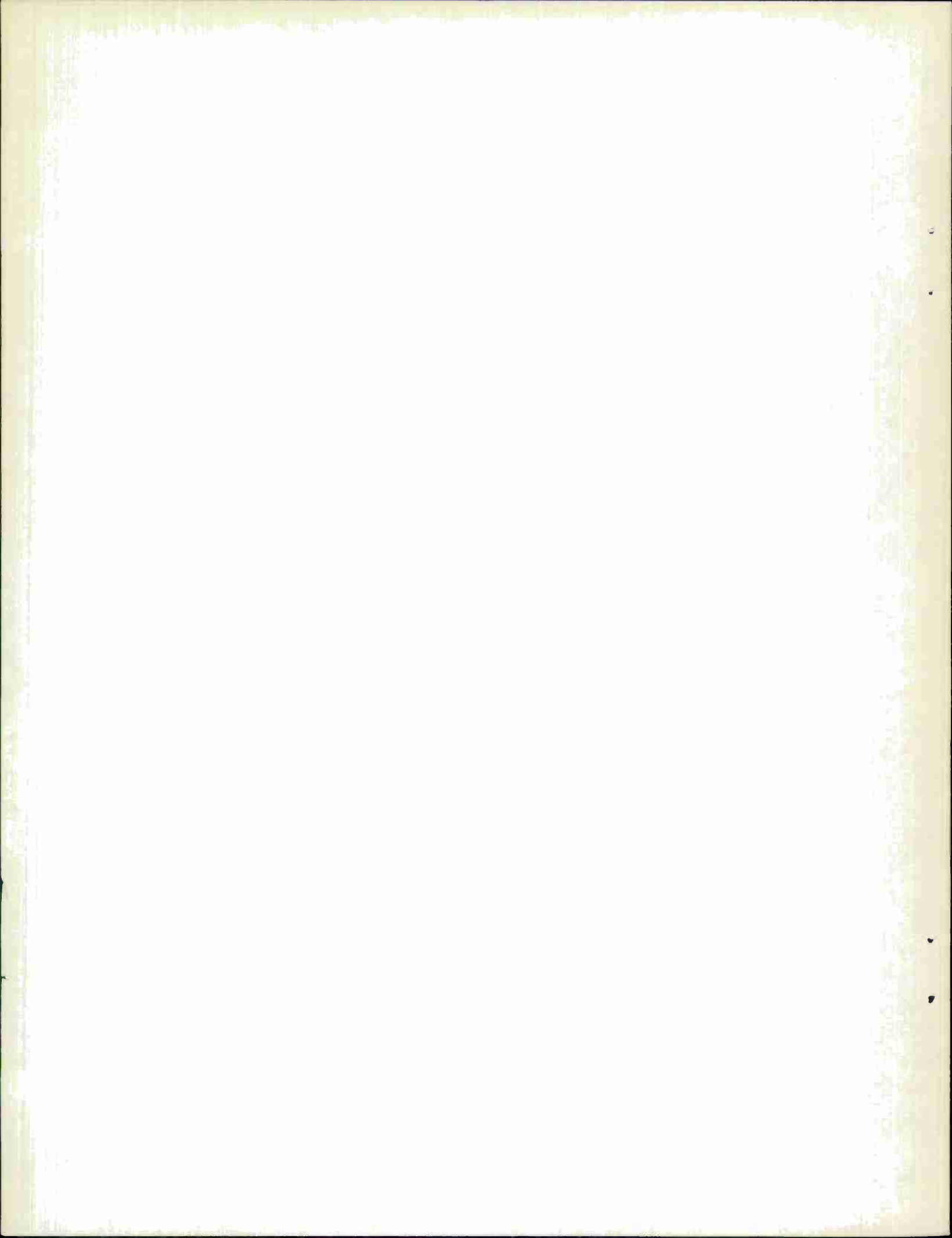
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#### ABSTRACT

This report describes the procedure used by the Haystack pointing computer program for obtaining the celestial coordinates of any point on the Moon at any time.

Accepted for the Air Force  
Franklin C. Hudson  
Chief, Lincoln Laboratory Office



# MOONTRACK

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## I. INTRODUCTION

MOONTRACK is a program in the Haystack Univac 490 pointing system whose output is the celestial coordinates of a point on the Moon at a given time. The program computes the coordinates of the center of the Moon by 4th difference interpolation in the tables of the apparent right ascension, declination, and radius vector of the Moon published in The American Ephemeris. The rates of change of the three quantities are computed by numerical differentiation. If the "offset" option is selected, the topocentric celestial coordinates of a particular point on the moon are computed using linear interpolation in tables derived from values of mean equator, orbit, longitude, and elongation given in the American Ephemeris (P. 51).

## II. INPUTS TO PROGRAM

### A. Inputs Furnished by Core Memory

The program uses the registers listed in Table I for input information. The year and day are used to select the appropriate entries from the ephemeris. The coordinates of the Moon are interpolated for the time which is the sum of the times in CELTIME and DELTATEE.

### B. Inputs Furnished by Magnetic Tape

The tape format of the Moon Ephemeris, which has been edited and recorded on tape by a CDC 3300 program described in Reference (1), is shown in Fig. 1. Each block of 192 words covers a period of one day. The ephemeris for each day requires 8 words for each of 24 hours. The program does not make use of the hour-year-month-day words in the block. The tape must be on Unit 1 (normally Servo B) of the Univac 490.

### C. Typewriter Inputs

After the ephemeris values for the center of the moon have been read in, the program asks whether offsets are to be entered. If so, the observer has the option of typing in 1) selenographic latitude and longitude (in degrees), 2) selenographic direction cosines, 3) observer coordinates (direction cosines centered on the sub-radar point), or 4) delay (in milliseconds) and

angle (degrees). Figure 2 shows typical keyboard sequences.

### III. PROGRAM OUTPUTS

#### A. Outputs Left in Core Memory

The apparent celestial coordinates of the selected point on the Moon corresponding to the time in the register CELTIME, together with their numerical derivatives, are stored in the appropriate registers, as illustrated in Table II. If the offset section is running, two registers are set to allow the DOPPLER program to compute offset doppler from leading edge doppler\*:  $D_{\text{off}} = D_{\text{l.e.}} \times \text{DOPFACTOR} + \text{MOONDOP2}$ . The offset section also sets MOONSW to 1, which causes some modifications to the coordinate conversion program.

---

\*Which comes from a special ephemeris tape - see Reference 4. Note that in "internal" doppler mode the offset doppler calculation is never done.

TABLE I  
CORE MEMORY INPUTS TO MOONTRACK PROGRAM

| <u>Register</u> | <u>Contents and Scaling</u>                                               |
|-----------------|---------------------------------------------------------------------------|
| W(CELTIME)      | Days B28                                                                  |
| W(DELTATEE)     | Days B28                                                                  |
| U(YEARMONTH)    | Year B15 (4 decimal digits)                                               |
| L(YEARMONTH)    | Month B0                                                                  |
| L(DAY)          | Day of Year B0                                                            |
| W(EQUATOR)      | Equatorial radius of Earth B17                                            |
| W(SIDERTIME)    | Right ascension of Haystack at<br>CONVERTIME-2 <sup>S</sup> (radians B26) |
| W(GEOCENLAT)    | Latitude of Haystack (degrees B20)                                        |

NOTE: Notation "B28" means that  
the binary point is to the right  
of bit 28.

3-62-3003

|                  |                 |                 |      |    |                         |                        |       |   |     |   |
|------------------|-----------------|-----------------|------|----|-------------------------|------------------------|-------|---|-----|---|
| I. D.            |                 | 13 <sub>d</sub> | 14   |    | Conventional Day Number |                        | 0     |   |     |   |
| All Zero         |                 | 19              | Hour | 14 | Year                    | 8                      | Month | 4 | Day | 0 |
| Right Ascension  |                 |                 | B26  |    |                         | Radians                |       |   |     |   |
| First Difference | Right Ascension |                 | B26  |    |                         | Radians                |       |   |     |   |
| Declination      |                 |                 | B26  |    |                         | Radians                |       |   |     |   |
| First Difference | Declination     |                 | B26  |    |                         | Radians                |       |   |     |   |
| Radius Vector    |                 |                 | B22  |    |                         | Earth Equatorial Radii |       |   |     |   |
| First Difference | Radius Vector   |                 | B22  |    |                         | Earth Equatorial Radii |       |   |     |   |

Fig. 1. Magnetic tape format for moon ephemeris.

TABLE II

## CORE MEMORY OUTPUTS OF MOONTRACK PROGRAM

| <u>Register</u> | <u>Contents and Scaling</u>                                                                 |
|-----------------|---------------------------------------------------------------------------------------------|
| W(RA)           | Apparent Right Ascension B27 in revolutions                                                 |
| W(DEC)          | Apparent Declination B27 in revolutions                                                     |
| W(RADIUS)       | Distance from center of Earth to center of Moon, B22 Earth Equatorial radii                 |
| W(RADOT)        | Numerical Derivative of Right Ascension B37 radians/sec.                                    |
| W(DEC DOT)      | Numerical Derivative of Declination B37 radians/sec.                                        |
| W(RADIUS DOT)   | Numerical Derivative of Radius Vector B24 nautical miles/sec                                |
| W(MOONSW\$)     | 0 for moon center run<br>1 for moon offset run                                              |
| W(DOPFACTOR\$)  | Dimensionless                                                                               |
| W(MOONDOP2\$)   | Cycles/sec B8. The last two values are used for offset doppler computations - see Ref. (4). |

RIGHT ASC        1H 14M 12.40S  
 DECLINATION     90 49 ' 22.58"  
 DAY OF YEAR     51  
 UNIVERSAL TIME 1 3H 45M 29.00S  
 DISTANCE(E.R.) 60.808804  
 OBJECT           MOON  
 OFFSET (Y/N)    Y\*  
 LAT+LONG(1) DIR. COS(2) OBSERVER COORD(3) DELAY+ANG(4)    1\*  
 LAT=    4.294\*  
 LONG=   34.769\*  
  
 LAT+LONG(1) DIR. COS(2) OBSERVER COORD(3) DELAY+ANG(4)    2\*  
 X(S)=   .568669\*  
 Y(S)=   .074867\*  
  
 LAT+LONG(1) DIR. COS(2) OBSERVER COORD(3) DELAY+ANG(4)    3\*  
 X(O)=   .5\*  
 Y(O)=   .5\*  
  
 LAT+LONG(1) DIR. COS(2) OBSERVER COORD(3) DELAY+ANG(4)    4\*  
 DELAY(MS)=    7.0\*  
 ANGLE=   180\*

Fig. 2. MOONTRACK initialization sequences.

## B. Typewriter Outputs

During initialization the MOONTRACK program will type, using the INTERCOM subroutine, certain information concerning the Moon (see Figure 3). Items printed are:

1. Julian Day corresponding to values in YEARMONTH, DAY, and CELTIME (7 digits).
2. Apparent Right Ascension of the Moon (Hours, Minutes, Seconds to hundredths).
3. Apparent Declination of the Moon (Degrees, Minutes, Seconds to hundredths).
4. Day of Year corresponding to values in YEARMONTH and DAY (up to 3 digits).
5. Universal Time for which the coordinates are interpolated. It is the time in CELTIME at initialization (Hours, Minutes, Seconds to hundredths).
6. The distance between the centers of the Earth and the Moon (Earth's Equatorial radii to millionths).
7. The words "OBJECT MOON".

At this point the observer may select offsets, if desired; see part II-C.

If, after a search through 12 files on Unit 1 (or the finding of an end of tape mark), the moon ephemerides are not found, the program will type "MOON EPHEMERIS FOR X/Y NOT AMONG FIRST 12 FILES" and will exit to the master control program error return. "X" and "Y" indicate the current month and year, respectively.

If there is a tape servo malfunction during search, the program will type "IIIC STATUS S1 ZZ" and will exit to the master control program error return. The two digit octal number "ZZ" comes from the tape status word and indicates the error condition.

## IV. ASTRONOMICAL SIGNIFICANCE

The apparent right ascension and declination of the Moon in the ephemerides are referred to the true equinox and equator of date and are corrected

for planetary aberration. They are geocentric apparent quantities; the parallax correction is made by the coordinate conversion program (COCON) in the Haystack system unless the moon offset program is running. (If MOONSW\$ is 1, COCON allows MOONTRACK to do the parallax correction and sets the center of the earth at the radar site for subsequent calculations.)

The values in the tables are computed for Ephemeris Time as argument. The equation

$$ET = UT + \Delta T$$

is used to convert from Universal Time to Ephemeris Time. The constant  $\Delta T$ , represented by the number in the register DELTATEE, is approximately 39 seconds.

The values for the radius vector and first difference of the radius vector which appear on the ephemeris tape (Figure 1) are computed from the Moon's horizontal parallax which occurs in the source data. The formula

$$D = \frac{1}{\sin h}$$

is used by the tape preparation program (Reference 1) to compute the distance D, in units of Earth's equatorial radii, from the geocentric equatorial horizontal parallax h. The register EQUATOR contains a number which represents the Earth's equatorial radius in nautical miles.

## V. PROGRAM DETAILS

The MOONTRACK program is a subroutine of the Haystack Univac 490 pointing program. The initialization section begins at MOONINIT, the working section at MOONCONT. There are several closed subroutines within the moon center part of MOONTRACK. These are: DAYFIND, STATUSCK, INTERPOL, LEFRNDOFF, and MOONTIME. An additional 29 closed subroutines perform the calculations required for pointing at an offset position on the moon. A listing of the program is given in Appendix IV.

### A. Initialization

The program, upon initialization, stores a Release Interrupt Lockout

instruction in the tape channel internal interrupt register, and a call to the STATUSCK subroutine in the external interrupt register. The area in core into which the tape data will be read is cleared, together with some additional registers. This is done to make diagnosis easier in case of malfunction.

The daily Moon ephemeris entries are serially numbered by the program which generates the magnetic tape (Reference 1). These serial numbers are called "Conventional Day Numbers" (CDN). An arbitrary decision was made to produce and use tapes such that the CDN for April 1963 is zero. The tape search process looks at the first word in each block; therefore the MOONTRACK program must compute the CDN of the block containing the entry for the required hour.

Using as inputs the year, day of year, and CELTIME, the program computes the Julian Day number for the typewriter. The ephemerides start and run continuously from 25 April 1963, which has a Julian Day Number of 2438144.5; this number is subtracted from the computed Julian Day number and appears on tape as the Conventional Day Number. The first CDN in a block is stored in SAFE and TAPEBLOCK and the Moon identification number is added to generate a tape search comparison word.

Six blocks of Moon ephemerides are read to provide sufficient data for 4th difference Bessel interpolation for a four day period.

If the six block search and read operations are successful control is regained at NORMAL and the tape is rewound without interrupt or interlock.

The MOONTIME subroutine is entered to select and store the address of the ephemeris entries corresponding to the hour of the day and to compute the interpolation argument P. The register TIME2 contains a number representing the integral number of hours in the sum of CELTIME and DELTATEE.

Besselian interpolation of right ascension is done by the INTERPOL subroutine and the interpolated result is converted to hours, minutes, and seconds and stored for type out. Declination and distance are then interpolated and stored for type out. The other quantities which are to be typed out by INTERCOM are set up. Control is transferred to INTERCOM 7 times for the seven line type out.

Subroutine 1 of the moon offset section is then called. This asks, via INTERCOM, whether the operator wants to type in offsets, and calls one of four input subroutines (numbers 2 through 5) for the operator's choice of input format. The input routines leave either selenographic coordinates ( $X_s, Y_s, Z_s$ ) or observer coordinates ( $X_o, Y_o, Z_o$ ) in core for the working section of the program.

This completes operation of the MOONTRACK initialization section.

#### B. Working Section

The MOONTRACK working section begins at MOONCONT. Control is transferred to the subroutine MOONTIME which selects the ephemeris entry corresponding to the current hour, stores the addresses of the table entries, and computes the interpolation argument P from the given value of CELTIME. The INTERPOL subroutine is then entered three times for the interpolation of right ascension, declination, radius and their time rates. All values are converted, scaled and stored properly in core memory.

If C/S MOONSW\$ is zero at this point, control is transferred to the master control program.

If C/S MOONSW\$ is set to 1, subroutines 6 through 29 of the moon offset section are executed sequentially. Numbers 6 through 24 calculate the selenographic coordinates  $l'$  and  $b'$  of the subradar point, the apparent position angle  $C'$  of the moon's axis of rotation, and the rates of change of these three quantities. 25 through 29 calculate offsets in right ascension and declination and add them to RA and DEC in common storage, and calculate the doppler offset parameters MOONDOP2\$ and DOPFACTOR\$.

The equations used were derived by Thomas Thompson from references 2 (pp. 60-62) and 5 (pp. 63, 76-77).

#### C. Subroutines - Moon Center Section

The initialization section of the MOONTRACK program makes use of the INTERPOL, DAYFIND, STATUSCK, LEFRNDOFF, and MOONTIME subroutines. The working section uses all except STATUSCK.

# 1. INTERPOL

The MOONTRACK interpolation subroutine uses Bessel's interpolation formula for (Reference 3) 4th difference interpolation of the Moon's ephemeris. The formula is

$$f_p = f_0 + P\delta f_{1/2} + \frac{P(P-1)}{4} [\delta^2 f_0 + \delta^2 f_1] \\ + \frac{P(P-1)(P-1/2)}{6} \delta^3 f_{1/2} + \frac{(P+1)P(P-1)(P-2)}{48} (\delta^4 f_0 + \delta^4 f_1)$$

The quantities in the formula are associated with computer registers as follows:

- a. The address of  $f_0$  is in index register 4.
- b. The interpolation argument  $P$  is in register  $P$ .
- c.  $\delta f_{1/2}$  is in register GAMMA.
- d.  $P(P-1)$  is in register PSQMP.
- e.  $\delta^2 f_0 + \delta^2 f_1$  is in register DMINB.
- f.  $\frac{P(P-1)}{6}$  is in register PSQMP6.
- g.  $\delta^3 f_{1/2}$  is in register DMIN2CPLB.
- h.  $(\delta^4 f_0 + \delta^4 f_1)$  is in register EP2BM2DMA.
- i.  $f_p$  is in the A register at the finish.

The subroutine also performs numerical differentiation using the following formula (Reference 3):

$$hf'_p = \delta f_{1/2} + \frac{2P-1}{4} [\delta^2 f_0 + \delta^2 f_1] \\ + \frac{3P^2 - 3P + 1/2}{6} \delta^3 f_{1/2}$$

At the completion of the subroutine,  $hf'_p$  is stored in the register NUMDERIV.

When the subroutine is entered, Index Register 4 contains the address of  $f_0$  and the register SETINTAD contains the address of  $\delta f_{1/2}$  of the quantity to be interpolated. Index register 3 is used to acquire the other two first difference registers.

## 2. DAYFIND

The DAYFIND subroutine computes the Julian Day number and CDN corresponding to the current day.

## 3. STATUSCK

The STATUSCK subroutine is entered from the external interrupt register associated with the tape channel when the interrupt occurs. Examination of the status code generates four possible outcomes:

a. If the code indicates a normal completion, control is returned to the program at the interrupted point.

b. If the code indicates that an end of tape mark was sensed, the tape is rewound and a message indicating failure to find the ephemeris is printed by the typewriter. The message is described in Section III B. Control is passed to the error return of the master control program.

c. If the code indicates that an end of file mark was sensed, the register IMPERIAL is indexed and tested for the value 12. When less than 12 an end of tape condition is assumed and the action is as described in (b) above.

d. If the code indicates anything but end of file, end of tape, or normal completion, a tape error has occurred. The message described in Section III B, indicating the type of error, is printed by the typewriter and control is passed to the error return of the master control program.

## 4. LEFRNDOFF

The LEFRNDOFF subroutine left shifts the AQ register the number of places indicated by the contents of index register 5 and rounds the A register.

## 5. MOONTIME

The MOONTIME subroutine computes the integral value of the current ephemeris hour and stores the addresses of the quantities to be interpolated.

It computes the value of the interpolation argument P.

#### D. Subroutines - Moon Offset Section

The following equations were used in the offset option section of the MOONTRACK program. The original MOONTRACK was not altered but augmented to accept additional input parameters and result in additional output parameters.

The additional subprograms or sections are numbered 1 through 29. The first five of these are initialization and the remaining are executed sequentially in the working section.

Appendix I is a list of internally stored constants and conversion factors.

Parameters concerning the offset are entered via the console during initialization. Additional ephemeris parameters have not been added to the EPHEMERIS tape but instead are located at the end of the program in four tables. The format of these tables, the interpolation procedure, and the Fortran program for generating them are given in Appendix III.

All other additional parameters are taken from COMMON storage or from the original moontrack program.

The labels used by the moon offset subroutines are defined in Appendix II and their scalings are given.

#### INITIALIZATION

Subprograms 1, 2, 3, 4, and 5 are independent subroutines.

##### (1) MXINIT

Via the console the following input is accepted:

|      |                                   |
|------|-----------------------------------|
|      | OFFSET (Y or N)                   |
| if Y | IAT/LONG (1), DIR-COSINE (2),     |
|      | OBSERVER-COORD (3), DELAY-ANG (4) |

(2) MXINPOSA

Called if LAT/LONG was selected. Accepts selenographic latitude ( $\beta$ ) and longitude ( $\lambda$ ) as input via the console.

$$\beta = \text{(degrees)} \quad -90^\circ \leq \beta \leq 90^\circ$$

$$\lambda = \text{(degrees)}, \quad -180^\circ \leq \lambda \leq 180^\circ$$

It then determines the values

$$X_s = \cos \beta \sin \lambda$$

$$Y_s = \sin \beta$$

$$Z_s = \cos \beta \cos \lambda$$

(3) MXINPOSB

Called if DIR-COSINE was selected. Accepts the selenographic direction cosines ( $\xi, \eta$ ) as input

$$X_s = \text{(} -1 \leq X_s \leq 1 \text{)}$$

$$Y_s = \text{(} -1 \leq Y_s \leq 1 \text{)}$$

Then finds the value

$$Z_s = [1 - X_s^2 - Y_s^2]^{1/2}$$

(4) MXINPOSC

This is the observer coordinate option, and accepts

$$X_o = \text{(} -1.0 \leq X_o \leq 1.0 \text{)}$$

$$Y_o = \text{(} -1.0 \leq Y_o \leq 1.0 \text{)}$$

to find

$$Z_o = (1 - X_o^2 - Y_o^2)^{1/2}$$

(5) MXINPOSD

This accepts the position as given by a delay and angle from the axis of rotation.

$$\text{DELAY} = (\text{milliseconds}, 0 \leq \text{DELAY} \leq 12.0)$$

$$\text{ANG} = (\text{degrees}, -360^\circ \leq \text{ANG} \leq 360^\circ)$$

The following is then calculated.

$$Z_o = 1 - \text{DELAY}/11.595 + \alpha[1 - 1/2 (\text{DELAY}/11.595)]$$

$$\Gamma_o = (1 - Z_o^2)^{\frac{1}{2}}$$

$$X_o = \Gamma_o \cos (90^\circ - \text{ANG})$$

$$Y_o = \Gamma_o \sin (90^\circ - \text{ANG})$$

where

$$\alpha = 4.52139 \times 10^{-3}$$

(6) MXLHA

$$\text{LHA}_o = \text{LST} - \alpha_o$$

$$d(\text{LHA}_o)/dt = \omega_\epsilon - d\alpha_o/dt$$

where

$$\alpha_o = \text{right ascension}$$

$$\text{LST} = \text{local sidereal time}$$

$$\omega_\epsilon = 7.292116 \times 10^{-5} \text{ rad/sec.}$$

(7) MXRO

$$\cos z_o = \sin \phi \sin \delta_o + \cos \phi \cos \delta_o \cos LHA$$

where

$\phi$  = geocentric latitude of site

$\delta_o$  = declination of moon

$$RT = [1 - 2 (\rho/D_o) \cos z_o + (\rho/D_o)^2]^{\frac{1}{2}}$$

$$R_o = D_o RT$$

$$DELAY = 2 R_o/c$$

where

$$1/c = 1/\text{speed of light} = .02127558 \text{ sec/e.r.}$$

$\rho$  = geocentric radius of site in E.R.

$D_o$  = center of earth to center of moon distance  
in E.R., from ephemeris.

(8) MXRODT

$$\begin{aligned} d(\cos z_o)/dt &= (\sin \phi \cos \delta_o - \cos \phi \sin \delta_o \cos LHA) d\delta_o/dt \\ &\quad - (\cos \phi \cos \delta_o \sin LHA) d(LHA)/dt \end{aligned}$$

$$dR_o/dt = \frac{1}{RT} [(1 - (\rho/D_o) \cos z_o) \frac{dD_o}{dt} - \rho_1 \frac{d(\cos z_o)}{dt}]$$

where

$$\rho_1 = \rho \text{ in n.m} = 3.438755435 \times 10^3$$

(9) MXDOP

$$DOPD = 2f_c \frac{dR_o}{dt} [1 - \frac{dR_o}{dt} \cdot \frac{1}{c}]$$

$$f_c = f_t/c$$

(10) MXA

$$A = -\cos \delta_o \sin LHA$$

$$\frac{dA}{dt} = -\sin \delta_o \sin LHA \frac{d\delta_o}{dt} + \cos \delta_o \cos LHA \frac{d(LHA)}{dt}$$

(11) MXB

$$B = \cos \delta_o \cos LHA - (\rho/D_o) \cos \phi$$

$$\begin{aligned} \frac{dB}{dt} = & -\sin \delta_o \cos LHA \frac{d\delta_o}{dt} - \cos \delta_o \sin LHA \frac{d(LHA)}{dt} \\ & + (\rho/D_o^2) \cos \phi \frac{dD_o}{dt} \end{aligned}$$

(12) MXC

$$C = \sin \delta_o - (\rho/D_o) \sin \phi$$

$$\frac{dC}{dt} = \cos \delta_o \frac{d\delta_o}{dt} + (\rho/D_o^2) \sin \phi \frac{dD_o}{dt}$$

(13) MXDELP

$$\sin \delta' = \frac{CD_o}{R_o}$$

$$\delta' = \sin^{-1} (\sin \delta')$$

calculates  $\cos \delta'$

(14) MXALF

$$AB = \frac{D_o \cos \delta'}{R_o}$$

$$\sin LHA' = A/AB$$

$$LHA' = \sin^{-1} (\sin LHA')$$

$$\alpha' = \begin{cases} LST - LHA' & \text{if difference is positive.} \\ LST - LHA' + 2\pi & \text{if difference is negative.} \end{cases}$$

(15) MXDECPDT

$$AB = [A^2 + B^2]^{\frac{1}{2}} = \frac{D_o \cos \delta'}{R_o}$$

$$\frac{d(AB)}{dt} = \frac{\frac{A}{AB} \frac{dA}{dt} + \frac{B}{AB} \frac{dB}{dt}}{AB}$$

$$\frac{d\delta'}{dt} = (AB \frac{dC}{dt} - C \frac{dAB}{dt}) / (R_o^2 / D_o^2)$$

(16) MXAPDT

$$\frac{d\alpha'}{dt} = \omega_e - \frac{[B \frac{dA}{dt} - A \frac{dB}{dt}]}{2 AB}$$

(17) MXA1

$$AA = -\cos \delta' \cos (\alpha' - \Omega')$$

$$\frac{dAA}{dt} = \sin \delta' \cos (\alpha' - \Omega') \frac{d\delta'}{dt} + \cos \delta' \sin (\alpha' - \Omega') \frac{d\delta'}{dt}$$

(18) MXB1

$$BB = -\cos \delta' \cos i \sin (\alpha' - \Omega') - \sin \delta' \sin i$$

$$\begin{aligned} \frac{d(BB)}{dt} &= [\sin \delta' \cos i \sin (\alpha' - \Omega') - \cos \delta' \sin i] \frac{d\delta'}{dt} \\ &\quad - \cos \delta' \cos i \cos (\alpha' - \Omega') \frac{d\alpha'}{dt} \end{aligned}$$

(19) MXC1

$$CC = \cos \delta' \sin i \sin (\alpha' - \Omega') - \sin \delta' \cos i$$

$$\begin{aligned} \frac{d(CC)}{dt} &= [-\sin \delta' \sin i \sin (\alpha' - \Omega') - \cos \delta' \cos i] \frac{d\delta'}{dt} \\ &\quad + \cos \delta' \sin i \cos (\alpha' - \Omega') \frac{d\alpha'}{dt} \end{aligned}$$

(20) MXSINBP

$$\sin b' = CC$$

$$b' = \sin^{-1} (\sin b')$$

calculates  $\cos b'$

(21) MXSINLP

$$l' = \sin^{-1} \left[ \frac{BB}{\cos b'} \right] - (\mathcal{C} - \Omega + \Delta)$$

calculates  $\sin l'$ ,  $\cos l'$

(22) MXSINCP

$$\sin C' = -\sin i \cos (\alpha' - \Omega') / \cos b'$$

$$C' = \sin^{-1} (\sin C')$$

calculates  $\cos C'$

(23) MXBPDT

$$\frac{db'}{dt} = \left( \frac{d(CC)}{dt} \right) / \cos b'$$

(24) MXLPDT

$$\frac{dl'}{dt} = \left[ A \frac{d(BB)}{dt} - B \frac{d(AA)}{dt} \right] / \cos^2 b' - \frac{d}{dt} (\mathcal{C} - \Omega + \Delta)$$

(25) MXFCL

$$\omega_x = db'/dt$$

$$\omega_y = -\cos b' dl'/dt$$

$$\omega_a = [\omega_x^2 + \omega_y^2]^{\frac{1}{2}}$$

$$FCL = -2 f_c b \omega_a \left[ 1 - \frac{1}{c} d R_o / dt \right],$$

where  $b$  = lunar radius in n.m.

(26) MXDA

$$\sin da = \omega_x / \omega_a$$

$$\cos da = \omega_y / \omega_a$$

(27)\* MXXYZ (If input was selenographic coords)

$$X_o = X_s \cos l' - Z_s \sin l'$$

$$Y_o = -X_s \sin l' \sin b' + Y_s \cos b' - Z_s \cos l' \sin b'$$

$$Z_o = X_s \sin l' \cos b' + Y_s \sin b' + Z_s \cos l' \cos b'$$

(28) MXDELALF

$$S = b/R_o, \quad b = \text{lunar radius}$$

$$\Delta\alpha = -[X_o \cos C' - Y_o \sin C'] S / \cos(\delta')$$

$$\Delta\delta = [Y_o \cos C' + X_o \sin C'] S$$

(29) MXDPDOP

$$RTX = [1 - 2 Z_o S + S^2]^{\frac{1}{2}}$$

$$D_p = \text{DELAY} \cdot RTX$$

$$\text{DOP1} = [1 - Z_o S] \text{DOPP}/RTX$$

$$\text{DOP2} = -X_d \text{FCL}/RTX = C/S \text{ MOONDOP2}\$, \text{ Hz B8.}$$

$$\text{DOPPLER} = \text{DOP1} + \text{DOP2}$$

$$X_d = X_o \cos da - Y_o \sin da$$

$$\alpha_p = \alpha' + \Delta\alpha$$

$$\delta_p = \delta' + \Delta\delta$$

\*Equ. (52), p. 77 of Reference 5.

(29) MXDPDOP (Continued)

$$R_p = R_o \cdot RTX$$

$$dR_p/dt = [(1 - Z_o S) dR_o/dt + \omega_b X_d]/RTX$$

$$C/S \text{ DOPFACTOR\$} = DOP1/DOPP = [1 - Z_o S]/RTX$$

E. Utility Subroutines - Moon Offset Section

1. ROUND                      Rounds value in AQ to A
2. SINX (COSX)              In: A = \* radians  
                              Q = B (binary point)  
                              Out: A = sin (cos) \* B28
3. SQRT                      In: A = N (binary point at 2M, where  
                                              M is an integer)  
                              Out: A =  $\sqrt{N}$  (binary point at M + 14)
4. SOVERFLOW                General error routine---prints the error  
                                              address on the high speed printer, sets  
                                              A to zero, and exits.
5. ASINX (ACOSX)            In: A = sin (cos) \*  
                                              Q = B (binary point)  
                              Out: A = \* B27 radians
6. SADD (SSUB)              In: A = X  
                                              Q = Y  
                                              Output: A = X , Y  
  
                                              This routine has an error return to the calling  
                                              address + 1, normal return to calling address  
                                              + 2.

| CONSTANTS    |              |                              |             |          |                                      |
|--------------|--------------|------------------------------|-------------|----------|--------------------------------------|
| <u>Quan.</u> | <u>Label</u> | <u>Value</u>                 | <u>Unit</u> | <u>B</u> | <u>Description</u>                   |
| 1/c          | MKQCCER      | .02127558                    | sec/e.r.    | 29       | reciprocal of speed of light         |
| 1/c          | MKQRCNM      | $6.1775959 \times 10^{-6}$   | sec/n.m.    | 37       | " " " " "                            |
| b            | MKQBER       | .2724876721                  | e.r.        | 29       | lunar radius                         |
| b            | MKQBNM       | 938.4449184                  | n.m.        | 19       | " "                                  |
| -            | MKQ11        | 11.595                       | ms          | 25       | center-to-limb time delay            |
| -            | MKHLEF       | 0.500                        | -           | 29       | - - - -                              |
| -            | MKQNMPER     | $3.4439903 \times 10^3$      | -           | 27       | conversion factor n.m./e.r.          |
| -            | MKQERPNM     | $2.903608566 \times 10^{-4}$ | -           | 40       | " " e.r./n.m.                        |
| -            | MKRADDEG     | .017453295                   | -           | 29       | " " rad./deg.                        |
| -            | MKONE28      | 1.000                        | -           | 28       | - - - -                              |
| -            | MKQR11       | .08624407                    | 1/ms        | 29       | 1/11.595                             |
| $\zeta$      | MKQRHO       | .99848                       | e.r.        | 29       | geocentric radius of site            |
| $\alpha$     | MKQALF       | $4.52139 \times 10^{-3}$     | -           | 29       |                                      |
| $\zeta$      | MKQRO        | $3.4387554 \times 10^3$      | n.m.        | 17       | geocentric radius of site            |
| $\omega_e$   | MKQWE        | $7.292116 \times 10^{-5}$    | rad/sec     | 42       | $\omega_e$ angular velocity of earth |
| $f_c$        | MKQFC        | $4.787638 \times 10^4$       | cyc/n.m.    | 13       | frequency of transmitter /c          |

Constants and Conversion Factors  
(moon offset section)

APPENDIX I.

# CONSTANTS & CONVERSION FACTORS

| <u>Label</u> | <u>Value</u>        | <u>B</u> |
|--------------|---------------------|----------|
| REVS RADIAN  | revolutions/radians | 31       |
| HALFDAY      | 1/2                 | 28       |
| HOURL        | days/hour           | 28       |
| SRAD         | seconds/radian      | 15       |
| HRAD         | radians/hour        | 28       |
| MINSRAD      | radians/minute      | 36       |
| HDAY         | days/hour           | 32       |
| MDAY         | days/min            | 39       |
| SDAY         | seconds/day         | 12       |
| SECSRAD      | radians/second      | 42       |
| SARAD        | seconds/radian      |          |
| RHRSEC       | hours/sec           | 40       |
| TWOPIE       | 2 $\pi$             | 26       |
| THIRD        | 1/3                 | 28       |
| SIXTH        | 1/6                 | 28       |

# APPENDIX II

## LABELS, Definitions, & Scaling (moon offset section)

### OUTPUT

| <u>Routine</u> | <u>Label</u> | <u>Description</u>                                                                                                                                  | <u>Unit</u> | <u>B</u> |
|----------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|
| 1              | MOONSW\$*    | 0 = no offset<br>1 = offset                                                                                                                         |             | 0        |
|                | MKPOSSW*     | 0 = selenographic position<br>B, $\lambda$<br>1 = selenographic position<br>$\xi, \eta$<br>2 = observer coordinates<br>3 = delay & axis of rotation |             | 0        |
| 2              | MKINBETA     | input $\beta$                                                                                                                                       | deg.        | 20       |
|                | MKINLAMBDA   | input $\lambda$                                                                                                                                     | deg.        | 20       |
|                | MKBETA       | input $\beta$                                                                                                                                       | rad.        | 27       |
|                | MKLAMBDA     | input $\lambda$                                                                                                                                     | rad.        | 27       |
|                | MKSINB       | sin $\beta$                                                                                                                                         | -           | 28       |
|                | MKCOSE       | cos $\beta$                                                                                                                                         | -           | 28       |
|                | MKSINL       | sin $\lambda$                                                                                                                                       | -           | 28       |
|                | MKCOSE       | cos $\lambda$                                                                                                                                       | -           | 28       |
|                | MKXS*        | $X_s$                                                                                                                                               | -           | 28       |
|                | MKYS*        | $Y_s$                                                                                                                                               | -           | 28       |
|                | MKZS*        | $Z_s$                                                                                                                                               | -           | 28       |
| 3              | MKXS2        | $X_s^2$                                                                                                                                             | -           | 28       |
|                | MKYS2        | $Y_s^2$                                                                                                                                             | -           | 28       |
|                | MKZS2        | $Z_s^2$                                                                                                                                             | -           | 28       |
|                | MKZS*        | $Z_s$                                                                                                                                               | -           | 28       |
| 4              | MKXO2        | $X_o^2$                                                                                                                                             | -           | 28       |
|                | MKYO2        | $Y_o^2$                                                                                                                                             | -           | 28       |
|                | MKZO2        | $Z_o^2$                                                                                                                                             | -           | 28       |
|                | MKZO*        | $Z_o$                                                                                                                                               | -           | 28       |

\*Indicate final output of routine

| <u>Routine</u> | <u>Label</u> | <u>Description</u>                  | <u>Unit</u> | <u>B</u> |
|----------------|--------------|-------------------------------------|-------------|----------|
| 5              | MKDANG       | $\pi/2$ - input *                   | rad         | 27       |
|                | MKSINDA      | $\sin(\pi/2 - *)$                   | -           | 28       |
|                | MKCOSDA      | $\cos(\pi/2 - *)$                   | -           | 28       |
|                | MKDKK2       | $D/11.595$                          | -           | 28       |
|                | MKT1         | $\alpha[1 - 1/2 (D/11.595)]$        | -           | 28       |
|                | MKT2         | $1 - D/11.595$                      | -           | 28       |
|                | MKZO*        | $Z_o$                               | --          | 28       |
|                | MKZO2        | $Z_o^2$                             | -           | 28       |
|                | MKZRO2       | $1 - Z_o$                           | -           | 28       |
|                | MKZRO        | $(1-Z_o)^{\frac{1}{2}}$             | -           | 28       |
|                | MKXO*        | $X_o$                               | -           | 28       |
|                | MKYO*        | $Y_o$                               | -           | 28       |
| 6              | MKLHA*       | lha (geocentric)                    | rad         | 26       |
|                | MKLHADT*     | $d(lha)/dt$                         | rad/sec     | 42       |
| 7              | MKGEOLAT     | $\phi_c$                            | rad         | 26       |
|                | MKSINGLAT    | $\sin \phi_c$                       | -           | 28       |
|                | MKCOSGLAT    | $\cos \phi_c$                       | -           | 28       |
|                | MKSINDEC     | $\sin \delta_o$                     | -           | 28       |
|                | MKCOSDEC     | $\cos \delta_o$                     | -           | 28       |
|                | MKCOSLHA     | $\cos(lha)$                         | -           | 28       |
|                | MKSINPHID    | $\sin \phi_c \sin \delta_o$         | -           | 28       |
|                | MKCOSPHID    | $\cos \phi_c \cos \delta_o$         | -           | 28       |
|                | MKCOSZO      | $\cos z_o$                          | -           | 28       |
|                | MK4          | $\xi/D_o$                           | -           | 33       |
|                | MKRDHODCOS   | $2 \xi/D_o \cos z_o$                | -           | 29       |
|                | MK42         | $(\xi/D_o)$                         | -           | 28       |
|                | MKRT2        | $(R_o/D_o)^2$                       | -           | 28       |
|                | MKR0*        | $R_o$                               | e.r.        | 23       |
|                | MKDELAY*     | delay                               | sec.        | 27       |
|                | MKRT         | $(R_o/D_o)$                         | -           | 28       |
| 8              | MKCOSDPHI    | $\sin \phi \cos \delta_o$           | -           | 28       |
|                | MKSINDPHI    | $\cos \phi \cos(lha) \sin \delta_o$ | -           | 28       |
|                | MKT1         |                                     | rad/sec     | 42       |
|                | MK2          | $\sin(lha) \cos \delta_o$           | -           | 42       |
|                | MKDDTCOS*    | $d(\cos z)/dt$                      | rad/sec     | 42       |

| <u>Routine</u> | <u>Label</u> | <u>Description</u>           | <u>Unit</u> | <u>B</u> |
|----------------|--------------|------------------------------|-------------|----------|
| 8 (cont'd)     | MKT3         | $(1 - MK4 \cos z_o) dR_o/dt$ | n.m./sec    |          |
|                | MKT4         | $2\rho_o d(\cos z_o)/dt$     | -           | 29       |
|                | MKT5         | $1/MKRT$                     | -           | 28       |
|                | MKT7         |                              | -           |          |
|                | MKRODT*      | $MKT5(MKT3 + MKT4)$          | n.m./sec    | 29       |
| 9              | MKT1         | $2 f_c dR_o/dt$              | cyc/sec     | 12       |
|                | MK20         | $1/c dR_o/dt$                | "           | 37       |
|                | MKT3         | $MK20 \cdot MKT1$            | "           | 12       |
|                | MKDOPP*      | Doppler: $MKT3 - MKT1$       | "           | 12       |
|                |              |                              |             |          |
| 10             | MK1          | $\cos \delta \cos (lha)$     | -           | 28       |
|                | MKT2         | $\sin \delta \sin (lha)$     | -           | 28       |
|                | MKT4         | $MKT2 d\delta/dt$            | rad/sec     | 42       |
|                | MKT3         | $MK1 d(lha)/dt$              | "           | 42       |
|                | MKCA*        | A                            | rad         | 28       |
|                | MKCADT*      | $dA/dt$                      | rad/sec     | 42       |
|                |              |                              |             |          |
| 11             | MK3          | $\sin \delta \cos (lha)$     | -           | 28       |
|                | MK5          | $MK4 \cos \phi$              | -           | 33       |
|                | MKCB*        | B                            | -           | 28       |
|                | MKT1         | $MK3 d\delta/dt$             | rad/sec     | 42       |
|                | MKT2         | $MK2 d(lha)/dt$              | "           | 42       |
|                | MKT3         | $MK5/D_o d D_o/dt$           | "           | 42       |
|                | MKCBDT*      | $dB/dt$                      | "           | 42       |
|                |              |                              |             |          |
| 12             | MK6          | $K4 \sin \phi_c$             |             | 33       |
|                | MKCC*        | C                            |             | 28       |
|                | MKT1         | $\cos \delta_o d\delta_o/dt$ | rad/sec     | 42       |
|                | MKT2         | $K6/D_o dD_o/dt$             | "           | 42       |
|                | MKCCDT*      | $dC/dt$                      | "           | 42       |
|                |              |                              |             |          |

| <u>Routine</u> | <u>Label</u> | <u>Description</u>                            | <u>Unit</u> | <u>B</u> |
|----------------|--------------|-----------------------------------------------|-------------|----------|
| 13             | MKSINDP      | $\sin \delta'$                                | -           | 28       |
|                | MKDP*        | $\delta'$                                     | rad         | 26       |
|                | MKCOSDP      | $\cos \delta'$                                | -           | 28       |
| 14             | MKAB         | AB                                            | -           | 28       |
|                | MKAB2        | $(AB)^2$                                      | -           | 28       |
|                | MKSINLHAP    | $\sin (lha')$                                 | -           | 28       |
|                | MKLHAP*      | $lha'$                                        | rad         | 26       |
|                | MKALFP*      | $\alpha'$                                     | rad         | 26       |
| 15             | MKT1         | $AdA/dt$                                      | rad/sec     | 42       |
|                | MKT2         | $BdB/dt$                                      | "           | "        |
|                | MKT3         | T1 & T2                                       | "           | "        |
|                | MKABDT       | $d(AB)/dt$                                    | "           | "        |
|                | MKT4         | $AB \ d \ C/dt$                               | "           | "        |
|                | MKT5         | $C \ d(AB)/dt$                                | "           | "        |
|                | MKT6         | T4-T5                                         | "           | "        |
|                | MKDPDT*      | $d\delta'/dt$                                 | "           | "        |
| 16             | MKT1         | $BdA/dt$                                      | rad/sec     | 42       |
|                | MKT2         | $AdB/dt$                                      | "           | "        |
|                | MKT3         | T1-T2                                         | "           | "        |
|                | MKT4         | $T3/AB^2$                                     | "           | "        |
|                | MKAPDT*      | $d\alpha'/dt$                                 | "           | "        |
| 17             | MK7          | $K7 = \alpha' - \Omega'$                      | rad         | 26       |
|                | MK8          | $K8 = \cos (\alpha' - \Omega')$               | -           | 28       |
|                | MK9          | $K9 = \sin (\alpha' - \Omega')$               | -           | "        |
|                | MK10         | $K10 = \cos \delta' \cos (\alpha' - \Omega')$ | -           | "        |
|                | MK11         | $K11 = \cos \delta' \cos (\alpha' - \Omega')$ | -           | "        |
|                | MK12         | $K12 = \sin \delta' \cos (\alpha' - \Omega')$ | -           | "        |
|                | MK13         | $K13 = \sin \delta' \sin (\alpha' - \Omega')$ | -           | "        |
|                | MKT1         | $K11 \ d\alpha'/dt$                           | rad/sec     | 42       |

| <u>Routine</u> | <u>Label</u> | <u>Description</u>                        | <u>Unit</u> | <u>B</u> |
|----------------|--------------|-------------------------------------------|-------------|----------|
| 17 (con'd)     | MKT2         | $K12 \, d\delta'/dt$                      | rad/sec     | 42       |
|                | MKCA1*       | -K10                                      | -           | 28       |
|                | MKCALDT*     | $K12 \, d\delta'/dt + K11 \, d\alpha'/dt$ | rad/sec     | 42       |
| 18             | MKT1         | $K11 \cos i$                              | -           | 28       |
|                | MKT2         | $\sin \delta' \sin i$                     | "           | "        |
|                | MKCB1*       | $B'$                                      | "           | "        |
|                | MKT3         | $\cos \delta' \sin i$                     | "           | "        |
|                | MKT4         | $K13 \cos i$                              | "           | "        |
|                | MKT7         | $T4 - T3$                                 | "           | "        |
|                | MKT5         | $T7 \, d\delta'/dt$                       | rad/sec     | 42       |
|                | MKT8         | $K10 \cos i$                              | -           | 28       |
|                | MKT6         | $T8 \, d\alpha'/dt$                       | rad/sec     | 42       |
|                | MKCB1DT      | $dB'/dt$                                  | "           | "        |
| 19             | MK14         | $K11 \sin i$                              | -           | 28       |
|                | MK15         | $\sin \delta' \cos i$                     | -           | "        |
|                | MK16         | $\cos \delta' \cos i$                     | -           | "        |
|                | MK17         | $K10 \sin i$                              | -           | "        |
|                | MK18         | $K13 \sin i$                              | -           | "        |
|                | MKCC1*       | $K14 - K15$                               | -           | "        |
|                | MKT1         | $K17 \, d\alpha'/dt$                      | rad/sec     | 42       |
|                | MKT3         | $K16 + K18$                               | -           | 28       |
|                | MKT2         | $T3 \, d\delta'/dt$                       | rad/sec     | 42       |
|                | MKCC1DT      | $dC'/dt$                                  | "           | "        |
| 20             | MKSINBP      | $\sin b'$                                 | -           | 28       |
|                | MKBP*        | $b'$                                      | rad         | 27       |
|                | MKCOBP       | $\cos b'$                                 | -           | 28       |

| <u>Routine</u> | <u>Label</u> | <u>Description</u>        | <u>Unit</u> | <u>B</u> |
|----------------|--------------|---------------------------|-------------|----------|
| 21             | MKT1         | $B'/\cos b'$              | -           | 28       |
|                | MKT2         | $\arcsin (B'/\cos b')$    | rad         | "        |
|                | MKLP*        | $\ell'$                   | "           | 26       |
|                | MKCOLP       | $\cos \ell'$              | -           | 28       |
|                | MKSINLP      | $\sin \ell'$              | -           | 28       |
| 22             | MKSINCP      | $\sin C'$                 | -           | 28       |
|                | MKCP*        | $C'$                      | rad         | 27       |
|                | MKCOLCP      | $\cos C'$                 | -           | 28       |
| 23             | MKBPD*       | $db'/dt$                  | rad/sec     | 42       |
| 24             | MKT4         | $B' dA'/dt$               | rad/sec     | 42       |
|                | MKT5         | $A' dB'/dt$               | "           | "        |
|                | MKT1         | $T5 - T4$                 | "           | "        |
|                | MKT3         | $\cos^2 b'$               | -           | 28       |
|                | MKT2         | $T1/T3$                   | rad/sec     | 42       |
|                | MKT4         | $T2-d/dt (\Delta-\Omega)$ | "           | "        |
|                | MKLPD*       | $dL'/dt$                  | "           | "        |
| 25             | MKW*         | $\omega_x$                | rad/sec     | 42       |
|                | MKW*         | $\omega_y$                | "           | "        |
|                | MKT1         | $\omega_x^2$              | "           | "        |
|                | MKT2         | $\omega_y^2$              | "           | "        |
|                | MKT3         | $\omega_x^2 + \omega_y^2$ | "           | "        |
|                | MKWA*        | $\omega_a$                | "           | 42       |
|                | MKT1         | $1/c dRo/dt$              |             | 37       |
|                | MKT2         | $2 f_c b \omega_a$        |             | 22       |
|                | MKT3         | $T2 \cdot T1$             |             | 22       |
|                | MKFCL*       | FCL                       | cyc/sec     | 22       |
| 26             | MKCOLDA*     | $\cos d_a$                | -           | 28       |
|                | MKSINDA*     | $\sin d_a$                | -           | 28       |

| <u>Routine</u> | <u>Label</u> | <u>Description</u> | <u>Unit</u> | <u>B</u> |
|----------------|--------------|--------------------|-------------|----------|
| 27             | MKT2         | $Z_s \sin l'$      | -           | 28       |
|                | MKT1         | $X_s \cos l'$      | -           | "        |
|                | MKX0*        | $X_o$              | -           | "        |
|                | MKT9         | $Z_s \cos l'$      | -           | "        |
|                | MKT5         | $T9 \sin b'$       | -           | "        |
|                | MKT10        | $X_s \sin l'$      | -           | "        |
|                | MKT4         | $T10 \sin b'$      | -           | "        |
|                | MKT3         | $Y_s \cos b'$      | -           | "        |
|                | MKY0*        | $Y_o$              | -           | "        |
|                | MKT6         | $T10 \cos b'$      | -           | "        |
|                | MKT7         | $Y_s \sin b'$      | -           | "        |
|                | MKT8         | $T9 \cos b'$       | -           | "        |
|                | MKZ0*        | $Z_o$              | -           | "        |
|                |              |                    |             |          |
|                |              |                    |             |          |
| 28             | MKS*         | S                  | -           | 35       |
|                | MKT1         | $S/\cos \delta'$   | -           | 28       |
|                | MKT2         | $X_o \cos C'$      | -           | "        |
|                | MKT3         | $Y_o \sin C'$      | -           | "        |
|                | MKT4         | $T2 + T3$          | -           | "        |
|                | MKDELALF*    | $\Delta\alpha$     | rad         | 35       |
|                | MKT5         | $X_o \sin C'$      | -           |          |
|                | MKT6         | $Y_o \cos C'$      | -           |          |
|                | MKT7         | $T6 - T5$          | -           |          |
|                | MKDELDEL*    | $\Delta\delta$     | rad         | 35       |
| 29             | MKS2         | $S^2$              | -           | 34       |
|                | MKT1         | $z_o S$            |             | 34       |
|                | MKT5         | $S^2 - 2 z_o S$    |             | 28       |
|                | MKRTX2       | $RTX^2$            |             | 28       |
|                | MKRTX        | RTX                |             | 28       |
|                | MKDPX*       | DP                 |             | 27       |
|                | MKT2         | 1-T1               |             |          |

| <u>Routine</u> | <u>Label</u> | <u>Description</u> | <u>Unit</u> | <u>B</u> |
|----------------|--------------|--------------------|-------------|----------|
| 29 (cont'd)    |              |                    |             |          |
|                | MKT3         | DOPF/RTX           |             | 12       |
|                | MKT4         | FCL/RTX            | cyc/sec     | 12       |
|                | RA*          |                    | rev         | 27       |
|                | RADOT*       | $\phi$             | -           | -        |
|                | DEC*         |                    | rev         | 27       |
|                | DECDOT*      | $\phi$             | -           | -        |
|                | RADIUS*      |                    | e.r.        | 22       |
|                | RADIUSDOT*   |                    | n.m./sec    | 24       |
|                | MKDOP1*      | DOP1               | cyc/sec     | 12       |
|                | MKDOP2*      | DOP2               | "           | "        |
|                | MKDOPPLER*   | DOPPLER            | "           | "        |
|                | MKXD*        | $X_d$              | "           | "        |
|                | MOONDOP2\$   | DOP2               |             | 8        |
|                | DOPFACTOR\$* | DOP1/DOP2          | -           | 28       |

## APPENDIX III MOON OFFSET EPHEMERIS TABLES: GENERATION AND USE

### CALCULATION OF T FOR EPHEMERIS INTERPOLATION

$$D_1 = \text{day of year} = L(\text{DAY}), \quad \text{days B0}$$
$$D_0 = \text{1st day of table} = L(\text{EPHDAY}), \quad \text{days B0}$$

T<sub>1</sub> = time of day = W (CELTIME), days B28

EPH(T) = interpolated ephemeris table value for present time.

$$1. \quad (D_1 - D_0) / 10 = K + R/10$$

K = integer  
R = remainder

$$2. \quad T = (R + T_1) / 10, \text{ days B27}$$
$$3. \quad EPH(T) = EPH_k + (EPH_{k+1} - EPH_k) T$$

## EPHEMERIS TABLE

The table of ephemeris values must be in the following format:

W(EPHCNT) = no. values in each of the four tables.

W(EPHDAY) = the day of year for the first value in each table.

The following storage allocations must remain in the order:

MKQK1 (EPHCNT locations)

MKQRST (EPHCNT locations)

MKQI (EPHCNT locations)

MKQSP (EPHCNT locations)

The four tables containing the data at ten (10) day intervals and consisting of EPHCNT values must be in the order:

$W(EPHRST) = 1st \text{ value of } (\mathcal{C} - \Omega + \Delta), \text{ rad B26}$

$W(EPHRSTDt) = 1st \text{ value of } d \left( \frac{\mathcal{C} - \Omega + \Delta}{dt} \right), \text{ rad/sec B42}$

$W(EPHI) = 1st \text{ value of } i, \text{ rad B26}$

$W(EPHSP) = 1st \text{ value of } \Omega', \text{ rad B27.}$

These tables must be updated at the beginning of each year, using the CDC 3300 Fortran program MOONKEPH, with input data from the American Ephemeris and Nautical Almanac. (See next two pages)

# APPENDIX IV LISTING OF MOONTRACK PROGRAM

PROGRAM NAME: MOONKEPH

MACHINE: CDC 3300

LANGUAGE: FORTRAN

AUTHORS: R. Shaputnic Cuomo and P. Crowther

PURPOSE: To generate a moon libration ephemeris deck for use in the MOONTRACK program of the Univac 490 Haystack Pointing System. This deck must be updated at the start of each year.

INPUT: Cards punched from Page 51 of the American Ephemeris and Nautical Almanac - numbers in free format (integer, floating point, or E-format), separated by spaces or commas.

| <u>Card Number</u> | <u>Contents</u>                                                                                               |
|--------------------|---------------------------------------------------------------------------------------------------------------|
| 1                  | Year                                                                                                          |
| 2                  | Month number, day, $i_1$ , $\Delta_1$ , $\Omega_1$ , $\Gamma_1$ , $\Omega_1$ , $C_1$ , $D_1$                  |
| $n + 1$            | Month <sub>n</sub> , day <sub>n</sub> , $i_n$ , $\Delta_n$ , $\Omega_n$ , $\Gamma_n$ , $\Omega_n$ , $n$ , $n$ |
| $n + 2$            | BLANK                                                                                                         |

Data cards are spaced at 10-day intervals and must include at least 3 intervals before the beginning of the year (marked as month #1, with negative day numbers) and 2 intervals after the end of the year.

OUTPUT: Cards in U490 SPURT format for insertion into the MOONTRACK deck.

| Column    | 1       | 12                                   | 22        |
|-----------|---------|--------------------------------------|-----------|
| EPHCNT    | EQUALS  | NN (number of entires in each table) |           |
|           | COMMENT | FOLLOWING VALUES FOR YEAR NNNN       |           |
| EPHRST    | DEC     | X.XXXXXXXXXXB26                      | NN values |
|           | DEC     | X.XXXXXXXXXXB26                      |           |
|           | :       |                                      |           |
|           | DEC     | X.XXXXXXXXXXB26                      | NN values |
| EPHRSDTDT | DEC     | .XXXXXXXXXB28                        |           |
|           | :       |                                      |           |
|           | :       |                                      |           |
|           | DEC     | .XXXXXXXXXB28                        | NN        |
| EPHC      | DEC     | .XXXXXXXXXB26                        |           |
|           | :       |                                      |           |
|           | :       |                                      |           |
|           | DEC     | .XXXXXXXX B26                        | NN        |
| EPHSP     | DEC     | XX.XXXXXXXXXXB26                     |           |
|           | :       |                                      |           |
|           | :       |                                      |           |
|           | DEC     | XX.XXXXXXXXXXB26                     |           |

where

$$EPHRST_j = j - \Omega_j + \Delta_j \text{ in radians, } 0 \leq EPHRST < 2$$

$$EPHRSDTDT_j = \frac{2^{14} \cdot 2\pi}{86400 \cdot 360} \left[ \frac{\Delta_{j-2} - 8\Delta_{j-1} + 8\Delta_{j+1} - \Delta_{j+2}}{120} \right]$$

$$+13.176393 + .05296]$$

$$EPHI_j = \frac{2\pi}{360} \times i_j$$

$$EPHSP_j = \frac{2\pi}{360} \times \Omega'_j$$

```

PROGRAM MOONKEPH
C SHAPUTNIC, 27 DEC 66
C MODIFIED BY P. CROWTHER--21 JANUARY 1969
  DIMENSION INAME(2),PTHING(12),IPTHING(3)
  CHARACTER PTHING
  EQUIVALENCE (PTHING,IPTHING)
  DIMENSION ZI(75),DEL(75),DOM(75),GAM(75),OM(75),DML(75),EC(75),
1THING(75),DTHING(75),DZI(75),DDOM(75)
  DIMENSION XTHING(75),A(20)
  QD=1.74532925E-2
  I=1
  CALL A CARD IN(A,NC)
  IYEAR = A(1)
3  A(1) = 0 $ CALL A CARD IN (A,NC)
  MO = A(1)+.5 $ IDAY = A(2)+SIGNF(0.5,A(2))
  ZI(I) = A(3) $ DEL(I) = A(4)
  DOM(I) = A(5) $ GAM(I)=A(6) $ OM(I) = A(7) $ DML(I) = A(8)
  EC(I) = A(9)
  IF(I .EQ. 1) 17,18
17 IDAYX = IDAY
18 IF(MO) 1,2,1
  1 I=I+1
  GO TO 3
  2 II=I-1
  DO 4 J=1,II
    TH =DML(J)-OM(J)+DEL(J)+720.
    ITH=TH/360.
  4 THING(J)=(TH-(ITH*360))*QD
    K=I-3
    CON1=13.176396*QD
    CON2=-.05296*QD
    DO 5 J=3,K
      XTHING(J)=((DEL(J-2)-8.*DEL(J-1)+8.*DEL(J+1)-DEL(J+2))/12.0)/10.0
  5 DTHING(J)=(QD*XTHING(J)+CON1-CON2)/86400.
    DO 6 J=3,K
      DZI(J)=QD*ZI(J)
  6 DDOM(J) = QD*DOM(J)
    DO 7 J=3,K
      DTHING(J) = 2.*+14*DTHING(J)
    KK = K-2 $ WRITE (61,201) KK $ WRITE (62,202)KK
201 FORMAT (22H EPHCNT EQUALS ,I2,1HD)
202 FORMAT (21HEPHCNT EQUALS ,I2,1HD)
    IDAY3=IDAYX+20 $ WRITE(61,301)IDAY3 $ WRITE(62,302) IDAY3
301 FORMAT(12H EPHDAY ,I2)
302 FORMAT (11HEPHDAY ,I2)
    WRITE(61,401)IYEAR $ WRITE(62,402)IYEAR
401 FORMAT(12X,10HCOMMENT ,26HFOLLOWING VALUES FOR YEAR ,I4)
402 FORMAT (11X,10HCOMMENT ,26HFOLLOWING VALUES FOR YEAR ,I4)
    INAME(1)=4HEPHR $ INAME(2) = 4HST
    DO 9 J=3,K
      ENCODE(10,1000,IPTHING)THING(J)
1000 FORMAT(F10.8)
    IF(PTHING(1).EQ.1R )10,11
  10 PTHING(1)=1R0
  11 WRITE(61,501)INAME,(PTHING(M),M=1,10)
    WRITE(62,502)INAME,(PTHING(M),M=1,10)
501 FORMAT(1X,2A4,3X,3HDEC,7X,10R1,3HB26)
502 FORMAT (2A4,3X,3HDEC,7X,10R1,3HB26)
    INAME(1)=INAME(2)=4H
  9 CONTINUE

```

```

      INAME(1)=4HEPHR$INAME(2)=4HSTD1
      DO 12 J=3,K
      WRITE(61,601)INAME,DTHING(J) $ WRITE(62,602)INAME,DTHING(J)
601  FORMAT(1X,2A4,3X,3HDEC,6X,F10.8,3HB28)
602  FORMAT (2A4,3X,3HDEC,6X,F10.8,3HB28)
      INAME(1)=INAME(2)=4H
12   CONTINUE
      INAME(1)=4HEPHI
      DO 13 J=3,K$WRITE(61,701)INAME,DZI(J) $ WRITE(62,702)INAME,DZI(J)
701  FORMAT (1X,2A4,3X,3HDEC,6X,F10.8,3HB26)
702  FORMAT (2A4,3X,3HDEC,6X,F10.8,3HB26)
      INAME(1)=4H
13   CONTINUE
      INAME(1)=4HEPHS $ INAME(2)=4HP
      DO 16 J=3,K
      ENCODE(11,1001,IPTHING)DDOM(J)
1001 FORMAT(F11.8)
      IF(PTHING(1).EQ. 1R ) 14,15
14   PTHING(1)=PTHING(2)=1R0
15   WRITE(61,801)INAME,(PTHING(M),M=1,11)
      WRITE(62,802)INAME,(PTHING(M),M=1,11)
801  FORMAT(1X, 2A4,3X,3HDEC,7X,11R1,3HB26)
802  FORMAT( 2A4,3X,3HDEC,7X,11R1,3HB26)
      INAME(1)=INAME(2)=4H
16   CONTINUE
      STOP
      END

```

FORTRAN DIAGNOSTIC RESULTS FOR MOONKEPH

NO ERRORS  
LOAD,56  
RUN,50

```

ACARDIN:      1969
ACARDIN: 1 -21 21.919 186.159 -0.414 259.5351 5.7780 138.6864 239.8968
ACARDIN: 1 -11 21.918 185.595 -0.376 260.6491 5.2485 270.4503 1.8043
ACARDIN: 1 -1 21.916 185.031 -0.338 261.7632 4.7189 42.2143 123.7118
ACARDIN: 1 9 21.915 184.466 -0.300 262.8772 4.1894 173.9783 245.6193
ACARDIN: 1 19 21.914 183.902 -0.263 263.9912 3.6599 305.7422 7.5268
ACARDIN: 1 29 21.913 183.338 -0.225 265.1053 3.1303 77.5062 129.4343
ACARDIN: 2 8 21.913 182.773 -0.187 266.2193 2.6008 209.2702 251.3418
ACARDIN: 2 18 21.912 182.209 -0.149 267.3333 2.0713 341.0341 13.2492
ACARDIN: 2 28 21.912 181.644 -0.111 268.4474 1.5417 112.7981 135.1567
ACARDIN: 3 10 21.911 181.079 -0.073 269.5614 1.0122 244.5620 257.0642
ACARDIN: 3 20 21.911 180.515 -0.035 270.6755 0.4826 16.3260 18.9717
ACARDIN: 3 30 21.911 179.950 0.003 271.7895 359.9531 148.0900 140.8792
ACARDIN: 4 9 21.911 179.385 0.041 272.9035 359.4236 279.8539 262.7867
ACARDIN: 4 19 21.911 178.821 0.079 274.0176 358.8940 51.6179 24.6942
ACARDIN: 4 29 21.912 178.256 0.117 275.1316 358.3645 183.3819 146.6017
ACARDIN: 5 9 21.912 177.691 0.155 276.2456 357.8349 315.1458 268.5092
ACARDIN: 5 19 21.913 177.127 0.193 277.3597 357.3054 86.9098 30.4167
ACARDIN: 5 29 21.913 176.562 0.231 278.4737 356.7759 218.6738 152.3242
ACARDIN: 6 8 21.914 175.998 0.269 279.5878 356.2463 350.4377 274.2317
ACARDIN: 6 18 21.915 175.434 0.307 280.7018 355.7168 122.2017 36.1391
ACARDIN: 6 28 21.916 174.869 0.345 281.8158 355.1873 253.9657 158.0466
ACARDIN: 7 8 21.918 174.305 0.383 282.9299 354.6577 25.7296 279.9541
ACARDIN: 7 18 21.919 173.741 0.421 284.0439 354.1282 157.4936 41.8616
ACARDIN: 7 28 21.921 173.177 0.458 285.1579 353.5986 289.2576 163.7691
ACARDIN: 8 7 21.923 172.612 0.496 286.2720 353.0691 61.0215 285.6766
ACARDIN: 8 17 21.925 172.048 0.534 287.3860 352.5396 192.7855 47.5841
ACARDIN: 8 27 21.927 171.484 0.571 288.5000 352.0100 324.5495 169.4916
ACARDIN: 9 6 21.929 170.920 0.609 289.6141 351.4805 96.3134 291.3991
ACARDIN: 9 16 21.931 170.355 0.646 290.7281 350.9509 228.0774 53.3066
ACARDIN: 9 26 21.934 169.791 0.684 291.8422 350.4214 359.8413 175.2141
ACARDIN: 10 6 21.936 169.227 0.721 292.9562 349.8919 131.6053 297.1216
ACARDIN: 10 16 21.939 168.663 0.758 294.0702 349.3623 263.3693 59.0290
ACARDIN: 10 26 21.942 168.099 0.795 295.1843 348.8328 35.1332 180.9365
ACARDIN: 11 5 21.945 167.536 0.833 296.2983 348.3033 166.8972 302.8440
ACARDIN: 11 15 21.948 166.972 0.870 297.4123 347.7737 298.6612 64.7515
ACARDIN: 11 25 21.951 166.409 0.907 298.5264 347.2442 70.4251 186.6590
ACARDIN: 12 5 21.954 165.845 0.943 299.6404 346.7146 202.1891 308.5665
ACARDIN: 12 15 21.958 165.282 0.980 300.7545 346.1851 333.9531 70.4740
ACARDIN: 12 25 21.961 164.719 1.017 301.8685 345.6556 105.7170 192.3815
ACARDIN: 12 35 21.965 164.156 1.053 302.9825 345.1260 237.4810 314.2890
ACARDIN: 12 45 21.969 163.593 1.090 304.0966 344.5965 9.2450 76.1965
ACARDIN: 12 55 21.973 163.030 1.126 305.2106 344.0669 141.0089 198.1040
ACARDIN:
EPHCNT      EQUALS      38D
EPHDAY      -1
COMMENT     FOLLOWING VALUES FOR YEAR 1969
EPRST       3.88381835826
DEC          6.18291439826
DEC          2.19884084826
DEC          4.49795608826
DEC          0.51386682826
DEC          2.81297857826
DEC          5.11207635826
DEC          1.12798535826
DEC          3.42710059826
DEC          5.72619663826
DEC          1.74210563826
DEC          4.04122087826
DEC          0.05713161826
DEC          2.35622765826

```

|     |               |
|-----|---------------|
| DEC | 4.65534114826 |
| DEC | 0.67125188826 |
| DEC | 2.97036538826 |
| DEC | 5.26947887826 |
| DEC | 1.28538961826 |
| DEC | 3.58450311826 |
| DEC | 5.88361660826 |
| DEC | 1.89954654826 |
| DEC | 4.19864084826 |
| DEC | 0.21456903826 |
| DEC | 2.51368427826 |
| DEC | 4.81279602826 |
| DEC | 0.82870851826 |
| DEC | 3.12782026826 |
| DEC | 5.42693375826 |
| DEC | 1.44286369826 |
| DEC | 3.74197544826 |
| DEC | 6.04110639826 |
| DEC | 2.05701633826 |
| DEC | 4.35616553826 |
| DEC | 0.37209547826 |
| DEC | 2.67122642826 |
| DEC | 4.97035562826 |
| DEC | 0.98630301826 |
| DEC | .04359783828  |
| DEC | .04359783828  |
| DEC | .04359808828  |
| DEC | .04359783828  |
| DEC | .04359786828  |
| DEC | .04359789828  |
| DEC | .04359764828  |
| DEC | .04359789828  |
| DEC | .04359789828  |
| DEC | .04359764828  |
| DEC | .04359789828  |
| DEC | .04359789828  |
| DEC | .04359764828  |
| DEC | .04359789828  |
| DEC | .04359786828  |
| DEC | .04359783828  |
| DEC | .04359808828  |
| DEC | .04359783828  |
| DEC | .04359805828  |
| DEC | .04359805828  |
| DEC | .04359783828  |
| DEC | .04359783828  |
| DEC | .04359805828  |
| DEC | .04359805828  |
| DEC | .04359783828  |
| DEC | .04359805828  |
| DEC | .04359802828  |
| DEC | .04359800828  |
| DEC | .04359822828  |
| DEC | .04359819828  |
| DEC | .04359819828  |
| DEC | .04359819828  |
| DEC | .04359816828  |
| DEC | .04359838828  |
| DEC | .04359835828  |
| DEC | .04359835828  |

|       |     |                 |
|-------|-----|-----------------|
| EPHI  | DEC | .38250636826    |
|       | DEC | .38248891826    |
|       | DEC | .38247145826    |
|       | DEC | .38245400826    |
|       | DEC | .38245400826    |
|       | DEC | .38243655826    |
|       | DEC | .38243655826    |
|       | DEC | .38241909826    |
|       | DEC | .38241909826    |
|       | DEC | .38241909826    |
|       | DEC | .38241909826    |
|       | DEC | .38241909826    |
|       | DEC | .38243655826    |
|       | DEC | .38243655826    |
|       | DEC | .38245400826    |
|       | DEC | .38245400826    |
|       | DEC | .38247145826    |
|       | DEC | .38248891826    |
|       | DEC | .38250636826    |
|       | DEC | .38254127826    |
|       | DEC | .38255872826    |
|       | DEC | .38259362826    |
|       | DEC | .38262853826    |
|       | DEC | .38266344826    |
|       | DEC | .38269834826    |
|       | DEC | .38273325826    |
|       | DEC | .38276816826    |
|       | DEC | .38282052826    |
|       | DEC | .38285542826    |
|       | DEC | .38290778826    |
|       | DEC | .38296014826    |
|       | DEC | .38301250826    |
|       | DEC | .38306486826    |
|       | DEC | .38311722826    |
|       | DEC | .38316958826    |
|       | DEC | .38323940826    |
|       | DEC | .38329176826    |
|       | DEC | .38336157826    |
| EPHSP | DEC | -0.00589921826  |
|       | DEC | -0.00523599826  |
|       | DEC | -0.00459022826  |
|       | DEC | -0.00392699826  |
|       | DEC | -0.00326377826  |
|       | DEC | -0.00260054826  |
|       | DEC | -0.00193732826  |
|       | DEC | -0.00127409826  |
|       | DEC | -0.00061087826  |
|       | DEC | 00.00005236826  |
|       | DEC | 00.000071558826 |
|       | DEC | 00.00137881826  |
|       | DEC | 00.00204204826  |
|       | DEC | 00.00270526826  |
|       | DEC | 00.00336849826  |
|       | DEC | 00.00403171826  |
|       | DEC | 00.00469494826  |
|       | DEC | 00.00535816826  |
|       | DEC | 00.00602139826  |
|       | DEC | 00.00668461826  |
|       | DEC | 00.00734784826  |
|       | DEC | 00.00799361826  |
|       | DEC | 00.00865683826  |
|       | DEC | 00.00932006826  |

|     |                |
|-----|----------------|
| DEC | 00.00996583826 |
| DEC | 00.01062906826 |
| DEC | 00.01127483826 |
| DEC | 00.01193805826 |
| DEC | 00.01258382826 |
| DEC | 00.01322960826 |
| DEC | 00.01387537826 |
| DEC | 00.01453859826 |
| DEC | 00.01518436826 |
| DEC | 00.01583014826 |
| DEC | 00.01645845826 |
| DEC | 00.01710423826 |
| DEC | 00.01775000826 |
| DEC | 00.01837832826 |

I FTN 060 ( STOP )

SPURT OUTPUT NO. 110  
MOONTRACK P.CROWTHER\*20FEB69  
NO. OF INSTRUCTIONS 07425  
00000 THRU 01453  
03652 THRU 07424

SPURT OUTPUT NO. 110

MOONTRACK

P.CROWTHER\*20FEB69

| CARDS | L1 ID LABEL | TA STATEMENT | LOC     | F JKB Y                       | NOTES                               |
|-------|-------------|--------------|---------|-------------------------------|-------------------------------------|
| .     | 00000       | MOONTRACK    | PROGRAM | P.CROWTHER*20FEB69            |                                     |
| .     | 00001       | MOONUTAG     | U-TAG   | MOONWORK*MOONINIT             |                                     |
| .     | 00002       |              | FD      | 1*MOONP                       | 00000 00243 00005                   |
| .     | 00003       | EPHEM        | MEANS   | C15                           | 00001 22242 42325                   |
| .     | 00004       | LUNAR        | EQUALS  | 100                           |                                     |
| .     | 00005       | MONITAPE     | EQUALS  | 55                            |                                     |
| .     | 00006       | TAPEINPUT    | EQUALS  | 35                            |                                     |
| .     | 00007       | EPHEMTAPE    | EQUALS  | 00002                         | EPHEMERIS TAPE UNIT                 |
| .     | 00010       | NUMFILES     | EQUALS  | 120                           |                                     |
| .     | 00011       | RECSIZE      | EQUALS  | 80                            |                                     |
| .     | 00012       | AREACNT      | EQUALS  | 11650                         |                                     |
| .     | 00013       |              | COMMENT | AREACNT = CNT TO RE CLEARED   |                                     |
| .     |             |              |         | BETWEEN YREMAIN AND LASTEPHEM |                                     |
| .     | 00014       | CELMOON      | FD      | 3*OBJECT MOON                 | 00002 24071 71210                   |
|       |             |              |         |                               | 00003 31052 22424                   |
|       |             |              |         |                               | 00004 23050 50505                   |
| .     | 00015       | MOONINIT     | ENTRY   |                               | 00005 61000 00000                   |
| .     | 00016       |              | MOVE    | 3*CELMOON*CELBODY             | 00006 10030 00002                   |
|       |             |              |         |                               | 00007 14030 63113                   |
|       |             |              |         |                               | 00010 10030 00003                   |
|       |             |              |         |                               | 00011 14030 63114                   |
|       |             |              |         |                               | 00012 10030 00004                   |
|       |             |              |         |                               | 00013 14030 63115                   |
| .     | 00017       |              | ENT     | A**W(IGNORE)                  | 00014 11030 01051                   |
| .     | 00020       |              | STR     | A**W(MONITAPE)                | 00015 15030 00055                   |
| .     | 00021       |              | ENT     | A**W(INTERUPT)                | 00016 11030 01052                   |
| .     | 00022       |              | STR     | A**W(TAPEINPUT)               | 00017 15030 00035                   |
| .     | 00023       |              | CLEAR   | AREACNT*YRREMAIN              | 00020 70100 02215                   |
|       |             |              |         |                               | 00021 16030 01436                   |
| .     | 00024       |              | ENT     | Q**W(EQUATOR)                 | 00022 10030 63323 B17               |
| .     | 00025       |              | MUL     | W(RHRSEC)                     | 00023 22030 01066                   |
| .     | 00026       |              | LSH     | AQ*1*QPOS                     | 00024 07200 00001                   |
| .     | 00027       |              | ADD     | A*1                           | 00025 20000 00001                   |
| .     | 00030       |              | STR     | A**W(ERNMSEC)                 | 00026 15030 01065 B28               |
| .     | 00031       |              | ENT     | A*U(YEARMONTH)                | 00027 11020 63147                   |
| .     | 00032       |              | SUB     | A*19610                       | 00030 21000 03651                   |
| .     | 00033       |              | STR     | A**W(MONTHPRINT)              | 00031 15030 01032                   |
| .     | 00034       |              | RSH     | AQ*300                        | 00032 03000 00036                   |
| .     | 00035       |              | DIV     | 4                             | 00033 23000 00004                   |
| .     | 00036       |              | STR     | A**W(YRREMAIN)                | 00034 15030 01436 (0,1,2,3)         |
| .     | 00037       |              | MUL     | 14610                         | 00035 22000 02665 DAYS IN 4 YRS     |
| .     | 00040       |              | STR     | Q**W(WHOLEYEAR)               | 00036 14030 01437                   |
| .     | 00041       |              | ENT     | Q**W(YRREMAIN)                | 00037 10030 01436                   |
| .     | 00042       |              | MUL     | 3650                          | 00040 22000 00555                   |
| .     | 00043       |              | RPL     | Y+Q**W(WHOLEYEAR)             | 00041 34030 01437                   |
| .     | 00044       |              | RJP     | DAYFIND                       | 00042 65000 00437                   |
| .     | 00045       |              | CL      | W(IMPERIAL)                   | 00043 16030 01441 SET EOF COUNT = 0 |
| .     | 00046       | TRYAGAIN     | ENT     | A**W(SAFE)                    | 00044 11030 01452                   |
| .     | 00047       |              | STR     | A**W(TAPEBLOCK)               | 00045 15030 01442                   |
| .     | 00050       |              | IN      | EPHEM**W(EPHEMA)              | 00046 73670 03653                   |
| .     | 00051       |              | SUB     | A*3                           | 00047 21000 00003 IDENT-3           |
| .     | 00052       |              | EX-FCT  | EPHEM**W(SRHIBIN)             | 00050 13670 01050                   |

|       |                            |       |       |       |
|-------|----------------------------|-------|-------|-------|
| 00053 | STR A*L(TAPESEARCH)        | 00051 | 15010 | 03661 |
| 00054 | EX-FCT EPHEM*W(TAPESEARCH) | 00052 | 13670 | 03661 |
| 00055 | JP \$                      | 00053 | 61000 | 00053 |
| 00056 | IN EPHEM*W(EPHEMB)         | 00054 | 73670 | 03654 |
| 00057 | RPL Y+1*W(TAPESEARCH)      | 00055 | 36030 | 03661 |
| 00060 | EX-FCT EPHEM*W(SRHIBIN)    | 00056 | 13670 | 01050 |
| 00061 | NO-OP                      | 00057 | 12000 | 00000 |
| 00062 | EX-FCT EPHEM*W(TAPESEARCH) | 00060 | 13670 | 03661 |
| 00063 | JP \$                      | 00061 | 61000 | 00061 |
| 00064 | IN EPHEM*W(EPHEMC)         | 00062 | 73670 | 03655 |
| 00065 | RPL Y+1*W(TAPESEARCH)      | 00063 | 36030 | 03661 |
| 00066 | EX-FCT EPHEM*W(SRHIBIN)    | 00064 | 13670 | 01050 |
| 00067 | NO-OP                      | 00065 | 12000 | 00000 |
| 00070 | EX-FCT EPHEM*W(TAPESEARCH) | 00066 | 13670 | 03661 |
| 00071 | JP \$                      | 00067 | 61000 | 00067 |
| 00072 | IN EPHEM*W(EPHEMD)         | 00070 | 73670 | 03656 |
| 00073 | RPL Y+1*W(TAPESEARCH)      | 00071 | 36030 | 03661 |
| 00074 | EX-FCT EPHEM*W(SRHIBIN)    | 00072 | 13670 | 01050 |
| 00075 | NO-OP                      | 00073 | 12000 | 00000 |
| 00076 | EX-FCT EPHEM*W(TAPESEARCH) | 00074 | 13670 | 03661 |
| 00077 | JP \$                      | 00075 | 61000 | 00075 |
| 00100 | IN EPHEM*W(EPHEME)         | 00076 | 73670 | 03657 |
| 00101 | RPL Y+1*W(TAPESEARCH)      | 00077 | 36030 | 03661 |
| 00102 | EX-FCT EPHEM*W(SRHIBIN)    | 00100 | 13670 | 01050 |
| 00103 | NO-OP                      | 00101 | 12000 | 00000 |
| 00104 | EX-FCT EPHEM*W(TAPESEARCH) | 00102 | 13670 | 03661 |
| 00105 | JP \$                      | 00103 | 61000 | 00103 |
| 00106 | IN EPHEM*W(EPHEMF)         | 00104 | 73670 | 03660 |
| 00107 | RPL Y+1*W(TAPESEARCH)      | 00105 | 36030 | 03661 |
| 00110 | EX-FCT EPHEM*W(SRHIBIN)    | 00106 | 13670 | 01050 |
| 00111 | NO-OP                      | 00107 | 12000 | 00000 |
| 00112 | EX-FCT EPHEM*W(TAPESEARCH) | 00110 | 13670 | 03661 |
| 00113 | JP \$                      | 00111 | 61000 | 00111 |
| 00114 | EX-FCT EPHEM*W(REWINDNO)   | 00112 | 13670 | 01053 |
| 00115 | JP \$                      | 00113 | 61000 | 00113 |
| 00116 | RJP MOONTIME               | 00114 | 65000 | 00504 |
| 00117 | ENT B4*L(RAAD)             | 00115 | 12410 | 01443 |
| 00120 | ENT A*L(RADIFAD)           | 00116 | 11010 | 01444 |
| 00121 | RJP INTERPOL               | 00117 | 65000 | 01136 |
| 00122 | ENT Q*0*ANEG               | 00120 | 10700 | 00000 |
| 00123 | SUB A*W(TWOPIE)*AP0S       | 00121 | 21630 | 01067 |
| 00124 | ADD A*W(TWOPIE)            | 00122 | 20030 | 01067 |
| 00125 | RSH AQ*27D                 | 00123 | 03000 | 00033 |
| 00126 | DIV W(HRAD)                | 00124 | 23030 | 01056 |
| 00127 | STR Q*W(RA2)               | 00125 | 14030 | 00710 |
| 00130 | CL Q                       | 00126 | 10000 | 00000 |
| 00131 | RSH AQ*23D                 | 00127 | 03000 | 00027 |
| 00132 | DIV W(MINSRAD)             | 00130 | 23030 | 01057 |
| 00133 | STR Q*W(RA4)               | 00131 | 14030 | 00713 |
| 00134 | RSH AQ*30D                 | 00132 | 03000 | 00036 |
| 00135 | MUL W(SRAD)                | 00133 | 22030 | 01055 |
| 00136 | LSH AQ*2*QPO5              | 00134 | 07200 | 00002 |
| 00137 | ADD A*1                    | 00135 | 20000 | 00001 |
| 00140 | STR A*W(RA6)               | 00136 | 15030 | 00716 |
| 00141 | ENT B4*L(DECAD)            | 00137 | 12410 | 01445 |
| 00142 | ENT A*L(DECDFAD)           | 00140 | 11010 | 01446 |
| 00143 | RJP INTERPOL               | 00141 | 65000 | 01136 |
| 00144 | STR A*W(GMT2)              | 00142 | 15030 | 00776 |
| 00145 | ENT Q*0*AP0S               | 00143 | 10600 | 00000 |

NORMAL

WAIT FOR INTERRUPT

|   |       |       |                           |       |       |       |                             |
|---|-------|-------|---------------------------|-------|-------|-------|-----------------------------|
| • | 00146 | CP    | A                         | 00144 | 15040 | 00000 |                             |
| • | 00147 | RSH   | AQ*22D                    | 00145 | 03000 | 00026 |                             |
| • | 00150 | DIV   | W(MINSRAD)                | 00146 | 23030 | 01057 |                             |
| • | 00151 | STR   | Q*W(DLN2)                 | 00147 | 14030 | 00743 |                             |
| • | 00152 | CL    | Q                         | 00150 | 10000 | 00000 |                             |
| • | 00153 | RSH   | AQ*24D                    | 00151 | 03000 | 00030 |                             |
| • | 00154 | DIV   | W(SECSRAD)                | 00152 | 23030 | 01063 |                             |
| • | 00155 | STR   | Q*W(DLN4)                 | 00153 | 14030 | 00746 |                             |
| • | 00156 | RSH   | AQ*30D                    | 00154 | 03000 | 00036 |                             |
| • | 00157 | MUL   | W(SARAD)                  | 00155 | 22030 | 01064 |                             |
| • | 00160 | LSH   | AQ*2*QP05                 | 00156 | 07200 | 00002 |                             |
| • | 00161 | ADD   | A*1                       | 00157 | 20000 | 00001 |                             |
| • | 00162 | STR   | A*W(DLN6)                 | 00160 | 15030 | 00751 |                             |
| • | 00163 | ENT   | A*W(GMT2)*ANEG            | 00161 | 11730 | 00776 |                             |
| • | 00164 | JP    | S+3                       | 00162 | 61000 | 00165 |                             |
| • | 00165 | ENT   | A*W(DLN2)                 | 00163 | 11030 | 00743 |                             |
| • | 00166 | STR   | A*CPW(DLN2)               | 00164 | 15070 | 00743 |                             |
| • | 00167 | ENT   | A*W(CELTIME)              | 00165 | 11030 | 63133 |                             |
| • | 00170 | ENT   | Q*0*AP05                  | 00166 | 10600 | 00000 |                             |
| • | 00171 | CP    | A                         | 00167 | 15040 | 00000 |                             |
| • | 00172 | RSH   | AQ*26D                    | 00170 | 03000 | 00032 |                             |
| • | 00173 | DIV   | W(HDAY)                   | 00171 | 23030 | 01060 |                             |
| • | 00174 | STR   | Q*W(GMT2)                 | 00172 | 14030 | 00776 |                             |
| • | 00175 | CL    | Q                         | 00173 | 10000 | 00000 |                             |
| • | 00176 | RSH   | AQ*23D                    | 00174 | 03000 | 00027 |                             |
| • | 00177 | DIV   | W(MDAY)                   | 00175 | 23030 | 01061 |                             |
| • | 00200 | STR   | Q*W(GMT4)                 | 00176 | 14030 | 01001 |                             |
| • | 00201 | RSH   | AQ*30D                    | 00177 | 03000 | 00036 |                             |
| • | 00202 | MUL   | W(SDAY)                   | 00200 | 22030 | 01062 |                             |
| • | 00203 | LSH   | AQ*2*QP05                 | 00201 | 07200 | 00002 |                             |
| • | 00204 | ADD   | A*1                       | 00202 | 20000 | 00001 |                             |
| • | 00205 | STR   | A*W(GMT6)                 | 00203 | 15030 | 01004 |                             |
| • | 00206 | ENT   | A*W(CELTIME)*ANEG         | 00204 | 11730 | 63133 |                             |
| • | 00207 | JP    | S+3                       | 00205 | 61000 | 00210 |                             |
| • | 00210 | ENT   | A*W(GMT2)                 | 00206 | 11030 | 00776 |                             |
| • | 00211 | STR   | A*CPW(GMT2)               | 00207 | 15070 | 00776 |                             |
| • | 00212 | ENT   | B4*L(DISTAD)              | 00210 | 12410 | 01447 |                             |
| • | 00213 | ENT   | A*L(DISTDIFAD)            | 00211 | 11010 | 01450 |                             |
| • | 00214 | STR   | A*L(SETINTAD)             | 00212 | 15010 | 01135 |                             |
| • | 00215 | RJP   | INTERPOL                  | 00213 | 65000 | 01136 |                             |
| • | 00216 | STR   | A*W(INITIAL18)            | 00214 | 15030 | 01017 |                             |
| • | 00217 | ENT   | A*W(JULIANDAY)            | 00215 | 11030 | 01440 |                             |
| • | 00220 | STR   | A*W(INITIAL3)             | 00216 | 15030 | 00654 |                             |
| • | 00221 | ENT   | A*L(DAY)                  | 00217 | 11010 | 63150 |                             |
| • | 00222 | STR   | A*W(INITIAL12)            | 00220 | 15030 | 00665 |                             |
| • | 00223 | PRINT | ENT A*U(KYBRDLEVEL)*AZERO | 00221 | 11420 | 63110 | DO WE USE CONSOLE TYPEWRITE |
| • | 00224 | JP    | AIRPORT                   | 00222 | 61000 | 00237 | NO                          |
| • | 00225 | RJP   | U(INTERCOM)               | 00223 | 65020 | 63426 |                             |
| • | 00226 | U-TAG | RGHTASC*0                 | 00224 | 00666 | 00000 |                             |
| • | 00227 | RJP   | U(INTERCOM)               | 00225 | 65020 | 63426 |                             |
| • | 00230 | U-TAG | DLN*0                     | 00226 | 00721 | 00000 |                             |
| • | 00231 | RJP   | U(INTERCOM)               | 00227 | 65020 | 63426 |                             |
| • | 00232 | U-TAG | INITIALDAT*0              | 00230 | 00655 | 00000 |                             |
| • | 00233 | RJP   | U(INTERCOM)               | 00231 | 65020 | 63426 |                             |
| • | 00234 | U-TAG | GMT*0                     | 00232 | 00754 | 00000 |                             |
| • | 00235 | RJP   | U(INTERCOM)               | 00233 | 65020 | 63426 |                             |
| • | 00236 | U-TAG | INITIALDIS*0              | 00234 | 01007 | 00000 |                             |
| • | 00237 | RJP   | U(INTERCOM)               | 00235 | 65020 | 63426 |                             |
| • | 00240 | U-TAG | INITIALBOD*0              | 00236 | 01020 | 00000 |                             |

|   |                 |                         |       |       |       |                                |
|---|-----------------|-------------------------|-------|-------|-------|--------------------------------|
| • | 00241 AIRPORT   | NO-UP                   | 00237 | 12000 | 00000 |                                |
| • | 00242           | RJP MXINIT              | 00240 | 65000 | 03662 | INITIALIZE OFFSET              |
| • | 00243           | RPL Y+1*L(MOONINIT)     | 00241 | 36010 | 00005 | SET FOR NORMAL EXIT            |
| • | 00244           | EXIT                    | 00242 | 61010 | 00005 | EXIT FROM INITIALIZATION       |
| • | 00245           | COMMENT                 |       |       |       |                                |
| • | 00246           | COMMENT                 |       |       |       |                                |
| • | 00247           | COMMENT                 |       |       |       |                                |
| • | 00250 MOONWORK  | ENTRY                   | 00243 | 61000 | 00000 |                                |
| • | 00251           | RPL Y+1*L(MOONWORK)     | 00244 | 36010 | 00243 | SET FOR NORMAL EXIT            |
| • | 00252           | RJP MOONTIME            | 00245 | 65000 | 00504 |                                |
| • | 00253 HARVARD   | ENT B4*L(RAAD)          | 00246 | 12410 | 01443 |                                |
| • | 00254           | ENT A*L(RADIFAD)        | 00247 | 11010 | 01444 |                                |
| • | 00255           | RJP INTERPOL            | 00250 | 65000 | 01136 |                                |
| • | 00256           | STR A*W(MKRA)           | 00251 | 15030 | 06643 |                                |
| • | 00257           | ENT Q*W(MKRA)           | 00252 | 10030 | 06643 |                                |
| • | 00260           | MUL W(REVSRADIAN)       | 00253 | 22030 | 01047 |                                |
| • | 00261           | RJP ROUND               | 00254 | 65000 | 01426 |                                |
| • | 00262           | STR A*W(RA)             | 00255 | 15030 | 63002 |                                |
| • | 00263           | ENT Q*W(NUMDERIV)       | 00256 | 10030 | 01127 |                                |
| • | 00264           | MUL W(RHRSEC)           | 00257 | 22030 | 01066 | B 40                           |
| • | 00265           | LSH AQ*1                | 00260 | 07000 | 00001 |                                |
| • | 00266           | STR A*W(RADOT)          | 00261 | 15030 | 63007 | B37 RADS/SEC                   |
| • | 00267           | LSH AQ*5                | 00262 | 07000 | 00005 | AT B42                         |
| • | 00270           | RJP ROUND               | 00263 | 65000 | 01426 |                                |
| • | 00271           | STR A*W(MKRADOT)        | 00264 | 15030 | 06641 |                                |
| • | 00272           | ENT B4*L(DECAD)         | 00265 | 12410 | 01445 |                                |
| • | 00273           | ENT A*L(DECDFAD)        | 00266 | 11010 | 01446 |                                |
| • | 00274           | RJP INTERPOL            | 00267 | 65000 | 01136 |                                |
| • | 00275           | STR A*W(MKDEC)          | 00270 | 15030 | 06644 |                                |
| • | 00276           | STR A*W(DECLINRAD)*SKIP | 00271 | 15130 | 00272 | SAVE DECLINATION IN RADIAN     |
| • | 00277 DECLINRAD | 0                       | 00272 | 00000 | 00000 | DEC IN RAD AT B26              |
| • | 00300           | ENT Q*26D               | 00273 | 10000 | 00032 |                                |
| • | 00301           | RJP COS                 | 00274 | 65000 | 06343 | GET COS AT B28                 |
| • | 00302           | RSH AQ*30D              | 00275 | 03000 | 00036 | TO Q AT B28                    |
| • | 00303           | MUL W(RADOT)            | 00276 | 22030 | 63007 | *RADOT AT B(N)                 |
| • | 00304           | LSH AQ*2                | 00277 | 07000 | 00002 |                                |
| • | 00305           | RJP ROUND               | 00300 | 65000 | 01426 |                                |
| • | 00306           | STR A*W(RADOT)          | 00301 | 15030 | 63007 | NEW RADOT IS (COS(DECL)*RADOT) |
| • | 00307           | ENT Q*W(DECLINRAD)      | 00302 | 10030 | 00272 | DEC IN RAD AT B26              |
| • | 00310           | MUL W(REVSRADIAN)       | 00303 | 22030 | 01047 | IN REV AT B26+B31=B57          |
| • | 00311           | RJP ROUND               | 00304 | 65000 | 01426 |                                |
| • | 00312           | STR A*W(DEC)            | 00305 | 15030 | 63003 | DEC IN REV AT B27              |
| • | 00313           | ENT Q*W(NUMDERIV)       | 00306 | 10030 | 01127 |                                |
| • | 00314           | MUL W(RHRSEC)           | 00307 | 22030 | 01066 |                                |
| • | 00315           | LSH AQ*1                | 00310 | 07000 | 00001 |                                |
| • | 00316           | STR A*W(DECDDOT)        | 00311 | 15030 | 63010 | B37 RADS/SEC                   |
| • | 00317           | LSH AQ*5                | 00312 | 07000 | 00005 | AT B42                         |
| • | 00320           | RJP ROUND               | 00313 | 65000 | 01426 |                                |
| • | 00321           | STR A*W(MKDECDDOT)      | 00314 | 15030 | 06642 |                                |
| • | 00322           | ENT B4*L(DISTAD)        | 00315 | 12410 | 01447 |                                |
| • | 00323           | ENT A*L(DISTDFAD)       | 00316 | 11010 | 01450 |                                |
| • | 00324           | RJP INTERPOL            | 00317 | 65000 | 01136 |                                |
| • | 00325           | STR A*W(RADIUS)         | 00320 | 15030 | 63006 | B22                            |
| • | 00326           | STR A*W(MKDDO)          | 00321 | 15030 | 06645 | IN E.P. AT B22                 |
| • | 00327           | ENT Q*W(NUMDERIV)       | 00322 | 10030 | 01127 |                                |
| • | 00330           | MUL W(ERNMSEC)          | 00323 | 22030 | 01065 |                                |
| • | 00331           | LSH AQ*4                | 00324 | 07000 | 00004 | IN NM/SEC AT B24               |
| • | 00332           | STR A*W(RADIUSDOT)      | 00325 | 15030 | 63011 | B24                            |

|   |       |           |                                    |       |       |       |                        |
|---|-------|-----------|------------------------------------|-------|-------|-------|------------------------|
| • | 00333 | LSH       | AQ*5                               | 00326 | 07000 | 00005 | AT B29                 |
| • | 00334 | RJP       | ROUND                              | 00327 | 65000 | 01426 |                        |
| • | 00335 | STR       | A*W(MKDDOT)                        | 00330 | 15030 | 06654 |                        |
| • | 00336 | ENT       | Q*A                                | 00331 | 10070 | 00000 |                        |
| • | 00337 | MUL       | W(MKQERPNI)                        | 00332 | 22030 | 06631 |                        |
| • | 00340 | LSH       | AQ*1                               | 00333 | 07000 | 00001 |                        |
| • | 00341 | RJP       | ROUND                              | 00334 | 65000 | 01426 |                        |
| • | 00342 | STR       | A*W(MKDDOTX)                       | 00335 | 15030 | 06655 |                        |
| • | 00343 | ENT       | A*W(MOONSW5)*ANOT                  | 00336 | 11530 | 63343 | INCLUDE OFFSET         |
| • | 00344 | EXIT      |                                    | 00337 | 61010 | 00243 | NO, EXIT FROM MOONWORK |
| • | 00345 | COMMENT   | INTERPOLATE EPHMERIS TAB           |       |       |       |                        |
|   |       | LE        |                                    |       |       |       |                        |
| • | 00346 | COMMENT   | DAY=EPHDAY=K+R                     |       |       |       |                        |
| • | 00347 | COMMENT   | CELTIME+R)/10=P TIME FOR INT       |       |       |       |                        |
|   |       | ERPULATE  | B27                                |       |       |       |                        |
| • | 00350 | COMMENT   | EPH(P)=(EPH(K+1)-EPH(K))P+EPH(K)   |       |       |       |                        |
| • | 00351 | RPL       | Y-1*W(MKDELAYCNT)*ANEG             | 00340 | 37730 | 07022 |                        |
| • | 00352 | EXIT      |                                    | 00341 | 61010 | 00243 | NO OFFSET YET          |
| • | 00353 | STR       | B1*L(MKB1STOR)                     | 00342 | 16110 | 00435 |                        |
| • | 00354 | CL        | A                                  | 00343 | 11000 | 00000 |                        |
| • | 00355 | ENT       | Q*L(DAY)                           | 00344 | 10010 | 63150 |                        |
| • | 00356 | SUB       | Q*LX(EPHDAY)*QPOS                  | 00345 | 27650 | 07170 |                        |
| • | 00357 | O         | O                                  | 00346 | 00000 | 00000 |                        |
| • | 00360 | DIV       | 10D*N00F                           | 00347 | 23200 | 00012 |                        |
| • | 00361 | RJP       | SOVERFLOW                          | 00350 | 65000 | 06257 |                        |
| • | 00362 | LSH       | AQ*30D                             | 00351 | 07000 | 00036 |                        |
| • | 00363 | ENT       | B7*A                               | 00352 | 12770 | 00000 |                        |
| • | 00364 | LSH       | Q*25D                              | 00353 | 05000 | 00031 |                        |
| • | 00365 | ENT       | A*W(CELTIME)                       | 00354 | 11030 | 63133 |                        |
| • | 00366 | RSH       | A*3                                | 00355 | 02000 | 00003 |                        |
| • | 00367 | STR       | A+Q*W(MKT1)                        | 00356 | 32030 | 07000 |                        |
| • | 00370 | CL        | Q                                  | 00357 | 10000 | 00000 |                        |
| • | 00371 | RSH       | AQ*3                               | 00360 | 03000 | 00003 |                        |
| • | 00372 | DIV       | W(TENB25)*N00F                     | 00361 | 23230 | 06622 |                        |
| • | 00373 | RJP       | SOVERFLOW                          | 00362 | 65000 | 06257 |                        |
| • | 00374 | STR       | Q*W(EPHP)                          | 00363 | 14030 | 07160 |                        |
| • | 00375 | COMMENT   | COMPUTE MKQKI, MKQSDT, MKQI, MKQSP |       |       |       |                        |
| • | 00376 | PUT       | W(TWOPIE)*W(MOD2PI)                | 00364 | 10030 | 01067 |                        |
|   |       |           |                                    | 00365 | 14030 | 07161 |                        |
| • | 00377 | BSK       | B1*B1                              | 00366 | 71101 | 00000 |                        |
| • | 00400 | EPHINTERP | ENT B7*EPHCNT+B7                   | 00367 | 12707 | 00046 |                        |
| • | 00401 | ENT       | Q*W(EPHRST+1+B7)                   | 00370 | 10037 | 07172 |                        |
| • | 00402 | SUB       | Q*W(EPHRST+B7)*QPOS                | 00371 | 27637 | 07171 |                        |
| • | 00403 | ADD       | Q*W(MOD2PI)                        | 00372 | 26030 | 07161 | 2*PI AT B26            |
| • | 00404 | MUL       | W(EPHP)                            | 00373 | 22030 | 07160 |                        |
| • | 00405 | LSH       | AQ*3                               | 00374 | 07000 | 00003 |                        |
| • | 00406 | RJP       | ROUND                              | 00375 | 65000 | 01426 |                        |
| • | 00407 | SUB       | A*W(MOD2PI)                        | 00376 | 21030 | 07161 |                        |
| • | 00410 | ADD       | A*W(EPHRST+B7)*APOS                | 00377 | 20637 | 07171 |                        |
| • | 00411 | ADD       | A*W(MOD2PI)                        | 00400 | 20030 | 07161 |                        |
| • | 00412 | STR       | A*W(MKQK1+B1)                      | 00401 | 15031 | 07162 |                        |
| • | 00413 | CL        | W(MOD2PI)                          | 00402 | 16030 | 07161 |                        |
| • | 00414 | BSK       | B1*3                               | 00403 | 71100 | 00003 |                        |
| • | 00415 | JP        | EPHINTERP                          | 00404 | 61000 | 00367 |                        |
| • | 00416 | RJP       | MXLHA                              | 00405 | 65000 | 04202 |                        |
| • | 00417 | RJP       | MXRO                               | 00406 | 65000 | 04220 |                        |
| • | 00420 | RJP       | MXRODT                             | 00407 | 65000 | 04351 |                        |

|   |       |          |                       |       |       |       |                           |
|---|-------|----------|-----------------------|-------|-------|-------|---------------------------|
| • | 00421 | RJP      | MXDOP                 | 00410 | 65000 | 04472 |                           |
| • | 00422 | RJP      | MXA                   | 00411 | 65000 | 04517 |                           |
| • | 00423 | RJP      | MXB                   | 00412 | 65000 | 04553 |                           |
| • | 00424 | RJP      | MXC                   | 00413 | 65000 | 04625 |                           |
| • | 00425 | RJP      | MXDELP                | 00414 | 65000 | 04661 |                           |
| • | 00426 | RJP      | MXALF                 | 00415 | 65000 | 04677 |                           |
| • | 00427 | RJP      | MXDECPDT              | 00416 | 65000 | 04740 |                           |
| • | 00430 | RJP      | MXAPDT                | 00417 | 65000 | 05017 |                           |
| • | 00431 | RJP      | MXA1                  | 00420 | 65000 | 05055 |                           |
| • | 00432 | RJP      | MXB1                  | 00421 | 65000 | 05146 |                           |
| • | 00433 | RJP      | MXC1                  | 00422 | 65000 | 05230 |                           |
| • | 00434 | RJP      | MXSINBP               | 00423 | 65000 | 05312 |                           |
| • | 00435 | RJP      | MXSINLP               | 00424 | 65000 | 05327 |                           |
| • | 00436 | RJP      | MXSINCP               | 00425 | 65000 | 05375 |                           |
| • | 00437 | RJP      | MXBPD                 | 00426 | 65000 | 05413 |                           |
| • | 00440 | RJP      | MXLPDT                | 00427 | 65000 | 05424 |                           |
| • | 00441 | RJP      | MXFCL                 | 00430 | 65000 | 05466 |                           |
| • | 00442 | RJP      | MXDA                  | 00431 | 65000 | 05543 |                           |
| • | 00443 | RJP      | MXXYZ                 | 00432 | 65000 | 05563 |                           |
| • | 00444 | RJP      | MXDELALF              | 00433 | 65000 | 05674 |                           |
| • | 00445 | RJP      | MXDPDOP               | 00434 | 65000 | 05761 |                           |
| • | 00446 | MKB1STOR | ENT B1*00             | 00435 | 12100 | 00000 |                           |
| • | 00447 |          | EXIT                  | 00436 | 61010 | 00243 | EXIT FROM MOONWORK        |
| • | 00450 | DAYFIND  | ENTKY                 | 00437 | 61000 | 00000 |                           |
| • | 00451 |          | ENT A*W(CELTIME)*ANEG | 00440 | 11730 | 63133 |                           |
| • | 00452 |          | JP FLATPOS            | 00441 | 61000 | 00456 |                           |
| • | 00453 | FLATNEG  | CP A                  | 00442 | 15040 | 00000 |                           |
| • | 00454 |          | SUB A*W(HALFDAY)*APOS | 00443 | 21630 | 01046 |                           |
| • | 00455 |          | JP LESSONE            | 00444 | 61000 | 00460 |                           |
| • | 00456 |          | RSH AQ*300            | 00445 | 03000 | 00036 |                           |
| • | 00457 |          | DIV W(HALFDAY)        | 00446 | 23030 | 01046 |                           |
| • | 00460 |          | LSH AQ*300            | 00447 | 07000 | 00036 |                           |
| • | 00461 |          | SUB A*1               | 00450 | 21000 | 00001 |                           |
| • | 00462 |          | JP TWOLESS*AZERO      | 00451 | 60400 | 00454 |                           |
| • | 00463 |          | JP TWOLESS*ANEG       | 00452 | 60700 | 00454 |                           |
| • | 00464 |          | ENT A*-3*SKIP         | 00453 | 11140 | 77774 |                           |
| • | 00465 | TWOLESS  | ENT A*-2              | 00454 | 11040 | 77775 |                           |
| • | 00466 |          | JP STORE              | 00455 | 61000 | 00472 |                           |
| • | 00467 | FLATPOS  | SUB A*W(HALFDAY)*ANEG | 00456 | 21730 | 01046 |                           |
| • | 00470 |          | JP MOREONE            | 00457 | 61000 | 00462 |                           |
| • | 00471 | LESSONE  | ENT A*-1              | 00460 | 11040 | 77776 |                           |
| • | 00472 |          | JP STORE              | 00461 | 61000 | 00472 |                           |
| • | 00473 | MOREONE  | RSH AQ*300            | 00462 | 03000 | 00036 |                           |
| • | 00474 |          | DIV W(HALFDAY)        | 00463 | 23030 | 01046 |                           |
| • | 00475 |          | LSH AQ*300            | 00464 | 07000 | 00036 |                           |
| • | 00476 |          | SUB A*1               | 00465 | 21000 | 00001 |                           |
| • | 00477 |          | JP CERO*AZERO         | 00466 | 60400 | 00471 |                           |
| • | 00500 |          | JP CERO*ANEG          | 00467 | 60700 | 00471 |                           |
| • | 00501 |          | ENT A*1*SKIP          | 00470 | 11100 | 00001 |                           |
| • | 00502 | CERO     | ENT A*0               | 00471 | 11000 | 00000 |                           |
| • | 00503 | STORE    | STR A*W(DAYINCRMT)    | 00472 | 15030 | 00503 |                           |
| • | 00504 |          | ADD A*W(WHOLEYEAR)    | 00473 | 20030 | 01437 |                           |
| • | 00505 |          | ADD A*2437300D        | 00474 | 20030 | 07421 | JD DEC 31 1960 GNWCH NOON |
| • | 00506 |          | ADD A*L(DAY)          | 00475 | 20010 | 63150 |                           |
| • | 00507 |          | STR A*W(JULIANDAY)    | 00476 | 15030 | 01440 |                           |
| • | 00510 |          | SUB A*2438145D        | 00477 | 21030 | 07422 | JD APR 25 1963 GNWCH NOON |
| • | 00511 |          | SUB A*W(DAYINCRMT)    | 00500 | 21030 | 00503 |                           |
| • | 00512 |          | STR A*W(SAFE)         | 00501 | 15030 | 01452 |                           |
| • | 00513 |          | EXIT                  | 00502 | 61010 | 00437 |                           |

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. 00514 DAYINCRMNT 0
. 00515 MOUNTIME ENTRY
. 00516 CL B4
. 00517 ENT A*W(CELTIME)
. 00520 ADD A*W(DELTAEE)*APUS
. 00521 SUB A*W(KEY)*SKIP
. 00522 ENT B4*5760
. 00523 RSH AQ*300
. 00524 DIV W(HOUR)
. 00525 STR Q*W(TIME2)
. 00526 CL Q
. 00527 DIV W(HOUR)
. 00530 LSH AQ*290
. 00531 SEL CL*W(KEY)
. 00532 STR A*W(P)
. 00533 ENT Q*W(TIME2)
. 00534 MUL RECSIZE
. 00535 STR Q*A
. 00536 ADD A*AEPHEM+2+B4
. 00537 STR A*L(RAAD)
. 00540 ENT Q*1
. 00541 RPT 5*ADV
. 00542 STR A+Q*L(RADIFAD)
. 00543 EXIT
. 00544 STATUSCK ENTRY
. 00545 RPL Y+1*L(STATUSCK)
. 00546 STR EPHEM*W(TAPSTAT)
. 00547 ENT A*U(TAPSTAT)
. 00550 RSH A*90
. 00551 SEL CL*3
. 00552 STR A*W(TAPSTAT+1)
. 00553 SUB A*24*ANOT
. 00554 RILJP TRYAGAIN
. 00555 SUB A*14*ANOT
. 00556 RILJP L(STATUSCK)
. 00557 SUB A*14*AZERO
. 00560 RILJP BUST
. 00561 RPL Y+1*L(IMPERIAL)
. 00562 SUB A*NUMFILES*AZERO
. 00563 RILJP TRYAGAIN
. 00564 ENT B4*L(MONTHPRINT)
. 00565 ENT A*W(YEARPRINT+B4)
. 00566 ENT B4*L(YEARMONTH)
. 00567 ADD A*W(MONTHPRINT-1+B4)
. 00570 STR A*W(NODATA2)
. 00571 CL A
. 00572 ENT G*NUMFILES
. 00573 DIV 12
. 00574 ADD A*60
. 00575 STR A*U(IMPERIAL)
. 00576 STR Q*A*AZERO
. 00577 ADD A*60
. 00600 LSH A*6
. 00601 ADD A*U(IMPERIAL)
. 00602 LSH A*6
. 00603 ADD A*3105000005
. 00604 STR A*W(NODATA2+4)
. 00605 RIL
. 00606 RJP U(INTERCOM)

```

```

00503 00000 00000
00504 61000 00000
00505 12400 00000
00506 11030 63133
00507 20630 63316
00510 21130 01101
00511 12400 01100
00512 03000 00036
00513 23030 01054
00514 14030 01451
00515 10000 00000
00516 23030 01054
00517 07000 00035
00520 52030 01101
00521 15030 01110
00522 10030 01451
00523 22000 00010
00524 14040 00000
00525 20004 01455
00526 15010 01443
00527 10000 00001
00530 70100 00005
00531 32010 01444
00532 61010 00504
00533 61000 00000
00534 36010 00533
00535 17670 00624
00536 11020 00624
00537 02000 00011
00540 52000 00003
00541 15030 00625
00542 21500 00024
00543 60100 00044
00544 21500 00014
00545 60110 00533
00546 21400 00014
00547 60100 00602
00550 36010 01441
00551 21400 00014
00552 60100 00044
00553 12410 01032
00554 11034 01070
00555 12410 63147
00556 20034 01031
00557 15030 00635
00560 11000 00000
00561 10000 00014
00562 23000 00012
00563 20000 00060
00564 15020 01441
00565 14440 00000
00566 20000 00060
00567 06000 00006
00570 20020 01441
00571 06000 00006
00572 20030 07423
00573 15030 00641
00574 60000 00000
00575 65020 63426

```

TAPE IS REWINDING

EXIT, STATUS = 40

54 = EOF

TAPE ERROR

EOF FOUND

SEARCH NEXT FILE

|                    |        |                               |       |       |       |                    |
|--------------------|--------|-------------------------------|-------|-------|-------|--------------------|
| . 00607            | U-TAG  | NODATA*0                      | 00576 | 00627 | 00000 |                    |
| . 00610            | EX-FCT | EPHEM**W(REWINDNO)            | 00577 | 13670 | 01053 |                    |
| . 00611            | JP     | \$                            | 00600 | 61000 | 00600 | WAIT FOR INTERRUPT |
| . 00612            | JP     | L(MOONINIT)                   | 00601 | 61010 | 00005 | ERROR EXIT         |
| . 00613 BUST       | ENT    | A*L(TAPSTAT+1)                | 00602 | 11010 | 00625 |                    |
| . 00614            | RSN    | AQ*3                          | 00603 | 03000 | 00003 |                    |
| . 00615            | LSH    | A*3                           | 00604 | 06000 | 00003 |                    |
| . 00616            | LSH    | AQ*3                          | 00605 | 07000 | 00003 |                    |
| . 00617            | ADD    | A*6060                        | 00606 | 20000 | 06060 |                    |
| . 00620            | STR    | A*L(TAPEBUST1+3)              | 00607 | 15010 | 00622 |                    |
| . 00621            | RJP    | U(INTERCOM)                   | 00610 | 65020 | 63426 |                    |
| . 00622            | U-TAG  | TAPEBUST*0                    | 00611 | 00615 | 00000 |                    |
| . 00623            | EX-FCT | EPHEM**W(REWINDNO)            | 00612 | 13670 | 01053 |                    |
| . 00624            | JP     | \$                            | 00613 | 61000 | 00613 | WAIT FOR INTERRUPT |
| . 00625            | JP     | L(MOONINIT)                   | 00614 | 61010 | 00005 | ERROR EXIT         |
| . 00626 TAPEBUST   | FD     | 1*A                           | 00615 | 06050 | 50505 |                    |
| . 00627            | -0     | \$+1                          | 00616 | 77777 | 00617 |                    |
| . 00630 TAPEBUST1  | FD     | 4*TAPE STATUS(S1)=            | 00617 | 31062 | 51205 |                    |
|                    |        |                               | 00620 | 30310 | 63132 |                    |
|                    |        |                               | 00621 | 30513 | 06140 |                    |
|                    |        |                               | 00622 | 44050 | 50505 |                    |
| . 00631            | -0     | -0                            | 00623 | 77777 | 77777 |                    |
| . 00632 TAPSTAT    | +0     |                               | 00624 | 00000 | 00000 |                    |
| . 00633            | +0     |                               | 00625 | 00000 | 00000 |                    |
| . 00634            | +0     |                               | 00626 | 00000 | 00000 |                    |
| . 00635 NODATA     | FD     | 1*A                           | 00627 | 06050 | 50505 |                    |
| . 00636            | -0     | \$+1                          | 00630 | 77777 | 00631 |                    |
| . 00637            | FD     | 4*MOON EPHEMERIS FOR          | 00631 | 22242 | 42305 |                    |
|                    |        |                               | 00632 | 12251 | 51222 |                    |
|                    |        |                               | 00633 | 12271 | 63005 |                    |
|                    |        |                               | 00634 | 13242 | 70505 |                    |
| . 00640 NODATA2    | FD     | 6* DATE NOT AMONG FIRST FILES | 00635 | 05110 | 63112 |                    |
|                    |        |                               | 00636 | 05232 | 43105 |                    |
|                    |        |                               | 00637 | 06222 | 42314 |                    |
|                    |        |                               | 00640 | 05131 | 62730 |                    |
|                    |        |                               | 00641 | 31050 | 50505 |                    |
|                    |        |                               | 00642 | 13162 | 11230 |                    |
| . 00641            | -0     |                               | 00643 | 77777 | 77777 |                    |
| . 00642 INITIALJD  | FD     | 1*A                           | 00644 | 06050 | 50505 |                    |
| . 00643            | U-TAG  | INITIAL2*\$+1                 | 00645 | 00652 | 00646 |                    |
| . 00644            | FD     | 3*JULIAN DAY                  | 00646 | 17322 | 11606 |                    |
|                    |        |                               | 00647 | 23051 | 10636 |                    |
|                    |        |                               | 00650 | 05050 | 50505 |                    |
| . 00645            | -0     |                               | 00651 | 77777 | 77777 |                    |
| . 00646 INITIAL2   | FD     | 1*D                           | 00652 | 11050 | 50505 |                    |
| . 00647            | -0     | INITIAL3                      | 00653 | 77777 | 00654 |                    |
| . 00650 INITIAL3   | 0      |                               | 00654 | 00000 | 00000 |                    |
| . 00651 INITIALDAT | FD     | 1*A                           | 00655 | 06050 | 50505 |                    |
| . 00652            | U-TAG  | INITIAL11*\$+1                | 00656 | 00663 | 00657 |                    |
| . 00653            | FD     | 3*DAY OF YEAR                 | 00657 | 11063 | 60524 |                    |
|                    |        |                               | 00660 | 13053 | 61206 |                    |
|                    |        |                               | 00661 | 27050 | 50505 |                    |
| . 00654            | -0     | -0                            | 00662 | 77777 | 77777 |                    |
| . 00655 INITIAL11  | FD     | 1*D                           | 00663 | 11050 | 50505 |                    |
| . 00656            | -0     | INITIAL12                     | 00664 | 77777 | 00665 |                    |
| . 00657 INITIAL12  | 0      |                               | 00665 | 00000 | 00000 |                    |
| . 00660 RGHTASC    | FD     | 1*A                           | 00666 | 06050 | 50505 |                    |
| . 00661            | 0      | RA1                           | 00667 | 00000 | 00704 |                    |
| . 00662            | FD     | 1*D                           | 00670 | 11050 | 50505 |                    |

|   |            |            |               |
|---|------------|------------|---------------|
| • | 00663      | 0          | RA2           |
| • | 00664      | FD         | 1*A           |
| • | 00665      | 0          | RA3           |
| • | 00666      | FD         | 1*D           |
| • | 00667      | 0          | RA4           |
| • | 00670      | FD         | 1*A           |
| • | 00671      | 0          | RA5           |
| • | 00672      | FD         | 1*X2B23       |
| • | 00673      | 0          | RA6           |
| • | 00674      | FD         | 1*A           |
| • | 00675      | -0         | RA7           |
| • | 00676 RA1  | FD         | 3*RIGHT ASC   |
|   |            |            |               |
| • | 00677      | -0         |               |
| • | 00700 RA2  | 0          |               |
| • | 00701 RA3  | 0015050000 |               |
| • | 00702      | -0         |               |
| • | 00703 RA4  | 0          |               |
| • | 00704 RA5  | 0022050000 |               |
| • | 00705      | -0         |               |
| • | 00706 RA6  | 0          |               |
| • | 00707 RA7  | 0030000000 |               |
| • | 00710      | -0         |               |
| • | 00711 DLN  | FD         | 1*A           |
| • | 00712      | 0          | DLN1          |
| • | 00713      | FD         | 1*D           |
| • | 00714      | 0          | DLN2          |
| • | 00715      | FD         | 1*A           |
| • | 00716      | 0          | DLN3          |
| • | 00717      | FD         | 1*D           |
| • | 00720      | 0          | DLN4          |
| • | 00721      | FD         | 1*A           |
| • | 00722      | 0          | DLN5          |
| • | 00723      | FD         | 1*X2B23       |
| • | 00724      | 0          | DLN6          |
| • | 00725      | FD         | 1*A           |
| • | 00726      | -0         | DLN7          |
| • | 00727 DLN1 | FD         | 3*DECLINATION |
|   |            |            |               |
| • | 00730      | -0         |               |
| • | 00731 DLN2 | 0          |               |
| • | 00732 DLN3 | 0011050000 |               |
| • | 00733      | -0         |               |
| • | 00734 DLN4 | 0          |               |
| • | 00735 DLN5 | 0072050000 |               |
| • | 00736      | -0         |               |
| • | 00737 DLN6 | 0          |               |
| • | 00740 DLN7 | 0052000000 |               |
| • | 00741      | -0         |               |
| • | 00742 GMT  | FD         | 1*A           |
| • | 00743      | 0          | GMT1          |
| • | 00744      | FD         | 1*D           |
| • | 00745      | 0          | GMT2          |
| • | 00746      | FD         | 1*A           |
| • | 00747      | 0          | GMT3          |
| • | 00750      | FD         | 1*D           |
| • | 00751      | 0          | GMT4          |

|       |       |       |         |
|-------|-------|-------|---------|
| 00671 | 00000 | 00710 |         |
| 00672 | 06050 | 50505 |         |
| 00673 | 00000 | 00711 |         |
| 00674 | 11050 | 50505 |         |
| 00675 | 00000 | 00713 |         |
| 00676 | 06050 | 50505 |         |
| 00677 | 00000 | 00714 |         |
| 00700 | 35620 | 76263 |         |
| 00701 | 00000 | 00716 |         |
| 00702 | 06050 | 50505 |         |
| 00703 | 77777 | 00717 |         |
| 00704 | 27161 | 41531 |         |
| 00705 | 05063 | 01005 |         |
| 00706 | 05050 | 50505 |         |
| 00707 | 77777 | 77777 |         |
| 00710 | 00000 | 00000 |         |
| 00711 | 00150 | 50000 | H(HOUR) |
| 00712 | 77777 | 77777 |         |
| 00713 | 00000 | 00000 |         |
| 00714 | 00220 | 50000 | M(MIN)  |
| 00715 | 77777 | 77777 |         |
| 00716 | 00000 | 00000 |         |
| 00717 | 00300 | 00000 | S(SEC)  |
| 00720 | 77777 | 77777 |         |
| 00721 | 06050 | 50505 |         |
| 00722 | 00000 | 00737 |         |
| 00723 | 11050 | 50505 |         |
| 00724 | 00000 | 00743 |         |
| 00725 | 06050 | 50505 |         |
| 00726 | 00000 | 00744 |         |
| 00727 | 11050 | 50505 |         |
| 00730 | 00000 | 00746 |         |
| 00731 | 06050 | 50505 |         |
| 00732 | 00000 | 00747 |         |
| 00733 | 35620 | 76263 |         |
| 00734 | 00000 | 00751 |         |
| 00735 | 06050 | 50505 |         |
| 00736 | 77777 | 00752 |         |
| 00737 | 11121 | 02116 |         |
| 00740 | 23063 | 11624 |         |
| 00741 | 23050 | 50505 |         |
| 00742 | 77777 | 77777 |         |
| 00743 | 00000 | 00000 |         |
| 00744 | 00110 | 50000 | D(DEG)  |
| 00745 | 77777 | 77777 |         |
| 00746 | 00000 | 00000 |         |
| 00747 | 00720 | 50000 | (MIN)   |
| 00750 | 77777 | 77777 |         |
| 00751 | 00000 | 00000 |         |
| 00752 | 00520 | 00000 | (SEC)   |
| 00753 | 77777 | 77777 |         |
| 00754 | 06050 | 50505 |         |
| 00755 | 00000 | 00772 |         |
| 00756 | 11050 | 50505 |         |
| 00757 | 00000 | 00776 |         |
| 00760 | 06050 | 50505 |         |
| 00761 | 00000 | 00777 |         |
| 00762 | 11050 | 50505 |         |
| 00763 | 00000 | 01001 |         |

|                     |                                                                     |       |                                               |
|---------------------|---------------------------------------------------------------------|-------|-----------------------------------------------|
| • 00752             | FD 1*A                                                              | 00764 | 06050 50505                                   |
| • 00753             | 0 GMT5                                                              | 00765 | 00000 01002                                   |
| • 00754             | FD 1*X2B23                                                          | 00766 | 35620 76263                                   |
| • 00755             | 0 GMT6                                                              | 00767 | 00000 01004                                   |
| • 00756             | FD 1*A                                                              | 00770 | 06050 50505                                   |
| • 00757             | -0 GMT7                                                             | 00771 | 77777 01005                                   |
| • 00760 GMT1        | FD 3*UNIVERSAL TIME                                                 | 00772 | 32231 63312                                   |
|                     |                                                                     | 00773 | 27300 62105                                   |
|                     |                                                                     | 00774 | 31162 21205                                   |
| • 00761             | -0                                                                  | 00775 | 77777 77777                                   |
| • 00762 GMT2        | 0                                                                   | 00776 | 00000 00000                                   |
| • 00763 GMT3        | 0015050000                                                          | 00777 | 00150 50000 H(HOUR)                           |
| • 00764             | -0                                                                  | 01000 | 77777 77777                                   |
| • 00765 GMT4        | 0                                                                   | 01001 | 00000 00000                                   |
| • 00766 GMT5        | 0022050000                                                          | 01002 | 00220 50000 M(MIN)                            |
| • 00767             | -0                                                                  | 01003 | 77777 77777                                   |
| • 00770 GMT6        | 0                                                                   | 01004 | 00000 00000                                   |
| • 00771 GMT7        | 0030000000                                                          | 01005 | 00300 00000 S(SEC)                            |
| • 00772             | -0                                                                  | 01006 | 77777 77777                                   |
| • 00773 INITIALDIS  | FD 1*A                                                              | 01007 | 06050 50505                                   |
| • 00774             | U-TAG INITIAL17*\$+1                                                | 01010 | 01015 01011                                   |
| • 00775             | FD 3*DISTANCE(E.R.)                                                 | 01011 | 11163 03106                                   |
|                     |                                                                     | 01012 | 23101 25112                                   |
|                     |                                                                     | 01013 | 75277 54005                                   |
| • 00776             | -0                                                                  | 01014 | 77777 77777                                   |
| • 00777 INITIAL17   | FD 1*X6B22                                                          | 01015 | 35660 76262                                   |
| • 01000             | -0 INITIAL18                                                        | 01016 | 77777 01017                                   |
| • 01001 INITIAL18   | 0                                                                   | 01017 | 00000 00000                                   |
| • 01002 INITIALBOD  | FD 1*A                                                              | 01020 | 06050 50505                                   |
| • 01003             | U-TAG INITIAL20*\$+1                                                | 01021 | 01026 01022                                   |
| • 01004             | FD 3*OBJECT                                                         | 01022 | 24071 71210                                   |
|                     |                                                                     | 01023 | 31050 50505                                   |
|                     |                                                                     | 01024 | 05050 50505                                   |
| • 01005             | -0                                                                  | 01025 | 77777 77777                                   |
| • 01006 INITIAL20   | FD 1*A                                                              | 01026 | 06050 50505                                   |
| • 01007             | -0 \$+1                                                             | 01027 | 77777 01030                                   |
| • 01010             | FD 0*MOON                                                           | 01030 | 22242 42300                                   |
| • 01011             | -0                                                                  | 01031 | 77777 77777                                   |
| • 01012 MONTHPRINT  | 0061000000                                                          | 01032 | 00610 00000                                   |
| • 01013             | 0062000000                                                          | 01033 | 00620 00000                                   |
| • 01014             | 0063000000                                                          | 01034 | 00630 00000                                   |
| • 01015             | 0064000000                                                          | 01035 | 00640 00000                                   |
| • 01016             | 0065000000                                                          | 01036 | 00650 00000                                   |
| • 01017             | 0066000000                                                          | 01037 | 00660 00000                                   |
| • 01020             | 0067000000                                                          | 01040 | 00670 00000                                   |
| • 01021             | 0070000000                                                          | 01041 | 00700 00000                                   |
| • 01022             | 0071000000                                                          | 01042 | 00710 00000                                   |
| • 01023             | 6160000000                                                          | 01043 | 61600 00000                                   |
| • 01024             | 6161000000                                                          | 01044 | 61610 00000                                   |
| • 01025             | 6162000000                                                          | 01045 | 61620 00000                                   |
| • 01026 HALFDAY     | 1000000000                                                          | 01046 | 10000 00000                                   |
| • 01027 REVS RADIAN | 2427630155                                                          | 01047 | 24276 30155 .636619772B29 2/PI                |
| • 01030 SRHIBIN     | 56000 EPHEMTAPE                                                     | 01050 | 56000 00002 SEARCH EPHEMERIS TAPE HD,RIN W /I |
| • 01031 IGNORE      | 6000000000                                                          | 01051 | 60000 00000                                   |
| • 01032 INTERRUPT   | RJP STATUSCK                                                        | 01052 | 65000 00533                                   |
| • 01033             | COMMENT SEE MOON WRITEUP FOR DESCRIPTI<br>ON OF FOLLOWING CONSTANTS |       |                                               |
| • 01034 REWINDNO    | 30100 EPHEMTAPE                                                     | 01053 | 30100 00002 REWIND EPHEMERIS TAPE W/INTERR    |

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. 01035 HOUR 0052525253
. 01036 SRAD 3266677130
. 01037 HRAD 1030124434
. 01040 MINSRAD 2167643242
. 01041 HDAY 1252525252
. 01042 MDAY 2660266026
. 01043 SDAY 2506000000
. 01044 SECSRAD 2304045527
. 01045 SARAD 3113343163
. 01046 ERNMSEC 0
. 01047 RHRSEC 2215053170
. 01050 TWOPIE 3110375524
. 01051 COMMENT INCLUDES 1961-1969
. 01052 YEARPRINT 0000746661
. 01053 0000746662
. 01054 0000746663
. 01055 0000746664
. 01056 0000746665
. 01057 0000746666
. 01060 0000746667
. 01061 0000746670
. 01062 0000746671
. 01063 KEY 4000000000
. 01064 FIRSTDIFF 0
. 01065 BETA 0
. 01066 GAMMA 0
. 01067 DELTA 0
. 01070 EPSILON 0
. 01071 FUNCTION 0
. 01072 P 0
. 01073 HALF 2000000000
. 01074 DMINB 0
. 01075 DMIN2CPLB 0
. 01076 EP2BM2UMA 0
. 01077 BESSEL 0
. 01100 0
. 01101 0
. 01102 0
. 01103 0
. 01104 PSQMP 0
. 01105 PSQMP6 0
. 01106 THIRD 1252525252
. 01107 SIXTH 0525252525
. 01110 KENNEDY 0
. 01111 NUMBERIV 0
. 01112 FBESSEL 0
. 01113 0
. 01114 0
. 01115 0
. 01116 0
. 01117 SETINTAD 0
. 01120 INTERPOL ENTRY
. 01121 SUB A*RECSIZE
. 01122 SUB A*RECSIZE
. 01123 ENT B3*A
. 01124 PUT W(B3)*W(FIRSTDIFF)
. 01125 ENT B3*RECSIZE+B3

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UP
01054 00525 25253 1118481120
01055 32666 77130 13750.98708815 43200/PI
01056 10301 24434 .2617993878829 PI/12
01057 21676 43242 .558505361829 PI/720 AT B36
01060 12525 25252 .333333333829 1/24 AT B32
01061 26602 66026 .711111111829 1/1440 AT B39
01062 25060 00000 86400.000812
01063 23040 45527 .595739051829 PI/43200 AT B42
01064 31133 43163 206264.8062811 64800/PI
01065 00000 00000
01066 22150 53170 .568888889829 1/3600 AT B40
01067 31103 75524 6.283185306826 2*PI

01070 00007 46661
01071 00007 46662
01072 00007 46663
01073 00007 46664
01074 00007 46665
01075 00007 46666
01076 00007 46667
01077 00007 46670
01100 00007 46671
01101 40000 00000
01102 00000 00000
01103 00000 00000
01104 00000 00000
01105 00000 00000
01106 00000 00000
01107 00000 00000
01110 00000 00000
01111 20000 00000
01112 00000 00000
01113 00000 00000
01114 00000 00000
01115 00000 00000
01116 00000 00000
01117 00000 00000
01120 00000 00000
01121 00000 00000
01122 00000 00000
01123 00000 00000
01124 12525 25252 .333333333829 1/3
01125 05252 52525 .166666667829 1/6
01126 00000 00000
01127 00000 00000
01130 00000 00000
01131 00000 00000
01132 00000 00000
01133 00000 00000
01134 00000 00000
01135 00000 00000
01136 61000 00000
01137 21000 00010
01140 21000 00010
01141 12370 00000
01142 10033 00000
01143 14030 01102
01144 12303 00010

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|   |       |     |                  |       |       |       |
|---|-------|-----|------------------|-------|-------|-------|
| • | 01126 | PUT | W(B3)*W(BETA)    | 01145 | 10033 | 00000 |
| • | 01127 | ENT | B3*RECSIZE+B3    | 01146 | 14030 | 01103 |
| • | 01130 | PUT | W(B3)*W(GAMMA)   | 01147 | 12303 | 00010 |
| • | 01131 | ENT | B3*RECSIZE+B3    | 01150 | 10033 | 00000 |
| • | 01132 | PUT | W(B3)*W(DELTA)   | 01151 | 14030 | 01104 |
| • | 01133 | ENT | B3*RECSIZE+B3    | 01152 | 12303 | 00010 |
| • | 01134 | PUT | W(B3)*W(EPSILON) | 01153 | 10033 | 00000 |
| • | 01135 | ENT | A*W(DELTA)       | 01154 | 14030 | 01105 |
| • | 01136 | SUB | A*W(BETA)        | 01155 | 12303 | 00010 |
| • | 01137 | STR | A*W(DMINB)       | 01156 | 10033 | 00000 |
| • | 01140 | ADD | A*W(DMINB)       | 01157 | 14030 | 01106 |
| • | 01141 | STR | A*W(BESSEL)      | 01160 | 11030 | 01105 |
| • | 01142 | ENT | A*W(DELTA)       | 01161 | 21030 | 01103 |
| • | 01143 | ADD | A*W(BETA)        | 01162 | 15030 | 01112 |
| • | 01144 | SUB | A*W(GAMMA)       | 01163 | 20030 | 01112 |
| • | 01145 | SUB | A*W(GAMMA)       | 01164 | 15030 | 01115 |
| • | 01146 | STR | A*W(DMIN2CPLB)   | 01165 | 11030 | 01105 |
| • | 01147 | ENT | A*W(EPSILON)     | 01166 | 20030 | 01103 |
| • | 01150 | SUB | A*W(FIRSTDIFF)   | 01167 | 21030 | 01104 |
| • | 01151 | SUB | A*W(BESSEL)      | 01170 | 21030 | 01104 |
| • | 01152 | STR | A*W(EP2BM2DMA)   | 01171 | 15030 | 01113 |
| • | 01153 | ENT | Q*W(P)           | 01172 | 11030 | 01106 |
| • | 01154 | MUL | W(GAMMA)         | 01173 | 21030 | 01102 |
| • | 01155 | LSH | AQ*1             | 01174 | 21030 | 01115 |
| • | 01156 | STR | A*W(BESSEL+1)    | 01175 | 15030 | 01114 |
| • | 01157 | STR | A*W(BESSEL)      | 01176 | 10030 | 01110 |
| • | 01160 | LSH | A*1              | 01177 | 22030 | 01104 |
| • | 01161 | RSH | AQ*1             | 01200 | 07000 | 00001 |
| • | 01162 | STR | Q*W(FBESSEL)     | 01201 | 15030 | 01116 |
| • | 01163 | STR | Q*W(FBESSEL+1)   | 01202 | 15030 | 01115 |
| • | 01164 | ENT | Q*W(P)           | 01203 | 06000 | 00001 |
| • | 01165 | MUL | W(P)             | 01204 | 03000 | 00001 |
| • | 01166 | LSH | AQ*1             | 01205 | 14030 | 01130 |
| • | 01167 | RJP | ROUND            | 01206 | 14030 | 01131 |
| • | 01170 | SUB | A*W(P)           | 01207 | 10030 | 01110 |
| • | 01171 | STR | A*W(PSQMP)       | 01210 | 22030 | 01110 |
| • | 01172 | RSH | AQ*300           | 01211 | 07000 | 00001 |
| • | 01173 | MUL | W(DMINB)         | 01212 | 65000 | 01426 |
| • | 01174 | RSH | AQ*1             | 01213 | 21030 | 01110 |
| • | 01175 | STR | A*W(BESSEL+2)    | 01214 | 15030 | 01122 |
| • | 01176 | LSH | A*1              | 01215 | 03000 | 00036 |
| • | 01177 | RSH | AQ*1             | 01216 | 22030 | 01112 |
| • | 01200 | STR | Q*W(FBESSEL+2)   | 01217 | 03000 | 00001 |
| • | 01201 | ENT | A*W(PSQMP)       | 01220 | 15030 | 01117 |
| • | 01202 | RSH | AQ*300           | 01221 | 06000 | 00001 |
| • | 01203 | DIV | 6                | 01222 | 03000 | 00001 |
| • | 01204 | JP  | CIVIL*GP05       | 01223 | 14030 | 01132 |
| • | 01205 | ADD | A*3*AP05         | 01224 | 11030 | 01122 |
| • | 01206 | SUB | Q*1              | 01225 | 03000 | 00036 |
| • | 01207 | JP  | LINCOLN          | 01226 | 23000 | 00006 |
| • | 01210 | SUB | A*3*ANE6         | 01227 | 60200 | 01233 |
| • | 01211 | ADD | Q*1              | 01230 | 20600 | 00003 |
| • | 01212 | STR | Q*W(PSQMP6)      | 01231 | 27000 | 00001 |
| • | 01213 | ENT | Q*W(P)           | 01232 | 61000 | 01235 |
| • | 01214 | SUB | Q*W(HALF)        | 01233 | 21700 | 00003 |
|   |       |     |                  | 01234 | 26000 | 00001 |
|   |       |     |                  | 01235 | 14030 | 01123 |
|   |       |     |                  | 01236 | 10030 | 01110 |
|   |       |     |                  | 01237 | 27030 | 01111 |

|   |       |     |                   |       |       |       |
|---|-------|-----|-------------------|-------|-------|-------|
| • | 01215 | MUL | W(PSQMP6)         | 01240 | 22030 | 01123 |
| • | 01216 | LSH | AQ*1              | 01241 | 07000 | 00001 |
| • | 01217 | RJP | ROUND             | 01242 | 65000 | 01426 |
| • | 01220 | ENT | Q*A               | 01243 | 10070 | 00000 |
| • | 01221 | MUL | W(DMIN2CPLB)      | 01244 | 22030 | 01113 |
| • | 01222 | LSH | AQ*1              | 01245 | 07000 | 00001 |
| • | 01223 | STR | A*W(BESSEL+3)     | 01246 | 15030 | 01120 |
| • | 01224 | LSH | A*1               | 01247 | 06000 | 00001 |
| • | 01225 | RSH | AQ*1              | 01250 | 03000 | 00001 |
| • | 01226 | STR | Q*W(FBESSEL+3)    | 01251 | 14030 | 01133 |
| • | 01227 | ENT | Q*W(PSQMP6)       | 01252 | 10030 | 01123 |
| • | 01230 | SUB | Q*W(THIRD)        | 01253 | 27030 | 01124 |
| • | 01231 | MUL | W(PSQMP)          | 01254 | 22030 | 01122 |
| • | 01232 | LSH | AQ*1              | 01255 | 07000 | 00001 |
| • | 01233 | RJP | ROUND             | 01256 | 65000 | 01426 |
| • | 01234 | ENT | Q*A               | 01257 | 10070 | 00000 |
| • | 01235 | MUL | W(EP2BM2DMA)      | 01260 | 22030 | 01114 |
| • | 01236 | RSH | AQ*2              | 01261 | 03000 | 00002 |
| • | 01237 | STR | A*W(BESSEL+4)     | 01262 | 15030 | 01121 |
| • | 01240 | LSH | A*1               | 01263 | 06000 | 00001 |
| • | 01241 | RSH | AQ*1              | 01264 | 03000 | 00001 |
| • | 01242 | STR | Q*W(FBESSEL+4)    | 01265 | 14030 | 01134 |
| • | 01243 | ENT | A*W(FBESSEL)      | 01266 | 11030 | 01130 |
| • | 01244 | SEL | CP*W(FBESSEL+2)   | 01267 | 51030 | 01132 |
| • | 01245 | JP  | FL0TEST1*AP0S     | 01270 | 60600 | 01340 |
| • | 01246 | ENT | Q*W(BESSEL+2)     | 01271 | 10030 | 01117 |
| • | 01247 | RPL | Y+Q*W(BESSEL)     | 01272 | 34030 | 01115 |
| • | 01250 | ENT | A*W(FBESSEL+2)    | 01273 | 11030 | 01132 |
| • | 01251 | RPL | A+Y*W(FBESSEL)    | 01274 | 24030 | 01130 |
| • | 01252 | SEL | CP*W(FBESSEL+3)   | 01275 | 51030 | 01133 |
| • | 01253 | JP  | FL0TEST2*AP0S     | 01276 | 60600 | 01362 |
| • | 01254 | ENT | Q*W(BESSEL+3)     | 01277 | 10030 | 01120 |
| • | 01255 | RPL | Y+Q*W(BESSEL)     | 01300 | 34030 | 01115 |
| • | 01256 | ENT | A*W(FBESSEL+3)    | 01301 | 11030 | 01133 |
| • | 01257 | RPL | A+Y*W(FBESSEL)    | 01302 | 24030 | 01130 |
| • | 01260 | SEL | CP*W(FBESSEL+4)   | 01303 | 51030 | 01134 |
| • | 01261 | JP  | FL0TEST3*AP0S     | 01304 | 60600 | 01404 |
| • | 01262 | ENT | Q*W(BESSEL+4)     | 01305 | 10030 | 01121 |
| • | 01263 | RPL | Y+Q*W(BESSEL)     | 01306 | 34030 | 01115 |
| • | 01264 | ENT | A*W(FBESSEL+4)    | 01307 | 11030 | 01134 |
| • | 01265 | RPL | A+Y*W(FBESSEL)    | 01310 | 24030 | 01130 |
| • | 01266 | ENT | Q*W(P)            | 01311 | 10030 | 01110 |
| • | 01267 | SUB | Q*W(HALF)         | 01312 | 27030 | 01111 |
| • | 01270 | MUL | W(DMINB)          | 01313 | 22030 | 01112 |
| • | 01271 | RJP | ROUND             | 01314 | 65000 | 01426 |
| • | 01272 | STR | A*W(KENNEDY)      | 01315 | 15030 | 01126 |
| • | 01273 | ENT | Q*W(PSQMP)        | 01316 | 10030 | 01122 |
| • | 01274 | ADD | Q*W(SIXTH)        | 01317 | 26030 | 01125 |
| • | 01275 | MUL | W(DMIN2CPLB)      | 01320 | 22030 | 01113 |
| • | 01276 | RJP | ROUND             | 01321 | 65000 | 01426 |
| • | 01277 | ADD | A*W(KENNEDY)      | 01322 | 20030 | 01126 |
| • | 01300 | ADD | A*W(GAMMA)        | 01323 | 20030 | 01104 |
| • | 01301 | STR | A*W(NUMDERIV)     | 01324 | 15030 | 01127 |
| • | 01302 | ENT | A*W(FBESSEL)*ANEG | 01325 | 11730 | 01130 |
| • | 01303 | JP  | PLUS              | 01326 | 61000 | 01333 |
| • | 01304 | LSH | A*1*AP0S          | 01327 | 06600 | 00001 |
| • | 01305 | ENT | A*W(BESSEL)*SKIP  | 01330 | 11130 | 01115 |
| • | 01306 | RPL | Y-1*W(BESSEL)     | 01331 | 37030 | 01115 |
| • | 01307 | JP  | SUM               | 01332 | 61000 | 01336 |

|                  |                          |                   |                    |
|------------------|--------------------------|-------------------|--------------------|
| • 01310 PLUS     | LSH A*1*ANEG             | 01333 06700 00001 |                    |
| • 01311          | ENT A**W(BESSEL)*SKIP    | 01334 11130 01115 |                    |
| • 01312          | RPL Y+1*W(BESSEL)        | 01335 36030 01115 |                    |
| • 01313 SUM      | ADD A**W(0+B4)           | 01336 20034 00000 |                    |
| • 01314          | EXIT                     | 01337 61010 01136 | EXIT FROM INTERPOL |
| • 01315 FL0TEST1 | ENT A**W(FBESSEL)*ANEG   | 01340 11730 01130 |                    |
| • 01316          | ADD A**W(FBESSEL+2)*SKIP | 01341 20130 01132 |                    |
| • 01317          | JP BOTHNEG1              | 01342 61000 01352 |                    |
| • 01320          | JP NOFL01*AP0S           | 01343 60600 01271 |                    |
| • 01321          | SEL CL*W(KEY)            | 01344 52030 01101 |                    |
| • 01322          | STR A**W(FBESSEL)        | 01345 15030 01130 |                    |
| • 01323          | ENT Q**W(BESSEL+2)       | 01346 10030 01117 |                    |
| • 01324          | ADD Q*1                  | 01347 26000 00001 |                    |
| • 01325          | RPL Y+Q**W(BESSEL)       | 01350 34030 01115 |                    |
| • 01326          | JP FIX1+3                | 01351 61000 01275 |                    |
| • 01327 BOTHNEG1 | ADD A**W(FBESSEL+2)      | 01352 20030 01132 |                    |
| • 01330          | JP NOFL01*ANEG           | 01353 60700 01271 |                    |
| • 01331          | SEL SET*W(KEY)           | 01354 50030 01101 |                    |
| • 01332          | STR A**W(FBESSEL)        | 01355 15030 01130 |                    |
| • 01333          | ENT Q**W(BESSEL+2)       | 01356 10030 01117 |                    |
| • 01334          | SUB Q*1                  | 01357 27000 00001 |                    |
| • 01335          | RPL Y+Q**W(BESSEL)       | 01360 34030 01115 |                    |
| • 01336          | JP FIX1+3                | 01361 61000 01275 |                    |
| • 01337 FL0TEST2 | ENT A**W(FBESSEL)*ANEG   | 01362 11730 01130 |                    |
| • 01340          | ADD A**W(FBESSEL+3)*SKIP | 01363 20130 01133 |                    |
| • 01341          | JP BOTHNEG2              | 01364 61000 01374 |                    |
| • 01342          | JP NOFL02*AP0S           | 01365 60600 01277 |                    |
| • 01343          | SEL CL*W(KEY)            | 01366 52030 01101 |                    |
| • 01344          | STR A**W(FBESSEL)        | 01367 15030 01130 |                    |
| • 01345          | ENT Q**W(BESSEL+3)       | 01370 10030 01120 |                    |
| • 01346          | ADD Q*1                  | 01371 26000 00001 |                    |
| • 01347          | RPL Y+Q**W(BESSEL)       | 01372 34030 01115 |                    |
| • 01350          | JP FIX2+3                | 01373 61000 01303 |                    |
| • 01351 BOTHNEG2 | ADD A**W(FBESSEL+3)      | 01374 20030 01133 |                    |
| • 01352          | JP NOFL02*ANEG           | 01375 60700 01277 |                    |
| • 01353          | SEL SET*W(KEY)           | 01376 50030 01101 |                    |
| • 01354          | STR A**W(FBESSEL)        | 01377 15030 01130 |                    |
| • 01355          | ENT Q**W(BESSEL+3)       | 01400 10030 01120 |                    |
| • 01356          | SUB Q*1                  | 01401 27000 00001 |                    |
| • 01357          | RPL Y+Q**W(BESSEL)       | 01402 34030 01115 |                    |
| • 01360          | JP FIX2+3                | 01403 61000 01303 |                    |
| • 01361 FL0TEST3 | ENT A**W(FBESSEL)*ANEG   | 01404 11730 01130 |                    |
| • 01362          | ADD A**W(FBESSEL+4)*SKIP | 01405 20130 01134 |                    |
| • 01363          | JP BOTHNEG3              | 01406 61000 01416 |                    |
| • 01364          | JP NOFL03*AP0S           | 01407 60600 01305 |                    |
| • 01365          | SEL CL*W(KEY)            | 01410 52030 01101 |                    |
| • 01366          | STR A**W(FBESSEL)        | 01411 15030 01130 |                    |
| • 01367          | ENT Q**W(BESSEL+4)       | 01412 10030 01121 |                    |
| • 01370          | ADD Q*1                  | 01413 26000 00001 |                    |
| • 01371          | RPL Y+Q**W(BESSEL)       | 01414 34030 01115 |                    |
| • 01372          | JP FIX3+3                | 01415 61000 01311 |                    |
| • 01373 BOTHNEG3 | ADD A**W(FBESSEL+4)      | 01416 20030 01134 |                    |
| • 01374          | JP NOFL03*ANEG           | 01417 60700 01305 |                    |
| • 01375          | SEL SET*W(KEY)           | 01420 50030 01101 |                    |
| • 01376          | STR A**W(FBESSEL)        | 01421 15030 01130 |                    |
| • 01377          | ENT Q**W(BESSEL+4)       | 01422 10030 01121 |                    |
| • 01400          | SUB Q*1                  | 01423 27000 00001 |                    |
| • 01401          | RPL Y+Q**W(BESSEL)       | 01424 34030 01115 |                    |
| • 01402          | JP FIX3+3                | 01425 61000 01311 |                    |

|                    |                                |  |                   |                                 |
|--------------------|--------------------------------|--|-------------------|---------------------------------|
| • 01403            | COMMENT                        |  |                   |                                 |
| • 01404 ROUND      | ENTRY                          |  | 01426 61000 00000 |                                 |
| • 01405            | JP S+4*ANEG                    |  | 01427 60700 01433 |                                 |
| • 01406            | EXIT QPOS                      |  | 01430 60210 01426 |                                 |
| • 01407            | ADD A*1                        |  | 01431 20000 00001 |                                 |
| • 01410            | EXIT                           |  | 01432 61010 01426 |                                 |
| • 01411            | EXIT QNEG                      |  | 01433 60310 01426 |                                 |
| • 01412            | SUB A*1                        |  | 01434 21000 00001 |                                 |
| • 01413            | EXIT                           |  | 01435 61010 01426 |                                 |
| • 01414            | COMMENT                        |  |                   |                                 |
| • 01415 YRREMAIN   | 0                              |  | 01436 00000 00000 |                                 |
| • 01416 WHOLEYEAR  | 0                              |  | 01437 00000 00000 |                                 |
| • 01417 JULIANDAY  | 0                              |  | 01440 00000 00000 |                                 |
| • 01420 IMPERIAL   | 0                              |  | 01441 00000 00000 |                                 |
| • 01421 TAPEBLOCK  | 0                              |  | 01442 00000 00000 |                                 |
| • 01422 RAAD       | 0                              |  | 01443 00000 00000 |                                 |
| • 01423 RADIFAD    | 0                              |  | 01444 00000 00000 |                                 |
| • 01424 DECAD      | 0                              |  | 01445 00000 00000 |                                 |
| • 01425 DECDIFAD   | 0                              |  | 01446 00000 00000 |                                 |
| • 01426 DISTAD     | 0                              |  | 01447 00000 00000 |                                 |
| • 01427 DISTDIFAD  | 0                              |  | 01450 00000 00000 |                                 |
| • 01430 TIME2      | 0                              |  | 01451 00000 00000 |                                 |
| • 01431 SAFE       | 0                              |  | 01452 00000 00000 |                                 |
| • 01432 AEPHEM     | RESERVE 1151D                  |  | 01453 00000 00000 |                                 |
| • 01433 LASTEPHEM  | 0                              |  | 03652 00000 00000 |                                 |
| • 01434 EPHEMA     | U-TAG AEPHEM+191D*AEPHEM       |  | 03653 01752 01453 |                                 |
| • 01435 EPHEMB     | U-TAG AEPHEM+383D*AEPHEM+192D  |  | 03654 02252 01753 |                                 |
| • 01436 EPHEMC     | U-TAG AEPHEM+575D*AEPHEM+384D  |  | 03655 02552 02253 |                                 |
| • 01437 EPHEMD     | U-TAG AEPHEM+767D*AEPHEM+576D  |  | 03656 03052 02553 |                                 |
| • 01440 EPHEME     | U-TAG AEPHEM+959D*AEPHEM+768D  |  | 03657 03352 03053 |                                 |
| • 01441 EPHEMF     | U-TAG AEPHEM+1151D*AEPHEM+960D |  | 03660 03652 03353 |                                 |
| • 01442 TAPESEARCH | 15 0                           |  | 03661 00015 00000 | 15 = TAPE ID FOR MOON           |
| • 01443            | COMMENT                        |  |                   |                                 |
| • 01444            | COMMENT ...SUBROUTINE 1...     |  |                   |                                 |
| • 01445            | COMMENT                        |  |                   |                                 |
| • 01446            | COMMENT CHECK FOR OFFSET       |  |                   |                                 |
| • 01447            | COMMENT IF SO=WHICH INPUT      |  |                   |                                 |
| • 01450            | COMMENT CALCULATE POSITION     |  |                   |                                 |
| • 01451            | COMMENT INITIALLY ONLY         |  |                   |                                 |
| • 01452 MXINIT     | ENTRY                          |  | 03662 61000 00000 |                                 |
| • 01453            | RJP U(INTERCOM)                |  | 03663 65020 63426 |                                 |
| • 01454            | U-TAG MKMES00*MKMES10          |  | 03664 07063 07071 |                                 |
| • 01455            | ENT A*W(MOONS*W\$)*ANOT        |  | 03665 11530 63343 |                                 |
| • 01456            | EXIT                           |  | 03666 61010 03662 | NO OFFSET- OUT                  |
| • 01457            | RJP U(INTERCOM)                |  | 03667 65020 63426 |                                 |
| • 01460            | U-TAG MKMES01*MKMES11          |  | 03670 07073 07111 | DETERMINE A*B,C,D CALCULATIONS  |
| • 01461            | ENT A*L(MKSWITCH)*AZERO        |  | 03671 11410 07115 |                                 |
| • 01462            | SUB A*1                        |  | 03672 21000 00001 |                                 |
| • 01463            | STR A*W(MKPOSSW)               |  | 03673 15030 06656 | MKPOSSW = 0,1,2,3               |
| • 01464            | ENT B7*A                       |  | 03674 12770 00000 |                                 |
| • 01465            | RJP L(MXINTAB+B7)              |  | 03675 65017 03701 |                                 |
| • 01466            | PUT 5*W(MKDELAYCNT)            |  | 03676 10000 00005 |                                 |
|                    |                                |  | 03677 14030 07022 |                                 |
| • 01467            | EXIT                           |  | 03700 61010 03662 | EXIT FROM OFFSET INITIALIZATION |
| • 01470 MXINTAB    | 0 MXINPOSA                     |  | 03701 00000 03705 |                                 |
| • 01471            | 0 MXINPOSB                     |  | 03702 00000 03761 |                                 |
| • 01472            | 0 MXINPOSC                     |  | 03703 00000 04026 |                                 |

|       |          |                                |       |       |       |                        |
|-------|----------|--------------------------------|-------|-------|-------|------------------------|
| 01473 | 0        | MXINPOSD                       | 03704 | 00000 | 04073 |                        |
| 01474 | COMMENT  |                                |       |       |       |                        |
| 01475 | COMMENT  | ...SUBROUTINE 2...             |       |       |       |                        |
| 01476 | COMMENT  |                                |       |       |       |                        |
| 01477 | COMMENT  | INPUT TYPE A                   |       |       |       |                        |
| 01500 | COMMENT  | SELEN LONG AND LAT             |       |       |       |                        |
| 01501 | COMMENT  | INPUT = LAT(BETA),LONG(LAMBDA) |       |       |       |                        |
| 01502 | COMMENT  | CALCULATE X(S),Y(S),Z(S)       |       |       |       |                        |
| 01503 | COMMENT  |                                |       |       |       |                        |
| 01504 | MXINPOSA | ENTRY                          | 03705 | 61000 | 00000 |                        |
| 01505 |          | RJP U(INTERCOM)                | 03706 | 65020 | 63426 | GET BETA               |
| 01506 |          | U-TAG MKMES02*MKMESI2          | 03707 | 07023 | 07027 |                        |
| 01507 |          | RJP U(INTERCOM)                | 03710 | 65020 | 63426 | GET LAMBDA             |
| 01510 |          | U-TAG MKMES03*MKMESI3          | 03711 | 07033 | 07037 |                        |
| 01511 |          | ENT Q*W(MKRADDEG)              | 03712 | 10030 | 06636 | RAD/DEG B29            |
| 01512 |          | MUL W(MKINBETA)                | 03713 | 22030 | 06662 | B20                    |
| 01513 |          | LSH AQ*8D                      | 03714 | 07000 | 00010 | A=B49                  |
| 01514 |          | RJP ROUND                      | 03715 | 65000 | 01426 |                        |
| 01515 |          | STR A*W(MKBETA)                | 03716 | 15030 | 06664 | B=27                   |
| 01516 |          | ENT Q*W(MKRADDEG)              | 03717 | 10030 | 06636 | B29                    |
| 01517 |          | MUL W(MKINLAMBDA)              | 03720 | 22030 | 06663 | B20                    |
| 01520 |          | LSH AQ*8D                      | 03721 | 07000 | 00010 | A=B49                  |
| 01521 |          | RJP ROUND                      | 03722 | 65000 | 01426 |                        |
| 01522 |          | STR A*W(MKLAMBDA)              | 03723 | 15030 | 06665 | B=27                   |
| 01523 |          | ENT A*W(MKBETA)                | 03724 | 11030 | 06664 | B27                    |
| 01524 |          | ENT Q*27D                      | 03725 | 10000 | 00033 |                        |
| 01525 |          | RJP SINX                       | 03726 | 65000 | 06354 |                        |
| 01526 |          | STR A*W(MKSINB)                | 03727 | 15030 | 06666 | SIN(BETA) B28          |
| 01527 |          | ENT A*W(MKLAMBDA)              | 03730 | 11030 | 06665 |                        |
| 01530 |          | ENT Q*27D                      | 03731 | 10000 | 00033 |                        |
| 01531 |          | RJP SINX                       | 03732 | 65000 | 06354 |                        |
| 01532 |          | STR A*W(MKSINL)                | 03733 | 15030 | 06670 | B28                    |
| 01533 |          | ENT A*W(MKBETA)                | 03734 | 11030 | 06664 |                        |
| 01534 |          | ENT Q*27D                      | 03735 | 10000 | 00033 |                        |
| 01535 |          | RJP COSX                       | 03736 | 65000 | 06343 |                        |
| 01536 |          | STR A*W(MKCOSB)                | 03737 | 15030 | 06667 | B28                    |
| 01537 |          | ENT A*W(MKLAMBDA)              | 03740 | 11030 | 06665 |                        |
| 01540 |          | ENT Q*27D                      | 03741 | 10000 | 00033 |                        |
| 01541 |          | RJP COSX                       | 03742 | 65000 | 06343 |                        |
| 01542 |          | STR A*W(MKCOSL)                | 03743 | 15030 | 06671 | B28                    |
| 01543 |          | ENT Q*W(MKCOSB)                | 03744 | 10030 | 06667 | X(S) = COSB X SINL B28 |
| 01544 |          | MUL W(MKSINL)                  | 03745 | 22030 | 06670 | B28                    |
| 01545 |          | LSH AQ*2                       | 03746 | 07000 | 00002 | A=B56                  |
| 01546 |          | RJP ROUND                      | 03747 | 65000 | 01426 |                        |
| 01547 |          | STR A*W(MKXS)                  | 03750 | 15030 | 06547 | B=28                   |
| 01550 |          | ENT Q*W(MKSINB)                | 03751 | 10030 | 06666 | Y(S) = S IN B          |
| 01551 |          | STR Q*W(MKYS)                  | 03752 | 14030 | 06550 | B28                    |
| 01552 |          | ENT Q*W(MKCOSB)                | 03753 | 10030 | 06667 | Z(S) = COSL X COSB     |
| 01553 |          | MUL W(MKCOSL)                  | 03754 | 22030 | 06671 | X                      |
| 01554 |          | LSH AQ*2                       | 03755 | 07000 | 00002 | X                      |
| 01555 |          | RJP ROUND                      | 03756 | 65000 | 01426 | X                      |
| 01556 |          | STR A*W(MKZS)                  | 03757 | 15030 | 06551 | B28                    |
| 01557 |          | EXIT                           | 03760 | 61010 | 03705 |                        |
| 01560 | COMMENT  |                                |       |       |       |                        |
| 01561 | COMMENT  | ...SUBROUTINE 3...             |       |       |       |                        |
| 01562 | COMMENT  |                                |       |       |       |                        |
| 01563 | COMMENT  | INPUT TYPE B                   |       |       |       |                        |
| 01564 | COMMENT  | SELEN DIRECTION COSINES        |       |       |       |                        |

|         |         |                      |       |       |       |                                    |
|---------|---------|----------------------|-------|-------|-------|------------------------------------|
| • 01565 | COMMENT | INPUT = X(S),Y(S)    |       |       |       |                                    |
| • 01566 | COMMENT | CALCULATE Z(S)       |       |       |       |                                    |
| • 01567 | MXINPOS | ENTRY                | 03761 | 61000 | 00000 | METHOD 2 FOR DETERMINING XS, YS, Z |
| • 01570 | COMMENT | GET X(S) AT B28      |       |       |       |                                    |
| • 01571 | RJP     | U(INTERCOM)          | 03762 | 65020 | 63426 | GET INPUT PARAMETERS               |
| • 01572 | U-TAG   | MKMS04*MKMESI4       | 03763 | 07043 | 07047 |                                    |
| • 01573 | ENT     | Q*W(MKXS)            | 03764 | 10030 | 06547 | B28                                |
| • 01574 | MUL     | W(MKXS)              | 03765 | 22030 | 06547 | B28                                |
| • 01575 | LSH     | AQ*2*QP0S            | 03766 | 07200 | 00002 | AT B58                             |
| • 01576 | ADD     | A*1                  | 03767 | 20000 | 00001 | ROUND OFF                          |
| • 01577 | COM     | A*W(MKONE28)*YMORE   | 03770 | 04730 | 06627 |                                    |
| • 01600 | ENT     | A*W(MKONE28)         | 03771 | 11030 | 06627 | 1.0 AT B28                         |
| • 01601 | STR     | A*W(MKXS2)           | 03772 | 15030 | 06672 | X(S)**2                            |
| • 01602 | ENT     | A*W(MKONE28)         | 03773 | 11030 | 06627 | 1.0 AT B28                         |
| • 01603 | SUB     | A*W(MKXS2)*AP0S      | 03774 | 21630 | 06672 | 1-X**2 AT B28                      |
| • 01604 | CL      | A                    | 03775 | 11000 | 00000 |                                    |
| • 01605 | COM     | A*W(MKONE28)*YMORE   | 03776 | 04730 | 06627 |                                    |
| • 01606 | ENT     | A*W(MKONE28)*SKIP    | 03777 | 11130 | 06627 | 1.0 AT B28                         |
| • 01607 | RJP     | SQRT                 | 04000 | 65000 | 06441 | AT B28                             |
| • 01610 | STR     | A*W(YSLIMIT+1)       | 04001 | 15030 | 07062 | STORE UPPER LIMIT                  |
| • 01611 | STR     | A*CPW(YSLIMIT)       | 04002 | 15070 | 07061 | STORE LOWER LIMIT                  |
| • 01612 | COMMENT | GET Y(S) AT B28      |       |       |       |                                    |
| • 01613 | RJP     | U(INTERCOM)          | 04003 | 65020 | 63426 |                                    |
| • 01614 | U-TAG   | MKMS05*MKMESI5       | 04004 | 07053 | 07057 |                                    |
| • 01615 | ENT     | Q*W(MKYS)            | 04005 | 10030 | 06550 | B28                                |
| • 01616 | MUL     | W(MKYS)              | 04006 | 22030 | 06550 | B28                                |
| • 01617 | LSH     | AQ*2*QP0S            | 04007 | 07200 | 00002 | AT B58                             |
| • 01620 | ADD     | A*1                  | 04010 | 20000 | 00001 | ROUND OFF                          |
| • 01621 | COM     | A*W(MKONE28)*YMORE   | 04011 | 04730 | 06627 |                                    |
| • 01622 | ENT     | A*W(MKONE28)         | 04012 | 11030 | 06627 | 1.0 AT B28                         |
| • 01623 | STR     | A*W(MKYS2)           | 04013 | 15030 | 06673 | Y(S)**2                            |
| • 01624 | ENT     | A*W(MKONE28)         | 04014 | 11030 | 06627 | 1 (B28)                            |
| • 01625 | SUB     | A*W(MKXS2)           | 04015 | 21030 | 06672 |                                    |
| • 01626 | SUB     | A*W(MKYS2)*AP0S      | 04016 | 21630 | 06673 | 1-X**2-Y**2                        |
| • 01627 | CL      | A                    | 04017 | 11000 | 00000 |                                    |
| • 01630 | STR     | A*W(MKZS2)           | 04020 | 15030 | 06674 | Z(S) **2 (B28)                     |
| • 01631 | COM     | A*W(MKONE28)*YMORE   | 04021 | 04730 | 06627 |                                    |
| • 01632 | ENT     | A*W(MKONE28)*SKIP    | 04022 | 11130 | 06627 | 1.0 AT B28                         |
| • 01633 | RJP     | SQRT                 | 04023 | 65000 | 06441 | AT B28                             |
| • 01634 | STR     | A*W(MKZS)            | 04024 | 15030 | 06551 | Z(S) AT B28                        |
| • 01635 | EXIT    |                      | 04025 | 61010 | 03761 |                                    |
| • 01636 | COMMENT |                      |       |       |       |                                    |
| • 01637 | COMMENT | ...SUBROUTINE 4...   |       |       |       |                                    |
| • 01640 | COMMENT |                      |       |       |       |                                    |
| • 01641 | COMMENT | INPUT TYPE C         |       |       |       |                                    |
| • 01642 | COMMENT | OBSERVER COORDINATES |       |       |       |                                    |
| • 01643 | COMMENT | INPUT = X(0),Y(0)    |       |       |       |                                    |
| • 01644 | COMMENT | CALCULATE Z(0)       |       |       |       |                                    |
| • 01645 | COMMENT |                      |       |       |       |                                    |
| • 01646 | MXINPOS | ENTRY                | 04026 | 61000 | 00000 |                                    |
| • 01647 | COMMENT | GET X(0) AT B28      |       |       |       |                                    |
| • 01650 | RJP     | U(INTERCOM)          | 04027 | 65020 | 63426 |                                    |
| • 01651 | U-TAG   | MKMS06*MKMESI6       | 04030 | 07116 | 07122 |                                    |
| • 01652 | ENT     | Q*W(MKX0)            | 04031 | 10030 | 06544 | B28                                |
| • 01653 | MUL     | W(MKX0)              | 04032 | 22030 | 06544 | B28                                |
| • 01654 | LSH     | AQ*2*QP0S            | 04033 | 07200 | 00002 | AT B58                             |
| • 01655 | ADD     | A*1                  | 04034 | 20000 | 00001 | ROUND OFF                          |
| • 01656 | COM     | A*W(MKONE28)*YMORE   | 04035 | 04730 | 06627 |                                    |

|       |         |                          |       |       |       |                                   |
|-------|---------|--------------------------|-------|-------|-------|-----------------------------------|
| 01657 | ENT     | A**W(MKONE28)            | 04036 | 11030 | 06627 | 1.0 AT B28                        |
| 01660 | STR     | A**W(MKX02)              | 04037 | 15030 | 06675 | X(0) \$52 (B28)                   |
| 01661 | ENT     | A**W(MKONE28)            | 04040 | 11030 | 06627 | 1.0 AT B28                        |
| 01662 | SUB     | A**W(MKX02)*AP05         | 04041 | 21630 | 06675 | 1-X**2 AT B28                     |
| 01663 | CL      | A                        | 04042 | 11000 | 00000 |                                   |
| 01664 | COM     | A**W(MKONE28)*YMORE      | 04043 | 04730 | 06627 |                                   |
| 01665 | ENT     | A**W(MKONE28)*SKIP       | 04044 | 11130 | 06627 | 1.0 AT B28                        |
| 01666 | RJP     | SQRT                     | 04045 | 65000 | 06441 | AT B28                            |
| 01667 | STR     | A**W(YOLIMIT+1)          | 04046 | 15030 | 07135 | STORE UPPER LIMIT                 |
| 01670 | STR     | A*CPW(YOLIMIT)           | 04047 | 15070 | 07134 | STORE LOWER LIMIT                 |
| 01671 | COMMENT | GET Y(0) AT B28          |       |       |       |                                   |
| 01672 | RJP     | U(INTERCOM)              | 04050 | 65020 | 63426 |                                   |
| 01673 | U-TAG   | MKME507*MKMESI7          | 04051 | 07126 | 07132 |                                   |
| 01674 | ENT     | Q**W(MKY0)               | 04052 | 10030 | 06545 | B28                               |
| 01675 | MUL     | W(MKY0)                  | 04053 | 22030 | 06545 |                                   |
| 01676 | LSH     | AQ*2*QPOS                | 04054 | 07200 | 00002 | AT B58                            |
| 01677 | ADD     | A*1                      | 04055 | 20000 | 00001 | ROUND OFF                         |
| 01700 | COM     | A**W(MKONE28)*YMORE      | 04056 | 04730 | 06627 |                                   |
| 01701 | ENT     | A**W(MKONE28)            | 04057 | 11030 | 06627 | 1.0 AT B28                        |
| 01702 | STR     | A**W(MKY02)              | 04060 | 15030 | 06676 | Y(0) **2 ( B28 )                  |
| 01703 | ENT     | A**W(MKONE28)            | 04061 | 11030 | 06627 |                                   |
| 01704 | SUB     | A**W(MKX02)              | 04062 | 21030 | 06675 |                                   |
| 01705 | SUB     | A**W(MKY02)*AP05         | 04063 | 21630 | 06676 | 1-X**2-Y**2                       |
| 01706 | CL      | A                        | 04064 | 11000 | 00000 |                                   |
| 01707 | STR     | A**W(MKZ02)              | 04065 | 15030 | 06677 | Z(0)**2= 1- X(0)**2- Y(0)**2 ( B2 |
| 01710 | COM     | A**W(MKONE28)*YMORE      | 04066 | 04730 | 06627 |                                   |
| 01711 | ENT     | A**W(MKONE28)*SKIP       | 04067 | 11130 | 06627 | 1.0 AT B28                        |
| 01712 | RJP     | SQRT                     | 04070 | 65000 | 06441 | AT B28                            |
| 01713 | STR     | A**W(MKZ0)               | 04071 | 15030 | 06546 |                                   |
| 01714 | EXIT    |                          | 04072 | 61010 | 04026 |                                   |
| 01715 | COMMENT |                          |       |       |       |                                   |
| 01716 | COMMENT | ...SUBROUTINE 5...       |       |       |       |                                   |
| 01717 | COMMENT |                          |       |       |       |                                   |
| 01720 | COMMENT | INPUT TYPE D             |       |       |       |                                   |
| 01721 | COMMENT | INPUT = DELAY,ANGLE      |       |       |       |                                   |
| 01722 | COMMENT | CALCULATE X(0),Y(0),Z(0) |       |       |       |                                   |
| 01723 | COMMENT |                          |       |       |       |                                   |
| 01724 | ENTRY   |                          | 04073 | 61000 | 00000 |                                   |
| 01725 | RJP     | U(INTERCOM)              | 04074 | 65020 | 63426 |                                   |
| 01726 | U-TAG   | MKME508*MKMESI8          | 04075 | 07136 | 07143 | DELAY                             |
| 01727 | RJP     | U(INTERCOM)              | 04076 | 65020 | 63426 |                                   |
| 01730 | U-TAG   | MKME509*MKMESI9          | 04077 | 07147 | 07154 | ANGLE                             |
| 01731 | ENT     | A**W(MKQ90)              | 04100 | 11030 | 06635 | B20                               |
| 01732 | ENT     | Q**W(MK1ANG)             | 04101 | 10030 | 06661 |                                   |
| 01733 | RJP     | SSUB                     | 04102 | 65000 | 06324 |                                   |
| 01734 | RJP     | SOVERFLOW                | 04103 | 65000 | 06257 |                                   |
| 01735 | ENT     | Q*A                      | 04104 | 10070 | 00000 |                                   |
| 01736 | MUL     | W(MKRADDEG)              | 04105 | 22030 | 06636 | B29                               |
| 01737 | LSH     | AQ*8D                    | 04106 | 07000 | 00010 | SCALE B27                         |
| 01740 | RJP     | ROUND                    | 04107 | 65000 | 01426 |                                   |
| 01741 | STR     | A**W(MKDANG)             | 04110 | 15030 | 06700 | 90 - IN RADIUS B27                |
| 01742 | ENT     | Q*27D                    | 04111 | 10000 | 00033 |                                   |
| 01743 | RJP     | SINX                     | 04112 | 65000 | 06354 |                                   |
| 01744 | STR     | A**W(MKSINDA)            | 04113 | 15030 | 06701 | B28 SIN                           |
| 01745 | ENT     | A**W(MKDANG)             | 04114 | 11030 | 06700 |                                   |
| 01746 | ENT     | Q*27D                    | 04115 | 10000 | 00033 |                                   |
| 01747 | RJP     | COSX                     | 04116 | 65000 | 06343 |                                   |
| 01750 | STR     | A**W(MKCOSDA)            | 04117 | 15030 | 06702 | B28 COS                           |

MXINPOSD

|         |         |                    |       |       |       |                                |
|---------|---------|--------------------|-------|-------|-------|--------------------------------|
| • 01751 | ENT     | Q*W(MKIDELAY)      | 04120 | 10030 | 06660 |                                |
| • 01752 | MUL     | W(MKQR11)          | 04121 | 22030 | 06620 | 1/11.595 B29                   |
| • 01753 | LSH     | AQ*4               | 04122 | 07000 | 00004 | A                              |
| • 01754 | RJP     | ROUND              | 04123 | 65000 | 01426 |                                |
| • 01755 | STR     | A*W(MKDKK2)        | 04124 | 15030 | 06705 | D/11.595 B28                   |
| • 01756 | ENT     | Q*A                | 04125 | 10070 | 00000 | DIVIDE BY 2                    |
| • 01757 | RSH     | Q*1                | 04126 | 01000 | 00001 | B28 D/2(1/11.595)              |
| • 01760 | ENT     | A*W(MKONE28)       | 04127 | 11030 | 06627 |                                |
| • 01761 | RJP     | SSUB               | 04130 | 65000 | 06324 |                                |
| • 01762 | RJP     | SOVERFLOW          | 04131 | 65000 | 06257 |                                |
| • 01763 | ENT     | Q*A                | 04132 | 10070 | 00000 | 1- ABOVE B28                   |
| • 01764 | MUL     | W(MKGALF)          | 04133 | 22030 | 06630 | CONSTANT ALPHA B29             |
| • 01765 | LSH     | AQ*1               | 04134 | 07000 | 00001 | SCALE AT 28                    |
| • 01766 | RJP     | ROUND              | 04135 | 65000 | 01426 |                                |
| • 01767 | STR     | A*W(MKT1)          | 04136 | 15030 | 07000 | K3=ALPH(1-1/2(D/11.595) B28    |
| • 01770 | ENT     | A*W(MKONE28)       | 04137 | 11030 | 06627 |                                |
| • 01771 | ENT     | Q*W(MKDKK2)        | 04140 | 10030 | 06705 |                                |
| • 01772 | RJP     | SSUB               | 04141 | 65000 | 06324 |                                |
| • 01773 | RJP     | SOVERFLOW          | 04142 | 65000 | 06257 |                                |
| • 01774 | STR     | A*W(MKT2)          | 04143 | 15030 | 07001 | K4                             |
| • 01775 | ENT     | Q*W(MKT1)          | 04144 | 10030 | 07000 | B28                            |
| • 01776 | RJP     | SADD               | 04145 | 65000 | 06305 |                                |
| • 01777 | RJP     | SOVERFLOW          | 04146 | 65000 | 06257 |                                |
| • 02000 | STR     | A*W(MKZ0)          | 04147 | 15030 | 06546 | Z(0) AT B28                    |
| • 02001 | ENT     | Q*A                | 04150 | 10070 | 00000 |                                |
| • 02002 | MUL     | W(MKZ0)            | 04151 | 22030 | 06546 |                                |
| • 02003 | LSH     | AQ*2*QP05          | 04152 | 07200 | 00002 | AT B58                         |
| • 02004 | ADD     | A*1                | 04153 | 20000 | 00001 | ROUND OFF                      |
| • 02005 | COM     | A*W(MKONE28)*YMORE | 04154 | 04730 | 06627 |                                |
| • 02006 | ENT     | A*W(MKONE28)       | 04155 | 11030 | 06627 | 1.0 AT B28                     |
| • 02007 | STR     | A*W(MKZ02)         | 04156 | 15030 | 06677 | B28                            |
| • 02010 | ENT     | A*W(MKONE28)       | 04157 | 11030 | 06627 |                                |
| • 02011 | SUB     | A*W(MKZ02)*AP05    | 04160 | 21630 | 06677 |                                |
| • 02012 | CL      | A                  | 04161 | 11000 | 00000 |                                |
| • 02013 | STR     | A*W(MKZRO2)        | 04162 | 15030 | 06703 | 1-Z**2 AT B28                  |
| • 02014 | COM     | A*W(MKONE28)*YMORE | 04163 | 04730 | 06627 |                                |
| • 02015 | ENT     | A*W(MKONE28)*SKIP  | 04164 | 11130 | 06627 | 1.0 AT B28                     |
| • 02016 | RJP     | SQRT               | 04165 | 65000 | 06441 | AT B28                         |
| • 02017 | STR     | A*W(MKZRO)         | 04166 | 15030 | 06704 |                                |
| • 02020 | ENT     | Q*W(MKZRO)         | 04167 | 10030 | 06704 | B28                            |
| • 02021 | MUL     | W(MKCO5DA)         | 04170 | 22030 | 06702 | B28                            |
| • 02022 | LSH     | AQ*2               | 04171 | 07000 | 00002 |                                |
| • 02023 | RJP     | ROUND              | 04172 | 65000 | 01426 |                                |
| • 02024 | STR     | A*W(MKX0)          | 04173 | 15030 | 06544 | X(0)                           |
| • 02025 | ENT     | Q*W(MKZRO)         | 04174 | 10030 | 06704 |                                |
| • 02026 | MUL     | W(MKSINDA)         | 04175 | 22030 | 06701 |                                |
| • 02027 | LSH     | AQ*2               | 04176 | 07000 | 00002 |                                |
| • 02030 | RJP     | ROUND              | 04177 | 65000 | 01426 |                                |
| • 02031 | STR     | A*W(MKY0)          | 04200 | 15030 | 06545 | Y(0)                           |
| • 02032 | EXIT    |                    | 04201 | 61010 | 04073 |                                |
| • 02033 | COMMENT |                    |       |       |       |                                |
| • 02034 | COMMENT | ...SUBROUTINE 6... |       |       |       |                                |
| • 02035 | COMMENT |                    |       |       |       |                                |
| • 02036 | ENTRY   |                    | 04202 | 61000 | 00000 |                                |
| • 02037 | ENT     | A*W(SIDERTIME)     | 04203 | 11030 | 63012 | LST IN RADIANS B26 (2 SEC OLD) |
| • 02040 | ADD     | A*W(DSIDERT)       | 04204 | 20030 | 04217 | 2 SECONDS IN RAD B26           |
| • 02041 | ENT     | Q*W(MKRA)          | 04205 | 10030 | 06643 | ALF(0) RAD B26                 |

|                 |            |                                              |       |       |       |                                                 |
|-----------------|------------|----------------------------------------------|-------|-------|-------|-------------------------------------------------|
| • U2042         | RJP        | SSUB                                         | 04206 | 65000 | 06324 |                                                 |
| • U2043         | RJP        | SOVERFLOW                                    | 04207 | 65000 | 06257 |                                                 |
| • U2044         | STR        | A**W(MKLHA)                                  | 04210 | 15030 | 06552 | LHA= LST-ALF(0) B26 RADIANS                     |
| • U2045         | ENT        | A**W(MKQWE)                                  | 04211 | 11030 | 06626 | B42                                             |
| • U2046         | ENT        | Q**W(MKRADOT)                                | 04212 | 10030 | 06641 |                                                 |
| • U2047         | RJP        | SSUB                                         | 04213 | 65000 | 06324 |                                                 |
| • U2050         | RJP        | SOVERFLOW                                    | 04214 | 65000 | 06257 |                                                 |
| • U2051         | STR        | A**W(MKLHADT)                                | 04215 | 15030 | 06553 | X D/DT(LHA) B43                                 |
| • U2052         | EXIT       |                                              | 04216 | 61010 | 04202 |                                                 |
| • U2053 OSIDERT | 0000023070 |                                              | 04217 | 00000 | 23070 | .0001458826 2 SECONDS SIDEREAL<br>TIME, RAD B26 |
| • U2054         | COMMENT    |                                              |       |       |       |                                                 |
| • U2055         | COMMENT    | ...SUBROUTINE 7...                           |       |       |       |                                                 |
| • U2056         | COMMENT    |                                              |       |       |       |                                                 |
| • U2057 MXRU    | ENTKY      |                                              | 04220 | 61000 | 00000 |                                                 |
| • U2060         | ENT        | A**W(MKLHA)                                  | 04221 | 11030 | 06552 |                                                 |
| • U2061         | ENT        | Q*26D                                        | 04222 | 10000 | 00032 |                                                 |
| • U2062         | RJP        | SINX                                         | 04223 | 65000 | 06354 |                                                 |
| • U2063         | STR        | A**W(MKSINLHA)                               | 04224 | 15030 | 06706 |                                                 |
| • U2064         | ENT        | Q**W(GEUCENLAT)                              | 04225 | 10030 | 63322 |                                                 |
| • U2065         | MUL        | W(MKRADEG)                                   | 04226 | 22030 | 06636 | B29                                             |
| • U2066         | LSH        | AQ*8D                                        | 04227 | 07000 | 00010 | SCALE AT B27 RADIANS                            |
| • U2067         | RJP        | ROUND                                        | 04230 | 65000 | 01426 |                                                 |
| • U2070         | STR        | A**W(MKGEO LAT)                              | 04231 | 15030 | 06647 | B27                                             |
| • U2071         | ENT        | Q*27D                                        | 04232 | 10000 | 00033 |                                                 |
| • U2072         | RJP        | SINX                                         | 04233 | 65000 | 06354 |                                                 |
| • U2073         | STR        | A**W(MKSINGLAT)                              | 04234 | 15030 | 06652 | B28 SIN(PHI(C))                                 |
| • U2074         | ENT        | A**W(MKLHA)                                  | 04235 | 11030 | 06552 | COS(LHA)                                        |
| • U2075         | ENT        | Q*26D                                        | 04236 | 10000 | 00032 | X                                               |
| • U2076         | RJP        | COSX                                         | 04237 | 65000 | 06343 | X                                               |
| • U2077         | STR        | A**W(MKCOSLHA)                               | 04240 | 15030 | 06707 | X B28                                           |
| • U2100         | ENT        | A**W(MKDEC)                                  | 04241 | 11030 | 06644 | DEC B26                                         |
| • U2101         | ENT        | Q*26D                                        | 04242 | 10000 | 00032 | X                                               |
| • U2102         | RJP        | SINX                                         | 04243 | 65000 | 06354 | X                                               |
| • U2103         | STR        | A**W(MKSINDEC)                               | 04244 | 15030 | 06650 | X                                               |
| • U2104         | ENT        | A**W(MKGEO LAT)                              | 04245 | 11030 | 06647 | GET COS(GLAT)                                   |
| • U2105         | ENT        | Q*27D                                        | 04246 | 10000 | 00033 |                                                 |
| • U2106         | RJP        | COSX                                         | 04247 | 65000 | 06343 | X                                               |
| • U2107         | STR        | A**W(MKCOSGLAT)                              | 04250 | 15030 | 06653 | X B28                                           |
| • U2110         | ENT        | A**W(MKDEC)                                  | 04251 | 11030 | 06644 | COS(DEC)                                        |
| • U2111         | ENT        | Q*26D                                        | 04252 | 10000 | 00032 | X                                               |
| • U2112         | RJP        | COSX                                         | 04253 | 65000 | 06343 | X                                               |
| • U2113         | STR        | A**W(MKCOSDEC)                               | 04254 | 15030 | 06651 | X B28                                           |
| • U2114         | ENT        | A**W(MKGHHO)                                 | 04255 | 11030 | 06624 | B                                               |
| • U2115         | CL         | Q                                            | 04256 | 10000 | 00000 |                                                 |
| • U2116         | RSH        | AQ*4                                         | 04257 | 03000 | 00004 | XXXXX                                           |
| • U2117         | DIV        | W(MKDO)*NOOF                                 | 04260 | 23230 | 06645 | D(0) B22                                        |
| • U2120         | RJP        | SOVERFLOW                                    | 04261 | 65000 | 06257 |                                                 |
| • U2121         | LSH        | A*1                                          | 04262 | 06000 | 00001 | X                                               |
| • U2122         | COM        | A**W(MKDO)*YMORE                             | 04263 | 04730 | 06645 | X ROUND                                         |
| • U2123         | ADD        | Q*1                                          | 04264 | 26000 | 00001 |                                                 |
| • U2124         | STR        | Q**W(MK4)                                    | 04265 | 14030 | 06571 | X RHO/D SCALED AT B33                           |
| • U2125         | MUL        | W(MK4)                                       | 04266 | 22030 | 06571 |                                                 |
| • U2126         | RJP        | ROUND                                        | 04267 | 65000 | 01426 |                                                 |
| • U2127         | STR        | A**W(MK42)                                   | 04270 | 15030 | 06777 | XXXXX SCALED AT B36                             |
| • U2130         | COMMENT    | INSERT JP MXRNEW HERE FOR OTH<br>ER EQUATION |       |       |       |                                                 |
| • U2131         | COMMENT    | IF GOING TO NEW CALC DO X DO                 |       |       |       |                                                 |

|   |       |         |                                |       |       |       |                             |
|---|-------|---------|--------------------------------|-------|-------|-------|-----------------------------|
| • | 02132 | ENT     | Q*W(MKSINGLAT)                 | 04271 | 10030 | 06652 | SIN(PHI)X SIN(DEC)          |
| • | 02133 | MUL     | W(MKSINDEC)                    | 04272 | 22030 | 06650 | X                           |
| • | 02134 | LSH     | AQ*2                           | 04273 | 07000 | 00002 | SCALE AT B28                |
| • | 02135 | RJP     | ROUND                          | 04274 | 65000 | 01426 | X                           |
| • | 02136 | STR     | A*W(MKSINPHID)                 | 04275 | 15030 | 06710 |                             |
| • | 02137 | ENT     | Q*W(MKCOSGLAT)                 | 04276 | 10030 | 06653 |                             |
| • | 02140 | MUL     | W(MKCOSDEC)                    | 04277 | 22030 | 06651 | B28                         |
| • | 02141 | LSH     | AQ*2                           | 04300 | 07000 | 00002 | X SCALE AT 28               |
| • | 02142 | RJP     | ROUND                          | 04301 | 65000 | 01426 |                             |
| • | 02143 | ENT     | Q*A                            | 04302 | 10070 | 00000 |                             |
| • | 02144 | MUL     | W(MKCOSLHA)                    | 04303 | 22030 | 06707 |                             |
| • | 02145 | LSH     | AQ*2                           | 04304 | 07000 | 00002 |                             |
| • | 02146 | RJP     | ROUND                          | 04305 | 65000 | 01426 |                             |
| • | 02147 | STR     | A*W(MKCOSPHID)                 | 04306 | 15030 | 06711 |                             |
| • | 02150 | ENT     | Q*W(MKSINPHID)                 | 04307 | 10030 | 06710 | AT B28                      |
| • | 02151 | RJP     | SAUD                           | 04310 | 65000 | 06305 |                             |
| • | 02152 | RJP     | SOVERFLOW                      | 04311 | 65000 | 06257 |                             |
| • | 02153 | STR     | A*W(MKCOSZ0)                   | 04312 | 15030 | 06712 |                             |
| • | 02154 | ENT     | Q*W(MKCOSZ0)                   | 04313 | 10030 | 06712 | B28                         |
| • | 02155 | MUL     | W(MK4)                         | 04314 | 22030 | 06571 | B33                         |
| • | 02156 | RSH     | AQ*2                           | 04315 | 03000 | 00002 | 2(RH0/D)COS(Z0) AT B58      |
| • | 02157 | RJP     | ROUND                          | 04316 | 65000 | 01426 |                             |
| • | 02160 | STR     | A*W(MKRH0DC0S)                 | 04317 | 15030 | 06713 | AT B28                      |
| • | 02161 | ENT     | Q*A                            | 04320 | 10070 | 00000 |                             |
| • | 02162 | ENT     | A*W(MK42)                      | 04321 | 11030 | 06777 |                             |
| • | 02163 | RSH     | A*BD                           | 04322 | 02000 | 00010 | AT B28                      |
| • | 02164 | RJP     | SSUB                           | 04323 | 65000 | 06324 | 1 - RH0/D(C0SZ)+RH0**2(B28) |
| • | 02165 | RJP     | SOVERFLOW                      | 04324 | 65000 | 06257 |                             |
| • | 02166 | ENT     | Q*W(MK0NE28)                   | 04325 | 10030 | 06627 |                             |
| • | 02167 | RJP     | SADD                           | 04326 | 65000 | 06305 |                             |
| • | 02170 | RJP     | SOVERFLOW                      | 04327 | 65000 | 06257 |                             |
| • | 02171 | STR     | A*W(MKRT2)                     | 04330 | 15030 | 06714 | R**2/D**2 B28               |
| • | 02172 | RSH     | A*2                            | 04331 | 02000 | 00002 | XXXXX                       |
| • | 02173 | RJP     | SGRT                           | 04332 | 65000 | 06441 |                             |
| • | 02174 | LSH     | A*1                            | 04333 | 06000 | 00001 |                             |
| • | 02175 | STR     | A*W(MKRT)                      | 04334 | 15030 | 06565 | B28                         |
| • | 02176 | ENT     | Q*A                            | 04335 | 10070 | 00000 |                             |
| • | 02177 | MUL     | W(MKD0)                        | 04336 | 22030 | 06645 | B22                         |
| • | 02200 | LSH     | AQ*3                           | 04337 | 07000 | 00003 | B50                         |
| • | 02201 | RJP     | ROUND                          | 04340 | 65000 | 01426 |                             |
| • | 02202 | STR     | A*W(MKRO)                      | 04341 | 15030 | 06554 | R(0) B23                    |
| • | 02203 | NO-OP   |                                | 04342 | 12000 | 00000 |                             |
| • | 02204 | ENT     | Q*W(MKQCCER)                   | 04343 | 10030 | 06615 | 1/C SEC/E                   |
| • | 02205 | MUL     | W(MKRO)                        | 04344 | 22030 | 06554 | B23                         |
| • | 02206 | LSH     | AQ*6                           | 04345 | 07000 | 00006 |                             |
| • | 02207 | RJP     | ROUND                          | 04346 | 65000 | 01426 |                             |
| • | 02210 | STR     | A*W(MKDELAY)                   | 04347 | 15030 | 06555 | B27                         |
| • | 02211 | EXIT    |                                | 04350 | 61010 | 04220 |                             |
| • | 02212 | COMMENT |                                |       |       |       |                             |
| • | 02213 | COMMENT | ...SUBROUTINE B...             |       |       |       |                             |
| • | 02214 | COMMENT |                                |       |       |       |                             |
| • | 02215 | ENTRY   |                                | 04351 | 61000 | 00000 |                             |
| • | 02216 | ENT     | Q*W(MKSINLHA)                  | 04352 | 10030 | 06706 | X                           |
| • | 02217 | MUL     | W(MKCOSDEC)                    | 04353 | 22030 | 06651 | X                           |
| • | 02220 | LSH     | AQ*2                           | 04354 | 07000 | 00002 | A=56 SCALE B28              |
| • | 02221 | RJP     | ROUND                          | 04355 | 65000 | 01426 | X                           |
| • | 02222 | STR     | A*W(MK2)                       | 04356 | 15030 | 06567 | X B28 K2                    |
| • | 02223 | COMMENT | INSERT JP MXROOTNEW FOR NEW EQ |       |       |       |                             |

|       |     |                 |       |       |       |                                |
|-------|-----|-----------------|-------|-------|-------|--------------------------------|
| 02224 | ENT | Q*W(MKCDSECE)   | 04357 | 10030 | 06651 | SIN(PHI)XCOS(DEC)              |
| 02225 | MUL | W(MKSINGLAT)    | 04360 | 22030 | 06652 | X                              |
| 02226 | LSH | AQ*2            | 04361 | 07000 | 00002 | X                              |
| 02227 | RJP | ROUND           | 04362 | 65000 | 01426 | X                              |
| 02230 | STR | A*W(MKCDOPHI)   | 04363 | 15030 | 06716 | X SCALED B28                   |
| 02231 | ENT | Q*W(MKCDOSGLAT) | 04364 | 10030 | 06653 | COS(PHI)XS=N(DEC)XCDLHA        |
| 02232 | MUL | W(MKSINDEC)     | 04365 | 22030 | 06650 | X                              |
| 02233 | LSH | AQ*2            | 04366 | 07000 | 00002 | X                              |
| 02234 | RJP | ROUND           | 04367 | 65000 | 01426 | X                              |
| 02235 | ENT | Q*A             | 04370 | 10070 | 00000 | A TO 6 FOR COSLHA              |
| 02236 | MUL | W(MKCDLHA)      | 04371 | 22030 | 06707 | X                              |
| 02237 | LSH | AQ*2            | 04372 | 07000 | 00002 | X                              |
| 02240 | RJP | ROUND           | 04373 | 65000 | 01426 | X                              |
| 02241 | STR | A*W(MKSINOPHI)  | 04374 | 15030 | 06715 | X SCALED B28                   |
| 02242 | ENT | A*W(MKCDOPHI)   | 04375 | 11030 | 06716 | -FACTOR 1 - FACTOR 2)D/DT(DEC) |
| 02243 | ENT | Q*W(MKSINOPHI)  | 04376 | 10030 | 06715 | X                              |
| 02244 | RJP | SSUB            | 04377 | 65000 | 06324 | X                              |
| 02245 | RJP | SOVERFLOW       | 04400 | 65000 | 06257 | X                              |
| 02246 | ENT | Q*A             | 04401 | 10070 | 00000 | B28-ABOVE D/DR(DEC)            |
| 02247 | MUL | W(MKDECDOT)     | 04402 | 22030 | 06642 | X                              |
| 02250 | LSH | AQ*2            | 04403 | 07000 | 00002 | A=R 70-SCALE 42                |
| 02251 | RJP | ROUND           | 04404 | 65000 | 01426 | X                              |
| 02252 | STR | A*W(MKT1)       | 04405 | 15030 | 07000 | X T1=B42                       |
| 02253 | ENT | Q*W(MK2)        | 04406 | 10030 | 06567 | X                              |
| 02254 | MUL | W(MKCDOSGLAT)   | 04407 | 22030 | 06653 | X                              |
| 02255 | LSH | AQ*2            | 04410 | 07000 | 00002 | X SCALE B28                    |
| 02256 | RJP | ROUND           | 04411 | 65000 | 01426 | X                              |
| 02257 | ENT | Q*A             | 04412 | 10070 | 00000 | X                              |
| 02260 | MUL | W(MKLHADT)      | 04413 | 22030 | 06553 | X D/DT(LHA) B42 RAD/SEC        |
| 02261 | LSH | AQ*2            | 04414 | 07000 | 00002 | A=70 SCALE AT 42               |
| 02262 | RJP | ROUND           | 04415 | 65000 | 01426 | X                              |
| 02263 | STR | A*W(MKT2)       | 04416 | 15030 | 07001 | X T2=B42                       |
| 02264 | ENT | A*W(MKT1)       | 04417 | 11030 | 07000 | Z1-Z2=D/DT(COSZ)               |
| 02265 | ENT | Q*W(MKT2)       | 04420 | 10030 | 07001 | X                              |
| 02266 | RJP | SSUB            | 04421 | 65000 | 06324 | X                              |
| 02267 | RJP | SOVERFLOW       | 04422 | 65000 | 06257 | X                              |
| 02270 | STR | A*W(MKDDTCOSZ)  | 04423 | 15030 | 06717 | X D/DT(COSZ) B42               |
| 02271 | ENT | Q*W(MK4)        | 04424 | 10030 | 06571 | B28                            |
| 02272 | MUL | W(MKCDOSZ)      | 04425 | 22030 | 06712 | B28                            |
| 02273 | RSH | AQ*3            | 04426 | 03000 | 00003 | X SCALE BACK TO B28            |
| 02274 | RJP | ROUND           | 04427 | 65000 | 01426 | X                              |
| 02275 | ENT | Q*A             | 04430 | 10070 | 00000 | X 1-ABOVE                      |
| 02276 | ENT | A*W(MKONE28)    | 04431 | 11030 | 06627 | X                              |
| 02277 | RJP | SSUB            | 04432 | 65000 | 06324 | X                              |
| 02300 | RJP | SOVERFLOW       | 04433 | 65000 | 06257 | X                              |
| 02301 | STR | A*W(MKT7)       | 04434 | 15030 | 07004 | X                              |
| 02302 | ENT | Q*A             | 04435 | 10070 | 00000 | X MULTIPLY BY D/DT(DO)         |
| 02303 | MUL | W(MKDDOT)       | 04436 | 22030 | 06654 | X RADIUS DOT IN N.M. B29       |
| 02304 | LSH | AQ*2            | 04437 | 07000 | 00002 | X                              |
| 02305 | RJP | ROUND           | 04440 | 65000 | 01426 | X                              |
| 02306 | STR | A*W(MKT3)       | 04441 | 15030 | 07002 | X T3=B29                       |
| 02307 | ENT | Q*W(MKQRO)      | 04442 | 10030 | 06623 | 2(RHO) N.M. B16                |
| 02310 | MUL | W(MKDDTCOSZ)    | 04443 | 22030 | 06717 | X 2(RHO)D/DT(COSX)B37          |
| 02311 | RJP | ROUND           | 04444 | 65000 | 01426 | X                              |
| 02312 | STR | A*W(MKT4)       | 04445 | 15030 | 07003 | X T4=B29                       |
| 02313 | CL  | Q               | 04446 | 10000 | 00000 | X                              |
| 02314 | ENT | A*W(MKONE28)    | 04447 | 11030 | 06627 | 1-B28                          |

|                    |                                        |                   |                                |
|--------------------|----------------------------------------|-------------------|--------------------------------|
| • 02315            | RSH A*2                                | 04450 02000 00002 | X MAKE 26 TO AVOID OVERFLOW-CH |
| • 02316            | DIV W(MKRT)*N00F                       | 04451 23230 06565 | EC                             |
| • 02317            | RJP SOVERFLOW                          | 04452 65000 06257 | X DIVIDE BY PT B28             |
| • 02320            | LSH A*1                                | 04453 06000 00001 | X ERROR                        |
| • 02321            | COM A*W(MKRT)*YMORE                    | 04454 04730 06565 | XXXXX                          |
|                    |                                        |                   | X ANSWER IN Q-B28 CHECK IF MAY |
|                    |                                        |                   | BE                             |
| • 02322            | ADD Q*1                                | 04455 26000 00001 | X ROUND                        |
| • 02323            | STR Q*W(MKT5)                          | 04456 14030 07012 | X 712(B28)                     |
| • 02324            | ENT A*W(MKT3)                          | 04457 11030 07002 | Z1                             |
| • 02325            | ENT Q*W(MKT4)                          | 04460 10030 07003 | X                              |
| • 02326            | RJP SSUB                               | 04461 65000 06324 | X                              |
| • 02327            | RJP SOVERFLOW                          | 04462 65000 06257 | X                              |
| • 02330            | ENT Q*A                                | 04463 10070 00000 | X Z1+Z2 IN A B27               |
| • 02331            | MUL W(MKT5)                            | 04464 22030 07012 | X MUL BY 1/RT B1 B2B           |
| • 02332            | LSH AQ*2                               | 04465 07000 00002 | X                              |
| • 02333            | RJP ROUND                              | 04466 65000 01426 | X                              |
| • 02334            | STR A*W(MKRODT)                        | 04467 15030 06556 | X D/DT(R0)=R29                 |
| • 02335            | COMMENT BACK TO HERE FROM NEW EQUATION |                   |                                |
| • 02336 MXRODTBACK | N0-0P                                  | 04470 12000 00000 |                                |
| • 02337            | EXIT                                   | 04471 61010 04351 |                                |
| • 02340            | COMMENT                                |                   |                                |
| • 02341            | COMMENT ...SUBROUTINE 9...             |                   |                                |
| • 02342            | COMMENT                                |                   |                                |
| • 02343 MXDUP      | ENTRY                                  | 04472 61000 00000 |                                |
| • 02344            | ENT Q*W(MKQFC)                         | 04473 10030 06632 | 2F(C)DR/DT                     |
| • 02345            | MUL W(MKRODT)                          | 04474 22030 06556 | X                              |
| • 02346            | LSH AQ*1                               | 04475 07000 00001 | X                              |
| • 02347            | RJP ROUND                              | 04476 65000 01426 | X                              |
| • 02350            | STR A*W(MKT1)                          | 04477 15030 07000 | X T1=B12                       |
| • 02351            | ENT Q*W(MKQRCNM)                       | 04500 10030 06640 | 1/C DR/DT                      |
| • 02352            | MUL W(MKRODT)                          | 04501 22030 06556 | X                              |
| • 02353            | LSH A*1                                | 04502 06000 00001 | X                              |
| • 02354            | RJP ROUND                              | 04503 65000 01426 | X                              |
| • 02355            | STR A*W(MK20)                          | 04504 15030 06611 | X K20=B37                      |
| • 02356            | ENT Q*W(MK20)                          | 04505 10030 06611 |                                |
| • 02357            | MUL W(MKT1)                            | 04506 22030 07000 | X AT R23                       |
| • 02360            | RSH AQ*7                               | 04507 03000 00007 | X                              |
| • 02361            | RJP ROUND                              | 04510 65000 01426 | X                              |
| • 02362            | STR A*W(MKT3)                          | 04511 15030 07002 | X T3=B12                       |
| • 02363            | ENT Q*W(MKT1)                          | 04512 10030 07000 |                                |
| • 02364            | RJP SSUB                               | 04513 65000 06324 |                                |
| • 02365            | RJP SOVERFLOW                          | 04514 65000 06257 | X                              |
| • 02366            | STR A*W(MKDOPP)                        | 04515 15030 06564 | X DOPP=R12                     |
| • 02367            | EXIT                                   | 04516 61010 04472 |                                |
| • 02370            | COMMENT                                |                   |                                |
| • 02371            | COMMENT ...SUBROUTINE 10...            |                   |                                |
| • 02372            | COMMENT                                |                   |                                |
| • 02373 MXA        | ENTRY                                  | 04517 61000 00000 |                                |
| • 02374            | ENT A*W(MK2)                           | 04520 11030 06567 |                                |
| • 02375            | STR A*W(MKCA)                          | 04521 15030 06720 | A=R2B                          |
| • 02376            | ENT Q*W(MKCOSECD)                      | 04522 10030 06651 | K1=CO5(DEC)COS(LHA)            |
| • 02377            | MUL W(MKCO5LHA)                        | 04523 22030 06707 | X R2B                          |
| • 02400            | LSH AQ*2                               | 04524 07000 00002 | X SCALE AT B2B                 |
| • 02401            | RJP ROUND                              | 04525 65000 01426 | X                              |
| • 02402            | STR A*W(MK1)                           | 04526 15030 06566 | X K1=R2B                       |
| • 02403            | ENT Q*W(MKSINDEC)                      | 04527 10030 06650 | T1=SIN(DEC)SIN(LHA)            |
| • 02404            | MUL W(MKSINLHA)                        | 04530 22030 06706 | X                              |

|         |         |                     |       |       |       |                                      |
|---------|---------|---------------------|-------|-------|-------|--------------------------------------|
| • U2405 | LSH     | AQ*2                | 04531 | 07000 | 00002 | X SCALE AT 28                        |
| • U2406 | RJP     | ROUND               | 04532 | 65000 | 01426 | X                                    |
| • U2407 | STR     | A*W(MKT2)           | 04533 | 15030 | 07001 | X T2=B28                             |
| • U2410 | ENT     | Q*A                 | 04534 | 10070 | 00000 | T2(DD/DT)=TJ                         |
| • U2411 | MUL     | W(MKDECDOT)         | 04535 | 22030 | 06642 |                                      |
| • U2412 | LSH     | AQ*2                | 04536 | 07000 | 00002 |                                      |
| • U2413 | RJP     | ROUND               | 04537 | 65000 | 01426 | X                                    |
| • U2414 | STR     | A*W(MKT4)           | 04540 | 15030 | 07003 | X T4=B43                             |
| • U2415 | ENT     | Q*W(MK1)            | 04541 | 10030 | 06566 | (K1)(D(LHA)/DT)=T3 B28               |
| • U2416 | MUL     | W(MKLHADT)          | 04542 | 22030 | 06553 | X B42                                |
| • U2417 | LSH     | AQ*2                | 04543 | 07000 | 00002 |                                      |
| • U2420 | RJP     | ROUND               | 04544 | 65000 | 01426 | X T3=B42                             |
| • U2421 | STR     | A*W(MKT3)           | 04545 | 15030 | 07002 | X                                    |
| • U2422 | ENT     | Q*W(MKT4)           | 04546 | 10030 | 07003 | T3-T4=D(A)/DT B42                    |
| • U2423 | RJP     | SSUB                | 04547 | 65000 | 06324 | X                                    |
| • U2424 | RJP     | SOVERFLOW           | 04550 | 65000 | 06257 | X                                    |
| • U2425 | STR     | A*W(MKCADT)         | 04551 | 15030 | 06721 | X D(A)/DT B42 RAD/SEC                |
| • U2426 | EXIT    |                     | 04552 | 61010 | 04517 |                                      |
| • U2427 | COMMENT |                     |       |       |       |                                      |
| • U2430 | COMMENT | ...SUBROUTINE 11... |       |       |       |                                      |
| • U2431 | COMMENT |                     |       |       |       |                                      |
| • U2432 | ENTRY   |                     | 04553 | 61000 | 00000 |                                      |
| • U2433 | ENT     | Q*W(MK4)            | 04554 | 10030 | 06571 | K5=K4COS(GLAT) K4 AT B33             |
| • U2434 | MUL     | W(MKCOSGLAT)        | 04555 | 22030 | 06653 | X B28                                |
| • U2435 | LSH     | AQ*2                | 04556 | 07000 | 00002 | X SCALE AT B37                       |
| • U2436 | RJP     | ROUND               | 04557 | 65000 | 01426 | X                                    |
| • U2437 | STR     | A*W(MK5)            | 04560 | 15030 | 06572 | X SCALED AT B33                      |
| • U2440 | ENT     | Q*A                 | 04561 | 10070 | 00000 | B=K1-K5                              |
| • U2441 | ENT     | A*W(MK1)            | 04562 | 11030 | 06566 | X K1=B28                             |
| • U2442 | RSB     | Q*5                 | 04563 | 01000 | 00005 | X SCALE K5 AT B28                    |
| • U2443 | RJP     | SSUB                | 04564 | 65000 | 06324 | X                                    |
| • U2444 | RJP     | SOVERFLOW           | 04565 | 65000 | 06257 | X                                    |
| • U2445 | STR     | A*W(MKCB)           | 04566 | 15030 | 06722 | X B=B28                              |
| • U2446 | ENT     | Q*W(MKSINDEC)       | 04567 | 10030 | 06650 | XXXXX                                |
| • U2447 | MUL     | W(MKCOSLHA)         | 04570 | 22030 | 06707 | XX                                   |
| • U2450 | LSH     | AQ*2                | 04571 | 07000 | 00002 | X                                    |
| • U2451 | RJP     | ROUND               | 04572 | 65000 | 01426 | XX                                   |
| • U2452 | STR     | A*W(MK3)            | 04573 | 15030 | 06570 | XX                                   |
| • U2453 | ENT     | Q*W(MK3)            | 04574 | 10030 | 06570 | T1=K3D(D)/DT                         |
| • U2454 | MUL     | W(MKDECDOT)         | 04575 | 22030 | 06642 |                                      |
| • U2455 | LSH     | AQ*2                | 04576 | 07000 | 00002 |                                      |
| • U2456 | RJP     | ROUND               | 04577 | 65000 | 01426 | X                                    |
| • U2457 | STR     | A*W(MKT1)           | 04600 | 15030 | 07000 | X T1=B45                             |
| • U2460 | ENT     | Q*W(MK2)            | 04601 | 10030 | 06567 |                                      |
| • U2461 | MUL     | W(MKLHADT)          | 04602 | 22030 | 06553 | X K2=B28*D(LHA)/DT=B43               |
| • U2462 | LSH     | AQ*2                | 04603 | 07000 | 00002 |                                      |
| • U2463 | RJP     | ROUND               | 04604 | 65000 | 01426 | X                                    |
| • U2464 | STR     | A*W(MKT2)           | 04605 | 15030 | 07001 | X T2=B45                             |
| • U2465 | ENT     | Q*W(MK5)            | 04606 | 10030 | 06572 |                                      |
| • U2466 | MUL     | W(MKDDOTX)          | 04607 | 22030 | 06655 | X K5=B33,DD0/DT IN ER/SEC AT B<br>40 |
| • U2467 | RSB     | AQ*9D               | 04610 | 03000 | 00011 |                                      |
| • U2470 | DIV     | W(MKD0)*N00F        | 04611 | 23230 | 06645 | X A0 AT 37,D0 AT 22                  |
| • U2471 | RJP     | SOVERFLOW           | 04612 | 65000 | 06257 | X CHECK ROUNDING                     |
| • U2472 | STR     | Q*W(MKT3)           | 04613 | 14030 | 07002 | X T3 AT 45                           |
| • U2473 | ENT     | A*W(MKT3)           | 04614 | 11030 | 07002 | X                                    |
| • U2474 | ENT     | Q*W(MKT2)           | 04615 | 10030 | 07001 | T3-T2                                |
| • U2475 | RJP     | SSUB                | 04616 | 65000 | 06324 | X                                    |
| • U2476 | RJP     | SOVERFLOW           | 04617 | 65000 | 06257 | X                                    |

|       |         |                     |       |       |       |                          |
|-------|---------|---------------------|-------|-------|-------|--------------------------|
| 02477 | ENT     | Q*W(MKT1)           | 04620 | 10030 | 07000 | X ANSWER-T1              |
| 02500 | RJP     | SSUB                | 04621 | 65000 | 06324 | X                        |
| 02501 | RJP     | SOVERFLOW           | 04622 | 65000 | 06257 | X                        |
| 02502 | STR     | A*W(MKCBOT)         | 04623 | 15030 | 06723 | X D(B)/DT AT B45 RAD/SEC |
| 02503 | EXIT    |                     | 04624 | 61010 | 04553 |                          |
| 02504 | COMMENT |                     |       |       |       |                          |
| 02505 | COMMENT | ...SUBROUTINE 12... |       |       |       |                          |
| 02506 | COMMENT |                     |       |       |       |                          |
| 02507 | ENTRY   |                     | 04625 | 61000 | 00000 |                          |
| 02510 | ENT     | Q*W(MK4)            | 04626 | 10030 | 06571 | K6=K4SIN(GLAT)           |
| 02511 | MUL     | W(MKSINGLAT)        | 04627 | 22030 | 06652 | X K4 AT B33( SIN AT B28  |
| 02512 | LSH     | AQ*2                | 04630 | 07000 | 00002 | X                        |
| 02513 | RJP     | ROUND               | 04631 | 65000 | 01426 | X                        |
| 02514 | STR     | A*W(MK6)            | 04632 | 15030 | 06573 | X K6 SCALED AT B33       |
| 02515 | ENT     | Q*A                 | 04633 | 10070 | 00000 | C=SIN(DEC)-K6            |
| 02516 | RSH     | Q*5                 | 04634 | 01000 | 00005 |                          |
| 02517 | ENT     | A*W(MKSINDEC)       | 04635 | 11030 | 06650 | X                        |
| 02520 | RJP     | SSUB                | 04636 | 65000 | 06324 | X                        |
| 02521 | RJP     | SOVERFLOW           | 04637 | 65000 | 06257 | X                        |
| 02522 | STR     | A*W(MKCC)           | 04640 | 15030 | 06724 | X C=B28                  |
| 02523 | ENT     | Q*W(MKCO5DEC)       | 04641 | 10030 | 06651 | T1=COS(DEC)XDD/DT B43    |
| 02524 | MUL     | W(MKDECDOT)         | 04642 | 22030 | 06642 |                          |
| 02525 | LSH     | AQ*2                | 04643 | 07000 | 00002 |                          |
| 02526 | RJP     | ROUND               | 04644 | 65000 | 01426 | X                        |
| 02527 | STR     | A*W(MKT1)           | 04645 | 15030 | 07000 | X T1=B45                 |
| 02530 | ENT     | Q*W(MK6)            | 04646 | 10030 | 06573 | X K6(DD/DT)              |
| 02531 | MUL     | W(MKDDOTX)          | 04647 | 22030 | 06655 |                          |
| 02532 | RSH     | AQ*9D               | 04650 | 03000 | 00011 |                          |
| 02533 | DIV     | W(MKDD)*NOOF        | 04651 | 23230 | 06645 | X D0=B22                 |
| 02534 | RJP     | SOVERFLOW           | 04652 | 65000 | 06257 | X                        |
| 02535 | STR     | Q*W(MKT2)           | 04653 | 14030 | 07001 | X T2=B45                 |
| 02536 | ENT     | A*W(MKT1)           | 04654 | 11030 | 07000 | X 45                     |
| 02537 | RJP     | SADD                | 04655 | 65000 | 06305 | X Q + T1                 |
| 02540 | RJP     | SOVERFLOW           | 04656 | 65000 | 06257 | X                        |
| 02541 | STR     | A*W(MKCCDT)         | 04657 | 15030 | 06725 | X D(C)/DT RAD/SEC AT B45 |
| 02542 | EXIT    |                     | 04660 | 61010 | 04625 |                          |
| 02543 | COMMENT |                     |       |       |       |                          |
| 02544 | COMMENT | ...SUBROUTINE 13... |       |       |       |                          |
| 02545 | COMMENT |                     |       |       |       |                          |
| 02546 | ENTRY   |                     | 04661 | 61000 | 00000 |                          |
| 02547 | ENT     | Q*W(MKCC)           | 04662 | 10030 | 06724 | C AT B28                 |
| 02550 | MUL     | W(MKT5)             | 04663 | 22030 | 07012 | C*(D0/R0) AT B56         |
| 02551 | LSH     | AQ*2                | 04664 | 07000 | 00002 | AT B28                   |
| 02552 | RJP     | ROUND               | 04665 | 65000 | 01426 |                          |
| 02553 | STR     | A*W(MKSINDP)        | 04666 | 15030 | 06726 | SIN(DECPRIME) AT B28     |
| 02554 | ENT     | Q*28D               | 04667 | 10000 | 00034 | X                        |
| 02555 | RJP     | ASINX               | 04670 | 65000 | 06505 | X                        |
| 02556 | RSH     | A*1                 | 04671 | 02000 | 00001 |                          |
| 02557 | STR     | A*W(MKDP)           | 04672 | 15030 | 06563 | X DP-SCALED B27          |
| 02560 | ENT     | Q*26D               | 04673 | 10000 | 00032 |                          |
| 02561 | RJP     | COSX                | 04674 | 65000 | 06343 | X                        |
| 02562 | STR     | A*W(MKCO5DP)        | 04675 | 15030 | 06727 | X COS(DP)-B28            |
| 02563 | EXIT    |                     | 04676 | 61010 | 04661 |                          |
| 02564 | COMMENT |                     |       |       |       |                          |
| 02565 | COMMENT | ...SUBROUTINE 14... |       |       |       |                          |
| 02566 | COMMENT |                     |       |       |       |                          |
| 02567 | ENTRY   |                     | 04677 | 61000 | 00000 |                          |
| 02570 | ENT     | Q*W(MKRT)           | 04700 | 10030 | 06565 | R0/D0 AT B28             |
| 02571 | MUL     | W(MKCO5DP)          | 04701 | 22030 | 06727 | X COS=B28, RT=B28        |

|       |                                 |                     |       |       |       |   |                   |
|-------|---------------------------------|---------------------|-------|-------|-------|---|-------------------|
| 02572 | LSH                             | AQ*2                | 04702 | 07000 | 00002 | X | SCALE AT 28       |
| 02573 | RJP                             | ROUND               | 04703 | 65000 | 01426 | X |                   |
| 02574 | STR                             | A*W(MKAB)           | 04704 | 15030 | 06732 | X | AB=B28            |
| 02575 | ENT                             | Q*A                 | 04705 | 10070 | 00000 |   | (AB)(AB)          |
| 02576 | MUL                             | W(MKAB)             | 04706 | 22030 | 06732 | X |                   |
| 02577 | LSH                             | AQ*2                | 04707 | 07000 | 00002 | X |                   |
| 02600 | RJP                             | ROUND               | 04710 | 65000 | 01426 | X |                   |
| 02601 | STR                             | A*W(MKAB2)          | 04711 | 15030 | 06733 | X | B28               |
| 02602 | ENT                             | A*W(MKCA)           | 04712 | 11030 | 06720 |   | SIN(LHA-)=A/AB    |
| 02603 | CL                              | Q*AP05              | 04713 | 10600 | 00000 |   |                   |
| 02604 | CP                              | Q                   | 04714 | 14000 | 00000 |   |                   |
| 02605 | RSH                             | AQ*2                | 04715 | 03000 | 00002 | X | SCALE AT 56       |
| 02606 | DIV                             | W(MKAB)*N00F        | 04716 | 23230 | 06732 | X | A=B28             |
| 02607 | RJP                             | SOVERFLOW           | 04717 | 65000 | 06257 | X |                   |
| 02610 | COMMENT MAY NEED ROUND OFF HERE |                     |       |       |       |   |                   |
| 02611 | STR                             | Q*W(MKSINLHAP)      | 04720 | 14030 | 06730 | X | B28               |
| 02612 | STR                             | Q*A                 | 04721 | 14040 | 00000 |   | LHA=ARCSIN LHA    |
| 02613 | ENT                             | Q*28D               | 04722 | 10000 | 00034 | X |                   |
| 02614 | RJP                             | ASINX               | 04723 | 65000 | 06505 | X |                   |
| 02615 | RSH                             | A*1                 | 04724 | 02000 | 00001 |   | X LHA IS NOW B2L  |
| 02616 | ENT                             | Q*W(MKCB)*QNEG      | 04725 | 10330 | 06722 |   |                   |
| 02617 | JP                              | S+3                 | 04726 | 61000 | 04731 |   |                   |
| 02620 | CP                              | A                   | 04727 | 15040 | 00000 |   |                   |
| 02621 | ADD                             | A*W(MKQ180)         | 04730 | 20030 | 06637 |   |                   |
| 02622 | STR                             | A*W(MKLHAP)         | 04731 | 15030 | 06731 | X | B27-LHA-          |
| 02623 | ENT                             | A*W(SIDERTIME)      | 04732 | 11030 | 63012 |   | ALF=LST-LHA-      |
| 02624 | ENT                             | Q*W(MKLHAP)         | 04733 | 10030 | 06731 | X |                   |
| 02625 | RJP                             | SSUB                | 04734 | 65000 | 06324 | X |                   |
| 02626 | RJP                             | SOVERFLOW           | 04735 | 65000 | 06257 | X |                   |
| 02627 | STR                             | A*W(MKALFP)         | 04736 | 15030 | 06561 | X | ALF=B27 RADIANS   |
| 02630 | EXIT                            |                     | 04737 | 61010 | 04677 |   |                   |
| 02631 | COMMENT                         |                     |       |       |       |   |                   |
| 02632 | COMMENT                         | ...SUBROUTINE 15... |       |       |       |   |                   |
| 02633 | COMMENT                         |                     |       |       |       |   |                   |
| 02634 | MXDECPDT                        | ENTRY               | 04740 | 61000 | 00000 |   |                   |
| 02635 | ENT                             | Q*W(MKCADT)         | 04741 | 10030 | 06721 |   | T1=ADA/DT         |
| 02636 | MUL                             | W(MKCA)             | 04742 | 22030 | 06720 | X | A=B28,DA/DT AT 45 |
| 02637 | LSH                             | AQ*2                | 04743 | 07000 | 00002 | X | SCALE AT 45       |
| 02640 | RJP                             | ROUND               | 04744 | 65000 | 01426 | X |                   |
| 02641 | STR                             | A*W(MKT1)           | 04745 | 15030 | 07000 | X | T1=B45            |
| 02642 | ENT                             | Q*W(MKCBDT)         | 04746 | 10030 | 06723 |   | T2=B08/DT         |
| 02643 | MUL                             | W(MKCB)             | 04747 | 22030 | 06722 | X |                   |
| 02644 | LSH                             | AQ*2                | 04750 | 07000 | 00002 | X | SCALE AT B37      |
| 02645 | RJP                             | ROUND               | 04751 | 65000 | 01426 | X |                   |
| 02646 | STR                             | A*W(MKT2)           | 04752 | 15030 | 07001 | X | T2=B45            |
| 02647 | ENT                             | Q*W(MKT1)           | 04753 | 10030 | 07000 |   | T3=T2+T1          |
| 02650 | RJP                             | SADD                | 04754 | 65000 | 06305 |   |                   |
| 02651 | RJP                             | SOVERFLOW           | 04755 | 65000 | 06257 | X |                   |
| 02652 | STR                             | A*W(MKT3)           | 04756 | 15030 | 07002 | X | T3=B45            |
| 02653 | CL                              | Q*AP05              | 04757 | 10600 | 00000 |   |                   |
| 02654 | CP                              | Q                   | 04760 | 14000 | 00000 |   |                   |
| 02655 | RSH                             | AQ*2                | 04761 | 03000 | 00002 | X | SCALE AT 73       |
| 02656 | DIV                             | W(MKAB)*N00F        | 04762 | 23230 | 06732 |   | D(AB)/DT=T3/AB    |
| 02657 | RJP                             | SOVERFLOW           | 04763 | 65000 | 06257 | X | T3-B,AB-B28       |
| 02660 | COMMENT MAY NEED ROUND OFF HERE |                     |       |       |       |   |                   |
| 02661 | STR                             | Q*W(MKABDT)         | 04764 | 14030 | 06734 | X | D(AB)/DT B45      |
| 02662 | ENT                             | Q*W(MKAB)           | 04765 | 10030 | 06732 |   | T4=(AB)DC/DT      |
| 02663 | MUL                             | W(MKCCDT)           | 04766 | 22030 | 06725 | X |                   |
| 02664 | LSH                             | AQ*2                | 04767 | 07000 | 00002 | X | SCALE AT 45       |

|         |                                 |       |             |                   |
|---------|---------------------------------|-------|-------------|-------------------|
| • 02665 | RJP ROUND                       | 04770 | 65000 01426 | X                 |
| • 02666 | STR A**W(MKT4)                  | 04771 | 15030 07003 | X T4=45           |
| • 02667 | ENT Q**W(MKCC)                  | 04772 | 10030 06724 | T5=CDAB/DT        |
| • 02670 | MUL W(MKABDT)                   | 04773 | 22030 06734 | X                 |
| • 02671 | LSH AQ*2                        | 04774 | 07000 00002 | X SCALE AT 45     |
| • 02672 | RJP ROUND                       | 04775 | 65000 01426 | X                 |
| • 02673 | STR A**W(MKT5)                  | 04776 | 15030 07012 | X T5=45           |
| • 02674 | ENT Q**A                        | 04777 | 10070 00000 | T6=T4-T5          |
| • 02675 | ENT A**W(MKT4)                  | 05000 | 11030 07003 | X                 |
| • 02676 | RJP SSUB                        | 05001 | 65000 06324 | X                 |
| • 02677 | RJP SOVERFLOW                   | 05002 | 65000 06257 | X                 |
| • 02700 | STR A**W(MKT6)                  | 05003 | 15030 07013 | X T6=45           |
| • 02701 | CL Q*AP0S                       | 05004 | 10600 00000 |                   |
| • 02702 | CP Q                            | 05005 | 14000 00000 |                   |
| • 02703 | RSH AQ*2                        | 05006 | 03000 00002 | X SCALE T6 AT B65 |
| • 02704 | DIV W(MKRT2)*N00F               | 05007 | 23230 06714 | X B28             |
| • 02705 | RJP SOVERFLOW                   | 05010 | 65000 06257 | X                 |
| • 02706 | COMMENT MAY NEED ROUNDOFF HERE  |       |             |                   |
| • 02707 | STR Q**W(MKDPDT)                | 05011 | 14030 06562 | X D(DP)/DT AT 45  |
| • 02710 | ENT A**W(MKDPDT)                | 05012 | 11030 06562 | IN RAD/SEC AT B42 |
| • 02711 | RSH AQ*5                        | 05013 | 03000 00005 |                   |
| • 02712 | RJP ROUND                       | 05014 | 65000 01426 |                   |
| • 02713 | STR A**W(DECD0T)                | 05015 | 15030 63010 | IN RAD/SEC AT B37 |
| • 02714 | EXIT                            | 05016 | 61010 04740 |                   |
| • 02715 | COMMENT                         |       |             |                   |
| • 02716 | COMMENT ...SUBROUTINE 16...     |       |             |                   |
| • 02717 | COMMENT                         |       |             |                   |
| • 02720 | ENTRY MXAPDT                    | 05017 | 61000 00000 |                   |
| • 02721 | ENT Q**W(MKCB)                  | 05020 | 10030 06722 | T1=BDA/DT         |
| • 02722 | MUL W(MKCADT)                   | 05021 | 22030 06721 | X                 |
| • 02723 | LSH AQ*2                        | 05022 | 07000 00002 | X SCALE AT 45     |
| • 02724 | RJP ROUND                       | 05023 | 65000 01426 | X                 |
| • 02725 | STR A**W(MKT1)                  | 05024 | 15030 07000 | X T1 AT 45        |
| • 02726 | ENT Q**W(MKCA)                  | 05025 | 10030 06720 | T2=ADB/DT         |
| • 02727 | MUL W(MKCBDT)                   | 05026 | 22030 06723 | X                 |
| • 02730 | LSH AQ*2                        | 05027 | 07000 00002 | X                 |
| • 02731 | RJP ROUND                       | 05030 | 65000 01426 | X                 |
| • 02732 | STR A**W(MKT2)                  | 05031 | 15030 07001 | X T2 AT 42        |
| • 02733 | ENT Q**A                        | 05032 | 10070 00000 | X T3=T1-T2        |
| • 02734 | ENT A**W(MKT1)                  | 05033 | 11030 07000 | X                 |
| • 02735 | RJP SSUB                        | 05034 | 65000 06324 |                   |
| • 02736 | RJP SOVERFLOW                   | 05035 | 65000 06257 |                   |
| • 02737 | STR A**W(MKT3)                  | 05036 | 15030 07002 | X T3 AT 45        |
| • 02740 | CL Q*AP0S                       | 05037 | 10600 00000 |                   |
| • 02741 | CP Q                            | 05040 | 14000 00000 |                   |
| • 02742 | RSH AQ*2                        | 05041 | 03000 00002 | X SCALE T3 AT 43  |
| • 02743 | DIV W(MKAB2)*N00F               | 05042 | 23230 06733 | T4=T3/ABZ         |
| • 02744 | RJP SOVERFLOW                   | 05043 | 65000 06257 | X AB2=B2B,T3=B37  |
| • 02745 | COMMENT MAY NEED ROUND OFF HERE |       |             |                   |
| • 02746 | STR Q**W(MKT4)                  | 05044 | 14030 07003 | X T4 AT 45        |
| • 02747 | ENT A**W(MKQWE)                 | 05045 | 11030 06626 | D(A)/DT=W(E)-T4   |
| • 02750 | RJP SSUB                        | 05046 | 65000 06324 | X                 |
| • 02751 | RJP SOVERFLOW                   | 05047 | 65000 06257 | X                 |
| • 02752 | STR A**W(MKAPDT)                | 05050 | 15030 06560 | X D(AP)/DT AT 45  |
| • 02753 | RSH AQ*5                        | 05051 | 03000 00005 |                   |
| • 02754 | RJP ROUND                       | 05052 | 65000 01426 |                   |
| • 02755 | STR A**W(RAD0T)                 | 05053 | 15030 63007 | RAD/SEC AT B37    |
| • 02756 | EXIT                            | 05054 | 61010 05017 |                   |
| • 02757 | COMMENT                         |       |             |                   |

|       |                  |                     |       |       |       |
|-------|------------------|---------------------|-------|-------|-------|
| 02760 | COMMENT          | ...SUBROUTINE 17... |       |       |       |
| 02761 | COMMENT          |                     |       |       |       |
| 02762 | ENTRY            |                     | 05055 | 61000 | 00000 |
| 02763 | ENT A*W(MKQI)    |                     | 05056 | 11030 | 07164 |
| 02764 | ENT Q*26D        |                     | 05057 | 10000 | 00032 |
| 02765 | RJP SINX         |                     | 05060 | 65000 | 06354 |
| 02766 | STR A*W(MKQISIN) |                     | 05061 | 15030 | 07166 |
| 02767 | ENT A*W(MKQI)    |                     | 05062 | 11030 | 07164 |
| 02770 | ENT Q*26D        |                     | 05063 | 10000 | 00032 |
| 02771 | RJP COSX         |                     | 05064 | 65000 | 06343 |
| 02772 | STR A*W(MKQICOS) |                     | 05065 | 15030 | 07167 |
| 02773 | ENT A*W(MKALFP)  |                     | 05066 | 11030 | 06561 |
| 02774 | ENT Q*W(MKQSP)   |                     | 05067 | 10030 | 07165 |
| 02775 | RJP SSUB         |                     | 05070 | 65000 | 06324 |
| 02776 | RJP SOVERFLOW    |                     | 05071 | 65000 | 06257 |
| 02777 | STR A*W(MK7)     |                     | 05072 | 15030 | 06574 |
| 03000 | ENT Q*26D        |                     | 05073 | 10000 | 00032 |
| 03001 | RJP COSX         |                     | 05074 | 65000 | 06343 |
| 03002 | STR A*W(MK8)     |                     | 05075 | 15030 | 06575 |
| 03003 | ENT Q*A          |                     | 05076 | 10070 | 00000 |
| 03004 | MUL W(MKCO5DP)   |                     | 05077 | 22030 | 06727 |
| 03005 | LSH AQ*2         |                     | 05100 | 07000 | 00002 |
| 03006 | RJP ROUND        |                     | 05101 | 65000 | 01426 |
| 03007 | STR A*W(MK10)    |                     | 05102 | 15030 | 06577 |
| 03010 | STR A*CPW(MKCA1) |                     | 05103 | 15070 | 06760 |
| 03011 | ENT A*W(MK7)     |                     | 05104 | 11030 | 06574 |
| 03012 | ENT Q*26D        |                     | 05105 | 10000 | 00032 |
| 03013 | RJP SINX         |                     | 05106 | 65000 | 06354 |
| 03014 | STR A*W(MK9)     |                     | 05107 | 15030 | 06576 |
| 03015 | ENT Q*A          |                     | 05110 | 10070 | 00000 |
| 03016 | MUL W(MKCO5DP)   |                     | 05111 | 22030 | 06727 |
| 03017 | LSH AQ*2         |                     | 05112 | 07000 | 00002 |
| 03020 | RJP ROUND        |                     | 05113 | 65000 | 01426 |
| 03021 | STR A*W(MK11)    |                     | 05114 | 15030 | 06600 |
| 03022 | ENT Q*A          |                     | 05115 | 10070 | 00000 |
| 03023 | MUL W(MKAPDT)    |                     | 05116 | 22030 | 06560 |
| 03024 | LSH AQ*2         |                     | 05117 | 07000 | 00002 |
| 03025 | RJP ROUND        |                     | 05120 | 65000 | 01426 |
| 03026 | STR A*W(MKT1)    |                     | 05121 | 15030 | 07000 |
| 03027 | ENT Q*W(MK8)     |                     | 05122 | 10030 | 06575 |
| 03030 | MUL W(MKSINDP)   |                     | 05123 | 22030 | 06726 |
| 03031 | LSH AQ*2         |                     | 05124 | 07000 | 00002 |
| 03032 | RJP ROUND        |                     | 05125 | 65000 | 01426 |
| 03033 | STR A*W(MK12)    |                     | 05126 | 15030 | 06601 |
| 03034 | ENT Q*A          |                     | 05127 | 10070 | 00000 |
| 03035 | MUL W(MKDPDT)    |                     | 05130 | 22030 | 06562 |
| 03036 | LSH AQ*2         |                     | 05131 | 07000 | 00002 |
| 03037 | RJP ROUND        |                     | 05132 | 65000 | 01426 |
| 03040 | STR A*W(MKT2)    |                     | 05133 | 15030 | 07001 |
| 03041 | ENT Q*W(MKT1)    |                     | 05134 | 10030 | 07000 |
| 03042 | RJP SADD         |                     | 05135 | 65000 | 06305 |
| 03043 | RJP SOVERFLOW    |                     | 05136 | 65000 | 06257 |
| 03044 | STR A*W(MKCA1DT) |                     | 05137 | 15030 | 06735 |
| 03045 | ENT Q*W(MK9)     |                     | 05140 | 10030 | 06576 |
| 03046 | MUL W(MKSINDP)   |                     | 05141 | 22030 | 06726 |
| 03047 | LSH AQ*2         |                     | 05142 | 07000 | 00002 |
| 03050 | RJP ROUND        |                     | 05143 | 65000 | 01426 |
| 03051 | STR A*W(MK13)    |                     | 05144 | 15030 | 06602 |
| 03052 | EXIT             |                     | 05145 | 61010 | 05055 |

GET SIN(I) AND COS(I)

K7=ALF--S-

X RAD B26

K10=(COS(DP))MK8

X SCALE AT 28

X K10-B28

K9=SIN(K7)

X

X K9=B28

K11=K9COS(DP)

X

X SCALE AT 28

X

X K11-B28

T1=K11D(A-)/DT

X

X

X T1 AT 45

K12=K8SIN(DP)

X

X

X

X K12-B28

T2=K12D(DP)/DT

X

X

X T2 AT 45

D(A1)/DT=T2+T1

X

X

X D(A1)/DT AT 45

K13=K9SIN(DP)

X

X

X

X K13=B28

|       |                  |                     |       |       |                              |
|-------|------------------|---------------------|-------|-------|------------------------------|
| 03053 | COMMENT          |                     |       |       |                              |
| 03054 | COMMENT          | ...SUBROUTINE 18... |       |       |                              |
| 03055 | COMMENT          |                     |       |       |                              |
| 03056 | ENTRY            |                     | 05146 | 61000 | 00000                        |
| 03057 | ENT Q*W(MKQIC0S) |                     | 05147 | 10030 | 07167                        |
| 03060 | MUL W(MK11)      |                     | 05150 | 22030 | 06600 X                      |
| 03061 | LSH AQ*2         |                     | 05151 | 07000 | 00002 X SCALE AT 28          |
| 03062 | RJP ROUND        |                     | 05152 | 65000 | 01426 X                      |
| 03063 | STR A*W(MKT1)    |                     | 05153 | 15030 | 07000 X T1-B28               |
| 03064 | ENT Q*W(MKSIN0P) |                     | 05154 | 10030 | 06726 T2=SIN(DP)SIN I        |
| 03065 | MUL W(MKQISIN)   |                     | 05155 | 22030 | 07166 X                      |
| 03066 | LSH AQ*2         |                     | 05156 | 07000 | 00002 X                      |
| 03067 | RJP ROUND        |                     | 05157 | 65000 | 01426 X                      |
| 03070 | STR A*W(MKT2)    |                     | 05160 | 15030 | 07001 X T2-B28               |
| 03071 | ENT Q*W(MKT1)    |                     | 05161 | 10030 | 07000 B1=-(T1+T2)            |
| 03072 | RJP SADD         |                     | 05162 | 65000 | 06305 X                      |
| 03073 | RJP SOVERFLOW    |                     | 05163 | 65000 | 06257 X                      |
| 03074 | STR A*CPW(MKCB1) |                     | 05164 | 15070 | 06736 X B1=B28               |
| 03075 | ENT Q*W(MKC0SDP) |                     | 05165 | 10030 | 06727 T3=C0S(DP)SIN I        |
| 03076 | MUL W(MKQISIN)   |                     | 05166 | 22030 | 07166 X                      |
| 03077 | LSH AQ*2         |                     | 05167 | 07000 | 00002 X                      |
| 03100 | RJP ROUND        |                     | 05170 | 65000 | 01426 X                      |
| 03101 | STR A*W(MKT3)    |                     | 05171 | 15030 | 07002 X T3=B28               |
| 03102 | ENT Q*W(MKQIC0S) |                     | 05172 | 10030 | 07167 T4=C0S I(MK13)         |
| 03103 | MUL W(MK13)      |                     | 05173 | 22030 | 06602 X                      |
| 03104 | LSH AQ*2         |                     | 05174 | 07000 | 00002 X                      |
| 03105 | RJP ROUND        |                     | 05175 | 65000 | 01426 X                      |
| 03106 | STR A*W(MKT4)    |                     | 05176 | 15030 | 07003 X                      |
| 03107 | ENT Q*W(MKT3)    |                     | 05177 | 10030 | 07002 T5=(T4-T3)D(DP/DT)     |
| 03110 | RJP SSUB         |                     | 05200 | 65000 | 06324 X                      |
| 03111 | RJP SOVERFLOW    |                     | 05201 | 65000 | 06257 X                      |
| 03112 | STR A*W(MKT7)    |                     | 05202 | 15030 | 07004 X                      |
| 03113 | ENT Q*A          |                     | 05203 | 10070 | 00000 X T4-T3 IN A(B28)      |
| 03114 | MUL W(MKDPDT)    |                     | 05204 | 22030 | 06562 X                      |
| 03115 | LSH AQ*2         |                     | 05205 | 07000 | 00002 X                      |
| 03116 | RJP ROUND        |                     | 05206 | 65000 | 01426 X                      |
| 03117 | STR A*W(MKT5)    |                     | 05207 | 15030 | 07012 X T5 AT 45             |
| 03120 | ENT Q*W(MK10)    |                     | 05210 | 10030 | 06577 T6=MK10 C0S I D(A-)/DT |
| 03121 | MUL W(MKQIC0S)   |                     | 05211 | 22030 | 07167 X B28                  |
| 03122 | LSH AQ*2         |                     | 05212 | 07000 | 00002 X                      |
| 03123 | RJP ROUND        |                     | 05213 | 65000 | 01426 X                      |
| 03124 | STR A*W(MKT8)    |                     | 05214 | 15030 | 07005 X                      |
| 03125 | ENT Q*A          |                     | 05215 | 10070 | 00000 X                      |
| 03126 | MUL W(MKAPDT)    |                     | 05216 | 22030 | 06560 X B45                  |
| 03127 | LSH AQ*2         |                     | 05217 | 07000 | 00002 X                      |
| 03130 | RJP ROUND        |                     | 05220 | 65000 | 01426 X                      |
| 03131 | STR A*W(MKT6)    |                     | 05221 | 15030 | 07013 X T6 AT 45             |
| 03132 | ENT Q*A          |                     | 05222 | 10070 | 00000 D(B1)/DT=T5-T6         |
| 03133 | ENT A*W(MKT5)    |                     | 05223 | 11030 | 07012 X                      |
| 03134 | RJP SSUB         |                     | 05224 | 65000 | 06324 X                      |
| 03135 | RJP SOVERFLOW    |                     | 05225 | 65000 | 06257 X                      |
| 03136 | STR A*W(MKCB1DT) |                     | 05226 | 15030 | 06737 X D(B1)/DT AT 45       |
| 03137 | EXIT             |                     | 05227 | 61010 | 05146                        |
| 03140 | COMMENT          |                     |       |       |                              |
| 03141 | COMMENT          |                     |       |       |                              |
| 03142 | COMMENT          | ...SUBROUTINE 19... |       |       |                              |
| 03143 | COMMENT          |                     |       |       |                              |
| 03144 | ENTRY            |                     | 05230 | 61000 | 00000                        |
| 03145 | ENT Q*W(MKQIC0S) |                     | 05231 | 10030 | 07167 K15=SIN(DP)C0S I       |

|       |         |                     |       |       |       |                      |
|-------|---------|---------------------|-------|-------|-------|----------------------|
| 03146 | MUL     | W(MKSINDP)          | 05232 | 22030 | 06726 | X                    |
| 03147 | LSH     | AQ*2                | 05233 | 07000 | 00002 | X                    |
| 03150 | RJP     | ROUND               | 05234 | 65000 | 01426 | X                    |
| 03151 | STR     | A*W(MK15)           | 05235 | 15030 | 06604 | X B28                |
| 03152 | ENT     | Q*W(MK11)           | 05236 | 10030 | 06600 | K14=K11SIN I         |
| 03153 | MUL     | W(MKQISIN)          | 05237 | 22030 | 07166 | X                    |
| 03154 | LSH     | AQ*2                | 05240 | 07000 | 00002 | X                    |
| 03155 | RJP     | ROUND               | 05241 | 65000 | 01426 | X                    |
| 03156 | STR     | A*W(MK14)           | 05242 | 15030 | 06603 | X K14-B28            |
| 03157 | ENT     | Q*W(MK15)           | 05243 | 10030 | 06604 | C1=K14-K15           |
| 03160 | RJP     | SSUB                | 05244 | 65000 | 06324 | X                    |
| 03161 | RJP     | SOVERFLOW           | 05245 | 65000 | 06257 | X                    |
| 03162 | STR     | A*W(MKCC1)          | 05246 | 15030 | 06740 | X B28                |
| 03163 | ENT     | Q*W(MKQISIN)        | 05247 | 10030 | 07166 | K17=K10SIN I         |
| 03164 | MUL     | W(MK10)             | 05250 | 22030 | 06577 | X                    |
| 03165 | LSH     | AQ*2                | 05251 | 07000 | 00002 | X                    |
| 03166 | RJP     | ROUND               | 05252 | 65000 | 01426 | X                    |
| 03167 | STR     | A*W(MK17)           | 05253 | 15030 | 06606 | X B28                |
| 03170 | ENT     | Q*A                 | 05254 | 10070 | 00000 | T1=K17D(A-)/DT       |
| 03171 | MUL     | W(MKAPDT)           | 05255 | 22030 | 06560 | X                    |
| 03172 | LSH     | AQ*2                | 05256 | 07000 | 00002 | X                    |
| 03173 | RJP     | ROUND               | 05257 | 65000 | 01426 | X                    |
| 03174 | STR     | A*W(MKT1)           | 05260 | 15030 | 07000 | X T1 AT 45           |
| 03175 | ENT     | Q*W(MKCCSDP)        | 05261 | 10030 | 06727 | K16=COS(DP)COS I     |
| 03176 | MUL     | W(MKQICOS)          | 05262 | 22030 | 07167 | X                    |
| 03177 | LSH     | AQ*2                | 05263 | 07000 | 00002 | X                    |
| 03200 | RJP     | ROUND               | 05264 | 65000 | 01426 | X                    |
| 03201 | STR     | A*W(MK16)           | 05265 | 15030 | 06605 | X K16-B28            |
| 03202 | ENT     | Q*W(MK13)           | 05266 | 10030 | 06602 | K18=K13SIN I         |
| 03203 | MUL     | W(MKQISIN)          | 05267 | 22030 | 07166 | X                    |
| 03204 | LSH     | AQ*2                | 05270 | 07000 | 00002 | X                    |
| 03205 | RJP     | ROUND               | 05271 | 65000 | 01426 | X                    |
| 03206 | STR     | A*W(MK18)           | 05272 | 15030 | 06607 | X K18-(B28)          |
| 03207 | ENT     | Q*W(MK16)           | 05273 | 10030 | 06605 | T2=(K18+K16)D(DP)/DT |
| 03210 | RJP     | SADD                | 05274 | 65000 | 06305 | X                    |
| 03211 | RJP     | SOVERFLOW           | 05275 | 65000 | 06257 | X                    |
| 03212 | STR     | A*W(MKT3)           | 05276 | 15030 | 07002 | X                    |
| 03213 | ENT     | Q*A                 | 05277 | 10070 | 00000 | X                    |
| 03214 | MUL     | W(MKDPDT)           | 05300 | 22030 | 06562 | X                    |
| 03215 | LSH     | AQ*2                | 05301 | 07000 | 00002 | X                    |
| 03216 | RJP     | ROUND               | 05302 | 65000 | 01426 | X                    |
| 03217 | STR     | A*W(MKT2)           | 05303 | 15030 | 07001 | X T2 AT 45           |
| 03220 | ENT     | Q*A                 | 05304 | 10070 | 00000 | DC1/DT=T2-T1         |
| 03221 | ENT     | A*W(MKT1)           | 05305 | 11030 | 07000 | X                    |
| 03222 | RJP     | SSUB                | 05306 | 65000 | 06324 | X                    |
| 03223 | RJP     | SOVERFLOW           | 05307 | 65000 | 06257 | X                    |
| 03224 | STR     | A*W(MKCC1DT)        | 05310 | 15030 | 06741 | X D(C1)/DT AT 45     |
| 03225 | EXIT    |                     | 05311 | 61010 | 05230 |                      |
| 03226 | COMMENT |                     |       |       |       |                      |
| 03227 | COMMENT | ...SUBROUTINE 20... |       |       |       |                      |
| 03230 | COMMENT |                     |       |       |       |                      |
| 03231 | MXSINBP | ENTRY               | 05312 | 61000 | 00000 |                      |
| 03232 |         | ENT A*W(MK14)       | 05313 | 11030 | 06603 | SIN BP-K14-K15       |
| 03233 |         | ENT Q*W(MK15)       | 05314 | 10030 | 06604 | X                    |
| 03234 |         | RJP SSUB            | 05315 | 65000 | 06324 | X                    |
| 03235 |         | RJP SOVERFLOW       | 05316 | 65000 | 06257 | X                    |
| 03236 |         | STR A*W(MKSINBP)    | 05317 | 15030 | 06743 | X B28                |
| 03237 |         | ENT Q*28D           | 05320 | 10000 | 00034 | BP                   |
| 03240 |         | RJP ASINX           | 05321 | 65000 | 06505 | X                    |

|       |                                  |       |       |       |                              |
|-------|----------------------------------|-------|-------|-------|------------------------------|
| 03241 | STR A*W(MKBP)                    | 05322 | 15030 | 06742 | X B27 RADIANS                |
| 03242 | ENT Q*27D                        | 05323 | 10000 | 00033 | COS BP                       |
| 03243 | RJP COSX                         | 05324 | 65000 | 06343 | X                            |
| 03244 | STR A*W(MKCOSBP)                 | 05325 | 15030 | 06744 | X B28                        |
| 03245 | EXIT                             | 05326 | 61010 | 05312 |                              |
| 03246 | COMMENT                          |       |       |       |                              |
| 03247 | COMMENT ...SUBROUTINE 21...      |       |       |       |                              |
| 03250 | COMMENT                          |       |       |       |                              |
| 03251 | ENTRY                            | 05327 | 61000 | 00000 |                              |
| 03252 | ENT A*W(MKCB1)                   | 05330 | 11030 | 06736 |                              |
| 03253 | CL Q*AP0S                        | 05331 | 10600 | 00000 |                              |
| 03254 | CP G                             | 05332 | 14000 | 00000 |                              |
| 03255 | RSH AQ*2                         | 05333 | 03000 | 00002 | X SCALE A1 AT R56            |
| 03256 | DIV W(MKCOSBP)*N00F              | 05334 | 23230 | 06744 | X                            |
| 03257 | RJP SOVERFLOW                    | 05335 | 65000 | 06257 | X                            |
| 03260 | COMMENT MAY NEED ROUND OFF HERE  |       |       |       |                              |
| 03261 | STR Q*W(MKT1)                    | 05336 | 14030 | 07000 | X T1=B28                     |
| 03262 | STR Q*A                          | 05337 | 14040 | 00000 | T2=ARCSIN T1                 |
| 03263 | ENT Q*28D                        | 05340 | 10000 | 00034 | X                            |
| 03264 | RJP ASINX                        | 05341 | 65000 | 06505 | X                            |
| 03265 | RSH A*1                          | 05342 | 02000 | 00001 |                              |
| 03266 | STR A*W(MKT2)                    | 05343 | 15030 | 07001 | X RADIANS B26                |
| 03267 | COMMENT CHECK COS OF SUM FOR NEG |       |       |       |                              |
| 03270 | COMMENT IF NEG ...ANG = 180-ANG  |       |       |       |                              |
| 03271 | ENT A*W(MKCOSBP)                 | 05344 | 11030 | 06744 |                              |
| 03272 | ENT Q*W(MKCA1)*AP0S              | 05345 | 10630 | 06760 |                              |
| 03273 | JP MKLAG                         | 05346 | 61000 | 05356 |                              |
| 03274 | JP MKL0K*QP0S                    | 05347 | 60200 | 05357 | ANG OK ...CONTINUE           |
| 03275 | ENT A*W(MKQ180)                  | 05350 | 11030 | 06637 | ANG IN WRONG QUAD...SUBTRACT |
| 03276 | ENT Q*W(MKT2)                    | 05351 | 10030 | 07001 |                              |
| 03277 | RJP SSUB                         | 05352 | 65000 | 06324 |                              |
| 03300 | RJP SOVERFLOW                    | 05353 | 65000 | 06257 |                              |
| 03301 | STR A*W(MKT2)                    | 05354 | 15030 | 07001 |                              |
| 03302 | JP \$+2                          | 05355 | 61000 | 05357 |                              |
| 03303 | JP MKLCON*QP0S                   | 05356 | 60200 | 05350 | WRONG QUAD IF Q POS          |
| 03304 | ENT A*W(MKT2)                    | 05357 | 11030 | 07001 |                              |
| 03305 | NO-OP                            | 05360 | 12000 | 00000 | X                            |
| 03306 | ENT Q*W(MKQK1)                   | 05361 | 10030 | 07162 | LP=T2-QK1                    |
| 03307 | RJP SSUB                         | 05362 | 65000 | 06324 | X                            |
| 03310 | RJP SOVERFLOW                    | 05363 | 65000 | 06257 | X                            |
| 03311 | STR A*W(MKLP)                    | 05364 | 15030 | 06745 | X RAD-B27                    |
| 03312 | ENT Q*26D                        | 05365 | 10000 | 00032 |                              |
| 03313 | RJP SINX                         | 05366 | 65000 | 06354 | X                            |
| 03314 | STR A*W(MKSINLP)                 | 05367 | 15030 | 06746 | X B28                        |
| 03315 | ENT A*W(MKLP)                    | 05370 | 11030 | 06745 | COS LP                       |
| 03316 | ENT Q*26D                        | 05371 | 10000 | 00032 |                              |
| 03317 | RJP COSX                         | 05372 | 65000 | 06343 | X                            |
| 03320 | STR A*W(MKCUSLP)                 | 05373 | 15030 | 06747 | X B28                        |
| 03321 | EXIT                             | 05374 | 61010 | 05327 |                              |
| 03322 | COMMENT                          |       |       |       |                              |
| 03323 | COMMENT ...SUBROUTINE 22...      |       |       |       |                              |
| 03324 | COMMENT                          |       |       |       |                              |
| 03325 | ENTRY                            | 05375 | 61000 | 00000 |                              |
| 03326 | ENT Q*W(MKQISIN)                 | 05376 | 10030 | 07166 | SIN CP=(SIN I)K8             |
| 03327 | MUL W(MK8)                       | 05377 | 22030 | 06575 | X AQ=B56                     |
| 03330 | DIV W(MKCOSBP)*N00F              | 05400 | 23230 | 06744 | X B28                        |
| 03331 | RJP SOVERFLOW                    | 05401 | 65000 | 06257 | X                            |
| 03332 | COMMENT MAY NEED ROUND OFF HERE  |       |       |       |                              |
| 03333 | STR Q*CPW(MKSINCP)               | 05402 | 14070 | 06751 |                              |

|   |       |                                 |       |       |       |                             |
|---|-------|---------------------------------|-------|-------|-------|-----------------------------|
| • | 03334 | ENT A*W(MKSINCP)                | 05403 | 11030 | 06751 |                             |
| • | 03335 | ENT Q*28D                       | 05404 | 10000 | 00034 | X                           |
| • | 03336 | RJP ASINX                       | 05405 | 65000 | 06505 | X                           |
| • | 03337 | STR A*W(MKCP)                   | 05406 | 15030 | 06750 | X B27                       |
| • | 03340 | ENT Q*27D                       | 05407 | 10000 | 00033 | COS CP                      |
| • | 03341 | RJP CUSX                        | 05410 | 65000 | 06343 |                             |
| • | 03342 | STR A*W(MKCOSCP)                | 05411 | 15030 | 06752 | X B28                       |
| • | 03343 | EXIT                            | 05412 | 61010 | 05375 |                             |
| • | 03344 | COMMENT                         |       |       |       |                             |
| • | 03345 | COMMENT ...SUBROUTINE 23...     |       |       |       |                             |
| • | 03346 | COMMENT                         |       |       |       |                             |
| • | 03347 | ENTRY                           | 05413 | 61000 | 00000 |                             |
| • | 03350 | ENT A*W(MKCC1DT)                | 05414 | 11030 | 06741 | D(R-)/DT                    |
| • | 03351 | CL Q*AP0S                       | 05415 | 10600 | 00000 |                             |
| • | 03352 | CP Q                            | 05416 | 14000 | 00000 |                             |
| • | 03353 | RSH AQ*2                        | 05417 | 03000 | 00002 | X COS B-=B28-SCALE AQ AT 65 |
| • | 03354 | DIV W(MKCOSBP)*N00F             | 05420 | 23230 | 06744 | X                           |
| • | 03355 | RJP SOVERFLOW                   | 05421 | 65000 | 06257 | X                           |
| • | 03356 | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                             |
| • | 03357 | STR Q*W(MKUPDT)                 | 05422 | 14030 | 06753 |                             |
| • | 03360 | EXIT                            | 05423 | 61010 | 05413 |                             |
| • | 03361 | COMMENT                         |       |       |       |                             |
| • | 03362 | COMMENT ...SUBROUTINE 24...     |       |       |       |                             |
| • | 03363 | COMMENT                         |       |       |       |                             |
| • | 03364 | ENTRY                           | 05424 | 61000 | 00000 |                             |
| • | 03365 | ENT Q*W(MKCB1)                  | 05425 | 10030 | 06736 | T4=BDA/DT                   |
| • | 03366 | MUL W(MKCA1DT)                  | 05426 | 22030 | 06735 | X                           |
| • | 03367 | LSH AQ*2                        | 05427 | 07000 | 00002 | X                           |
| • | 03370 | RJP ROUND                       | 05430 | 65000 | 01426 | X                           |
| • | 03371 | STR A*W(MKT4)                   | 05431 | 15030 | 07003 | X T4 AT 45                  |
| • | 03372 | ENT Q*W(MKCA1)                  | 05432 | 10030 | 06760 | T5=ADB/DT                   |
| • | 03373 | MUL W(MKCB1DT)                  | 05433 | 22030 | 06737 | X                           |
| • | 03374 | LSH AQ*2                        | 05434 | 07000 | 00002 | X                           |
| • | 03375 | RJP ROUND                       | 05435 | 65000 | 01426 | X                           |
| • | 03376 | STR A*W(MKT5)                   | 05436 | 15030 | 07012 | X T5 AT 45                  |
| • | 03377 | ENT Q*W(MKT4)                   | 05437 | 10030 | 07003 | T1=T5-T4                    |
| • | 03400 | RJP SSUB                        | 05440 | 65000 | 06324 | X                           |
| • | 03401 | RJP SOVERFLOW                   | 05441 | 65000 | 06257 | X                           |
| • | 03402 | STR A*W(MKT1)                   | 05442 | 15030 | 07000 | X T1 AT 45                  |
| • | 03403 | ENT Q*W(MKCOSBP)                | 05443 | 10030 | 06744 | T3=(COSBP)(COSBP)           |
| • | 03404 | MUL W(MKCOSBP)                  | 05444 | 22030 | 06744 | X                           |
| • | 03405 | LSH AQ*2                        | 05445 | 07000 | 00002 | X                           |
| • | 03406 | RJP ROUND                       | 05446 | 65000 | 01426 | X                           |
| • | 03407 | STR A*W(MKT3)                   | 05447 | 15030 | 07002 | X T3=B28                    |
| • | 03410 | ENT A*W(MKT1)                   | 05450 | 11030 | 07000 | T2=T1/T3                    |
| • | 03411 | CL Q*AP0S                       | 05451 | 10600 | 00000 |                             |
| • | 03412 | CP Q                            | 05452 | 14000 | 00000 |                             |
| • | 03413 | RSH AQ*2                        | 05453 | 03000 | 00002 | X SCALE T1 AT 65            |
| • | 03414 | DIV W(MKT3)*N00F                | 05454 | 23230 | 07002 | X                           |
| • | 03415 | RJP SOVERFLOW                   | 05455 | 65000 | 06257 | X                           |
| • | 03416 | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                             |
| • | 03417 | STR Q*W(MKT2)                   | 05456 | 14030 | 07001 | X T2 AT 45                  |
| • | 03420 | ENT A*W(MKT2)                   | 05457 | 11030 | 07001 |                             |
| • | 03421 | ENT Q*W(MKQSDT)                 | 05460 | 10030 | 07163 | T2=RSOT                     |
| • | 03422 | RJP SSUB                        | 05461 | 65000 | 06324 | X                           |
| • | 03423 | RJP SOVERFLOW                   | 05462 | 65000 | 06257 | X                           |
| • | 03424 | STR A*W(MKT4)                   | 05463 | 15030 | 07003 | X T4 AT 45                  |
| • | 03425 | STR A*W(MKL PDT)                | 05464 | 15030 | 06754 | D(LP)/DT AT 45              |

|   |       |                             |       |       |       |                                |
|---|-------|-----------------------------|-------|-------|-------|--------------------------------|
| • | 03426 | EXIT                        | 05465 | 61010 | 05424 |                                |
| • | 03427 | COMMENT                     |       |       |       |                                |
| • | 03430 | COMMENT ...SUBROUTINE 25... |       |       |       |                                |
| • | 03431 | COMMENT                     |       |       |       |                                |
| • | 03432 | ENTRY                       | 05466 | 61000 | 00000 |                                |
| • | 03433 | ENT A**W(MKBPDT)            | 05467 | 11030 | 06753 | W(X)=D(BP)/DT                  |
| • | 03434 | STR A**W(MKWX)              | 05470 | 15030 | 06755 | X 45                           |
| • | 03435 | ENT Q**W(MKCOSBP)           | 05471 | 10030 | 06744 | W(Y)=-COS(BP)D(LP)/DT          |
| • | 03436 | MUL W(MKLPDT)               | 05472 | 22030 | 06754 | X                              |
| • | 03437 | LSH AQ*2                    | 05473 | 07000 | 00002 | X                              |
| • | 03440 | RJP ROUND                   | 05474 | 65000 | 01426 | X                              |
| • | 03441 | CP A                        | 05475 | 15040 | 00000 | X                              |
| • | 03442 | STR A**W(MKWX)              | 05476 | 15030 | 06756 | X W(Y) AT 45                   |
| • | 03443 | ENT Q**W(MKWX)              | 05477 | 10030 | 06755 | T1=(WX)(WX)                    |
| • | 03444 | MUL W(MKWX)                 | 05500 | 22030 | 06755 | X                              |
| • | 03445 | RJP ROUND                   | 05501 | 65000 | 01426 | X                              |
| • | 03446 | STR A**W(MKT1)              | 05502 | 15030 | 07000 | X T1 AT 60                     |
| • | 03447 | ENT Q**W(MKWX)              | 05503 | 10030 | 06756 | T2=(WY)(WY)                    |
| • | 03450 | MUL W(MKWX)                 | 05504 | 22030 | 06756 | X                              |
| • | 03451 | RJP ROUND                   | 05505 | 65000 | 01426 | X                              |
| • | 03452 | STR A**W(MKT2)              | 05506 | 15030 | 07001 | X T2 AT 60                     |
| • | 03453 | ENT Q**W(MKT1)              | 05507 | 10030 | 07000 | T3=T1+T2                       |
| • | 03454 | RJP SADD                    | 05510 | 65000 | 06305 | X                              |
| • | 03455 | RJP SOVERFLOW               | 05511 | 65000 | 06257 | X                              |
| • | 03456 | STR A**W(MKT3)              | 05512 | 15030 | 07002 | X T3 AT 60                     |
| • | 03457 | RSH A*2                     | 05513 | 02000 | 00002 | X SCALE AT B26 FOR SQRT ROUTIN |
| • | 03460 | RJP SQRT                    | 05514 | 65000 | 06441 | E                              |
| • | 03461 | LSH A*2                     | 05515 | 06000 | 00002 | WA= SQRT(T3)                   |
| • | 03462 | STR A**W(MKWA)              | 05516 | 15030 | 06757 | X SCALE AT 4K FOR STORE        |
| • | 03463 | ENT Q**W(MKWA)              | 05517 | 10030 | 06757 | X W(A) AT 45                   |
| • | 03464 | MUL W(MKQBNM)               | 05520 | 22030 | 06633 | T2=2FBWA                       |
| • | 03465 | LSH AQ*3                    | 05521 | 07000 | 00003 | X                              |
| • | 03466 | RJP ROUND                   | 05522 | 65000 | 01426 | X                              |
| • | 03467 | ENT Q*A                     | 05523 | 10070 | 00000 | X A=2 B W(A) B45               |
| • | 03470 | MUL W(MKQFC)                | 05524 | 22030 | 06632 | X F=B23                        |
| • | 03471 | LSH AQ*6                    | 05525 | 07000 | 00006 | X                              |
| • | 03472 | RJP ROUND                   | 05526 | 65000 | 01426 |                                |
| • | 03473 | STR A**W(MKT2)              | 05527 | 15030 | 07001 | X T2=B22 CHECK MAX             |
| • | 03474 | ENT Q*A                     | 05530 | 10070 | 00000 | T2(T1)=T3                      |
| • | 03475 | MUL W(MK20)                 | 05531 | 22030 | 06611 | X                              |
| • | 03476 | RSH AQ*7                    | 05532 | 03000 | 00007 | X                              |
| • | 03477 | RJP ROUND                   | 05533 | 65000 | 01426 | X                              |
| • | 03500 | STR A**W(MKT3)              | 05534 | 15030 | 07002 | X T3=B22                       |
| • | 03501 | ENT Q*A                     | 05535 | 10070 | 00000 | FCL=T2-T3                      |
| • | 03502 | ENT A**W(MKT2)              | 05536 | 11030 | 07001 | X                              |
| • | 03503 | RJP SSUB                    | 05537 | 65000 | 06324 | X                              |
| • | 03504 | RJP SOVERFLOW               | 05540 | 65000 | 06257 | X                              |
| • | 03505 | STR A**W(MKFCL)             | 05541 | 15030 | 06557 | X B22-MAX=177(8)               |
| • | 03506 | EXIT                        | 05542 | 61010 | 05466 |                                |
| • | 03507 | COMMENT                     |       |       |       |                                |
| • | 03510 | COMMENT ...SUBROUTINE 26... |       |       |       |                                |
| • | 03511 | COMMENT                     |       |       |       |                                |
| • | 03512 | ENTRY                       | 05543 | 61000 | 00000 |                                |
| • | 03513 | ENT A**W(MKWX)              | 05544 | 11030 | 06755 | SIN DA                         |
| • | 03514 | CL Q*AP0S                   | 05545 | 10600 | 00000 |                                |
| • | 03515 | CP Q                        | 05546 | 14000 | 00000 |                                |
| • | 03516 | RSH AQ*2                    | 05547 | 03000 | 00002 | X SCALE AT 65                  |
| • | 03517 | DIV W(MKWA)*N00F            | 05550 | 23230 | 06757 | X                              |

|       |         |                         |       |       |       |                               |
|-------|---------|-------------------------|-------|-------|-------|-------------------------------|
| 03520 | RJP     | SOVERFLOW               | 05551 | 65000 | 06257 | X                             |
| 03521 | COMMENT | MAY NEED ROUND OFF HERE | 05552 | 14030 | 06762 | X                             |
| 03522 | STR     | Q*W(MKSINDDA)           | 05553 | 11030 | 06756 | COS DA                        |
| 03523 | ENT     | A*W(MKWY)               | 05554 | 10600 | 00000 |                               |
| 03524 | CL      | Q*APDS                  | 05555 | 14000 | 00000 |                               |
| 03525 | CP      | Q                       | 05556 | 03000 | 00002 | X                             |
| 03526 | RSH     | AQ*2                    | 05557 | 23230 | 06757 | X                             |
| 03527 | DIV     | W(MKWA)*N00F            | 05560 | 65000 | 06257 | X                             |
| 03530 | RJP     | SOVERFLOW               |       |       |       |                               |
| 03531 | COMMENT | MAY NEED ROUND OFF HERE | 05561 | 14030 | 06761 | X                             |
| 03532 | STR     | Q*W(MKCOSDDA)           | 05562 | 61010 | 05543 |                               |
| 03533 | EXIT    |                         |       |       |       |                               |
| 03534 | COMMENT |                         |       |       |       |                               |
| 03535 | COMMENT | ...SUBROUTINE 27...     |       |       |       |                               |
| 03536 | COMMENT |                         |       |       |       |                               |
| 03537 | ENTRY   |                         | 05563 | 61000 | 00000 |                               |
| 03540 | ENT     | A*W(MKPOSSW)            | 05564 | 11030 | 06656 | 0 OR 1 IF INPUT SELENOGRAPHIC |
|       |         |                         |       |       |       |                               |
| 03541 | SUB     | A*2*ANE6                | 05565 | 21700 | 00002 |                               |
| 03542 | EXIT    |                         | 05566 | 61010 | 05563 | N0-EXIT                       |
| 03543 | COMMENT |                         |       |       |       |                               |
| 03544 | COMMENT | CALCULATE X(0)          |       |       |       |                               |
| 03545 | COMMENT |                         |       |       |       |                               |
| 03546 | ENT     | Q*W(MKSINLP)            | 05567 | 10030 | 06746 | T2-Z(S)SINLP                  |
| 03547 | MUL     | W(MKZS)                 | 05570 | 22030 | 06551 | X R28                         |
| 03550 | LSH     | AQ*2                    | 05571 | 07000 | 00002 | X                             |
| 03551 | RJP     | ROUND                   | 05572 | 65000 | 01426 | X                             |
| 03552 | STR     | A*W(MKT2)               | 05573 | 15030 | 07001 | X T2=B28                      |
| 03553 | ENT     | Q*W(MKCOSLP)            | 05574 | 10030 | 06747 | T1=X(S)COSLP                  |
| 03554 | MUL     | W(MKXS)                 | 05575 | 22030 | 06547 | X                             |
| 03555 | LSH     | AQ*2                    | 05576 | 07000 | 00002 | X                             |
| 03556 | RJP     | ROUND                   | 05577 | 65000 | 01426 | X                             |
| 03557 | STR     | A*W(MKT1)               | 05600 | 15030 | 07000 | X T1=B28                      |
| 03560 | ENT     | Q*W(MKT2)               | 05601 | 10030 | 07001 | X(0)=T1-T2                    |
| 03561 | RJP     | SSUB                    | 05602 | 65000 | 06324 | X                             |
| 03562 | RJP     | SOVERFLOW               | 05603 | 65000 | 06257 | X                             |
| 03563 | STR     | A*W(MKX0)               | 05604 | 15030 | 06544 | X X(N)=B28                    |
| 03564 | COMMENT |                         |       |       |       |                               |
| 03565 | COMMENT | CALCULATE Y(0)          |       |       |       |                               |
| 03566 | COMMENT |                         |       |       |       |                               |
| 03567 | ENT     | Q*W(MKZS)               | 05605 | 10030 | 06551 | T5=Z(S)COSLPSINBP             |
| 03570 | MUL     | W(MKCOSLP)              | 05606 | 22030 | 06747 | X                             |
| 03571 | LSH     | AQ*2                    | 05607 | 07000 | 00002 | X                             |
| 03572 | RJP     | ROUND                   | 05610 | 65000 | 01426 | X                             |
| 03573 | STR     | A*W(MKT9)               | 05611 | 15030 | 07006 | X T9=Z(S)COSLP (B28)          |
| 03574 | ENT     | Q*A                     | 05612 | 10070 | 00000 | X                             |
| 03575 | MUL     | W(MKSINBP)              | 05613 | 22030 | 06743 | X                             |
| 03576 | LSH     | AQ*2                    | 05614 | 07000 | 00002 | X                             |
| 03577 | RJP     | ROUND                   | 05615 | 65000 | 01426 | X                             |
| 03600 | STR     | A*W(MKT5)               | 05616 | 15030 | 07012 | X T5=B28                      |
| 03601 | ENT     | Q*W(MKSINLP)            | 05617 | 10030 | 06746 | T4=X(S)SINBPSINLP             |
| 03602 | MUL     | W(MKXS)                 | 05620 | 22030 | 06547 | X                             |
| 03603 | LSH     | AQ*2                    | 05621 | 07000 | 00002 | X                             |
| 03604 | RJP     | ROUND                   | 05622 | 65000 | 01426 | X                             |
| 03605 | STR     | A*W(MKT10)              | 05623 | 15030 | 07007 | X T10=X(S)SINLP(B28)          |
| 03606 | ENT     | Q*A                     | 05624 | 10070 | 00000 | X                             |
| 03607 | MUL     | W(MKSINBP)              | 05625 | 22030 | 06743 | X                             |
| 03610 | LSH     | AQ*2                    | 05626 | 07000 | 00002 | X                             |
| 03611 | RJP     | ROUND                   | 05627 | 65000 | 01426 | X                             |

|                  |                                 |       |       |       |                   |
|------------------|---------------------------------|-------|-------|-------|-------------------|
| • 03612          | STR A*W(MKT4)                   | 05630 | 15030 | 07003 | X T4=B28          |
| • 03613          | ENT Q*W(MKYS)                   | 05631 | 10030 | 06550 | T3=Y(S)C0SBP      |
| • 03614          | MUL W(MKC0SBP)                  | 05632 | 22030 | 06744 | X                 |
| • 03615          | LSH AQ*2                        | 05633 | 07000 | 00002 | X                 |
| • 03616          | RJP ROUND                       | 05634 | 65000 | 01426 | X                 |
| • 03617          | STR A*W(MKT3)                   | 05635 | 15030 | 07002 | X T3=B28          |
| • 03620          | ENT Q*W(MKT4)                   | 05636 | 10030 | 07003 | Y(0)=T3-T4-T5     |
| • 03621          | RJP SSUB                        | 05637 | 65000 | 06324 | X                 |
| • 03622          | RJP SOVERFLOW                   | 05640 | 65000 | 06257 | X                 |
| • 03623          | ENT Q*W(MKT5)                   | 05641 | 10030 | 07012 | X                 |
| • 03624          | RJP SSUB                        | 05642 | 65000 | 06324 | X                 |
| • 03625          | RJP SOVERFLOW                   | 05643 | 65000 | 06257 | X                 |
| • 03626          | STR A*W(MKY0)                   | 05644 | 15030 | 06545 | X Y(0)=B28        |
| • 03627          | COMMENT                         |       |       |       |                   |
| • 03630          | COMMENT CLACULATE Z(0)          |       |       |       |                   |
| • 03631          | COMMENT                         |       |       |       |                   |
| • 03632          | ENT Q*W(MKC0SBP)                | 05645 | 10030 | 06744 | T6=X(S)SINLPC0SBP |
| • 03633          | MUL W(MKT10)                    | 05646 | 22030 | 07007 | X T6=T10C0SBP     |
| • 03634          | LSH AQ*2                        | 05647 | 07000 | 00002 | X                 |
| • 03635          | RJP ROUND                       | 05650 | 65000 | 01426 | X                 |
| • 03636          | STR A*W(MKT6)                   | 05651 | 15030 | 07013 | X T6=B28          |
| • 03637          | ENT Q*W(MKYS)                   | 05652 | 10030 | 06550 | T7=Y(S)SINBP      |
| • 03640          | MUL W(MKSINBP)                  | 05653 | 22030 | 06743 | X                 |
| • 03641          | LSH AQ*2                        | 05654 | 07000 | 00002 | X                 |
| • 03642          | RJP ROUND                       | 05655 | 65000 | 01426 | X                 |
| • 03643          | STR A*W(MKT7)                   | 05656 | 15030 | 07004 | X T7=B28          |
| • 03644          | ENT Q*W(MKC0SBP)                | 05657 | 10030 | 06744 | T8=Z(S)C0SLPC0SBP |
| • 03645          | MUL W(MKT9)                     | 05660 | 22030 | 07006 | X T8=T9C0SBP      |
| • 03646          | LSH AQ*2                        | 05661 | 07000 | 00002 | X                 |
| • 03647          | RJP ROUND                       | 05662 | 65000 | 01426 | X                 |
| • 03650          | STR A*W(MKT8)                   | 05663 | 15030 | 07005 | X T8=B28          |
| • 03651          | ENT Q*W(MKT6)                   | 05664 | 10030 | 07013 | Z(0)=T6+T7+T8     |
| • 03652          | RJP SADD                        | 05665 | 65000 | 06305 | X                 |
| • 03653          | RJP SOVERFLOW                   | 05666 | 65000 | 06257 | X                 |
| • 03654          | ENT Q*W(MKT7)                   | 05667 | 10030 | 07004 | X                 |
| • 03655          | RJP SADD                        | 05670 | 65000 | 06305 | X                 |
| • 03656          | RJP SOVERFLOW                   | 05671 | 65000 | 06257 | X                 |
| • 03657          | STR A*W(MKZ0)                   | 05672 | 15030 | 06546 | X Z(0)=B28        |
| • 03660          | EXIT                            | 05673 | 61010 | 05563 |                   |
| • 03661          | COMMENT                         |       |       |       |                   |
| • 03662          | COMMENT ...SUBROUTINE 28...     |       |       |       |                   |
| • 03663          | COMMENT                         |       |       |       |                   |
| • 03664 MXDELALF | ENTRY                           | 05674 | 61000 | 00000 |                   |
| • 03665          | ENT A*W(MKQBER)                 | 05675 | 11030 | 06634 | B IN ER AT B29    |
| • 03666          | CL Q*AP0S                       | 05676 | 10600 | 00000 |                   |
| • 03667          | CP Q                            | 05677 | 14000 | 00000 |                   |
| • 03670          | RSH AQ*1                        | 05700 | 03000 | 00001 | X                 |
| • 03671          | DIV W(MKRO)*N00F                | 05701 | 23230 | 06554 | X                 |
| • 03672          | RJP SOVERFLOW                   | 05702 | 65000 | 06257 | X                 |
| • 03673          | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                   |
| • 03674          | STR Q*W(MKS)                    | 05703 | 14030 | 06765 | X S AT 35         |
| • 03675          | ENT A*W(MKS)                    | 05704 | 11030 | 06765 | T1=S/C0SDP        |
| • 03676          | CL Q*AP0S                       | 05705 | 10600 | 00000 |                   |
| • 03677          | CP Q                            | 05706 | 14000 | 00000 |                   |
| • 03700          | RSH AQ*2                        | 05707 | 03000 | 00002 |                   |
| • 03701          | DIV W(MKC0SDP)*N00F             | 05710 | 23230 | 06727 | X                 |
| • 03702          | RJP SOVERFLOW                   | 05711 | 65000 | 06257 | X                 |
| • 03703          | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                   |
| • 03704          | STR Q*W(MKT1)                   | 05712 | 14030 | 07000 |                   |

|       |         |                               |       |       |       |                 |
|-------|---------|-------------------------------|-------|-------|-------|-----------------|
| 03705 | ENT     | Q*W(MKX0)                     | 05713 | 10030 | 06544 | T2=X(0)C0SCP    |
| 03706 | MUL     | W(MKC0SCP)                    | 05714 | 22030 | 06752 | X               |
| 03707 | LSH     | AQ*2                          | 05715 | 07000 | 00002 | X               |
| 03710 | RJP     | ROUND                         | 05716 | 65000 | 01426 | X               |
| 03711 | STR     | A*W(MKT2)                     | 05717 | 15030 | 07001 | X T2=B28        |
| 03712 | ENT     | Q*W(MKY0)                     | 05720 | 10030 | 06545 | T3=Y(0)SINCP    |
| 03713 | MUL     | W(MKSINCP)                    | 05721 | 22030 | 06751 | X               |
| 03714 | LSH     | AQ*2                          | 05722 | 07000 | 00002 | X               |
| 03715 | RJP     | ROUND                         | 05723 | 65000 | 01426 | X               |
| 03716 | STR     | A*W(MKT3)                     | 05724 | 15030 | 07002 | X T3=R28        |
| 03717 | ENT     | Q*W(MKT2)                     | 05725 | 10030 | 07001 | T4=T2+T3        |
| 03720 | RJP     | SSUB                          | 05726 | 65000 | 06324 | X               |
| 03721 | RJP     | SOVERFLOW                     | 05727 | 65000 | 06257 | X               |
| 03722 | STR     | A*W(MKT4)                     | 05730 | 15030 | 07003 | X T4=R28        |
| 03723 | ENT     | Q*W(MKT4)                     | 05731 | 10030 | 07003 | DELALF=(T4)(T1) |
| 03724 | MUL     | W(MKT1)                       | 05732 | 22030 | 07000 | X               |
| 03725 | LSH     | AQ*2                          | 05733 | 07000 | 00002 | X               |
| 03726 | RJP     | ROUND                         | 05734 | 65000 | 01426 | X               |
| 03727 | STR     | A*W(MKDELALF)                 | 05735 | 15030 | 06764 | X DELALF AT B35 |
| 03730 | ENT     | Q*W(MKX0)                     | 05736 | 10030 | 06544 | T5=X(0) SIN CP  |
| 03731 | MUL     | W(MKSINCP)                    | 05737 | 22030 | 06751 | X               |
| 03732 | LSH     | AQ*2                          | 05740 | 07000 | 00002 | X               |
| 03733 | STR     | A*W(MKT5)                     | 05741 | 15030 | 07012 | X T5=R28        |
| 03734 | ENT     | Q*W(MKY0)                     | 05742 | 10030 | 06545 | T6=Y(0)C0SCP    |
| 03735 | MUL     | W(MKC0SCP)                    | 05743 | 22030 | 06752 | X               |
| 03736 | LSH     | AQ*2                          | 05744 | 07000 | 00002 | X               |
| 03737 | RJP     | ROUND                         | 05745 | 65000 | 01426 | X               |
| 03740 | STR     | A*W(MKT6)                     | 05746 | 15030 | 07013 | X T6=B28        |
| 03741 | ENT     | Q*W(MKT5)                     | 05747 | 10030 | 07012 | T7=T6-T5        |
| 03742 | RJP     | SADD                          | 05750 | 65000 | 06305 | X               |
| 03743 | RJP     | SOVERFLOW                     | 05751 | 65000 | 06257 | X               |
| 03744 | STR     | A*W(MKT7)                     | 05752 | 15030 | 07004 | X T7=R28        |
| 03745 | ENT     | Q*A                           | 05753 | 10070 | 00000 | DELDEL=(T7)(S)  |
| 03746 | MUL     | W(MKS)                        | 05754 | 22030 | 06765 | X               |
| 03747 | LSH     | AQ*2                          | 05755 | 07000 | 00002 | X               |
| 03750 | RJP     | ROUND                         | 05756 | 65000 | 01426 | X               |
| 03751 | STR     | A*W(MKDELDEL)                 | 05757 | 15030 | 06763 | X DELDEL AT B35 |
| 03752 | EXIT    |                               | 05760 | 61010 | 05674 |                 |
| 03753 | COMMENT |                               |       |       |       |                 |
| 03754 | COMMENT | ...SUBROUTINE 29...           |       |       |       |                 |
| 03755 | COMMENT |                               |       |       |       |                 |
| 03756 | MXDP00P | ENTRY                         | 05761 | 61000 | 00000 |                 |
| 03757 | ENT     | Q*W(MKS)                      | 05762 | 10030 | 06765 | S2=(S)(S)       |
| 03760 | MUL     | W(MKS)                        | 05763 | 22030 | 06765 | X               |
| 03761 | RSH     | AQ*6                          | 05764 | 03000 | 00006 | X               |
| 03762 | RJP     | ROUND                         | 05765 | 65000 | 01426 | X               |
| 03763 | STR     | A*W(MKS2)                     | 05766 | 15030 | 06775 | X SXS B34       |
| 03764 | ENT     | Q*W(MKS)                      | 05767 | 10030 | 06765 | T1=Z(0)S        |
| 03765 | MUL     | W(MKZ0)                       | 05770 | 22030 | 06546 | X               |
| 03766 | LSH     | AQ*2                          | 05771 | 07000 | 00002 | X               |
| 03767 | RJP     | ROUND                         | 05772 | 65000 | 01426 | X               |
| 03770 | STR     | A*W(MKT1)                     | 05773 | 15030 | 07000 | X 2T1 AR 34     |
| 03771 | ENT     | Q*A                           | 05774 | 10070 | 00000 | RTZ2=1-2T1+S2   |
| 03772 | ENT     | A*W(MKS2)                     | 05775 | 11030 | 06775 | X B28           |
| 03773 | RJP     | SSUB                          | 05776 | 65000 | 06324 | X               |
| 03774 | RJP     | SOVERFLOW                     | 05777 | 65000 | 06257 | X               |
| 03775 | RSH     | AQ*6                          | 06000 | 03000 | 00006 | X PACK TO 28    |
| 03776 | STR     | A*W(MKT5)                     | 06001 | 15030 | 07012 | X               |
| 03777 | COMMENT | FOLLOWING RTX AS BEEN CHANGED |       |       |       |                 |

|   |       |                                 |       |       |       |                               |
|---|-------|---------------------------------|-------|-------|-------|-------------------------------|
|   |       | TO B28                          |       |       |       |                               |
| • | 04000 | ENT Q*W(MKONE28)                | 06002 | 10030 | 06627 | X                             |
| • | 04001 | RJP SADD                        | 06003 | 65000 | 06305 | X                             |
| • | 04002 | RJP SOVERFLOW                   | 06004 | 65000 | 06257 | X                             |
| • | 04003 | STR A*W(MKRTX2)                 | 06005 | 15030 | 06771 | X B28                         |
| • | 04004 | RSH A*2                         | 06006 | 02000 | 00002 | SCALE AT B26 FOR SWRT ROUTINE |
| • | 04005 | RJP SQRT                        | 06007 | 65000 | 06441 | X                             |
| • | 04006 | LSH A*1                         | 06010 | 06000 | 00001 | SCALE AT B28 FOR STORAGE      |
| • | 04007 | STR A*W(MKRTX)                  | 06011 | 15030 | 06772 | X RTX B28                     |
| • | 04010 | ENT Q*W(MKRTX)                  | 06012 | 10030 | 06772 | DP=DELAY(RTX)                 |
| • | 04011 | MUL W(MKDELAY)                  | 06013 | 22030 | 06555 | X DELAY=B27                   |
| • | 04012 | LSH AQ*2                        | 06014 | 07000 | 00002 |                               |
| • | 04013 | RJP ROUND                       | 06015 | 65000 | 01426 | X                             |
| • | 04014 | STR A*W(MKDPX)                  | 06016 | 15030 | 06773 | X DP B27                      |
| • | 04015 | ENT A*W(MKONE28)                | 06017 | 11030 | 06627 | T2=1-T1                       |
| • | 04016 | ENT Q*W(MKT1)                   | 06020 | 10030 | 07000 | X                             |
| • | 04017 | RSH Q*7                         | 06021 | 01000 | 00007 | X                             |
| • | 04020 | RJP SSUB                        | 06022 | 65000 | 06324 | X                             |
| • | 04021 | RJP SOVERFLOW                   | 06023 | 65000 | 06257 | X                             |
| • | 04022 | STR A*W(MKT2)                   | 06024 | 15030 | 07001 | X T2=B28                      |
| • | 04023 | ENT A*W(MKDOPP)                 | 06025 | 11030 | 06564 | T3=DOPP/RTX B12               |
| • | 04024 | CL Q*AP05                       | 06026 | 10600 | 00000 |                               |
| • | 04025 | CP Q                            | 06027 | 14000 | 00000 |                               |
| • | 04026 | RSH AQ*2                        | 06030 | 03000 | 00002 |                               |
| • | 04027 | DIV W(MKRTX)*N00F               | 06031 | 23230 | 06772 | X B28                         |
| • | 04030 | RJP SOVERFLOW                   | 06032 | 65000 | 06257 |                               |
| • | 04031 | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                               |
| • | 04032 | STR Q*W(MKT3)                   | 06033 | 14030 | 07002 | X T3=B12                      |
| • | 04033 | MUL W(MKT2)                     | 06034 | 22030 | 07001 | X                             |
| • | 04034 | LSH AQ*2                        | 06035 | 07000 | 00002 | X                             |
| • | 04035 | RJP ROUND                       | 06036 | 65000 | 01426 | X                             |
| • | 04036 | STR A*W(MKDOP1)                 | 06037 | 15030 | 06766 | X DOP1=B12                    |
| • | 04037 | ENT Q*W(MKY0)                   | 06040 | 10030 | 06545 | CALCULATE XD                  |
| • | 04040 | MUL W(MKSINDDA)                 | 06041 | 22030 | 06762 |                               |
| • | 04041 | LSH AQ*2                        | 06042 | 07000 | 00002 | X                             |
| • | 04042 | RJP ROUND                       | 06043 | 65000 | 01426 | X                             |
| • | 04043 | STR A*W(MKT7)                   | 06044 | 15030 | 07004 | X                             |
| • | 04044 | ENT Q*W(MKX0)                   | 06045 | 10030 | 06544 | X                             |
| • | 04045 | MUL W(MKCSDDA)                  | 06046 | 22030 | 06761 |                               |
| • | 04046 | LSH AQ*2                        | 06047 | 07000 | 00002 | X                             |
| • | 04047 | RJP ROUND                       | 06050 | 65000 | 01426 | X                             |
| • | 04050 | STR A*W(MKT6)                   | 06051 | 15030 | 07013 | X                             |
| • | 04051 | ENT Q*W(MKT7)                   | 06052 | 10030 | 07004 | X                             |
| • | 04052 | RJP SSUB                        | 06053 | 65000 | 06324 | X                             |
| • | 04053 | RJP SOVERFLOW                   | 06054 | 65000 | 06257 | X                             |
| • | 04054 | STR A*W(MKXD)                   | 06055 | 15030 | 06776 | X B28                         |
| • | 04055 | ENT A*W(MKFCL)                  | 06056 | 11030 | 06557 | T4=FCL/RTX                    |
| • | 04056 | CL Q*AP05                       | 06057 | 10600 | 00000 |                               |
| • | 04057 | CP Q                            | 06060 | 14000 | 00000 |                               |
| • | 04060 | RSH AQ*12D                      | 06061 | 03000 | 00014 |                               |
| • | 04061 | DIV W(MKRTX)*N00F               | 06062 | 23230 | 06772 | XB28                          |
| • | 04062 | RJP SOVERFLOW                   | 06063 | 65000 | 06257 | X                             |
| • | 04063 | COMMENT MAY NEED ROUND OFF HERE |       |       |       |                               |
| • | 04064 | STR Q*W(MKT4)                   | 06064 | 14030 | 07003 | X T4 AT 12                    |
| • | 04065 | MUL W(MKXD)                     | 06065 | 22030 | 06776 | DOP2=XDC(T4)                  |
| • | 04066 | LSH AQ*2                        | 06066 | 07000 | 00002 | X                             |
| • | 04067 | RJP ROUND                       | 06067 | 65000 | 01426 | X                             |
| • | 04070 | STR A*W(MKDOP2)                 | 06070 | 15030 | 06767 | X DOP2 AT 12                  |

|       |         |                    |       |       |       |                               |
|-------|---------|--------------------|-------|-------|-------|-------------------------------|
| 04071 | STR     | A*Q                | 06071 | 15000 | 00000 | DOPPLER=DOP1-DOP2             |
| 04072 | RSH     | A*4                | 06072 | 02000 | 00004 |                               |
| 04073 | STR     | A*CPW(MOONDOP2\$)  | 06073 | 15070 | 63170 |                               |
| 04074 | ENT     | A*W(MKDOP1)        | 06074 | 11030 | 06766 | X                             |
| 04075 | RJP     | SSUB               | 06075 | 65000 | 06324 | X                             |
| 04076 | RJP     | SOVERFLOW          | 06076 | 65000 | 06257 | X                             |
| 04077 | STR     | A*W(MKDOPPLER)     | 06077 | 15030 | 06770 | X DOPPLER AT 12               |
| 04100 | ENT     | A*W(MKDELALF)      | 06100 | 11030 | 06764 | SCALED AT 35                  |
| 04101 | RSH     | AQ*9D              | 06101 | 03000 | 00011 | SCALE AT 26                   |
| 04102 | RJP     | ROUND              | 06102 | 65000 | 01426 |                               |
| 04103 | ADD     | A*W(MKALFP)        | 06103 | 20030 | 06561 | SCALED AT 26                  |
| 04104 | ENT     | Q*A                | 06104 | 10070 | 00000 |                               |
| 04105 | MUL     | W(REVSRADIAN)      | 06105 | 22030 | 01047 |                               |
| 04106 | RJP     | ROUND              | 06106 | 65000 | 01426 |                               |
| 04107 | STR     | A*W(RA)            | 06107 | 15030 | 63002 |                               |
| 04110 | ENT     | A*W(MKDELDEL)      | 06110 | 11030 | 06763 | SCALED AT 35                  |
| 04111 | RSH     | AQ*9D              | 06111 | 03000 | 00011 | SCALE AT 26                   |
| 04112 | RJP     | ROUND              | 06112 | 65000 | 01426 |                               |
| 04113 | ADD     | A*W(MKDP)          | 06113 | 20030 | 06563 |                               |
| 04114 | ENT     | Q*A                | 06114 | 10070 | 00000 |                               |
| 04115 | MUL     | W(REVSRADIAN)      | 06115 | 22030 | 01047 |                               |
| 04116 | RJP     | ROUND              | 06116 | 65000 | 01426 |                               |
| 04117 | STR     | A*W(DEC)           | 06117 | 15030 | 63003 |                               |
| 04120 | ENT     | Q*W(MKRTX)         | 06120 | 10030 | 06772 | AT B28                        |
| 04121 | MUL     | W(MKRO)            | 06121 | 22030 | 06554 | AT B23                        |
| 04122 | LSH     | AQ*1               | 06122 | 07000 | 00001 | AT B52                        |
| 04123 | RJP     | ROUND              | 06123 | 65000 | 01426 |                               |
| 04124 | STR     | A*W(RADIUS)        | 06124 | 15030 | 63006 |                               |
| 04125 | ENT     | Q*W(MKT2)          | 06125 | 10030 | 07001 | AT B28                        |
| 04126 | MUL     | W(MKRODT)          | 06126 | 22030 | 06556 |                               |
| 04127 | RSH     | AQ*5               | 06127 | 03000 | 00005 | AT B52                        |
| 04130 | RJP     | ROUND              | 06130 | 65000 | 01426 |                               |
| 04131 | STR     | A*W(MKT8)          | 06131 | 15030 | 07005 | AT B52                        |
| 04132 | ENT     | Q*W(MKQBNM)        | 06132 | 10030 | 06633 |                               |
| 04133 | MUL     | W(MKWA)            | 06133 | 22030 | 06757 |                               |
| 04134 | RJP     | ROUND              | 06134 | 65000 | 01426 |                               |
| 04135 | ENT     | Q*A                | 06135 | 10070 | 00000 |                               |
| 04136 | MUL     | W(MKXD)            | 06136 | 22030 | 06776 |                               |
| 04137 | RSH     | AQ*7               | 06137 | 03000 | 00007 | AT B52                        |
| 04140 | RJP     | ROUND              | 06140 | 65000 | 01426 |                               |
| 04141 | ADD     | A*W(MKT8)          | 06141 | 20030 | 07005 |                               |
| 04142 | CL      | Q*AP05             | 06142 | 10600 | 00000 |                               |
| 04143 | CP      | Q                  | 06143 | 14000 | 00000 |                               |
| 04144 | DIV     | W(MKRTX)           | 06144 | 23030 | 06772 | AT B28                        |
| 04145 | STR     | Q*W(RADIUSDOT)     | 06145 | 14030 | 63011 | AT B24                        |
| 04146 | ENT     | Q*W(MKT2)          | 06146 | 10030 | 07001 | B28                           |
| 04147 | MUL     | 1                  | 06147 | 22000 | 00001 |                               |
| 04150 | LSH     | AQ*28D             | 06150 | 07000 | 00034 |                               |
| 04151 | DIV     | W(MKRTX)           | 06151 | 23030 | 06772 |                               |
| 04152 | STR     | Q*W(DOPFACTORS)    | 06152 | 14030 | 63167 | B28                           |
| 04153 | EXIT    |                    | 06153 | 61010 | 05761 |                               |
| 04154 | COMMENT |                    |       |       |       |                               |
| 04155 | JP      | ATAN               | 06154 | 61000 | 06154 |                               |
| 04156 | STR     | A*W(ATAN+62D)*AP05 | 06155 | 15630 | 06252 |                               |
| 04157 | CP      | A                  | 06156 | 15040 | 00000 | SET POSITIVE                  |
| 04160 | STR     | Q*W(ATAN+63D)*QP05 | 06157 | 14230 | 06253 |                               |
| 04161 | CP      | Q                  | 06160 | 14000 | 00000 | SET POSITIVE                  |
| 04162 | STR     | A-Q*W(ATAN+64D)    | 06161 | 33030 | 06254 | FLAG BEARS SIGN (\$Y\$-\$X\$) |
| 04163 | ENT     | Y+Q*A              | 06162 | 30070 | 00000 | RESTORE A                     |

|       |       |                    |       |       |       |                               |
|-------|-------|--------------------|-------|-------|-------|-------------------------------|
| 04164 | COM   | Q*A*YLESS          | 06163 | 04270 | 00000 | MIN (\$Y\$, \$X\$) TO A       |
| 04165 | LSH   | AQ*30D             | 06164 | 07000 | 00036 | INTERCHANGE A,Q               |
| 04166 | STR   | Q*W(ATAN+65D)      | 06165 | 14030 | 06255 | DIVISOR Q MAX (\$Y\$, \$Y\$)  |
| 04167 | RSH   | AQ*2               | 06166 | 03000 | 00002 | SCALE DIVIDEND AT 28          |
| 04170 | DIV   | W(ATAN+65D)*N00F   | 06167 | 23230 | 06255 | DIVISOR AT 0                  |
| 04171 | JP    | L(ATAN)            | 06170 | 61010 | 06154 |                               |
| 04172 | STR   | Q*W(ATAN+65D)      | 06171 | 14030 | 06255 | QUOTIENT AT 28                |
| 04173 | SUB   | A*A                | 06172 | 21070 | 00000 | CLEAR ACCUMULATOR             |
| 04174 | LSH   | AQ*6*QP0S          | 06173 | 07200 | 00006 | ROUND TO NEAREST 16TH         |
| 04175 | ADD   | A*1                | 06174 | 20000 | 00001 |                               |
| 04176 | ENT   | B7*A               | 06175 | 12770 | 00000 | LOAD INDEX REGISTER FOR TABLE |
|       |       |                    |       |       |       | LO                            |
| 04177 | STR   | Q*W(ATAN+66D)      | 06176 | 14030 | 06256 | Y-YR AT 34                    |
| 04200 | ENT   | Q*A                | 06177 | 10070 | 00000 | YR AT 4                       |
| 04201 | MUL   | W(ATAN+65D)        | 06200 | 22030 | 06255 | Y YR AT 4+28 32               |
| 04202 | ADD   | A*4                | 06201 | 20000 | 00004 | 4 1 AT 2 + 30 32              |
| 04203 | RSH   | AQ*4               | 06202 | 03000 | 00004 | SCALE AT 1 + Y YR AT 28 IN 0  |
|       |       |                    |       |       |       |                               |
| 04204 | STR   | Q*W(ATAN+65D)      | 06203 | 14030 | 06255 |                               |
| 04205 | ENT   | A*W(ATAN+66D)      | 06204 | 11030 | 06256 | Y YR AT 34                    |
| 04206 | RSH   | AQ*8D              | 06205 | 03000 | 00010 | SCALE DIVIDEND AT 34-2+30     |
| 04207 | DIV   | W(ATAN+65D)        | 06206 | 23030 | 06255 | (Y-Y)/(1+Y YR)                |
| 04210 | STR   | Q*W(ATAN+65D)      | 06207 | 14030 | 06255 | 2 AT 28                       |
| 04211 | MUL   | W(ATAN+65D)        | 06210 | 22030 | 06255 | Z 2 AT 56                     |
| 04212 | DIV   | W(ATAN+43D)        | 06211 | 23030 | 06227 | -3 AT 26, 0 AT 56-26 30       |
| 04213 | MUL   | W(ATAN+65D)        | 06212 | 22030 | 06255 | -Z 3/3 AT 28                  |
| 04214 | ADD   | A*W(ATAN+65D)      | 06213 | 20030 | 06255 | Z - Z 3/3 AT 28               |
| 04215 | ADD   | A*W(ATAN+45D+B7)   | 06214 | 20037 | 06231 | ADD TABLE ENTRY               |
| 04216 | ENT   | Q*W(ATAN+64D)*QNEG | 06215 | 10330 | 06254 | CHECK SIGN (\$Y\$, \$X\$)     |
| 04217 | SUB   | A*W(ATAN+44D)*SKIP | 06216 | 21130 | 06230 | COMPLEMENT ANGLE              |
| 04220 | CP    | A                  | 06217 | 15040 | 00000 | SET NEGATIVE                  |
| 04221 | RSH   | A*1                | 06220 | 02000 | 00001 | RESULT AT 27                  |
| 04222 | ENT   | Q*W(ATAN+63D)*QP0S | 06221 | 10230 | 06253 | SUPPLEMENT IF X NEGATIVE      |
| 04223 | ADD   | A*W(ATAN+44D)*SKIP | 06222 | 20130 | 06230 | PI/2 AT 28 PI AT 27           |
| 04224 | CP    | A                  | 06223 | 15040 | 00000 | SET POSITIVE                  |
| 04225 | ENT   | Q*W(ATAN+62D)*QP0S | 06224 | 10230 | 06252 | ACCORD PROPER SIGN            |
| 04226 | CP    | A                  | 06225 | 15040 | 00000 |                               |
| 04227 | JP    | L(ATAN)            | 06226 | 61010 | 06154 | EXIT                          |
| 04230 | 63774 | 42363              | 06227 | 63774 | 42363 | 3.0016901 AT 26               |
| 04231 | 31103 | 75524              | 06230 | 31103 | 75524 | PI/2 AT 28 PI AT 27           |
| 04232 | 0     | 0                  | 06231 | 00000 | 00000 | ARCTAN(00/16) AT 25           |
| 04233 | 00777 | 25336              | 06232 | 00777 | 25336 | 1                             |
| 04234 | 01772 | 55652              | 06233 | 01772 | 55652 | 2                             |
| 04235 | 02756 | 27552              | 06234 | 02756 | 27552 | 3                             |
| 04236 | 03726 | 67277              | 06235 | 03726 | 67277 | 4                             |
| 04237 | 04661 | 16716              | 06236 | 04661 | 16716 | 5                             |
| 04240 | 05573 | 03120              | 06237 | 05573 | 03120 | 6                             |
| 04241 | 06462 | 35661              | 06240 | 06462 | 35661 | 7                             |
| 04242 | 07326 | 14701              | 06241 | 07326 | 14701 | 8                             |
| 04243 | 10145 | 37512              | 06242 | 10145 | 37512 | 9                             |
| 04244 | 10740 | 02726              | 06243 | 10740 | 02726 | 10                            |
| 04245 | 11505 | 74016              | 06244 | 11505 | 74016 | 11                            |
| 04246 | 12227 | 43722              | 06245 | 12227 | 43722 | 12                            |
| 04247 | 12725 | 42304              | 06246 | 12725 | 42304 | 13                            |
| 04250 | 13400 | 51742              | 06247 | 13400 | 51742 | 14                            |
| 04251 | 14031 | 64134              | 06250 | 14031 | 64134 | 15                            |
| 04252 | 14441 | 76652              | 06251 | 14441 | 76652 | 16                            |
| 04253 | 0     | 0                  | 06252 | 00000 | 00000 | TEMPORARIES                   |
| 04254 | 0     | 0                  | 06253 | 00000 | 00000 |                               |

|                   |                             |   |       |       |       |        |
|-------------------|-----------------------------|---|-------|-------|-------|--------|
| . 04255           | 0                           | 0 | 06254 | 00000 | 00000 |        |
| . 04256           | 0                           | 0 | 06255 | 00000 | 00000 |        |
| . 04257           | 0                           | 0 | 06256 | 00000 | 00000 |        |
| . 04260 SOVERFLOW | ENTRY                       |   | 06257 | 61000 | 00000 |        |
| . 04261           | ENT Q*L(SOVERFLOW)          |   | 06260 | 10010 | 06257 |        |
| . 04262           | SUB Q*1                     |   | 06261 | 27000 | 00001 |        |
| . 04263           | LSH Q*15D                   |   | 06262 | 05000 | 00017 |        |
| . 04264           | ENT A*6060606060            |   | 06263 | 11030 | 07424 |        |
| . 04265           | ENT B7*4                    |   | 06264 | 12700 | 00004 |        |
| . 04266           | LSH A*3                     |   | 06265 | 06000 | 00003 |        |
| . 04267           | LSH AQ*3                    |   | 06266 | 07000 | 00003 |        |
| . 04270           | BJP B7*5-2                  |   | 06267 | 72700 | 06265 |        |
| . 04271           | STR A*W(SOVSTR)             |   | 06270 | 15030 | 06304 |        |
| . 04272           | RJP U(PRLOG)                |   | 06271 | 65020 | 63423 |        |
| . 04273           | 6 SOVMSG                    |   | 06272 | 00006 | 06277 |        |
| . 04274           | 1 0                         |   | 06273 | 00001 | 00000 |        |
| . 04275           | NO-OP                       |   | 06274 | 12000 | 00000 |        |
| . 04276           | CL A                        |   | 06275 | 11000 | 00000 |        |
| . 04277           | EXIT                        |   | 06276 | 61010 | 06257 |        |
| . 04300 SOVMSG    | FD 5*ARITHMETIC OVERFLOW AT |   | 06277 | 06271 | 63115 |        |
|                   |                             |   | 06300 | 22123 | 11610 |        |
|                   |                             |   | 06301 | 05243 | 31227 |        |
|                   |                             |   | 06302 | 13212 | 43405 |        |
|                   |                             |   | 06303 | 06310 | 50505 |        |
|                   |                             |   | 06304 | 00000 | 00000 |        |
| . 04301 SOVSTR    | 0                           |   | 06305 | 61000 | 00000 |        |
| . 04302           | COMMENT                     |   | 06306 | 60700 | 06314 |        |
| . 04303           | COMMENT                     |   | 06307 | 60300 | 06320 |        |
| . 04304 SADD      | ENTRY                       |   | 06310 | 32630 | 06342 |        |
| . 04305           | JP SADD1*ANEG               |   | 06311 | 61010 | 06305 | ERROR  |
| . 04306           | JP SADD2*QNEG               |   | 06312 | 61000 | 06321 |        |
| . 04307           | STR A*Q*W(TEMP)*APOS        |   | 06313 | 12710 | 06257 |        |
| . 04310           | EXIT                        |   | 06314 | 60200 | 06320 |        |
| . 04311           | JP SADXT                    |   | 06315 | 32730 | 06342 |        |
| . 04312           | ENT B7*L(SOVERFLOW)         |   | 06316 | 61010 | 06305 | ERROR  |
| . 04313 SADD1     | JP SADD2*QPOS               |   | 06317 | 61000 | 06321 |        |
| . 04314           | STR A*Q*W(TEMP)*ANEG        |   | 06320 | 32030 | 06342 |        |
| . 04315           | EXIT                        |   | 06321 | 36010 | 06305 |        |
| . 04316           | JP SADXT                    |   | 06322 | 11030 | 06342 |        |
| . 04317 SADD2     | STR A*Q*W(TEMP)             |   | 06323 | 61010 | 06305 | NORMAL |
| . 04320 SADXT     | RPL Y+1*L(SADD)             |   |       |       |       |        |
| . 04321           | ENT A*W(TEMP)               |   |       |       |       |        |
| . 04322           | EXIT                        |   |       |       |       |        |
| . 04323           | COMMENT                     |   |       |       |       |        |
| . 04324           | COMMENT                     |   |       |       |       |        |
| . 04325 SSUB      | ENTRY                       |   | 06324 | 61000 | 00000 |        |
| . 04326           | JP SSUB1*ANEG               |   | 06325 | 60700 | 06332 |        |
| . 04327           | JP SSUB2*QPOS               |   | 06326 | 60200 | 06336 |        |
| . 04330           | STR A-Q*W(TEMP)*APOS        |   | 06327 | 33630 | 06342 |        |
| . 04331           | EXIT                        |   | 06330 | 61010 | 06324 | ERROR  |
| . 04332           | JP SSBXT                    |   | 06331 | 61000 | 06337 |        |
| . 04333 SSUB1     | JP SSUB2*QNEG               |   | 06332 | 60300 | 06336 |        |
| . 04334           | STR A-Q*W(TEMP)*ANEG        |   | 06333 | 33730 | 06342 |        |
| . 04335           | EXIT                        |   | 06334 | 61010 | 06324 | ERROR  |
| . 04336           | JP SSBXT                    |   | 06335 | 61000 | 06337 |        |
| . 04337 SSUB2     | STR A-Q*W(TEMP)             |   | 06336 | 33030 | 06342 |        |
| . 04340 SSBXT     | RPL Y+1*L(SSUB)             |   | 06337 | 36010 | 06324 |        |
| . 04341           | ENT A*W(TEMP)               |   | 06340 | 11030 | 06342 |        |
| . 04342           | EXIT                        |   | 06341 | 61010 | 06324 | NORMAL |
| . 04343 TEMP      | 0 0                         |   | 06342 | 00000 | 00000 |        |

|           |                      |       |       |       |
|-----------|----------------------|-------|-------|-------|
| 04344     | COMMENT              |       |       |       |
| 04345     | COMMENT              |       |       |       |
| 04346 COS | ENTRY                | 06343 | 61000 | 00000 |
| 04347     | ENT B7*L(COS)        | 06344 | 12710 | 06343 |
| 04350     | STR B7*L(SIN)        | 06345 | 16710 | 06354 |
| 04351     | ENT B7*1             | 06346 | 12700 | 00001 |
| 04352     | STR B7*L(COS+32)     | 06347 | 16710 | 06375 |
| 04353     | JP \$+2*AP0S         | 06350 | 60600 | 06352 |
| 04354     | CP A*AZERO           | 06351 | 15440 | 00000 |
| 04355     | JP \$+4*AN0T         | 06352 | 60500 | 06356 |
| 04356     | ENT A*W(COS+66)      | 06353 | 11030 | 06431 |
| 04357 SIN | ENTRY                | 06354 | 61000 | 00000 |
| 04360     | CL L(\$+20)          | 06355 | 16010 | 06375 |
| 04361     | STR A*W(COS+74)*AP0S | 06356 | 15630 | 06437 |
| 04362     | CP A                 | 06357 | 15040 | 00000 |
| 04363     | RPT 29D              | 06360 | 70000 | 00035 |
| 04364     | LSH A*1*ANEG         | 06361 | 06700 | 00001 |
| 04365     | EXIT                 | 06362 | 61010 | 06354 |
| 04366     | LSH A*29D            | 06363 | 06000 | 00035 |
| 04367     | SUB Q*B7*QP0S        | 06364 | 27607 | 00000 |
| 04370     | JP COS+61            | 06365 | 61000 | 06424 |
| 04371     | COM Q*31D*YMORE      | 06366 | 04300 | 00037 |
| 04372     | ENT Q*30D            | 06367 | 10000 | 00036 |
| 04373     | STR Q*L(\$+1)        | 06370 | 14010 | 06371 |
| 04374     | ENT B7*0             | 06371 | 12700 | 00000 |
| 04375     | ENT Q*W(COS+65)      | 06372 | 10030 | 06430 |
| 04376     | MUL A                | 06373 | 22070 | 00000 |
| 04377     | RSH AQ*27D+B7        | 06374 | 03007 | 00033 |
| 04400     | ADD A*0              | 06375 | 20000 | 00000 |
| 04401     | SEL CL*X77774        | 06376 | 52040 | 77774 |
| 04402     | ENT B7*A             | 06377 | 12770 | 00000 |
| 04403     | RSH AQ*1             | 06400 | 03000 | 00001 |
| 04404     | JP \$+1+B7           | 06401 | 61007 | 06402 |
| 04405     | JP \$+3              | 06402 | 61000 | 06405 |
| 04406     | CP Q*SKIP            | 06403 | 14100 | 00000 |
| 04407     | CP Q                 | 06404 | 14000 | 00000 |
| 04410     | ENT A*W(COS+74)*AP0S | 06405 | 11630 | 06437 |
| 04411     | CP Q                 | 06406 | 14000 | 00000 |
| 04412     | STR Q*W(COS+74)      | 06407 | 14030 | 06437 |
| 04413     | MUL W(COS+74)        | 06410 | 22030 | 06437 |
| 04414     | LSH AQ*1             | 06411 | 07000 | 00001 |
| 04415     | STR A*W(COS+75)      | 06412 | 15030 | 06440 |
| 04416     | ENT B7*3             | 06413 | 12700 | 00003 |
| 04417     | ENT Q*W(COS+73)      | 06414 | 10030 | 06436 |
| 04420     | MUL W(COS+75)        | 06415 | 22030 | 06440 |
| 04421     | ENT Q*A              | 06416 | 10070 | 00000 |
| 04422     | ADD Q*W(COS+67+B7)   | 06417 | 26037 | 06432 |
| 04423     | BJP B7*\$-3          | 06420 | 72700 | 06415 |
| 04424     | MUL W(COS+74)        | 06421 | 22030 | 06437 |
| 04425     | LSH AQ*1             | 06422 | 07000 | 00001 |
| 04426     | EXIT                 | 06423 | 61010 | 06354 |
| 04427     | COM Q*X77745*YMORE   | 06424 | 04340 | 77745 |
| 04430     | JP COS+25            | 06425 | 61000 | 06370 |
| 04431     | CL A                 | 06426 | 11000 | 00000 |
| 04432     | EXIT                 | 06427 | 61010 | 06354 |
| 04433     | 2427630155           | 06430 | 24276 | 30155 |
| 04434     | 2000000000           | 06431 | 20000 | 00000 |
| 04435     | 3110375522           | 06432 | 31103 | 75522 |
| 04436     | 5325041750           | 06433 | 53250 | 41750 |

|            |                         |       |       |       |                               |
|------------|-------------------------|-------|-------|-------|-------------------------------|
| 04437      | 0506321276              | 06434 | 05063 | 21276 |                               |
| 04440      | 7731554634              | 06435 | 77315 | 54634 |                               |
| 04441      | 0002366574              | 06436 | 00023 | 66574 |                               |
| 04442      | 0                       | 06437 | 00000 | 00000 |                               |
| 04443      | 0                       | 06440 | 00000 | 00000 |                               |
| 04444 COSX | EQUALS COS              |       |       |       |                               |
| 04445 SINX | EQUALS SIN              |       |       |       |                               |
| 04446      | COMMENT                 |       |       |       |                               |
| 04447      | COMMENT                 |       |       |       |                               |
| 04450 SQRT | ENTRY                   | 06441 | 61000 | 00000 |                               |
| 04451      | CL Q                    | 06442 | 10000 | 00000 | CLEAR Q                       |
| 04452      | RPT 14D                 | 06443 | 70000 | 00016 | NORMALIZE                     |
| 04453      | RSH AQ*2*AZERO          | 06444 | 03400 | 00002 | SHIFT UNTIL A 0               |
| 04454      | RJP SOVERFLOW*ANOT      | 06445 | 64500 | 06257 |                               |
| 04455      | LSH AQ*28D              | 06446 | 07000 | 00034 | NORMALIZE IN A                |
| 04456      | STR A*W(SQRT+34D)*ANOT  | 06447 | 15530 | 06503 | STORE NORMALIZED RADICAND     |
| 04457      | JP SQRT+29D             | 06450 | 61000 | 06476 | RADICAND 0                    |
| 04460      | RSH A*3                 | 06451 | 02000 | 00003 | DIVIDE BY 8 FOR LINEAR APPROX |
| 04461      | COM A*W(SQRT+31D)*YMORE | 06452 | 04730 | 06500 | SKIP IF RIT 24 0              |
| 04462      | ADD A*W(SQRT+33D)*SKIP  | 06453 | 20130 | 06502 | ADD 7/8                       |
| 04463      | 15140 00000             | 06454 | 15140 | 00000 | CP,A,SKIP                     |
| 04464      | ADD A*W(SQRT+34D)*SKIP  | 06455 | 20130 | 06503 | ARG/8+7/8*ARG                 |
| 04465      | ADD A*W(SQRT+32D)*SKIP  | 06456 | 20130 | 06501 | ADD 9/32                      |
| 04466      | RSH A*1*SKIP            | 06457 | 02100 | 00001 | DIVIDE BY 2                   |
| 04467      | ADD A*W(SQRT+34D)       | 06460 | 20030 | 06503 | ARG/8+9/32*ARG                |
| 04470      | STR A*W(SQRT+35D)       | 06461 | 15030 | 06504 | LINEAR APPROX COMPLETE        |
| 04471      | ENT A*W(SQRT+34D)       | 06462 | 11030 | 06503 | ENTER RADICAND (SCALED AT 28) |
| 04472      | RSH AQ*2                | 06463 | 03000 | 00002 | SCALE AT 26                   |
| 04473      | DIV W(SQRT+35D)         | 06464 | 23030 | 06504 | DIVIDE (SCALED AT 28)         |
| 04474      | ADD Q*W(SQRT+35D)       | 06465 | 26030 | 06504 |                               |
| 04475      | RSH Q*1                 | 06466 | 01000 | 00001 |                               |
| 04476      | STR Q*W(SQRT+35D)       | 06467 | 14030 | 06504 |                               |
| 04477      | ENT A*W(SQRT+34D)       | 06470 | 11030 | 06503 | ENTER RADICAND                |
| 04500      | RSH AQ*2                | 06471 | 03000 | 00002 | SCALE 2(ARG) AT 26            |
| 04501      | DIV W(SQRT+35D)         | 06472 | 23030 | 06504 | DIVIDE RESULT IN Q            |
| 04502      | ENT Y+Q*W(SQRT+35D)     | 06473 | 30030 | 06504 | 2(RESULT TO A                 |
| 04503      | RSH AQ*1+B7*QP05        | 06474 | 03207 | 00001 |                               |
| 04504      | ADD A*1                 | 06475 | 20000 | 00001 | ROUND                         |
| 04505      | NO-OP                   | 06476 | 12000 | 00000 |                               |
| 04506      | EXIT                    | 06477 | 61010 | 06441 |                               |
| 04507      | 01000 00000             | 06500 | 01000 | 00000 |                               |
| 04510      | 04400 00000             | 06501 | 04400 | 00000 | 9/32 AT 28                    |
| 04511      | 16000 00000             | 06502 | 16000 | 00000 | 7/8 AT 28                     |
| 04512      | 0 0                     | 06503 | 00000 | 00000 | TEMPORARY                     |
| 04513      | 0 0                     | 06504 | 00000 | 00000 | TEMPORARYATAN                 |
| 04514      | COMMENT                 |       |       |       |                               |
| 04515 ASIN | ENTRY                   | 06505 | 61000 | 00000 |                               |
| 04516      | STR A*W(ASIN+27D)*APOS  | 06506 | 15630 | 06540 |                               |
| 04517      | CP A                    | 06507 | 15040 | 00000 | SET ARGUMENT POSITIVE         |
| 04520      | COM Q*57D*YMORE         | 06510 | 04300 | 00071 |                               |
| 04521      | ENT Q*57D               | 06511 | 10000 | 00071 |                               |
| 04522      | ADD Q*2                 | 06512 | 26000 | 00002 |                               |
| 04523      | JP ASIN+22D*AZERO       | 06513 | 60400 | 06533 |                               |
| 04524      | STR Q*L(ASIN+9D)*QP05   | 06514 | 14210 | 06516 |                               |
| 04525      | RJP SOVERFLOW           | 06515 | 65000 | 06257 |                               |
| 04526      | RSH AQ*0*ANOT           | 06516 | 03500 | 00000 | CHECK FOR ARGUMENT GREATER OR |

|                 |         |                       |       |       |       |                                      |
|-----------------|---------|-----------------------|-------|-------|-------|--------------------------------------|
| • 04527         | STR     | Q*W(ASIN+28D)*QP05    | 06517 | 14230 | 06541 |                                      |
| • 04530         | RJP     | SOVERFLOW             | 06520 | 65000 | 06257 |                                      |
| • 04531         | MUL     | W(ASIN+28D)           | 06521 | 22030 | 06541 |                                      |
| • 04532         | RSH     | AQ*28D                | 06522 | 03000 | 00034 |                                      |
| • 04533         | SUB     | Q*0*QN0T              | 06523 | 27500 | 00000 |                                      |
| • 04534         | JP      | \$+16                 | 06524 | 61000 | 06542 |                                      |
| • 04535         | ENT     | Y-Q*W(ASIN+26D)       | 06525 | 31030 | 06537 |                                      |
| • 04536         | RJP     | SGRT                  | 06526 | 65000 | 06441 | COMPUTE SQRT(1-ARG SQUARED)          |
| • 04537         |         |                       | 06527 | 12000 | 00000 |                                      |
| • 04540         | ENT     | Q*A                   | 06530 | 10070 | 00000 | ARCSINEX ARCTAN(X/SQRT(1-XSQUA<br>RE |
| • 04541         | ENT     | A*W(ASIN+28D)         | 06531 | 11030 | 06541 |                                      |
| • 04542         | RJP     | ATAN                  | 06532 | 65000 | 06154 | COMPUTE ARCSINE (-X)                 |
| • 04543         | ENT     | Q*W(ASIN+27D)*QP05    | 06533 | 10230 | 06540 |                                      |
| • 04544         | CP      | A                     | 06534 | 15040 | 00000 |                                      |
| • 04545         | NO-OP   |                       | 06535 | 12000 | 00000 |                                      |
| • 04546         | EXIT    |                       | 06536 | 61010 | 06505 |                                      |
| • 04547         |         | 20000 00000           | 06537 | 20000 | 00000 | 1 AT 28                              |
| • 04550         |         | 0 0                   | 06540 | 00000 | 00000 | TEMPORARY                            |
| • 04551         |         | 0 0                   | 06541 | 00000 | 00000 | TEMPORARY                            |
| • 04552         | ENT     | A*W(ASIN+26D)         | 06542 | 11030 | 06537 |                                      |
| • 04553         | JP      | \$-13                 | 06543 | 61000 | 06530 |                                      |
| • 04554 ASINX   | EQUALS  | ASIN                  |       |       |       |                                      |
| • 04555         | COMMENT |                       |       |       |       |                                      |
| • 04556         | COMMENT | RESULTANT VALUES      |       |       |       |                                      |
| • 04557         | COMMENT |                       |       |       |       |                                      |
| • 04560 MKX0    |         | 0 0                   | 06544 | 00000 | 00000 | B28                                  |
| • 04561 MKY0    |         | 0 0                   | 06545 | 00000 | 00000 | B28                                  |
| • 04562 MKZ0    |         | 0 0                   | 06546 | 00000 | 00000 | B28                                  |
| • 04563 MKXS    |         | 0 0                   | 06547 | 00000 | 00000 |                                      |
| • 04564 MKYS    |         | 0 0                   | 06550 | 00000 | 00000 |                                      |
| • 04565 MKZS    |         | 0 0                   | 06551 | 00000 | 00000 |                                      |
| • 04566 MKLHA   |         | 0 0                   | 06552 | 00000 | 00000 | LHA-B26                              |
| • 04567 MKLHADT |         | 0 0                   | 06553 | 00000 | 00000 | D/DT(LHA)-B37                        |
| • 04570 MKR0    |         | 0 0                   | 06554 | 00000 | 00000 | E.R. AT B23                          |
| • 04571 MKDELAY |         | 0 0                   | 06555 | 00000 | 00000 | B27 SECONDS                          |
| • 04572 MKRODT  |         | 0 0                   | 06556 | 00000 | 00000 | B27 NM/SEC                           |
| • 04573 MKFCL   |         | 0 0                   | 06557 | 00000 | 00000 | CYC/SEC B22                          |
| • 04574 MKAPDT  |         | 0 0                   | 06560 | 00000 | 00000 | D(ALF-)/DT-RAD/SEC-B37               |
| • 04575 MKALFP  |         | 0 0                   | 06561 | 00000 | 00000 | ALF- B27 RAD                         |
| • 04576 MKDPDT  |         | 0 0                   | 06562 | 00000 | 00000 | D(DEC-)/DT RAD/SEC P37               |
| • 04577 MKDP    |         | 0 0                   | 06563 | 00000 | 00000 | DEC- RADIANS B27                     |
| • 04600 MKDOPP  |         | 0 0                   | 06564 | 00000 | 00000 | DOPPLER IN CYCLES AT B12             |
| • 04601         | COMMENT |                       |       |       |       |                                      |
| • 04602         | COMMENT | CONSTANTS AT RUN TIME |       |       |       |                                      |
| • 04603         | COMMENT |                       |       |       |       |                                      |
| • 04604 MKRT    |         | 0 0                   | 06565 | 00000 | 00000 | R(0)/D(0) (B28)                      |
| • 04605 MK1     |         | 0 0                   | 06566 | 00000 | 00000 | B28                                  |
| • 04606 MK2     |         | 0 0                   | 06567 | 00000 | 00000 | B28                                  |
| • 04607 MK3     |         | 0 0                   | 06570 | 00000 | 00000 | B28                                  |
| • 04610 MK4     |         | 0 0                   | 06571 | 00000 | 00000 | RHO/D SCALED AT B33                  |
| • 04611 MK5     |         | 0 0                   | 06572 | 00000 | 00000 |                                      |
| • 04612 MK6     |         | 0 0                   | 06573 | 00000 | 00000 |                                      |
| • 04613 MK7     |         | 0 0                   | 06574 | 00000 | 00000 | RAD-B27                              |
| • 04614 MK8     |         | 0 0                   | 06575 | 00000 | 00000 | B28                                  |
| • 04615 MK9     |         | 0 0                   | 06576 | 00000 | 00000 | B28                                  |
| • 04616 MK10    |         | 0 0                   | 06577 | 00000 | 00000 | B28                                  |
| • 04617 MK11    |         | 0 0                   | 06600 | 00000 | 00000 | B28                                  |

|   |                 |            |                            |       |       |       |                                           |
|---|-----------------|------------|----------------------------|-------|-------|-------|-------------------------------------------|
| • | U4620 MK12      | 0          | 0                          | 06601 | 00000 | 00000 | B28                                       |
| • | U4621 MK13      | 0          | 0                          | 06602 | 00000 | 00000 | B28                                       |
| • | U4622 MK14      | 0          | 0                          | 06603 | 00000 | 00000 | B28                                       |
| • | U4623 MK15      | 0          | 0                          | 06604 | 00000 | 00000 | B28                                       |
| • | U4624 MK16      | 0          | 0                          | 06605 | 00000 | 00000 | B28                                       |
| • | U4625 MK17      | 0          | 0                          | 06606 | 00000 | 00000 | B28                                       |
| • | U4626 MK18      | 0          | 0                          | 06607 | 00000 | 00000 | B28                                       |
| • | U4627 MK19      | 0          | 0                          | 06610 | 00000 | 00000 |                                           |
| • | U4630 MK20      | 0          | 0                          | 06611 | 00000 | 00000 |                                           |
| • | U4631           | COMMENT    |                            |       |       |       |                                           |
| • | U4632           | COMMENT    |                            |       |       |       |                                           |
| • | U4633           | COMMENT    |                            |       |       |       |                                           |
| • | U4634           | COMMENT    | CONSTANTS AT ASSEMBLY TIME |       |       |       |                                           |
| • | U4635           | COMMENT    |                            |       |       |       |                                           |
| • | U4636 MKRK1     | 0          | 0                          | 06612 | 00000 | 00000 |                                           |
| • | U4637 MKRK2     | 0          | 0                          | 06613 | 00000 | 00000 |                                           |
| • | U4640 MKRK3     | 0          | 0                          | 06614 | 00000 | 00000 |                                           |
| • | U4641 MKQCCER   | 0053445040 |                            | 06615 | 00534 | 45040 | .02127558B29 1.0/C IN SEC/E.R.            |
| • | U4642 MKQNMPEK  | 33420      | 64260                      | 06616 | 33420 | 64260 | N.M./E.R. 3.4416059224(B27)               |
| • | U4643 MKQ11     | 2714121727 |                            | 06617 | 27141 | 21727 | 11.595825                                 |
| • | U4644 MKQR11    | 0260501354 |                            | 06620 | 02605 | 01354 | .0862440707B29 1/11.595                   |
| • | U4645 MKHLF     | 20000      | 00000                      | 06621 | 20000 | 00000 | 1/2 B29                                   |
| • | U4646 TENB25    | 2400000000 |                            | 06622 | 24000 | 00000 | 10825                                     |
| • | U4647 MKGR0     | 3267301310 |                            | 06623 | 32673 | 01310 | 3438.755435B17 GE0CEN RADIUS I            |
| • | U4650 MKQRH0    | 3774706124 |                            | 06624 | 37747 | 06124 | N N.M.<br>.99848B29 GE0CEN RADIUS IN E.R. |
| • | U4651 MKQRH0X   | 15534      | 37154                      | 06625 | 15534 | 37154 | EXTENSION OF ABOVE                        |
| • | U4652 MKQWE     | 23073      | 23776                      | 06626 | 23073 | 23776 | W(E) B42                                  |
| • | U4653 MKONE28   | 2000000000 |                            | 06627 | 20000 | 00000 | 1.0028                                    |
| • | U4654 MKQALF    | 0011205012 |                            | 06630 | 00112 | 05012 | .00452139B29 ALPHA                        |
| • | U4655 MKQERPNI  | 23016      | 71142                      | 06631 | 23016 | 71142 | E.R./N.M. B37                             |
| • | U4656 MKGFC     | 2751405503 |                            | 06632 | 27514 | 05503 | 48432.352B13 7840 MHZ IN 1/NM             |
| • | U4657 MKQBNM    | 3524707461 |                            | 06633 | 35247 | 07461 | 938.4449184B19 LUNAR RADIUS IN            |
| • | U4660 MKQBER    | 1056034021 |                            | 06634 | 10560 | 34021 | N.M.<br>.2724876721B29 LUNAR RADIUS IN    |
| • | U4661 MKQ90     | 0550000000 |                            | 06635 | 05500 | 00000 | E.R.<br>90.0820 90 DEGREES AT B20         |
| • | U4662 MKRADDEG  | 0043575065 |                            | 06636 | 00435 | 75065 | .0174532925B29 DEG/RAD                    |
| • | U4663 MKQ180    | 1444176652 |                            | 06637 | 14441 | 76652 | 3.141592654B26 PI                         |
| • | U4664 MKGRCNM   | 00031      | 72222                      | 06640 | 00031 | 72222 | I/C B37 SEC/N.M                           |
| • | U4665           | COMMENT    |                            |       |       |       |                                           |
| • | U4666           | COMMENT    | COMMON STORAGE EQUIVALENTS |       |       |       |                                           |
| • | U4667           | COMMENT    |                            |       |       |       |                                           |
| • | U4670 MKRADOT   | 0          |                            | 06641 | 00000 | 00000 | RAD/SEC AT B42                            |
| • | U4671 MKDECDOT  | 0          |                            | 06642 | 00000 | 00000 | RAD/SEC AT B42                            |
| • | U4672 MKRA      | 0          | 0                          | 06643 | 00000 | 00000 | ALPHA B26 RADIAN                          |
| • | U4673 MKDEC     | 0          | 0                          | 06644 | 00000 | 00000 | DEC B26 RADIAN                            |
| • | U4674 MKD0      | 0          |                            | 06645 | 00000 | 00000 | RADIUS IN E.R. AT B22                     |
| • | U4675 MKD02     | 0          | 0                          | 06646 | 00000 | 00000 | B22 D(0)**2                               |
| • | U4676 MKGEOLAT  | 0          | 0                          | 06647 | 00000 | 00000 | GE0CENTRIC LAT OF SITE - RADIA            |
| • | U4677 MKSINDEC  | 0          | 0                          | 06650 | 00000 | 00000 | NS<br>B28 SIN(DEC)                        |
| • | U4700 MKCOSDEC  | 0          | 0                          | 06651 | 00000 | 00000 | SIN(DEC) B28                              |
| • | U4701 MKSINGLAT | 0          | 0                          | 06652 | 00000 | 00000 | SIN(PHI)B28                               |
| • | U4702 MKCOSGLAT | 0          | 0                          | 06653 | 00000 | 00000 | COS(PHI) B28                              |
| • | U4703 MKDDOT    | 0          |                            | 06654 | 00000 | 00000 | N.M./SEC AT B29                           |
| • | U4704 MKDDOTA   | 0          |                            | 06655 | 00000 | 00000 | E.R./SEC AT B40                           |

|   |       |            |                                |   |       |                                          |
|---|-------|------------|--------------------------------|---|-------|------------------------------------------|
| . | 04705 | COMMENT    |                                |   |       |                                          |
| . | 04706 | COMMENT    | INPUT PARAMETERS               |   |       |                                          |
| . | 04707 | COMMENT    |                                |   |       |                                          |
| . | 04710 | MKPOSSW    | 0                              | 0 | 06656 | 00000 00000                              |
| . | 04711 | MKOFFSW    | 0                              | 0 | 06657 | 00000 00000 0= NO OFFSET *L = OFFSET     |
| . | 04712 | MKIDELAY   | 0                              | 0 | 06660 | 00000 00000 B25                          |
| . | 04713 | MKIANG     | 0                              | 0 | 06661 | 00000 00000                              |
| . | 04714 | MKINBETA   | 0                              | 0 | 06662 | 00000 00000 B20                          |
| . | 04715 | MKINLAMBDA | 0                              | 0 | 06663 | 00000 00000 B20                          |
| . | 04716 | COMMENT    |                                |   |       |                                          |
| . | 04717 | COMMENT    | CONSTANTS FROM ROUTINES 2 TO 5 |   |       |                                          |
| . | 04720 | COMMENT    |                                |   |       |                                          |
| . | 04721 | MKBETA     | 0                              | 0 | 06664 | 00000 00000 B27                          |
| . | 04722 | MKLAMBDA   | 0                              | 0 | 06665 | 00000 00000 B27                          |
| . | 04723 | MKSINB     | 0                              | 0 | 06666 | 00000 00000 B28                          |
| . | 04724 | MKCSB      | 0                              | 0 | 06667 | 00000 00000 B28                          |
| . | 04725 | MKSINL     | 0                              | 0 | 06670 | 00000 00000 B28                          |
| . | 04726 | MKCSL      | 0                              | 0 | 06671 | 00000 00000 B28                          |
| . | 04727 | MKXS2      | 0                              | 0 | 06672 | 00000 00000 B28                          |
| . | 04730 | MKYS2      | 0                              | 0 | 06673 | 00000 00000 B28                          |
| . | 04731 | MKZS2      | 0                              | 0 | 06674 | 00000 00000 B28                          |
| . | 04732 | MKX02      | 0                              | 0 | 06675 | 00000 00000 B28                          |
| . | 04733 | MKY02      | 0                              | 0 | 06676 | 00000 00000 B28                          |
| . | 04734 | MKZ02      | 0                              | 0 | 06677 | 00000 00000 B28                          |
| . | 04735 | MKDANG     | 0                              | 0 | 06700 | 00000 00000 90 - INPUT IN RADIAN B27     |
| . | 04736 | MKSINDA    | 0                              | 0 | 06701 | 00000 00000 B28                          |
| . | 04737 | MKCSDA     | 0                              | 0 | 06702 | 00000 00000 B28                          |
| . | 04740 | MKZRO2     | 0                              | 0 | 06703 | 00000 00000 B28 1-Z(0)**2=R(0)**2        |
| . | 04741 | MKZRO      | 0                              | 0 | 06704 | 00000 00000 B28                          |
| . | 04742 | COMMENT    |                                |   |       |                                          |
| . | 04743 | COMMENT    |                                |   |       |                                          |
| . | 04744 | MKDKK2     | 0                              | 0 | 06705 | 00000 00000                              |
| . | 04745 | MKSINLHA   | 0                              | 0 | 06706 | 00000 00000                              |
| . | 04746 | MKCSLHA    | 0                              | 0 | 06707 | 00000 00000 COS(LHA)                     |
| . | 04747 | MKSINPHID  | 0                              | 0 | 06710 | 00000 00000 SIN(PHI)X SIN(DEC)           |
| . | 04750 | MKCSPHID   | 0                              | 0 | 06711 | 00000 00000 COS(PHI)X COS(DEC)X COS(LHA) |
| . | 04751 | MKCSZ0     | 0                              | 0 | 06712 | 00000 00000 COS Z0 PG.3 B28              |
| . | 04752 | MKRHODCOS  | 0                              | 0 | 06713 | 00000 00000 COSZ(RH0/D) B29              |
| . | 04753 | MKRT2      | 0                              | 0 | 06714 | 00000 00000 B28                          |
| . | 04754 | MKSINDPHI  | 0                              | 0 | 06715 | 00000 00000 B28                          |
| . | 04755 | MKCSDPHI   | 0                              | 0 | 06716 | 00000 00000 B28                          |
| . | 04756 | MKDDTCOSZ  | 0                              | 0 | 06717 | 00000 00000 B37                          |
| . | 04757 | MKCA       | 0                              | 0 | 06720 | 00000 00000 A- B28                       |
| . | 04760 | MKCADT     | 0                              | 0 | 06721 | 00000 00000 DA/DT B37                    |
| . | 04761 | MKCB       | 0                              | 0 | 06722 | 00000 00000 B28-B                        |
| . | 04762 | MKCBDT     | 0                              | 0 | 06723 | 00000 00000 D(B)/DT-B37                  |
| . | 04763 | MKCC       | 0                              | 0 | 06724 | 00000 00000 C-B28                        |
| . | 04764 | MKCCDT     | 0                              | 0 | 06725 | 00000 00000 DC/DT-B37                    |
| . | 04765 | MKSINDP    | 0                              | 0 | 06726 | 00000 00000 SIN(DP) B28                  |
| . | 04766 | MKCSUP     | 0                              | 0 | 06727 | 00000 00000 COS(DP) B28                  |
| . | 04767 | MKSINLHAP  | 0                              | 0 | 06730 | 00000 00000 SIN(LHA-) B28                |
| . | 04770 | MKLHAP     | 0                              | 0 | 06731 | 00000 00000 LHA- B27 RAD                 |
| . | 04771 | MKAB       | 0                              | 0 | 06732 | 00000 00000 B28-AB=(RT)COS DP            |
| . | 04772 | MKAB2      | 0                              | 0 | 06733 | 00000 00000 (AB)(AB)-B28                 |
| . | 04773 | MKABDT     | 0                              | 0 | 06734 | 00000 00000 D(AB)/DT B37                 |
| . | 04774 | MKCAIDT    | 0                              | 0 | 06735 | 00000 00000 B37                          |
| . | 04775 | MKCB1      | 0                              | 0 | 06736 | 00000 00000 B28                          |

COMMENT INPUT PARAMETERS FOR INTERCOM

|       |       |       |              |
|-------|-------|-------|--------------|
| 06737 | 00000 | 00000 |              |
| 06740 | 00000 | 00000 | B28          |
| 06741 | 00000 | 00000 | B37          |
| 06742 | 00000 | 00000 | B27          |
| 06743 | 00000 | 00000 | B28          |
| 06744 | 00000 | 00000 | B28          |
| 06745 | 00000 | 00000 | B27          |
| 06746 | 00000 | 00000 | B28          |
| 06747 | 00000 | 00000 | B28          |
| 06750 | 00000 | 00000 | B27 RAD      |
| 06751 | 00000 | 00000 | B28          |
| 06752 | 00000 | 00000 | B28          |
| 06753 | 00000 | 00000 | RAD/SEC B37  |
| 06754 | 00000 | 00000 | ROD/SEC B37  |
| 06755 | 00000 | 00000 | B37 RAD/SEC  |
| 06756 | 00000 | 00000 | B37          |
| 06757 | 00000 | 00000 | B37          |
| 06760 | 00000 | 00000 | B27          |
| 06761 | 00000 | 00000 |              |
| 06762 | 00000 | 00000 |              |
| 06763 | 00000 | 00000 | B28          |
| 06764 | 00000 | 00000 | DELALF-B28   |
| 06765 | 00000 | 00000 | S=B/R0 (B28) |
| 06766 | 00000 | 00000 | D0P1-B14     |
| 06767 | 00000 | 00000 | D0P2-B14     |
| 06770 | 00000 | 00000 | D0PPLER-B14  |
| 06771 | 00000 | 00000 | B27          |
| 06772 | 00000 | 00000 | B27          |
| 06773 | 00000 | 00000 | B24          |
| 06774 | 00000 | 00000 | B28          |
| 06775 | 00000 | 00000 | (S) (S) B28  |
| 06776 | 00000 | 00000 |              |
|       |       |       |              |
| 06777 | 00000 | 00000 |              |
| 07000 | 00000 | 00000 | B28          |
| 07001 | 00000 | 00000 | B28          |
| 07002 | 00000 | 00000 | TEMP         |
| 07003 | 00000 | 00000 |              |
| 07004 | 00000 | 00000 |              |
| 07005 | 00000 | 00000 |              |
| 07006 | 00000 | 00000 |              |
| 07007 | 00000 | 00000 |              |
| 07010 | 00000 | 00000 |              |
| 07011 | 00000 | 00000 |              |
| 07012 | 00000 | 00000 |              |
| 07013 | 00000 | 00000 |              |
| 07014 | 00000 | 00000 |              |
| 07015 | 00000 | 00000 |              |
| 07016 | 00000 | 00000 |              |
| 07017 | 00000 | 00000 |              |
| 07020 | 00000 | 00000 |              |
| 07021 | 00000 | 00000 |              |
| 07022 | 00000 | 00000 |              |

|                 |                                       |                   |                                 |
|-----------------|---------------------------------------|-------------------|---------------------------------|
| • 05070 MKMES02 | FD 0*A                                | 07023 06000 00000 |                                 |
| • 05071         | -0 \$+1                               | 07024 77777 07025 |                                 |
| • 05072         | FD 0*LAT=                             | 07025 21063 14400 |                                 |
| • 05073         | 77777 77777                           | 07026 77777 77777 |                                 |
| • 05074 MKMESI2 | FD 0*X20                              | 07027 35622 40000 |                                 |
| • 05075         | 10 MKINBETA                           | 07030 00010 06662 |                                 |
| • 05076         | 7227777777                            | 07031 72277 77777 | -90.0B20 LIMITS OF BETA(DEG)    |
| • 05077         | 0550000000                            | 07032 05500 00000 | 90.0B20                         |
| • 05100 MKMES03 | FD 0*A                                | 07033 06000 00000 |                                 |
| • 05101         | -0 \$+1                               | 07034 77777 07035 |                                 |
| • 05102         | FD 0*LONG=                            | 07035 21242 31444 |                                 |
| • 05103         | 77777 77777                           | 07036 77777 77777 |                                 |
| • 05104 MKMESI3 | FD 0*X20                              | 07037 35622 40000 |                                 |
| • 05105         | 10 MKINLAMBDA                         | 07040 00010 06663 |                                 |
| • 05106         | 6457777777                            | 07041 64577 77777 | -180.0B20 LIMITS OF LAMBDA(DEG) |
| • 05107         | 1320000000                            | 07042 13200 00000 | 180.0B20                        |
| • 05110 MKMES04 | FD 0*A                                | 07043 06000 00000 |                                 |
| • 05111         | -0 \$+1                               | 07044 77777 07045 |                                 |
| • 05112         | FD 0*X(S)=                            | 07045 35513 04044 |                                 |
| • 05113         | 77777 77777                           | 07046 77777 77777 |                                 |
| • 05114 MKMESI4 | FD 0*X28                              | 07047 35627 00000 |                                 |
| • 05115         | 10 MKXS                               | 07050 00010 06547 |                                 |
| • 05116         | 5777777777                            | 07051 57777 77777 | -1.0B28 LIMITS OF X(S)          |
| • 05117         | 2000000000                            | 07052 20000 00000 | 1.0B28                          |
| • 05120 MKMES05 | FD 0*A                                | 07053 06000 00000 |                                 |
| • 05121         | -0 \$+1                               | 07054 77777 07055 |                                 |
| • 05122         | FD 0*Y(S)=                            | 07055 36513 04044 |                                 |
| • 05123         | 77777 77777                           | 07056 77777 77777 |                                 |
| • 05124 MKMESI5 | FD 0*X28                              | 07057 35627 00000 |                                 |
| • 05125         | 10 MKYS                               | 07060 00010 06550 |                                 |
| • 05126 YSLIMIT | 5777777777                            | 07061 57777 77777 | -1.0B28 LIMITS OF Y(S)          |
| • 05127         | 2000000000                            | 07062 20000 00000 | 1.0B28                          |
| • 05130 MKMES00 | FD 0*A                                | 07063 06000 00000 |                                 |
| • 05131         | -0 \$+1                               | 07064 77777 07065 |                                 |
| • 05132         | FD 0*OFFSET (Y/N)                     | 07065 24131 33012 |                                 |
| • 05133         | 77777 77777                           | 07066 31055 13674 |                                 |
| • 05134 MKMESI0 | FD 0*Y                                | 07067 23400 00000 |                                 |
| • 05135         | 0 MOONSW\$                            | 07070 77777 77777 |                                 |
| • 05136 MKMES01 | FD 0*A                                | 07071 36000 00000 |                                 |
| • 05137         | -0 \$+1                               | 07072 00000 63343 |                                 |
| • 05140         | FD 0*LAT+LONG(1) DIR. COS(2) OBSERVER | 07073 06000 00000 |                                 |
|                 | CO                                    | 07074 77777 07075 |                                 |
|                 |                                       | 07075 21063 14221 |                                 |
|                 |                                       | 07076 24231 45161 |                                 |
|                 |                                       | 07077 40051 11627 |                                 |
|                 |                                       | 07100 75051 02430 |                                 |
|                 |                                       | 07101 51624 00524 |                                 |
|                 |                                       | 07102 07301 22733 |                                 |
|                 |                                       | 07103 12270 51024 |                                 |
|                 |                                       | 07104 24271 15163 |                                 |
|                 |                                       | 07105 40051 11221 |                                 |
|                 |                                       | 07106 06364 20623 |                                 |
|                 |                                       | 07107 14516 44000 |                                 |
|                 |                                       | 07110 77777 77777 |                                 |
|                 |                                       | 07111 24000 00000 |                                 |
|                 |                                       | 07112 00010 07115 |                                 |
|                 |                                       | 07113 00000 00001 | 1                               |
| • 05141         | FD 0*ORD(3) DELAY+ANG(4)              |                   |                                 |
| • 05142         | 77777 77777                           |                   |                                 |
| • 05143 MKMESI1 | FD 0*0                                |                   |                                 |
| • 05144         | 10 MKSWITCH                           |                   |                                 |
| • 05145         | 0000000001                            |                   |                                 |

|                |                                        |       |       |       |                                |
|----------------|----------------------------------------|-------|-------|-------|--------------------------------|
| 05146          | 0000000004                             | 07114 | 00000 | 00004 | 4                              |
| 05147 MKSWITCH | 1                                      | 07115 | 00000 | 00001 |                                |
| 05150 MKMES06  | FD 0*A                                 | 07116 | 06000 | 00000 |                                |
| 05151          | -0 \$+1                                | 07117 | 77777 | 07120 |                                |
| 05152          | FD 0*X(0)=                             | 07120 | 35512 | 44044 |                                |
| 05153          | 77777 77777                            | 07121 | 77777 | 77777 |                                |
| 05154 MKMESI6  | FD 0*X28                               | 07122 | 35627 | 00000 |                                |
| 05155          | 10 MKX0                                | 07123 | 00010 | 06544 |                                |
| 05156          | 5777777777                             | 07124 | 57777 | 77777 | -1.0R28 LIMITS OF X(0)         |
| 05157          | 2000000000                             | 07125 | 20000 | 00000 | 1.0B28                         |
| 05160 MKMES07  | FD 0*A                                 | 07126 | 06000 | 00000 |                                |
| 05161          | -0 \$+1                                | 07127 | 77777 | 07130 |                                |
| 05162          | FD 0*Y(0)=                             | 07130 | 36512 | 44044 |                                |
| 05163          | 77777 77777                            | 07131 | 77777 | 77777 |                                |
| 05164 MKMESI7  | FD 0*X28                               | 07132 | 35627 | 00000 |                                |
| 05165          | 10 MKY0                                | 07133 | 00010 | 06545 |                                |
| 05166 YOLIMIT  | 5777777777                             | 07134 | 57777 | 77777 | -1.0B28 LIMITS OF Y(0)         |
| 05167          | 2000000000                             | 07135 | 20000 | 00000 | 1.0B28                         |
| 05170 MKMES08  | FD 0*A                                 | 07136 | 06000 | 00000 |                                |
| 05171          | -0 \$+1                                | 07137 | 77777 | 07140 |                                |
| 05172          | FD 0*DELAY(MS)=                        | 07140 | 11122 | 10636 |                                |
|                |                                        | 07141 | 51223 | 04044 |                                |
| 05173          | 77777 77777                            | 07142 | 77777 | 77777 |                                |
| 05174 MKMESI8  | FD 0*X25                               | 07143 | 35626 | 50000 |                                |
| 05175          | 10 MKIDELAY                            | 07144 | 00010 | 06660 |                                |
| 05176          | 0000000000                             | 07145 | 00000 | 00000 | 0.0B25 LIMITS OF DELAY(MS)     |
| 05177          | 3000000000                             | 07146 | 30000 | 00000 | 12.0B25                        |
| 05200 MKMES09  | FD 0*A                                 | 07147 | 06000 | 00000 |                                |
| 05201          | -0 \$+1                                | 07150 | 77777 | 07151 |                                |
| 05202          | FD 0*ANGLE=                            | 07151 | 06231 | 42112 |                                |
|                |                                        | 07152 | 44000 | 00000 |                                |
| 05203          | 77777 77777                            | 07153 | 77777 | 77777 |                                |
| 05204 MKMESI9  | FD 0*X20                               | 07154 | 35622 | 40000 |                                |
| 05205          | 10 MKIANG                              | 07155 | 00010 | 06661 |                                |
| 05206          | 5137777777                             | 07156 | 51377 | 77777 | -360.0B20 LIMITS OF ANGLE(DEG) |
|                |                                        | 07157 | 26400 | 00000 | 360.0B20                       |
| 05207          | 2640000000                             | 07160 | 00000 | 00000 |                                |
| 05210 EPHP     | 0 0                                    | 07161 | 00000 | 00000 | FOR EPHRST INTERP ONLY         |
| 05211 MOD2PI   | 0                                      |       |       |       |                                |
| 05212          | COMMENT FOLLOWING VALUES AT B26,B42,B2 |       |       |       |                                |
|                | 6,B26                                  |       |       |       |                                |
| 05213 MKQK1    | 0 0                                    | 07162 | 00000 | 00000 |                                |
| 05214 MKQRSOT  | 0 0                                    | 07163 | 00000 | 00000 | X D/DT(R-S)                    |
| 05215 MKQI     | 0 0                                    | 07164 | 00000 | 00000 | X                              |
| 05216 MKQSP    | 0 0                                    | 07165 | 00000 | 00000 | X                              |
| 05217 MKQISIN  | 0 0                                    | 07166 | 00000 | 00000 | SIN I B28                      |
| 05220 MKQICUS  | 0 0                                    | 07167 | 00000 | 00000 | COS I B28                      |
| 05221          | COMMENT EPHCNT = NO. OF VALUES IN EACH |       |       |       |                                |
|                | OF THE 4 TABLES                        |       |       |       |                                |
| 05222          | COMMENT EPHDAY = DAY OF VALIDITY OF FI |       |       |       |                                |
|                | RST ENTRY IN EACH OF 4 TBLS            |       |       |       |                                |
| 05223 EPHDAY   | -1                                     | 07170 | 77777 | 77776 |                                |
| 05224          | COMMENT                                |       |       |       |                                |
| 05225          | COMMENT EPHEMERIS INPUT                |       |       |       |                                |
| 05226          | COMMENT THE STORAGE AND TABLES MUST BE |       |       |       |                                |
|                | IN THE ORDER RST,RSTOT,I,SP            |       |       |       |                                |
| 05227          | COMMENT                                |       |       |       |                                |
| 05230          | COMMENT FOLLOWING VALUES FOR YEAR 1969 |       |       |       |                                |

|   |       |          |            |                                |       |       |               |
|---|-------|----------|------------|--------------------------------|-------|-------|---------------|
| • | U5231 | EPHCNT   | EQUALS     | 38D                            |       |       |               |
| • | U5232 |          | COMMENT    | FOLLOWING VALUES FOR YEAR 1969 |       |       |               |
| • | U5233 | EPHRST   | 1742203655 | 07171                          | 17422 | 03655 | 3.88381835826 |
| • | U5234 |          | 3056646750 | 07172                          | 30566 | 46750 | 6.18291439826 |
| • | U5235 |          | 1062716356 | 07173                          | 10627 | 16356 | 2.19884084826 |
| • | U5236 |          | 2177364062 | 07174                          | 21773 | 64062 | 4.49795608826 |
| • | U5237 |          | 0203431432 | 07175                          | 02034 | 31432 | 0.51386682826 |
| • | U5240 |          | 1320076564 | 07176                          | 13200 | 76564 | 2.81297857826 |
| • | U5241 |          | 2434542044 | 07177                          | 24345 | 42044 | 5.11207635826 |
| • | U5242 |          | 0440607227 | 07200                          | 04406 | 07227 | 1.12798535826 |
| • | U5243 |          | 1555254733 | 07201                          | 15552 | 54733 | 3.42710059826 |
| • | U5244 |          | 2671720026 | 07202                          | 26717 | 20026 | 5.72619663826 |
| • | U5245 |          | 0675765211 | 07203                          | 06757 | 65211 | 1.74210563826 |
| • | U5246 |          | 2012432715 | 07204                          | 20124 | 32715 | 4.04122087826 |
| • | U5247 |          | 0016500265 | 07205                          | 00165 | 00265 | 0.05713161826 |
| • | U5250 |          | 1133143360 | 07206                          | 11331 | 43360 | 2.35622765826 |
| • | U5251 |          | 2247610677 | 07207                          | 22476 | 10677 | 4.65534114826 |
| • | U5252 |          | 0253656247 | 07210                          | 02536 | 56247 | 0.67125188826 |
| • | U5253 |          | 1370323566 | 07211                          | 13703 | 23566 | 2.97036538826 |
| • | U5254 |          | 2504771104 | 07212                          | 25047 | 71104 | 5.26947887826 |
| • | U5255 |          | 0511036454 | 07213                          | 05110 | 36454 | 1.28538961826 |
| • | U5256 |          | 1625503773 | 07214                          | 16255 | 03773 | 3.58450311826 |
| • | U5257 |          | 2742151312 | 07215                          | 27421 | 51312 | 5.88361660826 |
| • | U5260 |          | 0746221272 | 07216                          | 07462 | 21272 | 1.89954654826 |
| • | U5261 |          | 2062664201 | 07217                          | 20626 | 64201 | 4.19864084826 |
| • | U5262 |          | 0066733773 | 07220                          | 00667 | 33773 | 0.21456903826 |
| • | U5263 |          | 1203401477 | 07221                          | 12034 | 01477 | 2.51368427826 |
| • | U5264 |          | 2320046631 | 07222                          | 23200 | 46631 | 4.81279602826 |
| • | U5265 |          | 0324114366 | 07223                          | 03241 | 14366 | 0.82870851826 |
| • | U5266 |          | 1440561520 | 07224                          | 14405 | 61520 | 3.12782026826 |
| • | U5267 |          | 2555227036 | 07225                          | 25552 | 27036 | 5.42693375826 |
| • | U5270 |          | 0561277017 | 07226                          | 05612 | 77017 | 1.44286369826 |
| • | U5271 |          | 1675744150 | 07227                          | 16757 | 44150 | 3.74197544826 |
| • | U5272 |          | 3012413713 | 07230                          | 30124 | 13713 | 6.04110639826 |
| • | U5273 |          | 1016463673 | 07231                          | 10164 | 63673 | 2.05703633826 |
| • | U5274 |          | 2133133250 | 07232                          | 21331 | 33250 | 4.35616553826 |
| • | U5275 |          | 0137203230 | 07233                          | 01372 | 03230 | 0.37209547826 |
| • | U5276 |          | 1253652772 | 07234                          | 12536 | 52772 | 2.67122642826 |
| • | U5277 |          | 2370322347 | 07235                          | 23703 | 22347 | 4.97035562826 |
| • | U5300 |          | 0374374552 | 07236                          | 03743 | 74552 | 0.98630301826 |
| • | U5301 | EPHRSTOT | 0054511643 | 07237                          | 00545 | 11643 | .04359783828  |
| • | U5302 |          | 0054511643 | 07240                          | 00545 | 11643 | .04359783828  |
| • | U5303 |          | 0054511746 | 07241                          | 00545 | 11746 | .04359808828  |
| • | U5304 |          | 0054511643 | 07242                          | 00545 | 11643 | .04359783828  |
| • | U5305 |          | 0054511653 | 07243                          | 00545 | 11653 | .04359786828  |
| • | U5306 |          | 0054511663 | 07244                          | 00545 | 11663 | .04359789828  |
| • | U5307 |          | 0054511560 | 07245                          | 00545 | 11560 | .04359764828  |
| • | U5310 |          | 0054511663 | 07246                          | 00545 | 11663 | .04359789828  |
| • | U5311 |          | 0054511663 | 07247                          | 00545 | 11663 | .04359789828  |
| • | U5312 |          | 0054511560 | 07250                          | 00545 | 11560 | .04359764828  |
| • | U5313 |          | 0054511663 | 07251                          | 00545 | 11663 | .04359789828  |
| • | U5314 |          | 0054511663 | 07252                          | 00545 | 11663 | .04359789828  |
| • | U5315 |          | 0054511560 | 07253                          | 00545 | 11560 | .04359764828  |
| • | U5316 |          | 0054511663 | 07254                          | 00545 | 11663 | .04359789828  |
| • | U5317 |          | 0054511653 | 07255                          | 00545 | 11653 | .04359786828  |
| • | U5320 |          | 0054511643 | 07256                          | 00545 | 11643 | .04359783828  |
| • | U5321 |          | 0054511746 | 07257                          | 00545 | 11746 | .04359808828  |
| • | U5322 |          | 0054511643 | 07260                          | 00545 | 11643 | .04359783828  |

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| • 05323       | 0054511643 | 07261 | 00545 11643 | •04359783828   |
| • 05324       | 0054511736 | 07262 | 00545 11736 | •04359805828   |
| • 05325       | 0054511736 | 07263 | 00545 11736 | •04359805828   |
| • 05326       | 0054511643 | 07264 | 00545 11643 | •04359783828   |
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| • 05330       | 0054511736 | 07266 | 00545 11736 | •04359805828   |
| • 05331       | 0054511736 | 07267 | 00545 11736 | •04359805828   |
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| • 05344       | 0054512067 | 07302 | 00545 12067 | •04359838828   |
| • 05345       | 0054512056 | 07303 | 00545 12056 | •04359835828   |
| • 05346       | 0054512056 | 07304 | 00545 12056 | •04359835828   |
| • 05347 EPHI  | 0141727677 | 07305 | 01417 27677 | •38250636826   |
| • 05350       | 0141725454 | 07306 | 01417 25454 | •38248891826   |
| • 05351       | 0141723230 | 07307 | 01417 23230 | •38247145826   |
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| • 05413       | 0142076642 | 07351 | 01420 76642 | •38329176826   |
| • 05414       | 0142107757 | 07352 | 01421 07757 | •38336157826   |
| • 05415 EPHSP | 7776372616 | 07353 | 77763 72616 | -0.00589921826 |

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| • 05416 | 7776521552 | 07354 | 77765 | 21552 | -0.00523599826 |
| • 05417 | 7776646263 | 07355 | 77766 | 46263 | -0.00459022826 |
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| • 05425 | 7777657735 | 07363 | 77776 | 57735 | -0.00061087826 |
| • 05426 | 0000006671 | 07364 | 00000 | 06671 | 00.00005236826 |
| • 05427 | 0000135625 | 07365 | 00001 | 35625 | 00.00071558826 |
| • 05430 | 0000264562 | 07366 | 00002 | 64562 | 00.00137881826 |
| • 05431 | 0000413516 | 07367 | 00004 | 13516 | 00.00204204826 |
| • 05432 | 0000542452 | 07370 | 00005 | 42452 | 00.00270526826 |
| • 05433 | 0000671407 | 07371 | 00006 | 71407 | 00.00336849826 |
| • 05434 | 0001020343 | 07372 | 00010 | 20343 | 00.00403171826 |
| • 05435 | 0001147300 | 07373 | 00011 | 47300 | 00.00469494826 |
| • 05436 | 0001276234 | 07374 | 00012 | 76234 | 00.00535816826 |
| • 05437 | 0001425170 | 07375 | 00014 | 25170 | 00.00602139826 |
| • 05440 | 0001554124 | 07376 | 00015 | 54124 | 00.00668461826 |
| • 05441 | 0001703061 | 07377 | 00017 | 03061 | 00.00734784826 |
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| • 05456 | 0004032706 | 07414 | 00040 | 32706 | 00.01583014826 |
| • 05457 | 0004155173 | 07415 | 00041 | 55173 | 00.01645845826 |
| • 05460 | 0004301705 | 07416 | 00043 | 01705 | 00.01710423826 |
| • 05461 | 0004426416 | 07417 | 00044 | 26416 | 00.01775000826 |
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|         |            | 07421 | 00112 | 30264 |                |
|         |            | 07422 | 00112 | 32001 |                |
|         |            | 07423 | 31050 | 00005 |                |
|         |            | 07424 | 60606 | 06060 |                |

SPURT OUTPUT NO. 111

| MOONTRACK    |       | P.CROWTHER*20FEB69 |       |              |       |
|--------------|-------|--------------------|-------|--------------|-------|
| LABEL        | LOC   | LABEL              | LOC   | LABEL        | LOC   |
| AS\$S\$S1111 | 07421 | AS\$S\$S1112       | 07422 | AS\$S\$S1113 | 07423 |
| AS\$S\$S1114 | 07424 | ACQAZIM            | 63071 | ACQELEV      | 63075 |
| ACQUI        | 63427 | ACTUALTIME         | 63142 | ADSCN        | 63416 |
| AEBUXLINES   | 63507 | AEPHEM             | 01453 | AESCN        | 63417 |
| AIRPORT      | 00237 | ALNGOFFSET         | 63517 | ALNGARCSN    | 63506 |
| ARCOFAZIM    | 63524 | ARCOFDEC           | 63526 | ARCOFELEV    | 63522 |
| ARCOFRA      | 63530 | AREACNT            | 02215 | ASIN         | 06505 |
| ASINX        | 06505 | ASTRODEC           | 63106 | ASTRORA      | 63105 |
| ATAN         | 06154 | AUPEREQUAT         | 63341 | AUTOSWITCH   | 63025 |
| AUTOT        | 63437 | AZDIFS             | 63120 | AZELOTIME    | 63532 |
| AZELBXSCAN   | 63500 | AZELIND\$          | 63162 | AZIM         | 63053 |
| AZIMOFFSET   | 63512 | AZIMOUT            | 64000 | AZIMOVER     | 63325 |
| AZIMADD      | 63442 | AZIMERROR\$        | 63027 | AZIMIN       | 75000 |
| AZMTHSCAN    | 63501 | AZTRACKERR         | 63022 | BODYSIZE     | 63462 |
| BOTHNEG1     | 01352 | BOTHNEG2           | 01374 | BOTHNEG3     | 01416 |
| BESSEL       | 01115 | BETA               | 01103 | BLASTOFF     | 63146 |
| BUST         | 00602 | COCON              | 63414 | CONVERTIME   | 63135 |
| CORCT        | 63420 | COS                | 06343 | COSORIENT    | 63065 |
| COSAZEL      | 63070 | COSX               | 06343 | CAZIM        | 63060 |
| CELBODY      | 63113 | CELCOMP\$          | 63424 | CELEV        | 63061 |
| CELM000      | 00002 | CELTIME            | 63133 | CERO         | 00471 |
| CHCOR        | 63422 | CHPAR              | 63431 | CIVIL        | 01233 |
| CRANGE       | 63057 | CRSSOFFSET         | 63516 | DOPFACTOR\$  | 63167 |
| JOPFREQ\$    | 63166 | DOPPOUT            | 66000 | DOPPAD       | 63444 |
| DOPPL        | 63164 | DOPPLER\$          | 63165 | DOPSWITCH\$  | 63163 |
| DATANALYZE   | 63425 | DAY                | 63150 | DAYFIND      | 00437 |
| JAYINCRMNT   | 00503 | DAYREG\$           | 63172 | DEC          | 63003 |
| DECOFFSET    | 63515 | DECAD              | 01445 | DECDOT       | 63010 |
| DECUIFAD     | 01446 | DECLINRAD          | 00272 | DECLINSCAN   | 63505 |
| DELTA        | 01105 | DELTATEE           | 63316 | DISTAD       | 01447 |
| DISTDIFAD    | 01450 | DLN                | 00721 | DLN1         | 00737 |
| DLN2         | 00743 | DLN3               | 00744 | DLN4         | 00746 |
| DLN5         | 00747 | DLN6               | 00751 | DLN7         | 00752 |
| DMIN2CPLB    | 01113 | DMINB              | 01112 | DRIFTAZIM\$  | 63534 |
| DRIFTELEV\$  | 63535 | DRIFTSCAN\$        | 63533 | DSECONDS     | 63141 |
| DSIDERT      | 04217 | DUMSECTG           | 63154 | DYDMP        | 63421 |
| ELDIFS       | 63121 | ELEV               | 63054 | ELEVOFFSET   | 63513 |
| ELEVOUT      | 65000 | ELEVADD            | 63443 | ELEVERROR\$  | 63030 |
| ELEVIN       | 76000 | ELTRACKERR         | 63023 | ELVTNSCAN    | 63502 |
| EP2BM2DMA    | 01114 | EPHCNT             | 00046 | EPHDAY       | 07170 |
| EPHEMA       | 03653 | EPHEMB             | 03654 | EPHEMC       | 03655 |
| EPHEMD       | 03656 | EPHEME             | 03657 | EPHEMF       | 03660 |
| EPHEMTAPE    | 00002 | EPHI               | 07305 | EPHINTERP    | 00367 |
| EPHP         | 07160 | EPHRST             | 07171 | EPHRSTDT     | 07237 |
| EPHSP        | 07353 | EPSILON            | 01106 | EQUATOR      | 63323 |
| ERNMSEC      | 01065 | ESTSHIFTED         | 63143 | EXPNAME      | 63350 |
| FBESSEL      | 01130 | FIRSTDIFF          | 01102 | FIRSTELEV    | 63104 |
| FIRSTTHRU    | 63153 | FIX1               | 01272 | FIX2         | 01300 |
| FIX3         | 01306 | FLOTEST1           | 01340 | FLOTEST2     | 01362 |
| FLOTEST3     | 01404 | FLATNEG            | 00442 | FLATPOS      | 00456 |
| FLATTENING   | 63337 | FRAMESIZE          | 63101 | FREQUENCY    | 63317 |
| FUNCTION     | 01107 | GAMMA              | 01104 | GEOCNLAT     | 63322 |

GEODETLAT 63321  
 GMT2 00776  
 GMT5 01002  
 GMTMODU24 63145  
 HOUR 01054  
 HALF 01111  
 HDAY 01060  
 HRAU 01056  
 ID12RADIO 67777  
 ID15RADIO 71776  
 ID18RADIO 72777  
 ID1ENTPNT 63410  
 ID1RECRD 63210  
 ID1SYSPAR 63310  
 ID21RADIO 74776  
 ID24RADIO 75777  
 ID2CELCOR 63001  
 ID2RADIO 63441  
 ID2SYSNAM 77677  
 ID3RADIO 63776  
 ID6RADIO 64777  
 ID9RADIO 66776  
 INAZIMADD 63446  
 INITIAL12 00665  
 INITIAL2 00652  
 INITIALBOD 01020  
 INITIALJD 00644  
 INTERCUM 63426  
 INTERPOL 01136  
 INTRELCKSW 63460  
 KEY 01101  
 KYBRDSPEC1 63344  
 KYBRDSPEC4 63347  
 LESSONE 00460  
 LSPERAU 63336  
 MOONINIT 00005  
 MOONUTAG 00000  
 MODESWITCH 63024  
 MOREONE 00462  
 MCPGM 63412  
 MINKEG 63152  
 MKOFFSW 06657  
 MK10 06577  
 MK13 06602  
 MK16 06605  
 MK19 06610  
 MK3 06570  
 MK5 06572  
 MK8 06575  
 MKAB2 06733  
 MKAPDT 06560  
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 MKCOSBP 06744  
 MKCOSDA 06761  
 MKCOSDPHI 06716  
 MKCOSLHA 06707  
 MKCOSZO 06712  
 MKCA1DT 06735  
 MKCB1 06736

GMT 00754  
 GMT3 00777  
 GMT6 01004  
 GMTSHIFTED 63144  
 HOURMINUTE 63137  
 HALFDAY 01046  
 HEIGHT 63326  
 ID10RADIO 66777  
 ID13RADIO 70775  
 ID16RADIO 71777  
 ID19RADIO 73776  
 ID1RADCOR 63050  
 ID1SYSENT 77576  
 ID1TIME 63130  
 ID22RADIO 74777  
 ID25RADIO 76775  
 ID2ENPNT 63411  
 ID2RECRD 63211  
 ID2SYSFAR 63311  
 ID4RADIO 63777  
 ID7RADIO 65776  
 IGNORE 01051  
 INELEVAOD 63447  
 INITIAL17 01015  
 INITIAL20 01026  
 INITIALDAT 00655  
 INTER 63413  
 INTERDOPP 74000  
 INTERRANGE 76777  
 JULIANDAY 01440  
 KMPERNM 63342  
 KYBRDSPEC2 63345  
 LONGITUDE 63320  
 LINCOLN 01235  
 LUNAR 00100  
 MOONSW\$ 63343  
 MOONWORK 00243  
 MONITAPE 00055  
 MAINSWITCH 63334  
 MDAY 01061  
 MINSRAD 01057  
 MKONE28 06627  
 MK11 06600  
 MK14 06603  
 MK17 06606  
 MK2 06567  
 MK4 06571  
 MK6 06573  
 MK9 06576  
 MKABDT 06734  
 MKB1STOR 00435  
 MKBPDT 06753  
 MKCOSCP 06752  
 MKCOSDEC 06651  
 MKCOSGLAT 06653  
 MKCOSLP 06747  
 MKCA 06720  
 MKCADT 06721  
 MKCB1DT 06737

GMT1 00772  
 GMT4 01001  
 GMT7 01005  
 HOLDNOHOLD 63511  
 HOURREG 63151  
 HARVARD 00246  
 HIRESDOP\$ 63171  
 ID11PADIO 67776  
 ID14RADIO 70776  
 ID17RADIO 72776  
 ID1CELCOR 63000  
 ID1RADIO 63440  
 ID1SYSNAM 77676  
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 ID2SYSENT 77577  
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 INITIAL18 01017  
 INITIAL3 00654  
 INITIALDIS 01007  
 INTERAZIM 72000  
 INTERELEV 73000  
 INTERRUPT 01052  
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 MOONDOP2\$ 63170  
 MOONTIME 00504  
 MOD2PI 07161  
 MONTHPRINT 01032  
 MCPFILLER 71000  
 MILLSTNADD 63451  
 MINUS 01327  
 MK1 06566  
 MK12 06601  
 MK15 06604  
 MK18 06607  
 MK20 06611  
 MK42 06777  
 MK7 06574  
 MKAB 06732  
 MKALFP 06561  
 MKBETA 06664  
 MKCOSB 06667  
 MKCOSDA 06702  
 MKCOSDP 06727  
 MKCOSL 06671  
 MKCOSPHID 06711  
 MKCA1 06760  
 MKCB 06722  
 MKCBDT 06723

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|-----------|-------|-----------|-------|------------|-------|
| MKCC      | 06724 | MKCC1     | 06740 | MKCC1DT    | 06741 |
| MKCCDT    | 06725 | MKCP      | 06750 | MKD0       | 06645 |
| MKD02     | 06646 | MKD0P1    | 06766 | MKD0P2     | 06767 |
| MKD0PP    | 06564 | MKD0PPLER | 06770 | MKDANG     | 06700 |
| MKD0T     | 06654 | MKD0TX    | 06655 | MKDDTC05Z  | 06717 |
| MKD0TR    | 06774 | MKDEC     | 06644 | MKDECD0T   | 06642 |
| MKDELALF  | 06764 | MKDELAY   | 06555 | MKDELAYCNT | 07022 |
| MKDELDEL  | 06763 | MKDKK2    | 06705 | MKDP       | 06563 |
| MKDPDT    | 06562 | MKDPX     | 06773 | MKFCL      | 06557 |
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| MKLCON    | 05350 | MKLHA     | 06552 | MKLHADT    | 06553 |
| MKLHAP    | 06731 | MKLP      | 06745 | MKL PDT    | 06754 |
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| MKMES06   | 07116 | MKMES07   | 07126 | MKMES08    | 07136 |
| MKMES09   | 07147 | MKMESI0   | 07071 | MKMESI1    | 07111 |
| MKMESI2   | 07027 | MKMESI3   | 07037 | MKMESI4    | 07047 |
| MKMESI5   | 07057 | MKMESI6   | 07122 | MKMESI7    | 07132 |
| MKMESI8   | 07143 | MKMESI9   | 07154 | MKPOSSW    | 06656 |
| MKQ11     | 06617 | MKQ180    | 06637 | MKQ90      | 06635 |
| MKQALF    | 06630 | MKQBER    | 06634 | MKQBNM     | 06633 |
| MKQCCER   | 06615 | MKQERPNI  | 06631 | MKQFC      | 06632 |
| MKQI      | 07164 | MKQIC05   | 07167 | MKQISIN    | 07166 |
| MKQK1     | 07162 | MKQNM PER | 06616 | MKQRO      | 06623 |
| MKQR11    | 06620 | MKQRCNM   | 06640 | MKQRH0     | 06624 |
| MKQRH0X   | 06625 | MKQRSOT   | 07163 | MKQSP      | 07165 |
| MKQWE     | 06626 | MKRO      | 06554 | MKR0DT     | 06556 |
| MKRA      | 06643 | MKRAD0T   | 06641 | MKRADDEG   | 06636 |
| MKRHODC05 | 06713 | MKRK1     | 06612 | MKRK2      | 06613 |
| MKRK3     | 06614 | MKRT      | 06565 | MKRT2      | 06714 |
| MKRTX     | 06772 | MKRTX2    | 06771 | MKS        | 06765 |
| MKS2      | 06775 | MKSINB    | 06666 | MKSINRP    | 06743 |
| MKSINCP   | 06751 | MKSINDA   | 06701 | MKSINDDA   | 06762 |
| MKSINDEC  | 06650 | MKSINDP   | 06726 | MKSINDPHI  | 06715 |
| MKSINGLAT | 06652 | MKSINL    | 06670 | MKSINLHA   | 06706 |
| MKSINLHAP | 06730 | MKSINLP   | 06746 | MKSINPHID  | 06710 |
| MKSWITCH  | 07115 | MKT1      | 07000 | MKT10      | 07007 |
| MKT11     | 07010 | MKT12     | 07011 | MKT13      | 07014 |
| MKT14     | 07015 | MKT15     | 07016 | MKT16      | 07017 |
| MKT17     | 07020 | MKT18     | 07021 | MKT2       | 07001 |
| MKT3      | 07002 | MKT4      | 07003 | MKT5       | 07012 |
| MKT6      | 07013 | MKT7      | 07004 | MKT8       | 07005 |
| MKT9      | 07006 | MKWA      | 06757 | MKWX       | 06755 |
| MKXY      | 06756 | MKX0      | 06544 | MKX02      | 06675 |
| MKXJ      | 06776 | MKXS      | 06547 | MKXS2      | 06672 |
| MKY0      | 06545 | MKY02     | 06676 | MKYS       | 06550 |
| MKYS2     | 06673 | MKZ0      | 06546 | MKZ02      | 06677 |
| MKZR0     | 06704 | MKZR02    | 06703 | MKZS       | 06551 |
| MKZS2     | 06674 | MSFREQ    | 63332 | MXA        | 04517 |
| MXA1      | 05055 | MXALF     | 04677 | MXAPDT     | 05017 |
| MXB       | 04553 | MXB1      | 05146 | MXBPD      | 05413 |
| MXC       | 04625 | MXC1      | 05230 | MXDOP      | 04472 |
| MXDA      | 05543 | MXDECPDT  | 04740 | MXDELALF   | 05674 |
| MXDELP    | 04661 | MXDPDOP   | 05761 | MXFCL      | 05466 |
| MXINIT    | 03662 | MXINPOSA  | 03705 | MXINPOSB   | 03761 |
| MXINPOSC  | 04026 | MXINPOSD  | 04073 | MXINTAB    | 03701 |
| MXLHA     | 04202 | MXLPDT    | 05424 | MXR0       | 04220 |

|             |       |
|-------------|-------|
| MXROBACK    | 04342 |
| MXSINBP     | 05312 |
| MXXYZ       | 05563 |
| NOFL01      | 01271 |
| NORMAL      | 00112 |
| NUMFILES    | 00014 |
| PERIODAZIM  | 63523 |
| PERIODRA    | 63527 |
| PLOTP       | 63436 |
| PREVIOUSM   | 63461 |
| PRLOG       | 63423 |
| ROUND       | 01426 |
| RA1         | 00704 |
| RA4         | 00713 |
| RA7         | 00717 |
| RADARMODE   | 63312 |
| RADIODEC    | 63541 |
| RADIFAD     | 01444 |
| RADIUSDOT   | 63011 |
| RANGEADD    | 63445 |
| RD0T0IFS    | 63123 |
| RDMTR       | 63430 |
| RECAZIM     | 67000 |
| RECRD       | 63415 |
| REFRACCOR\$ | 63031 |
| REMAINDER   | 01227 |
| RGHTASC     | 00666 |
| SOVMSG      | 06277 |
| SADU1       | 06314 |
| SAFE        | 01452 |
| SCELTIME    | 63134 |
| SECONDS     | 63140 |
| SETINTAD    | 01135 |
| SINORIENT   | 63064 |
| SIXTH       | 01125 |
| SLAVEUPTS   | 63124 |
| SRA         | 63004 |
| SRHIBIN     | 01050 |
| SSUB1       | 06332 |
| STOR2       | 01223 |
| STORE       | 00472 |
| SYNCAINBCW  | 63543 |
| SYNCELBCW\$ | 63546 |
| SYSCOMREG2  | 63453 |
| SYSCOMREG5  | 63456 |
| SYSNAMES    | 77700 |
| SYSTATD     | 63315 |
| TAPEBUST1   | 00617 |
| TAPSTAT     | 00624 |
| THIRD       | 01124 |
| TIMEMODE    | 63103 |
| TRACKINDIC  | 63026 |
| TRYAGAIN    | 00044 |
| TWOPIE      | 01067 |
| VIZDEC1     | 63014 |
| VIZRA2      | 63015 |
| WFFREQ      | 63333 |
| YEARMONTH   | 63147 |
| YRTRAN      | 63327 |

|              |       |
|--------------|-------|
| MXRODT       | 04351 |
| MXSINCP      | 05375 |
| NODATA       | 00627 |
| NOFL02       | 01277 |
| NMPERAU      | 63340 |
| P            | 01110 |
| PERIODDEC    | 63525 |
| PLOTAZIM\$\$ | 63020 |
| PLANP        | 63434 |
| PRINRECSW    | 63160 |
| PSOMP        | 01122 |
| RA           | 63002 |
| RA2          | 00710 |
| RA5          | 00714 |
| RAAD         | 01443 |
| RADCBXSCAN   | 63503 |
| RADIOMETER   | 63102 |
| RADINDIC     | 63157 |
| RANGE        | 63052 |
| RANGEDOT     | 63062 |
| RDBOXLINES   | 63510 |
| RDXXX        | 63433 |
| RECELEV      | 70000 |
| RECRDSWTC    | 63155 |
| REFRACIND\$  | 63161 |
| REVS RADIAN  | 01047 |
| RHRSEC       | 01066 |
| SOVSTR       | 06304 |
| SADD2        | 06320 |
| SARAD        | 01064 |
| SDAY         | 01062 |
| SECSRAD      | 01063 |
| SIDERTIME    | 63012 |
| SINAZEL      | 63066 |
| SKIP         | 63331 |
| SLAVEMODES   | 63125 |
| SRAD         | 01055 |
| SSBXT        | 06337 |
| SSUB2        | 06336 |
| STOR3        | 01251 |
| STATUSCK     | 00533 |
| SYNCAZBCW\$  | 63545 |
| SYNCTIMING   | 63542 |
| SYSCOMREG3   | 63454 |
| SYSCOMREG6   | 63457 |
| SYSTAT1      | 63313 |
| TAPEBLOCK    | 01442 |
| TAPEINPUT    | 00035 |
| TEMP         | 06342 |
| TIME2        | 01451 |
| TIMEP        | 63435 |
| TRUERANGE    | 63063 |
| TTYSTATUS    | 63111 |
| TWOSECDOP    | 63017 |
| VIZDEC2      | 63016 |
| WFORD        | 63432 |
| WHOLEYEAR    | 01437 |
| YEARPRINT    | 01070 |
| YSLIMIT      | 07061 |

|            |       |
|------------|-------|
| MXRODTBACK | 04470 |
| MXSINLP    | 05327 |
| NODATA2    | 00635 |
| NOFL03     | 01305 |
| NUMDEFIV   | 01127 |
| POLE       | 63324 |
| PERIODELEV | 63521 |
| PL0TELEV\$ | 63021 |
| PLUS       | 01333 |
| PRINT      | 00221 |
| PSOMP6     | 01123 |
| RAOFFSET   | 63514 |
| RA3        | 00711 |
| RA6        | 00716 |
| RADOT      | 63007 |
| RADECOTIME | 63531 |
| RADIOPA    | 63540 |
| RADIUS     | 63006 |
| RANGEOUT   | 70777 |
| RASCTNSCAN | 63504 |
| RDIFS      | 63122 |
| RECORDSIZE | 63112 |
| RECFILE    | 63212 |
| RECSIZE    | 00010 |
| RELEASESW  | 63156 |
| REWINDNO   | 01053 |
| SOVERFLOW  | 06257 |
| SADD       | 06305 |
| SADXT      | 06321 |
| SAZIM      | 63055 |
| SDC        | 63005 |
| SELEV      | 63056 |
| SIN        | 06354 |
| SINX       | 06354 |
| SLAVE      | 63126 |
| SORT       | 06441 |
| SRADTIME   | 63136 |
| SSIR       | 06324 |
| STOR1      | 01205 |
| STOR4      | 01265 |
| SUM        | 01336 |
| SYNCEINBCW | 63544 |
| SYSCOMREG1 | 63452 |
| SYSCOMREG4 | 63455 |
| SYSENTRIES | 77600 |
| SYSTAT2    | 63314 |
| TAPERUST   | 00615 |
| TAPESEARCH | 03661 |
| TENB25     | 06622 |
| TIMECORR   | 63107 |
| TIMEHOLD   | 63520 |
| TRUE TIME  | 63132 |
| TWOLESS    | 00454 |
| VELOFLIGHT | 63335 |
| VIZRA1     | 63013 |
| WFADD      | 63450 |
| YOLIMIT    | 07134 |
| YRREMAIN   | 01436 |
| ZRTRAN     | 63330 |

SPURT OUTPUT NO. 112

MOONTRACK

P.CROWTHER\*20FEB69

| LABEL      | LOC   | LABEL     | LOC   | LABEL      | LOC   |
|------------|-------|-----------|-------|------------|-------|
| MOONUTAG   | 00000 | EPHEMTAPE | 00002 | CELMOON    | 00002 |
| MOONINIT   | 00005 | RECSIZE   | 00010 | NUMFILES   | 00014 |
| TAPEINPUT  | 00035 | TRYAGAIN  | 00044 | EPHCNT     | 00046 |
| MONITAPE   | 00055 | LUNAR     | 00100 | NORMAL     | 00112 |
| PRINT      | 00221 | AIRPORT   | 00237 | MOONWORK   | 00243 |
| HARVARD    | 00246 | DECLINRAD | 00272 | EPHINTERP  | 00367 |
| MKB1STOR   | 00435 | DAYFIND   | 00437 | FLATNEG    | 00442 |
| TWOLESS    | 00454 | FLATPOS   | 00456 | LESSONE    | 00460 |
| MOREONE    | 00462 | CERO      | 00471 | STORE      | 00472 |
| DAYINCRMNT | 00503 | MOONTIME  | 00504 | STATUSCK   | 00533 |
| BUST       | 00602 | TAPEBUST  | 00615 | TAPEBUST1  | 00617 |
| TAPSTAT    | 00624 | NODATA    | 00627 | NODATA2    | 00635 |
| INITIALJD  | 00644 | INITIAL2  | 00652 | INITIAL3   | 00654 |
| INITIALDAT | 00655 | INITIAL11 | 00663 | INITIAL12  | 00665 |
| RGHTASC    | 00666 | RA1       | 00704 | RA2        | 00710 |
| RA3        | 00711 | RA4       | 00713 | RA5        | 00714 |
| RA6        | 00716 | RA7       | 00717 | DLN        | 00721 |
| DLN1       | 00737 | DLN2      | 00743 | DLN3       | 00744 |
| DLN4       | 00746 | DLN5      | 00747 | DLN6       | 00751 |
| DLN7       | 00752 | GMT       | 00754 | GMT1       | 00772 |
| GMT2       | 00776 | GMT3      | 00777 | GMT4       | 01001 |
| GMT5       | 01002 | GMT6      | 01004 | GMT7       | 01005 |
| INITIALDIS | 01007 | INITIAL17 | 01015 | INITIAL18  | 01017 |
| INITIALBOD | 01020 | INITIAL20 | 01026 | MONTHPRINT | 01032 |
| HALFDAY    | 01046 | REVSADIAN | 01047 | SRHIBIN    | 01050 |
| IGNORE     | 01051 | INTERUPT  | 01052 | REWINDNO   | 01053 |
| HOUR       | 01054 | SRAD      | 01055 | HRAD       | 01056 |
| MINSRAD    | 01057 | HDAY      | 01060 | MDAY       | 01061 |
| SDAY       | 01062 | SECSRAD   | 01063 | SARAD      | 01064 |
| ERNMSEC    | 01065 | RHRSEC    | 01066 | TWOPIE     | 01067 |
| YEARPRINT  | 01070 | KEY       | 01101 | FIRSTDIFF  | 01102 |
| BETA       | 01103 | GAMMA     | 01104 | DELTA      | 01105 |
| EPSILON    | 01106 | FUNCTION  | 01107 | P          | 01110 |
| HALF       | 01111 | DMINB     | 01112 | DMIN2CPLB  | 01113 |
| EP26M2DMA  | 01114 | BESSEL    | 01115 | PSQMP      | 01122 |
| PSQMP6     | 01123 | THIRD     | 01124 | SIXTH      | 01125 |
| KENNEDY    | 01126 | NUMDERIV  | 01127 | FBESSEL    | 01130 |
| SETINTAD   | 01135 | INTERPOL  | 01136 | STOR1      | 01205 |
| STOR2      | 01223 | REMAINDER | 01227 | CIVIL      | 01233 |
| LINCOLN    | 01235 | STOR3     | 01251 | STOR4      | 01265 |
| NOFL01     | 01271 | FIX1      | 01272 | NOFL02     | 01277 |
| FIX2       | 01300 | NOFL03    | 01305 | FIX3       | 01306 |
| MINUS      | 01327 | PLUS      | 01333 | SUM        | 01336 |
| FLOTTEST1  | 01340 | BOTHNEG1  | 01352 | FLOTTEST2  | 01362 |
| BOTHNEG2   | 01374 | FLOTTEST3 | 01404 | BOTHNEG3   | 01416 |
| ROUND      | 01426 | YRREMAIN  | 01436 | WHOLEYEAR  | 01437 |
| JULIANDAY  | 01440 | IMPERIAL  | 01441 | TAPEBLOCK  | 01442 |
| RAAD       | 01443 | RADIFAD   | 01444 | DECAD      | 01445 |
| DECUIFAD   | 01446 | DISTAD    | 01447 | DISTDIFAD  | 01450 |
| TIME2      | 01451 | SAFE      | 01452 | AEPHEM     | 01453 |
| AREACNT    | 02215 | LASTEPHEM | 03652 | EPHEMA     | 03653 |
| EPHEMB     | 03654 | EPHEMC    | 03655 | EPHEMD     | 03656 |

|            |       |           |       |            |       |
|------------|-------|-----------|-------|------------|-------|
| EPHEME     | 03657 | EPHEMF    | 03660 | TAPESARCH  | 03661 |
| MXINIT     | 03662 | MXINTAB   | 03701 | MXINPOSA   | 03705 |
| MXINPOSB   | 03761 | MXINPOSC  | 04026 | MXINPOSD   | 04073 |
| MXLHA      | 04202 | DSIDERT   | 04217 | MXR0       | 04220 |
| MXROBACK   | 04342 | MXRODT    | 04351 | MXRODTBACK | 04470 |
| MXDOP      | 04472 | MXA       | 04517 | MXB        | 04553 |
| MXC        | 04625 | MXDELP    | 04661 | MXALF      | 04677 |
| MXDECPDT   | 04740 | MXAPDT    | 05017 | MXA1       | 05055 |
| MXB1       | 05146 | MXC1      | 05230 | MXSINBP    | 05312 |
| MXSINLP    | 05327 | MXLCON    | 05350 | MXLAG      | 05356 |
| MXLUK      | 05357 | MXSINCP   | 05375 | MXBPD      | 05413 |
| MXLPDT     | 05424 | MXFCL     | 05466 | MXDA       | 05543 |
| MXXYZ      | 05563 | MXDELALF  | 05674 | MXDPDOP    | 05761 |
| ATAN       | 06154 | SOVERFLOW | 06257 | SOVMSG     | 06277 |
| SOVSTR     | 06304 | SADD      | 06305 | SADD1      | 06314 |
| SADU2      | 06320 | SADXT     | 06321 | SSUB       | 06324 |
| SSUB1      | 06332 | SSUB2     | 06336 | SSBXT      | 06337 |
| TEMP       | 06342 | COSX      | 06343 | COS        | 06343 |
| SINX       | 06354 | SIN       | 06354 | SQRT       | 06441 |
| ASINX      | 06505 | ASIN      | 06505 | MXX0       | 06544 |
| MKY0       | 06545 | MKZ0      | 06546 | MXXS       | 06547 |
| MKYS       | 06550 | MKZ5      | 06551 | MKLHA      | 06552 |
| MKLHADT    | 06553 | MKRO      | 06554 | MKDELAY    | 06555 |
| MKRODT     | 06556 | MKFCL     | 06557 | MKAPDT     | 06560 |
| MKALFP     | 06561 | MKOPDT    | 06562 | MKDP       | 06563 |
| MKDOPP     | 06564 | MKRT      | 06565 | MK1        | 06566 |
| MK2        | 06567 | MK3       | 06570 | MK4        | 06571 |
| MK5        | 06572 | MK6       | 06573 | MK7        | 06574 |
| MK8        | 06575 | MK9       | 06576 | MK10       | 06577 |
| MK11       | 06600 | MK12      | 06601 | MK13       | 06602 |
| MK14       | 06603 | MK15      | 06604 | MK16       | 06605 |
| MK17       | 06606 | MK18      | 06607 | MK19       | 06610 |
| MK20       | 06611 | MKRK1     | 06612 | MKRK2      | 06613 |
| MKRK3      | 06614 | MKQCCER   | 06615 | MKQNMPER   | 06616 |
| MKQ11      | 06617 | MKQRI1    | 06620 | MKHLF      | 06621 |
| TENB25     | 06622 | MKQRO     | 06623 | MKGRH0     | 06624 |
| MKORH0X    | 06625 | MKQWE     | 06626 | MKONE28    | 06627 |
| MKQALF     | 06630 | MKQERPNN  | 06631 | MKQFC      | 06632 |
| MKQBNM     | 06633 | MKQBER    | 06634 | MKQ90      | 06635 |
| MKRADDEG   | 06636 | MKQ180    | 06637 | MKQRCNM    | 06640 |
| MKRADDT    | 06641 | MKDECDT   | 06642 | MKRA       | 06643 |
| MKDEC      | 06644 | MKD0      | 06645 | MKD02      | 06646 |
| MKE0LAT    | 06647 | MKSINDEC  | 06650 | MKC0SDEC   | 06651 |
| MKSINGLAT  | 06652 | MKC0SGLAT | 06653 | MKDD0T     | 06654 |
| MKD00TX    | 06655 | MKP0SSW   | 06656 | MKOFFSW    | 06657 |
| MKIUELAY   | 06660 | MKIANG    | 06661 | MKINBETA   | 06662 |
| MKINLAMBOA | 06663 | MKBETA    | 06664 | MKLAMBDA   | 06665 |
| MKSINB     | 06666 | MKC0SB    | 06667 | MKSINL     | 06670 |
| MKC0SL     | 06671 | MKXS2     | 06672 | MKYS2      | 06673 |
| MKZS2      | 06674 | MKX02     | 06675 | MKY02      | 06676 |
| MKZ02      | 06677 | MKDANG    | 06700 | MKSINDA    | 06701 |
| MKC0SDA    | 06702 | MKZRO2    | 06703 | MKZRO      | 06704 |
| MKDKK2     | 06705 | MKSINLHA  | 06706 | MKC0SLHA   | 06707 |
| MKSINPHID  | 06710 | MKC0SPHID | 06711 | MKC0S20    | 06712 |
| MKRH0UC0S  | 06713 | MKRT2     | 06714 | MKSINDPHI  | 06715 |
| MKCUSDPHI  | 06716 | MKDDTC0S2 | 06717 | MKCA       | 06720 |
| MKCADT     | 06721 | MKCB      | 06722 | MKCBDT     | 06723 |
| MKCC       | 06724 | MKCCDT    | 06725 | MKSINDP    | 06726 |
| MKC0SDP    | 06727 | MKSINLHAP | 06730 | MKLHAP     | 06731 |

|               |       |               |       |               |       |
|---------------|-------|---------------|-------|---------------|-------|
| MKAB          | 06732 | MKAB2         | 06733 | MKABDT        | 06734 |
| MKCA1DT       | 06735 | MKCB1         | 06736 | MKCB1DT       | 06737 |
| MKCC1         | 06740 | MKCC1DT       | 06741 | MKBP          | 06742 |
| MKSINBP       | 06743 | MKCOSBP       | 06744 | MKLP          | 06745 |
| MKSINLP       | 06746 | MKCOSLP       | 06747 | MKCP          | 06750 |
| MKSINCP       | 06751 | MKCOSCP       | 06752 | MKBPD         | 06753 |
| MKL PDT       | 06754 | MKWX          | 06755 | MKWY          | 06756 |
| MKWA          | 06757 | MKCA1         | 06760 | MKCOSDDA      | 06761 |
| MKSINDDA      | 06762 | MKDELDEL      | 06763 | MKDELALF      | 06764 |
| MKS           | 06765 | MKDOP1        | 06766 | MKDOP2        | 06767 |
| MKDUPPLER     | 06770 | MKRTX2        | 06771 | MKRTX         | 06772 |
| MKDPX         | 06773 | MKDDTR        | 06774 | MKS2          | 06775 |
| MKXD          | 06776 | MK42          | 06777 | MKT1          | 07000 |
| MKT2          | 07001 | MKT3          | 07002 | MKT4          | 07003 |
| MKT7          | 07004 | MKT8          | 07005 | MKT9          | 07006 |
| MKT10         | 07007 | MKT11         | 07010 | MKT12         | 07011 |
| MKT5          | 07012 | MKT6          | 07013 | MKT13         | 07014 |
| MKT14         | 07015 | MKT15         | 07016 | MKT16         | 07017 |
| MKT17         | 07020 | MKT18         | 07021 | MKDELAYCNT    | 07022 |
| MKMES02       | 07023 | MKMES12       | 07027 | MKMES03       | 07033 |
| MKMES13       | 07037 | MKMES04       | 07043 | MKMES14       | 07047 |
| MKMES05       | 07053 | MKMES15       | 07057 | YSLIMIT       | 07061 |
| MKMES00       | 07063 | MKMES10       | 07071 | MKMES01       | 07073 |
| MKMES11       | 07111 | MKSWITCH      | 07115 | MKMES06       | 07116 |
| MKMES16       | 07122 | MKMES07       | 07126 | MKMES17       | 07132 |
| YOLIMIT       | 07134 | MKMES08       | 07136 | MKMES18       | 07143 |
| MKMES09       | 07147 | MKMES19       | 07154 | EPHP          | 07160 |
| MOD2PI        | 07161 | MKQK1         | 07162 | MKQSDT        | 07163 |
| MKQI          | 07164 | MKQSP         | 07165 | MKQISIN       | 07166 |
| MKQICOS       | 07167 | EPHDAY        | 07170 | EPHRST        | 07171 |
| EPHRSTDT      | 07237 | EPHI          | 07305 | EPHSP         | 07353 |
| A\$\$\$\$1111 | 07421 | A\$\$\$\$1112 | 07422 | A\$\$\$\$1113 | 07423 |
| A\$\$\$\$1114 | 07424 | ID1CELCOR     | 63000 | ID2CELCOR     | 63001 |
| RA            | 63002 | DEC           | 63003 | SRA           | 63004 |
| SDC           | 63005 | RADIUS        | 63006 | RADOT         | 63007 |
| DECDOT        | 63010 | RADIUSDOT     | 63011 | SIDERTIME     | 63012 |
| VIZRA1        | 63013 | VIZDEC1       | 63014 | VIZRA2        | 63015 |
| VIZDEC2       | 63016 | TWOSECDOP     | 63017 | PL0TAZIM\$\$  | 63020 |
| PL0TELEV\$\$  | 63021 | AZTRACKERR    | 63022 | ELTRACKERR    | 63023 |
| MODESWITCH    | 63024 | AUTOSWITCH    | 63025 | TRACKINDIC    | 63026 |
| AZIMERROR\$   | 63027 | ELEVERROR\$   | 63030 | REFRACCORS    | 63031 |
| ID1RADCOR     | 63050 | ID2RADCOR     | 63051 | RANGE         | 63052 |
| AZIM          | 63053 | ELEV          | 63054 | SAZIM         | 63055 |
| SELEV         | 63056 | CRANGE        | 63057 | CAZIM         | 63060 |
| CELEV         | 63061 | RANGEDOT      | 63062 | TRUERANGE     | 63063 |
| SINORIENT     | 63064 | COSORIENT     | 63065 | SINAZEL       | 63066 |
| COSAZEL       | 63070 | ACQAZIM       | 63071 | ACQELEV       | 63075 |
| FRAMESIZE     | 63101 | RADIOMETER    | 63102 | TIMEMODE      | 63103 |
| FIRSTELEV     | 63104 | ASTORA        | 63105 | ASTRODEC      | 63106 |
| TIMECORR      | 63107 | KYBRDLEVEL    | 63110 | TTYSTATUS     | 63111 |
| RECORDSIZE    | 63112 | CELBODY       | 63113 | AZDIFS        | 63120 |
| ELDIFS        | 63121 | RDIFS         | 63122 | RD0TDIFS      | 63123 |
| SLAVEOPTS     | 63124 | SLAVEMODES    | 63125 | SLAVE         | 63126 |
| LINECOUNT\$   | 63127 | ID1TIME       | 63130 | ID2TIME       | 63131 |
| TRUETIME      | 63132 | CELTIME       | 63133 | SCELTIME      | 63134 |
| CONVERTIME    | 63135 | SRADTIME      | 63136 | HOURLMINUTE   | 63137 |
| SECONDS       | 63140 | DSECONDS      | 63141 | ACTUALTIME    | 63142 |
| ESTSHIFTED    | 63143 | GMTSHIFTED    | 63144 | GMTMODU24     | 63145 |
| BLASTOFF      | 63146 | YEARMONTH     | 63147 | DAY           | 63150 |

HOURREG 63151  
 DUMSECTG 63154  
 RADINDIC 63157  
 AZELIND\$ 63162  
 DOPPLER\$ 63165  
 MOONDOP2\$ 63170  
 ID1RECRD 63210  
 ID1SYSPAR 63310  
 SYSTAT1 63313  
 DELTATEE 63316  
 GEODETLAT 63321  
 POLE 63324  
 YRTRAN 63327  
 MSFREQ 63332  
 VELOFLIGHT 63335  
 NMPERAU 63340  
 MOONSW\$ 63343  
 KYBRDSPEC3 63346  
 IDENTPNT 63410  
 INTER 63413  
 ADSCN 63416  
 DYOMP 63421  
 CELCOMPGM 63424  
 ACQUI 63427  
 WFORD 63432  
 TIMEP 63435  
 ID1RADIO 63440  
 ELEVADD 63443  
 INAZIMADD 63446  
 MILLSTNADD 63451  
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| 13. ABSTRACT<br><br><p style="text-align: center;">This report describes the procedure used by the Haystack pointing computer program for obtaining the celestial coordinates of any point on the Moon at any time.</p>                                                     |  |                                                                             |                      |
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