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FINAL REPORT

TO

THE NATIONAL AERONAUTICS AND SPACE AGENCY

FOR

LAUNCH VEHICLE GROUND TRUTH EPHEMERAS

FOR

MICRO-NETWORK APPLICATIONS

(Grant No. NAG-5-715)

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LAUNCH VEHICLE GROUND TRUTH EPHEMERAS

We have carried out the development software packages for computation of orbits and trajectories in the following programming languages:

APPLE BASIC
MICROSOFT BASIC
TRUE BASIC

This report is organized as follows:

1. List of various programs
2. Listings of the codes of programs
3. Sample input and outputs of each program.

This project is concluded with the submittal of this report.

LAUNCH VEHICLE GROUND TRUTH EPHEMERAS

LIST OF PROGRAMS

I. ORBIT RELATED PROGRAMS

(Language used : TRUE BASIC)

1. ERRAN-I/06
2. ERRAN-I/4
3. ORBIT-I/13

(Language used: APPLE BASIC)

1. SUNSYNC	2. OI&H	3. CIRCORB(5)
4. PCS(9)	5. JULIAN	6. IOPI(8)
7. DELTA(10)	8. AZ-O(6)	9. PCS4.KORK
10. ORBIT(7)	11. HELIO-COORD	12. PCS
13. HPBASIC	14. SUN-ANG	15. TARK

II. TRAJECTORIES UTILIZING RUNGE-KUTTA ANALYSIS

(Language used: TRUE BASIC)

1.T_ELPTCAL PSET
2. T_MATH.ELIP
3.T_JD1.1$S

III. WORLD PICTURE

(Language used: MICROSOFT BASIC)

1. MPATH.ELIP (input data include).
2. PATHPICTURE (used video address)
3. ELPTCALPEST 1.064

```
10   REM SAMPLE ORBIT PROGRAM (TRAJECTORIES UTILIZING RUNGE-KUTTA ANALYSIS)
20   CLOSE #1!MAKE SURE ALL FILES ARE CLOSED FROM PREVIOUS RUN.
21   OPTION BASE 1
22   PUBLIC TWOPI,RAD1,PI1,PIOV2,GZERO,RE,CMU,DJ,CAPLAT,CAPLNG,CAPHT,SLAT(5),SI
23   PUBLIC SHT(5),PRINT1,XPRINT,CNMI,CFPS,B,F10,AP,ERATE,TIGN,TBO,STWT,FLOW
24   PUBLIC THX,THY,THZ,THR,GTH,ATH,WT,ACCEL,VEARTH,VIMF,GCTOT,ATDOT,VLOSS
25   PUBLIC CMACH,QH,ATAKP,ATAKY,ATAK,Q,QA,DZ,ITHR,IUNIT,ITRK,ICRASH,MSUN,MMOO
27   PUBLIC MDRAG,MTHRST,I62,MONTH(12),LMON$(12)
28   PUBLIC  SIMPO(6),ELMO(6),STVO(6),BUFFER(100,2),BUFPTR,LATT,LONG,BUFLIM,MO
29   LET PI1=PI
30   LET BUFLIM=32
50   DIM AA1(4),BB1(4),CC1(4)
51   DIM ELM(6),STV(6),YY1(6),PRMT(5),YEAR(6),AUX(8,6),DERY(6),DUM(56)
53   LET MONTH(1),MONTH(3),MONTH(5),MONTH(7),MONTH(8),MONTH(10),MONTH(12)=31
54   LET MONTH(2)=28
56   LET MONTH(4),MONTH(6),MONTH(9),MONTH(11)=30
65   LET MONDD(1)=0
66   LET MONDD(2)=31
67   LET MONDD(3)=59
68   LET MONDD(4)=90
69   LET MONDD(5)=120
70   LET MONDD(6)=151
71   LET MONDD(7)=181
72   LET MONDD(8)=212
73   LET MONDD(9)=243
74   LET MONDD(10)=273
75   LET MONDD(11)=304
76   LET MONDD(12)=334
77   LET MONDD(13)=365
78   LET LMON$(1)="JAN"
79   LET LMON$(2)="FEB"
80   LET LMON$(3)="MAR"
81   LET LMON$(4)="APR"
82   LET LMON$(5)="MAY"
83   LET LMON$(6)="JUN"
84   LET LMON$(7)="JUL"
85   LET LMON$(8)="AUG"
86   LET LMON$(9)="SEP"
87   LET LMON$(10)="OCT"
88   LET LMON$(11)="NOV"
89   LET LMON$(12)="DEC"
102  LET PIOV2=PI1/2
103  LET RAD1=57.2957795
104  LET TWOPI=2*PI1
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```
105  LET BUFPTR,LATT=1
106  LET LONG=2 !BASIC CONSTANTS
107  DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
108  DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
109  FOR I=1 TO 6
110    LET ELM(I)=0
111    LET YY1(I)=0
112    LET YEAR(I)=0
115    LET DERY(I)=0
120  NEXT I
130  FOR I=1 TO 5
140    LET PRMT(I)=0
150  NEXT I
160  FOR I=1 TO 8
170    FOR J=1 TO 6
180      LET AUX(I,J)=0
190    NEXT J
200  NEXT I
210  FOR I=1 TO 56
220    LET DUM(I)=0
230  NEXT I
233  REM THE FOLLOWING ARE PRESET VALUES USED TO SPEEED THE EVALUATION OF THE I
234  LET IINP,IUNIT=0
235  LET ITRK,I62=0
236  LET ICRASH=1
237  LET MSUN,MMOON,MDRAG=1
240  LET MTHRST=0
241  LET MOBL=5
242  LET YEAR(1)=1974
243  LET YEAR(2)=8
244  LET YEAR(3)=15
245  LET YEAR(4)=23
246  LET YEAR(5)=0
247  LET YEAR(6)=0
248  LET ELM(1)=6526.32
249  LET ELM(2)=0
250  LET ELM(3)=-4.148
251  LET ELM(4)= 10.30655
252  LET ELM(5)=0
253  LET ELM(6)=116
254  LET PRMT(1)=0
255  LET PRMT(2)=48
256  LET PRMT(3)=20
257  LET PRMT(4)=2
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258  REM THIS ENDS THE REMARKS OF THE PRESET.
259  LET RE=6378.16
260  LET CMU=398601.2
270  LET CAPLAT=28.447 ! LATITUDE AT THE CAPE
280  LET CAPLNG=-80.565 ! LONGITUDE AT THE CAPE
295  LET BUFFER(BUFPTR,LATT)=CAPLAT
296  LET BUFFER(BUFPTR,LONG)=CAPLNG !THIS IS THE LAUNCH SITE LOCATION.
297  LET CAPHT=.02
300  LET CNMI=.539956803
310  LET CFPS=3280.839895
320  LET ERATE=7.2921E-05
330  LET GZERO=.00980665
350  LET ITHR=0
352  PRINT
353  PRINT "ENTER IINP,0 FOR R,LAT,LONG,VEL,GAM,AZ,PRINT OR 1 FOR ELEMENTS A,E,
360  PRINT "ENTER IUNIT,0 FOR KM, KGM,SEC; 1 FOR N,NI,FPS:";IUNIT
365  PRINT "ENTER ITRK,ENTER THE NUMBER OF TRACKING STATIONS OR 0 FOR "
366  PRINT "      NO TRACKING DATA GENERAATED:"; ITRK
369  PRINT "ENTER ICRASH-VACUM INPACT PTINTOUT:";ICRASH
371  PRINT "ENTER I62,0 FOR 1962 U.S.STD ATMOSPHERE, 1 FOR DYNAMIC ATMOSPHERE:'
375  PRINT "ENTER MSUN,1 TO INCLUDE PERTURBING FORCE OTHERWISE ENTER0:",MSUN
380  PRINT "ENTER MMOON, 1 TO INCLUDE FORCE:", MMOON
381  PRINT "ENTER MDRAG, 1 TO INCLUDE FORCER:", MDRAG
385  PRINT "ENTER MTHRST,1 TO INCLUDE FORCE:",MTHRST
386  PRINT "ENTER MOGL, HIGHEST ORDER OF OBLATENESS INCLUDED:", MOBL
440  REM IINP=0 FOR R,LAT,LONG,VEL,GAM,AZ PRINT;=1 FOR ESEMENTS A,E,I,NODE,ARGI
441  REM PERIGEE ,MEAN ANOM IUNIT=0 FOR KM,KGM,SEC:=1 FOR N,NI,FPS
443  REM ITRK=0 FOR NO TRADKINTG DATA GENERATED:=NO.OF TRACKING STATIONS FOR WI
444  REM IS TO BE GENERATED.
445  REM ICRASH=1 FOR VACUUM OMPACT PTINTOUT
446  REM I62=0 FOR 1962 U.S.STD ATMOSPHERE;=1 FOR DYNAMIC ATMOSPHERE
447  REM MSUN, MMOON, MDRAG, MTHRST=1 TO INCLUDE EACH PERTURBING FORCE
448  REM MOBL=HIGHEST ORDER OF OBLATENESS INCLUDED
450  PRINT "ENTER THE YEAR:", YEAR(1)
451  PRINT "ENTER THE MONTH(1-12):", YEAR(2)
460  PRINT "ENTER THE DAY (1-31):", YEAR(3)
461  PRINT "ENTER THGE HOURS()-23):", YEAR(4)
470  PRINT "ENTER THE MINUTES(0-59):", YEAR(5)
472  PRINT "ENTER THE SECONDS(0-59):", YEAR(6)
480  REM CALENDAR DATE OF START EPOCH
490  PRINT "ENTER STATE VECTOR OR ESEMENTS AT START EPOCH"
500  PRINT USING "ENTER FIRST ITEM=####.####:":ELM(1)
503  PRINT USING "ENTER THE SECOND ITEM=##.###": ELM(2)
504  PRINT USING "ENTER THIRD ITEM=##.####": ELM(3)
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510  PRINT USING "ENTER FOURTH ITEM=##.####":ELM(4)
512  PRINT USING "ENTER FIFTH ITEM=###.####":ELM(5)
514  PRINT USING "ENTER SIXTH ITEM=###.####":ELM(6)
520  REM STATE VECTOR OR ELEMENTS AT START EPOCH
521  REM PRMT(1)=START TIME, HRS(NORMALLY 0.0)
522  REM PRMT(2)=END TIME, HRS
523  REM PRMT(3)= INITIAL STEP SIZE MIN
524  REM PRMT(4)= UPPER ERROR BOUND
525  CLEAR
528  PRINT
529  PRINT "PRMT(1)=START TINMEM HRS(NORMALLY 0.0)"
530  PRINT "PRMT(2)=END TIME,HRS"
531  PRINT "PRMT(3)= INITIAL STEP SIZE, MIN"
532  PRINT "PRMT(4)=UPPER ERROR BOUND"
540  FOR I=1 TO 4
545   PRINT TAB(1,1),"ENTER PRMT";I;TAB(1,14),":"; PRMT(I)
546   PRINT
550  NEXT I
555  REM PRINT1=PRINT1 STEP, MIN(IF PRINT1=0. EVERY INTEGSTEP IS PRINTED.)
556  REM PRINT" PRINT1",PRINT1
557  LET PRINT1=0
560  FOR I=1 TO 6
570    LET DERY(I)=.16666666667
575  NEXT I
630  REM DERY(I)= ERROR IS FOR YY1(I), TOTALLING1.0
640  CALL GJDATE(DJ,YEAR(),0)
650  LET DZ=DJ
670  IF (IINP>0) THEN GOTO 770   ! THE LINE NUMBER 770 SHOULD EXACTLY CORRECT
680  IF (IUNIT=0) THEN GOTO 710   ! THE LINE NUMBER 710 SHOULD EXACTLY CORRECT
690  LET ELM(1)=ELM(1)/CNMI
700  LET ELM(4)= ELM(4)/CFPS
710  FOR I=1 TO 6
720    LET STV(I)=ELM(I)
730  NEXT I
740  CALL RTOXYZ(STV(),YY1(),DJ)
750  CALL XTOELM(YY1(),ELM())
760  GOTO 800
770  IF (IUNIT=1) THEN LET ELM(1)=ELM(1)/CNMI
780  CALL ELMTOR(ELM(),STV(),DJ)
790  CALL RTOXYZ(STV(),YY1(),DJ)
800  LET PRMT(1)=PRMT(1)*3600
810  LET PRMT(2)=PRMT(2)*3600
820  LET PRMT(3)=PRMT(3)*60
830  LET PRINT1=PRINT1*60
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```
840  LET XPRINT=PRMT(1)+PRINT1
841 PRINT ITRK
850  IF (ITRK=0) THEN GOTO 858
851  FOR I=1 TO ITRK
853   PRINT "ENTER DATA FOR TRACKING STATION";I
854   PRINT "LATITUDE:";SLAT(I)
855   PRINT "LONGITUDE:"; SLONG(I)
856   PRINT "HEIGHT:"; SHT(I)   !LOCATIONS OF TRACKING STATIONS
857  NEXT I
858  IF (MDRAG=1) THEN
859   PRINT "ENTER B(BALLISTIC COEFFICIENT):",B
860   PRINT "ENTER F10:",F10
861   PRINT "ENTERT AP:", AP
862  END IF
863  IF (IUNIT=1) THEN LET B=B*6.36588038E-09
864  REM B=BALLISTIC COEFFICIENT, CA/2M (KM,KG)
865  IF (MTHRST=0) THEN GOTO 884
866  PRINT "ENTER IGNITION TIME(IIN HOURS):", TIGN
867  PRINT "ENTER BURNOUT TIME(IN HOURS):",TBO
868  PRINT "ENTER INITIAL WEIGHT:",STWT
869  PRINT "ENTER PTOPELLANT WEIGHT:",WP
870  LET TBO=TBO*3600
871  LET TIGN=TIGN*3600
872  REM TVO, TIGN PRINT IN HRS
874  PRINT "ENTER THRUST(LB.):", THR
875  PRINT "ENTER THRUST ELEVATION:",GTH
876  PRINT "ENTER THRUST (BLDY ) AZIMUTH AT IGNITION:", ATH
877  REM TIGN= IGNITION TIME, TBO=BUTNOUT TIME, STWU= INITIAL WEITGHT (LB)
878  REM REM WP= PROPELLANT WEIGHT (LB), THR=THRUST(LB), GTH=THRUST ELECVATION
880  REM AT IGNITIION, ATH=THRUST(BODY) AZIMUTH AT IGNITION
882  LET FLOW=WP/(TBO-TIGN)
884  LET NDIM=6
885  OPEN #1:SCREEN 0,1,0,1
886  PRINT #1: "TRAJECTORY USING RUNGE-KUTTA ANALYSIS"
887  PRINT #1:"START EPOCH"
888  CALL CDATE(DJ)
890  IF (IINP=0) THEN PRINT #1: "PRINT STATE VECTOR"
896  PRINT #1, USING "TSFIUD= ####.###": STV(1)
897  PRINT #1, USING "LATITUDE= ##.###": STV(2)
898  PRINT #1, USING "LONGITUDE= ###.####": STV(3)
899  PRINT #1, USING "VELOCITY= ##.####":STV(4)
900  PRINT #1, USING "FLTPATH= #.##":STV(5)
902  PRINT #1, USING "AZIMUTH= ###.####": STV(6)
910  IF (IINP=1) THEN PRINT #1 :"PRINT ORBIT ELEMENTS"
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911  PRINT #1, USING "A= ######.####":ELM(1)
914  PRINT #1, USING "B= #.#######":ELM(2)
916  PRINT #1, USING "INCL=##.####": ELM(3)
918  PRINT #1, USING "RA OF ASC NODE= ###.####": ELM(4)
920  PRINT #1, USING "ARH OF PER= ###.####":ELM(5)
922  PRINT #1, USING "MEAN ANOM= ##.##": ELM(6)
923  PRINT #1:"PERTURBATIONS INCLUDED:"
924  IF (MSUN=1) THEN PRINT #1:"  SUN"
925  IF (MMOON=1) THEN PRINT #1:"  MOON"
926  IF (MOBL>=1) THEN PRINT #1,USING "  OBLATENESS OF ORDER:=##.#":MOBL
928  IF (MDRAG>=1) AND (I62>=1) THEN PRINT #1:"  DRAG(B= ";B;" F10=";F10;"AP=";
930  IF (MDRAG>=1) AND (I62=0) THEN PRINT #1:" DRAG(1962 STD ATMOSPHERE, B=";B;
932  IF (MTHRST>=1) THEN PRINT #1:"THRUST(TIGN=";TIGN;"TBO=";TBO;"STWT=";STWT;'
933  PRINT #1:"  ( THR="; THR;"GTH=";GTH;"ATH=";ATH;")"
940  PRINT #1:"OUTPUT FORMAT"
941  PRINT #1:""
942  PRINT #1:""
950  PRINT #1: " \          \   TIME   ALTITUDE   RANGE  THRUST"
955  PRINT #1: "\          \","WEIGHT","ACCEL(BODY AXIS)","SEMIMAJOR AXIS","ECCI
960  PRINT #1: "\          \","INCLINATION","RA OF ASC NODE","ARG OF PERIGEE","T
965  PRINT #1:"RADIYS","GEOC LATITUDE","LONGITUDE","INERTIAL VELOCITY"
970  PRINT #1:"\          \","FLT PATH ELEV","AZIMUTH","APOGEE RADIUS","PERIGEE
972  PRINT #1:"\          \","PERIOD","EARTH REL VELOCITY","PITCH","YAW"
974  PRINT #1:"\          \","APOGEE ALTITUDE","PERIGEE ALTITUDE","WT FLOW RATE'
976  PRINT #1:"\          \","PICTDH RATE","YAW RATE","APOGEE VELOCITY","PERIGEI
978  PRINT #1:"\          \","ELEV FROM CAPE","VELOCITY LOSS","MACH NO","QH"
980  PRINT #1:"\          \","PITCH ATTACK","YAW ATTACK","TOTAL ATTACK","Q"
985  PRINT #1:"\          \","Q ALPHA","TRUE ANOMALY","X","Y"
986  PRINT #1:"\          \","Z";"XDOT","YDOT","ZDOT"
990  CALL DRKGS(PRMT(),YY1(),DERY(),NDIM,IHLF,AUX(,))
995  GOTO 350
999  END
1010 SUB ANGLE(SINX,COSX,X)
1011 REM SOLVE FOR ANGLEX GIVEN SINE AND COSINE
1012 DECLARE PUBLIC PI1,PIOV2
1013 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
1030 LET TEST =.96
1040 IF ((ABS(SINX)-TEST)<0) THEN GOTO 1070
1050 IF ((ABS(SINX)-TEST)=0) THEN GOTO 1070
1060 IF ((ABS(SINX)-TEST)>0) THEN GOTO 1090
1070 IF COSX<0 THEN LET X=ATN(SINX/COSX)+PI1! MAIN TAINS PROPER QUADRANT ORIEN
1071 IF (COSX>=0) AND (SINX<0) THEN LET X=ATN(SINX/COSX)+TWOPI
1072 IF (COSX>=0) AND (SINX>=0) THEN LET X=ATN(SINX/COSX)
1080 EXIT SUB
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1090 LET X=FNARCOS(COSX)
1100 IF (SINX<0) THEN GOTO 1130
1110 IF (SINX=0) THEN GOTO 1130
1120 IF (SINX>0) THEN GOTO 1140
1130 LET X=2*PI1-X
1140 END SUB
2010 SUB ANGLEH(SINHX,COSHX,X)
2011 DECLARE PUBLIC PI1,PIOV2
2012 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
2030 LET ASINHX=ABS(SINHX)
2040 LET X=LOG(ASINHX+SQR(ASINHX*ASINHX+1))
2050 IF (SINHX<0) THEN GOTO 2060
2052 IF (SINHX=0) THEN GOTO 2130
2054 IF (SINHX>0) THEN GOTO 2130
2060 IF (COSHX<0) THEN GOTO 2090
2070 IF (COSHX=0) THEN GOTO 2110
2080 IF (COXHX>0) THEN GOTO 2110
2090 LET X=X-PI1
2100 EXIT SUB
2110 LET X=-X
2120 EXIT SUB
2130 IF (COSHX<0) THEN LET X=PI1-X
2140 END SUB
3010 SUB ATAKAN(STV(),GTH, ATH,ATAK,ATAKP,ATAKY)
3020 REM ATAKAN CALCUA=LATES THE TOTAL ANGLE OF ATTACK(BETWEEN THE THRUST OR B(
3030 REM AND THE VELOCITY VECTOR), THE PITCH ANGLE OF ATTACK ATAKP(BODY AZIMUT
3040 REM AZIMUTH)GIVEN THE STATE VECTOR
3060 REM STV(R,LSAT,LONG,V,GAM,AZ),BOKY E;EVATION GTH AND BODY AZIMUTH ATH
3061 DECLARE PUBLIC RAD1,PIOV2
3062 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
3080 LET ATAKP=GTH-STV(5)
3090 LET ATAKY=ATH-STV(6)
3110 LET CCV=COS(STV(5)/RAD1)
3120 LET XV=CCV*SIN(STV(6)/RAD1)
3130 LET YV=CCV*COS(STV(6)/RAD1)
3140 LET ZV=SIN(STV(5)/RAD1)
3150 LET CCT=COS(GTH/RAD1)
3160 LET XT=CCT*SIN(ATH/RAD1)
3170 LET YT=CCT*COS(ATH/RAD1)
3180 LET ZT=SIN(GTH/RAD1)
3190 LET ATAK=FNARCOS(XV*XT+YV*YT+ZV*ZT)*RAD1
3200 END SUB
3510 SUB BDYPRT(X,Y,Z,DJ,XDD,YDD,ZDD,NPRT)
3520 REM COMPUTES PERTURBING ACCELERATIONS XDD,YDD,ZDD DUE TO SUN(MPRT=1) OR M(
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3530 REM NPRT=2) GIVEN X,Y,Z AND JULEAN DATE DJ NEEDS SUBROUTINES SUNMES AND LU
3550 REM DATA CMUS=1.32712499D11, CMUM=4902.78
3555 LET CMUS=1.327122499E+11
3556 LET CMUM=4902.78
3560 IF (NPRT=1) THEN CALL SUNMEL(DJ,XX,YY,ZZ)
3570 IF (NPRT=2) THEN CALL LUNEPH(DJ,XX,YY,ZZ)
3580 LET RR2=XX*XX+YY*YY+ZZ*ZZ
3590 LET RR3=RR2*SQR(RR2)
3600 LET XP=X-XX
3610 LET YP=Y-YY
3620 LET ZP=Z-ZZ
3630 LET RP2=XP*XP+YP*YP+ZP*ZP
3640 LET RP3=RP2*SQR(RP2)
3650 IF (NPRT=1) THEN LET CM=CMUS
3660 IF (NPRT=2) THEN LET CM=CMUM
3670 LET XDD=-CM*(XP/RP3+XX/RR3)
3680 LET YDD=-CM*(YP/RP3+YY/RR3)
3690 LET ZDD=-CM*(ZP/RP3+ZZ/RR3)
3700 END SUB
4010 SUB DRKGS (PRMT(),YY1(),DERY(),NDIM,IHLF,AUX(,))
4031 DECLARE PUBLIC TWOPI,RAD1,PI1
4032 DIM AA1(4),BB1(4),CC1(4)
4060 FOR I=1 TO NDIM
4065   LET AUX(8,I) =6.666666666666667E-2*DERY(I)
4070 NEXT I
4071 LET X=PRMT(1)
4072 LET XEND=PRMT(2)
4073 LET H=PRMT(3)
4090 LET PRMT(5)=0
4100 CALL FCT(X,YY1(),DERY())
4101 LET TEMPA=H*(XEND-X)
4110 IF (TEMPA<0) THEN GOTO 5410
4120 IF (TEMPA=0) THEN GOTO 5390
4130 IF (TEMPA>0) THEN GOTO 4140
4140 LET AA1(1)=.5
4141 LET AA1(2)=.2928932188134525
4150 LET AA1(3)=1.707106781186547
4151 LET AA1(4)=.1666666666666667
4160 LET BB1(1)=2
4161 LET BB1(2)=1
4162 LET BB1(3)=1
4163 LET BB1(4)=2
4170 LET CC1(1)=.5
4171 LET CC1(2)=.2928932188134525
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4172 LET CC1(3)=1.707106781186547
4173 LET CC1(4)=.5
4190 FOR I=1 TO NDIM
4200  LET AUX(1,I)=YY1(I)
4210  LET AUX(2,I)=DERY(I)
4220  LET AUX(3,I)=0
4230  LET AUX(6,I)=0
4240 NEXT I
4250 LET IREC=0
4251 LET H=H+H
4252 LET IHLF=-1
4253 LET ISTEP=0
4260 LET IEND=0
4270 LET TEMPA=(X+H-XEND)*H
4280 IF (TEMPA<0) THEN GOTO 4330
4290 IF (TEMPA=0) THEN GOTO 4320
4300 IF (TEMPA>0) THEN GOTO 4310
4310 LET H=XEND-X
4320 LET IEND=1
4330 CALL OUTP(X,YY1(),DERY(),IREC,NDIM,PRMT())
4340 IF (PRMT(5)<0) THEN EXIT SUB
4350 IF (PRMT(5)=0) THEN GOTO 4365
4360 IF (PRMT(5)>0) THEN EXIT SUB
4365 LET ITEST=0
4370 LET ISTEP=ISTEP+1
4380 LET J=1
4390 LET AJ=AA1(J)
4391 LET BJ=BB1(J)
4392 LET CJ=CC1(J)
4400 FOR I=1 TO NDIM
4421  LET R1=H*DERY(I)
4422  LET R2=AJ*(R1-BJ*AUX(6,I))
4430  LET YY1(I)=YY1(I)+R2
4440  LET R2=R2+R2+R2
4450  LET AUX(6,I)=AUX(6,I)+R2-CJ*R1
4460 NEXT I
4470 LET TEMPA=J-4
4480 IF (TEMPA<0) THEN 4510
4490 IF (TEMPA=0) THEN 4590
4500 IF (TEMPA>0) THEN 4590
4510 LET J=J+1
4520 LET TEMPB=J-3
4530 IF (TEMPB<0) THEN GOTO 4560
4540 IF (TEMPB=0) THEN GOTO 4570
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4550 IF (TEMPB>0) THEN GOTO 4560
4560 LET X=X+.5*H
4570 CALL FCT(X,YY1(),DERY())
4580 GOTO 4390
4590 IF (ITEST<0) THEN GOTO 4620
4600 IF (ITEST=0) THEN GOTO 4620
4610 IF (ITEST>0) THEN GOTO 4740
4620 FOR I=1 TO NDIM
4621   LET AUX(4,I)=YY1(I)
4622 NEXT I
4630 LET ITEST=1
4640 LET ISTEP=ISTEP+ISTEP-2
4650 LET IHLF=IHLF+1
4660 LET X=X-H
4670 LET H=.5*H
4680 FOR I=1 TO NDIM
4690  LET YY1(I)=AUX(1,I)
4700  LET DERY(I)=AUX(2,I)
4710  LET AUX(6,I)=AUX(3,I)
4720 NEXT I
4730 GOTO 4370
4740 LET IMOD=SGN(ISTEP/2)*INT(ISTEP/2)
4750 LET TEMPA=ISTEP-IMOD-IMOD
4760 IF (TEMPA<0) THEN GOTO 4790
4770 IF (TEMPA=0) THEN GOTO 4850
4780 IF (TEMPA>0) THEN GOTO 4790
4790 CALL FCT(X,YY1(),DERY())
4800 FOR I=1 TO NDIM
4810  LET AUX(5,I)=YY1(I)
4820  LET AUX(7,I)=DERY(I)
4830 NEXT I
4840 GOTO 4370
4850 LET DELT=0
4860 FOR I=1 TO NDIM
4863   LET DELT=DELT+AUX(8,I)*ABS(AUX(4,I)-YY1(I))
4867 NEXT I
4870 LET TEMPB=DELT-PRMT(4)
4880 IF (TEMPB<0) THEN GOTO 4990
4890 IF (TEMPB=0) THEN GOTO 4990
4900 IF (TEMPB>0) THEN GOTO 4910
4910 LET TEMPA=IHLF-10
4920 IF (TEMPA<0) THEN GOTO 4950
4930 IF (TEMPA>=0) THEN GOTO 5360
4950 FOR I=1 TO NDIM
```

```
4953  LET AUX(4,I)=AUX(5,I)
4957 NEXT I
4960 LET ISTEP=ISTEP+ISTEP-4
4970 LET X=X-H
4971 LET IEND=0
4980 GOTO 4650
4990 CALL FCT(X,YY1(),DERY())
5000 FOR I=1 TO NDIM
5010  LET AUX(1,I)= YY1(I)
5020  LET AUX(2,I)=DERY(I)
5030  LET AUX(3,I)=AUX(6,I)
5040  LET YY1(I)=AUX(5,I)
5050  LET DERY(I)=AUX(7,I)
5060 NEXT I
5070 CALL OUTP((X-H),YY1(),DERY(),IHLF,NDIM,PRMT())
5080 IF (PRMT(5)<0) THEN EXIT SUB
5090 IF (PRMT(5)=0) THEN GOTO 5110
5100 IF (PRMT(5)>0) THEN EXIT SUB
5110 FOR I=1 TO  NDIM
5120  LET YY1(I)=AUX(1,I)
5130  LET DERY(I)=AUX(2,I)
5140 NEXT I
5150 LET IREC=IHLF
5160 IF (IEND<0) THEN GOTO 5190
5170 IF (IEND=0) THEN GOTO 5190
5180 IF (IEND>0) THEN GOTO 5420
5190 LET IHLF=IHLF-1
5200 LET ISTEP=SGN(ISTEP/2)*INT(ISTEP/2)
5201 LET H=H+H
5210 IF (IHLF<0) THEN GOTO 4270
5220 IF (IHLF=0) THEN GOTO 5240
5230 IF (IHLF>0) THEN GOTO 5240
5240 LET IMOD=SGN(ISTEP/2)*INT(ISTEP/2)
5250 LET TEMPA=ISTEP-IMOD-IMOD
5260 IF (TEMPA<0) THEN GOTO 4270
5270 IF (TEMPA)=0 THEN GOTO 5290
5280 IF (TEMPA)>0 THEN GOTO 4270
5290 LET TEMPB=DELT-.02*PRMT(4)
5300 IF (TEMPB<=0) THEN GOTO 5330
5310 IF (TEMPB>0)  THEN GOTO 4270
5330 LET IHLF=IHLF-1
5340 LET ISTEP=SGN(ISTEP/2)*INT(ISTEP/2)
5341 LET H=H+H
5350 GOTO 4270
```

```
5360 LET IHLF=11
5370 CALL FCT(X,YY1(),DERY())
5380 GOTO 5420
5390 LET IHLF=12
5400 GOTO 5420
5410 LET IHLF=13
5420 CALL OUTP(X,YY1(),DERY(),IHLF,NDIM,PRMT())
5430 END SUB
6005 SUB DRGACC (YY1(),XDD,YDD,ZDD)
6010 REM CALCULATES ACCELERATIONX XDD,YDD,ZDD, DUE TO DRAG GIVEN RECTANGULAR
6021 REM COORDINMATE STATE BECTOR YY1(X,Y,Z,XD,YD,ZD)
6030 REM NEEDS LUBROUTINES LONGRA, DRAGB, DRAGC, DRAGD
6031 DECLARE PUBLIC RAD1,PI1
6032 DECLARE PUBLIC GZERO,RE,CMU,DJ,TWOPI,CAPLAT,CAPLNG,CAPHT,SLAT(),SLONG(),SI
6033 DECLARE PUBLIC XPRINT,CNMI,CFPS,B,F10,AP,ERATE,TIGN,TBO,STWT,FLOW,THX,THY,
6034 DECLARE PUBLIC WT,ACCEL,VEARTH,VIMF,GTDOT,ATDOT,VLOSS,CMACH,QH,ATAKP,ATAK
6035 DECLARE PUBLIC IUNIT,ITRK,ICRASH,MSUN,MMOON,MOBL,MDRAG,MTHRUSR,I62
6036 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
6051 LET CMACH=0
6070 LET SRAD=SQR(YY1(1)*YY1(1)+YY1(2)*YY1(2)+YY1(3)*YY1(3))
6080 LET SLA=FNARSIN(YY1(3)/SRAD)*RAD1
6090 IF YY1(1)<0 THEN LET RA=ATN(YY1(2)/YY1(1))+PI1
6091 IF YY1(1)>=0 AND YY1(2)<0 THEN LET RA=ATN(YY1(2)/YY1(1))+TWOPI
6092 IF YY1(1)>=0 AND YY1(2)>=0 THEN LET RA=ATN(YY1(2)/YY1(1))
6100 CALL LONGRA(RA,ALONG,DJ)
6110 LET SLON=ALONG*RAD1
6120 CALL DRAGB(SRAD,SLA,SLON,DJ,F10,AP,D,I62)
6130 LET D=D*1E+09
6140 LET VEX=YY1(4)+ERATE*YY1(2)
6150 LET VEY=YY1(5)-ERATE*YY1(1)
6160 LET VEARTH=SQR(VEX*VEX+VEY*VEY+YY1(6)*YY1(6))
6170 LET CC=-B*D*VEARTH
6180 CALL VSOUND(SRAD,SLA,VS)
6190 IF (VS<.001) THEN GOTO 6210
6200 LET CMACH=VEARTH/VS
6210 LET Q=D*VEARTH*VEARTH*10442.683
6220 LET XDD=CC*VEX
6230 LET YDD=CC*VEY
6240 LET ZDD=CC*YY1(6)
6250 END SUB
7005 SUB DRAGE (R,GEOC,D)
7010 REM DENSITY OYTPUT IN KG/METER3;TABLE NORMALIZED TO DENSITY AT 0 AL
7020 DIM DENS(100)
7030 LET DENS(1)=1
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7031 LET DENS(2)=.60117
7032 LET DENS(3)=.33756
7033 LET DENS(4)=.15898
7034 LET DENS(5)=.072579
7040 LET DENS(6)=.032722
7041 LET DENS(7)=.015029
7042 LET DENS(8)=.0069089
7043 LET DENS(9)=.0032618
7044 LET DENS(10)=.0016051
7050 LET DENS(11)=8.3827E-04
7051 LET DENS(12)=4.5776E-04
7052 LET DENS(13)=2.4973E-04
7053 LET DENS(14)=1.3604E-04
7054 LET DENS(15)=7.1457E-05
7060 LET DENS(16)=3.538E-05
7061 LET DENS(17)=1.632E-05
7062 LET DENS(18)=6.494E-06
7063 LET DENS(19)=2.588E-06
7064 LET DENS(20)=9.8859
7070 LET DENS(21)=4.06E-07
7071 LET DENS(22)=1.728E-07
7072 LET DENS(23)=.00000008024
7073 LET DENS(24)=.00000003774
7074 LET DENS(25)=.00000001988
7075 LET DENS(26)=.00000001041
7076 LET DENS(27)=.000000006195
7077 LET DENS(28)=.000000004017
7078 LET DENS(29)=.00000000277
7079 LET DENS(30)=.000000002001
7080 LET DENS(31)=.000000001498
7081 LET DENS(32)=.000000001181
7082 LET DENS(33)=.0000000009459
7083 LET DENS(34)=.0000000007845
7084 LET DENS(35)=.000000000656
7085 LET DENS(36)=.0000000005588
7086 LET DENS(37)=.0000000004782
7087 LET DENS(38)=4.111E-8
7088 LET DENS(39)=.0000000003548
7089 LET DENS(40)=.0000000003069
7090 LET DENS(41)=.0000000002708
7091 LET DENS(42)=.0000000002375
7092 LET DENS(43)=.0000000002088
7093 LET DENS(44)=.000000000184
7094 LET DENS(45)=.0000000001625
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7095 LET DENS(46)=.0000000001439
7096 LET DENS(47)=.0000000001277
7097 LET DENS(48)=.0000000001138
7098 LET DENS(49)=.0000000001017
7099 LET DENS(50)=9.09199999999E-11
7100 LET DENS(51)=.00000000008145
7101 LET DENS(52)=.00000000007308
7102 LET DENS(53)=.00000000006566
7103 LET DENS(54)=.00000000005908
7104 LET DENS(55)=.00000000005323
7105 LET DENS(56)=.00000000004802
7106 LET DENS(57)=.0000004339
7107 LET DENS(58)=.00000000003925
7108 LET DENS(59)=.00000000003554
7109 LET DENS(60)=.00000000002926
7110 LET DENS(61)=.00000000002429
7111 LET DENS(62)=.00000000002024
7112 LET DENS(63)=.00000000001692
7113 LET DENS(64)=.00000000001420
7114 LET DENS(65)=.00000000001196
7115 LET DENS(66)=.00000000001010
7116 LET DENS(67)= 8.561E-2
7117 LET DENS(68)=.000000000007277
7118 LET DENS(69)=.000000000006204
7119 LET DENS(70)=.000000000005305
7120 LET DENS(71)=.000000000004562
7121 LET DENS(72)=.000000000003932
7122 LET DENS(73)=.000000000003396
7123 LET DENS(74)=.000000000002939
7124 LET DENS(75)=.000000000002549
7125 LET DENS(76)=.000000000002215
7126 LET DENS(77)=.000000000001920
7127 LET DENS(78)=.000000000001682
7128 LET DENS(79)=.000000000001470
7129 LET DENS(80)=.000000000001287
7130 LET DENS(81)=.000000000001133
7131 LET DENS(82)=9.983E-13
7132 LET DENS(83)=.0000000000008808
7133 LET DENS(84)=.0000000000007781
7134 LET DENS(85)=.0000000000006881
7135 LET DENS(86)=.0000000000006093
7136 LET DENS(87)=.0000000000005401
7137 LET DENS(88)=.0000000000004793
7138 LET DENS(89)=.0000000000004258
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7139 LET DENS(90)=.0000000000003797
7140 LET DENS(91)=.0000000000003380
7141 LET DENS(92)=.0000000000003018
7142 LET DENS(93)=.0000000000002697
7143 LET DENS(94)=.0000000000002412
7144 LET DENS(95)=.0000000000002159
7145 LET DENS(96)=.0000000000001934
7146 LET DENS(97)=.0000000000001734
7147 LET DENS(98)=.0000000000001556
7148 LET DENS(99)=.0000000000001397
7150 LET DENS(100)=.0000000000001255
7200 LET DZ=5
7210 CALL GEODHT(R,GEOC,Z,GEOD,0)
7220 IF (Z>=700) THEN GOTO 7310
7230 IF (Z>=2900)  THEN LET DZ=10
7240 LET ZMZL=MOD(Z,DZ)
7250 LET ZL=Z-ZMZL
7260 LET IL=SGN(ZL/DZ)*INT(ZL/DZ)+1
7270 IF (Z>=2900) THEN LET IL=IL+29
7272 IF IL>=100 THEN 7300
7280 LET D=ZMZL/DZ*(DENS(IL+1)-DENS(IL))+DENS(IL)
7290 LET D=D*1.225
7300 EXIT SUB
7310 LET D=0
7320 END SUB
8010 SUB GEODHT(R,GEOC,H,GEOD,IAC)
8020 REM THIS SUBROUTINE DETERMINES GEODETIC ALTITUDE AND DEODETIC
8030 REM LATITUDE GIVEN GEOCENTRIC RADIUS AND LATITUDE
8031 DECLARE PUBLIC RAD1
8040 LET ITER=0
8060 LET A=6378.16
8070 LET B=6356.77472
8080 LET ES=1-B*B/A/A
8090 LET C=A*ES/B
8100 REM PRINT IS GEOCENTRIC RADIUS R AND LATITUDE GEOC. FOR IAC=0, CALCULATIO
8110 REM GEOD, THE GEODETIC LATITUDE, AND H, GEODETIC HEIGHT IS APPTOXIMATE CL
8120 REM IAC=1 SOLUTION IS BY ITERATION UNIIL CORRECTION IS LESS THAN ER.
8121 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
8140 LET ER=.0000002
8150 LET GEOCR=GEOC/RAD1
8160 IF (GEOC=0) THEN GOTO 8330
8170 IF (IAC>0) THEN GOTO 8220
8180 LET SS=SIN(2*GEOCR)
8190 LET CC=COS(2*GEOCR)
```

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8200 LET GEOD=GEOCR+C/2*SS*(1+ES/4*(1-CC))/(1-C*CC)
8210 GOTO 8300
8220 LET GEOD=GEOCR
8230 LET SIG=SIN(GEOD)
8240 LET GEODN=GEOC+FNARSIN(C*SIG*COS(GEOD)/SQR(1-ES*SIG*SIG))
8250 LET DELT = ABS(GEODN-GEOD)
8260 LET ITER=ITER+1
8270 IF ITER>50 THEN GOTO 8300
8280 LET GEOD=GEODN
8290 IF (DELT>ER) THEN GOTO 8230
8300 LET SIG=SIN(GEOD)
8310 LET H=R*SIN(GEOCR)/SIG-A*(1-ES)/SQR(1-ES*SIG*SIG)
8320 EXIT SUB
8330 LET GEOD=0
8340 LET H=R-A
8350 END SUB
8510 SUB GRANGE (STV(), CLAT, CLONG, RANGE)
8520 REM THIS SUBROUTINE CALCULATES THE GROUND RANGE IN KM FROM AN INTIAL POIN
8530 REM (LATITUDE=CLAT, LONGITUDE=CLONG,DEGRTEES) GIVEN STATE VECTOR STV, GRO
8540 REM RANGE IS DEFINED AS GREAT CIRCLE DISTANCE(<=180 DEG) OVER A SPHERE OF
8670 DECLARE PUBLIC RAD1,PIOV2
8671 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
8672 LET REV=6371.02
8690 IF (CLONG<0) THEN LET CLONG=CLONG+360
8700 IF (STV(3)<0) THEN LET STV(3)=STV(3)+360
8710 LET RANGE=REV*FNARCOS(SIN(CLAT/RAD1)*SIN(STV(2)/RAD1)+COS(CLAT/RAD1)*COS(
8720 END SUB
9010 SUB KEPEON(AM,E,EC,KFAIL)
9025 LET J,KFAIL=0
9040 IF E>=1 THEN GOTO 9170
9050 LET L=1
9060 LET EC=AM
9070 LET SE=SIN(EC)
9080 LET CE=COS(EC)
9090 IF (L<>1) THEN 9160
9100 LET DAM=EC-E*SE-AM
9110 IF (ABS(DAM)<=.000004) THEN LET L=2
9120 LET EC=EC-DAM/(1-E*CE)
9130 LET J=J+1
9140 IF (J<=20) THEN GOTO 9070
9150 LET KFAIL=1
9160 EXIT SUB
9170 LET F=AM
9180 LET EF=EXP(F)
```

```
9190 LET SHF=(EF-1/EF)/2
9200 LET CHF=(EF+1/EF)/2
9210 LET AMM=E*SHF-F
9220 LET DELT=AMM-AM
9230 IF (ABS(DELT)<=.0000004) THEN EXIT SUB
9240 LET F=F-DELT/(E*CHF-1)
9250 IF (J>=20) THEN 9280
9260 LET J=J+1
9270 GOTO 9070
9280 LET KFAIL=1
9290 END SUB
9510 SUB LONGRA(RA,ALONG,DJ)
9520 REM THIS ROUTINE COMPUTES THE ONIGITUDE OF A POINT WITH RIGHR
9530 REM ASCENSION RA AT TIME DJ JULOAN DAYS(TRUE OF DATE EQUINOX)
9531 DECLARE PUBLIC TWOPI
9550 LET DJX=DJ-2400000.5
9560 LET RAGR=1.722186613+.0172027913*(DJX-36933)+TWOPI*(DJX-SGN(DJX)*INT(DJX))
9570 LET RAGR=MOD (RAGR,TWOPI)
9589 LET ALONG=RA-RAGR
9590 LET PIM=-TWOPI/2
9600 IF (ALONG<PIM) THEN LET ALONG=ALONG+TWOPI
9610 END SUB
10010 SUB OBL(X,Y,Z,XDD,YDD,ZDD,NTERM)
10020 REM CALCULATES THE ACCELERATIONS XDD,YDD,ZDD,DUE TO DELATENESS(TERMS UP T
10030 REM INCLUDING F(NTERM), NTERM MAX OF 5) GIVEN RECTANGULAR COORDINATES X,Y
10050 REM DATA 390601.2D0,6378.16D0, 1.0827D-3,-2.546D-6,-1.649D-6,-.21D-6
10052 LET CMU=398601.2
10053 LET RE=6378.16
10054 LET CJ2=.0010827
10057 LET CJ3=-2.546E-06
10058 LET CJ4=-1.649E-06
10059 LET CJ5=-2.1E-07
10060 LET R=SQR(X*X+Y*Y+Z*Z)
10070 LET RR=RE/R
10080 LET RR2=RR*RR
10090 LET RR3=RR*RR2
10100 LET ZR=Z/R
10110 LET ZR2=ZR*ZR
10120 LET ZR4=ZR2*ZR2
10130 LET XDD=CJ2*RR2*(1.5-7.5*ZR2)
10140 LET ZDD=CJ2*RR2*(4.5-7.5*ZR2)*ZR
10150 IF (NTERM<3) THEN GOTO 10240
10160 LET XDD=XDD+CJ3*ZR*RR3*(7.5-17.5*ZR2)
10170 LET ZDD=ZDD+CJ3*RR3*(-1.5+15*ZR2-17.5*ZR4)
```

```
10180 IF (NTERM<4) THEN GOTO 10240
10190 LET XDD=XDD+CJ4*RR*RR3*(-1.875+26.25*ZR2-39.375*ZR4)
10200 LET ZDD=ZDD+CJ4*RR*RR3*(-9.375+43.75*ZR2-39.375*ZR4)*ZR
10210 IF (NTERM<5) THEN GOTO 10240
10220 LET XDD=XDD+CJ5*RR2*RR3*ZR*(-86.625*ZR4+78.75*ZR2-13.125)
10230 LET ZDD=ZDD+CJ5*RR2*RR3*(1.875-39.375+118.125*ZR4-86.625*ZR4*ZR2)
10240 LET R3=CMU/R^3
10250 LET YDD=-XDD*Y*R3
10260 LET XDD=-XDD*X*R3
10270 LET ZDD=-ZDD*R*R3
10280 END SUB
10290
10500
10510 SUB RADARD(ST(),SLAT,SLONG,SHT,ELEV,AZ,RANGE)
10530 REM THIS SUBROOUTINE DETERMINES THE ELEVATION,AZIMUTH AND RAMGE OF A SATI
10540 REM OF STATE VECTOR ST RELATIVE TO THE GEODETIC GORIZONTAL PLANE WITH OR
10550 REM GGIVEN TRACKING STATION GEODETEC LATITUDE SLAT, LONGITUDE SLONG, AND
10560 REM (NORMAL TO THE ELLIPSOID) SHT
10571 DECLARE PUBLIC RAD1
10572 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
10590 LET A=6378.16
10600 LET B=6356.77472
10610 LET BA=B/A
10620 LET BAA=BA*BA
10630 LET XX=ST(1)*COS(ST(2)/RAD1)
10640 LET XECI=XX*COS(ST(3)/RAD1)
10650 LET YECI=XX*SIN(ST(3)/RAD1)
10660 LET ZP=ST(1)*SIN(ST(2)/RAD1)
10670 LET RL=SLAT/RAD1
10680 LET RLN=SLONG/RAD1
10690 LET S=SIN(RL)
10700 LET SN=SIN(RLN)
10710 LET C=COS(RL)
10720 LET CN=COS(RLN)
10730 LET TN=SN/CN
10740 LET XPP=-SN*XECI+CN*YECI
10750 LET DD=SQR(1+BAA*TN*TN)
10760 LET YP=-CN*XECI-SN*YECI+A*(1-BAA)/DD
10770 LET YPP=S*YP+C*ZP
10780 LET ZPP=-C*YP+S*ZP-BA*B/C/DD
10790 LET RANGE=SQR(XPP*XPP+YPP*YPP+ZPP*ZPP)
10800 LET ELEV=FNARSIN(ZPP/RANGE)
10810 LET AZ=450-ATN(YPP/XPP)*RAD1
10820 IF (AZ>=360) THEN LET AZ=AZ-360
```

```
10830 END SUB
10900
11000
11010 SUB RTASCN(DJ,ALONG,RAX)
11020 REM THIS ROUTINE COMPUTES THE TIGHT ASCINSION OF A POINT WITH LONGITUDE A
11030 REM AT TIMEE DJ JULIAN DAYS(TRUE OF DATE EQUINOX)
11031 DECLARE PUBLIC TWOPI,PI1
11032 REM THESE CALCULATIONS EFFECT VALUES OF X,Y,Z,XDOT,YDOT,ZDOT
11050 LET DJX=DJ-2400000.5
11060 LET RAGR=1.72218613+.0172027913*(DJX-36933)+TWOPI*(DJX-SGN(DJX)*INT(DJX))
11078 LET RAGR=RAGR-TWOPI*(SGN(RAGR/TWOPI)*INT(RAGR/TWOPI))
11090 LET RAX=RAGR+ALONG
11094 IF (RAX>PI1) THEN LET RAX=RAX-TWOPI
11100 END SUB
11500
11510 SUB RTOXYZ(T(),X(),DJ)
11520 REM CONVERT T(RADIUS.LAT,LONG,BELOCITU,GAMMA,AZZIMUTH)TO X(X,Y,Z,XDOT,YDO
11530 REM AT TIME DJ JULIAN DAYS NEEDS SUBROUTINE RTASCN
11545 DECLARE PUBLIC RAD1
11570 LET TLT=T(2)/RAD1
11580 LET TLN=T(3)/RAD1
11590 LET TG=T(5)/RAD1
11600 LET TA=T(6)/RAD1
11610 LET CLT=COS(TLT)
11620 LET SLT=SIN(TLT)
11630 LET CG=COS(TG)
11640 CALL RTASCN(DJ,TLN,RA)
11650 LET SRA=SIN(RA)
11660 LET CRA=COS(RA)
11670 LET X(1)=T(1)*CLT*CRA
11680 LET X(2)=T(1)*CLT*SRA
11690 LET X(3)=T(1)*SLT
11700 LET XDT=T(4)*CG*SIN(TA)
11710 LET YDT=T(4)*CG*COS(TA)
11720 LET ZDT=T(4)*SIN(TG)
11730 LET X(4)=-SRA*XDT-CRA*SLT*YDT+CRA*CLT*ZDT
11740 LET X(5)=CRA*XDT-SRA*SLT*YDT+SRA*CLT*ZDT
11750 LET X(6)=CLT*YDT+SLT*ZDT
11760 END SUB
11780
12000
12010 SUB SUNMEL (DJ,X,Y,Z)
12020 REM THIS SUBROUTINE GIVES APPROXIMATE X,Y,Z OF THE SUN RELATIVE TO EARTH
12030 REM MEAN ELEMENTS OF THE EARTH EARYCENTER
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12031 DECLARE PUBLIC RAD1,PIOV2
12032 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
12050 LET T=(DJ-2415020)/36525
12060 LET TT=T*T
12070 LET A=1.00000023
12080 LET E=.016751-.0000418*T-1.26E-07*TT
12090 LET AM=358.476+359.049*T-.00015*TT-3.3333E-06*T*TT
12100 LET RAM=99*T
12110 LET RAM=MOD(RAM,1)*360
12120 LET AM=AM+RAM
12130 LET AM=MOD(AM,360)
12140 LET AMR=AM/RAD1
12150 LET AW=101.220833+1.719175*T+.000452777778*TT+.0000033333333*T*TT
12160 LET AW=MOD(AW,360)
12170 LET AI=23.452294-.0130125*T-.00000164*TT
12180 CALL KEPEON(AMR,E,EC,KFAIL)
12190 LET CEC=COS(EC)
12200 LET R=A*(1-E*CEC)
12210 LET TH=FNARCOS(A/R*(CEC-E))
12220 IF (AM>180) THEN LET TH=6.28318531-TH
12230 LET AIR=AI/RAD1
12240 LET ARG=AW/RAD1+TH
12250 LET SARG=SIN(ARG)
12260 LET CAU=140598500
12270 LET X=-R*COS(ARG)*CAU
12280 LET Y=-R*COS(AIR)*SARG*CAU
12290 LET Z=-R*SARG*SIN(AIR)*CAU
12300 END SUB
12500
12510 SUB TOPECI(V,G,A,RA,DEC,X,Y,Z)
12520 REM THIS SUBROUTINE TRANSFORMS A POLAR TOPOCENTRIC VECTOR(MAGNITDE V,ELE\
12530 REM AZIMUTH A) WITH TOPECENTRIC ORIGIN AT RT ASC RA AND DECLONATION DEC :
12540 REM ECI(X,Y,Z,)
12541 DECLARE PUBLIC RAD1
12560 LET GR=G/RAD1
12570 LET AR=A/RAD1
12580 LET RAR=RA/RAD1
12590 LET DECR=DEC/RAD1
12600 LET CG=COS(GR)
12610 LET XP=V*CG*SIN(AR)
12620 LET YP=V*CG*COS(AR)
12630 LET ZP=V*SIN(GR)
12640 LET SA=SIN(RAR)
12650 LET CA=COS(RAR)
```

```
12660 LET SD=SIN(DECR)
12670 LET CD=COS(DECR)
12680 LET X=-SA*XP-CA*SD*YP+CA*CD*ZP
12690 LET Y=CA*XP-SA*SD*YP+SA*CD*ZP
12700 LET Z=CD*YP+SD*ZP
12710 END SUB
13000
13010 SUB VSOUND(RSAT,GEOC,VS)
13020 REM VSOUND DETERMINES THE SPEED OF SOUND VS(KPS) AT GEOCENTRIC RADIUS
13030 REM RSATBASED ON THE 62 US STD ATMOSPHERE
13032 DIM AA1(9)
13050 REM DATA 2.824793081D2,-5.240572992D0,-.1266060595. 1.873293836D02,-5.10
13051 LET AA1(1)=282.4793081
13052 LET AA1(2)=-5.240572992
13053 LET AA1(3)=-.1266010595
13054 LET AA1(4)=.01873293836
13055 LET AA1(5)=-5.104746533E-4
13056 LET AA1(6)=6.050186406E-06
13057 LET AA1(7)=-3.550162735E-08
13058 LET AA1(8)=1.014102927E-10
13059 LET AA1(9)=-1.1244449619E-13
13060 IF (RSAT>6528.16) THEN GOTO 13160
13070 CALL GEODHT(RSAT,GEOC,Z,GEOD,0)
13080 LET TM=AA1(1)
13090 LET Q=1
13100 FOR I=1 TO 8
13110 LET Q=Q*Z
13120 LET TM=TM+AA1(I+1)*Q
13130 NEXT I
13140 LET VS=SQR(.4018743*ABS(TM))
13150 MAT AA1=0
13151 EXIT SUB
13160 LET VS=0
13161 MAT AA1=0
13171 END SUB
13500
13510 SUB FCT(X,YY1(),DERY())
13520 REM FORCE EQUATIONS FIR IRBITAK FKUGGT, IOTUIBS ARE SYB*NSYB-1),CONSTAMT
13530 REM (MTNRST-1) NEEDS SUBROUTINES BDYPRT,DEL,DRGACC,TOPECI,LONGRA,DRAGB,SU
13540 REM LUNEPH,DRAGC,DRAGD
13570 DECLARE PUBLIC GZERO,RE,CMU,DJ,TWOPI,CAPLAT,CAPLNG,CAPHT,SLAT(),SLONG(),S
13571 DECLARE PUBLIC XPRINT,CNMI,CFPS,B,F10,AP,ERATE,TIGN,TBO,STWT,FLOW,THX,TH
13575 DECLARE PUBLIC ATH,WT,ACCEL,VEARTH,VIMP,GTDOT,ATDOT,VLOSS,CMACH,QH,ATAKP,
13577 DECLARE PUBLIC Q,QA,DZ,ITHR,IUNIT,ITRK,ICRASH,MSUN,MMOON,MOBL,MDRAG,MTHR
```

```
13578 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
13580 LET XX=YY1(1)
13590 LET YY=YY1(2)
13600 LET ZZ=YY1(3)
13610 LET DJ=X/86400 +DZ
13620 LET DERY(1)=YY1(4)
13630 LET DERY(2)=YY1(5)
13640 LET DERY(3)=YY1(6)
13650 LET R2=XX*XX+YY*YY+ZZ*ZZ
13660 LET R=SQR(R2)
13670 LET CR3=-CMU/R2/R
13680 LET DERY(4)=CR3*XX
13690 LET DERY(5)=CR3*YY
13700 LET DERY(6)=CR3*ZZ
13710 IF (MSUN<1) THEN GOTO 13760
13720 CALL BDYPRT(XX,YY,ZZ,DJ,XDD,YDD,ZDD,1)
13730 LET DERY(4)=DERY(4)+XDD
13740 LET DERY(5)=DERY(5)+YDD
13750 LET DERY(6)=DERY(6)+ZDD
13760 IF (MMOON<1) THEN 13810
13770 CALL BDYPRT(XX,YY,ZZ,DJ,XDD,YDD,ZDD,2)
13780 LET DERY(4)=DERY(4)+XDD
13790 LET DERY(5)=DERY(5)+YDD
13800 LET DERY(6)=DERY(6)+ZDD
13810 IF (MOBL<1) THEN GOTO 13860
13820 CALL OBL(XX,YY,ZZ,XDD,YDD,ZDD,MOBL)
13830 LET DERY(4)=DERY(4)+XDD
13840 LET DERY(5)=DERY(5)+YDD
13850 LET DERY(6)=DERY(6)+ZDD
13860 IF (MDRAG<1) THEN GOTO 13910
13870 CALL DRGACC(YY1(),XDD,YDD,ZDD)
13880 LET DERY(4)=DERY(4)+XDD
13890 LET DERY(5)=DERY(5)+YDD
13900 LET DERY(6)=DERY(6)+ZDD
13910 IF (MTHRST<1) THEN GOTO 13975
13915 IF (X<TIGN)OR(X>TBO) THEN GOTO 13975
13920 IF (ITHR>0) THEN GOTO 13945
13925 LET ITHR=1
13930 IF XX<0 THEN LET RA=ATN(YY/XX)+PI1
13931 IF XX>=0 AND YY<0 THEN LET RA=ATN(YY/XX)+TWOPI
13932 IF XX>=0 AND YY>=0 THEN LET RA=ATN(YY/XX)
13935 LET DEC=FNARSIN(ZZ/R)
13940 CALL TOPECI(THR,GTH,ATH,RA,DEC,THX,THY,THZ)
13945 LET WT=STWT-(X-TIGN)*FLOW
```

```
13950 LET CMASS=WT/GZERO
13955 LET VIMF=32.174048556*THR/FLOW*LOG(STWT/WT)
13960 LET DERY(4)=DERY(4)+THX/CMASS
13965 LET DERY(5)=DERY(5)+THY/CMASS
13970 LET DERY(6)=DERY(6)+THZ/CMASS
13975 IF (THR=0) THEN GOTO 13985
13980 LET ACCEL=(XDD*THX+YDD*THY+ZDD*THZ)/THR
13985 END SUB
14000
14010 SUB GJDATE(TJULDA,YEAR(),MM)
14020 REM IF MM=0,OUTPUT IS JULIAN DATE, IF MM=1,OUTPUT IS YEAR,MONTH,DAT,HOUT,
14031 DECLARE PUBLIC MONDD(),MONTH()
14040 DIM ITIME(6)
14120 IF (MM=0) THEN GOTO 14570
14130 LET IYEAR=1952
14140 LET IDAY=TJULDA-2434011.5
14150 IF (IDAT>0) THEN GOTO 14210
14160 LET IYEAR=IYEAR-4
14170 LET IDAY=IDAY+1461
14180 IF (IDAY<0) THEN GOTO 14160
14190 IF (IDAY>=0) THEN GOTO 14240
14210 LET I=SGN(IDAY/1461)*INT(IDAY/1461)
14220 LET IYEAR=IYEAR+I*4
14230 LET IDAY=IDAY-I*1461
14240 LET MONTH(2)=29
14250 LET I=IDAY-366
14260 IF (I<0) THEN GOTO 14330
14270 LET MONTH(2)=28
14280 LET IDAY=I
14290 LET IYEAR=IYEAR+1
14300 LET I=SGN(IDAY/365)*INT(IDAY/365)
14310 LET IDAY=IDAY-I*365
14320 LET IYEAT=IYEAR+I
14330 LET IMONTH=0
14340 LET J=IDAY
14350 FOR I=1 TO 12
14360   IF (J<=0) THEN GOTO 14410
14370   LET IDAY=J
14380   LET IMONTH=IMONTH+1
14390   LET J=J-MONTH(I)
14400 NEXT I
14410 LET T=TJULDA-.5
14420 LET I=T
14430 LET S=I
```

```
14440 LET T=(T-S)*24
14450 LET IHOUR=T
14460 LET S=IHOUR
14470 LET T=(T-S)*60
14480 LET IMIN=T
14490 LET S=MIN
14500 LET YEAR(6)=(T-S)*60
14510 LET YEAR(1)=IYEAR
14520 LET YEAR(2)=IMONTH
14530 LET YEAR(3)=IDAY
14540 LET YEAR(4)=IHOUR
14550 LET YEAR(5)=IMIN
14560 EXIT SUB
14570 FOR I=1 TO 6
14580   LET ITIME(I)=SGN(YEAR(I))*INT(YEAR(I))
14590 NEXT I
14600 LET N=ITIME(1)-1950
14610 LET K=ITIME(2)
14620 LET M=MONDD(K)+ITIME(3)
14630 IF (K<3) THEN 14660
14640 LET NX=N+2
14650 IF (NX=((NX/4)*4)) THEN LET M=M+1
14660 LET T=N*365+(N+1)/4+M
14670 LET TX=(ITIME(4)*60+ITIME(5))*60+ITIME(6)
14680 LET TJULDA=2433281.5+(T+TX/86400)
14681 MAT ITIME=0
14690 END SUB
15000
15010 SUB VACIMP(STV(),DJ,ELM(),SIMP(),TIMP,RIMP,IUNIT)
15020 REM THIS SUBROUTIME,GIVEN A STATE VECTOR STV(RADIUS,LATITUDE,LONGITUDE,VI
15030 REM FLOGHT PATH ELEVATION ANGLE,ZIMUTH),ORBIT ELEMENTS ELM(A,B,INCL,NODE,
15040 REM PER,MEAN ANOM)AND TIME,JULIAN DATE,DJ,DETERMINES CONDITIONS AT IMPAC
15050 REM BECTOR) SIMP,TIME FROM PRESINT TO OMPACT TIMP(MIN),TANMGE TO IMPACT I
15080 REM REQUIRES SUBROUTINE PSTRN1(MODIFIED PSTRN WITH ELM SUPPLIED EXTERNALI
15091 DECLARE PUBLIC TWOPI,RAD1,PIOV2
15092 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
15100 LET TIMP=0
15110 LET EROR=.0000017
15140 LET A=6378.16
15150 LET B=6356.77472
15160 LET RP=ELM(1)*(1-ELM(2))
15170 IF (RP>A) THEN GOTO 15600
15180 LET ES=ELM(2)*ELM(2)
15190 LET ESM=1-ES
```

```
15200 LET THCOSX=(ELM(1)*ESM-A)/ELM(2)/A
15210 IF (THCOSX>1) THEN LET THCOS=1
15220 IF (THCOSX<-1) THEN LET THCOSX=-1
15230 LET THOLD=FNARCOS(THCOSX)
15240 LET THOLD=TWOPI-THOLD
15250 LET ESMS=ESM*ESM
15260 LET SI=SIN(ELM(3)/RAD1)
15270 LET OM=ELM(5)/RAD1
15280 LET AES=ELM(1)^2*ESMS
15290 LET C=AES*(1/B/B-1/A/A)*SI*SI
15300 LET CC=AES/A/A
15310 LET ITER=0
15320 LET SN=SIN(THOLD)
15330 LET CS=COS(THOLD)
15340 LET STO=SIN(THOLD+OM)
15350 LET THNEW=THOLD+(1+2*ELM(2)*CS+ES*CS*CS-C*STO*STO-CC)/(ELM(2)*SN+ES*CS*SI
15360 LET ITER=ITER+1
15370 IF (ITER>=50) THEN GOTO 15410
15380 IF (ABS(THNEW-THOLD)<EROR) THEN GOTO 15430
15390 LET THOLD=THNEW
15400 GOTO 15320
15410 IF (RP>B) THEN EXIT SUB
15420 PRINT "VACUUM IMPACT ITERATION DID NOT CONVERGE"
15430 LET COSTH=((ELM(1)*ESM-STV(1))/ELM(2)/STV(1))
15440 CALL ARCCOS(COSTH,THPRES)
15450 IF (STV(5)<0) OR (STV(5)>180) THEN LET THPRES=TWOPI-THPRES
15460 LET DTH=(THNEW-THPRES)*RAD1
15470 IF (DTH<0) THEN LET DTH=DTH+360
15471 IF (DTH>=360) THEN LET DTH=DTH-360
15490 CALL PSTRNI(STV(),ELM(),DTH,1,SIMP)
15500 LET TIMP=DTH/60
15510 REM RANGE-TO-IMPACT IS HERE DEFINED AS GREAT CIRCLE TANGE OVER A
15520 REM SPHERE OF EQUIVALENT VOLUME,6371.01KM RADIUS
15530 LET CLAT=SIMP(2)
15540 LET CLONG=SIMP(3)
15550 CALL GRANGE (STV(),CLAT,CLONG,RIMP)
15560 IF (IUNIT=0) THEN EXIT SUB
15570 LET SIMP(4)=SIMP(4)/.0003048
15580 LET RIMP=RIMP*.000539956803
15590 EXIT SUB
15600 FOR I=1 TO 6
15610 LET SIMP(I)=0
15620 NEXT I
15630 LET TIMP=0
```

```
15640 LET RIMP=0
15650 END SUB
15700
15710
15720
15730 SUB CDATE (DATEJ)
15731 DECLARE PUBLIC MONTH(),LMON$()
15920 LET IYEAR=1952
15930 LET RIDAY=DATEJ-2434011.5
15940 IF (RIDAY>0)THEN
15941  LET IDAY= SGN(RIDAY)*INT(RIDAY)
15942  GOTO 16000
15943 END IF
15950 LET IYEAR=IYEAR-4
15960 LET RIDAY=RIDAY+1461
15970 IF RIDAY<0 THEN 15950
15980 IF RIDAY=0 THEN 16030
15990 IF RIDAY>0 THEN 16030
16000 LET I=SGN(RIDAY/1461)*INT(RIDAY/1461)
16010 LET IYEAR=IYEAR+I*4
16020 LET IDAY=IDAY-I*1461
16030 LET MONTH(2)=29
16040 LET I=IDAY-366
16050 IF (I<0) THEN GOTO 16120
16060 LET MONTH(2)=28
16070 LET IDAY=I
16080 LET IYEAR=IYEAR+1
16090 LET I=SGN(IDAY/365)*INT(IDAY/365)
16100 LET IDAY=IDAY-I*365
16110 LET IYEAR=IYEAR+I
16120 LET IMONTH=0
16130 LET J=IDAY
16140 FOR I=1 TO 12
16150  IF J<=0 THEN
16151   LET I=12
16152   GOTO 16190
16153  END IF
16160 LET IDAY=J
16170 LET IMONTH=IMONTH+1
16180 LET J=J-MONTH(I)
16190 NEXT I
16200 LET T=DATEJ-.5
16210 LET RI=T
16220 LET S=SGN(RI)*INT(RI)
```

```
16230 LET T=(T-S)*24 +.000139
16232 LET IHOUR=SGN(T)*INT(T)
16234 LET S=IHOUR
16236 LET T=(T-S)*60
16240 LET IMIN=SGN(T)*INT(T)
16250 LET S=IMIN
16260 LET ISEC=SGN(T-S)*INT(T-S)*60
16270 PRINT LMON$(IMONTH);IDAY;IYEAR;"HOUR";IHOUR;"MIN";IMIN;"SEC";ISEC
16290 END SUB
16300
16301
16302
16310 SUB ELMTOR(ELM(),T(),DJ)
16320 REM ELMTOR TRANSFORMS THE CLASSICAL ELEMENTS (A,E,I,NODE,ARGUMENT OF
16330 REM PERIGEE,MENA ANOMALY) INTO THE POLAR STATE VECTOR (RADIUS,
16340 REM LATITUDE, LONGITUDE, VELOCITY, GAMMA, AZIMUTH) AT EPOCH DJ
16350 REM FULIAN DAYS
16360 REM ANGLE PRINT AND OUTPUT IN DEGREES
16370 REM NEEDS SUVTOUTINES LONGRA, KEPEON,ANGLE
16371 DECLARE PUBLIC TWOPI,RAD1
16372 OPTION NOLET
16373 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
16390 CMU=398601.2
16410 AM=ELM(6)/RAD1
16411 E=ELM(2)
16420 AI=ELM(3)/RAD1
16421 ANODE=ELM(4)/RAD1
16430 ARG=ELM(5)/RAD1
16440 IF (E>=1) THEN GOTO 16760
16450 CALL KEPEON(AM,E,EC,KFAIL)
16460 CEC=COS(EC)
16470 SEC=SIN(EC)
16480 EEC=1-E*CEC
16490 R=ELM(1)*EEC
16500 V=SQR(CMU*(2/R-1/ELM(1)))
16510 SE=SQR(1-E*E)
16520 T(5)=ATN(E*SEC/SE)*RAD1
16530 CTA=(CEC-E)/EEC
16540 STA=SEC*SE/EEC
16550 CALL ANGLE(STA,CTA,TA)
16560 PHI=TA+ARG
16570 SINI=SIN(AI)
16580 ALAT=FNARSIN(SINI*SIN(PHI))
16590 CLAT=COS(ALAT)
```

```
16600 IF (CLAT=0) THEN 16730
16610 SBETA=COS(AI)/CLAT
16620 CBETA=SIN(AI)*COS(PHI)/CLAT
16630 CALL ANGLE(SBETA,CBETA,BETA)
16640 SNU=SBETA*SIN(PHI)
16650 CNU=COS(PHI)/CLAT
16660 CALL ANGLE(SNU,CNU,ANU)
16670 RAL=ANU+ANODE
16680 IF RAL>=TWOPI THEN RAL=RAL-TWOPI
16690 CALL LONGRA(RAL,ALONG,DJ)
16700 T(1)=R
16701 T(2)=ALAT*RAD1
16702 T(3)=ALONG*RAD1
16710 T(4)=V
16711 T(6)=BETA*RAD1
16720 EXIT SUB
16730 BETA=TWOPI/2
16740 ALONG=0
16750 GOTO 16700
16760 PRINT "FAILURE IN ELMTOR, ORBIT HYPERBOLIC"
16770 END SUB
16771
16772
16773
17010 SUB XTOELM(S(),ELM())
17020 REM CONVERT STATE VECTOR S(X,Y,Z,XDOT,YDOT,ZDOT) TO CLASSICAL ELEMENTS
17030 REM ELM(A,E,I,NODE,ARGPERIGEE,MEANANOM)
17040 REM NEEDS SUBOUUTINE ANGLE,ANGLE
17041 DECLARE PUBLIC TWOPI,PI1,RAD1
17042 OPTION NOLET
17070 CMU=398601.2
17080 X=S(1)
17090 Y=S(2)
17200 Z=S(3)
17210 XD=S(4)
17220 YD=S(5)
17230 ZD=S(6)
17240 R=SQR(X^2+Y^2+Z^2)
17250 V=SQR(XD^2+YD^2+ZD^2)
17260 RDOTR=X*XD+Y*YD+Z*ZD
17270 RDOT=RDOTR/R
17280 D=2/R-V*V/CMU
17290 A=ABS(1/D)
17300 SINGAM=RDOT/V
```

```
17310 COSGSQ=1-SINGAM*SINGAM
17320 P=R*R*V*V*COSGSQ/CMU
17340 IF (D>=0) THEN 17430
17360 E=SQR(1+P/A)
17365 RP=A*(E-1)
17368 COSHF=(1+R/A)/E
17370 SINHF=RDOTR/E/SQR(CMU*A)
17380 CALL ANGLEH(SINHF,COSHF,EANOM)
17390 MANOM=-EANOM+E*SINHF
17400 CTANOM=(P-R)/E/R
17410 STANOM=SQR(P/A)*SINHF/(E*COSHF-1)
17420 GOTO 17500
17430 ECOSE=1-R/A
17440 ESINE=RDOTR/SQR(CMU*A)
17450 IF ECOSE<0 THEN EANOM=ATN(ESINE/ECOSE)+PI1
17451 IF ECOSE>=0 AND ESINE<0 THEN EANOM=ATN(ESINE/ECOSE)+TWOPI
17452 IF ECOSE>=0 AND ESINE>=0 THEN EANOM=ATN(ESINE/ECOSE)
17453 REM PUTS ANGLE INTO PROPER QUADRANT.
17460 E=SQR(ESINE*ESINE+ECOSE*ECOSE)
17470 AM=EANOM-ESINE
17480 STANOM=A/R*SQR(1-E*E)*SIN(EANOM)
17490 CTANOM=A/R*(COS(EANOM)-E)
17500 CALL ANGLE(STANOM,CTANOM,TANOM)
17510 H1=Y*ZD-Z*YD
17520 H2=Z*XD-X*ZD
17530 H3=X*YD-Y*XD
17540 CSQ=H1*H1+H2*H2
17550 HSQ=CSQ+H3^2
17560 C=SQR(CSQ)
17570 H=SQR(HSQ)
17580 SINI=C/H
17590 COSI=H3/H
17600 CALL ANGLE(SINI,COSI,AI)
17610 SINOM=H1/C
17620 COSOM=-H2/C
17630 CALL ANGLE(SINOM,COSOM,OM)
17634 SINU=Z*H/R/C
17636 COSU=(Y*H1-X*H2)/R/C
17640 CALL ANGLE(SINU,COSU,U)
17649 PER=U-TANOM
17650 ELM(1)=A
17660 ELM(2)=E
17670 ELM(3)=AI*RAD1
17680 ELM(4)=OM*RAD1
```

```
17690 ELM(5)=PER*RAD1
17700 ELM(6)=AM*RAD1
17710 END SUB
18000
18001
18002
18010 SUB OUTP (T,S(),DS(),IHLF,NDIM,PRMT())
18011 DECLARE PUBLIC TWOPI,RAD1
18012 DECLARE PUBLIC GZERO,RE,CMU,DJ,CAPLAT,CAPLNG,CAPHT,SLAT(),SLONG(),SHT(),I
18013 DECLARE PUBLIC CNMI,CFPS,B,F10,AP,ERATE,TIGN,TBO,STWT,FLOW
18014 DECLARE PUBLIC THX,THY,THZ,THR,GTH,ATH,WT,ACCEL,VEARTH,VIMF,GCDOT,ATDOT,V
18015 DECLARE PUBLIC ATAKP,ATAKY,ATAK,Q,QA,DZ,ITHR,IUNIT,ITRK,ICRASH,MSUN,MMOON
18016 DECLARE PUBLIC MTHRUST,I62,BUFFER(,),BUFPTR,LATT,LONG,BUFLIM,SIMPO(),ELMO
18017 DIM ETRK(5),ATRK(5),RTRK(5),SEL(5),SAZ(5),SRNG(5)
18018 DEF FNARSIN(X)= ATN(X/SQR(1-X*X))
18019 DIM STV(6)
18020 ATAK=0
18030 ATAKP=0
18040 ATAKY=0
18050 QA=0
18070 DJ=T/86400+DZ
18080 IF (PRINT1=0) THEN GOTO 18150
18090 IF T=0 THEN GOTO 18150
18100 H=PRMT(3)*(.5)^IHLF
18110 IF ABS(XPRINT-T)>=(H/2) THEN GOTO 19100!FIRST CLEAR THE ARRAYS.
18120 REM PRINTS AT CLOSEST INTEFRATION STEP
18130 REM MAY SKIPA PRINT IF H IS DOUBLED JUST BEFORE A PRINT
18140 XPRINT=XPRINT+PRINT1
18150 CALL XTOELM(S(),ELMO())
18160 REM S=(X,Y,Z,XD,YD,ZD)
18170 IF (ELMO(2)>=1) THEN GOTO 19040
18180 CALL ELMTOR(ELMO(),STVO(),DJ)
18190 REM STV=(R,LAT,LONG,V,GAM,AZ)
18200 LET RADSTV=STVO(1)
18210 LET GEOCLT=STVO(2)
18220 CALL GEODHT (RADSTV,GEOCLT,HT,GEODLT,0)
18230 IF (HT<0) THEN PRMT(5)=1
18240 ES=1-ELMO(2)*ELMO(2)
18250 SES=SQR(ES)
18260 CTA=(ELMO(1)*ES-STVO(1))/ELMO(2)/STVO(1)
18270 RANGE=0
18275 CALL ARCCOS(CTA,TA)
18280 TA=TA*RAD1
18290 IF (STVO(5)>180) THEN STVO(5)=STVO(5)-360
```

```
18300 IF STVO(5)<0 THEN TA=-TA
18310 IF T>0 THEN GOTO 18350
18320 CLAT=STVO(2)
18330 CLONG=STVO(3)
18340 GOTO 18360
18350 CALL GRANGE(STVO(),CLAT,CLONG,RANGE)
18360 APORAD=ELMO(1)*(1+ELMO(2))
18370 PERRAD=ELMO(1)*(1-ELMO(2))
18380 DAM=ELMO(1)/CMU
18390 PERIOD=TWOPI*ELMO(1)*SQR(DAM)/60
18400 APOVEL=SQR(PERRAD/APORAD/DAM)
18410 PERVEL=1/APOVEL/DAM
18420 APOALT=APORAD-RE
18430 PERALT=PERRAD-RE
18440 CALL RADARD(STVO(),CAPLAT,CAPLNG,CAPHT,ECAPE,AZCAPE,RCAPE)
18450 IF (MTHRST=0) THEN GOTO 18580
18560 CALL ATAKAN(STVO(),GTH,ATH,ATAK,ATAKP,ATAKY)
18570 QA=Q*ATAK/RAD1
18580 CALL CDATE(DJ)
18581 PRINT "STEP=";BUFPTR
18582 BUFPTR=BUFPTR+1
18583 BUFFER(BUFPTR,LATT)=STVO(2)
18584 BUFFER(BUFPTR,LONG)=STVO(3)! STORE OFF THE LOCATION COORDINATES.
18585 IF (BUFPTR>=BUFLIM) OR (SQR((ABS(BUFFER(BUFPTR-1,LATT))-ABS(STVO(2)))^2+
18586  CALL SAVNPRNT
18587  STOP
18588 END IF
18590 IF (IUNIT>0) THEN GOTO 18850
18600 PRINT "TIME=";T,"ALT=";HT,"RANG=";RANGE,"THR=";THR
18602 PRINT "WT=";WT,"ACXB=";ACCEL,"A=";ELMO(1),"ECC=";ELMO(2)
18604 PRINT "INCL=";ELMO(3),"NODE=";ELMO(4),"ARGP=";ELMO(5),"MAN=";ELMO(6)
18606 PRINT "RAD1 =";STVO(1),"LAT =";STVO(2),"LONG=";STVO(3),"VEL=";STVO(4)
18608 PRINT "ELEV=";STVO(5),"AZIM=";STVO(6),"RAPO=";APORAD,"RPER=";PERRAD
18610 PRINT "TAU =";PERIOD," VE =";VEARTH,"PITCH=";GTH,"YAW=";ATH
18612 PRINT "HAPO=";APOALT,"HPER=";PERALT,"WDOT=";FLOW,"VIMF=";VIMF
18614 PRINT "PDOT=";GCTOT,"YDOT=";ATDOT,"VAPO=";APOVEL,"VPER=";PERVEL
18615 PRINT "CAPE=";ECAPE,"VLOS=";VLOSS,"MACH=";CMACH,"QH=";QH
18616 PRINT "PATK=";ATAKP,"YATK=";ATAKY,"ATAK=";ATAK,"Q =";Q
18618 PRINT "QALF=";QA,"TAN=";TA," X  =";S(1)," Y =";S(2)
18620 PRINT "Z  =";S(3),"XDOT=";S(4),"YDOT=";S(5),"ZDOT=";S(6)
18622 PRINT
18650 IF IUNIT=0 THEN 18660
18652 ELMO(1)=ASTORE
18654 STVO(1)=RSTORE
```

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18656 STVO(4)=VSTORE
18660 IF ITRK=0 THEN 18800
18670 FOR I=1 TO 6
18680  SEL(I)=0
18690  SAZ(I)=0
18700  SRNG(I)=0
18710 NEXT I
18720 FOR I=1 TO ITRK
18721  CALL RADARD(STVO(),SLAT(I),SLONG(I),SHT(I),SEL(I),SAZ(I),SRNG(I))
18722 NEXT I
18750 IF IUNIT=0 THEN 18790
18760 FOR I=1 TO 6
18770  SRNG(I)=SRNG(I)*CNMI
18780 NEXT I
18790 PRINT "EL1=";STR$(SEL(1));"  EL2=";STR$(SEL(2));"  EL3=";STR$(SEL(3));"
18791 PRINT "EL5=";STR$(SEL(5));"  AZ1=";STR$(SAZ(1));"  AZ2=";STR$(SAZ(2));"
18792 PRINT "AZ4=";STR$(SAZ(4));"  AZ5=";STR$(SAZ(5));"  RNG1=";STR$(SRNG(1));'
18793 PRINT "RNG3=";STR$(SRNG(3));"  RNG4=";STR$(SRNG(4));"  RNG5=";STR$(SRNG(5
18800 IF ICRASH=0 THEN 19100
18810 CALL VACIMP(STVO(),DJ,ELMO(),SIMPO(),TIMP,RIMP,0)
18820 IF IUNIT>0 THEN 18833
18830 PRINT "RIMP=";STR$(RIMP);"  TIMP=";STR$(TIMP);"  LATI=";STR$(SIMPO(2));"
18831 PRINT "VILI=";STR$(SIMPO(4));"  ELVI=";STR$(SIMPO(5))
18832 GOTO 19100
18833 RIMP=RIMP*CNMI
18834 SIMPO(4)=SIMPO(4)*CEPS
18840 PRINT "RIMP=";STR$(RIMP);"  TIMP=";STR$(TIMP);"  LATI=";STR$(SIMPO(2));"
18841 PRINT "VELI=";STR$(SIMPO(4));"  ELVI=";STR$(SIMPO(5))
18845 GOTO 19100
18850 ALT=ALT*CNMI
18860 RANGE=RANGE*CNMI
18870 ASTORE=ELMO(1)
18880 ELMO(1)=ASTORE*CNMI
18890 RSTORE=STVO(1)
18900 STVO(1)=RSTORE*CNMI
18910 VSTORE=STVO(4)
18920 STVO(4)=VSTORE*CFPS
18930 APORAD=APORAD*CNMI
18940 PERRAD=PERRAD*CNMI
18950 VEARTH=VEARTH*CFPS
18960 APOALT=APOALT*CNMI
18970 PERALT=PERALT*CNMI
18980 VIMP=VIMP*CFPS
19000 APOVEL=APOVEL*CFPS
```

```
19010 PERVEL=PERVEL*CFPS
19020 VLOSS=VLOSS*CFPS
19030 GOTO 18600
19040 STVO(1)=SQR(S(1)^2+S(2)^2+S(3)^2)
19050 STVO(4)=SQR(S(4)^2+S(5)^2+S(6)^2)
19060 RDOT=(S(1)*S(4)+S(2)*S(5)+S(3)*S(6))/STV(1)
19070 STVO(5)=FNARSIN(RDOT/STVO(4))*RAD1
19080 STVO(2)=FNARSIN(S(3)/STVO(1))*RAD1
19090 GOTO 18420
19100 FOR I=1 TO 5
19101   ETRK(I),ATRK(I),RTRK(I),SEL(I),SAZ(I),SRNG(I)=0
19102 NEXT I
19103 FOR I=1 TO 6
19104  SIMPO(I),ELMO(I),STVO(I)=0
19105 NEXT I
19110 END SUB
19150
19151
19152
19160 SUB LUNEPH(TJ,VX,VY,VZ)
19170 REM EPHEMERIS OF THE MOON
19180 DECLARE PUBLIC TWOPI,PI1
19185 OPTION NOLET
19190 XIS=.40916335
19200 SECRA=.0000048481368
19210 FX=(943242+47625.6*TJ)*SECRA
19220 XLUNE=(1029621+47435*TJ)*SECRA
19230 XL=(233258+47033.97*TJ)*SECRA
19240 XLP=(1286413+3548.161*TJ)*SECRA
19250 D=(670604+43886.7*TJ)*SECRA
19270 PI2=TWOPI
19280 I1=XL/PI2
19390 I2=D/PI2
19400 I3=XLP/PI2
19410 I4=FX/PI2
19420 XL=XL-I1*PI2
19430 D=D-I2*PI2
19440 XLP=XLP-I3*PI2
19450 FX=FX-I4*PI2
19460 A=22640*SIN(XL)-4586*SIN(XL-20*D)+2369*SIN(2*D)
19470 B=769*SIN(2*XL)-668*SIN(XLP)-412*SIN(2*FX)
19480 C=-212*SIN(2*XL-2*D)-206*SIN(XL+XLP-2*D)+192*SIN(XL+2*D)
19490 DD=-165*SIN(XLP-2*D)+148*SIN(XL-XLP)-125*SIN(D)
19500 E=-110*SIN(XL+XLP)+55*SIN(2*D-2*FX)-45*SIN(XL+2*FX)
```

```
19510 G=40*SIN(XL-2*FX)-38*SIN(XL-4*D)+36*SIN(3*XL)
19520 H=-31*SIN(.2*XL-4*D)+28*SIN(XL-XLP-2*D)-24*SIN(XLP+2*D)
19530 HH=19*SIN(XL-D)+18*SIN(XLP+D)
19540 XLAM=XLUNE+(A+B+C+DD+E+G+H+HH)*SECRA
19541 I5=SGN(XLAM/PI2)*INT(XLAM/PI2)
19542 XLAM=XLAM-RI5*PI2
19550 AA=18641*SIN(FX)+1010*SIN(XL+FX)+1000*SIN(XL-FX)+624*SIN(2*D-FX)
19560 BA=-199*SIN(XL-2*D-FX)-167*SIN(XL-2*D+FX)+117*SIN(2*D+FX)
19570 CA=62*SIN(2*XL+FX)+33*SIN(XL+2*D-FX)+32*SIN(2*XL-FX)
19580 DA=-30*SIN(XLP-2*D+FX)-16*SIN(2*XL-2*D+FX)
19590 EA=15*SIN(XL+2*D+FX)-12*SIN(XLP+2*D-FX)
19600 BETA=(AA+BA+CA+DA+EA)*SECRA
19610 I7=SGN(BETA/PI2)*INT(BETA/PI2)
19620 BETA=BETA-I7*PI2
19630 AB=3422.6+186.5*COS(XL)+34.3*COS(XL-2*D)+28.2*COS(2*D)
19640 BB=10.2*COS(2*XL)+3.1*COS(XL+2*D)+1.9*COS(XLP-2*D)
19650 CB=1.4*COS(XL+XLP-2*D)+1.2*COS(XL-XLP)-COS(D)
19660 DB=-.9*COS(XL+XLP)-.7*COS(XL-2*FX)+.6*COS(3*XL)-.6*COS(XL-4*D)
19670 OMGA=(AB+BB+CB+DB)*SECRA
19680 I6=SGN(OMGA/PI2)*INT(ABS(OMGA/PI2))
19690 OMGA=OMGA-I6*PI2
19700 SIMM=SIN(OMGA)
19710 COBE=COS(BETA)
19720 VX=6378.16*COS(XLAM)*COBE/SIMM
19730 VY=6378.16*SIN(XLAM)*COBE/SIMM
19740 VZ=6378.16*SIN(BETA)/SIMM
19750 END SUB
20000
20001
20002
20010 SUB PSTRNI(T(),ELM(),DT,ISTEP,S())
20011 REM GIBEN A POLAR STATE VECTOR T(RADIUS,LATITUDE,LONGITUDE,VELOCITY,
20012 REM GAMMA,AZIMUTH), PATTRN CALCULATES A NEW POLAR STATE VECTOR SATDT
20013 REM SECONDS(ISTEP=0)OR DEGREES(ISTWP=1)LATER, ANGLE IN DEGREES
20014 REM DT RETURN AS TIME WHITHER PRINT AS TIME OR ANGLE
20015 REM NEEDS SUBROUTINES RTOELM,KEPEON
20016 DECLARE PUBLIC TWOPI,RAD1,PI1
20017 DECLARE PUBLIC GZERO,RE,CMU,DJ,CAPLAT,CAPLNG,CAPHT,SLAT(),SLONG(),SHT(),I
20018 DECLARE PUBLIC THX,THY,THZ,THR,GTH,ATH,WT,ACCEL,VEARTH,VIMF,GCTOT,ATDOT,V
20019 OPTION NOLET
20020 CMU=398601.2
20050 QN=SQR(CMU/ELM(1)/ELM(1))
20060 AM=ELM(6)/RAD1
20070 IF AM<0 THEN AM=AM+TWOPI
```

```
20080 E=ELM(2)
20090 CALL KEPEON(AM,E,EC,KFAIL)
20100 CEC=COS(EC)
20110 COST=(CEC-E)/(1-E*CEC)
20120 CALL ARCCOS(COST,TA)
20130 IF T(5)<0 THEN TA=TWOPI-TA
20140 IF ISTEP=0 THEN 20280
20150 TAS=TA+DT/RAD1
20160 PER=TWOPI*ELM(1)*SQR(ELM(1)/CMU)
20170 DTDEG=DT
20180 CTAS=COS(TAS)
20190 COSECS=(E+CTAS)/(1+E*CTAS)
20200 CALL ARCCOS(COSECS,ECS)
20210 IF (TAS>PI1) THEN ECS=TWOPI-ECS
20220 AMS=ECS-E*SIN(ECS)
20230 DT=(AMS-AM)/QN
20233 IF DT<PER THEN 20240
20236 IF DTDEG>360 THEN 20240
20239 DT=DT-PER
20240 ELM(6)=AMS*RAD1
20250 DJJ=DJ+DT/86400
20260 CALL ELMTOR(ELM(),S(),DJJ)
20270 EXIT SUB
20280 TP=AM/QN
20290 TS=TP+DT
20300 AMS=QN*TS
20310 GOTO 20240
20320 END SUB
20400
20401
20402
20500 SUB ARCCOS(COS1,ANG)
20510 REM THIS ROUTINE SOLVES FOR THE ANGLE(ANG) IF RADIANS WHOSE COSINE IS COS
20511 DECLARE PUBLIC PIOV2
20520 REM ROUNDOFF PROTECTION
20522 OPTION NOLET
20523 DEF FNARCOS(X)=PIOV2-ATN(X/SQR(1-X*X))
20530 IF (COS1>1)  THEN COS1=1
20550 ANG=FNARCOS(COS1)
20560 END SUB
20600
20601
20602
20610 SUB DRAGB(SRAD,SLAT,SLONG,DJ,F10,AP,D,I62)
```

```
20630 REM THIS SUBROUTINE CALCULATES THE ATMOSPHERIC DENSITY D GIVEN THE GEOCI
20640 REM VLATITUDE, AND LONGITUDE OF A SATELLITE (SRAD,SLAT,SLOONG),THE JULIA
20650 REM DECMETRIC SOLAR FLUX,F10, AND THE GEOMAGNETIC INDEX AF(INCLUDES EFFE
20660 REM DIURNAL BULGE). IF I62=0, F10A AND AP AREE IFNORED AND DENSITY IS CO
20680 REM REQUIRES SUBROUTINES SUNMEL,LONGRA,DJDATE
20681 DECLARE PUBLIC RAD1,TWOPI
20686 OPTION NOLET
20691 DIM AA1(20),YEAR (6)
20692 DATA -5.51057E-4,7.2687E-7,1.5837E-8,-2.9804E-11,1.8408-14,2.5106E-6,-2.
20694 DATA 8.3468E-11,-1.2606E-13,6.9437E-17,2.9099646E-9,3.8388E-11,-1.3402E-
20696 DATA 2.1941E-16,-1.3715E-19,2.6736E-14,-6.6437E-15,2.0816E-17,-4.6025E-2
20710 H=SRAD-6378
20720 CALL DRAGE(SRAD,SLAT,D)
20730 IF (H<200) OR (I62=0) OR (H>=700) THEN EXIT SUB
20740 CALL GEODHT(SRAD,SLAT,Z,GEOD,0)
20750 CALL SUNMEL(DJ,X,Y,V)
20760 RSUN=SQR(X^2+Y^2+V^2)
20770 SINL=V/RSUN
20780 COSL=SQR(1-SINL^2)
20790 IF X<0 THEN RA=ATN(Y/X)+PI1
20791 IF (X>=0) AND (Y<0) THEN RA=ATN(Y/X)+TWOPI
20792 IF (X>=0) AND (Y>0) THEN RA=ATN(Y/X)
20800 CALL LONGRA(RA,ALONG,DJ)
20810 TFACT=1+.4*((1+SINL*SIN(SLAT/RAD1)+COSL*COS(SLAT/RAD1)*COS(ALONG+.523599-
20820 CALL GJDATE(DJ,YEAR(),1)
20830 YEAR(2)=4
20835 YEAR(3)=7
20850 FOR I=4 TO 6
20860 YEAR(I)=0
20870 NEXT I
20880 CALL GJDATE(DJAP,YEAR(),0)
20890 DAYNO=DJ-DJAP
20900 TN=1025+4.5*(F10-170)+.5*F10*COS(DAYNO/182.5)+1.5*AP
20910 TEMP=TN*IFACT
20920 TR=TEMP-1300
20930 Z2=Z^2
20940 Z3=Z*Z2
20950 Z4=Z*Z3
20960 TR2=TR^2
20970 TR3=TR*TR2
20980 TR4=TR*TR3
20990 DL=(AA1(1)+AA1(2)*Z+AA1(3)*Z2+AA1(4)*Z3+AA1(5)*Z4)*TR+(AA1(6)+AA1(7)*Z+A
21010 IF DL<10 THEN 21040
21020 D=D*10^DL
```

```
21031 EXIT SUB
21040 PRINT "DENSITY NOT CORRECTED TO DYNAMIC MODEL"
21060 END SUB
21500
21750
23000 SUB SAVNPRNT
23005 DECLARE PUBLIC BUFFER(,),BUFPTR
23010 REM ***********************************************************
23015 REM *THIS SHORT PROGRAM PRESENTS THE OURPUR OF STORED DATA    *
23020 REM *FROM THE ELOPTICAL PATH PROGRTAM . THE DATA IS SAVED     *
23025 REM *IN FILE OF THE USER'S CHOICE.                            *
23030 REM *SUBSEQUENT VIEWING OF THE PATH AND THE WORLD MAY BE      *
23035 REM *ACCOMPLISHED BY USING THIS PROGRAM. "MPATH.ELIP."        *
23040 REM *REDISPLAYS ALL THE VALUES IN ANY DATA FILE WHERE THE     *
23045 REM *FIRST VALUE READ EQUALS THE SIZE OF THE ARRAY WHERE THE *
23050 REM *DATA RESIDES AND THE REMAINNING DATA POINTS ARE ARRANGED*
23055 REM *AS LATITUDE, LONGITUDE.                                  *
23060 REM *THERE ARE NO PROVILIONS FOR ERROR CHECKING OF FILE NAMES*
23061 REM *THEREFORE, IF AN INCORRECT OR MIISSPELLED FILENAME IS    *
23062 REM *ENTERED THEN THE PROGRAM WILL STOP AND IT MUST BE        *
23063 REM *RESTARTED.                                               *
23064 REM ***********************************************************
23065 OPTION BASE 1
23066 CLEAR
23067 SET WINDOW 1,620,1,392
23068 OPEN #1: NAME "T_CZCSOVL", ACCESS INPUT ! A COPY OF THE WORLD MAP.
23070 REM THIS WILL READ THE MAP BACK ONTO THE SCREE
23071 LET K=272
23072 LET J=392
23073 REM GENERATES A PICTURE OF THE WORLD
23074 FOR I=1 TO 20638
23075  INPUT #1:A
23076  FOR N=7 TO 0 STEP -1
23077   LET T1=A-2^N
23078  IF K>512 THEN
23079    LET K=1
23080    LET J=J-1
23081  END IF
23082   IF T1>=0 THEN
23083    PLOT POINTS: K,J
23084    LET A=A-2^N
23085   END IF
23086   LET K=K+1
23087  NEXT N
```

```
23088 NEXT I
23089 LET J=2
23090 REM MOVE TO THE STARTING LOCATION.
23091 ASK WINDOW X1,X2,Y1,Y2
23092 LET X=((X2/360)*(180+BUFFER(1,2)) -29)
23093 LET Y=392-((Y2/180)*(90-BUFFER(1,1)) +13)
23095 DO WHILE J<=BUFPTR
23096 LET X1=((X2/360)*(180+BUFFER(J,2))-29)
23097 IF (X1>512) THEN LET X1=MOD(X1,512)
23101 PLOT LINES:X,Y;X1,(392-((Y2/180)*(90-BUFFER(J,1))+13))
23113 LET X=X1
23114 LET Y=(392-((Y2/180)*(90-BUFFER(J,1))+13))
23115 LET J=J+1
23116 LOOP
23120 END SUB
```

```
Ok. RUN >> RESULT

ENTER IINP,0 FOR R,LAT,LONG,VEL,GAM,AZ,PRINT OR 1 FOR ELEMENTS A,E,I: 0
ENTER IUNIT,0 FOR KM, KGM,SEC; 1 FOR N,NI,FPS: 0
ENTER ITRK,ENTER THE NUMBER OF TRACKING STATIONS OR 0 FOR
      NO TRACKING DATA GENERAATED: 0
ENTER ICRASH-VACUM INPACT PTINTOUT: 1
ENTER I62,0 FOR 1962 U.S.STD ATMOSPHERE, 1 FOR DYNAMIC ATMOSPHERE: 0
ENTER MSUN,1 TO INCLUDE PERTURBING FORCE OTHERWISE ENTER0:       1
ENTER MMOON, 1 TO INCLUDE FORCE:                 1
ENTER MDRAG, 1 TO INCLUDE FORCER:                1
ENTER MTHRST,1 TO INCLUDE FORCE:                 0
ENTER MOGL, HIGHEST ORDER OF OBLATENESS INCLUDED:                5
ENTER THE YEAR:  1974
ENTER THE MONTH(1-12):           8
ENTER THE DAY (1-31):            15
ENTER THGE HOURS()-23):          23
ENTER THE MINUTES(0-59):         0
ENTER THE SECONDS(0-59):         0
ENTER STATE VECTOR OR ESEMENTS AT START EPOCH
ENTER FIRST ITEM=6526.3200:
ENTER THE SECOND ITEM=  .000
ENTER THIRD ITEM=-4.1480
ENTER FOURTH ITEM=10.3065
ENTER FIFTH ITEM=   .0000
ENTER SIXTH ITEM=116.0000


PRMT(1)=START TINMEM HRS(NORMALLY 0.0)
PRMT(2)=END TIME,HRS
PRMT(3)= INITIAL STEP SIZE, MIN
PRMT(4)=UPPER ERROR BOUND

                ENTER PRMT 1
   : 0


                ENTER PRMT 2
   : 48


                ENTER PRMT 3
   : 20
```

```
                ENTER PRMT 4
  : 2

 0
ENTER B(BALLISTIC COEFFICIENT):  0
ENTER F10:        0
ENTERT AP:        0

TRAJECTORY USING RUNGE-KUTTA ANALYSIS
START EPOCH
AUG 17  1974 HOUR 5 MIN 0 SEC 0
PRINT STATE VECTOR
TSFIUD= 6526.320
LATITUDE=    .000
LONGITUDE= - 4.1480
VELOCITY= 10.3065
FLTPATH=  .00
AZIMUTH= 116.0000
A=  25026.8713
B=  .7392275
INCL=26.0000
RA OF ASC NODE= 216.0451
ARH OF PER= 180.0000
MEAN ANOM=    .00
PERTURBATIONS INCLUDED:
  SUN
  MOON
  OBLATENESS OF ORDER:= 5.0
 DRAG(1962 STD ATMOSPHERE, B= 0 )
  ( THR= 0 GTH= 0 ATH= 0 )
OUTPUT FORMAT


 \          \   TIME   ALTITUDE   RANGE  THRUST
\          \     WEIGHT          ACCEL(BODY AXIS)                SEMIMAJOR AXIS
ECCEBNTRICITY
\          \     INCLINATION     RA OF ASC NODE  ARG OF PERIGEE  MEAN ANOMALY
RADIYS           GEOC LATITUDE   LONGITUDE       INERTIAL VELOCITY
\          \     FLT PATH ELEV   AZIMUTH         APOGEE RADIUS   PERIGEE RADIUS
\          \     PERIOD          EARTH REL VELOCITY              PITCH
YAW
\          \     APOGEE ALTITUDE PERIGEE ALTITUDE                WT FLOW RATE
OMPULSIVE VELOCITY               IMPULSIVE VELOCITY
```

```
\        \     PICTDH RATE      YAW RATE         APOGEE VELOCITY PERIGEE VELOCI
\        \     ELEV FROM CAPE   VELOCITY LOSS    MACH NO         QH
\        \     PITCH ATTACK     YAW ATTACK       TOTAL ATTACK    Q
\        \     Q ALPHA          TRUE ANOMALY     X               Y
\        \     ZXDOT            YDOT             ZDOT
AUG 17  1974 HOUR 5 MIN 0 SEC 0
STEP= 1
TIME= 0         ALT= 147.021     RANG= 0          THR= 0
WT= 0           ACXB= 0          A= 25026.9       ECC= .739227
INCL= 26.       NODE= 216.045    ARGP= 180.       MAN= 0
RAD1 = 6526.32  LAT = 1.42299e-14                 LONG=-4.14803   VEL= 10.3066
ELEV= 0         AZIM= 116.       RAPO= 43527.4    RPER= 6526.32
TAU = 656.703    VE = 9.88101    PITCH= 0         YAW= 0
HAPO= 37149.3   HPER= 148.16     WDOT= 0          VIMF= 0
PDOT= 0         YDOT= 0          VAPO= 1.54532    VPER= 10.3065
CAPE= 2.44962e-2                 VLOS= 0          MACH= .516302   QH= 0
PATK= 0         YATK= 0          ATAK= 0          Q = 2.10214e+6
QALF= 0         TAN= 8.53774e-7                    X  = 5276.89    Y = 3840.23
Z  = 0          XDOT=-5.45082    YDOT= 7.49002    ZDOT=-4.51809

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 5 SEC 0
STEP= 2
TIME= 300       ALT= 446.476     RANG= 2401.03    THR= 0
WT= 0           ACXB= 0          A= 24990.5       ECC= .738811
INCL= 25.9962   NODE= 216.042    ARGP= 180.057    MAN= 2.74107
RAD1 = 6826.86  LAT =-11.2099    LONG= 18.5752    VEL= 10.0411
ELEV= 11.1282   AZIM= 113.608    RAPO= 43453.7    RPER= 6527.23
TAU = 655.272    VE = 8.94365    PITCH= 0         YAW= 0
HAPO= 37075.6   HPER= 149.072    WDOT= 0          VIMF= 0
PDOT= 0         YDOT= 0          VAPO= 1.54786    VPER= 10.3046
CAPE=-.393552   VLOS= 0          MACH= 0          QH= 0
PATK= 0         YATK= 0          ATAK= 0          Q = 0
QALF= 0         TAN= 26.2718      X  = 3346.11     Y = 5800.71
Z  =-1327.17    XDOT=-7.25334    YDOT= 5.49317    ZDOT=-4.24716

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 10 SEC 0
STEP= 3
TIME= 600       ALT= 1244.76     RANG= 4762.14    THR= 0
WT= 0           ACXB= 0          A= 24947.8       ECC= .738327
INCL= 25.9895   NODE= 216.03     ARGP= 180.083    MAN= 5.50138
```

```
RAD1 = 7628.2    LAT =-19.2351   LONG= 39.0337   VEL= 9.40903
ELEV= 20.4378    AZIM= 107.82    RAPO= 43367.5   RPER= 6528.16
TAU = 653.594     VE = 8.94365   PITCH= 0        YAW= 0
HAPO= 36989.3    HPER= 150.      WDOT= 0         VIMF= 0
PDOT= 0          YDOT= 0         VAPO= 1.55084   VPER= 10.3024
CAPE=-.720472    VLOS= 0         MACH= 0         QH= 0
PATK= 0          YATK= 0         ATAK= 0         Q = 0
QALF= 0          TAN= 48.6637     X  = 1035.52    Y = 7127.52
Z  =-2513.08     XDOT=-7.98831   YDOT= 3.39704   ZDOT=-3.62999

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 15 SEC 0
STEP= 4
TIME= 900        ALT= 2346.16    RANG= 6572.25   THR= 0
WT= 0            ACXB= 0         A= 24926.6      ECC= .73809
INCL= 25.9851    NODE= 216.015   ARGP= 180.098   MAN= 8.26661
RAD1 = 8734.26   LAT =-23.6307   LONG= 55.9128   VEL= 8.67652
ELEV= 27.4463    AZIM= 101.133   RAPO= 43324.6   RPER= 6528.51
TAU = 652.759     VE = 7.44621   PITCH= 0        YAW= 0
HAPO= 36946.5    HPER= 150.346   WDOT= 0         VIMF= 0
PDOT= 0          YDOT= 0         VAPO= 1.55231   VPER= 10.3015
CAPE=-.964574    VLOS= 0         MACH= 0         QH= 0
PATK= 0          YATK= 0         ATAK= 0         Q = 0
QALF= 0          TAN= 66.0896     X  =-1371.1     Y = 7883.53
Z  =-3501.04     XDOT=-7.96896   YDOT= 1.72796   ZDOT=-2.9651

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 20 SEC 0
STEP= 5
TIME= 1200       ALT= 3592.53    RANG= 7920.79   THR= 0
WT= 0            ACXB= 0         A= 24917.5      ECC= .737989
INCL= 25.9833    NODE= 216.001   ARGP= 180.11    MAN= 11.0307
RAD1 = 9986.54   LAT =-25.5143   LONG= 69.1156   VEL= 7.98942
ELEV= 32.5526    AZIM= 95.0878   RAPO= 43306.3   RPER= 6528.67
TAU = 652.403     VE = 7.44621   PITCH= 0        YAW= 0
HAPO= 36928.2    HPER= 150.506   WDOT= 0         VIMF= 0
PDOT= 0          YDOT= 0         VAPO= 1.55294   VPER= 10.301
CAPE=-1.14679    VLOS= 0         MACH= 0         QH= 0
PATK= 0          YATK= 0         ATAK= 0         Q = 0
QALF= 0          TAN= 79.3644     X  =-3712.03    Y = 8212.69
Z  =-4301.57     XDOT=-7.60434   YDOT= .538191   ZDOT=-2.39067
```

```
RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 30 SEC 0
STEP= 6
TIME= 1800       ALT= 6190.73    RANG= 9708.5    THR= 0
WT= 0            ACXB= 0         A= 24907.7      ECC= .737881
INCL= 25.9831    NODE= 215.984   ARGP= 180.128   MAN= 16.5585
RAD1 = 12598.8   LAT =-25.7202   LONG= 87.0143   VEL= 6.87552
ELEV= 39.0721    AZIM= 86.1812   RAPO= 43286.6   RPER= 6528.78
TAU = 652.017     VE = 5.3714    PITCH= 0        YAW= 0
HAPO= 36908.4    HPER= 150.622   WDOT= 0         VIMF= 0
PDOT= 0          YDOT= 0         VAPO= 1.55361   VPER= 10.3006
CAPE=-1.38915    VLOS= 0         MACH= 0         QH= 0
PATK= 0          YATK= 0         ATAK= 0         Q = 0
QALF= 0          TAN= 97.7435     X  =-7987.88    Y = 8064.1
Z  =-5467.61     XDOT=-6.64004   YDOT=-.864694   ZDOT=-1.56041

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 40 SEC 0
STEP= 7
TIME= 2400       ALT= 8714.64    RANG= 10795.4   THR= 0
WT= 0            ACXB= 0         A= 24904.       ECC= .737832
INCL= 25.984     NODE= 215.975   ARGP=-179.862   MAN= 22.0849
RAD1 = 15138.1   LAT =-24.3144   LONG= 97.7792   VEL= 6.05446
ELEV= 42.7979    AZIM= 80.5436   RAPO= 43278.9   RPER= 6529.03
TAU = 651.872     VE = 5.3714    PITCH= 0        YAW= 0
HAPO= 36900.8    HPER= 150.869   WDOT= 0         VIMF= 0
PDOT= 0          YDOT= 0         VAPO= 1.55389   VPER= 10.3003
CAPE=-1.49956    VLOS= 0         MACH= 0         QH= 0
PATK= 0          YATK= 0         ATAK= 0         Q = 0
QALF= 0          TAN= 109.845     X  =-11699.1    Y = 7310.48
Z  =-6233.       XDOT=-5.75605   YDOT=-1.5705    ZDOT=-1.02855

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 5 MIN 50 SEC 0
STEP= 8
TIME= 3000       ALT= 11086.2    RANG= 11501.2   THR= 0
WT= 0            ACXB= 0         A= 24902.3      ECC= .737807
INCL= 25.9849    NODE= 215.97    ARGP=-179.857   MAN= 27.6107
RAD1 = 17525.1   LAT =-22.6037   LONG= 104.573   VEL= 5.4298
ELEV= 45.03      AZIM= 76.8314   RAPO= 43275.4   RPER= 6529.21
TAU = 651.806     VE = 4.16569   PITCH= 0        YAW= 0
```

```
HAPO= 36897.2    HPER= 151.054    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55403    VPER= 10.3001
CAPE=-1.44877    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 118.545      X  =-14925.7     Y = 6243.32
Z  =-6735.83     XDOT=-5.02357    YDOT=-1.94892    ZDOT=-.669398

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 6 MIN 0 SEC 0
STEP= 9
TIME= 3600       ALT= 13294.7     RANG= 11978.3    THR= 0
WT= 0            ACXB= 0          A= 24901.4       ECC= .737792
INCL= 25.9857    NODE= 215.968    ARGP=-179.855    MAN= 33.1359
RAD1 = 19748.5   LAT =-20.9357    LONG= 109.022    VEL= 4.93563
ELEV= 46.3729    AZIM= 74.2473    RAPO= 43273.4    RPER= 6529.34
TAU = 651.771     VE = 4.16569    PITCH= 0         YAW= 0
HAPO= 36895.3    HPER= 151.184    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55411    VPER= 10.2999
CAPE=-1.38146    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 125.215      X  =-17752.8     Y = 5004.68
Z  =-7056.56     XDOT=-4.41885    YDOT=-2.15953    ZDOT=-.413094

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 6 MIN 10 SEC 0
STEP= 10
TIME= 4200       ALT= 15347.6     RANG= 12306.9    THR= 0
WT= 0            ACXB= 0          A= 24900.8       ECC= .737782
INCL= 25.9863    NODE= 215.966    ARGP=-179.853    MAN= 38.661
RAD1 = 21815.7   LAT =-19.3946    LONG= 111.985    VEL= 4.53156
ELEV= 47.1345    AZIM= 72.3595    RAPO= 43272.2    RPER= 6529.44
TAU = 651.749     VE = 3.38665    PITCH= 0         YAW= 0
HAPO= 36894.1    HPER= 151.278    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55416    VPER= 10.2998
CAPE=-1.32905    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 130.575      X  =-20247.8     Y = 3670.32
Z  =-7244.4      XDOT=-3.91194    YDOT=-2.27653    ZDOT=-.221763

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 6 MIN 20 SEC 0
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STEP= 11
TIME= 4800        ALT= 17256.5    RANG= 12532.6   THR= 0
WT= 0             ACXB= 0         A= 24900.5      ECC= .737776
INCL= 25.9867     NODE= 215.965   ARGP=-179.852   MAN= 44.1859
RAD1 = 23738.2    LAT =-17.9893   LONG= 113.946   VEL= 4.19229
ELEV= 47.4851     AZIM= 70.926    RAPO= 43271.4   RPER= 6529.51
TAU = 651.734      VE = 3.38665   PITCH= 0        YAW= 0
HAPO= 36893.3     HPER= 151.347   WDOT= 0         VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.55419   VPER= 10.2997
CAPE=-1.28934     VLOS= 0         MACH= 0         QH= 0
PATK= 0           YATK= 0         ATAK= 0         Q = 0
QALF= 0           TAN= 135.035     X  =-22461.9    Y = 2283.91
Z  =-7331.27      XDOT=-3.47932   YDOT=-2.33757   ZDOT=-7.37955e-2

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 6 MIN 40 SEC 0
STEP= 12
TIME= 6000        ALT= 20687.9    RANG= 12778.8   THR= 0
WT= 0             ACXB= 0         A= 24899.5      ECC= .737761
INCL= 25.9874     NODE= 215.963   ARGP=-179.851   MAN= 55.2372
RAD1 = 27194.4    LAT =-15.534    LONG= 115.936   VEL= 3.64782
ELEV= 47.3165     AZIM= 68.9027   RAPO= 43269.3   RPER= 6529.62
TAU = 651.694      VE = 2.48225   PITCH= 0        YAW= 0
HAPO= 36891.1     HPER= 151.459   WDOT= 0         VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.55428   VPER= 10.2996
CAPE=-1.23641     VLOS= 0         MACH= 0         QH= 0
PATK= 0           YATK= 0         ATAK= 0         Q = 0
QALF= 0           TAN= 142.175     X  =-26195.3    Y =-547.509
Z  =-7282.92      XDOT=-2.77316   YDOT=-2.36573   ZDOT= .139515

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 7 MIN 0 SEC 0
STEP= 13
TIME= 7200        ALT= 23668.2    RANG= 12847.    THR= 0
WT= 0             ACXB= 0         A= 24899.       ECC= .737753
INCL= 25.9879     NODE= 215.963   ARGP=-179.851   MAN= 66.2876
RAD1 = 30196.6    LAT =-13.4489   LONG= 116.31    VEL= 3.22362
ELEV= 46.2995     AZIM= 67.5527   RAPO= 43268.3   RPER= 6529.68
TAU = 651.677      VE = 2.48225   PITCH= 0        YAW= 0
HAPO= 36890.2     HPER= 151.521   WDOT= 0         VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.55432   VPER= 10.2995
CAPE=-1.20601     VLOS= 0         MACH= 0         QH= 0
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```
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 147.792      X  =-29174.8     Y =-3367.95
Z  =-7023.05     XDOT=-2.21211    YDOT=-2.32745    ZDOT= .28505

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 7 MIN 20 SEC 0
STEP= 14
TIME= 8400       ALT= 26256.9     RANG= 12801.6    THR= 0
WT= 0            ACXB= 0          A= 24898.7       ECC= .737749
INCL= 25.9882    NODE= 215.962    ARGP=-179.85     MAN= 77.3376
RAD1 = 32804.6   LAT =-11.6332    LONG= 115.692    VEL= 2.8797
ELEV= 44.609     AZIM= 66.5973    RAPO= 43267.8    RPER= 6529.72
TAU = 651.667     VE = 2.06167    PITCH= 0         YAW= 0
HAPO= 36889.6    HPER= 151.562    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55434    VPER= 10.2995
CAPE=-1.1888     VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 152.451      X  =-31542.5     Y =-6120.19
Z  =-6614.92     XDOT=-1.74732    YDOT=-2.25558    ZDOT= .389763

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 7 MIN 40 SEC 0
STEP= 15
TIME= 9600       ALT= 28498.3     RANG= 12678.7    THR= 0
WT= 0            ACXB= 0          A= 24898.6       ECC= .737746
INCL= 25.9885    NODE= 215.962    ARGP=-179.85     MAN= 88.3875
RAD1 = 35062.8   LAT =-10.016     LONG= 114.418    VEL= 2.59373
ELEV= 42.311     AZIM= 65.8944    RAPO= 43267.4    RPER= 6529.75
TAU = 651.66      VE = 2.06167    PITCH= 0         YAW= 0
HAPO= 36889.3    HPER= 151.592    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55435    VPER= 10.2995
CAPE=-1.17912    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 156.465      X  =-33395.      Y =-8773.89
Z  =-6098.2      XDOT=-1.34982    YDOT=-2.16486    ZDOT= .467775

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 8 MIN 0 SEC 0
STEP= 16
TIME= 10800      ALT= 30425.5     RANG= 12500.9    THR= 0
WT= 0            ACXB= 0          A= 24898.5       ECC= .737744
```

```
INCL= 25.9886    NODE= 215.962    ARGP=-179.851    MAN= 99.4373
RAD1 = 37004.5   LAT =-8.54703    LONG= 112.689    VEL= 2.35252
ELEV= 39.4169    AZIM= 65.3642    RAPO= 43267.2    RPER= 6529.78
TAU = 651.656     VE = 1.90232    PITCH= 0         YAW= 0
HAPO= 36889.     HPER= 151.617    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55436    VPER= 10.2994
CAPE=-1.17321    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 160.024      X  =-34801.5     Y =-11311.2
Z  =-5499.66     XDOT=-1.00126    YDOT=-2.0625     ZDOT= .527175

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 8 MIN 20 SEC 0
STEP= 17
TIME= 12000      ALT= 32063.7     RANG= 12283.     THR= 0
WT= 0            ACXB= 0          A= 24898.4       ECC= .737742
INCL= 25.9888    NODE= 215.962    ARGP=-179.851    MAN= 110.487
RAD1 = 38655.1   LAT =-7.19051    LONG= 110.633    VEL= 2.14811
ELEV= 35.9106    AZIM= 64.959     RAPO= 43267.     RPER= 6529.8
TAU = 651.653     VE = 1.90232    PITCH= 0         YAW= 0
HAPO= 36888.8    HPER= 151.641    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55437    VPER= 10.2994
CAPE=-1.1684     VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 163.253      X  =-35812.7     Y =-13720.7
Z  =-4838.42     XDOT=-.689402    YDOT=-1.95214    ZDOT= .572916

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 8 MIN 40 SEC 0
STEP= 18
TIME= 13200      ALT= 33432.2     RANG= 12035.4    THR= 0
WT= 0            ACXB= 0          A= 24898.4       ECC= .737741
INCL= 25.9889    NODE= 215.962    ARGP=-179.851    MAN= 121.537
RAD1 = 40033.9   LAT =-5.91964    LONG= 108.338    VEL= 1.97586
ELEV= 31.7652    AZIM= 64.6485    RAPO= 43266.9    RPER= 6529.83
TAU = 651.651     VE = 1.86831    PITCH= 0         YAW= 0
HAPO= 36888.7    HPER= 151.667    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55438    VPER= 10.2994
CAPE=-1.16271    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 166.238      X  =-36467.3     Y =-15993.9
Z  =-4128.83     XDOT=-.405681    YDOT=-1.83564    ZDOT= .608174
```

```
RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 9 MIN 0 SEC 0
STEP= 19
TIME= 14400      ALT= 34545.6     RANG= 11765.7    THR= 0
WT= 0            ACXB= 0          A= 24898.3       ECC= .737739
INCL= 25.989     NODE= 215.962    ARGP=-179.851    MAN= 132.587
RAD1 = 41155.8   LAT =-4.71382    LONG= 105.866    VEL= 1.83336
ELEV= 26.9599    AZIM= 64.4128    RAPO= 43266.8    RPER= 6529.86
TAU = 651.65      VE = 1.86831    PITCH= 0         YAW= 0
HAPO= 36888.6    HPER= 151.696    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55439    VPER= 10.2993
CAPE=-1.15471    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 169.042      X  =-36795.1     Y =-18124.1
Z  =-3382.14     XDOT=-.143886    YDOT=-1.71383    ZDOT= .635055

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 9 MIN 20 SEC 0
STEP= 20
TIME= 15600      ALT= 35415.2     RANG= 11479.7    THR= 0
WT= 0            ACXB= 0          A= 24898.3       ECC= .737738
INCL= 25.989     NODE= 215.962    ARGP=-179.851    MAN= 143.636
RAD1 = 42032.    LAT =-3.55666    LONG= 103.265    VEL= 1.71971
ELEV= 21.4995    AZIM= 64.2387    RAPO= 43266.7    RPER= 6529.89
TAU = 651.649     VE = 1.87656    PITCH= 0         YAW= 0
HAPO= 36888.5    HPER= 151.728    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55439    VPER= 10.2993
CAPE=-1.14342    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN= 171.712      X  =-36819.5     Y =-20105.1
Z  =-2607.48     XDOT= .100651    YDOT=-1.58691    ZDOT= .654981

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 9 MIN 40 SEC 0
STEP= 21
TIME= 16800      ALT= 36049.1     RANG= 11182.2    THR= 0
WT= 0            ACXB= 0          A= 24898.3       ECC= .737736
INCL= 25.989     NODE= 215.962    ARGP=-179.851    MAN= 154.686
RAD1 = 42670.7   LAT =-2.43456    LONG= 100.574    VEL= 1.63508
ELEV= 15.4348    AZIM= 64.1174    RAPO= 43266.7    RPER= 6529.92
```

```
TAU = 651.649     VE = 1.87656    PITCH= 0          YAW= 0
HAPO= 36888.5     HPER= 151.764   WDOT= 0           VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.5544      VPER= 10.2993
CAPE=-1.12828     VLOS= 0         MACH= 0           QH= 0
PATK= 0           YATK= 0         ATAK= 0           Q = 0
QALF= 0           TAN= 174.288     X  =-36558.9      Y =-21930.6
Z  =-1812.58      XDOT= .331547   YDOT=-1.45468     ZDOT= .66891

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 10 MIN 0 SEC 0
STEP= 22
TIME= 18000       ALT= 36453.2    RANG= 10877.1     THR= 0
WT= 0             ACXB= 0         A= 24898.3        ECC= .737735
INCL= 25.989      NODE= 215.962   ARGP=-179.851     MAN= 165.736
RAD1 = 43077.9    LAT =-1.33581   LONG= 97.8215     VEL= 1.58016
ELEV= 8.88074     AZIM= 64.043    RAPO= 43266.6     RPER= 6529.96
TAU = 651.649     VE = 1.88504    PITCH= 0          YAW= 0
HAPO= 36888.5     HPER= 151.803   WDOT= 0           VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.5544      VPER= 10.2993
CAPE=-1.1091      VLOS= 0         MACH= 0           QH= 0
PATK= 0           YATK= 0         ATAK= 0           Q = 0
QALF= 0           TAN= 176.802     X  =-36028.       Y =-23594.
Z  =-1004.24      XDOT= .551688   YDOT=-1.31665     ZDOT= .677466

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 10 MIN 20 SEC 0
STEP= 23
TIME= 19200       ALT= 36631.     RANG= 10567.6     THR= 0
WT= 0             ACXB= 0         A= 24898.3        ECC= .737733
INCL= 25.989      NODE= 215.962   ARGP=-179.851     MAN= 176.785
RAD1 = 43257.     LAT =-.24989    LONG= 95.0369     VEL= 1.55572
ELEV= 2.02053     AZIM= 64.0122   RAPO= 43266.6     RPER= 6530.01
TAU = 651.65      VE = 1.88504    PITCH= 0          YAW= 0
HAPO= 36888.5     HPER= 151.847   WDOT= 0           VIMF= 0
PDOT= 0           YDOT= 0         VAPO= 1.55441     VPER= 10.2992
CAPE=-1.08598     VLOS= 0         MACH= 0           QH= 0
PATK= 0           YATK= 0         ATAK= 0           Q = 0
QALF= 0           TAN= 179.281     X  =-35238.2      Y =-25087.9
Z  =-188.66       XDOT= .763443   YDOT=-1.17202     ZDOT= .681016

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
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```
AUG 17  1974 HOUR 10 MIN 40 SEC 0
STEP= 24
TIME= 20400      ALT= 36584.1     RANG= 10257.2    THR= 0
WT= 0            ACXB= 0          A= 24898.3       ECC= .737731
INCL= 25.9889    NODE= 215.962    ARGP=-179.852    MAN= 187.835
RAD1 = 43209.7   LAT = .8331      LONG= 92.2451    VEL= 1.5622
ELEV=-4.91205    AZIM= 64.0235    RAPO= 43266.6    RPER= 6530.05
TAU = 651.651     VE = 1.87966    PITCH= 0         YAW= 0
HAPO= 36888.5    HPER= 151.894    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55441    VPER= 10.2992
CAPE=-1.05923    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN=-178.247      X  =-34198.3     Y =-26403.8
Z  = 628.262     XDOT= .968811    YDOT=-1.01973    ZDOT= .679715

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 11 MIN 0 SEC 0
STEP= 25
TIME= 21600      ALT= 36312.      RANG= 9948.81    THR= 0
WT= 0            ACXB= 0          A= 24898.4       ECC= .73773
INCL= 25.9888    NODE= 215.962    ARGP=-179.852    MAN= 198.885
RAD1 = 42935.5   LAT = 1.92292    LONG= 89.4712    VEL= 1.59947
ELEV=-11.6703    AZIM= 64.0775    RAPO= 43266.6    RPER= 6530.1
TAU = 651.652     VE = 1.87966    PITCH= 0         YAW= 0
HAPO= 36888.5    HPER= 151.943    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55442    VPER= 10.2991
CAPE=-1.02932    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN=-175.756      X  =-32914.9     Y =-27531.7
Z  = 1440.7      XDOT= 1.16953    YDOT=-.858408    ZDOT= .673519

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 11 MIN 20 SEC 0
STEP= 26
TIME= 22800      ALT= 35812.4     RANG= 9645.73    THR= 0
WT= 0            ACXB= 0          A= 24898.4       ECC= .737728
INCL= 25.9887    NODE= 215.962    ARGP=-179.852    MAN= 209.934
RAD1 = 42432.1   LAT = 3.02965    LONG= 86.7413    VEL= 1.66692
ELEV=-18.0379    AZIM= 64.1763    RAPO= 43266.7    RPER= 6530.15
TAU = 651.654     VE = 1.86804    PITCH= 0         YAW= 0
HAPO= 36888.5    HPER= 151.993    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55442    VPER= 10.2991
```

```
CAPE=-.996793   VLOS= 0          MACH= 0          QH= 0
PATK= 0         YATK= 0          ATAK= 0          Q = 0
QALF= 0         TAN=-173.22       X  =-31392.7     Y =-28459.7
Z  = 2242.65    XDOT= 1.36716    YDOT=-.686308    ZDOT= .662183

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 11 MIN 40 SEC 0
STEP= 27
TIME= 24000     ALT= 35080.8     RANG= 9351.5     THR= 0
WT= 0           ACXB= 0          A= 24898.5       ECC= .737727
INCL= 25.9885   NODE= 215.962    ARGP=-179.852    MAN= 220.984
RAD1 = 41694.9  LAT = 4.16423    LONG= 84.0841    VEL= 1.76375
ELEV=-23.8597   AZIM= 64.3243    RAPO= 43266.7    RPER= 6530.2
TAU = 651.656    VE = 1.86804    PITCH= 0         YAW= 0
HAPO= 36888.6   HPER= 152.044    WDOT= 0          VIMF= 0
PDOT= 0         YDOT= 0          VAPO= 1.55442    VPER= 10.299
CAPE=-.962237   VLOS= 0          MACH= 0          QH= 0
PATK= 0         YATK= 0          ATAK= 0          Q = 0
QALF= 0         TAN=-170.609      X  =-29634.4     Y =-29173.6
Z  = 3027.7     XDOT= 1.56311    YDOT=-.501195    ZDOT= .645233

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 12 MIN 0 SEC 0
STEP= 28
TIME= 25200     ALT= 34110.4     RANG= 9070.24    THR= 0
WT= 0           ACXB= 0          A= 24898.5       ECC= .737725
INCL= 25.9884   NODE= 215.961    ARGP=-179.852    MAN= 232.033
RAD1 = 40717.2  LAT = 5.33901    LONG= 81.5334    VEL= 1.88944
ELEV=-29.0489   AZIM= 64.5286    RAPO= 43266.8    RPER= 6530.25
TAU = 651.658    VE = 1.88297    PITCH= 0         YAW= 0
HAPO= 36888.6   HPER= 152.093    WDOT= 0          VIMF= 0
PDOT= 0         YDOT= 0          VAPO= 1.55443    VPER= 10.299
CAPE=-.926272   VLOS= 0          MACH= 0          QH= 0
PATK= 0         YATK= 0          ATAK= 0          Q = 0
QALF= 0         TAN=-167.888      X  =-27641.4     Y =-29656.2
Z  = 3788.67    XDOT= 1.75872    YDOT=-.30018     ZDOT= .621911

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 12 MIN 20 SEC 0
STEP= 29
TIME= 26400     ALT= 32891.9     RANG= 8806.93    THR= 0
```

```
WT= 0            ACXB= 0          A= 24898.6       ECC= .737724
INCL= 25.9882    NODE= 215.961    ARGP=-179.852    MAN= 243.083
RAD1 = 39489.4   LAT = 6.56857    LONG= 79.1302    VEL= 2.0442
ELEV=-33.5766    AZIM= 64.7996    RAPO= 43266.9    RPER= 6530.3
TAU = 651.661     VE = 1.88297    PITCH= 0         YAW= 0
HAPO= 36888.7    HPER= 152.139    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55443    VPER= 10.299
CAPE=-.889546    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN=-165.015      X  =-25413.1     Y =-29886.2
Z  = 4517.29     XDOT= 1.95527    YDOT=-.079459    ZDOT= .591078

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 12 MIN 40 SEC 0
STEP= 30
TIME= 27600      ALT= 31412.8     RANG= 8567.95    THR= 0
WT= 0            ACXB= 0          A= 24898.7       ECC= .737723
INCL= 25.9879    NODE= 215.961    ARGP=-179.853    MAN= 254.132
RAD1 = 37999.1   LAT = 7.87082    LONG= 76.9279    VEL= 2.22948
ELEV=-37.4512    AZIM= 65.1532    RAPO= 43267.     RPER= 6530.34
TAU = 651.664     VE = 1.99424    PITCH= 0         YAW= 0
HAPO= 36888.9    HPER= 152.179    WDOT= 0          VIMF= 0
PDOT= 0          YDOT= 0          VAPO= 1.55443    VPER= 10.2989
CAPE=-.852755    VLOS= 0          MACH= 0          QH= 0
PATK= 0          YATK= 0          ATAK= 0          Q = 0
QALF= 0          TAN=-161.936      X  =-22947.9     Y =-29837.
Z  = 5203.59     XDOT= 2.15392    YDOT= .166088    ZDOT= .551051

RIMP=0  TIMP=0  LATI=0  LONI=0
VILI=0  ELVI=0
AUG 17  1974 HOUR 13 MIN 0 SEC 0
STEP= 31
```