REAL-TIME AUXILIARY COMPUTING FACILITY APOLLO 9 OPERATIONAL SUPPORT TEAM HANDBOOK

Flight Analysis Branch
MISSION PLANNING AND ANALYSIS DIVISION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
MSC INTERNAL NOTE NO. 69-FM-47

REAL-TIME AUXILIARY COMPUTING FACILITY
APOLLO 9 OPERATIONAL SUPPORT
TEAM HANDBOOK

By
Mission Operations Section
TRW Systems Group

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MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
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NOMENCLATURE

ABDP  APOLLO BLOCK DATA PROGRAM
AGC   APOLLO GUIDANCE COMPUTER
AGOP  APOLLO GENERALIZED OPTICS PROGRAM
AOT   ALIGNMENT OPTICAL TELESCOPE
APS   ASCENT PROPULSION SYSTEM
ARMACR RTACF APOLLO REFERENCE MISSION PROGRAM
ARMP  APOLLO REFERENCE MISSION PROGRAM
ARRS  APOLLO REAL-TIME RENDEZVOUS SUPPORT PROGRAM
ARS   APOLLO REENTRY SUPPORT PROGRAM
BCD   BINARY CODED DECIMAL
C.G.  CENTER OF GRAVITY
CLA   CONTINGENCY LANDING AREA
CM    COMMAND MODULE
CMC   COMMAND MODULE COMPUTER
COAS  CREWMAN OPTICAL ALIGNMENT SIGHT
COL   COLUMN
CSM   COMMAND AND SERVICE MODULE
DAP   DIGITAL AUTOPILOT
DD80  MAGNETIC TAPE TO MICROFILM CONVERTER
DMT   DETAILED MANEUVER TABLE
DPS   DESCENT PROPULSION SYSTEM
DSKYUP DSKY UPDATE
ECI   EARTH CENTERED INERTIAL
EI    ENTRY INTERFACE
FAB   FLIGHT ANALYSIS BRANCH
FAP FORTRAN ASSEMBLY PROGRAM
FASTRAND UNIVAC MASS STORAGE MAGNETIC DRUM UNIT
FCAI FLIGHT DIRECTOR ATTITUDE INDICATOR
FDO FLIGHT DYNAMICS OFFICER
FORTTRAN FORMULA TRANSLATION
G DECELERATION
GEMMV GENERAL ELECTRIC MISSILE AND SATELLITE MULTI-VEHICLE PROGRAM
G.E.T. GROUND ELAPSED TIME
GMT GREENWICH MEAN TIME
GMTIUGRR GREENWICH MEAN TIME OF THE INERTIAL GUIDANCE REFERENCE RELEASE
GMTL/O GREENWICH MEAN TIME OF LIFT-OFF
GMTZS GREENWICH MEAN TIME OF ZEROING SPACECRAFT
GOST GUIDANCE OPTICAL SUPPORT TABLE
GPMP GENERAL PURPOSE MANEUVER TABLE
GRR GUIDANCE REFERENCE RELEASE
IBSYS IBM SYSTEM (BASIC OPERATING SYSTEM FOR THE IBM 7094)
I.D. IDENTIFICATION
IGA INNER GIMBAL ANGLE
IMU INERTIAL MEASUREMENT UNIT
IU INSTRUMENT UNIT
L/D LIFT-TO-DRAg RATIO
LES LUNAR ESCAPE SYSTEM
LET LAUNCH ESCAPE TOWER
LM LUNAR MODULE
LM RCS LUNAR MODULE, REACTION CONTROL SYSTEM CONSUMABLES PROGRAM
LO LIFT-OFF
LOS  LINE OF SIGHT
LOST  LUNAR OPTICAL SIGHTING TABLE
LPD   LANDING POINT DESIGNATOR
LV    LAUNCH VEHICLE
LVLH  LOCAL VERTICAL/LOCAL HORIZONTAL
MGA   MIDDLE GIMBAL ANGLE
MPAD  MISSION PLANNING AND ANALYSIS DIVISION
MPT   MISSION PLAN TABLE
MRS   MASS PROPERTIES, REACTION CONTROL SYSTEM, SERVICE PROPULSION SYSTEM PROGRAM
MSC   MANNED SPACECRAFT CENTER
MSFC  MARSHALL SPACE FLIGHT CENTER
MSFN  MANNED SPACE FLIGHT NETWORK
NASA  NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OST   OPTICAL SIGHTING TABLE
PAO   PUBLIC AFFAIRS OFFICE
PCF   PROGRAM CONTROL FILE
PGNCS PRIMARY GUIDANCE AND NAVIGATION CONTROL SYSTEM
PIT   PARAMETER ITERATION TECHNIQUE
PLA   PRIMARY LANDING AREA
PSAT  PREDICTED SITE ACQUISITION TABLE
PTC   PASSIVE THERMAL CONTROL
PVT   PRESSURE-VOLUME-TEMPERATURE
OGA   OUTER GIMBAL ANGLE
RCS   REACTION CONTROL SYSTEM
REFSMMAT  REFERENCE SYSTEM TO STABLE MEMBER MATRIX TRANSFORMATION
REM   ROENTGEN EQUIVALENT MAN

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<td>RET</td>
<td>RETRO ELAPSED TIME</td>
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<td>RTACF</td>
<td>REAL-TIME AUXILIARY COMPUTING FACILITY</td>
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<td>RTCC</td>
<td>REAL-TIME COMPUTING COMPLEX</td>
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<td>SCS</td>
<td>STABILIZATION CONTROL SYSTEM</td>
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<td>SEENA</td>
<td>SPACECRAFT ELECTRICAL ENERGY NETWORK ANALYSIS</td>
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<td>SUPERCRITICAL HELIUM SYSTEM PROGRAM</td>
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<td>SECOND STAGE OF THE SATURN IB LAUNCH VEHICLE</td>
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<td>FT/SEC</td>
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<td>HR</td>
<td>HOUR</td>
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<tr>
<td>KG</td>
<td>KILOGRAMS</td>
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<tr>
<td>KM</td>
<td>KILOMETER</td>
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</table>
LB  POUND
M  METER
MIN  MINUTE
M/CSEC  METERS PER CENTISECOND
M/SEC  METERS PER SECOND
N MI  NAUTICAL MILES
RAD  RADIANS
SEC  SECOND
REAL-TIME AUXILIARY COMPUTING FACILITY

APOLLO 9 OPERATIONAL SUPPORT TEAM HANDBOOK

MISSION OPERATIONS SECTION
TRW SYSTEMS GROUP

1. INTRODUCTION

THIS DOCUMENT PRESENTS THE OPERATING INSTRUCTIONS FOR THE APOLLO 9 REAL-TIME AUXILIARY COMPUTING FACILITY (RTACF) PROCESSORS AND IS INTENDED FOR USE BY THOSE INDIVIDUALS ASSIGNED TO THE RTACF APOLLO 9 OPERATIONAL SUPPORT TEAM. THE PROCESSORS DESCRIBED IN THIS HANDBOOK WERE DEVELOPED BY THE RTACF OPERATIONAL SUPPORT TEAM TO FULFILL THE RTACF REQUIREMENTS FOR THE SUPPORT OF THE APOLLO 9 MISSION. A DETAILED DISCUSSION OF THESE REQUIREMENTS AND A GENERAL DESCRIPTION OF THE PROCESSORS ARE PRESENTED IN THE RTACF APOLLO 9 FLIGHT ANNEX (REFERENCE 1).

SINCE THE REQUIREMENTS AND THE PROCESSORS Configured TO FUL- FILL THOSE REQUIREMENTS WILL BE CONTINUALLY CHANGING PRIOR TO THE MISSION, AND POSSIBLY EVEN DURING THE MISSION, THIS HANDBOOK HAS BEEN PLACED ON COMPUTER CARDS FOR CONVENIENCE OF UPDATING.
2. OPERATING INSTRUCTIONS FOR THE GEMMV PROCESSORS

2.1 GENERAL

THIS SECTION PRESENTS THE TAPE SETUP AND THE CONTROL CARDS REQUIRED TO OPERATE THE GEMMV PROCESSORS ON THE UNIVAC 1108 DATA PROCESSING SYSTEM. ALSO PRESENTED IS A BRIEF DESCRIPTION OF EACH PROCESSOR ALONG WITH THE ON-LINE INPUTS REQUIRED FOR THEIR OPERATION.

2.2 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

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<th>TAPE UNIT</th>
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<td>GEMMV PROGRAM (PCF) TAPE</td>
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<tr>
<td>B</td>
<td>MISSION TABLE TAPE</td>
</tr>
<tr>
<td>F</td>
<td>MISSION DATA TAPE</td>
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</table>

2.3 CONTROL CARD LISTING AND ON-LINE DECK SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8

* MSG
  ASG A = XXXX
  ASG B = XXXX
  ASG F = XXXX
  ASG G,N,V
  XOT CUR

  TRW A,B,F,G,N,V IN A

  EXECUTE GEMMV PROGRAM (PCF) TAPE NUMBER
  MISSION TABLE TAPE NUMBER
  MISSION DATA TAPE NUMBER
  SCRATCH UNITS ON FASTRAND
  EXECUTE THE FOLLOWING INSTRUCTIONS
  REWIND UNITS A,B,F,G,N,V
  INPUT THE ENTIRE USER PCF FROM UNIT A

  SOURCE LANGUAGE CORRECTIONS (PATCHES)

  EXECUTE GEMMV PROGRAM
  N IS THE FILE NUMBER OF THE DATA TAPE
  M IS THE NUMBER OF GEMMV TABLES TO INPUT

  GEMMV TABLES
A-ARRAY UPDATES FOR PHASE 1

EXECUTE PHASE 1

A-ARRAY UPDATES FOR PHASE 2

EXECUTE PHASE 2

GEMMV A-ARRAY UPDATES AND PHASE EXECUTE CARDS

A-ARRAY UPDATES FOR PHASE N WHERE N IS THE LAST GEMMV PHASE

EXECUTE PHASE N LAST CARD IN THE GEMMV DECK END OF FILE CARD

* INDICATES 7/8 OVERPUNCH IN COLUMN 1
** K IS THE NEXT FILE TO BE READ FROM THE PCF TAPE
2.4 THE GEMMV PROCESSORS

This section presents a brief description of the GEMMV processors and the on-line inputs required to operate each processor. Also included is a figure for each processor that depicts the sequence of the GEMMV phases, the flags used to skip specific phases, the groups of phases that perform functions, and the spans of phases covered by the iterative (PIT) mode and boundary value mode.
2.4.1 ORBITAL MANEUVER PROCESSOR. - THIS PROCESSOR WILL BE USED TO SIMULATE ANY SPS OR RCS ORBITAL MANEUVER FOR WHICH THE BURN QUANTITIES HAVE PREVIOUSLY BEEN DETERMINED. THE OUTPUT DISPLAY FOR THIS PROCESSOR WILL BE A DMT.
ORBITAL MANEUVER PROCESSOR
(FILE 7 UNIVAC 1108)

A. STANDARD GEMMV INPUT QUANTITIES FOR THE ORBITAL MANEUVER DECK ARE LISTED BELOW

PHASE 1 - COAST TO ORBIT MANEUVER

INITIALIZATION
A905-11  FLAGS TO SKIP APPROPRIATE PHASES
A4871-3  VECTOR IDENTIFICATION
A368     REVOLUTION NUMBER
A93-5    LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
A1138-40 VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A240-2   POSITION COORDINATES (ER) (X, Y, Z)
A248-50  VELOCITY COORDINATES (ER/HR) (X, Y, Z)
A280     CURRENT WEIGHT (LB)

ORBITAL MANEUVER
A1148-50 TIME OF RCS IGNITION (HR, MIN, SEC)
          (G.E.T.)
A1018-26  REFSMMAT STORED ROW-WISE (NOT NECESSARY
          IF REFSMMAT IS COMPUTED AT IGNITION)
A912     FLAG TO COMPUTE REFSMMAT AT DEORBIT IGNITION
          (SINCE ALREADY SET TO 1 ON TAPE, SET TO 0 ONLY IF REFSMMAT IS INPUT.)
A913-5   IMU ROLL, PITCH, AND YAW GIMBAL ANGLES,
          RESPECTIVELY (NECESSARY IF REFSMMAT IS
          COMPUTED OR IF ALIGNMENT OPTION 6 IS SPECIFIED)
A924     ALIGNMENT OPTION
A925-7   BODY ROLL, PITCH, AND YAW, RESPECTIVELY,
          WHICH CORRESPOND TO ALIGNMENT OPTION
A932     GUIDANCE OPTION
A941-2   TERMINATION INDEX AND VALUE, RESPECTIVE-
          LY, OF RCS BURN
A928-9   TERMINATION INDEX AND VALUE, RESPECTIVE-
          LY, OF SPS BURN

PHASE 2 - (NOT EXECUTED)
PHASE 3 - (NOT EXECUTED)
PHASE 4 - (NOT EXECUTED)
PHASE 5 - (NOT EXECUTED)
PHASE 6 - (NOT EXECUTED)
PHASE 7 - (NOT EXECUTED)
PHASE 8 - (NOT EXECUTED)
PHASE 9 - RCS ULLAGE PRIOR TO ORBIT MANEUVER

PHASE 10 - SPS ORBIT MANEUVER

A120 INTEGRATION INTERVAL (MUST BE SET TO 0.25 SEC ONLY WHEN ORBITAL MANEUVER BURN IS LESS THAN 0.50 SEC.)

PHASE 11 - COAST TO APOGEE OR PERIGEE

PHASE 12 - COAST TO APOGEE OR PERIGEE

PHASE 13 - SHORT DURATION COAST

PHASE 14 - COAST FOR 1 SEC

A139 SET TO 1 TO TERMINATE RUN.

PHASES 15-20 - COAST FOR 1 SEC

B. IF A NAVIGATION UPDATE IS REQUIRED AT 12 MINUTES PRIOR TO SPS IGNITION, SET IN ADDITION THE FOLLOWING INDICES:

PHASE 1 - COAST TO ORBIT MANEUVER

A1148-50 G.E.T. WHICH IS 12 MINUTES PRIOR TO SPS IGNITION (HR, MIN, SEC) (THIS SHOULD REPLACE THE RCS IGNITION TIME.)

A4270 SET TO 1 TO OBTAIN NAVIGATION UPDATE AT THE END OF THE FIRST PHASE.

PHASE 8 - COAST FROM FIXED DELTA T SEPARATION TO DEORBIT

A648-9 TERMINATION INDEX AND VALUE, RESPECTIVELY (NORMALY, THE INDEX SHOULD BE 123, AND THE VALUE SHOULD BE 705 SEC.)

C. IF P-40 DELTA V'S OR P-30 DELTA V'S AND DELTA V RESIDUALS IN THE RCS CONTROL ARE TO BE INPUT, SET IN ADDITION THE FOLLOWING INDICES:

PHASE 1 - INITIAL COAST PHASE

A925 ROLL ANGLE AT IGNITION (LVLH)

PHASE 9 - ULLAGE PRIOR TO DEORBIT BURN

A996-8 RESIDUAL DELTA VX, DELTA VY, DELTA VZ, INPUT, RESPECTIVELY

A999-1001 P-40 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY

A987-9 P-30 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
2.4.2 AVERAGE-G NAVIGATION EVALUATION PROCESSOR. - THIS PROCESSOR WILL BE USED TO DETERMINE WHETHER IT IS NECESSARY TO PERFORM A NAVIGATION UPDATE PRIOR TO A PLANNED MANEUVER.

THE NAVIGATION UPDATE EVALUATION IS PERFORMED BY THE GEMMV PROGRAM BY EMPLOYING THE FOLLOWING LOGIC. A SPACECRAFT TELEMETRY VECTOR AND A RTCC STATE VECTOR ARE INPUT IN PHASE 1 AND PROPAGATED TO THE MANEUVER TIME. THE MANEUVER IS SIMULATED USING THE TELEMETRY VECTOR AND CMC GUIDANCE. THEN THE INCREMENTAL VELOCITIES THROUGHOUT THE SIMULATION ARE APPLIED TO THE RTCC STATE VECTOR.

![Diagram of navigation evaluation process](image-url)
AVERAGE-G NAVIGATION EVALUATION PROCESSOR
(FILE 9 UNIVAC 1108)

A. STANARD GEMMV INPUT QUANTITIES FOR AVERAGE-G DECK ARE LISTED BELOW.

PHASE 1 - COAST TO ULLAGE PHASE

VECTOR 1
A4871-3 VECTOR IDENTIFICATION
A368 REVOLUTION NUMBER
A93-5 LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
A1138-40 VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A240-2 POSITION COORDINATES (ER) (X, Y, Z)
A248-50 VELOCITY COORDINATES (ER/HR) (X, Y, Z)
A280 CURRENT WEIGHT (LB)

VECTOR 2
A2138-40 VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A1240-2 POSITION COORDINATES (ER) (X, Y, Z)
A1248-50 VELOCITY COORDINATES (ER/HR) (X, Y, Z)
A1280 CURRENT WEIGHT (LB)
A96 SET TO 1 IF VECTOR TIMES ARE DIFFERENT.

ORBIT MANEUVER
A1148-50 TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)
A11018-26 REFSSMMAT STORED ROW-WISE (NOT NECESSARY IF REFSSMMAT IS COMPUTED AT IGNITION)
A912 SET TO 0 FOR INPUT REFSSMMAT
A913-5 IMU ROLL, PITCH, AND YAW GIMBAL ANGLES, RESPECTIVELY (NECESSARY IF REFSSMMAT IS COMPUTED)
A924 ALIGNMENT OPTION
A925-7 BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO ALIGNMENT OPTION
A932 GUIDANCE OPTION
A941-2 TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS ULLAGE BURN
A928-9 TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS MANEUVER

2-9
PHASE 2 - RCS ULLAGE PHASE
PHASE 3 - SPS MANEUVER PHASE
PHASE 4 - COAST TO FIRST GAMMA STOP (VECTOR 1)
PHASE 5 - COAST TO SECOND GAMMA STOP (VECTOR 1)
PHASE 6 - TEN-SECOND COAST CALL DMT (VECTOR 1)
PHASE 7 - COAST TO FIRST GAMMA STOP (VECTOR 2)
PHASE 8 - COAST TO SECOND GAMMA STOP (VECTOR 2)
PHASE 9 - TEN-SECOND COAST CALL DMT (VECTOR 2)

PHASE 10 - RUN TERMINATION

A139 SET TO 1 TO TERMINATE RUN.
2.4.3 CONTINGENCY LANDING AREA (CLA) PROCESSOR. - THIS PROCESSOR WILL BE USED TO DETERMINE THE DEORBIT MANEUVER IGNITION TIME REQUIRED TO ACHIEVE A TARGET LONGITUDE WHICH IS normally located in a contingency landing area. THIS PROCESSOR HAS THE CAPABILITY TO SIMULATE A MANEUVER AT A FIXED TIME OR AT A SPECIFIED TIME INTERVAL PRIOR TO THE DEORBIT MANEUVER, AND AN ENTRY PROFILE CONSISTING OF A CONSTANT LIFT VECTOR ORIENTATION TO A SPECIFIED G-LOAD, AND THEN A CONSTANT BANK ANGLE TO DROGUE CHUTE DEPLOYMENT. THIS PROCESSOR CAN ALSO SIMULATE A ZERO AND FULL LIFT ENTRY PROFILE.
A. STANDARD GEMMV INPUT QUANTITIES FOR THE CLA DECK ARE LISTED BELOW.

**PHASE 1 - INITIAL COAST PHASE**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A905-11</td>
<td>INITIALIZATION FLAGS TO SKIP APPROPRIATE PHASES</td>
</tr>
<tr>
<td>A4871-3</td>
<td>VECTOR IDENTIFICATION</td>
</tr>
<tr>
<td>A368</td>
<td>REVOLUTION NUMBER</td>
</tr>
<tr>
<td>A93-5</td>
<td>LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)</td>
</tr>
<tr>
<td>A1138-40</td>
<td>VECTOR TIME (HR, MIN, SEC) (G.M.T.)</td>
</tr>
<tr>
<td>A240-2</td>
<td>POSITION COORDINATES (ER) (X,Y,Z)</td>
</tr>
<tr>
<td>A248-50</td>
<td>VELOCITY COORDINATES (ER/HR) (X,Y,Z)</td>
</tr>
<tr>
<td>A280</td>
<td>CURRENT WEIGHT (LB)</td>
</tr>
<tr>
<td>A1906</td>
<td>ITERATION FLAG (SET TO 1 TO SUPPRESS ITERATION)</td>
</tr>
<tr>
<td>A1148-50</td>
<td>FIXED TIME MANEUVER TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)</td>
</tr>
<tr>
<td>A916</td>
<td>ALIGNMENT OPTION FOR MANEUVER</td>
</tr>
<tr>
<td>A917-9</td>
<td>BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION</td>
</tr>
<tr>
<td>A931</td>
<td>GUIDANCE OPTION FOR MANEUVER</td>
</tr>
<tr>
<td>A920-1</td>
<td>TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN</td>
</tr>
<tr>
<td>A922-3</td>
<td>TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN</td>
</tr>
<tr>
<td>A1148-50</td>
<td>FIXED DELTA T MANEUVER TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)</td>
</tr>
<tr>
<td>A916</td>
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<td>A920-1</td>
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</tr>
<tr>
<td>A922-3</td>
<td>TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN</td>
</tr>
</tbody>
</table>

**DEORBIT MANEUVER**
TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)

IF A FIXED TIME MANEUVER HAS BEEN PERFORMED, SET A1148-50 IN PHASE 4 INSTEAD OF PHASE 1.

REFSMAT STORED ROW-WISE (NOT NECESSARY IF REFSMAT IS COMPUTED AT IGNITION)

FLAG TO COMPUTE REFSMAT AT DEORBIT IGNITION (SINCE ALREADY SET TO 1 ON TAPE SET TO 0 ONLY IF REFSMAT IS INPUT.)

IMU ROLL, PITCH, AND YAW GIMBAL ANGLES, RESPECTIVELY (NECESSARY IF REFSMAT IS COMPUTED OR IF ALIGNMENT OPTION 6 IS SPECIFIED)

ALIGNMENT OPTION

BODY ROLL, PITCH, AND YAW, RESPECTIVELY, WHICH CORRESPOND TO ALIGNMENT OPTION

GUIDANCE OPTION

TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN

TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS DEORBIT BURN

ENTRY

LIFT VECTOR ORIENTATION (BANK ANGLE)
FLOWN TO A SPECIFIED G-LEVEL (USED ONLY IF A911 IS SET TO 0)

LIFT VECTOR ORIENTATION (BANK ANGLE)
FLOWN FROM A SPECIFIED G-LEVEL (IF A911=0) OR FROM 300K FEET (IF A911=1)

LONGITUDE OF TARGET

SET TO 0 TO EXECUTE THE COAST TO X-G'S PHASE.

SET TO SPECIFIED G-LEVEL TO INITIATE THE ENTRY MODE (NECESSARY ONLY IF A911 IS SET TO 0).

ENTRY LIFT MULTIPLIER TO BE USED FROM A SPECIFIED G-LEVEL (IF A911=0) OR FROM 300K FEET (IF A911=1)

ENTRY WEIGHT (LB)
SET TO 0 IF FOOTPRINT IS DESIRED.

PHASE 2 - FIXED TIME RCS SEPARATION
PHASE 3 - FIXED TIME SPS SEPARATION
PHASE 4 - COAST AFTER FIXED TIME SEPARATION
PHASE 5 - COAST TO DEORBIT BURN

PHASE 6 - RCS SEPARATION AT FIXED TIME PRIOR TO DEORBIT

NUMBER OF SECONDS AFTER THE FIXED DELTA T MANEUVER INITIATION THAT PHASE 6 IS TO TERMINATE (SET TO A LARGE NUMBER IF A TERMINATION IS INPUT FOR PHASE 6)
PHASE 7 - SPS SEPARATION AT FIXED TIME PRIOR TO DEORBIT
PHASE 8 - COAST FROM SEPARATION TO DEORBIT
PHASE 9 - RCS ULLAGE PRIOR TO DEORBIT BURN
PHASE 9 - RCS ULLAGE PRIOR TO DEORBIT BURN
PHASE 10 - SPS DEORBIT BURN
PHASE 11 - COAST TO 433K FEET
PHASE 12 - COAST TO 300K FEET
PHASE 13 - COAST TO X-G POINT
PHASE 14 - COAST TO 23.3K FEET
PHASE 15 - MAXIMUM LIFT FOOTPRINT EXECUTION
PHASE 16 - MINIMUM LIFT FOOTPRINT EXECUTION

B. IF A NAVIGATION UPDATE IS REQUIRED AT 12 MINUTES PRIOR TO DEORBIT IGNITION, SET IN ADDITION THE FOLLOWING INDICES.

PHASE 1 - INITIAL COAST

A1148-50 G.E.T. WHICH IS 12 MINUTES PRIOR TO DEORBIT IGNITION (HR, MIN, SEC) (THIS SHOULD REPLACE THE RCS IGNITION TIME.)
A909 SET TO 0 SO THAT THE COAST FROM SEPARATION TO DEORBIT PHASE WILL BE EXECUTED. (THIS PHASE WILL BE USED TO EXECUTE THE NAVIGATION UPDATE.)

PHASE 5 - COAST TO DEORBIT BURN

A4270 SET TO 1 TO EXECUTE NAVIGATION UPDATE AT END OF THIS PHASE.

PHASE 8 - COAST FROM SEPARATION TO DEORBIT

A649 SET TO 705 TO TERMINATE THIS COAST 705 SECONDS PRIOR TO RCS ULLAGE. (IN CASE OF AN RCS DEORBIT BURN THIS VALUE SHOULD BE SET TO 720 SECONDS.)

C. IF P-40 DELTA V'S OR P-30 DELTA V'S AND DELTA V RESIDUALS IN THE RCS CONTROL AXIS ARE TO BE INPUT, SET IN ADDITION THE FOLLOWING INDICES.

PHASE 1 - INITIAL COAST PHASE

A925 ROLL ANGLE AT IGNITION (LVLH)

PHASE 9 - ULLAGE PRIOR TO DEORBIT BURN

A996-8 RESIDUAL DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
A999-1001 P-40 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
A987-9 P-30 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
D. IF IT IS DESIRED TO ITERATE ON DELTA V WHILE HOLDING TIME OF IGNITION FIXED, SET IN ADDITION THE FOLLOWING INDICES.

PHASE 1 - INITIAL COAST PHASE

A1901 SET TO 0 TO CALL SPECIAL ITERATION IN PIT MODE.
A147 SET TO 6 TO START ITERATIVE LOOP AT BEGINNING OF SPS DEORBIT PHASE.
A148-9 TARGET INDEX AND VALUE, RESPECTIVELY, FOR PIT MODE

E. IF IT IS DESIRED TO COMPUTE A REFSMMAT AT SOME TIME OTHER THAN DEORBIT IGNITION, SET IN ADDITION THE FOLLOWING INDEX.

PHASE - WHERE REFSMMAT IS DESIRED

A1128 SET TO 1 TO COMPUTE REFSMMAT AT BEGINNING OF THE PHASE.
2.4.4 PRIMARY LANDING AREA (PLA) PROCESSOR. — THIS PROCESSOR WILL BE USED TO DETERMINE THE DEORBIT MANEUVER IGNITION TIME AND THE TIME TO REVERSE BANK ANGLE REQUIRED TO ACHIEVE A TARGET (LONGITUDE AND LATITUDE) LANDING POINT WHICH IS NORMALLY LOCATED IN A PRIMARY LANDING AREA. IT HAS THE CAPABILITY TO SIMULATE A MANEUVER AT A FIXED TIME OR AT A SPECIFIED TIME INTERVAL PRIOR TO THE DEORBIT MANEUVER, THE DEORBIT MANEUVER, AND AN ENTRY PROFILE CONSISTING OF A SPECIFIED LIFT VECTOR ORIENTATION TO A GIVEN G-LOAD, AND THEN A POSITIVE BANK ANGLE FOLLOWED BY THE NEGATIVE OF THAT BANK ANGLE TO DROGUE CHUTE DEPLOYMENT. THE PROCESSOR ALSO HAS THE CAPABILITY TO SIMULATE A ZERO AND FULL LIFT ENTRY PROFILE.

THE PLA PROCESSOR IS THE ONLY GEMMV PROCESSOR THAT EMPLOYS THE BOUNDARY VALUE MODE. THE PROCESSOR USES THE ITERATIVE MODE (PIT), PRIOR TO THE BOUNDARY MODE, TO DETERMINE THE IGNITION TIME REQUIRED TO ACHIEVE A LONGITUDE TARGET LANDING POINT. THIS IGNITION TIME IS THEN USED BY THE BOUNDARY VALUE MODE AS AN INITIAL GUESS. IF THE IGNITION TIME TO ACHIEVE A LONGITUDE TARGET IS AVAILABLE, THE PIT MODE MAY BE SUPPRESSED.
PRIMARY LANDING AREA PROCESSOR
(FILE 2 UNIVAC 1108)

A. STANDARD GEMMV INPUT QUANTITIES FOR THE PLA DECK ARE LISTED BELOW

PHASE 1 - INITIAL COAST PHASE

INITIALIZATION
A905-11  FLAGS TO SKIP APPROPRIATE PHASES
A4871-3  VECTOR IDENTIFICATION
A368  REVOLUTION NUMBER
A93-5  LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
A1138-40  VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A240-2  POSITION COORDINATES (ER) (X, Y, Z)
A248-50  VELOCITY COORDINATES (ER/HR) (X, Y, Z)
A280  CURRENT WEIGHT (LB)
A1906  ITERATION FLAG (SET TO 1 TO SUPPRESS ITERATION)

FIXED TIME MANEUVER
A1148-50  TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)
A916  ALIGNMENT OPTION FOR MANEUVER
A917-9  BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION
A931  GUIDANCE OPTION FOR MANEUVER
A920-1  TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN
A922-3  TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN

FIXED DELTA T MANEUVER
A1148-50  TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)
A916  ALIGNMENT OPTION FOR MANEUVER
A917-9  BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION
A931  GUIDANCE OPTION FOR MANEUVER
A920-1  TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN
A922-3  TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN

2-19
DEORBIT MANEUVER

A1148-50  TIME OF RCS IGNITION (HR, MIN, SEC)
(G.E.T.) IF A FIXED TIME MANEUVER HAS
BEEN PERFORMED, SET A1148-50 IN
PHASE 4 INSTEAD OF PHASE 1.

A1018-26  REFSMMAT STORED ROW-WISE (NOT NECESSARY
IF REFSMMAT IS COMPUTED AT IGNITION)

A912  FLAG TO COMPUTE REFSMMAT AT DEORBIT
IGNITION (SINCE ALREADY SET TO 1 ON TAPE,
SET TO 0 ONLY IF REFSMMAT IS INPUT.)

A913-5  IMU ROLL, PITCH, AND YAW GIMBAL ANGLES,
RESPECTIVELY (NECESSARY IF REFSMMAT IS
COMPUTED OR IF ALIGNMENT OPTION 6
IS SPECIFIED)

A924  ALIGNMENT OPTION

A925-7  BODY ROLL, PITCH, AND YAW RESPECTIVELY,
WHICH CORRESPOND TO ALIGNMENT OPTION

A932  GUIDANCE OPTION

A941-2  TERMINATION INDEX AND VALUE,
RESPECTIVELY, OF RCS BURN

A928-9  TERMINATION INDEX AND VALUE,
RESPECTIVELY, OF SPS BURN

ENTRY

A901  LIFT VECTOR ORIENTATION (BANK ANGLE)
FLOWN TO A SPECIFIED G-LEVEL (USED ONLY
IF A911 IS SET TO 0.)

A902  LIFT VECTOR ORIENTATION (BANK ANGLE)
FLOWN FROM A SPECIFIED G-LEVEL (IF A911
= C) IF A911 = 1, SEE F.

A1902-3  LONGITUDE AND LATITUDE OF THE TARGET
A911  SET TO 0 TO EXECUTE THE COAST TO X-G*S
PHASE.

A29C7  SET TO SPECIFIED G-LEVEL TO INITIATE
THE ENTRY MODE (NECESSARY ONLY IF
A911 IS SET TO 0.)

A1172  ENTRY LIFT MULTIPLIER TO BE USED FROM A
SPECIFIED G-LEVEL (IF A911=0) OR FROM
300K FEET (IF A911=1)

A904  ENTRY WEIGHT (LB)

A933  SET TO 0 IF FOOTPRINT IS DESIRED.

PHASE 2 - FIXED TIME RCS SEPARATION
PHASE 3 - FIXED TIME SPS SEPARATION
PHASE 4 - COAST AFTER FIXED TIME SEPARATION
PHASE 5 - COAST TO DEORBIT BURN

PHASE 6 - RCS SEPARATION AT FIXED TIME PRIOR TO DEORBIT

A97  NUMBER OF SECONDS AFTER THE FIXED DELTA T
MANEUVER INITIATION THAT PHASE 6 IS TO
TERMINATE (SET TO A LARGE NUMBER IF A
TERMINATION IS INPUT FOR PHASE 6)
PHASE 7 - SPS SEPARATION AT FIXED TIME PRIOR TO DEORBIT
PHASE 8 - COAST FROM SEPARATION TO DEORBIT
PHASE 9 - RCS ULLAGE PRIOR TO DEORBIT BURN
PHASE 10 - SPS DEORBIT BURN
PHASE 11 - COAST TO 400K FEET
PHASE 12 - COAST TO 300K FEET
PHASE 13 - COAST TO X-G POINT
PHASE 14 - COAST TO 23.3K FEET

PHASE 15 - COAST TO DEORBIT

A655 SET TO 125000 ONLY IF A911 = 0, A901 = 180, AND A2907 = 1.

PHASE 16 - RCS SEPARATION AT FIXED TIME PRIOR TO DEORBIT
PHASE 17 - SPS SEPARATION AT FIXED TIME PRIOR TO DEORBIT
PHASE 18 - COAST FROM SEPARATION TO DEORBIT
PHASE 19 - RCS ULLAGE PRIOR TO DEORBIT BURN
PHASE 20 - SPS DEORBIT BURN
PHASE 21 - COAST TO 400K FEET
PHASE 22 - COAST TO 300K FEET
PHASE 23 - COAST TO X-G POINT
PHASE 24 - COAST TO BANK REVERSE
PHASE 25 - REVERSE BANK
PHASE 26 - COAST TO 23.3K FEET
PHASE 27 - MAXIMUM LIFT FOOTPRINT EXECUTION
PHASE 28 - MINIMUM LIFT FOOTPRINT EXECUTION

B. IF A NAVIGATION UPDATE IS REQUIRED AT 12 MINUTES PRIOR TO DEORBIT IGNITION, SET IN ADDITION THE FOLLOWING INDICES

PHASE 1 - INITIAL COAST
A1148-50 G.E.T. WHICH IS 12 MINUTES PRIOR TO DEORBIT IGNITION (HR, MIN, SEC) (THIS SHOULD REPLACE THE RCS IGNITION TIME.)
A909 SET TO 0 SO THAT THE COAST FROM SEPARATION TO DEORBIT PHASE WILL BE EXECUTED. (THIS PHASE WILL BE USED TO EXECUTE THE NAVIGATION UPDATE.)

PHASE 8 - COAST FROM SEPARATION TO DEORBIT (PIT MODE) AND
PHASE 18 - COAST FROM SEPARATION TO DEORBIT (BOUNDARY MODE)
A649 SET TO 705 TO TERMINATE THIS COAST 705 SECONDS PRIOR TO RCS ULLAGE (FOR AN RCS DEORBIT BURN THIS VALUE SHOULD BE SET TO 720 SECONDS.)

PHASE 15 - COAST TO DEORBIT BURN
A4270 SET TO 1 TO EXECUTE NAVIGATION UPDATE AT END OF THIS PHASE.
C. IF P-40 DELTA V'S OF P-30 DELTA V'S AND DELTA V RESIDUAL IN THE RCS CONTROL AXES ARE TO BE INPUT, SET IN ADDITION THE FOLLOWING INDICES

PHASE 1 - INITIAL COAST PHASE

A925 ROLL ANGLE AT IGNITION (LVLH)

PHASE 9 - ULLAGE PRIOR TO DEORBIT BURN

PHASE 19 - ULLAGE PRIOR TO DEORBIT BURN

A996-8 RESIDUAL DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
A999-1001 P-40 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY
OR A987-9 P-30 DELTA VX, DELTA VY, DELTA VZ INPUT, RESPECTIVELY

D. IF IT IS DESIRED TO ITERATE ON DELTA V WHILE HOLDING TIME OF IGNITION FIXED, SET IN ADDITION THE FOLLOWING INDICES

PHASE 1 - INITIAL COAST PHASE

A1901 SET TO 0 TO CALL SPECIAL ITERATION IN PIT MODE.
A147 SET TO 6 TO START ITERATIVE LOOP AT BEGINNING OF SPS DEORBIT PHASE.
A148-9 TARGET INDEX AND VALUE, RESPECTIVELY, FOR PIT MODE

E. IF IT IS DESIRED TO SUPPRESS THE PIT MODE, SET IN ADDITION THE FOLLOWING INDEX

PHASE 1 - INITIAL COAST PHASE

A19C6 SET TO 1.

F. IF THE COAST TO X-G POINT PHASE IS NOT EXECUTED, SET IN ADDITION THE FOLLOWING INDICES

PHASE 1 - INITIAL COAST PHASE

A902 SET TO 0.

PHASE 15 - COAST TO DEORBIT

A902 LIFT VECTOR ORIENTATION (BANK ANGLE) FLOWN FROM 300K FEET
2.4.5 HYBRID DEORBIT PROCESSOR. - THIS PROCESSOR WILL BE USED TO DETERMINE THE HYBRID DEORBIT IGNITION TIME REQUIRED TO ACHIEVE A TARGET LONGITUDE. THIS PROCESSOR HAS THE CAPABILITY TO SIMULATE A MANEUVER AT A SPECIFIED TIME, THE HYBRID DEORBIT MANEUVER, AND ENTRY PROFILE CONSISTING OF A CONSTANT LIFT VECTOR ORIENTATION TO A SPECIFIED G-LOAD, AND THEN A CONSTANT BANK ANGLE TO DROGUE CHUTE DEPLOYMENT.

A HYBRID DEORBIT IS PERFORMED IN TWO BURNS BY USING THE SM AND CM RCS THRUSTERS TO ACCOMPLISH A FIXED INCREMENTAL VELOCITY CHANGE WITH A CONSTANT INERTIAL THRUST VECTOR ORIENTATION. THIS ORIENTATION IS DEFINED AS FOLLOWS. AT THE CENTROID OF THE HYBRID DEORBIT BURNS, THE THRUST VECTOR DIRECTION IS OPPOSITE THE GEOCENTRIC LOCAL HORIZONTAL. AFTER THE CM/RCS BURN, A 60-SECOND COAST ALLOWS TIME TO PERFORM CM/RCS SEPARATION AND REORIENTATION OF THE CM SO THAT THE EFFECTIVE THRUST VECTOR ORIENTATION REMAINS CONSTANT.


<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>COAST</td>
<td>A905</td>
<td>COAST</td>
<td>A906</td>
<td>SPS</td>
<td>A905</td>
<td>COAST</td>
<td>A907</td>
<td>SM/RCS</td>
<td>A908</td>
<td>NOTEXECUTED</td>
<td>A909</td>
<td>COAST</td>
<td>CM/RCS</td>
<td>A910</td>
</tr>
</tbody>
</table>

**FIXED TIME SLP**

**H YBRID BURN**

**PIT MODE**

**ENTRY**

**FOOTPRINT**

2-24
HYBRID DEORBIT PROCESSOR
(FILE 8 UNIVAC 1108)

A. STANDARD GEMMV INPUT QUANTITIES FOR THE HYBRID DEORBIT DECK LISTED BELOW

PHASE I - INITIAL COAST PHASE

<table>
<thead>
<tr>
<th>INITIALIZATION</th>
<th>HYBRID DEORBIT MANEUVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>INITIALIZATION FLAGS TO SKIP APPROPRIATE PHASES</td>
<td>TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.)</td>
</tr>
<tr>
<td>VECTOR IDENTIFICATION</td>
<td>REFSMMAT STORED ROW-WISE (NOT NECESSARY IF REFSMMAT IS COMPUTED AT IGNITION)</td>
</tr>
<tr>
<td>REVOLUTION NUMBER</td>
<td>FLAG TO COMPUTE REFSMMAT AT DEORBIT IGNITION (SINCE ALREADY SET TO 1 ON TAPE, SET TO 0 ONLY IF REFSMMAT IS INPUT.)</td>
</tr>
<tr>
<td>LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)</td>
<td>IMU ROLL, PITCH, AND YAW GIMBAL ANGLES, RESPECTIVELY, (NECESSARY IF REFSMMAT IS COMPUTED OR IF ALIGNMENT OPTION 6 IS SPECIFIED)</td>
</tr>
<tr>
<td>VECTOR TIME (HR, MIN, SEC) (G.M.T.)</td>
<td>ALIGNMENT OPTION FOR HYBRID MANEUVER (SET TO 1 ON TAPE.)</td>
</tr>
<tr>
<td>POSITION COORDINATES (ER) (X, Y, Z)</td>
<td>BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION (SET TO 0, 0, 180 ON TAPE.)</td>
</tr>
<tr>
<td>VELOCITY COORDINATES (ER/HR) (X, Y, Z)</td>
<td>CM BODY ROLL (SET TO 180 ON TAPE.)</td>
</tr>
<tr>
<td>CURRENT WEIGHT (LB)</td>
<td>HYBRID DEORBIT GUIDANCE OPTION (SET TO 6 ON TAPE.)</td>
</tr>
<tr>
<td>ITERATION FLAG (ALREADY SET TO 0 ON TAPE SET TO 1 TO SUPPRESS ITERATION.)</td>
<td>CM PREBURN WEIGHT</td>
</tr>
<tr>
<td></td>
<td>DELTA V OF SM RCS BURN</td>
</tr>
<tr>
<td></td>
<td>DELTA T OF COAST BETWEEN SM RCS AND CM RCS BURNS (SET TO 60 ON TAPE.)</td>
</tr>
<tr>
<td></td>
<td>DELTA V OF CM RCS BURN</td>
</tr>
<tr>
<td></td>
<td>LIFT VECTOR ORIENTATION (BANK ANGLE) FLOWN TO A SPECIFIED G-LEVEL (USED ONLY IF A911 IS SET TO 0)</td>
</tr>
</tbody>
</table>

2-25
A902 LIFT VECTOR ORIENTATION (BANK ANGLE)
FLOWN FROM A SPECIFIED G-LEVEL (IF
A911 = 0) OR FROM 300K FEET (IF A911 =1)
A1902 LONGITUDE OF TARGET
A911 SET TO 0 TO EXECUTE THE COAST TO
X-G'S PHASE.
A2907 SET TO SPECIFIED G-LEVEL TO INITIATE THE
ENTRY MODE (NECESSARY ONLY IF A911 IS
SET TO 0).
A1172 ENTRY LIFT MULTIPLIER TO BE USED FROM A
SPECIFIED G-LEVEL (IF A911 = 0) OR FROM
300K FEET (IF A911 = 1)
A933 SET TO 0 IF FOOTPRINT IS DESIRED.

PHASE 2 - ULLAGE MANEUVER PHASE
PHASE 3 - SPS DEORBIT BURN PHASE
PHASE 4 - COAST TO HYBRID DEORBIT BURN TIME PHASE
PHASE 5 - COAST TO SM RCS BURN PHASE
PHASE 6 - SM RCS BURN PHASE
PHASE 7 - NOT EXECUTED
PHASE 8 - COAST BETWEEN SM AND CM BURNS PHASE
PHASE 9 - CM RCS BURN PHASE
PHASE 10 - NOT EXECUTED
PHASE 11 - COAST TO 400K PHASE
PHASE 12 - COAST TO 300K PHASE
PHASE 13 - COAST TO X-G'S PHASE
PHASE 14 - COAST TO 23.3K PHASE
PHASE 15 - MAXIMUM LIFT FOOTPRINT PHASE
PHASE 16 - MINIMUM LIFT FOOTPRINT PHASE

B. IF AN ULLAGE OR A PARTIAL SPS DEORBIT BURN IS TO BE
PERFORMED PRIOR TO THE HYBRID DEORBIT, SET IN ADDITION

PHASE 1 - INITIAL COAST PHASE
A1018-26 REFSMMAT STORED ROW-WISE (NOT NECESSARY
IF REFSMMAT IS COMPUTED AT ULLAGE OR
SPS IGNITION)
A928-9 TERMINATION INDEX AND VALUE,
RESPECTIVELY, OF SPS BURN
A1148-50 TIME OF ULLAGE MANEUVER (HR, MIN, SEC)
(G.E.T.)
A905 SET TO 0 FOR ULLAGE
A906 SET TO 0 FOR SPS BURN

PHASE 2 - ULLAGE MANEUVER PHASE
A1128 FLAG TO COMPUTE REFSMMAT AT ULLAGE
OR SPS IGNITION (SINCE ALREADY SET TO 0
ON TAPE SET TO 1 ONLY IF REFSMMAT IS
TO BE COMPUTED FOR ULLAGE OR SPS
IGNITION.)
A1027-29  IMU ROLL, PITCH, AND YAW GIMBAL ANGLES, RESPECTIVELY, FOR ULLAGE OR SPS MANEUVER (NECESSARY ONLY IF REFSMMAT IS COMPUTED AT ULLAGE OR SPS IGNITION)

A225  ATTITUDE OPTION FOR ULLAGE OR SPS MANEUVER (SET TO 4 ON TAPE.)

A1118-20  ROLL, PITCH, AND YAW ATTITUDES FOR ULLAGE OR SPS MANEUVER

A930  GUIDANCE OPTION FOR ULLAGE OR SPS MANEUVER (SET TO 4 ON TAPE.)

A648  ULLAGE TERMINATION INDEX (SET TO 123 ON TAPE.)

A649  ULLAGE TERMINATION VALUE (SET TO 15 ON TAPE.)

**PHASE 4 - COAST TO HYBRID DEORBIT BURN TIME PHASE**

A912  SET TO 0 IF REFSMMAT INPUT

A1018-26  REFSMMAT STORED ROW-WISE (NOT NECESSARY ONLY IF PLATFORM ALIGNMENT HAS BEEN PERFORMED AFTER ULLAGE OR SPS MANEUVER)

A1148-50  TIME OF SM RCS BURN (HR, MIN, SEC) (G.E.T.)

**IF NO ULLAGE OR SPS, PUT ALL UPDATES IN FIRST PHASE.**
2.4.6 CONTINGENCY LANDING AREA (CLA) PROCESSOR WITH VENTING.-
THIS PROCESSOR WILL BE USED TO SIMULATE S-IVB VENTING
IN ORDER TO GENERATE AN IU NAVIGATION UPDATE, SEPARATION, AND A
CLA DEORBIT.
CONTINGENCY LANDING AREA PROCESSOR WITH VENTING

(FILE 10 UNIVAC 1108)

A. STANDARD GEMMV INPUT QUANTITIES FOR NAVIGATION UPDATE DECK ARE LISTED BELOW

PHASE -1 - S-IVB VENTING COAST PHASE 1

A4871-3 VECTOR IDENTIFICATION
A368 REVOLUTION NUMBER
A93-5 LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
A1138-40 VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A240-2 POSITION COORDINATES (ER) (X,Y,Z)
A248-50 VELOCITY COORDINATES (ER/HR) (X,Y,Z)
A280 CURRENT WEIGHT (LB)

ADDITIONAL UPDATES
A1148-50 TIME OF FIXED TIME OR FIXED DELTA T SEP (HR, MIN, SEC) (G.E.T.)
A293 S-IVB REFERENCE AREA

PHASE 0 - S-IVB VENTING COAST PHASE 2

A15C SET TO 1 TO SKIP THIS PHASE

PHASE 1 - COAST PHASE AFTER VENTING

INITIALIZATION

A150 SET TO 1 TO SKIP THIS PHASE
A905-11 FLAGS TO SKIP APPROPRIATE PHASES

FIXED TIME MANEUVER
A916 ALIGNMENT OPTION FOR MANEUVER
A917-9 BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION
A931 GUIDANCE OPTION FOR MANEUVER
A920-1 TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN
A922-3 TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN

FIXED DELTA T MANEUVER
A916 ALIGNMENT OPTION FOR MANEUVER
A917-9 BODY ROLL, PITCH, AND YAW ANGLES, RESPECTIVELY, WHICH CORRESPOND TO THE ALIGNMENT OPTION
A931 GUIDANCE OPTION FOR MANEUVER
TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN
TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS BURN

TIME OF RCS IGNITION (HR, MIN, SEC) (G.E.T.) IF A FIXED TIME MANEUVER HAS BEEN PERFORMED, SET A1148-50 IN PHASE 4 INSTEAD OF PHASE 1. (NOT REQUIRED IF FIXED DELTA T SEP IS PERFORMED)

REFSMMAT STORED ROW-WISE (NOT NECESSARY IF REFSMMAT IS COMPUTED AT IGNITION)

FLAG TO COMPUTE REFSMMAT AT DEORBIT IGNITION (SINCE ALREADY SET TO 1 ON TAPE SET TO 0 ONLY IF REFSMMAT IS INPUT.)

IMU ROLL, PITCH, AND YAW GIMBAL ANGLES, RESPECTIVELY (NECESSARY IF REFSMMAT IS COMPUTED OR IF ALIGNMENT OPTION 6 IS SPECIFIED)

ALIGNMENT OPTION

BODY ROLL, PITCH, AND YAW, RESPECTIVELY, WHICH CORRESPOND TO ALIGNMENT OPTION

GUIDANCE OPTION

TERMINATION INDEX AND VALUE, RESPECTIVELY, OF RCS BURN

TERMINATION INDEX AND VALUE, RESPECTIVELY, OF SPS DEORBIT BURN

ENTRY

LIFT VECTOR ORIENTATION (BANK ANGLE) FLOWN TO A SPECIFIED G-LEVEL (USED ONLY IF A911 IS SET TO 0)

LIFT VECTOR ORIENTATION (BANK ANGLE) FLOWN FROM A SPECIFIED G-LEVEL (IF A911=0) OR FROM 300K FEET (IF A911=1)

LONGITUDE OF TARGET

SET TO 0 TO EXECUTE THE COAST TO X-G'S PHASE.

SET TO SPECIFIED G-LEVEL TO INITIATE THE ENTRY MODE (NECESSARY ONLY IF A911 IS SET TO 0).

ENTRY LIFT MULTIPLIER TO BE USED FROM A SPECIFIED G-LEVEL (IF A911=0) OR FROM 300K FEET (IF A911=1)

ENTRY WEIGHT (LB)

SET TO 0 IF FOOTPRINT IS DESIRED.
PHASE 2 - FIXED TIME RCS SEPARATION

A280 SEPARATION WEIGHT (IF FIXED TIME SEP IS EXECUTED)
A293 CSM REFERENCE AREA (IF FIXED TIME SEP IS EXECUTED)

PHASE 3 - FIXED TIME SPS SEPARATION

PHASE 4 - COAST AFTER FIXED TIME SEPARATION

PHASE 5 - COAST TO DEORBIT BURN

PHASE 6 - RCS SEPARATION AT FIXED TIME PRIOR TO DEORBIT

A280 SEPARATION WEIGHT (IF FIXED DELTA T SEP IS EXECUTED)
A293 CSM REFERENCE AREA (IF FIXED DELTA T SEP IS EXECUTED)
A97 NUMBER OF SECONDS AFTER THE FIXED DELTA T MANEUVER INITIATION THAT PHASE 6 IS TO TERMINATE (SET TO A LARGE NUMBER IF A TERMINATION IS INPUT FOR PHASE 6)

PHASE 7 - SPS SEPARATION AT FIXED TIME PRIOR TO DEORBIT

PHASE 8 - COAST FROM SEPARATION TO DEORBIT

PHASE 9 - RCS ULLAGE PRIOR TO DEORBIT BURN

PHASE 10 - SPS DEORBIT BURN

PHASE 11 - COAST TO 433K FEET

PHASE 12 - COAST TO 300K FEET

PHASE 13 - COAST TO X-G POINT

PHASE 14 - COAST TO 23.3K FEET

PHASE 15 - MAXIMUM LIFT FOOTPRINT EXECUTION

PHASE 16 - MINIMUM LIFT FOOTPRINT EXECUTION

B. ADDITIONAL GEMMV INPUT QUANTITIES FOR IU NAVIGATION UPDATE DATA ARE LISTED BELOW:

PHASE WHERE IU NAVIGATION UPDATE IS DESIRED:

A152 SET TO 1 TO CALL IU NAVIGATION UPDATE AT END OF PHASE OR -1 AT BEGINNING OF PHASE
A153 SET TO GMTLQ -GMTUUGRR (SEC).
A309 LAUNCH AZIMUTH

C. IF P-40 DELTA V'S OR P-30 DELTA V'S AND DELTA V RESIDUALS IN THE RCS CONTROL AXIS ARE TO BE INPUT, SET IN ADDITION THE FOLLOWING INDICES:

PHASE 1 - INITIAL COAST PHASE
ROLL ANGLE AT IGNITION (LVLH)

PHASE 9 - ULLAGE PRIOR TO DEORBIT BURN

A925

A996-8
RESIDUAL DELTA VX, DELTA VY, DELTA VZ
INPUT, RESPECTIVELY

A999-1001
P-40 DELTA VX, DELTA VY, DELTA VZ INPUT,
RESPECTIVELY

A987-9
P-30 DELTA VX, DELTA VY, DELTA VZ INPUT,
RESPECTIVELY

D. IF IT IS DESIRED TO ITERATE ON DELTA V WHILE HOLDING TIME
OF IGNITION FIXED, SET IN ADDITION THE FOLLOWING INDICES.

PHASE 1 - INITIAL COAST PHASE

A1901
SET TO 0 TO CALL SPECIAL ITERATION IN
PIT MODE.

A147
SET TO 6 TO START ITERATIVE LOOP AT
BEGINNING OF SPS DEORBIT PHASE.

A148-9
TARGET INDEX AND VALUE, RESPECTIVELY,
FOR PIT MODE

E. IF IT IS DESIRED TO COMPUTE A REFSMMAT AT SOME TIME
OTHER THAN DEORBIT IGNITION, SET IN ADDITION THE
FOLLOWING INDEX.

PHASE - WHERE REFSMMAT IS DESIRED

A1128
SET TO 1 TO COMPUTE REFSMMAT AT
BEGINNING OF THE PHASE.
2.4.7 FDO ORBIT DIGITALS PROCESSOR. - THIS PROCESSOR WILL BE USED TO DISPLAY, FOR ANY THRESHOLD TIME, THE ORBITAL PARAMETERS CORRESPONDING TO THE THRESHOLD TIME AS WELL AS THE ASSOCIATED APOGEE AND PERIGEE PARAMETERS. THE OUTPUT WILL BE IN THE FORMAT OF THE RTCC FDO ORBIT DIGITALS DISPLAY.
FDO ORBIT DIGITALS PROCESSOR

(SPECIAL FDO ORBIT DIGITALS DECK FILE 4 UNIVAC 1108)

STANDARD GEMMV INPUT QUANTITIES FOR THIS PROCESSOR ARE LISTED BELOW.

PHASE 1 - INITIAL COAST PHASE

INITIALIZATION

A4871-3 VECTOR IDENTIFICATION
A368 REVOLUTION NUMBER
A93-5 LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
A1138-40 VECTOR TIME (HR, MIN, SEC) (G.M.T.)
A240-2 POSITION COORDINATES (ER) (X,Y,Z)
A248-50 VELOCITY COORDINATES (ER/HR) (X,Y,Z)
A280 CURRENT WEIGHT (LB)

ADDITIONAL UPDATES

A150* SET TO 1 ONLY IF THE ORBIT DIGITALS ARE TO BE BASED ON THE PRESENT VECTOR.
A648-9 SET TO THE PROPER TERMINATION INDEX AND VALUE, RESPECTIVELY, IF THE ORBIT DIGITALS ARE NOT TO BE BASED ON THE INPUT VECTOR.

PHASE 2 - COAST TO APOGEE OR PERIGEE

A86* SET TO 1 TO SAVE VECTOR AT BEGINNING OF PHASE FOR FDO ORBIT DIGITALS SUMMARY SHEET.
A648-9* TERMINATION INDEX AND VALUE, RESPECTIVELY (NORMALLY THE INDEX WILL BE 315, FLIGHT-PATH ANGLE AND THE VALUE WILL BE 0.)

PHASE 3 - COAST TO APOGEE OR PERIGEE

PHASE 4 - SHORT DURATION COAST

A648-9* TERMINATION INDEX AND VALUE, RESPECTIVELY (NORMALLY THE INDEX WILL BE 123 PHASE TIME AND THE VALUE WILL BE 10.)
A142* SET TO 1 TO CALL FDO ORBIT DIGITALS SUMMARY SHEET.

PHASE 5 - RUN TERMINATION

A139* SET TO 1 TO TERMINATE RUN.

*THESE A-ARRAYS HAVE ALREADY BEEN SET TO THE CORRECT VALUE IN THE SPECIAL FDO ORBIT DIGITALS ON-LINE DECK.
2.4.8 RELATIVE MOTION PROCESSOR. - THIS PROCESSOR WILL BE USED TO COMPUTE THE RELATIVE MOTION OF TWO VEHICLES AND OUTPUT THE MOTION DIGITALS DISPLAY.
RELATIVE MOTION PROCESSOR
(FILE 4 UNIVAC 1108)

STANDARD GEMMV INPUT QUANTITIES FOR THE RELATIVE MOTION PROCESSOR ARE LISTED BELOW:

PHASE 1 - INITIAL COAST PHASE

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4871-3</td>
<td>VECTOR IDENTIFICATION</td>
</tr>
<tr>
<td>A368</td>
<td>REVOLUTION NUMBER</td>
</tr>
<tr>
<td>A93-5</td>
<td>LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)</td>
</tr>
<tr>
<td>A1138-40</td>
<td>VECTOR TIME (HR, MIN, SEC) (G.M.T.)</td>
</tr>
<tr>
<td>A240-2</td>
<td>POSITION COORDINATES (ER) (X, Y, Z)</td>
</tr>
<tr>
<td>A248-50</td>
<td>VELOCITY COORDINATES (ER/HR) (X, Y, Z)</td>
</tr>
<tr>
<td>A280</td>
<td>CURRENT WEIGHT (LB)</td>
</tr>
<tr>
<td>A293</td>
<td>CROSS SECTIONAL AREA OF THE REFERENCE VEHICLE</td>
</tr>
<tr>
<td>A1018-26</td>
<td>REFSSMAT STORED ROW-WISE</td>
</tr>
</tbody>
</table>

REFERENCE VEHICLE INITIALIZATION

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1368</td>
<td>REVOLUTION NUMBER</td>
</tr>
<tr>
<td>A2138-40</td>
<td>VECTOR TIME (HR, MIN, SEC) (G.M.T.)</td>
</tr>
<tr>
<td>A1240-2</td>
<td>POSITION COORDINATES (ER) (X, Y, Z)</td>
</tr>
<tr>
<td>A1248-50</td>
<td>VELOCITY COORDINATES (ER/HR) (X, Y, Z)</td>
</tr>
<tr>
<td>A1280</td>
<td>CURRENT WEIGHT (LB)</td>
</tr>
<tr>
<td>A1293</td>
<td>CROSS SECTIONAL AREA OF THE RELATIVE VEHICLE</td>
</tr>
</tbody>
</table>

ADDITIONAL UPDATES

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A96</td>
<td>SET TO 1 IF THE RELATIVE VEHICLE VECTOR TIME IS PRIOR TO THE TIME RELATIVE MOTION DATA IS DESIRED.</td>
</tr>
<tr>
<td>A117</td>
<td>SET TO 2 (HIGHEST VEHICLE CAPABILITY BEING USED).</td>
</tr>
<tr>
<td>A114</td>
<td>SET TO 2 (FLAG TO CALL THE WRITE 2 - RELATIVE MOTION SUBROUTINE).</td>
</tr>
<tr>
<td>A111</td>
<td>SET TO 0 TO SPECIFY CONSTANT INTEGRATION STEP SIZE.</td>
</tr>
<tr>
<td>A120</td>
<td>SET TO DESIRED INTEGRATION STEP SIZE IN SECONDS (NORMALY SET TO 1 IN THRUSTING PHASES AND 20 IN COASTING PHASES).</td>
</tr>
<tr>
<td>A4204</td>
<td>SET TO N. (OUTPUT WILL BE EVERY N INTEGRATION STEPS THIS VARIABLE SHOULD BE ADJUSTED WITH A120 TO ACHIEVE SOME SPECIFIED CONSTANT OUTPUT INTERVAL THROUGHOUT THE EXECUTION OF THE PROCESSOR.)</td>
</tr>
</tbody>
</table>
PHASE WHERE RELATIVE MOTION OUTPUT IS NOT DESIRED

A42C4 SET TO 0. (THIS MAY BE RESET TO N IN ANY PHASE WHERE RELATIVE MOTION OUTPUT IS AGAIN DESIRED.)
2.4.9 GROUND TRACK, CMC OR IU NAVIGATION UPDATE, AND PDA DATA CAPABILITIES.—IF IT IS DESIRED TO PRODUCE A GROUND TRACK, A
NAVIGATION UPDATE, OR PDA DATA WITH ANY OF THE GEMMV PROCESSORS
PREVIOUSLY DESCRIBED, THE FOLLOWING ADDITIONAL CN-LINE INPUTS
WILL BE REQUIRED.

A. ADDITIONAL GEMMV INPUT QUANTITIES FOR GROUND TRACK DATA
ARE LISTED BELOW.

PHASES WHERE GROUND TRACK IS TO BEGIN

- A114  SET TO 5 TO CALL WRITE 5 (GROUND TRACK
  SUBROUTINE).
- A111  SET TO 0 TO SPECIFY CONSTANT INTEGRATION.
- A120  SET TO DESIRED INTEGRATION STEP SIZE IN
  SECONDS. (NORMALLY SET TO 20 SECONDS IN
  COASTING PHASES AND TO 1 IN THRUSTING
  PHASES.)
- A4213 SET TO N. (OUTPUT WILL BE EVERY N INTEGRA-
  TION STEPS THIS VARIABLE WILL BE ADJUSTED
  WITH A120 TO ACHIEVE SOME SPECIFIED CON-
  STANT OUTPUT FREQUENCY THROUGHOUT PRO-
  CESSOR EXECUTION.)
- A4201 SET TO 0 TO SUPPRESS WRITE 1 OUTPUT.

PHASES WHERE GROUND TRACK IS NOT DESIRED

- A4213 SET TO 0. (THIS MAY BE RESET TO N IN ANY
  PHASE WHERE GROUND TRACK IS AGAIN DE-
  Sired.)
- A4201 SET TO 100000 TO ACTIVATE WRITE 1.

B. ADDITIONAL GEMMV INPUT QUANTITY FOR CMC NAVIGATION UPDATE
DATA IS LISTED BELOW.

PHASES WHERE CMC NAVIGATION UPDATE IS DESIRED

- A4279 SET TO 1 TO CALL NAVIGATION UPDATE AT END
  OF A PHASE.

C. ADDITIONAL GEMMV INPUT QUANTITIES FOR IU NAVIGATION UPDATE
DATA ARE LISTED BELOW.

PHASES WHERE IU NAVIGATION UPDATE IS DESIRED

- A152 SET TO 1 TO CALL IU NAVIGATION UPDATE AT
  END OF PHASE OR -1 AT BEGINNING OF PHASE
- A153 SET TO GMTL/0 -GMTIUGRR (SEC).
- A309 LAUNCH AZIMUTH
D. ADDITIONAL GEMMV INPUT QUANTITIES FOR PAO DATA ARE LISTED BELOW: PHASE WHERE PAO DATA IS DESIRED

A154 SET TO 1 TO CALL PAO SUMMARY SHEET AT END OF PHASE.
A158 PAO HEADER (STARTING IN COLUMN 8, SET TO RCD AND SET COLUMN 12 TO AN 8)

BOTH VEHICLES MUST HAVE SAME STOPS IN FIRST PHASE.
3. OPERATING INSTRUCTIONS FOR THE GEMMV POST PROCESSORS

3.1 GENERAL

A GEMMV POST PROCESSOR IS A PROGRAM THAT IS AUTOMATICALLY EXECUTED AFTER THE GEMMV TRAJECTORY PROGRAM HAS GENERATED AND STORED THE NECESSARY INPUT DATA ON A TAPE. THERE ARE PRESENTLY FIVE POST PROCESSORS THE GUIDANCE OPTICAL SIGHTING TABLE (GOST), RADIATION, APOLLO REENTRY SIMULATION (ARS), EXTERNAL DELTA V AND STAR SIGHTING TABLE (SST).

3.2 THE GEMMV POST PROCESSORS

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE GEMMV POST PROCESSORS ALONG WITH A LISTING OF THE CONTROL CARDS AND THE CN-LINE INPUT REQUIRED TO OPERATE EACH PROCESSOR.
3.2.1 GOST PROCESSOR. - THIS PROCESSOR WILL PRIMARILY BE USED TO VERIFY THE CM IMU STABLE MEMBER ALIGNMENT MADE BY USING THE CNROAD OPTICAL SIGHTING EQUIPMENT CONSISTING OF A SCANNING TELESCOPE, A SEXTANT, AND A BORESIGHT. BY USING A CATALOG OF STAR AND EARTH FIXED LANDMARK LOCATIONS, THIS PROCESSOR WILL CALCULATE IMU GIMBAL ANGLES, RFSMMATS, AND THE SHAFT AND TRUINION ANGLES OF THE OPTICAL EQUIPMENT. THE PROCESSOR HAS SEVERAL OPTIONS WHICH MAY BE USED TO DETERMINE THE POSITION OF STARS ON THE INSTRUMENT RETICLES, TO DETERMINE THE NECESSARY SPACECRAFT ATTITUDE FOR VIEWING A GROUND TARGET, TO DETERMINE RFSMMAT, AND TO DETERMINE IMU GIMBAL ANGLES.

ALTHOUGH THE GOST PROCESSOR CAN BE RUN WITH ANY GEMMV PROCESSOR, A SPECIAL DECK HAS BEEN SET UP USING FILE 4 OF THE MISSION DATA TAPE.

THE UNIVAC 1108 DATA PROCESSING SYSTEM CONTROL CARDS ARE LISTED BELOW:

COLUMN 1 4 8
* MSG
  ASG A = XXXX
  ASG B = XXXX
  ASG F = XXXX
  ASG G,N,V
  XQT CUR
    TRW A,B,F,G,N,V
    IN A
  *
  *
  *
  N XQT GEMMV
  *
  *
  FILE
    XQT CUR
      ERS
      IN A
    XQT DGOST
      *
      *
  FILE
    FOF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1
GOST PROCESSOR
(SPECIAL GOST DECK FILE 4 UNIVAC 1108)

A. THE INPUT QUANTITIES FOR THE GEMMV PART OF THE PROCESSOR ARE THE SAME FOR ALL GOST OPTIONS (WITH TWO EXCEPTIONS WHICH ARE INDICATED). THE STANDARD INPUT QUANTITIES ARE LISTED BELOW:

PHASE 1 - COAST

- VECTOR IDENTIFICATION
- REVOLUTION NUMBER
- LIFT-OFF TIME (HR, MIN, SEC) (G.M.T.)
- VECTOR TIME (HR, MIN, SEC) (G.M.T.)
- POSITION COORDINATES (ER) (X, Y, Z)
- VELOCITY COORDINATES (ER/HR) (X, Y, Z)
- CURRENT WEIGHT (LB)
- TIME OF GOST COMPUTATION (HR, MIN, SEC) (G.E.T.
- IMU ROLL, PITCH, YAW GIMBAL ANGLES, RESPECTIVELY (NOT NECESSARY FOR GOST OPTION 4 OR 14 AND 5 OR 15)
- REFSSMAT STORED ROW-WISE (NOT NECESSARY FOR GOST OPTION 1 OR 11)
- SET TO 6 TO OBTAIN CORRECT ATTITUDE OPTION
- SET TO 2 TO WRITE 2CO WORD-RECORD.
- SET TO 2 TO CALL IN GOST PROGRAM FROM PCF TAPE.

*THESE A-ARRAYS HAVE ALREADY BEEN SET TO THE CORRECT VALUE IN THE SPECIAL GOST ON-LINE DECK.

B. THE OPTIONS OF THE GOST PART OF THE PROCESSOR AS WELL AS THE CARD FORMATS ARE LISTED BELOW. OPTION 1 OR 11 REQUIRES TWO INPUT CARDS WHILE OPTION 5 OR 15 REQUIRES FOUR INPUT CARDS. THE REMAINING OPTIONS EACH REQUIRE ONLY ONE CARD. ALL DATA PUNCHED IN COLUMNS 10 THROUGH 70 MUST HAVE DECIMAL POINTS. THE GOST INPUT CARDS ARE PLACED IN THE SPECIAL GOST ON-LINE DECK JUST AFTER THE 'XQT DGOST' CARD.
OPTION 1 OR 11

INPUT
THE IDENTIFICATION OF TWO STARS AND THE
SEXTANT SHAFT AND TRUNNION ANGLES FOR
EACH STAR

COMPUTE
REFSMAT

OPTION 2 OR 12

INPUT
NO INPUTS ARE NEEDED FOR OPTION 2 OR 12.

COMPUTE
THE LOCATION OF TWO STARS WHICH ARE IN
THE SCANNING TELESCOPE FIELD OF VIEW AT
A SPECIFIED SPACECRAFT ATTITUDE AND IMU
ALIGNMENT. THE TWO STARS MUST SATISFY
THE CONDITION THAT ONE STAR LIES ON THE
R-LINE AND THE OTHER STAR LIES AS CLOSE
AS POSSIBLE TO THE R-LINE OF THE
TELESCOPE RECTICLE PATTERN.

OPTION 3 OR 13

INPUT
THE IDENTIFICATION OF TWO STARS
SEXTANT SHAFT AND TRUNNION ANGLES
FOR EACH OF THE INPUT STARS

COMPUTE

OPTION 4 OR 14

INPUT
THE SPACECRAFT LVLH ROLL AND YAW ANGLES
PLUS THE SPACECRAFT PITCH ANGLE TO THE
HORIZON

COMPUTE
GIMBAL ANGLES AND LVLH PITCH ANGLE

OPTION 5 OR 15

INPUT
THIS OPTION IS THE SAME AS OPTION 1 OR
11 EXCEPT THE IMU GIMBAL ANGLES ARE INPUT
IN THE GOST RATHER THAN THE GEMMV
PROGRAM

COMPUTE
REFSMAT
**INPUT FORMAT**

<table>
<thead>
<tr>
<th>OPTION NUMBER</th>
<th>COLUMNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 CR 11</td>
<td>1 - 2</td>
</tr>
<tr>
<td></td>
<td>10 - 25</td>
</tr>
<tr>
<td></td>
<td>30 - 45</td>
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<td></td>
<td>50 - 65</td>
</tr>
<tr>
<td>11</td>
<td>STAR NO. 1</td>
</tr>
<tr>
<td>11</td>
<td>SHAFT NO. 1</td>
</tr>
<tr>
<td>11</td>
<td>TRUNNION NO. 1</td>
</tr>
<tr>
<td>12</td>
<td>STAR NO. 2</td>
</tr>
<tr>
<td>12</td>
<td>SHAFT NO. 2</td>
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<td>13</td>
<td>STAR NO. 2</td>
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<td>14</td>
<td>LVLH ROLL</td>
</tr>
<tr>
<td>15</td>
<td>STAR NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>SHAFT NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>TRUNNION NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>STAR NO. 2</td>
</tr>
<tr>
<td>15</td>
<td>SHAFT NO. 2</td>
</tr>
<tr>
<td>15</td>
<td>TRUNNION NO. 2</td>
</tr>
<tr>
<td>15</td>
<td>ROLL GA NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>PITCH GA NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>YAW GA NO. 1</td>
</tr>
<tr>
<td>15</td>
<td>ROLL GA NO. 2</td>
</tr>
<tr>
<td>15</td>
<td>PITCH GA NO. 2</td>
</tr>
<tr>
<td>15</td>
<td>YAW GA NO. 2</td>
</tr>
</tbody>
</table>

**NORMALLY THESE COLUMNS SHOULD BE BLANK. IF NON-BLANK, COLUMNS 10-25 SHOULD CONTAIN THE ROLL GIMBAL ANGLE, COLUMNS 30-45 SHOULD CONTAIN THE PITCH GIMBAL ANGLE, AND COLUMNS 50-65 SHOULD CONTAIN THE YAW GIMBAL ANGLE. IF ANY OF THESE ANGLES ARE ZERO, THEY MUST BE PUNCHED .00001.**

**NORMALLY A BLANK OR 0. EITHER IS RECOGNIZED BY THE PROGRAM AS A 31.7-DEGREE PITCH BETWEEN THE X-BODY AXIS AND LINE OF SIGHT TO THE HORIZON. OTHERWISE, THE PITCH ANGLE (IF OTHER THAN 31.7 DEG) SHOULD BE INPUT.**
3.2.2 RADIATION PROCESSOR. - THIS PROCESSOR WILL BE USED TO DETERMINE GEOMAGNETIC PARAMETERS AND THE RADIATION DOSE RATES IN THE COMMAND MODULE AT GIVEN INTERVALS ALONG A TRAJECTORY. IT WILL ALSO BE USED TO CALCULATE REM DOSE IN THE COMMAND MODULE OVER A PARTICULAR PORTION OF THE APOLLO 9 MISSION.

THE UNIVAC 1108 DATA PROCESSING SYSTEM CONTROL CARDS ARE LISTED BELOW.

COLUMN 1 4 8
* MSG
  ASG A=XXXX
  ASG B=XXXX
  ASG F=XXXX
  ASG G,H,N,V
  XOT CUR
    TRW A,B,G,N,V,F,H
    IN A
  ...
  ...
  ...
  ...
  N XOT GEMMV
  ...
  ...
  ...
  ...
  FILE
    XOT CUR
    ERS
    IN A
  ...
  N XOT DECK1
  FILE
  ENF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1

COMMENTS
GEMMV PROGRAM (PCF) TAPE NUMBER
MISSION TABLE TAPE NUMBER
MISSION DATA TAPE NUMBER
SCRATCH UNITS ON FASTRAN
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND A,B,G,N,V,F, AND H UNITS.
INPUT THE ENTIRE USER PCF FROM UNIT A

SOURCE LANGUAGE CORRECTIONS

START EXECUTION OF THE GEMMV PROGRAM.

GEMMV DATA CARDS

LAST GEMMV DATA CARD
EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY.
INPUT THE ENTIRE USER PCF FROM UNIT A
START EXECUTION OF RADIATION PROCESSOR.
LAST RADIATION DATA CARD
END OF FILE CARD
RADIATION PROCESSOR

(ALL GEMMV FILES UNIVAC 1108)

ADDITIONAL GEMMV INPUT QUANTITIES FOR THE RADIATION PROCESSOR ARE LISTED BELOW.

PHASE WHERE FIRST RADIATION OUTPUT IS DESIRED:

A114  SET TO 3 TO CALL WRITE 3 (RADIATION EPHEMERIS) SUBROUTINE.
A80   SET TO 3 TO CALL RADIATION PROCESSOR FROM PCF TAPE.
A111  SET TO 0 TO SPECIFY CONSTANT INTEGRATION INTERVAL.
A120  SET TO DESIRED INTEGRATION STEP SIZE (SEC).
A42C7 SET TO N (OUTPUT WILL BE EVERY N INTEGRATION STEPS).

PHASE WHERE LAST RADIATION OUTPUT IS DESIRED:

A42C7 SET TO 0.
3.2.3 ARS PROCESSOR. - THE APOLLO REENTRY SIMULATION PROCESSOR WILL BE USED TO ACCEPT A STATE VECTOR AT 425,000 FEET AND COMPUTE THE NECESSARY GUIDED ENTRY PROFILE TO HIT A TARGET LATITUDE AND LONGITUDE. THE STATE VECTOR IS GENERATED BY ONE OF THE GEMMV DEORBIT PROCESSORS AND IS WRITTEN INTO A 200-WORD RECORD WHICH INTERFACES WITH THE ARS PROCESSOR. OPTIONS EXIST WITHIN THE PROCESSOR TO USE ONE OF SIX DIFFERENT ENTRY MODES WHICH ARE DESCRIBED BELOW.

MODE 1 - AUTOMATIC GUIDANCE AND NAVIGATION CONTROL.

IN THIS STEERING MODE, THE ARS PROCESSOR USES THE CMC ENTRY LOGIC TO COMPUTE THE ENTRY STEERING COMMANDS AND TO SIMULATE THE ENTRY TRAJECTORY REQUIRED TO ACHIEVE THE TARGET LANDING POINT.

MODE 2 - OPEN LOOP FOLLOWED BY GUIDANCE AND NAVIGATION CONTROL.

IN THIS ENTRY MODE, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL, AT WHICH TIME THE CM IS ROLLED TO A SECOND BANK ANGLE, DESIGNATED AS THE BACKUP BANK ANGLE. THIS ATTITUDE IS MAINTAINED UNTIL THE SECOND G-LEVEL IS REACHED. FROM THIS TIME UNTIL DROGUE CHUTE DEPLOYMENT, THE ARS PROCESSOR USES THE GUIDANCE AND NAVIGATION CONTROL LOGIC TO COMPUTE THE STEERING COMMANDS NECESSARY TO ACHIEVE THE TARGET LANDING POINT. THIS STEERING MODE REQUIRES THE INPUT OF AN INITIAL AND BACKUP BANK ANGLE AND TWO G-LEVELS.

MODE 3 - BANK/REVERSE-BANK.

IN THIS ENTRY MODE, WHICH IS USED TO COMPUTE BACKUP GUIDANCE QUANTITIES, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL, IT IS THEN FOLLOWED BY A BACKUP BANK ANGLE TO A COMPUTED TIME TO REVERSE BANK, AND THE REVERSE BANK ANGLE IS FLOWN TO DROGUE CHUTE DEPLOYMENT. IN THIS STEERING MODE, THE INITIAL BANK ANGLE AND G-LEVEL ARE INPUT, AND THE BACKUP BANK ANGLE AND TIME TO REVERSE BANK ARE COMPUTED BY THE ARS PROCESSOR.

MODE 4 - COMBINED BANK/REVERSE-BANK AND GUIDANCE AND NAVIGATION CONTROL.

THIS ENTRY MODE IS THE SAME AS THAT DESCRIBED IS THE SECOND STEERING MODE WITH THE EXCEPTION THAT THE PROCESSOR COMPUTES THE BACKUP BANK ANGLE. THE INPUTS CONSIST OF THE INITIAL BANK ANGLE AND THE TWO G-LEVELS.

MODE 5 - ROLLING.

IN THIS ENTRY, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL FOLLOWED BY A CONSTANT ROLL RATE TO DROGUE CHUTE DEPLOYMENT. THIS MODE REQUIRES THE INPUT OF THE INITIAL BANK ANGLE, G-LEVEL, AND ROLL RATE.
MODE 6 - OPEN LOOP

This entry can either be a bank/reverse-bank as described in the third steering mode or a constant bank-angle entry from 400,000 feet to drogue chute deployment. The bank/reverse-bank option of this steering mode requires the input of the initial and backup bank angles, the g-level, and the time to reverse bank. A constant bank angle entry can be specified by inputting the value of the bank angle to be used as the initial bank angle and inputting the g-level and time to reverse bank as large values.
THE UNIVAC 1108 DATA PROCESSING SYSTEM CONTROL CARDS ARE LISTED BELOW.

COLUMN 1 4 8

MSG
ASG A=XXXX
ASG B=XXXX
ASG F=XXXX
ASG G,N,V,K
XQT CUR

CCMMENTS

GEMMV PROGRAM (PCF) TAPE NUMBER
MISSIGN TABLE TAPE NUMBER
MISSIGN DATA TAPE NUMBER
SCRATCH UNITS ON FASTRAND
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND A,B,G,N,V, AND F K UNITS
INPUT THE ENTIRE USER PCF FROM UNIT A

SOURCE LANGUAGE CORRECTICNS
(PATCHES)

N XQT GEMMV

START EXECUTION OF THE GEMMV PROGRAM.

GEMMV DATA CARDS

FILE
XQT CUR

LAST GEMMV DATA CARD
EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY.
INPUT THE ENTIRE USER PCF FROM UNIT A

EXECUTE ARS PROGRAM (SCS FCR BACKUP MODES AND DAP FOR G AND N ENTRIES

N XQT COLSUS/XXX

ENDARS

LAST ARS INPUT CARD
EOF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1

3-10
ARS PROCESSOR

(FILES 1, 2, AND 8 UNIVAC 1108)

ADDITIONAL GEMMV INPUT QUANTITIES FOR THE ARS PROCESSOR ARE LISTED BELOW:

PHASE 1

A83
A2918

SET TO 1 TO CALL ARS PROCESSOR.
SET TO 1 FOR AUTOMATIC GUIDANCE AND NAVIGATION ENTRY MODE.
SET TO 2 FOR OPEN LOOP GUIDANCE AND NAVIGATION ENTRY MODE.
SET TO 3 FOR BANK/REVERSE-BANK ENTRY MODE.
SET TO 4 FOR COMBINED BLANK/REVERSE-BANK AND GUIDANCE AND NAVIGATION ENTRY MODE.
SET TO 5 FOR ROLLING ENTRY MODE.
SET TO 6 FOR OPEN LOOP CONSTANT BANK ANGLE OR BANK REVERSE ENTRY MODE.

A2914
G-LEVEL TO INITIATE BACKUP GUIDANCE MODE
(SET WHEN A2918 EQUALS A 2 OR 4.)

A2915
TIME TO REVERSE BANK IN TOTAL SECONDS
(G.T.E.)
(SET WHEN A2918 EQUALS 6.)

A1929
DIRECTION TO BEGIN BANK
=0 SOUTH THEN NORTH
=1 NORTH THEN SOUTH

COAST TO 400K PHASE

A79
SET TO 2 TO WRITE 2CC-WORD RECORD AT END OF PHASE.

A649
SET TO 425,000 CC. (TERMINATE ON AN ALTITUDE OF 425,000 FT)
3.2.4 EXTERNAL DELTA V AND REFSMMAT UPDATE PROCESSOR - THIS PROCESSOR WILL BE USED TO CONVERT THE REFSMMAT AND EXTERNAL DELTA V QUANTITIES CALCULATED BY THE GEMMV PROGRAM TO THE CMC UPLINK FORMAT.

THE UNIVAC 1108 DATA PROCESSING SYSTEM CONTROL CARDS ARE LISTED BELOW:

COLUMN 1 4 8

MSG

ASG A = XXXX
ASG B = XXXX
ASG F = XXXX
ASG G,N,V

XQT CUR

TRW A,B,F,G,N,V

IN A

* *

N XQT GEMMV

* *

FILE

XQT CUR

ERS

IN A

N XQT DSKYUP

FILE

EOF

CCMENTS

GEMMV PROGRAM (PCF) TAPE NUMBER
MISSION TABLE TAPE NUMBER
MISSION DATA TAPE NUMBER
SCRATCH UNITS ON FAST-RAND.
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND UNITS A,B,F,G,N, AND V.
INPUT THE ENTIRE USER PCF FROM UNIT A

SOURCE LANGUAGE CORRECTIONS (PATCHES)

EXECUTE GEMMV PROGRAM.

GEMMV UPDATES

LAST GEMMV DATA CARD
EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY.
INPUT THE ENTIRE USER PCF FROM UNIT A
EXECUTE DSKYUP PROGRAM.
LAST DSKYUP DATA CARD
END OF FILE CARD

*INDICATES 7/8 OVERPUNCH IN COLUMN 1
EXTERNAL DELTA V AND REFSMMAT UPDATE PROCESSOR

(ALL GEMMV FILES UNIVAC 1108)

ADDITIONAL GEMMV INPUT QUANTITIES FOR THE EXTERNAL DELTA V
AND REFSMMAT UPDATE PROCESSOR:

PHASE WHERE EXTERNAL DELTA V OR REFSMMAT UPDATE OUTPUT IS
DESIRED:

A80
A79

SET TO 6 TO CALL THE EXTERNAL DELTA V
AND REFSMMAT UPDATE PROCESSOR.
SET TO 2 TO WRITE THE 200 WORD-RECORD
FOR DEORBIT.
SET TO 5 TO WRITE THE 200 WORD-RECORD
FOR ORBIT.
4. OPERATING INSTRUCTIONS FOR THE WORK SCHEDULE PROCESSOR

4.1 GENERAL


4.2 PROGRAM DESCRIPTION

THE WORK SCHEDULE PROCESSOR IS DIVIDED INTO THREE SEPARATE MODULES. MODULE I (ANY GEMV PROCESSOR) IS USED TO GENERATE AN EPHEMERIS TAPE WHICH BECOMES THE INPUT TO THE NEXT MODULE. THE EPHEMERIS TAPE CONTAINS ALL THE PERTINENT ORBIT AND MANEUVER DATA OVER A SPECIFIED TIME INTERVAL. MODULE II ACCEPTS THE EPHEMERIS TAPE AND GENERATES THAT EPHEMERIS AND TRACKING DATA REQUESTED AND OUTPUTS THEM ON THE APPROPRIATE SUMMARY SHEETS. THE DATA WHICH CAN BE OBTAINED FROM MODULE II INCLUDES THE FOLLOWING: SPACECRAFT DAYLIGHT-DARKNESS, SPACECRAFT MOON SIGHTING, COMPUTED EVENTS, LANDMARK SIGHTING, SPACECRAFT STAR SIGHTING, CLOSEST APPROACH, AND POINTING DATA. THESE DATA ARE ALSO SAVED ON AN INTERFACE TAPE WHICH SERVES AS THE INPUT TO MODULE III. THE PROCESSOR MAY BE TERMINATED AT THIS POINT IF ONLY THE EPHEMERIS AND TRACKING DATA ARE DESIRED. THE PROCESSOR OUTPUT THEN CONSISTS OF THE EPHEMERIS AND TRACKING DATA SUMMARY SHEETS.

THE EXECUTION OF MODULE III IS PERFORMED WHEN THE WORK SCHEDULE IS DESIRED. IT Sorts THE INFORMATION CONTAINED ON THE INTERFACE TAPE AND INPUT EVENT CARDS AND GENERATES A PLOT TAPE WHICH IS DELIVERED TO THE DDO0 WHERE A FILM OF THE WORK SCHEDULE IS PRODUCED. HARD COPIES OF THE FILM ARE MADE AFTER FILM IS RETURNED TO BUILDING 45.
### 4.3 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>GEMMV PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>B</td>
<td>MISSION TABLE TAPE</td>
</tr>
<tr>
<td>F</td>
<td>MISSION DATA TAPE</td>
</tr>
<tr>
<td>I</td>
<td>EPHEMERIS TAPE (SYSTEM)</td>
</tr>
<tr>
<td>S</td>
<td>PLOT PACKAGE (SYSTEM)</td>
</tr>
<tr>
<td>T</td>
<td>SORT PACKAGE (SYSTEM)</td>
</tr>
<tr>
<td>Q</td>
<td>EPHEMERIS TAPE GENERATED BY MODULE I</td>
</tr>
<tr>
<td>R</td>
<td>DATA TAPE GENERATED BY MODULE II</td>
</tr>
<tr>
<td>J</td>
<td>SORTED TAPE FOR USE BY MODULE III</td>
</tr>
<tr>
<td>G</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>N</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>K</td>
<td>SCRATCH TAPE</td>
</tr>
</tbody>
</table>
4.4 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

4.4.1 MODULE I

COLUMN 1  4  8

MSG
ASG A = XXXX
ASG B = XXXX
ASG F = XXXX
ASG I = $EPHEM
ASG S = $PLOTS
ASG T = $SORT
ASG Q
ASG R
ASG J = SAVE
ASG G,N,K
XOUT CUR

TRW A,B,F,G,J,N,Q,R,I,S,T,K
IN A
N XOUT GEMMV

FILE

4.4.2 MODULE II

COLUMN 1  4  8
XOUT CUR
ERS
IN A
XOUT MAIN

FILE 5
4.4.3 MODULE III

COLUMN 1  4  8
XQT CUR
ERS
IN A
IN S
IN T
XQT MAIN 3
.
.
.
.
FILE
EOF

EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY
INPUT THE ENTIRE USER PCF FROM UNIT A
INPUT THE ENTIRE USER PCF FROM UNIT S
INPUT THE ENTIRE USER PCF FROM UNIT T
EXECUTE MODULE III

MODULE III DATA CARDS

END OF MODULE III INPUT
END OF FILE CARD
4.5 INPUTS TO THE WORK SCHEDULE PROCESSOR

4.5.1 INPUTS TO MODULE I. - THE FOLLOWING INPUTS ARE IN ADDITION TO ANY OF THE STANDARD GEMMV INPUT QUANTITIES AS DESCRIBED IN SECTION 2.

PHASE 1

A80  SET TO 4 TO CALL MODULE II AFTER GEMMV TERMINATION
A114 SET TO 4 TO CALL WRITE 4 SUBROUTINE (USED TO GENERATE THE TAPES FOR MODULE II)
A102 SET TO 20 (OUTPUT UNIT FOR WRITE 4).
A111 SET TO 0 TO SPECIFY CONSTANT INTEGRATION.
A120 SET TO DESIRED INTEGRATION INTERVAL (SEC).
A138 SET TO DAY OF YEAR OF LIFT-OFF.

PHASE WHERE WORK SCHEDULE OUTPUT IS DESIRED

A4210 SET TO N (OUTPUT WILL BE EVERY N INTEGRATION STEPS) A4210 IS USUALLY ADJUSTED SO THAT WRITE 4 WILL OUTPUT APPROXIMATELY EVERY 20 SECONDS OF ORBIT PROPAGATION TIME E.G., IF A120 IS SET TO 10 SEC, THEN A4210 WOULD BE SET TO 2.

PHASE AFTER LAST WORK SCHEDULE OUTPUT IS DESIRED

A648-9 TERMINATION INDEX AND VALUE, RESPECTIVELY (NORMALLY THE INDEX SHOULD BE A123 PHASE TIME, AND THE VALUE SHOULD BE 10 SEC)
A102 SET TO -20 (WRITES AN ECF ON TAPE UNIT 20)

THE LAST PHASE IN THE DECK SHOULD HAVE A139 SET TO 1 TO TERMINATE THE RUN.

4.5.2 INPUTS TO MODULE II

CARD 1 - THIS CARD IS USED TO SPECIFY THE TYPES OF DATA TO BE PROCESSED (I3).

COLUMNS
2-4 NUMBER OF RADAR STATIONS TO BE PROCESSED (PRESENTLY 27)
6-8 NUMBER OF LANDMARKS TO BE PROCESSED (TYPE I CARDS)
10-12 NUMBER OF STARS TO BE PROCESSED (TYPE II CARDS)
14-16 NUMBER OF POINTING TARGETS TO BE PROCESSED (TYPE III CARDS)
18-20 NUMBER OF CLOSEST APPROACH TARGETS (TYPE IV CARDS)
22-24 FLAG FOR DAYLIGHT-DARKNESS COMPUTATION
   (IF = 0, DO NOT COMPUTE, IF GREATER THAN 0, COMPUTE)
26-28 FLAG FOR MOON SIGHTING COMPUTATION
   (IF = 0, DO NOT COMPUTE, IF GREATER THAN 0, COMPUTE)
30-32 FLAG TO COMPUTE EVENTS (APOGEE, PERIGEE, ASCENDING MODE, REVOLUTION NUMBER, ETC.)
   (IF = 0, EVENTS WILL NOT BE COMPUTED, IF GREATER THAN 0, THEY WILL BE COMPUTED)
34-36 NUMBER OF ACTIVE VEHICLES IN THE GEMMV RUN
38-40 MINIMUM ELEVATION ANGLE FOR RADAR STATIONS (0-90 DEGREES)
42-44 ANGLE FOR LANDMARK SIGHTINGS (0-90 DEGREES)
46-48 FLAG TO PRINT ALTITUDE AS A COMPUTED EVENT. THE NUMBER INPUT IN THIS FIELD
   IS THE T IN MINUTES AT WHICH ALTITUDE WILL BE PRINTED (I.E., A 15 WILL REQUEST
   ALTITUDE TO BE PRINTED EVERY 15 MINUTES OVER THE INTERVAL SPECIFIED IN THE
   FOLLOWING SIX FIELDS)
50-52 HR (G.E.T.)
54-56 MIN (G.E.T.) START ALTITUDE PRINT
   (IF 46-48 GREATER THAN 0)
58-60 SEC (G.E.T.)
62-64 HR (G.E.T.)
66-68 MIN (G.E.T.) STOP ALTITUDE PRINT
   (IF 46-48 GREATER THAN 0)
70-72 SEC (G.E.T.)

CARD 2 - IF COLUMNS 2-64 OF THIS CARD ARE BLANK, THE ENTIRE TRAJECTORY GENERATED WILL BE PROCESSED. OTHERWISE COLUMNS 2-16 SPECIFY START TIME FOR VEHICLE 1, COLUMNS 18-32 SPECIFY STOP TIME FOR VEHICLE 1. LIKewise, COLUMNS 34-48 AND 50-64 SPECIFY START AND STOP TIMES FOR VEHICLE 2.

COLUMNS
2-4 DAY (I3) START TIME
6-8 HR (I3) VEHICLE 1 (G.E.T.)
10-12 MIN (I3)
14-16 SEC (I3)
18-20 DAY (I3)
22-24 HR (I3) STOP TIME
26-28 MIN (I3) VEHICLE 1 (G.E.T.)
30-32 SEC (I3)
34-36 DAY (I3)
38-40 HR (I3) START TIME
42-44 MIN (I3) VEHICLE 2 (G.E.T.)
46-48 SEC (I3)
50-52 DAY (I3)
54-56 HR (I3) STOP TIME
58-60 MIN (I3) VEHICLE 2 (G.E.T.)
62-64 SEC (I3)
66-75 MINIMUM ECCENTRICITY FOR WHICH APOGEE AND PERIGEE WILL BE PRINTED (E10)

DATA CARDS - IF USED, THESE CARDS MUST FOLLOW CARD 2.

TYPE I CARDS - THESE CARDS ARE USED ONLY IF LANDMARK DATA ARE TO BE PROCESSED. ANY NUMBER OF CARDS MAY BE INPUT, BUT THEY MUST BE INPUT IN ASCENDING ORDER (I3).

COLUMNS
2-4 I.D. NUMBER OF LANDMARK 1
6-8 I.D. NUMBER OF LANDMARK 2
10-12 I.D. NUMBER OF LANDMARK 3

TYPE II CARDS - THESE CARDS ARE USED ONLY IF STAR DATA ARE TO BE PROCESSED. ANY NUMBER OF CARDS MAY BE USED, BUT THEY MUST BE INPUT IN ASCENDING ORDER (I3).

COLUMNS
2-4 I.D. NUMBER OF STAR 1
6-8 I.D. NUMBER OF STAR 2
10-12 I.D. NUMBER OF STAR 3

TYPE III CARDS - THESE CARDS ARE USED ONLY IF POINTING DATA ARE TO BE PROCESSED. EACH TARGET MUST BE SPECIFIED ON A SEPARATE CARD. UP TO 5 POINTING TARGET CARDS MAY BE PROCESSED.

COLUMNS
1-12 I.D. OF POINTING TARGET (A12)
14-23 LATITUDE OF TARGET (DEG)(E10)
25-34 LONGITUDE OF TARGET (DEG)(E10)
36-44 ALTITUDE OF TARGET (FT)(E8)
45-48 ELEVATION ANGLE DESIRED (DEG)(E4)
50-51 FLAG FOR THE TYPE OF RANGE (A2) SET TO S- FOR SLANT RANGE (USED FOR WSRR TEST) LEAVE BLANK FOR GROUND RANGE

TYPE IV CARDS - THESE CARDS ARE USED ONLY IF 'CLOSEST APPROACH TARGET' DATA ARE TO BE PROCESSED. EACH TARGET MUST BE SPECIFIED ON A SEPARATE CARD. UP TO FIVE TARGET CARDS MAY BE PROCESSED.
### COLUMN S

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-12</td>
<td>I.D. of Target (A12)</td>
</tr>
<tr>
<td>15-23</td>
<td>Latitude of Target (DEG)(E9)</td>
</tr>
<tr>
<td>25-34</td>
<td>Longitude of Target (DEG)(E10)</td>
</tr>
<tr>
<td>40-49</td>
<td>Altitude of Target (FT)(E10)</td>
</tr>
</tbody>
</table>

### 4.5.3 Inputs to Module III

**Card 1** - This card determines if the plot tape from Module II is to be sorted.

**Columns**

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>Sort = Sort Module II tape.</td>
</tr>
</tbody>
</table>

**Card 2** - This card determines the column arrangement, time scales desired, mission name, and current date. Each column on the card corresponds to the same numbered columns of the plot. To delete an option from the plot, punch an R in the respective column.

**Columns**

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set to 0 for GET (I1).</td>
</tr>
<tr>
<td></td>
<td>Set to 1 for RET (I1).</td>
</tr>
<tr>
<td></td>
<td>Set to 2 for GMT (I1).</td>
</tr>
<tr>
<td></td>
<td>Set to 3 for EST (I1).</td>
</tr>
<tr>
<td>2</td>
<td>Same input as column 1 (I1)</td>
</tr>
<tr>
<td>3</td>
<td>Same input as column 1 (I1)</td>
</tr>
<tr>
<td>4</td>
<td>Set to 4 to specify radar output (I1)</td>
</tr>
<tr>
<td>5</td>
<td>Set to 5 to specify sunrise/sunset in column 5 (I1)</td>
</tr>
<tr>
<td>6</td>
<td>Set to 6 to specify moonrise/moonset in column 6 (I1)</td>
</tr>
<tr>
<td>7</td>
<td>Set to 7 to specify computed events in column 7 (I1)</td>
</tr>
<tr>
<td>10</td>
<td>Desired time scale (I1)</td>
</tr>
<tr>
<td></td>
<td>1 = 2 hours</td>
</tr>
<tr>
<td></td>
<td>2 = 15 minutes</td>
</tr>
<tr>
<td></td>
<td>3 = 1 hour</td>
</tr>
<tr>
<td></td>
<td>4 = 30 minutes</td>
</tr>
<tr>
<td></td>
<td>5 = 42 minutes</td>
</tr>
<tr>
<td>12-30</td>
<td>Mission name (A18)</td>
</tr>
<tr>
<td>33-44</td>
<td>Current date (A12)</td>
</tr>
</tbody>
</table>

**Card 3** - This card determines the vehicle, time range, and vehicle name of the plot.

**Columns**

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Number of vehicle (1 or 2) to be plotted (I2)</td>
</tr>
<tr>
<td>5-6</td>
<td>Day (I2)</td>
</tr>
<tr>
<td>8-9</td>
<td>HR (I2) START time of plot. If zeroes</td>
</tr>
<tr>
<td>11-12</td>
<td>MIN (I2) are input; Plot starts at</td>
</tr>
</tbody>
</table>
14-15 SEC (I2) BEGINNING OF TAPE (G.E.T.)
17-18 DAY (I2)
20-21 HR (I2) STOP TIME OF PLOT. IF ZEROES
23-24 MIN (I2) ARE INPUT, PLOT STOPS AT END
26-27 SEC (I2) OF TAPE (G.E.T.)
33-38 VEHICLE NAME (A6)

CARD 4 - THESE CARDS ARE USED TO INPUT EVENTS AT THE TIME
THEY OCCUR. USE ONE CARD PER EVENT, AND AS MANY
CARDS AS ARE NECESSARY.

COLUMNS
1-2 SET TO 11 TO INDICATE INPUT EVENT CARD
5-6 DAY (I2)
7-9 HR (I3) TIME OF INPUT EVENT IN G.E.T.
11-12 MIN (I2)
14-15 SEC (I2)
21-80 INPUT STATEMENT (A42)

IF ANOTHER VEHICLE IS DESIRED OR IF ANOTHER TIME RANGE
IS DESIRED FOR THE SAME VEHICLE, INPUT A CARD (2 IN
COLUMN 2) TO CALL THE SECOND VEHICLE OR A SECOND CASE,
THEN ANOTHER CARD 3 IS INPUT WITH THE SAME FORMAT AS
DESCRIBED ABOVE. FOLLOWING THIS CARD WILL BE THE INPUT
EVENTS ASSOCIATED WITH THIS VEHICLE OR TIME RANGE.

IF ANOTHER COLUMN ARRANGEMENT OR ANOTHER TIME SCALE IS
DESIRED, THE FOLLOWING CARD IS INPUT

CARD 5

COLUMNS
1-2 SET TO 3 TO INDICATE THAT A CARD 2 IS TO
BE READ NEXT (I2).

FOLLOWING THIS CARD, ANOTHER CARD 2 IS INPUT ALONG WITH
THE CARDS 3 AND 4 ASSOCIATED WITH IT.

CARD 6

COLUMNS
2 SET TO 6 TO INDICATE END OF RUN. MUST
ALWAYS BE THE LAST CARD IN MODULE III
(I1).
4.6 Inputs for the Predicted Site Acquisition Table (PSAT) Option

In order to generate PSAT data, modules I and II only are used. Module I input is identical to that described in Section 4.4.1, and module II is identical to the inputs described in Section 4.4.2, except for the following:

Card 1

Columns

2-4  Set to 27 if all 27 stations are to be processed (I3).
34-36  1 or 2 depending on the number of vehicles which are to be processed (I3)
38-40  Minimum elevation angle (I3)

Card 2

Columns

1-64  Blank if the entire trajectory is to be processed for PSAT.

If portions of the generated trajectory are to be processed, set the following:

2-4  Day (I3)
6-8  HR (I3) Start time
10-12  Min (I3) Vehicle 1 (G.E.T.)
14-16  SEC (I3)
18-20  Day (I3)
22-24  HR (I3) Stop time
26-28  Min (I3) Vehicle 1 (G.E.T.)
30-32  SEC (I3)
34-36  Day (I3)
38-40  HR (I3) Start time
42-44  Min (I3) Vehicle 2 (G.E.T.)
46-48  SEC (I3)
50-52  Day (I3)
54-56  HR (I3) Stop time
58-60  Min (I3) Vehicle 2 (G.E.T.)
62-64  SEC (I3)
66-75  Minimum eccentricity for which apogee and perigee will be printed (E10)

Replace the file 5 card in module II with a file card followed by an EOF card.
5. OPERATING INSTRUCTIONS FOR THE RTACF MONITOR SYSTEM PROCESSORS

5.1 GENERAL

THIS SECTION PRESENTS THE ON-LINE INPUTS REQUIRED FOR EXECUTING THE APOLLO 9 MONITOR SYSTEM PROCESSORS. A BRIEF DISCUSSION OF THE PURPOSE OF EACH PROCESSOR AND THE TAPE SETUPS AND CONTROL CARD LISTINGS REQUIRED TO OPERATE THIS GROUP OF PROCESSORS ON IBM 7094 AND UNIVAC 1108 DATA SYSTEMS.

5.2 TAPE SETUP FOR THE IBM 7094 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>MONITOR SYSTEM DATA TAPE</td>
</tr>
<tr>
<td>A3</td>
<td>OFF-LINE OUTPUT (PCF) TAPE</td>
</tr>
<tr>
<td>B1</td>
<td>MONITOR SYSTEM PROGRAM TAPE</td>
</tr>
<tr>
<td>B5</td>
<td>ARSS DATA TAPE</td>
</tr>
<tr>
<td>A5</td>
<td>UPDATE ARSS DATA TAPE</td>
</tr>
</tbody>
</table>

5.3 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>MONITOR PROGRAM TAPE</td>
</tr>
<tr>
<td>B</td>
<td>MISSION DATA TAPE</td>
</tr>
</tbody>
</table>

5.4 CONTROL CARD LISTING FOR THE IBM 7094 DATA PROCESSING SYSTEM

THERE ARE NO CONTROL CARDS REQUIRED TO EXECUTE MONITOR SYSTEM PROCESSORS ON THE IBM 7094 DATA PROCESSING SYSTEM.
5.5 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8
MSG
ASG A = XXXX
ASG B = XXXX
XQT CUR

TRW A,B
IN A

N XQT OLPROC

_EOF

COMMENTS
PROGRAM (PCF) TAPE NUMBER
MISSION MONITOR DATA TAPE
EXECUTE THE FOLLOWING
INSTRUCTIONS
REWIND UNITS A AND B
INPUT THE ENTIRE USER PCF
FROM UNIT A
EXECUTE THE MISSION MONITOR
(PROC) PROGRAM
MISSION MONITOR DATA CARDS
END OF FILE CARD
5.6 Inputs to the Monitor System Processors

This section presents the inputs required to operate the Apollo 9 mission monitor system processors along with brief description of each processor. Except for the first processor which uses some gemmV type inputs, all the inputs have field specifications indicated in parentheses after the card, if all the fields are the same, or after the variable specifications are not in strict accordance with the processor's FORTRAN format statement, a brief explanation is given.

A field specification consists of the following

- A letter (I, E, O, A) to designate the kind of input the processor will expect.
- A number to designate the maximum number of columns allowed for each input.

The letter I specifies integer input, right justified, and no decimal point. The letter E specifies decimal input, left justified, and a decimal point. The letter O specifies octal input, left justified, and no decimal point. The letter A specifies letters, digits, punctuation, and blank input, left justified.
5.6.1 CHECKOUT MONITOR PROCESSOR. - THIS PROCESSOR WILL BE USED TO GENERATE THE RTCC CHECKOUT MONITOR DISPLAY, USING EITHER A S-IVB TELEMETRY, A CSM TELEMETRY, OR A RTCC TRACKING VECTOR. IT WILL ALSO BE USED TO STORE THESE VECTORS IN THE PROPER INPUT FORMAT FOR THE APOLLO REAL-TIME RENDEZVOUS SUPPORT AND GEMMV PROGRAMS.
CHECKOUT MCNITOR PROCESSOR
(IBM 794 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1

FILE NUMBER

COLUMNS

1-2

01

CARD 2

INPUT IS THE SAME FORMAT AS THE GEMMV
PROGRAM AND THE CARDS MAY BE IN ANY ORDER.

A124 GREENWICH HOUR ANGLE
A4871-3 VECTOR IDENTIFICATION
A368 REVELATION NUMBER
A93-5 LIFT-OFF TIME (HR, MIN, SEC) (GMT)
A1138-40 VECTOR TIME (HR, MIN, SEC) (GMT)
A240-2 POSITION COORDINATES (FT, KM, OR ER)
   (X, Y, Z)
A248-50 VELOCITY COORDINATES (FT/SEC, M/SEC, OR
   ER/HR) (X, Y, Z)
A280 CURRENT WEIGHT (LB)
A309 LAUNCH AZIMUTH
A211 SET TO 0 TO INPUT A GREENWICH ECI VECTOR.
   SET TO 1 TO INPUT A BESSELIAN ECI VECTOR.
   SET TO 3 TO INPUT AN IU TELEMETRY VECTOR.
A70-78 POS MATRIX ONLY IF A BESSELIAN VECTOR IS
   INPUT (INPUT THE POS MATRIX ROW-WISE.)
BTEM31 SET TO 0 IF THE INPUT VECTOR UNITS ARE
   KM-M/SEC OR ER-ER/HR.
   SET TO 1 IF THE INPUT VECTOR UNITS ARE
   FT-FT/SEC.
BTEM32 SET TO GMTRUGRR-GMTL/O IN SEC ONLY IF AN
   IU VECTOR IS INPUT.
BTEM33 SET TO 1 TO GENERATE UPDATED ARRS INPUT
   DECK FOR TRACKING.

TRA CARD TERMINATES THE INPUT FOR A CASE.

COLUMNS

8-10

TRA (A3)

12-14

2.4 (A3)

NOTE - ADDITIONAL CASES ARE INPUT BY REPEATING CARDS 2 THROUGH
      THE TRA CARD.
5.6.2 Aerodynamics and Mass Properties Processor — The Aerodynamics and Mass Properties Processor will be used to determine the CM entry aerodynamics as well as the CSM center of gravity location, moments of inertia, product moments of inertia, and engine trim angles at any time during the mission. The processor is composed of four options from which the CSM trim aerodynamics, CSM center of gravity location, mass properties table, and digital autopilot command load can be generated.
AERODYNAMICS AND MASS PROPERTIES PROCESSOR
(IBM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1
FILE NUMBER
COLUMNS
1-2 02

CARD 2
CALCULATION OPTION (I3)
COLUMNS
3 1 GENERATE THE AERODYNAMICS TABLE OF THE
   PRESENT VEHICLE.
2 DETERMINE THE NEW CENTER OF GRAVITY
   LOCATION OF THE VEHICLE AFTER ADDING
   OR SUBTRACTING THE DESIGNATED MODULES.
3 GENERATE THE MASS PROPERTIES TABLE.
4 GENERATE THE DIGITAL AUTOPILOT LOAD.

OPTION 1

CARD 3
PARAMETERS OF PRESENT VEHICLE
COLUMNS
1-7 WEIGHT OF PRESENT VEHICLE (F7.2)
8-14 XCG - X STATION OF CENTER OF GRAVITY
   (F7.2)
15-21 YCG - Y STATION OF CENTER OF GRAVITY
   (F7.2)
22-28 ZCG - Z STATION OF CENTER OF GRAVITY
   (F7.2)
29-40 COMMENTS (2A6)

OPTION 2

CARD 3
NUMBER OF MODULES TO BE INPUT FOR A RUN
   (I3)

CARD 4
PARAMETERS OF THE MODULES
COLUMNS
4-11 WEIGHT OF MODULE PLUS IF IT IS TO BE
   ADDED OR MINUS IF IT IS TO BE SUBTRACTED
   (F8.3)
12-18 XCG - X STATION OF CENTER OF GRAVITY OF
   MODULE (F7.3)
19-24 YCG - Y STATION OF CENTER OF GRAVITY OF MODULE (F6.2)
25-30 ZCG - Z STATION OF CENTER OF GRAVITY OF MODULE (F6.2)

THE FOLLOWING INPUTS ARE NEEDED ON CARD 4 IF NEW SPACECRAFT
MENTS OF INERTIA ARE TO BE CALCULATED

COLUMNS
31-37 IXX - MOMENT OF INERTIA OF THE MODULE
   ABOUT THE X-AXIS (F7.0)
38-44 IXY - MOMENT OF INERTIA OF THE MODULE
   ABOUT THE Y-AXIS (F7.0)
45-51 IZZ - MOMENTS OF INERTIA OF THE MODULE
   ABOUT THE Z-AXIS (F7.0)

THE FOLLOWING INPUTS ARE NEEDED ON CARD 4 IF NEW SPACECRAFT
PRODUCT MOMENTS OF INERTIA ARE TO BE CALCULATED

COLUMNS
52-58 IXY - PRODUCT MOMENT OF INERTIA (F7.2)
59-65 Ixz - PRODUCT MOMENT OF INERTIA (F7.2)
66-72 IYz - PRODUCT MOMENT OF INERTIA (F7.2)

CARD 5
OPTIONS FOR EACH CASE IN THE RUN

COLUMNS
1-3 NUMBER OF MODULES FOR A CASE (I3)
4-6 1 COMPUTE AERODYNAMICS (I3).
    0 DO NOT COMPUTE AERODYNAMICS (I3).
7-9 1 USE ONLY THOSE MODULES SPECIFIED ON
    CARD 6 FOR A CASE (I3).
    0 USE THE FIRST N MODULES FOR A CASE
    WHERE N IS THE NUMBER IN COL. 1-3 AND
    CARD 6 IS NOT INCLUDED FOR THE CASE
    (I3).
11-22 COMMENTS (A12)

CARD 6
MODULES TO BE USED FOR A CASE (I813)

COLUMNS
1-3 EACH NUMBER IN FIELDS 1-3, 4-6, ETC., COR-
4-6 SPONDS TO THE ORDER IN WHICH THE MODULE
   WERE INPUT (E.G., TO USE THE SECOND AND
   FOURTH OF THE INPUT MODULES FOR A CASE
   (COL. 1-3)=002, (COL. 4-6)=004 AND (COL.
   7-76)=BLANK).
74-76 (COL. 7-76)=BLANK).

OPTION 3 AND 4.

CARD 3
OPTION 3 - INPUT SPS MIXTURE RATIO (F7.2)

OPTION 4 - INPUT THRUST LEVEL (LB) (F7.2)

OPTION 3 - CONFIGURATION FLAG
   =1: GENERATE TOTAL MASS PROPERTIES
   =2: GENERATE MASS PROPERTIES FOR SPS BOTTOM, LM TOP, APS TOP
   =3: GENERATE MASS PROPERTIES FOR SPS TOP, LM BOTTOM

OPTION 3 - COMMENTS (2A6)

MODULE 1
COMMAND MODULE

MODULE 2
SERVICE MODULE (SAME FORMAT AS CARD 4)

MODULE 3
RCS QUAD A

MODULE 4
RCS QUAD B (F7.2)

MODULE 5
RCS QUAD C (F7.2)

MODULE 6
RCS QUAD D (F7.2)

MODULE 7
SPS FUEL (F7.2)

MODULE 9
SPS OXID (F7.2)
MODULE 11  PRIMARY H₂ (F7.2)
MODULE 12  SECONDARY H₂ (F7.2)
MODULE 13  PRIMARY O₂ (F7.2)
MODULE 14  SECONDARY O₂ (F7.2)
MODULE 15  POTABLE WATER (F7.2)
MODULE 16  WASTE WATER (F7.2)
MODULE 17-25 THESE ARE OPTION CARDS FOR INPUTTING ADDITIONAL MODULES AND ARE THE SAME FORMAT AS MODULE 3. IT IS ONLY NECESSARY TO INPUT AS MANY CARDS AS THERE ARE ADDITIONAL MODULES.
CONTROL CARD FOLLOWS LAST MISC CARD (F7.2)

COLUMN 1 0.

TO DELETE THE CSM MASS PROPERTIES CALCULATIONS SET THE MIXTURE RATIO OR THRUST (CARD 3) TO ZERO. THE FOLLOWING INPUTS ARE NEEDED IF MASS PROPERTIES FOR THE ASCENT STAGE ARE TO BE CALCULATED.

CARD

COLUMN

1-7 OPTION 3 - APS MIXTURE RATIO (F7.2)
1-7 OPTION 4 - APS MIXTURE RATIO (F7.2)
12-23 OPTION 3 - COMMENT (2A6)
8-14 OPTION 4 - DOCKING ANGLE (F7.2)

MODULE 27 ASCENT STAGE

COLUMN

1-7 WEIGHT OF MODULE (F7.2)
8-14 XCG - X STATION OF CENTER OF GRAVITY OF MODULE (F7.2)
15-21 YCG - Y STATION OF CENTER OF GRAVITY OF MODULE (F7.2)
22-28 ZCG - Z STATION OF CENTER OF GRAVITY OF MODULE (F7.2)
29-35 IXX - MOMENT OF INERTIA OF THE MODULE ABOUT THE X-AXIS (F7.2)
IYY - MOMENT OF INERTIA OF THE MODULE ABOUT THE Y-AXIS (F7.2)
IZZ - MOMENT OF INERTIA OF THE MODULE ABOUT THE Z-AXIS (F7.2)
IXY - PRODUCT MOMENT OF INERTIA (F7.2)
IXZ - PRODUCT MOMENT OF INERTIA (F7.2)
IYZ - PRODUCT MOMENT OF INERTIA (F7.2)

MODULE 28

APSFUEL

MODULE 29

WEIGHT (LB) (F7.2)

MODULE 30

APSOXIDIZER (F7.2)

MODULE 31

RCS FUEL A (F7.2)

MODULE 32

RCS FUEL B (F7.2)

MODULE 33

RCS OXID A (F7.2)

MODULE 34

RCS OXID B (F7.2)

MODULE 35

ASC O2 1 (F7.2)

MODULE 36

ASC O2 2 (F7.2)

MODULE 37

ASC H2O 1 (F7.2)

MODULE 38

ASC H2O 2 (F7.2)

MODULE 39

LM MISC (F7.2)

MODULE 40

LM MISC (F7.2)

MODULE 41

LM MISC (F7.2)

MODULE 42

LM MISC (F7.2)

MODULE 43

LM MISC (F7.2)

MODULE 44

LM MISC (F7.2)

MODULE 45

LM MISC (F7.2)

MODULE 46

LM MISC (F7.2)

CONTROL CARD

FOLLOWS LAST MISC CARD (F7.2)

COLUMN

1  0.
TO DELETE THE ASCENT STAGE MASS PROPERTIES CALCULATIONS SET THE MIXTURE RATIO TO ZERO. THE FOLLOWING INPUTS ARE NEEDED IF MASS PROPERTIES FOR THE DESCENT STAGE ARE TO BE CALCULATED.

**CARD**

**MODULE 48**

**DESCENT STAGE**

**COLUMNS**

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7</td>
<td>WEIGHT OF MODULE (F7.2)</td>
</tr>
<tr>
<td>8-14</td>
<td>XCG - X STATION OF CENTER OF GRAVITY OF MODULE (F7.2)</td>
</tr>
<tr>
<td>15-21</td>
<td>YCG - Y STATION OF CENTER OF GRAVITY OF MODULE (F7.2)</td>
</tr>
<tr>
<td>22-28</td>
<td>ZCG - Z STATION OF CENTER OF GRAVITY OF MODULE (F7.2)</td>
</tr>
<tr>
<td>29-35</td>
<td>IXX - MOMENT OF INERTIA OF THE MODULE ABOUT THE X-AXIS (F7.2)</td>
</tr>
<tr>
<td>36-42</td>
<td>IYY - MOMENT OF INERTIA OF THE MODULE ABOUT THE Y-AXIS (F7.2)</td>
</tr>
<tr>
<td>43-49</td>
<td>IZZ - MOMENT OF INERTIA OF THE MODULE ABOUT THE Z-AXIS (F7.2)</td>
</tr>
<tr>
<td>50-56</td>
<td>IXY - PRODUCT MOMENT OF INERTIA (F7.2)</td>
</tr>
<tr>
<td>57-63</td>
<td>IXZ - PRODUCT MOMENT OF INERTIA (F7.2)</td>
</tr>
<tr>
<td>64-70</td>
<td>IYZ - PRODUCT MOMENT OF INERTIA (F7.2)</td>
</tr>
</tbody>
</table>

**MODULE 49**

**DPS FUEL 1 (F7.2)**

**CONTROL CARD**

**FOLLOWS LAST MISC CARD (F7.2)**

5-14
CONTROL CARD
COLUMN

1  0.

To delete mass properties calculations for the descent stage set the mixture ratio to zero.
5.6.3 COMMAND FORMATTING AND GENERAL CONVERSION PROCESSOR.—

This processor contains ten options in which data in engineering units are converted to octal or data in octal are converted to engineering units. Nine of the options are concerned with up-linked or down-linked CMC quantities and possess fixed formats, scale factors, and octal precisions. The seventh option is for general conversion from engineering units to octal, or vice versa, given the number, scale factors, precision, and multipliers if necessary.
COMMAND FORMATTING AND GENERAL CONVERSION PROCESSOR

(IBM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1

FILE NUMBER

COLUMNS
1-2
03

CARD 2

PROCESSOR AND CONVERSION OPTIONS

COLUMNS
1
1 NAVIGATION UPDATE
2 ORBIT EXTERNAL DELTA V
3 DEORBIT EXTERNAL DELTA V
4 REFSMOMAT
5 RTCC RESTART VECTOR (NUMERIC)
6 RTCC RESTART VECTOR (ALPHANUMERIC)
7 GENERAL CONVERSION

2
0 DECIMAL TO OCTAL CONVERSION (FOR PROCESSOR OPTION 6, THIS IS ALPHANUMERIC TO OCTAL CONVERSION.)
1 OCTAL TO DECIMAL CONVERSION (FOR PROCESSOR OPTION 6, THIS IS OCTAL TO ALPHANUMERIC CONVERSION.)

PROCESSOR OPTION 1, 5, FOR DECIMAL TO OCTAL CONVERSION

CARD 3

COLUMNS
1-20
X POSITION COORDINATE (FT) (E20)

CARD 4

Y POSITION COORDINATE (FT) (E20)

CARD 5

Z POSITION COORDINATE (FT) (E20)

CARD 6

X VELOCITY COORDINATE (FT/SEC) (E20)

CARD 7

Y VELOCITY COORDINATE (FT/SEC) (E20)

CARD 8

Z VELOCITY COORDINATE (FT/SEC) (E20)

CARD 9

VECTOR TIME (G.M.T.)
**PROCESSOR OPTION 1, 5, FOR OCTAL TO DECIMAL CONVERSION, OR**

**PROCESSOR OPTION 6 FOR OCTAL TO ALPHANUMERICS.**

| CARD 3 | COLUMNS 1-10 | X POSITION COORDINATE (KM) (010) |
| CARD 4 | COLUMNS 1-20 | EXTERNAL DELTA VX COMPONENT (FT/SEC) (E20) |
| CARD 5 | COLUMNS 1-10 | IGNITION TIME (SEC) (010) |
| CARD 6 | COLUMNS 1-10 | EXTERNAL DELTA VX COMPONENT (FT/SEC) (E20) |

**PROCESSOR OPTION 2 WITH DECIMAL TO OCTAL CONVERSIONS**

| CARD 3 | COLUMNS 1-10 | Y POSITION COORDINATE (KM) (010) |
| CARD 4 | COLUMNS 1-10 | EXTERNAL DELTA VY COMPONENT (FT/SEC) (E20) |
| CARD 5 | COLUMNS 1-10 | EXTERNAL DELTA VZ COMPONENT (FT/SEC) (E20) |
| CARD 6 | COLUMNS 1-10 | EXTERNAL DELTA VX COMPONENT (M/CS) (010) |
| CARD 7 | COLUMNS 1-10 | EXTERNAL DELTA VY COMPONENT (M/CS) (010) |
| CARD 8 | COLUMNS 1-10 | EXTERNAL DELTA VZ COMPONENT (M/CS) (010) |
| CARD 9 | COLUMNS 1-10 | VECTOR TIME (CS) (01C) |

**PROCESSOR OPTION 3 WITH DECIMAL TO OCTAL CONVERSION**

| CARD 3 | COLUMNS 1-10 | IGNITION TIME (SEC) (010) |
| CARD 4 | COLUMNS 1-10 | EXTERNAL DELTA VX COMPONENT (M/CS) (010) |
| CARD 5 | COLUMNS 1-10 | EXTERNAL DELTA VY COMPONENT (M/CS) (010) |
| CARD 6 | COLUMNS 1-10 | EXTERNAL DELTA VZ COMPONENT (M/CS) (010) |
| CARD 3 | COLUMNS 1-20 | LATITUDE OF IGNITION (DEG) (E20) |
| CARD 4 | LONGITUDE OF IGNITION (DEG) (O10) |
| CARD 5 | IGNITION TIME (G.E.T.) |
| COLUMNS 1-3 | HOURS (I3) |
| 4-5 | MINUTES (I2) |
| 6-10 | SECONDS (E5) |
| CARD 6 | EXTERNAL DELTA VX COMPONENT (FT/SEC)(O10) |
| CARD 7 | EXTERNAL DELTA VY COMPONENT (FT/SEC)(O10) |
| CARD 8 | EXTERNAL DELTA VZ COMPONENT (FT/SEC)(O10) |

PROCESSOR OPTION 3 WITH OCTAL TO DECIMAL CONVERSION

| CARD 3 | COLUMNS 1-10 | LATITUDE OF IGNITION (DEG) 0-360 DEGREES (O10) |
| CARD 4 | LONGITUDE OF IGNITION (DEG) 0-360 DEGREES (O10) |
| CARD 5 | IGNITION TIME (CS) (C10) |
| CARD 6 | EXTERNAL DELTA VX COMPONENT (M/CS) (O10) |
| CARD 7 | EXTERNAL DELTA VY COMPONENT (M/CS) (O10) |
| CARD 8 | EXTERNAL DELTA VZ COMPONENT (M/CS) (O10) |

PROCESSOR OPTION 4 WITH DECIMAL TO OCTAL CONVERSION

| CARD 3 | COLUMNS 1-20 | FIRST ELEMENT OF REFSMMAT (E20) |
| CARDS 4-11 | ELEMENTS OF REFSMMAT INPUT ROW-WISE (E20) |

PROCESSOR OPTION 4 WITH OCTAL TO DECIMAL CONVERSION

| CARD 3 | COLUMNS 1-10 | FIRST ELEMENT OF REFSMMAT (O10) |
**PROCESSOR OPTION 6 WITH ALPHANUMERIC TO OCTAL CONVERSION**

**CARD 4-11** ELEMENTS OF REFSENSMAT INPUT ROW-WISE (O10)

**CARD 3**  
**X POSITION COMPONENT (KM)**

<table>
<thead>
<tr>
<th>COLUMNS</th>
<th>MOST SIGNIFICANT DIGITS (A4)</th>
<th>LEAST SIGNIFICANT DIGITS (A4)</th>
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<tr>
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<td>6-9</td>
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</table>

**CARD 4**  
**Y POSITION COORDINATE (KM) (A4)**

**CARD 5**  
**Z POSITION COORDINATE (KM) (A4)**

**CARD 6**  
**X VELOCITY COORDINATE (M/CS) (A4)**

**CARD 7**  
**Y VELOCITY COORDINATE (M/CS) (A4)**

**CARD 8**  
**Z VELOCITY COORDINATE (M/CS) (A4)**

**CARD 9**  
**VECTOR TIME (CS) (A4)**

**PROCESSOR OPTION 7 WITH DECIMAL TO OCTAL CONVERSION**

**CARD 3**

<table>
<thead>
<tr>
<th>COLUMNS</th>
<th>DECIMAL NUMBER TO BE CONVERTED TO OCTAL (E20)</th>
<th>SCALE FACTOR (I2)</th>
<th>PRECISION (I2)</th>
<th>MULTIPLIER OF THE NUMBER TO BE CONVERTED (E20)</th>
<th>COMMENTS (3A6)</th>
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<td>24-25</td>
<td>SCALE FACTOR (I2)</td>
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<td></td>
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<tr>
<td>29-30</td>
<td>PRECISION (I2)</td>
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<td>31-50</td>
<td>MULTIPLIER OF THE NUMBER TO BE CONVERTED</td>
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<tr>
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<td>(E20)</td>
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<tr>
<td>55-72</td>
<td>COMMENTS (3A6)</td>
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**PROCESSOR OPTION 7 WITH OCTAL TO DECIMAL CONVERSION**

**CARD 3**

<table>
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<th>COLUMNS</th>
<th>OCTAL NUMBER TO BE CONVERTED TO DECIMAL (O15)</th>
<th>SCALE FACTOR (I2)</th>
<th>PRECISION (I2)</th>
<th>DIVISOR OF THE NUMBER TO BE CONVERTED (E20)</th>
<th>COMMENTS (3A6)</th>
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<td>24-25</td>
<td>SCALE FACTOR (I2)</td>
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<tr>
<td>29-30</td>
<td>PRECISION (I2)</td>
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<td></td>
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<tr>
<td>31-50</td>
<td>DIVISOR OF THE NUMBER TO BE CONVERTED</td>
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</tr>
<tr>
<td></td>
<td>(E20)</td>
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<tr>
<td>55-72</td>
<td>COMMENTS (3A6)</td>
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<tr>
<td>55-72</td>
<td>COMMENTS (3A6)</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**PROCESSOR OPTION 9 WITH OCTAL TO DECIMAL CONVERSION**

**CARD 3**

5-20
COLUMNS 1-5 OCTAL NUMBER TO BE CONVERTED (05)
CARDS 4-N OCTAL NUMBER TO BE CONVERTED (05)
CARDS N+1 1-5 99999

NOTE: PROGRAM CANNOT BE RECYCLED AFTER EXECUTING OPTION 9

PROCESSOR OPTION 10 WITH DECIMAL TO OCTAL CONVERSION

CARD 3

COLUMNS 1-20 PITCH TRIM ANGLE (DEG) (E20)
CARD 4 YAW TRIM ANGLE (DEG) (E20)
CARD 5 VEHICLE WEIGHT (LB) (E20)

PROCESSOR OPTION 10 WITH OCTAL TO DECIMAL CONVERSION

CARD 3

COLUMNS 1-5 PITCH TRIM ANGLE (CDU PULSES/SEC) (05)
CARD 4 YAW TRIM ANGLE (CDU PULSES/SEC) (05)
CARD 5 VEHICLE WEIGHT (LB) (E20)
5.6.4 K-FACTOR PROCESSOR - THIS PROCESSOR WILL BE USED TO COMPUTE THE ATMOSPHERIC DENSITY K-FACTOR FOR THE RTCC. THE K-FACTOR VALUE IS DETERMINED BY PROPAGATING ONE INPUT STATE VECTOR TO THE TIME OF A LATER INPUT STATE VECTOR. THE VALUE OF THE ATMOSPHERIC DENSITY MULTIPLIER IS ADJUSTED UNTIL THE PROPAGATED VECTOR AND THE SECOND STATE VECTOR AGREE TO SOME SPECIFIED ACCURACY.
K-FACTOR PROCESSOR

(IBM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1

FILE NUMBER

COLUMNS

1-2

04

CARD 2

COMPARISON OPTION

COLUMN

1

1 COMPARE EACH VECTOR TO THE FIRST VECTOR.

2 COMPARE EACH VECTOR TO THE PRECEEDING VECTOR.

CARD 3

VEHICLE WEIGHT (LB) (E10)

VEHICLE REFERENCE AREA (FT2) (E10)

DRAG COEFFICIENT (E10)

CARD 4

VECTOR OPTION

COLUMN

1

1 VECTOR IS TO BE INPUT IN DECIMAL RECTANGULAR COORDINATES (ER, ER/HR) (X, Y, Z, XDOT, YDOT, ZDOT).

2 VECTOR IS TO BE INPUT IN DECIMAL RECTANGULAR COORDINATES (FT, FT/SEC) (X, Y, Z, XDOT, YDOT, ZDOT).

3 VECTOR IS TO BE INPUT IN GEODETIC SPHERICAL COORDINATES (FT, FT/SEC, DEG) (V, H, ).

4 VECTOR IS TO BE INPUT IN GEOCENTRIC SPHERICAL COORDINATES (FT, FT/SEC, DEG) (V, R, ).


6 VECTOR IS TO BE INPUT IN OCTAL RECTANGULAR COORDINATES (ER, ER/HR) (X, Y, Z, XDOT, YDOT, ZDOT).

K1-GUESS K-FACTOR (E10) MUST BE INPUT

K2-GUESS K-FACTOR (E10) AND BE

K3-GUESS K-FACTOR (E10) REASONABLE VALUES.
CARD 5

COLUMNS
13-16 VECTOR IDENTIFICATION (A4)

CARD 6
VECTOR TIME (G.M.T.)

COLUMNS
12-15 HOURS (E4)
17-19 MINUTES (E3)
21-25 SECONDS (E5)

CARD 7
LIFT-OFF TIME (G.M.T.) (NOTE THAT THIS
FOLLOWS VECTOR TIME).

COLUMNS
12-15 HOURS (E4)
17-19 MINUTES (E3)
21-25 SECONDS (E5)

CARD 8

COLUMNS
12-14 REVOLUTION NUMBER (13)

FCR VECTOR OPTION 1 2 3 4 5°

CARD 9

COLUMNS
1-20 X XDOT V V A (E20)
21-40 Y YDOT E (E20)
41-60 Z ZDOT I (E20)

CARD 10

COLUMNS
1-20 X XDOT H R G (E20)
21-40 Y YDOT H (E20)
41-60 Z ZDOT D C L (E20)

FCR VECTOR OPTION 6°

CARD 9

COLUMNS
12-23 X(O12)
25-36 Y(O12)
38-51 Z(O12)
CARD 10

COLUMNS
12-23  X(DOT)
25-36  Y(DOT)
38-51  Z(DOT)

NOTE - ADDITIONAL VECTORS ARE INPUT BY REPEATING CARDS 5-10. PLACE AN END-OF-FILE CARD AT THE END OF THE ON-LINE DECK TO TERMINATE THE INPUT.
5.6.5 PVT EQUATION PROCESSOR - THIS PROCESSOR WILL BE USED TO DETERMINE THE AMOUNT OF OXIDIZER AND FUEL REMAINING IN EACH TANK AND HOW MUCH OF THIS CAN BE CONSIDERED USEFUL PROPELLANT. USING ONBOARD VALUES OF HELIUM TEMPERATURE AND PRESSURE, THE PROCESSOR EMPLOYS THE REAL GAS EQUATION TO DETERMINE THE VOLUME OF HELIUM USED TO PRESSURIZE THE FUEL OXIDIZER SYSTEM. ONCE THE VOLUME OF HELIUM IS DETERMINED IN EACH TANK, THE AMOUNT OF FUEL OR OXIDIZER IS COMPUTED FROM THE KNOWN TOTAL VOLUME OF EACH TANK. THE AMOUNT OF USEABLE PROPELLANT IS THEN DETERMINED FROM THE FUEL TO OXIDIZER MIXTURE RATIO BEING USED AND THE ABILITY (EFFICIENCY) OF EACH TANK TO EXPEL ALL ITS CONTENTS.
PVT EQUATION PROCESSOR
(IRM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1
FILE NUMBER
COLUMNS
1-2 05

CARD 2
TANK LOGIC FOR EACH QUAD (E10)
COLUMNS
1-10 QUAD A
11-20 QUAD B
21-30 QUAD C
31-40 QUAD D
31-40 QUAD D

CARD 3
SOURCE PRESSURE (LB/IN**2) (E10)

CARD 4
TEMPERATURE (DEG) (E10)

CARD 5
DELTA TEMPERATURE (DEG) (E10)

CARD 6
OXIDIZER PRESSURE (LB/IN2) (E10)

CARD 7
FUEL PRESSURE (LB/IN2) (E10)

CARD 8
MIXTURE RATIO 1 (E10)

CARD 9
MIXTURE RATIO 2 (E10)

CARD 10
OXIDIZER REMAINING (LB) (E10)

CARD 11
FUEL REMAINING (LB) (E10)

NOTE: PLACE TWO BLANK CARDS AT THE END OF THE ON-LINE DECK TO TERMINATE THE INPUT.
5.6.6 REFSMMAT PROCESSOR. - THIS PROCESSOR WILL COMPUTE THE REFSMMAT THAT WILL BE USED FROM LIFT-OFF UNTIL THE IMU IS REALIGNED IN ORBIT. THE REFSMMAT IS COMPUTED FROM THE LAUNCH PAD LOCATION, FLIGHT AZIMUTH, TIME OF GUIDANCE REFERENCE RELEASE (GRP), AND THE VALUES OF THE PRECESSION AND NUTATION ANGLES.
REFSMAT PROCESSOR  
(IBM 7094)

ON-LINE INPUT

CARD 1

FILE NUMBER

COLUMNS
1-2 C6

CARD 2

COLUMNS
1-20 LONGITUDE OF PAD 0-360 deg (E20)
21-40 LATITUDE OF PAD 0-90 deg (E20)
41-60 ALTITUDE OF PAD (M) (E20)

CARD 3

COLUMNS
1-20 AXO* IS THE ANGULAR ROTATION ABOUT +X (RAD) (E20)
21-40 AYO* IS THE ANGULAR ROTATION ABOUT -Y (RAD) (E20)
41-60 CAZ IS FLIGHT AZIMUTH 0-360 deg (E20)

CARD 4

COLUMNS
1-20 TEPHEM IS THE TIME FROM Besselian Refere-
21-40 TGRR IS THE TIME FROM MIDNIGHT PRIOR TO
41-60 CAZD IS THE GREENWICH HOUR ANGLE, OR RO-

AXO AND AYO ARE THE PRECESSION AND NUTATION ANGLES AND THE
VALUES MAY BE OBTAINED FROM NASA-FAB.
5.6.7 SPACECRAFT-TO-SUN ALIGNMENT PROCESSOR. - THE SPACECRAFT-TO-SUN ALIGNMENT PROCESSOR WILL BE USED TO DETERMINE THE IMU GIMBAL ANGLES REQUIRED TO ORIENT THE CSM SO THAT A GIVEN LOCATION ON THE SPACECRAFT BODY WILL BE POINTED AT THE SUN. THIS LOCATION IS SPECIFIED BY PITCH AND YAW ANGLES FROM THE SPACECRAFT X-AXIS.
SPACECRAFT-TO-SUN ALIGNMENT PROCESSOR
(IBM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1
COLUMN 1-2
FILE NUMBER
07

CARD 2
COLUMN 1-5
COORDINATES OF THE SUN (E5)
RIGHT ASCENSION OF THE SUN (HR)
RIGHT ASCENSION OF THE SUN (MIN)
RIGHT ASCENSION OF THE SUN (SEC)

COLUMN 6-10
DECLINATION OF THE SUN (DEG)
DECLINATION OF THE SUN (MIN)
DECLINATION OF THE SUN (SEC)

CARD 3
REFSMMAT INPUT ROW-WISE (E10)
COLUMN 12-20
REFSMMAT (1,1)
COLUMN 22-30
REFSMMAT (1,2)
COLUMN 32-40
REFSMMAT (1,3)

CARD 4
REFSMMAT (2,1), (2,2), (2,3) (E10)

CARD 5
REFSMMAT (3,1), (3,2), (3,3) (E10)

CARD 6
ANGLES USED TO LOCATE THE POSITION ON THE SPACECRAFT TO BE DIRECTED TOWARDS THE SUN (E10)
COLUMN 1-10
YAW FROM SPACECRAFT X-AXIS (DEG)
COLUMN 11-20
PITCH FROM SPACECRAFT X-AXIS (DEG)

CARD 7
COLUMN 21-23
END

NOTE: ADDITIONAL CASES ARE INPUT BY REPEATING CARD 6
5.6.8 GIMBAL AND FLIGHT DIRECTOR ATTITUDE INDICATOR (FDAI) ANGLES CONVERSION PROCESSOR. - THIS PROCESSOR WILL BE USED TO CONVERT FDAI ANGLES TO IMU GIMBALS, OR GIMBALS TO FDAI ANGLES.
GIMBAL AND FDAI ANGLES CONVERSION PROCESSOR

(IBM 7094 AND UNIVAC 1108)

CARD 1

<table>
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CARD 2

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<th>COLUMN</th>
<th>ANGLES TO BE CONVERTED</th>
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<tbody>
<tr>
<td>1</td>
<td>1 GIMBAL ANGLES TO FDAI ANGLES</td>
</tr>
<tr>
<td></td>
<td>2 FDAI ANGLES TO GIMBAL ANGLES</td>
</tr>
<tr>
<td>10-19</td>
<td>I.G.A. OR FDAI ROLL ANGLE</td>
</tr>
<tr>
<td>20-29</td>
<td>M.G.A. OR FDAI PITCH ANGLE</td>
</tr>
<tr>
<td>30-39</td>
<td>O.G.A. OR FDAI YAW ANGLE</td>
</tr>
</tbody>
</table>

NOTE - ADDITIONAL CASES CAN BE RUN BY REPEATING CARD 2. A BLANK CARD WILL TERMINATE THE RUN.
5.6.9 GIMANG PROCESSOR -
DATA NOT AVAILABLE AT THIS TIME
5.6.10 RESSELIAN AND STABLE MEMBER VECTOR CONVERSION PROCESSOR. - THIS PROCESSOR WILL CONVERT RESSELIAN TO STABLE MEMBER VECTORS, OR STABLE MEMBER TO RESSELIAN BY ROTATING THROUGH AN INPUT REFSSMAT.
BESSELIAN AND STABLE MEMBER VECTOR CONVERSION PROCESSOR

(IBM 7094 AND UNIVAC 1108)

CARD 1

COLUMN 1

IF SET TO 1, REFSSMAT IS TO BE INPUT ON THE NEXT THREE CARDS

CARD 2-4

REFSSMAT INPUT ROW-WISE (E9)

COLUMN

12-20
22-30
32-40
REFSSMAT \( (N,M) \)
REFSSMAT \( (N,M+1) \)
REFSSMAT \( (N,M+2) \)

CARD 5

COLUMN 1

VECTOR TO BE CONVERTED
\= 2 BESSELIAN
\= 3 STABLE MEMBER

CARD 6

COLUMN 1

INPUT VECTOR TYPE
\= 0 OCTAL VECTOR
\= 1 DECIMAL VECTOR

CARD 7

POSITION COORDINATES

COLUMNS

12-23 \( x \)
25-36 \( y \)
38-49 \( z \)

CARD 8

VELOCITY COORDINATES

COLUMNS

12-23 \( x\text{-dot} \)
25-36 \( y\text{-dot} \)
38-49 \( z\text{-dot} \)

NOTE - ADDITIONAL CONVERSIONS CAN BE MADE BY REPEATING THE NECESSARY CARDS. A BLANK CARD WILL TERMINATE THE RUN.
5.6.11 EXTRAVEHICULAR MOBILITY UNIT WATER USAGE PROCESSOR. -
THIS PROCESSOR COMPUTES THE RATE OF LOSS OF COOLANT WATER DURING
EXTRAVEHICULAR ACTIVITY.
EMU WATER USAGE PROCESSOR
(IBM 7094 AND UNIVAC 1108)

ON-LINE CARD INPUT

CARD 1

FILE NUMBER

COLUMNS
1-2  11

CARD 2

COMMENT CARD

COLUMNS
2-7  TRACKING STATION I.D. (REQUIRED)
8-19  TIME THE DATA WAS READ (HR, MIN, SEC)
20-63  ADDITIONAL COMMENTS

CARD 3

INPUT PARAMETERS

COLUMNS
6-15  PLSS PRIMARY OXYGEN SUBSYSTEM
21-30  DECAY RATE (LB/HR)
36-45  EMU LEAK RATE (LB/HR)
51-60  HEAT FROM EQUIPMENT OPERATION (BTU/HR)
66-75  HEAT LEAK FROM SUIT ENVIRONMENT

CARD 4

INPUT PARAMETERS

COLUMNS
6-15  HEAT FROM BODY FUNCTIONS (BTU/HR)
21-30  SUBLIMATOR LOOP MASS FLOW RATE (LB/HR)
36-45  LCG WATER INLET TEMPERATURE (DEG)
51-60  LCG WATER OUTLET TEMPERATURE (DEG)
66-75  TOTAL WATER TRANSPORT LOOP MASS FLOW RATE (LB/HR)

CARD 5

INPUT PARAMETERS

COLUMNS
6-15  EFFICIENCY NUMBER
21-30  HEAT OUTPUT FROM THE REACTION OF CARBON DIOXIDE WITH LITHIUM HYDROXIDE (BTU/HR)
36-45  FEED WATER PRESSURE

NOTE - ADDITIONAL CASES CAN BE RUN BY REPEATING CARDS 2-5. A BLANK CARD WILL TERMINATE THE RUN.
5.6.12 LM DIAGNOSTIC PROGRAM. - THIS PROGRAM WILL BE USED TO
ASSIST THE LM SYSTEMS PERSONNEL IN THE REAL-TIME EVALUATION OF
VEHICLE FAILURES. THE ONLY INPUTS NECESSARY ARE A LIST OF THE
SENSORS WHICH HAVE DETECTED FAILURES. THE OUTPUT WILL BE A
SUMMARY REPORT DESIGNATING THE COMMON FAILURE MODE OF THE GROUP
OF INPUT PARAMETERS.
L4 DIAGNOSTIC PROGRAM
(UNIVAC 1108)

CARD 1
FILE NUMBER
COLUMNS 1-2
12

CARD 2
LIST OF SENSORS (A6)
COLUMNS 1-6

CARD N
NTH PARAMETER NUMBER

CARD N+1
RETURN TO SYSTEM MONITOR
COLUMNS 1-6
999999
6. OPERATING INSTRUCTIONS FOR THE RTACF ORBITAL LIFETIME PROGRAM

6.1 GENERAL

This section presents the on-line inputs to the Apollo 9 orbital lifetime program, a brief discussion of the purpose of the program, and the tape setup and control cards required to operate the program on the IBM 7094 data processing system.

6.2 PROGRAM DESCRIPTION

This program will be used to compute the predicted orbital lifetime of a space vehicle given a state vector, the aerodynamic characteristics of the vehicle, and the model atmosphere to be used.

6.3 TAPE SETUP FOR THE IBM 7094 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>MSFC SYSTEM TAPE</td>
</tr>
<tr>
<td>B1</td>
<td>PROGRAM TAPE</td>
</tr>
<tr>
<td>A3</td>
<td>OUTPUT TAPE</td>
</tr>
<tr>
<td>A4</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>B3</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>B4</td>
<td>SCRATCH TAPE</td>
</tr>
</tbody>
</table>
6.4 INPUTS TO THE ORBITAL LIFETIME PROGRAM

THE INPUTS TO THE ORBITAL LIFETIME PROGRAM ARE GIVEN ON THE FOLLOWING PAGES.
ORBITAL LIFETIME PROGRAM
(SPECIAL TAPE - IBM 7094 ONLY)

CARD 1
VECTOR INPUT OPTION

COLUMNS
2
0 VECTOR WILL BE IN OCTAL (I1).
1 VECTOR WILL BE IN DECIMAL (I1).
5
0 UNITS OF THE VECTOR (ER, ER/HR) (I1)
1 UNITS OF THE VECTOR (FT, FT/SEC) (I1)
7-12
ATMOSPHERE OPTION - FORMAT (A6)
SPECUS SPECIAL 1962 U.S. STANDARD ATMOSPHERE
ARDC 1959 ARDC ATMOSPHERE
USSTD 1962 U.S. STANDARD ATMOSPHERE
POE POE ATMOSPHERE
SMALL H. SMALL ATMOSPHERE
SPECAR SPECIAL 1959 ARDC ATMOSPHERE

CARD 2
VECTOR IDENTIFICATION

COLUMNS
13-31
THREE SIX-CHARACTER WORDS (A18)

CARD 3
LIFT-OFF TIME (G.M.T.)

COLUMNS
12-15
HOURS (E3)
17-19
MINUTES (E3)
21-25
SECONDS (E4)
27-29
MONTH (E3)
31-33
DAY (E3)
35-39
YEAR (E5)

CARD 4
VECTOR TIME (G.M.T.)

COLUMNS
12-15
HOURS (E4) (MUST BE LESS THAN 24)
17-19
MINUTES (E3)
21-25
SECONDS (E4)
27-29
MONTH (E3)
31-38
DAY (E3) (MUST BE ACTUAL DAY OF VECTOR)
35-39
YEAR (E5)

CARD 5

COLUMNS
1-10
VEHICLE WEIGHT (LB)
11-20
VEHICLE REFERENCE AREA (SQ FT)
21-30
VEHICLE DRAG COEFFICIENT IF NOT EQUAL TO +2.0
CARD 6
STOP TIME FOR DENSITY K-FACTORY COMPUTATION (HR,MIN,SEC) (G.E.T.). USE BLANK CARD IF NO DENSITY K-FACTOR IS TO BE COMPUTED.

COLUMNS
1-4 HOURS (F5)
5-7 MINUTES (F3)
8-10 SECONDS (F3)

CARD 7
POSITION COORDINATES

COLUMNS
12-31 X (E20)
33-52 Y (E20)
54-73 Z (E20)

CARD 8
VELOCITY COORDINATES

COLUMNS
12-31 XDOT (E20)
33-52 YDOT (E20)
54-73 ZDOT (E20)

OCTAL VECTOR OPTION

CARD 7
POSITION COORDINATES

COLUMNS
12-23 X (C12)
25-36 Y (C12)
38-51 Z (C12)

CARD 8
VELOCITY COORDINATES

COLUMNS
12-23 XDOT (C12)
25-36 YDOT (C12)
38-51 ZDOT (C12)
7. OPERATING INSTRUCTIONS FOR THE APOLLO REAL-TIME RENDEZVOUS SUPPORT (ARRS) PROGRAM (MONSTER)

7.1 GENERAL

THIS SECTION PRESENTS A DESCRIPTION OF THE ARRS PROGRAM, THE TAPE SETUP AND CONTROL CARDS REQUIRED TO OPERATE THE ARRS AS AN ON-LINE PROGRAM ON THE UNIVAC 1108 DATA PROCESSING SYSTEMS.

7.2 PROGRAM DESCRIPTION

ARRS IS COMPOSED OF A NUMBER OF PROCESSORS AND Routines REQUIRED TO SUPPORT A RENDEZVOUS MISSION. THOSE WHICH WILL BE OF CONCERN TO THE APOLLO 9 MISSION ARE DESCRIBED BELOW.

THE GENERAL PURPOSE MANEUVER PROCESSOR (GPMP) IS USED TO COMPUTE IMPULSIVE MANEUVERS AT A SPECIFIED POINT IN AN ORBIT TO ACHIEVE DESIRED ORBITAL CONDITIONS.

THE TWO-IMPULSE AND TERMINAL PHASE PROCESSOR COMPUTES A SET OF TWO MANEUVERS BY SPECIFYING WHEN THEY SHOULD BE PERFORMED AND BY SPECIFYING THE CONDITION, SUCH AS PHASE AND HEIGHT OFFSETS, AFTER THE FINAL MANEUVER POINT.

THE MISSION PLAN TABLE (MPT) PROCESSOR ACCEPTS VECTORS BEFORE AND AFTER IMPULSIVE MANEUVERS AND COMPUTES THE REQUIRED FINITE BURN QUANTITIES NECESSARY TO ACHIEVE THE ORBIT AFTER THE MANEUVER.

THE RELATIVE PRINT ROUTINE COMPUTES RELATIVE QUANTITIES, SUCH AS RANGE RANGE RATE, AND LOOK ANGLES, BETWEEN TWO ORBITING VEHICLES.

THE TRACKING ROUTINE COMPUTES THE TRACKING STATION COVERAGE OF A VEHICLE FROM THE INITIAL VECTOR THROUGH ALL THE MANEUVERS IN THE MISSION PLAN TABLE.

THE CONCENTRIC RENDEZVOUS PROCESSOR COMPUTES A RENDEZVOUS PLAN BY USING CONCENTRIC FLIGHT PLAN LOGIC. THIS PROCESSOR MAY BE USED TO COMPUTE THE SECOND MANEUVER OF THE TWO IMPULSE RENDEZVOUS PLAN AFTER THE FIRST MANEUVER HAS BEEN EXECUTED BY THE SPACECRAFT, A CAPABILITY NON-EXISTENT IN THE TWO-IMPULSE AND TERMINAL PHASE PROCESSOR.

THE CONVERSION ROUTINE CONVERTS VECTORS FROM ONE COORDINATE SYSTEM TO A NUMBER OF OTHER COORDINATE SYSTEMS.
THE ORBIT DIGITALS ROUTINE OUTPUTS ORBITAL PARAMETERS ASSOCIATED WITH A GIVEN VECTOR AT TWO INDEPENDENT TIMES.

DAYLIGHT/DARKNESS PROCESSORS, WHICH WAS DESIGNED TO COMPUTE A TABLE OF LIGHTING CONDITIONS ASSOCIATED WITH A GIVEN ORBIT.

7.3 TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ARRS PROGRAM TAPE</td>
</tr>
<tr>
<td>I</td>
<td>EPHEMERIS TAPE</td>
</tr>
<tr>
<td>K</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>L</td>
<td>DATA TAPE</td>
</tr>
</tbody>
</table>

7.4 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8
MSG
ASG A = XXXX
ASG I = $EPHEM
ASG K = XXXX
ASG L = XXXX
XQT CUR

TRW A, I, L, K
IN A

N XQT ARRS
EXECUTE ARRS PROGRAM

EOF

7.5 INPUTS TO THE ARRS PROGRAM

THE INPUTS FOR THIS PROGRAM WERE NOT AVAILABLE AT THE TIME OF THIS WRITING AND WILL BE PUBLISHED AT A LATER DATE.
8. OPERATING INSTRUCTION FOR THE APOLLO BLOCK DATA PROGRAM

8.1 GENERAL


8.2 PROGRAM DESCRIPTION

THE APOLLO BLOCK DATA PROGRAM (ABDP) HAS THE CAPABILITY OF PERFORMING FOUR BASIC SIMULATIONS: ORBIT PROPAGATION, ORBIT MANEUVERS, DEORBIT MANEUVERS AND ATMOSPHERIC ENTRY. DATA FOR DIFFERENT TYPES OF DEORBITS WILL BE COMPUTED BY THE ABDP FOR EACH REvolution DURING THE EARTH ORBITAL PORTIONS OF MANNED APOLLO MISSIONS. THESE DATA WILL BE MADE AVAILABLE TO THE FLIGHT CREW IN BLOCKS OF SIX REVOLUTIONS AND WILL BE USED TO DEORBIT THE SPACECRAFT IN THE EVENT OF A CONTINGENCY WHICH NECESSITATES RAPID MISSION TERMINATION.

8.3 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>OFF-LINE OUTPUT TAPE</td>
</tr>
<tr>
<td>D</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>H</td>
<td>DATA TAPE (OPTIONAL)</td>
</tr>
<tr>
<td>J</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>X</td>
<td>ABDP PROGRAM (PCF) TAPE</td>
</tr>
</tbody>
</table>
8.4 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8
MSG
ASG C,D,J
ASG = XXXX
ASG = XXXX
XOT CUR
TRW X
IN X
TRI X
N XOT CUR

CCMMENTS
SCRATCH UNITS ON FASTRAND
DATA TAPE NUMBER
ABDP PROGRAM (PCF) TAPE NUMBER
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND TAPE X
INPUT THE ENTIRE USER PCF FROM UNIT X
REWIND TAPE X WITH INTERLOCK
EXECUTE ABDP

ABDP DATA CARDS

LAST CARD OF ABDP DATA CARDS
END OF FILE CARD

8.5 INPUTS TO THE APOLLO BLOCK DATA PROGRAM
THE INPUTS TO THE APOLLO BLOCK DATA PROGRAM ARE PRESENTED IN THE APOLLO BLOCK DATA PROGRAM USER'S MANUAL (REFERENCE 3,4).
9. OPERATING INSTRUCTIONS FOR RTACF APOLLO REFERENCE MISSION PROGRAM (ARMACR) PROCESSOR

9.1 GENERAL

THIS SECTION PRESENTS THE TAPE SETUP AND THE CONTROL CARDS REQUIRED TO OPERATE THE ARMACR PROCESSORS ON THE UNIVAC 1108 COMPUTER, ALONG WITH THE ON-LINE INPUTS REQUIRED FOR THEIR OPERATION. THE ARMACR PROGRAM IS DESCRIBED IN DETAIL IN REFERENCE 5.

9.2 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>EPHemeris TAPE UNIT</td>
</tr>
<tr>
<td>R</td>
<td>ARMACR PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>U</td>
<td>MISSION DATA TAPE</td>
</tr>
<tr>
<td>O</td>
<td>OUTPUT UNIT FOR EPHemeris GENERATOR</td>
</tr>
</tbody>
</table>
9.3 CONTROL CARD LISTING AND ON-LINE DECK SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8

* MSG
  ASG I = $EPH
  ASG R = XXXX
  ASG U = XXXX
  ASG Q = SCRATCH OR SAVE

  XQT CUR
  TRW R
  IN R
  TRI R

  N XQT ARMACR
  PHASE (M,N,O,P)

  .
  .

  COLUMNS 1
  PHASE (M,N)
  .
  .

  ENDRUN
  .
  .

  *INDICATES 7/8 OVERPUNCH IN COLUMN 1

  COMMENTS
  EPHemeris tape unit
  ARMACR program (PCF) tape number
  Mission data tape number
  Output unit for ephemeris generator. Not necessary
  If no ephemeris is desired
  Execute the following instructions
  Rewind unit R
  Input the entire user PCF
  From unit R
  Rewind unit R with interlock
  Execute ARMACR program
  M is the phase number
  N is the phase type
  O is the data update number
  P is the file number of the data tape

  ARMACR updates for phase 1

  ARMACR updates for phase M

  Last card in the ARMACR phase updates

  Input octal vector from 1CO4
  Input reFSMmat from 1004
  End of file card

*INDICATES 7/8 OVERPUNCH IN COLUMN 1
9.4 THE ARMACR PROCESSORS

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE ARMACR PROCESSORS AND THE ON-LINE INPUTS REQUIRED TO OPERATE EACH PROCESSOR.
9.4.1 CSM EXTERNAL DELTA V MANEUVER PROCESSOR. - THIS PROCESSOR WILL BE USED TO SIMULATE ANY SPS OR RCS MANEUVER FOR WHICH THE BURN QUANTITIES HAVE PREVIOUSLY BEEN DETERMINED.
EXTERNAL DELTA V MANEUVER PROCESSOR
(FILE 2, UNIVAC 1108)

A. STANDARD ARMACR INPUT QUANTITIES FOR THE EXTERNAL DELTA V MANEUVER PROCESSOR ARE LISTED BELOW

PHASE (1,0,3,2) = EXTERNAL DELTA V MANEUVER FILE, INITIAL COAST PHASE

IVECT  I  OCTAL VECTOR INPUT FLAG
    =0 OCTAL VECTOR WILL NOT BE INPUT
    =1 ONE OCTAL VECTOR IN BESSELIAN COORDINATES
    =2 TWO OCTAL VECTORS IN BESSELIAN COORDINATES

IREFM  I  INPUT REFSSMMAF FLAG
       =0 REFSSMMAF WILL NOT BE INPUT
       =1 ONE REFSSMMAF WILL BE INPUT
       =2 TWO REFSSMMAFS WILL BE INPUT

CDRAGl  (FP)  COEFFICIENT OF DRAG (SET 2.0 CN TAPE)

AREA  (FP)  VEHICLE REFERENCE AREA (SET TO 239.9 ON TAPE)

GETHRS  (FP)  TIME OF RCR IGNITION IN HR,MIN,SEC (G.E.T.)

PHASE (2,2) = PRECOMPUTE PHASE

GO02  I  EXTERNAL DELTA V FLAG (SET TO 2 ON. TAPE)
      =2 INPUT P-30'S IN LVHL
      =3 INPUT P-40'S IN LVHL
      =4 INPUT VELOCITY INCREMENT IN ECI OR MCI
      =5 INPUT VELOCITY TO-BE-GAINED ECI OR MCI

GO06  I  NUMBER OF RCS JETS DURING ULLAGE (SET TO 4 ON TAPE)

GO25  (FP)  NUMBER OF SECONDS OF RCS ULLAGE MINUS RCS ULLAGE OVERLAP TIME (SET TO 14. CN TAPE)

GO37  (FP)  EXTERNAL DELTA V TARGET INPUTS, DELTA
SPSIGN (FP)  TIME OF SPS IGNITION IN HR,MIN,SEC, (G.E.T.)
DVRES (FP)  DELTA V RESIDUALS
GARES (FP)  GIMBAL ANGLES AT WHICH RESIDUALS ARE READ

PHASE (3,2) = ATTITUDE ORIENTATION/IMU ALIGNMENT PHASE

ZDIR I  Z-AXIS DIRECTION (PRESET TO -1 IN PROGRAM)
  =-1 Z-AXIS DOWN AND ASTRONAUT'S HEADS UP
  = 0 Z-AXIS UP AND ASTRONAUT'S HEADS DOWN

PHASE (4,1) = RCS ULLAGE

ITYPE I  OPEN LOOP GUIDANCE (SET TO 11 ON TAPE)
  = C FOR NO RCS ULLAGE
  = 11 FOR RCS ULLAGE

IRCS I  NUMBER OF QUADS FOR RCS ULLAGE (SET TO 3 ON TAPE)
  = 1 RCS JETS IN QUADS A AND C ARE ON
  = 2 RCS JETS IN QUADS B AND D ARE ON
  = 3 RCS JETS IN QUADS A, B, C AND D ARE ON

TTRHRS (FP)  RCS ULLAGE MINUS RCS ULLAGE OVERLAP IN HR,MIN,SEC (SET TO C,,0,,14 ON TAPE)

PHASE (5,2) = SPS BUILDUP PLUS STEADY STATE
PHASE (6,2) = SPS TAILOFF
PHASE (7,1) = COAST AFTER SPS MANEUVER
PHASE (8,2) = COAST TO RUN TERMINATION
ENDRUN

INPUT OCTAL VECTOR FROM 1004
INPUT REFSMAT FROM 1004
EOF    END OF FILE CARD
B. IF THE MANEUVER IS PERFORMED WITHOUT AN ULLAGE, INPUT THE FOLLOWING ADDITIONAL QUANTITIES

PHASE (1,0,3,2) = EXTERNAL DELTA V MANEUVER FILE, INITIAL COAST PHASE

GETHRS  (FP)  TIME OF SPS IGNITION IN HR, MIN, SEC (G.E.T.)

PHASE (2,2) = PRECOMPUTE PHASE

G006  0  NUMBER OF RCS JETS DURING ULLAGE
G025  0.  NUMBER OF SECONDS OF RCS ULLAGE

PHASE (4,1) = RCS ULLAGE PHASE

ITYPE  0  NO RCS ULLAGE
TTRHRS  (FP)  RCS ULLAGE PHASE ELAPSE TIME IN HR, MIN, SEC (SET TO O., O., O.)

C. IF THE MANEUVER IS PERFORMED WITH THE SM RCS THRUSTERS, INPUT THE FOLLOWING QUANTITIES

PHASE (2,2) = PRECOMPUTE PHASE

G005  0  PERFORM RCS SHORT BURN TEST
G006  0  NUMBER OF RCS JETS USED DURING ULLAGE
G023  (FP)  CNBOARD VALUE OF RCS THRUST (100 LBS/JET)
G025  0.  NUMBER OF SECONDS OF RCS ULLAGE
G041  0.  ONBOARD VALUE OF SPS TAILOFF
SPSIGN  (FP)  TIME OF SPS IGNITION IN HR, MIN, SEC (G.E.T.)

PHASE (3,2) = ATTITUDE ORIENTATION/IMU ALIGNMENT PHASE

ENDFP1  BCD  SET TO 'DELETE' TO CANCEL PITCH TRIM TABLE
ENDFY1  BCD  SET TO 'DELETE' TO CANCEL YAW TRIM TABLE

PHASE (4,1) = RCS ULLAGE

ITYPE  0  NO RCS THRUST
PHASE (5,2) = SPS BUILDUP PLUS STEADY STATE

**TTRHRS (FP)** PHASE ELAPSE TIME IN HR, MIN, SEC (SET TO 0, 0, 0)

**GO24 (FP)** ONBOARD VALUE OF RCS ISP

**ENDFP1 BCD** SET TO 'DELETE' TO CANCEL PITCH TRIM TABLE

**ENDFY1 BCD** SET TO 'DELETE' TO CANCEL YAW TRIM TABLE

**TTABLE (FP)** TOTAL RCS THRUST

**WRTABL (FP)** TOTAL WEIGHT FLOW

PHASE (6,2) = SPS TAILOFF

**ITYPE 0** NO SPS TAILOFF THRUST

**TTRHRS (FP)** PHASE ELAPSE TIME IN HR, MIN, SEC (SET TO 0, 0, 0)
9.4.7 LM EXTERNAL DELTA V MANEUVER PROCESSOR. - THIS PROCESSOR WILL BE USED TO SIMULATE ANY DPS, APS, OR RCS MANEUVER FOR WHICH THE BURN QUANTITIES HAVE PREVIOUSLY BEEN DETERMINED.
LM EXTERNAL DELTA V MANEUVER PROCESSOR
(FILE 6, UNIVAC 1108)

A. STANDARD ARMACR INPUT QUANTITIES FOR THE EXTERNAL DELTA V MANEUVER PROCESSOR ARE LISTED BELOW

PHASE (1,0,3,2) = EXTERNAL DELTA V MANEUVER FILE, INITIAL COAST PHASE

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
</table>
| IVECT    | OCTAL VECTOR INPUT FLAG  
=0 OCTAL VECTOR WILL NOT BE INPUT  
=1 ONE OCTAL VECTOR IN BESSELIAN COORDINATES  
=2 TWO OCTAL VECTORS IN BESSELIAN COORDINATES |
| IREFM    | INPUT REFSSMAT FLAG  
=0 REFSSMAT WILL NOT BE INPUT  
=1 ONE REFSSMAT WILL BE INPUT  
=2 TWO REFSSMATS WILL BE INPUT |
| NV       | NUMBER OF VEHICLES (SET TO 2.0 ON TAPE) |
| CDRAG2   | COEFFICIENT OF DRAG (SET 2.0 ON TAPE) |
| AREA2    | VEHICLE REFERENCE AREA (SET TO 129.4 ON TAPE) |
| GETHRS   | TIME OF RCR IGNITION IN HR, MIN, SEC (G.E.T.) |

PHASE (2,2) = PRECOMPUTE PHASE

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
</table>
| G002     | EXTERNAL DELTA V FLAG (SET TO 2 ON TAPE)  
=2 INPUT P-30'S IN LVLH  
=3 INPUT P-40'S IN LVLH  
=4 INPUT VELOCITY INCREMENT IN ECI OR MCI  
=5 INPUT VELOCITY TO-BE-GAINED ECI OR MCI |
| G006     | NUMBER OF RCS JETS DURING ULLAGE (SET TO 4 ON TAPE) |
| G025     | NUMBER OF SECONDS OF RCS ULLAGE MINUS RCS ULLAGE OVERLAP TIME (SET TO 14 ON TAPE) |
**GO37** (FP)  EXTERNAL DELTA V TARGET INPUTS. DELTA VX, DELTA VY, DELTA VZ, RESPECTIVELY

**SPSIGN** (FP)  TIME OF SPS IGNITION IN HR, MIN, SEC, (G.E.T.)

**DVRES** (FP)  DELTA V RESIDUALS

**GARES** (FP)  GIMBAL ANGLES AT WHICH RESIDUALS ARE READ (PITCH, YAW, ROLL)

**PHASE (3,2)** = ATTITUDE ORIENTATION/IMU ALIGNMENT PHASE

- **ZDIR** 1  Z-AXIS DIRECTION (PRESET TO -1 IN PROGRAM)
  - -1 Z-AXIS DOWN AND ASTRONAUT'S FACE UP
  - 0 Z-AXIS UP AND ASTRONAUT'S FACE DOWN

**PHASE (4,1)** = RCS ULLAGE

- **ITYPE** 1  OPEN LOOP GUIDANCE (SET TO 11 ON TAPE)
  - 0 FOR NO RCS ULLAGE
  - 11 FOR RCS ULLAGE

- **IRCS** 1  NUMBER OF QUADS FOR RCS ULLAGE (SET TO 3 ON TAPE)
  - 1 RCS JETS IN QUADS A AND C ARE ON
  - 2 RCS JETS IN QUADS B AND D ARE ON
  - 3 RCS JETS IN QUADS A, B, C AND D ARE ON

- **TTRHRS** (FP) RCS ULLAGE MINUS RCS ULLAGE OVERLAP IN HR, MIN, SEC (SET TO 0.0, 0.14 ON TAPE)

**PHASE (5,2)** = DPS BUILDUP PLUS STEADY STATE

**PHASE (6,2)** = DPS TAILOFF

**PHASE (7,1)** = COAST AFTER SPS MANEUVER

**PHASE (8,2)** = COAST TO RUN TERMINATION

**PHASE (9,2)** = COAST AFTER LM MANEUVER

**PHASE (10,2)** = COAST AFTER LM MANEUVER

**FNCRUN**

**INPUT OCTAL VECTOR FROM 1004**

9-12
INPUT REFSMMAT FROM 1004

EOF

END OF FILE CARD

B. IF THE MANEUVER IS PERFORMED WITHOUT AN ULLAGE, INPUT THE FOLLOWING ADDITIONAL QUANTITIES:

PHASE (1,0,3,2) = EXTERNAL DELTA V MANEUVER FILE, INITIAL COAST PHASE

GETHRS (FP) TIME OF DPS IGNITION IN HR, MIN, SEC (G.E.T.)

PHASE (2,2) = PRECOMPUTE PHASE

GO06 0. NUMBER OF RCS JETS DURING ULLAGE
GO25 0. NUMBER OF SECONDS OF RCS ULLAGE

PHASE (4,1) = RCS ULLAGE PHASE

ITYPE 0. NO RCS ULLAGE
TTRHRS (FP) RCS ULLAGE PHASE ELAPSE TIME IN HR, MIN, SEC (SET TO 0,0,0,0.1)

C. IF THE MANEUVER IS PERFORMED WITH THE SM RCS THRUSTERS, INPUT THE FOLLOWING QUANTITIES

PHASE (2,2) = PRECOMPUTE PHASE

GO05 0. PERFORM RCS SHORT BURN TEST
GO06 0. NUMBER OF RCS JETS USED DURING ULLAGE
GO23 (FP) ONBOARD VALUE OF RCS THRUST (100 LBS/JET)
GO25 0. NUMBER OF SECONDS OF RCS ULLAGE
GO41 0. ONBOARD VALUE OF SPS TAILOFF
SPSIGN (FP) TIME OF SPS IGNITION IN HR, MIN, SEC (G.E.T.)

PHASE (3,2) = ATTITUDE ORIENTATION/IMU ALIGNMENT PHASE

ENDFP1 BCD SET TO 'DELETE' TO CANCEL PITCH TRIM TABLE

ENDFY1 BCD SET TO 'DELETE' TO CANCEL YAW TRIM TABLE
PHASE (4,1) = RCS ULLAGE

ITYPE  0.  NC RCS THRUST
TTRHRS (FP) PHASE ELAPSE TIME IN HR,MIN,SEC
         (SET TO 0.,0.,0.)

PHASE (5,2) = SPS BUILDUP PLUS STEADY STATE

GO24   (FP) ONBOARD VALUE OF RCS ISP
ENDFP1  BCD SET TO 'DELETE' TO CANCEL PITCH TRIM TABLE
ENDFY1  BCD SET TO 'DELETE' TO CANCEL YAW TRIM TABLE
TTABLE (FP) TOTAL RCS THRUST
WRTABL (FP) TOTAL WEIGHT FLCW

PHASE (6,2) = SPS TAILOFF

ITYPE  0.  NO SPS TAILOFF THRUST
TTRHRS (FP) PHASE ELAPSE TIME IN HR,MIN,SEC
         (SET TO 0.,0.,0.)
9.4.3 GENERAL MANEUVER PROCESSOR
DATA NOT AVAILABLE AT THIS TIME
9.4.4 MANEUVER EVALUATION PROCESSOR. - THE ARMACR MANEUVER EVALUATION PROCESSOR COASTS A PRE-BURN VECTOR TO THE IMPULSIVE MANEUVER TIME. THE 200/WORD RECORD IS WRITTEN AND IS USED BY THE MONSTER MPT PROCESSOR TO CALCULATE THE P30 DELTA V BURNED DURING THE MANEUVER.
MANEUVER EVALUATION FILE
(FILE 1, UNIVAC 1108)

PHASE (1,0,3,1) = MANEUVER EVALUATION, PREBURN COAST PHASE
GETHRS (FP) G.E.T. OF THE POST BURN VECTOR TIME
*I Vect 1 INPUT VECTOR FOR CSM VEHICLE

PHASE (2,2) = COAST TO IMPULSIVE MANEUVER POINT
GETHRS (FP) G.E.T. OF IMPULSIVE MANEUVER TIME
*NV 2 TWO VEHICLES
*I Vect 1 INPUT VECTOR FOR S-IVB (LM) VEHICLE
*DIREC -1. COAST BACKWARD
*I INTFC 1 WRITE 200-WORD RECORD
*TOTOLP -17. SUPPRESS PRINT GROUPS 1-17
*HARS(142) BCD MANEUVER I.C.

PHASE (3,2) = THIRD COAST PHASE
*NTAPE 0 TERMINATE PRINT
*DIREC 1. COAST FORWARD

PHASE (4,2) = FOURTH COAST PHASE

PHASE (7,2) = SEVENTH COAST PHASE
ENDRUN

INPUT PREBURN OCTAL VECTOR FROM 1004
INPUT POSTBURN OCTAL VECTOR FROM 10C4

EOF END OF FILE

*INDICATES THESE VALUES ARE PRESET IN THE MANEUVER EVALUATION DECK.
9.4.5 CONTINGENCY LANDING AREA (CLA) PROCESSOR. - THIS PROCESSOR WILL BE USED TO DETERMINE THE ORBIT MANEUVER IGNITION TIME REQUIRED TO ACHIEVE A TARGET LONGITUDE WHICH IS NORMALLY LOCATED IN A CONTINGENCY LANDING AREA.
CONTINGENCY LANDING AREA PROCESSOR
(FILE 7, UNIVAC 1108)

A. STANDARD ARMACR INPUT QUANTITIES ARE LISTED BELOW

PHASE (1,0,2) = CLA FILE, INITIAL COAST PHASE

<table>
<thead>
<tr>
<th>IVECT</th>
<th>OCTAL VECTOR INPUT FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OCTAL VECTOR WILL NOT BE INPUT</td>
</tr>
<tr>
<td>1</td>
<td>ONE OCTAL VECTOR IN BESSELIAN COORDINATES</td>
</tr>
<tr>
<td>2</td>
<td>TWO OCTAL VECTORS IN BESSELIAN COORDINATES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IREFM</th>
<th>INPUT REFSSMAT FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>REFSSMAT W NOT BE INPUT</td>
</tr>
<tr>
<td>1</td>
<td>ONE REFSSMAT WILL BE INPUT</td>
</tr>
<tr>
<td>2</td>
<td>TWO REFSSMAT WILL BE INPUT</td>
</tr>
</tbody>
</table>

PHASE (2,2) = COAST TO SPS IGNITION

PHASE (3,2) = COAST BACK TO RCS ULLAGE

PHASE (4,2) = RCS ULLAGE

PHASE (5,2) = SPS BUILDUP PLUS STEADY STATE

PHASE (6,2) = SPS TAILOFF

PHASE (7,2) = COAST AFTER SPS CUTOFF

PHASE (8,2) = COAST TO SPS IGNITION

*LOOP 1 ITERATION LOCP NUMBER

*SREMMAT 2 MAX NUMBER OF PARTIAL DERIVATIVE MATRICES TO BE COMPUTED

*INDEPV INDEPENDENT VARIABLE IN ITERATION LOOP (GETHRS, PHASE 8)

*DEPV DEPENDENT VARIABLE IN ITERATION LOOP (LONGITUDE, PHASE 17)

TARGET (FP) LONGITUDE TARGET

GETHRS (FP) TIME OF SPS IGNITION IN HRS,MIN,SEC (G.E.T.)

PHASE (9,2) = COAST BACK TO RCS ULLAGE

TTRHRS (FP) ULLAGE TIME-1SEC (-SEC)
ROLL1 (FP) CSM ATTITUDES
ATYPE I ATTITUDE OPTION
= 3 LVLH ATTITUDES
= 10 GIMBAL ANGLES
= 14 HORIZON MONITOR
IPTYPE 3 REALIGN IMU (SET CNLY IF REFSSMAT IS COMPUTED)
G012 10 REALIGN IMU TO ATTAIN GIMBAL ANGLES IN GO57 (SET CNLY IF REFSSMAT IS COMPUTED)
GO57 (FP) PITCH, YAW, ROLL, GIMBAL ANGLES

PHASE (10,2) = RCS ULLAGE
IRCS I NUMBER OF JETS FOR RCS ULLAGE (SET TO 3 ON TAPE)
= 1 RCS JETS IN QUADS A AND C ARE ON
= 2 RCS JETS IN QUADS B AND D ARE ON
= 3 RCS JETS IN QUADS A, B, C AND D ARE ON
TTRHRS (FP) RCS ULLAGE MINLS OVERLAP IN HR, MIN, SEC (SET TO O.,0.,14. ON TAPE)

PHASE (11,2) = SPS BUILDUP PLUS STEADY STATE
TXMTOV (FP) TOTAL DELT V GAINED

PHASE (12,2) = SPS TAILOFF

PHASE (13,2) = COAST AFTER SPS CUTOFF

PHASE (14,2) = COAST TO 425K

PHASE (15,2) = COAST TO 400K

PHASE (16,2) = COAST TO XG*S
RKANG (FP) BANK ANGLE FLOW TO SPECIFIED G-LEVEL (SET TO 0 ON TAPE)
GLEVEL (FP) G-LEVEL TERMINATION (SET TO .2 ON TAPE)
IMASS (FP) ENTRY WEIGHT

PHASE (17,2) = COAST TO 23.3K
FMLT (FP) ENTRY LIFT MULTIPLIER (SET TO .57358 ON TAPE)

9-22
B. IF A FIXED TIME RCS SEPARATION OR MANEUVER IS REQUIRED, SET IN ADDITION THE FOLLOWING INDICES

PHASE (2,2) = COAST TO SPS IGNITION

NTAPE 6 PRINT THE FOLLOWING PHASES

GETHRS (FP) TIME OF RCS IGNITION IN HR, MIN, SEC (G.E.T.)

PHASE (4,2) = RCS ULLAGE

IRCS I NUMBER OF JETS FOR RCS ULLAGE (SET TO 3 ON TAPE)

= 1 RCS JETS IN QUADS A AND C ARE ON
= 2 RCS JETS IN QUADS B AND D ARE ON
= 3 RCS JETS IN QUADS A, B, C AND D ARE ON

XMTDV (FP) TOTAL DELTA V FOR THE PHASE

ROLL1 (FP) CSM ATTITUDES

ATYPE I ATTITUDE OPTION

= 3 LVLH ATTITUDES
= 10 GIMBAL ANGLES
= 14 HORIZON MONITOR

IMASS (FP) ENTRY WEIGHT

C. IF A FIXED TIME SPS SEPARATION OR MANEUVER IS REQUIRED, SET IN ADDITION THE FOLLOWING INDICES

PHASE (2,2) = COAST TO SPS IGNITION

NTAPE 6 PRINT THE FOLLOWING PHASES

GETHRS (FP) TIME OF SPS IGNITION IN HRS, MIN, SEC (G.E.T.)

PHASE (3,2) = COAST BACK TO RCS ULLAGE

TTRHRS (FP) ULLAGE TIME-1SEC (-SEC)

ROLL1 (FP) CSM ATTITUDES

ATYPE I ATTITUDE OPTION

= 3 LVLH ATTITUDES
= 10 GIMBAL ANGLES
= 14 HORIZON MONITOR

9-23
IMASS (FP)  ENTRY WEIGHT

PHASE (4,2) = RCS ULLAGE

IRCS  I  NUMBER OF JETS FOR RCS ULLAGE (SET TO 3 ON TAPE)
= 1 RCS JETS IN QUADS A AND C ARE ON
= 2 RCS JETS IN QUADS B AND D ARE ON
= 3 RCS JETS IN QUADS A, B, C AND D ARE ON

TTRHRS (FP)  RCS ULLAGE MINLS OVERLAP IN HR, MIN, SEC (SET TO 0,0,14 ON TAPE)

PHASE (5,2) = SPS BUILDUP PLUS STEADY STATE

XMTOV (FP)  TOTAL DELTA V FOR THE PHASE
TSTOP  0  THIS ALLOWS A DELTA V TERMINATION

PHASE (6,2) = SPS TAILOFF

TTRHRS (FP)  TAILOFF DELTA T

C. IF A FIXED DELTA T RCS SEPARATION OR MANEUVER IS REQUIRED, SET IN ADDITION THE FOLLOWING INDICES

PHASE (2,2) = COAST TO SPS IGNITION

*LOOP  1  ITERATION LOOP NUMBER
*SELMAT  2  MAX NUMBER OF PARTIAL DERIVATIVE MATRICES TO BE COMPUTED
*INDEPV  INDEPENDENT VARIABLE IN ITERATION LOOP (GETHRS, PHASE 2)
*DEPV  DEPENDENT VARIABLE IN ITERATION LOOP (LONGITUDE, PHASE 17)

TARGET (FP)  LONGITUDE TARGET
GETHRS (FP)  TIME OF SPS IGNITION IN HRS, MIN, SEC (G.E.T.)

PHASE (4,2) = RCS ULLAGE

IRCS  I  NUMBER OF JETS FOR RCS ULLAGE (SET TO 3 ON TAPE)
= 1 RCS JETS IN QUADS A AND C ARE ON
= 2 RCS JETS IN QUADS B AND D ARE ON
= 3 RCS JETS IN QUADS A, B, C AND D ARE ON

9-24
XMTOV (FP)  TOTAL DELTA V FOR THE PHASE
ROLL1 (FP)  CSM ATTITUDES
ATYPE  I  ATTITUDE OPTION
= 3 LVLH ATTITUDES
= 10 GIMBAL ANGLES
= 14 HORIZON MONITOR
IMASS (FP)  ENTRY WEIGHT

PHASE (8,2) = COAST TO SPS IGNITION
*TSTOP  31  SET TO TERMINATE ON A TIME (TTF)
AFTER SEP MANEUVER

F. IF A FIXED DELTA T SPS SEPARATION OR MANEUVER IS REQUIRED,
SET IN ADDITION THE FOLLOWING INDICES

PHASE (2,2) = COAST TO SPS IGNITION
*LOOP  1  ITERATION LOOP NUMBER
*SELMAT  2  MAX NUMBER OF PARTIAL DERIVATIVE
          MATRICES TO BE COMPUTED
*INDEPV  INDEPENDENT VARIABLE IN ITERATION
          LOOP (GETHRS, PHASE 2)
*DEPV  DEPENDENT VARIABLE IN ITERATION
        LOOP (LONGITUDE, PHASE 17)
TARGET (FP)  LONGITUDE TARGET
GETHRS (FP)  TIME OF SPS IGNITION IN HRS, MIN, SEC
             (G.E.T.)

PHASE (3,2) = COAST BACK TO RCS ULLAGE
TTPHRS (FP)  RCS ULLAGE MINUS OVERLAP IN HR, MIN,
              SEC (SET TO 0,0,14. ON TAPE)
ROLL1 (FP)  CSM ATTITUDES
ATYPE  I  ATTITUDE OPTION
= 3 LVLH ATTITUDES
= 10 GIMBAL ANGLES
= 14 HORIZON MONITOR
IMASS (FP)  ENTRY WEIGHT
PHASE (4, 2) = RCS ULLAGE

IRCS 1 NUMBER OF JETS FOR RCS ULLAGE (SET TO 3 ON TAPE)
= 1 RCS JETS IN QUADS A AND C ARE ON
= 2 RCS JETS IN QUADS B AND D ARE ON
= 3 RCS JETS IN QUADS A, B, C AND D ARE ON

TTHRS (FP) RCS ULLAGE MINUS OVERLAP IN HR, MIN, SEC (SET TO 0, 0, 14. ON TAPE)

PHASE (5, 2) = SPS BUILDUP PLUS STEADY STATE

XMTOV (FP) TOTAL DELTA V FOR THE PHASE

TSTOP 0 THIS ALLOWS A DELTA V TERMINATION

PHASE (6, 2) = SPS TAILOFF

TTRHRS (FP) TAILOFF DELTA T

*NOTE - THESE CARDS ARE PROVIDED IN THE ON-LINE TRAY.
9.4.6 CHECKOUT MONITOR, CMC, LGC, AGS, AND IU NAVIGATION UPDATES OR LIFTOFF REFSSMAT CAPABILITIES. IF IT IS DESIRED TO PRODUCE A CHECKOUT MONITOR, A CMC, AGS, OR IU NAVIGATION UPDATE OR LIFTOFF REFSSMAT WITH ANY OF THE ARMACR PROCESSORS PREVIOUSLY DESCRIBED, THE FOLLOWING ON-LINE INPUTS WILL BE REQUIRED.

A. ADDITIONAL ARMACR INPUT QUANTITIES FOR THE CHECKOUT MONITOR DATA ARE LISTED BELOW

PHASE WHERE CHECKOUT MONITOR IS DESIRED

PHASE (N,M) = ANY PHASE

ICOM I FLAG TO CALL FOR THE CHECKOUT MONITOR
= 1 VEHICLE 1
= 2 VEHICLE 2
= 3 BOTH VEHICLES

ICOMPR I TIME DURING A PHASE AT WHICH THE CHECKOUT MONITOR IS DESIRED
= 1 AT THE END OF A PHASE (PRESET IN PROGRAM TO 1)
= 2 AT THE BEGINNING OF A PHASE
= 3 AT THE BEGINNING AND END OF A PHASE

B. ADDITIONAL ARMACR INPUT QUANTITIES FOR THE NAVIGATION UPDATE DATA ARE LISTED BELOW

PHASE WHERE NAVIGATION UPDATE IS DESIRED

PHASE (M,M) = ANY PHASE

NAVUPD I FLAG TO CALL FOR NAVIGATION UPDATE DISPLAY
= 0 NAVIGATION UPDATE DISPLAY WILL NOT BE GENERATED
= 1 NAVIGATION UPDATE DISPLAY WILL BE GENERATED AT THE TERMINAL POINT OF EACH PHASE IN WHICH NAVUPD IS INPUT
= 2 LGC NAVIGATION UPDATE DISPLAY WILL BE GENERATED AT THE POINT OF EACH PHASE IN WHICH NAVUPD IS INPUT
= 3 AGS NAVIGATION UPDATE DISPLAY WILL BE GENERATED AT THE TERMINAL OF EACH PHASE IN WHICH NAVUPD IS INPUT

9-27
= 4 CSM AND LGC NAVIGATION UPDATE
DISPLAY WILL BE GENERATED AT
THE TERMINAL POINT OF EACH
PHASE

= 5 CSM AND AGS NAVIGATION UPDATE
DISPLAY WILL BE GENERATED AT
THE TERMINAL POINT OF EACH
PHASE

GETK (FP) ZERO REFERENCE TIME OF THE AGS
CCOMPUTER (HR, MIN, SEC)

IUNAV 1 IL TELEMETRY UPDATE DISPLAY WILL BE
GENERATED AT THE TERMINAL POINT OF
EACH PHASE IN WHICH IUNAV IS INPUT

DTGRK (FP) GUIDANCE REFERENCE RELEASE IN SEC
(REQUIRED TO COMPUTE IUNAV)

PHI (FP) GOOD LATITUDE OF LAUNCH PAD (REQUIRED
TO COMPUTE IUNAV)

LAMBDA (FP) LONGITUDE OF LAUNCH PAD (REQUIRED
TO COMPUTE IUNAV)

LAZ (FP) LAUNCH AZIMUTH (REQUIRED TO COMPUTE
IUNAV)

IF VENTING IS TO BE CONSIDERED, INCLUDE THE FOLLOWING
QUANTITIES.

ITURN 2 MAINTAIN THE VEHICLE LVLH ATTITUDE
SPECIFIED IN THE ALIGNMENT OPTION

ATYPE 3 ALIGN VEHICLE 1 FROM THE LVLH PLANE

ITYPE 11 OPEN LOOP STEERING

TCINT (FP) THRUST PHASE INTEGRATION STEP-SIZE
(SET TO 0.0041666 HRS)

TTABLE (FP) TABULAR VALUES OF VENTING THRUST

SITABL (FP) CONSTANT VALUE OF SPECIFIC IMPULSE
C. The following additional input quantities are required to compute the liftoff REFSMMAT that will be used from liftoff until the IMU is realigned in orbit. The following figure is the IU pad alignment.

IMU pad alignment

The ZIMU-axis is aligned with the geocentric radius vector of the launch site, the XIMU-axis is aligned with the launch azimuth vector, and the YIMU-axis completes the right-hand coordinate system.
THE LIFTOFF REFSSMMAT BASED ON THE IMU ALIGNMENT AT LIFTOFF WILL BE COMPUTED IN PHASE ONE. THE FOLLOWING ARE REQUIRED.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATYPE(3) 5</td>
<td>COMPUTE LIFTOFF REFSSMMAT</td>
</tr>
<tr>
<td>ROLL3 (FP)</td>
<td>IMU ALIGNMENT AT LIFTOFF (SET TO 0..-90..0.)</td>
</tr>
<tr>
<td>LAZ (FP)</td>
<td>FLIGHT AZIMUTH</td>
</tr>
<tr>
<td>GETVEC (FP)</td>
<td>TIME OF LIFTOFF IN HR,MIN,SEC (G.E.T.)</td>
</tr>
<tr>
<td>HRS (FP)</td>
<td>HOUR OF LIFTOFF (G.M.T.)</td>
</tr>
<tr>
<td>MINS (FP)</td>
<td>MINUTES OF LIFTOFF (G.M.T.)</td>
</tr>
<tr>
<td>SECS (FP)</td>
<td>SECONDS OF LIFTOFF (G.M.T.)</td>
</tr>
</tbody>
</table>

9-30
9.4.7 IU TELEMETRY VECTOR CONVERTER PROCESSOR. - THIS PROCESSOR WILL CONVERT AN INPUT VECTOR IN IU TELEMETRY PLATFORM COORDINATES TO ECI BESSELIAN COORDINATES EITHER AT THE INPUT VECTOR TIME OR PROPAGATE TO A POINT. THE OUTPUT WILL BE IN THE FORM OF A CHECKOUT MONITOR SUMMARY SHEET.
IU TELEMETRY VECTOR CONVERSION
(FILE I, UNIVAC 1108)

A. STANDARD ARMACR inputs to convert an IU telemetry vector to ECI are as follows

PHASE (1,0,3,1) = GENERAL PURPOSE FILE, INITIAL COAST PHASE

- ISCALE 1  INPUT UNITS ARE IN KM AND KM/SEC
- OSCALE 4  OUTPUT UNITS ARE FEET AND FEET PER SEC
- INJECT 41 VECTOR INPUT FLAG (IU PLATFORM STABLE)
- GMTVEC (FP)  INPUT VECTOR TIME IN HR, MIN, SEC (G.M.T.)
- XPL (FP)  POSITION VECTOR IN KILOMETERS (X, Y, Z)
- YPT (FP)  VELOCITY VECTOR IN KM/SEC (DX, DY, DZ)
- ZPL (FP)  VEHICLE WEIGHT IN LBS
- IMASS (FP)  LAUNCH AZIMUTH IN DEGREES
- LAZ (FP)  CALL CHECKOUT MONITOR FOR VEHICLE 1
- ICOM 1  CHECKOUT MONITOR AT START OF PHASE
- ICOMPR 2  GMTZS-GMTUGRR IN HRS POSITIVE NUMBER

B. IF THE INPUT VECTOR IS PROPAGATED TO A TIME, INPUT THE ADDITIONAL FOLLOWING INSTRUCTIONS

- GETHRS (FP)  TERMINATION TIME IN HR, MIN, SEC (G.E.T.)
- AREA (FP)  REFERENCE AREA IN FEET SQUARED
- ICOMPR 3  OUTPUT CHECKOUT MONITOR AT BEGINNING AND END OF PHASE

9-33
9.4.8 Radar Tracking and Summary. - This processor generates radar tracking data for each specified radar station at every print point. After all tracking data has been generated, summary of acquisition and loss of data for each radar station can be generated.

A. Addition Armacr Input Quantities for Radar Tracking are listed below

**Phase (1,0,3,1) = General Purpose File**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVECT</td>
<td>Octal Vector Input Flag</td>
</tr>
<tr>
<td>IREFM</td>
<td>Input RefsMat Flag</td>
</tr>
</tbody>
</table>

**Phase (N,M) = Phase Where Radar Tracking Data is Generated**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NODRUM</td>
<td>Assign Internal Print Unit to Unit Y</td>
</tr>
<tr>
<td>TUTALP</td>
<td>Suppress Print Groups 1-17</td>
</tr>
<tr>
<td>TITLE</td>
<td>Suppress IML Print Block</td>
</tr>
<tr>
<td>IPRINT</td>
<td>Print Frequency of Radar Tracking</td>
</tr>
<tr>
<td>ITHPR</td>
<td>Print Frequency of Radar Tracking</td>
</tr>
<tr>
<td>TCINT</td>
<td>Integration Step Size for Thrusting Phase (HR)</td>
</tr>
<tr>
<td>CINE</td>
<td>Integration Step Size for Near Earth Coasting Phase (HR)</td>
</tr>
<tr>
<td>CINNE</td>
<td>Integration Step Size for Far Earth Coasting Phase (HR)</td>
</tr>
<tr>
<td>CINL</td>
<td>Integration Step Size for Near Moon Coasting Phase (HR)</td>
</tr>
<tr>
<td>CINNL</td>
<td>Integration Step Size for Far Moon Coasting Phase (HR)</td>
</tr>
<tr>
<td>RADPRT</td>
<td>Radar Output Indicator</td>
</tr>
</tbody>
</table>

- = 1. Prints radar tracking data for all visible stations at print points
- = 2. Prints radar acquisition and termination events and time of occurrence
= 3. PRINTS RADAR OUTPUT AND RADAR EVENTS (OPTICNS 1+2)

= 4. PRINTS RADAR OUTPUT AND RADAR EVENTS (OPTICNS 1+2) PLUS VEHICLE STATE VECTOR AT EVENT POINTS (PRINT GROUPS MUST BE SET)

= 5. PRINTS RADAR OUTPUT, RADAR EVENTS, VEHICLE STATE VECTOR AT EVENTS, AND ACQUISITION TERMINATION SUMMARY IF PRRAD IS SET

PRRAD 2. 

RADAR SUMMARY PRINT AND TAPE ARE GENERATED FROM DATA COMPUTED FOR EACH RADAR STATION THAT IS TRACKING AND TERMINATES

RADAR 1 

NUMBER OF RADAR STATION STORED ON PCF TAPE OR STATION NAME AND CHARACTERISTICS IF STATIONS ARE INPUT MANUALLY

R. IF THE PRINT TAPE CONTAINING THE RADAR TRACK DATA IS TO BE SAVED FOR FURTHER PROCESSING BY ANOTHER PROGRAM, INCLUDING THE FOLLOWING INPUT QUANTITIES

ASG L = SAVE RADAR TRACKING TAPE

ASG Y = Y ASSIGN TO TAPE UNIT

PHASE (N,M) = PHASE WHERE RADAR TRACKING DATA IS GENERATED

RADAR 1 STATION NUMBERS DESIRED ON TAPE

RADPRT 5. PRINT RADAR TRACKING AND ACQ-LOSS SUMMARY GENERATE RADAR SUMMARY TAPE

PRRAD 2. GENERATE RADAR SUMMARY TAPE
0.4.9 EPHemeris Tape Generator. - This processor will be used to generate an ephemeris tape for use by the Apollo Generalized Optics Program and the work schedule processor. The standard output unit for this ephemeris is "Q" (20). The tape may be generated in conjunction with any armacr run by setting the appropriate flags.

A. Additional armacr input quantities for the ephemeris tape generator are listed below.

Phase where ephemeris output is desired

Phase (n,m) = any phase

IEphem  1  turn on ephemeris generator
Cine   1  *depending on the proximity of the earth or moon all of these should be set to the desired integration step size, since armacr outputs a point for each step.
Cinne
Cinl
Cinl

Phase where no ephemeris output is desired

Phase (n,m) = any phase

IEphem  0  turn off ephemeris output

B. *Note iephem remains on or off until reset
9.4.10 POSTFLIGHT EPHEMERIS TAPE GENERATOR. - THIS PROCESSOR WILL BE USED TO GENERATE AN EPHEMERIS TAPE FOR USE IN POSTFLIGHT ANALYSIS. THE PROCESSOR GENERATES THE VARIABLE FORMAT TAPE WHICH IS THEN REPROCESSED BY A POST PROCESSOR TO PLACE THE VARIABLES IN THE FORMAT SPECIFIED FOR POSTFLIGHT ANALYSIS.

A. ADDITIONAL ARMACR INPUT QUANTITIES FOR THE EPHEMERIS TAPE GENERATOR ARE LISTED BELOW

ASG Y = Y
ASG F = SAVE

ASSIGN TO TAPE UNIT
PCST FLIGHT EPHEMERIS TAPE

PHASE(1,0,3,1) = GENERAL PURPOSE FILE

IVECT I OCTAL VECTOR INPUT FLAG
IREFM I INPUT REFSSMAT FLAG

PHASE (N,M) = EVERY PHASE WHERE POSTFLIGHT EPHEMERIS IS GENERATED

NODRUM 1 ASSIGN INTERNAL PRINT UNIT TO UNIT Y
OSCALE 4 OUTPUT UNITS ARE FEET AND FT/SEC
VLIST (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE (MUST BE INPUT IN EVERY PHASE WHERE TAPE IS DESIRED)
IPRINT I PRINT FREQUENCY OF VARIABLE FORMAT TAPE
TOTALP -17. SUPPRESS PRINT GROUPS 1-17
TITLE -1. SUPPRESS IML PRINT BLOCK
ITHPR I PRINT FREQUENCY OF VARIABLE FORMAT TAPE FOR THRUSTING PHASES
TCINT (FP) INTEGRATION STEP SIZE FOR THRUSTING PHASE (HR)
CINE (FP) INTEGRATION STEP SIZE FOR NEAR EARTH COASTING PHASE (HR)
CINNE (FP) INTEGRATION STEP SIZE FOR FAR EARTH COASTING PHASE (HR)
CINL (FP) INTEGRATION STEP SIZE FOR NEAR MOON COASTING PHASE (HR)

CINNL (FP) INTEGRATION STEP SIZE FOR FAR MOON COASTING PHASE (HR)
### ATTITUDE OPTIONS

#### 1. ALIGN FORM THE LOCAL HORIZONTAL

<table>
<thead>
<tr>
<th>ATYPE</th>
<th>ROLL(1)</th>
<th>ROLL(2)</th>
<th>ROLL(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>(FP)</td>
<td>(FP)</td>
<td>(FP)</td>
</tr>
</tbody>
</table>

- **TYPE**: ALGIN VEHICLE FROM THE LVLH PLANE
- **ROLL(1)**: YAW ANGLE FROM THE VELOCITY VECTOR PROJECTION IN THE LVLH PLANE
- **ROLL(2)**: PITCH ANGLE FROM THE LVLH PLANE
- **ROLL(3)**: ROLL ANGLE ABOUT THE RESULTANT X-AXIS

#### 2. ALIGN USING REFSMMAT AND GIMBAL ANGLES

<table>
<thead>
<tr>
<th>ATYPE</th>
<th>ROLL(1)</th>
<th>ROLL(2)</th>
<th>ROLL(3)</th>
<th>IREFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>(FP)</td>
<td>(FP)</td>
<td>(FP)</td>
<td>1</td>
</tr>
</tbody>
</table>

- **ATYPE**: 10
- **ROLL(1)**: PITCH GIMBAL ANGLE (INNER)
- **ROLL(2)**: YAW GIMBAL ANGLE (MIDDLE)
- **ROLL(3)**: ROLL GIMBAL ANGLE (CUTER)
- **IREFM**: INPUT REFSMMAT IN GEMMV FORMAT AFTER ENDRUN CARD

If REFSMMAT is input in standard ARMACR format, include the following variables in place of IREFM

<table>
<thead>
<tr>
<th>ATYPE</th>
<th>PAXIS3</th>
<th>YAXIS3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>(FP)</td>
<td>(FP)</td>
</tr>
</tbody>
</table>

- **PAXIS3**: FIRST ROW OF REFSMMAT (THREE QUANTITIES SEPARATED BY COMMAS)
- **YAXIS3**: SECOND ROW OF REFSMMAT (THREE QUANTITIES SEPARATED BY COMMAS)
- **YAXIS3**: THIRD ROW OF REFSMMAT (THREE QUANTITIES SEPARATED BY COMMAS)
3. ALIGN FROM THE LINE-OF-SIGHT TO THE HORIZON

ATYPE 14
ALIGN VEHICLE 1 FROM THE LINE-OF-SIGHT TO THE HORIZON

RMODEL 0
SPHERICAL EARTH MODEL (NOMINAL VALUE)
1
OBLATE EARTH MODEL

LKDIR 1
ALIGN TO HORIZON FORWARD (NOMINAL VALUE)
-1
ALIGN TO HORIZON AFT

ROLL(1) (FP)
YAW ANGLE FROM ORBITAL PLANE

ROLL(2) (FP)
PITCH ANGLE FROM LINE-OF-SIGHT TO HORIZON

ROLL(3) (FP)
ROLL ANGLE ABOUT LINE-OF-SIGHT TO HORIZON

4. ALIGN THE THRUST VECTOR USING LVLH ATTITUDES, GIMBAL ANGLES, AND ENGINE TRIM ANGLES (COMPUTE REFSSMAT)

ATYPE 3
ALIGN VEHICLE 1 FROM LVLH PLANE

ROLL(1) (FP)
YAW ANGLE FROM THE VELOCITY VECTOR PROJECTION IN THE LVLH PLANE

ROLL(2) (FP)
PITCH ANGLE FROM THE LVLH PLANE

ROLL(3) (FP)
ROLL ANGLE ABOUT THE RESULTANT X-AXIS

IPTYPE 3
REALIGN THE IMU

GC12 10
ALIGN THE IMU SO THAT THE GIMBAL ANGLES SPECIFIED IN G057 ARE ATTAINED

G057 (FP)
PITCH, YAW, AND ROLL GIMBAL ANGLES DESIRED AFTER REALIGNMENT OF THE IMU (THREE QUANTITIES SEPARATED BY COMMAS)

IALIGN 0
DEFLECT THE VEHICLE FROM THE THRUST VECTOR BY THE ENGINE DEFLECTION ANGLES

ENDFPA (FP)
ENGINE PITCH TRIM ANGLE (CONSTANT VALUE)
ENGINE YAW TRIM ANGLE (CONSTANT VALUE)

GUIDANCE OPTIONS

1. EXTERNAL DELTA V

IPTYPE 2

EXTERNAL DELTA V (INPUT) TARGETING (USED IN PRECOMPUTE PHASE PRIOR TO AN EXTERNAL DELTA V MANEUVER)

G022 0

EXTERNAL DELTA V FLAG
- 2 INPUT P-30'S IN LVLH
- 3 INPUT P-40'S IN LVLH
- 4 INPUT VELOCITY INCREMENT IN ECI OR MCI
- 5 INPUT VELOCITY-TO-BE-GAINED ECI OR MCI

G023 (FP)

CROSS PRODUCT STEERING CONSTANT

G027 (FP)

SPS THRUST MAGNITUDE USED IN THE ONBOARD GUIDANCE LOGIC

G027 (FP)

TIME OF SPS IGNITION IN HRS (G.E.T.)

G037 (FP)

EXTERNAL DELTA V COMPONENTS (VX, VY, VZ)

INAV 1

AVERAGE-G INTEGRATION ROUTINE, INITIALIZING TO ACTUAL STATE VECTOR

2. ORBITAL RATE

ITURN 2

MAINTAIN THE VEHICLE LVLH ATTITUDE SPECIFIED IN THE ALIGNMENT OPTION

3. OPEN LOOP

IPTYPE 11

CALLS OPEN LOOP STEERING

TTR (FP)

THRUST DURATION IN SECONDS

XMTMOV (FP)

TOTAL DELTA V GAINED IN A PARTICULAR PHASE

TXMTMOV (FP)

TOTAL DELTA V GAINED DURING A SUCCESSION OF THREE THRUSTING PHASES (ULLAGE + STEADY STATE + TAILOFF). IN SPS STEADY STATE PHASE INCLUDE G023 AND G025.

9-42
IDELVX 1
TERMINE THRUSTING WHEN DELTA V ALONG X-AXIS EQUALS XMTOV

0
TERMINE THRUSTING WHEN DELTA V ALONG VELOCITY VECTOR EQUALS XMTOV

<table>
<thead>
<tr>
<th>PRIMARY PHASE TERMINATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE OF TERMINATION</td>
</tr>
<tr>
<td>CRBIT COUNT</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>CENTRAL BODY LONGITUDE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ALTITUDE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>INERTIAL FLIGHT-PATH ANGLE</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PERIAPSIS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>APOLAPSIS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PHASE TIME LAPSE</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

9-43
<table>
<thead>
<tr>
<th>GECOGRAPHIC FLIGHT PATH ANGLE</th>
<th>19</th>
<th>EARTH</th>
<th>GAMETH - DESIRED EARTH RELATIVE FLIGHT PATH ANGLE (DEG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO PHASE TIME LAPSE</td>
<td>23</td>
<td>MOON</td>
<td>TTR = 0. ZER0 PHASE TIME LAPSE</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>EARTH</td>
<td></td>
</tr>
</tbody>
</table>

UNITS OF INPUT AND OUTPUT QUANTITIES

<table>
<thead>
<tr>
<th>ISCALE</th>
<th>CONTROLS THE UNITS OF INPUT QUANTITIES. DISTANCE IS MEASURED IN THE UNITS BELOW, AND VELOCITY IN THOSE UNITS PER SECOND</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>= 1 KILOMETERS</td>
</tr>
<tr>
<td></td>
<td>= 2 INTERNATIONAL STATUTE MILES</td>
</tr>
<tr>
<td></td>
<td>= 3 U.S. NAUTICAL MILES</td>
</tr>
<tr>
<td></td>
<td>= 4 INTERNATIONAL FEET</td>
</tr>
<tr>
<td></td>
<td>= 5 DISTANCE IS MEASURED IN EARTH RADII AND VELOCITY IN EARTH RADII PER HOUR</td>
</tr>
<tr>
<td></td>
<td>= 6 DISTANCE IS MEASURED IN INTERNATIONAL STATUTE MILES AND VELOCITY IN INTERNATIONAL FEET PER SECOND.</td>
</tr>
<tr>
<td></td>
<td>= 7 DISTANCE IS MEASURED IN U.S. NAUTICAL MILES AND VELOCITY IN INTERNATIONAL FEET PER SECOND.</td>
</tr>
</tbody>
</table>

9-44
OSCALE I

CONTROLS THE UNITS OF OUTPUT QUANTITIES. DISTANCE IS MEASURED IN THE UNITS BELOW, AND VELOCITY IN THOSE UNITS PER SECOND.

= 1 KILOMETERS

= 2 INTERNATIONAL STATUTE MILES

= 3 U.S. NAUTICAL MILES

= 4 INTERNATIONAL FEET

= 5 DISTANCE IS MEASURED IN EARTH RADIi AND VELOCITY IN EARTH RADIi PER HOUR.

= 6 DISTANCE IS MEASURED IN INTERNATIONAL STATUTE MILES AND VELOCITY IN INTERNATIONAL FEET PER SECOND.

= 7 DISTANCE IS MEASURE IN U.S. NAUTICAL MILES AND VELOCITY IN INTERNATIONAL FEET PER SECOND.

EARTH AND MCON REFERENCE OPTIONS

INJECT I

SUGGESTS REFERENCE BODY AND INPUT COORDINATE SYSTEM

= 10 INERTIAL GEOCENTRIC CARTESIAN RESTART COORDINATES
RXYZ = X, Y, Z COMPONENTS OF RESTART POSITION IN UNITS OF EARTH RADIUS (DOUBLE PRECISION)
RDXYZ = X, Y, Z COMPONENTS OF RESTART VELOCITY IN UNITS OF EARTH RADIUS PER HOUR (DOUBLE PRECISION)

= 11 INERTIAL GEOCENTRIC CARTESIAN COORDINATES, ISCALE CONTROL
INPUT UNITS.
X = X COMPONENT OF POSITION
Y = Y COMPONENT OF POSITION
Z = Z COMPONENT OF POSITION
DX = X COMPONENT OF VELOCITY
DY = Y COMPONENT OF VELOCITY
DZ = Z COMPONENT OF VELOCITY

= 20 INERTIAL SELENCENTRIC CARTESIAN RESTART COORDINATES
RXYZ = X,Y,Z COMPONENTS OF RESTART POSITION IN UNITS OF EARTH RADII (DOUBLE PRECISION)
RDXYZ = X,Y,Z COMPONENTS OF RESTART VELOCITY IN UNITS OF EARTH RADII PER HOUR (DOUBLE PRECISION)

= 21 INERTIAL SELENCENTRIC CARTESIAN COORDINATES. ISCALE CONTROLS INPUT UNITS.
XL = X COMPONENT OF POSITION
YL = Y COMPONENT OF POSITION
ZL = Z COMPONENT OF POSITION
DXL = X COMPONENT OF VELOCITY
DYL = Y COMPONENT OF VELOCITY
DZL = Z COMPONENT OF VELOCITY
10. OPERATING INSTRUCTIONS FOR THE APOLLO REFERENCE MISSION PROGRAM (ARMACR) POST PROCESSORS.

10.1 GENERAL

THE ARMACR POST PROCESSOR IS A PROGRAM THAT IS AUTOMATICALLY EXECUTED AFTER THE ARMACR TRAJECTORY PROGRAM HAS GENERATED AND STORED THE NECESSARY INPUT DATA ON A TAPE. THERE ARE PRESENTLY THREE POST PROCESSORS REPORT GENERATOR (GROUND TRACK, RELATIVE MOTION, REFSSMAT TO REFSSMAT, DOCKED ALIGNMENT, OPEN HATCH THERMAL CONTROL), APOLLO REENTRY SIMULATION (ARS), AND THE GUIDANCE OPTICAL SIGHTING TABLE (GOST).

10.2 THE ARMACR POST PROCESSORS

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE ARMACR POST PROCESSORS ALONG WITH A LISTING OF THE CONTROL CARDS AND THE ON-LINE INPUTS REQUIRED TO OPERATE EACH PROCESSOR.
10.2.1 REPORT GENERATOR PROCESSOR. - THIS PROCESSOR IS USED TO OUTPUT TABULAR DATA IN A DESIRED FORMAT. THE DATA, A MAXIMUM OF 13 VARIABLES PER TABLE, ARE OBTAINED FROM THE VARIABLE FORMAT TAPE GENERATED BY ARMACR AND OUTPUT IN THE FORMAT SPECIFIED IN THE REPORT GENERATOR.

A. TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>REPORT GENERATOR (PCF) PROGRAM TAPE</td>
</tr>
<tr>
<td>F</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>I</td>
<td>EPHEMERIS TAPE</td>
</tr>
<tr>
<td>R</td>
<td>ARMACR PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>U</td>
<td>DATA TAPE</td>
</tr>
<tr>
<td>Y</td>
<td>SCRATCH TAPE</td>
</tr>
</tbody>
</table>
B. CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1  4  8
MSG
ASG A=XXXX

ASG F
ASG I=$EPHEM

ASG R=XXXX
ASG U=XXXX
ASG Y
XQT CUR

TRW R
IN R

EN XQT ARMACR

ENDRUN
XQT CUR

ERS

TRW A
IN A

TRI A

N XQT REPORT

EDF

COMMENTS
REPORT GENERATOR PROGRAM
(PCF) TAPE
SCRATCH TAPE
SINGLE PRECISION EPHEMERIS TAPE
ARMACR PROGRAM (PCF) TAPE
ARMACR DATA TAPE
SCRATCH TAPE
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND UNIT R
INPUT THE ENTIRE USER PCF FROM UNIT R

SOURCE LANGUAGE CORRECTIONS (PATCHES)

ARMACR DATA CARDS

END CF ARMACR DATA
EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY
REWIND UNIT A
INPUT THE ENTIRE USER PCF FROM UNIT A
REWIND UNIT A WITH INTERLOCK
EXECUTE REPORT GENERATOR

REPORT GENERATOR DATA CARDS

END OF FILE CARD
C. Inputs to the Report Generator Processor. The four option cards are listed below with the remaining format cards contained in the on-line decks.

COLUMN

Card 1 1-3 Number of Cases (integer)

4-6 Option to start processing the Nth record instead of the first record (used in conjunction with card 4) and to create only one table for multiple phases.

= 0 No option

= 1 Begin processing with the Nth record, and create only one table per case

= 2 Begin processing with the Nth record, but begin table headings on a new page for each phase

7-9 File number on the data tape in which cards 5-40 are located.

= N File number

= 0 Cards 5-40 are read from card reader

Card 2 1-3 Number of Tables (integer)

4-6 Total number of phases (integer)

Positive number = phase to be processed are listed on card 3

Negative number = absolute value is number of consecutive phases to be processed starting with phase specified in col 1-2 of card 3.

Card 3 1-2 First phase to be processed

3-4 Successive phases to be processed

5-6 If the number in columns 4-6 of card 2 is positive

Card 4 1-3 Data records to be used for each phase

= Positive or zero, the data record to be used for additional phases must be specified in col 4-73.

= -1, same data record option for all phase

= -2,-3,-4,etc., every 2nd,3rd,4th, etc., data record will be used to generate the table

10-4
CARD 5-N  THE FORMAT CARDS ARE SET IN THE
APPROPRIATE ON-LINE DECKS.

CARD 40 1-6  THE FOLLOWING CONVERSION
7-12 OPTIONS AVAILABLE IN ADDITION TO
THOSE LISTED ON 15-30

D. INPUTS TO GROUND TRACK PROCESSOR (ARMACR) ARE LISTED BELOW

PHASE(N,M) = PHASE WHERE GROUND TRACK IS CALLED

TCINT  (FP)  INTEGRATION STEP SIZE FOR THRUSTING
            PHASE (SEC)

CINF   (FP)  INTEGRATION STEP SIZE FOR NEAR-EARTH
            COASTING PHASE (HR)

CINNE  (FP)  INTEGRATION STEP SIZE FOR FAR-EARTH
            COASTING PHASE (HR)

CINL   (FP)  INTEGRATION STEP SIZE FOR NEAR-MOON
            COASTING PHASE (HR)

CINNL  (FP)  INTEGRATION STEP SIZE FOR FAR-MOON
            COASTING PHASE (HR)

IPRINT 1  PRINT FREQUENCY MULTIPLIER

OSCALE 7  OUTPUT UNITS ARE N MI AND FPS

TOTALP -17. SUPPRESS ARMACR PRINT

TITLE -1. SUPPRESS ARMACR PRINT

VLIST1 (BCD) VARIABLE TO BE WRITTEN ON THE VARIABLE
FORMAT TAPE =T,KDAYS,KHRS,KMIN,SEC,ALT,ENDLST

F. INPUTS TO THE RELATIVE MOTION PROCESSOR (ARMACR). THIS
PROCESSOR WILL BE USED TO COMPUTE THE RELATIVE MOTION OF
TWO VEHICLES AND OUTPUT THE RELATIVE MOTION DIGITALS DIS-
PLAY. THE INPUTS ARE LISTED BELOW.

PHASE(N,M) = PHASE WHERE RELATIVE MOTION IS CALLED

TCINT  (FP)  INTEGRATION STEP SIZE FOR THRUSTING
            PHASE (SEC)

CINE   (FP)  INTEGRATION STEP SIZE FOR NEAR-EARTH
            COASTING PHASE (HR)
CINNE (FP) INTEGRATION STEP SIZE FOR FAR-EARTH COASTING PHASE (HR)
CINL (FP) INTEGRATION STEP SIZE FOR NEAR-MOON COASTING PHASE (HR)
CINNL (FP) INTEGRATION STEP SIZE FOR FAR-MOON COASTING PHASE (HR)
IPRINT I PRINT FREQUENCY MULTIPLIER
OSCALE 7 OUTPUT UNITS ARE N MI AND FPS
TOTALP -17 SUPPRESS ARMACR PRINT
TITLE -1 SUPPRESS ARMACR PRINT
VLST1 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE
                     =I, RANGE, RRATE, RCZ, RCX, RCY, ENDLST

F. INPUTS (ARMACR) TO THE REFSMATA MAT TO REFSMATA MAT PROCESSOR. THIS
PROCESSOR COMPUTES A LVLH SPACECRAFT (CSM AND/OR LM) ATTITUDE
BASED ON A PREFERRED REFSMATA MAT AND 0,0,0 GIMBAL ANGLES. THIS LVLH ATTITUDE
AND A NEW INPUT REFSMATA MAT ARE USED TO COMPUTE THE CORRESPONDING GIMBAL
ANGLES.

PHASE (N, M) = ALIGN TO PREFERRED LVLH ATTITUDE

*ATYPE(I) 10 ALIGN SPACECRAFT BASED ON REFSMATA MAT
           AND GIMBAL ANGLES
IVECT I READ STATE VECTOR IN 1004 FORMAT
       =1 INPUT ONE VECTOR
       =2 INPUT TWO VECTORS
ROLL1 (FP) GIMBAL ANGLES SET TO 0,0,0,0.
            (IGA, MGA, OGA)
IREFM I INPUT PREFERRED REFSMATA MAT IN 1004 FORMAT
       = 1 ONE REFSMATA MAT WILL BE INPUT
       = 2 TWO REFSMATA MATS WILL BE INPUT
GETHRS (FP) TIME (HR, MIN, SEC) AT WHICH GIMBAL
            ANGLE COMPUTATION IS DESIRED
BGEND 1 PRINT FIRST AND LAST POINT IN EACH PHASE
NV I NUMBER OF VEHICLES
VLST1 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE FOR VEHICLE 1
            =IGA, MGA, OGA, RFID11, RFID12, ENDLST* 10-6
VLIST2 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE FOR VEHICLE 2
=IGA, MGA, OGA, RFID21, RFID22, ENDLST*

PHASE (N+1,M) = COMPUTE IMU GIMBAL ANGLES BASED ON NEW INPUT REFSMMAT

*ATYPE(I+2) 2
ALIGN IMU BASED ON INPUT REFSMMAT

IREFM 1
INPUT PREFERRED REFSMMAT IN 1004 FORMAT
= 1 ONE REFSMMAT WILL BE INPUT
= 2 TWO REFSMMATS WILL BE INPUT

VLIST1 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE FOR VEHICLE 1
=IGA, MGA, OGA, RFID11, RFID12, ENDLST*

VLIST2 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE FOR VEHICLE 2
=IGA, MGA, OGA, RFID21, RFID22, ENDLST*

PHASF (N+2,M) = TERMINATE RUN

NTAPE 0 
FLAG TO TERMINATE RUN

ENDRUN

VECTOR FOR VEHICLE ONE
VECTOR FOR VEHICLE TWO
PREFERRED REFSMMAT ONE
PREFERRED REFSMMAT TWO
NEW REFSMMAT ONE
NEW REFSMMAT TWO

*NOTE - THE LETTER I IS THE NUMBER OF THE VEHICLE. (I=1 FOR CSM, AND 2 FOR LM)

**NOTE - IF TWO VEHICLES ARE INPUT AND THE VECTORS ARE NOT AT THE SAME TIME, A PHASE MUST BE INCLUDED, PRIOR TO THE LVLH ALIGNMENT PHASE, IN WHICH THE EARLIER VECTOR IS COASTED UP TO THE TIME OF THE LATER VECTOR.
G. INPUTS (ARMACR) TO THE DOCKING ALIGNMENT PROCESSOR. THIS
PROCESSOR WILL BE USED TO COMPUTE EITHER LM IMU GIMBAL
ANGLES AND FDAI ANGLES, A LM REFSSMAT, OR CSM IMU GIMBAL
ANGLES WHILE IN A DOCKED CONFIGURATION. THE IMU GIMBAL
ANGLES OF ONE VEHICLE CAN BE COMPUTED FROM THE GIMBAL
ANGLES AND REFSSMAT OF THE SECOND VEHICLE AND THE REFSSMAT
OF THE FIRST VEHICLE. IN ADDITION, A LM REFSSMAT CAN BE
COMPUTED FROM THE LM GIMBAL ANGLES AND THE CSM GIMBAL
ANGLES AND REFSSMAT.

LM GIMBAL ANGLE COMPUTATION

PHASE (1,0,3,1) = FIRST COAST PHASE

ROLL1 (FP) CSM IMU GIMBAL ANGLES (IGA,MGA,OGA)
*TOTALP -17 SUPPRESS ARMACR PRINT
*IREFM 1 INPUT CSM REFSSMAT IN 1004 FORMAT

PHASE (2,2) = SECOND COAST PHASE

*INJECT 31 DOCKED VEHICLE CONFIGURATION
*ATYPE(2) 2 ALIGN LM TO NOMINAL DOCKED CONFIGURATION
*ROLL2 (FP) NOMINAL DOCKED CONFIGURATION (SET TO 180,0,120.)
*IMASS(2) 999 VEHICLE TWO DUMMY WEIGHT

PHASE (3,2) = THIRD COAST PHASE

ROLL(6) (FP) NEGATIVE OF ROLL DOCKING ANGLE OFFSET
*ATYPE(2) 2 ALIGN LM TO DOCKING ANGLES

PHASE (4,2) = FOURTH COAST PHASE

*IREFM 1 INPUT LM REFSSMAT IN 1004 FORMAT
*VLIST1 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE
*VLIST2 (BCD) VARIABLES TO BE WRITTEN ON THE
=IGA,MGA,OGA,RFID11,RFID12,ENDLST*
VARIABLE FORMAT TAPE
=IGA,MGA,OGA,RFID21,RFID22,ENDLST*
10-8
PHASE (5,2) = FIFTH COAST PHASE
*NTAPE 0 TERMINATE RUN
ENDRUN

CSM 1004 REFSMMAT
LM 1004 REFSMMAT

LM REFSMMAT COMPUTATION

PHASE (1,0,3,1) = FIRST COAST PHASE

ROLL1 (FP) CSM IMU GIMBAL ANGLES (IGA, MGA, OGA)
*TOTALP -17. SUPPRESS ARMACR PRINT
*IREFM 1 INPUT CSM REFSMMAT IN 1004 FORMAT

PHASE (2,2) = SECOND COAST PHASE

*INJECT 31 DOCKED VEHICLE CONFIGURATION
*ATYPE(2) 2 ALIGN LM TO NOMINAL DOCKED CONFIGURATION
*ROLL2 (FP) NOMINAL DOCKED CONFIGURATION (SET TO 180., 0., 120.)
*IMASS(2) 999. VEHICLE TWO DUMMY WEIGHT

PHASE (3,2) = THIRD COAST PHASE

ROLL(6) (FP) NEGATIVE OF ROLL DOCKING ANGLE OFFSET
*ATYPE(2) 2 ALIGN LM TO DOCKING ANGLES

PHASE (4,2) = FOURTH COAST PHASE

GO57 (FP) LM IMU GIMBAL ANGLES (IGA, MGA, OGA)
*IPTYPE 3 IMU ALIGNMENT
ALIGN IMU ONLY
CALCULATE REFSMMAT
VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE =IGA,MGA,OGA,RFID11,RFID12,ENDLST*
VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE =IGA,MGA,OGA,RFID21,RFID22,XIMUX2, XIMUY2,XIMUZ2,YIMUX2,YIMUY2,YIMUZ2,ZIMUX2,ZIMUY2,ZIMUZ2,ENDLST*

PHASE (5,2) = FIFTH COAST PHASE

TERMINATE RUN

CSM 10C4 REFSMMAT

CSM GIMBAL ANGLE COMPUTATION

PHASE (1,3,1) = FIRST COAST PHASE

SUPPRESS ARMACR PRINT

PHASE (2,2) = SECOND COAST PHASE

DOCKED VEHICLE CONFIGURATION

VEHICLE TWO DUMMY WEIGHT

PHASE (3,2) = THIRD COAST PHASE

LM IMU GIMBAL ANGLES (IGA,MGA,OGA)

INPUT LM REFSMMAT IN 1004 FORMAT

ALIGN LM TO REFSMMAT AND IMU GIMBAL ANGLES

10-10
PHASE (4,2) = FOURTH COAST PHASE

*INJECT 30 ALIGN CSM TO LM
*ATYPE 2 ALIGN CSM TO NOMINAL DOCKED CONFIGURATION.
*RROLL (FP) NOMINAL DOCKED CONFIGURATION (SET TO 180., C., 120.)

PHASE (5,2) = FIFTH COAST PHASE

ROLL(3) (FP) NEGATIVE OF ROLL DOCKING ANGLE OFFSET
*ATYPE 2 ALIGN WITH DOCKING ANGLES

PHASE (6,2) = SIXTH COAST PHASE

ROLL 2 (FP) LM IMU GIMBAL ANGLES (IGA, MGA, OGA)
*INJECT 31 DOCKED VEHICLE CONFIGURATION
*IREFM 2 INPUT LM AND CSM REFSMMAT IN 1004
*ATYPE(2) 10 ALIGN LM TO REFSMMAT AND IMU GIMBAL ANGLES
*VLIST1 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE
=IGA, MGA, OGA, RFID11, RFID12, ENDLST*
*VLIST2 (BCD) VARIABLES TO BE WRITTEN ON THE VARIABLE FORMAT TAPE
=IGA, MGA, OGA, RFID21, RFID22, ENDLST*

PHASE (7,2) = SEVENTH COAST PHASE

*NTAPE 0 TERMINATE RUN

ENDRUN

LM 1004 REFSMMAT
CSM 1004 REFSMMAT
LM 1004 REFSMMAT

*NOTE - THESE INPUTS ARE ALREADY SET IN THE ON-LINE DECKS.
H. INPUTS (ARMACR) TO THE OPEN HATCH THERMAL CONTROL PROCESSOR ARE NOT AVAILABLE AT THIS TIME.
ARS PROCESSOR. - THE APOLLO REENTRY SIMULATION PROCESSOR WILL BE USED TO ACCEPT A STATE VECTOR AT 425,000 FEET AND COMPUTE THE NECESSARY GUIDED ENTRY PROFILE TO HIT A TARGET LATITUDE AND LONGITUDE. THE STATE VECTOR IS GENERATED BY ONE OF THE ARMACR PROCESSORS AND IS WRITTEN INTO A 200-WORD RECORD WHICH INTERFACES WITH THE ARS PROCESSOR. OPTIONS EXIST WITHIN THE PROCESSOR TO USE ONE OF SIX DIFFERENT ENTRY MODES WHICH ARE DESCRIBED BELOW.

MODE 1 - AUTOMATIC GUIDANCE AND NAVIGATION CONTROL

IN THIS STEERING MODE, THE ARS PROCESSOR USES THE CMC ENTRY LOGIC TO COMPUTE THE ENTRY STEERING COMMANDS AND TO SIMULATE THE ENTRY TRAJECTORY REQUIRED TO ACHIEVE THE TARGET LANDING POINT.

MODE 2 - OPEN LOOP FOLLOWED BY GUIDANCE AND NAVIGATION CONTROL

IN THIS ENTRY MODE, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL, AT WHICH TIME THE CM IS ROLLED TO A SECOND BANK ANGLE, DESIGNATED AS THE BACKUP BANK ANGLE. THIS ATTITUDE IS MAINTAINED UNTIL THE SECOND G-LEVEL IS REACHED. FROM THIS TIME UNTIL DROGUE CHUTE DEPLOYMENT, THE ARS PROCESSOR USES THE GUIDANCE AND NAVIGATION CONTROL LOGIC TO COMPUTE THE STEERING COMMANDS NECESSARY TO ACHIEVE THE TARGET LANDING POINT. THIS STEERING MODE REQUIRES THE INPUT OF AN INITIAL AND BACKUP BANK ANGLE AND TWO G-LEVELS.

MODE 3 - BANK/REVERSE-BANK

IN THIS ENTRY MODE, WHICH IS USED TO COMPUTE BACKUP GUIDANCE QUANTITIES, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL. IT IS THEN FOLLOWED BY A BACKUP BANK ANGLE TO A COMPUTED TIME TO REVERSE BANK, AND THE REVERSE BANK ANGLE IS FLOWN TO DROGUE CHUTE DEPLOYMENT. IN THIS STEERING MODE, THE INITIAL BANK ANGLE AND G-LEVEL ARE INPUT, AND THE BACKUP BANK ANGLE AND TIME TO REVERSE BANK ARE COMPUTED BY THE ARS PROCESSOR.

MODE 4 - COMBINED BANK/REVERSE-BANK AND GUIDANCE AND NAVIGATION CONTROL

THIS ENTRY MODE IS THE SAME AS THAT DESCRIBED IS THE SECOND STEERING MODE WITH THE EXCEPTION THAT THE PROCESSOR COMPUTES THE BACKUP BANK ANGLE. THE INPUTS CONSIST OF THE INITIAL BANK ANGLE AND THE TWO G-LEVELS.

MODE 5 - ROLLING

IN THIS ENTRY, AN INITIAL BANK ANGLE IS MAINTAINED FROM 400,000 FEET TO A SPECIFIED G-LEVEL FOLLOWED BY A CONSTANT ROLL RATE TO DROGUE CHUTE DEPLOYMENT. THIS MODE REQUIRES THE INPUT OF THE INITIAL BANK ANGLE, G-LEVEL, AND ROLL RATE.
**MODE 6 - OPEN LOOP**

This entry can either be a bank/reverse-bank as described in the third steering mode or a constant bank-angle entry from 400,000 feet to drogue chute deployment. The bank/reverse-bank option of this steering mode requires the input of the initial and backup bank angles, the g-level, and the time to reverse bank. A constant bank angle entry can be specified by inputting the value of the bank angle to be used as the initial bank angle and inputting the g-level and time to reverse bank as large values.

**A. TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM**

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>EPHEMERIS TAPE</td>
</tr>
<tr>
<td>K</td>
<td>SCRATCH UNIT ON FASTRAND</td>
</tr>
<tr>
<td>R</td>
<td>ARMACR PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>U</td>
<td>MISSION DATA TAPE</td>
</tr>
<tr>
<td>V</td>
<td>SCRATCH TAPE</td>
</tr>
<tr>
<td>T</td>
<td>ARS PROGRAM (PCF) TAPE</td>
</tr>
</tbody>
</table>
CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM.

COLUMN 1 4 8
* MSG
   ASG I = $EPHEM
   ASG K
   ASG R = XXXX
   ASG T = XXXX
   ASG U = XXXX
   ASG V
   XQT CUR
      TRW R
      IN R
      TRI R
      N XQT ARMACR
      PHASE (M, N, O, P)

  ...

COLUMN 1
PHASE (M, N)
  ...
  ENDRUN

  ...

XQT
ERS
TRW T
IN T
XQT COLSUS/XXX

COMMENTS
EMPHEMERIS TAPE UNIT
SCRATCH UNIT ON FASTRAND
ARMACR PROGRAM (PCF) TAPE
NUMBER
ARS PROGRAM (PCF) TAPE
UNIT
MISSION DATA TAPE NUMBER
SCRATCH UNIT (200-WORD
RECORD)
EXECUTE THE FOLLOWING
INSTRUCTIONS
REWIND UNIT R
INPUT THE ENTIRE USER PCF
FROM UNIT R
REWIND UNIT R WITH
INTERLOCK
EXECUTE ARMACR PROGRAM
M IS THE PHASE NUMBER
N IS THE PHASE TYPE
O IS THE DATE UPDATE
NUMBER
P IS THE FILE NUMBER OF
THE DATA TAPE

ARMACR UPDATES FOR PHASE 1

ARMACR UPDATES FOR PHASE M

LAST CARD IN THE ARMACR
PHASE UPDATES
INPUT OCTAL VECTOR FROM
1004
INPUT REFERMATT FROM 1004
EXECUTE THE FOLLOWING
INSTRUCTIONS
ERASE LAST PROGRAM FROM
MEMORY
REWIND UNIT T
INPUT THE ENTIRE USER PCF
FROM UNIT T
EXECUTE ARS PROGRAM ISCS
FOR BACKUP MODES AND DAP
FOR G AND N ENTRIES

10-16
ENDRUN
EOF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1

ARS DATA CARDS
LAST CARD OF THE ARS DATA CARDS
END OF FILE CARD
C. INPUTS TO ARS PROCESSORS

ADDITIONAL ARMACR INPUT QUANTITIES FOR THE ARS PROCESSOR ARE LISTED BELOW

PHASE (1,0,3,P) = ANY FILE FOR ARS ENTRY

<table>
<thead>
<tr>
<th>ARS(38) (FP)</th>
<th>ARS(48)</th>
<th>ARS(90) (FP)</th>
<th>ARS(95) (FP)</th>
<th>ARS(49) (FP)</th>
<th>ARS(50) (FP)</th>
<th>ARS(99) (FP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTRY WEIGHT (SET TO 12425.0 ON TAPE)</td>
<td>1. PREBURN SUMMARY SHEET</td>
<td>FOOTPRINT OPTION = 0. DO NOT COMPUTE FOOTPRINT = 1. COMPUTE FOOTPRINT</td>
<td>EMS INITIALIZATION G-LEVEL OR ALTITUDE (SET TO 0.05G IN ARS PROGRAM)</td>
<td>LAD (SET TO 0.27 ON TAPE)</td>
<td>LOD (SET TO 0.207 ON TAPE)</td>
<td>DIRECTION TO BEGIN BANK = 0 SOUTH THEN NORTH = 1 NORTH THEN SOUTH</td>
</tr>
</tbody>
</table>

PHASE (N,M) = ANY PHASE

INTFC I 200-WORD RECORD FLAG
THIS 200-WORD ARRAY CONTAINS THE INFORMATION NECESSARY TO WRITE THE INTERFACE RECORD USED TO INITIATE OTHER PROGRAMS ARMACR COMPUTES WORDS 1-37 AND 130-136. ALL OTHER WORDS WILL BE ZERO UNLESS THEY HAVE BEEN INPUT.
= 0 THE 200-WORD RECORD WILL NOT BE WRITTEN. = N THE 200-WORD RECORD WILL BE WRITTEN FOR VEHICLE (N), WHERE N = 1 OR 2, AT THE TERMINAL POINT OF THE PHASE IN WHICH INTFC IS INPUT.

MODE 1 - AUTOMATIC GUIDANCE AND NAVIGATION CONTROL

PHASE (1,0,3,P) = ANY FILE FOR ARS ENTRY

<table>
<thead>
<tr>
<th>ARS(38)</th>
<th>ARS(40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTOMATIC GUIDANCE AND NAVIGATION CONTROL STEERING MODE</td>
<td>XIGS</td>
</tr>
</tbody>
</table>

10-18
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE

MODE 2 – OPEN LOOP FOLLOWED BY GUIDANCE AND NAVIGATION CONTROL

PHASE (1,0,3,P) = ANY FILE FOR ARS ENTRY

ARS(39) 2. OPEN LOOP WITH G AND N TAKEOVER
ARS(40) (FP) X1 G'S (SET TO 1.0 CN TAPE)
ARS(41) (FP) INITIAL BANK TO X1 G'S (SET TO 180.0 ON TAPE)
ARS(42) (FP) X2 G'S
ARS(43) (FP) BACKUP BANK TO X2 G'S
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE

MODE 3 BANK/REVERSE-BANK

PHASE (1,0,3,P) = ANY FILE FOR ARS ENTRY

ARS(39) 3. BANK/REVERSE-BANK
ARS(40) (FP) X1 G'S (SET TO 1.0 CN TAPE)
ARS(41) (FP) INITIAL BANK TO X1 G'S (SET TO 180.0 ON TAPE)
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE

MODE 4 COMBINED BANK/REVERSE-BANK AND GUIDANCE AND NAVIGATION CONTROL

PHASE(1,0,3,P) = ANY FILE FOR ARS ENTRY

ARS(39) 4. COMBINED BANK/REVERSE-BANK AND GUIDANCE AND NAVIGATION CONTROL
ARS(40) (FP) X1 G'S (SET TO 1° CN TAPE)
ARS(41) (FP) INITIAL BANK TO X1 G'S (SET TO 180° ON TAPE)
ARS(42) (FP) X2 G'S
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE

MODE 5 ROLLING

PHASE(1,0,3,P) = ANY FILE FOR ARS ENTRY

ARS(39) 5. ROLLING
ARS(40) (FP) X1 G'S (SET TO 1° CN TAPE)
ARS(41) (FP) INITIAL BANK TO X1 G'S (SET TO 180° ON TAPE)
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE

MODE 6 OPEN LOOP

PHASE(1,0,3,P) = ANY FILE FOR ARS ENTRY

ARS(39) 6. OPEN LOOP
ARS(40) (FP) X1 G'S (SET TO 1° CN TAPE)
ARS(41) (FP) INITIAL BANK TO X1 G'S (SET TO 180° ON TAPE)
ARS(43) (FP) BACKUP BANK TO GETHRS
ARS(44) (FP) GETRR (TIME TO REVERSE BANK SEC)
ARS(52) (FP) TARGET LONGITUDE
ARS(53) (FP) TARGET LATITUDE
10.2.3 GOST PROCESSOR. - THIS PROCESSOR WILL PRIMARILY BE USED TO VERIFY THE CM IMU STABLE MEMBER ALIGNMENT MADE BY USING THE CNBOARD OPTICAL SIGHTING EQUIPMENT CONSISTING OF A SCANNING TELESCOPE, A SEXTANT, AND A BORE SIGHT. BY USING A CATALOG OF STAR AND EARTH FIXED LANDMARK LOCATIONS, THIS PROCESSOR WILL CALCULATE IMU GIMBAL ANGLES, REFSSMATS, AND THE SHAFT AND TRU Nin angles of the optical equipment. The processor has several options which may be used to determine the position of stars on the instrument reticles, to determine the necessary spacecraft attitude for viewing a ground target, to determine REFSSMAT, and to determine IMU gimbAL angles.
A. TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>GEMMV PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>I</td>
<td>EPHEMERIS TAPE UNIT</td>
</tr>
<tr>
<td>R</td>
<td>ARMACR PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>U</td>
<td>MISSION DATA TAPE</td>
</tr>
<tr>
<td>V</td>
<td>SCRATCH TAPE (200-WORD RECORD)</td>
</tr>
</tbody>
</table>

B. CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

**COLUMN 1 4 8**

<table>
<thead>
<tr>
<th>MSG</th>
<th>ASG A = XXXX</th>
<th>ASG I = $EPHEM</th>
<th>ASG R = XXXX</th>
<th>ASG U = XXXX</th>
<th>ASG V</th>
</tr>
</thead>
<tbody>
<tr>
<td>XQT CUR</td>
<td>TRW R</td>
<td>IN R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N XQT ARMACR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENDRUN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMENTS**

EXECUTE THE FOLLOWING INSTRUCTIONS

REWIND UNIT R

INPUT THE ENTIRE USER PCF FROM UNIT R

SCURCE LANGUAGE CORRECTIONS (PATCHES)

EXECUTE ARMACR PROGRAM

ARMACR UPDATES

LAST ARMACR DATA CARD

EXECUTE THE FOLLOWING INSTRUCTIONS

ERASE LAST PROGRAM FROM MEMORY

POSITION TAPE A TO A END OF FILE

POSITION TAPE A TO A END OF FILE

INPUT THE ENTIRE USER PCF FROM UNIT A

REWIND UNIT I

EXECUTE GOST PROGRAM

GOST DATA CARDS

END OF FILE CARD

*INDICATES 7/8 OVERPUNCH IN COLUMN 1*
A. THE INPUT QUANTITIES FOR THE ARMACR PART OF THE PROCESSOR ARE THE SAME FOR ALL GOST OPTIONS (WITH TWO EXCEPTIONS WHICH ARE INDICATED). THE STANDARD INPUT QUANTITIES ARE LISTED BELOW.

PHASE (1,0,3,1) = INITIAL COAST PHASE

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVECT</td>
<td>OCTAL VECTOR INPUT FLAG</td>
</tr>
<tr>
<td></td>
<td>= 0 NO VECTOR DATA SET WILL BE INPUT</td>
</tr>
<tr>
<td></td>
<td>= 1 ONE OCTAL VECTOR IN BESSELIAN COORDINATES</td>
</tr>
<tr>
<td></td>
<td>= 2 TWO OCTAL VECTORS IN BESSELIAN COORDINATES</td>
</tr>
<tr>
<td>IREFM</td>
<td>INPUT REFSSMAT FLAG</td>
</tr>
<tr>
<td></td>
<td>= 0 REFSSMAT WILL NOT BE INPUT</td>
</tr>
<tr>
<td></td>
<td>= 1 ONE REFSSMAT WILL BE INPUT</td>
</tr>
<tr>
<td></td>
<td>= 2 TWO REFSSMATS WILL BE INPUT</td>
</tr>
<tr>
<td>ATYPE</td>
<td>INPUT IMU GIMBAL ANGLE</td>
</tr>
<tr>
<td>ROLL1</td>
<td>GIMBAL ANGLES (P,Y,R) (SET TO 0.,0.,0. ON TAPE)</td>
</tr>
<tr>
<td>GETHRS</td>
<td>PHASE TERMINATION</td>
</tr>
<tr>
<td>IINTFC</td>
<td>200-WORD RECORD FLAG</td>
</tr>
</tbody>
</table>

B. THE OPTIONS OF THE GOST PART OF THE PROCESSOR TO BE INPUT, AS WELL AS THE CARD FORMATS ARE LISTED BELOW. OPTION 1 OR 11 REQUIRES TWO INPUT CARDS WHILE OPTION 5 OR 15 REQUIRES FOUR INPUT CARDS. THE REMAINING OPTIONS EACH REQUIRE ONLY ONE CARD. ALL DATA PUNCHED IN COLUMNS 10 THROUGH 70 MUST HAVE DECIMAL POINTS. THE GOST INPUT CARDS ARE PLACED IN THE SPECIAL GOST ON-LINE DECK JUST AFTER THE 'XCG DGOST' CARD.

OPTION 1 OR 11

INPUT THE IDENTIFICATION OF TWO STARS AND THE Sextant SHAFT AND TRUNNICION ANGLE

COMPUTE REFSSSMAT
**OPTION 2 OR 12**

Input

No inputs are needed for option 2 or 12

Compute

The location of two stars which are in the scanning telescope field of view at a specified spacecraft attitude and IMU alignment. The two stars must satisfy the condition that one star lies on the R-line and the other star lies as close as possible to the M-line of the telescope recticle pattern.

**OPTION 3 OR 13**

Input

The identification of stars

Compute

The sextant shaft and trunnion angles for each of the input stars.

**OPTION 4 OR 14**

Input

The spacecraft LVLH roll and yaw angles plus the spacecraft pitch angle to the horizon.

Compute

Gimbal angles and LVLH pitch angle

**OPTION 5 OR 15**

Input

This option is the same as option 1 or 11 except IMU gimbal angles are input in the GOST rather than the GEMMV program.

Compute

REFSMMAT COLUMNS

<table>
<thead>
<tr>
<th>OPTION NUMBER</th>
<th>1-2</th>
<th>10-25</th>
<th>30-45</th>
<th>50-65</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OR 11</td>
<td>11</td>
<td>STAR NO.1</td>
<td>SHAFT NO.1</td>
<td>TRUNNION NO.1</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>STAR NO.2</td>
<td>SHAFT NO.2</td>
<td>TRUNNION NO.2</td>
</tr>
<tr>
<td>2 OR 12</td>
<td>12</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>3 OR 13</td>
<td>13</td>
<td>STAR NO.1</td>
<td>STAR NO.2</td>
<td></td>
</tr>
<tr>
<td>4 OR 14</td>
<td>14</td>
<td>LVLH ROLL</td>
<td>**</td>
<td>LVLH YAW</td>
</tr>
<tr>
<td>5 OR 15</td>
<td>15</td>
<td>STAR NO.1</td>
<td>SHAFT NO.1</td>
<td>TRUNNION NO.1</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>STAR NO.2</td>
<td>SHAFT NO.2</td>
<td>TRUNNION NO.2</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>ROLL GA NO.1</td>
<td>PITCH GA NO.1</td>
<td>YAW GA NO.1</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>ROLL GA NO.2</td>
<td>PITCH GA NO.2</td>
<td>YAW GA NO.2</td>
</tr>
</tbody>
</table>
*Normally these columns should be blank. If non-blank, columns 10-15 should contain the roll gimbal angle, columns 30-45 should contain the pitch gimble angle, and columns 50-65 should contain the yaw gimbal angle. If any of these angles are zero, they must be punched .00001.

**Normally a blank or 0. Either is recognized by the program as a 31.7 degree pitch between the X-body axis and line-of-sight to the horizon. Otherwise, the pitch angle (if other than 31.7 deg) should be input.
10.2.4 EARTH-LIGHT ILLUMINANCE PROCESSOR. - THIS PROCESSOR WILL BE USED TO COMPUTE THE TOTAL AMOUNT OF REFLECTED EARTH-LIGHT ON THE SPACECRAFT SCANNING TELESCOPE.
A. TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

TAPE UNIT

A
I
R
U
V

TAPE DESCRIPTION

GEMMV PROGRAM (PCF) TAPE
EPHEMERIS TAPE UNIT
ARMACR PROGRAM (PCF) TAPE
MISSION DATA TAPE
SCRATCH TAPE (200-WORD RECORD)

B. CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

COLUMN 1 4 8

MSG
ASG A = XXXX
ASG I = $EPHEM
ASG R = XXXX
ASG U = XXXX
ASG V

XOT CUR

TRW R
IN R

EN XOT ARMACR

ENDRUN
N XOT CUR

ERS
PER A
PER A
PER A
PER A

COMMENTS
GEMMV PROGRAM (PCF) TAPE NUMBER
SUN, MOON, AND STAR EPHEMERIDES
ARMACR PROGRAM (PCF) TAPE NUMBER
MISSION DATA TAPE NUMBER
SCRATCH TAPE (200-WORD RECORD)
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND UNIT R
INPUT THE ENTIRE USER PCF FROM UNIT R
SOURCE LANGUAGE CORRECTIONS (PATCHES)
EXECUTE ARMACR PROGRAM

ARMACR UPDATES
LAST ARMACR DATA CARD
EXECUTE THE FOLLOWING INSTRUCTIONS
ERASE LAST PROGRAM FROM MEMORY
POSITION TAPE A TO A END OF FILE
POSITION TAPE A TO A END OF FILE
POSITION TAPE A TO A END OF FILE
POSITION TAPE A TO A END OF FILE

10-29
PER A
PER A
PER A
IN A
TRW I
NXOT LUMAN
EOF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1

POSITION TAPE A TO A END OF FILE
POSITION TAPE A TO A END OF FILE
POSITION TAPE A TO A END OF FILE
INPUT THE ENTIRE USER PCF FROM UNIT A
REWIND UNIT I
ILLUMINANCE DATA CARDS
GCST DATA CARDS
END OF FILE CARD
EARTH-LIGHT ILLUMINANCE PROCESSOR
(FILE 8, UNIVAC 1108)

A. THE STANDARD ARMACR INPUT QUANTITIES ARE LISTED BELOW

<table>
<thead>
<tr>
<th>IVECT</th>
<th>I</th>
<th>OCTAL VECTOR INPUT FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NO VECTOR DATA SET WILL BE INPUT</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ONE OCTAL VECTOR IN BESSELIAN COORDINATES</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>TWO OCTAL VECTORS IN BESSELIAN COORDINATES</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IREFM</th>
<th>I</th>
<th>INPUT REFSMMAT FLAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>REFSMMAT WILL NOT BE INPUT</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ONE REFSMMAT WILL BE INPUT</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>TWO REFSMMATS WILL BE INPUT</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GETHRS</th>
<th>(FP)</th>
<th>PHASE TERMINATION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>IINTFC</th>
<th>I</th>
<th>200-WORD RECORD FLAG</th>
</tr>
</thead>
</table>

B. INPUTS TO THE EARTH-LIGHT ILLUMINANCE PROCESSOR ARE LISTED BELOW

CARD 1

<table>
<thead>
<tr>
<th>COLUMNS</th>
<th>DATA CARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-30</td>
<td>SHAFT ANGLE</td>
</tr>
</tbody>
</table>

CARD 2

<table>
<thead>
<tr>
<th>COLUMNS</th>
<th>NEXT FILE ON PCF TO BE EXECUTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-6</td>
<td>FILE N (NORMALLY SET TO C)</td>
</tr>
</tbody>
</table>

10-31
11. SOLAR PARTICLE ALERT NETWORK PROGRAM (SPAN)

11.1 GENERAL

This section presents a brief description of the SPAN program, including tape and control card setups and input instructions.

11.2 PROGRAM DESCRIPTION

The Solar Particle Alert Network (SPAN) program processes solar flare data from the Solar Particle Alert Network to determine the solar particle environment in the Earth-Moon region of space.

11.3 TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>SPAN Program Tape</td>
</tr>
<tr>
<td>A, B</td>
<td>First and second data tapes produced by the 418 from paper tape. Both units A and B, Unit A alone, or neither unit may be utilized, depending on whether paper tapes are provided.</td>
</tr>
</tbody>
</table>

11.4 CONTROL CARD SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

```
COLUMN 1 4 8
MSG
ASG A = XXXX
ASG B = XXXX
ASG X = XXXX
XOT CUR
  TRW A
  TRW B
  TRW X
  IN X
N XOT RFANAL
  .
  .
  .
EOF
```

Comments

FIRST TAPE GENERATED BY 418 IS PROVIDED
SECOND TAPE GENERATED BY 418 IS PROVIDED
SPAN PROGRAM (PCF) TAPE
REWIND UNIT A
REWIND UNIT B
REWIND UNIT X
INPUT THE ENTIRE PCF FROM UNIT X
EXECUTE SPAN PROGRAM
DATA

11-1
11.5 Inputs

An input sheet for SPAN, containing as many as 30 inputs, is provided by the Trajectory Staff Support Room. One or two punched paper tapes may also be provided, in which case, these tapes are processed by the 418 in Building 12, with the results being put on one or two magnetic tapes. If two tapes are produced, units A and B will be assigned to these tape numbers. If one tape is produced, unit A will be assigned to that number. The card input data for SPAN begins in col. 1 and consists of the numbers and letters on the SPAN input sheet, as provided by the SSR, including the two input sequence numbers. Only those cards containing data on the provided sheet need to be input.
12. OPERATING INSTRUCTIONS FOR THE APOLLO GENERALIZED OPTICS PROGRAM (AGOP)

12.1 GENERAL

THE APOLLO GENERALIZED OPTICS PROGRAM INCLUDES THOSE COMPUTATIONS PRESENTLY BEING PERFORMED BY GOST, SOME OPTICS OF THE WORK SCHEDULE PROCESSOR, A LM OPT (LOST), STAR SIGHTING TABLE (SST), AND OTHER RELATED OPTICS/ANTENNA POINTING CALCULATIONS. THESE CALCULATIONS CAN BE MADE FOR EITHER VEHICLE (CSM OR LM), BOTH VEHICLES, OR VEHICLES IN A DOCKED CONFIGURATION. THERE ARE 9 OPTIONS PRESENTLY AVAILABLE WITH 3 OF THESE TO BE USED FOR SUPPORT OF APOLLO 9.

12.2 PROGRAM DESCRIPTION

OPTION 1 OF THE APOLLO GENERALIZED OPTICS PROGRAM WILL BE USED FOR CISLUNAR NAVIGATION. THIS PROGRAM OPTION DEFINES AN INERTIAL ATTITUDE WHICH WILL ALIGN THE OPTICAL SYSTEM TO THE HORIZON OR SOME SPECIFIED LANDMARK ON THE EARTH OR MOON. OUTPUT CONSIST OF IMU GIMBAL ANGLES AND THE OPTICS SHAFT AND TRUCTION ANGLES TO POINT THE SEXTANT AT THE SPECIFIED STAR. IF THE REQUIRED ATTITUDE CANNOT BE OBTAINED WITHOUT GOING THROUGH GIMBAL LOCK, A 'PSEUDO METHOD' IS AVAILABLE WHEREBY A YAW GIMBAL ANGLE IS INPUT AND THE PROGRAM COMPUTES THE PITCH AND ROLL GIMBAL ANGLES NECESSARY TO EFFECT THE DESIRED ALIGNMENT.

OPTION 2 WILL ACCEPT A STATE VECTOR AND COMPUTE THE RIGHT ASCENSION AND DECLINATION OF THE SPACECRAFT WITH RESPECT TO THE EARTH, AND THE RIGHT ASCENSION AND DECLINATION OF THE EARTH, MCCA AND SUN WITH RESPECT TO THE SPACECRAFT. ADDITIONALLY IT COMPUTES THE SAME QUANTITIES REFERENCED TO AN INPUT LANDMARK WHEN MODE 2 IS SELECTED.

MODE 2 OF OPTION 2 WILL COMPUTE RIGHT ASCENSION, DECLINATION, AND THE UNIT VECTOR FROM THE SPACECRAFT TO THE SPECIFIED LANDMARK OR TO THE CENTER OF THE EARTH, MCCA, AND SUN AS DESIRED.

OPTION 3 WILL OUTPUT THE RIGHT ASCENSION AND DECLINATION OF ALL STARS IN THE CATALOG (EARTH REFERENCED, 1969)

OPTION 5 COMPUTES THE IMU GIMBAL ANGLE REQUIRED TO PLACE THE SPACECRAFT IN A PASSIVE THERMAL CONTROL (PTC) ATTITUDE, WITH THE +X-AXIS ORIENTED 90 DEGREES WITH RESPECT TO THE SUN AND TO THE EARTH FOR OMNIDIRECTIONAL COMMUNICATION. IN ORDER TO AVOID GIMBAL LOCK, THIS OPTION IS CONSTRAINED TO 20 DEGREES IN YAW GIMBAL ANGLE. IF THE ALIGNMENT REQUIRES GREATER THAN 20 DEGREES, A NEW PREFERRED REFSSSMAT WILL BE COMPUTED WHICH WILL RESULT IN GIMBALS EQUAL TO 0,0,0.

OPTION 6 COMPUTES THE ANGLE IN THE SPACECRAFT XZ PLANE FROM THE SPACECRAFT X-AXIS TO THE LUNAR HORIZON AND THE LUNAR TERMINATOR. THE OUTPUT GIVES THE PITCH DOWN ANGLE TO THE HORIZON AND THE TERMINATOR, WITH AN INDICATION AS TO WHETHER THE HORIZON IS LIT.

OPTION 7 (OST) WILL PRIMARILY BE USED TO VERIFY THE CMC AND LM STABLE MEMBER ALIGNMENT MADE BY USING THE ONBOARD OPTICAL SIGHTING EQUIPMENT. THIS OPTION IS DIVIDED INTO 5 MODES WHICH ARE AS FOLLOWS:

MODE 1 COMPUTES THE YAW GIMBAL ANGLE REQUIRED TO PLACE THE Z-AXIS IN THE LOCAL VERTICAL PLANE AND A PITCH ANGLE WHICH WILL PLACE THE HORIZON ON THE LANDING POINT DESIGNATOR (LPD). THE NECESSARY INPUTS ARE REFSSSMAT, GIMBAL ANGLES, AND TIME.

MODE 2 USES AN INPUT REFSSSMAT, SPACECRAFT ATTITUDE, AND TIME INTERVAL TO COMPUTE AOS, LOS, AND OPTICS ANGLES FOR 10 STARS. THESE QUANTITIES WILL ALSO BE COMPUTED FOR INPUT STARS (FROM 1 TO 10).

MODE 3 COMPUTES A REFSSSMAT BY SPECIFYING THE TIME OF THE STAR SIGHTINGS, STARS I.D., OPTICS ANGLES, AND SPACECRAFT ATTITUDE. THE CAPABILITY EXISTS TO INPUT TWO SETS OF GIMBAL ANGLES WITH THE ABOVE INPUT DATA AND COMPUTE THE REFSSSMAT.

MODE 4 USES AN INPUT REFSSSMAT, SPACECRAFT ATTITUDE FOR BOTH VEHICLES, AND A TIME TO COMPUTE THE SECOND VEHICLE REFSSSMAT. IF BOTH REFSSSMATS ARE INPUT, THE SECOND VEHICLE ATTITUDE WILL BE COMPUTED.
MODE 5 COMPUTES THE CSM GIMBAL ANGLES REQUIRED TO POINT THE ART AT THE DESIRED TARGET. THE INPUTS ARE REFSSMAT, DOCKING ANGLE, CME STAR I.D. AND OPTICS ANGLES.

OPTION 9 (SST) WILL BE USED TO COMPUTE GROUND AND CELESTIAL SIGHTING DATA FOR SELECTED TARGETS. THE SPACECRAFT ATTITUDE CAN BE FIXED AND THE OPTICS MOVED, OR THE OPTICS ANGLES ARE FIXED AND THE SPACECRAFT IS MOVED IN ORDER TO SIGHT THE TARGET. THIS OPTION IS DIVIDED INTO 5 MODES WHICH ARE AS FOLLOWS.

MODE 1 COMPUTES IMU GIMBAL ANGLES FOR SIGHTING A SPECIFIED LANDMARK. INPUTS ARE REFSSMAT, LANDMARK, ELEVATION ANGLE, OPTICS DATA, AND A TIME.

MODE 2 COMPUTES IMU GIMBAL ANGLES FOR SIGHTING A SPECIFIED STAR. INPUTS ARE REFSSMAT, STAR I.D. OR RIGHT ASCENSION AND DECLINATION, TIME, AND OPTICS DATA.

MODE 3 COMPUTES THE OPTICS ANGLES FOR SIGHTING A SPECIFIED LANDMARK. INPUTS ARE REFSSMAT, LANDMARK, OPTICS SYSTEM, ELEVATION ANGLE, GIMBAL ANGLES, AND A TIME.

MODE 4 COMPUTES THE OPTICS ANGLES FOR SIGHTING A SPECIFIED STAR. INPUTS ARE REFSSMAT, STAR I.D. OR RIGHT ASCENSION AND DECLINATION, TIME, AND THE OPTICAL SYSTEM.

MODE 5 COMPUTES AN IMAGINARY STAR GIVEN THE REFSSMAT, GIMBAL ANGLES, AND OPTICAL SYSTEM.

THE REQUIRED INPUTS DESCRIBED ABOVE ARE EITHER INPUT INTO ARMACR OR AGOP. NORMALLY, THE ARMACR INPUTS ARE STATE VECTOR, REFSSMAT, GIMBAL ANGLES, TIME INTERVAL AND STEP SIZE. THE AGOP INPUTS ARE DESCRIBED BELOW.
12.3 TAPE SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM.

Tape Unit

A  AGOP Program (PCF) Tape
I  Ephemeris Tape Unit
R  Armacr Program (PCF) Tape
U  Mission Data Tape
Q  Ephemeris Tape from Armacr

12.4 CONTROL CARD LISTING AND ONLINE DECK SETUP FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM.

COLUMN 1 4 8
* MSG
  ASG A = XXXX
  ASG I = $EPHEM
  ASG R = XXXX
  ASG U = XXXX
  ASG Q

  XOT CUR
    TRW R
    IN R
    TRI R
    N XOT ARMACR
  .
  .
  .
  XOT CUR
    ERS
    TRW A, Q
    IN A
    XOT AGOP

G
  .
  .
  .
  TRA 2,4

G
  .
  .
  .
  TRA 2,4

EOF

*INDICATES 7/8 OVERPUNCH IN COLUMN 1
12.5 AGOP INPUT DEFINITIONS

AGOP INPUTS CAN BE DIVIDED INTO TWO TYPES, GENERAL AND REQUIRED. THE GENERAL INPUTS ARE THOSE THAT ARE COMMON TO ALL THE OPTIONS, WHILE THE REQUIRED INPUTS ARE COMMON TO SPECIFIC OPTIONS OR MODES. THE GENERAL INPUTS ARE LISTED BELOW FOLLOWED BY THE REQUIRED INPUTS FOR EACH OPTION.

GENERAL INPUTS

*G4 VEHICLE EPHEMERIS TAPE UNIT (IF OTHER THAN Q)

G14 IF SET TO 1, REFSSMAT MUST BE INPUT IN G31-9

G24-9 IMU GIMBAL ANGLES (O.G.A, I.M.A, M.G.A)

G29 SET TO 0 ON TAPE (EXPECTS GA'S TO BE INPUT IN G24-6 SET TO 1 TO PICK UP GA'S FROM ARM EPHEMERIS TAPE

*G30 ACTIVE VEHICLE
   =0 CSM
   =1 LM
   =2 CSM AND LM

G31-9 REFSSMAT (TSM2I)

G127 CSM SPECIAL OPTION FLAG
   =0 NO EFFECT
   =1 REPEAT RUN(WHERE LM OPTICS WERE USED) FOR CSM OPTICS

G1127 LM SPECIAL OPTION FLAG
   =0 NO EFFECT
   =1 REPEAT RUN(WHERE CSM OPTICS WERE USED) FOR LM OPTICS

G128 SPECIFIES WHICH SECTION OF THE EPH. TAPE CONTAINS CSM DATA
   =0 CSM FIRST 40
   =1 CSM SECOND 40

G1128 SPECIFIES WHICH SECTION OF THE EPH. TAPE CONTAINS LM DATA
   =0 LM FIRST 40
   =1 LM SECOND 40

G255 ELEVATION ANGLE

G343 SET TO 1 TO INPUT FDAI ANGLES
*G34J-42  LM FDAI ANGLES (R,P,Y)
G348-50  SECOND SET OF IMU GIMBAL ANGLES FOR MODE 3 ONLY
G361-69  SECOND REFSSMAT FOR LM OPTICS ONLY
*G20JO  NUMBER OF STARS
*G20J1-10  STAR I.D.(1-10). IF SET TO 392 INPUT RIGHT ASCENSION AND DECLINATION OF THE STAR
*G420  RIGHT ASCENSION OF A STAR
*G427  DECLINATION OF A STAR
*G2C11  NUMBER OF LANDMARKS
*G2012  LANDMARK NUMBER (1 TO 86)
        IF NEW EARTH LANDMARKS ARE TO BE INPUT, SET G2012 TO 1 AND INPUT THE COORDINATES AS FOLLOWS:
        L =1 DEC LONGITUDE, LATITUDE, HEIGHT
        IF MOON LANDMARKS ARE TO BE INPUT, SET G2012 TO 60 AND INPUT THE COORDINATES AS FOLLOWS:
        ML = DEC LONGITUDE, LATITUDE, HEIGHT
*G1129  DOCKED CONFIGURATION (SET TO 1)
*G1130  DOCKING ANGLE

OPTICAL DATA - FLAG TO SPECIFY WHICH OPTICAL SYSTEM TO BE USED, FOLLOWED BY THE CORRESPONDING INPUTS.

G373  SET TO 0 TO USE THE CSM SXT/SCT (SEXTANT/TELESCPE) OPTICAL SYSTEM
G411-12  SHAFT ANGLES FOR TWO STARS
G413-14  TRUNNION ANGLES FOR TWO STARS
G373  SET TO 1 TO USE THE LM COAS (CREWMAN OPTICAL ALIGNMENT SIGHT) OPTICAL SYSTEM
G352  COAS MOUNTED ON LM AXIS
=0 X-AXIS
=1 Z-AXIS
G353-54  EL (CCAS ELEVATION ANGLE) FOR TWO STARS
G355-56  SXP (POSITION ON COAS RETICLE LINE) FOR
TWO STARS

G373  SET TO 2 TO USE THE LM AOT (ALIGNMENT
OPTICAL TELESCOPE) OPTICAL SYSTEM

G371-72  AOT LINE I.D. FOR TWO STARS
=1 +Y-AXIS
=2 +X-AXIS
=3 -Y-AXIS
=4 -X-AXIS

G352  AOT DETENT POSITIONS (0 TO 5)

G353-54  A1 (ANGLE TO PLACE STAR ON LINE I.D.)
FOR TWO STARS

G355-56  A2 (ANGLE TO PLACE STAR ON SPIRAL)
FOR TWO STARS

THE FOLLOWING INPUTS CAN BE USED IF AGOP IS TO BE
EXECUTED ALONE. (NO EPHEMERIS TAPE)

G1  CURRENT GREENWICH LONGITUDE

*G3  SET TO 1 FOR EARTH REFERENCED INPUTS
     SET TO 2 FOR LUNAR REFERENCED INPUTS

G5  SET TO 1 IF ALL INPUT WILL BE FROM CARDS.
    SET TO 0 IF EPHEMERIS TAPE WILL BE USED
    FOR ANY INPUTS.
    (FOR INSTANCE THE VECTOR AND TIME MAY BE
    TAKEN FROM THE TAPE. IN ALL CASES, CARD
    INPUT OVER-RIDES EPHEMERIS TAPE INPUT.

*G7  YEAR

*G16  DAY OF YEAR OF LIFT-OFF

*G10-12  HR, MIN, SEC OF LIFT-OFF

G13  VECTOR TIME (G.E.T. HOURS)

G18-20  POSITION VECTOR (BESSELIAN ECI ER)

G21-23  POSITION VECTOR (BESSELIAN MCI ER)

G106-8  POSITION VECTOR (BESSELIAN ECI FT)

G109-11  POSITION VECTOR (BESSELIAN MCI FT)

G112  SET TO 0 IF POSITION VECTOR IS IN FT,
     1 IF IN ER
VECTOR TIME (G.E.T. HRS, MIN, SEC)

G101
G113

SET GC 1 IF G.E.T. IS INPUT IN HRS, MIN, SEC

OPTION 1 - CISLUNAR NAVIGATION

G201

MODE TC BE USED
1 STAR/EARTH HORIZON
2 STAR/MOON HORIZON
3 STAR/EARTH LANDMARK
4 STAR/MOON LANCMARK

G206-8

G.E.T. START HR, MIN, SECS

G210-12

G.E.T. STOP HR, MIN, SECS

G214

DELTA T MIN

*G2000

NUMBER OF STARS

*G2001

STAR I.D.

G215

SET GC 1 FOR 'PSEUDO METHOD' (YAW GIMBAL INPUT)

G26

DESIREC YAW FOR G215=1

OPTION 2 - REFERENCE BODY COMPUTATION

G225

SET TO 1

G226-8

G.E.T. START HR, MIN, SECS

G229-31

G.E.T. STOP HR, MIN, SEC

*G2011

NUMBER OF LANDMARKS

*G2012

LANDMARK NUMBER

G236

DELTA T MIN

G237

OPTION FOR MODE 2 OF OPTION 2
0 EITHER 0 OR NO INPUT CALLS MODE 1
1 CENTER OF EARTH *THESE OPTIONS OUT-
2 CENTER OF MOON *PUT RIGHT ASCENSION,
*DECLINATION, AND
*UNIT VECTOR TO THE
3 CENTER OF SUN *SPECIFIED BODY FROM
4 LANDMARK (E OR M) *THE SPACECRAFT
OPTION 3 - STAR CATALOG

G24C  SET TO 1

OPTION 4 - ANTENNA POINTING

G24-0  IMU GIMBAL ANGLES (O.G.A., I.G.A., M.G.A.)
       (INPUT IF OTHER THAN THOSE ON THE
       EPH. TAPE)

*G3C  ACTIVE VEHICLE
       =0  CSM
       =1  LM
       =2  CSM AND LM

G25C  ANTENNA POINTING OPTION
       =1  S-BAND HI-GAIN (MOVABLE)
       =2  S-BAND STEerable (MOVABLE)
       =3  RENCEVOUS RADAR (MOVABLE)
       =4  S-BAND HI-GAIN (FIXED) (TO COMPUTE
            LM GIMBALS WHEN DOCKED INPUT CSM AS
            VEHICLE TWO, LM AS VEHICLE ONE, AND
            A NEGATIVE DOCKING ANGLE)
       =5  S-BAND STEerable (FIXED) (TO COMPUTE
            CSM GIMBALS WHEN DOCKED INPUT THE CSM
            REFSEMMAT INTO G-ARRAY G31-9 AND
            G1031-9)
       =6  RENCEVOUS RADAR (FIXED) (TO COMPUTE
            CSM GIMBALS WHEN DOCKED INPUT THE CSM
            REFSEMMAT INTO G-ARRAY G31-9 AND
            G1031-9)

G252-4  G.E.T. START HR, MIN, SECS
G263-5  G.E.T. STOP HR, MIN, SECS
G267  DELTA T MIN
G255  DESIRED ELEVATION ANGLE
*G2011  NUMBER OF LANDMARKS
*G2012  LANDMARK NUMBER
G268-9  ANTENNA PITCH AND YAW ANGLES (REQUIRED
        FOR G250=4,5, OR 6)
G270  AXIS DIRECTION (LM MUST BE VEH. 2)
       =0  HEACS UP
       =1  HEACS DOWN

12-10
OPTION 5 - PASSIVE THERMAL CONTROL (PTC) ATTITUDE

G275    SET TO 1
G279-81 G.E.T. START HR, MIN, SECS
G283-5  G.E.T. STOP HR, MIN, SECS
G286    DELTA T MIN

OPTION 6 - TERMINATOR-HCRIZON ANGLES

G300    SET TO 1 FOR OPTION 6
G301-303 G.E.T. OF START HR, MIN, SECS
G304-306 G.E.T. OF STOP HR, MIN, SECS
G307    DELTA TIME BETWEEN COMPUTATIONS (MINS)
G310    SET TO 1 TO HAVE OPTION 6 EXECUTED FOR FIRST AND LAST POINTS ONLY OF THE EPHEMERIS TAPE

OPTION 7 - OST

MODE 1 LM HCRIZON CHECK

G1333    SET TO 1 TO CALL MODE 1 (VEHICLE TWO)
*G30     LM VEHICLE ACTIVE (SET TO 1)
G1331-33 G.E.T. START HR, MIN, SEC
G1334-36 G.E.T. STOP HR, MIN, SEC
G1337    DELTA T MIN
G1128    SET TO 2 TO READ VEHICLE TWO DATA FROM THE SECOND HALF OF EPH. TAPE

MODE 2 ALIGNMENT AND MANEUVER CHECK

G330     SET TO 2 TO CALL MODE 2
*G30     ACTIVE VEHICLE
=0 CSM
=1 LM
=2 CSM AND LM
G373  SET TO DESIRED OPTICAL SYSTEM
     =0 ONLY INPUT REQUIRED
     =1 INPUT G352
     =2 INPUT G371-72 AND G352

G359  OPTION FLAG
     =0 STAR SEARCH
     =1 STARS WILL BE INPUT

G360  STAR NUMBER TO BEGIN SEARCH
     (WILL BEGIN WITH 1 IF NOT SET)

*G20J0  NUMBER OF STARS (REQUIRED IF G359=1)

*G20J1-10  STAR I.D.'S (REQUIRED IF G359=1)

G331-33  G.E.T. START HR, MIN, SEC (REQUIRED INPUT)

G334-36  G.E.T. STOP HR, MIN, SEC (REQUIRED INPUT)

G337  DELTA T MIN

MODE 3 COMPUTE REFSSMMAT

G330  SET TO 3 TO CALL MODE 3

*G30  ACTIVE VEHICLE
     =0 CSM
     =1 LM
     =2 CSM AND LM

G373  SET TO DESIRED OPTICAL SYSTEM
     (INPUT RELATED OPTICS ANGLES)

G344  SET TO 1 TO INPUT TWO SETS OF ATTITUDES

*G20J0  NUMBER OF STARS

*G20J1-2  TWO STAR I.D.'S

G331-33  G.E.T. START HR, MIN, SEC

G334-36  G.E.T. STOP HR, MIN, SEC

G337  DELTA T MIN

MODE 4 DOCKING ALIGNMENT

G330  SET TO 4 TO CALL MODE 4

*G30  CSM AND LM ACTIVE (SET TO 2)
*G1129  DOCKED CONFIGURATION (SET TO 1)

*G1130  DOCKING ANGLE

G385  OPTICN FLAG
    =0  COMPUTE GIMBAL AND FDAI ANGLES
    =1  COMPUTE REFSMMAT
        (INPUT REQUIRED G-ARRAYS)

G331-33  G.E.T. START HR, MIN, SEC

G334-36  G.E.T. STOP HR, MIN, SEC

G337  DELTA T MIN

MODE 5 POINT AOT WITH CSM

G330  SET TO 5 TO CALL MODE 5

*G30  CSM ANC LM ACTIVE (SET TO 2)
    =0  CSM
    =1  LM
    =2  CSM AND LM

*G1129  DOCKED CONFIGURATION (SET TO 1)

*G1130  DOCKING ANGLE

G373  SET TO 2 TO CALL AOT OPTICS
      (INPUT RELATED OPTICS ANGLES)

*G20J0  SET TO 1 TO INPUT 1 STAR

*G20J1  STAR I.D.

G331-33  G.E.T. START HR, MIN, SEC

G334-36  G.E.T. STOP HR, MIN, SEC

G337  DELTA T MIN

OPTION 8 - SST

MODE 1 LANDMARK FIXED OPTICS

G400  SET TO 1 TO CALL MODE 1

*G3C  ACTIVE VEHICLE
    =0  CSM
    =1  LM
    =2  CSM AND LM
*G2011  NUMBER OF LANDMARKS
*G2012  LANDMARK NUMBER
G255    ELEVATION ANGLE
G373    SET TO DESIRED OPTICAL SYSTEM
        (INPUT RELATED OPTICS ANGLES)
G401-03 G.E.T. START HR, MIN, SEC
G404-06 G.E.T. STOP HR, MIN, SEC
G407    DELTA T MIN

MODE 2 STAR FIXED OPTICS
G400    SET TO 2 TO CALL MODE 2
*G30    ACTIVE VEHICLE
        =0  CSM
        =1  LM
        =2  CSM AND LM
G373    SET TO DESIRED OPTICAL SYSTEM
        (INPUT RELATED OPTICS ANGLES)
*G20J0  NUMBER OF STARS
*G20J1  STAR I.D.
G401-03 G.E.T. START HR, MIN, SEC
G404-06 G.E.T. STOP HR, MIN, SEC
G407    DELTA T MIN

MODE 3 LANDMARK MOVABLE OPTICS
G40C    SET TO 3 TO CALL MODE 3
*G3C    ACTIVE VEHICLE
        =0  CSM
        =1  LM
        =2  CSM AND LM
*G2011  NUMBER OF LANDMARKS
*G2012  LANDMARK NUMBER
G255    ELEVATION ANGLE
G373  SET TO DESIRED OPTICAL SYSTEM
      =0  ONLY INPUT REQUIRED
      =1  INPUT G352
      =2  INPUT G371-72 AND G352

G401-03  G.E.T. START HR, MIN, SEC
G404-06  G.E.T. STOP HR, MIN, SEC
G407     DELTA T MIN

MODE 4 STAR MOUVABLE OPTICS

G40C     SET TO 4 TO CALL MODE 4
*G30     ACTIVE VEHICLE
         =0  CSM
         =1  LM
         =2  CSM AND LM

*G2OJO   NUMBER OF STARS
*G2OJI   STAR I.D.

G373     SET TO DESIRED OPTICAL SYSTEM
         =0  ONLY INPUT REQUIRED
         =1  INPUT G352
         =2  INPUT G371-72 AND G352

G401-03  G.E.T. START HR, MIN, SEC
G404-06  G.E.T. STOP HR, MIN, SEC
G407     DELTA T MIN

MODE 5 STAR SPECIAL

G40C     SET TO 5 TO CALL MODE 5
*G30     ACTIVE VEHICLE
         =0  CSM
         =1  LM
         =2  CSM AND LM

G373     SET TO DESIRED OPTICAL SYSTEM
         (INPUT RELATED OPTICS ANGLES)

G401-03  G.E.T. START HR, MIN, SEC
G404-06  G.E.T. STOP HR, MIN, SEC
G407     DELTA T MIN

12-15
*These G-arrays are used for either vehicle one or vehicle two. The remaining G-arrays listed above are for vehicle one, but can be changed to vehicle two by adding 1000 to the G-array.

**To specify a single time point, the start and stop time should be equal.
13. OPERATING INSTRUCTION FOR THE MASS PROPERTIES, REACTION CONTROL SYSTEM, SERVICE PROPULSION SYSTEM (MRS) PROGRAM

13.1 GENERAL

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE MRS PROGRAM, THE TAPE SETUP AND CONTROL CARDS REQUIRED TO OPERATE THE PROGRAM ON THE IBM 7094 AND UNIVAC 1108 DATA SYSTEMS.

13.2 PROGRAM DESCRIPTION

THE MRS PROGRAM WILL BE USED TO GENERATE A COMPLETE REACTION CONTROL SYSTEM PROPELLANT BUDGET USING PREVIOUSLY SUPPLIED DATA FOR INDIVIDUAL MANEUVER PROPELLANT CONSUMPTION AND INTERNALLY COMPUTED MASS PROPERTIES CHARACTERISTICS.

13.3 TAPE SETUP FOR THE IBM 7094 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5</td>
<td>NEW BLOCKED EVENT DEFINITIONS</td>
</tr>
<tr>
<td>B5</td>
<td>TIMELINE EVENTS</td>
</tr>
<tr>
<td>B6</td>
<td>BLOCKED EVENT DEFINITIONS</td>
</tr>
</tbody>
</table>

13.4 TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>NEW BLOCKED EVENT DEFINITIONS</td>
</tr>
<tr>
<td>G</td>
<td>TIMELINE EVENTS</td>
</tr>
<tr>
<td>I</td>
<td>BLOCKED EVENT DEFINITIONS</td>
</tr>
<tr>
<td>X</td>
<td>MRS PROGRAM TAPE</td>
</tr>
</tbody>
</table>

13.5 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>COLUMN</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG F= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG G= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG I= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG X= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XQT CUR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRW F,G,I,X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IN X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMMENTS

NEW BLOCKED EVENT DEFINITIONS TAPE
TIMELINE EVENTS TAPE
BLOCKED EVENT DEFINITIONS
MRS PROGRAM (PCF) TAPE
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND UNITS F,G,I, AND X
INPUT THE ENTIRE USER PCF FROM UNIT X
EXECUTE THE MRS PROGRAM
MRS DATA CARDS
END OF DATA

13.6 INPUTS TO THE MRS PROGRAM

THE INPUTS TO THE MRS PROGRAM ARE PRESENTED IN THE CSM MRS PROGRAM DESCRIPTION (REFERENCE 6).
14. OPERATING INSTRUCTIONS FOR THE LUNAR MODULE (LM) REACTION CONTROL SYSTEM (RCS) CONSUMABLES PROGRAM

14.1 GENERAL

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE LM RCS PROGRAM, THE TAPE SETUP AND CONTROL CARDS REQUIRED TO OPERATE THE PROGRAM ON THE IBM 7094 AND UNIVAC 1108 DATA SYSTEMS.

14.2 PROGRAM DESCRIPTION

THE LM RCS PROGRAM GENERATES LM RCS PROPELLANT CONSUMPTION BUDGETS IN RESPONSE TO AN INPUT MISSION TIMELINE EVENT DESCRIPTION. IT IS BASICALLY A BUDGET PROGRAM AND NOT A ACTUAL SIMULATION OF VEHICLE PERFORMANCE. THE RCS PROPELLANT CONSUMPTION DATA AND MASS PROPERTIES DATA USED TO COMPUTE THE PROFILE ARE STORED IN THE PROGRAM PRE-FLIGHT, BUT CAN BE UPDATED IN REAL-TIME.

14.3 TAPE SETUP FOR THE IBM 7094 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>LM RCS PROGRAM (PCF) TAPE</td>
</tr>
<tr>
<td>A5</td>
<td>NEW BLOCKED EVENT DEFINITION</td>
</tr>
<tr>
<td>A6</td>
<td>NAMELIST LMDATA TAPE</td>
</tr>
<tr>
<td>A7</td>
<td>OUTPUT TAPE</td>
</tr>
<tr>
<td>B5</td>
<td>TIMELINE EVENTS</td>
</tr>
<tr>
<td>B6</td>
<td>BLOCKED EVENT DEFINITIONS</td>
</tr>
</tbody>
</table>

14.4 TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
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<tbody>
<tr>
<td>F</td>
<td>NEW BLOCKED EVENT DEFINITION</td>
</tr>
<tr>
<td>G</td>
<td>TIMELINE EVENTS</td>
</tr>
<tr>
<td>H</td>
<td>NAMELIST LMDATA TAPE</td>
</tr>
<tr>
<td>I</td>
<td>BLOCKED EVENT DEFINITIONS</td>
</tr>
<tr>
<td>J</td>
<td>OUTPUT TAPE</td>
</tr>
<tr>
<td>X</td>
<td>LM RCS PROGRAM (PCF) TAPE</td>
</tr>
</tbody>
</table>

14.5 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>COLUMN 1</th>
<th>4</th>
<th>8</th>
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<td>MSG</td>
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</tr>
<tr>
<td>ASG F= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG G= XXXX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASG I= XXXX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMMENTS
NEW BLOCKED EVENT DEFINITIONS TAPE
TIMELINE EVENTS TAPE
BLOCKED EVENT DEFINITIONS TAPE
ASG X= XXXX
ASG H,J
XQT CUR

TRW F,G,I,H,J,X
IN X

N XQT LEMDRV

EOF

LM RCS PROGRAM (PCF) TAPE
SCRATCH TAPES
EXECUTE THE FOLLOWING
INSTRUCTIONS
REWIND UNITS F,G,I,H,J,
AND X
INPUT THE ENTIRE USER PCF
FROM UNIT X
EXECUTE THE LM RCS
PROGRAM
LM RCS DATA CARDS
END OF DATA

14.6 INPUTS TO THE LM RCS PROGRAM

THE INPUTS TO THIS PROGRAM ARE CONTAINED IN THE LM RCS
CONSUMABLES PROGRAM USER'S MANUAL (REFERENCE 7).
15. OPERATING INSTRUCTION FOR THE DESCENT PROPULSION SYSTEM
SUPERCRITICAL HELIUM SYSTEM (SHE) PROGRAM

15.1 GENERAL

THIS SECTION PRESENTS A BRIEF DESCRIPTION OF THE SHE PROGRAM, THE TAPE SETUP AND CONTROL CARDS REQUIRED TO OPERATE THE PROGRAM ON THE UNIVAC 1108 DATA PROCESSING SYSTEMS.

15.2 PROGRAM DESCRIPTION

THIS PROGRAM MODELS THE DPS SUPERCRITICAL HELIUM PROPellant TANK PRESSURIZATION SYSTEM, AND OUTPUTS THE MAXIMUM PRESSURE THAT WILL RESULT DURING THE MISSION.

15.3 TAPE SETUP FOR THE UNIVAC 1108 PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>TAPE UNIT</th>
<th>TAPE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SHE PROGRAM TAPE</td>
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</tbody>
</table>

15.4 CONTROL CARD LISTING FOR THE UNIVAC 1108 DATA PROCESSING SYSTEM

<table>
<thead>
<tr>
<th>COLUMN</th>
<th>1</th>
<th>4</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>MSG</td>
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</tr>
<tr>
<td>ASG A= XXXX</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>XQT CUR</td>
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<td></td>
</tr>
<tr>
<td>TRW A</td>
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<tr>
<td>IN A</td>
<td></td>
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<td></td>
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<tr>
<td>N XQT MAIN</td>
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<tr>
<td>EOF</td>
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</tbody>
</table>

Comments:
SHE PROGRAM (PCF) TAPE
EXECUTE THE FOLLOWING INSTRUCTIONS
REWIND UNIT A
INPUT THE ENTIRE USER PCF FROM UNIT A
EXECUTE THE SHE PROGRAM
SHE DATA CARDS
END OF DATA
15.5 INPUTS TO THE SHE PROGRAM

THE INPUTS TO THIS PROGRAM ARE PRESENTED IN THE DESCENT PROPULSION SYSTEM SUPERCRITICAL HELIUM SYSTEM PROGRAM USER'S GUIDE (REFERENCE 8), BUT ARE IN THE PROCESS OF BEING CHANGED. THEREFORE, THE INPUTS REQUIRED WILL BE PUBLISHED AT A LATER TIME.
16. OPERATING INSTRUCTION FOR THE SPACECRAFT ELECTRICAL ENERGY NETWORK ANALYSIS (SEENA) PROGRAM

16.1 GENERAL

THE SEENA PROGRAM IS A ELECTRICAL POWER SYSTEM PROGRAM THAT CAN BE CONFIGURED TO COMPUTE THE ELECTRICAL POWER PROFILE FOR ANY SPACECRAFT. THE PROGRAM IS DESIGNED TO CALL VARIOUS BLOCKS OF POWER CONSUMING COMPONENTS AND COMPUTE THE ENERGY CONSUMED.

A USER'S MANUAL IS BEING PREPARED AT THIS TIME.
REFERENCES

1. OPERATIONAL SUPPORT PLAN FOR REAL-TIME AUXILIARY COMPUTING FACILITY APOLLO 9 FLIGHT ANNEX MSC INTERNAL NOTE NO. 68-FM-, NUMBER AND DATE TO BE ASSIGNED.

2. TASK AGREEMENT FOR OPERATIONAL SUPPORT FOR THE REAL-TIME AUXILIARY COMPUTING FACILITY, TASK MSC/TRW A-130, AMENDMENT NO. 8, SEPTEMBER 20, 1968.


5. APOLLO REFERENCE MISSION PROGRAM USER'S MANUAL - VERSION ARM06, TRW REPORT 05952-H578-R0-00, AUGUST 26, 1968.

