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PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST)

Volume II - Utilization Manual

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FOREWORD

THIS FINAL REPORT DESCRIBING THE FORMULATION OF THE PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST) IS PROVIDED IN ACCORDANCE WITH PART 3.6 OF NASA CONTRACT NAS1-13611. THE REPORT IS PRESENTED IN THREE VOLUMES AS FOLLOWS -

VOLUME 1	-	PROGRAM TO OPTIMIZE SIMULATED TRAJ-ECTORIES - FORMULATION MANUAL
VOLUME 2	-	PROGRAM TO OPTIMIZE SIMULATED TRAJ-ECTORIES - UTILIZATION MANUAL
VOLUME 3	-	PROGRAM TO OPTIMIZE SIMULATED TRAJ-ECTORIES - PROGRAMMERS MANUAL

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CONTENTS (CONTD)

ABBREVIATIONS

SEVERAL ABBREVIATIONS ARE USED IN THIS DOCUMENT TO SPECIFY THE UNITS OF THE INPUT AND OUTPUT VARIABLES. THIS SECTION PRESENTS THE LIST OF ABBREVIATIONS USED AND THE CORRESPONDING DEFINTIONS.

ABBREVIATION	DEFINITION
DEG	ANGULAR DEGREES
DEG K	DEGREES KELVIN
DEG R	DEGREES RANKINE
FT	FEET
FT2,FT**2	FEET SQUARED
FT3,FT**3	FEET CUBED
J	JOULE
KG	KILOGRAM
KM	KILOMETER
M	METER
M2	METER SQUARED
M3	METER CUBED
MHZ	MEGAHERTZ
N	NEWTON
N/D	NON-DIMENSIONAL
N.MI.	NAUTICAL MILE
RAD	RADIAN
S,SEC	SECOND
S2,SEC**2	SECOND SQUARED
T/O	TARGETING/OPTIMIZATION
W	WATT

1. SUMMARY

THIS VOLUME PROVIDES INFORMATION PERTINENT TO USERS OF THE PROGRAM. IT DESCRIBES THE INPUT REQUIRED AND OUTPUT AVAILABLE FOR EACH OF THE TRAJECTORY AND TARGETING/OPTIMIZATION OPTIONS. A SAMPLE INPUT LISTING AND THE RESULTING OUTPUT ARE ALSO PRESENTED.

THE PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST) IS A GENERALIZED POINT MASS, DISCRETE PARAMETER TARGEING AND OPTIMIZATION PROGRAM. POST PROVIDES THE CAPABILITY TO TARGET AND OPTIMIZE POINT MASS TRAJECTORIES FOR A POWERED OR UNPOWERED VEHICLE NEAR AN ARBITRARY ROTATING, OBLATE PLANET. POST HAS BEEN USED SUCCESSFULLY TO SOLVE A WIDE VARIETY OF ATMOSPHERIC ASCENT AND REENTRY PROBLEMS, AS WELL AS EXOATMOSPHERIC ORBITAL TRANSFER PROBLEMS. THE GENERALITY OF THE PROGRAM IS EVIDENCED BY ITS N-PHASE SIMULATION CAPABILITY WHICH FEATURES GENERALIZED PLANET AND VEHICLE MODELS. THIS FLEXIBLE SIMULATION CAPABILITY IS AUGMENTED BY AN EFFICIENT DISCRETE PARAMETER OPTIMIZATION CAPABILITY WHICH INCLUDES EQUALITY AND INEQUALITY CONSTRAINTS.

POST WAS ORIGINALLY WRITTEN IN FORTRAN IV FOR THE CDC 6000 SERIES COMPUTERS. HOWEVER, SOME VERSIONS ARE ALSO OPERATIONAL ON THE IBM 370 AND UNIVAC 1108 COMPUTERS.

OTHER VOLUMES IN THE FINAL REPORT ARE:

VOLUME I - FORMULATION MANUAL - DOCUMENTS THE EQUATIONS AND NUMERICAL TECHNIQUES USED IN POST.

VOLUME III - PROGRAMERS MANUAL - DOCUMENTS THE PROGRAM STRUCTURE AND LOGIC, SUBROUTINE DESCRIPTIONS, AND OTHER PERTINENT PROGRAMING INFORMATION.

2. INTRODUCTION

THE PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST) WAS DEVELOPED TO PROVIDE THE CAPABILITY TO SIMULATE AND OPTIMIZE ASCENT AND REENTRY TRAJECTORIES FOR SHUTTLE TYPE VEHICLES. HOWEVER, THE GENERALITY OF THE PROGRAM ALSO ALLOWS VARIOUS OTHER TYPES OF VEHICLES TO BE SIMULATED.

THE PROGRAM WAS WRITTEN ACCORDING TO GUIDLINES DESIGNED TO PROVIDE COMPLETE GENERALITY WHEREVER POSSIBLE WITHOUT SACRIFICING COMPUTATIONAL SPEED OR COMPUTER STORAGE. THE GUIDLINES ADHERED TO ARE -

1) COMPUTER CORE SIZE OF APPROXIMATELY 70000 OCTAL,
2) FORTRAN IV PROGRAMMING LANGUAGE,
3) MINIMUM PROGRAM EXECUTION TIME,
4) MODULAR PROGRAM CONSTRUCTION,
5) GENERALIZED ROUTINES TO ALLOW SIMULATION OF VARIOUS TYPES OF VEHICLES,
6) GENERALITY OF INPUT, OUTPUT, TARGETING AND STOPPING VARIABLES,
7) COMPATIBILITY OF OPERATION ON BOTH 6500 AND 6600 CDC COMPUTERS USING THE SCOPE OPERATING SYSTEM.

INFORMATION PERTINENT TO THE USER IS PRESENTED IN THE FOLLOWING SECTIONS OF THIS REPORT. INCLUDED ARE DESCRIPTIONS OF THE INPUT AND OUTPUT, A SAMPLE INPUT LISTING AND THE RESULTING COMPUTER RUN PRINTOUT.

3. GENERAL INFORMATION

THIS SECTION DISCUSSES PROCEDURES FOR NEW USERS, THE INPUT FORMAT, THE HOLLERITH INPUT SYMBOLS, AND DEFINITIONS OF THE VARIOUS COORDINATE SYSTEM USED IN THE PROGRAM.

3.A. PROCEDURES FOR NEW USERS

THE FOLLOWING DISCUSSION GIVES THE STEPS TO BE TAKEN IN FORMULATING A PROBLEM AS AN AID TO USERS WHO ARE NOT FAMILIAR WITH THE PROGRAM INPUT PROCEDURE.

1) DETERMINE THE SEQUENCE OF EVENTS WHICH WILL DESCRIBE THE PROBLEM ACCORDING TO THE INSTRUCTIONS IN THE SECTION ENTITLED EVENT CRITERIA/PHASE DEFINITION.

2) IF THIS IS NOT A TARGETING/OPTIMIZATION TYPE PROBLEM, GO TO STEP 3, OTHERWISE DEFINE THE CONTROL PARAMETERS, TARGET CONDITIONS, INEQUALITY CONSTRAINTS, AND OPTIMIZATION INPUTS ACCORDING TO THE INSTRUCTIONS IN THE SECTION ENTITLED TARGETING/OPTIMIZATION INPUTS.

3) SET UP THE PROPER NAMELIST INPUT SEQUENCE (EXCLUDING TABLES) ACCORDING TO THE SECTION ENTITLED NAMELIST INPUT SEQUENCE.

4) SPECIFY THE APPROPRIATE PARAMETERS IN THE FIRST PHASE FROM THE FOLLOWING SECTIONS -

   A) EVENT CRITERIA/PHASE DEFINITION INPUTS
   B) NUMERICAL INTEGRATION METHODS
   C) INITIAL POSITION AND VELOCITY
   D) VEHICLE/PROPELLANT WEIGHT INPUTS
   E) METHODS OF GUIDANCE (STEERING)
   F) PRINT VARIABLE REQUESTS
   G) ANY OTHER APPROPRIATE INPUTS FOR THE DESIRED OPTIONS DESCRIBED IN THE SECTION ENTITLED GENERAL SIMULATION OPTIONS.

5) DETERMINE THE TABLES TO BE INPUT (IF ANY) BASED ON THE OPTIONS SELECTED IN STEP 4. INCLUDE THE APPROPRIATE NAMELISTS FOR TABLES AS REQUIRED ACCORDING TO THE SECTION ENTITLED NAMELIST INPUT SEQUENCE.

6) DETERMINE THE INPUTS REQUIRED FOR PHASES AS IN STEPS 4 AND 5 ABOVE.

7) SET UP THE REQUIRED CONTROL CARDS ACCORDING TO THE PROCEDURES DICTATED BY THE COMPUTER AND OPERATING SYSTEM BEING USED.

3.A. PROCEDURES FOR NEW USERS (CONTD)

8) COMPARE THE RESULTING INPUT DECK WITH THAT IN THE SECTION ENTITLED SAMPLE INPUT/OUTPUT TO ENSURE THAT THE NAMELISTS ARE IN THE PROPER SEQUENCE, ETC.

9) SUBMIT THE JOB AND SEE WHETHER THERE ARE ANY INPUT ERRORS OR IF THE DESIRED TRAJECTORY SEQUENCE WAS OBTAINED. CORRECT ALL INPUT ERRORS AND RESUBMIT UNTIL THE DESIRED RESULTS ARE OBTAINED.

3.B. NAMELIST INPUT FORMAT

ALL PROGRAM INPUTS ARE MADE USING THE NAMELIST INPUT CAPABILITY.

THE NAMELIST INPUT FORMAT ALLOWS CARD COLUMNS 2 THRU 80 TO BE USED FOR INPUT. EACH VARIABLE INPUT MUST BE FOLLOWED BY A COMMA BEFORE THE NEXT VARIABLE IS INPUT. THE VARIABLES ARE INPUT AS FOLLOWS -

```
NAME1 = VALUE1, NAME2 = VALUE2, ETC.
```

VARIABLES MAY BE INPUT ONE TO A CARD OR SEVERAL TO A CARD DEPENDING ON USER PREFERENCE.

SUBSCRIPTED VARIABLES MAY BE INPUT AS AN ARRAY OR AS INDIVIDUAL ELEMENTS. THE FIRST ELEMENT OF THE ARRAY IS ASSUMED IF NO SUBSCRIPT IS PRESENT ON A SUBSCRIPTED INPUT VARIABLE. THE FOLLOWING EXAMPLE SHOWS VARIOUS METHODS OF INPUT WHICH ARE ALL EQUIVALENT -

```
EVENT = 1.0, 1.0,

      OR

EVENT(1) = 1.0, EVENT(2) = 1.0,

      OR

EVENT = 1.0, EVENT(2) = 1.0,
```

IN GENERAL, DECIMAL POINTS SHOULD NOT BE USED WITH INTEGER TYPE VARIABLES. IN ANY CASE, IF NO DECIMAL POINT IS INPUT FOR A VARIABLE, THE DECIMAL IS ASSUMED TO BE AFTER THE LAST DIGIT FOR THAT VARIABLE. AS A RESULT, IT IS BEST TO OMIT DECIMAL POINTS FOR ALL VARIABLES UNLESS REQUIRED.

THE NAMELIST USED IN POST IS AN EXTENSION OF THE STANDARD FORTRAN NAMELIST AND HAS THE FOLLOWING ADDED CAPABILITIES.

1. SPECIAL LIST OPTIONS.

   THE INITIAL DOLLAR FOR EACH NAMELIST INPUT MAY BE PRECEEDED IN COLUMN 1 BY ANY OF THREE PRINT CONTROL CHARACTERS AS FOLLOWS -

   BLANK WILL PRODUCE A CARD IMAGE PRINT ONLY FOR CARDS ON WHICH ERRORS WERE DETECTED.

3.B. NAMELIST INPUT FORMAT (CONTD)

P WILL PRODUCE A PRINT OF EACH CARD ENCOUNTERED ON THE INPUT FILE.

L WILL PRINT EACH CARD ENCOUNTERED ON THE INPUT FILE, BUT WILL ALSO INSERT THE CARD COUNT AFTER THE CARD IMAGE.

2. EMBEDDED COMMENT CARDS.

   C OR SLASH IN COLUMN 1 OF ANY CARD WILL CAUSE THE CARD TO BE TREATED AS A COMMENT. FURTHERMORE, WHEN A SLASH IS ENCOUNTERED IN ANY OTHER COLUMN, THE SLASH AND THE REMAINDER OF THE CARD TO THE RIGHT OF THE SLASH WILL BE TREATED AS A COMMENT.

3. SPECIAL HOLLERITH STRINGS.

   HOLLERITH STRINGS MAY BE INPUT AS OHXSTRINGX WHERE STRING IS THE HOLLERITH CHARACTER STRING AND X IS ANY CHARACTER NOT CONTAINED IN STRING. FOR EXAMPLE, TO INPUT THE HOLLERITH CHARACTERS ABCDEF111X IN VARIABLE W , W = OH*ABCDEF111X*, WOULD BE ACCEPTABLE. THE SYMBOL 0 FOR THIS OPTION IS THE NUMBER ZERO.

4. REPEATED SPECIFICATION.

   THE FOLLOWING NOTATION MAY BE USED TO REPEAT A PARAMETER VALUE IN ANY NUMBER OF SUCCESSIVE ARRAY LOCATIONS. M*XXX, WHERE XXX CAN BE EITHER REAL, INTEGER, HOLLERITH LOGICAL, OR OCTAL INPUT PARAMETER VALUES AND WHERE M IS THE NUMBER OF SUCCESSIVE LOCATIONS IN ANY ARRAY WHERE XXX IS TO BE STORED. FOR EXAMPLE, X = 10*1., WOULD SET X(1) THROUGH X(10) = 1.

5. IMPROVED ERROR DIAGNOSTICS.

   THE EXTENDED NAMELIST PRINTS A DIAGNOSTIC BELOW ANY CARD IN ERROR WITH AN ARROW POINTING TO THE ERRONEOUS COLUMN ON THE CARD.

3.B.I. NAMELIST INPUT SEQUENCE

ALL VARIABLES REQUIRED BY THE PROGRAM AS INPUT ARE INPUT VIA NAMELISTS ACCORDING TO THE TYPE OF INPUT BEING PROCESSED. THE FOUR (4) NAMELISTS USED IN THE INPUT PROCESS ARE -

1) SEARCH - READ ONCE PER PROBLEM. IT CONTAINS ALL INPUT REQUIRED FOR THE TARGETING/OPTIMIZATION OPTION PLUS ALL OTHER DATA CAPABLE OF BEING INPUT ONLY ONCE PER PROBLEM, SUCH AS CONVERSION CONSTANTS, ETC.

2) GENDAT - READ ONCE PER PHASE. IT CONTAINS ALL CONSTANT INPUT DATA REQUIRED TO DESCRIBE THE CURRENT PHASE. THESE INPUTS DESCRIBE SUCH THINGS AS THE PROGRAM CONTROLS TO BE USED, THE VEHICLE PHYSICAL CHARACTERISTICS, THE ATTITUDE CONTROL LAW (GUIDANCE) TO BE USED, ETC.

3) TBLMLT - READ ONCE PER PHASE PROVIDED THE VALUE OF THE VARIABLE ENDPHS IN NAMELIST GENDAT IS EQUAL TO ZERO. OTHERWISE IT IS NOT READ FOR THAT PHASE. IT CONTAINS ALL TABLE MULTIPLIERS ASSOCIATED WITH THE TABLES BEING INPUT. EVERY TABLE IN THE PROGRAM HAS ITS OWN NUMERIC TABLE MULTIPLIER. NOTE - THIS NAMELIST MUST BE INPUT IN A PHASE IF ANY TABLES ARE TO BE INPUT FOR THAT PHASE EVEN IF THERE ARE NO TABLE MULTIPLIERS TO BE INPUT. THIS NAMELIST IS INPUT AFTER NAMELIST GENDAT.

4) TAB - READ ONCE PER TABLE FOR EACH PHASE PROVIDED THE VALUE OF THE VARIABLE ENDPHS IN TBLMLT IS EQUAL TO ZERO IN THAT PHASE. OTHERWISE IT IS NOT READ FOR THAT PHASE. NOTE - IF TABLES ARE TO BE INPUT IN A PHASE, THE NAMELIST TBLMLT MUST BE INPUT IMMEDIATELY FOLLOWING NAMELIST GENDAT FOR THAT PHASE. THE TABLES ARE THEN INPUT IN NAMELIST TAB WITH AN INPUT OF NAMELIST TAB REQUIRED FOR EACH TABLE BEING INPUT.

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3.B.1. NAMELIST INPUT SEQUENCE (CONTD)

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THE SEQUENCE IN WHICH THE NAMELISTS ARE INPUT IS ALWAYS THE SAME AS FAR AS NAMELISTS SEARCH AND GENDAT ARE CONCERNED. NAMELIST SEARCH IS THE FIRST TO BE INPUT FOR A GIVEN PROBLEM FOLLOWED BY AN INPUT OF NAMELIST GENDAT FOR EACH PHASE OF THE PROBLEM. THE OTHER NAMELISTS (TBLMLT AND TAB) ARE ONLY REQUIRED IN A GIVEN PHASE IF TABLES OR TABLE MULTIPLIERS ARE TO BE INPUT FOR THAT PHASE. IF THE VARIABLE ENDPHS IS NOT INPUT IN NAMELIST GENDAT FOR A GIVEN PHASE, NAMELIST TBLMLT MUST THEN BE INPUT FOR THAT PHASE IMMEDIATELY AFTER NAMELIST GENDAT. FURTHER, IF THE VARIABLE ENDPHS IS NOT INPUT IN NAMELIST TBLMLT AN INPUT OF NAMELIST TAB MUST BE MADE FOR EACH TABLE BEING INPUT. THE LAST NAMELIST TAB THEN MUST CONTAIN THE VARIABLE ENDPHS=1. NAMELIST GENDAT IS THEN INPUT FOR THE NEXT PHASE UNLESS THE VARIABLE ENDPRB=1 IS INPUT IN THAT PHASE. IN THIS CASE, NAMELIST SEARCH IS THEN INPUT FOR THE NEXT PROBLEM.

AN EXAMPLE OF THE NAMELIST INPUT SEQUENCE IS SHOWN BELOW FOR A TYPICAL PROBLEM WHICH CONTAINS TWO PHASES. NOTICE THAT THERE ARE THREE EVENTS REQUIRED TO SIMULATE A TWO PHASE PROBLEM SINCE AN EVENT BEGINS THE CORRESPONDING PHASE.

```
P$SEARCH
 .          INPUT DATA FOR SEARCH/OPTIMIZATION
 .          (REQUIRED ONLY ONCE PER PROBLEM)
 .
 $
P$GENDAT
 .          GENERAL INPUT DATA FOR THE FIRST PHASE.  INPUT
 .          THE VARIABLE EVENT(1)=1.0, IN THIS NAMELIST.
 .
 $
P$TBLMLT
 .          TABLE MULTIPLIERS FOR THE FIRST PHASE.  THIS
 .          NAMELIST MUST BE INPUT SINCE TABLES ARE BEING
 .          INPUT IN THIS PHASE EVEN THOUGH THERE MAY NOT BE
 .          ANY MULTIPLIERS INPUT FOR THIS PHASE.
 $
P$TAB
 .          TABLE INPUT DATA FOR THE FIRST TABLE BEING INPUT
 .          FOR THIS PHASE.
 .
 $
```

```
P$TAB
 .         TABLE INPUT DATA FOR THE SECOND TABLE BEING
 .         INPUT FOR THIS PHASE.  ASSUME THAT THIS IS THE
 .         LAST TABLE TO BE INPUT FOR THIS PHASE.  IN THIS
 .         CASE, THE VARIABLE ENDPHS=1, WOULD BE INPUT IN
 .         THIS NAMELIST.
 $
P$GENDAT
 .         GENERAL INPUT DATA FOR THE SECOND PHASE.  ASSUME
 .         THAT THERE ARE NO NEW TABLES TO BE INPUT FOR
 .         THIS PHASE.  IN THIS CASE, THE VARIABLE ENDPHS=1,
 .         WOULD BE INPUT IN THIS NAMELIST.
 $
P$GENDAT
 .         GENERAL INPUT DATA FOR THE THIRD PHASE.  ASSUME
 .         THAT THIS IS THE LAST PHASE OF A SINGLE RUN JOB.
 .         IN THIS CASE, ENDPHS=1, ENDPRB=1, AND ENDJOB=1,
 .         WOULD BE INPUT IN THIS NAMELIST.
 $
```

3.C. HOLLERITH INPUT SYMBOLS

CERTAIN INPUT VARIABLES ARE USED WHICH REFER TO AN ALPHA-NUMERIC (MNEMONIC) NAME OF A VARIABLE. IN THESE INSTANCES THE HOLLERITH (BCD) NAME OF A VARIABLE BECOMES AN INPUT VALUE. ALL HOLLERITH (BCD) TYPE INPUT VARIABLES ARE INPUT AS FOLLOWS -

NAME1 = NHVALUE,

WHERE, N IS THE NUMBER OF LETTERS IN VALUE AND VALUE IS THE NAME OF THE VARIABLE BEING SPECIFIED. FOR EXAMPLE, IF THE OPTIMIZATION VARIABLE IS DESIRED TO BE CROSSRANGE, THE INPUT FOR OPTVAR WOULD BE -

OPTVAR = 5HCRRNG,

WHERE CRRNG IS THE HOLLERITH NAME ASSOCIATED WITH CROSSRANGE IN THE PROGRAM.

ALL HOLLERITH NAMES FOR INPUT VARIABLES ARE THE SAME AS THE NAMELIST INPUT SYMBOLS EXCEPT FOR VARIABLES THAT ARE SUB-SCRIPTED. ALL HOLLERITH NAMES OF INTERNALLY COMPUTED VARIABLES ARE THE SAME AS THEIR OUTPUT SYMBOLS.

THE HOLLERITH NAMES OF SUBSCRIPTED INPUT VARIABLES ARE -

HOLLERITH NAME	NAMELIST INPUT SYMBOL
ALPPCI I=1,4	ALPPC(I) I=1,4
BETPCI I=1,4	BETPC(I) I=1,4
BNKPCI I=1,4	BNKPC(I) I=1,4
DTIMRJ J=1,4	DTIMR(J) J=1,4
ETAPCI I=1,4	ETAPC(I) I=1,4

3.C. HOLLERITH INPUT SYMBOLS (CONTD)

HOLLERITH NAME	NAMELIST INPUT SYMBOL
GINTJ J=1,10	GINT(J) J=1,10
GXPI GYPI GZPI I=1,15	GXP(I) GYP(I) GZP(I) I=1,15
ISPVJ J=1,15	ISPV(J) J=1,15
KDGI I=1,3	KDG(I) I=1,3
KRGI I=1,3	KRG(I) I=1,3
PITPCI I=1,4	PITPC(I) I=1,4
ROLPCI I=1,4	ROLPC(I) I=1,4
SPECIJ J=1,9	SPECI(J) J=1,9
TIMRFJ J=1,4	TIMRF(J) J=1,4
VXI VYI VZI	VXI(1) VXI(2) VXI(3)
XI YI ZI	XI(1) XI(2) XI(3)
YAWPCI I=1,4	YAWPC(I) I=1,4

3.D. COORDINATE SYSTEMS

THE COORDINATE SYSTEMS USED IN THE PROGRAM ARE DEFINED AS FOLLOWS -

(1) EARTH CENTERED INERTIAL (ECI) AXES (XI,YI,ZI). THIS SYSTEM IS AN EARTH CENTERED, CARTESIAN SYSTEM WITH ZI COINCIDENT WITH THE NORTH POLE, XI COINCIDENT WITH THE GREENWICH MERIDIAN AT TIME ZERO AND IN THE EQUATORIAL PLANE, AND YI COMPLETING A RIGHT-HAND SYSTEM. THE TRANSLATIONAL EQUATIONS OF MOTION ARE SOLVED WITH RESPECT TO THIS SYSTEM.

(2) EARTH CENTERED ROTATING (ECR) AXES (XR,YR,ZR). THIS SYSTEM IS SIMILAR TO THE ECI SYSTEM EXCEPT THAT IT ROTATES WITH THE EARTH SUCH THAT XR IS ALWAYS COINCIDENT WITH THE GREENWICH MERIDIAN.

(3) EARTH POSITION COORDINATES. THESE ARE THE FAMILIAR LATITUDE, LONGITUDE, AND AZIMUTH PARAMETERS. LATITUDE IS MEASURED POSITIVE IN THE NORTHERN HEMISPHERE. LONGITUDE IS MEASURED POSITIVE EAST OF GREENWICH. AZIMUTH IS MEASURED POSITIVE CLOCKWISE FROM TRUE NORTH, I.E., FROM NORTH TO EAST.

(4) INERTIAL LAUNCH (L) AXES (XL,YL,ZL). THIS IS AN INERTIAL CARTESIAN SYSTEM WHICH IS USED AS AN INERTIAL REFERENCE FROM WHICH THE INERTIAL ATTITUDE ANGLES OF THE VEHICLE ARE MEASURED. THIS COORDINATE SYSTEM IS AUTOMATICALLY LOCATED AT THE GEODETIC LATITUDE AND INERTIAL LONGITUDE OF THE VEHICLE AT THE BEGINNING OF THE SIMULATION UNLESS OVERRIDDEN BY USER INPUT OF LATL AND LONL. THE AZIMUTH ANGLE AZL IS ZERO UNLESS OVERRIDDEN BY USER INPUT. THE ORIENTATION OF THIS SYSTEM IS SUCH THAT XL IS ALONG THE POSITIVE RADIUS VECTOR IF LATL IS INPUT AS GEOCENTRIC LATITUDE, OR ALONG THE LOCAL VERTICAL IF LATL IS NOT INPUT OR IS INPUT AS THE GEODETIC LATITUDE, ZL IS IN THE LOCAL HORIZONTAL PLANE AND IS DIRECTED ALONG THE AZIMUTH SPECIFIED BY AZL, AND YL COMPLETES A RIGHT-HAND SYSTEM. THIS SYSTEM IS INTENDED FOR USE IN SIMULATING ASCENT PROBLEMS FOR LAUNCH VEHICLES WHICH USE EITHER INERTIAL PLATFORM OR STRAPDOWN TYPE ANGULAR COMMANDS. THE INERTIAL ANGLES (ROLI, YAWI, AND PITI) ARE ALWAYS MEASURED WITH RESPECT TO THIS SYSTEM AND ARE AUTOMATICALLY COMPUTED REGARDLESS OF THE STEERING OPTION (IGUID) BEING USED.

(5) GEOGRAPHIC (G) AXES (XG,YG,ZG). THIS SYSTEM IS LOCATED AT THE SURFACE OF THE PLANET AT THE CURRENT VEHICLE GEOCENTRIC LATITUDE AND LONGITUDE. THE XG AXIS IS IN THE LOCAL HORIZONTAL PLANE AND POINTS NORTH, THE YG AXIS IS IN THE LOCAL HORIZONTAL PLANE AND POINTS EAST, AND ZG COMPLETES A RIGHT-HAND SYSTEM. THIS SYSTEM IS USED TO CALCULATE PARAMETERS ASSOCIATED WITH AZIMUTH AND ELEVATION ANGLES.

(6) BODY (B) AXES (XB,YB,ZB). THE BODY AXES ARE A RIGHT-HAND CARTESIAN SYSTEM ALIGNED WITH THE AXES OF THE VEHICLE AND CENTERED AT THE VEHICLE CENTER-OF-GRAVITY. THE XB AXIS IS DIRECTED FORWARD ALONG THE LONGITUDINAL AXIS OF THE VEHICLE, YB POINTS RIGHT (OUT THE RIGHT WING), AND ZB POINTS DOWNWARD COMPLETING A RIGHT-HAND SYSTEM. ALL AERODYNAMIC AND THRUST FORCES ARE CALCULATED IN THE BODY SYSTEM. THESE FORCES ARE THEN TRANSFORMED TO THE INERTIAL (I) SYSTEM WHERE THEY ARE COMBINED WITH THE GRAVITATIONAL FORCES.

(7) BODY REFERENCE (BR) AXES (XBR,YBR,ZBR). THE BODY REFERENCE SYSTEM IS A RIGHT-HAND CARTESIAN SYSTEM ALIGNED WITH THE BODY AXES AS FOLLOWS. THE XBR AXIS IS DIRECTED ALONG THE NEGATIVE XB AXIS, THE YBR AXIS IS DIRECTED ALONG THE POSITIVE YB AXIS, AND THE ZBR AXIS IS DIRECTED ALONG THE NAGATIVE ZB AXIS. THIS SYSTEM IS USED TO LOCATE THE VEHICLE CENTER-OF-GRAVITY, AERODYNAMIC REFERENCE (CENTER-OF-PRESSURE), AND ENGINF GIMBAL LOCATIONS FOR THE STATIC TRIM OPTION.

(8) ORBITAL ELEMENTS. THIS IS A NON-RECTANGULAR COORDINATE SYSTEM USED IN DESCRIBING ORBITAL MOTION. THE ORBITAL ELEMENTS ARE APOGEE ALTITUDE, PERIGEE ALTITUDE, INCLINATION, LONGITUDE OF THE ASCENDING NODE, TRUE ANOMALY, AND ARGUMENT OF PERIGEE. THE APOGEE AND PERIGEE ALTITUDES REPLACE THE STANDARD ORBITAL ELEMENTS SEMIMAJOR AXIS AND ECCENTRICITY.

(9) VERNAL EQUINOX (VE) AXES (XVE,YVE,ZVE). THIS IS THE 1950 MEAN EQUATOR AND MEAN EQUINOX EARTH CENTERED INERTIAL SYSTEM. THE XVE AXIS IS IN THE EQUATORIAL PLANE AND IS DIRECTED TOWARD THE VERNAL EQUINOX OF 1950, THE ZVE AXIS IS DIRECTED ALONG THE NORTH POLE, AND YVE COMPLETES THE RIGHT-HAND SYSTEM.

3.E. VEHICLE ATTITUDE ANGLES/RATES

THE PROGRAM CALCULATES THE VEHICLE ATTITUDE WITH RESPECT TO SEVERAL COORDINATE SYSTEMS. THESE ATTITUDE ANGLES ARE DEFINED AS FOLLOWS -

1) AERODYNAMIC ANGLES. THESE ANGLES DEFINE THE VEHICLE ORIENTATION WITH RESPECT TO THE ATMOSPHERIC RELATIVE VELOCITY VECTOR. THESE ANGLES ARE USED TO CALCULATE THE AERODYNAMIC FORCES AND MOMENTS ACTING ON THE VEHICLE. THE AERODYNAMIC ANGLES ARE DEFINED AS FOLLOWS -

   ALPHA - ANGLE OF ATTACK. POSITIVE ALPHA IS NOSE UP (ABOVE THE ATMOSPHERIC RELATIVE VELOCITY VECTOR) WHEN FLYING THE VEHICLE UPRIGHT (BANK ANGLE BETWEEN -90 DEG AND +90 DEG). (THIRD EULER ROTATION ABOUT THE STABILITY (VELOCITY) AXES)

   BETA - ANGLE OF SIDESLIP. POSITIVE BETA IS NOSE LEFT WHEN FLYING THE VEHICLE UPRIGHT. (SECOND EULER ROTATION ABOUT THE STABILITY (VELOCITY) AXES)

   BNKANG - BANK ANGLE. POSITIVE BNKANG IS A BANK TO THE RIGHT, I.E., RIGHT WING DOWN. (FIRST EULER ROTATION ABOUT THE STABILITY (VELOCITY) AXES)

2) INERTIAL EULER ANGLES. THESE ANGLES DEFINE THE VEHICLE ORIENTATION WITH RESPECT TO THE LAUNCH (L) INERTIAL COORDINATE SYSTEM. THESE ANGLES ARE DEFINED AS FOLLOWS -

   ROLI - INERTIAL ROLL ANGLE. THIS IS THE ROLL ANGLE (FIRST EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM.

   YAWI - INERTIAL YAW ANGLE. THIS IS THE YAW ANGLE (SECOND EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM.

   PITI - INERTIAL PITCH ANGLE. THIS IS THE PITCH ANGLE (THIRD EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM.

3.E. VEHICLE ATTITUDE ANGLES/RATES (CONTD)

3) RELATIVE EULER ANGLES. THESE ANGLES PROVIDE THE VEHICLE ORIENTATION WITH RESPECT TO THE LOCAL HORIZONTAL COORDINATE SYSTEM. THE LOCAL HORIZONTAL PLANE IS DEFINED TO BE PERPENDICULAR TO THE RADIUS VECTOR. THESE ANGLES ARE DEFINED BY A YAW, PITCH AND ROLL SEQUENCE. THESE ANGLES ARE DEFINED AS FOLLOWS -

YAWR - RELATIVE YAW ANGLE. THIS IS THE AZIMUTH ANGLE OF THE XB AXIS MEASURED CLOCKWISE FROM NORTH. THAT IS, FROM NORTH TO EAST. (FIRST EULER ROTATION ABOUT THE GEOGRAPHIC (G) COORDINATE SYSTEM)

PITR - RELATIVE PITCH ANGLE. THIS IS THE ELEVATION ANGLE OF THE XB AXIS ABOVE THE LOCAL HORIZONTAL PLANE. PITR IS POSITIVE WHEN XB IS ABOVE THE LOCAL HORIZONTAL AND RANGES FROM -90 DEG TO +90 DEG. WHEN PITCHING THE VEHICLE THROUGH + OR - 90 DEG, THE AZIMUTH ANGLE (YAWR) WILL GO THROUGH A 180 DEG DISCONTINUITY. (SECOND EULER ROTATION ABOUT THE GEOGRAPHIC (G) COORDINATE SYSTEM)

ROLR - RELATIVE ROLL ANGLE. THIS IS THE ROLL ANGLE ABOUT THE XB AXIS IN THE RIGHT-HAND SENSE. ZERO ROLL IMPLIES THAT THE YB AXIS IS IN THE LOCAL HORIZONTAL PLANE. (THIRD EULER ROTATION ABOUT THE GEOGRAPHIC (G) COORDINATE SYSTEM)

4) INERTIAL AERODYNAMIC ANGLES. THESE ANGLES ARE DEFINED IN EXACTLY THE SAME MANNER AS THE AERODYNAMIC ANGLES EXCEPT THAT THEY ARE MEASURED WITH RESPECT TO THE INERTIAL VELOCITY VECTOR. THESE ANGLES ARE DEFINED AS FOLLOWS -

ALPHI - INERTIAL ANGLE OF ATTACK. POSITIVE ALPHA IS NOSE UP (ABOVE THE INERTIAL VELOCITY VECTOR) WHEN FLYING THE VEHICLE UPRIGHT (BANKI BETWEEN -90 DEG AND +90 DEG).

BETAI - INERTIAL ANGLE OF SIDESLIP. POSITIVE BETAI IS NOSE LEFT WHEN FLYING THE VEHICLE UPRIGHT.

BANKI - INERTIAL BANK ANGLE. POSITIVE BANKI IS A BANK TO THE RIGHT WHEN FLYING THE VEHICLE UPRIGHT.

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3.E. VEHICLE ATTITUDE ANGLES/RATES (CONTD)

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THE PROGRAM CALCULATES THE VEHICLE BODY ATTITUDE BY INTEGRATING THE QUATERNION RATE EQUATIONS. THE RESULTING QUATERNION ELEMENTS ARE THEN USED TO DEFINE THE TRANSFORMATION MATRIX BETWEEN THE INERTIAL L-FRAME AND THE BODY FRAME.

THE INERTIAL BODY RATES ARE DEFINE AS -

ROLBD - ROLL BODY RATE. THE ANGULAR RATE ABOUT THE XB-AXIS IN DEG/SEC.

PITBD - PITCH BODY RATE. THE ANGULAR RATE ABOUT THE YB-AXIS IN DEG/SEC.

YAWBD - YAW BODY RATE. THE ANGULAR RATE ABOUT THE ZB-AXIS IN DEG/SEC.

4. OPERATIONAL CONTROLS

THE INPUTS ASSOCIATED WITH GENERAL PROGRAM OPTIONS ARE DISCUSSED IN THIS SECTION. THESE OPTIONS CONCERN THE TYPE OF INPUT AND OUTPUT UNITS TO BE USED AND THE MULTIPLE RUN FEATURE OF THE PROGRAM.

4.A. INPUT/OUTPUT CONVERSION FACTORS

THE PROGRAM HAS THE CAPABILITY TO ACCEPT INPUT IN EITHER ENGLISH OR METRIC UNITS. THE ONLY RESTRICTION BEING THAT THE INPUT UNITS CANNOT BE MIXED. THE OUTPUT VARIABLES CAN ALSO BE PRINTED IN EITHER ENGLISH OR METRIC UNITS, BUT NOT BOTH.

THE PROGRAM ALSO HAS THE CAPABILITY TO PRINT THE TABLE DATA BEING USED BY THE PROGRAM. THIS FEATURE IS USEFUL IN THAT INPUT ERRORS IN THE TABLE FORMAT ARE EASILY DETECTED BY READING THIS PRINTOUT.

ALL OF THE ENGLISH TO METRIC CONVERSION CONSTANTS CAN BE CHANGED BY INPUT IF DESIRED. THE STORED VALUES OF THESE CONSTANTS WERE OBTAINED FROM THE FOLLOWING DOCUMENT -

> THE INTERNATIONAL SYSTEM OF UNITS
> PHYSICAL CONSTANTS AND CONVERSION FACTORS
> E. A. MECHTLY, MARSHALL FLIGHT CENTER
> NASA SP-7012, 1964

CARE MUST BE TAKEN WHEN USING METRIC SYSTEM INPUT AND OUTPUT. THE INPUT UNITS MUST BE OF THE SAME TYPE AS THE ENGLISH UNITS. FOR EXAMPLE, VALUES FOR WEIGHTS MUST BE INPUT IN UNITS OF FORCE (NEWTONS) RATHER THAN MASS (KG). VARIABLES OUTPUT IN NAUTICAL MILES IN ENGLISH UNITS WILL BE KILOMETERS IN METRIC.

ALL VARIABLES ASSOCIATED WITH THE INPUT/OUTPUT UNITS ARE INPUT IN NAMELIST SEARCH AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CDENS	SLUGS/FT3 PER KG/M3	.001940 31965	ATMOSPHERIC DENSITY CONVERSION CONSTANT.
CFORCE	NT/LB	4.4482216 152605	FORCE (THRUST AND AERODYNAMIC) CONVERSION CONSTANT.
CHEAT	JOULES/ BTU	1054.3502 6448888	AEROHEATING CONVERSION CONSTANT.
CMASS	KG/SLUG	14.5939 029	MASS CONVERSION CONSTANT.

4.A. INPUT/OUTPUT CONVERSION FACTORS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CMPFT	M/FT	.3048	LENGTH CONVERSION CONSTANT.
CPRES	LBS/FT2 PER NT/CM2	.02088 54347	ATMOSPHERIC PRESSURE CONVERSION CONSTANT.
CTEMP	DEG F PER DEG C	1.8	ATMOSPHERIC TEMPERATURE CONVERSION CONSTANT.
FTPNM	FT/NM	6076.1155	DISTANCE CONVERSION CONSTANT.
IOFLAG	INTEGER	0	INPUT/OUTPUT UNITS FLAG. = 0, ENGLISH/ENGLISH = 1, ENGLISH/METRIC = 2, METRIC /ENGLISH = 3, METRIC /METRIC
IPRO	INTEGER	0	CONTROLS PRINT OUT OF TRAJECTORIES DURING TARGETING/OPTIMIZATION. =-1, ONLY PRINT THE FINAL TRAJECTORY GENERATED DURING TARGETING/OPTIMIZATION. = 0, SAME AS -1, AND FIRST NOMINAL = 1, SAME AS -1, AND ALL NOMINALS = 2, PRINT ALL TRAJECTORIES (NOMINALS, PERTURBED, AND TRIAL STEPS)
LISTIN	INTEGER	2	CONTROLS SUMMARY-OF-INPUT PRINTOUT =-1, NO SUMMARY. = 0, TABLE SUMMARY ONLY. = 1, TABLE AND NAMELIST SUMMARY. = 2, NAMELIST SUMMARY ONLY.

4.B. MULTIPLE RUNS

THE PROGRAM HAS THE CAPABILITY TO PERFORM MULTIPLE RUNS. THE WORD RUN IS THE SAME AS THE WORD PROBLEM INSOFAR AS THE PROGRAM IS CONCERNED. THE RUN NUMBERS ARE ASSIGNED AS INTEGERS BY THE PROGRAM BEGINNING WITH NUMBER ONE (1) ACCORDING TO THE ORDER IN WHICH THE INPUTS FOR THE RUNS ARE ARRANGED IN THE DATA DECK.

WHEN RUNNING NON-SEARCH/OPTIMIZATION TYPE MULTIPLE RUNS, I.E., IF SRCHM =0, THE USER ONLY NEEDS TO INPUT THE VARIABLE MULTRF WHICH INDICATES THE SOURCE OF THE INPUT DATA FOR THE CURRENT RUN.

THE SOURCE OF INPUT DATA FOR A MULTIPLE RUN CAN BE SPECIFIED IN ONE OF THREE WAYS AS FOLLOWS -

1. THE INPUTS FOR THE CURRENT RUN ARE THE SUMMATION OF THE INPUTS FROM ALL THE PREVIOUS RUNS.

2. THE INPUTS FOR THE CURRENT RUN ARE THE INPUTS FOR THE FIRST RUN PLUS ONLY THE INPUT CHANGES FOR THIS RUN.

3. THE INPUTS FOR THE CURRENT RUN ARE UNRELATED TO ANY PREVIOUS RUNS. I.E., THIS IS A COMPLETELY SEPARATE RUN.

THE MULTIPLE RUN CAPABILITY ALLOWS THE USER TO CHANGE THE INPUT DATA IN ANY OF THE NAMELISTS ASSOCIATED WITH THE BASIC DATA DECK. IN ADDITION, THE USER CAN ADD OR DELETE PHASES IN THE BASIC DATA DECK. THESE PROCEDURES ARE SUMMARIZED AS FOLLOWS -

1. CHANGES TO AN EXISTING PHASE - IDENTIFY THE PHASE TO BE CHANGED BY INPUTTING THE VARIABLE EVENT IN NAMELIST GENDAT ALONG WITH THE DESIRED CHANGES FOR THAT PHASE.

2. ADDING A NEW PHASE - A NEW PHASE IS ADDED BY MERELY INCLUDING THE DESIRED INPUTS FOR THAT PHASE. THE POSITION OF THE PHASE RELATIVE TO THE PHASES IN THE DECK BEING CHANGED IS DETERMINED BY THE INPUT VARIABLE EVENT.

3. DELETING A PHASE - A PHASE IS DELETED MERELY BY SETTING ITS EVENT NUMBER NEGATIVE, I.E., INPUT EVENT = -10, IN NAMELIST GENDAT TO DELETE PHASE 10.

THE NAMELIST INPUT SEQUENCE FOR A MULTIPLE RUN FOLLOWS THE SAME RULES AS THOSE PREVIOUSLY DISCUSSED IN THE SECTION ENTITLED NAMELIST INPUT SEQUENCE. A RUN CAN BE TERMINATED IN ANY OF THE NAMELISTS BY SETTING ENDPRB=1 IN THAT NAMELIST. THE END OF THE INPUT DATA FOR THE JOB IS SIGNIFIED BY SETTING ENDJOB=1 IN THE LAST NAMELIST IN THE DATA DECK.

THE TARGETING/OPTIMIZATION RESULTS FROM A GIVEN RUN ARE CARRIED OVER FROM THAT RUN TO THE NEXT RUN. THAT IS, THE VALUES OF THE INDEPENDENT VARIABLES ARE RETAINED FROM ONE RUN TO THE NEXT UNLESS OVERRIDDEN BY USER INPUT. THE NEXT RUN TO BE MADE DURING TARGETING/OPTIMIZATION CAN BE SPECIFIED AS A CONDITIONAL RUN. THAT IS, THE USER CAN INDICATE THAT THE CURRENT RUN IS TO BE MADE ONLY IF THE DESIGNATED RUNS HAVE TERMINATED ACCORDING TO ONE OF THE FOLLOWING CONDITIONS -

1. RUN THE CURRENT RUN ONLY IF ANY OF THE SPECIFIED RUNS IS SUCCESSFUL, I.E., IF *** PROBLEM SOLVED WAS OBTAINED.

2. RUN THE CURRENT RUN ONLY IF ANY OF THE SPECIFIED RUNS FAILED ON THE FIRST NOMINAL, I.E., IF *** UNUSABLE NOMINAL WAS OBTAINED.

3. RUN THE CURRENT RUN REGARDLESS OF THE CONDITION OF ANY OF THE PREVIOUS RUNS.

THE CONDITIONAL RUN CAPABILITY IS USEFUL IN RUNNING PROBLEMS THAT MAY OR MAY NOT WORK BECAUSE OF POOR INITIAL GUESSES. IN THIS CASE, THE USER COULD INPUT A MULTIPLE RUN WHICH WOULD PERFORM A REDUCED SEARCH (E.G., A 1X1) BASED ON THE USER SPECIFIED INITIAL GUESS, FOLLOWED BY A RUN WHICH WOULD REPEAT THE FIRST PROBLEM USING THE VALUES OBTAINED FROM THE 1X1 SEARCH.

THE FOLLOWING SEQUENCE OF RUNS SHOWS HOW THE CONDITIONAL RUN CAPABILITY CAN BE USED.

RUN NO. 1 - FIRST GUESS

RUN NO. 2 - RUN THIS PROBLEM ONLY IF RUN NO. 1 FAILS
(I.E., IF *** UNUSABLE NOMINAL WAS OBTAINED)
INPUTS REQUIRED - NXTRUN = 2,
IFRUNF(1) = 1,0,0,0,0,

RUN NO. 3 - RUN THIS PROBLEM ONLY IF RUN NO. 2 WORKS
(I.E., IF *** PROBLEM SOLVED WAS OBTAINED)
INPUTS REQUIRED - NXTRUN = 1,
IFRUNF(1) = 2,0,0,0,0,

RUN NO. 4 - RUN THIS PROBLEM ONLY IF RUN NO. 1 OR 3 WORKS
(I.E., IF *** PROBLEM SOLVED WAS OBTAINED)
INPUTS REQUIRED - NXTRUN = 1,
IFRUNF(1) = 1,3,0,0,0,

RUN NO. 5 - RUN THIS PROBLEM ONLY IF RUN NO. 4 WORKS
(I.E., IF *** PROBLEM SOLVED WAS OBTAINED)
INPUTS REQUIRED - NXTRUN = 1,
IFRUNF(1) = 4,0,0,0,0,

THE VARIABLES ASSOCIATED WITH MULTIPLE RUNS ARE INPUT IN NAMELIST SEARCH AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IFRUNF(J) J=1,5	INTEGER	0	AN ARRAY CONTAINING THE RUN NUMBERS TO BE USED IN CONJUNCTION WITH THE VARIABLE NXTRUN TO DETERMINE WHICH RUN IS TO BE MADE NEXT. IF IFRUNF IS NOT INPUT OR IS ZERO, THE PREVIOUS RUN NUMBER WILL BE USED IN CONJUNCTION WITH NXTRUN.
MULTRF	INTEGER	1	A FLAG TO INDICATE HOW THE INPUT DATA FOR THE CURRENT RUN IS TO BE FORMED WHEN RUNNING MULTIPLE RUNS. = 1, THE INPUT DATA FOR THIS RUN THE DATA FOR THE FIRST RUN PLUS ALL INPUT CHANGES FOR THIS AND ALL PREVIOUS RUNS. = 2, THE INPUT DATA FOR THIS RUN IS THE DATA FOR THE FIRST RUN PLUS ONLY THE INPUT CHANGES FOR THIS RUN. = 3, THIS RUN IS A COMPLETELY INDEPENDENT RUN, I.E., THESE MULTIPLE RUNS ARE COMPLETELY SEPARATE PROBLEMS.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NXTRUN	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT THIS IS THE NEXT RUN WHEN USING THE SEARCH/OPTIMIZATION OPTION. = 1, PROCEED WITH THIS RUN ONLY IF ANY OF THE RUNS IN THE ARRAY IFRUNF(J) WAS SUCCESSFUL. I.E., IF *** PROBLEM SOLVED WAS OBTAINED ON ANY OF THE RUNS IN IFRUNF(J). = 2, PROCEED WITH THIS RUN ONLY IF THE FIRST NOMINAL TRAJECTORY ON ANY OF THE RUNS IN THE ARRAY IFRUNF(J) FAILED. I.E., IF *** UNUSABLE NOMINAL WAS OBTAINED ON ANY OF THE RUNS IFRUNF(J). = 3, PROCEED WITH THIS RUN REGARDLESS OF THE SUCCESS OR FAILURE OF ANY OF THE RUNS IN THE ARRAY IFRUNF(J).

4.C. MULTIPLE VEHICLE OPTION

THE PROGRAM HAS THE CAPABILITY TO SIMULATE TWO VEHICLES. ONE OF THE VEHICLES IS ACTIVE (PURSUER) AND ONE IS PASSIVE (TARGET). THE INPUTS FOR THE ACTIVE VEHICLE ARE THE SAME AS WHEN USING THE SINGLE VEHICLE OPTION. THE TARGET VEHICLE INPUTS CONSIST ONLY OF THE INITIAL STATE VECTOR. THE TARGET VEHICLE IS ASSUMED TO BE OUT OF THE ATMOSPHERE AND NON-THRUSTING SO THAT THE ONLY FORCE ACTING ON THE TARGET VEHICLE IS THE GRAVITY FORCE.

THE CONSTANT VALUED INPUT VARIABLES FOR THIS MODULE ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
MVEHF(1)	INTEGER	0	MULTIPLE VEHICLE OPTION FLAG. = 0, USE SINGLE VEHICLE OPTION. = 1, USE TWO VEHICLE OPTION.
MVEHF(2)	INTEGER	0	TARGET VEHICLE INITIALIZATION OPTION FLAG. = 0, INPUT TARGET VEHICLE ECI POSITION AND VELOCITY COMPONENTS, I.E., XIT(I) AND VXIT(I), I=1,2,3. = 1, INPUT TARGET CENTERED DELTA ECI POSITION AND VELOCITY COMPONENTS OF THE TARGET VEHICLE, I.E., DXI(I) AND DVXI(I), I=1,2,3. = 2, INPUT ECI POSITION AND VELOCITY COMPONENTS OF THE TARGET VEHICLE AND TARGET CENTERED RELATIVE POSITION AND VELOCITY COMP-ONENTS OF THE PURSUER VEHICLE, I.E., XIT(J), VXIT(J), DXRT(J) AND DVXRT(J), J=1,2,3. = 3, INPUT TARGET VEHICLE ORBIT PARAMETERS, I.E., INCT, ALTPT, ALTAT, TRUANT, ARGPT, LANT, AND PGCLTT.
ALTAT	N.MI. (KM)	0.	THE ALTITUDE OF APOGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.

4.C. MULTIPLE VEHICLE OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALTPT	N.MI. (KM)	0.	THE ALTITUDE OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
ARGPT	DEG	0.	THE ARGUMENT OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2) =3.
DVXI(I) I=1,3	FT/SEC (M/S)	0.	THE DELTA ECI INERTIAL VELOCITY COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES, I.E., DVXI(I)=VXI(I) - VXIT(I) USED IF MVEHF(2)=1.
DVXRT(I) I=1,3	FT/SEC (M/S)	0.	THE TARGET CENTERED VELOCITY COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE. USED IF MVEHF(2)=2.
DXI(I) I=1,3	FT (M)	0.	THE DELTA ECI POSITION COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES, I.E., DXI(I)=XI(I) - XIT(I) USED IF MVEHF(2)=1.
DXRT(I) I=1,3	FT (M)	0.	THE TARGET CENTERED POSITION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE. THE ORIENTATION OF XRT(2) IS ALONG THE POSITIVE RADIUS VECTOR TO THE TARGET VEHICLE, XRT(1) IS FORMED AS XIT(I) CROSS VXIT(I), AND XRT(3) COMPLETES A RIGHT-HAND SYSTEM. USED IF MVEHF(2)=2.
INCT	DEG	0.	THE INCLINATION OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
LANT	DEG	0.	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.

4.C. MULTIPLE VEHICLE OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PGCLTT	DEG	0.	THE GEOCENTRIC LATITUDE OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
TRUANT	DEG	0.	THE TRUE ANOMALY OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
VXIT(I) I=1,3	FT/SEC (M/S)	0.	THE ECI VELOCITY COMPONENTS OF THE TARGET VEHICLE. USED IF MVEHF(2)=0,2.
XIT(I) I=1,3	FT (M)	0.	THE ECI POSITION COMPONENTS OF THE TARGET VEHICLE. USED IF MVEHF(2)=0,2.

THE OUTPUT VARIABLES FOR THIS MODULE ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ALTAT	N.MI. (KM)	THE ALTITUDE OF APOGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ALTPT	N.MI. (KM)	THE ALTITUDE OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ANGMOT	DEG	THE ANGULAR MOMENTUM OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
APORT	FT	THE APOGEE RADIUS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
APVELT	FT/SEC (M/S)	THE INERTIAL VELOCITY AT APOGEE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ARGPT	DEG	THE ARGUMENT OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ARGVT	DEG	THE ARGUMENT OF VEHICLE LATITUDE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
AXIT AYIT AZIT	FT/SEC (M/S)	THE TOTAL ACCELERATION COMPONENTS OF THE TARGET VEHICLE IN THE ECI COORDINATE SYSTEM.
AZVIT	DEG	THE AZIMUTH OF THE INERTIAL VELOCITY VECTOR OF THE TARGET VEHICLE.
DAXI DAYI DAZI	FT/SEC**2 (M/S2)	THE TOTAL ACCELERATION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE IN THE ECI COORDINATE SYSTEM. DAXI(I)=AXI(I) - AXIT(I)
DECLT	DEG	THE DECLINATION OF THE OUTGOING ASYMPTOTE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
DRT	FT (M)	THE SEPARATION DISTANCE BETWEEN THE PURSUER AND TARGET VEHICLES. COMPUTED IF MVEHF(1)=1.
DVCIRT	FT/SEC (M/S)	THE DELTA VELOCITY REQUIRED TO CIRCULARIZE THE CURRENT ORBIT OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
DVXI DVYI DVZI	FT/SEC (M/S)	THE DELTA ECI INERTIAL VELOCITY COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES. DVXI(I)=VXI(I) - VXIT(I)
DVXRT DVYRT DVZRT	FT/SEC (M/S)	THE TARGET CENTERED VELOCITY COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE.
DXI DYI DZI	FT (M)	THE DELTA ECI POSITION COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES. DXI(I)=XI(I) - XIT(I)
DXRT DYRT DZRT	FT (M)	THE TARGET CENTERED POSITION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE.
ECCANT	DEG	THE ECCENTRIC ANOMALY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
ECCENT	DEG	THE ECCENTRICITY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ENRGVT	FT2/S2 (M2/S2)	THE ORBITAL ENERGY OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
GAMIT	DEG	THE INERTIAL FLIGHT PATH ANGLE OF THE TARGET VEHICLE.
GCLATT	DEG	THE CURRENT GEOCENTRIC LATITUDE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1.
GCRADT	FT (M)	THE GEOCENTRIC RADIUS TO THE TARGET VEHICLE.
HYPVT	FT/SEC (M/S)	THE HYPERBOLIC EXCESS VELOCITY OF THE TARGET. VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
INCT	DEG	THE INCLINATION OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
LANT	DEG	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
LANVET	DEG	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE ORBIT WITH RESPECT TO THE VERNAL EQUINOX. COMPUTED IF MVEHF(1)=1, AND IF BOTH NPC(1) AND NPC(31) ARE INPUT NON-ZERO.
LONGT	DEG	THE CURRENT LONGITUDE OF THE TARGET VEHICLE MEASURED EAST OF THE GREENWICH MERIDIAN. COMPUTED IF MVEHF(1)=1.
MEAANT	DEG	THE MEAN ANOMALY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PERIDT	MIN	THE ORBITAL PERIOD OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGCLTT	DEG	THE GEOCENTRIC LATITUDE OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.

4.C. MULTIPLE VEHICLE OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
PGERT	FT (M)	THE PERIGEE RADIUS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGLONT	DEG	THE INERTIAL LONGITUDE OF PERIGEE OF THE TARGET VEHICLE ORBIT MEASURED EAST OF THE XI AXIS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGVELT	FT/SEC (M/S)	THE INERTIAL VELOCITY AT PERIGEE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
RTASCT	DEG	THE RIGHT ASCENSION OF THE OUTGOING ASYMPTOTE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
SEMAXT	FT (M)	THE SEMI-MAJOR AXIS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
TIMSPT	MIN	THE TIME SINCE PERIGEE PASSAGE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
TIMTPT	MIN	THE TIME TO PERIGEE PASSAGE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
TRUANT	DEG	THE TRUE ANOMALY OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
TRUMXT	DEG	THE MAXIMUM TRUE ANOMALY OF THE TARGET VEHICLE FOR HYPERBOLIC ORBITS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
VCIRCT	FT/SEC (M/S)	THE CIRCULAR VELOCITY OF THE TARGET VEHICLE AT THE CURRENT RADIUS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
VELIT	FT/SEC (M/S)	THE INERTIAL VELOCITY OF THE TARGET VEHICLE.
VXIT VYIT VZIT	FT/SEC (M/S)	THE ECI VELOCITY COMPONENTS OF THE TARGET VEHICLE.

4.C. MULTIPLE VEHICLE OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
XIT YIT ZIT	FT (M)	THE ECI POSITION COMPONENTS OF THE TARGET VEHICLE.

5. TARGETING/OPTIMIZATION INPUTS

POST HAS THE CAPABILITY OF PERFORMING TARGETING WITH OR WITH OUT INEQUALITY CONSTRAINTS, UNCONSTRAINED OPTIMIZATION, AND CONSTRAINED (EQUALITY AND/OR INEQUALITY) OPTIMIZATION. THE GENERALITY OF POST ENABLES THE USER TO SELECT THE INDEPENDENT AND DEPENDENT VARIABLES FOR THE PROBLEM FROM A LIST OF OVER 400 PROGRAM VARIABLES.

ANY TYPE OF EVENT (PRIMARY, SECONDARY, OR ROVING) CAN BE USED IN TARGETING/OPTIMIZATION. HOWEVER, THE USER MUST INSURE THAT THE EVENTS SELECTED WILL ALWAYS OCCUR. THE ASSOCIATION OF AN EVENT NUMBER WITH THE DEFINITIONS OF THE TARGETING AND OPTIMIZATION VARIABLES ENABLES SUCH THINGS AS INTERMEDIATE TARGETING AND OPTIMIZATION TO BE PERFORMED WITH THE PROGRAM. THIS CORRESPONDENCE ALSO ENABLES THE PROGRAM TO REMEMBER THE STATE VARIABLES AT THE BEGINNING OF THE PHASES WHERE THE INDEPENDENT VARIABLES ARE INTRODUCED. THUS, WHEN INTEGRATING THE PERTURBED TRAJECTORIES AND THE TRIAL STEPS, ONLY THAT SEGMENT OF THE TRAJECTORY AFFECTED BY THE CONTROL PARAMETERS BEING CHANGED IS INTEGRATED, THEREBY REDUCING THE TIME REQUIRED TO GENERATE THE SENSITIVITY MATRIX.

FOR AN OPTIMIZATION PROBLEM, THE OPTIMIZATION VARIABLE MUST BE DEFINED IN NAMELIST SEARCH. THE VARIABLES OPTVAR, OPTPH, AND OPT ARE USED FOR THIS PURPOSE. FOR TARGETING (CONSTRAINED) PROBLEMS, THE DEPENDENT VARIABLES MUST BE DEFINED IN NAMELIST SEARCH. THE VARIABLES NDEPV, DEPVR, DEPPH, IDEPVR, DEPVAL, AND DEPTL ARE USED FOR THIS PURPOSE. BOTH SETS OF INPUTS ARE NEEDED FOR A CONSTRAINED OPTIMIZATION PROBLEM. IN ANY CASE, THE SEARCH MODE (SRCHM), THE NUMBER OF ITERATIONS (MAXITR), AND THE INDEPENDENT VARIABLES (NINDV, INDVR, INDPH, AND U) MUST BE DEFINED IN NAMELIST SEARCH.

IN ADDITION TO THE REQUIRED NAMELIST SEARCH INPUTS, THERE ARE SEVERAL OTHERS WHICH CAN BE USED TO FURTHER INCREASE THE RATE OF CONVERGENCE ON DIFFICULT OPTIMIZATION PROBLEMS. FOR THE MOST PART, THESE INPUTS ARE RELATED TO PROBLEM SCALING (MODEW AND WOPT), SEARCH DIRECTION STEPSIZE CONTROL (PCTCC), AND CONVERGENCE TOLERANCES (CONEPS(I)).

MONOVARIANT TABLES. FOR EXAMPLE, SUPPOSE THE FIRST AND FOURTH Y ARGUMENTS OF THE MONOVARIANT PITT TABLE ARE TO BE USED AS CONTROL PARAMETERS. THE INPUTS WOULD THEN BE AS FOLLOWS -

```
TABL(1) = 4HPITT,4HPITT,
TABLY(1) = 1,4,
INDVR(1) = 6HTABL1 ,6HTABL2 ,
INDPH(1) = XX., YY.,
U(1) = AA., BB.,
```

EACH CONTROL PARAMETER IS UNIQUELY SPECIFIED BY THE FOLLOWING VARIABLES WHICH ARE INPUT IN NAMELIST SEARCH - AND ARE AS FOLLOWS -

1) THE HOLLERITH NAME OF EACH CONTROL VARIABLE. THIS IS INPUT AS THE ARRAY INDVR(I), I=1,NINDV.

2) THE INITIAL VALUE OF EACH CONTROL VARIABLE. INPUT AS THE ARRAY U(I), I=1,NINDV. IF SRCHM IS NON-ZERO, U(I) OVERRIDES ANY VALUE INPUT FOR THAT VARIABLE IN NAMELIST GENDAT FOR PHASE INDPH(I).

3) THE PHASE NUMBER (EVENT) AT WHICH EACH INDVR IS INITIATED. INPUT AS THE ARRAY INDPH(I), I=1,NINDV. THE VARIABLE WHOSE HOLLERITH NAME APPEARS IN INDVR(I) IS SET EQUAL TO U(I) AT THE BEGINNING OF THE PHASE SPECIFIED BY INDPH(I).

4) THE PERTURBATION FOR EACH CONTROL VARIABLE TO BE USED TO GENERATE THE SENSITIVITIES. INPUT AS THE ARRAY PERT(I), I=1,NINDV. THE SENSITIVITY DE(J)/DU(I) IS DETERMINED BY FINITE DIFFERENCING U(I) BY PERT(I) AND CALCULATING THE CHANGE IN EACH E(J). FOR VARIABLES WHOSE NOMINAL VALUE IS GREATER THAN 10.0, THE VALUE OF PERT(I) SHOULD BE INPUT ROUGHLY SIX ORDERS OF MAGNITUDE LESS THAN THE NOMINAL VALUE OF THE VARIABLE. THE STORED VALUES FOR PERT(I) ARE 1.0E-4.

5) THE NUMBER OF CONTROL (INDEPENDENT) VARIABLES TO BE USED. INPUT AS THE VARIABLE NINDV. THE FIRST NINDV VARIABLES IN THE ARRAY INDVR(I) WILL BE USED AS CONTROL VARIABLES. THE NUMBER OF CONTROL VARIABLES MUST BE GREATER THAN OR EQUAL TO THE NUMBER OF TARGET VARIABLES PLUS THE OPTIMIZATION VARIABLE UNLESS SOME OF THE TARGET VARIABLES ARE INEQUALITY CONSTRAINTS.

5.A. CONTROL (INDEPENDENT) VARIABLES

THE SEARCH/OPTIMIZATION OPTION ALLOWS THE USER TO SPECIFY AS MANY AS 25 CONTROL VARIABLES FOR EACH PROBLEM. THE INITIAL VALUE OF EACH CONTROL VARIABLE AND THE PHASE IN WHICH IT OCCURS ARE ALSO SPECIFIED BY INPUT. IF A CONTROL VARIABLE IS A GUIDANCE (STEERING) VARIABLE, SUCH AS A PITCH RATE OR ANGLE, THE APPROPRIATE GUIDANCE OPTION (IGUID) MUST BE REQUESTED IN NAMELIST GENDAT FOR THE CORRESPONDING PHASE.

THE VALUE OF A GIVEN CONTROL VARIABLE AS CALCULATED BY THE TARGETING/OPTIMIZATION ALGORITHM WILL BE CARRIED OVER FROM ONE PHASE TO THE NEXT UNTIL OVERRIDDEN BY USER INPUT OR BY A NEW CONTROL VARIABLE. FOR EXAMPLE, IF THE LINEAR TERM IN THE PITCH ANGLE POLYNOMIAL (HOLLERITH INPUT SYMBOL PITPC2) IS A CONTROL VARIABLE IN PHASE 1.0, AND IS NOT A CONTROL VARIABLE IN PHASE 2.0, THE CALCULATED VALUE OF THE PITCH RATE IN PHASE 1.0 WILL CONTINUE INTO PHASE 2.0 UNLESS THE COEFFICIENT PITPC(2) IS INPUT IN NAMELIST GENDAT FOR PHASE 2.0.

A CONTROL VARIABLE MAY BE CONSTRAINED BY ALSO DEFINING IT TO BE A DEPENDENT VARIABLE WITH AN UPPER OR LOWER BOUND. REFER TO SECTION 5.B FOR SPECIFIC INSTRUCTIONS.

THE CONTROL PARAMETERS CAN BE SELECTED FROM ANY VARIABLES IN THE FOLLOWING CATEGORIES -

1) VARIABLES IN NAMELIST GENDAT SUCH AS INITIAL VEHICLE POSITION AND VELOCITY, INITIAL VEHICLE ORIENTATION, VEHICLE ATTITUDE POLYNOMIAL COEFFICIENTS, ETC. FOR EXAMPLE, SUPPOSE THE INITIAL VELOCITY (VELI) IS TO BE USED AS A CONTROL PARAMETER. THE INPUTS WOULD THEN BE AS FOLLOWS -

```
INDVR(1) = 4HVELI,
INDPH(1) = XX.,
U(1) = AA.,
```

2) CONSTANT VALUED TABLE MULTIPLIERS IN NAMELIST TBLMLT. FOR EXAMPLE, SUPPOSE THE TABLE MULTIPLIER FOR THE THRUST TABLE (TVC1M) IS TO BE USED AS A CONTROL PARAMETER. THE INPUTS WOULD THEN BE AS FOLLOWS -

```
INDVR(1) = 5HTVC1M,
INDPH(1) = XX.,
U(1) = AA.,
```

3) USER SPECIFIED Y ARGUMENTS FROM USER SPECIFIED TABLES IN NAMELIST TAB. THE TABLES AND Y VALUES TO BE USED ARE SPECIFIED BY THE VARIABLES TABL AND TABLY WHICH ARE INPUT IN NAMELIST SEARCH. THIS FEATURE IS LIMITED TO

5.A. CONTROL (INDEPENDENT) VARIABLES (CONTD)

IN ADDITION TO THE ABOVE REQUIRED INPUTS, THERE ARE SOME OTHERS ASSOCIATED WITH THE CONTROL VARIABLES WHICH COULD BE USED TO SPEED THE TARGETING/OPTIMIZATION PROCESS ON DIFFICULT PROBLEMS. IN MOST CASES, THE STORED VALUES WILL PROVIDE THE BEST RESULTS. NO USER INPUTS ARE REQUIRED IF THE STORED VALUES ARE TO BE USED. THESE INPUTS ARE INPUT IN NAMELIST SEARCH AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
MODEW	INTEGER	1	CONTROLS TYPE OF WEIGHTING TO BE USED FOR THE INDEPENDENT VARIABLES = 0, USE INPUT WEIGHTING, WU(I). SEE INPUT INSTRUCTIONS FOR WU(I). = 1, AUTOMATIC CONTROL WEIGHTING WU(I) = 1.0/U(I)
TABL(I) I=1,25	HOLLERITH	0	THE NAME OF THE TABLE CONTAINING THE Y ARGUMENT TO BE USED.
TABLY(I) I=1,25	INTEGER	0	THE INDEX OF THE Y ARGUMENT. THE FIRST Y ARGUMENT IS DESIGNATED AS 1, THE SECOND AS 2, ETC.
WU(I) I=1,25	SAME AS THE VAR. SPECIFIED BY INDVR(I)	0.0	INDEPENDENT VARIABLE WEIGHTING USED IF MODEW = 0. WU(I) LT 1.0/U(I) MORE SENSITIVE WU(I) = 1.0/U(I) SAME AS MODEW = 1. WU(I) GT 1.0/U(I) LESS SENSITIVE

5.B. CONSTRAINT (DEPENDENT) VARIABLES

THE DEPENDENT VARIABLES CAN BE EITHER EQUALITY CONSTRAINTS OR INEQUALITY CONSTRAINTS BASED ON USER INPUT. ANY CALCULATED OUTPUT OR INDEPENDENT VARIABLE CAN BE USED AS A DEPENDENT VARIABLE AND AS MANY AS 25 CAN BE SPECIFIED.

TO CONSTRAIN A CONTROL (INDEPENDENT) VARIABLE, DECLARE IT TO BE A DEPENDENT VARIABLE AND SET IDEPVR NON-ZERO. FOR EXAMPLE, SUPPOSE ALPHA IS TO BE A CONTROL VARIABLE IN PHASE N, BUT MUST NOT EXCEED 45 DEGREES. SET INDRV(I) = 6HALPHA , INDPH(I) = N, DEPVR(J) = 6HALPHA , DEPPH(J) = N, DEPVAL(J) = 45., IDEPVR(J) = 1.

THE INEQUALITY CONSTRAINTS MAY BE EITHER FUNCTIONAL OR SINGLE VALUED. THESE TWO TYPES OF CONSTRAINTS ARE EXPLAINED IN SECTIONS 6.A.7 AND 6.A.14 OF THIS REPORT.

ALL INPUTS ASSOCIATED WITH THE DEPENDENT VARIABLES ARE INPUT IN NAMELIST SEARCH. THE REQUIRED VARIABLES ARE AS FOLLOWS -

1) THE HOLLERITH NAME OF EACH DEPENDENT VARIABLE. INPUT IN THE ARRAY DEPVR(I), I=1,NDEPV.

2) THE PHASE NUMBER (EVENT) ASSOCIATED WITH EACH DEPENDENT VARIABLE - DEPPH(I), I=1,NDEPV. THE VARIABLE SPECIFIED BY DEPVR(I) WILL BE SATISFIED AT THE PLUS SIDE OF THE EVENT SPECIFIED BY DEPPH(I). IF DEPPH(I) IS GREATER THAN FESN, THE LAST PHASE IS ASSUMED.

3) THE DESIRED VALUE OF EACH DEPENDENT VARIABLE - DEPVAL(I), I=1,NDEPV.

4) THE DESIRED ACCURACY TOLERANCE WITHIN WHICH DEPVR(I) IS CONSIDERED TO BE SATISIFIED - DEPTL(I), I=1,NDEPV.

5) THE NUMBER OF DEPENDENT VARIABLES TO BE USED - NDEPV. THE FIRST NDEPV VARIABLES IN THE ARRAY DEPVR(I) WILL BE USED AS DEPENDENT VARIABLES.

6) THE TYPE OF CONSTRAINT FOR EACH DEPVR(I) - IDEPVR(I), I=1,NDEPV. THE FOLLOWING VALUES FOR IDEPVR(I) CAN BE SPECIFIED -

```
IDEPVR(I) =  0, IF DEPVR(I) IS TO BE AN EQUALITY
                CONSTRAINT
          =  1, IF DEPVR(I) IS TO BE AN INEQUALITY
                CONSTRAINT WITH AN UPPER BOUND
          = -1, IF DEPVR(I) IS TO BE AN INEQUALITY
                CONSTRAINT WITH A LOWER BOUND
```

5.B. CONSTRAINT (DEPENDENT) VARIABLES (CONTD)

OTHER INPUTS WHICH ARE NOT REQUIRED BUT WHICH MAY HELP THE TARGETING/OPTIMIZATION PROCESS ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IFDEG(I) I=1,25	INTEGER	0	CONTROLS 360 - 0 DEGREE DISCONTINUITY IN DEPVR(I). FOR EXAMPLE, IF DEPVR(I) = 6HTRUAN , AND DEPVAL = 359.95, A DISCONTINUITY EXISTS NEAR THE DESIRED VALUE, AND IFDEG SHOULD BE USED. = 0, NO CORRECTION MADE. = 1, IF ABS(E(I)) IS GREATER THAN 180.0, SET E(I) = E(I) PLUS OR MINUS 180.0.
NPAD(1)	DECIMAL	9.0	DESIRED AVERAGE OF MINIMUM AND MAXIMUM NUMBER OF DIGITS DIFFERENT BETWEEN RESPECTIVE DEPENDENT AND OPTIMIZATION VARIABLE VALUES TO BE ACHIEVED BY ADJUSTING PERT(I). INCREASING THE VALUE OF NPAD(1) WILL CAUSE PERT(I) TO BECOME LARGER, WHILE DECREASING NPAD(1) WILL CAUSE PERT(I) TO BECOME SMALLER. THIS OPTION IS DISABLED IF NPAD(1) IS INPUT GREATER THAN 15.
NPAD(2)	DECIMAL	4.0	NUMBER OF SIGNIFICANT FIGURES DIFFERENT BETWEEN NOMINAL AND PERTURBED DEPENDENT OR OPTIMIZATION VARIABLE VALUE BELOW WHICH THE VARIABLE IS IGNORED IN SELECTING MINIMUM AND MAXIMUM REQUIRED FOR PERT ADJUSTMENT.
NPAD(3)	DECIMAL	14.4494	NUMBER OF SIGNIFICANT FIGURES DIFFERENT BETWEEN NOMINAL AND PERTURBED DEPENDENT OR OPTIMIZATION VARIABLE VALUES, ABOVE WHICH THE VARIABLE IS IGNORED IN SELECTING MINIMUM AND MAXIMUM REQUIRED FOR PERT ADJUSTMENT.

5.B. CONSTRAINT (DEPENDENT) VARIABLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PDLMAX	DECIMAL	2.0	MAGNITUDE OF DIFFERENCE BETWEEN NPAD(1) AND AVERAGE OF MINIMUM AND MAXIMUM NUMBER OF DIGITS DIFFERENT BETWEEN RESPECTIVE DEPENDENT AND OPTIMIZATION VARIABLES, ABOVE WHICH A SECOND PERTURBED TRAJECTORY IS PROPAGATED TO MORE ACCURATELY APPROXIMATE THE SENSITIVITIES.

EXAMPLE OF NPAD DEFINITION

```
    PERTURBED DEPVR(I) OR OPTVAR =  .134754263872382E06
-     NOMINAL   DEPVR(I) OR OPTVAR = -.134752628408132E06
= PERTURBATION DEPVR(I) OR OPTVAR =  .000001635464250E06
```

NUMBER OF DIGITS DIFFERENT DUE TO NOISE (4)

NUMBER OF DIGITS DIFFERENT (10)

NUMBER OF DIGITS DIFFERENT DUE TO CHANGE IN POLARITY (15)

5.C. OPTIMIZATION VARIABLE

THE PROGRAM HAS THE CAPABILITY TO EITHER MINIMIZE OR MAXIMIZE A SPECIFIED VARIABLE WITH OR WITHOUT SATISFYING SPECIFIED CONSTRAINTS.

THE FOLLOWING INPUTS ARE REQUIRED TO DEFINE THE OPTIMIZATION VARIABLE. ALL VARIABLES ASSOCIATED WITH THE OPTIMIZATION PROCESS ARE INPUT IN NAMELIST SEARCH.

1) THE HOLLERITH NAME OF THE OPTIMIZATION VARIABLE. INPUT AS THE VARIABLE OPTVAR. ANY OF THE OUTPUT VARIABLES CAN BE USED AS AN OPTIMIZATION VARIABLE, PROVIDED IT IS SENSITIVE TO AT LEAST ONE OF THE INDEPENDENT VARIABLES.

2) TYPE OF OPTIMIZATION DESIRED - OPT. IF NO OPTIMIZATION IS DESIRED, INPUT OPT AS 0. IF THE VARIABLE DEFINED BY OPTVAR IS TO BE MINIMIZED, INPUT OPT = -1. IF OPTVAR IS TO BE MAXIMIZED, INPUT OPT = +1.

3) THE PHASE NUMBER (EVENT) ASSOCIATED WITH THE OPTIMIZATION VARIABLE - OPTPH. THE VARIABLE SPECIFIED BY OPTVAR WILL BE OPTIMIZED AT THE PLUS SIDE OF THE EVENT SPECIFIED BY OPTPH.

4) THE WEIGHTING FOR THE OPTIMIZATION VARIABLE - WOPT. WOPT SHOULD BE INPUT AS APPROXIMATELY 1 OVER THE ANTICIPATED VALUE OF OPTVAR.

5) THE DECIMAL PERCENTAGE CHANGE TO BE MADE IN THE CONTROL VARIABLES FOR THE INITIAL TRIAL STEP ON EACH ITERATION - PCTCC.

5.D. TARGETING/OPTIMIZATION ALGORITHMS

POST CONTAINS FOUR (4) TARGETING/OPTIMIZATION ALGORITHMS. THESE ALGORITHMS ARE DIRECT METHODS BASED UPON FIRST ORDER GRADIENT INFORMATION. THE PRINCIPLE DIFFERENCE BETWEEN THESE TECHNIQUES IS THAT THREE OF THESE ALGORITHMS ARE UNCONSTRAINED METHODS WHILE THE FOURTH IS A CONSTRAINED METHOD. EFFICIENT UTILIZATION OF THESE ALGORITHMS REQUIRES A BASIC UNDERSTANDING OF TARGETING/OPTIMIZATION CONCEPTS AND NOMENCLATURE, AND A COMPLETE UNDERSTANDING OF POST INPUT PROCEDURES. FOR CONVENIENCE, A BRIEF SUMMARY OF THE KEY CONCEPTS AND TERMINOLOGY IS REVIEWED BELOW.

OPTIMIZATION VARIABLE

THE VARIABLE TO BE OPTIMIZED (I.E., MAXIMIZED OR MINIMIZED) IS INPUT AS OPTVAR, AND IS CALCULATED ON THE POSITIVE SIDE OF THE EVENT SPECIFIED BY OPTPH. SINCE ALL ALGORITHMS IN POST ARE FORMULATED AS MINIMIZATION ROUTINES, OPTVAR IS TRANSFORMED INTERNALLY TO A NEW FUNCTION

P1 = - OPT*WOPT*OPTVAR,

WHERE WOPT SCALES OPTVAR, AND OPT FLAGS MAXIMIZATION OR MINIMIZATION. CLEARLY, IF OPT =+1 (MAXIMIZATION), THEN

MIN(P1) = MIN(-WOPT*OPTVAR) = WOPT*MAX(OPTVAR),

AND IF OPT =-1 (MINIMIZATION) , THEN

MIN(P1) = MIN(+WOPT*OPTVAR) = WOPT*MIN(OPTVAR).

CONSTRAINTS

THE PROBLEM CONSTRAINTS ARE INPUT BY DEFINING THE NUMBER OF CONSTRAINTS (NDEPV), THEIR HOLLERITH NAMES (DEPVR), THE EVENTS AT WHICH THEY ARE CALCULATED (DEPPH), THEIR DESIRED VALUES (DEPVAL), THEIR TOLERANCES (DEPTL), AND THE TYPE OF CONSTRAINT (IDEPVR).

THE ACTUAL ERROR IN THE J-TH CONSTRAINT IS

E(J) = DEPVR(J) - DEPVAL(J),

AND THE WEIGHTED ERROR IS

WE(J) = (DEPVR(J) - DEPVAL(J))/ABS(DEPTL(J)) .

THE J-TH CONSTRAINT IS SAID TO BE AN EQUALITY CONSTRAINT IF IT IS OF THE FORM

DEPVR(J) = DEPVAL(J),

AND IS SAID TO BE AN INEQUALITY CONSTRAINT IF IT IS OF THE FORM

DEPVR(J) LE DEPVAL(J), (UPPER BOUND)

OR

DEPVR(J) GE DEPVAL(J), (LOWER BOUND) .

TYPICALLY, TARGET CONDITIONS (E.G., ALTITUDE, VELOCITY, ETC.) ARE FORMULATED AS EQUALITY CONSTRAINTS, AND ENVIRONMENT CONDITIONS (DYNAMIC PRESSURE LIMITS, ETC.) ARE FORMULATED AS INEQUALITY CONSTRAINTS. ONE MISTAKE THAT IS FREQUENTLY MADE IS THE USE OF EQUALITY CONSTRAINTS WITH LARGE TOLERANCES INSTEAD OF INEQUALITY CONSTRAINTS WITH SMALL TOLERANCES. THIS PRACTICE TENDS TO CONFUSE THE TARGETING LOGIC AND HENCE WASTE COMPUTER TIME. ANOTHER COMMON ERROR WHICH HAS A SIMILAR EFFECT, IS AN ATTEMPT TO HELP THE TARGETING ROUTINE BY USING EXTREMELY LARGE TOLERANCES. THE BEST GUIDE TO THE SELECTION OF THE TYPES OF CONSTRAINTS AND THEIR ASSOCIATED TOLERANCES IS THAT THEY MAKE GOOD PHYSICAL SENSE.

THE J-TH INEQUALITY CONSTRAINT IS SAID TO BE

VIOLATED IF

WE(J) LE -1.0 ,

NOT VIOLATED IF

WE(J) GE +1.0,

TIGHT IF

-1.0 GE WE(J) LE +1.0,

AND ACTIVE IF

A) P2 LE 1.0,

AND

B) R(J) = I(SMAT*T(SMAT))SMAT*G1(J) GE -1.0E-06

WHERE I(*) AND T(*) DENOTE INVERSE AND TRANSPOSE, RESPECTIVELY.

CLEARY, THE SET OF ACTIVE CONSTRAINTS IS A SUBSET OF THE SET OF TIGHT CONSTRAINTS, SINCE IF

R(J) LT -1.E-06,

THEN THE J-TH CONSTRAINT CAN BE DROPPED ON THAT PARTICULAR ITERATION. THE COMPLETE SET OF ACTIVE CONSTRAINTS FOR AN ITERATION IS THE UNION OF ALL EQUALITY CONSTRAINTS (THEY ARE ALWAYS ACTIVE) AND THE SET OF ACTIVE INEQUALITIES. THE TOTAL NUMBER OF ACTIVE CONSTRAINTS IS OUTPUT AS NAC, AND THEIR INDICES BY THE ARRAY IAC(J).

CONSTRAINT PENALTY FUNCTION (P2)

THE PENALTY FUNCTION FOR THE VIOLATED CONSTRAINTS IS CALCULATED AS

```
P2 =  SUM ( WE(I)**2 ) .
      I=1,NAC
```

A SUFFICIENT CONDITION WHICH INSURES THAT THE CONSTRAINTS ARE SATISFIED WITHIN THE TOLERANCE SPECIFIED BY DEPTL(I) IS THAT

P2 LE 1.0 .

WHEN UNCONSTRAINED METHODS ARE USED THIS SECOND PENALTY FUNCTION IS RECOMPUTED INTERNALLY AS

```
P2 = P1 + WCON*SUM( WE(I)**2 ) ,
               I=1,NAC
```

WHERE THE PENALTY CONSTANT IS INPUT AS WCON. IT CAN BE SHOWN THAT FOR A SUFFICIENTLY LARGE WEIGHTING CONSTANT, THE MINIMUM OF P2 CORRESPONDS TO THE CONSTRAINED MINIMUM.

INDEPENDENT VARIABLES AND WEIGHTING

THE INDEPENDENT VARIABLES ARE INPUT BY DEFINING THEIR HOLLERITH NAMES (INDVR), AND THE EVENTS AT WHICH THEY ARE TO BE ACTIVATED (INDPH). IT IS THESE VARIABLES THAT ARE INTERNALLY

ADJUSTED BY THE SELECTED ALGORITHM IN ORDER TO OPTIMIZE OPTVAR AND SIMULTANEOUSLY SATISFY THE CONSTRAINT EQUATIONS. THE INDEPENDENT VARIABLES ARE INTERNALLY WEIGHTED TO INSURE PROPER OVERALL SCALING. THIS IS ACCOMPLISHED BY PREMULTIPLYING THE THE ACTUAL VARIABLES BY A DIAGONAL WEIGHTING MATRIX. IN TERMS OF OUTPUT VARIABLES, THE SCALED INDEPENDENT VARIABLES ARE GIVEN BY

```
WU(I) = WVEC(I)*U(I) , I = 1,NINDV.
```

NOMINALLY, THE WEIGHTING MATRIX IS GIVEN BY

```
WVEC(I) = 1.0/ABS(U(I)) , I = 1,NINDV,
```

WHERE U(I) IS THE INPUT VALUES OF THE INDEPENDENT VARIABLES.

AS A CONSEQUENCE OF THE WEIGHTING OF BOTH THE DEPENDENT AND THE INDEPENDENT VARIABLES, THE FUNCTIONAL RELATIONSHIPS USED TO DETERMINE THE INDEPENDENT VARIABLE CORRECTIONS ARE ALSO SCALED. THUS, THE ACTUAL FUNCTIONAL RELATIONS USED INTERNALLY ARE

```
P1    = P1( WU(1),...,WU(NINDV) ) ,

WE(I) = WE( WU(1),...,WU(NINDV) ) ,
```

AND

```
P2    = P2( WE(1),...,WE(NAC) ) .
```

SENSITIVITY CALCULATIONS

THE COMPLEXITY OF THESE FUNCTIONS REQUIRES THAT THEIR DERIVATIVES BE APPROXIMATED BY FIRST DIFFERENCES. THESE APPROXIMATIONS TO THE SENSITIVITIES ARE THEN PROCESSED BY THE OPTIMIZATION ALGORITHM ORDER TO SOLVE THE PROBLEM FORMULATED IN NAMELIST SEARCH. THE GRADIENTS OF P1 AND P2 ARE DENOTED BY G1(I) AND G2(I), RESPECTIVELY AND THE GRADIENT OF THE CONSTRAINT VECTOR IS DENOTED BY SMAT(I,J). THE DIFFERENCE FORMULAE USED TO APPROXIMATE THESE PARTIAL DERIVATIVES ARE

```
G1(J) = (P1(U(1),.,U(J)+PERT(J),.,U(M))-P1(U(1),.,U(M)))/PERT(J),

SMAT(I,J) = ( WEI(U +PERT(J)) - WEI(U) )/PERT(J),
```

AND

```
G2(J) = 2*SUM(WE(I)*SMAT(I,J)) , J=1,NINDV .
          I=1,NAC
```

NOTE THAT THE GRADIENT OF P2 IS COMPUTED FROM SMAT AND NOT BY DIFFERENCING P2 DIRECTLY. THE REASON FOR THIS IS THAT IT REDUCES THE ERROR IN G2(I) AT P2 EQ 0.0.

THE UNSCALED GRADIENTS CAN BE COMPUTED FROM

```
GRAD(OPTVAR) = - WVEC(I)*G1(I)/WOPT*OPT,
```

AND

```
GRAD(DEPVR(I)) = DEPTL(I)*WVEC(J)*SMAT(I,J)
```

ESTIMATED NET COST FUNCTION

WHEN THE PROJECTED GRADIENT METHOD IS USED (I.E., SRCHM=4) AN ADDITIONAL PENALTY FUNCTION CAN BE DEFINED WHICH INCLUDES THE EFFECTS OF CONSTRAINT VIOLATION WITHOUT THE INTRODUCTION OF AN ARBITRARY WEIGHTING CONSTANT. THIS PENALTY FUNCTION IS CALLED THE ESTIMATED NET COST FUNCTION, AND IS COMPUTED AS

```
P1NET = P1 - T(G1)T(SMAT)*I(SMAT*T(SMAT))WE .
```

THE FIRST TERM OF P1NET IS THE ACTUAL WEIGHTED COST FUNCTION. THE SECOND TERM IS A LINEARIZED APPROXIMATION TO THE CHANGE IN P1 RESULTING FROM A MINIMUM NORM CORRECTION BACK TO THE SET OF ACTIVE CONSTRAINTS. THE SECOND TERM REPRESENTS THE INDUCED COST ASSOCIATED WITH THE CONSTRAINT VIOLATION WHICH RESULTS FROM DETERMINING THE DIRECTION OF SEARCH FROM A LINEARIZED APPROXIMATION TO THE NONLINEAR CONSTRAINTS. THE TERM ESTIMATED IS USED IN DESCRIBING P1NET BECAUSE THE SENSITIVITY MATRIX IS NOT RECOMPUTED AS A FUNCTION OF THE STEPSIZE TAKEN IN THE SEARCH DIRECTION.

DIRECTION OF SEARCH

THE FINAL KEY CONCEPT IS THE IDEA OF A DIRECTION OF SEARCH. HEURISTICALLY, THE DIRECTION OF SEARCH IS NOTHING MORE THAN A PARTICULAR LINE IN THE INDEPENDENT VARIABLE SPACE ALONG WHICH THE CONSTRAINT ERROR IS REDUCED, OR THE COST FUNCTION IS DECREASED.

IN A MORE PRECISE SENSE, THE DIRECTION OF SEARCH AT U(I) IS A HALF-RAY EMANATING FROM U(I). THUS, FOR ANY POSITIVE SCALAR, GAMAST, THE EQUATION

```
     U(I) = U(I) + GAMAST*DU(I) , I = 1,NINDV
```

SETS THE LIMITS OF THIS HALF-RAY AND REPRESENTS MOVEMENT IN THE DIRECTION DU(I), FROM U(I).

THE VARIOUS MATHEMATICAL TECHNIQUES USED IN POST TO DETERMINE THE DIRECTION OF SEARCH (S) ARE BASED ON G1(I), SMAT(I.J), AND G2(I). THESE TECHNIQUES, WHICH ARE DISCUSSED IN DETAIL IN THE FORMULATION MANUAL, ARE SUMMARIZED ACCORDING TO THE SRCHM FLAG. IN ORDER TO SIMPLIFY THE NOTATION, THE ROW/COLUMN SUBSCRIPTS ARE REPLACED BY THE SUBSRIPT N, WHERE N DENOTES THE N-TH ELEMENT OF THE ITERATION SEQUENCE.

DIRECTION OF SEARCH EQUATIONS

```
     SRCHM = 1, ( THE STEEPEST DESCENT METHOD APPLIED TO P2  )

      S(N) = - G2(N)

     SRCHM = 2, ( THE CONJUGATE GRADIENT METHOD APPIED TO P2 )

      S(N) = - G2(N), IF N=0, OTHERWISE
      S(N) = - G2(N) + ( T(G2(N))G2(N)/T(G2(N-1))G2(N-1) )*G2(N-1)

     SRCHM = 3, ( THE DAVIDON METHOD APPLIED TO P2 )

      S(N) = -G2(N), IF N=0, OTHERWISE
      S(N) = -H(N)G2(N), WHERE
      H(N) = H(N-1) + A(N) + B(N)
      D(N) = U(N) - U(N-1)
      G(N) = G2(N) - G2(N-1)
      A(N) = D(N)T(D(N))/T(D(N))G(N)
      B(N) = -H(N-1)G(N)T(H(N-1)G(N))/T(G(N))H(N-1)G(N)

     SRCHM = 4, ( THE ACCELERATED PROJECTED GRADIENT METHOD )

       A) MINIMUM NORM CONSTRAINT CORRECTION

      S(N) = - T(SMAT)I(SMAT*T(SMAT))WE(N)
```

B) PROJECTED GRADIENT DIRECTION

```
 P(N) = I - T(SMAT)*I(SMAT*T(SMAT))*SMAT
PG(N) = P(N)G1(N)
 S(N) = -PG(N) , IF N=0 , OTHERWISE
 S(N) = -H(N)PG(N),
 H(N) = H(N-1) + A(N) + B(N), AS IN DAVIDONS METHOD
```

A UNIT VECTOR, DU(N), IN THE DIRECTION, S(N), IS THEN CALCULATED FROM THE EQUATION

```
DU(N)= S(N)/T(S(N))S(N).
```

AFTER DU(I) IS DETERMINED, THE MAGNITUDE OF THE CORRECTION TAKEN IN THAT DIRECTION IS CALCULATED BY MINIMIZING EITHER PINET OR P2. THE RESULTS OF THESE ONE-DIMENSIONAL MINIMIZATIONS ARE INCLUDED IN THE ITERATION SUMMARY.

ONE DIMENSIONAL MINIMIZATION

THE MONOVARIANT MINIMIZATION IS PERFORMED EXCLUSIVELY BY POLYNOMIAL INTERPOLATION. FIRST THE ACTUAL FUNCTION, F, TO BE MINIMIZED IS APPROXIMATED BY ONE OR MORE QUADRATIC OR CUBIC POLYNOMIALS UNTIL A SUFFICIENTLY ACCURATE CURVEFIT, P, IS OBTAINED, THAT IS

```
P(GAMA)  =   SUM ( A(I)* GAMA**I )  =  F(GAMA)
             I=0,N
```

FOR ALL GAMA OF INTEREST. THEN THE INDEPENDENT VARIABLE VALUE, GAMA MINIMIZING F IS APPROXIMATED BY THE VALUE GAMAST MINIMIZING P(GAMA).

THE MINIMIZATION ROUTINE (GENMIN) MAKES USE OF ALL THE INFORMATION IT ACCUMULATES ABOUT F TO OBTAIN A GOOD CURVEFIT. FIRST, F IS FIT WITH A QUADRATIC POLYNOMIAL, P1, BASED ON

1) F(0)
2) DFDS(0)
3) F(GAMA(1)), WHERE GAMA(1) IS AN INITIAL ESTIMATE OF THE GAMAST VALUE MINIMIZING F.

THE INDEPENDENT VARIABLE VALUE MINIMIZING THE QUADRATIC IS

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GAMA(2) = -A(1)/(2*A(2)) .
```

IF ABS((GAMA(2)-GAMA(1))/GAMA(1)) LE CONSEX(I), THEN GAMAST IS TAKEN TO BE GAMA(2) AND THE MINIMIZATION PROCEDURE IS CONSIDERED COMPLETE. SIMILARLY, IF ABS((P1(GAMA(2))- F(GAMA(2)))/F(GAMA(2))) LT FITERR(I), GAMAST IS TAKEN EQUAL TO GAMA(2) AND THE PROCESS IS TERMINATED. OTHERWISE F IS FIT WITH A CUBIC POLYNOMIAL, P2, BASED ON

1) F(0)
2) DFDS(0)
3) F(GAMA(1))
4) F(GAMA(2))

THE INDEPENDENT VARIABLE VALUE GAMA(3) MINIMIZING THE CUBIC IS

```
GAMA(3) =(-A(2)+SQRT(A(2)**2-3A(1)*A(3)))/3.0*A(3).
```

IF ABS((GAMA(3)-GAMA(2))/GAMA(2)) LE CONSEX(I), THEN GAMAST IS TAKEN TO BE GAMA(3) AND THE MINIMIZATION IS STOPPED. SIMILARLY, IF ABS((P2(GAMA(3)-F(GAMA(3))/F(GAMA(3)))) LE FITERR(I), THEN GAMAST IS TAKEN EQUAL TO GAMA(3) AND THE PROCEDURE IS STOPPED. IF NONE OF THESE STOPPING CONDITIONS ARE MET, THE ACCUMULATED SET OF FUNCTION VALUES IS SEARCHED FOR A NONMONOTONIC SEQUENCE (I.E., UP-DOWN-UP SEQUENCE OF FUNCTION VALUES). IF THE MINIMUM HAS BEEN BRACKETED, THEN THE BRACKETING POINTS ARE ARRANGED IN THE ORDER OF ASCENDING ABSCISSA VALUES. THEN THE FIRST POINT WHOSE ORDINATE VALUE IS LESS THAN THAT OF THE FOLLOWING POINT IS SELECTED. FOR SIMPLICITY OF NOTATION, RELABEL THIS POINT (GAMA(2),F(GAMA(2)), THE PRECEDING POINT (GAMA(1),F(GAMA(1)), AND THE FOLLOWING POINT (GAMA(3),F(GAMA(3)). A QUADRATIC, P3, IS THEN FIT TO

1) F(GAMA(1)) , GAMA(1)
2) F(GAMA(2)) , GAMA(2)
3) F(GAMA(3)) , GAMA(3)

AGAIN THE INDEPENDENT VARIABLE VALUE, GAMA(4), MINIMIZING THE QUADRATIC IS

```
GAMA(4) = -A(1)/(2.0*A(2)).
```

SIMILARLY, IF ABS((GAMA(4)-GAMA(3))/GAMA(3)) LE CONSEX(I) OR IF ABS((P3(GAMA(4)-F(GAMA(4)))/F(GAMA(4))) LE FITERR(I), THEN GAMAST IS TAKEN TO BE GAMA(4) AND THE PROCESS IS TERMINATED. IF NEITHER OF THESE STOPPING CONDITIONS IS MET, THEN A FINAL CUBIC, P4, IS FIT TO

1) F(GAMA(1)) , GAMA(1)
2) F(GAMA(2)) , GAMA(2)
3) F(GAMA(3)) , GAMA(3)
4) F(GAMA(4)) , GAMA(4).

THE INDEPENDENT VARIABLE VALUE, GAMA(5), MINIMIZING THE CUBIC IS

GAMA(5) = (-A(2)+SQRT(A(2)**2-3A(1)*A(3))/3*A(3).

IF ABS((GAMA(5)-GAMA(4))/GAMA(4)) LE CONSEX(I) OR IF ABS(P4(GAMA(5))-F(GAMA(5))/F(GAMA(5))) LE FITERR(I), THEN GAMAST IS TAKEN TO BE GAMA(5). IF NONE OF THESE STOPPING CONDITIONS ARE SATISFIED, THE ACCUMULATED SET OF SAMPLE POINTS IS SEARCHED FOR THE POINT WITH MINIMUM ORDINATE VALUE. THE ABSCISSA VALUE OF THIS POINT IS TAKEN TO BE GAMAST, AND THE MINIMIZATION IS CONSIDERED COMPLETE.

THIS PROCEDURE MAY BE SUMMARIZED AS FOLLOWS

STEP 1.0 - APPROXIMATE F BY A QUADRATIC POLYNOMIAL BASED UPON F(0), DFDS(0), F(GAMA(1)).

STEP 2.0 - APPROXIMATE F BY A CUBIC POLYNOMIAL BASED UPON F(0), DFDS(0), F(GAMA(1)).

STEP 3.0 - APPROXIMATE F BY A QUADRATIC POLYNOMIAL BASED UPON F(GAMA(I)),F(GAMA(J)),F(GAMA(K)),WHERE I,J, AND K ARE DETERMINED TO BRACKET THE MINIMUM.

STEP 4.0 - APPROXIMATE F BY A CUBIC POLYNOMIAL BASED UPON F(GAMA(I)), F(GAMA(J)), F(GAMA(K), F(GAMA(4)) .

STEP 5.0 - DETERMINE THE MINIMUM ORDINATE VALUE BY DIRECTLY SEARCHING THE SET OF ACCUMULATED VALUES.

CONVERGENCE TESTS

THE FINAL CONSIDERATION IS THAT OF DETERMINING WHEN AND IF THE SOLUTION TO THE PROBLEM HAS BEEN COMPUTED. CONVERGENCE OR CONVERGENCE FAILURE IS DETECTED AUTOMATICALLY IN SUBROUTINE TEST AND DEPENDS CRITICALLY UPON THE TOLERANCES CONEPS(J). THE STORED VALUES FOR THESE TOLERANCES ARE SMALLER THAN GENERALLY REQUIRED. THUS, ADEQUATE CONVERGENCE MAY BE ACHIEVED BEFORE ALL OF THE CONVERGENCE TESTS ARE SATISFIED WITHIN THE TOLERANCES SPECIFIED IN

THE ARRAY CONEPS(J). THIS CAN BE DETERMINED FROM ANALYSIS OF THE ITERATION SUMMARY PRINTOUT BY MAKING A FEW SIMPLE CHECKS. THE CONSTRAINTS (EQUALITY AND INEQUALITY) ARE SATISFIED WITHIN THE INPUT TOLERANCES IF

P2 LE 1.0 .

THUS, ON TARGETING PROBLEMS IF P2 LE 1.0, THEN A SOLUTION HAS BEEN COMPUTED. NOTE THAT THIS CONDITION IS SUFFICIENT BUT NOT NECESSARY, SINCE IF P2 LE NAC THE CONSTRAINTS MAY BE SATISFIED. ON OPTIMIZATION PROBLEMS, THE FOLLOWING ADDITIONAL TESTS MUST BE MADE

A) CTHA GE CONEPS(1),

AND

B) R(J) GE 0.0, FOR ALL J = 1,NAC,

WHERE CTHA IS THE ANGLE BETWEEN THE COST GRADIENT AND THE PROJECTION OF THE COST GRADIENT ONTO THE INTERSECTION OF THE LINEARIZED ACTIVE CONSTRAINTS, AND R(J) ARE THE COEFFICIENTS OF THE EXPANSION OF THE COST GRADIENT IN TERMS OF THE INDIVIDUAL ACTIVE CONSTRAINT GRADIENTS. CONDITION B IS A MATHEMATICAL STATEMENT OF THE FACT THAT, AT THE OPTIMUM, NO FEASIBLE DIRECTION CAN HAVE AN ANGLE OF LESS THAN 90 DEGREES BETWEEN IT AND -G1(I).

IN ADDITION, POST ALSO CONTAINS SEVERAL ITERATION CREEP TESTS. THESE TESTS ARE DESIGNED TO PREVENT THE ITERATION FROM PROCEEDING WHEN NO PROGRESS IS BEING MADE. THESE TESTS ARE

A) ABS(UMAG-OLDU)/UMAG LE CONEPS(2)

B) ABS((P1NOM-OLDP1)/P1NOM) LE CONEPS(3)

C) ABS((P2NOM-OLDP2)/P2NOM) LE CONEPS(4)

D) ABS((G2MAG-OLDG2)/G2MAG) LE CONEPS(5)

IF ALL OF THESE CHECKS ARE SATISFIED ON TWO SUCCESSIVE ITERATIONS, THEN THE MESSAGE

*** NO CHANGE IN STATE DURING 2 CONSECUTIVE ITERATIONS

IS PRINTED AND THE ITERATION IS TERMINATED BECAUSE NONE OF THE PARAMETERS ARE CHANGING. IN GENERAL, THIS MEANS THAT THE PROGRAM HAS CONVERGED BUT NOT TO THE DESIRED SOLUTION. IF THIS MESSAGE APPEARS , THEN THE PROBLEM SET-UP SHOULD BE CHECKED BEFORE ADDITIONAL ITERATIONS ARE ATTEMPTED.

SUMMARY

BASED UPON THESE DEFINITIONS AND CONCEPTS, THE BASIC POST TARGETING AND OPTIMIZATION MACROLOGIC CAN BE OUTLINE AS FOLLOWS -

STEP 1.0 - READ IN THE INITIAL VALUES OF U(I).

STEP 2.0 - PROPAGATE THE NOMINAL TRAJECTORY AND CALCULATE P1, WE(I), AND P2.

STEP 3.0 - COMPUTE G1(I), SMAT(I,J), AND G2(I).

STEP 4.0 - COMPUTE THE DIRECTION OF SEARCH DU(I) BASED ON SRCHM.

STEP 5.0 - IF P2 GT 1.0, DETERMINE GAMAST SUCH THAT P2(U(I)+GAMAST*DU(I)) IS MINIMIZED, WHERE

0.0 GE GAMAST LE MIN(GAMAX,STPMAX).

STEP 6.0 - IF P2 LE 1.0, DETERMINE GAMAST SUCH THAT P1NET(U(I)+GAMAST*DU(I)) IS MINIMIZE, WHERE

0.0 GE GAMAST LE MIN(PCTCC*UMAG,STPMAX),

THEN A RETARGETING STEP IS TAKEN AS IN STEP 5.0 WITHOUT RECOMPUTING THE SENSITIVITY MATRIX.

STEP 7.0 - UPDATE THE INDEPENDENT VARIABLES

U(I) = U(I) + GAMAST*DU(I)

STEP 8.0 - TEST FOR CONVERGENCE. IF CONVERGED, THEN EXIT. IF NOT CONVERGED AND ITERATION COUNTER LE MAXITR, THEN RETURN TO STEP 2.0.

THERE ARE SEVERAL INPUT VARIABLES ASSOCIATED WITH THE TARGETING/OPTIMIZATION ALOGRITHM. THESE VARIABLES ARE INPUT IN NAMELIST SEARCH AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CONEPS(1)	DEG	89.9	CONVERGENCE TOLERANCE ON THE ANGLE BETWEEN THE OPTIMIZATION VARIABLE GRADIENT AND ITS PROJECTION ONTO THE PLANE TANGENT TO THE INTERSECTION OF THE CONSTRAINT (DEPENDENT VARIABLE) SURFACES. IF CTHA IS GREATER THAN OR EQUAL TO CONEPS(1), THE VARIABLE IS OPTIMIZED FOR THE GIVEN CONTROL PARAMETERS.
CONEPS(2)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN THE MAGNITUDE OF THE CONTROL PARAMETERS BETWEEN SUCCESSIVE ITERATIONS.
CONEPS(3)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN P1 ON SUCCESSIVE ITERATIONS.
CONEPS(4)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN P2 ON SUCCESSIVE ITERATIONS.
CONEPS(5)	N/D	0.10	THE MINIMUM PERCENTAGE CHANGE IN THE VALUES OF G2MAG ON SUCCESSIVE ITERATIONS.
CONSEX(1)	DECIMAL	1.0E-6	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE OPTIMIZATION TRIAL STEPS BEFORE CURVE FIT PROCESS IS TERMINATED. IF ABS((GAMA(I)-GAMA(I-1))/GAMA(I)) IS LESS THAN CONSEX(1), THEN NO MORE TRIAL STEPS ARE TAKEN TO MINIMIZE P1.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CONSEX(2)	DECIMAL	.001	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE TARGETING TRIAL STEPS BEFORE CURVE FIT PROCESS IS TERMINATED. IF ABS((GAMA(I)-GAMA(I-1))/GAMA(I)) IS LESS THAN CONSEX(2), THEN NO MORE TRIAL STEPS ARE TAKEN TO MINIMIZE P2.
FITERR(1)	DECIMAL	1.0E-6	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE OPTIMIZATION TRIAL VALUES BEFORE CURVE FIT PROCESS IS TERMINATED. IF ABS((P1TRY(I)-P1TRY(I-1))/P1TRY(I) IS LESS THAN FITERR(1), THEN NO MORE TRIAL STEPS ARE TAKEN TO MINIMIZE P1.
FITERR(2)	DECIMAL	.001	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE TARGETING TRIAL VALUES BEFORE CURVE FIT PROCESS IS TERMINATED. IF ABS((P2TRY(I)-P2TRY(I-1))/P2TRY(I) IS LESS THAN FITERR(2), THEN NO MORE TRIAL STEPS ARE TAKEN TO MINIMIZE P2.
MAXITR	INTEGER	10	MAXIMUM NUMBER OF ITERATIONS DURING SEARCH/OPTIMIZATION. IF MAXITR IS INPUT AS ZERO AND SRCHM AS NONZERO, THEN A SINGLE TRAJECTORY WILL BE RUN USING THE INPUT U(I) VALUES FOR THE VARIABLES SPECIFIED BY INDVR(I).

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
P2MIN	DECIMAL	1.0	THE PROBLEM IS CONSIDERED TARGETED IF P2 (THE MAGNITUDE OF THE ERROR VECTOR E(I)) IS LESS THAN P2MIN. HENCE IF OPT = 0.0, AND P2 IS LESS THAN P2MIN, THE PROBLEM IS SOLVED AND THE SEARCH IS TERMINATED. NOTE THAT NO OPTIMIZATION IS ATTEMPTED UNLESS P2 IS LESS THAN P2MIN. IT SHOULD BE NOTED THAT ALL DEPENDENT VARIABLES WILL BE WITHIN THE SPECIFIED TOLERENCES WHEN P2 IS LESS THAN 1.0. THEREFORE, P2MIN SHOULD GENERALLY INPUT EQUAL TO 1.0, EXCEPT FOR UNCONSTRAINED OPTIMIZATION TYPE PROBLEMS, IN WHICH CASE IT SHOULD BE INPUT LESS THAN THE ESTIMATED MINIMUM OF THE VARIABLE SPECIFIED BY OPTVAR.
SRCHM	INTEGER	0	CONTROLS THE TECHNIQUE USED FOR SEARCH/OPTIMIZATION. = 0, NO SEARCH/OPTIMIZATION. IGNORE ALL SEARCH/OPTIMIZATON INPUT. = 1, USE STEEPEST DESCENT METHOD TO MINIMIZE P2. = 2, USE CONJUGATE GRADIENT METHOD TO MINIMIZE P2. = 3, USE DAVIDON METHOD TO MINIMIZE P2. = 4, USE PROJECTED GRADIENT METHOD TO MINIMIZE P2. IF OPT IS NON-ZERO, OPTVAR WILL BE OPTIMIZED SUBJECT TO P2 LESS THAN P2MIN. THIS TECHNIQUE SHOULD BE USED FOR ALL SEARCH/OPTIMIZATION.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
STMINP	DECIMAL	.1	MAXIMUM PERCENTAGE THAT A TRIAL STEP IS ALLOWED TO BE REDUCED BY BASED UPON THE CURVE FIT. ONLY VERY UNUSUAL PROBLEMS REQUIRE CHANGING THIS PARAMETER. SOMETIMES A QUADRATIC CURVE FIT MIGHT PREDICT A MINIMUM AT 1.0E-10 TIMES THE PREVIOUS STEP IF THE FUNCTION INCREASED TOO RAPIDLY ON THAT PREVIOUS STEP, WHEN IN FACT A STEP OF .1 TIMES THE PREVIOUS STEP WOULD PRODUCE A MUCH MORE REALISTIC VALUE.
WCON	DECIMAL	100.0	WEIGHTING CONSTANT FOR P2 WHEN OPT IS NONZERO AND SRCHM IS NOT EQUAL TO FOUR. P2 IS SET EQUAL TO WOPT*P1 + WCON*P2. THEREFORE, TO MINIMIZE THE AUGMENTED P2 IS EQUIVALENT TO SIMULTANEOUSLY MINIMIZING P2 AND OPTIMIZING P1.

5.E. TARGETING/OPTIMIZATION OUTPUT

THE PROGRAM PRINTS VARIOUS AMOUNTS OF INFORMATION FOR EACH ITERARION BASED ON THE VALUE OF IDEB WHICH IS INPUT IN NAMELIST SEARCH. THE VARIOUS OPTIONS ASSOCIATED WITH IDEB ARE SUMMARIZED AS FOLLOWS -

IDEB = 0, PRINT ONLY THE ITERATION SUMMARIES. THAT IS, DO NOT PRINT THE TRIAL STEP SUMMARIES.

IDEB = 1, PRINT THE CENTRAL PROCESSOR (CP) TIME REQUIRED FOR EACH TRAJECTORY, THE TRIAL STEP SUMMARIES, AND THE ITERATION SUMMARIES.

THE TRIAL STEP SUMMARIES CONTAIN THE FOLLOWING PARAMETERS -

```
*** TRIAL STEP
GAMA
DU
WU(I)
U(I)
WE(I)
E(I)
P1

OPTVAR
P2
```

THE ITERATION SUMMARIES CONTAIN THE FOLLOWING PARAMETERS -

```
*** ITERATION NUMBER I

CP/ITR
PERT
SMAT
G1(I)
G1MAG
G2(I)
G2MAG
PG1(I)
PG1MAG
WVEC
```

5.E. TARGETING/OPTIMIZATION OUTPUT (CONTD)

```
NAC
IAC
RATIO      (OBTAINED ONLY ON OPTIMIZATION STEPS AND
            IF IDEB = 1)
CTHA       (OBTAINED ONLY ON OPTIMIZATION STEPS)
DP1DS
DP2DS
STPMAX
UMAG
DUMAG
PCTCC      (OBTAINED ONLY ON OPTIMIZATION STEPS)
GAMAST
P1TRY
P2TRY
YPRED
WU(I)
U(I)
WE(I)
E(I)
P1

OPTVAR
P2

DFDC       (OBTAINED ONLY ON THE LAST ITERATION)
```

OUTPUT SYMBOL	UNITS	DEFINITION
CP/ITR	SEC	THE AMOUNT OF CENTRAL PROCESSOR (CP) TIME REQUIRED FOR THE CURRENT ITERATION.
CTHA	DEG	THE ANGLE BETWEEN THE UNCONSTRAINED GRADIENT AND THE PROJECTED GRADIENT FOR P1. THIS ANGLE GOES TO 90 DEG AS P1 IS OPTIMIZED.
DFDC(I) I=1,25	OPTVAR/ DEPVR(I)	THE PARTIALS OF THE PERFORMANCE INDEX (OPTVAR) WITH RESPECT TO THE ACTIVE CON- STRAINTS.
DP1DS DP2DS	N/D	THE TOTAL DERIVATIVES OF P1 AND P2 WITH RESPECT TO THE STEPSIZE PARAMETER (GAMAS).

5.E. TARGETING/OPTIMIZATION OUTPUT (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
DU(I) I=1,25	N/D INDVR(I)	A UNIT VECTOR IN THE DIRECTION OF SEARCH. OBTAINED ONLY IF IDEB = 1.
E(I) I=1,25	SAME AS DEPVR(I)	THE TARGET ERRORS (ACTUAL - DESIRED).
GAMAST(I) I=1,6	N/D	THE VALUE OF GAMAS FOR EACH TRIAL STEP.
G1(I) I=1,25	N/D	THE WEIGHTED GRADIENT COMPONENTS FOR P1.
G1MAG	N/D	THE MAGNITUDE OF THE WEIGHTED GRADIENT OF P1.
G2(I) I=1,25	N/D	THE WEIGHTED GRADIENT COMPONENTS FOR P2.
G2MAG	N/D	THE MAGNITUDE OF THE WEIGHTED GRADIENT OF P2.
IAC(I) I=1,25	INTEGER	THE INDICES OF THE ACTIVE CONSTRAINTS.
NAC	INTEGER	THE NUMBER OF ACTIVE CONSTRAINTS.
OPTVAR	SAME AS VARIABLE IN OPTVAR	THE VALUE OF THE OPTIMIZATION VARIABLE.
PCTCC	N/D	THE MAXIMUM STEPSIZE ALLOWED FOR OPTIMIZ-ATION.
PERT(I) I=1,25	SAME AS INDVR(I)	THE PERTURBATIONS IN THE CONTROL PARAMETERS USED TO GENERATE THE SENSITIVITY MATRIX (SMAT) BY MEANS OF FIRST DIFFERENCES.
PG1(I) I=1,25	N/D	THE WEIGHTED PROJECTED GRADIENT COMPONENTS P1.

5.E. TARGETING/OPTIMIZATION OUTPUT (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
PG1MAG	N/D	THE MAGNITUDE OF THE WEIGHTED PROJECTED GRADIENT OF P1.
P1	N/D	THE VALUE OF THE WEIGHTED OPTIMIZATION PENALTY FUNCTION.
P1TRY(I) P2TRY(I) I=1,6	N/D	THE VALUES OF P1 AND P2 FOR EACH TRIAL STEP.
P2	N/D	THE VALUE OF THE TARGETING PENALTY FUNCTION (WEIGHTED). THE PROBLEM IS WITHIN THE USER SPECIFIED TOLERANCES IF P2 IS LESS THAN 1.
RATIO(I) I=1,4	N/D	THE DECIMAL PERCENTAGE CHANGE IN UMAG, P1, P2, AND GMAG, RESPECTIVELY, SINCE THE LAST ITERATION.
SMAT(I,J) I=1,25 J=1,25	DEPVR(I)/ INDVR(J)	THE ELEMENTS OF THE SENSITIVITY MATRIX FOR EACH TARGET (DEPENDENT) VARIABLE.
STPMAX	N/D	THE MAXIMUM STEPSIZE ALLOWED FOR TARGETING.
U(I) I=1,25	SAME AS INDVR(I)	THE VALUES OF THE CONTROL PARAMETERS.
UMAG	N/D	THE MAGNITUDE OF THE WEIGHTED CONTROL PARAMETER VECTOR (WU(I),I=1,NINDV).
WE(I) I=1,25	N/D	THE WEIGHTED ERRORS. WE(I) IS EQUAL TO E(I) DIVIDED BY DEPTL(I).
WU(I) I=1,25	N/D	THE WEIGHTED VALUES OF THE CONTROL PARAMETERS.
YPRED(I) I=1,6	N/D	THE VALUE OF P1 (OR P2) OBTAINED FROM THE CURVE FIT ROUTINE FOR EACH TRIAL STEP.

5.F. TRAJECTORY DECOMPOSITION OPTION

THE PROGRAM CAN SOLVE BOTH CONSTRAINED AND UNCONSTRAINED OPTIMIZATION PROBLEMS UTILIZING A DECOMPOSITION TECHNIQUE. THIS TECHNIQUE ALLOWS THE USER TO BREAK A COMPLICATED PROBLEM DOWN INTO AS MANY AS 5 LESS COMPLICATED SUB-PROBLEMS. THE PROGRAM COORDINATES THE SOLUTION OF THE SUB-PROBLEMS BY MEANS OF A MASTER LEVEL ALGORIHM.

THE GENERAL PROCEDURES FOR USING THE DECOMPOSITION OPTION ARE SUMMARIZED AS FOLLOWS -

1) SET UP THE PROBLEM TO BE SOLVED AS A SERIES OF EVENTS THAT DESCRIBE THE PROBLEM FROM BEGINNING TO END.

2) INPUT THE MASTER PROBLEM TARGETING AND OPTIMIZATION VARIABLES IN NAMELIST SEARCH. THE DECOMPOSITION OPTION IS ACTIVATED IF SRCHMM IS INPUT AS A POSITIVE NUMBER.

3) DEFINE THE SUB-PROBLEMS BY SPECIFYING THE FINAL EVENT NUMBER FOR EACH SEGMENT BY MEANS OF THE VARIABLE SGFESN(I), I=1,5 IN NAMELIST SEARCH.

4) SET UP EACH SUB-PROBLEM AS AN NXN TARGETING PROBLEM, I.E., THERE MUST BE THE SAME NUMBER OF INDEPENDENT AND DEPENDENT VARIABLES FOR EACH SUB-PROBLEM. INPUT NINDV AS THE TOTAL NUMBER OF SUB-PROBLEM INDEPENDENT VARIABLES AND NDEPV AS THE TOTAL NUMBER OF SUB-PROBLEM DEPENDENT VARIABLES. THE NUMBER OF INDEPENDENT VARIABLES FOR EACH SUB-PROBLEM IS COMPUTED INTERNALLY BY THE PROGRAM BASED ON INDPH(I) AND SGFESN(J).

5) THE MASTER PROBLEM OPTIMIZATION VARIABLE IS FORMED AS THE SUM OF THE OPTIMIZATION VARIABLES FOR EACH SUB-PROBLEM. THEREFORE, INPUT THE VARIABLES OPTVRM, OPTPHM, WOPTM, AND NOPTVM TO DEFINE THE OPTIMIZATION VARIABLES FOR EACH SUB-PROBLEM AS REQUIRED.

6) THE TOTAL NUMBER OF MASTER PROBLEM CONTROLS MUST BE LESS THAN OR EQUAL TO 10. THE MAXIMUM NUMBER OF MASTER PROBLEM CONTROLS FOR EACH SUB-PROBLEM IS 5. THE MAXIMUM NUMBER OF SUB-PROBLEM CONTROLS FOR EACH SUB-PROBLEM IS ALSO 5.

7) DEPENDENT VARIABLE I FOR A GIVEN SUB-PROBLEM CAN BE USED AS A MASTER PROBLEM CONTROL BY SPECIFYING INDVRM(J) = 6HDEPVLI, I=1,5.

5.F. TRAJECTORY DECOMPOSITION OPTION (CONTD)

THE FOLLOWING SAMPLE INPUT ILLUSTRATES THE DECOMPOSITION INPUTS -

```
P$SEARCH
C*** MASTER PROBLEM ***
 SRCHMM = 1,
 SGFESN = 100.,     250.,     400.,
 NINDVM = 8,        NDEPVM = 1,
 INDVRM = 6HDEPVL1,6HWGTSG ,6HPITPC2,6HPITPC2,
          6HDEPVL1,6HCRITR ,6HALPPC1,
          6HALPPC1,
 INDPHM = 100.,     1.,       30.,      40.,
          250.,     200.,     200.,
          300.,
 UM     = 25678.,  1.4E6,  -.29,  -.01,
          26.5,  5.,  0.,
          0.,
 PERTM   = 0.,  1.,  .001,   .001,
          0.,  .1,  .001,
          .001,
 DEPVRM = 6HWPROP  ,
 DEPPHM = 400.,
 DEPVLM = 0.,
 DEPTLM = .1,
 NOPTVM = 1,
 OPTVRM = 6HWEIGHT,
 OPTPHM = 400.,
 OPTM   = 1,
C*** SUB-PROBLEMS ***
 SRCHM  = 4,
 NINDV  = 8,        NDEPV  = 8,
 INDVR  = 6HPITPC2,6HCRITR ,6HPITPC2,
        = 6HBETPC1,6HCRITR ,
        = 6HBETPC1,6HCRITR ,6HCRITR  ,
 INDPH  = 10.,      100.,     20.,
          200.,     250.,
          300.,     400.,     300.,
 U      = -.65,  63.8,  -.43,
          8.,  300.,
          -40.,  110.,  .19,
 DEPVR  = 6HVELI  ,6HGCRAD ,6HGAMMAI,
          6HINC   ,6HALTA  ,
          6HVELI  ,6HGAMMAI,6HINC    ,
```

```
DEPPH  = 100.,    100.,    100.,
         250.,    250.,
         400.,    400.,    400.,
DEPVAL = 25678.,  21411900.,  0.,
         26.5,    19323.,
         10087.,  0.,  5.,
$
```

ALL VARIABLES ASSOCIATED WITH THIS OPTION ARE INPUT IN NAMELIST SEARCH AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CONEPM(2)	N/D	0.01	THE MINIMUM ALLOWABLE DECIMAL PERCENTAGE CHANGE IN THE MAGNITUDE OF THE MASTER PROBLEM CONTROL PARAMETER VECTOR ON SUCCESSIVE ITERATIONS.
CONEPM(3)	N/D	0.01	THE MINIMUM ALLOWABLE DECIMAL PERCENTAGE CHANGE IN P1M ON SUCCESSIVE ITERATIONS.
CONEPM(3)	N/D	0.01	THE MINIMUM ALLOWABLE DECIMAL PERCENTAGE CHANGE IN P2M ON SUCCESSIVE ITERATIONS.
CONSXM(I) I=1,2	N/D	1.0E-6 .001	THE RELATIVE CHANGE IN THE MASTER PROBLEM CONTROL PARAMETER VECTOR MAGNITUDE ON TWO SUCCESSIVE TRIAL STEPS FOR OPTIMIZATION AND TARGETING, RESPECTIVELY, BELOW WHICH THE CURVE-FITTING PROCESS IS TERMINATED.
DEPVRM(I) I=1,10	HOLLERITH	0.0	THE HOLLERITH NAME OF MASTER PROBLEM DEPENDENT VARIABLE I.
DEPPHM(I) I=1,10	DECIMAL	9000	THE EVENT AT WHICH MASTER PROBLEM DEPENDENT VARIABLE I IS TO BE SATISFIED.
DEPTLM(I) I=1,10	SAME AS DEPVLM(I)	1.0	THE DESIRED ACCURACY LEVEL WITHIN WHICH DEPVRM(I) IS CONSIDERED TO BE SATISFIED.

5.F. TRAJECTORY DECOMPOSITION OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DEPVLM(I) I=1,10	SAME AS THE VARI- ABLE IN DEPVRM(I)	0.0	THE DESIRED VALUE OF DEPVRM(I). THE VALUES OF DEPVLM ARE INPUT IN ENGLISH UNITS IF IOFLAG=0 OR 1, AND IN METRIC UNITS IF IOFLAG=2 OR 3.
FESNM	DECIMAL	9000	THE FINAL EVENT SEQUENCE NUMBER FOR THE MASTER PROBLEM.
FITERM(I) I=1,2	DECIMAL	1.0E-6 .001	THE RELATIVE DIFFERENCE BETWEEN PREDICTED AND ACTUAL VALUES OF MASTER PROBLEM P1M AND P2M, RESPECTIVELY, BELOW WHICH THE CURVE-FITTING PROCESS IS TERMINATED.
GAMAXM	DECIMAL	10.	THE MAXIMUM STEPSIZE ALLOWED FOR EACH MASTER PROBLEM ITERATION.
IDEBM	INTEGER	0	MASTER PROBLEM TRIAL STEP OUTPUT FLAG FOR DEBUGGING RUNS THAT FAIL TO CONVERGE. = 0, DO NOT PRINT TRIAL STEP SUMMARIES. = 1, PRINT TRIAL STEP SUMMARIES.
INDPHM(I) I=1,10	DECIMAL	0.0	THE EVENT AT WHICH INDVRM(I) IS TO BE INITIATED.
INDVRM(I) I=1,10	HOLLERITH	0.0	THE HOLLERITH NAME OF MASTER PROBLEM INDEPENDENT VARIABLE I.
IPROM	INTEGER	0	A FLAG TO CONTROL THE PRINTOUT OF TRAJECTORIES FOR THE MASTER PROBLEM ITERATION. = -1, ONLY PRINT THE CONVERGED MASTER PROBLEM TRAJECTORIES. = 0, PRINT THE NOMINAL AND CONVERGED MASTER PROBLEM TRAJECTORIES. = 2, PRINT ALL MASTER PROBLEM TRAJECTORIES.
MAXITM	INTEGER	10	THE MAXIMUM NUMBER OF ITERATIONS FOR THE MASTER PROBLEM.

5.F. TRAJECTORY DECOMPOSITION OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
MODEWM	INTEGER	1	MASTER PROBLEM WEIGHTING MODE FLAG. = 0, USE INPUT CONTROL WEIGHTING FACTORS, I.E., WUM(I). = 1, USE AUTOMATIC CONTROL WEIGHTING WHERE WUM(I)= 1./UM(I).
NDEPVM	INTEGER	0	THE NUMBER OF MASTER PROBLEM DEPENDENT VARIABLES (CONSTRAINTS).
NINDVM	INTEGER	0	THE NUMBER OF MASTER PROBLEM INDEPENDENT VARIABLES (CONTROLS). A MAXIMUM OF 5 CAN BE SPECIFIED FOR EACH SUB-PROBLEM.
NOPTVM	INTEGER	0	THE NUMBER OF SUB-PROBLEM OPTIMIZATION VARIABLES TO BE USED.
OPTM	INTEGER	0	MASTER PROBLEM OPTIMIZATION MODE INDICATOR. = -1, MINIMIZE THE MASTER PROBLEM OPTIMIZATION VARIABLE. = 0, NO OPTIMIZATION. = 1, MAXIMIZE THE MASTER PROBLEM OPTIMIZATION VARIABLE.
OPTPHM(I) I=1,5	DECIMAL	9000	THE EVENT NUMBER AT WHICH TO EVALUATE THE OPTIMIZATION VARIABLE FOR THE ITH SUB-PROBLEM.
OPTVRM(I) I=1,5	HOLLERITH	0.0	THE HOLLERITH NAME OF THE OPTIMIZATION VARIABLE FOR THE ITH SUB-PROBLEM.
PCTCCM	DECIMAL	.05	THE MAXIMUM ALLOWABLE DECIMAL PERCENTAGE CHANGE IN THE MAGNITUDE OF THE MASTER PROBLEM CONTROL VARIABLES DURING ANY GIVEN ITERATION.
PERTM(I) I=1,10	SAME AS THE VAR. SPECIFIED BY INDVRM(I)	1.0E-4	THE ADDITIVE PERTURBATION ON UM(I) USED TO CALCULATE THE PARTIALS OF OPTVRM AND DEPVRM WITH RESPECT TO INDVRM.

5.F. TRAJECTORY DECOMPOSITION OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
SGFESN(I) I=1,5	DECIMAL	0	THE FINAL EVENT SEQUENCE NUMBER FOR SUB-PROBLEM I.
SRCHMM	INTEGER	0	THE SEARCH MODE INDICATOR FOR THE MASTER PROBLEM. = 0, NO MASTER PROBLEM ITERATION. = 1, USE PROJECTED GRADIENT MODE. = 2, USE ACCELERATED PROJECTED GRADIENT MODE.
STMP1M STMP2M	DECIMAL	.1	THE MAXIMUM RELATIVE REDUCTION IN THE STEP LENGTH ALLOWED IN CURVE FITTING THE MASTER PROBLEM VARIABLES P1M AND P2M.
UM(I) I=1,10	SAME AS THE VAR. SPECIFIED BY INDVRM(I)	0.0	THE INITIAL VALUES OF THE MASTER PROBLEM CONTROL VARIABLES CONTAINED IN INDVRM(I).
WFCM(I) I=1,10	DECIMAL	0.0	THE WEIGHTING FACTOR FOR MASTER PROBLEM CONTROL PARAMETER I.
WOPTM(I) I=1,5	DECIMAL	1.0	THE WEIGHTING FACTOR FOR MASTER PROBLEM OPTIMIZATION VARIABLE I USED TO COMPUTE P1M. INPUT AS APPROXIMATELY ONE OVER THE ESTIMATED VALUE OF OPTVRM.

ALL OUTPUT VARIABLES ASSOCIATED WITH THIS OPTION ARE PRINTED AUTOMATICALLY BY THE PROGRAM FOR EACH ITERATION AND FOR EACH TRIAL STEP BASED ON THE INPUT VALUE OF IDEBM. THESE OUTPUT VARIABLES ARE DEFINED AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
CP/TSM	SEC	THE AMOUNT OF CENTRAL PROCESSOR TIME (CP) REQUIRED FOR THE CURRENT MASTER PROBLEM ITERATION.

OUTPUT SYMBOL	UNITS	DEFINITION
DP1DSM	N/D	THE DERIVATIVE OF THE MASTER PROBLEM OPTIMIZATION VARIABLE IN THE DIRECTION OF SEARCH.
DP2DSM	N/D	THE DERIVATIVE OF THE MASTER PROBLEM CONSTRAINT ERROR FUNCTION IN THE DIRECTION OF SEARCH.
EM(I) I=1,10	SAME AS THE VAR. SPECIFIED BY DEPVRM	THE CURRENT MASTER PROBLEM CONSTRAINT ERRORS. COMPUTED AS ACTUAL - DESIRED VALUES.
GAMSTM	N/D	THE VALUE OF GAMASM FOR EACH TRIAL STEP.
G1M(I) I=1,10	N/D	THE ITH COMPONENT OF THE MASTER PROBLEM GRADIENT TO THE OPTIMIZATION VARIABLE.
G1MAGM	N/D	THE MAGNITUDE OF THE G1M VECTOR.
G2M(I) I=1,10	N/D	THE ITH COMPONENT OF THE MASTER PROBLEM GRADIENT TO THE CONSTRAINT ERROR FUNCTION.
G2MAGM	N/D	THE MAGNITUDE OF THE G2M VECTOR.
OPTVLM	SAME AS OPTVRM	THE CURRENT VALUE OF THE MASTER PROBLEM OPTIMIZATION VARIABLE.
P1M	N/D	THE VALUE OF THE WEIGHTED MASTER PROBLEM OPTIMIZATION FUNCTION. CALCULATED AS THE WEIGHTED SUM OF OPTVRM(K),K=1,5.
P1TRYM P2TRYM	N/D	THE VALUES OF P1M AND P2M FOR EACH TRIAL STEP.
P2M	N/D	THE MASTER PROBLEM CONSTRAINT FUNCTION. CALCULATED AS THE SUMMATION OF THE WEIGHTED ERRORS SQUARED.
SRDIRM	N/D	THE ITH COMPONENT OF THE CURRENT SEARCH DIRECTION IN THE MASTER PROBLEM CONTROL SPACE.

5.F. TRAJECTORY DECOMPOSITION OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
STPMXM	N/D	THE MAXIMUM ABSOLUTE CHANGE IN THE MAGNITUDE OF THE MASTER PROBLEM CONTROL VECTOR ON THE CURRENT ITERATION.
UM(I)	SAME AS INDVRM(I)	THE CURRENT VALUES OF THE MASTER PROBLEM CONTROL PARAMETERS.
WEM(I) I=1,10	N/D	THE CURRENT MASTER PROBLEM WEIGHTED CONSTRAINT ERRORS.
WEMAGM	N/D	THE VECTOR MAGNITUDE OF WEM(I).
WFCM(I) I=1,10	DECIMAL	THE WEIGHTING FACTOR FOR MASTER PROBLEM CONTROL PARAMETER I.
WUM(I)	N/D	THE CURRENT WEIGHTED VALUES OF THE MASTER PROBLEM CONTROL PARAMETER.
WUMAGM	N/D	THE MAGNITUDE OF THE MASTER PROBLEM WEIGHTED CONTROL PARAMETER VECTOR.
YPREDM	N/D	THE VALUE OF P1M (OR P2M) OBTAINED FROM THE CURVEFIT ROUTINE FOR EACH TRIAL STEP.

6. TRAJECTORY SIMULATION INPUTS

THIS SECTION DESCRIBES THE TRAJECTORY SIMULATION INPUTS. THE PROGRAM HAS FOUR BASIC CATEGORIES OF INPUT WHICH DEFINE THE SPECIFIC COMPUTATIONAL OPTIONS, THE BASIC VEHICLE INPUTS, THE TYPE OF STEERING COMMANDS, AND THE TABLE DATA USED TO USED TO DEFINE TIME VARYING VEHICLE CHARACTERISTICS.

THESE CATAGORIES OF INPUT ARE CLASSIFIED AS (1) GENERAL SIMULATION OPTIONS, (2) METHODS OF GUIDANCE (STEERING), (3) TABLE MULTIPLIERS, AND (4) TABLE INPUT FORMAT.

6.A. GENERAL SIMULATION OPTIONS

THE SELECTION OF GENERAL SIMULATION OPTIONS IS ACCOMPLISHED BY THE USER ASSIGNING PARTICULAR VALUES TO THE PROGRAM CONTROL ARRAY, NPC(I). THE ELEMENTS OF THIS ARRAY ARE USED INTERNALLY TO SELECT THE APPROPRIATE CALCULATIONS FOR THE OPTIONS SELECTED. THUS, ALTHOUGH THE PROGRAM CONTAINS NUMEROUS OPTIONS, ANY USER WHO DOES NOT INTEND TO USE ALL OF THE PROGRAM CAPABILITIES IS NOT PENALIZED IN TERMS OF RUN TIME. THE INPUTS CORRESPONDING TO THE OPTIONS SELECTED VIA THE NPC ARRAY MUST BE SPECIFIED AS INPUT IN NAMELIST GENDAT UNLESS THE STORED VALUES ARE TO BE USED, IN WHICH CASE THE VARIABLES NEED NOT BE INPUT.

ALL CONSTANT VALUED INPUT ASSOCIATED WITH THE SIMULATION AND THE AUXILARY CALCULATION OPTIONS ARE PRESENTED IN THIS SECTION.

INPUTS ARE GENERALLY REQUIRED FOR THE FOLLOWING OPTIONS IN ORDER TO PRODUCE MEANINGFUL SIMULATIONS. THE SECTIONS FOR EACH OF THESE OPTIONS SHOULD BE REVIEWED TO SEE WHICH OPTIONS ARE REQUIRED AND THE INPUTS REQUIRED FOR THOSE OPTIONS.

1. AERODYNAMIC INPUTS
2. AEROHEATING CALCULATIONS
3. ATMOSPHERE MODEL/WINDS INPUTS
4. EVENT CRITERIA/PHASE DEFINITION INPUTS
5. GRAVITATIONAL INPUTS
6. METHODS OF GUIDANCE (STEERING)
7. INITIAL POSITION AND VELOCITY
8. NUMERICAL INTEGRATION METHODS
9. PROPULSION/THROTTLING INPUTS
10. VEHICLE/PROPELLANT WEIGHT INPUTS

ALL OPTIONS WHICH ARE NOT LISTED ABOVE SHOULD BE REVIEWED ONLY IF THEY ARE DESIRED. OTHERWISE THE INPUTS FOR THE ABOVE LIST ARE ALL THAT ARE REQUIRED TO PRODUCE MEANINGFUL SIMULATION FOR MOST PROBLEMS.

6.A.1. AERODYNAMIC INPUTS

THIS SECTION PRESENTS THE INPUT ASSOCIATED WITH THE AERODYNAMIC CHARACTERISTICS OF THE VEHICLE.

THE AERODYNAMIC FORCE COEFFICIENTS IN PITCH CAN OPTIONALLY BE INPUT AS AXIAL AND NORMAL FORCE COEFFICIENTS IF NPC(8)=1 OR AS LIFT AND DRAG FORCE COEFFICIENTS IF NPC(8)=2.

ONLY THE FORCE COEFFICIENTS NEED TO BE INPUT UNLESS THE STATIC TRIM OPTION IS REQUESTED, I.E., NPC(10)=1,2,3, IN WHICH CASE THE APPROPRIATE AERODYNAMIC MOMENT COEFFICIENTS ARE ALSO NEEDED.

ALL CONSTANT INPUT VARIABLES FOR THE AERODYNAMIC OPTIONS ARE INPUT IN NAMELIST GENDAT. THESE VARIABLES ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(8)	INTEGER	1	AERODYNAMIC COEFFICIENT FLAG. = 0, NO AERODYNAMIC COEFFICIENTS. = 1, INPUT TABLES OF AXIAL FORCE (CAOT AND CAT), NORMAL FORCE (CNOT AND CNAT), AND SIDE FORCE (CYOT AND CYBT) COEFFICIENTS. = 2, INPUT TABLES OF DRAG FORCE (CDOT AND CDT), LIFT FORCE (CLOT AND CLT), AND SIDE FORCE (CYOT AND CYBT) COEFFICIENTS. = 4, SAME AS OPTION NPC(8)=2, EXCEPT THAT VISCOUS AERO CORRECTIONS ARE ADDED TO CL AND CD.
AEXP	N/D	.64	AXIAL EXPONENT. USED IN CALCULATION OF VISCOUS CORRECTIONS IF NPC(8)=4.
CINF	N/D	1.0	CHAPMAN-RUBESIN VISCOSITY COEFFICIENT. USED IF NPC(8)=4.
LREF	FT (M)	0.	REFERENCE LENGTH USED IN THE STATIC TRIM EQUATIONS, NPC(10)=1,2,3, AND IN THE CALCULATION OF REYNOLDS NUMBER.

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6.A.1. AERODYNAMIC INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
LREFY	FT (M)	0.	REFERENCE LENGTH IN YAW. USED IN THE YAW STATIC TRIM EQUATIONS.
SREF	FT**2 (M2)	0.	THE AERODYNAMIC REFERENCE AREA USED TO COMPUTE THE AERODYNAMIC FORCES WHEN NPC(8)=1,2 AND THE MOMENTS IF NPC(8)=1,2 AND NPC(10)=1,2,3.
VINFI	N/D	.007	INVISCID VALUE OF RAREFACTION PARAMETER. USED IF NPC(8)=4.

ALL OF THE AERODYNAMIC COEFFICIENTS ARE INPUT AS TABLES IN NAMELIST TAB. THESE TABLES ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CADPT CADYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC AXIAL FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8)=1 AND IN THE STATIC TRIM EQUATIONS IF NPC(10) =1,2,3.
CAIOT	N/D	0.	TABLE OF INVISCID AXIAL COEFFICIENT AT MAXIMUM L/D. USED IF NPC(8)=4.
CAOT	N/D	0.	AXIAL FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=1.
CAT	N/D	0.	AXIAL FORCE COEFFICIENT TABLE. USED IF NPC(8)=1.

6.A.1. AERODYNAMIC INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CDDPT CDDYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC DRAG FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8)=2 AND IN THE STATIC TRIM EQUATIONS IF NPC(10) =1,2,3.
CDOT	N/D	0.	DRAG FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=2.
CDT	N/D	0.	DRAG FORCE COEFFICIENT TABLE. USED IF NPC(8)=2.
CLDPT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC LIFT FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN PITCH. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8)=2 AND IN THE STATIC TRIM EQUATIONS IF NPC(10)=1,2,3.
CLOT	N/D	0.	LIFT FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=2.
CLT	N/D	0.	LIFT FORCE COEFFICIENT TABLE. USED IF NPC(8)=2.
CMAT CWBT	N/D	0.	TABLES OF AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10)=1,2,3.
CMDPT CWDYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC PITCHING AND YAWING MOMENT COEFF- ICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10)=1,2,3.
CMOT CWOT	N/D	0.	TABLES OF AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS FOR ZERO ALPHA AND BETA. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10) =1,2,3.

6.A.1. AERODYNAMIC INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CNAT	N/D	0.	NORMAL FORCE COEFFICIENT TABLE. THE NORMAL FORCE COEFFICIENT SLOPE CAN BE INPUT AS CNAT IF THE MNEMONIC MULTIPLIER CNANM = 5HALPHA, IS INPUT IN NAMELIST TBLMLT. USED IF NPC(8) =1.
CNDPT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC NORMAL FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN PITCH. EQUATIONS IF NPC(8)=1 AND IN THE STATIC TRIM EQUATIONS IF NPC(10) =1,2,3.
CNOT	N/D	0.	NORMAL FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=1.
CYBT	N/D	0.	SIDE FORCE COEFFICIENT TABLE. THE SIDE FORCE COEFFICIENT SLOPE CAN BE INPUT AS CYBT IF THE MNEMONIC MULTIPLIER CYBNM = 4HBETA, IS INPUT IN NAMELIST TBLMLT.
CYDYT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC SIDE FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN YAW. USED IN IN THE AERODYNAMIC FORCE EQUATIONS AND IN THE STATIC TRIM EQUATIONS IF NPC(10)=1,2,3.
CYOT	N/D	0.	SIDE FORCE COEFFICIENT TABLE FOR ZERO BETA.
XREFT YREFT ZREFT	FT (M)	0.	TABLES OF THE AERODYNAMIC REFERENCE (OR CENTER-OF-PRESSURE) LOCATION ALONG THE XBR, YBR, AND ZBR AXES, RESPECTIVELY, WHEN USING THE STATIC TRIM OPTION, I.E., IF NPC(10)=1,2,3.

6.A.1. AERODYNAMIC INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ZLALPT	DEG	0.	ZERO-LIFT ANGLE OF ATTACK TABLE. USED IF NPC(8)=4.

THE OUTPUTS ASSOCIATED WITH THE AERODYNAMIC CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
CA CY CN	N/D	AERODYNAMIC AXIAL, SIDE, AND NORMAL FORCE COEFFICIENTS. CALCULATED IF NPC(8)=1,2.
CADP CNDP	N/D	INCREMENTAL AERODYNAMIC AXIAL AND NORMAL FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS IN PITCH. CALCULATED IF NPC(8)=1.
CADY	N/D	INCREMENTAL AERODYNAMIC AXIAL FORCE COEFFICIENT DUE TO FLAP DEFLECTIONS IN YAW. CALCULATED IF NPC(8)=1.
CD CL	N/D	AERODYNAMIC DRAG AND LIFT FORCE COEFFICIENTS. CALCULATED IF NPC(8)=2.
CDDP CLDP	N/D	INCREMENTAL AERODYNAMIC DRAG AND LIFT COEFF-ICIENTS DUE TO FLAP DEFLECTIONS IN PITCH. CALCULATED IF NPC(8)=2.
CDDY	N/D	INCREMENTAL AERODYNAMIC DRAG COEFFICIENT DUE TO FLAP DEFLECTION IN YAW. CALCULATED IF NPC(8)=2.
CM CW	N/D	AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS USED IN THE STATIC TRIM OPTION. CALCULATED IF NPC(10)=1,2,3.
CMDP CWDY	N/D	INCREMENTAL AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS DUE TO FLAP DEFLECTIONS IN PITCH AND YAW, RESPECTIVELY. CALCULATED IF NPC(8)=1,2 AND NPC(10)=1,2,3.

6.A.1. AERODYNAMIC INPUTS (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
CYDY	N/D	INCREMENTAL AERODYNAMIC SIDE FORCE COEFFICIENT DUE TO FLAP DEFLECTIONS IN YAW. CALCULATED IF NPC(8)=1,2.
DCDV	N/D	DELTA CD DUE TO VISCOUS EFFECTS. CALCULATED IF NPC(8)=4.
DCLV	N/D	DELTA CL DUE TO VISCOUS EFFECTS. CALCULATED IF NPC(8)=4.
DRAG	LBS (N)	AERODYNAMIC DRAG FORCE. CALCULATED IF NPC(5)=1,2,3 AND NPC(8)=1,2.
FAXB FAYB FAZB	LBS (N)	AERODYNAMIC FORCES IN THE BODY COORDINATE SYSTEM. CALCULATED IF NPC(5)=1,2,3 AND NPC(8)=1,2.
LIFT	LBS (N)	AERODYNAMIC LIFT FORCE. CALCULATED IF NPC(5)=1,2,3 AND NPC(8)=1,2.
QALPHA	LB-DEG/ FT**2 (N-DEG/ M2)	PRODUCT OF DYNAMIC PRESSURE AND ANGLE OF ATTACK. USED AS AN AIRLOADS INDICATOR IN THE PITCH PLANE.
QALTOT	LB-DEG/ FT**2 (N-DEG/ M2)	PRODUCT OF DYNAMIC PRESSURE AND THE TOTAL ANGLE OF ATTACK. USED AS AN AIRLOADS INDICATOR.
VINV	N/D	RAREFATION PARAMETER USED TO COMPUTE VISCOUS EFFECTS.

6.A.2. AEROHEATING CALCULATIONS

THE AEROHEATING CALCULATIONS ARE SELECTED BY THE INPUT VARIABLES NPC(15) AND NPC(26). SEVERAL OPTIONS ARE AVAILABLE TO THE USER.

THE FOLLOWING VARIABLES ARE INPUT IN NAMELIST GENDAT FOR VARIOUS HEATING CALCULATION OPTIONS.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(15)	INTEGER	0	AEROHEATING RATE OPTION FLAG. = 0, DO NOT CALCULATE AEROHEATING RATE. = 1, CALCULATE AEROHEATING RATE (HEATRT) AND TOTAL HEAT(TLHEAT) USING CHAPMANS EQUATION FOR STAGNATION POINT HEATING. = 2, OBTAIN THE HEATING RATE USING HTRTT AS A TABLE LOOK-UP. = 3, CALCULATE HEATING RATE AS THE PRODUCT OF OPTIONS 1 AND 2 ABOVE. = 4, ONLY CALCULATE THE TURBULENT HEATING RATE (HTURBD) AND THE TURBULENT HEAT (HTURB) USING THE TABLE LOOK-UP OF HTRTT AS A MULTIPLIER. = 5, CALCULATE BOTH HEATRT AND HTURBD AS IN THE OPTIONS 3 AND 4 ABOVE TO YIELD THE LAMINAR HEATING (TLHEAT) AND THE TURBULENT HEATING (HTURB). = 6, CALCULATE HEATRT AS THE MAX-IMUM CENTERLINE HEAT RATE.
NPC(26)	INTEGER	0	SPECIAL AEROHEATING CALCULATIONS FLAG. = 0, NO SPECIAL AEROHEATING CALCULATIONS. = 1, CALCULATE AEROHEATING FOR A TEN PANEL VEHICLE MODEL BASED ON HEATING RATIOS REFERENCED TO THE TOTAL HEAT (TLHEAT) OBTAINED USING NPC(15). = 2, CALCULATE SPECIAL AEROHEATING INDICATORS FOR LAUCH VEHICLE ASCENT. THESE ARE DESIGNATED

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			AS STAGNATION POINT (AHI), BOTTOM SIDE (HTBT), TOP SIDE (HTTP), RIGHT SIDE (HTRT), AND LEFT SIDE (HTLF).
ARP(I) I=1,10	FT**2 (M2)	0.	THE SURFACE AREA OF PANEL I. USED IF NPC(26)=1.
HEATK(I) I=1,3	DECIMAL	1. 17600. 26000.	COEFFICIENTS USED IN COMPUTING CHAPMANS HEATING RATE. USED IF NPC(15)=1,3,4.
HRAT(I) I=1,10	DECIMAL	0.	THE HEAT RATIO FOR PANEL I WITH RESPECT TO THE REFERENCE TOTAL HEAT (TLHEAT). THE NUMBER OF PANELS TO BE CONSIDERED IS ALSO CONTROLLED BY THIS INPUT SINCE THE FIRST N PANELS WITH NONZERO VALUES OF HRAT WILL BE USED. USED IF NPC(26)=1.
ITAP(I) I=1,10	INTEGER	0	A FLAG TO INDICATE WHICH WEIGHT PER UNIT AREA TABLE (WUAIT) IS TO BE USED FOR PANEL I. USED IF NPC(26)=1.
RHOSL	SLUGS/ FT**3 (KG/M3)	.0023769	SEA LEVEL DENSITY USED IN COMPUTING CHAPMANS HEATING RATE. USED IF NPC(15)=1,3,4.
RN	FT (M)	1.0	NOSE RADIUS USED IN COMPUTING CHAPMAN HEATING RATE. USED IF NPC(15)=1,3,4.

THE FOLLOWING TABLES ARE INPUT IN NAMELIST TAB FOR THE VARIOUS HEATING CALCULATION OPTIONS.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
HTRTT	BTU/ FT**2-SEC (W/M2)	0.	THE TABLE OF AEROHEATING RATE AS A FUNCTION OF THE INPUT ARGUMENTS IF NPC(15)=2, OR A MULTIPLIER TO BE USED

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			IN CALCULATING HEATING RATE IF NPC(15)=3,4,5. WHEN USING NPC(15)=2, THE DATA FOR HTRTT IS USUALLY GIVEN AS A TRIVARIANT FUNCTION OF ATMOSPHERIC RELATIVE VELOCITY (VELA), OBLATE ALTITUDE (ALTITO), AND ANGLE OF ATTACK (ALPHA).
WUAIT I=1,2	LB/FT**2 (N/M2)	0.	TABLES OF WEIGHT PER UNIT AREA. TWO TABLES ARE PROVIDED TO ENABLE TWO MATERIALS OF DIFFERENT DENSITY TO BE CONSIDERED. THE TABLE TO BE USED FOR EACH PANEL IS SPECIFIED BY THE INPUT VARIABLE ITAP(I) IN NAMELIST GENDAT. USED IF NPC(26)=1.

THE OUTPUTS ASSOCIATED WITH THE AEROHEATING CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
AHI	FT-LB/ FT**2 (NM/M2)	THE AEROHEATING INDICATOR WHICH IS COMPUTED AS THE INTEGRAL OF THE PRODUCT OF DYNP AND VELA. CALCULATED IF NPC(26)=2.
AHID	FT-LB/ FT**2/SEC (NM/M2/S)	THE DERIVATIVE OF AHI. CALCULATED IF NPC(26)=2.
HEATRT	BTU/ FT**2-SEC (W/M2)	AERODYNAMIC HEATING RATE. CALCULATED IF NPC(15)=1,2,3,4,5.
HTBT HTLF HTTP HTRT	FT-LB/ FT**2 (NM/M2)	THE AERODYNAMIC HEATING INDICATORS FOR THE BOTTOM, LEFT, TOP, AND RIGHT SIDES OF THE VEHICLE, RESPECTIVELY. THESE PARAMETERS ARE AHI MODIFIED FOR ANGLE OF ATTACK AND SIDSLIP. CALCULATED IF NPC(26)=2.

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6.A.2. AEROHEATING CALCULATIONS (CONTD)

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OUTPUT SYMBOL	UNITS	DEFINITION
HTBTD HTLFD HTTPD HTRTD	FT-LB/ FT**2/SEC (NM/M2/S)	THE DERIVATIVES OF HTBT, HTLF, HTTP, AND HTRT, RESPECTIVELY. CALCULATED IF NPC(26)=2.
HTURB	BTU/FT**2 (J/M2)	THE STAGNATION POINT HEATING FOR TURBULENT FLOW. CALCULATED IF NPC(15)=4,5.
HTURBD	BTU/ FT**2/SEC (W/M2)	THE DERIVATIVE OF HTURB. CALCULATED IF NPC(15)=4,5.
THTP	BTU/FT**2 (J/M2)	THE TOTAL HEAT OF THE CURRENT PANEL FOR WHICH THE HEATING IS BEING-EVALUATED. USE OF THIS VARIABLE AS A TABLE ARGUMENT OF WUAIT, I=1,2, ALLOWS THE USER TO INPUT THE WEIGHT PER UNIT AREA AS A FUNCTION OF THE TOTAL HEAT FOR EACH PANEL. CALCULATED IF NPC(26)=1.
THTPL	DECIMAL	THE LOGARITHM OF THTP. THIS PARAMETER IS USED IN THE SAME MANNER AS THTP EXCEPT THAT IT IS THE LOGARITHM OF THTP. CALCULATED IF NPC(26)=1.
TLHEAT	BTU/FT**2 (J/M2)	TOTAL HEAT. CALCULATED IF NPC(15)=1,2,3,4,5.
TLHTJ J=1,10	BTU/FT**2 (J/M2)	THE TOTAL HEAT OF PANEL J. CALCULATED IF NPC(26)=1.
TLPWT	LBS (N)	THE TOTAL WEIGHT OF ALL PANELS BEING EVALUATED. CALCULATED IF NPC(26)=1.
WTPJ J=1,10	LBS (N)	THE WEIGHT OF PANEL J. CALCULATED IF NPC(26)=1.

6.A.3. ANALYTICAL IMPACT POINT CALCULATIONS

THIS OPTION ALLOWS THE USER TO DETERMINE THE LATITUDE, LONGITUDE, AND TIME OF THE VACUUM IMPACT POINT OF THE VEHICLE ASSUMING THAT THE THRUST IS INSTANTANEOUSLY TERMINATED.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(29)	INTEGER	0	ANALYTICAL VACUUM IMPACT POINT CALCULATION FLAG. = 0, DO NOT COMPUTE IMPACT POINTS. = 1, CALCULATE IMPACT POINTS AT THE END OF EACH INTEGRATION STEP. THE OUTPUT VARIABLES MUST BE REQUESTED IN THE PRINT ARRAY, PRNT(I). = 2, COMPUTE IMPACT POINTS ONLY AT PHASE CHANGES AND PRINT AN IMPACT POINT PRINT BLOCK. = 3, COMPUTE IMPACT POINTS AT THE END OF EACH INTEGRATION STEP AND PRINT AN IMPACT POINT PRINT BLOCK WITH EACH REGULAR PRINTOUT
ALTIP	FT (M)	0.	THE DESIRED ALTITUDE AT IMPACT WHEN USING THE ANALYTICAL IMPACT OPTION, I.E., IF NPC(29)=1,2,3.

THE OUTPUTS ASSOCIATED WITH THE ANALYTICAL IMPACT POINT CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
DPRGIJ J=1,2	N.MI. (KM)	THE DOT PRODUCT RANGE OF THE VEHICLE AT IMPACT. THESE PARAMETERS ARE DEFINED EXACTLY THE SAME AS DPRNG1 AND DPRNG2 EXCEPT THAT THE ARE THE VALUES AT IMPACT. COMPUTED IF NPC(29) AND NPC(12) ARE BOTH INPUT NON-ZERO.
GDLTIP	DEG	THE GEODETIC LATITUDE OF THE VACUUM IMPACT POINT. CALCULATED IF NPC(29)=1,2,3.
LONGIP	DEG	THE LONGITUDE OF THE VACUUM IMPACT POINT EAST OF THE PRIME MERIDIAN. CALCULATED IF NPC(29) =1,2,3.

6.A.3. ANALYTICAL IMPACT POINT CALCULATIONS

OUTPUT SYMBOL	UNITS	DEFINITION
RIPJ J=1,3	FT (M)	THE INERTIAL POSITION COMPONENTS OF THE VACUUM IMPACT POINT. CALCULATED IF NPC(29)=1,2,3.
TIMIP	SEC	THE TIME OF IMPACT WHEN USING THE ANALYTICAL IMPACT POINT OPTION. CALCULATED IF NPC(29) =1,2,3.
VIPJ J=1,3	FT/SEC (M/S)	THE INERTIAL VELOCITY COMPONENTS OF THE VEHICLE AT IMPACT. CALCULATED IF NPC(29)=1,2,3.

6.A.4. ATMOSPHERE MODEL/WINDS INPUTS

THE PROGRAM HAS THE CAPABILITY TO SIMULATE ANY ATMOSPHERE WHICH CAN BE DESCRIBED BY TABLES OF ATMOSPHERIC DENSITY, PRESSURE, TEMPERATURE, AND SPEED OF SOUND. THE PROGRAM ALSO HAS TWO SPECIFIC ATMOSPHERE MODELS STORED IN THE PROGRAM FOR USER CONVENIENCE. ATMOSPHERIC WINDS CAN ALSO SELECTED BY USER INPUT. THE ATMOSPHERE MODEL IS SELECTED BY THE VARIABLE NPC(5). THE ATMOSPHERIC WINDS ARE SELECTED BY THE VARIABLE NPC(6).

THE FOLLOWING VARIABLES ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(5)	INTEGER	2	ATMOSPHERE MODEL FLAG. = 0, NO ATMOSPHERE. = 1, GENERAL ATMOSPHERE USING INPUT TABLES PREST, ATEMT, CST, DENST, AND CONSTANTS ATMOSK(I), I=1,2. = 2, 1962 STANDARD ATMOSPHERE. = 3, 1963 PATRICK AFB ATMOSPHERE.
NPC(6)	INTEGER	0	ATMOSPHERIC WINDS FLAG. = 0, NO WINDS. = 1, WINDS DEFINED BY TABLES OF WIND SPEED (VWT), WIND AZIMUTH (AZWT), AND VERTICAL COMPONENT (VWWT). = 2, WINDS DEFINED BY TABLES OF NORTHERLY (VWUT), EASTERLY (VWVT), AND VERTICAL (VWWT) COMPONENTS.
ATMOSK(I) I=1,2	DECIMAL	1.	ATMOSPHERIC CONSTANTS USED TO COMPUTE THE SPEED OF SOUND (CS) AND THE ATMOSPHERIC DENSITY (DENS), RESPECTIVELY, WHEN USING THE TABLE LOOK-UP ATMOSPHERE OPTION, I.E., WHEN NPC(5)=1.
AZWB	DEG	180.	WIND AZIMUTH BIAS. USED IF NPC(6) =1. IF AZWB = 180., THE WIND AZIMUTH TABLE (AZWT) MUST BE INPUT IN METEOROLOGICAL TERMS.

6.A.4. ATMOSPHERE MODEL/WINDS INPUTS (CONTD)

THE FOLLOWING TABLES ASSOCIATED WITH THE ATMOSPHERE MODEL AND ATMOSPHERIC WINDS OPTIONS ARE INPUT IN NAMELIST TAB.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ATEMT	DEG R (DEG K)	0.	ATMOSPHERIC TEMPERATURE TABLE. USED IF NPC(5)=1.
AZWT	DEG	0.	WIND AZIMUTH TABLE. USED IN CON- JUNCTION WITH VWT WHEN NPC(6)=1.
CST	FT/SEC (M/S)	0.	SPEED OF SOUND TABLE. USED IF NPC(5)=1.
DENKT	DECIMAL	0.	A DENSITY MULTIPLIER TABLE WHICH IS USED TO SIMULATE DENSITY DISPERSIONS. THE DENSITY FROM THE ATMOSPHERE MODEL BEING USED WILL BE MULTIPLIED BY THE TABLE LOOK-UP VALUE OF DENKT WHICH MUST BE INPUT AS THE DESIRED DECIMAL PERCENTAGE CHANGE IN DENSITY. DENS = DENS*(1.0 + DENKT)
DENST	SLUGS/ FT**3 (KG/M3)	0.	ATMOSPHERIC DENSITY TABLE. USED IF NPC(5)=1.
PREST	LB/FT**2 (N/M2)	0.	ATMOSPHERIC PRESSURE TABLE. USED IF NPC(5)=1.
VWT	FT/SEC (M/S)	0.	WIND SPEED TABLE. USED IN CON- JUNCTION WITH AZWT WHEN NPC(6)=1.
VWUT VWVT VWWT	FT/SEC (M/S)	0.	TABLES OF WIND SPEED COMPONENTS IN THE NORTH, EAST, AND VERTICAL DIRECTIONS. USED IF NPC(6)=2.

6.A.4. ATMOSPHERE MODEL/WINDS INPUTS (CONTD)

THE OUTPUTS ASSOCIATED WITH THE ATMOSPHERE MODEL/WINDS OPTIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ATEM	DEG R (DEG K)	ATMOSPHERIC TEMPERATURE. CALCULATED IF NPC(5) =1,2,3.
CS	FT/SEC (M/S)	SPEED OF SOUND. CALCULATED IF NPC(5)=1,2,3.
DENS	SLUGS/ FT**3 (KG/M3)	ATMOSPHERIC DENSITY. CALCULATED IF NPC(5) =1,2,3. DENS = DENS*(1.0 + DENKT)
DYNP	LB/FT**2 (N/M2)	DYNAMIC PRESSURE. CALCULATED IF NPC(5)=1,2,3.
MACH	N/D	MACH NUMBER. CALCULATED IF NPC(5)=1,2,3.
MACHDT	1/SEC	RATE OF CHANGE OF MACH WITH RESPECT TO TIME.
PRES	LB/FT**2 (N/M2)	ATMOSPHERIC PRESSURE. CALCULATED IF NPC(5) =1,2,3.
REYNO	N/D	REYNOLDS NUMBER BASED ON THE REFERENCE LENGTH LREF. CALCULATED IF NPC(5)=1,2,3.
UW VW WW	FT/SEC (M/S)	COMPONENTS OF THE WIND VELOCITY VECTOR IN THE GEOGRAPHIC (G) COORDINATE SYSTEM IN THE NORTH, EAST, AND DOWN DIRECTIONS, RESPECTIVELY. CALCULATED IF NPC(6)=1,2.
VMU	LB-SEC/ FT**2 (N-S/M2)	ATMOSPHERIC VISCOSITY. USED TO CALCULATE REYNOLDS NUMBER. CALCULATED IF NPC(5)=1,2,3.

6.A.5. CONIC CALCULATION OPTION

THE PROGRAM HAS THE CAPABILITY TO CALCULATE KEPLERIAN CONIC CONDITIONS FOR BOTH ELLIPTICAL AND HYPERBOLIC ORBITS. THIS OPTION MUST BE REQUESTED IF ANY CONIC PARAMETERS ARE TO BE USED FOR TARGETING/OPTIMIZATION.

THE VARIABLES ASSOCIATED WITH THE CONIC CALCULATIONS ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(1)	INTEGER	0	CONIC CALCULATION FLAG. = 0, DO NOT CALCULATE CONIC PARAMETERS. = 1, CALCULATE CONIC AT THE END OF EACH INTEGRATION STEP BUT DO NOT PRINT CONIC PRINT BLOCK. = 2, CALCULATE AND PRINT CONIC BLOCK ONLY AT PHASE CHANGES. = 3, CALCULATE CONIC AT THE END OF EACH INTEGRATION STEP AND PRINT CONIC BLOCK WITH EACH PRINTOUT.

THE CONIC OUTPUT VARIABLES MUST BE REQUESTED INDIVIDUALLY IN THE REGULAR PRINT BLOCK IF NPC(1)=1, AS DESCRIBED IN SECTION 6.A.16. THE OUTPUTS ASSOCIATED WITH THE CONIC CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ALTA	N.MI. (KM)	ALTITUDE OF APOGEE ABOVE THE OBLATE PLANET. CALCULATED IF NPC(1)=1,2,3.
ALTP	N.MI. (KM)	ALTITUDE OF PERIGEE ABOVE THE OBLATE PLANET. CALCULATED IF NPC(1)=1,2,3.
ANGMOM	FT**2/ SEC**2 (M2/S2)	ORBITAL ANGULAR MOMENTUM. CALCULATED IF NPC(1)=1,2,3.
APORAD	FT (M)	GEOCENTRIC RADIUS OF APOGEE. CALCULATED IF NPC(1)=1,2,3.

6.A.5. CONIC CALCULATION OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
APVEL	FT/SEC	INERTIAL VELOCITY AT APOGEE. CALCULATED IF NPC(1)=1,2,3.
ARGP	DEG	ARGUMENT OF PERIGEE. CALCULATED IF NPC(1) =1,2,3.
ARGV	DEG	ARGUMENT OF THE VEHICLE. CALCULATED IF NPC(1) =1,2,3. ARGV IS THE ANGLE BETWEEN THE ASCENDING NODE AND THE VEHICLE IN THE ORBIT PLANE MEASURED POSITIVE IN THE DIRECTION OF THE VEHICLE MOTION.
DECLIN	DEG	DECLINATION OF THE OUTGOING ASYMPTOTE. CALCULATED IF NPC(1)=1,2,3.
DVCIR	FT/SEC (M/S)	THE DELTA VELOCITY REQUIRED TO CIRCULARIZE THE CURRENT ORBIT. CALCULATED IF NPC(1)=1,2,3.
ECCAN	DEG	ECCENTRIC ANOMALY. CALCULATED IF NPC(1)=1,2,3.
ECCEN	N/D	ORBITAL ECCENTRICITY. CALCULATED IF NPC(1) =1,2,3.
ENERGY	FT**2/ SEC**2 (M2/S2)	ORBITAL ENERGY. CALCULATED IF NPC(1)=1,2,3.
HYPVEL	FT/SEC (M/S)	HYPERBOLIC EXCESS VELOCITY. CALCULATED IF NPC(1)=1,2,3.
INC	DEG	ORBIT INCLINATION ANGLE. CALCULATED IF NPC(1)=1,2,3.
LAN	DEG	LONGITUDE OF THE ASCENDING NODE EAST OF THE PRIME MERIDIAN AT TIME=0. CALCULATED IF NPC(1)=1,2,3.
LANVE	DEG	THE LONGITUDE OF THE ASCENDING NODE WITH RESPECT TO THE VERNAL EQUINOX. THIS VARIABLE IS COMPUTED ONLY IF NPC(1) AND NPC(31) ARE BOTH INPUT NON-ZERO.
MEAAN	DEG	MEAN ANOMALY. CALCULATED IF NPC(1)=1,2,3.
PERIOD	MIN	ORBITAL PERIOD. CALCULATED IF NPC(1)=1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
PGCLAT	DEG	GEOCENTRIC LATITUDE OF PERIGEE. CALCULATED IF NPC(1)=1,2,3. POSITIVE IN THE NORTHERN HEMISPHERE.
PGERAD	FT (M)	GEOCENTRIC RADIUS OF PERIGEE. CALCULATED IF NPC(1)=1,2,3.
PGLON	DEG	INERTIAL LONGITUDE OF PERIGEE MEASURED POSITIVE EAST OF THE XI AXIS. CALCULATED IF NPC(1) =1,2,3.
PGVEL	FT/SEC (M/S)	INERTIAL VELOCITY AT PERIGEE. CALCULATED IF NPC(1)=1,2,3.
RTASC	DEG	RIGHT ASCENSION OF THE OUTGOING ASYMPTOTE. CALCULATED IF NPC(1)=1,2,3.
SEMJAX	FT (M)	SEMI-MAJOR AXIS. CALCULATED IF NPC(1)=1,2,3.
TIMSP	MIN	TIME SINCE PERIGEE PASSAGE. CALCULATED IF NPC(1)=1,2,3.
TIMTP	MIN	TIME TO PERIGEE PASSAGE. CALCULATED IF NPC(1)=1,2,3.
TRUAN	DEG	TRUE ANOMALY. CALCULATED IF NPC(1)=1,2,3.
TRUNMX	DEG	MAXIMUM TRUE ANOMALY FOR HYPERBOLIC ORBITS. CALCULATED IF NPC(1)=1,2,3.
VCIRC	FT/SEC (M/SEC)	THE CIRCULAR VELOCITY AT THE CURRENT RADIUS. COMPUTED IF NPC(1)=1,2,3.

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUTS

THE USER MUST DEFINE A SEQUENCE OF EVENTS WHICH WILL DESCRIBE THE PROBLEM BEING SIMULATED FROM BEGINNING TO END. AN EVENT IS DEFINED AS AN INTERRUPTION IN THE TRAJECTORY SIMULATION WHEN A USER SPECIFIED VARIABLE REACHES THE DESIRED VALUE. AN EVENT MUST BE CREATED ANY TIME THE USER WISHES TO CHANGE ANY INPUT DATA FOR THE PROBLEM OR TO CAUSE ANY CHANGE IN THE METHOD OF SIMULATING THE PROBLEM. ALL EVENTS EXCEPT FOR THE FIRST EVENT MUST HAVE A USER SPECIFIED PARAMETER WHICH IS REFERRED TO AS THE EVENT CRITERIA. A GIVEN EVENT WILL OCCUR WHEN THE EVENT CRITERIA VARIABLE FOR THAT EVENT REACHES THE USER SPECIFIED VALUE. IN THIS WAY, THE USER CAN SET UP HIS PROBLEM TO SUIT HIS OWN PARTICULAR NEEDS BY THE APPROPRIATE INPUTS. THERE IS NO LIMIT TO THE NUMBER OF EVENTS THAT CAN BE USED. THE ONLY LIMIT IMPOSED IS THE SIZE OF THE DATA REGION ALLOCATED FOR CONSTANT INPUT VARIABLES (IGEN) AND FOR EVENT CRITERIA AND TABLES (IBKT). THESE VALUES CAN BE CHANGED VIA A PROGRAM MODIFICATION TO SUIT USER REQUIREMENTS.

AS AN EXAMPLE, THE FOLLOWING SERIES OF EVENTS COULD BE USED TO DESCRIBE AN ASCENT PROBLEM FOR A TWO STAGE VEHICLE WITH FOUR PITCH RATES IN THE FIRST STAGE AND TWO PITCH RATES IN THE SECOND STAGE.

EVENT NUMBER	DESCRIPTION
1	LIFT-OFF.
2	INITIATE PITCH RATE 1 AT TIME = 20 SEC.
3	INITIATE PITCH RATE 2 AT TIME = 30 SEC.
4	INITIATE PITCH RATE 3 AT TIME = 60 SEC.
5	INITIATE PITCH RATE 4 AT TIME = 90 SEC.
6	JETTISON STAGE 1 WHEN WPROP = 0.
7	INITIATE PITCH RATE 5 AT 20 SEC AFTER EVENT 6.
8	INITIATE PITCH RATE 6 AT 100 SEC AFTER EVENT 7.
9	ORBIT INJECTION AT INERTIAL VELOCITY = 25568.

THE FIRST EVENT FOR THIS PROBLEM IS EVENT NUMBER 1 AND THE LAST EVENT IS EVENT NUMBER 9. EACH OF THE 6 PITCH RATES COULD BE USED AS CONTROL PARAMETERS (INDEPENDENT VARIABLES) TO SATISFY SPECIFIED TARGETS (DEPENDENT VARIABLES) IF DESIRED.

THE EVENT NUMBERS FOR A GIVEN PROBLEM ARE SPECIFIED AS REAL NUMBERS BY THE USER IN MONOTONIC INCREASING ORDER. THESE EVENT NUMBERS ARE USED BY THE PROGRAM TO DETERMINE THE ORDER IN WHICH

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUTS (CONTD)

THE EVENTS ARE TO OCCUR. THE PROGRAM REQUIRES THAT EACH PROBLEM HAVE A MINIMUM OF TWO (2) EVENTS, AN INITIAL EVENT AND A FINAL EVENT. A PHASE IS INITIATED BY THE CORRESPONDING EVENT, THEREFORE, THE EVENT CRITERIA FOR A GIVEN EVENT SPECIFIES THE CONDITIONS AT WHICH THE CORRESPONDING PHASE WILL BEGIN. A PROBLEM IS TERMINATED BY SPECIFYING THE LAST EVENT WHICH IS TO OCCUR. THE PROBLEM CAN ALSO BE TERMINATED IN A PSUEDO-ABORT MODE BY SPECIFYING THE MAXIMUM TRAJECTORY TIME, MAXIMUM ALTITUDE, OR MINIMUM ALTITUDE. ALTHOUGH EVENT NUMBERS MUST BE MONOTONIC INCREASING, THEY NEED NOT BE CONSECUTIVE. THIS ALLOWS THE USER TO EASILY ADD OR DELETE EVENTS FROM AN INPUT DECK.

EACH EVENT MUST HAVE A UNIQUE NUMBER ASSIGNED TO IT. EVENTS ARE SPECIFIED AS BEING ONE OF FOUR TYPES, PRIMARY, SECONDARY, PRIMARY ROVING, OR REPEATING ROVING.

THE EVENT TYPES ARE DESIGNED TO PROVIDE FLEXIBILITY IN THE SETUP OF A GIVEN PROBLEM. THE EVENT TYPES ARE DEFINED AS FOLLOWS -

1) PRIMARY EVENTS - USED TO DESCRIBE THE MAIN SEQUENTIAL EVENTS OF THE TRAJECTORY BEING SIMULATED. THESE EVENTS MUST OCCUR AND MUST OCCUR IN ASCENDING ORDER ACCORDING TO THE EVENT NUMBER. MOST PROBLEMS WILL USUALLY BE SIMULATED BY A SERIES OF PRIMARY EVENTS.

2) SECONDARY EVENTS - USED TO DESCRIBE EVENTS WHICH MAY OR MAY NOT OCCUR DURING THE SPECIFIED TRAJECTORY SEGMENT.
SECONDARY EVENTS MUST OCCUR IN ASCENDING ORDER IN THE INTERVAL BOUNDED BY THE PRIMARY EVENTS ON EITHER SIDE OF THE SECONDARY EVENT. A PRIMARY EVENT OCCUR-ANCE WILL NULLIFY THE SECONDARY EVENTS FOR THE THE PREVIOUS PRIMARY EVENT IF THEY HAVE NOT OCCURRED.

3) ROVING PRIMARY EVENTS - THESE EVENTS CAN OCCUR ANY TIME AFTER OCCURRENCE OF ALL PRIMARY EVENTS WITH SMALLER EVENT NUMBERS. THESE EVENTS CAN BE USED TO INTERRUPT THE TRAJECTORY ON THE SPECIFIED CRITERIA REGARDLESS OF THE STATE OF THE TRAJECTORY OR VEHICLE.

4) REPEATING ROVING EVENTS - SAME AS PRIMARY ROVING EVENTS EXCEPT THAT THE VALUES ARE INPUT AS THE ARRAY ROVET IN NAMELIST GENDAT. THE NUMBER OF TIMES THAT THE EVENT IS TO REPEAT IS SPECIFIED BY USER INPUT OF NTIMES IN NAMELIST GENDAT. THE REPEATING EVENTS WILL BE NUMBERED XXX.000 THROUGH XXX.099 INTERNALLY BY THE PROGRAM. FOR EXAMPLE, XXX.003 IS THE THIRD REPETITION OF THE REPEATING ROVING EVENT XXX.000.

THE PROGRAM MONITORS AS MANY AS TEN (10) EVENTS AT A TIME, DEPENDING ON THE EVENT TYPES, TO DETERMINE WHICH EVENT IS TO OCCUR NEXT. THIS PROVIDES THE USER WITH A POWERFUL TOOL TO ENABLE THE SIMULATION OF COMPLEX PROBLEMS.

THE MULTIPLE EVENT MONITORING IS DONE IN THE FOLLOWING SEQUENCE -

1) THE NEXT PRIMARY EVENT IS MONITORED.

2) AS MANY AS NINE (9) ROVING EVENTS ARE MONITORED PROVIDED THERE ARE NO SECONDARY EVENTS. A ROVING PRIMARY EVENT IS ADDED TO THE LIST OF THOSE BEING MONITORED AS SOON AS THE PRIMARY EVENT IMMEDIATELY PRECEEDING THAT ROVING EVENT HAS OCCURRED.

3) AS MANY AS NINE (9) SECONDARY EVENTS ARE MONITORED, PROVIDED THERE ARE NO ROVING EVENTS.
   NOTE - CAUTION MUST BE EXERCISED WHEN USING SECONDARY EVENTS BECAUSE OF THEIR NATURE. SINCE AS MANY AS NINE (9) SECONDARIES ARE MONITORED AT A TIME, ANY ONE OF THOSE NINE WILL OCCUR AS SOON AS ITS CRITERIA HAS BEEN MET. BECAUSE THEY ARE SECONDARY EVENTS, THE EVENT WHICH OCCURS WILL CANCEL THE SECONDARIES WITH SMALLER EVENT NUMBERS.

4) A TOTAL OF NINE (9) ROVING AND SECONDARY EVENTS ARE MONITORED.

SINCE THE PROGRAM CAN ONLY MONITOR NINE (9) EVENTS IN ADDITION TO THE NEXT PRIMARY EVENT, THE SUM OF PRIMARY ROVING AND SECONDARY EVENTS MUST BE LESS THAN OR EQUAL TO NINE (9) OR A FATAL ERROR WILL RESULT.

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUTS (CONTD)

THE METHOD BY WHICH THE PROGRAM MONITORS THE EVENT CRITERIA REQUIRES THAT THE DESIRED CUTOFF VARIABLE BE CONTINUOUS. THE PROGRAM CHECKS THE VALUES OF THE CRITERIA BEING MONITORED AT EACH INTEGRATION STEP. IF NONE OF THE CRITERIA VALUES HAVE BRACKETED THE DESIRED CUT-OFF CONDITION, THE PROGRAM TAKES ANOTHER INTEGRATION STEP. IF A CRITERIA VARIABLE WAS BRACKETED ON A GIVEN STEP, THE PROGRAM BACKS UP TO THE PREVIOUS STEP, COMPUTES A NEW STEP SIZE BASED ON THE SLOPE OF THE CRITERIA VARIABLE AND TAKES A NEW STEP. THIS PROCESS IS REPEATED UNTIL THE CRITERIA VARIABLE VALUE IS WITHIN THE SPECIFIED TOLERANCE OF THE DESIRED VALUE. IF THE DESIRED CONDITIONS CANNOT BE ACHIEVED IN 20 ITERATIONS, THE PROGRAM PRINTS AN ERROR MESSAGE AND STOPS. GENERALLY THIS SITUATION IS CAUSED BY AN INPUT ERROR.

THE INPUT DATA REQUIRED TO DESCRIBE THE EVENTS AND THEIR ASSOCIATED CRITERIA ARE AS FOLLOWS -

1) EVENT SEQUENCE NUMBER - EVENT(1)
2) TYPE OF EVENT - EVENT(2)
3) EVENT CRITERIA VARIABLE NAME - CRITR
4) EVENT CRITERIA VARIABLE VALUE - VALUE
5) EVENT CRITERIA MODEL - MDL

FOR MOST PROBLEMS, THE USER ONLY NEEDS TO INPUT VALUES FOR THE ABOVE VARIABLES, HOWEVER, THE CAPABILITY EXISTS TO ALLOW THE CRITERIA VARIABLE DERIVATIVE (DERIV), AND THE ACCURACY TOLERANCE (TOL) TO BE INPUT AS WELL.

THE SAMPLE INPUT LISTING SECTION OF THIS REPORT ILLUSTRATES THE USE AND DESIGNATION OF EVENTS.

ALL INPUT VARIABLES ASSOCIATED WITH EVENT CRITERIA/ PHASE DEFINITION ARE INPUT IN NAMELIST GENDAT. THE INPUT VARIABLES ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CRITR	HOLLERITH	TIME	THE NAME OF THE EVENT CRITERIA VARIABLE. THIS IS THE VARIABLE TO BE MONITORED TO INITIATE THE CORRESPONDING PHASE. ANY APPROPRIATE VARIABLE FROM THE LIST OF OUTPUT VARIABLES CAN BE USED FOR THIS PURPOSE.

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			OPTION 2. ROVET(1) = X1, ROVET(2) = X2, ROVET(NTIMES+1) = XN. WHERE XI = VALUE OF CRITR FOR THE I-TH OCCURRENCE OF THE EVENT. NOTE - THIS OPTION IS LIMITED TO 9 REPETITIONS.
TOL	SAME AS THE CRITERIA VARIABLE	1.E-6	THE DESIRED ACCURACY TOLERANCE FOR THE SPECIFIED CRITERIA VARIABLE (CRITR). THE EVENT WILL OCCUR WHEN THE ACTUAL VALUE OF CRITR IS WITHIN THIS TOLERANCE OF THE DESIRED VALUE.
VALUE	DECIMAL	1.E10	THE VALUE OF THE CRITERIA VARIABLE (CRITR) AT WHICH THE EVENT IS TO OCCUR.

THERE ARE OTHER INPUTS CONCERNING THE PHASE/DEFINITION PROCESS WHICH ACT AS TERMINATION PARAMETERS. THESE VARIABLES ARE INPUT IN NAMELIST GENDAT AND ARE DEFINED AS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALTMAX	FT (M)	1.E20	MAXIMUM ALTITUDE, I.E., THE TRAJECTORY WILL TERMINATE IF THE VALUE OF OBLATE ALTITUDE (ALTITO) EXCEEDS THIS VALUE.
ALTMIN	FT (M)	-5000.	MINIMUM ALTITUDE, I.E., THE TRAJECTORY WILL TERMINATE IF THE VALUE OF OBLATE ALTITUDE (ALTITO) BECOMES LESS THAN THIS VALUE.
ENDJOB	INTEGER	0	END-OF-JOB FLAG. = 0, NOT THE END OF THE JOB = 1, END OF THE JOB BEING PROCESSED (REQUIRED INPUT FOR EACH JOB)
ENDPHS	INTEGER	0	END-OF-PHASE FLAG. = 0, NOT THE END OF THE PHASE BEING INPUT = 1, END OF THE PHASE BEING INPUT (REQUIRED INPUT FOR EACH PHASE)

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
EVENT(1)	DECIMAL	0.	THE EVENT SEQUENCE NUMBER FOR THE CURRENT PHASE. THIS VARIABLE MUST BE INPUT FOR EACH PHASE. = XXX.000, DENOTES PRIMARY EVENTS. = XXX.X00, DENOTES SECONDARY EVENTS.
EVENT(2)	DECIMAL	0.	THE TYPE OF EVENT. THE EVENTS ARE ASSUMED TO BE NON-ROVING (ORDERED) UNLESS OVERRIDDEN BY THIS INPUT. = 0., NON-ROVING (ORDERED) EVENT = 1., PRIMARY ROVING EVENT
MDL	INTEGER	1	THE EVENT CRITERIA MODEL TO BE USED. = 1, IGNORE THE SIGN OF THE DERIVATIVE = 2, INITIATE THE EVENT ONLY IF THE DERIVATIVE OF CRITR IS POSITIVE = 3, INITIATE THE EVENT ONLY IF THE DERIVATIVE OF CRITR IS NEGATIVE
NTIMES	INTEGER	0	THE NUMBER OF TIMES TO REPEAT THE EVENT BEING INPUT. THE EVENT MUST BE A ROVING EVENT, I.E., EVENT(2)=1, AND ROVET MUST BE INPUT. = 0, DO NOT REPEAT THE EVENT. = POS NUMBER, REPEAT THE EVENT NTIMES USING OPTION 1 OF ROVET. = NEG NUMBER, REPEAT THE EVENT NTIMES USING OPTION 2 OF ROVET.
ROVET(I) I=1,10	DECIMAL	0.0	THE INPUT ARRAY CONTAINING THE VALUES OF THE CRITERIA VARIABLE AT WHICH THE REPEATING ROVING EVENTS ARE TO OCCUR. OPTION 1. ROVET(1) = X, ROVET(2) = DX, WHERE X = VALUE OF CRITR ON FIRST OCCURRENCE OF THE EVENT, AND X + N*DX AS THE VALUE OF CRITR ON THE N-TH REPETITION OF THE EVENT.

6.A.6. EVENT CRITERIA/PHASE DEFINITION INPUT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ENDPRB	INTEGER	0	END-OF-PROBLEM FLAG. = 0, NOT THE END OF THE PROBLEM BEING INPUT = 1, END OF THE PROBLEM BEING INPUT (REQUIRED INPUT FOR EACH PROBLEM)
FESN	DECIMAL	100.	THE FINAL EVENT SEQUENCE NUMBER FOR THE CURRENT PROBLEM. THE PROBLEM WILL TERMINATE UPON REACHING THE EVENT DESIGNATED BY FESN. FESN MUST BE INPUT LESS THAN OR EQUAL TO THE LAST EVENT SEQUENCE NUMBER INPUT.
MAXTIM	SEC	1.E10	MAXIMUM TRAJECTORY TIME. THE TRAJECTORY WILL TERMINATE IF THE VALUE OF TIME EXCEEDS THIS VALUE. THIS IS A PSUEDO ABORT MODE AND SHOULD ONLY BE USED AS A BACK-UP TRAJECTORY TERMINATION PROCEDURE IN CASE THE DESIGNATE FINAL EVENT (FESN) DOES NOT OCCUR.
NPC(18)	INTEGER	0	TRAJECTORY TERMINATION FLAG. = 0, DO NOT TERMINATE TRAJECTORY. = 1, TERMINATE THE TRAJECTORY UPON REACHING THE CURRENT EVENT. THIS OPTION PROVIDES THE USER WITH A PSUEDO ABORT CAPABILITY WHICH CAN BE USED IN CONJUNCTION WITH ROVING OR SECONDARY EVENTS.

6.A.7. FUNCTIONAL INEQUALITIES

[illegible] CAPABILITY [illegible] [illegible] MAY CROSS [illegible] BOUNDARY (UPPER OR LOWER) DURING THE COURSE OF [illegible]. THE USER CAN USE THIS FEATURE IN CONJUNCTION WITH THE TARGETING/OPTIMIZATION OPTION TO TARGET TO SOME DESIRED END CONDITIONS WHILE ADHERING TO A TIME VARYING CONSTRAINT. AN EXAMPLE WOULD BE SATISFYING A TRACKER LOOK ANGLE VERSUS SLANT RANGE DISTANCE CONSTRAINT.

THE GENERALIZED FUNCTIONAL INEQUALITIES CAN ONLY BE SATISFIED WHEN USING THE TARGETING/OPTIMIZATION OPTION. THAT IS, SOME CONTROL PARAMETERS MUST BE SPECIFIED WHICH WILL AFFECT THE SPECIFIED FUNCTIONAL INEQUALITY VARIABLES. THE FUNCTIONAL INEQUALITIES WILL BE SATISFIED WHEN THE VALUE OF THE CONSTRAINT VIOLATION FVALJ IS DRIVEN TO ZERO BY THE TARGETING/OPTIMIZATION ALGORITHM.

THREE (3) GENERALIZED FUNCTIONAL INEQUALITY CONSTRAINTS ARE AVAILABLE. THE FUNCTIONAL INEQUALITY OPTION IS OBTAINED IF NPC(11)=1 IS INPUT. IT IS NOT ACTIVE IF NPC(11)=0. THE FOLLOWING VARIABLES ASSOCIATED WITH FUNCTIONAL INEQUALITIES ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(11)	INTEGER	0	FUNCTIONAL INEQUALITY CONSTRAINTS OPTION FLAG. = 0, NO FUNCTIONAL INEQUALITY CONSTRAINTS. = 1, COMPUTE FUNCTIONAL INEQUALITY CONSTRAINTS FVALI, I=1,2,3, BASED ON THE TABLE INPUT OF THE INEQUALITY BOUNDARY (FLIT, I=1, 2,3).
MONF(J) J=1,2,3	HOLLERITH	0.	THE NAME OF THE VARIABLE TO BE USED AS THE FUNCTIONAL INEQUALITY.

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6.A.7. FUNCTIONAL INEQUALITIES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NEQS(J) J=1,3	INTEGER	0	THE TYPE OF BOUNDARY TO BE CONSIDERED FOR THE FUNCTIONAL INEQUALITY WHEN USING NPC(11)=1. =-1, LOWER BOUND. = 1, UPPER BOUND.

THE FOLLOWING VARIABLES ASSOCIATED WITH FUNCTIONAL INEQUALITIES ARE INPUT IN NAMELIST TAB.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
FLJT J=1,2,3	SAME AS THE VARIABLE IN MONF(J)	0.	THE VALUE OF THE BOUNDARY OF THE FUNCTIONAL INEQUALITY AS A FUNCTION OF THE TABLE ARGUMENT.

THE FOLLOWING OUTPUTS ARE ASSOCIATED WITH THE FUNCTIONAL INEQUALITIES.

OUTPUT SYMBOL	UNITS	DEFINITION
DFVALJ J=1,2,3	DECIMAL	THE INSTANTANEOUS VALUE OF THE CONSTRAINT VIOLATION SQUARED. CALCULATED IF NPC(11)=1.
FVALJ J=1,2,3	DECIMAL	THE VALUE OF THE INEQUALITY CONSTRAINT VIOLATION PARAMETER (INTEGRAL OF DFVALJ). IF FVALJ IS ZERO, THE CONSTRAINT WAS NOT VIOLATED. THEREFORE, SPECIFY FVALJ AS AN EQUALITY CONSTRAINT, I.E., INPUT DEPVR(I)= 6HFVALJ , IN NAMELIST SEARCH WITH A DESIRED VALUE (DEPVAL) OF ZERO TO SATISFY THE FUNCTIONAL INEQUALITY. CALCULATED IF NPC(11)=1.

6.A.8. GENERALIZED DEPENDENT VARIABLE OPTION

[illegible] CALCULATE FOUR ARBITRARY [illegible] VARIABLES BASED ON THE VALUES OF TWO GENERALIZED TABLE INPUTS. THIS OPTION IS USEFUL IN THAT THESE GENERALIZED VARIABLES, DGENV, PGENV, RGENV, AND SGENV CAN BE USED AS TARGET, CONSTRAINT, EVENT CRITERIA, OR OPTIMIZATION VARIABLES. THESE VARIABLES ARE DEFINED AS-

GENV1 = TABLE LOOK-UP OF GENV1T,

GENV2 = TABLE LOOK-UP OF GENV2T,

DGENV = GENV2 - GENV1,

PGENV = GENV2 * GENV1,

RGENV = GENV2 / GENV1,

SGENV = GENV2 + GENV1,

WHERE THE TABLES GENV1T AND GENV2T ARE INPUT IN NAMELIST TAB PRIOR TO THE PHASE IN WHICH DGENV IS TO BE USED. TYPICAL APPLICATIONS OF THIS VARIABLE ARE -

1) EVENT CRITERIA -
   CRITR = 5HDGENV,

2) TARGET AND/OR CONSTRAINT -
   DEPVR = 5HDGENV,

3) OPTIMIZATION VARIABLE -
   OPTVAR = 5HDGENV,

AN EXAMPLE OF HOW THIS VARIABLE COULD BE USED IS OUTLINED AS FOLLOWS -

INTERRUPT ON AN ALTITUDE-VELOCITY (H-V) PROFILE. SUPPOSE IT IS DESIRED TO INTERRUPT THE SIMULATION WHEN THE TRACE OF THE ACTUAL TRAJECTORY IN THE H-V SPACE INTERSECTS AN INPUT H-V PROFILE. IN THIS CASE, THE EVENT CRITERIA (CRITR) IS NOT CONSTANT BUT IS A SET OF ORDERED PAIRS OF ALTITUDE AND VELOCITY (I.E., A FUNCTION). THE INPUT FOR THIS EXAMPLE WOULD BE AS FOLLOWS -

THE EVENT CRITERIA WOULD BE

CRITR = 5HDGENV, VALUE = 0.,

6.A.8. GENERALIZED DEPENDENT VARIABLE OPTION (CONTD)

THE TABLES TO DEFINE THE VARIABLE DGENV WOULD BE INPUT IN THE PRECEDING PHASE AS -

```
P$TAB
 TABLE = 6HGENV1T,1,6HALTITO,2,1,1,1,
         0.,0., 1.0E6,1.0E6,
 $
P$TAB
 TABLE = 6HGENV2T,1,6HVELA  ,4,1,1,1,
         1000.,49000., 1500.,71000.,
         3000.,80000., 5000.,95000.,
 $
```

THE PROGRAM WILL THEN INTERRUPT WHEN DGENV EQUALS 0, WHICH IS THE CONDITION WHEN THE ACTUAL H-V PROFILE INTERSECTS THE INPUT CURVE.

THE FOLLOWING TABLES ASSOCIATED WITH THE GENERALIZED DEPENDENT VARIABLE OPTION ARE INPUT IN NAMELIST TAB.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
GENVIT I=1,2	DECIMAL	0.	THE TABLES USED TO CALCULATE THE GENERALIZED DEPENDENT VARIABLES DGENV, PGENV, RGENV, AND SGENV.

THE OUTPUT VARIABLE ASSOCIATED WITH THE GENERALIZED DEPENDENT VARIABLE OPTION IS AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
DGENV	DECIMAL	THE GENERALIZED DIFFERENCE VARIABLE. THIS VARIABLE IS CALCULATED AS THE DIFFERENCE BETWEEN TWO INPUT TABLES AS FOLLOWS -

DGENV = GENV2T - GENV1T

6.A.8. GENERALIZED DEPENDENT VARIABLE OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
GENVI I=1,2	DECIMAL	TABLE LOOKUP VALUE OF TABLE GENVIT, I=1,2.
PGENV	DECIMAL	THE GENERALIZED PRODUCT VARIABLE. THIS VARIABLE IS CALCULATED AS THE PRODUCT OF TWO INPUT TABLES AS FOLLOWS - PGENV = GENV2T * GENV1T
RGENV	DECIMAL	THE GENERALIZED RATIO VARIABLE. THIS VARIABLE IS CALCULATED AS THE RATIO OF TWO INPUT TABLES AS FOLLOWS - RGENV = GENV2T / GENV1T
SGENV	DECIMAL	THE GENERALIZED SUM VARIABLE. THIS VARIABLE IS CALCULATED AS THE SUM OF TWO INPUT TABLES AS FOLLOWS - SGENV = GENV2T + GENV1T

6.A.9. GENERAL INTEGRATION VARIABLES

THE PROGRAM CAN OPTIONALLY COMPUTE THE INTEGRALS OF TEN USER SPECIFIED VARIABLES. THIS FEATURE ENABLES THE USER TO COMPUTE INTEGRALS OF VARIABLES WHICH ARE NOT INCLUDED IN THE NORMAL INTERGRATION LIST. FOR EXAMPLE, SUPPOSE THE TOTAL IMPULSE IS REQUIRED FOR INFORMATION PURPOSES. THIS WOULD BE OBTAINED BY INTEGRATING THRUST BY SETTING GDERV(1)=6HTHRUST, AND BY REQUESTING GINT1 AS A PRINT VARIABLE.

THE INPUT PROCEDURE FOR USING THIS OPTION IS -

1) INPUT NPC(24) = 1,
2) INPUT THE HOLLERITH NAMES OF THE DERIVATIVES GDERV(I).
3) INCLUDE THE INTEGRAL NAMES, GINTJ, IN THE PRINT BLOCK.

THE VARIABLES FOR THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(24)	INTEGER	0	GENERAL INTEGRATION VARIABLE FLAG. = 0, NOT USED. = 1, INTEGRATE THE VARIABLES SPECIFIED BY GDERV(I), I=1,10, TO FORM THE INTEGRALS GINTJ, J=1,10.
GDERV(J) J=1,10	HOLLERITH	0	THE NAME OF GENERAL INTEGRATION VARIABLE J. THE INTEGRAL OF THE VARIABLE SPECIFIED BY GDERV(J) IS CONTAINED IN GINTJ. THE INTEGRATION OF VARIABLE J IS TURNED OFF IF GDERV(J)=0., IS INPUT.
GINT(J) J=1,10	DECIMAL	0.	THE VALUE OF THE INTEGRAL OF GENERAL INTEGRATION VARIABLE J. THIS INPUT ALLOWS THE USER TO RESET THE INTEGRALS AT ANY PHASE.

6.A.9. GENERAL INTEGRATION VARIABLES (CONTD)

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE -

OUTPUT SYMBOL	UNITS	DEFINITION
GINTJ J=1,10	DECIMAL	THE VALUE OF THE INTEGRAL FOR THE GENERAL INTEGRATION VARIABLE SPECIFIED BY GDERV(J). CALCULATED IF NPC(24)=1.

6.A.10. GRAVITATIONAL INPUTS

THE GRAVITY MODEL IS SELECTED FOR EITHER AN OBLATE OR SPHERICAL PLANET BY THE VALUE OF NPC(16). THE GRAVITY MODEL FOR THE OBLATE PLANET MODEL INCLUDES THE SECOND, THIRD, AND FOURTH HARMONICS WHICH REPRESENT THE VARIATION IN THE GRAVITY ACCELERATION AS A FUNCTION OF OBLATENESS AND LATITUDE.

ALL INPUT VARIABLES ASSOCIATED WITH THE GRAVITY MODEL ARE INPUT IN NAMELIST GENDAT. THESE VARIABLES ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(16)	INTEGER	0	GRAVITY MODEL OPTION FLAG = 0, USE GRAVITY MODEL FOR AN OBLATE PLANET. INPUT J2,J3,J4,RE,RP, MU, AND OMEGA. = 1, USE GRAVITY MODEL FOR A SPHERICAL PLANET OF RADIUS RE. INPUT RE AND MU.
J2 J3 J4	DECIMAL	1.0823E-3 0. 0.	SECOND, THIRD, AND FOURTH HARMONICS IN THE GRAVITY POTENTIAL FUNCTION. USED IF NPC(16)=0.
MU	FT**3/ SEC**2 (M3/S2)	1.40765 39E+16	GRAVITATIONAL CONSTANT OF THE ATTRACTING PLANET.
OMEGA	RAD/SEC	7.29211 E-5	ROTATION RATE OF THE ATTRACTING PLANET.
RE	FT (M)	20925741.	EQUATORIAL RADIUS OF THE ATTRACTING PLANET.
RP	FT (M)	20855590.	POLAR RADIUS OF THE ATTRACTING PLANET. USED IF NPC(16)=0.

6.A.10. GRAVITATIONAL INPUTS

THE OUTPUTS ASSOCIATED WITH THE GRAVITY CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
GXI GYI GZI	FT/SEC**2 (M/S2)	THE GRAVITY ACCELERATION VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES.

6.A.11. HOLD DOWN/HORIZONTAL TAKEOFF OPTION

THE PROGRAM HAS THE CAPABILITY TO SIMULATE HOLD DOWN. THAT IS, THE EQUATIONS OF MOTION ARE INTEGRATED ASSUMING THE VEHICLE IS RIGIDLY ATTACHED AT THE INPUT INITIAL CONDITIONS. RELEASE OF THE VEHICLE IS ACHIEVED BY MAKING THE NEXT EVENT OCCUR AT A GIVEN VALUE OF AXIAL ACCELERATION (AXB), TIME, ETC, AND BY SETTING NPC(14)=0, IN THAT PHASE.

WHEN USING THE HOLD-DOWN OPTION, THE RELATIVE POSITION AND VELOCITY COMPONENTS REMAIN CONSTANT WHILE THE INERTIAL POSITION CHANGES BY THE EARTH ROTATION RATE TIMES TIME. THE INERTIAL VELOCITY MAGNITUDE ALSO REMAINS CONSTANT.

THE PROGRAM CAN ALSO SIMULATE HORIZONTAL TAKEOFF. THIS OPTION MAINTAINS THE VEHICLE AT A CONSTANT ALTITUDE ABOVE THE OBLATE PLANET. THE VEHICLE CAN ACCELERATE HORIZONTALLY WHEN USING THIS OPTION. THIS ALLOWS THE USER TO TERMINATE THE HORIZONTAL TAKEOFF OPTION BY AN EVENT ON A CALCULATED PARAMETER SUCH AS VELA, AVERT, ETC. VEHICLE ATTITUDE AND PHYSICAL CHARACTERISTICS CAN BE CHANGED AT ANY EVENT WHEN USING THIS OPTION. THIS ALLOWS THE USER TO EXAMINE THE ENTIRE TAKEOFF SEQUENCE IN AS MUCH DETAIL AS DESIRED CONSISTENT WITH THE POINT MASS ASSUMPTIONS OF THE PROGRAM.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(14)	INTEGER	0	HOLD DOWN OPTION FLAG. = 0, NO HOLD DOWN OPTION. = 1, INTEGRATE THE EQUATIONS OF MOTION BASED ON HOLDING THE VEHICLE DOWN. = 2, USE THE HORIZONTAL TAKEOFF MODEL.

THE OUTPUT VARIABLES FOR THIS MODULE ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
AHORIZ	FT/SEC**2 (M/S2)	THE MEASURABLE ACCELERATION IN THE LOCAL HORIZONTAL PLANE.
AVERT	FT/SEC**2 (M/S2)	THE MEASURABLE ACCELERATION IN THE VERTICAL (RADIAL) DIRECTION.

6.A.12. INITIAL POSITION AND VELOCITY

THE INITIAL POSITION AND VELOCITY STATES CAN BE INPUT IN SEVERAL WAYS DEPENDING ON USER PREFERENCE. THE OPTIONS FOR THE VELOCITY VECTOR INPUT ARE SELECTED BY THE VALUE OF NPC(3). THE OPTIONS FOR THE POSITION VECTOR INPUT ARE SELECTED BY THE VALUE OF NPC(4). THE OPTIONS ARE SUMMARIZED AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(3)	INTEGER	4	VELOCITY VECTOR INITIALIZATION FLAG. = 1, INPUT EARTH CENTERED INERTIAL COMPONENTS, VXI(J), J=1,3. = 2, INPUT INERTIAL COMPONENTS IN THE LOCAL HORIZONTAL (G) FRAME, GAMMAI, VELI, AND AZVELI. = 3, INPUT ATMOSPHERIC RELATIVE COMPONENTS IN THE LOCAL HORIZONTAL (G) FRAME, GAMMAA, VELA, AND AZVELA. = 4, INPUT EARTH RELATIVE COMPONENTS IN THE LOCAL HORIZONTAL (G) FRAME, GAMMAR, VELR, AND AZVELR. = 5, INPUT ORBITAL PARAMETERS, INC, ALTP, ALTA, TRUAN, ARGP, LAN, AND PGCLAT. NPC(4) IS NOT USED IF NPC(3)=5.
NPC(4)	INTEGER	2	POSITION VECTOR INITIALIZATION FLAG. = 1, INPUT EARTH CENTERED INERTIAL COMPONENTS, XI(J), J=1,3. = 2, INPUT SPHERICAL COORDINATES, GEOCENTRIC OR GEODETIC LATITUDE, GCLAT OR GDLAT, RELATIVE OR INERTIAL LONGITUDE, LONG OR LONGI, AND OBLATE ALTITUDE OR GEOCENTRIC RADIUS, ALTITO OR GCRAD.

THE FOLLOWING LIST DEFINES THE INPUT VARIABLES FOR THE VARIOUS OPTIONS DEFINED ABOVE FOR NPC(3) AND NPC(4). ALL VARIABLES IN THIS LIST ARE INPUT IN NAMELIST GENDAT.

6.A.12. INITIAL POSITION AND VELOCITY (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALTA	N.MI. (KM)	0.	INITIAL APOGEE ALTITUDE. USED IF NPC(3)=5.
ALTITO	FT (M)	0.	INITIAL ALTITUDE ABOVE THE OBLATE PLANET. USED IF NPC(4)=2 AND IF GCRAD IS NOT INPUT.
ALTP	N.MI. (KM)	0.	INITIAL PERIGEE ALTITUDE. USED IF NPC(3)=5.
ARGP	DEG	0.	INITIAL ARGUMENT OF PERIGEE. USED IF NPC(3)=5.
AZVELA	DEG	0.	INITIAL AZIMUTH ANGLE OF THE VELOCITY RELATIVE TO THE ATMOSPHERE. USED IF NPC(3)=3.
AZVELI	DEG	0.	INITIAL AZIMUTH ANGLE OF THE INERTIAL VELOCITY VECTOR. USED IF NPC(3)=2.
AZVELR	DEG	0.	INITIAL AZIMUTH ANGLE OF THE RELATIVE VELOCITY VECTOR. USED IF NPC(3)=4.
GAMMAA	DEG	0.	INITIAL ATMOSPHERIC RELATIVE FLIGHT PATH ANGLE. USED IF NPC(3)=3.
GAMMAI	DEG	0.	INITIAL VALUE OF INERTIAL FLIGHT PATH ANGLE. USED IF NPC(3)=2.
GAMMAR	DEG	0.	INITIAL RELATIVE FLIGHT PATH ANGLE. USED IF NPC(3)=4.
GCLAT	DEG	0.	INITIAL GEOCENTRIC LATITUDE. USED IF NPC(4)=2 AND IF GDLAT IS NOT INPUT
GCRAD	FT (M)	0.	INITIAL GEOCENTRIC RADIUS. USED IF NPC(4)=2 AND IF ALTITO IS NOT INPUT.
GDLAT	DEG	0.	INITIAL GEODETIC LATITUDE. USED IF NPC(4)=2 AND IF GCLAT IS NOT INPUT.

6.A.12. INITIAL POSITION AND VELOCITY (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
INC	DEG	0.	INITIAL INCLINATION ANGLE. USED IF NPC(3)=5.
LAN	DEG	0.	INITIAL LONGITUDE OF THE ASCENDING NODE MEASURED EAST OF THE XI AXIS. USED IF NPC(3)=5.
LONG	DEG	0.	INITIAL EAST LONGITUDE RELATIVE TO THE PRIME MERIDIAN. USED IF NPC(4)=2 AND IF LONGI IS NOT INPUT.
LONGI	DEG	0.	INITIAL LONGITUDE EAST OF THE XI AXIS. USED IF NPC(4)=2, AND LONG IS NOT INPUT.
PGCLAT	DEG	0.	INITIAL GEOCENTRIC LATITUDE OF PERIGEE. MEASURED POSITIVE IN THE NORTHERN HEMISPHERE. USED IF NPC(3) =5.
TRUAN	DEG	0.	INITIAL TRUE ANOMALY. USED IF NPC(3)=5.
VELA	FT/SEC (M/S)	0.	INITIAL ATMOSPHERIC RELATIVE VELOCITY USED IF NPC(3)=3.
VELI	FT/SEC (M/S)	0.	INITIAL VALUE OF INERTIAL VELOCITY. USED IF NPC(3)=2.
VELR	FT/SEC (M/S)	0.	INITIAL RELATIVE VELOCITY. USED IF NPC(3)=4.
VXI(J) J=1,3	FT/SEC (M/S)	0.	THE INITIAL VALUES OF THE INERTIAL VELOCITY VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES. USED IF NPC(3)=1.
XI(J) J=1,3	FT (M)	0.	THE INITIAL VEHICLE POSITION VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES. USED IF NPC(4)=1.

6.A.13. INSTANTANEOUS VELOCITY ADDITIONS

THE PROGRAM HAS THE CAPABILITY TO INSTANTANEOUSLY ADD DELTA INERTIAL VELOCITY AT THE BEGINNING OF ANY PHASE. THE AMOUNT OF DELTA VELOCITY TO BE ADDED CAN BE INPUT DIRECTLY OR CAN BE CALCULATED BASED ON THE AMOUNT OF PROPELLANT REMAINING AT THE TIME OF THE DELTA VELOCITY ADDITION. THE SPECIFIC DELTA VELOCITY ADDITION OPTION IS REQUESTED WHENEVER NPC(9)=3 OR 4 IS INPUT.

THE DELTA VELOCITY ADDITION IS MADE IN THE DIRECTION OF THE THRUST VECTOR JUST PRIOR TO THE DELTA VELOCITY ADDITION. IN THIS MANNER, THE USUAL GUIDANCE OPTIONS APPLY IN ORIENTING THE VEHICLE FOR A DELTA VELOCITY ADDITION.

WHEN USING THE DELTA VELOCITY OPTION IN CONJUNCTION WITH THE SEARCH/OPTIMIZATION OPTION, CARE MUST BE EXERCISED WHEN SPECIFYING THE DEPENDENT PHASES (DEPPH) AND THE OPTIMIZATION VARIABLE PHASE (OPTPH) BECAUSE THE DEPENDENT VARIABLES (DEPVR) AND THE OPTIMIZATION VARIABLE (OPTVAR) ARE EVALUATED AT THE PLUS SIDE OF A PHASE AFTER THE DELTA VELOCITY ADDITION HAS BEEN MADE.

THE VARIABLES ASSOCIATED WITH THE DELTA VELOCITY ADDITION OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DVIMAG	FT/SEC (M/S)	0.	THE AMOUNT OF DELTA INERTIAL VELOCITY TO BE ADDED WHEN USING THE INSTANTANEOUS VELOCITY ADDITION OPTION. USED IF NPC(9)=3.
GO	FT/SEC**2 (M/S2)	32.174	WEIGHT TO MASS CONVERSION FACTOR.
ISPV(I) I=1	SEC	1.E11	THE SPECIFIC IMPULSE TO BE USED WHEN COMPUTING THE DELTA VELOCITY ADDITION. USED IF NPC(9)=3,4.
WPROPI	LBS (N)	0.	THE INITIAL WEIGHT OF PROPELLANT. THIS PARAMETER IS NOT USED TO COMUTE THE GROSS WEIGHT OF THE VEHICLE BUT IS USED ONLY AS AN INDICATOR OF THE AVAILABLE PROPELLANT FOR A GIVEN STAGE SO THAT THE REMAINING PROPELLANT

6.A.13. INSTANTANEOUS VELOCITY ADDITIONS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			(WPROP) CAN BE COMPUTED FOR USE AS A CRITERIA VARIABLE OR AS PART OF THE WEIGHT TO BE JETTISONED BASED ON THE VALUE OF NPC (13).

6.A.14. MONITOR VARIABLES

THE PROGRAM HAS THE CAPABILITY TO CALCULATE EITHER THE MAXIMUM OR MINIMUM VALUE ATTAINED BY USER SPECIFIED VARIABLES DURING THE COURSE OF A TRAJECTORY. THIS FEATURE IS USEFUL IN PROVIDING INFORMATION SUCH AS MAXIMUM DYNAMIC PRESSURE, ACCELERATION, ETC., AS WELL AS THE TIME OF OCCURRENCE OF THESE CONDITIONS.

THIS FEATURE IS ALSO USEFUL IN CONTROLLING THE MAXIMUM OR MINIMUM VALUES ATTAINED BY USER SPECIFIED VARIABLES BY MEANS OF THE TARGETING/OPTIMIZATION OPTION. FOR EXAMPLE, SUPPOSE THE USER WISHES TO TARGET TO SOME END CONDITIONS WHILE MAINTAINING AN UPPER BOUND ON THE MAXIMUM DYNAMIC PRESSURE. IN THIS CASE, THE VARIABLE MONX(1)=4HDYNP, WOULD BE INPUT IN NAMELIST GENDAT AND THE VARIABLE XMAX1 WOULD BE USED AS A DEPENDENT VARIABLE WITH AN UPPER BOUND, I.E., INPUT DEPVR(I)=5HXMAX1, IDEPVR(I)=1, AND DEPVAL(I)=UPPER BOUND VALUE, IN NAMELIST SEARCH.

ALL GENERALIZED MONITOR VARIABLES ARE INPUT IN NAMELIST GENDAT. TEN (10) GENERALIZED MONITOR VARIABLES ARE AVAILABLE. ANY COMPUTED PARAMETER WHICH IS LISTED IN THE SECTION ENTITLED OUTPUT VARIABLES CAN BE USED AS A GENERALIZED MONITOR VARIABLE.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
MONX(I) I=1,10	HOLLERITH	0.	THE NAME OF THE VARIABLE TO BE MONITORED FOR MAXIMUM AND MINIMUM VALUES. THE FIRST N MONX VARIABLES THAT ARE NONZERO WILL BE USED.
MONY(I) I=1,10	HOLLERITH	0.	THE NAME OF THE VARIABLE WHOSE VALUE IS TO BE DETERMINED WHEN MONX(I) REACHES THE MAXIMUM AND MINIMUM VALUES.
XMAX(I) I=1,10	DECIMAL	-1.0E20	THE INITIAL VALUE OF XMAX(I). THIS VARIABLE CAN BE INPUT IN ANY PHASE TO REINITIALIZE THE SEARCH FOR ANOTHER MAXIMUM OF THE VARIABLE INPUT AS MONX(I).

6.A.14. MONITOR VARIABLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
XMIN(I) I=1,10	DECIMAL	+1.0E20	THE INITIAL VALUE OF XMIN(I). THIS VARIABLE CAN BE INPUT IN ANY PHASE TO REINITIALIZE THE SEARCH FOR ANOTHER MINIMUM OF THE VARIABLE INPUT AS MONX(I).
YXMN(I) I=1,10	DECIMAL	+1.0E20	THE INITIAL VALUE OF YXMN(I). THIS VARIABLE CAN BE INPUT IN ANY PHASE TO REINITIALIZE THE SEARCH FOR ANOTHER MINIMUM OF THE VARIABLE INPUT AS MONY(I).
YXMX(I) I=1,10	DECIMAL	-1.0E20	THE INITIAL VALUE OF YXMX(I). THIS VARIABLE CAN BE INPUT IN ANY PHASE TO REINITIALIZE THE SEARCH FOR ANOTHER MAXIMUM OF THE VARIABLE INPUT AS MONY(I).

THE FOLLOWING OUTPUTS ARE ASSOCIATED WITH THE GENERALIZED MONITOR VARIABLES.

OUTPUT SYMBOL	UNITS	DEFINITION
XMAXJ J=1,10	DECIMAL	THE MAXIMUM VALUE OF MONX(J).
XMINJ J=1,10	DECIMAL	THE MINIMUM VALUE OF MONX(J).
YXMNJ J=1,10	DECIMAL	THE VALUE OF MONY(J) AT XMINJ.
YXMXJ J=1,10	DECIMAL	THE VALUE OF MONY(J) AT XMAXJ.

6.A.15. NUMERICAL INTEGRATION METHODS

THE PROGRAM CONTAINS BOTH GENERAL AND SPECIAL PURPOSE INTEGRATION METHODS. THE GENERAL PURPOSE INTEGRATION METHODS ARE -

1) FOURTH ORDER RUNGE-KUTTA
2) VARIABLE STEP/ORDER PREDICTOR-CORRECTOR
3) EIGHTH ORDER RUNGE-KUTTA

AND THE SPECIAL PURPOSE METHODS ARE-

1) LAPLACE CONIC INTEGRATION
2) ENCKE PERTURBED CONIC INTEGRATION

RUNGE-KUTTA SHOULD BE USED FOR PROBLEMS THAT HAVE A LARGE NUMBER OF EVENTS, AND PREDICTOR-CORRECTOR SHOULD BE USED FOR PROBLEMS THAT HAVE ONLY A FEW EVENTS. THIS IS BECAUSE PREDICTOR-CORRECTOR HAS TO BE RESTARTED AT EVERY EVENT.

THE LAPLACE CONIC METHOD SHOULD BE USED FOR PROBLEMS WHEN ONLY APPROXIMATE ORBITAL INTEGRATION IS DESIRED, AND THE ENCKE METHOD SHOULD BE USED WHEN VERY ACCURATE ORBITAL INTEGRATION IS DESIRED.

THE INTEGRATION STEPSIZE IS INPUT AS A CONSTANT IN NAMELIST GENDAT. THE INTEGRATION STEPSIZE CAN ALSO BE COMPUTED FROM THE ARGUMENT OF A MONOVARIANT TABLE, PROVIDED THE ARGUMENT IS A TIME VARIABLE. THIS WILL INSURE THAT EVERY TABLE POINT IS EXACTLY INCLUDED IN THE INTEGRATION.

THE VARIABLES FOR THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(2)	INTEGER	1	INTEGRATION METHOD FLAG. = 1, FOURTH ORDER RUNGE-KUTTA. = 2, VARIABLE STEP/ORDER PREDICTOR-CORRECTOR. = 3, LAPLACE CONIC INTEGRATION. NPC(2)=3, SHOULD BE USED FOR INTEGRATING ORBITS ABOUT A SPHERICAL PLANET. I.E., IF J2, J3, AND J4 ARE ZERO.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			= 4, ENCKE-S METHOD OF INTEGRATION. NPC(2)=4, SHOULD BE USED FOR INTEGRATING ORBITS ABOUT AN OBLATE PLANET. I.E., IF J2, J3, AND J4 ARE NOT ZERO. = 5, EIGHTH ORDER RUNGE-KUTTA. = 6, ENCKES METHOD APPLIED TO EIGHTH ORDER RUNGE-KUTTA.
NPC(20)	INTEGER	0	FLAG TO SPECIFY THE TYPE OF SPECIAL INTEGRATION STEP SIZE (DT) PREDICTION TO BE USED. = 0, NONE. = 1, USE THE ARGUMENT VALUES OF THE MONOVARIANT TYPE TABLES WHICH HAVE TABLE(2)=-1, AS INTEGRATION TIMES. THE ARGUMENTS FOR THESE TABLES MUST BE A TIME PARAMETER, E.G., TIME, TIMES, TDURP, TIMRFJ, ETC.
DLTMAX	SEC	1.0E10	THE MAXIMUM ALLOWABLE STEPSIZE WHEN USING THE VARIABLE STEP/ORDER INTEGRATOR, I.E., WHEN NPC(2)=2.
DLTMIN	SEC	0.0	THE MINIMUM ALLOWABLE STEPSIZE WHEN USING THE VARIABLE STEP/ORDER INTEGRATOR, I.E., WHEN NPC(2)=2.
DT	SEC	1.0	THE INTEGRATION INTERVAL (STEPSIZE).
DTM	DECIMAL	1.	A MULTIPLIER ON THE INTEGRATION INTERVAL (DT) TO BE USED IN COMPUTING THE INTEGRATION INTERVAL FOR THE PERTURBED TRAJECTORIES AND THE TRIAL STEP TRAJECTORIES.
EPSINT	DECIMAL	1.0	ABSOLUTE ERROR TOLERANCE ON THE LOCAL INTEGRATION ERROR. THE SAME ERROR TOLERANCE IS TO BE USED FOR ALL DIFFERENTIAL EQUATIONS IN THE SYSTEM. FOR A DIFFERENTIAL EQUATION OF ORDER D, THE ERROR ESTIMATED BY

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6.A.15. NUMERICAL INTEGRATION METHODS (CONTD)

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INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			THE INTEGRATOR IS THE ERROR IN THE (D-1) TH DERIVATIVE. FOR EXAMPLE, FOR A SECOND ORDER EQUATION DETERMINING DISPLACEMENT IN UNITS OF FEET, THE TOLERANCE IS ON VELOCITY IN UNITS OF FEET/SECOND. THE INTEGRATOR STEPSIZE AND ORDER SELECTION ALGORITHM HOLD THE ESTIMATE OF THE LOCAL ERROR (OBTAINED BY COMPARING THE PREDICTOR AND CORRECTOR COMPUTATION) TO LESS THAN EPSINT/10.

6.A.16. PRINT VARIABLE REQUESTS (CONTD)

*** HYPERBOLIC ORBIT ***

HYPVEL	SEMJAX	ECCEN	DECLIN	RTASC	PERIOD
TRUAN	TRUNMX	INC	ENERGY	ANGMOM	ALTP
PGERAD	PGCLAT	PGLON	ARGV	TIMTP	TIMSP
ECCAN	MEAAN	PGVEL	DVCIR	VCIRC	LANVE

VELOCITY LOSSES PRINT BLOCK. OBTAINED IF NPC(25)=2 OR 3.

*** VELOCITY LOSSES ***

DLR	TVLR	ATL	GLR	VIDEAL	DLI
TVLI	GLI				

TRACKING STATION PRINT BLOCK. OBTAINED IF NPC(28)=2 OR 3.

*** TRKNAM(J) TRACKING STATION ***

TRKLTJ	TRKLNJ	TRKHTJ	SLTRGJ	ELEVJ	TKAZMJ
LKAJ	LKBJ	SLOS1J	SLOS2J	SLOS3J	

ANALYTICAL IMPACT POINT PRINT BLOCK. OBTAINED IF NPC(29)=2 OR 3.

*** VACUUM IMPACT ***

TIMIP	ALTIP	GDLTIP	LONGIP	DPRGI1	DPRGI2
RIP1	RIP2	RIP3	VIP1	VIP2	VIP3

THE FOLLOWING VARIABLES ASSOCIATED WITH THE PRINT VARIABLE REQUESTS ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(19)	INTEGER	1	FLAG TO CONTROL PRINTING OF INPUT CONDITIONS FOR EACH PHASE. = 0, DO NOT PRINT INPUT CONDITION SUMMARIES. = 1, PRINT INPUT CONDITION SUMMARIES FOR EACH PHASE.
PINC	SEC	0.	PRINT INTERVAL. IF PINC IS INPUT EQUAL TO ZERO, PRINTOUTS WILL OCCUR AT THE END OF EACH INTEGRATION STEP. OTHERWISE, PINC MUST BE INPUT AS A MULTIPLE OF THE INTEGRATION INTERVAL (DT).

6.A.16. PRINT VARIABLE REQUESTS

THE PROGRAM HAS THE CAPABILITY TO PRINT AS MANY AS 198 OUTPUT VARIABLES AT EACH PRINT TIME. A NOMINAL PRINT BLOCK IS OBTAINED AUTOMATICALLY WITHOUT USER INPUT IF DESIRED. HOWEVER THE USER CAN CHANGE PART OR ALL OF THE PRINT BLOCK IF DESIRED BY OVERRIDDING THE STORED VALUES WITH THE DESIRED NAMES BY MEANS OF THE ARRAY PRNT. THE ARRAY OF PRINT VARIABLES CAN BE TERMINATED AT ANY POINT BY INPUTTING PRNT(I)=5HPSTOP. THE PRINT REQUEST ARRAY PRNT(I) MUST BE INPUT SEQUENTIALLY WITH NO GAPS. SINCE THERE ARE 90 VARIABLES IN THE NOMINAL PRINT BLOCK, THE USER WOULD ADD TO THIS LIST BY BEGINNING HIS INPUT WITH ELEMENT 91 OF THE ARRAY PRNT(I). FOR EXAMPLE, THE VARIABLE TIMRF1 WOULD BE ADDED TO THE NOMINAL BLOCK AS FOLLOWS -

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PRNT(91)=6HTIMRF1,5HPSTOP,
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THE VARIABLES WHICH ARE PRINTED IN THE NOMINAL PRINT BLOCK ARE AS FOLLOWS-

TIME	TIMES	TDURP	DENS	PRES	ATEM
ALTITO	GCRAD	GDLAT	GCLAT	LONG	LONGI
VELI	GAMMAI	AZVELI	XI	VXI	AXI
VELR	GAMMAR	AZVELR	YI	VYI	AYI
VELA	GAMMAA	AZVELA	ZI	VZI	AZI
GAMAD	AZVAD	DWNRNG	CRRNG	DPRNG1	DPRNG2
THRUST	WEIGHT	WDOT	WEICON	WPROP	ASMG
ETA	ETAL	IPNULL	IYNULL	INCPCH	INCYAW
FTXB	FAXB	AXB	ALPHA	ALPDOT	ALPTOT
FTYB	FAYB	AYB	BETA	BETDOT	QALPHA
FTZB	FAZB	AZB	BNKANG	BNKDOT	QALTOT
CA	CD	DRAG	ROLI	YAWR	ROLBD
CN	CL	LIFT	YAWI	PITR	PITBD
CY	HEATRT	TLHEAT	PITI	ROLR	YAWBD
DYNP	MACH	REYNO	ASXI	ASYI	ASZI

OTHER SPECIAL PRINT BLOCKS CAN BE REQUESTED IN ADDITION TO THE MAIN PRINT BLOCK DESCRIBED ABOVE. ANY OF THE VARIABLES LISTED IN THE SPECIAL PRINT BLOCKS MAY BE PRINTED INDIVIDUALLY USING THE PRNT ARRAY. THESE SPECIAL PRINT BLOCKS ARE SUMMARIZED AS FOLLOWS-

CONIC PRINT BLOCK. OBTAINED IF NPC (1)=2 OR 3.

*** ELLIPTIC ORBIT ***

ALTP	ALTA	ECCEN	INC	PERIOD	ARGP
ENERGY	SEMJAX	TRUAN	LAN	ANGMOM	PGERAD
APORAD	PGCLAT	PGLON	ARGV	TIMTP	TIMSP
ECCAN	MEAAN	PGVEL	APVEL	DVCIR	VCIRC
LANVE					

6.A.16. PRINT VARIABLE REQUESTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PRNT(I) I=1,198	HOLLERITH	0.	PRINT VARIABLE NAMES. THESE CAN BE ANY OF THE VARIABLES CONTAINED IN THE LIST OF OUTPUT VARIABLES. A NOMINAL PRINT BLOCK IS OBTAINED UNLESS OVERRIDDEN BY THIS INPUT. THE PRINT LIST CAN BE TERMINATED AT ANY POINT BY INPUT OF PRNT(I)=5HPSTOP.
TITLE(I) I=1,10	HOLLERITH	0.	A 10 WORD TITLE TO BE USED FOR PROBLEM/PHASE IDENTIFICATION. EACH WORD CONTAINS 10 CHARACTERS, THEREBY PROVIDING A TOTAL OF 100 CHARACTERS FOR THE TITLE. THIS TITLE IS PRINTED AT THE TOP OF EACH PAGE OF PRINTOUT.

6.A.17. PROFILE TAPE OPTION

THE PROGRAM HAS THE CAPABILITY TO WRITE THE CONTENTS OF THE PRINT BLOCK ON A TAPE AT A USER SPECIFIED INTERVAL (PRNC). THIS TAPE WHICH CONTAINS THE TIME HISTORY OF THE TRAJECTORY PRINT BLOCK IS REFERRED TO AS A PROFILE TAPE AND IS WRITTEN ON LOGICAL UNIT PROFIL. THE CONTENTS OF PROFIL MUST BE COPIED TO A PHYSICAL TAPE AT THE CONCLUSION OF THE PROGRAM EXECUTION VIA CONTROL CARDS IF IT IS TO BE SAVED FOR LATER USE.

THE PROFILE TAPE CAN BE READ BY PROGRAMS CONTAINING THE NECESSARY PROFILE TAPE READ ROUTINES. THESE PROGRAMS CAN BE USED TO GENERATE A WIDE VARIETY OF DATA FROM THE PROFILE TAPE SUCH AS PLOTS, PUNCHED CARDS, ETC.

THE CONTENTS OF THE PROFILE TAPE CONSISTS OF TWO IDENTIFYING BINARY RECORDS FOLLOWED BY AS MANY 500 WORD RECORDS AS REQUIRED TO WRITE THE DATA FOR A TRAJECTORY PHASE. THIS SEQUENCE OF RECORDS IS REPEATED FOR EACH PHASE IN THE TRAJECTORY. ADDITIONAL TRAJECTORIES ARE WRITTEN AS SEPARATE BINARY FILES FOR EACH TRAJECTORY PRINTED WHILE USING THIS OPTION. THE VARIABLES ARE ACCESSED FROM THE PROFILE TAPE BY NAME AND THE NAMES ARE THE SAME AS THOSE IN THE PRNT ARRAY.

THE VARIABLES ASSOCIATED WITH THE PROFILE TAPE OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
FID(J) J=1,2	HOLLERITH	UD265 FILE I.D. 0000	THE TWO WORD (20 CHARACTERS) FILE IDENTIFICATION TO BE WRITTEN ON THE PROFILE TAPE WHEN USING THE PROFILE TAPE OPTION, I. E., IF PRNC IS INPUT GREATER THAN OR EQUAL TO ZERO.

6.A.17. PROFILE TAPE OPTION (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PRNC	SEC	1HU	PROFILE TAPE WRITE INTERVAL. THIS VARIABLE ACTIVATES THE PROFILE TAPE WRITE OPTION IN ADDITION TO SPECIFYING THE WRITE INTERVAL. IF PRNC=0, THE PRINT BLOCK WILL BE WRITTEN ON THE PROFILE TAPE AT THE END OF EACH INTEGRATION STEP. IF PRNC IS INPUT GREATER THAN ZERO, IT MUST BE A MULTIPLE OF DT.

6.A.18. PROPULSION/THROTTLING INPUTS

THE TYPE OF ENGINES TO BE USED (ROCKET OR JET) IS SPECIFIED BY NPC(9). THE THRUST AND FLOWRATE (OR SPECIFIC FUEL CONSUMPTION FOR JETS) ARE INPUT AS TABLES VIA NAMELIST TAB. THE CONSTANT INPUT VARIABLES ARE INPUT VIA NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(7)	INTEGER	0	ACCELERATION LIMIT OPTION FLAG. = 0, NO ACCELERATION LIMIT. = 1, LIMIT ACCELERATION TO ASMAX BY CALCULATING THE REQUIRED THROTTLE PARAMETER (ETAL).
NPC(9)	INTEGER	0	PROPULSION TYPE FLAG. = 0, NO THRUST. = 1, NENG ROCKET ENGINES. INPUT A THRUST TABLE (TVCIT) FOR EACH ENGINE AND EITHER A FLOWRATE TABLE (WDIT) OR VACUUM SPECIFIC IMPULSE (ISPV(I)) BASED ON THE VALUE OF NPC(21). = 2, NENG JET ENGINES. INPUT A TABLE OF NET THRUST (TVCIT) AND SPECIFIC FUEL CONSUMPTION (WDIT) FOR EACH ENGINE. = 3, INSTANTANEOUS DELTA VELOCITY ADDITION USING THE DESIRED DELTA VELOCITY (DVIMAG) AND THE SPECIFIC IMPULSE (ISPV). = 4, INSTANTANEOUS DELTA VELOCITY ADDITION USING THE INPUT WEIGHT OF PROPELLANT (WPROPI) AND THE SPECIFIC IMPULSE (ISPV).

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(21)	INTEGER	0	FLAG TO INDICATE THE METHOD BY WHICH FLOWRATE IS TO BE COMPUTED FOR ROCKET ENGINES. = 0, FLOWRATE IS A TABLE LOOK-UP OF THE INPUT FLOWRATE TABLE (WDIT, I=1,15). = 1, COMPUTE FLOWRATE USING VACUUM THRUST AND THE INPUT VACUUM SPECIFIC IMPULSE (ISPV(I), I=1,15).
NPC(22)	INTEGER	0	THROTTLING PARAMETER INPUT OPTION FLAG. = 0, THE THROTTLING PARAMETER (ETA) IS OBTAINED BY EVALUATING A CUBIC POLYNOMIAL WHERE THE CONSTANT TERM IS SET EQUAL TO THE VALUE OF ETA AT THE TIME NPC(22)=0 IS REQUESTED. THE COEFFICIENTS ARE INPUT AS ETAPC(I), I=2,4. = 1, THE THROTTLING PARAMETER (ETA) IS OBTAINED BY EVALUATING A CUBIC POLYNOMIAL AS WHEN NPC(22)=0 EXCEPT THAT THE CONSTANT TERM IS INPUT AS ETAPC(1). = 2, THE THROTTLING PARAMETER (ETA) IS A TABLE LOOK-UP OF THE INPUT TABLE ETAT. = 3, THE THROTTLING PARAMETER (ETA) IS A PIECEWISE LINEAR FUNCTION OF THE EVENT SPECIFIED BY DESNE. INPUT THE INITIAL VALUE OF ETA IN THE FIRST PHASE AS ETA. THE DESIRED VALUE OF ETA AT EVENT DESNE IS INPUT AS DETA.

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(27)	INTEGER	0	ACTIVATION FLAG FOR THE OPTION TO INTEGRATE THE FLOWRATE OF SPECIFIED ENGINES. IWPF(I) MUST ALSO BE INPUT. = 0, INACTIVE. = 1, ACTIVE.
ASMAX	G-S	3.0	SENSED (MEASURABLE) ACCELERATION LIMIT. USED IF NPC(7)=1 AND NPC(9)=1,2 TO DETERMINE THE THROTTLING PARAMETER VALUE (ETAL) REQUIRED TO MAINTAIN THE SENSED ACCELERATION (ASMG) AT OR BELOW THE VALUE SPECIFIED BY ASMAX.
DESNE	DECIMAL	THE NEXT PRIMARY EVENT NUMBER	THE EVENT NUMBER AT WHICH THE VALUE OF THE THROTTLING PARAMETER (ETA) IS TO ATTAIN THE DESIRED VALUE (DETA) AS A LINEAR FUNCTION OF THE CRITERIA VARIABLE (CRITR) FOR THE EVENT SPECIFIED BY DESNE. USED IF NPC(22)=3.
DETA	DECIMAL	0.	THE DESIRED VALUE OF THE THROTTLING PARAMETER (ETA) AT THE EVENT SPECIFIED BY DESNE. USED IF NPC(22) =3.
ETA	DECIMAL	1.0	THE INITIAL VALUE OF THE THROTTLING PARAMETER WHEN USING NPC(22)=3.
ETAARG	HOLLERITH	TIMES	THE NAME OF THE VARIABLE TO BE USED AS THE ARGUMENT FOR THE ETA POLYNOMIAL. USED IF NPC(22)=0,1.
ETAPC(I) I=1,4	DECIMAL	1.0,3*0.	THROTTLING PARAMETER (ETA) POLYNOMIAL COEFFICIENTS. USED IF NPC(22)=0 OR 1.

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IENGA(J) J=1,15	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT TO CALCULATE THE THROTTLE SETTING FOR ENGINE J USING THE ACCELERATION LIMIT EQUATIONS. = 0, USE ONLY THE INPUT THROTTLE SETTING BASED ON THE VALUE OF NPC(22). = 1, CALCULATE THE THROTTLE SETTING REQUIRED TO LIMIT THE ACCEL-ERATION TO THE VALUE SPECIFIED BY ASMAX. NPC(7)=1 MUST ALSO BE INPUT.
ISPV(I) I=1,15	SEC	1.0E11	VACUUM SPECIFIC IMPULSE FOR ENGINE I. USED IF NPC(21)=1.
IWPF(I) I=1,15	INTEGER	0	FLAG TO INDICATE WHICH ENGINES ARE TO BE INCLUDED IN THE SPECIFIC FLOWRATE INTEGRATION OBTAINED WHEN NPC(27) = 1. = 0, DO NOT INCLUDE ENGINE I. = 1, INCLUDE ENGINE I.
NENG	INTEGER	1	THE NUMBER OF THRUSTING ENGINES (EITHER ROCKET OR JET). USED IF NPC(9)=1,2.
PSL	LB/FT**2 (N/M2)	VARIES BASED ON NPC(5)	SEA LEVEL ATMOSPHERIC PRESSURE USED IN COMPUTING JET ENGINE THRUST AND FLOWRATE. USED IF NPC(9)=2. IF NOT INPUT, PSL WILL BE SET EQUAL TO THE ATMOSPHERIC PRESSURE AT ALTITO=0.
PWPROP	LBS (N)	0.	THE VALUE OF THE PROPELLANT CONSUMED BY THE ENGINES SPECIFIED BY IWPF(I) WHEN USING THE SPECIAL PROPELLANT FLOWRATE INTEGRATION OPTION. USED IF NPC(27)=1. THIS INPUT ALLOWS THE USER TO RESET THE VALUE OF PWPROP AT ANY PHASE.

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

THE OUTPUT VARIABLES ASSOCIATED WITH THE PROPULSION OPTIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
AEJ J=1,15	FT**2 (M2)	TABLE LOOK-UP VALUE OF EXIT AREA FOR ENGINE J. CALCULATED IF NPC(9)=1.
ETAL	N/D	THE THROTTLE SETTING OF THE ENGINES USED TO LIMIT THE ACCELERATION TO THE SPECIFIED VALUE (ASMAX) WHEN USING NPC(7)=1.
FTXB FTYB FTZB	LBS (N)	THRUST FORCES IN THE BODY COORDINATE SYSTEM. CALCULATED IF NPC(9)=1,2.
PWDOT	LB/SEC (N/S)	THE FLOWRATE RESULTING FROM THE SUMMATION OF INDIVIDUAL FLOWRATES OF THE ENGINES INCLUDED IN THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
PWPROP	LB (N)	THE PROPELLANT CONSUMED BY THE SPECIFIED ENGINES FOR THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
THRJ J=1,15	LBS (N)	VALUE OF NET THRUST FOR ENGINE J. CALCULATED IF NPC(9)=1,2.
THRUST	LBS (N)	NET THRUST (VACUUM THRUST CORRECTED FOR ATMOSPHERIC BACKPRESSURE EFFECTS). CALCULATED IF NPC(9)=1,2.
TTLISP	SEC	THE TOTAL VACUUM SPECIFIC IMPULSE. CALCULATED IF NPC(9)=1,2.
TVAC	LBS (N)	VACUUM THRUST. CALCULATED IF NPC(9)=1.
WDJ J=1,15	LB/SEC (N/S)	TABLE LOOK-UP VALUE OF FLOWRATE FOR ENGINE J. CALCULATED IF NPC(9)=1,2.

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
TSL	DEG R (DEG K)	VARIES BASED ON NPC(5)	SEA LEVEL ATMOSPHERIC TEMPERATURE USED IN COMPUTING JET ENGINE THRUST AND FLOWRATE. USED IN NPC(9)=2. IF NOT INPUT, TSL WILL BE SET EQUAL TO THE ATMOSPHERIC TEMPERATURE AT ZERO ALTITUDE.

THE FOLLOWING TABLE INPUTS ASSOCIATED WITH THE PROPULSION OPTIONS ARE INPUT IN NAMELIST TAB.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
AEIT I=1,15	FT**2 (M2)	0.	TABLE OF EXIT AREA FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1.
ETAT	N/D	0.	TABLE OF THE THROTTLING PARAMETER. USED IF NPC(22)=2.
PIJT YIJT J=1,15	DEG	0.	TABLES OF THE THRUST VECTOR INCIDENCE ANGLES IN PITCH AND YAW FOR ENGINE J. WHEN USING THE STATIC TRIM OPTION, NPC(10)=1,2,3, THESE TABLES WILL BE USED ONLY FOR THE ENGINES WHICH HAVE IENGT(J)=0.
TVCIT I=1,15	LBS (N)	0.	VACUUM THRUST TABLE FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1, OR NET THRUST OVER THE ATMOSPHERIC PRESSURE RATIO WHEN USING JET ENGINES, I.E., IF NPC(9)=2.
WDIT I=1,15	LB/SEC OR LB/SEC/LB (N/S OR N/S/N)	0.	FLOWRATE TABLE FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1 AND NPC(21)=0. OR SPECIFIC FUEL CONSUMPTION WHEN USING JET ENGINES, I.E., IF NPC(9)=2.

6.A.18. PROPULSION/THROTTLING INPUTS (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
WDOT	LB/SEC (N/S)	TOTAL WEIGHT FLOWRATE.
WEICON	LBS (N)	THE AMOUNT OF PROPELLANT CONSUMED SINCE IT WAS ZEROED OUT BY INPUT.
WPROP	LBS (N)	WEIGHT OF THE REMAINING PROPELLANT.

6.A.19 RANGE CALCULATIONS

THE PROGRAM HAS THE CAPABILITY TO CALCULATE DOWNRANGE, CROSSRANGE, AND DOT PRODUCT (NON-DIRECTIONAL) RANGE BASED ON SEVERAL DEFINITIONS OF THESE PARAMETERS. THE DESIRED OPTION IS SELECTED BY THE APPROPRIATE INPUT OF NPC(12). THE DOT PRODUCT RANGE IS CALCULATED REGARDLESS OF THE SPECIFIC OPTION SELECTED FOR DOWNRANGE AND CROSSRANGE.

THE VARIABLES ASSOCIATED WITH THE RANGE CALCULATIONS ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(12)	INTEGER	0	CROSSRANGE AND DOWNRANGE OPTION FLAG. = 0, DO NOT CALCULATE CROSSRANGE AND DOWNRANGE. = 1, COMPUTE CROSSRANGE (CRRNG) AND DOWNRANGE (DWNRNG) BASED ON RELATIVE GREAT CIRCLES. = 2, COMPUTE CRRNG AND DWNRNG BASED ON INERTIAL GREAT CIRCLES. = 3, COMPUTE CRRNG AND DWNRNG RELATIVE TO THE GROUND TRACK OF THE REFERENCE CIRCULAR ORBIT DEFINED BY ALTREF AND AZREF. = 4, ZERO OUT CRRNG AND COMPUTE DWNRNG USING THE BREGUET RANGE EQUATION FOR CRUISE FLIGHT.
ALTREF	N.MI. (KM)	100.	ALTITUDE OF THE REFERENCE CIRCULAR ORBIT FOR USE IN COMPUTING THE CROSSRANGE RELATIVE TO THE GROUND TRACK OF THE REFERENCE ORBIT. USED IF NPC(12)=3.
AZREF	DEG	0.	THE AZIMUTH REFERENCE FOR USE IN COMPUTING DWNRNG AND CRRNG. USED IF NPC(12)=1,2,3.
CLCDMX	DECIMAL	0.	THE VALUE OF THE MAXIMUM LIFT TO DRAG RATIO FOR CRUISE FLIGHT USED TO COMPUTE DOWNRANGE (DWNRNG) BY MEANS OF THE BREGUET EQUATION. USED IF NPC(12)=4.

6.A.19. RANGE CALCULATIONS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
LATREF LONREF	DEG	0.	REFERENCE LATITUDE AND LONGITUDE FOR USE IN COMPUTING THE VARIOUS RANGE PARAMETERS. USED IF NPC(12) =1,2,3,4.
TIMREF	DECIMAL	0.	THE REFERENCE TIME TO BE USED FOR THE INERTIAL RANGE CALCULATIONS. USED IF NPC(12)=2.

THE OUTPUTS ASSOCIATED WITH THE RANGE CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
CRRNG	N.MI. (KM)	CROSSRANGE DISTANCE. CALCULATED IF NPC(12) =1,2,3.
DPRNG1 DPRNG2	N.MI. (KM)	THE DOT PRODUCT (NON-DIRECTIONAL) RANGE FROM THE REFERENCE POINT (SPECIFIED BY LATREF AND LONREF) TO THE CURRENT VEHICLE POSITION (GCLAT AND LONG). THE AVERAGE RADIUS TO THE SURFACE OF THE OBLATE PLANET BETWEEN THE INITIAL AND CURRENT VEHICLE LOCATIONS IS USED IN THE CALCULATION OF DPRNG1 AND DPRNG2. DPRNG1 IS ALWAYS LESS THAN HALF THE EARTHS CIRCUMFERENCE, WHEREAS DPRNG2 WILL BE GREATER THAN HALF THE EARTHS CIRCUMFERENCE IF THE VEHICLE TRAVELS MORE THAN HALF THE EARTHS CIRCUMFERENCE. CALCULATED IF NPC(12)=1,2,3,4.
DWNRNG	N.MI. (KM)	DOWNRANGE DISTANCE. CALCULATED IF NPC(12) =1,2,3,4.
RS	FT (M)	RADIUS TO THE SURFACE OF THE OBLATE PLANET. USED TO COMPUTE ALTITO AND IN THE RANGE CALCULATIONS IF NPC(12)=1,2,3.
RSO	FT (M)	RADIUS TO THE SURFACE OF THE OBLATE AT THE LATITUDE SPECIFIED BY LATREF. USED IN THE RANGE CALCULATIONS IF NPC(12)=1,2,3.

6.A.20 SPECIAL CALCULATIONS FEATURE

THE PROGRAM HAS A FEATURE THAT ALLOWS THE PROGRAM TO BE MODIFIED QUICKLY TO CALCULATE SPECIAL VARIABLES OF A TEMPORARY NATURE. THIS IS ACCOMPLISHED THROUGH THE USE OF SPECIAL INPUT VARIABLES (NSPEC AND SPECI) AND OUTPUT VARIABLES SPECVJ, J=1,9.

THE DESIRED CALCULATIONS ARE PROGRAMMED INTO SUBROUTINE CALSPEC USING THE SPECIAL VARIABLES (NSPEC, SPECI, SPECV) AND ANY OF THE REGULAR PROGRAM VARIABLES. IN THIS MANNER, THE INPUT/OUTPUT AND INTERNAL PROGRAM INTERFACES ARE ALWAYS AVAILABLE.

THE STEPS REQUIRED TO UTILIZE THIS FEATURE ARE AS FOLLOWS -

1. DETERMINE THE EQUATIONS TO BE PROGRAMMED.

2. DEFINE ANY FLAGS TO BE USED AS THE INPUT ARRAY NSPEC(J), J=1,5. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

3. DEFINE ANY INPUT VARIABLES TO BE USED AS THE ARRAY SPECI(J), J=1,9. THESE VARIABLES ARE PRESET TO ZERO IF NOT INPUT.

4. DEFINE THE DESIRED OUTPUT VARIABLES AS THE ARRAY SPECV(J) J=1,9. THE OUTPUT SYMBOL FOR THIS ARRAY IS SPECVJ, J=1,9.

5. CODE THE DESIRED EQUATIONS INTO SUBROUTINE CALSPEC. THE ARRAYS TEMP(I) AND STEMP(I), I=1,25 SHOULD BE USED FOR ANY INTERMEDIATE CALCULATIONS TO MINIMIZE THE CORE REQUIREMENTS.

6. THE VARIABLES SPECVJ CAN BE USED AS DEPENDENT VARIABLES, OPTIMIZATION VARIABLE, TABLE ARGUMENTS, ETC. THE INPUT VARIABLES SPECIJ CAN BE USED AS INDEPENDENT VARIABLES, DEPENDENT VARIABLES, TABLE ARGUMENTS, ETC.

6.A.20. SPECIAL CALCULATIONS FEATURE (CONTD)

THE VARIABLES ASSOCIATED WITH THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NSPEC(J) J=1,5	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE IN THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).
SPECI(J) J=1,9	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE IN THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
SPECVJ J=1,9	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).

6.A.21. STATIC TRIM INPUTS

THE PROGRAM HAS THE CAPABILITY TO COMPUTE THE ENGINE DEFLECTION ANGLES IN PITCH AND YAW THAT ARE REQUIRED TO BALANCE THE AERODYNAMIC AND THRUST MOMENTS WHEN USING THE ROCKET ENGINE OPTION OR THE AERODYNAMIC FLAP DEFLECTION ANGLES IN PITCH AND YAW WHEN USING THE JET ENGINE OPTION.

THE ENGINES WHICH ARE TO BE USED IN THE STATIC TRIM PROCESS FOR THE ROCKET ENGINE OPTION ARE SPECIFIED BY USER INPUT. THIS GENERALITY ALLOWS THE USED TO SIMULATE CONFIGURATIONS WHICH HAVE BOTH GIMBALLED AND NON-GIMBALLED ENGINES IN THE SAME STAGE.

THE INCIDENCE ANGLES IN PITCH AND YAW CAN BE INPUT SEPARATELY FOR EACH ENGINE BY MEANS OF TABLES PIJT AND YIJT, J=1,15, PROVIDED IENGT(J) IS INPUT AS ZERO. THE ENGINES WHICH ARE TO BE USED TO BALANCE THE AERODYNAMIC AND THRUST MOMENTS ARE SPECIFIED BY THE VARIABLE IENGT(J) INPUT EQUAL TO 1. THE INITIAL THRUST INCIDENCE ANGLES IN PITCH AND YAW FOR THESE ENGINES ARE INPUT AS IPO AND IYO.

THE STATIC TRIM OPTION IS OBTAINED IF NPC(10) IS INPUT AS 1,2, OR 3. THE FOLLOWING VARIABLES ASSOCIATED WITH THE STATIC TRIM OPTION ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(10)	INTEGER	0	STATIC TRIM OPTION FLAG. = 0, NO STATIC TRIM. = 1, STATIC TRIM IN PITCH ONLY. = 2, STATIC TRIM IN YAW ONLY. = 3, STATIC TRIM IN BOTH PITCH AND YAW.
GXP(I) GYP(I) GZP(I) I=1,15	FT (M)	0.	LOCATION OF THE ENGINE GIMBAL IN BODY REFERENCE (XBR,YBR,ZBR) SYSTEM FOR ENGINE I. USED IF NPC(10) =1, 2, OR 3.

6.A.21. STATIC TRIM INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IENGT(J) J=1,15	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT TO CALCULATE THE INCIDENCE ANGLES FOR ENGINE J USING THE STATIC TRIM EQUATIONS. = 0, USE ONLY THE INPUT PROGRAMMED INCIDENCE ANGLES OBTAINED FROM TABLES PIJT AND YIJT. = 1, CALCULATE THE INCIDENCE ANGLES FROM THE STATIC TRIM EQUATIONS. NPC(10)=1,2,3 MUST ALSO BE INPUT.
INCPCH INCYAW	DEG	0.	INITIAL THRUST INCIDENCE ANGLES IN PITCH AND YAW FOR THE ENGINES THAT ARE TO BE USED TO TRIM THE VEHICLE IN THE STATIC TRIM EQUATIONS, I.E., IF IENGT(J)=1, AND NPC(10)=1,2,3.
LREF	FT (M)	0.	REFERENCE LENGTH USED IN THE STATIC TRIM EQUATIONS, NPC(10)=1,2,3, AND IN THE CALCULATION OF REYNOLDS NUMBER
LREFY	FT (M)	0.	REFERENCE LENGTH IN YAW. USED IN YAW STATIC TRIM EQUATIONS.
SREF	FT**2 (M2)	0.	THE AERODYNAMIC REFERENCE AREA USED TO COMPUTE THE AERODYNAMIC FORCES WHEN NPC(8)=1,2 AND THE MOMENTS IF NPC(8)=1,2 AND NPC(10)=1,2,3.

THE TABLE INPUTS FOR THE STATIC TRIM OPTION ARE INPUT IN NAMELIST TAB AND ARE THE SAME AS THOSE PRESENTED IN THE AERO-DYNAMIC INPUTS SECTION WITH THE ADDITION OF THE FOLLOWING TABLES -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
XCGT YCGT ZCGT	FT (M)	0.	TABLES OF CENTER-OF-GRAVITY LOCATION ALONG THE XBR,YBR, AND ZBR AXES, RESPECTIVELY, WHEN USING THE STATIC TRIM OPTION, I.E., IF NPC(10)=1,2,3.

THE OUTPUTS ASSOCIATED WITH THE STATIC TRIM OPTION MUST BE REQUESTED BY MEANS OF THE ARRAY PRNT AS DESCRIBED IN THE PRINT REQUEST SECTION. THE SINE AND COSINE OF THE INCIDENCE ANGLES, RATHER THAN THE ANGLES THEMSELVES, ARE COMPUTED IN ORDER TO REDUCE THE RUNNING TIME OF THE PROGRAM. THE INCIDENCE ANGLES CAN BE DETERMINED BY TAKING EITHER THE INVERSE SINE OR COSINE, HENCE, ONLY THE SINE OR COSINE SHOULD BE PRINTED TO OBTAIN THE ANGLES FOR EACH ENGINE. THE INCIDENCE ANGLES INCPCH AND INCYAW ARE THE PITCH AND YAW DEFLECTIONS FOR ALL ENGINES USED TO STATIC TRIM THE VEHICLE, SINCE ALL ENGINES USED TO STATIC TRIM THE VEHICLE ARE DEFLECTED BY THE SAME AMOUNT.

THE OUTPUT VARIABLES FOR THE STATIC TRIM OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
AMYB AMZB	FT-LB (NM)	THE AERODYNAMIC MOMENTS ABOUT THE PITCH AND YAW AXES, RESPECTIVELY. CALCULATED IF NPC(10)=1,2,3.
CIPJ SIPJ J=1,15	N/D	COSINE AND SINE OF THE PITCH INCIDENCE ANGLE OF THE THRUST VECTOR FOR ENGINE J.
CIYJ SIYJ J=1,15	N/D	COSINE AND SINE OF THE YAW INCIDENCE ANGLE OF THE THRUST VECTOR FOR ENGINE J.
DFLP DFLY	DEG	PITCH AND YAW FLAP DEFLECTIONS. CALCULATED IF NPC(9)=2, OR IF NPC(9)=1 AND IENGT(J)=0, J=1,15, AND NPC(10)=1,2,3.

6.A.21. STATIC TRIM INPUTS (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
FMYB FMZB	FT-LB (NM)	THE AERODYNAMIC MOMENTS DUE TO FLAP DEFLECTIONS IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3 AND IF FLAPS ARE BEING USED TO TRIM THE VEHICLE
INCPCH INCYAW	DEG	THRUST INCIDENCE ANGLES IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3.
IPNULL IYNULL	DEG	THE THRUST VECTOR INCIDENCE ANGLES IN PITCH AND YAW REQUIRED TO TRACK THE VEHICLE CENTER-OF-GRAVITY. CALCULATED IF NPC(10) =1,2,3.
TMYB TMZB	FT-LB (NM)	THE THRUST MOMENTS IN PITCH AND YAW DUE TO THE NON-TRIMMING ENGINES. CALCULATED IF NPC(10) =1,2,3.
TTMYB TTMZB	FT-LB (NM)	THE THRUST MOMENTS REQUIRED TO TRIM THE VEHICLE IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3.
XCG YCG ZCG	FT (M)	VEHICLE CENTER-OF-GRAVITY LOCATION ALONG THE XBR, YBR, AND ZBR, RESPECTIVELY. COMPUTED IF NPC(10)=1,2,3.
XREF YREF ZREF	FT (M)	THE AERODYNAMIC REFERENCE (OR CENTER-OF-PRESSURE) LOCATION ALONG THE XBR, YBR, AND ZBR AXES, RESPECTIVELY. CALCULATED IF NPC(10)=1,2,3.

6.A.22. TIME REFERENCE INPUTS

THERE ARE SEVERAL TIME REFERENCES AVAILABLE WHICH ALLOW THE USER TO INITIATE EVENTS OR INPUT TABLE DATA AS FUNCTIONS OF ANY OF THESE TIME REFERENCES.

THE VARIOUS TIMES ARE SUMMARIZED AS-

1) TRAJECTORY TIME (TIME),

2) TIME SINCE THE LAST EVENT (TIMES),

3) TIME SINCE THE LAST PRIMARY EVENT (TDURP), AND

4) FOUR TIMES WHICH CAN BE REFERENCED FROM ANY ARBITRARY POINT (TIMRFJ, J=1,4).

INITIAL VALUES OF TIME AND TIMRFJ CAN BE INPUT. THESE INPUTS ARE CALLED TIME AND TIMRF(J), RESPECTIVELY, AND THE INPUTS ARE MADE VIA NAMELIST GENDAT. THE PHASE TIMES, TIMES AND TDURP, ARE STRICTLY OUTPUT VARIABLES AND CANNOT BE CHANGED BY INPUT. THE FOUR REFERENCE TIMES ARE INTEGRATED WHEN THEIR DERIVATIVES, DTIMR(J), ARE INPUT NONZERO. THESE ARE THE DERIVATIVES OF TIMRFJ WITH RESPECT TO TIME. IF TIMRFJ IS TO BE SECONDS, THE DERIVATIVE DTIMR(J) SHOULD BE INPUT AS 1. IF TIMRFJ IS TO BE MINUTES, THEN DTIMR(J) SHOULD BE INPUT AS 1/60. IF TIMRFJ IS TO BE HOURS, THEN DTIMR(J) SHOULD BE INPUT AS 1/3600, ETC. ANOTHER USE OF TIMRFJ IS THAT OF SIMULATING TIMER ERRORS. IN THIS CASE, DTIMR(J) WOULD BE INPUT DIFFERENT FROM 1. FOR EXAMPLE, A PLUS 2 PERCENT TIMER ERROR FOR REFERENCE TIME 1 WOULD BE SIMULATED BY INPUTTING DTIMR(1)=1.02.

THE INPUTS FOR THE REFERENCE TIMES ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DTIMR(J) J=1,4	SEC	0.	THE DERIVATIVE OF TIME REFERENCE J. THIS INPUT ACTIVATES THE INTEGRATION OF TIMRF(J) WHEN INPUT NONZERO. IT ALSO IS THE DERIVATIVE OF TIMRF(J) WITH RESPECT TO TIME AND SHOULD BE INPUT EQUAL TO 1 EXCEPT WHEN SIMULATING TIMER ERRORS.
TIME	SEC	0.	THE INITIAL VALUE OF TRAJECTORY TIME.

6.A.22. TIME REFERENCE INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
TIMRF(J) J=1,4	SEC	0.	TIME REFERENCE J. THESE TIMES ARE ACTIVATED WHEN THEIR DERIVATIVES ARE INPUT NONZERO. THE DERIVATIVES ARE INPUT AS DTIMR(J). TIMRF(J) ACCUMULATES UNTIL IT IS RESET BY INPUT, OR UNTIL THE DERIVATIVE DTIMR(J) IS INPUT EQUAL TO ZERO.

THE OUTPUTS ASSOCIATED WITH THE TIME REFERENCES ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
TDURP	SEC	THE TIME SINCE THE OCCURRENCE OF THE LAST PRIMARY EVENT.
TIME	SEC	CURRENT TRAJECTORY (PROBLEM) TIME.
TIMES	SEC	THE TIME SINCE THE BEGINNING OF THE CURRENT PHASE.
TIMRFJ J=1,4	SEC	REFERENCE TIMES. THESE WILL BE CALCULATED IF THE DERIVATIVES (DTIMR(J),J=1,4) ARE INPUT GREATER THAN ZERO.

6.A.23. TRACKING STATIONS

THE PROGRAM HAS THE CAPABILITY TO CALCULATE PARAMETERS FOR AS MANY AS 5 TRACKING STATIONS PER PHASE. THE TRACKING STATIONS ARE LOCATED ON THE OBLATE PLANET BY USER INPUT.

THE VARIABLES ASSOCIATED WITH THE TRACKING STATION OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(28)	INTEGER	0	TRACKING STATION OPTION FLAG. = 0, DO NOT USE TRACKING STATION OPTION. = 1, COMPUTE TRACKING PARAMETERS FOR AS MANY AS 5 TRACKING STATIONS AT THE END OF EACH INTEGRATION STEP. THE OUTPUT VARIABLES MUST BE REQUESTED IN THE PRINT ARRAY, PRNT(I). = 2, COMPUTE TRACKING PARAMETERS ONLY AT PHASE CHANGES AND PRINT A TRACKING STATION PRINT BLOCK. = 3, COMPUTE TRACKING PARAMETERS AT THE END OF EACH INTEGRATION STEP AND PRINT A TRACKING STATION PRINT BLOCK WITH EACH REGULAR PRINTOUT.
ELEMIN	DEG	0.0	THE MINIMUM ELEVATION ANGLE (ELEVJ) BELOW WHICH THE PRINTOUT FOR TRACKER J WILL BE SUPPRESSED. USED IF NPC(28) = 2,3.
JTKFLG(I) I=1,5	INTEGER	0.	A FLAG TO INDICATE WHETHER TRACKER I IS TO BE USED. = 0, DO NOT USE TRACKER I. = 1, USE TRACKER I.
TRKGLT(I) I=1,5	DECIMAL	0.	THE GEODETIC LATITUDE OF TRACKER I. MEASURED POSITIVE IF IN THE NORTHERN HEMISPHERE.
TRKHIT(I) I=1,5	DECIMAL	0.	THE HEIGHT OF TRACKER I ABOVE THE OBLATE PLANET.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
TRKLON(I) I=1,5	DECIMAL	0.	THE LONGITUDE OF TRACKER I MEASURED POSITIVE EAST OF THE GREENWICH MERIDIAN.
TRKNAM(I) I=1,5	HOLLERITH	0	THE NAME OF TRACKER I. THIS IS A 10 CHARACTER IDENTIFICATION WHICH IS PRINTED WITH THE TRACKER PRINT BLOCK.

THE OUTPUTS ASSOCIATED WITH THE TRACKING STATION CALCULATIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ELEVI I=1,5	DEG	THE ELEVATION ANGLE OF THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MEASURED POSITIVE ABOVE THE LOCAL HORIZONTAL PLANE AT TRACKER I. CALCULATED IF NPC(28)=1,2,3.
LKAI I=1,5	DEG	LOOK ANGLE A OF TRACKER I. THIS IS THE CONE ANGLE WHICH THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MAKES WITH THE NEGATIVE XB BODY AXIS. CALCULATED IF NPC(28)=1,2,3.
LKBI I=1,5	DEG	LOOK ANGLE B OF TRACKER I. THIS IS THE CLOCK ANGLE WHICH THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MAKES WITH THE POSITIVE ZB BODY AXIS WHEN PROJECTED INTO THE YB,ZB PLANE. THE ANGLE IS MEASURED POSITIVE IN A COUNTER-CLOCKWISE DIRECTION WHEN LOOKING ALONG THE POSITIVE XB BODY AXIS. CALCULATED IF NPC(28) =1,2,3.
SLOS1I SLOS2I SLOS3I I=1,5	DB	THE SPACE LOSS OF TELEMETRY SIGNALS FROM THE VEHICLE TO TRACKER I FOR FREQUENCIES OF 420 MHZ (COMMAND FREQUENCY), 2287.5 MHZ (TELEMETRY FREQUENCY), AND 5765.0 MHZ (TRACKING FREQUENCY). CALCULATED IF NPC(28)=1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
SLTRGI I=1,5	FT (M)	THE SLANT RANGE DISTANCE FROM TRACKER I TO THE VEHICLE. CALCULATED IF NPC(28)=1,2,3.
TKAZMI I=1,5	DEG	THE AZIMUTH OF THE SLANT RANGE VECTOR AT TRACKER I MEASURED CLOCKWISE FROM GEOGRAPHIC NORTH. CALCULATED IF NPC(28)=1,2,3.
TRKHTI I=1,5	FT (M)	THE ALTITUDE OF TRACKER I ABOVE THE OBLATE PLANET.
TRKLNI I=1,5	DEG	THE LONGITUDE OF TRACKER I EAST OF THE PRIME MERIDIAN.
TRKLTI I=1,5	DEG	THE GEODETIC LATITUDE OF TRACKING STATION I.

6.A.24. VEHICLE/PROPELLANT WEIGHT INPUTS

THE GROSS WEIGHT OF THE VEHICLE AT THE BEGINNING OF EACH PHASE CAN BE SPECIFIED AS THE SUM OF THE GROSS WEIGHT WITHOUT PAYLOAD (WGTSG) AND THE PAYLOAD WEIGHT (WPLD). FOR PHASES OTHER THAN THE FIRST, THE GROSS WEIGHT CAN OPTIONALLY BE COMPUTED INTERNALLY BY SUBTRACTING THE INPUT JETTISON WEIGHT (WJETT) AND THE REMAINING PROPELLANT (WPROP), IF DESIRED, FROM THE VEHICLE WEIGHT AT THE END OF THE PREVIOUS PHASE.

THE TWO ABOVE OPTIONS ARE OBTAINED AUTOMATICALLY BASED ON THE PARAMETERS BEING INPUT AS FOLLOWS -

1) IF WGTSG AND WPLD ARE INPUT IN A GIVEN PHASE, THE GROSS WEIGHT FOR THAT PHASE WILL BE THE SUM OF WGTSG AND WPLD.

2) IF WGTSG IS NOT INPUT (OR EQUAL TO ZERO) IN A PHASE OTHER THAN THE FIRST, THEN THE GROSS WEIGHT FOR THAT PHASE WILL BE COMPUTED BY SUBTRACTING THE INPUT JETTISON WEIGHT (WJETT) AND THE REMAINING PROPELLANT (WPROP) BASED ON THE VALUE OF NPC(13).

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(13)	INTEGER	0	PROPELLANT JETTISION OPTION FLAG. = 0, DO NOT JETTISON THE REMAINING PROPELLANT (WPROP). = 1, JETTISON THE REMAINING PROP- ELLANT (WPROP) AT THE BEGINNING OF THE CURRENT PHASE. = 2, SAVE THE AMOUNT OF PROPELLANT REMAINING AT THE END OF THE PREVIOUS PHASE TO BE JETTISONED AT A LATER TIME. = 3, JETTISION THE AMOUNT OF PROPELLANT SAVED BY NPC(13)=2 ABOVE.

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6.A.24. VEHICLE/PROPELLANT WEIGHT INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(17)	INTEGER	0	WEIGHT JETTISON OPTION FLAG BASED FMASST. = 0, NOT USED. = 1, COMPUTE WJETTM USING THE MASS FRACTION TABLE FMASST AS FOLLWS - WJETTM = WPROPI/FMASST - WPROPI = 2, SET WJETT EQUAL TO WJETTM. = 3, SET WJETTM EQUAL TO THE TABLE LOOK-UP OF FMASST.
GO	FT/SEC**2 (M/S**2)	32.174	WEIGHT TO MASS CONVERSION CONSTANT.
PWPROP	LBS (N)	0.	THE VALUE OF THE PROPELLANT CONSUMED BY THE ENGINES SPECIFIED BY IWPF(I) WHEN USING THE SPECIAL PROPELLANT FLOWRATE INTEGRATION OPTION. USED IF NPC(27)=1. THIS INPUT ALLOWS THE USER TO RESET THE VALUE OF PWPROP AT ANY PHASE.
WEICON	LBS (N)	0.	THE INITIAL VALUE OF THE AMOUNT OF PROPELLANT CONSUMED. THIS CAN BE INPUT IN ANY PHASE TO RESET THE AMOUNT OF PROPELLANT CONSUMED.
WGTSG	LBS (N)	0.	THE VEHICLE GROSS WEIGHT (EXCLUDING WPLD) AT THE BEGINNING OF THE PHASE IN WHICH WGTSG IS INPUT. IF WGTSG IS NOT INPUT (OR EQUAL TO ZERO) IN A PHASE OTHER THAN THE FIRST, THE INITIAL WEIGHT WILL BE COMPUTED USING WEIGHT, WJETT, WPLD, AND WPROP BASED ON THE VALUES OF NPC(13) AND NPC(17). IF NPC(5)=1.
WJETT	LBS (N)	0.	THE WEIGHT TO BE JETTISONED AT THE BEGINNING OF THE PHASE IN WHICH WJETT IS INPUT.

6.A.24. VEHICLE/PROPELLANT WEIGHT INPUTS (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
WPLD	LBS (N)	0.	THE PAYLOAD WEIGHT. THIS PARAMETER CAN ONLY BE INPUT IN A PHASE IF WGTSG IS ALSO INPUT FOR THAT PHASE. IN THIS CASE, WGTSG MUST BE INPUT AS THE GROSS WEIGHT WITHOUT ANY PAYLOAD WEIGHT. THE VALUE OF WPLD WILL BE CARRIED OVER FROM ONE PHASE TO THE NEXT UNLESS OVERRIDDEN BY LATER INPUT.
WPROPI	LBS (N)	0.	THE INITIAL WEIGHT OF PROPELLANT. THIS PARAMETER IS NOT USED TO COMPUTE THE GROSS WEIGHT OF THE VEHICLE BUT IS USED ONLY AS AN INDICATOR OF THE AVAILABLE PROPELLANT FOR A GIVEN STAGE SO THAT THE REMAINING PROPELLANT (WPROP) CAN BE COMPUTED FOR USE AS A CRITERIA VARIABLE OR AS PART OF THE WEIGHT TO BE JETTISONED BASED ON THE VALUE OF NPC (13).

THE TABLE INPUTS ASSOCIATED WITH THE VEHICLE/PROPELLANT WEIGHT CALCULATIONS ARE INPUT IN NAMELIST TAB AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
FMASST	DECIMAL	0.	A TABLE WHICH IS USED IN CONJUNCTION WITH NPC(17) TO DETERMINE THE VALUE OF WJETTM AS FOLLOWS - IF NPC(17)=1, COMPUTE WJETTM AS WJETTM = WPROPI/FMASST-WPROPI IF NPC(17)=3, COMPUTE WJETTM AS WJETTM = FMASST

6.A.24. VEHICLE/PROPELLANT WEIGHT INPUTS (CONTD)

THE OUTPUTS ASSOCIATED WITH THE VEHICLE/PROPELLANT WEIGHT PARAMETERS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
DMASS	SLUGS/SEC (KG/S)	RATE OF CHANGE IN VEHICLE MASS.
MASS	SLUGS (KG)	VEHICLE MASS.
PJETTS	LBS (N)	THE PROPELLANT WEIGHT TO BE JETTISONED. CALCULATED INTERNALLY BY THE PROGRAM BASED ON THE VALUE OF NPC(13).
PWDOT	LB/SEC (N/S)	THE FLOWRATE RESULTING FROM THE SUMMATION OF INDIVIDUAL FLOWRATES OF THE ENGINES INCLUDED IN THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
PWPROP	LB (N)	THE PROPELLANT CONSUMED BY THE SPECIFIED ENGINES FOR THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
WDOT	LB/SEC (N/S)	TOTAL WEIGHT FLOWRATE.
WEICON	LBS (N)	THE AMOUNT OF PROPELLANT CONSUMED SINCE IT WAS ZEROED OUT BY INPUT.
WEIGHT	LBS (N)	CURRENT VEHICLE WEIGHT.
WJETTM	LBS (N)	THE JETTISON WEIGHT CALCULATED INTERNALLY BY THE PROGRAM BASED ON THE VALUE OF NPC(17).
WPROP	LBS (N)	WEIGHT OF THE REMAINING PROPELLANT.

6.A.25. VELOCITY LOSSES

THE PROGRAM HAS THE CAPABILITY TO OPTIONALLY COMPUTE THE IDEAL VELOCITY AND THE RELATIVE VELOCITY LOSS TERMS. THESE LOSSES AND THE IDEAL VELOCITY ARE NOT COMPUTED UNLESS NPC(25) IS INPUT NON-ZERO. THE CALCULATION OF THE VELOCITY LOSSES REQUIRES THE INTEGRATION OF FIVE ADDITIONAL DIFFERENTIAL EQUATIONS. AS A CONSEQUENCE, THIS OPTION SUBSTANTIALLY INCREASES THE SINGLE PASS RUN TIME. IN ADDITION, THE INTEGRATION STEP SIZE SHOULD BE KEPT SMALL DURING THE ENTIRE TRAJECTORY IN ORDER TO OBTAIN ACCURATE RESULTS. THE USE OF THE VELOCITY LOSS OPTION ALSO REQUIRES THAT NPC(9) BE INPUT NON ZERO SINCE THE VELOCITY LOSSES ARE USUALLY ASSOCIATED WITH EXPENDITURE OF ENERGY VIA THRUSTING.

THE FOLLOWING VARIABLES ASSOCIATED WITH THE VELOCITY LOSS OPTIONS ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(25)	INTEGER	0	VELOCITY LOSS CALCULATION FLAG. = 0, DO NOT CALCULATE VELOCITY LOSSES. = 1, CALCULATE THE IDEAL VELOCITY (VIDEAL), THE RELATIVE DRAG LOSS (DLR), THE RELATIVE THRUST VECTORING LOSS (TVLR), THE ATMOSPHERIC THRUST LOSS (ATL), AND THE RELATIVE GRAVITY LOSS (GLR) BUT DO NOT PRINT THE VELOCITY LOSS BLOCK. = 2, SAME AS WHEN NPC(25)=1, EXCEPT PRINT THE VELOCITY LOSS BLOCK ONLY AT PHASE CHANGES. = 3, SAME AS WHEN NPC(25)=1, EXCEPT PRINT THE VELOCITY LOSS BLOCK AT EACH PRINT TIME.

THE OUTPUT VARIABLES ASSOCIATED WITH THE VELOCITY LOSS OPTIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ATL	FT/SEC (M/S)	THE VALUE OF THE ATMOSPHERIC THRUST LOSS TERM. COMPUTED IF NPC(25)=1,2,3.

6.A.25. VELOCITY LOSSES (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
DLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL AERODYNAMIC DRAG LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
DLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE AERODYNAMIC DRAG LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
GLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL GRAVITY LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
GLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE GRAVITY LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
TVLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL THRUST VECTORING LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
TVLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE THRUST VECTORING LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
VIDEAL	FT/SEC (M/S)	THE TOTAL IDEAL VELOCITY. COMPUTED IF NPC(25) =1,2,3.

6.A.26. VELOCITY MARGIN CALCULATIONS

THE PROGRAM CAN OPTIONALLY COMPUTE THE AMOUNT OF VELOCITY MARGIN AVAILABLE AND THE AMOUNT REQUIRED BASED ON A PERCENTAGE OF THE IDEAL VELOCITY. SINCE THE IDEAL VELOCITY IS REQUIRED IF NPC(23)=2 IS REQUESTED, NPC(25) MUST ALSO BE INPUT NONZERO EXCEPT FOR THOSE PHASES THAT ARE NOT TO BE INCLUDED IN THE VELOCITY MARGIN CALCULATIONS, IN WHICH CASE NPC(25) SHOULD BE INPUT AS ZERO.

THERE ARE SEVERAL POSSIBLE WAYS IN WHICH THE VELOCITY MARGIN CALCULATIONS CAN BE MADE BASED ON THE VALUE OF NEWSTG AND NPC(23). NEWSTG CONTROLS THE INTIALIZATION FOR THE VELOCITY MARGIN CALCULATIONS AND CAN BE USED REPEATEDLY DURING A GIVEN RUN. NPC(23) CONTROLS THE CALCULATION OF THE ACTUAL VELOCITY MARGIN AND THE EXCESS VELOCITY MARGIN. NPC(23) CAN ALSO BE CHANGED REPEATEDLY FROM ONE VALUE TO ANOTHER DURING A RUN.

THE VARIABLE NEWSTG SAVES THE VALUE OF VIDEAL AS SIDEAL AT THE BEGINNING OF THE PHASE IN WHICH IT IS INPUT AS A POSITIVE INTEGER. IN ADDITION, THE SUM SQUARED VALUE OF THE GROUPED IDEAL VELOCITY IS SAVED AS THE VARIABLE SSVIDL BASED ON THE VALUE OF NEWSTG AS FOLLOWS -

```
  1) NEWSTG = 1,    SSVIDL = SSVIDL + (VIDEAL - SIDEAL)**2

  2) NEWSTG = 2,    SSVIDL = 0.0

  3) NEWSTG = 3,    SSVIDL = DVMARR**2

  4) NEWSTG = 4,    SSVIDL = DVEXS**2 IF DVEXS .GT. 0.0
                           = 0.0      IF DVEXS .LE. 0.0
```

THE CURRENT AVAILABLE VELOCITY MARGIN IS COMPUTED AS FOLLOWS IF NPC(23) IS INPUT AS A POSITIVE INTEGER -

```
        DVMAR = GO*ISPV(1)*ALOG(WEIGHT/(WEIGHT-WPROP))
```

THE EXCESS VELOCITY MARGIN (DVEXS) IS COMPUTED SEVERAL WAYS DEPENDING ON THE VALUE OF NPC(23) AS FOLLOWS -

```
  1) NPC(23) = 1,   INPUT DVMARR (OR USE CURRENT VALUE) AND COMPUTE

        DVEXS = DVMAR - DVMARR

  2) NPC(23) = 2,   INPUT DVPCT AND COMPUTE

        DVMARR = DVPCT*SQRT(SSVIDL+(VIDEAL-SIDEAL)**2)

        DVEXS = DVMAR - DVMARR
```

6.A.26. VELOCITY MARGIN CALCULATIONS (CONTD)

3) NPC(23) = 3, INPUT DVMARR (OR USE CURRENT VALUE) AND COMPUTE

DVEXS = DVMAR - SQRT(SSVIDL+DVMARR**2)

THE FOLLOWING VARIABLES ASSOCIATED WITH THE VELOCITY MARGIN OPTIONS ARE INPUT IN NAMELIST GENDAT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(23)	INTEGER	0	FLAG WHICH CONTROLS VELOCITY MARGIN CALCULATIONS. = 0, DO NOT COMPUTE VELOCITY MARGIN. =1,2,3,4, CALCULATE VELOCITY MARGIN AS DESCRIBED ABOVE.
DVMARR	FT/SEC (M/S)	0.0	THE DELTA VELOCITY MARGIN REQUIRED. USED IF NPC(23)=1,3.
DVPCT	DECIMAL	0.	THE DECIMAL PERCENTAGE OF THE ROOT-SUM-SQUARE OF THE IDEAL VELOCITIES OF THE VARIOUS STAGE TO BE USED IN COMPUTING THE REQUIRED MARGIN WHEN NPC(23)=2.
GO	FT/SEC**2 (M/S2)	32.174	THE WEIGHT TO MASS CONVERSION CONSTANT USED IN COMPUTING DVMAR WHEN NPC(23)=1,2,3.
ISPV(1)	SEC	0.	THE SPECIFIC IMPULSE TO BE USED WHEN COMPUTING THE AVAILABLE VELOCITY MARGIN. USED IF NPC(23)=1,2,3.
NEWSTG	INTEGER	0	A FLAG TO INDICATE THE BEGINNING OF A NEW STAGE WHEN CALCULATING THE VELOCITY MARGIN. = 0, NOT THE BEGINNING OF A NEW STAGE. =1,2,3,4, SAVE SSVIDL AND SIDEAL AS DESCRIBED ABOVE.

6.A.26. VELOCITY MARGIN CALCULATIONS (CONTD)

THE OUTPUT VARIABLES ASSOCIATED WITH THE VELOCITY MARGIN OPTIONS ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
DVEXS	FT/SEC (M/S)	THE EXCESS VELOCITY MARGIN. WHEN DVEXS EQUALS ZERO, THE AMOUNT OF VELOCITY MARGIN AVAILABLE EQUALS THE REQUIRED VELOCITY MARGIN BASED ON THE VALUE OF NPC(23).
DVMAR	FT/SEC (M/S)	THE AVAILABLE VELOCITY MARGIN BASED ON ISPV(1) AND THE REMAINING PROPELLANT (WPROP). CALCULATED IF NPC(23)=1,2,3.
DVMARR	FT/SEC (M/S)	THE REQUIRED VELOCITY MARGIN. THIS IS EITHER THE CURRENT INPUT VALUE OR CALCULATED VALUE BASED ON THE VALUE OF NPC(23).

6.A.27. WEIGHT CALCULATION OPTION

THE PROGRAM CAN OPTIONALLY COMPUTE THE WEIGHT OR THE RATE OF CHANGE OF WEIGHT THROUGH A WEIGHT CALCULATION OPTION THAT ALLOWS THE WEIGHT AND FLOW RATE TO BE SPECIFIED AS A SUM OF TWO TABLES. THIS OPTION CAN BE USED TO SIMULATE ABLATION DURING ASCENT OR REENTRY.

THE FOLLOWING VARIABLES ASSOCIATED WITH THE WEIGHT CALCULATION OPTION ARE INPUT IN NAMELIST GENDAT -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(30)	INTEGER	0	A FLAG TO SPECIFY THE WEIGHT CALCULATION OPTION TO BE USED. = 0, DO NOT USE WEIGHT CALCULATION OPTION. = 1, CALCULATE WEIGHT AS THE SUM OF TABLES WGT1T AND WGT2T. WEIGHT = WGT1T + WGT2T = 2, CALCULATE FLOW RATE AS THE SUM OF TABLES WGTD1T AND WGTD2T. WDOT = WGTD1T + WGTD2T

THE TABLES FOR THIS MODEL ARE INPUT IN NAMELIST TAB AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
WGTJT J=1,2	LBS (N)	0.	TABLES USED TO COMPUTE WEIGHT WHEN NPC(30)=1.
WGTDJT J=1,2	LB/SEC (N/S)	0.	TABLES USED TO COMPUTE FLOW RATE WHEN NPC(30)=2.

6.A.28. SUN-SHADOW AND SUN ANGLE OPTION

THE PROGRAM HAS THE CAPABILITY TO CALCULATE THE SUN UNIT VECTOR WITH RESPECT TO THE EARTH CENTERED INERTIAL (ECI) SYSTEM BY USING THE GREENWICH HOUR ANGLE (GHA), THE GREENWICH HOUR ANGLE OF THE SUN (GHAS), THE DECLINATION OF THE SUN (DECL), AND THE TIME OF REFERENCE (LAUNCH) PAST MIDNIGHT (TRPM). THESE VARIABLES ARE USED TO CALCULATE THE SUN-VEHICLE ORIENTATION ANGLES, THE SUN-SHADOW CONDITION, AND THE VEHICLE STATE VECTOR IN THE VERNAL EQUINOX (VE) COORDINATE SYSTEM. THE VERNAL EQUINOX SYSTEM (XVE,YVE,ZVE) IS DEFINED SUCH THAT XVE LIES IN THE EQUATORIAL PLANE AND POINTS TOWARD THE VERNAL EQUINOX (FIRST POINT OF ARIES), ZVE POINTS TOWARD THE NORTH POLE, AND YVE COMPLETES A RIGHT-HAND SYSTEM. THE GREENWICH HOUR ANGLE, THE RIGHT ASCENSION AND DECLINATION OF THE SUN REMAIN CONSTANT DURING THE SIMULATION.

THE VEHICLE POSITION AND VELOCITY VECTORS ARE GIVEN BY -

```
XVE = C(ANG)*XI - S(ANG)*YI
YVE = S(ANG)*XI + C(ANG)*YI
ZVE = ZI

VXVE = C(ANG)*VXI - S(ANG)*VYI
VYVE = S(ANG)*VXI + C(ANG)*VYI
VZVE = VZI

WHERE -
        ANG = GHA + OMEGA*TRPM
        C(ANG) = COS(ANG)
        S(ANG) = SIN(ANG)
```

THE SUN UNIT VECTOR IN THE VE SYSTEM IS GIVEN BY -

```
XSVE = C(DECL)*C(RAS)
YSVE = C(DECL)*S(RAS)
ZSVE = S(DECL)

WHERE -
        RAS = GHA + GHAS
```

THE SUN UNIT VECTOR IN THE ECI SYSTEM IS THEN -

```
XSI =  C(ANG)*XSVE + S(ANG)*YSVE
YSI = -S(ANG)*XSVE + C(ANG)*YSVE
ZSI =  ZSVE
```

6.A.28. SUN-SHADOW AND SUN ANGLE OPTION (CONTD)

THE INPUTS ASSOCIATED WITH THIS OPTION ARE MADE VIA NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(31)	INTEGER	0	A FLAG TO ACTIVATE THE VERNAL EQUINOX, SUN-SHADOW AND SUN ANGLE OPTION. = 0, DO NOT ACTIVATE THIS OPTION. = 1, ACTIVATE THIS OPTION.
DATE(I) I=1,3	DECIMAL	1HU	THE DATE (MONTH,DAY,YEAR) FOR WHICH THE ZERO HOUR (MIDNIGHT) VALUES OF GHA, RAS, AND DECL ARE DESIRED. IF DATE IS NOT INPUT (OR IS INPUT AS 1HU) THE INPUT VALUES OF GHA, GHAS, AND DECL WILL BE USED.
DECL	DEG	0.	THE DECLINATION OF THE SUN. (OBTAINABLE FROM AN EPHEMERIS TABLE)
GHA	DEG	0.	THE GREENWICH HOUR ANGLE. THE ANGLE BETWEEN THE VERNAL EQUINOX AND THE GREENWICH MERIDIAN AT MIDNIGHT ON THE DAY OF LAUNCH. (OBTAINABLE FROM AN EPHEMERIS TABLE)
GHAS	DEG	180.	THE GREENWICH HOUR ANGLE OF THE SUN. GHAS IS THE ANGLE BETWEEN THE GREENWICH MERIDIAN AT MID-NIGHT AND THE SUN ON THE DAY OF LAUNCH.
TRPM	SEC	0.	THE TIME OF REFERENCE PAST MID-NIGHT. THIS IS USUALLY THE LAUNCH TIME FOR ASCENT PROBLEMS OR THE TIME OF EPOCH FOR REND-EZVOUS PROBLEMS.

THE PROGRAM COMPUTES THE CONE AND CLOCK ANGLES OF THE SUN VECTOR WITH RESPECT TO THE VEHICLE BODY SYSTEM. THESE ANGLES ARE ANALAGOUS TO THE LOOK ANGLES OBTAINED FROM THE TRACKER PRINTOUT.

```
SCONE = ACOS(VDOT(XB,XSI))
SCLOCK = ATAN3(YSB,ZSB)

WHERE -
        XSB = MATRIX(IB) * VECTOR(XSI)
```

THE PROGRAM ALSO COMPUTES A SHADOW FUNCTION (SHADF) ASSUMING A CYLINDRICAL SHADOW. IF SHADF IS LESS THAN ZERO, THE VEHICLE IS IN THE EARTHS SHADOW. IF SHADF IS GREATER THAN OR EQUAL TO ZERO, THE VEHICLE IS IN THE SUNLIGHT. THE CONDITIONS AT SHADOW ENTRY OR EXIT CAN BE OBTAINED BY CAUSING AN EVENT TO OCCUR WHEN SHADF = 0. THE SHADOW FUNCTION IS COMPUTED AS -

```
SHADF = AM - (RE+RP)/2, IF VDOT(XI,XSI) IS LT 0.
OR
SHADF =-AM + (RE+RP)/2, IF VDOT(XI,XSI) IS GE 0.

WHERE -
        AM = SQRT(VDOT(A,A))
        A(I) = XI(I) - X(I), I=1,3
        X(I) = VDOT(XI,XSI)*XSI(I), I=1,3
```

THE VEHICLE IS ENTERING THE SHADOW IF THE SLOPE OF SHADF IS NEGATIVE, AND IS EXITING THE SHADOW IF THE SLOPE OF SHADF IS POSITIVE.

THE OUTPUTS FOR THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
LANVE	DEG	THE LONGITUDE OF THE ASCENDING NODE WITH RESPECT TO THE VERNAL EQUINOX. THIS VARIABLE IS COMPUTED ONLY IF NPC(1) AND NPC(31) ARE BOTH INPUT NON-ZERO.
RAS	DEG	THE RIGHT ASCENSION OF THE SUN WITH RESPECT TO THE VERNAL EQUINOX SYSTEM XVE AXIS.

6.A.28. SUN-SHADOW AND SUN ANGLE OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
SCLOCK	DEG	THE CLOCK ANGLE OF THE SUN VECTOR WITH RESPECT TO THE ZB AXIS, MEASURED POSITIVE TOWARD THE YB AXIS.
SCONE	DEG	THE CONE ANGLE BETWEEN THE SUN VECTOR AND THE POSITIVE XB AXIS.
SHADF	FT	THE SHADOW FUNCTION. IF SHADF .LT. 0, THEN THE VEHICLE IS IN THE SHADOW. IF SHADF .GE. 0, THEN THE VEHICLE IS IN THE SUNLIGHT.
VXVE VYVE VZVE	FT/SEC	THE VEHICLE VELOCITY VECTOR IN THE VERNAL EQUINOX SYSTEM.
XSI YSI ZSI	N/D	THE SUN UNIT VECTOR IN THE ECI SYSTEM.
XVE YVE ZVE	FT	THE VEHICLE POSITION VECTOR IN THE VERNAL EQUINOX SYSTEM.

6.A.29. PARACHUTE DRAG OPTION

THE PROGRAM HAS THE CAPABILITY TO SIMULATE THE INFLATION OF AS MANY AS 3 PARACHUTES IN ANY GIVEN PHASE. THE INFLATION IS SIMULATED BY CALCULATING THE RATE OF INFLATION WHICH IS THEN INTEGRATED TO PRODUCE THE CURRENT PARACHUTE DIAMETER. THE INCREASE IN THE TOTAL DRAG IS THEN CALCULATE BY SUMMING THE DRAG CONTRIBUTIONS FOR EACH PARACHUTE.

THE RATE OF INFLATION FOR EACH PARACHUTE IS CALCULATED AS FOLLOWS -

DIARP(I) = VELAP/PARIF(I)

WHERE - VELAP IS EITHER THE ATMOSPHERIC RELATIVE VELOCITY (VELA) AT THE START OF THE CURRENT PHASE OR THE CURRENT VALUE OF VELA DEPENDING ON THE VALUE OF NPC(32).

- PARIF(I) IS THE PARACHUTE INFLATION FACTOR FOR PARACHUTE I.

THE DRAG FOR EACH PARACHUTE IS CALCULATED AS FOLLOWS -

DRAGP(I) = DYNP*(PI/FP4)*CDP(I)*DIAMP(I)**2

WHERE - DYNP IS THE DYNAMIC PRESSURE,

- CDP(I) IS THE DRAG COEFFICIENT FOR PARACHUTE I,

- DIAMP(I) IS THE CURRENT DIAMETER OF PARACHUTE I.

THIS OPTION CAN BE USED TO SIMULATE SEVERAL DIFFERENT PARACHUTE DEPLOYMENT SEQUENCES. SOME OF THE POSSIBLE SEQUENCES ARE -

1) INFLATE ALL THREE PARACHUTES SIMULTANEOUSLY WITH EACH PARACHUTE HAVING USER SPECIFIED INFLATION FACTORS AND DRAG COEFFICIENT TABLES. ROVING EVENTS CAN BE USED TO TERMINATE THE INFLATION OF EACH PARACHUTE WHEN THE SPECIFIED DIAMETER HAS BEEN REACHED. PARACHUTE INFLATION IS TERMINATED BY SPECIFYING PARIF(I)=0, IN NAMELIST GENDAT.

2) INFLATE THE PARACHUTES SEQUENTIALLY. THE PARACHUTE INFLATION CAN BE TERMINATED FOR EACH CHUTE BY SPECIFYING THE PARACHUTE DRAG LEVEL. THE DRAG LEVELS FOR THE PARACHUTES CAN BE SPECIFIED AS A CONSTANT VALUE OR AS A SPECIFIED PERCENTAGE OF THE PARACHUTE DRAG LEVEL AT A PREVIOUS PHASE BY USING THE VARIABLES DRGPSJ AND DRAGPJ.

6.A.29. PARACHUTE DRAG OPTION (CONTD)

THE CONSTANT VALUED INPUT VARIABLES FOR THIS MODULE ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(32)	INTEGER	0	THE PARACHUTE DRAG OPTION FLAG. = 0, DO NOT COMPUTE PARACHUTE DRAG. = 1, COMPUTE PARACHUTE DRAG WITH VELAP = VELA AT THE BEGINNING OF THE CURRENT PHASE. = 2, COMPUTE PARACHUTE DRAG WITH VELAP = CURRENT VALUE OF VELA.
DRGPK(I) I=1,3	DECIMAL	0.0	THE SCALE FACTOR APPLIED TO DRAGP(I) TO YIELD DRGPP(I).
IDRGP(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE VALUE OF DRGPP(I) AT THE BEGINNING OF THE CURRENT PHASE IS TO BE SAVED AS THE VARIABLE DRGPS(I). = 0, DO NOT COMPUTE DRGPS(I). = 1, COMPUTE DRGPS(I) = DRGPP(I).
PARIF(I) I=1,3	DECIMAL	0.0	THE PARACHUTE INFLATION FACTOR FOR PARACHUTE I. IF PARIF(I) = 0.0, THEN DIARP(I) = 0.0.

THE TABLES FOR THIS MODEL ARE INPUT IN NAMELIST TAB AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CDPIT I=1,3	N/D	0.0	THE DRAG COEFFICIENT TABLE FOR PARACHUTE I.

THE OUTPUT VARIABLES FOR THIS MODULE ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
CDPJ J=1,3	N/D	THE DRAG COEFFICIENT FOR PARACHUTE J.

6.A.29. PARACHUTE DRAG OPTION (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
DIAMPJ J=1,3	FT (M)	THE CURRENT DIAMETER OF PARACHUTE J.
DIARPJ J=1,3	FT/SEC (M/SEC)	THE CURRENT INFLATION RATE OF PARACHUTE J.
DRAGPJ J=1,3	LBS (N)	THE CURRENT DRAG FORCE DUE TO PARACHUTE J.
DRAGPT	LBS (N)	THE TOTAL DRAG RESULTING FROM ALL PARACHUTES.
DRGPPJ J=1,3	LBS (N)	THE VALUE OF DRAGPJ SCALED BY THE INPUT VALUE OF DRGPK(J).
DRGPSJ J=1,3	LBS (N)	THE SAVED VALUE OF DRGPPJ AT THE BEGINNING OF THE PHASE IN WHICH IDRGP(J) IS INPUT AS 1.
FAXBPJ J=1,3	LBS (N)	THE COMPONENTS OF DRAGPT ALONG THE VEHICLE BODY AXES.
VELAP	FT/SEC (M/SEC)	THE VALUE OF VELA USED TO COMPUTE THE PARACHUTE INFLATION RATE. SEE NPC(32).

6.B. METHODS OF GUIDANCE (STEERING)

THE GUIDANCE (STEERING) OPTIONS CONTROL THE ATTITUDE OF THE VEHICLE DURING THE TRAJECTORY SIMULATION. THE GENERAL TYPES OF STEERING OPTIONS THAT ARE AVAILABLE ARE -

1) BODY RATES
2) AERODYNAMIC ANGLES
3) INERTIAL EULER ANGLES
4) RELATIVE EULER ANGLES.
5) INERTIAL AERODYNAMIC ANGLES.

THE BODY RATES ARE COMPUTED FROM -

1) QUADRATIC POLYNOMIALS.

THE AERODYNAMIC ANGLES, THE INERTIAL EULER ANGLES, AND THE RELATIVE EULER ANGLES ARE COMPUTED FROM -

1) CUBIC POLYNOMIALS
2) TABLES
3) PIECEWISE LINEAR FUNCTIONS
4) CLOSED LOOP LINEAR FEEDBACK

THE VARIABLES WHICH SELECT THE GUIDANCE OPTION ARE INPUT IN NAME-LIST GENDAT, AND ARE CARRIED OVER FROM PHASE TO PHASE UNLESS THEY ARE OVERRIDDEN BY LATER INPUT. THE VARIABLES USED IN THE ATTITUDE CALCULATIONS (E.G., POLYNOMIAL COEFFICIENTS, ETC.) CAN BE INPUT IN EITHER NAMELIST GENDAT OR USED AS INDEPENDENT VARIABLES IN NAMELIST SEARCH. IF CORRESPONDING DATA ARE INPUT IN BOTH OF THESE NAMELISTS, THEN THE NAMELIST SEARCH INPUT OVERRIDES THE NAMELIST GENDAT INPUT.

IN GENERAL, THE DIRECT ANGLE VALUE OPTIONS REQUIRE LESS COMPUTATIONAL EFFORT. THIS IS BECAUSE THE INERTIAL BODY RATE OPTIONS REQUIRE THE NUMERICAL INTEGRATION OF THE QUATERNION RATE EQUATIONS. THUS, STEERING WITH ANGLES IS RECOMMENDED WHENEVER PRACTICAL.

6.B.1. BODY RATES

THIS OPTION, WHICH IS GENERALLY USED TO SIMULATE STRAP-DOWN TYPE SYSTEMS, CALCULATES THE VEHICLE BODY ATTITUDE BY INTEGRATING THE QUATERNION RATE EQUATIONS. THE RESULTING QUATERNION ELEMENTS ARE THEN USED TO DEFINE THE TRANSFORMATION MATRIX BETWEEN THE INERTIAL L-FRAME AND THE BODY FRAME.

THE INERTIAL BODY RATES ARE DEFINED AS -

ROLBD - ROLL BODY RATE. THE ANGULAR RATE ABOUT THE XB-AXIS IN DEG/SEC.
YAWBD - YAW BODY RATE. THE ANGULAR RATE ABOUT THE ZB-AXIS IN DEG/SEC.
PITBD - PITCH BODY RATE. THE ANGULAR RATE ABOUT THE YB-AXIS IN DEG/SEC.

THERE ARE TEN(10) OPTIONS FOR COMPUTING THESE RATES, AND TWO(2) OPTIONS FOR INITIALIZING THE ATTITUDE OF THE VEHICLE. THESE OPTIONS ARE DEFINED BY IGUID(5) AND IGUID(12), RESPECTIVELY. UTILIZATION OF THIS OPTION ALSO REQUIRES THE SPECIFICATION OF THE L-FRAME (SEE THE SECTION ON COORDINATE SYSTEMS) .

THE INPUT PROCEDURE FOR USING THIS OPTION IS -

1) INPUT IGUID(1)=-1.
2) INPUT IGUID(5)= TO THE DESIRED VALUE.
3) INPUT IGUID(12) = TO THE DESIRED VALUE.
4) INPUT VALUES FOR LONL, LATL, AND AZL.
5) INPUT THE POLYNOMIAL ARGUMENTS.
6) INPUT THE POLYNOMIAL COEFFICIENTS.

ALL INPUT VARIABLES ASSOCIATED WITH BODY RATES ARE INPUT IN NAMELIST GENDAT. THESE INPUT VARIABLES ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(1)	INTEGER	0	TYPE OF GUIDANCE (STEERING) DESIRED. = -1,INERTIAL BODY RATE POLYNOMIALS. ALSO INPUT VALUES FOR IGUID(5) AND IGUID(12).

6.B.1. BODY RATES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(5)	INTEGER	1	AERODYNAMIC ANGLE RATE/INERTIAL BODY RATE COMBINATIONS FLAG. = 1, ROLBD, PITBD, AND YAWBD POLYNOMIALS. = 2, BNKDOT, PITBD, AND YAWBD POLYNOMIALS. = 3, ROLBD, ALPDOT, AND YAWBD POLYNOMIALS. = 4, ROLBD, PITBD, AND BETDOT POLYNOMIALS. = 5, BNKDOT, ALPDOT, AND YAWBD POLYNOMIALS. = 6, ROLBD, ALPDOT, AND BETDOT POLYNOMIALS. = 7, BNKDOT, PITBD, AND BETDOT POLYNOMIALS. = 8, ALPDOT, BETDOT, AND BNKDOT POLYNOMIALS. = 9, YAWRD, PITRD, AND ROLRD POLYNOMIALS. = 10, ROLBD AND YAWBD POLYNOMIALS WITH ALPDOT COMPUTED TO DRIVE ALPHA FROM ITS CURRENT VALUE TO THE VALUE INPUT AS DALPHA AT THE BEGINNING OF THE NEXT PRIMARY PHASE. THIS ALLOWS THE USER TO DRIVE ALPHA TO A DESIRED VALUE AND STILL STAY IN THE SAME INERTIAL PITCH PLANE.
IGUID(12)	INTEGER	2	INERTIAL BODY RATE INITIALIZATION FLAG. = 1, INITIALIZE BODY RATES USING ALPHA, BETA, AND BNKANG. = 2, INITIALIZE BODY RATES USING ROLI, YAWI, AND PITI.
ALPARG BETARG BNKARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ANGLE OF ATTACK, SIDESLIP AND BANK. USED IF IGUID(1)=-1 OR 0.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALPPC(I) BETPC(I) BNKPC(I) I=1,4	DECIMAL	0.	ANGLE OF ATTACK (ALPHA), SIDESLIP (BETA), AND BANK (BNKANG) POLYNOMIAL COEFFICIENTS, RESPECTIVELY, WHERE 1= CONSTANT TERM, 2= LINEAR (RATE) TERM, 3= QUADRATIC TERM, AND 4= CUBIC TERM. USED IF IGUID(1)=-1 OR 0.
AZL	DEG	0.	THE AZIMUTH OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM MEASURED CLOCKWISE FROM NORTH.
LATL	DEG	GDLAT	LATITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM. THIS CAN BE INPUT AS EITHER GEODETIC OR GEOCENTRIC LATITUDE. IF GEODETIC LAT ITUDE IS INPUT, THE L FRAME BECOMES A PLUMB LINE SYSTEM. IF LATL IS NOT INPUT, IT IS SET EQUAL TO GDLAT.
LONL	DEG	LONGI	INERTIAL EAST LONGITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM. IF LONL IS NOT INPUT, IT IS SET EQUAL TO LONGI.
ROLARG PITARG YAWARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ROLL, PITCH, AND YAW. USED IF IGUID(1)=-1,1,2.
ROLI YAWI PITI	DEG	0.	THE INITIAL VALUES OF THE INERTIAL EULER ATTITUDE ANGLES OF THE VEHICLE WITH RESPECT TO THE LAUNCH PAD (L) COORDINATE SYSTEM. USED IF IGUID(1) =-1 AND IGUID(12)=2 OR IF IGUID(1) =1 AND IGUID(4)=3 OR IGUID(9), IGUID(10), AND IGUID(11)=3.
ROLPC(I) PITPC(I) YAWPC(I) I=1,4	DECIMAL	0.	ROLL, PITCH, AND YAW ANGLE POLYNOMIAL COEFFICIENTS, RESPECTIVELY. USED IF IGUID(1)=-1,1 OR 2.

6.B.1. BODY RATES (CONTD)

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ALPDOT BETDOT BNKDOT	DEG/SEC	RATE OF CHANGE IN ANGLE OF ATTACK, SIDESLIP, AND BANK.
DEJ J=0,3	N/D	RATE OF CHANGE IN THE QUATERNIONS. CALCULATED IF IGUID(1)=-1.
EJ J=0,3	N/D	THE VALUES OF THE QUATERNIONS. CALCULATED IF IGUID(1)=-1.
ROLBD PITBD YAWBD	DEG/SEC	VEHICLE BODY RATES WITH RESPECT TO THE LAUNCH PAD INERTIAL (L) COORDINATE SYSTEM. CALCULATED IF IGUID(1)=-1.

6.B.2. AERODYNAMIC ANGLES

THIS OPTION, WHICH IS GENERALLY USED FOR REENTRY SIMULATIONS, DEFINES THE ATTITUDE OF THE VEHICLE WITH RESPECT TO THE ATMOSPHERIC RELATIVE VELOCITY VECTOR.

THE AERODYNAMIC ANGLES ARE DEFINED AS -

ALPHA - ANGLE OF ATTACK. POSITIVE ALPHA IS NOSE UP (ABOVE THE ATMOSPHERIC RELATIVE VELOCITY VECTOR) WHEN FLYING THE VEHICLE UPRIGHT (BANK ANGLE BETWEEN -90 DEG AND +90 DEG).

BETA - ANGLE OF SIDESLIP. POSITIVE BETA IS NOSE LEFT WHEN FLYING THE VEHICLE UPRIGHT.

BNKANG - BANK ANGLE. POSITIVE BNKANG IS A BANK TO THE RIGHT WHEN FLYING THE VEHICLE UPRIGHT.

THERE ARE SEVERAL GENERAL FUNCTIONAL RELATIONSHIPS THAT CAN BE USED TO COMPUTE THESE ANGLES. THE PARTICULAR INPUTS VARIABLES FOR EACH OF THESE OPTIONS ARE DESCRIBED BELOW.

POLYNOMIALS

WHEN THIS OPTION IS USED, THE ANGLES ARE COMPUTED FROM A CUBIC POLYNOMIAL, E.G.,

```
ALPHA = SUM ( ALPPC(I)*ALPARG**(I-1) ),
        I=1,4
```

WHERE THE POLYNOMIAL COEFFICIENTS AND THE POLYNOMIAL ARGUMENTS ARE SPECIFIED BY USER INPUT. THUS, THE INPUT PROCEDURE FOR USING THIS OPTION IS -

1) INPUT IGUID(1)=0.
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(3)= 0 OR 1 , OR IGUID(6), IGUID(7), AND IGUID(8) = 0 OR 1.
4) INPUT THE HOLLERITH NAME OF THE POLYNOMIAL ARGUMENTS, ALPARG, BETARG, AND BNKARG. FOR EXAMPLE, IF IT IS DESIRED THAT THE ARGUMENT OF THE ANGLE OF ATTACK POLYNOMIAL BE MACH NUMBER, THEN THE REQUIRED NAMELIST GENDAT INPUT WOULD BE

   ```
   ALPARG = 4HMACH,
   ```

6.B.2. AERODYNAMIC ANGLES (CONTD)

5) INPUT THE DESIRED VALUES FOR THE COEFFICIENTS, ALPPC(I), BETPC(I), AND BNKPC(I). THE STORED VALUES OF THESE COEFFICIENTS IS ZERO. THUS, THE HIGHEST ORDER COEFFICIENT THAT IS INPUT DETERMINES THE ORDER OF THE POLYNOMIAL.

TABLES

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM TABLE INTERPOLATION, E.G.,

ALPHA = ALPHAM*ALPHAT ,

WHERE THE TABLE MULTIPLIER IS INPUT IN NAMELIST TBLMLT, AND THE TABLE IS INPUT IN NAMELIST TAB. THIS OPTION IS GENERAL BECAUSE THESE TABLES CAN BE MONOVARIANT, BIVARIANT, OR TRIVARIANT FUNCTIONS OF ANY INTERNALLY COMPUTED VARIABLES (SEE SECTION ON TABLE INPUTS).

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=0,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(3)=2, OR IGUID(6), IGUID(7), OR IGUID(8) = 2.
4) INPUT THE VALUE OF THE TABLE MULTIPLIER IN NAMELIST TBLMLT.

PIECEWISE LINEAR FUNCTIONS

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A GENERAL PIECEWISE LINEAR FUNCTION, E.G.,

ALPHA = A1 + ((A2 - A1)/(C2 - C1))*(C - C1) ,

WHERE

A1 = ALPHA AT THE BEGINNING OF THE CURRENT PHASE. THIS CAN BE EITHER INPUT OR CARRIED ACROSS THE EVENT.
A2 = THE DESIRED VALUE OF ALPHA, INPUT AS DALPHA, AT THE EVENT SPECIFIED BY DESN(1).
C1 = THE VALUE OF VARIABLE NAMED CRITR IN EVENT = DESN(1) AT THE BEGINNING OF THE CURRENT EVENT.
C2 = THE DESIRED VALUE OF CRITR AT EVENT = DESN(1).
C = THE CURRENT VALUE OF THE VARIABLE NAMED CRITR IN EVENT = DESN(1).

CLEARY, IF THE VARIABLE CRITR IS NONLINEAR IN TIME, THEN ALTHOUGH THE STEERING ANGLES ARE LINEAR IN CRITR, THEY ARE NONLINEAR IN TIME.

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=0.
2) INPUT IGUID(2) = TO THE DESIRED VALUE.
3) INPUT IGUID(3)=3, OR IGUID(6), IGUID(7), OR IGUID(8) = 3.
4) INPUT THE DESIRED VALUES DALPHA, DBETA, AND DBANK.
5) INPUT THE DESN(I) = TO THE DESIRED VALUES IF THEY ARE DIFFERENT FROM THE NEXT PRIMARY, NONROVING EVENT.

LINEAR FEEDBACK

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A LINEAR ERROR, ERROR RATE FEEDBACK STEERING LAW, E.G.,

ALPHA = A1 + KDG(1)*(FA - FD) + KRG(1)*(FDA) ,

WHERE

- A1 = NOMINAL STEERING ANGLE PROFILE INPUT AS A TABLE NAMED GNOMIT, I = 1,2,3, WHERE THE INDEX, I, DENOTES THE STEERING CHANNEL.
- KDG(I) = THE DISPLACEMENT ERROR GAIN FOR STEERING CHANNEL I.
- KRG(I) = THE RATE ERROR GAIN FOR STEERING CHANNEL I.
- FD = THE DESIRED FUNCTION VALUE INPUT AS A TABLE NAMED GDFIT, WHERE THE INDEX I DENOTES THE STEERING CHANNEL.
- FA = THE ACTUAL VALUE OF THE VARIABLE WHOSE NAME IS INPUT AS DGF.
- FDA = THE ACTUAL VALUE OF THE SLOPE OF FD.

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=0,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(3)= 4, OR IGUID(6), IGUID(7), OR IGUID(8) = 4.
4) INPUT THE GAINS KDG(I) AND KRG(I).

6.B.2. AERODYNAMIC ANGLES (CONTD)

5) INPUT THE NOMINAL PROFILES GNOMIT.
6) INPUT THE MAXIMUM AND MINIMUM CONTROL PROFILES AS GNMXIT AND GNMNIT.
7) INPUT THE NAME OF THE VARIABLE TO BE CONTROLLED AS DGF(I).
8) INPUT THE DESIRED VALUE OF THE VARIABLE SPECIFIED BY DGF(I) AS THE TABLE NAMED GDFIT.
9) INPUT THE INITIALIZATION FLAG IDGF(I)=1, WHENEVER DGF(I) IS INPUT.

ALL CONSTANT INPUT VARIABLES ASSOCIATED WITH AERODYNAMIC ANGLES ARE INPUT IN NAMELIST GENDAT. THESE INPUT VARIABLES ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(1)	INTEGER	0	TYPE OF GUIDANCE (STEERING) DESIRED. = 0, ANGLE OF ATTACK, SIDESLIP, AND BANK. ALSO INPUT VALUES FOR IGUID(2) AND IGUID(3) OR IGUID(6), IGUID(7), AND IGUID(8).
IGUID(2)	INTEGER	0	ATTITUDE CHANNEL SELECTOR. = 0, CALCULATE ALL ATTITUDE ANGLES BASED UPON THE SAME TYPE OF FUNCTIONAL RELATIONSHIP, I.E., POLYNOMIALS, TABLES, ETC. = 1, CALCULATE EACH ATTITUDE ANGLE SEPARATELY BY A FUNCTIONAL RELATIONSHIP SPECIFIED BY IGUID(6), IGUID(7), IGUID(8), OR IGUID(9), IGUID(10), AND IGUID(11). THIS FLAG ENABLES ONE TO SELECT DIFFERENT TYPES OF ATTITUDE CALCULATIONS IN EACH ATTITUDE CHANNEL. HOWEVER, IT IS NOT POSSIBLE TO INTERMIX ALPHA, BETA, AND BNKANG WITH YAW, PITCH, AND ROLL.

IGUID(3)	INTEGER	0	FLAG TO SPECIFY THE STEERING OPTION WHEN COMMANDING ALL CHANNELS SIMULTANEOUSLY USING AERODYNAMIC ANGLE OF ATTACK, SIDESLIP, AND BANK. = 0, ANGLE OF ATTACK, SIDESLIP, AND BANK ARE THIRD ORDER POLYNOMIALS WITH THE CONSTANT TERMS SET EQUAL TO THE VALUES OF ALPHA, BETA, AND BNKANG AT THE TIME IGUID(3)=0 IS REQUESTED. = 1, SAME AS IGUID(3)=0 EXCEPT THAT THE CONSTANT TERMS ARE THE INPUT VALUES. = 2, ANGLE OF ATTACK, SIDESLIP, AND BANK ARE OBTAINED FROM TABLE LOOK-UPS OF ALPHAT, BETAT, AND BANKT. = 3, ANGLE OF ATTACK, SIDESLIP, AND BANK ARE PIECEWISE LINEAR FUNCTIONS OF THE CRITR VARIABLE AT THE EVENTS DESN(I), I=1,2,3, RESPECTIVELY. = 4, ANGLE OF ATTACK, SIDESLIP, AND BANK ARE COMPUTED VIA LINEAR FEEDBACK TO MAKE THE VARIABLE SPECIFIED BY DGF(I), I=1,2,3 FOLLOW THE PROFILE CONTAINED IN GDFIT, I=1,2,3 FOR ANGLE OF ATTACK, SIDESLIP, AND BANK, RESPECTIVELY. = 5, SAME AS IGUID(3)=0 EXCEPT THAT THE CONSTANT TERMS ARE THE DESIRED INCREMENTAL VALUES OF ALPHA, BETA, AND BNKANG AT THE TIME IGUID(3)=5 IS REQUESTED

6.B.2. AERODYNAMIC ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(6)	INTEGER	0	SEPARATE CHANNEL OPTIONS FOR ANGLE OF ATTACK. = 0, SAME AS WHEN IGUID(3)=0. = 1, SAME AS WHEN IGUID(3)=1. = 2, SAME AS WHEN IGUID(3)=2. = 3, SAME AS WHEN IGUID(3)=3. = 4, SAME AS WHEN IGUID(3)=4. = 5, SAME AS WHEN IGUID(3)=5.
IGUID(7)	INTEGER	0	SEPARATE CHANNEL OPTIONS FOR SIDESLIP ANGLE. = 0, SAME AS WHEN IGUID(3)=0. = 1, SAME AS WHEN IGUID(3)=1. = 2, SAME AS WHEN IGUID(3)=2. = 3, SAME AS WHEN IGUID(3)=3. = 4, SAME AS WHEN IGUID(3)=4. = 5, SAME AS WHEN IGUID(3)=5.
IGUID(8)	INTEGER	0	SEPARATE CHANNEL OPTION FOR BANK ANGLE. = 0, SAME AS WHEN IGUID(3)=0. = 1, SAME AS WHEN IGUID(3)=1. = 2, SAME AS WHEN IGUID(3)=2. = 3, SAME AS WHEN IGUID(3)=3. = 4, SAME AS WHEN IGUID(3)=4. = 5, SAME AS WHEN IGUID(3)=5.
ALPARG BETARG BNKARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ANGLE OF ATTACK, SIDESLIP AND BANK. USED IF IGUID(1)=-1 OR 0.
ALPHA BETA BNKANG	DEG	0.	INITIAL VALUES OF ANGLE OF ATTACK, SIDESLIP, AND BANK, RESPECTIVELY. USED IF IGUID(1)=-1 OR 0, DEPENDING ON THE VALUES OF IGUID(12) AND IGUID(3) OR IGUID(6), IGUID(7), AND IGUID(8).

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALPPC(I) BETPC(I) BNKPC(I) I=1,4	DECIMAL	0.	ANGLE OF ATTACK (ALPHA), SIDESLIP (BETA), AND BANK (BNKANG) POLYNOMIAL COEFFICIENTS, RESPECTIVELY, WHERE 1= CONSTANT TERM, 2= LINEAR (RATE) TERM, 3= QUADRATIC TERM, AND 4= CUBIC TERM. USED IF IGUID(1)=-1 OR 0.
DALPHA DBETA DBANK	DEG	0.	THE DESIRED VALUES OF ALPHA, BETA, AND BNKANG AT THE EVENTS SPECIFIED BY DESN(I), I=1,3. USED IF IGUID(1) =0 AND IGUID(3)=3 OR IGUID(6), IGUID(7), AND IGUID(8)=3.
DESN(I) I=1,3	DECIMAL	THE NEXT PRIMARY EVENT NUMBER	THE EVENT NUMBERS AT WHICH THE ANGLES DYAW, DPITCH, AND DYAW OR DALPHA, DBETA, AND DBANK ARE TO BE ATTAINED AS A LINEAR FUNCTION OF THE CRITERIA VARIABLES (CRITR) FOR THE SPECIFIED EVENT NUMBERS.
DGF(I) I=1,3	HOLLERITH	0	THE NAME OF THE VARIABLE TO BE CONTROLLED IN CHANNEL I BY THE LINEAR FEEDBACK GUIDANCE EQUATIONS. THE DESIRED VALUE OF THIS VARIABLE IS INPUT AS THE TABLE GDFIT IN NAME-LIST TAB. CHANNEL 1 CORRESPONDS TO ALPHA OR YAW, CHANNEL 2 CORRESPONDS TO BETA OR PITCH, AND CHANNEL 3 CORRESPONDS TO BNKANG OR ROLL, RESPECTIVELY DEPENDING ON THE IGUID OPTIONS SELECTED.
IDGF(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE LINEAR FEEDBACK GUIDANCE FOR CHANNEL I IS TO BE INITIALIZED. THIS FLAG MUST BE INPUT EQUAL TO 1 FOR A GIVEN CHANNEL WHENEVER A DIFFERENT FUNCTION (DGF) IS INPUT FOR THAT CHANNEL. = 0, DO NOT INITIALIZE CHANNEL I. = 1, INITIALIZE CHANNEL I.

6.B.2. AERODYNAMIC ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
KDG(I) I=1,3	DECIMAL	1.	THE DISPLACEMENT GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
KRG(I) I=1,3	DECIMAL	1.	THE RATE GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.

THE TABLE INPUTS ASSOCIATED WITH THE AERODYNAMIC ANGLES ARE INPUT IN NAMELIST TAB. THESE INPUTS ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALPHAT BETAT BANKT	DEG	0.	TABLES OF ANGLE OF ATTACK, SIDESLIP, AND BANK. USED IF IGUID(1)=0, AND IGUID(3)=2.
GDFIT I=1,3	DECIMAL	0.	THE DESIRED PROFILE FOR THE VARIABLE SPECIFIED BY DGF(I), I=1,3, WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNMXIT GNMNIT I=1,3	DEG	360. -360.	THE MAXIMUM AND MINIMUM PROFILES FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNOMIT I=1,3	DEG	0.	THE NOMINAL PROFILE FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE -

OUTPUT SYMBOL	UNITS	DEFINITION
ALPHA BETA BNKANG	DEG	ANGLE OF ATTACK, SIDESLIP, AND BANK. SEE THE SECTION ON GUIDANCE (STEERING) OPTIONS FOR THE SPECIFIC DEFINITIONS.

6.B.3. INERTIAL EULER ANGLES

THIS OPTION DEFINES THE ATTITUDE OF THE VEHICLE WITH RESPECT TO THE INERTIAL L-FRAME, AND IS GENERALLY USED TO SIMULATE VEHICLES WITH INERTIAL PLATFORMS.

THE INERTIAL EULER ANGLES ARE DEFINED AS FOLLOWS -

ROLI - INERTIAL ROLL ANGLE. THIS IS THE ROLL ANGLE (FIRST EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM ABOUT THE XL AXIS.

YAWI - INERTIAL YAW ANGLE. THIS IS THE YAW ANGLE (SECOND EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM ABOUT THE ONCE ROTATED ZL AXIS.

PITI - INERTIAL PITCH ANGLE. THIS IS THE PITCH ANGLE (THIRD EULER ROTATION) WITH RESPECT TO THE L COORDINATE SYSTEM ABOUT THE TWICE ROTATED YL AXIS.

THERE ARE SEVERAL GENERAL FUNCTIONAL RELATIONSHIPS THAT CAN BE USED TO COMPUTE THESE ANGLES. THE PARTICULAR INPUTS VARIABLES FOR EACH OF THESE OPTIONS ARE DESCRIBED BELOW.

POLYNOMIALS

WHEN THIS OPTION IS USED, THE ANGLES ARE COMPUTED FROM A CUBIC POLYNOMIAL, E.G.,

```
PITI = SUM ( PITPC(I)*PITARG**(I-1) ),
       I=1,4
```

WHERE THE POLYNOMIAL COEFFICIENTS AND THE POLYNOMIAL ARGUMENTS ARE SPECIFIED BY USER INPUT. THUS, THE INPUT PROCEDURE FOR USING THIS OPTION IS -

1) INPUT IGUID(1)=1.
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)= 0 OR 1 , OR IGUID(9), IGUID(10), AND IGUID(11) = 0 OR 1.
4) INPUT THE HOLLERITH NAME OF THE POLYNOMIAL ARGUMENTS, ROLARG, YAWARG, AND PITARG.
5) INPUT THE DESIRED VALUES FOR THE COEFFICIENTS, ROLPC(I), YAWPC(I), AND PITPC(I).

TABLES

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM TABLE INTERPOLATION, E.G.,

PITI = PITM*PITT,

WHERE THE TABLE MULTIPLIER IS INPUT IN NAMELIST TBLMLT, AND THE TABLE IS INPUT IN NAMELIST TAB. THIS OPTION IS GENERAL BECAUSE THESE TABLES CAN BE MONOVARIANT, BIVARIANT, OR TRIVARIANT FUNCTIONS OF ANY INTERNALLY COMPUTED VARIABLES (SEE SECTION ON TABLE INPUTS).

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=1,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)=2, OR IGUID(9), IGUID(10), OR IGUID(11) = 2.
4) INPUT THE VALUE OF THE TABLE MULTIPLIER IN NAMELIST TBLMLT.
5) INPUT THE TABLES ROLT, YAWT, AND PITT .

PIECEWISE LINEAR FUNCTIONS

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A GENERAL PIECEWISE LINEAR FUNCTION, E.G.,

PITI = A1 + ((A2 - A1)/(C2 - C1))*(C - C1) ,

WHERE

- A1 = PITI AT THE BEGINNING OF THE CURRENT PHASE. THIS CAN BE EITHER INPUT OR CARRIED ACROSS THE EVENT.
- A2 = THE DESIRED VALUE OF PITI, INPUT AS DPITCH, AT THE EVENT SPECIFIED BY DESN(1).
- C1 = THE VALUE OF VARIABLE NAMED CRITR IN EVENT = DESN(1) AT THE BEGINNING OF THE CURRENT EVENT.
- C2 = THE DESIRED VALUE OF CRITR AT EVENT = DESN(1).
- C = THE CURRENT VALUE OF THE VARIABLE NAMED CRITR IN EVENT = DESN(1).

6.B.3. INERTIAL EULER ANGLES (CONTD)

CLEARY, IF THE VARIABLE CRITR IS NONLINEAR IN TIME, THEN ALTHOUGH THE STEERING ANGLES ARE LINEAR IN CRITR, THEY ARE NONLINEAR IN TIME.

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=1,
2) INPUT IGUID(2) = TO THE DESIRED VALUE.
3) INPUT IGUID(4)=3, OR IGUID(9), IGUID(10), OR IGUID(11) = 3.
4) INPUT THE DESIRED VALUES DROLL, DYAW, AND DPITCH.
5) INPUT THE DESN(I) = TO THE DESIRED VALUES IF THEY ARE DIFFERENT FROM THE NEXT PRIMARY, NONROVING EVENT.

LINEAR FEEDBACK

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A LINEAR ERROR, ERROR RATE FEEDBACK STEERING LAW, E.G.,

PITI = A1 + KDG(1)*(FA - FD) + KRG(1)*(FDA) ,

WHERE

- A1 = NOMINAL STEERING ANGLE PROFILE INPUT AS A TABLE NAMED GNOMIT, I = 1,2,3, WHERE THE INDEX, I, DENOTES THE STEERING CHANNEL.
- KDG(I) = THE DISPLACEMENT ERROR GAIN FOR STEERING CHANNEL I.
- KRG(I) = THE RATE ERROR GAIN FOR STEERING CHANNEL I.
- FD = THE DESIRED FUNCTION VALUE INPUT AS A TABLE NAMED GDFIT, WHERE THE INDEX I DENOTES THE STEERING CHANNEL.
- FA = THE ACTUAL VALUE OF THE VARIABLE WHOSE NAME IS INPUT AS DGF.
- FDA = THE ACTUAL VALUE OF THE SLOPE OF FD.

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=1,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)=4, OR IGUID(9), IGUID(10), OR IGUID(11) = 4.
4) INPUT THE GAINS KDG(I) AND KRG(I).
5) INPUT THE NOMINAL PROFILES GNOMIT.
6) INPUT THE MAXIMUM AND MINIMUM CONTROL PROFILES AS GNMXIT AND GNMNIT.
7) INPUT THE NAME OF THE VARIABLE TO BE CONTROLLED AS DGF(I).
8) INPUT THE DESIRED VALUE OF THE VARIABLE SPECIFIED BY DGF(I) AS THE TABLE NAMED GDFIT.

6.B.3. INERTIAL EULER ANGLES (CONTD)

9) INPUT THE INITIALIZATION FLAG IDGF(I)=1, WHENEVER DGF(I) IS INPUT.

ALL CONSTANT INPUT VARIABLES ASSOCIATED WITH INERTIAL EULER ANGLES ARE INPUT IN NAMELIST GENDAT. THESE INPUT VARIABLES ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(1)	INTEGER	0	TYPE OF GUIDANCE (STEERING) DESIRED. = 1, INERTIAL EULER ATTITUDE ANGLES, I.E., ROLI, YAWI, AND PITI MEASURED WITH RESPECT TO THE L FRAME. ALSO INPUT VALUES FOR IGUID(2) AND IGUID(4) OR IGUID(9), IGUID(10), AND IGUID(11).
IGUID(2)	INTEGER	0	ATTITUDE CHANNEL SELECTOR. = 0, CALCULATE ALL ATTITUDE ANGLES BASED UPON THE SAME TYPE OF FUNCTIONAL RELATIONSHIP, I.E., POLYNOMIALS, TABLES, ETC. = 1, CALCULATE EACH ATTITUDE ANGLE SEPARATELY BY A FUNCTIONAL RELATIONSHIP SPECIFIED BY IGUID(6), IGUID(7), IGUID(8), OR IGUID(9), IGUID(10), AND IGUID(11). THIS FLAG ENABLES ONE TO SELECT DIFFERENT TYPES OF ATTITUDE CALCULATIONS IN EACH ATTITUDE CHANNEL. HOWEVER, IT IS NOT POSSIBLE TO INTERMIX ALPHA, BETA, AND BNKANG WITH YAW, PITCH, AND ROLL.
IGUID(4)	INTEGER	0	EULER ANGLE STEERING (INERTIAL OR RELATIVE). = 0, YAW, PITCH, AND ROLL ARE COMPUTED AS THIRD ORDER POLYNOMIALS AND THE CONSTANT TERMS ARE SET EQUAL TO THE VALUES OF YAWR, PITR, AND ROLR OR YAWI, PITI, AND ROLI AT THE TIME IGUID(4) IS REQUESTED.

6.B.3. INERTIAL EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			= 1, YAW, PITCH, AND ROLL ARE GIVEN BY THIRD ORDER POLYNOMIALS AS IN IGUID(4)=0, EXCEPT THAT THE CONSTANT TERMS ARE THE INPUT VALUES AT THE TIME THIS OPTION IS REQUESTED. = 2, YAW, PITCH, AND ROLL ARE COMPUTED FROM TABLES OF YAWT, PITT, AND ROLT. = 3, YAW, PITCH, AND ROLL ARE PIECEWISE LINEAR FUNCTIONS OF THE CRITR VARIABLE AT THE EVENTS DESN(1), DESN(2), AND DESN(3), RESPECTIVELY. = 4, YAW, PITCH, AND ROLL ARE COMPUTED VIA LINEAR FEEDBACK TO MAKE THE VARIABLE SPECIFIED BY DGF(I), I=1,2,3 FOLLOW THE PROFILE CONTAINED IN GDFIT, I=1,2,3 FOR YAW, PITCH, AND ROLL, RESPECTIVELY. = 5, SAME AS IGUID(4)=0 EXCEPT THAT THE CONSTANT TERMS ARE THE DESIRED INCREMENTAL VALUES OF YAW, PITCH, AND ROLL AT THE TIME IGUID(4)=5 IS REQUESTED.
IGUID(9)	INTEGER	0	SEPARATE CHANNEL OPTION FOR YAW ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.
IGUID(10)	INTEGER	0	SEPARATE CHANNEL OPTION FOR PITCH ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.

6.B.3. INERTIAL EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(11)	INTEGER	0	SEPARATE CHANNEL OPTION FOR ROLL ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.
AZL	DEG	0.	THE AZIMUTH OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM MEASURED CLOCKWISE FROM NORTH.
LATL	DEG	GDLAT	LATITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM. THIS CAN BE INPUT AS EITHER GEODETIC OR GEOCENTRIC LATITUDE. IF GEODETIC LAT ITUDE IS INPUT, THE L FRAME BECOMES A PLUMB LINE SYSTEM. IF LATL IS NOT INPUT, IT IS SET EQUAL TO GDLAT.
LONL	DEG	LONGI	INERTIAL EAST LONGITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM. IF LONL IS NOT INPUT, IT IS SET EQUAL TO LONGI.
DGF(I) I=1,3	HOLLERITH	0	THE NAME OF THE VARIABLE TO BE CONTROLLED IN CHANNEL I BY THE LINEAR FEEDBACK GUIDANCE EQUATIONS. THE DESIRED VALUE OF THIS VARIABLE IS INPUT AS THE TABLE GDFIT IN NAME-LIST TAB. CHANNEL 1 CORRESPONDS TO ALPHA OR YAW, CHANNEL 2 CORRESPONDS TO BETA OR PITCH, AND CHANNEL 3 CORRESPONDS TO BNKANG OR ROLL, RESPECTIVELY DEPENDING ON THE IGUID OPTIONS SELECTED.
DYAW DPITCH DROLL	DEG	0.	THE DESIRED VALUES OF THE YAW, PITCH, AND ROLL ANGLES AT THE EVENTS SPECIFIED BY DESN(I), I=1,3. USED IF IGUID(1)=1,2 AND IGUID(4)=3 OR IGUID(9), IGUID(10), AND IGUID(11)=3.

6.B.3. INERTIAL EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IDGF(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE LINEAR FEEDBACK GUIDANCE FOR CHANNEL I IS TO BE INITIALIZED. THIS FLAG MUST BE INPUT EQUAL TO 1 FOR A GIVEN CHANNEL WHENEVER A DIFFERENT FUNCTION (DGF) IS INPUT FOR THAT CHANNEL. = 0, DO NOT INITIALIZE CHANNEL I. = 1, INITIALIZE CHANNEL I.
KDG(I) I=1,3	DECIMAL	1.	THE DISPLACEMENT GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
KRG(I) I=1,3	DECIMAL	1.	THE RATE GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
ROLARG PITARG YAWARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ROLL, PITCH, AND YAW. USED IF IGUID(1)=-1,1,2.
ROLI YAWI PITI	DEG	0.	THE INITIAL VALUES OF THE INERTIAL EULER ATTITUDE ANGLES OF THE VEHICLE WITH RESPECT TO THE LAUNCH PAD (L) COORDINATE SYSTEM. USED IF IGUID(1) =-1 AND IGUID(12)=2 OR IF IGUID(1) =1 AND IGUID(4)=3 OR IGUID(9), IGUID(10), AND IGUID(11)=3.
ROLPC(I) PITPC(I) YAWPC(I) I=1,4	DECIMAL	0.	ROLL, PITCH, AND YAW ANGLE POLYNOMIAL COEFFICIENTS, RESPECTIVELY. USED IF IGUID(1)=-1,1 OR 2.

THE TABLE INPUTS ASSOCIATED WITH THE INERTIAL EULER ANGLES ARE INPUT IN NAMELIST TAB. THESE INPUTS ARE -

6.B.3. INERTIAL EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
GDFIT I=1,3	DECIMAL	0.	THE DESIRED PROFILE FOR THE VARIABLE SPECIFIED BY DGF(I), I=1,3, WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNMXIT GNMNIT I=1,3	DEG	360. -360.	THE MAXIMUM AND MINIMUM PROFILES FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNOMIT I=1,3	DEG	0.	THE NOMINAL PROFILE FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
YAWT PITT ROLT	DEG	0.	TABLES OF YAW, PITCH, AND ROLL ANGLES. USED IF IGUID(1)=1,2 AND IGUID(4)=2.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE -

OUTPUT SYMBOL	UNITS	DEFINITION
ROLI YAWI PITI	DEG	INERTIAL VEHICLE ATTITUDE ANGLES MEASURED WITH RESPECT TO THE LAUNCH PAD INERTIAL (L) COORDINATE SYSTEM. AT LAUNCH, ALL THREE ANGLES ARE ZERO WHEN THE VEHICLE IS VERTICAL, I.E., WHEN XB IS IN THE RADIAL (OR LOCAL VERTICAL) DIRECTION, ZB IS ALONG THE AZIMUTH SPECIFIED BY AZL, AND YB COMPLETES A RIGHT-HAND SYSTEM.

6.B.4. RELATIVE EULER ANGLES

THIS OPTION DEFINES THE ATTITUDE OF THE VEHICLE WITH RESPECT TO THE RELATIVE GEOGRAPHIC FRAME, AND IS GENERALLY USED TO SIMULATE VEHICLES WHICH USE A LOCAL HORIZONTAL REFERENCE SYSTEM.

THE RELATIVE EULER ANGLES ARE DEFINED AS FOLLOWS -

YAWR - RELATIVE YAW ANGLE. THIS IS THE AZIMUTH ANGLE OF THE XB AXIS MEASURED CLOCKWISE FROM THE DESIGNATED REFERENCE POINT.

PITR - RELATIVE PITCH ANGLE. THIS IS THE ELEVATION ANGLE OF THE XB AXIS ABOVE THE LOCAL HORIZONTAL PLANE. PITR IS POSITIVE WHEN XB IS ABOVE THE LOCAL HORIZONTAL AND RANGES FROM -90 DEG TO +90 DEG. WHEN PITCHING THE VEHICLE OVER THE TOP, THE AZIMUTH ANGLE (YAWR) WILL GO THROUGH A 180 DEG DISCONTINUITY. THEREFORE, THE RELATIVE ANGLES SHOULD NOT BE COMMANDED IN THESE INSTANCES, BUT SHOULD BE REPLACED WITH INERTIAL ANGLE OR BODY RATE COMMANDS.

ROLR - RELATIVE ROLL ANGLE. THIS IS THE ROLL ANGLE ABOUT THE XB AXIS IN THE RIGHT-HAND SENSE. ZERO ROLL IMPLIES THAT THE YB AXIS IS IN THE LOCAL HORIZONTAL PLANE.

THERE ARE SEVERAL GENERAL FUNCTIONAL RELATIONSHIPS THAT CAN BE USED TO COMPUTE THESE ANGLES. THE PARTICULAR INPUTS VARIABLES FOR EACH OF THESE OPTIONS ARE DESCRIBED BELOW.

POLYNOMIALS

WHEN THIS OPTION IS USED, THE ANGLES ARE COMPUTED FROM A CUBIC POLYNOMIAL, E.G.,

```
PITR = SUM ( PITPC(I)*PITARG**(I-1) ),
        I=1,4
```

WHERE THE POLYNOMIAL COEFFICIENTS AND THE POLYNOMIAL ARGUMENTS ARE SPECIFIED BY USER INPUT. THUS, THE INPUT PROCEDURE FOR USING THIS OPTION IS -

1) INPUT IGUID(1)=2.

2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)= 0 OR 1 , OR IGUID(9), IGUID(10), AND IGUID(11) = 0 OR 1.
4) INPUT THE HOLLERITH NAME OF THE POLYNOMIAL ARGUMENTS, YAWARG, PITARG, AND YAWARG.
5) INPUT THE DESIRED VALUES FOR THE COEFFICIENTS, ROLPC(I), YAWPC(I), AND PITPC(I).
6) INPUT IGUID(13) = TO THE DESIRED VALUE.

TABLES

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM TABLE INTERPOLATION, E.G.,

PITR = PITM*PITT,

WHERE THE TABLE MULTIPLIER IS INPUT IN NAMELIST TBLMLT, AND THE TABLE IS INPUT IN NAMELIST TAB. THIS OPTION IS GENERAL BECAUSE THESE TABLES CAN BE MONOVARIANT, BIVARIANT, OR TRIVARIANT FUNCTIONS OF ANY INTERNALLY COMPUTED VARIABLES (SEE SECTION ON TABLE INPUTS).

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=2,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)=2, OR IGUID(9), IGUID(10), OR IGUID(11) = 2.
4) INPUT THE VALUE OF THE TABLE MULTIPLIER IN NAMELIST TBLMLT.
5) INPUT THE TABLES ROLT, YAWT, AND PITT .
6) INPUT IGUID(13) = TO THE DESIRED VALUE.

PIECEWISE LINEAR FUNCTIONS

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A GENERAL PIECEWISE LINEAR FUNCTION, E.G.,

PITR = A1 + ((A2 - A1)/(C2 - C1))*(C - C1) ,

WHERE

A1 = PITR AT THE BEGINNING OF THE CURRENT PHASE. THIS CAN BE EITHER INPUT OR CARRIED ACROSS THE EVENT.

6.B.4. RELATIVE EULER ANGLES (CONTD)

A2 = THE DESIRED VALUE OF PITR, INPUT AS DPITCH, AT THE EVENT SPECIFIED BY DESN(1).
C1 = THE VALUE OF VARIABLE NAMED CRITR IN EVENT = DESN(1) AT THE BEGINNING OF THE CURRENT EVENT.
C2 = THE DESIRED VALUE OF CRITR AT EVENT = DESN(1).
C = THE CURRENT VALUE OF THE VARIABLE NAMED CRITR IN EVENT = DESN(1).

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=2,
2) INPUT IGUID(2) = TO THE DESIRED VALUE.
3) INPUT IGUID(4)=3, OR IGUID(9), IGUID(10), OR IGUID(11) = 3.
4) INPUT THE DESIRED VALUES DROLL, DYAW, AND DPITCH.
5) INPUT THE DESN(I) = TO THE DESIRED VALUES IF THEY ARE DIFFERENT FROM THE NEXT PRIMARY, NONROVING EVENT.
6) INPUT IGUID(13) = TO THE DESIRED VALUE.

LINEAR FEEDBACK

WHEN THIS OPTION IS USED THE ANGLES ARE COMPUTED FROM A LINEAR ERROR, ERROR RATE FEEDBACK STEERING LAW, E.G.,

PITR = A1 + KDG(1)*(FA - FD) + KRG(1)*(FDA) ,

WHERE

A1 = NOMINAL STEERING ANGLE PROFILE INPUT AS A TABLE NAMED GNOMIT, I = 1,2,3, WHERE THE INDEX, I, DENOTES THE STEERING CHANNEL.
KDG(I) = THE DISPLACEMENT ERROR GAIN FOR STEERING CHANNEL I.
KRG(I) = THE RATE ERROR GAIN FOR STEERING CHANNEL I.
FD = THE DESIRED FUNCTION VALUE INPUT AS A TABLE NAMED GDFIT, WHERE THE INDEX I DENOTES THE STEERING CHANNEL.
FA = THE ACTUAL VALUE OF THE VARIABLE WHOSE NAME IS INPUT AS DGF.
FDA = THE ACTUAL VALUE OF THE SLOPE FD.

THE INPUT PROCEDURE FOR THIS OPTION IS -

1) INPUT IGUID(1)=2,
2) INPUT IGUID(2)= TO THE DESIRED VALUE.
3) INPUT IGUID(4)=4, OR IGUID(9), IGUID(10), OR IGUID(11) = 4.
4) INPUT THE GAINS KDG(I) AND KRG(I).
5) INPUT THE NOMINAL PROFILES GNOMIT.
6) INPUT THE MAXIMUM AND MINIMUM CONTROL PROFILES AS GNMXIT AND GNMNIT.
7) INPUT THE NAME OF THE VARIABLE TO BE CONTROLLED AS DGF(I).
8) INPUT THE DESIRED VALUE OF THE VARIABLE SPECIFIED BY DGF(I) AS THE TABLE NAMED GDFIT.
9) INPUT THE INITIALIZATION FLAG IDGF(I)=1, WHENEVER DGF(I) IS INPUT.
10) INPUT IGUID(13) = TO THE DESIRED VALUE.

ALL CONSTANT INPUT VARIABLES ASSOCIATED WITH RELATIVE EULER ANGLES ARE INPUT IN NAMELIST GENDAT. THESE INPUT VARIABLES ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(1)	INTEGER	0	TYPE OF GUIDANCE (STEERING) DESIRED. = 2, RELATIVE EULER ATTITUDE ANGLES, I.E., YAWR, PITR, AND ROLR MEASURED WITH RESPECT TO THE G FRAME. ALSO INPUT VALUES FOR IGUID(2), IGUID(13), AND IGUID(4) OR IGUID(9), IGUID(10), AND IGUID(11).
IGUID(2)	INTEGER	0	ATTITUDE CHANNEL SELECTOR. = 0, CALCULATE ALL ATTITUDE ANGLES BASED UPON THE SAME TYPE OF FUNCTIONAL RELATIONSHIP, I.E., POLYNOMIALS, TABLES, ETC.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			= 1, CALCULATE EACH ATTITUDE ANGLE SEPARATELY BY A FUNCTIONAL RELATIONSHIP SPECIFIED BY IGUID(6), IGUID(7), IGUID(8), OR IGUID(9), IGUID(10), AND IGUID(11). THIS FLAG ENABLES ONE TO SELECT DIFFERENT TYPES OF ATTITUDE CALCULATIONS IN EACH ATTITUDE CHANNEL. HOWEVER, IT IS NOT POSSIBLE TO INTERMIX ALPHA, BETA, AND BNKANG WITH YAW, PITCH, AND ROLL.
IGUID(4)	INTEGER	0	EULER ANGLE STEERING (INERTIAL OR RELATIVE). = 0, YAW, PITCH, AND ROLL ARE COMPUTED AS THIRD ORDER POLYNOMIALS AND THE CONSTANT TERMS ARE SET EQUAL TO THE VALUES OF YAWR, PITR, AND ROLR OR YAWI, PITI, AND ROLI AT THE TIME IGUID(4) IS REQUESTED. = 1, YAW, PITCH, AND ROLL ARE GIVEN BY THIRD ORDER POLYNOMIALS AS IN IGUID(4)=0, EXCEPT THAT THE CONSTANT TERMS ARE THE INPUT VALUES AT THE TIME THIS OPTION IS REQUESTED. = 2, YAW, PITCH, AND ROLL ARE COMPUTED FROM TABLES OF YAWT, PITT, AND ROLT. = 3, YAW, PITCH, AND ROLL ARE PIECEWISE LINEAR FUNCTIONS OF THE CRITR VARIABLE AT THE EVENTS DESN(1), DESN(2), AND DESN(3), RESPECTIVELY. = 4, YAW, PITCH, AND ROLL ARE COMPUTED VIA LINEAR FEEDBACK TO MAKE THE VARIABLE SPECIFIED BY DGF(I), I=1,2,3 FOLLOW THE PROFILE CONTAINED IN GDFIT, I=1,2,3 FOR YAW, PITCH, AND ROLL, RESPECTIVELY.

6.B.4. RELATIVE EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
			= 5, SAME AS IGUID(4)=0 EXCEPT THAT THE CONSTANT TERMS ARE THE DESIRED INCREMENTAL VALUES OF YAW, PITCH, AND ROLL AT THE TIME IGUID(4)=5 IS REQUESTED.
IGUID(9)	INTEGER	0	SEPARATE CHANNEL OPTION FOR YAW ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.
IGUID(10)	INTEGER	0	SEPARATE CHANNEL OPTION FOR PITCH ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.
IGUID(11)	INTEGER	0	SEPARATE CHANNEL OPTION FOR ROLL ANGLE. = 0, SAME AS WHEN IGUID(4)=0. = 1, SAME AS WHEN IGUID(4)=1. = 2, SAME AS WHEN IGUID(4)=2. = 3, SAME AS WHEN IGUID(4)=3. = 4, SAME AS WHEN IGUID(4)=4. = 5, SAME AS WHEN IGUID(4)=5.
IGUID(13)	INTEGER	1	YAW REFERENCE OPTION. = 1, RELATIVE YAW ANGLE (YAWR) IS MEASURED CLOCKWISE FROM GEOGRAPHIC NORTH. = 2, RELATIVE YAW ANGLE (YAWR) IS MEASURED CLOCKWISE FROM THE ATMOSPHERIC RELATIVE VELOCITY VECTOR AZIMUTH ANGLE. = 3, RELATIVE YAW ANGLE (YAWR) IS MEASURED CLOCKWISE FROM THE INERTIAL VELOCITY VECTOR AZIMUTH ANGLE.

6.B.4. RELATIVE EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ROLPC(I) PITPC(I) YAWPC(I) I=1,4	DECIMAL	0.	ROLL, PITCH, AND YAW ANGLE POLYNOMIAL COEFFICIENTS, RESPECTIVELY. USED IF IGUID(1)=-1,1 OR 2.
DGF(I) I=1,3	HOLLERITH	0	THE NAME OF THE VARIABLE TO BE CONTROLLED IN CHANNEL I BY THE LINEAR FEEDBACK GUIDANCE EQUATIONS. THE DESIRED VALUE OF THIS VARIABLE IS INPUT AS THE TABLE GDFIT IN NAME-LIST TAB. CHANNEL 1 CORRESPONDS TO ALPHA OR YAW, CHANNEL 2 CORRESPONDS TO BETA OR PITCH, AND CHANNEL 3 CORRESPONDS TO BNKANG OR ROLL, RESPECTIVELY DEPENDING ON THE IGUID OPTIONS SELECTED.
DYAW DPITCH DROLL	DEG	0.	THE DESIRED VALUES OF THE YAW, PITCH, AND ROLL ANGLES AT THE EVENTS SPECIFIED BY DESN(I), I=1,3. USED IF IGUID(1)=1,2 AND IGUID(4)=3 OR IGUID(9), IGUID(10), AND IGUID(11)=3.
IDGF(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE LINEAR FEEDBACK GUIDANCE FOR CHANNEL I IS TO BE INITIALIZED. THIS FLAG MUST BE INPUT EQUAL TO 1 FOR A GIVEN CHANNEL WHENEVER A DIFFERENT FUNCTION (DGF) IS INPUT FOR THAT CHANNEL. = 0, DO NOT INITIALIZE CHANNEL I. = 1, INITIALIZE CHANNEL I.
KDG(I) I=1,3	DECIMAL	1.	THE DISPLACEMENT GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
KRG(I) I=1,3	DECIMAL	1.	THE RATE GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.

6.B.4. RELATIVE EULER ANGLES (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ROLARG PITARG YAWARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ROLL, PITCH, AND YAW. USED IF IGUID(1)=-1,1,2.
YAWR PITR ROLR	DEG	0.	THE INITIAL VALUES OF THE RELATIVE EULER ANGLES OF THE VEHICLE WITH RESPECT TO THE LOCAL GEOGRAPHIC (G) COORDINATE SYSTEM. USED IF IGUID(1) =2 AND IGUID(4)=3 OR IGUID(9), IGUID(10), AND IGUID(11)=3.

THE TABLE INPUTS ASSOCIATED WITH THE RELATIVE EULER ANGLES ARE INPUT IN NAMELIST TAB. THESE INPUTS ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
GDFIT I=1,3	DECIMAL	0.	THE DESIRED PROFILE FOR THE VARIABLE SPECIFIED BY DGF(I), I=1,3, WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNMXIT GNMNIT I=1,3	DEG	360. -360.	THE MAXIMUM AND MINIMUM PROFILES FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNOMIT I=1,3	DEG	0.	THE NOMINAL PROFILE FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
YAWT PITT ROLT	DEG	0.	TABLES OF YAW, PITCH, AND ROLL ANGLES. USED IF IGUID(1)=1,2 AND IGUID(4)=2.

6.B.4. RELATIVE EULER ANGLES (CONTD)

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE -

OUTPUT SYMBOL	UNITS	DEFINITION
YAWR PITR ROLR	DEG	VEHICLE ATTITUDE ANGLES RELATIVE TO THE LOCAL GEOGRAPHIC (G) SYSTEM. YAWR IS THE AZIMUTH OF THE XB AXIS MEASURED CLOCKWISE FROM NORTH, PITR IS THE PITCH ANGLE MEASURED POSITIVE ABOVE THE LOCAL HORIZONTAL PLANE, AND ROLR IS THE BANK ANGLE ABOUT THE XB AXIS MEASURED POSITIVE IN THE RIGHT-HAND SENSE.

6.B.5. INERTIAL AERODYNAMIC ANGLES

THIS OPTION, WHICH IS GENERALLY USED FOR ORBITAL MANEUVER SIMULATIONS, DEFINES THE ATTITUDE OF THE VEHICLE WITH RESPECT TO THE INERTIAL VELOCITY VECTOR.

THE INERTIAL AERODYNAMIC ANGLES ARE DEFINED AS -

ALPHI - INERTIAL ANGLE OF ATTACK. POSITIVE ALPHA IS NOSE UP (ABOVE THE INERTIAL VELOCITY VECTOR) WHEN FLYING THE VEHICLE UPRIGHT (BANKI BETWEEN -90 DEG AND +90 DEG).

BETAI - INERTIAL ANGLE OF SIDESLIP. POSITIVE BETAI IS NOSE LEFT WHEN FLYING THE VEHICLE UPRIGHT.

BANKI - INERTIAL BANK ANGLE. POSITIVE BANKI IS A BANK TO THE RIGHT WHEN FLYING THE VEHICLE UPRIGHT.

THIS OPTION IS OBTAINED WHEN IGUID(1)=3, IS INPUT. THE AVAILABLE STEERING COMMANDS AND INPUTS ASSOCIATED WITH THIS OPTION ARE EXACTLY THE SAME AS FOR THE AERODYNAMIC ANGLE OPTION.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE -

OUTPUT SYMBOL	UNITS	DEFINITION
ALPHI BETAI BANKI	DEG	INERTIAL ANGLE OF ATTACK, SIDESLIP, AND BANK. CALCULATED IF IGUID(1)=3.

6.B.6. GENERAL OPEN LOOP GUIDANCE

THIS OPTION ALLOWS THE USER TO CODE AND SIMULATE HIS OWN OPEN LOOP GUIDANCE LAW. THE SUBROUTINE OLGM IS USED FOR THIS IN A MANNER SIMILAR TO THE SPECIAL CALCULATIONS ROUTINE CALSPEC. A SET OF INPUT AND OUTPUT ARRAYS ARE AVAILABLE FOR THIS OPTION.

THE USE OF THIS OPTION IS SUMMARIZED BELOW -

1. DETERMINE THE EQUATIONS TO BE PROGRAMMED.

2. DEFINE ANY FLAGS TO BE USED AS THE INPUT ARRAY IGF(J), J=1,6. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

3. DEFINE ANY INPUT VARIABLES TO BE USED AS THE ARRAY GVRI(J),J=1,10. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

4. DEFINE ANY OUTPUT VARIABLES TO BE USED AS THE ARRAY GVRC(J), J=1,10. THE OUTPUT SYMBOL FOR THIS ARRAY IS GVRCJ, J=1,10.

5. INPUT THE VARIABLE IGUID(14)=1, AND SPECIFY THE DESIRED GUIDANCE METHOD THROUGH THE USUAL IGUID INPUTS. ANY OF THE AVAILABLE IGUID OPTIONS CAN BE USED.

6. CODE THE DESIRED EQUATIONS INTO SUBROUTINE OLGM. THE ARRAYS TEMP(I) AND STEMP(I), I=1,25 SHOULD BE USED FOR ANY TEMPORARY CALCULATIONS TO MINIMIZE THE CORE REQUIREMENTS. THE FORTRAN SYMBOLS FOR THE INPUTS ASSOCIATED WITH THE SELECTED STEERING OPTION SHOULD BE SET EQUAL TO THE STEERING COMMANDS. THAT IS, THE USER CAN CALCULATE THE VALUES OF THE POLYNOMIAL COEFF-ICIENTS RATHER THAN MERELY SPECIFYING THEM BY INPUT.

7. THE VARIABLES GVRIJ, J=1,10 CAN BE USED AS INDEPENDENT VARIABLES FOR THE TARGETING/OPTIMIZATION OPTION AND THE VARIABLES GVRCJ, J=1,10 CAN BE USED AS DEPENDENT VARI-ABLES OR AS AN OPTIMIZATION VARIABLE.

THE VARIABLES ASSOCIATED WITH THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(14)	INTEGER	0	GENERAL OPEN OR CLOSED LOOP GUIDANCE OPTION. = 0, DO NOT USE. = 1, USE GENERAL OPEN LOOP GUIDANCE PROGRAMMED IN SUBROUTINE OLGM.
GVRI(J) J=1,10	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE WITH THE GENERAL GUIDANCE OPTIONS.
IGF(J) J=1,6	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE WITH THE GENERAL GUIDANCE OPTIONS.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
GVRCJ J=1,10	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE GENERAL GUIDANCE OPTIONS.

6.B.7. GENERAL OPEN LOOP GUIDANCE OVERRIDE

THIS OPTION ALLOWS THE USER TO CODE AND SIMULATE HIS OWN OPEN LOOP GUIDANCE OVERRIDE LAW. THIS OPTION IS USED IN THE SAME MANNER AS THE OPEN LOOP GUIDANCE OPTION EXCEPT THAT THE ANGLE COMMANDS CALCULATED BY THE USER SELECTED STEERING OPTION ONLY IF SOME USER SPECIFIED CONDITION IS VIOLATED. FOR EXAMPLE, THE ANGLE OF ATTACK COMMAND COULD BE OVERRIDDEN BY ONE THAT WOULD MAINTAIN A SPECIFIED QALPHA LIMIT IF THE LIMIT WERE EXCEEDED BY THE COMMAND FROM THE BASIC STEERING LAW. A SET OF INPUT AND OUTPUT ARRAYS ARE AVAILABLE FOR THIS OPTION TO DEFINE THE LIMITS AND OTHER CONSTANTS AS REQUIRED.

THE USE OF THIS OPTION IS SUMMARIZED BELOW -

1. DETERMINE THE EQUATIONS TO BE PROGRAMMED.

2. DEFINE ANY FLAGS TO BE USED AS THE INPUT ARRAY IGF(J), J=1,6. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

3. DEFINE ANY INPUT VARIABLES TO BE USED AS THE ARRAY GVRI(J),J=1,10. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

4. DEFINE ANY OUTPUT VARIABLES TO BE USED AS THE ARRAY GVRC(J), J=1,10. THE OUTPUT SYMBOL FOR THIS ARRAY IS GVRCJ, J=1,10.

5. INPUT THE VARIABLE IGUID(15)=1, AND SPECIFY THE DESIRED GUIDANCE METHOD THROUGH THE USUAL IGUID INPUTS. ANY OF THE AVAILABLE IGUID OPTIONS FOR ANGLES CAN BE USED.

6. CODE THE DESIRED EQUATIONS INTO SUBROUTINE OLGOM. THE ARRAYS TEMP(I) AND STEMP(I), I=1,25 SHOULD BE USED FOR ANY TEMPORARY CALCULATIONS TO MINIMIZE THE CORE REQUIREMENTS. THE FORTRAN SYMBOLS FOR THE INPUTS ASSOCIATED WITH THE SELECTED STEERING OPTION SHOULD BE SET EQUAL TO THE STEERING COMMANDS. THAT IS, THE USER CAN CALCULATE THE VALUES OF THE POLYNOMIAL COEFFICIENTS RATHER THAN MERELY SPECIFYING THEM BY INPUT.

7. THE VARIABLES GVRIJ, J=1,10 CAN BE USED AS INDEPENDENT VARIABLS FOR THE TARGETING/OPTIMIZATION OPTION AND THE VARIABLS GVRCJ, J=1,10 CAN BE USED AS DEPENDENT VARIABLES OR AS AN OPTIMIZATION VARIABLE.

6.B.7. GENERAL OPEN LOOP GUIDANCE OVERRIDE (CONTD)

THE VARIABLES ASSOCIATED WITH THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(15)	INTEGER	0	GENERAL OPEN LOOP GUIDANCE OVERRIDE OPTION. = 0, DO NOT USE. = 1, USE THE GENERAL OPEN LOOP GUIDANCE OVERRIDE MODEL IN SUBROUTINE OLGOM.
GVRI(J) J=1,10	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE WITH THE GENERAL GUIDANCE OPTIONS.
IGF(J) J=1,6	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE WITH THE GENERAL GUIDANCE OPTIONS.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
GVRCJ J=1,10	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE GENERAL GUIDANCE OPTIONS.

6.B.8. GENERAL CLOSED LOOP GUIDANCE

THIS OPTION ALLOWS THE USER TO CODE AND SIMULATE HIS OWN CLOSED LOOP GUIDANCE LAW. THE SUBROUTINE CLGM IS USED FOR THIS OPTION IN THE SAME MANNER AS OLGM IS USED FOR THE OPEN LOOP OPTION, WITH THE SAME INPUT AND OUTPUT ARRAYS BEING USED. THE ACTUAL EQUATIONS ARE CODED IN ROUTINES GSENSR, GNAV, GGUID, AND GCNTRL WITH CLGM BEING THE EXECUTIVE FOR THESE ROUTINES.

THE USE OF THIS OPTION IS SUMMARIZED BELOW -

1. DETERMINE THE EQUATIONS TO BE PROGRAMMED.

2. DEFINE ANY FLAGS TO BE USED AS THE INPUT ARRAY IGF(J), J=1,6. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

3. DEFINE ANY INPUT VARIABLES TO BE USED AS THE ARRAY GVRI(J),J=1,10. THESE FLAGS ARE PRESET TO ZERO IF NOT INPUT.

4. DEFINE ANY OUTPUT VARIABLES TO BE USED AS THE ARRAY GVRC(J), J=1,10. THE OUTPUT SYMBOL FOR THIS ARRAY IS GVRCJ, J=1,10.

5. INPUT THE VARIABLE IGUID(14)=2, AND SPECIFY THE DESIRED GUIDANCE METHOD THROUGH THE USUAL IGUID INPUTS. ANY OF THE AVAILABLE IGUID OPTIONS CAN BE USED.

6. CODE THE DESIRED EQUATIONS INTO SUBROUTINES GSENSR, GNAV, GGUID, AND GCNTRL WHICH ARE CALLED BY CLGM. THE ARRAYS TEMP(I) AND STEMP(I), I=1,25 SHOULD BE USED FOR ANY TEMPORARY CALCULATIONS TO MINIMIZE THE CORE REQUIREMENTS. THE FORTRAN SYMBOLS FOR THE INPUTS ASSOCIATED WITH THE SELECTED STEERING OPTION SHOULD BE SET EQUAL TO THE STEERING COMMANDS. THAT IS, THE USER CAN CALCULATE THE VALUES OF THE POLYNOMIAL COEFF-ICIENTS RATHER THAN MERELY SPECIFYING THEM BY INPUT.

7. THE VARIABLES GVRIJ, J=1,10 CAN BE USED AS INDEPENDENT VARIABLES FOR THE TARGETING/OPTIMIZATION OPTION AND THE VARIABLES GVRCJ, J=1,10 CAN BE USED AS DEPENDENT VARI-ABLES OR AS AN OPTIMIZATION VARIABLE.

6.B.8. GENERAL CLOSED LOOP GUIDANCE (CONTD)

THE VARIABLES ASSOCIATED WITH THIS OPTION ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(14)	INTEGER	0	GENERAL OPEN OR CLOSED LOOP GUIDANCE OPTION. = 0, DO NOT USE. = 2, USE GENERAL CLOSED LOOP GUIDANCE PROGRAMMED IN SUBROUTINE CLGM.
DTG	SEC	1.0	THE GENERAL GUIDANCE CYCLE TIME FOR THE GENERAL GUIDANCE OPTIONS.
GVRI(J) J=1,10	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE WITH THE GENERAL GUIDANCE OPTIONS.
IGF(J) J=1,6	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE WITH THE GENERAL GUIDANCE OPTIONS.

THE OUTPUTS ASSOCIATED WITH THIS OPTION ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
GVRCJ J=1,10	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE GENERAL GUIDANCE OPTIONS.

6.B.9. OPEN LOOP APPROXIMATION TO LINEAR SINE

THIS STEERING LAW IS AN OPEN LOOP APPROXIMATION TO THE LINEAR SINE GUIDANCE ALGORITHM. THE DESIRED PITCH AND YAW ATTITUDES ARE COMMANDED TO YIELD DESIRED RADIAL AND NORMAL COMPONENTS OF THRUST ACCELERATION. TWO CONSTANTS (ARO AND BR) ARE USED TO CALCULATE THE PITCH COMMANDS. TWO OTHER CONSTANTS (ANO AND BN) ARE USED TO CALCULATE THE YAW COMMANDS. THE STEERING LAW CALCULATES THE REQUIRED ROLL AXIS ORIENTATION BASED ON A CROSS PRODUCT METHOD. THIS METHOD REQUIRES THAT THE PITCH AXIS ORIENTATION BE KNOWN. THE ALGORITHM INITIALIZES THE PITCH AXIS BASED ON A USER INPUT INITIALIZATION FLAG. THE PITCH AXIS IS TAKEN AS THE CURRENT PITCH AXIS AT THE TIME OF INITIALIZATION. ALL PITCH COMMANDS ARE THEN COMPUTED ABOUT THIS AXIS UNTIL THE PITCH AXIS IS REINITIALIZED AT A LATER TIME BY USER INPUT. THE VEHICLE BODY RATES ARE CALCULATED BASED ON THE DELTA PITCH AND YAW COMMANDS DIVIDED BY THE INTEGRATION STEP SIZE.

THE UNIT RADIAL AND NORMAL COMMANDS ARE COMPUTED AS FOLLOWS -

$$URC = BR + (ARO - GR - AC)/ASM$$

$$UNC = BN - (ANO/ASM)$$

WHERE - ARO,BR,ANO,BN ARE INPUT CONSTANTS,
GR IS THE RADIAL COMPONENT OF GRAVITY,
AC IS THE CENTRIPETAL ACCELERATION, AND
ASM IS THE CURRENT THRUST ACCELERATION.

THIS OPTION IS OBTAINED BY DEFINING THE FOLLOWING INPUTS IN NAMELIST GENDAT -

(1) INPUT IGUID(14) = 1,
(2) INPUT IGUID(1) = -1, IGUID(5) = 1, AND IGUID(12) = 2,
(3) INPUT IGF(1) = 1, TO INITIALIZE THE PITCH AXIS,
(4) INPUT IGF(2) = 1 OR 2 AS DESIRED,
(5) INPUT GVRI(1) = ARO,
(6) INPUT GVRI(2) = BR,
(7) INPUT GVRI(3) = ANO,
(8) INPUT GVRI(4) = BN,
(9) INPUT GVRI(5) = THE DESIRED RATE LIMIT.

THE CONSTANT VALUED INPUT VARIABLES FOR THIS MODULE ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

6.B.9. OPEN LOOP APPROXIMATION TO LINEAR SINE (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGF(1)	INTEGER	0	PITCH AXIS INITIALIZATION FLAG. = 0, DO NOT INITIALIZE THE PITCH AXIS. = 1, INITIALIZE THE PITCH AXIS TO THE CURRENT PROGRAM VALUE.
IGF(2)	INTEGER	0	A FLAG TO INDICATE THE TYPE OF STEERING TO BE USED. = 1, PITCH PLANE STEERING ONLY. = 2, PITCH AND YAW PLANE STEERING.
GVRI(1)	FPSS	0.	(ARO) A CONSTANT USED TO DEFINE THE DESIRED RADIAL ACCELERATION.
GVRI(2)	N/D	0.	(BR) A CONSTANT USED TO DEFINE THE DESIRED RADIAL ACCELERATION.
GVRI(3)	FPSS	0.	(ANO) A CONSTANT USED TO DEFINE THE DESIRED NORMAL ACCELERATION.
GVRI(4)	N/D	0.	(BN) A CONSTANT USED TO DEFINE THE DESIRED NORMAL ACCELERATION.

THE OUTPUT VARIABLES FOR THIS MODULE ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
GVRC(I) I=1,2	DEG/SEC	THE COMMANDED PITCH AND YAW RATES BEFORE LIMITERS.
GVRC(I) I=3,5	N/D	THE INITIAL PITCH AXIS UNIT VECTOR IN ECI COORDINATES.
GVRC(6)	N/D	(URC) THE DESIRED RADIAL THRUST ACCELERATION COMPONENT. URC IS EQUAL TO THE SINE OF THE DESIRED LOCAL PITCH ANGLE.
GVRC(7)	FPSS	(GR) THE RADIAL GRAVITY ACCELERATION COMPONENT.
GVRC(8)	FPSS	(AC) THE CENTRIPETAL ACCELERATION.

6.B.9. OPEN LOOP APPROXIMATION TO LINEAR SINE (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
GVRC(9)	N/D	(UNC) THE DESIRED NORMAL THRUST ACCELERATION COMPONENT. UNC IS THE SINE OF THE DESIRED YAW ANGLE WITH RESPECT TO THE PITCH PLANE.
PITBD YAWBD	DEG/SEC	THE PITCH AND YAW RATES AFTER LIMITERS.

6.B.10. GENERALIZED ACCELERATION STEERING (CONTD)

IN THE ABOVE EXAMPLE, THE USER WOULD HAVE IMPLEMENTED THE STEERING COMMANDS BY REQUESTING THE FOLLOWING PARAMETERS IN NAMELIST GENDAT FOR THE APPROPRIATE PHASE -

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IGUID(1) = 0,0,1,          /AERODYNAMIC ANGLES/
NPC(22) = 1,               /ETA POLYNOMIAL/
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THE CONSTANT VALUED INPUT VARIABLES FOR THIS MODULE ARE INPUT IN NAMELIST GENDAT AND ARE AS FOLLOWS -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DEPTLS(I) I=1,4	DECIMAL	1.0	THE TOLERANCES ON THE DEPENDENT STEERING VARIABLES.
DEPVLS(I) I=1,4	DECIMAL	0.	THE DESIRED VALUES OF THE DEPENDENT STEERING VARIABLES.
DEPVRS(I) I=1,4	HOLLERITH	0	THE HOLLERITH NAMES OF THE DEPENDENT STEERING VARIABLES.
INDVRS(I) I=1,4	HOLLERITH	0	THE HOLLERITH NAMES OF THE INDEPENDENT STEERING VARIABLES. THE NUMBER OF INDVRS MUST EQUAL NDEPVS.
MAXITS	INTEGER	4	MAXIMUM NUMBER OF ITERATIONS FOR THE GENERALIZED STEERING ALGORITHM PER INTEGRATION PASS.
NDEPVS	INTEGER	0	THE NUMBER OF DEPENDENT STEERING VARIABLES. NDEPVS MUST BE LESS THAN OR EQUAL TO 4. = 0 GENERALIZED ACCELERATION STEERING OPTION IS NOT ACTIVE. = 1,4 STEERING OPTION IS ACTIVE WITH NDEPVS VARIABLES.
PERTS(I) I=1,4	DECIMAL	1.0E-4	PERTURBATION SIZE FOR THE INDEPENDENT STEERING VARIABLES.
US(I) I=1,4	DECIMAL	0.	THE INITIAL GUESS FOR THE VALUES OF THE INDEPENDENT STEERING VARIABLES.

6.B.10. GENERALIZED ACCELERATION STEERING

THE GENERALIZED ACCELERATION STEERING OPTION ENABLES THE USER TO SPECIFY A SET OF STEERING EQUATIONS THAT ARE SOLVED AT EACH INSTANT OF TIME TO DETERMINE THE STEERING VARIABLES. THE STEERING EQUATIONS ARE SET UP IN NAMELIST GENDAT BY SPECIFYING THE HOLLERITH NAMES OF THE DEPENDENT AND THE INDEPENDENT STEERING VARIABLES. IN SETTING UP THE STEERING EQUATIONS, THE FOLLOWING RULES APPLY -

1. THE DEPENDENT STEERING VARIABLES MUST BE DIRECTLY RELATED TO SOME FORM OF THE VEHICLE ACCELERATION. FOR EXAMPLE, DRAG AND LIFT ARE DIRECTLY RELATED TO THE VEHICLE ACCELERATION SINCE THEY ARE FORCES. VELAD, GAMAD, AND MACHDT ARE OTHER EXAMPLES OF VARIABLES THAT ARE DIRECTLY RELATED TO THE VEHICLE ACCELERATION.

2. THE NUMBER OF DEPENDENT STEERING VARIABLES MUST BE LESS THAN OR EQUAL TO 4.

3. THE NUMBER OF INDEPENDENT STEERING VARIABLES MUST BE EQUAL TO THE NUMBER OF DEPENDENT STEERING VARIABLES.

4. THE INDEPENDENT STEERING VARIABLES MUST DIRECTLY EFFECT THE DEPENDENT STEERING VARIABLES AT EVERY INSTANT OF TIME. FOR EXAMPLE, THE CONSTANT TERM IN THE ALPHA POLYNOMIAL WITH THE PROPER IGUID VALUES COULD BE USED.

THIS TYPE OF STEERING IS BEST DESCRIBED AS INSTANTANEOUS, ITERATIVE STEERING. THIS MEANS THAT THE STEERING EQUATIONS ARE SOLVED EACH INTEGRATION PASS, AND AS A CONSEQUENCE, THE STEERING CRITERIA CAN BE SATISFIED CONTINUOUSLY WITH THIS OPTION. FOR EXAMPLE, LEVEL UNACCELERATED FLIGHT CAN BE MAINTAINED BY DETERMINING THE THROTTLE SETTING AND THE ANGLE OF ATTACK THAT CAUSES THE DERIVATIVES OF VELOCITY AND FLIGHT PATH ANGLE TO BE ZERO. SINCE THE STEERING EQUATIONS ARE SOLVED EVERY DERIVATIVE PASS, THE RUN TIME INCREASES SOMEWHAT WHEN THIS OPTION IS USED. THE INPUT FOR THIS EXAMPLE IS PRESENTED BELOW.

```
NDEPVS    = 2 ,
DEPVRS    = 6HGAMAD ,6HVELAD ,   / DEPENDENT VARIABLES  /
DEPVLS    =      0.0,      0.0,  / DEPENDENT VALUES     /
DEPTLS    =   1.0E-4,   1.0E-4,  / DEPENDENT TOLERANCES /
INDVRS    = 6HALPPC1,6HETAPC1,   / INDEPENDENT VARIABLES/
US        =      5.3,      0.4,  / INITIAL GUESS
```

THE OUTPUT VARIABLES FOR THIS MODULE ARE AS FOLLOWS -

OUTPUT SYMBOL	UNITS	DEFINITION
ESI I=1,4	DECIMAL	THE ERRORS IN THE DEPENDENT STEERING VARIABLES.
GSAITS	DECIMAL	THE NUMBER OF ITERATIONS REQUIRED BY THE GENERALIZED STEERING ALGORITHM DURING THE LAST INTEGRATION STEP.
USI I=1,4	DECIMAL	THE CONVERGED VALUES OF THE INDEPENDENT STEERING VARIABLES.

6.C. TABLE MULTIPLIER INPUT

EACH TABLE HAS ITS OWN NUMERIC MULTIPLIER. ALL NUMERIC TABLE MULTIPLIERS ARE INPUT IN NAMELIST TBLMLT. THE INPUT SYMBOL FOR A NUMERIC MULTIPLIER IS ALWAYS FORMED BY REPLACING THE T AT THE END OF THE TABLE NAME BY AN M WHICH DENOTES MULTIPLIER. FOR EXAMPLE, THE MULTIPLIER FOR TABLE PREST IS PRESM. ALL NUMERIC MULTIPLIERS ARE PRESET TO 1.0 IN THE PROGRAM UNLESS OVERRIDDEN BY INPUT.

IN ADDITION TO THE NUMERIC TABLE MULTIPLIERS, THERE ARE SOME SPECIAL PURPOSE MULTIPLIERS FOR CERTAIN AERODYNAMIC TABLES WHICH ARE SPECIFIED BY HOLLERITH NAMES. THESE ARE CALLED MNEMONIC MULTIPLIERS AND CAN BE ANY INTERNALLY COMPUTED VARIABLE WHICH IS IN THE OUTPUT VARIABLE LIST. THESE MULTIPLIERS ARE USED TO MULTIPLY TABLE LOOK-UP VALUES OF THE CORRESPONDING AERODYNAMIC COEFFICIENT TABLES. ALL MNEMONIC MULTIPLIERS ARE INPUT IN NAMELIST TBLMLT. THE LIST OF TABLES WHICH HAVE THIS FEATURE AND THE CORRESPONDING MNEMONIC MULTIPLIERS ARE AS FOLLOWS -

TABLE NAME	MNEMONIC MULTIPLIER INPUT SYMBOL	STORED VALUE	PROBABLE VALUE IF CONSTANT VALUED OR MONOVARIANT TABLES ARE INPUT
CADPT	CADPNM	DFLP	DFLP
CADYT	CADYNM	DFLY	DFLY
CAT	CANM	ONE	ALPHA OR ALPTOT
CDDPT	CDDPNM	DFLP	DFLP
CDDYT	CDDYNM	DFLY	DFLY
CDT	CDNM	ONE	ALPHA
CLDPT	CLDPNM	DFLP	DFLP
CLT	CLNM	ONE	ALPHA
CMAT	CMANM	ONE	ALPHA
CMDPT	CMDPNM	DFLP	DFLP
CNAT	CNANM	ONE	ALPHA
CNDPT	CNDPNM	DFLP	DFLP
CWBT	CWBNM	ONE	BETA
CWDYT	CWDYNM	DFLY	DFLY
CYBT	CYBNM	ONE	BETA
CYDYT	CYDYNM	DFLY	DFLY

SOME EXAMPLES OF HOW THESE MNEMONIC TABLE MULTIPLIERS ARE USED ARE AS FOLLOWS -

1) ASSUME THAT THE NORMAL FORCE COEFFICIENT SLOPE IS GIVEN PER DEGREE ALPHA. IN THIS CASE, CNAT WOULD BE INPUT AS THE COEFFICIENT SLOPE WITH CNANM INPUT AS

    CNANM = 5HALPHA,

   THE CNAT TABLE LOOK-UP VALUE WOULD THEN BE MULTIPLIED BY THE VALUE OF ALPHA TO OBTAIN THE VALUE OF THE NORMAL FORCE COEFFICIENT.

2) ASSUME THAT THE NORMAL FORCE COEFFICIENT IS GIVEN AS A BIVARIANT FUNCTION OF ALPHA AND MACH. IN THIS CASE, THE MNEMONIC MULTIPLIER CNANM WOULD BE INPUT AS

    CNANM = 3HONE,

   THE NORMAL FORCE COEFFICIENT WOULD THEN BE THE ACTUAL TABLE LOOK-UP VALUE.

6.D. TABLE DATA INPUT

THE TABLE INPUTS FOR POST ARE GENERALIZED TO INCLUDE -

1) ALLOWABLE SIZE FOR EACH TABLE OF 1500 ENTRIES. THE TOTAL SIZE OF ALL TABLES IS LIMITED BY THE CORE STORAGE ALLOCATED TO IBKT. BOTH OF THESE VALUES CAN BE CHANGED BY A SIMPLE PROGRAM MODIFICATION TO SATISFY USER REQUIREMENTS.

2) GENERALIZED ARGUMENT SPECIFICATION. THE ARGUMENT TO BE USED FOR EACH TABLE IS SPECIFIED BY INPUT AND CAN BE ANY COMPUTED OUTPUT VARIABLE.

3) CONSTANT VALUED, MONOVARIANT, BIVARIANT, OR TRIVARIANT TABLE TYPES.

4) LINEAR OR CUBIC INTERPOLATION CAPABILITY.

EACH TABLE IS INPUT IN NAMELIST TAB AS THE ARRAY TABLE. AS A RESULT, EACH TABLE BEING INPUT REQUIRES A SEPARATE INPUT OF NAMELIST TAB. TERMINATION OF THE TABLE INPUT DATA FOR A GIVEN PHASE IS INDICATED BY THE PRESENCE OF ENDPHS=1, IN THE LAST INPUT OF NAMELIST TAB FOR THAT PHASE.

THE ELEMENTS OF THE TABLE ARRAY ARE DIFFERENT DEPENDING ON THE TYPE OF TABLE BEING INPUT.

TABLE POINTERS ARE USED BY THE TABLE LOOK-UP ROUTINES FOR ALL TABLES (EXCEPT CONSTANT VALUED TABLES) TO PROVIDE EFFICIENT OPERATION OF THE TABLE LOOK-UP ROUTINES. THESE POINTERS SHOULD ALWAYS BE INPUT AS 1. THE NUMBER OF POINTERS FOR A GIVEN TABLE DEPENDS ON THE TABLE TYPE, I.E., MONOVARIANT, BIVARIANT, OR TRIVARIANT. FOR EXAMPLE, A MONOVARIANT TABLE HAS 1 POINTER WHICH IS INPUT AS TABLE(7), A BIVARIANT TABLE HAS 5 POINTERS WHICH ARE INPUT AS TABLE(10) THROUGH TABLE(14), AND A TRIVARIANT TABLE HAS 21 POINTERS WHICH ARE INPUT AS TABLE(13) THROUGH TABLE(33).

CONSTANT VALUED TABLES

THE TABLE ELEMENTS FOR CONSTANT VALUED TABLES ARE -

TABLE(1) THE HOLLERITH NAME OF THE TABLE.

TABLE(2)	THE TABLE TYPE. = 0, CONSTANT VALUED TABLE.
TABLE(3)	THE TABLE VALUE. A TYPICAL CONSTANT VALUED TABLE WOULD BE INPUT AS FOLLOWS - TABLE=6HTVC1T ,0,2000000.,

MONOVARIANT TABLES

MONOVARIANT TABLES ARE FORMED BY A SERIES OF ORDERED PAIRS OF X AND F(X) WHICH REPRESENT A CURVE. THE CURVE IS A SERIES OF LINE SEGMENTS IF LINEAR INTERPOLATION IS USED AND IS A SERIES OF SMOOTH LINES IF CUBIC INTERPOLATION IS USED.

THE SIZE OF A MONOVARIANT TABLE IS OBTAINED BY -

N = 7 + 2*NX

THE TABLE ELFMENTS FOR MONOVARIANT TABLES ARE -

TABLE(1)	THE HOLLERITH NAME OF THE TABLE.
TABLE(2)	THE TABLE TYPE. =-1, MONOVARIANT TABLE WHERE THE X VALUES ARE TO BE USED AS INTEGRATION POINTS. THE TABLE ARGUMENT MUST BE SOME FORM OF TIME, I.E., TIME, TDURP, TIMES, ETC., AND NPC(20) MUST BE INPUT AS 1. = 1, MONOVARIANT TABLE.
TABLE(3)	THE HOLLERITH NAME OF THE X ARGUMENT.
TABLE(4)	THE NUMBER OF X VALUES IN THE CURVE.
TABLE(5)	THE INTERPOLATION TYPE. = 0, STEP TABLE, I.E., NO INTERPOLATION. = 1, LINEAR INTERPOLATION. = 3, CUBIC INTERPOLATION.
TABLE(6)	THE TYPE OF X VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES.
TABLE(7)	THE INITIAL VALUE OF THE X POINTER.

TABLE(8)	THE FIRST TABLE VALUE (X1). A TYPICAL MONO-VARIANT TABLE WOULD BE INPUT AS FOLLOWS -

```
TABLE=6HALPHAT,1,6HMACH  ,L,1,1,1,
X1,F(X1),X2,F(X2),....,XL,F(XL),
```

BIVARIANT TABLES

BIVARIANT TABLES ARE FORMED BY A FAMILY OF MONOVARIANT CURVES, WHERE A MONOVARIANT CURVE IS INPUT FOR EACH VALUE OF Y. AS A RESULT, THE ARGUMENTS ARE X AND Y AND THE FUNCTION IS F(X,Y). THE X ARGUMENTS IN EACH CURVE DO NOT NEED TO BE THE SAME VALUE, HOWEVER, THERE MUST BE THE SAME NUMBER OF X VALUES IN EACH CURVE.

THE SIZE OF A BIVARIANT TABLE IS OBTAINED BY -

N = 14 + NY*(2*NX+1)

THE TABLE ELEMENTS FOR BIVARIANT TABLES ARE -

TABLE(1)	THE HOLLERITH NAME OF THE TABLE.
TABLE(2)	THE TABLE TYPE. = 2, BIVARIANT TABLE.
TABLE(3)	THE HOLLERITH NAME OF THE X ARGUMENT.
TABLE(4)	THE HOLLERITH NAME OF THE Y ARGUMENT.
TABLE(5)	THE NUMBER OF X VALUES IN EACH CURVE.
TABLE(6)	THE NUMBER OF Y VALUES (CURVES) IN THE FAMILY.
TABLE(7)	THE INTERPOLATION TYPE. = 1, LINEAR INTERPOLATION. = 3, CUBIC INTERPOLATION.
TABLE(8)	THE TYPE OF X VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES.
TABLE(9)	THE TYPE OF Y VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES.

TABLE(10)	THE INITIAL VALUE OF THE YL CURVE POINTER (INPUT = 1).
TABLE(11)	THE INITIAL VALUE OF THE X POINTER ON THE YL CURVE (INPUT = 1).
TABLE(12)	THE INITIAL VALUE OF THE X POINTER ON THE YL+1 CURVE (INPUT = 1).
TABLE(13)	THE INITIAL VALUE OF THE X POINTER ON THE YL+2 CURVE (INPUT = 1).
TABLE(14)	THE INITIAL VALUE OF THE X POINTER ON THE YL+3 CURVE (INPUT = 1).
TABLE(15)	THE FIRST TABLE VALUE (Y1). A TYPICAL BI-VARIANT TABLE WOULD BE INPUT AS FOLLOWS -

```
TABLE=6HCDT   ,2,6HMACH  ,6HALPHA ,L,M,
1,1,1,1,1,1,1,1,
Y1,X1,F(X1,Y1),X2,F(X2,Y1),...,XL,F(XL,Y1),
Y2,X1,F(X1,Y2),X2,F(X2,Y2),...,XL,F(XL,Y2),
.
.
.
YM,X1,F(X1,YN),X2,F(X2,YN),...,XL,F(XL,YM),
```

TRIVARIANT TABLES

TRIVARIANT TABLES ARE FORMED BY A FAMILY OF BIVARIANT TABLES, WHERE A BIVARIANT TABLE IS INPUT FOR EACH VALUE OF Z. AS A RESULT, THE ARGUMENTS ARE X,Y,Z AND THE FUNCTION IS F(X,Y,Z). THE Y ARGUMENTS IN EACH BIVARIANT TABLE NEED NOT BE THE SAME VALUE, HOWEVER, THERE MUST BE THE SAME NUMBER OF Y VALUES IN EACH BIVARIANT TABLE.

THE SIZE OF A TRIVARIANT TABLE IS OBTAINED BY -

N = 33 + NZ*(NY*(2*NX+1)+1)

THE TABLE ELEMENTS FOR TRIVARIANT TABLES ARE -

TABLE(18)	THE INITIAL VALUE OF THE X POINTER ON THE YL CURVE OF THE ZL FAMILY (INPUT = 1).
TABLE(19)	THE INITIAL VALUE OF THE X POINTER ON THE YL+1 CURVE OF THE ZL FAMILY (INPUT = 1).
TABLE(20)	THE INITIAL VALUE OF THE X POINTER ON THE YL+2 CURVE OF THE ZL FAMILY (INPUT = 1).
TABLE(21)	THE INITIAL VALUE OF THE X POINTER ON THE YL+3 CURVE OF THE ZL FAMILY (INPUT = 1).
TABLE(22)	THE INITIAL VALUE OF THE X POINTER ON THE YL CURVE OF THE ZL+1 FAMILY (INPUT = 1).
TABLE(23)	THE INITIAL VALUE OF THE X POINTER ON THE YL+1 CURVE OF THE ZL+1 FAMILY (INPUT = 1).
TABLE(24)	THE INITIAL VALUE OF THE X POINTER ON THE YL+2 CURVE OF THE ZL+1 FAMILY (INPUT = 1).
TABLE(25)	THE INITIAL VALUE OF THE X POINTER ON THE YL+3 CURVE OF THE ZL+1 FAMILY (INPUT = 1).
TABLE(26)	THE INITIAL VALUE OF THE X POINTER ON THE YL CURVE OF THE ZL+2 FAMILY (INPUT = 1).
TABLE(27)	THE INITIAL VALUE OF THE X POINTER ON THE YL+1 CURVE OF THE ZL+2 FAMILY (INPUT = 1).
TABLE(28)	THE INITIAL VALUE OF THE X POINTER ON THE YL+2 CURVE OF THE ZL+2 FAMILY (INPUT = 1).
TABLE(29)	THE INITIAL VALUE OF THE X POINTER ON THE YL+3 CURVE OF THE ZL+2 FAMILY (INPUT = 1).
TABLE(30)	THE INITIAL VALUE OF THE X POINTER ON THE YL CURVE OF THE ZL+3 FAMILY (INPUT = 1).
TABLE(31)	THE INITIAL VALUE OF THE X POINTER ON THE YL+1 CURVE OF THE ZL+3 FAMILY (INPUT = 1).
TABLE(32)	THE INITIAL VALUE OF THE X POINTER ON THE YL+2 CURVE OF THE ZL+3 FAMILY (INPUT = 1).

TABLE(1)	THE HOLLERITH NAME OF THE TABLE.
TABLE(2)	THE TABLE TYPE. = 3, TRIVARIANT TABLE.
TABLE(3)	THE HOLLERITH NAME OF THE X ARGUMENT.
TABLE(4)	THE HOLLERITH NAME OF THE Y ARGUMENT.
TABLE(5)	THE HOLLERITH NAME OF THE Z ARGUMENT.
TABLE(6)	THE NUMBER OF X VALUES IN EACH CURVE.
TABLE(7)	THE NUMBER OF Y VALUES (CURVES) IN EACH FAMILY.
TABLE(8)	THE NUMBER OF Z VALUES (FAMILIES) IN THE TABLE.
TABLE(9)	THE INTERPOLATION TYPE. = 1, LINEAR INTERPOLATION. = 3, CUBIC INTERPOLATION.
TABLE(10)	THE TYPE OF X VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES
TABLE(11)	THE TYPE OF Y VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES
TABLE(12)	THE TYPE OF Z VALUES. =-1, DECREASING VALUES. = 1, INCREASING VALUES
TABLE(13)	THE INITIAL VALUE OF THE ZL FAMILY POINTER (INPUT = 1).
TABLE(14)	THE INITIAL VALUE OF THE YL POINTER IN THE ZL FAMILY (INPUT = 1).
TABLE(15)	THE INITIAL VALUE OF THE YL POINTER IN THE ZL+1 FAMILY (INPUT = 1).
TABLE(16)	THE INITIAL VALUE OF THE YL POINTER IN THE ZL+2 FAMILY (INPUT = 1).
TABLE(17)	THE INITIAL VALUE OF THE YL POINTER IN THE ZL+3 FAMILY (INPUT = 1).

TABLE(33) THE INITIAL VALUE OF THE X POINTER ON THE YL+3 CURVE OF THE ZL+3 FAMILY (INPUT = 1).

TABLE(34) THE FIRST TABLE VALUE (Z1). A TYPICAL TRI-VARIANT TABLE WOULD BE INPUT AS FOLLOWS -

```
TABLE=5HHTRTT,3,6HALTITO,4HVELA,5HALPHA,L,M,N,
1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,
1,1,1,
Z1,Y1,X1,F(X1,Y1,Z1),...,XL,F(XL,Y1,Z1),
    .
    .
    .
    YM,X1,F(X1,YM,Z1),...,XL,F(XL,YM,Z1),
Z2,Y1,X1,F(X1,Y1,Z2),...,XL,F(XL,Y1,Z2),
    .
    .
    .
    YM,X1,F(X1,YM,Z2),...,XL,F(XL,YM,Z2),
.
.
.
ZN,Y1,X1,F(X1,Y1,ZN),...,XL,F(XL,Y1,ZN),
    .
    .
    .
    YM,X1,F(X1,YM,ZN),...,XL,F(XL,YM,ZN),
```

7. ERROR MESSAGES AND TROUBLE-SHOOTING

THE PROGRAM PRINTS OUT ERROR MESSAGES WHENEVER A SITUATION ARISES WHICH PREVENTS THE PROGRAM FROM CONTINUING (FATAL ERROR) OR WHENEVER A SITUATION ARISES WHICH THE USER SHOULD BE AWARE OF (NON-FATAL ERROR) BUT WHICH WILL NOT IN ITSELF CAUSE THE PROGRAM TO TERMINATE.

THERE ARE CIRCUMSTANCES WHICH CAN ARISE DUE TO INPUT ERRORS WHICH WILL PRODUCE CONDITIONS THAT CANNOT EASILY BE DIAGNOSED INTERNALLY BY THE PROGRAM. THESE CASES WILL INVARIABLY CAUSE THE PROGRAM TO TERMINATE WITH A CORE DUMP. DIAGNOSIS IN THESE CASES CAN USUALLY BE MADE BY CHECKING THE INPUT AND THE TRAJECTORY PRINTOUT UP TO THE TIME OF THE DUMP. IN CERTAIN CASES, THE CORE DUMP MUST BE EXAMINED TO DETERMINE THE PROGRAM LOGIC THAT CAUSED THE DUMP. FOR EXAMPLE, AN INPUT ERROR IN A THRUST TABLE COULD PRODUCE INFINITE THRUST. THE PROGRAM WOULD THEN DUMP AS SOON AS IT ATTEMPTED TO USE THAT VALUE. THESE TYPES OF INPUT ERRORS CANNOT GENERALLY BE ACCOMODATED BY AN ERROR MESSAGE. AS A RESULT, ONLY THE MOST PROBABLE INPUT ERRORS HAVE BEEN INCLUDED IN THE LIST OF ERROR MESSAGES.

ERROR MESSAGES ARE USUALLY CAUSED BY INPUT ERRORS OR BY INVALID PROBLEM DEFINITION. AS A RESULT, THE FIRST COURSE OF ACTION TO BE TAKEN WHEN AN ERROR MESSAGE (OR DUMP) IS OBTAINED IS TO REVIEW ALL INPUT DATA AND THE PROBLEM FORMULATION.

THE SELECTION AND PLACEMENT OF CONTROL PARAMETERS IS VERY IMPORTANT TO THE SUCCESSFUL OPERATION OF THE SEARCH/OPTIMIZATION ALGORITHMS. CASES WHICH SHOW POOR CONVERGENCE SHOULD BE EXAMINED TO ENSURE THAT THE SELECTION OF CONTROL PARAMETERS AND PROBLEM SETUP CAN PRODUCE A SOLUTION. POOR CONVERGENCE IS SOMETIMES CAUSED BY UNEQUAL WEIGHTING OF THE TARGET VARIABLES. THAT IS, THE DESIRED TOLERANCES FOR THE TARGET VARIABLES ARE NOT OF THE SAME PERCENTAGE. THIS CAUSES THE ALGORITHM TO TRY TO SATISFY THE TARGET VARIABLE WHICH HAS THE LARGEST WEIGHTED ERROR EVEN THOUGH THE ACTUAL ERROR MAY BE SMALL. CONTROL PARAMETER WEIGHTING IS ALSO IMPORTANT. THE AUTOMATIC WEIGHTING PROCESS GENERALLY PROVIDES THE BEST WEIGHTING FOR MOST PROBLEMS. HOWEVER, PROBLEMS WHICH ENCOMPASS DIFFERENT FLIGHT REGIMES IN THE SAME RUN USUALLY MUST BE WEIGHTED MANUALLY OR BY SOME SPECIFIC WEIGHTING METHOD IN ORDER TO PRODUCE A SOLUTION.

THE TROUBLE SHOOTING LIST SHOULD BE REVIEWED IF AN ERROR MESSAGE OR UNEXPECTED RESULTS WERE OBTAINED FROM THE TRAJECTORY SIMULATION.

TROUBLE SHOOTING

1) CHECK THE SEQUENCE OF NAMELISTS TO SEE THAT THEY ARE IN THE PROPER ORDER.

2) CHECK TO SEE THAT EACH NAMELIST IS TERMINATED BY A $ IN COLUMNS 2 THROUGH 80.

3) CHECK TO SEE THAT EACH PHASE IS TERMINATED BY ENDPHS = 1, IN NAMELISTS GENDAT, TBLMLT, OR TAB AS THE CASE MAY BE.

4) CHECK TO SEE THAT THE PHASE (EVENT) NUMBERS ARE ASSIGNED IN ASCENDING ORDER.

5) CHECK TO SEE THAT THE LAST PHASE CONTAINS ENDPRB=1, AND ENDJOB=1.

6) CHECK TO SEE THAT THE FINAL EVENT SEQUENCE NUMBER (FESN) IS LESS THAN OR EQUAL TO THE LAST PHASE OF THE PROBLEM.

7) CHECK TO SEE THAT THE EVENT CRITERIA FOR EACH PRIMARY EVENT CAN BE ATTAINED IN THE PRESCRIBED ORDER OF OCCURRANCE.

8) IF SERCH ERRORS HAVE OCCURRED, CHECK ALL HOLLERITH INPUT VARIABLES TO BE SURE THAT THE NAMES ARE VALID.

ERROR MESSAGES

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
ACCEL LIMIT, THRUST	PROP/NON-FATAL	THE SPECIFIED ACCELERATION LIMIT (ASMAX) COULD NOT BE ATTAINED BY THROTTLING. CHECK THE MAGNITUDE OF THE AERODYNAMIC FORCES AND THE ANGLE OF ATTACK.
DATA BUFFER	READAT/FATAL	THE CONSTANT VALUED INPUT DATA EXCEEDS 2000 CELLS OR THE TABLE DATA EXCEEDS 2000 CELLS. REDUCE THE AMOUNT OF INPUT DATA OR CHECK THE TABLE INPUTS FOR THE CORRECT FORMAT.

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
DIMENSION TABLE NAME	READAT/FATAL	THE INDICATED TABLE IS INPUT INCORRECTLY. CHECK TABLE INPUT.
-DINPT-ESN= I NOT FOUND	DINPT/FATAL	DATA FOR EVENT I DOES NOT EXIST. MACHINE ERROR, RERUN THE JOB.
DIRECTION OF SEARCH UPHILL	TRYIT2/FATAL	THE TARGET ERRORS CANNOT BE REDUCED ANY FURTHER WITH THE GIVEN SET OF CONTROLS. CHECK THE PROBLEM FORMULATION OR THE SIZE OF THE PERTURBATIONS (PERT).
END FILE TAPE 1 -DINPT - ESN = I	DINPT/FATAL	END OF FILE WAS ENCOUNTERED TRYING TO READ DATA FOR EVENT I. MACHINE ERROR, RERUN THE JOB.
EOF ENCOUNT-ERED BY INPUTN	SYSTEM/FATAL	THE SYSTEM ENCOUNTERED AN END OF FILE WHILE READING INPUT. CHECK TO SEE THAT ALL NAMELISTS ARE INPUT AND ARE TERMINATED BY A $ AND THAT EACH PHASE IS TERMINATED BY ENDPHS=1.
EOF READAT	READAT/FATAL	AN END OF FILE WAS ENCOUNTERED TRYING TO READ PREVIOUSLY PROCESSED INPUT DATA. MACHINE ERROR, RERUN THE JOB.
FATAL SERCH ERRORS	READAT/FATAL	THE HOLLERITH INPUT NAMES SHOWN ARE INCORRECT. CHECK ALL VARIABLES CONTAINING HOLLERITH INPUTS TO SEE THAT THE NAMES ARE VALID AND SPELLED CORRECTLY.
GIMAG=0,CK-INPUTS	GMAG/FATAL	THE GRADIENT OF THE OPTIMIZATION VARIABLE (OPTVAR) WITH RESPECT TO THE CONTROLS IS ZERO. AT LEAST ONE CONTROL PARAMETER MUST BE USED WHICH WILL AFFECT THE VARIABLE SPECIFIED BY OPTVAR.

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
G2MAG=0,CK INPUTS	GMAG/FATAL	THE GRADIENT OF THE TARGET VARIABLES (DEPVR) WITH RESPECT TO THE CONTROLS IS ZERO. CHECK THE INPUTS FOR NAMELIST SEARCH.
GCRAD = 0 SEE NPC(4)	MOTIAL/FATAL	SELF-EXPLANATORY.
GENTAB, I XS=ARGUMENT VALUE X=TABLE VALUE	TAB/NON-FATAL	THE TABLE ARGUMENT (XS) OF TABLE I EXCEEDS THE TABLE VALUE (X). EXTRAPOLATION IS USED TO OBTAIN THE TABLE VALUE CORRESPONDING TO XS.
ILLEGAL CNTRL CRITR	READAT/FATAL	THE FIRST PHASE OR A PHASE THAT DOES NOT EXIST WAS SPECIFIED AS A CONTROL PARAMETER. CHECK THE INPUTS INDVR AND INDPH IN NAMELIST SEARCH.
INVERSION OF A SINGULAR MATRIX WAS ATTEMPTED	INVM/FATAL	ONE OF THE TARGET VARIABLES (DEPVR) IS NOT AFFECTED BY ANY OF THE CONTROL PARAMETERS. CHECK THE INPUTS FOR NAMELIST SEARCH.
***ITERATION LIMIT	ITERO/FATAL	THE SPECIFIED ITERATION LIMIT WAS REACHED. CHECK MAXITR IN NAMELIST SEARCH.
MASS .LE.0	MOTIAL/FATAL	THE VEHICLE MASS IS LESS THAN OR EQUAL TO ZERO. CHECK TO SEE THAT WGTSG IS INPUT CORRECTLY.
MISSING CNTRL CRITR	READAT/FATAL	A CRITERIA FOR A PHASE THAT DOES NOT EXIST WAS REQUESTED AS A CONTROL.
MISSING TARGT CRITR	READAT/FATAL	A CRITERIA FOR A PHASE THAT DOES NOT EXIST WAS REQUESTED AS A TARGET.
NAMELIST ERROR	RGENDAT/FATAL RSEARCH/FATAL RTAB/FATAL RTBLMLT/FATAL	A NAMELIST ERROR HAS OCURRED. CHECK INPUT DATA.

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
***NO CHANGE IN STATE DURING 2 CONSECUTIVE ITERATIONS	ITERO/FATAL	THE CONTROL PARAMETERS COULD NOT IMPROVE THE TARGET ERRORS OR THE OPTIMIZATION VARIABLE DURING THE LAST TWO ITERATIONS.
NO EVENT NO.	READAT/FATAL	A PHASE WAS INPUT WITH NO EVENT NUMBER (EVENT) OR IT IS ZERO. INPUT THE EVENT NUMBER AS EVENT(1).
NO PHASE = OPTPH	TRAJ/FATAL	THE PHASE SPECIFIED IN OPTPH DID NOT OCCUR OR DOES NOT EXIST.
OPTIMIZATION UPHILL	TRYIT1/FATAL	THE OPTIMIZATION VARIABLE CANNOT BE IMPROVED WITH THE GIVEN SET OF CONTROL PARAMETERS. CHECK THE PROBLEM FORMULATION OR THE SIZE OF THE PERTURBATIONS (PERT).
PARITY ERR TAPE 1 -DINPT- ESN=I	DINPT/FATAL	A READ PARITY ERROR OCURRED TRYING TO READ DATA FOR EVENT I. MACHINE ERROR, RERUN THE JOB.
PCTGO .LT. 50 PERCENT	TGOEM/NON-FATAL	THE TIME TO GO WAS REDUCED BY MORE THAN 50 PERCENT TRYING TO HIT THE SEPCIFIED EVENT.
***PROBLEM SOLVED	ITERO/NOT AN ERROR	THE PROBLEM HAS BEEN TARGETED AND OPTIMIZED TO THE SPECIFIED TOLERANCES.
SERCH I	SERCH/FATAL	THE HOLLERITH INPUT VARIABLE I IS NOT VALID OR IT IS MISSPELLED. THIS IS A NON-FATAL ERROR IF THE MISSPELLED VARIABLE IS A PRINT VARIABLE. CHECK THE HOLLERITH NAME IN QUESTION.
SETIC, PHASE I DOES NOT EXIST	SETIC/FATAL	PHASE NUMBER I WAS REQUESTED AS A CONTROL PARAMETER PHASE BUT DOES NOT EXIST. CHECK THE PHASE NUMBERS INPUT IN INDPH.

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
SETIC PARITY	SETIC/FATAL	A PARITY ERROR OCCURRED TRYING TO READ THE INITIAL CONDITIONS FOR A PHASE DURING SEARCH/ OPTIMIZATION. MACHINE ERROR, RERUN THE JOB.
STATIC TRIM, THRUST	XITER/NON-FATAL	THE THRUST IS INSUFFICIENT TO BALANCE THE AERODYNAMIC MOMENTS. CHECK THE STATIC TRIM INPUTS OR THE PROBLEM SETUP.
TGOMI	TGOEMI/FATAL	NO EVENT CRITERIA HAVE BEEN INPUT. CHECK THE VALUE OF CRITR.
TIME LIMIT INSUFFICIENT FOR ANOTHER ITERATION	ITERO/FATAL	SELF EXPLANATORY. CHECK CP TIME ESTIMATE.
TIME TO GO EXCEEDED 20 ITERATIONS TRYING TO HIT ESN = I	CYCXM/FATAL	THE CONDITIONS FOR THE SPECIFIED EVENT COULD NOT BE MET IN 20 ITERATIONS. CHECK EVENT CRITERIA INPUTS.
TOO MANY CRASHES	FGAMA/FATAL	SIX SUCCESSIVE TRAJECTORIES CRASHED IN TRYING TO GENERATE A SUCCESSFUL TRIAL STEP. CHECK PROBLEM SETUP.
TRAJECTORY TERMINATED BY ALTMAX = XXX	PHZXM/FATAL	SELF-EXPLANATORY. CHECK THE PROBLEM SETUP OR REDUCE THE INTEGRATION STEPSIZE.
TRAJECTORY TERMINATED BY ALTMIN = XXX	PHZXM/FATAL	SELF-EXPLANATORY. CHECK THE PROBLEM SETUP OR REDUCE THE INTEGRATION STEPSIZE.
TRAJECTORY TERMINATED BY MASS .LE. 0	PHZXM/FATAL	SELF-EXPLANATORY. CHECK THE PROBLEM SETUP.

MESSAGE	SOURCE/TYPE	CONDITION/CORRECTIVE ACTION
TRAJECTORY TERMINATED BY MAXTIM = XXX	PHZXM/FATAL	SELF-EXPLANATORY. CHECK THE PROBLEM SETUP OR THE EVENT CRITERIA AND MODEL TO SEE THAT THE DESIRED CONDITIONS CAN BE ATTAINED.
TRIM AND MAX-G UNSAT	PROP/NON-FATAL	THE SPECIFIED ACCELERATION LIMIT AND STATIC TRIM COULD NOT BE ACHIEVED.
TWOBDY DID NOT CONVRG	TWOBDY/NON-FATAL	THE INDICATED ORBIT INTEGRATION DID NOT CONVERGE. CHECK THE VALUE OF DT.
UNABLE TO LIMIT ACCEL	PROP/NON-FATAL	THE SPECIFIED ACCELERATION LIMIT COULD NOT BE ACHIEVED EVEN BY THROTTLING THE ENGINES TO ZERO.
UNUSABLE NOMINAL	NOMINL/FATAL	THE NOMINAL TRAJECTORY DURING SEARCH/OPTIMIZATION DID NOT REACH THE FINAL EVENT (FESN). CHECK THE PROBLEM SETUP.

8. SAMPLE PROBLEM

THIS SECTION PRESENTS A SAMPLE INPUT LISTING AND ASSOCIATED OUTPUT OF AN ASCENT TRAJECTORY FOR A SHUTTLE TYPE VEHICLE. THE PROBLEM IS TO MAXIMIZE THE BURNOUT WEIGHT TO A SPECIFIED ORBIT.

THE SAMPLE TRAJECTORY REQUIRED 7 ITERATIONS TO SOLVE THE PROBLEM AT A COST OF APPROXIMATELY 4 MINUTES OF CENTRAL PROCESSOR (CP) TIME AND APPROXIMATELY 12 MINUTES OF PERIPHERAL PROCESSOR (PP) TIME ON THE MARTIN MARIETTA CORPORATION CDC 6400 COMPUTER.

THE CONTROL PARAMETERS FOR THE SAMPLE PROBLEM WERE THE GROSS VEHICLE WEIGHT AT LIFTOFF AND 8 PITCH RATES THROUGHOUT THE TRAJECTORY. THE TARGET CONDITIONS WERE SPECIFIED AS A DESIRED ALTITUDE, INERTIAL VELOCITY, AND INERTIAL FLIGHT PATH ANGLE. THE OPTIMIZATION PAYOFF PARAMETER WAS THE WEIGHT OF THE VEHICLE AT BURNOUT.

THE SEQUENCE OF EVENTS FOR THE SAMPLE PROBLEM IS SUMMARIZED AS FOLLOWS -

EVENT NUMBER	EVENT TYPE	DESCRIPTION
1.0	PRIMARY	LIFTOFF.
2.0	PRIMARY	INTERRUPT AT 15 SEC FROM LIFTOFF TO INITIATE PITCH RATE 1.
3.0	PRIMARY	INTERRUPT AT 25 SEC FROM LIFTOFF TO INITIATE PITCH RATE 2.
4.0	PRIMARY	INTERRUPT AT 40 SEC FROM LIFTOFF TO INITIATE PITCH RATE 3.
5.0	PRIMARY	INTERRUPT AT 60 SEC FROM LIFTOFF TO INITIATE PITCH RATE 4.
6.0	PRIMARY	INTERRUPT AT 120 SEC FROM LIFTOFF TO INITIATE PITCH RATE 5.
7.0	PRIMARY	INTERRUPT AT 150 SEC FROM LIFTOFF TO INITIATE PITCH RATE 6.
8.0	PRIMARY	INTERRUPT WHEN THE REMAINING PROPELLANT (WPROP) GOES TO ZERO TO INITIATE A COAST PHASE.

8. SAMPLE PROBLEM (CONTD)

9.0	PRIMARY	INTERRUPT AT 7 SEC FROM THE PREVIOUS PHASE TO INITIATE JETTISON OF STAGE 1 AND START OF STAGE 2 FLIGHT. ALSO INITIATE PITCH RATE 7
10.0	PRIMARY	INTERRUPT AT 100 SEC FROM THE PREVIOUS PHASE TO INITIATE PITCH RATE 8.
11.0	PRIMARY	INTERRUPT AT 150 SEC FROM THE PREVIOUS PHASE TO ACTIVATE THE CONIC CALCULATIONS.
12.0	PRIMARY	INTERRUPT WHEN THE REMAINING PROPELLANT (WPROP GOES TO ZERO TO TERMINATE THE TRAJECTORY.

8.A. SAMPLE PROBLEM INPUT

THIS SECTION PRESENTS A LISTING OF THE INPUT DATA DECK USED TO GENERATE THE TRAJECTORY PRINTOUT IN THE NEXT SECTION.

```
P$SEARCH
C   ************************************************************************
C   PROBLEM
C      MAXIMIZE WEIGHT
C      SUBJECT TO
C                  ALTITO - 303805  =  0
C                  VELI   -  25853  =  0
C                  GAMMAI -      0  =  0
C   ************************************************************************
 SRCHM      =          4,
 IPRO       =         -1,
 MAXITR     =         10,
 OPT        =        1.0,
 OPTVAR     = 6HWEIGHT,
 OPTPH      =       12.0,
 WOPT       =     1.0E-6,
 CONEPS     =      89.98,
C
 NINDV      =          9,
 PERT       =        1.0,
 INDVR      = 6HWGTSG  , 6HPITPC2, 6HPITPC2, 6HPITPC2, 6HPITPC2,
 INDPH      =          1,        2,        3,        4,        5,
 U          =4031000.0,     -1.8,      -.5,      -.2,      -.3,
 INDVR(6)   = 6HPITPC2, 6HPITPC2, 6HPITPC2, 6HPITPC2,
 INDPH(6)   =          6,        7,        9,       10,
 U(6)       =       -.25,      -.3,     -.15,     -.05,
C
 NDEPV      =          3,
 DEPVR      = 6HALTITO, 6HVELI   , 6HGAMMAI,
 DEPVAL     = 303805.0,  25853.0,      0.0,
 DEPTL      =      100.0,       .1,     .001,
 $
P$GENDAT
 TITLE      =50H SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER    ,
 EVENT      =          1,
C
 NPC(2)     =          1, 4, 2,
 NPC(8)     =          2, 1,
 NPC(16)    =          1,
 NPC(21)    =          1,
C
 IGUID(1)   =          1,
 IGUID(4)   =          1,
C
```

```
 MAXTIM    =   1000.0,
 ALTMAX    =2000000.0,
 FESN      =        12,
 DT        =      5.0,
 PINC      =     20.0,
 GDLAT     =     28.5,
 LONG      =    279.4,
 AZL       =     90.0,
 NENG      =        1,
 WPROPI    =2249000.0,
 ISPV      =    439.0,
 GXP       =   218.42,
 GYP       =      0.0,
 GZP       =    33.33,
 SREF      =  4500.00,
 LREF      =  218.833,
 $
P$TBLMLT
 $
P$TAB
 TABLE     = 6HTVC1T ,0,5472000.0,
 $
P$TAB
 TABLE     = 6HAE1T  ,0,232.5,
 $
P$TAB
 TABLE     = 6HCDT   ,2,6HMACH  ,6HALPHA ,12,5,1,1,1,1,1,1,1,1,
 -20.,
 0.0, 1.456,  .5, 1.585, .7, 1.598, .8, 1.242, 1., 3.157, 1.2,2.996,
 1.5, 1.816, 2.0, 1.301, 3.,  .850, 5.,  .482, 7.,  .382, 10.,  .396,
 - 5.,
 0.0,  .263,  .5,  .338, .7,  .110, .8,  .302, 1.,  .690, 1.2, .671,
 1.5,  .563, 2.0,  .480, 3.,  .383, 5.,  .256, 7.,  .212, 10.,  .210,
   0.,
 0.0,  .180,  .5,  .18 , .7,  .200, .8,  .251, 1.,  .495, 1.2, .502,
 1.5,  .485, 2.0,  .456, 3.,  .391, 5.,  .272, 7.,  .231, 10.,  .231,
   5.,
 0.0,  .263,  .5,  .338, .7,  .110, .8,  .302, 1.,  .690, 1.2, .671,
 1.5,  .563, 2.0,  .480, 3.,  .383, 5.,  .256, 7.,  .212, 10.,  .210,
  20.,
 0.0, 1.456,  .5, 1.585, .7, 1.598, .8, 1.242, 1., 3.157, 1.2,2.996,
 1.5, 1.816, 2.0, 1.301, 3.,  .850, 5.,  .482, 7.,  .382, 10.,  .396
 $
```

```
P$TAB
 TABLE     = 6HCLT    ,2,6HMACH   ,6HALPHA ,12,4,1,1,1,1,1,1,1,1,
 -20.,
 0.0, -1.010,  .5,-1.025, .7, -.99,  .8, -.815, 1.,-1.08 , 1.2,-1.11,
 1.5,  -.895, 2.0, -.788, 3.,-.635,  5., -.480, 7., -.43 , 10., -.43,
   0.,
 0.0,   .015,  .5,  .04 , .7, .01 ,  .8, -.045, 1.,  .08 , 1.2, .038,
 1.5,  -.02 , 2.0, -.108, 3.,-.145,  5., -.15,  7., -.15 , 10.,-.15 ,
   5.,
 0.0,   .545,  .5,   .75, .7,  .53,  .8,  .365, 1.,  .69 , 1.2, .638,
 1.5,   .43 , 2. ,  .242, 3.,  .11,  5., .025 , 7.,  .00 , 10., .00 ,
  20.,
 0.0,  2.135,  .5, 2.24 , .7, 2.09,  .8,1.595 , 1., 2.52 , 1.2,2.438,
 1.5,  1.78 , 2. , 1.292, 3., .875,  5., .55  , 7.,  .45 , 10., .45 ,
 $
P$TAB
 TABLE     = 6HCMAT  ,1,6HMACH   ,12,1,1,1,
 0.0, .019,  .7, .0218,  .9, .0302,  1., .023,  1.2,-.011,  1.5,-.032,
 1.8,-.0395, 2.,-.0419,  3.,-.0396,  5.,-.0187,  7.,-.0082, 10., 0.0,
 $
P$TAB
 TABLE     = 6HXREFT ,1,6HMACH   ,12,1,1,1,
 0.0,137.86,  .7,140.05,  .9,136.77,  1.,147.71,  1.2,145.52,
 1.5,144.43,  1.8,141.58,  2.,138.3,  3.,131.74,  5.,118.83,
 7.,109.42,  10.,91.91,
 ENDPHS    =         1,
 $
P$GENDAT
 EVENT     =         2, CRITR     = 6HTIME    ,  VALUE     = 15.0,
 IGUID(4)  =         0,
 ENDPHS    =         1,
 $
P$GENDAT
 EVENT     =         3, CRITR     = 6HTIME    ,  VALUE     = 25.0,
 ENDPHS    =         1,
 $
P$GENDAT
 EVENT     =         4, CRITR     = 6HTIME    ,  VALUE     = 40.0,
 ENDPHS    =         1,
 $
P$GENDAT
 EVENT     =         5, CRITR     = 6HTIME    ,  VALUE     = 60.0,
 NPC(7)    =         1,
 ASMAX     =       3.0,
 ENDPHS    =         1,
 $
```

```
P$GENDAT
 EVENT     =          6, CRITR     = 6HTIME   ,  VALUE     = 120.0,
 ENDPHS    =          1,
 $
P$GENDAT
 EVENT     =          7, CRITR     = 6HTIME   ,  VALUE     = 150.0,
 DT        =       10.0,
 ENDPHS    =          1,
 $
P$GENDAT
 EVENT     =          8, CRITR     = 6HWPROP  ,  VALUE     = 0.0,
 NPC(7)    =          0,
 NPC(9)    =          0, 0,
 WEICON    =        0.0,
 ENDPHS    =          1,
 $
P$GENDAT
 EVENT     =          9, CRITR     = 6HTDURP  ,  VALUE     = 7.,
 DT        =       20.0,
 PINC      =       50.0,
 NPC(7)    =          1,
 NPC(9)    =          1,
 WJETT     =   665000.0,
 WPROPI    =   809000.0,
 ISPV      =      459.0,
 GXP       =      142.0,
 GYP       =        0.0,
 GZP       =       25.0,
 SREF      =     4840.0,
 LREF      =      135.0,
 $
P$TBLMLT
 $
P$TAB
 TABLE     = 6HTVC1T ,0,1431000.0,
 $
P$TAB
 TABLE     = 6HAE1T  ,0,154.54,
 $
P$TAB
 TABLE    = 6HCDT    ,2,6HMACH   ,6HALPHA ,12,7,1,1,1,1,1,1,1,
 -20.,
 0,.024, .2,.024, .6,.026, .8,.028, .9,.035, 1.3,.093, 1.5,.122,
 2,.116, 2.48,.1, 3,.092, 3.9,.082, 40,.03,
 - 4.,
 0,.024, .2,.024, .6,.026, .8,.028, .9,.035, 1.3,.093, 1.5,.122,
 2,.116, 2.48,.1, 3,.092, 3.9,.082, 40,.03,
```

```
  0.,
 0,.026, .2,.026, .6,.026, .8,.024, .9,.036, 1.3,.092, 1.5,.118,
 2,.106, 2.48,.091, 3,.082, 3.9,.074, 40,.022,
  5.,
 0,.042, .2,.042, .6,.04, .8,.042, .9,.076, 1.3,.124, 1.5,.142,
 2,.124, 2.48,.098, 3,.088, 3.9,.079, 40,.033,
 10.,
 0,.076, .2,.076, .6,.08, .8,.1, .9,.13, 1.3,.194, 1.5,.192,
 2,.165, 2.48,.127, 3,.114, 3.9,.095, 40,.057,
 20.,
 0,.36, .2,.36, .6,.362, .8,.44, .9,.41, 1.3,.39, 1.5,.36 , 2,.32,
 2.48,.242, 3,.224, 3.9,.216, 40,.238,
 30.,
 0,.36, .2,.36, .6,.36, .8,.44, .9,.41, 1.3,.39, 1.5,.36, 2,.32,
 2.48,.44, 3,.418, 3.9,.4, 40,.3,
 $
P$TAB
 TABLE   = 6HCLT   ,2,6HMACH   ,6HALPHA ,12,7,1,1,1,1,1,1,1,1,
 -20.,
 0,-.07, .2,-.08, .6,-.12, .8,-.12, .9,-.12, 1.3,-.12, 1.5,-.12,
 2,-.13, 2.48,-.14, 3,-.12, 3.9,-.1, 40,-.14,
  4.,
 0,-.07, .2,-.08, .6,-.12, .8,-.12, .9,-.12, 1.3,-.12, 1.5,-.12,
 2,-.13, 2.48,-.14, 3,-.12, 3.9,-.1, 40,-.14,
  0.,
 0,.08, .2,.08, .6,.08, .8,.06, .9,.06, 1.3,.07, 1.5,.04, 2,0.0,
 2.48,-.02, 3,-.03, 3.9,-.04, 40,.03,
  5.,
 0,.29, .2,.29, .6,.29, .8,.28, .9,.28, 1.3,.3, 1.5,.24, 2,.17,
 2.48,.12, 3,.09, 3.9,.08, 40,.21,
 10.,
 0,.5, .2,.6, .6,.49, .8,.48, .9,.52, 1.3,.52, 1.5,.41, 2,.33,
 2.48,.25, 3,.2, 3.9,.15, 40,.4,
 20.,
 0,.94, .2,.94, .6,.92, .8,.9, .9,.94, 1.3,.89, 1.5,.75, 2,.63,
 2.48,.51, 3,.43, 3.9,.39, 40,.76,
 30.,
 0,.94, .2,.94, .6,.92, .8,.9, .9,.94, 1.3,.89, 1.5,.75, 2,.68,
 2.48,.67, 3,.65, 3.9,.62, 40,.76,
 $
P$TAB
 TABLE   = 6HCMAT   ,0,0.0,
 $
P$TAB
 TABLE   = 6HXCGT   ,1,6HWEICON,5,1,1,1,
 0,87.64, 202250,93.93, 404500,99.68, 606750,104.04, 809000,104.37,
 $
```

```
P$TAB
 TABLE     = 6HYCGT   ,0,0.0,
 $
P$TAB
 TABLE     = 6HZCGT   ,1,6HWEICON,5,1,1,1,
 0,31.33, 202250,31.5, 404500,31.75, 606750,32.42, 809000,33.83,
 ENDPHS    =        1,
 $
P$GENDAT
 EVENT     =       10, CRITR     = 6HTDURP  ,  VALUE     = 100.0,
 ENDPHS    =        1,
 $
P$GENDAT
 EVENT     =       11, CRITR     = 6HTDURP  ,  VALUE     = 150.0,
 NPC(1)    =        2,
 ENDPHS    =        1,
 $
P$GENDAT
 EVENT     =       12, CRITR     = 6HWPROP  ,  VALUE     = 0.,
 ENDPHS    =        1,
 ENDPRB    =        1,
 ENDJOB    =        1,
 $
```

8.B. SAMPLE PROBLEM OUTPUT

THE SAMPLE OUTPUT SHOWS THE TARGET ERRORS AT THE END OF THE NOMINAL TRAJECTORY AND THE ITERATION SUMMARIES FOR EACH ITERATION TAKEN DURING THE SOLUTION OF THE SAMPLE PROBLEM. THE FIRST AND LAST PHASES OF THE ANSWER TRAJECTORY ARE PRINTED FOLLOWING THE LAST ITERATION TO ILLUSTRATE THE TRAJECTORY PRINTOUT FORMAT.

THE ANSWERS SHOWN WERE OBTAINED ON THE MARTIN MARIETTA CDC 6500 COMPUTER. ANSWERS OBTAINED ON OTHER COMPUTERS AND OPERATING SYSTEMS WILL PROBABLY DIFFER SLIGHTLY FROM THESE RESULTS DUE TO NUMERICAL ACCURACY DIFFERENCES BETWEEN THE COMPUTERS AND OPERATING SYSTEMS.

*** NOMINAL TRAJECTORY

INDVR	WGTSG	PITPC2	PITPC2	PITPC2	PITPC2	PITPC2
	PITPC2	PITPC2	PITPC2			
INDPH	1.000	2.000	3.000	4.000	5.000	6.000
	7.000	9.000	10.000			
U(I)	4.03100000E+06	-1.80000000E+00	-5.00000000E-01	-2.00000000E-01	-3.00000000E-01	-2.50000000E-01
	-3.00000000E-01	-1.50000000E-01	-5.00000000E-02			
WE(I)	1.56612474E+03	-5.44597270E+03	2.77641668E+03			
DEPVR	ALTITO	VELI	GAMMAI			
DEPPH	900.000	900.000	900.000			
E(I)	1.56612474E+05	-5.44597270E+02	2.77641668E+00			
P1	-3.08000000E-01					

OPTVAR	WEIGHT
OPTPH	12.000
OPTVAL	3.08000000E+05
P2	3.98198560E+07

```
*** ITERATION NUMBER  2

CP/ITR 4.15332031E+00
PERT    1.00000000E+00       1.00000000E-04       1.00000000E-04       1.00000000E-04       1.00000000E-04       1.00000000E-04
        1.00000000E-04       1.00000000E-04       1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -2.01935148E+00       6.66833907E+05       9.81580809E+05       1.28275574E+06       3.69240451E+06       1.56696721E+06
        1.53088367E+06       2.74219593E+06       1.23054410E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.72987466E-02      -1.51843188E+03      -2.33659456E+03      -3.19840206E+03      -9.71378043E+03      -4.03955378E+03
       -3.70507836E+03      -6.86029774E+03      -4.49803055E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.43507944E-05       8.15689953E+00       1.20797416E+01       1.58866601E+01       4.68029027E+01       2.24673788E+01
        2.61684152E+01       6.04561671E+01       5.02903253E+01
G1(I)  -4.03099998E+00      -1.91846539E-10       8.88178420E-12       3.55271368E-12      -1.06581410E-11      -1.33226763E-11
        5.32907052E-12       0.                   0.
G1MAG   4.03099998E+00
G2(I)   1.67586156E+08       3.10921816E+06       1.33017507E+06       7.28943806E+05       3.33404725E+06       1.18616052E+06
        1.36801298E+06       1.35819189E+06       3.37293113E+05
G2MAG   1.67670630E+08
PG1(I)-1.21200717E-05       -4.32305879E-03      -5.63860628E-04       3.70886881E-04       5.06709123E-03       1.04892704E-03
       -9.75106896E-04      -8.78631027E-04       1.09092910E-03
PGIMAG 6.98971017E-03
NAC                  3
IAC                  1                    2                    3
DP1DS   2.00032871E-02
DP2DS  -6.67870257E+05
STPMAX 1.00000000E+10
UMAG    3.11494766E+00
DUMAG   1.34156844E-02
GAMAST 0.                    1.34156844E-02       0.                   0.                   0.                   0.
P1TRY  -3.05150821E-01      -3.04882464E-01       0.                   0.                   0.                   0.
P2TRY   4.47996828E+03       6.87666150E-01       0.                   0.                   0.                   0.
YPRED   0.                   0.                   4.47946431E+03       0.                   0.                   0.
INDVR      WGTSG               PITPC2               PITPC2               PITPC2               PITPC2               PITPC2
           PITPC2              PITPC2               PITPC2
INDPH       1.000               2.000                3.000                4.000                5.000                6.000
            7.000               9.000               10.000
U(I)    4.02788246E+06      -1.83573102E+00      -5.04752357E-01      -2.01152913E-01      -3.10491074E-01      -2.57593894E-01
       -3.21000926E-01      -1.67882649E-01      -5.25189431E-02
WE(I)  -5.55636549E-02      -8.22574814E-01       8.91600009E-02
DEPVR      ALTITO              VELI                 GAMMAI
DEPPH     900.000             900.000              900.000
E(I)   -5.55636549E+00      -8.22574814E-02       8.91600009E-05
P1     -3.04882464E-01

OPTVAR     WEIGHT
OPTPH      12.000
OPTVAL 3.04882464E+05
P2      6.87666150E-01
```

```
*** ITERATION NUMBER  1

CP/ITR 4.05468750E+00
PERT    1.00000000E+00    1.00000000E-04    1.00000000E-04    1.00000000E-04    1.00000000E-04    1.00000000E-04
        1.00000000E-04    1.00000000E-04    1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -2.38568020E+00    6.54143145E+05    9.62028831E+05    1.25603096E+06    3.61315005E+06    1.53065130E+06
        1.49398101E+06    2.67895543E+06    1.19850416E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.65042773E-02   -1.58383267E+03   -2.43463470E+03   -3.32878950E+03   -1.00727933E+04   -4.19535476E+03
       -3.91591001E+03   -7.40352320E+03   -4.92977078E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.63089205E-05    8.69061070E+00    1.28664238E+01    1.69211226E+01    4.98123988E+01    2.37018261E+01
        2.72735672E+01    6.23430600E+01    5.10367928E+01
G1(I)  -4.03100000E+00   -3.19744231E-11    1.77635684E-11    7.10542736E-12    1.59872116E-11    1.77635684E-11
        1.59872116E-11    0.                8.88178420E-13
G1MAG   4.03100000E+00
G2(I)   1.49134225E+10    4.34262783E+06    1.83378669E+08    9.91744277E+07    4.46068795E+08    1.59127967E+08
        1.87427873E+08    1.85471988E+08    4.28943454E+07
G2MAG   1.49311047E+10
PG1(I)-1.17325747E-05    -4.27028347E-03   -5.40848816E-04    4.03532974E-04    5.00689488E-03    9.28137301E-04
       -9.69809896E-04   -8.32986975E-04    1.01904708E-03
PG1MAG 6.87707100E-03
WVEC    2.48077400E-07    5.55555556E-01    2.00000000E+00    5.00000000E+00    3.33333333E+00    4.00000000E+00
        3.33333333E+00    6.66666667E+00    2.00000000E+01
NAC                  3
IAC                  1                 2                 3
DP1DS   1.95399530E-02
DP2DS  -5.46177126E+08
STPMAX 1.00000000E+10
UMAG    3.11088422E+00
DUMAG   1.45812976E-01
GAMAST 0.                 1.45812976E-01    1.45796573E-01    0.                0.                0.
P1TRY -3.06000000E-01    -3.05150821E-01    0.                0.                0.                0.
P2TRY   3.98198560E+07    4.47996828E+03    0.                0.                0.                0.
YPRED   0.                0.                4.47946431E+03    0.                0.                0.
INDVR       WGTSG             PITPC2            PITPC2            PITPC2            PITPC2            PITPC2
            PITPC2            PITPC2            PITPC2
INDPH        1.000             2.000             3.000             4.000             5.000             6.000
             7.000             9.000            10.000
U(I)    4.02815082E+06   -1.84378758E+00   -5.05604901E-01   -2.01316794E-01   -3.11252280E-01   -2.57351877E-01
       -3.19577814E-01   -1.66363036E-01   -5.22747414E-02
WE(I)  -2.74660273E+01   -5.63949384E+01    2.33494442E+01
DEPVR       ALTITO             VELI              GAMMAI
DEPPH      900.000           900.000           900.000
E(I)   -2.74660273E+03   -5.63949384E+00    2.33494442E-02
P1     -3.05150821E-01

OPTVAR      WEIGHT
OPTPH       12.000
OPTVAL 3.05150821E+05
P2      4.47996828E+03
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*** ITERATION NUMBER 4

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CP/ITR 4.20312500E+00
PERT    1.00000000E+00      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04
        1.00000000E-04      1.00000000E-04      1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -1.99205613E+00      6.42046868E+05      9.62245374E+05      1.29176991E+06      3.74610007E+06      1.57068878E+06
        1.52013445E+06      2.71447211E+06      1.21426574E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.64005961E-02     -1.68246815E+03     -2.52749073E+03     -3.35566653E+03     -9.84370029E+03     -3.97204993E+03
       -3.70803506E+03     -6.90904231E+03     -4.41260392E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.35983596E-05      7.95268776E+00      1.19246260E+01      1.59749706E+01      4.75432725E+01      2.27423205E+01
        2.62376176E+01      6.03689516E+01      4.99856575E+01
GI(I)  -4.03100000E+00     -9.59232693E-11     -8.68178420E-12     -2.13162821E-11     -2.66453526E-11     -8.68178420E-12
       -1.06581410E-11     -2.66453526E-12      0.
G1MAG   4.03100000E+00
G2(I)   3.83709921E+06      2.62861048E+05      1.09525420E+05      5.85769159E+04      2.55245973E+05      8.65836474E+04
        9.68111026E+04      8.40818279E+04      1.25919373E+04
G2MAG   3.85967632E+06
PG1(I)-1.54994209E-06       1.88161360E-04      1.50524056E-04     -1.00678098E-04      4.45335121E-04     -6.46347112E-04
       -1.48481275E-03      1.05834758E-04      1.82966263E-03
PG1MAG 2.49956473E-03
NAC                 3
IAC                 1                    2                   3
DP1DS  -1.85408109E-02
DP2DS  -5.26565404E+04
STPMAX  1.00000000E+10
UMAG    3.28958023E+00
DUMAG   2.66864921E-03
GAMAST 0.                   2.66864921E-03      0.                  0.                  0.                  0.
P1TRY  -3.08320835E-01     -3.08370314E-01      0.                  0.                  0.                  0.
P2TRY   7.02609174E+01      1.05942637E-03      0.                  0.                  0.                  0.
YPRED   0.                  0.                  0.                  3.03518138E+01      7.02108208E+01      0.
INDVR      WGTSG               PITPC2              PITPC2              PITPC2              PITPC2              PITPC2
           PITPC2              PITPC2              PITPC2
INDPH      1.000               2.000               3.000               4.000               5.000               6.000
           7.000               9.000               10.000
U(I)    4.03137031E+06     -7.80336623E-01     -4.65492882E-01     -2.10978840E-01     -5.11376062E-01     -2.92337894E-01
       -2.81845214E-01     -1.52273369E-01     -6.05703539E-02
WE(I)  -2.67577171E-04     -3.03028245E-02      1.18782830E-02
DEPVR      ALTITO              VELI                GAMMAI
DEPPH      900.000             900.000             900.000
E(I)   -2.67577171E-02     -3.03028245E-03      1.18782830E-05
P1     -3.08370314E-01

OPTVAR     WEIGHT
OPTPH      12.000
OPTVAL  3.08370314E+05
P2      1.05942637E-03
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*** ITERATION NUMBER  3

CP/ITR 4.04882813E+00
PERT    1.00000000E+00      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04
        1.00000000E-04      1.00000000E-04      1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -2.01716463E+00      6.67049938E+05      9.81922243E+05      1.28380638E+06      3.69782726E+06      1.56859644E+06
        1.53327449E+06      2.74778068E+06      1.23305609E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.72921114E-02     -1.53180956E+03     -2.35578507E+03     -3.22116732E+03     -9.76491138E+03     -4.05526073E+03
       -3.71570519E+03     -6.86337461E+03     -4.47873891E+03
PARTIALS OF GAMMA1 WITH RESPECT TO U(I)
SMAT   -3.44722796E-05      6.22748934E+00      1.21810233E+01      1.60244368E+01      4.72217906E+01      2.26430873E+01
        2.63439475E+01      6.07734298E+01      5.04199798E+01
G1(I)  -4.03099996E+00      6.39468462E-11     -8.88178420E-12      1.06581410E-11      5.32907052E-12      2.66453526E-11
       -5.32907052E-12      0.                  8.88178420E-13
G1MAG   4.03099996E+00
G2(I)   2.27854526E+09      3.09425417E+07      1.33791938E+07      7.40353450E+06      3.40158931E+07      1.14815513E+07
        1.19426382E+07      1.04507210E+07      2.18944244E+06
G2MAG   2.45857188E+06
PG1(I)-1.16148191E-05      -4.22364559E-03     -5.47908116E-04      3.73013796E-04      4.95064178E-03      1.01577253E-03
       -9.94180730E-04     -8.55672326E-04      1.13114251E-03
PG1MAG 6.84246748E-03
NAC                  3
IAC                  1                  2                   3
CTHA    8.99027426E+01
DP1DS -6.84246365E-03
DP2DS -2.36646826E-03
STPMAX 1.00000000E+10
UMAG    3.11494766E+00
PCTCC   3.00000000E-01
GAMAST 0.                   4.67242148E-01      9.34464297E-01      8.99321952E-01      0.                  0.
P1TRY -3.04860254E-01      -3.07549649E-01     -3.08521770E-01     -3.08488307E-01      0.                  0.
P2TRY   6.8[illegible] 66150E-01     2.46321100E+04      5.98375972E+05      5.13085500E+05      0.                  0.
YPRED   0.                  0.                 -3.09722738E-01     -3.08529166E-01      0.                  0.
NAC                  3
IAC                  1                  2                   3
DP1DS   1.33029381E-01
DP2DS   0.
STPMAX 1.00000000E+10
UMAG    3.29020538E+00
DUMAG   2.07087181E-02
GAMAST 0.                   2.07087181E-02      2.58858976E-02      2.22191756E-02      2.22127272E-02      0.
P1TRY -3.11276638E-01      -3.08521770E-01     -3.07633053E-01     -3.08320835E-01      0.                  0.
P2TRY   5.98375972E+05      2.79546716E+03      1.63252709E+04      7.02609174E+01      0.                  0.
YPRED   0.                  0.                  0.                  3.03518138E+01      7.02106208E+01      0.
INDVR      WGTSG             PITPC2              PITPC2              PITPC2              PITPC2              PITPC2
           PITPC2            PITPC2              PITPC2
INDPH       1.000             2.000               3.000               4.000               5.000               6.000
            7.000             9.000              10.000
U(I)    4.03132084E+06     -7.78703566E-01     -4.65304990E-01     -2.10937587E-01     -5.11170366E-01     -2.92377398E-01
       -2.82116845E-01     -1.52569031E-01     -6.06181715E-02
WE(I)   8.16111977E+00     -1.66778899E+00     -9.35693030E-01
DEPVR      ALTITO              VELI                GAMMA1
DEPPH     900.000            900.000             900.000
E(I)    8.16111977E+02     -1.66778899E-01     -9.35693030E-04
P1     -3.08320835E-01

OPTVAR     WEIGHT
OPTPH      12.000
OPTVAL  3.08320835E+05
P2      7.02609174E+01
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*** ITERATION NUMBER  5


CP/ITR 4.02539063E+00
PERT    1.00000000E+00      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04
        1.00000000E-04      1.00000000E-04      1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -1.99093270E+00      6.41952161E+05      9.62089761E+05      1.29159207E+06      3.74553619E+06      1.57056611E+06
        1.51966315E+06      2.71339072E+06      1.21380079E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.64009802E-02     -1.66004339E+03     -2.52382996E+03     -3.35069924E+03     -9.83049719E+03     -3.96790690E+03
       -3.70503616E+03     -6.90689883E+03     -4.41576126E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.35580721E-05      7.93579621E+00      1.16994592E+01      1.59413237E+01      4.74459406E+01      2.27004531E+01
        2.61964165E+01      6.02952511E+01      4.99561888E+01
G1(I)  -4.03099990E+00      0.                  4.44089210E-11      1.77635684E-11      5.32907052E-12      2.22044605E-11
        3.19744231E-11      0.                  8.86176420E-13
G1MAG   4.03099990E+00
G2(I)   2.89661404E+08      5.28123564E+06      2.20430168E+06      1.16930690E+06      5.14324266E+06      1.70444221E+06
        1.86838175E+06      1.70103019E+06      3.52968585E+05
G2MAG   8.58268176E+04
PG1(I)-1.54166388E-06       1.86572961E-04      1.49008719E-04     -1.01852707E-04      4.45670211E-04     -6.42717081E-04
       -1.48140050E-03      1.05345610E-04      1.82475703E-03
PG1MAG 2.49288587E-03
NAC                   3
IAC                   1                   2                   3
CTHA    8.99645668E+01
DP1DS  -2.49287261E-03
DP2DS  -2.78685125E-04
STPMAX  1.00000000E+10
UMAG    3.28958025E+00
PCTCC   1.50000000E-01
GAMAST  0.                  2.46716517E-01      4.93437034E-01      4.93437034E-01      0.                  0.
P1TRY  -3.08370237E-01     -3.08907355E-01     -3.09305883E-01      0.                  0.                  0.
P2TRY   1.05942637E-03      6.40643422E+02      9.67871929E+03      0.                  0.                  0.
YPRED   0.                  0.                 -3.09583897E-01      1.00000000E+10      0.                  0.
NAC                   3
IAC                   1                   2                   3
DP1DS   5.58143044E-01
DP2DS   0.
STPMAX  1.00000000E+10
UMAG    3.38813435E+00
DUMAG   5.27655692E-04
GAMAST  0.                  5.27655692E-04      6.59569615E-04      0.                  0.                  0.
P1TRY  -3.09600390E-01     -3.09305883E-01      0.                  0.                  0.                  0.
P2TRY   9.67871929E+03      1.21114819E-01      0.                  0.                  0.                  0.
YPRED   0.                  0.                 -3.09583897E-01      1.00000000E+10      0.                  0.
INDVR       WGTSG              PITPC2              PITPC2              PITPC2              PITPC2              PITPC2
            PITPC2             PITPC2              PITPC2
INDPH       1.000               2.000               3.000               4.000               5.000               6.000
            7.000               9.000              10.000
U(I)    4.03230588E+06     -8.46360301E-01     -4.80188244E-01     -2.06935431E-01     -5.37778343E-01     -2.60533310E-01
       -1.93916886E-01     -1.55450389E-01     -7.66382535E-02
WE(I)   3.72149658E-02      3.27485491E-01     -1.11727876E-01
DEPVR       ALTITO             VELI                GAMMAI
DEPPH       900.000            900.000             900.000
E(I)    3.72149658E+00      3.27485491E-02     -1.11727676E-04
P1     -3.09305883E-01

OPTVAR      WEIGHT
OPTPH       12.000
OPTVAL  3.09305883E+05
P2      1.21114819E-01
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*** ITERATION NUMBER  6


CP/ITR 4.02441406E+00
PERT    1.00000000E+00        1.00000000E-04        1.00000000E-04        1.00000000E-04        1.00000000E-04        1.00000000E-04
        1.00000000E-04        1.00000000E-04        1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -1.99841928E+00        6.42222452E+05        9.63165551E+05        1.29336346E+06        3.74805344E+06        1.56176855E+06
        1.50326445E+06        2.69037343E+06        1.20894658E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.64124500E-02       -1.64303891E+03       -2.46712835E+03       -3.27142671E+03       -9.68415464E+03       -4.01524422E+03
       -3.78092906E+03       -6.96153762E+03       -4.18373659E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.30634936E-05        7.97409703E+00        1.19617494E+01        1.60297420E+01        4.76151387E+01        2.26158217E+01
        2.60262334E+01        6.00726126E+01        4.99608556E+01
G1(I)  -4.03099997E+00        6.39468462E-11        4.44089210E-11        1.77635684E-11        1.06581410E-11        0.
        0.                    2.66453526E-12        8.88178420E-13
G1MAG   4.03099997E+00
G2(I)   7.97852609E+08        1.49647492E+07        6.24223358E+06        3.30653767E+06        1.46949210E+07        5.04410586E+06
        5.63253880E+06        5.10525466E+06        9.96315629E+05
G2MAG   9.38235165E+05
PG1(I)-5.43448037E-07        -1.57107764E-04       -2.94866110E-05       -2.14892706E-04        5.05052961E-04       -8.79149527E-06
       -7.33012971E-04       -1.38693448E-04        1.14336093E-03
PG1MAG 1.48010317E-03
NAC                  3
IAC                  1                     2                     3
CTHA    8.99789628E+01
DP1DS  -1.48005633E-03
DP2DS   1.04946286E-02
STPMAX 1.00000000E+10
UMAG    3.38813435E+00
PCTCC   3.00000000E-01
GAMAST 0.                     5.08220152E-01        1.01644030E+00        1.01644030E+00        0.                    0.
P1TRY  -3.09306685E-01       -3.09683461E-01       -3.10084124E-01        0.                    0.                    0.
P2TRY   1.21114819E-01        3.95061727E+03        7.30532085E+04        0.                    0.                    0.
YPRED   0.                    0.                   -3.10112315E-01       -3.10084124E-01        0.                    0.
NAC                  3
IAC                  1                     2                     3
DP1DS   2.17997237E+00
DP2DS   0.
STPMAX 1.00000000E+10
UMAG    3.86259947E+00
DUMAG   3.33100205E-04
GAMAST 0.                     3.33100205E-04        4.16375256E-04        0.                    0.                    0.
P1TRY  -3.10610273E-01       -3.10084124E-01        0.                    0.                    0.                    0.
P2TRY   7.30532085E+04        8.30042339E-01        0.                    0.                    0.                    0.
YPRED   0.                    0.                   -3.10112315E-01       -3.10084124E-01        0.                    0.
INDVK       WGTSG                PITPC2                PITPC2                PITPC2                PITPC2                PITPC2
            PITPC2               PITPC2                PITPC2
INDPH       1.000                 2.000                 3.000                 4.000                 5.000                 6.000
            7.000                 9.000                10.000
U(I)    4.03308412E+06       -6.52383144E-01       -4.70089721E-01       -1.77426249E-01       -6.41861132E-01       -2.59023175E-01
       -4.28781327E-02       -1.41136039E-01       -1.17692968E-01
WE(I)   1.36593395E-01       -3.24744396E-01       -6.40193823E-01
DEPVR       ALTITO                VELI                  GAMMAI
DEPPH     900.000               900.000               900.000
E(I)    1.36593395E+01       -3.24744396E-02       -6.40193823E-04
P1     -3.10084124E-01

OPTVAR      WEIGHT
OPTPH       12.000
OPTVAL 3.10084124E+05
P2      8.30042339E-01
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*** ITERATION NUMBER  7

CP/ITR 4.10644531E+00
PERT    1.00000000E+00      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04      1.00000000E-04
        1.00000000E-04      1.00000000E-04      1.00000000E-04
PARTIALS OF ALTITO WITH RESPECT TO U(I)
SMAT   -2.01989090E+00      6.38333634E+05      9.55778396E+05      1.28127010E+06      3.71850962E+06      1.55013887E+06
        1.48094122E+06      2.65095188E+06      1.20375229E+06
PARTIALS OF VELI   WITH RESPECT TO U(I)
SMAT   -3.64666057E-02     -1.56662260E+03     -2.35748992E+03     -3.12762735E+03     -9.31962739E+03     -4.01005144E+03
       -3.90634610E+03     -7.13459818E+03     -3.75903582E+03
PARTIALS OF GAMMAI WITH RESPECT TO U(I)
SMAT   -3.19790206E-05      7.99461777E+00      1.19790048E+01      1.60359613E+01      4.76416283E+01      2.25369347E+01
        2.57799152E+01      5.96676080E+01      5.00729524E+01
G1(I)  -4.03099995E+00     -3.19744231E-11     -8.88178420E-12     -7.10542736E-12      5.32907052E-12     -4.44089210E-12
       -2.66453526E-11      0.                 -8.88178420E-13
G1MAG   4.03099995E+00
G2(I)   1.27450392E+08      2.37175609E+06      9.91510677E+05      5.26051805E+05      2.35078760E+06      8.39386888E+05
        9.73767463E+05      8.77156022E+05      1.47936314E+05
G2MAG   1.14914072E+06
PG1(I)-3.49669282E-07      -6.61715169E-04     -1.36309069E-04     -2.27520965E-04      5.60508659E-04      5.46091271E-04
        4.09471833E-04     -3.30061531E-04     -1.10871481E-04
PG1MAG  1.18722322E-03
NAC                  3
IAC                  1                   2                   3
CTHA    8.99831248E+01
DP1DS  -1.18723830E-03
DP2DS   4.28381963E-03
STPMAX  1.00000000E+10
UMAG    3.86259947E+00
PCTCC   6.00000000E-01
GAMAST  0.                  1.15877964E+00      1.38553667E-01      2.48621407E-01      2.49239767E-01      0.
P1TRY  -3.10063555E-01     -3.05706337E-01     -3.10213075E-01     -3.10280819E-01     -3.10281123E-01      0.
P2TRY   8.30042339E-01      2.79159425E+06      2.21672770E+02      1.85595394E+03      1.87303756E+03      0.
YPRED   0.                  0.                 -3.10165803E-01     -3.10249688E-01     -3.10280821E-01      0.
NAC                  3
IAC                  1                   2                   3
DP1DS   1.01352671E-01
DP2DS   0.
STPMAX  1.00000000E+10
UMAG    3.90727424E+00
DUMAG   9.75882201E-04
GAMAST  0.                  9.75882201E-04      1.21985275E-03      0.                  0.                  0.
P1TRY  -3.10380031E-01     -3.10281123E-01      0.                  0.                  0.                  0.
P2TRY   1.87303756E+03      1.02467571E-01      0.                  0.                  0.                  0.
YPRED   0.                  0.                 -3.10165803E-01     -3.10249688E-01     -3.10280821E-01      0.
INDVR       WGTSG              PITPC2              PITPC2              PITPC2              PITPC2              PITPC2
            PITPC2             PITPC2              PITPC2
INDPH        1.000              2.000               3.000               4.000               5.000               6.000
             7.000              9.000              10.000
U(I)    4.03328112E+06     -4.02959110E-01     -4.55853620E-01     -1.67888963E-01     -6.77243251E-01     -2.87672429E-01
       -6.85708451E-02     -1.30635729E-01     -1.16711775E-01
WE(I)  -9.56351042E-03      3.19537885E-01      1.64818263E-02
DEPVR       ALTITO             VELI                GAMMAI
DEPPH      900.000            900.000             900.000
E(I)   -9.56351042E-01      3.19537885E-02      1.64818263E-05
P1     -3.10281123E-01

OPTVAR     WEIGHT
OPTPH      12.000
OPTVAL  3.10281123E+05
P2      1.02467571E-01
```

8.B.0.9

*** SENSITIVITY ANALYSIS

DFDC -5.67849448E-09 -2.543123l3E-06 -5.33054736E-05

```
*** INPUT SUMMARY FOR PROBLEM NO.   1 ***

SEARCH/OPTIMIZATION INPUTS
        NINDV  =   9              NDEPV  =   3              SRCHM  =   4              MODEW  =   1
        INDVR  =    WGTSG      ,    PITPC2     ,    PITPC2     ,    PITPC2     ,    PITPC2     ,    PITPC2     ,
                    PITPC2     ,    PITPC2     ,    PITPC2     ,
        INDPH  =    1.000,          2.000,          3.000,          4.000,          5.000,          6.000,
                    7.000,          9.000,          10.000,
        U      =  4.03328112E+06,-4.02959110E-01,-4.55853620E-01,-1.67888963E-01,-6.77243251E-01,-2.87672429E-01,
                 -6.65708451E-02,-1.30635729E-01,-1.16711775E-01,
        WVU    =  2.46077400E-07, 5.55555556E-01, 2.00000000E+00, 5.00000000E+00, 3.33333333E+00, 4.00000000E+00,
                  3.33333333E+00, 6.66666667E+00, 2.00000000E+01,
        PERT   =  2.48077400E-07, 5.55555556E-05, 2.00000000E-04, 5.00000000E-04, 3.33333333E-04, 4.00000000E-04,
                  3.33333333E-04, 6.66666667E-04, 2.00000000E-03,
        DEPVR  =    ALTITO     ,    VELI       ,    GAMMAI     ,
        DEPPH  =   900.000,        900.000,        900.000,
        DEPVAL =  3.03605000E+05, 2.58530000E+04, 0.            ,
        DEPTL  =  1.00000000E+02, 1.00000000E-01, 1.00000000E-03,
        IDEPVR =         0,              0,              0,
        IFDEG  =         0,              0,              0,
        OPTVAR =    WEIGHT     ,
        OPTPH  =    12.000,
        OPT    =   1              MAXITR =  10              IDEB   =   0              IPRO   =  -1
        PGEPS  =  1.00000000E+00 P2MIN  =  1.00000000E+00 STMNP1 =  1.00000000E-01 STMNP2 =  1.00000000E-01
        CONSX1 =  1.00000000E-06 CONSX2 =  1.00000000E-03 WCON   =  1.00000000E+02 FITER1 =  1.00000000E-06
        FITER2 =  1.00000000E-03 PCTCC  =  6.00000000E-01 WOPT   =  1.00000000E-06 CONEP1 =  8.99800000E+01
        CONEP2 =  1.00000000E-01 CONEP3 =  1.00000000E-01 CONEP4 =  1.00000000E-01 CONEP5 =  1.00000000E-01
        CONEP6 =  1.00000000E-01 GAMAX  =  1.00000000E+01
```

```
 SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER                                                                          PROBLEM NO.     1

INPUT UNITS = ENGLISH, OUTPUT UNITS = ENGLISH

INITIAL CONDITIONS
        TIME    =  0.              TIMEO   =  0.
        GCLAT   =  2.85000000E+01 GDLAT   =  2.85000000E+01 LONG    =  2.79400000E+02 LONGI   =  2.79400000E+02
        GCRAD   =  2.09257410E+07 ALTITO  =  0.
        VELR    =  0.              GAMMAR  =  0.              AZVELR  =  0.

PROGRAM TERMINATION PARAMETERS
        FESN    =    12.000        MAXTIM  =  1.00000000E+03 ALTMIN  = -5.00000000E+03 ALTMAX  =  2.00000000E+06

THE LAUNCH PAD INERTIAL (L) FRAME IS DEFINED BY
        LATL    =  2.85000000E+01 LONL    =  2.79400000E+02 AZL     =  9.00000000E+01

ATTRACTING PLANET MODEL
        RE      =  2.09257410E+07 RP      =  2.09257410E+07 OMEGA   =  7.29211000E-05 MU         1.40765390E+16
        J2      =  0.              J3      =  0.              J4      =  0.
```

```
SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER                                                                       PROBLEM NO.     1

BEGIN PHASE    1.000

1962 U.S. STANDARD ATMOSPHERE MODEL

AERODYNAMIC COEFFICIENTS SPECIFIED BY DRAG AND LIFT COEFFICIENTS
        SREF    =  4.50000000E+03 LREF    =  2.16833000E+02 LREFY  =  0.

PROPULSION CALCULATED FOR  1 ROCKET ENGINES

VEHICLE WEIGHT PARAMETERS
        WGTSG   =  4.03328112E+06 WPLD    =  0.               WPROP  =  2.24900000E+06 WJETT  =  0.
        GO      =  3.21740000E+01

NUMBER OF INTEGRALS FOR THIS PHASE =    8
INTEGRATION SCHEME = FOURTH ORDER RUNGE-KUTTA
        DT      =  5.00000000E+00 PINC    =  2.00000000E+01

USE INERTIAL ROLL, YAW, AND PITCH COMMANDS
        ROLPC   =  0.              , 0.              , 0.              , 0.              ,
        PITPC   =  0.              , 0.              , 0.              , 0.              ,
        YAWPC   =  0.              , 0.              , 0.              , 0.              ,
        YAWI    =  0.              YAWR    =  0.              DYAW    =  0.              DESN    =  0.
        PITI    =  0.              PITR    =  0.              DPITCH  =  0.              DESN    =  0.
        ROLI    =  0.              ROLR    =  0.              DROLL   =  0.              DESN    =  0.

THE NEXT EVENT TO OCCUR WILL BE ONE OF THE FOLLOWING
        ESN     =     2.000        TYPE    = PRIMRY           CRITR   = TIME             VALUE   =  1.50000000E+01
        TOL     =  1.00000000E-06 MDL     =  1

TABLES AND MULTIPLIERS FOR THIS PHASE
        CDT    , 1.00000000E+00  CLT    , 1.00000000E+00  CMAT   , 1.00000000E+00  TVCIT  , 1.00000000E+00  AEIT   , 1.00000000E+00
        XREFT  , 1.00000000E+00

PROGRAM CONTROL FLAGS
        NPC    ( 1) =  0 NPC    ( 2) =  1 NPC    ( 3) =  4 NPC    ( 4) =  2 NPC    ( 5) =  2 NPC    ( 6) =  0 NPC    ( 7) =  0
        NPC    ( 8) =  2 NPC    ( 9) =  1 NPC    (10) =  0 NPC    (11) =  0 NPC    (12) =  0 NPC    (13) =  0 NPC    (14) =  0
        NPC    (15) =  0 NPC    (16) =  1 NPC    (17) =  0 NPC    (18) =  0 NPC    (19) =  1 NPC    (20) =  0 NPC    (21) =  1
        NPC    (22) =  0 NPC    (23) =  0 NPC    (24) =  0 NPC    (25) =  0 NPC    (26) =  0 NPC    (27) =  0 NPC    (28) =  0
        NPC    (29) =  0 NPC    (30) =  0 NPC    (31) =  0 NPC    (32) =  0 NPC    (33) =  0 NPC    (34) =  0 NPC    (35) =  0

GUIDANCE CONTROL FLAGS
        IGUID ( 1) =  1 IGUID ( 2) =  0 IGUID ( 3) =  0 IGUID ( 4) =  1 IGUID ( 5) =  1 IGUID ( 6) =  0 IGUID ( 7) =  0
        IGUID ( 8) =  0 IGUID ( 9) =  0 IGUID (10) =  0 IGUID (11) =  0 IGUID (12) =  2 IGUID (13) =  1 IGUID (14) =  0
        IGUID (15) =  0 IGUID (16) =  0 IGUID (17) =  0 IGUID (18) =  0 IGUID (19) =  0 IGUID (20) =  0 IGUID (21) =  0
        IGUID (22) =  0 IGUID (23) =  0 IGUID (24) =  0 IGUID (25) =  0
```

SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER

PROBLEM NO. 1

*** PHASE 1.000 ***

TIME	0.	TIMES	0.	TOURP	0.	DENS	2.37690697E-03	PRES	2.11621660E+03	ATEM	5.18670000E+02
ALTITO	-4.76837158E-07	GCRAD	2.09257410E+07	GDLAT	2.85000000E+01	GCLAT	2.85000000E+01	LONG	2.79400000E+02	LONGI	2.79400000E+02
VELI	1.34101168E+03	GAMMAI	0.	AZVELI	9.00000000E+01	XI	3.00354800E+06	VXI	1.32300480E+03	AXI	1.06789869E+00
VELR	0.	GAMMAR	0.	AZVELR	0.	YI	-1.81429627E+07	VYI	2.19022024E+02	AYI	-6.57146330E+00
VELA	0.	GAMMAA	9.00000000E+01	AZVELA	0.	ZI	9.98490063E+06	VZI	0.	AZI	3.61657625E+00
GAMAD	0.	AZVAD	0.	DWNRNG	0.	CRRNG	0.	DPRNG1	0.	DPRNG2	0.
THRUST	4.97997964E+06	WEIGHT	4.03328112E+06	WDOT	1.24646925E+04	WEICON	1.49011612E-08	WPROP	2.24900000E+06	ASMG	1.23472168E+00
ETA	1.00000000E+00	ETAL	1.00000000E+00	IPNULL	0.	IYNULL	0.	INCPCH	0.	INCYAW	0.
FTXB	4.97997964E+06	FAXB	-0.	AXB	3.97259353E+01	ALPHA	0.	ALPDOT	0.	ALPTOT	0.
FTYB	0.	FAYB	0.	AYB	0.	BETA	0.	BETDOT	0.	QALPHA	0.
FTZB	0.	FAZB	-0.	AZB	0.	BNKANG	9.00000000E+01	BNKDOT	0.	QALTOT	0.
CA	1.80000000E-01	CD	1.80000000E-01	DRAG	0.	ROLI	0.	YAWR	0.	ROLBD	0.
CN	1.50000000E-02	CL	1.50000000E-02	LIFT	0.	YAWI	0.	PITR	8.99999892E+01	PITBD	0.
CY	0.	HEATRT	0.	TLHEAT	0.	PITI	0.	ROLR	0.	YAWBD	0.
DYNP	0.	MACH	0.	REYNO	0.	ASXI	5.70200852E+00	ASYI	-3.44430413E+01	ASZI	1.89555780E+01

*** PHASE 1.000 ***

TIME	1.50000000E+01	TIMES	1.50000000E+01	TOURP	1.50000000E+01	DENS	2.31267089E-03	PRES	2.04581341E+03	ATEM	5.15341815E+02
ALTITO	9.33310129E+02	GCRAD	2.09266743E+07	GDLAT	2.84999856E+01	GCLAT	2.84999856E+01	LONG	2.79399993E+02	LONGI	2.79462664E+02
VELI	1.34683100E+03	GAMMAI	5.50859101E+00	AZVELI	9.00299007E+01	XI	3.02352433E+06	VXI	1.34110394E+03	AXI	1.32648099E+00
VELR	1.29291759E+02	GAMMAR	8.96287597E+01	AZVELR	2.13369064E+02	YI	-1.81404764E+07	VYI	1.07996292E+02	AYI	-6.25804904E+00
VELA	1.29291759E+02	GAMMAA	8.96287597E+01	AZVELA	2.13369064E+02	ZI	9.98534136E+06	VZI	6.10765341E+01	AZI	4.54117835E+00
GAMAD	-5.72311544E-03	AZVAD	2.00817421E+00	DWNRNG	0.	CRRNG	0.	DPRNG1	0.	DPRNG2	0.
THRUST	4.99634838E+06	WEIGHT	3.84631074E+06	WDOT	1.24646925E+04	WEICON	1.86970387E+05	WPROP	2.06202961E+06	ASMG	1.29485853E+00
ETA	1.00000000E+00	ETAL	1.00000000E+00	IPNULL	0.	IYNULL	0.	INCPCH	0.	INCYAW	0.
FTXB	4.99634838E+06	FAXB	-1.59202357E+04	AXB	4.16607773E+01	ALPHA	-1.48963081E-01	ALPDOT	0.	ALPTOT	3.44063788E-01
FTYB	0.	FAYB	0.	AYB	0.	BETA	3.10145300E-01	BETDOT	0.	QALPHA	-2.87941442E+00
FTZB	0.	FAZB	-1.09857008E+03	AZB	-9.18942751E-03	BNKANG	1.23339716E+02	BNKDOT	0.	QALTOT	6.65065616E+00
CA	1.83025437E-01	CD	1.82991982E-01	DRAG	1.59173258E+04	ROLI	0.	YAWR	2.70029901E+02	ROLBD	0.
CN	1.26296037E-02	CL	1.31054076E-02	LIFT	1.13995728E+03	YAWI	0.	PITR	8.99449297E+01	PITBD	0.
CY	0.	HEATRT	0.	TLHEAT	0.	PITI	0.	ROLR	1.80000000E+02	YAWBD	0.
DYNP	1.93297185E+01	MACH	1.16179631E-01	REYNO	1.75964633E+08	ASXI	5.97065742E+00	ASYI	-3.61220822E+01	ASZI	1.98788049E+01

END OF PHASE 1.000

```
SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER                                                          PROBLEM NO.    1

BEGIN PHASE  11.000

1962 U.S. STANDARD ATMOSPHERE MODEL

COMPUTE CONIC PARAMETERS

AERODYNAMIC COEFFICIENTS SPECIFIED BY DRAG AND LIFT COEFFICIENTS
        SREF   =  4.84000000E+03 LREF   =  1.35000000E+02 LREFY  =  0.

PROPULSION CALCULATED FOR  1 ROCKET ENGINES

CALCULATE ETAL TO LIMIT ACCELERATION
        ASMAX  =  3.00000000E+00

ENGINES USED TO THROTTLE
         1

VEHICLE WEIGHT PARAMETERS
        WGTSG  =  3.57822526E+05 WPLD   =  0.               WPROP  =  4.75414027E+04 WJETT  =  0.
        GO     =  3.21740000E+01

NUMBER OF INTEGRALS FOR THIS PHASE =    8
INTEGRATION SCHEME = FOURTH ORDER RUNGE-KUTTA
        DT     =  2.00000000E+01 PINC   =  5.00000000E+01

USE INERTIAL ROLL, YAW, AND PITCH COMMANDS
        ROLPC  =  0.              , 0.              , 0.              , 0.              ,
        PITPC  = -9.66287352E+01,-1.16711775E-01, 0.              , 0.              ,
        YAWPC  =  0.              , 0.              , 0.              , 0.              ,
        YAWI   =  0.             YAWR   =  9.59726436E+01 DYAW   =  0.              DESN   =  0.
        PITI   = -9.66287352E+01 PITR   =  4.48101073E+00 DPITCH =  0.              DESN   =  0.
        ROLI   =  0.             ROLR   =  9.18808286E-13 DROLL  =  0.              DESN   =  0.

THE NEXT EVENT TO OCCUR WILL BE ONE OF THE FOLLOWING
        ESN    =   12.000        TYPE   = PRIMRY          CRITR  = WPROP           VALUE  =  0.
        TOL    =  1.00000000E-06 MDL    =  1

TABLES AND MULTIPLIERS FOR THIS PHASE
        CDT    , 1.00000000E+00  CLT    , 1.00000000E+00  CMAT   , 1.00000000E+00  XCGT   , 1.00000000E+00  YCGT   , 1.00000000E+00
        ZCGT   , 1.00000000E+00  TVC1T  , 1.00000000E+00  AE1T   , 1.00000000E+00  XREFT  , 1.00000000E+00

PROGRAM CONTROL FLAGS
        NPC    ( 1) =   2 NPC    ( 2) =   1 NPC    ( 3) =   4 NPC    ( 4) =   2 NPC    ( 5) =   2 NPC    ( 6) =   0 NPC    ( 7) =   1
        NPC    ( 8) =   2 NPC    ( 9) =   1 NPC    (10) =   0 NPC    (11) =   0 NPC    (12) =   0 NPC    (13) =   0 NPC    (14) =   0
        NPC    (15) =   0 NPC    (16) =   1 NPC    (17) =   0 NPC    (18) =   0 NPC    (19) =   1 NPC    (20) =   0 NPC    (21) =   1
        NPC    (22) =   0 NPC    (23) =   0 NPC    (24) =   0 NPC    (25) =   0 NPC    (26) =   0 NPC    (27) =   0 NPC    (28) =   0
        NPC    (29) =   0 NPC    (30) =   0 NPC    (31) =   0 NPC    (32) =   0 NPC    (33) =   0 NPC    (34) =   0 NPC    (35) =   0

GUIDANCE CONTROL FLAGS
        IGUID ( 1) =   1 IGUID ( 2) =   0 IGUID ( 3) =   0 IGUID ( 4) =   0 IGUID ( 5) =   1 IGUID ( 6) =   0 IGUID ( 7) =   0
        IGUID ( 8) =   0 IGUID ( 9) =   0 IGUID (10) =   0 IGUID (11) =   0 IGUID (12) =   2 IGUID (13) =   1 IGUID (14) =   0
        IGUID (15) =   0 IGUID (16) =   0 IGUID (17) =   0 IGUID (18) =   0 IGUID (19) =   0 IGUID (20) =   0 IGUID (21) =   0
        IGUID (22) =   0 IGUID (23) =   0 IGUID (24) =   0 IGUID (25) =   0
```

```
SAMPLE PROBLEM FOR ASCENT W/ DROP TANK ORBITER                                                              PROBLEM NO.    1

TIME    4.37456932E+02                                    *** ELLIPTIC ORBIT ***
ALTP   -6.56796054E+02 ALTA    5.03586066E+01 ECCEN  1.49168348E-01 INC     2.85000000E+01 PERIOD 7.00943695E+01 ARGP    2.79779035E+02
ENERGY-3.80946732E+08 SEMJAX 1.84757514E+07 TRUAN  1.81330711E+02 LAN     1.89400000E+02 ANGMOM 5.04269162E+11 PGERAD 1.57197371E+07
APORAD 2.12317257E+07 PGCLAT-2.80489481E+01 PGLON  1.10495990E+02 ARGV    1.01109746E+02 TIMTP  3.47011622E+01 TIMSP   3.53932072E+01
ECCAN  1.81546489E+02 MEAAN   1.61777148E+02 PGVEL  3.20787275E+04 APVEL   2.37507363E+04 DVCIR   1.99978613E+03 VCIRC   2.57493081E+04
LANVE  1.89400000E+02

                                                          *** PHASE    11.000 ***
TIME    4.37456932E+02 TIMES   0.             TDURP  0.             DENS    3.44501515E-09 PRES    2.01763300E-03 ATEM    3.41168380E+02
ALTITC 3.04960868E+05 GCRAD   2.12307219E+07 GDLAT  2.79186046E+01 GCLAT   2.79186046E+01 LONG    2.90167924E+02 LONGI   2.91995650E+02
VELI    2.37520582E+04 GAMMAI-2.33267805E-01 AZVELI 9.59726436E+01 XI      7.02620764E+06 VXI     2.23048738E+04 AXI     8.26092668E+01
VELR    2.23919664E+04 GAMMAR-2.47436615E-01 AZVELR 9.63368729E+01 YI     -1.73942758E+07 VYI     7.65391572E+03 AYI     5.08582088E+01
VELA    2.23919664E+04 GAMMAA-2.47436615E-01 AZVELA 9.63368729E+01 ZI      9.94057977E+06 VZI    -2.22909900E+03 AZI    -1.99119531E+01
GAMAD   6.58799535E-03 AZVAD   3.42876240E-02 DWNRNG 0.             CRRNG   0.             DPRNG1 0.             DPRNG2 0.
THRUST 1.07363350E+06 WEIGHT 3.57822526E+05 WDOT   2.33907148E+03 WEICON 7.61458597E+05 WPRUP   4.75414027E+04 ASMG    3.00000000E+00
ETA     1.00000000E+00 ETAL    7.50268212E-01 IPNULL 0.             IYNULL 0.             INCPCH 0.             INCYAW 0.
FTXB    1.07363350E+06 FAXB   -1.66106776E+02 AXB    9.65219834E+01 ALPHA   4.72845235E+00 ALPDOT 0.             ALPTOT 4.74242774E+00
FTYB    0.             FAYB    0.             AYB    0.             BETA    3.64225921E-01 BETDOT 0.             QALPHA 4.08380151E+00
FTZB    0.             FAZB   -6.28680574E+02 AZB   -5.65284948E-02 BNKANG-1.57297107E-03 BNKDOT 0.             QALTOT 4.09587157E+00
CA      3.97371193E-02 CD      5.19996124E-02 DRAG   2.17365732E+02 ROLI    0.             YAWR    9.59726436E+01 ROLBD   0.
CN      1.50396964E-01 CL      1.46609433E-01 LIFT   6.12848157E+02 YAWI    0.             PITR    4.48101073E+00 PITBD   0.
CY      0.             HEATRT 0.             TLHEAT 0.             PITI   -9.66287352E+01 ROLR    9.18808286E-13 YAWBD   0.
DYNP    8.63665574E-01 MACH    2.47287807E+01 REYNO  3.93080063E+04 ASXI    9.30045549E+01 ASYI    2.52718812E+01 ASZI   -5.28973288E+00

                                                          *** PHASE    11.000 ***
TIME    4.59264198E+02 TIMES   2.18072658E+01 TDURP  2.18072658E+01 DENS    3.68995220E-09 PRES    2.14880703E-03 ATEM    3.39250012E+02
ALTITO 3.03804044E+05 GCRAD   2.12295450E+07 GDLAT  2.77570002E+01 GCLAT   2.77570002E+01 LONG    2.91717432E+02 LONGI   2.93636270E+02
VELI    2.58530320E+04 GAMMAI 1.64818263E-05 AZVELI 9.67388059E+01 XI      7.53212452E+06 VXI     2.40870305E+04 AXI     8.07369090E+01
VELR    2.44930787E+04 GAMMAR 1.73969630E-05 AZVELR 9.71148546E+01 YI     -1.72106460E+07 VYI     6.99928739E+03 AYI     5.41723792E+01
VELA    2.44930787E+04 GAMMAA 1.73969630E-05 AZVELA 9.71148546E+01 ZI      9.88707980E+06 VZI    -2.68459504E+03 AZI    -2.18585972E+01
GAMAD   1.41085632E-02 AZVAD   3.70416185E-02 DWNRNG 0.             CRRNG   0.             DPRNG1 0.             DPRNG2 0.
THRUST 9.31056380E+05 WEIGHT 3.10281123E+05 WDOT   2.02844600E+03 WEICON 8.09000000E+05 WPROP   0.             ASMG    3.00000000E+00
ETA     1.00000000E+00 ETAL    6.50633622E-01 IPNULL 0.             IYNULL 0.             INCPCH 0.             INCYAW 0.
FTXB    9.31056380E+05 FAXB   -2.13216514E+02 AXB    9.65219787E+01 ALPHA   3.39554618E+00 ALPDOT 0.             ALPTOT 3.41628173E+00
FTYB    0.             FAYB    0.             AYB    0.             BETA    3.76048734E-01 BETDOT 0.             QALPHA 3.75826277E+00
FTZB    0.             FAZB   -6.17695942E+02 AZB   -6.40507842E-02 BNKANG 1.14184047E-07 BNKDOT 0.             QALTOT 3.78121333E+00
CA      3.98013658E-02 CD      4.65609246E-02 DRAG   2.49427573E+02 ROLI    0.             YAWR    9.67388059E+01 ROLBD   0.
CN      1.15305994E-01 CL      1.12746181E-01 LIFT   6.03982983E+02 YAWI    0.             PITR    3.39556357E+00 PITBD  -1.16711775E-01
CY      0.             HEATRT 0.             TLHEAT 0.             PITI   -9.91738999E+01 ROLR    1.12152418E-12 YAWBD   0.
DYNP    1.10682128E+00 MACH    2.71263292E+01 REYNO  4.02819135E+04 ASXI    9.18182244E+01 ASYI    2.88519537E+01 ASZI   -7.31265468E+00

TIME    4.59264198E+02                                    *** ELLIPTIC ORBIT ***
ALTP    4.99997150E+01 ALTA    1.06472701E+02 ECCEN  8.01678822E-03 INC     2.85000000E+01 PERIOD 8.73846641E+01 ARGP    1.02567370E+02
ENERGY-3.26873990E+08 SEMJAX 2.14011132E+07 TRUAN  2.09369531E-03 LAN     1.89400000E+02 ANGMOM 5.48848106E+11 PGERAD 2.12295450E+07
APORAD 2.15726814E+07 PGCLAT 2.77572459E+01 PGLON  2.93633921E+02 ARGV    1.02569463E+02 TIMTP  8.73841640E+01 TIMSP   5.00113758E-04
ECCAN  2.07697734E-03 MEAAN   2.06032665E-03 PGVEL  2.58530320E+04 APVEL   2.54418121E+04 DVCIR   1.03010195E+02 VCIRC   2.57500218E+04
LANVE  1.89400000E+02

END OF PHASE   11.000

*** TRAJECTORY TERMINATED AT FESN =    12.000  (TIME = 4.59264196E+02)

*** TRAJECTORY CP TIME =    6.898
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9. LISTS OF VARIABLES

THIS SECTION PRESENTS A LIST OF ALL INPUT VARIABLES AND ALL TRAJECTORY OUTPUT VARIABLES USED IN THE PROGRAM. THE TARGETING/ OPTIMIZATION OUTPUTS ARE PRESENTED IN SECTION 4.F.

THE INPUT VARIABLES ARE LISTED ACCORDING TO THE NAMELIST IN WHICH THEY APPEAR AS INPUT. THE INPUTS FOR NAMELIST TBLMLT ARE NOT INCLUDED SINCE THE MULTIPLIERS WHICH ARE INPUT IN THAT NAMELIST FOLLOW THE RULES GIVEN IN THE TABLE MULTIPLIER SECTION OF THIS REPORT.

THE OUTPUT VARIABLES ARE PRESENTED IN ALPHABETICAL ORDER AT END OF THIS SECTION. THIS LIST SHOULD BE CONSULTED WHEN LOOKING FOR HOLLERITH (BCD) NAMES OF TARGETING/OPTIMIZATION VARIABLES, TABLE ARGUMENTS, EVENT CRITERIA, PRINT REQUESTS, ETC.

9.A. INPUTS FOR NAMELIST SEARCH

THIS SECTION CONTAINS A LIST OF ALL INPUT VARIABLES FOR NAMELIST SEARCH. IT IS INTENDED ONLY AS A SUMMARY OF ALL THE INPUTS FOR THE BENEFIT OF USERS WHO ARE FAMILIAR WITH THE VARIOUS OPTIONS. MORE DETAILED INSTRUCTIONS ON HOW TO INPUT VARIABLES SUCH AS CONTROL PARAMETERS, ETC., ARE FOUND IN THE SPECIFIC SECTIONS THAT DISCUSS THE TOPIC IN QUESTION.

THE INPUT VARIABLES FOR NAMELIST SEARCH IN ALPHABETICAL ORDER ARE -

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CDENS	SLUGS/FT3 PER KG/M3	.001940 31965	ATMOSPHERIC DENSITY CONVERSION CONSTANT.
CFORCE	NT/LB	4.4482216 152605	FORCE (THRUST AND AERODYNAMIC) CONVERSION CONSTANT.
CHEAT	JOULES/ BTU	1054.3502 6448888	AEROHEATING CONVERSION CONSTANT.
CMASS	KG/SLUG	14.5939 029	MASS CONVERSION CONSTANT.
CMPFT	M/FT	.3048	LENGTH CONVERSION CONSTANT.
CONEPS(1)	DEG	89.9	CONVERGENCE TOLERANCE ON THE ANGLE BETWEEN THE OPTIMIZATION VARIABLE GRADIENT AND ITS PROJECTION ONTO THE PLANE TANGENT TO THE INTERSECTION OF THE CONSTRAINT (DEPENDENT VARIABLE) SURFACES.
CONEPS(2)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN THE MAGNITUDE OF THE CONTROL PARAMETERS BETWEEN SUCCESSIVE ITERATIONS.
CONEPS(3)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN P1 ON SUCCESSIVE ITERATIONS.

9.A. INPUTS FOR NAMELIST SEARCH (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CONEPS(4)	N/D	0.10	THE MINIMUM ALLOWABLE PERCENTAGE CHANGE IN P2 ON SUCCESSIVE ITERATIONS.
CONEPS(5)	N/D	0.10	THE MINIMUM PERCENTAGE CHANGE IN THE VALUES OF G2MAG ON SUCCESSIVE ITERATIONS.
CONSEX(1)	DECIMAL	1.0E-6	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE OPTIMIZATION TRIAL STEPS BEFORE CURVE FIT PROCESS IS TERMINATED.
CONSEX(2)	DECIMAL	.001	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE TARGETING TRIAL STEPS BEFORE CURVE FIT PROCESS IS TERMIN- ATED.
CPRES	LBS/FT2 PER NT/CM2	.02088 54347	ATMOSPHERIC PRESSURE CONVERSION CONSTANT.
CTEMP	DEG F PER DEG C	1.8	ATMOSPHERIC TEMPERATURE CONVERSION CONSTANT.
DEPPH(I) I=1,25	DECIMAL	9000	THE EVENT AT WHICH DEPENDENT VARIABLE (TARGET) I IS TO BE SATISFIED.
DEPTL(I) I=1,25	SAME AS DEPVAL	1.0	THE DESIRED ACCURACY LEVEL WITHIN WHICH DEPVR(I) IS CONSIDERED TO BE SATISFIED.
DEPVAL(I) I=1,25	SAME AS THE VARI- ABLE IN DEPVR(I)	0.0	THE DESIRED VALUE OF DEPVR(I). THE VALUES OF DEPVAL ARE INPUT IN ENGLISH UNITS IF IOFLAG=0 OR 1, AND IN METRIC UNITS IF IOFLAG=2 OR 3.
DEPVR(I) I=1,25	HOLLERITH	0.0	THE HOLLERITH NAME OF DEPENDENT VARIABLE I.

9.A. INPUTS FOR NAMELIST SEARCH (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ENDJOB	INTEGER	0	END-OF-JOB FLAG.
ENDPRB	INTEGER	0	END-OF-PROBLEM FLAG.
FITERR(1)	DECIMAL	1.0E-6	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE OPTIMIZATION TRIAL VALUES BEFORE CURVE FIT PROCESS IS TERMINATED.
FITERR(2)	DECIMAL	.001	PERCENTAGE DIFFERENCE BETWEEN TWO CONSECUTIVE TARGETING TRIAL VALUES BEFORE CURVE FIT PROCESS IS TERMINATED.
FTPNM	FT/NM	6076.1155	DISTANCE CONVERSION CONSTANT.
IDEB	INTEGER	0	CONTROLS TRIAL STEP PRINTOUT. USED PRIMARILY FOR DEBUGGING PROBLEMS THAT FAIL TO CONVERGE.
IDEPVR(I) I=1,25	INTEGER	0	FLAG TO INDICATE THE TYPE OF CONSTRAINT DESIRED FOR DEPVR(I).
IFDEG(I) I=1,25	INTEGER	0	CONTROLS 360 - 0 DEGREE DISCONTINUITY IN DEPVR(I). FOR EXAMPLE, IF DEPVR(I) = 6HTRUAN , AND DEPVAL = 359.95, A DISCONTINUITY EXISTS NEAR THE DESIRED VALUE, AND IFDEG SHOULD BE USED.
IFRUNF(J) J=1,5	INTEGER	0	AN ARRAY CONTAINING THE RUN NUMBERS TO BE USED IN CONJUNCTION WITH THE VARIABLE NXTRUN TO DETERMINE WHICH RUN IS TO BE MADE NEXT.
INDPH(I) I=1,25	DECIMAL	0.0	PHASE AT WHICH INDVR(I) IS TO BE INITIATED.
INDVR(I) I=1,25	HOLLERITH	0.0	HOLLERITH NAME OF THE ITH INDEPENDENT VARIABLE USED FOR THE SEARCH PROCESS.
IOFLAG	INTEGER	0	INPUT/OUTPUT UNITS FLAG.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IPRO	INTEGER	0	CONTROLS PRINT OUT OF TRAJECTORIES DURING SEARCH/OPTIMIZATION.
LISTIN	INTEGER	2	CONTROLS SUMMARY-OF-INPUT PRINTOUT
MAXITR	INTEGER	10	MAXIMUM NUMBER OF ITERATIONS DURING SEARCH/OPTIMIZATION.
MODEW	INTEGER	1	CONTROLS TYPE OF WEIGHTING TO BE USED FOR THE INDEPENDENT VARIABLES
MULTRF	INTEGER	1	A FLAG TO INDICATE HOW THE INPUT DATA FOR THE CURRENT RUN IS TO BE FORMED WHEN RUNNING MULTIPLE RUNS.
NDEPV	INTEGER	0	NUMBER OF DEPENDENT VARIABLES TO BE SATISFIED FOR THE SEARCH/OPTIMIZATION.
NINDV	INTEGER	0	NUMBER OF INDEPENDENT VARIABLES TO BE USED FOR CONTROL IN THE SEARCH/OPTIMIZATION PROCESS.
NPAD(1)	DECIMAL	9.0	DESIRED AVERAGE OF MINIMUM AND MAXIMUM NUMBER OF DIGITS DIFFERENT BETWEEN RESPECTIVE DEPENDENT AND OPTIMIZATION VARIABLE VALUES TO BE ACHIEVED BY ADJUSTING PERT(I).
NPAD(2)	DECIMAL	4.0	NUMBER OF SIGNIFICANT FIGURES DIFFERENT BETWEEN NOMINAL AND PERTURBED DEPENDENT OR OPTIMIZATION VARIABLE VALUE BELOW WHICH THE VARIABLE IS IGNORED IN SELECTING MINIMUM AND MAXIMUM REQUIRED FOR PERT ADJUSTMENT.
NPAD(3)	DECIMAL	14.4494	NUMBER OF SIGNIFICANT FIGURES DIFFERENT BETWEEN NOMINAL AND PERTURBED DEPENDENT OR OPTIMIZATION VARIABLE VALUES, ABOVE WHICH THE VARIABLE IS IGNORED IN SELECTING MINIMUM AND MAXIMUM REQUIRED FOR PERT ADJUSTMENT.

9.A. INPUTS FOR NAMELIST SEARCH (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NXTRUN	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT THIS IS THE NEXT RUN WHEN USING THE SEARCH/OPTIMIZATION OPTION.
OPT	DECIMAL	0.0	FLAGS THE TYPE OF OPTIMIZATION TO BE PERFORMED.
OPTPH	DECIMAL	900.0	PHASE AT WHICH THE VARIABLE SPECIFIED BY OPTVAR IS TO BE OPTIMIZED.
OPTVAR	HOLLERITH	0.0	HOLLERITH NAME OF THE VARIABLE TO BE OPTIMIZED.
PCTCC	DECIMAL	.3	MAXIMUM PERCENTAGE CHANGE IN THE MAGNITUDE OF THE CONTROL VECTOR, U(I) DURING AN OPTIMIZATION STEP (NOT USED FOR TARGETING).
PDLMAX	DECIMAL	2.0	MAGNITUDE OF DIFFERENCE BETWEEN NPAD(I) AND AVERAGE OF MINIMUM AND MAXIMUM NUMBER OF DIGITS DIFFERENT BETWEEN RESPECTIVE DEPENDENT AND OPTIMIZATION VARIABLES, ABOVE WHICH A SECOND PERTURBED TRAJECTORY IS PROPAGATED TO MORE ACCURATELY APPROXIMATE THE SENSITIVITIES.
PERT(I) I=1,25	SAME AS THE VAR. SPECIFIED BY INDVR(I)	1.0E-4	PERTURBATION ON THE INDEPENDENT VARIABLE, INDVR(I) WHOSE VALUE IS CURRENTLY U(I). USED TO DETERMINE THE SENSITIVITY DE(J)/DU(I).
P2MIN	DECIMAL	1.0	THE PROBLEM IS CONSIDERED TARGETED IF P2 (THE MAGNITUDE OF THE ERROR VECTOR E(I)) IS LESS THAN P2MIN.
SRCHM	INTEGER	0	CONTROLS THE TECHNIQUE USED FOR SEARCH/OPTIMIZATION.
STMINP	DECIMAL	.1	MAXIMUM PERCENTAGE THAT A TRIAL STEP IS ALLOWED TO BE REDUCED BY BASED UPON THE CURVE FIT.

9.A. INPUTS FOR NAMELIST SEARCH (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
TABL(I) I=1,25	HOLLERITH	0	THE NAME OF THE TABLE CONTAINING THE Y ARGUMENT TO BE USED.
TABLY(I) I=1,25	INTEGER	0	THE INDEX OF THE Y ARGUMENT. THE FIRST Y ARGUMENT IS DESIGNATED AS 1, THE SECOND AS 2, ETC.
U(I) I=1,25	SAME AS THE VAR. SPECIFIED BY INDVR(I)	0.0	INITAL VALUES TO BE USED FOR THE VARIABLES SPECIFIED BY INDVR(I) AT PHASE INDPH(I).
WCON	DECIMAL	100.0	WEIGHTING CONSTANT FOR P2 WHEN OPT IS NONZERO AND SRCHM IS NOT EQUAL TO FOUR.
WOPT	DECIMAL	1.0	WEIGHTING FOR THE OPTIMIZATION VAR-IABLE. SHOULD BE APPROXIMATELY ONE OVER THE NORMAL VALUE OF OPTVAR.
WU(I) I=1,25	SAME AS THE VAR. SPECIFIED BY INDVR(I)	0.0	INDEPENDENT VARIABLE WEIGHTING USED IF MODEW = 0. WU(I) LT 1.0/U(I) MORE SENSITIVE WU(I) = 1.0/U(I) SAME AS MODEW = 1. WU(I) GT 1.0/U(I) LESS SENSITIVE

9.B. INPUTS FOR NAMELIST GENDAT

THIS SECTION CONTAINS A LIST OF ALL INPUT VARIABLES FOR NAMELIST GENDAT. IT IS INTENDED ONLY AS A SUMMARY OF ALL THE INPUTS FOR THE BENEFIT OF USERS WHO ARE FAMILIAR WITH THE VARIOUS OPTIONS. MORE DETAILED INSTRUCTIONS ON THE USE OF THESE VARIABLES CAN BE FOUND IN THE SECTIONS THAT DISCUSS THE SPECIFIC OPTIONS.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
AEXP	N/D	.64	AXIAL EXPONENT. USED IN CALCULATION OF VISCOUS CORRECTIONS IF NPC(8)=4.
ALPARG BETARG BNKARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ANGLE OF ATTACK, SIDESLIP AND BANK. USED IF IGUID(1)=-1 OR 0.
ALPPC(I) BETPC(I) BNKPC(I) I=1,4	DECIMAL	0.	ANGLE OF ATTACK (ALPHA), SIDESLIP (BETA), AND BANK (BNKANG) POLYNOMIAL COEFFICIENTS, RESPECTIVELY.
ALPHA BETA BNKANG	DEG	0.	INITIAL VALUES OF ANGLE OF ATTACK, SIDESLIP, AND BANK, RESPECTIVELY.
ALTA	N.MI. (KM)	0.	INITIAL APOGEE ALTITUDE. USED IF NPC(3)=5.
ALTAT	N.MI. (KM)	0.	THE ALTITUDE OF APOGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
ALTIP	FT (M)	0.	THE DESIRED ALTITUDE AT IMPACT WHEN USING THE ANALYTICAL IMPACT OPTION, I.E., IF NPC(29)=1,2,3.
ALTITO	FT (M)	0.	INITIAL ALTITUDE ABOVE THE OBLATE PLANET. USED IF NPC(4)=2 AND IF ALTITO IS NOT INPUT.
ALTMAX	FT (M)	1.E20	MAXIMUM ALTITUDE, I.E., THE TRAJECTORY WILL TERMINATE IF THE VALUE OF OBLATE ALTITUDE (ALTITO) EXCEEDS THIS VALUE.
ALTMIN	FT (M)	-5000.	MINIMUM ALTITUDE, I.E., THE TRAJECTORY WILL TERMINATE IF THE VALUE OF OBLATE ALTITUDE (ALTITO) BECOMES LESS THAN

9.B. INPUTS FOR NAMELIST GENDAT (CONT)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ALTP	N.MI. (KM)	0.	INITIAL PERIGEE ALTITUDE. USED IF NPC(3)=5.
ALTPT	N.MI. (KM)	0.	THE ALTITUDE OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
ALTREF	N.MI. (KM)	100.	ALTITUDE OF THE REFERENCE CIRCULAR ORBIT FOR USE IN COMPUTING THE CROSSRANGE RELATIVE TO THE GROUND TRACK OF THE REFERENCE ORBIT. USED IF NPC(12)=3.
ARGP	DEG	0.	INITIAL ARGUMENT OF PERIGEE. USED IF NPC(3)=5.
ARGPT	DEG	0.	THE ARGUMENT OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2) =3.
ARP(I) I=1,10	FT**2 (M2)	0.	THE SURFACE AREA OF PANEL I. USED IF NPC(26)=1.
ASMAX	G-S	3.0	SENSED (MEASURABLE) ACCELERATION LIMIT.
ATMOSK(I) I=1,2	DECIMAL	1.	ATMOSPHERIC CONSTANTS USED TO COMPUTE THE SPEED OF SOUND (CS) AND THE ATMOSPHERIC DENSITY (DENS), RESPECTIVELY.
AZL	DEG	0.	THE AZIMUTH OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM MEASURED CLOCKWISE FROM NORTH.
AZREF	DEG	0.	THE AZIMUTH REFERENCE FOR USE IN COMPUTING DWNRNG AND CRRNG. USED IF NPC(12)=1,2,3.
AZVELA	DEG	0.	INITIAL AZIMUTH ANGLE OF THE VELOCITY RELATIVE TO THE ATMOSPHERE. USED IF NPC(3)=3.
AZVELI	DEG	0.	INITIAL AZIMUTH ANGLE OF THE INERTIAL VELOCITY VECTOR. USED IF NPC(3)=2.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
AZVELR	DEG	0.	INITIAL AZIMUTH ANGLE OF THE RELATIVE VELOCITY VECTOR. USED IF NPC(3)=4.
AZWB	DEG	180.	WIND AZIMUTH BIAS. USED IF NPC(6) =1.
CINF	N/D	1.0	CHAPMAN-RUBESIN VISCOSITY COEFF-ICIENT. USED IF NPC(8)=4.
CLCDMX	DECIMAL	0.	THE VALUE OF THE MAXIMUM LIFT TO DRAG RATIO FOR CRUISE FLIGHT USED TO COMPUTE DOWNRANGE (DWNRNG) BY MEANS OF THE BREGUET EQUATION. USED IF NPC(12)=4.
CRITR	HOLLERITH	TIME	THE NAME OF THE EVENT CRITERIA VARIABLE.
DALPHA DBETA DBANK	DEG	0.	THE DESIRED VALUES OF ALPHA, BETA, AND BNKANG AT THE EVENTS SPECIFIED BY DESN(I), I=1,3.
DATE(I) I=1,3	DECIMAL	1NU	THE DATE (MONTH,DAY,YEAR) FOR WHICH THE ZERO HOUR (MIDNIGHT) VALUES OF GHA, RAS, AND DECL ARE DESIRED. IF DATE IS NOT INPUT (OR IS INPUT AS 1NU) THE INPUT VALUES OF GHA, GHAS, AND DECL WILL BE USED.
DECL	DEG	0.	THE DECLINATION OF THE SUN. (OBTAINABLE FROM AN EPHEMERIS TABLE)
DEPTLS(I) I=1,4	DECIMAL	1.0	THE TOLERANCES ON THE DEPENDENT STEERING VARIABLES.
DEPVLS(I) I=1,4	DECIMAL	0.	THE DESIRED VALUES OF THE DEPENDENT STEERING VARIABLES.
DEPVRS(I) I=1,4	HOLLERITH	0	THE HOLLERITH NAMES OF THE DEPENDENT STEERING VARIABLES.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DESN(I) I=1,3	DECIMAL	THE NEXT PRIMARY EVENT NUMBER	THE EVENT NUMBERS AT WHICH THE ANGLES DYAW, DPITCH, AND DYAW OR DALPHA, DBETA, AND DBANK ARE TO BE ATTAINED.
DESNE	DECIMAL	THE NEXT PRIMARY EVENT NUMBER	THE EVENT NUMBER AT WHICH THE VALUE OF THE THROTTLING PARAMETER (ETA) IS TO ATTAIN THE DESIRED VALUE.
DETA	DECIMAL	0.	THE DESIRED VALUE OF THE THROTTLING PARAMETER (ETA) AT THE EVENT SPECIFIED BY DESNE. USED IF NPC(22) =3.
DGF(I) I=1,3	HOLLERITH	0	THE NAME OF THE VARIABLE TO BE CONTROLLED IN CHANNEL I BY THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
DLTMAX	SEC	1.0E10	THE MAXIMUM ALLOWABLE STEPSIZE WHEN USING THE VARIABLE STEP/ORDER INTEGRATOR, I.E., WHEN NPC(2)=2.
DLTMIN	SEC	0.0	THE MINIMUM ALLOWABLE STEPSIZE WHEN USING THE VARIABLE STEP/ORDER INTEGRATOR, I.E., WHEN NPC(2)=2.
DRGPK(I) I=1,3	DECIMAL	0.0	THE SCALE FACTOR APPLIED TO DRAGP(I) TO YIELD DRGPP(I).
DT	SEC	1.0	THE INTEGRATION INTERVAL (STEPSIZE).
DTG	SEC	1.0	THE GENERAL GUIDANCE CYCLE TIME FOR THE GENERAL GUIDANCE OPTIONS.
DTIMR(J) J=1,4	SEC	0.	THE DERIVATIVE OF TIME REFERENCE J. THIS INPUT ACTIVATES THE INTEGRATION OF TIMRF(J) WHEN INPUT NONZERO.
DTM	DECIMAL	1.	A MULTIPLIER ON THE INTEGRATION INTERVAL (DT) TO BE USED IN COMPUTING THE INTEGRATION INTERVAL FOR THE PERTURBED TRAJECTORIES AND THE TRIAL STEP TRAJECTORIES.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DVIMAG	FT/SEC (M/S)	0.	THE AMOUNT OF DELTA INERTIAL VELOCITY TO BE ADDED WHEN USING THE INSTANTANEOUS VELOCITY ADDITION OPTION. USED IF NPC(9)=3.
DVMARR	FT/SEC (M/S)	0.0	THE DELTA VELOCITY MARGIN REQUIRED. USED IF NPC(23)=1,3.
DVPCT	DECIMAL	0.	THE DECIMAL PERCENTAGE OF THE ROOT-SUM-SQUARE OF THE IDEAL VELOCITIES OF THE VARIOUS STAGE TO BE USED IN COMPUTING THE REQUIRED MARGIN WHEN NPC(23)=2.
DVXI(I) I=1,3	FT/SEC (M/S)	0.	THE DELTA ECI INERTIAL VELOCITY COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES, I.E., DVXI(I)=VXI(I) - VXIT(I) USED IF MVEHF(2)=1.
DVXRT(I) I=1,3	FT/SEC (M/S)	0.	THE TARGET CENTERED VELOCITY COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE. USED IF MVEHF(2)=2.
DXI(I) I=1,3	FT (M)	0.	THE DELTA ECI POSITION COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES, I.E., DXI(I)=XI(I) - XIT(I) USED IF MVEHF(2)=1.
DXRT(I) I=1,3	FT (M)	0.	THE TARGET CENTERED POSITION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE. THE ORIENTATION OF XRT(2) IS ALONG THE POSITIVE RADIUS VECTOR TO THE TARGET VEHICLE, XRT(1) IS FORMED AS XIT(I) CROSS VXIT(I), AND XRT(3) COMPLETES A RIGHT-HAND SYSTEM. USED IF MVEHF(2)=2.
DYAW DPITCH DROLL	DEG	0.	THE DESIRED VALUES OF THE YAW, PITCH, AND ROLL ANGLES AT THE EVENTS SPECIFIED BY DESN(I), I=1,3.

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INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ELEMIN	DEG	0.0	THE MINIMUM ELEVATION ANGLE (ELEVJ) BELOW WHICH THE PRINTOUT FOR TRACKER J WILL BE SUPPRESSED. USED IF NPC(28) = 2,3.
ENDJOB	INTEGER	0	END-OF-JOB FLAG.
ENDPHS	INTEGER	0	END-OF-PHASE FLAG.
ENDPRB	INTEGER	0	END-OF-PROBLEM FLAG.
EPSINT	DECIMAL	1.0	ABSOLUTE ERROR TOLERANCE ON THE LOCAL INTEGRATION ERROR. THE SAME ERROR TOLERANCE IS TO BE USED FOR ALL DIFFERENTIAL EQUATIONS IN THE SYSTEM. USED IF NPC(2) = 2.
ETA	DECIMAL	1.0	THE INITIAL VALUE OF THE THROTTLING PARAMETER WHEN USING NPC(22)=3.
ETAARG	HOLLERITH	TIMES	THE NAME OF THE VARIABLE TO BE USED AS THE ARGUMENT FOR THE ETA POLYNOMIAL. USED IF NPC(22)=0,1.
ETAPC(I) I=1,4	DECIMAL	1.0,3*0.	THROTTLING PARAMETER (ETA) POLYNOMIAL COEFFICIENTS. USED IF NPC(22)=0 OR 1.
EVENT(1)	DECIMAL	0.	THE EVENT SEQUENCE NUMBER FOR THE CURRENT PHASE.
EVENT(2)	DECIMAL	0.	THE TYPE OF EVENT.
FESN	DECIMAL	100.	THE FINAL EVENT SEQUENCE NUMBER FOR THE CURRENT PROBLEM.
FID(J) J=1,2	HOLLERITH	UD265 FILE I.D. 0000	THE TWO WORD (20 CHARACTERS) FILE IDENTIFICATION TO BE WRITTEN ON THE PROFILE TAPE.
GAMMAA	DEG	0.	INITIAL ATMOSPHERIC RELATIVE FLIGHT PATH ANGLE. USED IF NPC(3)=3.
GAMMAI	DEG	0.	INITIAL VALUE OF INERTIAL FLIGHT PATH ANGLE. USED IF NPC(3)=2.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
GAMMAR	DEG	0.	INITIAL RELATIVE FLIGHT PATH ANGLE. USED IF NPC(3)=4.
GCLAT	DEG	0.	INITIAL GEOCENTRIC LATITUDE. USED IF NPC(4)=2 AND IF GDLAT IS NOT INPUT.
GCRAD	FT (M)	0.	INITIAL GEOCENTRIC RADIUS. USED IF NPC(4)=2 AND IF ALTITO IS NOT INPUT.
GDERV(J) J=1,10	HOLLERITH	0	THE NAME OF GENERAL INTEGRATION VARIABLE J.
GDLAT	DEG	0.	INITIAL GEODETIC LATITUDE. USED IF NPC(4)=2 AND IF GCLAT IS NOT INPUT.
GHA	DEG	0.	THE GREENWICH HOUR ANGLE. THE ANGLE BETWEEN THE VERNAL EQUINOX AND THE GREENWICH MERIDIAN AT MIDNIGHT ON THE DAY OF LAUNCH. (OBTAINABLE FROM AN EPHEMERIS TABLE)
GHAS	DEG	180.	THE GREENWICH HOUR ANGLE OF THE SUN. GHAS IS THE ANGLE BETWEEN THE GREENWICH MERIDIAN AT MID-NIGHT AND THE SUN ON THE DAY OF LAUNCH.
GINT(J) J=1,10	DECIMAL	0.	THE VALUE OF THE INTEGRAL OF GENERAL INTEGRATION VARIABLE J.
GO	FT/SEC**2 (M/S2)	32.174	WEIGHT TO MASS CONVERSION FACTOR.
GVRI(J) J=1,10	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE WITH THE GENERAL GUIDANCE OPTIONS.
GXP(I) GYP(I) GZP(I) I=1,15	FT (M)	0.	LOCATION OF THE ENGINE GIMBAL IN BODY REFERENCE (XBR,YBR,ZBR) SYSTEM FOR ENGINE I. USED IF NPC(10) =1, 2, OR 3.
HEATK(I) I=1,3	DECIMAL	1. 17600. 26000.	COEFFICIENTS USED IN COMPUTING CHAPMANS HEATING RATE. USED IF NPC(15)=1,3,4.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
HRAT(I) I=1,10	DECIMAL	0.	THE HEAT RATIO FOR PANEL I WITH RESPECT TO THE REFERENCE TOTAL HEAT (TLHEAT).
IDGF(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE LINEAR FEEDBACK GUIDANCE FOR CHANNEL I IS TO BE INITIALIZED.
IDRGP(I) I=1,3	INTEGER	0	A FLAG TO INDICATE THAT THE VALUE OF DRGPP(I) AT THE BEGINNING OF THE CURRENT PHASE IS TO BE SAVED AS THE VARIABLE DRGPS(I).
IENGA(J) J=1,15	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT TO CALCULATE THE THROTTLE SETTING FOR ENGINE J USING THE ACCELERATION LIMIT EQUATIONS.
IENGT(J) J=1,15	INTEGER	1	A FLAG TO INDICATE WHETHER OR NOT TO CALCULATE THE INCIDENCE ANGLES FOR ENGINE J USING THE STATIC TRIM EQUATIONS.
IGF(J) J=1,6	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE WITH THE GENERAL GUIDANCE OPTIONS.
IGUID(1)	INTEGER	0	TYPE OF GUIDANCE (STEERING) DESIRED, I.E., BODY RATES, AERODYNAMIC ANGLES, OR EULER ANGLES.
IGUID(2)	INTEGER	0	ATTITUDE CHANNEL SELECTOR.
IGUID(3)	INTEGER	0	FLAG TO SPECIFY THE STEERING OPTION WHEN COMMANDING ALL CHANNELS SIMULTANEOUSLY USING AERODYNAMIC ANGLE OF ATTACK, SIDESLIP, AND BANK.
IGUID(4)	INTEGER	0	EULER ANGLE STEERING (INERTIAL OR RELATIVE).
IGUID(5)	INTEGER	1	AERODYNAMIC ANGLE RATE/INERTIAL BODY RATE COMBINATIONS FLAG.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
IGUID(6)	INTEGER	0	SEPARATE CHANNEL OPTIONS FOR ANGLE OF ATTACK.
IGUID(7)	INTEGER	0	SEPARATE CHANNEL OPTIONS FOR SIDE SLIP ANGLE.
IGUID(8)	INTEGER	0	SEPARATE CHANNEL OPTION FOR BANK ANGLE.
IGUID(9)	INTEGER	0	SEPARATE CHANNEL OPTION FOR YAW ANGLE.
IGUID(10)	INTEGER	0	SEPARATE CHANNEL OPTION FOR PITCH ANGLE.
IGUID(11)	INTEGER	0	SEPARATE CHANNEL OPTION FOR ROLL ANGLE.
IGUID(12)	INTEGER	2	INERTIAL BODY RATE INITIALIZATION FLAG.
IGUID(13)	INTEGER	1	YAW REFERENCE OPTION FLAG.
IGUID(14)	INTEGER	0	GENERAL OPEN OR CLOSED LOOP GUIDANCE OPTION.
IGUID(15)	INTEGER	0	GENERAL OPEN LOOP GUIDANCE OVER-RIDE OPTION.
INC	DEG	0.	INITIAL INCLINATION ANGLE. USED IF NPC(3)=5.
INCPCH INCYAW	DEG	0.	INITIAL THRUST INCIDENCE ANGLES IN PITCH AND YAW FOR THE ENGINES THAT ARE TO BE USED TO TRIM THE VEHICLE.
INCT	DEG	0.	THE INCLINATION OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
INDVRS(I) I=1,4	HOLLERITH	0	THE HOLLERITH NAMES OF THE INDEPENDENT STEERING VARIABLES. THE NUMBER OF INDVRS MUST EQUAL NDEPVS.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
ISPV(I) I=1,15	SEC	1.0E11	VACUUM SPECIFIC IMPULSE FOR ENGINE I. USED IF NPC(21)=1.
ITAP(I) I=1,10	INTEGER	0	A FLAG TO INDICATE WHICH WEIGHT PER UNIT AREA TABLE (WUAIT) IS TO BE USED FOR PANEL I. USED IF NPC(26)=1.
IWPF(I) I=1,15	INTEGER	0	FLAG TO INDICATE WHICH ENGINES ARE TO BE INCLUDED IN THE SPECIFIC FLOWRATE INTEGRATION OBTAINED WHEN NPC(27) = 1.
J2 J3 J4	DECIMAL	1.0823E-3 0. 0.	SECOND, THIRD, AND FOURTH HARMONICS IN THE GRAVITY POTENTIAL FUNCTION. USED IF NPC(16)=0.
JTKFLG(I) I=1,5	INTEGER	0.	A FLAG TO INDICATE WHETHER TRACKER I IS TO BE USED WHEN CALCULATING TRACKER PARAMETERS, I.E., IF NPC(28) =1,2,3.
KDG(I) I=1,3	DECIMAL	1.	THE DISPLACEMENT GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
KRG(I) I=1,3	DECIMAL	1.	THE RATE GAIN FOR CHANNEL I TO BE USED IN THE LINEAR FEEDBACK GUIDANCE EQUATIONS.
LAN	DEG	0.	INITIAL LONGITUDE OF THE ASCENDING NODE MEASURED EAST OF THE XI AXIS. USED IF NPC(3)=5.
LANT	DEG	0.	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
LATL	DEG	GDLAT	LATITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM.
LATREF LONREF	DEG	0.	REFERENCE LATITUDE AND LONGITUDE FOR USE IN COMPUTING THE VARIOUS RANGE PARAMETERS. USED IF NPC(12) =1,2,3,4.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
LONG	DEG	0.	INITIAL EAST LONGITUDE RELATIVE TO THE PRIME MERIDIAN. USED IF NPC(4)=2 AND IF LONGI IS NOT INPUT.
LONGI	DEG	0.	INITIAL LONGITUDE EAST OF THE XI AXIS. USED IF NPC(4)=2, AND LONG IS NOT INPUT.
LONL	DEG	LONGI	INERTIAL EAST LONGITUDE OF THE LAUNCH CENTERED INERTIAL (L) COORDINATE SYSTEM.
LREF	FT (M)	0.	REFERENCE LENGTH USED IN THE STATIC TRIM EQUATIONS, NPC(10)=1,2,3, AND IN THE CALCULATION OF REYNOLDS NUMBER
LREFY	FT (M)	0.	REFERENCE LENGTH IN YAW. USED IN THE YAW STATIC TRIM EQUATIONS.
MAXITS	INTEGER	4	MAXIMUM NUMBER OF ITERATIONS FOR THE GENERALIZED STEERING ALGORITHM PER INTEGRATION PASS.
MAXTIM	SEC	1.E10	MAXIMUM TRAJECTORY TIME.
MDL	INTEGER	1	THE EVENT CRITERIA MODEL TO BE USED.
MONF(J) J=1,2,3	HOLLERITH	0.	THE NAME OF THE VARIABLE TO BE USED AS THE FUNCTIONAL INEQUALITY.
MONX(I) I=1,10	HOLLERITH	0.	THE NAME OF THE VARIABLE TO BE MONITORED FOR MAXIMUM AND MINIMUM VALUES.
MONY(I) I=1,10	HOLLERITH	0.	THE NAME OF THE VARIABLE WHOSE VALUE IS TO BE DETERMINED WHEN MONX(I) REACHES THE MAXIMUM AND MINIMUM VALUES.
MU	FT**3/ SEC**2 (M3/S2)	1.40765 39E+16	GRAVITATIONAL CONSTANT OF THE ATTRACTING PLANET.
MVEHF(I)	INTEGER	0	MULTIPLE VEHICLE OPTION FLAG.

9.B. INPUTS FOR NAMELIST GENDAT (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
MVEHF(2)	INTEGER	0	TARGET VEHICLE INITIALIZATION OPTION FLAG.
NDEPVS	INTEGER	0	THE NUMBER OF DEPENDENT STEERING VARIABLES. NDEPVS MUST BE LESS THAN OR EQUAL TO 4.
NENG	INTEGER	1	THE NUMBER OF THRUSTING ENGINES (EITHER ROCKET OR JET). USED IF NPC(9)=1,2.
NEQS(J) J=1,3	INTEGER	0	THE TYPE OF BOUNDARY TO BE CONSIDERED FOR THE FUNCTIONAL INEQUALITY WHEN USING NPC(11)=1.
NEWSTG	INTEGER	0	A FLAG TO INDICATE THE BEGINNING OF A NEW STAGE WHEN CALCULATING THE VELOCITY MARGIN.
NPC(1)	INTEGER	0	CONIC CALCULATION FLAG.
NPC(2)	INTEGER	1	INTEGRATION METHOD FLAG.
NPC(3)	INTEGER	4	VELOCITY VECTOR INITIALIZATION FLAG.
NPC(4)	INTEGER	2	POSITION VECTOR INITIALIZATION FLAG.
NPC(5)	INTEGER	2	ATMOSPHERE MODEL FLAG.
NPC(6)	INTEGER	0	ATMOSPHERIC WINDS FLAG.
NPC(7)	INTEGER	0	ACCELERATION LIMIT OPTION FLAG.
NPC(8)	INTEGER	1	AERODYNAMIC COEFFICIENT TYPE FLAG.
NPC(9)	INTEGER	0	PROPULSION TYPE FLAG.
NPC(10)	INTEGER	0	STATIC TRIM OPTION FLAG.
NPC(11)	INTEGER	0	FUNCTIONAL INEQUALITY CONSTRAINTS OPTION FLAG.
NPC(12)	INTEGER	0	CROSSRANGE AND DOWNRANGE OPTION FLAG.

9.B. INPUTS FOR NAMELIST GENDAT (CONT)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(13)	INTEGER	0	PROPELLANT JETTISION OPTION FLAG.
NPC(14)	INTEGER	0	HOLD DOWN OPTION FLAG.
NPC(15)	INTEGER	0	AEROHEATING RATE OPTION FLAG.
NPC(16)	INTEGER	0	GRAVITY MODEL OPTION FLAG.
NPC(17)	INTEGER	0	WEIGHT JETTISON OPTION FLAG BASED FMASST.
NPC(18)	INTEGER	0	TRAJECTORY TERMINATION FLAG.
NPC(19)	INTEGER	1	FLAG TO CONTROL PRINTING OF INPUT CONDITIONS FOR EACH PHASE.
NPC(20)	INTEGER	0	FLAG TO SPECIFY THE TYPE OF SPECIAL INTEGRATION STEP SIZE (DT) PREDICTION TO BE USED.
NPC(21)	INTEGER	0	FLAG TO INDICATE THE METHOD BY WHICH FLOWRATE IS TO BE COMPUTED FOR ROCKET ENGINES.
NPC(22)	INTEGER	0	THROTTLING PARAMETER INPUT OPTION FLAG.
NPC(23)	INTEGER	0	FLAG WHICH CONTROLS THE VELOCITY MARGIN CALCULATIONS.
NPC(24)	INTEGER	0	GENERAL INTEGRATION VARIABLE FLAG.
NPC(25)	INTEGER	0	VELOCITY LOSS CALCULATION FLAG.
NPC(26)	INTEGER	0	SPECIAL AEROHEATING CALCULATIONS FLAG.
NPC(27)	INTEGER	0	ACTIVATION FLAG FOR THE OPTION TO INTEGRATE THE FLOWRATE OF SELECTED ENGINES.
NPC(28)	INTEGER	0	TRACKING STATION OPTION FLAG.
NPC(29)	INTEGER	0	ANALYTICAL VACUUM IMPACT POINT CALCULATION FLAG.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
NPC(30)	INTEGER	0	WEIGHT CALCULATION OPTION FLAG.
NPC(31)	INTEGER	0	A FLAG TO ACTIVATE THE VERNAL EQUINOX, SUN-SHADOW AND SUN ANGLE OPTION.
NPC(32)	INTEGER	0	THE PARACHUTE DRAG OPTION FLAG.
NPC(I) I=33,35	INTEGER	0	NOT USED.
NSPEC(J) J=1,5	INTEGER	0	THE ARRAY OF INPUT FLAGS FOR USE IN THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).
NTIMES	INTEGER	0	THE NUMBER OF TIMES TO REPEAT THE EVENT BEING INPUT. THE EVENT MUST BE A ROVING EVENT, I.E., EVENT(2)=1, AND ROVET MUST BE INPUT.
OMEGA	RAD/SEC	7.29211 E-5	ROTATION RATE OF THE ATTRACTING PLANET.
PARIF(I) I=1,3	DECIMAL	0.0	THE PARACHUTE INFLATION FACTOR FOR PARACHUTE I. IF PARIF(I) = 0.0, THEN DIARP(I) = 0.0.
PERTS(I) I=1,4	DECIMAL	1.0E-4	PERTURBATION SIZE FOR THE INDEPENDENT STEERING VARIABLES.
PGCLAT	DEG	0.	INITIAL GEOCENTRIC LATITUDE OF PERIGEE. MEASURED POSITIVE IN THE NORTHERN HEMISPHERE. USED IF NPC(3) =5.
PGCLTT	DEG	0.	THE GEOCENTRIC LATITUDE OF PERIGEE OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
PINC	SEC	0.	PRINT INTERVAL.
PRNC	SEC	1HU	PROFILE TAPE WRITE INTERVAL.
PRNT(I) I=1,198	HOLLERITH	0.	PRINT VARIABLE NAMES.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PWPROP	LBS (N)	0.	THE VALUE OF THE PROPELLANT CONSUMED BY THE ENGINES SPECIFIED BY IWPF(I).
RE	FT (M)	20925741.	EQUATORIAL RADIUS OF THE ATTRACTING PLANET.
RHOSL	SLUGS/ FT**3 (KG/M3)	.0023769	SEA LEVEL DENSITY USED IN COMPUTING CHAPMANS HEATING RATE. USED IF NPC(15)=1,3,4.
RN	FT (M)	1.0	NOSE RADIUS USED IN COMPUTING CHAPMAN HEATING RATE. USED IF NPC(15)=1,3,4.
ROLARG PITARG YAWARG	HOLLERITH	TIMES	THE NAMES OF THE VARIABLES TO BE USED AS ARGUMENTS IN THE CUBIC POLYNOMIALS FOR ROLL, PITCH, AND YAW. USED IF IGUID(1)=-1,1,2.
ROLI YAWI PITI	DEG	0.	THE INITIAL VALUES OF THE INERTIAL EULER ATTITUDE ANGLES OF THE VEHICLE WITH RESPECT TO THE LAUNCH PAD (L) COORDINATE SYSTEM.
ROLPC(I) PITPC(I) YAWPC(I) I=1,4	DECIMAL	0.	ROLL, PITCH, AND YAW ANGLE POLYNOMIAL COEFFICIENTS, RESPECTIVELY. USED IF IGUID(1)=-1,1 OR 2.
ROVET(I) I=1,10	DECIMAL	0.0	THE INPUT ARRAY CONTAINING THE VALUES OF THE CRITERIA VARIABLE AT WHICH THE REPEATING ROVING EVENTS ARE TO OCCUR.
RP	FT (M)	20855590.	POLAR RADIUS OF THE ATTRACTING PLANET. USED IF NPC(16)=0.
SPECI(J) J=1,9	DECIMAL	0.	THE CONSTANT VALUED INPUT VARIABLES FOR USE IN THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).
PSL	LB/FT**2 (N/M2)	VARIES BASED ON NPC(5)	SEA LEVEL ATMOSPHERIC PRESSURE USED IN COMPUTING JET ENGINE THRUST AND FLOWRATE.

9.B. INPUTS FOR NAMELIST GENDAT (CONT)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
SREF	FT**2 (M2)	0.	THE AERODYNAMIC REFERENCE AREA USED TO COMPUTE THE AERODYNAMIC FORCES WHEN NPC(8)=1,2 AND THE MOMENTS IF NPC(8)=1,2 AND NPC(10)=1,2,3.
TIME	SEC	0.	THE INITIAL VALUE OF TRAJECTORY TIME.
TIMREF	DECIMAL	0.	THE REFERENCE TIME TO BE USED FOR THE INERTIAL RANGE CALCULATIONS. USED IF NPC(12)=2.
TIMRF(J) J=1,4	SEC	0.	TIME REFERENCE J.
TITLE(I) I=1,10	HOLLERITH	0.	A 10 WORD TITLE TO BE USED FOR PROBLEM/PHASE IDENTIFICATION.
TOL	SAME AS THE CRITERIA VARIABLE	1.E-6	THE DESIRED ACCURACY TOLERANCE FOR THE SPECIFIED CRITERIA VARIABLE (CRITR).
TRKGLT(I) I=1,5	DECIMAL	0.	THE GEODETIC LATITUDE OF TRACKER I. MEASURED POSITIVE IF IN THE NORTHERN HEMISPHERE. USED IF NPC(28)=1,2,3.
TRKHIT(I) I=1,5	DECIMAL	0.	THE HEIGHT OF TRACKER I ABOVE THE OBLATE PLANET. USED IF NPC(28) =1,2,3.
TRKLON(I) I=1,5	DECIMAL	0.	THE LONGITUDE OF TRACKER I MEASURED POSITIVE EAST OF THE GREENWICH MERIDIAN. USED IF NPC(28)=1,2,3.
TRKNAM(I) I=1,5	HOLLERITH	0	THE NAME OF TRACKER I. THIS IS A 10 CHARACTER IDENTIFICATION WHICH IS PRINTED WITH THE TRACKER PRINT BLOCK. USED IF NPC(28)=1,2,3.
TRPM	SEC	0.	THE TIME OF REFERENCE PAST MID-NIGHT. THIS IS USUALLY THE LAUNCH TIME FOR ASCENT PROBLEMS OR THE TIME OF EPOCH FOR REND-EZVOUS PROBLEMS.

9.B. INPUTS FOR NAMELIST GENDAT (CONT)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
TRUAN	DEG	0.	INITIAL TRUE ANOMALY. USED IF NPC(3)=5.
TRUANT	DEG	0.	THE TRUE ANOMALY OF THE TARGET VEHICLE. USED IF MVEHF(2)=3.
TSL	DEG R (DEG K)	VARIES BASED ON NPC(5)	SEA LEVEL ATMOSPHERIC TEMPERATURE USED IN COMPUTING JET ENGINE THRUST AND FLOWRATE.
US(I) I=1,4	DECIMAL	0.	THE INITIAL GUESS FOR THE VALUES OF THE INDEPENDENT STEERING VARIABLES.
VALUE	DECIMAL	1.E10	THE VALUE OF THE CRITERIA VARIABLE (CRITR) AT WHICH THE EVENT IS TO OCCUR.
VELA	FT/SEC (M/S)	0.	INITIAL ATMOSPHERIC RELATIVE VELOCITY USED IF NPC(3)=3.
VELI	FT/SEC (M/S)	0.	INITIAL VALUE OF INERTIAL VELOCITY. USED IF NPC(3)=2.
VELR	FT/SEC (M/S)	0.	INITIAL RELATIVE VELOCITY. USED IF NPC(3)=4.
VINFI	N/D	.007	INVISCID VALUE OF RAREFACTION PARAMETER. USED IF NPC(8)=4.
VXI(J) J=1,3	FT/SEC (M/S)	0.	THE INITIAL VALUES OF THE INERTIAL VELOCITY VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES. USED IF NPC(3)=1.
VXIT(I) I=1,3	FT/SEC (M/S)	0.	THE ECI VELOCITY COMPONENTS OF THE TARGET VEHICLE. USED IF MVEHF(2)=0,2.
WEICON	LBS (N)	0.	THE INITIAL VALUE OF THE AMOUNT OF PROPELLANT CONSUMED.
WGTSG	LBS (N)	0.	THE VEHICLE GROSS WEIGHT (EXCLUDING WPLD) AT THE BEGINNING OF THE PHASE IN WHICH WGTSG IS INPUT.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
WJETT	LBS (N)	0.	THE WEIGHT TO BE JETTISONED AT THE BEGINNING OF THE PHASE IN WHICH WJETT IS INPUT.
WPLD	LBS (N)	0.	THE PAYLOAD WEIGHT.
WPROPI	LBS (N)	0.	THE INITIAL WEIGHT OF PROPELLANT.
XI(J) J=1,3	FT (M)	0.	THE INITIAL VEHICLE POSITION VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES. USED IF NPC(4)=1.
XIT(I) I=1,3	FT (M)	0.	THE ECI POSITION COMPONENTS OF THE TARGET VEHICLE. USED IF MVEHF(2)=0,2.
XMAX(I) I=1,10	DECIMAL	-1.0E20	THE INITIAL VALUE OF XMAX(I).
XMIN(I) I=1,10	DECIMAL	+1.0E20	THE INITIAL VALUE OF XMIN(I).
YAWR PITR ROLR	DEG	0.	THE INITIAL VALUES OF THE RELATIVE EULER ANGLES OF THE VEHICLE WITH RESPECT TO THE LOCAL GEOGRAPHIC (G) COORDINATE SYSTEM.
YXMN(I) I=1,10	DECIMAL	+1.0E20	THE INITIAL VALUE OF YXMN(I).
YXMX(I) I=1,10	DECIMAL	-1.0E20	THE INITIAL VALUE OF YXMX(I).

9.C. INPUTS FOR NAMELIST TAB

THIS SECTION SUMMARIZES ALL THE TABLE INPUTS FOR THE PROGRAM. ALL TABLES ARE INPUT IN NAMELIST TAB WITH A NEW INPUT OF NAMELIST TAB BEING REQUIRED FOR EACH TABLE. SEE THE SECTION ON NAMELIST INPUT SEQUENCE FOR DETAILS ON THE USE OF NAMELIST TAB.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
AEIT I=1,15	FT**2 (M2)	0.	TABLE OF EXIT AREA FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1.
ALPHAT BETAT BANKT	DEG	0.	TABLES OF ANGLE OF ATTACK, SIDESLIP, AND BANK. USED IF IGUID(1)=0, AND IGUID(3)=2.
ATEMT	DEG R (DEG K)	0.	ATMOSPHERIC TEMPERATURE TABLE. USED IF NPC(5)=1.
AZWT	DEG	0.	WIND AZIMUTH TABLE. USED IN CONJUNCTION WITH VWT WHEN NPC(6)=1.
CADPT CADYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC AXIAL FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8)=1 AND IN THE STATIC TRIM EQUATIONS IF NPC(10) =1,2,3.
CAIOT	N/D	0.	TABLE OF INVISCID AXIAL COEFFICIENT AT MAXIMUM L/D. USED IF NPC(8)=4.
CAOT	N/D	0.	AXIAL FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=1.
CAT	N/D	0.	AXIAL FORCE COEFFICIENT TABLE. USED IF NPC(8)=1.
CDDPT CDDYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC DRAG FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8)=2 AND IN THE STATIC TRIM EQUATIONS IF NPC(10) =1,2,3.

9.C. INPUTS FOR NAMELIST TAB (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CDOT	N/D	0.	DRAG FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=2.
CDPIT I=1,3	N/D	0.0	THE DRAG COEFFICIENT TABLE FOR PARACHUTE I.
CDT	N/D	0.	DRAG FORCE COEFFICIENT TABLE. USED IF NPC(8)=2.
CLDPT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC LIFT FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN PITCH. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8) =2 AND IN THE STATIC TRIM EQUATIONS IF NPC(10)=1,2,3.
CLOT	N/D	0.	LIFT FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=2.
CLT	N/D	0.	LIFT FORCE COEFFICIENT TABLE. USED IF NPC(8)=2.
CMAT CWBT	N/D	0.	TABLES OF AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10)=1,2,3.
CMDPT CWDYT	PER DEG	0.	TABLES OF INCREMENTAL AERODYNAMIC PITCHING AND YAWING MOMENT COEFF- ICIENTS DUE TO FLAP DEFLECTIONS. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10)=1,2,3.
CMOT CWOT	N/D	0.	TABLES OF AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS FOR ZERO ALPHA AND BETA. USED IN THE STATIC TRIM EQUATIONS, I.E., IF NPC(10)=1,2,3.

9.C. INPUTS FOR NAMELIST TAB (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
DENST	SLUGS/ FT**3 (KG/M3)	0.	ATMOSPHERIC DENSITY TABLE. USED IF NPC(5)=1.
ETAT	N/D	0.	TABLE OF THE THROTTLING PARAMETER. USED IF NPC(22)=2.
FLJT J=1,2,3	SAME AS THE VARIABLE IN MONF(J)	0.	THE VALUE OF THE BOUNDARY OF THE FUNCTIONAL INEQUALITY AS A FUNCTION OF THE TABLE ARGUMENT.
FMASST	DECIMAL	0.	A TABLE WHICH IS USED IN CONJUNCTION WITH NPC(17) TO DETERMINE THE VALUE OF WJETTM.
GDFIT I=1,3	DECIMAL	0.	THE DESIRED PROFILE FOR THE VARIABLE SPECIFIED BY DGF(I), I=1,3, WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GENVIT I=1,2	DECIMAL	0.	THE TABLES USED TO CALCULATE THE GENERALIZED DEPENDENT VARIABLES DGENV, PGENV, RGENV, AND SGENV.
GNMXIT GNMNIT I=1,3	DEG	360. -360.	THE MAXIMUM AND MINIMUM PROFILES FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
GNOMIT I=1,3	DEG	0.	THE NOMINAL PROFILE FOR THE COMMANDED ANGLE IN CHANNEL I WHEN USING THE LINEAR FEEDBACK GUIDANCE OPTION.
HTRTT	BTU/ FT**2-SEC (W/M2)	0.	THE TABLE OF AEROHEATING RATE AS A FUNCTION OF THE INPUT ARGUMENTS IF NPC(15)=2, OR A MULTIPLIER TO BE USED IN CALCULATING HEATING RATE IF NPC(15)=3,4,5.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
CNAT	N/D	0.	NORMAL FORCE COEFFICIENT TABLE. THE NORMAL FORCE COEFFICIENT SLOPE CAN BE INPUT AS CNAT IF THE MNEMONIC MULTIPLIER CNANM = 5HALPHA, IS INPUT IN NAMELIST TBLMLT. USED IF NPC(8)=1.
CNDPT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC NORMAL FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN PITCH. USED IN THE AERODYNAMIC FORCE EQUATIONS IF NPC(8) =1 AND IN THE STATIC TRIM EQUATIONS IF NPC(10)=1,2,3.
CNOT	N/D	0.	NORMAL FORCE COEFFICIENT TABLE FOR ZERO ALPHA. USED IF NPC(8)=1.
CST	FT/SEC (M/S)	0.	SPEED OF SOUND TABLE. USED IF NPC(5)=1.
CYBT	N/D	0.	SIDE FORCE COEFFICIENT TABLE. THE SIDE FORCE COEFFICIENT SLOPE CAN BE INPUT AS CYBT IF THE MNEMONIC MULTIPLIER CYBNM = 4HBETA, IS INPUT IN NAMELIST TBLMLT.
CYDYT	PER DEG	0.	TABLE OF INCREMENTAL AERODYNAMIC SIDE FORCE COEFFICIENT DUE TO THE FLAP DEFLECTION IN YAW. USED IN IN THE AERODYNAMIC FORCE EQUATIONS AND IN THE STATIC TRIM EQUATIONS IF NPC(10)=1,2,3.
CYOT	N/D	0.	SIDE FORCE COEFFICIENT TABLE FOR ZERO BETA.
DENKT	DECIMAL	0.	A DENSITY MULTIPLIER TABLE WHICH IS USED TO SIMULATE DENSITY DISPERSIONS. THE DENSITY FROM THE ATMOSPHERE MODEL BEING USED WILL BE MULTIPLIED BY THE TABLE LOOK-UP VALUE OF DENKT WHICH MUST BE INPUT AS THE DESIRED DECIMAL PERCENTAGE CHANGE IN DENSITY. DENS = DENS*(1.0 + DENKT)

9.C. INPUTS FOR NAMELIST TAB (CONTD)

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
PIJT YIJT J=1,15	DEG	0.	TABLES OF THE THRUST VECTOR INCIDENCE ANGLES IN PITCH AND YAW FOR ENGINE J.
PREST	LB/FT**2 (N/M2)	0.	ATMOSPHERIC PRESSURE TABLE. USED IF NPC(5)=1.
TVCIT I=1,15	LBS (N)	0.	VACUUM THRUST TABLE FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1, OR NET THRUST OVER THE ATMOSPHERIC PRESSURE RATIO WHEN USING JET ENGINES, I.E., IF NPC(9)=2.
VWT	FT/SEC (M/S)	0.	WIND SPEED TABLE. USED IN CON-JUNCTION WITH AZWT WHEN NPC(6)=1.
VWUT VWVT VWWT	FT/SEC (M/S)	0.	TABLES OF WIND SPEED COMPONENTS IN THE NORTH, EAST, AND VERTICAL DIRECTIONS. USED IF NPC(6)=2.
WDIT I=1,15	LB/SEC OR LB/SEC/LB (N/S OR N/S/N)	0.	FLOWRATE TABLE FOR ENGINE I WHEN USING ROCKET ENGINES, I.E., IF NPC(9)=1 AND NPC(21)=0. OR SPECIFIC FUEL CONSUMPTION WHEN USING JET ENGINES, I.E., IF NPC(9)=2.
WGTJT J=1,2	LBS (N)	0.	TABLES USED TO COMPUTE WEIGHT WHEN NPC(30)=1.
WGTDJT J=1,2	LB/SEC (N/S)	0.	TABLES USED TO COMPUTE FLOW RATE WHEN NPC(30)=2.
WUAIT I=1,2	LB/FT**2 (N/M2)	0.	TABLES OF WEIGHT PER UNIT AREA. TWO TABLES ARE PROVIDED TO ENABLE TWO MATERIALS OF DIFFERENT DENSITY TO BE CONSIDERED. THE TABLE TO BE USED FOR EACH PANEL IS SPECIFIED BY THE INPUT VARIABLE ITAP(I) IN NAMELIST GENDAT. USED IF NPC(26)=1.

INPUT SYMBOL	UNITS	STORED VALUE	DEFINITION
XCGT YCGT ZCGT	FT (M)	0.	TABLES OF CENTER-OF-GRAVITY LOCATION ALONG THE XBR,YBR, AND ZBR AXES, RESPECTIVELY, WHEN USING THE STATIC TRIM OPTION, I.E., IF NPC(10)=1,2,3.
XREFT YREFT ZREFT	FT (M)	0.	TABLES OF THE AERODYNAMIC REFERENCE (OR CENTER-OF-PRESSURE) LOCATION ALONG THE XBR, YBR, AND ZBR AXES, RESPECTIVELY, WHEN USING THE STATIC TRIM OPTION, I.E., IF NPC(10)=1,2,3.
YAWT PITT ROLT	DEG	0.	TABLES OF YAW, PITCH, AND ROLL ANGLES. USED IF IGUID(1)=1,2 AND IGUID(4)=2.
ZLALPT	DEG	0.	ZERO-LIFT ANGLE OF ATTACK TABLE. USED IF NPC(8)=4.

9.D. OUTPUT VARIABLES

THIS SECTION PRESENTS AN ALPHABETICAL LIST OF THE OUTPUT VARIABLES. THIS LIST SHOULD ALSO BE USED TO DETERMINE THE NAMES OF INTERNALLY COMPUTED VARIABLES WHICH ARE TO BE USED AS TARGETS, EVENT CRITERIA VARIABLES, OPTIMIZATION VARIABLES, AND TABLE ARGUMENTS.

OUTPUT SYMBOL	UNITS	DEFINITION
AEJ J=1,15	FT**2 (M2)	TABLE LOOK-UP VALUE OF EXIT AREA FOR ENGINE J. CALCULATED IF NPC(9)=1.
AHI	FT-LB/ FT**2 (NM/M2)	THE AEROHEATING INDICATOR WHICH IS COMPUTED AS THE INTEGRAL OF THE PRODUCT OF DYNP AND VELA. CALCULATED IF NPC(26)=2.
AHID	FT-LB/ FT**2/SEC (NM/M2/S)	THE DERIVATIVE OF AHI. CALCULATED IF NPC(26)=2.
AHORIZ	FT/SEC**2 (M/S2)	THE MEASURABLE ACCELERATION IN THE LOCAL HORIZONTAL PLANE.
ALPDOT BETDOT BNKDOT	DEG/SEC	RATE OF CHANGE IN ANGLE OF ATTACK, SIDESLIP, AND BANK.
ALPHA BETA BNKANG	DEG	ANGLE OF ATTACK, SIDESLIP, AND BANK. SEE THE SECTION ON GUIDANCE (STEERING) OPTIONS FOR THE SPECIFIC DEFINITIONS.
ALPHI BETAI BANKI	DEG	INERTIAL ANGLE OF ATTACK, SIDESLIP, AND BANK. SEE THE SECTION ON GUIDANCE (STEERING) OPTIONS FOR THE SPECIFIC DEFINITIONS.
ALPTOT	DEG	TOTAL ANGLE OF ATTACK.
ALTA	N.MI. (KM)	ALTITUDE OF APOGEE ABOVE THE OBLATE PLANET. CALCULATED IF NPC(1)=1,2,3.
ALTAT	N.MI. (KM)	THE ALTITUDE OF APOGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ALTITO	FT (M)	ALTITUDE OF THE VEHICLE ABOVE THE OBLATE PLANET.

9.D. OUTPUT VARIABLES (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
ALTP	N.MI. (KM)	ALTITUDE OF PERIGEE ABOVE THE OBLATE PLANET. CALCULATED IF NPC(1)=1,2,3.
ALTPT	N.MI. (KM)	THE ALTITUDE OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
AMYB AMZB	FT-LB (NM)	THE AERODYNAMIC MOMENTS ABOUT THE PITCH AND YAW AXES, RESPECTIVELY. CALCULATED IF NPC(10)=1,2,3.
ANGMOM	FT**2/ SEC**2 (M2/S2)	ORBITAL ANGULAR MOMENTUM. CALCULATED IF NPC(1)=1,2,3.
ANGMOT	DEG	THE ANGULAR MOMENTUM OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
APORAD	FT (M)	GEOCENTRIC RADIUS OF APOGEE. CALCULATED IF NPC(1)=1,2,3.
APORT	FT	THE APOGEE RADIUS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
APVEL	FT/SEC (M/S)	INERTIAL VELOCITY AT APOGEE. CALCULATED IF NPC(1)=1,2,3.
APVELT	FT/SEC (M/S)	THE INERTIAL VELOCITY AT APOGEE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ARGP	DEG	ARGUMENT OF PERIGEE. CALCULATED IF NPC(1) =1,2,3.
ARGPT	DEG	THE ARGUMENT OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ARGV	DEG	ARGUMENT OF THE VEHICLE. CALCULATED IF NPC(1) =1,2,3. ARGV IS THE ANGLE BETWEEN THE ASCENDING NODE AND THE VEHICLE IN THE ORBIT PLANE MEASURED POSITIVE IN THE DIRECTION OF THE VEHICLE MOTION.

9.D. OUTPUT VARIABLES (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
ARGVT	DEG	THE ARGUMENT OF VEHICLE LATITUDE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ASM	FT/SEC**2 (M/S2)	MEASURABLE (SENSED) ACCELERATION MAGNITUDE.
ASMG	G-S	MEASURABLE (SENSED) ACCELERATION IN G-S.
ASXI ASYI ASZI	FT/SEC**2 (M/S2)	COMPONENTS OF MEASURABLE (SENSED) VEHICLE ACCELERATION IN THE EARTH CENTERED INERTIAL COORDINATE SYSTEM.
ATEM	DEG R (DEG K)	ATMOSPHERIC TEMPERATURE. CALCULATED IF NPC(5) =1,2,3.
ATL	FT/SEC (M/S)	THE VALUE OF THE ATMOSPHERIC THRUST LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
AVERT	FT/SEC**2 (M/S2)	THE MEASURABLE ACCELERATION IN THE VERTICAL (RADIAL) DIRECTION.
AXB AYB AZB	FT/SEC**2 (M/S2)	COMPONENTS OF MEASURABLE (SENSED) ACCELERATION IN THE BODY COORDINATE SYSTEM.
AXI AYI AZI	FT/SEC**2 (M/S2)	COMPONENTS OF TOTAL VEHICLE ACCELERATION IN THE EARTH CENTERED INERTIAL SYSTEM.
AXIT AYIT AZIT	FT/SEC (M/S)	THE TOTAL ACCELERATION COMPONENTS OF THE TARGET VEHICLE IN THE ECI COORDINATE SYSTEM.
AZVAD	DEG/SEC	RATE OF CHANGE IN THE AZIMUTH ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ATMOSPHERE.
AZVELA	DEG	AZIMUTH (HEADING) ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ATMOSPHERE.

OUTPUT SYMBOL	UNITS	DEFINITION
AZVELI	DEG	AZIMUTH (HEADING) ANGLE OF THE INERTIAL VELOCITY VECTOR.
AZVELR	DEG	AZIMUTH (HEADING) ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ROTATING PLANET.
AZVIT	DEG	THE AZIMUTH OF THE INERTIAL VELOCITY VECTOR OF THE TARGET VEHICLE.
CA CY CN	N/D	AERODYNAMIC AXIAL, SIDE, AND NORMAL FORCE COEFFICIENTS. CALCULATED IF NPC(8)=1,2.
CADP CNDP	N/D	INCREMENTAL AERODYNAMIC AXIAL AND NORMAL FORCE COEFFICIENTS DUE TO FLAP DEFLECTIONS IN PITCH. CALCULATED IF NPC(8)=1.
CADY	N/D	INCREMENTAL AERODYNAMIC AXIAL FORCE COEFFICIENT DUE TO FLAP DEFLECTIONS IN YAW. CALCULATED IF NPC(8)=1.
CD CL	N/D	AERODYNAMIC DRAG AND LIFT FORCE COEFFICIENTS. CALCULATED IF NPC(8)=2.
CDDP CLDP	N/D	INCREMENTAL AERODYNAMIC DRAG AND LIFT COEFF-ICIENTS DUE TO FLAP DEFLECTIONS IN PITCH. CALCULATED IF NPC(8)=2.
CDDY	N/D	INCREMENTAL AERODYNAMIC DRAG COEFFICIENT DUE TO FLAP DEFLECTION IN YAW. CALCULATED IF NPC(8)=2.
CDPJ J=1,3	N/D	THE DRAG COEFFICIENT FOR PARACHUTE J.
CIPJ SIPJ J=1,15	N/D	COSINE AND SINE OF THE PITCH INCIDENCE ANGLE OF THE THRUST VECTOR FOR ENGINE J.
CIYJ SIYJ J=1,15	N/D	COSINE AND SINE OF THE YAW INCIDENCE ANGLE OF THE THRUST VECTOR FOR ENGINE J.

OUTPUT SYMBOL	UNITS	DEFINITION
CM CW	N/D	AERODYNAMIC PITCHING AND YAWING MOMENT COEFF- ICIENTS USED IN THE STATIC TRIM OPTION. CALCULATED IF NPC(10)=1,2,3.
CMDP CWDY	N/D	INCREMENTAL AERODYNAMIC PITCHING AND YAWING MOMENT COEFFICIENTS DUE TO FLAP DEFLECTIONS IN PITCH AND YAW, RESPECTIVELY. CALCULATED IF NPC(8)=1,2 AND NPC(10)=1,2,3.
CRRNG	N.MI. (KM)	CROSSRANGE DISTANCE. CALCULATED IF NPC(12) =1,2,3.
CS	FT/SEC (M/S)	SPEED OF SOUND. CALCULATED IF NPC(5)=1,2,3.
CYDY	N/D	INCREMENTAL AERODYNAMIC SIDE FORCE COEFFICIENT DUE TO FLAP DEFLECTIONS IN YAW. CALCULATED IF NPC(8)=1,2.
DAXI DAYI DAZI	FT/SEC**2 (M/S2)	THE TOTAL ACCELERATION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE IN THE ECI COORDINATE SYSTEM. DAXI(I)=AXI(I) - AXIT(I)
DCDV	N/D	DELTA CD DUE TO VISCOUS EFFECTS. CALCULATED IF NPC(8)=4.
DCLV	N/D	DELTA CL DUE TO VISCOUS EFFECTS. CALCULATED IF NPC(8)=4.
DECLIN	DEG	DECLINATION OF THE OUTGOING ASYMPTOTE. CALCULATED IF NPC(1)=1,2,3.
DECLT	DEG	THE DECLINATION OF THE OUTGOING ASYMPTOTE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
DENS	SLUGS/ FT**3 (KG/M3)	ATMOSPHERIC DENSITY. CALCULATED IF NPC(5) =1,2,3.
DEJ J=0,3	N/D	RATE OF CHANGE IN THE QUATERNIONS. CALCULATED IF IGUID(1)=-1.

9.D. OUTPUT VARIABLES (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
DFLP DFLY	DEG	PITCH AND YAW FLAP DEFLECTIONS. CALCULATED IF NPC(9)=2, OR IF NPC(9)=1 AND IENGT(J)=0, J=1,15, AND NPC(10)=1,2,3.
DFVALJ J=1,2,3	DECIMAL	THE INSTANTANEOUS VALUE OF THE CONSTRAINT VIOLATION SQUARED. CALCULATED IF NPC(11)=1.
DGENV	DECIMAL	THE GENERALIZED DEPENDENT VARIABLE. THIS VARIABLE IS CALCULATED AS THE DIFFERENCE BETWEEN TWO INPUT TABLES AS FOLLOWS - DGENV = GENV2T - GENV1T
DIAMPJ J=1,3	FT (M)	THE CURRENT DIAMETER OF PARACHUTE J.
DIARPJ J=1,3	FT/SEC (M/SEC)	THE CURRENT INFLATION RATE OF PARACHUTE J.
DLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL AERODYNAMIC DRAG LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
DLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE AERODYNAMIC DRAG LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
DMASS	SLUGS/SEC (KG/S)	RATE OF CHANGE IN VEHICLE MASS.
DPRGIJ J=1,2	N.MI. (KM)	THE DOT PRODUCT RANGE OF THE VEHICLE AT IMPACT. THESE PARAMETERS ARE DEFINED EXACTLY THE SAME AS DPRNG1 AND DPRNG2 EXCEPT THAT THE ARE THE VALUES AT IMPACT. COMPUTED IF NPC(29) AND NPC(12) ARE BOTH INPUT NON-ZERO.
DPRNG1 DPRNG2	N. MI. (KM)	THE DOT PRODUCT (NON-DIRECTIONAL) RANGE FROM THE REFERENCE POINT (SPECIFIED BY LATREF AND LONREF) TO THE CURRENT VEHICLE POSITION (GCLAT AND LONG).
DRAG	LBS (N)	AERODYNAMIC DRAG FORCE. CALCULATED IF NPC(5) =1,2,3 AND NPC(8)=1,2.
DRAGPJ J=1,3	LBS (N)	THE CURRENT DRAG FORCE DUE TO PARACHUTE J.

OUTPUT SYMBOL	UNITS	DEFINITION
DRAGPT	LBS (N)	THE TOTAL DRAG RESULTING FROM ALL PARACHUTES.
DRGPPJ J=1,3	LBS (N)	THE VALUE OF DRAGPJ SCALED BY THE INPUT VALUE OF DRGPK(J).
DRGPSJ J=1,3	LBS (N)	THE SAVED VALUE OF DRGPPJ AT THE BEGINNING OF THE PHASE IN WHICH IDRGP(J) IS INPUT AS 1.
DRT	FT (M)	THE SEPARATION DISTANCE BETWEEN THE PURSUER AND TARGET VEHICLES. COMPUTED IF MVEHF(1)=1.
DUA DVA DWA	FT/SEC**2 (M/S2)	VEHICLE ACCELERATION COMPONENTS RELATIVE TO THE ATMOSPHERE.
DVCIR	FT/SEC (M/S)	THE DELTA VELOCITY REQUIRED TO CIRCULARIZE THE CURRENT ORBIT. CALCULATED IF NPC(1)=1,2,3.
DVCIRT	FT/SEC (M/S)	THE DELTA VELOCITY REQUIRED TO CIRCULARIZE THE CURRENT ORBIT OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
DVEXS	FT/SEC (M/S)	THE EXCESS VELOCITY MARGIN. WHEN DVEXS EQUALS ZERO, THE AMOUNT OF VELOCITY MARGIN AVAILABLE EQUALS THE REQUIRED VELOCITY MARGIN BASED ON THE VALUE OF NPC(23).
DVMAR	FT/SEC (M/S)	THE AVAILABLE VELOCITY MARGIN BASED ON ISPV(1) AND THE REMAINING PROPELLANT (WPROP). CALCULATED IF NPC(23)=1,2,3.
DVMARR	FT/SEC (M/S)	THE REQUIRED VELOCITY MARGIN. THIS IS EITHER THE CURRENT INPUT VALUE OR CALCULATED VALUE BASED ON THE VALUE OF NPC(23).
DVXI DVYI DVZI	FT/SEC (M/S)	THE DELTA ECI INERTIAL VELOCITY COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES. DVXI(I)=VXI(I) - VXIT(I)
DVXRT DVYRT DVZRT	FT/SEC (M/S)	THE TARGET CENTERED VELOCITY COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE.

OUTPUT SYMBOL	UNITS	DEFINITION
DWNRNG	N.MI. (KM)	DOWNRANGE DISTANCE. CALCULATED IF NPC(12) =1,2,3,4.
DXI DYI DZI	FT (M)	THE DELTA ECI POSITION COMPONENTS BETWEEN THE PURSUER AND TARGET VEHICLES. DXI(I)=XI(I) - XIT(I)
DXRT DYRT DZRT	FT (M)	THE TARGET CENTERED POSITION COMPONENTS OF THE PURSUER VEHICLE RELATIVE TO THE TARGET VEHICLE.
DYNP	LB/FT**2 (N/M2)	DYNAMIC PRESSURE. CALCULATED IF NPC(5)=1,2,3.
EJ J=0,3	N/D	THE VALUES OF THE QUATERNIONS. CALCULATED IF IGUID(1)=-1.
ECCAN	DEG	ECCENTRIC ANOMALY. CALCULATED IF NPC(1)=1,2,3.
ECCANT	DEG	THE ECCENTRIC ANOMALY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
ECCEN	N/D	ORBITAL ECCENTRICITY. CALCULATED IF NPC(1) =1,2,3.
ECCENT	DEG	THE ECCENTRICITY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ELEVI I=1,5	DEG	THE ELEVATION ANGLE OF THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MEASURED POSITIVE ABOVE THE LOCAL HORIZONTAL PLANE AT TRACKER I. CALCULATED IF NPC(28)=1,2,3.
ENERGY	FT**2/ SEC**2 (M2/S2)	ORBITAL ENERGY. CALCULATED IF NPC(1)=1,2,3.
ENRGYT	FT2/S2 (M2/S2)	THE ORBITAL ENERGY OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
ESI I=1,4	DECIMAL	THE ERRORS IN THE DEPENDENT STEERING VARIABLES.

OUTPUT SYMBOL	UNITS	DEFINITION
ETAL	N/D	THE THROTTLE SETTING OF THE ENGINES USED TO LIMIT THE ACCELERATION TO THE SPECIFIED VALUE (ASMAX) WHEN USING NPC(7)=1.
FAXB FAYB FAZB	LBS (N)	AERODYNAMIC FORCES IN THE BODY COORDINATE SYSTEM. CALCULATED IF NPC(5)=1,2,3 AND NPC(8) =1,2.
FAXBPJ J=1,3	LBS (N)	THE COMPONENTS OF DRAGPT ALONG THE VEHICLE BODY AXES.
FMYB FMZB	FT-LB (NM)	THE AERODYNAMIC MOMENTS DUE TO FLAP DEFLECTIONS IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3 AND IF FLAPS ARE BEING USED TO TRIM THE VEHICLE
FTXB FTYB FTZB	LBS (N)	THRUST FORCES IN THE BODY COORDINATE SYSTEM. CALCULATED IF NPC(9)=1,2.
FVALJ J=1,2,3	DECIMAL	THE VALUE OF THE INEQUALITY CONSTRAINT VIOLATION PARAMETER (INTEGRAL OF DFVALJ).
GAMAD	DEG/SEC	RATE OF CHANGE IN THE FLIGHT PATH ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ATMOSPHERE.
GAMIT	DEG	THE INERTIAL FLIGHT PATH ANGLE OF THE TARGET VEHICLE.
GAMMAA	DEG	FLIGHT PATH ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ATMOSPHERE. POSITIVE WHEN VELA IS ABOVE THE LOCAL HORIZONTAL PLANE.
GAMMAI	DEG	FLIGHT PATH ANGLE OF THE INERTIAL VELOCITY VECTOR. POSITIVE WHEN VELI IS ABOVE THE LOCAL HORIZONTAL PLANE.
GAMMAR	DEG	FLIGHT PATH ANGLE OF THE VELOCITY VECTOR RELATIVE TO THE ROTATING PLANET. POSITIVE WHEN VELR IS ABOVE THE LOCAL HORIZONTAL PLANE.
GCLAT	DEG	GEOCENTRIC LATITUDE OF THE VEHICLE. POSITIVE WHEN IN THE NORTHERN HEMISPHERE.

OUTPUT SYMBOL	UNITS	DEFINITION
GCLATT	DEG	THE CURRENT GEOCENTRIC LATITUDE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1.
GCRAD	FT (M)	GEOCENTRIC RADIUS TO THE VEHICLE.
GCRADT	FT (M)	THE GEOCENTRIC RADIUS TO THE TARGET VEHICLE.
GDLAT	DEG	GEODETIC LATITUDE OF THE VEHICLE. POSITIVE WHEN IN THE NORTHERN HEMISPHERE.
GDLTIP	DEG	THE GEODETIC LATITUDE OF THE VACUUM IMPACT POINT. CALCULATED IF NPC(29)=1,2,3.
GENVI I=1,2	DECIMAL	TABLE LOOKUP VALUE OF TABLE GENVIT, I=1,2.
GINTJ J=1,10	DECIMAL	THE VALUE OF THE INTEGRAL FOR THE GENERAL INTEGRATION VARIABLE SPECIFIED BY GDERV(J). CALCULATED IF NPC(24)=1.
GLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL GRAVITY LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
GLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE GRAVITY LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
GSAITS	DECIMAL	THE NUMBER OF ITERATIONS REQUIRED BY THE GENERALIZED STEERING ALGORITHM DURING THE LAST INTEGRATION STEP.
GVRCJ J=1,10	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE GENERAL GUIDANCE OPTIONS.
GXI GYI GZI	FT/SEC**2 (M/S2)	THE GRAVITY ACCELERATION VECTOR COMPONENTS ALONG THE XI, YI, AND ZI AXES.
HEATRT	BTU/ FT**2-SEC (W/M2)	AERODYNAMIC HEATING RATE. CALCULATED IF NPC(15)=1,2,3,4,5.

OUTPUT SYMBOL	UNITS	DEFINITION
HTBT HTLF HTTP HTRT	FT-LB/ FT**2 (NM/M2)	THE AERODYNAMIC HEATING INDICATORS FOR THE BOTTOM, LEFT, TOP, AND RIGHT SIDES OF THE VEHICLE, RESPECTIVELY. THESE PARAMETERS ARE AHI MODIFIED FOR ANGLE OF ATTACK AND SIDSLIP, CALCULATED IF NPC(26)=2.
HTBTD HTLFD HTTPD HTRTD	FT-LB/ FT**2/SEC (NM/M2/S)	THE DERIVATIVES OF HTBT, HTLF, HTTP, AND HTRT, RESPECTIVELY. CALCULATED IF NPC(26)=2.
HTURB	BTU/FT**2 (J/M2)	THE STAGNATION POINT HEATING FOR TURBULENT FLOW. CALCULATED IF NPC(15)=4,5.
HTURBD	BTU/ FT**2/SEC (W/M2)	THE DERIVATIVE OF HTURB. CALCULATED IF NPC(15)=4,5.
HYPVEL	FT/SEC (M/S)	HYPERBOLIC EXCESS VELOCITY. CALCULATED IF NPC(1)=1,2,3.
HYPVT	FT/SEC (M/S)	THE HYPERBOLIC EXCESS VELOCITY OF THE TARGET. VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
IBJK J=1,3 K=1,3	N/D	ELEMENTS OF THE IB MATRIX WHICH IS THE TRANSFORMATION FROM THE EARTH CENTERED INERTIAL (I) TO THE BODY (B) SYSTEM.
INC	DEG	ORBIT INCLINATION ANGLE. CALCULATED IF NPC(1)=1,2,3.
INCPCH INCYAW	DEG	THRUST INCIDENCE ANGLES IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3.
INCT	DEG	THE INCLINATION OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
IPNULL IYNULL	DEG	THE THRUST VECTOR INCIDENCE ANGLES IN PITCH AND YAW REQUIRED TO TRACK THE VEHICLE CENTER-OF-GRAVITY. CALCULATED IF NPC(10) =1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
LAN	DEG	LONGITUDE OF THE ASCENDING NODE EAST OF THE PRIME MERIDIAN AT TIME=0. CALCULATED IF NPC(1)=1,2,3.
LANT	DEG	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
LANVE	DEG	THE LONGITUDE OF THE ASCENDING NODE WITH RESPECT TO THE VERNAL EQUINOX. THIS VARIABLE IS COMPUTED ONLY IF NPC(1) AND NPC(31) ARE BOTH INPUT NON-ZERO.
LANVET	DEG	THE LONGITUDE OF THE ASCENDING NODE OF THE TARGET VEHICLE ORBIT WITH RESPECT TO THE VERNAL EQUINOX. COMPUTED IF MVEHF(1)=1, AND IF BOTH NPC(1) AND NPC(31) ARE INPUT NON-ZERO.
LIFT	LBS (N)	AERODYNAMIC LIFT FORCE. CALCULATED IF NPC(5) =1,2,3 AND NPC(8)=1,2.
LKAI I=1,5	DEG	LOOK ANGLE A OF TRACKER I. THIS IS THE CONE ANGLE WHICH THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MAKES WITH THE NEGATIVE XB BODY AXIS. CALCULATED IF NPC(28)=1,2,3.
LKBI I=1,5	DEG	LOOK ANGLE B OF TRACKER I. THIS IS THE CLOCK ANGLE WHICH THE SLANT RANGE VECTOR FROM TRACKER I TO THE VEHICLE MAKES WITH THE POSITIVE ZB BODY AXIS WHEN PROJECTED INTO THE YB,ZB PLANE. THE ANGLE IS MEASURED POSITIVE IN A COUNTER-CLOCKWISE DIRECTION WHEN LOOKING ALONG THE POSITIVE XB BODY AXIS. CALCULATED IF NPC(28) =1,2,3.
LONG	DEG	LONGITUDE OF THE VEHICLE MEASURED EAST OF THE PRIME MERIDIAN.
LONGI	DEG	INERTIAL LONGITUDE OF THE VEHICLE MEASURED EAST OF THE XI AXIS.
LONGIP	DEG	THE LONGITUDE OF THE VACUUM IMPACT POINT EAST OF THE PRIME MERIDIAN. CALCULATED IF NPC(29) =1,2,3.

9.D. OUTPUT VARIABLES (CONTD)

OUTPUT SYMBOL	UNITS	DEFINITION
LONGT	DEG	THE CURRENT LONGITUDE OF THE TARGET VEHICLE MEASURED EAST OF THE GREENWICH MERIDIAN. COMPUTED IF MVEHF(1)=1.
MACH	N/D	MACH NUMBER. CALCULATED IF NPC(5)=1,2,3.
MACHDT	1/SEC	RATE OF CHANGE OF MACH WITH RESPECT TO TIME.
MASS	SLUGS (KG)	VEHICLE MASS.
MEAAN	DEG	MEAN ANOMALY. CALCULATED IF NPC(1)=1,2,3.
MEAANT	DEG	THE MEAN ANOMALY OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PERIOD	MIN	ORBITAL PERIOD. CALCULATED IF NPC(1)=1,2,3.
PERIDT	MIN	THE ORBITAL PERIOD OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGCLAT	DEG	GEOCENTRIC LATITUDE OF PERIGEE. CALCULATED IF NPC(1)=1,2,3. POSITIVE IN THE NORTHERN HEMISPHERE.
PGCLTT	DEG	THE GEOCENTRIC LATITUDE OF PERIGEE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGENV	DECIMAL	THE GENERALIZED PRODUCT VARIABLE. THIS VARIABLE IS CALCULATED AS THE PRODUCT OF TWO INPUT TABLES AS FOLLOWS - PGENV = GENV2T * GENV1T
PGERAD	FT (M)	GEOCENTRIC RADIUS OF PERIGEE. CALCULATED IF NPC(1)=1,2,3.
PGERT	FT (M)	THE PERIGEE RADIUS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGLON	DEG	INERTIAL LONGITUDE OF PERIGEE MEASURED POSITIVE EAST OF THE XI AXIS. CALCULATED IF NPC(1) =1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
PGLONT	DEG	THE INERTIAL LONGITUDE OF PERIGEE OF THE TARGET VEHICLE ORBIT MEASURED EAST OF THE XI AXIS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PGVEL	FT/SEC (M/S)	INERTIAL VELOCITY AT PERIGEE. CALCULATED IF NPC(1)=1,2,3.
PGVELT	FT/SEC (M/S)	THE INERTIAL VELOCITY AT PERIGEE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
PJETTS	LBS (N)	THE PROPELLANT WEIGHT TO BE JETTISONED. CALCULATED INTERNALLY BY THE PROGRAM BASED ON THE VALUE OF NPC(13).
PRES	LB/FT**2 (N/M2)	ATMOSPHERIC PRESSURE. CALCULATED IF NPC(5) =1,2,3.
PWDOT	LB/SEC (N/S)	THE FLOWRATE RESULTING FROM THE SUMMATION OF INDIVIDUAL FLOWRATES OF THE ENGINES INCLUDED IN THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
PWPROP	LB (N)	THE PROPELLANT CONSUMED BY THE SPECIFIED ENGINES FOR THE SPECIAL FLOWRATE INTEGRATION OPTION. ACTIVATED BY NPC(27) = 1, AND IWPF(I) = 1.
QALPHA	LB-DEG/ FT**2 (N-DEG/ M2)	PRODUCT OF DYNAMIC PRESSURE AND ANGLE OF ATTACK. USED AS AN AIRLOADS INDICATOR IN THE PITCH PLANE.
QALTOT	LB-DEG/ FT**2 (N-DEG/ M2)	PRODUCT OF DYNAMIC PRESSURE AND THE TOTAL ANGLE OF ATTACK. USED AS AN AIRLOADS INDICATOR.
RAS	DEG	THE RIGHT ASCENSION OF THE SUN WITH RESPECT TO THE VERNAL EQUINOX SYSTEM XVE AXIS.
REYNO	N/D	REYNOLDS NUMBER BASED ON THE REFERENCE LENGTH LREF. CALCULATED IF NPC(5)=1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
RGENV	DECIMAL	THE GENERALIZED RATIO VARIABLE. THIS VARIABLE IS CALCULATED AS THE RATIO OF TWO INPUT TABLES AS FOLLOWS - RGENV = GENV2T / GENV1T
RIPJ J=1,3	FT (M)	THE INERTIAL POSITION COMPONENTS OF THE VACUUM IMPACT POINT. CALCULATED IF NPC(29)=1,2,3.
ROLBD PITBD YAWBD	DEG/SEC	VEHICLE BODY RATES WITH RESPECT TO THE LAUNCH PAD INERTIAL (L) COORDINATE SYSTEM. CALCULATED IF IGUID(1)=-1.
ROLI YAWI PITI	DEG	INERTIAL VEHICLE ATTITUDE ANGLES MEASURED WITH RESPECT TO THE LAUNCH PAD INERTIAL (L) COORDINATE SYSTEM. AT LAUNCH, ALL THREE ANGLES ARE ZERO WHEN THE VEHICLE IS VERTICAL, I.E., WHEN XB IS IN THE RADIAL (OR LOCAL VERTICAL) DIRECTION, ZB IS ALONG THE AZIMUTH SPECIFIED BY AZL, AND YB COMPLETES A RIGHT-HAND SYSTEM.
ROLID YAWID PITID	DEG/SEC	THE INERTIAL EULER RATES WITH RESPECT TO THE LAUNCH CENTERED (L) INERTIAL COORDINATE SYSTEM.
RS	FT (M)	RADIUS TO THE SURFACE OF THE OBLATE PLANET. USED TO COMPUTE ALTITO AND IN THE RANGE CALCULATIONS IF NPC(12)=1,2,3.
RSO	FT (M)	RADIUS TO THE SURFACE OF THE OBLATE AT THE LATITUDE SPECIFIED BY LATREF. USED IN THE RANGE CALCULATIONS IF NPC(12)=1,2,3.
RTASC	DEG	RIGHT ASCENSION OF THE OUTGOING ASYMPTOTE. CALCULATED IF NPC(1)=1,2,3.
RTASCT	DEG	THE RIGHT ASCENSION OF THE OUTGOING ASYMPTOTE OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
SCLOCK	DEG	THE CLOCK ANGLE OF THE SUN VECTOR WITH RESPECT TO THE ZB AXIS, MEASURED POSITIVE TOWARD THE YB AXIS.

OUTPUT SYMBOL	UNITS	DEFINITION
SCONE	DEG	THE CONE ANGLE BETWEEN THE SUN VECTOR AND THE POSITIVE XB AXIS.
SEMAXT	FT (M)	THE SEMI-MAJOR AXIS OF THE TARGET VEHICLE ORBIT. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
SEMJAX	FT (M)	SEMI-MAJOR AXIS. CALCULATED IF NPC(1)=1,2,3.
SHADF	FT	THE SHADOW FUNCTION.
SGENV	DECIMAL	THE GENERALIZED SUM VARIABLE. THIS VARIABLE IS CALCULATED AS THE SUM OF TWO INPUT TABLES AS FOLLOWS - SGENV = GENV2T + GENV1T
SLOS1I SLOS2I SLOS3I I=1,5	DB	THE SPACE LOSS OF TELEMETRY SIGNALS FROM THE VEHICLE TO TRACKER I FOR FREQUENCIES OF 420 MHZ (COMMAND FREQUENCY), 2287.5 MHZ (TELEMETRY FREQUENCY), AND 5765.0 MHZ (TRACKING FREQUENCY). CALCULATED IF NPC(28)=1,2,3.
SLTRGI I=1,5	FT (M)	THE SLANT RANGE DISTANCE FROM TRACKER I TO THE VEHICLE. CALCULATED IF NPC(28)=1,2,3.
SPECVJ J=1,9	DECIMAL	THE OUTPUT VARIABLES ASSOCIATED WITH THE SPECIAL CALCULATIONS ROUTINE (CALSPEC).
TDURP	SEC	THE TIME SINCE THE OCCURRENCE OF THE LAST PRIMARY EVENT.
THRJ J=1,15	LBS (N)	VALUE OF NET THRUST FOR ENGINE J. CALCULATED IF NPC(9)=1,2.
THRUST	LBS (N)	NET THRUST (VACUUM THRUST CORRECTED FOR ATMOSPHERIC BACKPRESSURE EFFECTS). CALCULATED IF NPC(9)=1,2.
THTP	BTU/FT**2 (J/M2)	THE TOTAL HEAT OF THE CURRENT PANEL FOR WHICH THE HEATING IS BEING-EVALUATED. CALCULATED IF NPC(26)=1.

OUTPUT SYMBOL	UNITS	DEFINITION
THTPL	DECIMAL	THE LOGARITHM OF THTP. THIS PARAMETER IS USED IN THE SAME MANNER AS THTP EXCEPT THAT IT IS THE LOGARITHM OF THTP. CALCULATED IF NPC(26)=1.
TIME	SEC	CURRENT TRAJECTORY (PROBLEM) TIME.
TIMES	SEC	THE TIME SINCE THE BEGINNING OF THE CURRENT PHASE.
TIMIP	SEC	THE TIME OF IMPACT WHEN USING THE ANALYTICAL IMPACT POINT OPTION. CALCULATED IF NPC(29) =1,2,3.
TIMRFJ J=1,4	SEC	REFERENCE TIMES. THESE WILL BE CALCULATED IF THE DERIVATIVES (DTIMR(J),J=1,4) ARE INPUT GREATER THAN ZERO.
TIMSP	MIN	TIME SINCE PERIGEE PASSAGE. CALCULATED IF NPC(1)=1,2,3.
TIMSPT	MIN	THE TIME SINCE PERIGEE PASSAGE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
TIMTP	MIN	TIME TO PERIGEE PASSAGE. CALCULATED IF NPC(1)=1,2,3.
TIMTPT	MIN	THE TIME TO PERIGEE PASSAGE FOR THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1) =1,2,3.
TKAZMI I=1,5	DEG	THE AZIMUTH OF THE SLANT RANGE VECTOR AT TRACKER I MEASURED CLOCKWISE FROM GEOGRAPHIC NORTH. CALCULATED IF NPC(28)=1,2,3.
TLHEAT	BTU/FT**2 (J/M2)	TOTAL HEAT. CALCULATED IF NPC(15)=1,2,3,4,5.
TLHTJ J=1,10	BTU/FT**2 (J/M2)	THE TOTAL HEAT OF PANEL J. CALCULATED IF NPC(26)=1.
TLPWT	LBS (N)	THE TOTAL WEIGHT OF ALL PANELS BEING EVALUATED. CALCULATED IF NPC(26)=1.

OUTPUT SYMBOL	UNITS	DEFINITION
TMYB TMZB	FT-LB (NM)	THE THRUST MOMENTS IN PITCH AND YAW DUE TO THE NON-TRIMMING ENGINES. CALCULATED IF NPC(10) =1,2,3.
TRKHTI I=1,5	FT (M)	THE ALTITUDE OF TRACKER I ABOVE THE OBLATE PLANET.
TRKLNI I=1,5	DEG	THE LONGITUDE OF TRACKER I EAST OF THE PRIME MERIDIAN.
TRKLTI I=1,5	DEG	THE GEODETIC LATITUDE OF TRACKING STATION I.
TRUAN	DEG	TRUE ANOMALY. CALCULATED IF NPC(1)=1,2,3.
TRUANT	DEG	THE TRUE ANOMALY OF THE TARGET VEHICLE. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
TRUMXT	DEG	THE MAXIMUM TRUE ANOMALY OF THE TARGET VEHICLE FOR HYPERBOLIC ORBITS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.
TRUNMX	DEG	MAXIMUM TRUE ANOMALY FOR HYPERBOLIC ORBITS. CALCULATED IF NPC(1)=1,2,3.
TTLISP	SEC	THE TOTAL VACUUM SPECIFIC IMPULSE. CALCULATED IF NPC(9)=1,2.
TTMYB TTMZB	FT-LB (NM)	THE THRUST MOMENTS REQUIRED TO TRIM THE VEHICLE IN PITCH AND YAW. CALCULATED IF NPC(10)=1,2,3.
TVAC	LBS (N)	VACUUM THRUST. CALCULATED IF NPC(9)=1.
TVLI	FT/SEC (M/S)	THE VALUE OF THE INERTIAL THRUST VECTORING LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
TVLR	FT/SEC (M/S)	THE VALUE OF THE RELATIVE THRUST VECTORING LOSS TERM. COMPUTED IF NPC(25)=1,2,3.
U V W	FT/SEC (M/S)	VEHICLE INERTIAL VELOCITY COMPONENTS IN THE GEOGRAPHIC (G) COORDINATE SYSTEM.

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OUTPUT SYMBOL	UNITS	DEFINITION
UA VA WA	FT/SEC (M/S)	COMPONENTS OF VEHICLE VELOCITY RELATIVE TO THE ATMOSPHERE IN THE GEOGRAPHIC (G) COORDINATE SYSTEM.
UB VB WB	FT/SEC (M/S)	COMPONENTS OF VEHICLE VELOCITY RELATIVE TO THE ATMOSPHERE IN THE BODY SYSTEM.
UBAR	N/D	THE NON-DIMENSIONAL TANGENTIAL VELOCITY. THIS IS THE TANGENTIAL VELOCITY DIVIDED BY THE CURRENT CIRCULAR VELOCITY.
UNX UNY UNZ	N/D	THE CURRENT UNIT NORMAL VECTOR OF THE VEHICLE. CALCULATED AS XI(I) CROSS VXI(I).
UR VR WR	FT/SEC (M/S)	COMPONENTS OF VEHICLE VELOCITY RELATIVE TO THE ROTATING PLANET IN THE GEOGRAPHIC (G) COORD-INATE SYSTEM.
URX URY URZ	N/D	THE CURRENT UNIT RADIUS VECTOR IN THE ECI SYSTEM. CALCULATED AS THE UNIT XI(I) VECTOR.
USI I=1,4	DECIMAL	THE CONVERGED VALUES OF THE INDEPENDENT STEERING VARIABLES.
UTX UTY UTZ	N/D	THE CURRENT UNIT TANGENT VECTOR OF THE VEHICLE. CALCULATED AS UNX CROSS URX.
UW VW WW	FT/SEC (M/S)	COMPONENTS OF THE WIND VELOCITY VECTOR IN THE GEOGRAPHIC (G) COORDINATE SYSTEM IN THE NORTH, EAST, AND DOWN DIRECTIONS, RESPECTIVELY. CALCULATED IF NPC(6)=1,2.
VCIRC	FT/SEC (M/SEC)	THE CIRCULAR VELOCITY AT THE CURRENT RADIUS. COMPUTED IF NPC(1)=1,2,3.
VCIRCT	FT/SEC (M/S)	THE CIRCULAR VELOCITY OF THE TARGET VEHICLE AT THE CURRENT RADIUS. COMPUTED IF MVEHF(1)=1, AND NPC(1)=1,2,3.

OUTPUT SYMBOL	UNITS	DEFINITION
VELA	FT/SEC (M/S)	VEHICLE VELOCITY RELATIVE TO THE ATMOSPHERE.
VELAD	FT/SEC**2 (M/S)	RATE OF CHANGE IN VEHICLE VELOCITY RELATIVE TO THE ATMOSPHERE.
VELAP	FT/SEC (M/SEC)	THE VALUE OF VELA USED TO COMPUTE THE PARACHUTE INFLATION RATE. SEE NPC(32).
VELI	FT/SEC (M/S)	INERTIAL VEHICLE VELOCITY.
VELIT	FT/SEC (M/S)	THE INERTIAL VELOCITY OF THE TARGET VEHICLE.
VELR	FT/SEC (M/S)	VEHICLE VELOCITY RELATIVE TO THE ROTATING PLANET.
VIDEAL	FT/SEC (M/S)	THE TOTAL IDEAL VELOCITY. COMPUTED IF NPC(25) =1,2,3.
VINV	N/D	RAREFATION PARAMETER USED TO COMPUTE VISCOUS EFFECTS.
VIPJ J=1,3	FT/SEC (M/S)	THE INERTIAL VELOCITY COMPONENTS OF THE VEHICLE AT IMPACT. CALCULATED IF NPC(29)=1,2,3.
VMU	LB-SEC/ FT**2 (NS/M2)	ATMOSPHERIC VISCOSITY. USED TO CALCULATE REYNOLDS NUMBER. CALCULATED IF NPC(5)=1,2,3.
VXI VYI VZI	FT/SEC (M/S)	COMPONENTS OF THE INERTIAL VEHICLE VELOCITY VECTOR IN THE EARTH-CENTERED INERTIAL (I) COORDINATE SYSTEM.
VXIT VYIT VZIT	FT/SEC (M/S)	THE ECI VELOCITY COMPONENTS OF THE TARGET VEHICLE.
VXVE VYVE VZVE	FT/SEC	THE VEHICLE VELOCITY VECTOR IN THE VERNAL EQUINOX SYSTEM.

OUTPUT SYMBOL	UNITS	DEFINITION
WDJ J=1,15	LB/SEC (N/S)	TABLE LOOK-UP VALUE OF FLOWRATE FOR ENGINE J. CALCULATED IF NPC(9)=1,2.
WDOT	LB/SEC (N/S)	TOTAL WEIGHT FLOWRATE.
WEICON	LBS (N)	THE AMOUNT OF PROPELLANT CONSUMED SINCE IT WAS ZEROED OUT BY INPUT.
WEIGHT	LBS (N)	CURRENT VEHICLE WEIGHT.
WJETTM	LBS (N)	THE JETTISON WEIGHT CALCULATED INTERNALLY BY THE PROGRAM BASED ON THE VALUE OF NPC(17).
WPROP	LBS (N)	WEIGHT OF THE REMAINING PROPELLANT.
WTPJ J=1,10	LBS (N)	THE WEIGHT OF PANEL J. CALCULATED IF NPC(26)=1.
XCG YCG ZCG	FT (M)	VEHICLE CENTER-OF-GRAVITY LOCATION ALONG THE XBR, YBR, AND ZBR, RESPECTIVELY. COMPUTED IF NPC(10)=1,2,3.
XI YI ZI	FT (M)	COMPONENTS OF THE VEHICLE POSITION VECTOR IN THE EARTH-CENTERED INERTIAL (I) COORDINATE SYSTEM.
XIT YIT ZIT	FT (M)	THE ECI POSITION COMPONENTS OF THE TARGET VEHICLE.
XMAXJ J=1,10	DECIMAL	THE MAXIMUM VALUE OF MONX(J).
XMINJ J=1,10	DECIMAL	THE MINIMUM VALUE OF MONX(J).
XR YR ZR	FT (M)	THE COMPONENTS OF THE VEHICLE POSITION VECTOR IN EARTH-CENTERED ROTATING (ECR) COORDINATES.

OUTPUT SYMBOL	UNITS	DEFINITION
XREF YREF ZREF	FT (M)	THE AERODYNAMIC REFERENCE (OR CENTER-OF-PRESSURE) LOCATION ALONG THE XBR, YBR, AND ZBR AXES, RESPECTIVELY. CALCULATED IF NPC(10)=1,2,3.
XSI YSI ZSI	N/D	THE SUN UNIT VECTOR IN THE ECI SYSTEM.
XVE YVE ZVE	FT	THE VEHICLE POSITION VECTOR IN THE VERNAL EQUINOX SYSTEM.
YAWR PITR ROLR	DEG	VEHICLE ATTITUDE ANGLES RELATIVE TO THE LOCAL GEOGRAPHIC (G) SYSTEM. YAWR IS THE AZIMUTH OF THE XB AXIS MEASURED CLOCKWISE FROM NORTH, PITR IS THE PITCH ANGLE MEASURED POSITIVE ABOVE THE LOCAL HORIZONTAL PLANE, AND ROLR IS THE BANK ANGLE ABOUT THE XB AXIS MEASURED POSITIVE IN THE RIGHT-HAND SENSE.
YAWRD PITRD ROLRD	DEG/SEC	THE RELATIVE EULER RATES WITH RESPECT TO THE GEOGRAPHIC (G) COORDINATE SYSTEM.
YXMNJ J=1,10	DECIMAL	THE VALUE OF MONY(J) AT XMINJ.
YXMXJ J=1,10	DECIMAL	THE VALUE OF MONY(J) AT XMAXJ.

10. INDICES

THIS SECTION PRESENTS A SUBJECT INDEX AND A VARIABLE INDEX AS AN AIDE TO THE USER IN LOCATING PROGRAM INPUT AND OUTPUT VARIABLES.

THE SUBJECT INDEX CONTAINS A LIST OF COMMONLY USED TRAJECTORY PARAMETERS. THE VARIABLE NAME CORRESPONDING TO A GIVEN PARAMETER IS PRESENTED ACCORDING TO GENERALLY ACCEPTED DEFINITIONS.

THE VARIABLE INDEX CONTAINS A LIST OF ALL INPUT AND OUTPUT VARIABLES AND THE SECTION NUMBER WHERE THE VARIABLE IS DEFINED OR DISCUSSED.

THE USE OF THESE INDICES IS OUTLINED AS FOLLOWS -

1. LOCATE THE DEFINITION OF THE DESIRED PARAMETER IN THE SUBJECT INDEX.

2. LOOK UP THE VARIABLES ASSOCIATED WITH THE DESIRED PARAMETER IN THE VARIABLE INDEX TO DETERMINE THE SECTIONS IN WHICH THE VARIABLES ARE DEFINED.

3. LOOK UP THE VARIABLE DEFINITIONS IN THE INDICATED SECTIONS.

10.A. SUBJECT INDEX

10.B. INDEX OF VARIABLES

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
ASXI	OUTPUT	TMOTM	9.D		
ASYI	OUTPUT	TMOTM	9.D		
ASZI	OUTPUT	TMOTM	9.D		
ATEM	OUTPUT	ATMOS1	6.A.4	,9.D	
		ATMOS2			
		ATMOS3			
ATEMT	INPUT/TAB	ATMOS1	6.A.4	,9.C	
ATL	OUTPUT	BLKDAT	6.A.25	,9.D	
ATMOSK(I)	INPUT/GENDAT	ATMOS1	6.A.4	,9.B	
AVERT	OUTPUT	TMOTM	6.A.11	,9.D	
AXB	OUTPUT	TMOTM	9.D		
AXI	OUTPUT	TMOTM	9.D		
AXIT	OUTPUT	TMOTM	4.C	,9.D	
AYB	OUTPUT	TMOTM	9.D		
AYI	OUTPUT	TMOTM	9.D		
AYIT	OUTPUT	TMOTM	4.C	,9.D	
AZB	OUTPUT	TMOTM	9.D		
AZI	OUTPUT	TMOTM	9.D		
AZIT	OUTPUT	TMOTM	4.C	,9.D	
AZL	INPUT/GENDAT	MOTIAL	6.B	,9.B	
AZREF	INPUT/GENDAT	AUXFMI	6.A.19	,9.B	
		XRNGEI			
AZVAD	OUTPUT	DGAMLA	9.D		
AZVELA	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		GAMLAM			
AZVELI	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		AUXFM			
AZVELR	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		AUXFM			
AZVIT	OUTPUT	AUXFM	4.C	,9.D	
AZWB	INPUT/GENDAT	WINDS	6.A.4	,9.B	
AZWT	INPUT/TAB	WINDS	6.A.4	,9.C	
BETA	INPUT/GENDAT	GUID1	6.B	,9.B	,9.D
		MOTION			
BETAI	OUTPUT	AUXFM	6.B	,9.D	
BETARG	INPUT/GENDAT	GUID1	6.B	,9.B	
		GUID2			
BETAT	INPUT/TAB	GUID1	6.B	,9.C	
BETDOT	OUTPUT	GUID2	6.B	,9.D	
BETPC(I)	INPUT/GENDAT	GUID1	6.B	,9.B	
		GUID2			
BETPCI	HOLLERITH	GUID1	3.C		
		GUID2			
BANKI	OUTPUT	AUXFM	6.B	,9.D	
BANKT	INPUT/TAB	GUID1	6.B	,9.C	
BNKANG	INPUT/GENDAT	GUID1	6.B	,9.B	,9.D
		AUXFM			
BNKARG	INPUT/GENDAT	GUID1	6.B	,9.B	

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
CMDPNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CMDPT	INPUT/TAB	AERO	6.A.1	,6.A.21	,9.C
CMOT	INPUT/TAB	AERO	6.A.1	,9.C	
CMPFT	INPUT/SEARCH	CONVO	4.A	,9.A	
CN	OUTPUT	AERO	6.A.1	,9.D	
CNANM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CNAT	INPUT/TAB	AERO	6.A.1	,9.C	
CNDP	OUTPUT	AERO	6.A.1	,9.D	
CNDPNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CNDPT	INPUT/TAB	AERO	6.A.1	,6.A.21	,9.C
CNOT	INPUT/TAB	AERO	6.A.1	,9.C	
CONEPS(I)	INPUT/SEARCH	MINMYS TEST	5.D	,9.A	
CONSEX(I)	INPUT/SEARCH	TRYIT1	5.D	,9.A	
CPRES	INPUT/SEARCH	CONVO	4.A	,9.A	
CP/ITR	T/O OUTPUT	ITERO	5.E		
CRITR	INPUT/GENDAT	READAT	6.A.6	,9.B	
CRRNG	OUTPUT	AUXFM XRNGE1	6.A.19	,9.D	
CS	OUTPUT	ATMOS1 ATMOS2 ATMOS3	6.A.4	,9.D	
CST	INPUT/TAB	ATMOS1	6.A.4	,9.C	
CTEMP	INPUT/SEARCH	CONVO	4.A	,9.A	
CTHA	T/O OUTPUT	TEST	5.D	,5.E	
CW	OUTPUT	AERO	6.A.1	,9.D	
CWBNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CWBT	INPUT/TAB	AERO	6.A.1	,9.C	
CWDY	OUTPUT	AERO	6.A.1	,9.D	
CWDYNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CWDYT	INPUT/TAB	AERO	6.A.1	,6.A.21	,9.C
CWOT	INPUT/TAB	AERO	6.A.1	,9.C	
CY	OUTPUT	AERO	6.A.1	,9.D	
CYBNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CYBT	INPUT/TAB	AERO	6.A.1	,9.C	
CYDY	OUTPUT	AERO	6.A.1	,9.D	
CYDYNM	INPUT/TBLMLT	AERO	6.A.1	,6.C	
CYDYT	INPUT/TAB	AERO	6.A.1	,6.A.21	,9.C
CYOT	INPUT/TAB	AERO	6.A.1	,9.C	
DALPHA	INPUT/GENDAT	GUIDI	6.B	,9.B	
DATE(I)	INPUT/GENDAT	EPHEM	6.A.28	,9.B	
DAXI	OUTPUT	TMOTM	4.C	,9.D	
DAYI	OUTPUT	TMOTM	4.C	,9.D	
DAZI	OUTPUT	TMOTM	4.C	,9.D	
DBETA	INPUT/GENDAT	GUIDI	6.B	,9.B	
DBANK	INPUT/GENDAT	GUIDI	6.B	,9.B	
DCDV	OUTPUT	AERO4	6.A.1	,9.D	
DCLV	OUTPUT	AERO4	6.A.1	,9.D	

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
DTG	INPUT/GENDAT	CLGM	6.B	,9.B	
DTIMR(J)	INPUT/GENDAT	MOTIAL	6.A.22	,9.B	
DTIMRJ	HOLLERITH	BLKDAT	3.C		
DTM	INPUT/GENDAT	CYCXM	6.A.15	,9.B	
DU(I)	T/O OUTPUT	GRAD	5.D	,5.E	
		UNITDU			
DUA	OUTPUT	DGAMLA	9.D		
DUMAG	T/O OUTPUT	UNITDU	5.D	,6.E	
DVA	OUTPUT	DGAMLA	9.D		
DVCIR	OUTPUT	CONIC	6.A.5	,9.D	
DVCIRT	OUTPUT	CONICT	4.C	,9.D	
DVEXS	OUTPUT	AUXFM	6.A.26	,9.D	
DVIMAG	INPUT/GENDAT	DVADDM	6.A.13	,9.B	
DVMAR	OUTPUT	AUXFM	6.A.26	,9.D	
DVMARR	INPUT/GENDAT	AUXFM	6.A.26	,9.B	,9.D
DVPCT	INPUT/GENDAT	AUXFM	6.A.26	,9.B	
DVXI	OUTPUT	BLKDAT	4.C	,9.D	
DVXI(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
DVXRT	OUTPUT	AUXFM	4.C	,9.D	
DVXRT(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
DVYI	OUTPUT	BLKDAT	4.C	,9.D	
DVYRT	OUTPUT	AUXFM	4.C	,9.D	
DVZI	OUTPUT	BLKDAT	4.C	,9.D	
DVZRT	OUTPUT	AUXFM	4.C	,9.D	
DWA	OUTPUT	DGAMLA	9.D		
DWNRNG	OUTPUT	AUXFM	6.A.19	,9.D	
		XRNGEI			
DXI	OUTPUT	BLKDAT	4.C	,9.D	
DXI(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
DXRT	OUTPUT	AUXFM	4.C	,9.D	
DXRT(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
DYAW	INPUT/GENDAT	GUIDI	6.B	,9.B	
DYI	OUTPUT	BLKDAT	4.C	,9.D	
DYRT	OUTPUT	AUXFM	4.C	,9.D	
DYNP	OUTPUT	MOTION	9.D		
DZI	OUTPUT	BLKDAT	4.C	,9.D	
DZRT	OUTPUT	AUXFM	4.C	,9.D	
E(I)	T/O OUTPUT	CALE	5.D	,5.E	
		GRAD			
ECCAN	OUTPUT	CONIC	6.A.5	,9.D	
ECCANT	OUTPUT	CONICT	4.C	,9.D	
ECCEN	OUTPUT	CONIC	6.A.5	,9.D	
ECCENT	OUTPUT	CONICT	4.C	,9.D	
EJ	OUTPUT	BLKDAT	6.B.1	,9.D	
ELEMIN	INPUT/GENDAT	PBLOCK	6.A.23	,9.B	
ELEVI	OUTPUT	TRACKM	6.A.23	,9.D	
ENDJOB	INPUT/ALL	READAT	3.B.1	,6.A.6	,9.A
			,9.B	,9.C	

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION	
DECL	INPUT/GENDAT	EPHEM	6.A.28	,9.B
DECLIN	OUTPUT	CONIC	6.A.5	,9.D
DECLT	OUTPUT	CONICT	4.C	,9.D
DEJ	OUTPUT	GUID2	6.B.1	,9.D
DENKT	INPUT/TAB	ATMOS	6.A.4	,9.C
DENS	OUTPUT	ATMOS1 ATMOS2 ATMOS3	6.A.4	,9.D
DENST	INPUT/TAB	ATMOS1	6.A.4	,9.C
DEPPH(I)	INPUT/SEARCH	CALE	5.B	,9.A
DEPTL(I)	INPUT/SEARCH	CALE	5.B	,9.A
DEPTLS(I)	INPUT/GENDAT	GSA	6.B.10	,9.B
DEPVAL(I)	INPUT/SEARCH	CALE	5.B	,9.A
DEPVLS(I)	INPUT/GENDAT	CALES	6.B.10	,9.B
DEPVR(I)	INPUT/SEARCH	CALE	5.B	,9.A
DEPVRS(I)	INPUT/GENDAT	CALES	6.B.10	,9.B
DESN(I)	INPUT/GENDAT	GUIDI	6.B	,9.B
DESNE	INPUT/GENDAT	MOTIAL	6.A.18	,9.B
DETA	INPUT/GENDAT	MOTIAL	6.A.18	,9.B
DFDC(I)	T/O OUTPUT	ITERO REVISE	5.E	
DFVALJ	OUTPUT	MOTION	6.A.7	,9.D
DFLP	OUTPUT	TRIM	6.A.21	,9.D
DFLY	OUTPUT	TRIM	6.A.21	,9.D
DGENV	OUTPUT	AUXFM	6.A.8	,9.D
DGF(I)	INPUT/GENDAT	GUIDX	6.B	,9.B
DIAMPJ	OUTPUT	BLKDAT	6.A.29	,9.D
DIARPJ	OUTPUT	AERO	6.A.29	,9.D
DLI	OUTPUT	BLKDAT	6.A.25	,9.D
DLR	OUTPUT	BLKDAT	6.A.25	,9.D
DLTMAX	INPUT/GENDAT	SVDQI	6.A.15	,9.B
DLTMIN	INPUT/GENDAT	SVDQI	6.A.15	,9.B
DMASS	OUTPUT	PROP	6.A.24	,9.D
DPITCH	INPUT/GENDAT	GUIDI	6.B	,9.B
DPRGIJ	OUTPUT	DPRNG	6.A.3	,9.D
DPRNG1	OUTPUT	DPRNG	6.A.19	,9.D
DPRNG2	OUTPUT	DPRNG	6.A.19	,9.D
DP1DS	T/O OUTPUT	TRYIT1	5.E	
DP2DS	T/O OUTPUT	TRYIT1	5.E	
DRAG	OUTPUT	AUXFM	6.A.1	,9.D
DRAGPJ	OUTPUT	AERO	6.A.29	,9.D
DRAGPT	OUTPUT	AERO	6.A.29	,9.D
DRGPK(I)	INPUT/GENDAT	AERO	6.A.29	,9.B
DRGPPJ	OUTPUT	AERO	6.A.29	,9.D
DRGPSJ	OUTPUT	AERO	6.A.29	,9.D
DROLL	INPUT/GENDAT	GUIDI	6.B	,9.B
DRT	OUTPUT	AUXFM	4.C	,9.D
DT	INPUT/GENDAT	CYCXMI	6.A.15	,9.B

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
ENDPHS	INPUT/ALL	READAT	3.B.1	,6.A.6	,9.A
			,9.B	,9.C	
ENDPRB	INPUT/ALL	READAT	3.B.1	,6.A.6	,9.A
			,9.B	,9.C	
ENERGY	OUTPUT	CONIC	6.A.5	,9.D	
ENRGYT	OUTPUT	CONICT	4.C	,9.D	
EPSINT	INPUT/GENDAT	SVDQI	6.A.15	,9.B	
ESI	OUTPUT	CALES	6.B.10	,9.D	
ETA	INPUT/GENDAT	PROP	6.A.18	,9.B	
ETAARG	INPUT/GENDAT	PROP	6.A.18	,9.B	
ETAL	OUTPUT	PROP	6.A.18	,9.D	
ETAPC(I)	INPUT/GENDAT	PROP	6.A.18	,9.B	
ETAPCI	HOLLERITH	PROP	3.C		
ETAT	INPUT/TAB	PROP	6.A.18	,9.C	
EVENT(I)	INPUT/GENDAT	READAT	6.A.6	,9.B	
FAXB	OUTPUT	AERO	6.A.1	,9.D	
FAXBPJ	OUTPUT	AERO	6.A.29	,9.D	
FAYB	OUTPUT	AERO	6.A.1	,9.D	
FAZB	OUTPUT	AERO	6.A.1	,9.D	
FESN	INPUT/GENDAT	TRAJ	6.A.6	,9.B	
		TRAJX			
FID(J)	INPUT/GENDAT	INFXMI	6.A.17	,9.B	
FITERR(I)	INPUT/SEARCH	TRYIT1	5.D	,9.A	
		TRYIT2			
FLJT	INPUT/TAB	MOTION	6.A.7	,9.C	
FMASST	INPUT/TAB	WGTINI	6.A.24	,9.C	
FMYB	OUTPUT	TRIM	6.A.21	,9.D	
FMZB	OUTPUT	TRIM	6.A.21	,9.D	
FTPNM	INPUT/SEARCH	CONVO	4.A	,9.A	
FTXB	OUTPUT	PROP	6.A.18	,9.D	
FTYB	OUTPUT	PROP	6.A.18	,9.D	
FTZB	OUTPUT	PROP	6.A.18	,9.D	
FVALJ	OUTPUT	BLKDAT	6.A.7	,9.D	
G1(I)	T/O OUTPUT	GRAD	5.D	,5.E	
G1MAG	T/O OUTPUT	GMAG	5.D	,5.E	
G2(I)	T/O OUTPUT	GRAD	5.D	,5.E	
G2MAG	T/O OUTPUT	GMAG	5.D	,5.E	
GAMAD	OUTPUT	DGAMLA	9.D		
GAMAST(I)	T/O OUTPUT	FGAMA	5.D	,5.E	
		TRYIT1			
GAMIT	OUTPUT	AUXFM	4.C	,9.D	
GAMMAA	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		GAMLAM			
GAMMAI	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		AUXFM			
GAMMAR	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D
		AUXFM			
GCLAT	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	,9.D

10.B. INDEX OF VARIABLES (CONTD)

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
LATREF	INPUT/GENDAT	AUXFMI XRNGEI	6.A.19	,9.B	
LATL	INPUT/GENDAT	MOTIAL	6.B	,9.B	
LIFT	OUTPUT	AUXFM	6.A.1	,9.D	
LISTIN	INPUT/SEARCH	INPUTX	4.A	,9.B	
LKAI	OUTPUT	TRACKM	6.A.23	,9.D	
LKBI	OUTPUT	TRACKM	6.A.23	,9.D	
LONG	INPUT/GENDAT	MOTIAL AUXFM	6.A.12	,9.B	,9.D
LONGI	INPUT/GENDAT	MOTIAL AUXFM	6.A.12	,9.B	,9.D
LONGIP	OUTPUT	ANMPT	6.A.3	,9.D	
LONGT	OUTPUT	AUXFM	4.C	,9.D	
LONL	INPUT/GENDAT	MOTIAL	6.B	,9.B	
LONREF	INPUT/GENDAT	AUXFMI XRNGEI	6.A.19	,9.B	
LREF	INPUT/GENDAT	AUXFM	6.A.1	,9.B	
LREFY	INPUT/GENDAT	TRIM	6.A.1	,9.B	
MACH	OUTPUT	MOTION	6.A.4	,9.D	
MACHDT	OUTPUT	AUXFM	6.A.4	,9.D	
MASS	OUTPUT	BLKDAT MOTION	6.A.24	,9.D	
MAXITR	INPUT/SEARCH	NOMINL	5.D	,9.A	
MAXITS	INPUT/GENDAT	CALES	6.B.10	,9.B	
MAXTIM	INPUT/GENDAT	PHZXM	6.A.6	,9.B	
MDL	INPUT/GENDAT	READAT	6.A.6	,9.B	
MEAAN	OUTPUT	CONIC	6.A.5	,9.D	
MEAANT	OUTPUT	CONICT	4.C	,9.D	
MODEW	INPUT/SEARCH	WUCAL	5.A	,9.A	
MONF(J)	INPUT/GENDAT	MOTION	6.A.7	,9.B	
MONX(I)	INPUT/GENDAT	MONITR	6.A.14	,9.B	
MONY(I)	INPUT/GENDAT	MONITR	6.A.14	,9.B	
MU	INPUT/GENDAT	GRAV	6.A.10	,9.B	
MULTRF	INPUT/SEARCH	READAT	4.B	,9.A	
MVEHF(I)	INPUT/GENDAT	MOTIAL AUXFM	4.C	,9.B	
NAC	T/O OUTPUT	UPDATS	5.D	,5.E	
NDEPV	INPUT/SEARCH	CALE GRAD	5.B	,5.D	,9.A
NDEPVS	INPUT/GENDAT	GSA	6.B.10	,9.B	
NENG	INPUT/GENDAT	PROP	6.A.18	,9.B	
NEQS(J)	INPUT/GENDAT	MOTION	6.A.7	,9.B	
NEWSTG	INPUT/GENDAT	AUXFMI	6.A.26	,9.B	
NINDV	INPUT/SEARCH	GRAD	5.A	,5.D	,9.A
NPAD(I)	INPUT/SEARCH	PAD	5.A	,5.B	,9.A
NPC(1)	INPUT/GENDAT	AUXFM	6.A.5	,9.B	
NPC(2)	INPUT/GENDAT	DERIV DYNXM	6.A.15	,9.B	

10.B. INDEX OF VARIABLES (CONTD)

10.B. INDEX OF VARIABLES (CONTD)

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10.B. INDEX OF VARIABLES (CONTD)

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10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
SLOS3I	OUTPUT	TRACKM	6.A.23	,9.D	
SLTRGI	OUTPUT	TRACKM	6.A.23	,9.D	
SMAT(I,J)	T/O OUTPUT	ITERO UPDATS	5.D	,5.E	
SPECI(J)	INPUT/GENDAT	CALSPE	6.A.20	,9.B	
SPECIJ	HOLLERITH	CALSPE	3.C		
SPECVJ	OUTPUT	CALSPE	6.A.20	,9.D	
SRCHM	INPUT/SEARCH	GRAD TSPXM	5.D	,9.A	
SREF	INPUT/GENDAT	AERO	6.A.1	,9.B	
STMINP	INPUT/SEARCH	TRYIT1 TRYIT2	5.D	,9.A	
STPMAX	T/O OUTPUT	TRYIT1 TRYIT2	5.D	,5.E	
TABL(I)	INPUT/SEARCH	READAT	5.A	,9.A	
TABLE(I)	INPUT/TAB	READAT	6.D		
TABLY(I)	INPUT/SEARCH	READAT	5.A	,9.A	
TDURP	OUTPUT	DERIV	6.A.22	,9.D	
THRJ	OUTPUT	PROP	6.A.18	,9.D	
THRUST	OUTPUT	PROP	6.A.18	,9.D	
THTP	OUTPUT	HSWGT	6.A.2	,9.D	
THTPL	OUTPUT	HSWGT	6.A.2	,9.D	
TIME	INPUT/GENDAT	BLKDAT	6.A.22	,9.B	,9.D
TIMES	OUTPUT	DERIV	6.A.22	,9.D	
TIMIP	OUTPUT	ANMPT	6.A.3	,9.D	
TIMREF	INPUT/GENDAT	AUXFMI	6.A.19	,9.B	
TIMRF(J)	INPUT/GENDAT	BLKDAT	6.A.22	,9.B	
TIMRFJ	OUTPUT	BLKDAT	6.A.22	,9.D	
TIMSP	OUTPUT	CONIC	6.A.5	,9.D	
TIMSPT	OUTPUT	CONICT	4.C	,9.D	
TIMTP	OUTPUT	CONIC	6.A.5	,9.D	
TIMTPT	OUTPUT	CONICT	4.C	,9.D	
TITLE(I)	INPUT/GENDAT	PAGER	6.A.16	,9.B	
TKAZMI	OUTPUT	TRACKM	6.A.23	,9.D	
TLHEAT	OUTPUT	BLKDAT	6.A.2	,9.D	
TLHTJ	OUTPUT	HSWGT	6.A.2	,9.D	
TLPWT	OUTPUT	HSWGT	6.A.2	,9.D	
TMYB	OUTPUT	MOMENT	6.A.21	,9.D	
TMZB	OUTPUT	MOMENT	6.A.21	,9.D	
TOL	INPUT/GENDAT	READAT	6.A.6	,9.B	
TRKGLT(I)	INPUT/GENDAT	TRACKM	6.A.23	,9.B	
TRKHIT(I)	INPUT/GENDAT	TRACKM	6.A.23	,9.B	
TRKHTI	OUTPUT	TRACKM	6.A.23	,9.D	
TRKLNI	OUTPUT	TRACKM	6.A.23	,9.D	
TRKLON(I)	INPUT/GENDAT	TRACKM	6.A.23	,9.B	
TRKLTI	OUTPUT	TRACKM	6.A.23	,9.D	
TRKNAM(I)	INPUT/GENDAT	PBLOCK	6.A.23	,9.B	
TRPM	INPUT/GENDAT	AUXFMI	6.A.28	,9.B	

10.B. INDEX OF VARIABLES (CONTD)

10.B. INDEX OF VARIABLES (CONTD)

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
VIDEAL	OUTPUT	BLKDAT	6.A.25	,9.D	
VINFI	INPUT/GENDAT	AERO4	6.A.1	,9.B	
VINV	OUTPUT	AERO4	6.A.1	,9.D	
VIPJ	OUTPUT	ANMPT	6.A.3	,9.D	
VMU	OUTPUT	AUXFM	6.A.4	,9.D	
VR	OUTPUT	AUXFM	9.D		
VW	OUTPUT	WINDS	6.A.4	,9.D	
VWT	INPUT/TAB	WINDS	6.A.4	,9.C	
VWUT	INPUT/TAB	WINDS	6.A.4	,9.C	
VWVT	INPUT/TAB	WINDS	6.A.4	,9.C	
VWWT	INPUT/TAB	WINDS	6.A.4	,9.C	
VXI	OUTPUT	BLKDAT	9.D		
VXI(J)	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	
VXIT	OUTPUT	MOTION	4.C	,9.D	
VXIT(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
VXVE	OUTPUT	AUXFM	6.A.28	,9.D	
VYI	OUTPUT	BLKDAT	9.D		
VYIT	OUTPUT	MOTION	4.C	,9.D	
VYVE	OUTPUT	AUXFM	6.A.28	,9.D	
VZI	OUTPUT	BLKDAT	9.D		
VZIT	OUTPUT	MOTION	4.C	,9.D	
VZVE	OUTPUT	AUXFM	6.A.28	,9.D	
W	OUTPUT	DGAMLA	9.D		
WA	OUTPUT	GAMLAM	9.D		
WB	OUTPUT	MOTION	9.D		
WCON	INPUT/SEARCH	GRAD	5.D	,9.A	
WDIT	INPUT/TAB	PROP	6.A.18	,9.C	
WDJ	OUTPUT	PROP	6.A.18	,6.A.24	,9.D
WDOT	OUTPUT	PROP MOTION	6.A.18	,6.A.24	,9.D
WE(I)	T/O OUTPUT	ITERO	5.D	,5.E	
WEICON	OUTPUT	PROP	6.A.18	,6.A.24	,9.D
WEIGHT	OUTPUT	MOTION	6.A.24	,9.D	
WGTDJT	INPUT/TAB	MOTION	6.A.27	,9.C	
WGTJT	INPUT/TAB	MOTION	6.A.27	,9.C	
WGTSG	INPUT/GENDAT	WGTINI	6.A.24	,9.B	
WJETT	INPUT/GENDAT	WGTINI	6.A.24	,9.B	
WJETTM	OUTPUT	WGTINI	6.A.24	,9.D	
WOPT	INPUT/SEARCH	CALE	5.C	,9.A	
WPLD	INPUT/GENDAT	WGTINI	6.A.24	,9.B	
WPROP	OUTPUT	PROP	6.A.18	,6.A.24	,9.D
WPROPI	INPUT/GENDAT	DVADDM WGTINI	6.A.13	,6.A.24	,9.B
WR	OUTPUT	AUXFM	9.D		
WTPJ	OUTPUT	HSWGT	6.A.2	,9.D	
WU(I)	INPUT/SEARCH	WUCAL	5.A	,9.A	
WUAIT	INPUT/TAB	HSWGT	6.A.2	,9.C	
WW	OUTPUT	WINDS	6.A.4	,9.D	

VARIABLE	TYPE/NAMELIST	ROUTINE	SECTION		
XCG	OUTPUT	TRIM	6.A.21	,9.D	
XCGT	INPUT/TAB	TRIM	6.A.21	,9.C	
XI	OUTPUT	BLKDAT	9.D		
XI(J)	INPUT/GENDAT	MOTIAL	6.A.12	,9.B	
XIT	OUTPUT	MOTION	4.C	,9.D	
XIT(I)	INPUT/GENDAT	MOTIAL	4.C	,9.B	
XMAX(I)	INPUT/GENDAT	MONITR	6.A.14	,9.B	
XMAXJ	OUTPUT	MONITR	6.A.14	,9.D	
XMIN(I)	INPUT/GENDAT	MONITR	6.A.14	,9.B	
XMINJ	OUTPUT	MONITR	6.A.14	,9.D	
XR	OUTPUT	AUXFM	9.D		
XREF	OUTPUT	TRIM	6.A.21	,9.D	
XREFT	INPUT/TAB	TRIM	6.A.1	,9.C	
XREFT	INPUT/TAB	TRIM	6.A.1	,6.A.21	,9.C
XSI	OUTPUT	AUXFMI	6.A.28	,9.D	
XVE	OUTPUT	AUXFM	6.A.28	,9.D	
YAWARG	INPUT/GENDAT	GUID1	6.B	,9.B	
		GUID2			
YAWBD	OUTPUT	BLKDAT	6.B	,9.D	
YAWI	INPUT/GENDAT	GUID1	6.B	,9.B	,9.D
		BACKOI			
YAWID	OUTPUT	GUID1	6.B	,9.D	
YAWPC(I)	INPUT/GENDAT	GUIDI	6.B	,9.B	
		GUID1			
		GUID2			
YAWPCI	HOLLERITH	GUIDI	3.C		
		GUID1			
		GUID2			
YAWR	INPUT/GENDAT	GUIDI	6.B	,9.B	,9.D
		BACKOR			
YAWRD	OUTPUT	GUID1	6.B	,9.D	
YAWT	INPUT/TAB	GUID1	6.B	,9.C	
YCG	OUTPUT	TRIM	6.A.21	,9.D	
YCGT	INPUT/TAB	TRIM	6.A.21	,9.C	
YI	OUTPUT	BLKDAT	9.D		
YIJT	INPUT/TAB	PROP	6.A.18	,9.C	
YIT	OUTPUT	MOTION	4.C	,9.D	
YPRED(I)	I/O OUTPUT	ITERO	5.E		
		TRYIT1			
		TRYIT2			
YR	OUTPUT	AUXFM	9.D		
YREF	OUTPUT	TRIM	6.A.21	,9.D	
YREFT	INPUT/TAB	TRIM	6.A.1	,9.C	
YREFT	INPUT/TAB	TRIM	6.A.1	,6.A.21	,9.C
YSI	OUTPUT	AUXFMI	6.A.28	,9.D	
YVE	OUTPUT	AUXFM	6.A.28	,9.D	
YXMN(I)	INPUT/GENDAT	MONITR	6.A.14	,9.B	
YXMNJ	OUTPUT	MONITR	6.A.14	,9.D	

10.B. INDEX OF VARIABLES (CONTD)