

LGC IDLING PROGRAM (P00)

REV 03 12/03/69

PURPOSE:

- (1) TO PROVIDE A PROGRAM TO FULFILL THE FOLLOWING REQUIREMENTS:
- (A) PROVIDE AN INDICATION TO THE CREW THAT THE LGC IS ENGAGED IN NO CONTROL OR COMPUTATIONAL OPERATIONS WHICH MIGHT REQUIRE CONSIDERATION FOR COORDINATION WITH OTHER CREW TASKS IN PROGRESS.
- (B) MAINTAIN THE LGC IN A CONDITION OF READINESS FOR ENTRY INTO OTHER PROGRAMS.
- (2) TO UPDATE THE LM AND CSM STATE VECTORS EVERY FOUR TIME STEPS.

ASSUMPTIONS:

- (1) THE IMU MAY OR MAY NOT BE ON. IF ON, THE IMU IS INERTIALLY STABILIZED BUT NOT NECESSARILY ALIGNED TO AN ORIENTATION WHICH IS KNOWN TO THE LGC.
- (2) THE DAP IS AVAILABLE FOR MANUALLY CONTROLLED ATTITUDE MANEUVERS IF THE IMU IS ON. IF ATTITUDE MANEUVERS ARE MADE BY THE CREW CARE MUST BE TAKEN TO AVOID IMU GIMBAL LOCK BY OBSERVING THE ICDS (V16 N20) OR BY MONITORING THE FDAI BALL.
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+03
+EDIT
+03
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- (3) DURING THIS PROGRAM THE COASTING INTEGRATION ROUTINE WILL PERIODICALLY UPDATE THE LM STATE VECTOR (IF NOT ON THE LUNAR SURFACE) AND THE CSM STATE VECTOR TO APPROXIMATELY THE CURRENT TIME AS DESCRIBED IN SECTION 5.6.11 OF R567. THE CAPABILITY TO SELECT AN LGC PROGRAM (V37E--E) IS INHIBITED BY THE LGC DURING THIS INTEGRATION. V37 USE AT THIS TIME WILL RESULT IN A PROGRAM ALARM (01520).
- (4) TO MONITOR THE PROGRESS OF STATE VECTOR INTEGRATION, THE TIME ASSOCIATED WITH THE ADVANCING (REGRESSING) STATE IS AVAILABLE BY KEYING IN V06N38E:
- V06N38
R1-TET-HRS
R2-TET-MINS
R3-TET-SECS
- TET-THE TIME (GET) TO WHICH THE STATE VECTOR INTEGRATION PROCESS HAS PRESENTLY CALCULATED THE STATE VECTOR. IN HRS, MINS, SECS TO NEAREST .01 SEC.
- (5) THIS PROGRAM IS AUTOMATICALLY SELECTED BY V96E, WHICH MAY BE DONE DURING ANY PROGRAM. STATE VECTOR INTEGRATION IS PERMANENTLY INHIBITED FOLLOWING V96E. NORMAL INTEGRATION FUNCTIONS WILL RESUME AFTER SELECTION OF ANY PROGRAM. USE OF V96 CAN CAUSE INCORRECT W-MATRIX EXTRAPOLATION SINCE STATE VECTOR SYNCHRONIZATION IS NOT MAINTAINED.
- (6) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CGNT

LGC

GROUND

CREW

FORWARD TO PRESENT
TIME EVERY 4 TIME
STEPS (REFER SECTION
5.6.11 OF R567).

#50

:
:
:

IS THERE A REQUEST
FOR A NEW PROGRAM?

#60

Y N
:
:
:
:
.....

EXIT POO
AND GC TC
PROGRAM
SELECTED
VIA ROO

#70

CHANGE CONTRL NOTES

#80

LOGIC REV 01 PCR 80,146,234,507,614
REV 02 EDITGRAL
REV 03 EDITCRIAL

#90

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LGC POWER DOWN PROGRAM (P06)

REV 02 08/07/69

PURPOSE: (1) TO TRANSFER THE LGC FROM THE OPERATE TO THE STANDBY CONDITION.

ASSUMPTIONS: (1) THE NORMAL CONDITION OF READINESS OF THE PGNC'S WHEN NOT IN USE IS STANDBY. IN THIS CONDITION THE IMU STANDBY CIRCUIT BREAKER IS ON, THE IMU OPERATE CIRCUIT BREAKER IS OFF, THE LGC/DSKY CIRCUIT BREAKER IS ON AND THE STANDBY LIGHT ON THE DSKY IS ON. IN THIS CONFIGURATION BOTH THE IMU AND LGC ARE OFF, WITH POWER APPLIED ONLY TO THE IMU HEAT CONTROL CIRCUITRY AND THE LGC TIMING CIRCUITRY.

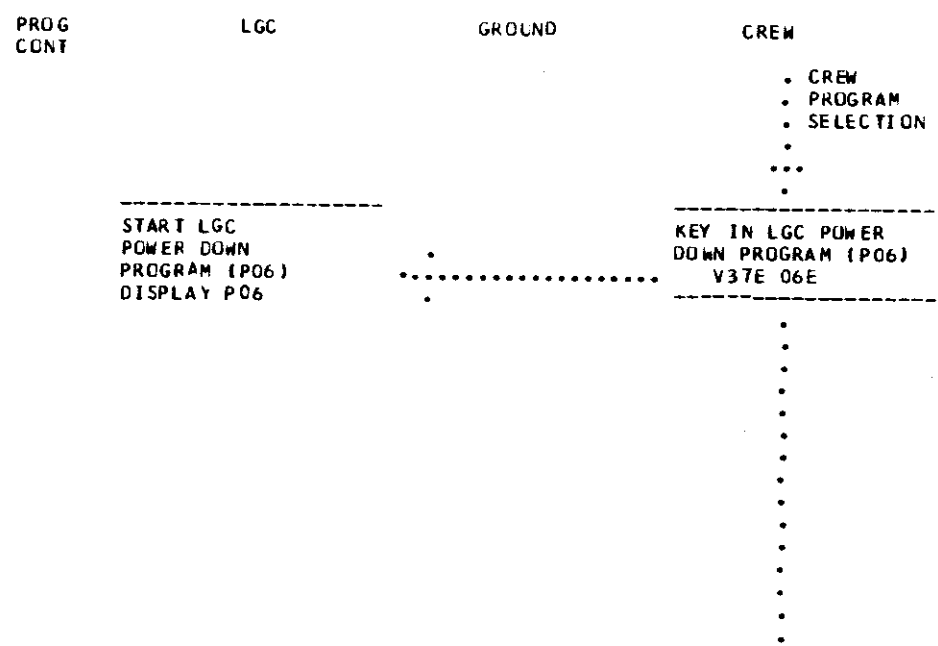
(2) A POSSIBLE CONDITION OF READINESS OF THE PGNC'S WHEN NOT COMPLETELY ON IS THE SAME AS STANDBY (1) ABOVE, EXCEPT THAT THE STANDBY LIGHT ON THE DSKY IS OFF. IN THIS CONFIGURATION THE LGC IS RUNNING FOR COMPUTATIONAL PURPOSES THAT DO NOT REQUIRE THE IMU.

(3) IF THE COMPUTER POWER IS SWITCHED OFF IT WILL BE NECESSARY TO PERFORM A COMPUTER FRESH START (V36E) TO INITIALIZE THE ERASABLE STORAGE. THE LGC UPDATE PROGRAM (P27) WOULD HAVE TO BE DONE TO UPDATE THE LM AND GSN STATE VECTORS AND COMPUTER CLOCK TIME.

(4) THE LGC IS CAPABLE OF MAINTAINING AN ACCURATE VALUE OF GROUND ELAPSED TIME (GET) FOR ONLY 23 HRS WHEN IN THE STANDBY MODE. IF THE LGC IS NOT BROUGHT OUT OF THE STANDBY CONDITION TO THE RUNNING CONDITION (SEE (2) ABOVE) AT LEAST ONCE WITHIN 23 HOURS THE LGC VALUE OF GET MUST BE UPDATED.

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(5) ONCE THE PROGRAM HAS BEEN SELECTED THE LGC MUST BE SHUT DOWN UNLESS V69E IS PERFORMED BEFORE A PROCEED (STANDBY) RESPONSE IS MADE TO THE V5CN25 (00062) DISPLAY. AFTER P06 SELECTION THE LGC WILL NOT HONOR A NEW PROGRAM REQUEST (V37E--E), A TERMINATE (V34E), A V33E, OR AN ENTER IN RESPONSE TO THE LGC REQUEST FOR LGC STANDBY.

(6) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.



#10

MONITOR DSKY:
OBSERVE DISPLAY
CF P06

#20

SET NO DC VERB 37
FLAG

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+OZ
+EDIT
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STORE LGC CLOCK TIME

#30

RESET TRACK FLAG

#40

RESET DRIFT FLAG

#50

RESET REFSMMAT FLAG.

RESET IMUSE FLAG

#60

RESET RENDEZVOUS
FLAG

INATE

TURN ON STANDBY
LIGHT

.....
OBSERVE STANDBY
LIGHT TO COME ON.

#120

.....
RELEASE PROCEED
(STANDBY) BUTTON

#130

.....
PUT LGC IN STANDBY.
BLANK ALL DSKY
LIGHTS

.....
MONITOR DSKY:
OBSERVE ALL DSKY
LIGHTS TO GO BLANK.

#140

.....
EXIT P06

.....
EXIT P06

NOTE: WHEN IT
IS DESIRED TO
BRING THE LGC FROM
STANDBY TO OPERATE
THE FOLLOWING PROC-
EDURES APPLY.

#150

.....
WAIT FOR
STANDBY ENTRY

.....
KEY IN PROCEED
(STANDBY) BUTTON
AND HOLD ON

#160

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POWERED ASCENT PROGRAM (P12)

REV 02 12/03/69

PURPOSE:

- (1) TO DISPLAY TO THE CREW, PRIOR TO ASCENT ENGINE IGNITION, CERTAIN LGC-STORED PARAMETERS ASSOCIATED WITH THE POWERED ASCENT, FOR POSSIBLE MODIFICATION BY THE CREW.
- (2) TO DISPLAY TO THE CREW, PRIOR TO ASCENT ENGINE IGNITION, CERTAIN F041 BALL READINGS ASSOCIATED WITH THE EARLY PHASES OF THE ASCENT MANEUVER.
- (3) TO CONTROL THE PGNS DURING COUNTDOWN, IGNITION, THRUSTING AND THRUST TERMINATION OF A PGNS-CONTROLLED APS POWERED ASCENT MANEUVER FROM THE LUNAR SURFACE.

ASSUMPTIONS:

(1) THE LGC HAS STORED INJECTION VALUES WHICH DEFINE AN ASCENT TRAJECTORY. THESE VALUES ARE ALTITUDE OF INJECTION, THE DISTANCE AT INJECTION BETWEEN THE LM AND THE CSM ORBITAL PLANE, AND THE LM VERTICAL (V(R)) AND HORIZONTAL (V(Y)) AND (V(Z)) VELOCITIES AT INJECTION. THIS TRAJECTORY IS DESIGNED TO BE COPLANAR WITH THAT OF THE CSM AND TO RESULT IN AN APOLUNE OF 30 NM. ALL ALTITUDES ARE MEASURED WITH RESPECT TO THE MAGNITUDE OF THE LANDING SITE POSITION VECTOR WHICH IS AN LGC INITIALIZATION PARAMETER.

THIS PREDEFINED ASCENT TRAJECTORY MAY BE PARTIALLY MODIFIED DURING THIS PROGRAM BY ASTRONAUT INPUT (SEE ASSUMPTION (2) AND LOGIC BELOW FOR DOWNRANGE VELOCITY, RADIAL VELOCITY, AND CROSSRANGE DISPLAY).

(2) THE PGNS WILL CONTROL THE LM ASCENT MANEUVER SUCH THAT THE LM VELOCITY AT INJECTION IS PARALLEL TO THE CSM ORBITAL PLANE, EITHER IN THAT PLANE, OR AT A SPECIFIED DISTANCE FROM THAT PLANE AS CONTROLLED BY ASTRONAUT DEFINITION OF CROSSRANGE. THE ASTRONAUT CAN ALSO CHANGE THE REQUIRED INJECTION CONDITIONS BY MODIFYING THE NOMINAL INITIAL DOWNRANGE AND RADIAL VELOCITY DISPLAY VALUES. (SEE DISPLAY OF V06N76 IN LOGIC BELOW). CROSSRANGE SHOULD NOT BE SPECIFIED SUCH AS TO CAUSE THE ASCENT TRAJECTORY TO CROSS THROUGH THE CSM ORBITAL PLANE.

(3) THE INITIAL PERIOD OF THE ASCENT TRAJECTORY WILL CONSIST OF TWO PHASES:

(A) VERTICAL RISE PHASE-FROM TIG UNTIL THE RADIAL VELOCITY (V(R)) OF THE LM EXCEEDS 40 FT/SEC, THE LM WILL BE HELD BY THE PGNS TO AN ATTITUDE SUCH THAT THE LM +X AXIS IS PARALLEL TO THE LM POSITION VECTOR AT TIG. AT TIG THE PGNS WILL COMMAND THE LM AROUND ITS X AXIS (YAW) UNTIL THE LM +Z AXIS POINTS DOWNRANGE.

(B) PITCHOVER PHASE-WHEN V(R) EXCEEDS 40 FT/SEC, THE PGNS WILL COMMAND THE LM TO PITCH DOWN AN AMOUNT DEFINED BY THE GUIDANCE EQUATIONS.

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+02
+EDIT
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THE LM ATTITUDE WILL SUBSEQUENTLY BE CONTROLLED BY THE GUIDANCE EQUATIONS.

(4) THE X-AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNS ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNS DAMPS THE YAW RATE, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS DAMPED, AND THEN MAINTAINS THAT ATTITUDE.

THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE. THUS THE OPTION IS INHIBITED BY THIS PROGRAM FROM TIG(AS) UNTIL APPROXIMATELY 12 SECONDS AFTER V(R) EQUALS +40 FT/SEC.

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+02
+EDIT
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(5) THE IMU IS ON AND MUST BE AT A KNOWN ORIENTATION BEFORE THIS PROGRAM MAY BE COMPLETED. NORMALLY, THE LUNAR SURFACE ALIGN PROGRAM (P57) HAS BEEN COMPLETED BEFORE SELECTION OF THIS PROGRAM. IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANEUVER.

(6) ENGINE IGNITION MAY BE SLIPPED BEYOND TIG(AS) IF DESIRED BY THE CREW OR IF STATE VECTOR INTEGRATION CANNOT BE COMPLETED IN TIME. VARIATION OF THE TIME OF ASCENT IGNITION (TIG(AS)) EITHER BY DESIGN OR INADVERTANT SLIPPAGE WILL CHANGE THE RELATIVE PHASING WITH RESPECT TO THE CSM OF THE ASCENT TRAJECTORY AND THE RESULTANT LM ORBIT.

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+02
+EDIT
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+02
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+02
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+EDIT
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+02
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(7) IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN AUTO THE PGNS WILL CONTROL THE TOTAL VEHICLE ATTITUDE AND GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS AND VEHICLE ATTITUDE RATES (SEE ASSUMPTION (9)) FOR DISPLAY ON THE FDAI. THE CREW MAY EXERCISE CONTROL AROUND THE YAW AXIS ONLY WITH THE ACA (X-AXIS OVERRIDE) IF THE X-AXIS OVERRIDE CAPABILITY IS PERMITTED BY THE PROGRAM IN PROGRESS. THIS MANUAL CONTROL WILL BE IN THE RATE COMMAND/ATTITUDE HOLD MODE.
IF A THRUSTING MANEUVER IS PERFORMED WITH THE GUIDANCE CONTROL SWITCH IN PGNS AND THE MODE CONTROL SWITCH IN ATTITUDE HOLD THE PGNS WILL HOLD THE VEHICLE ATTITUDE AND WILL GENERATE EITHER MODE I OR MODE II ATTITUDE ERRORS FOR DISPLAY ON THE FDAI. THE CREW MAY EXERCISE MANUAL ATTITUDE CONTROL ABOUT ALL VEHICLE AXES WITH THE ACA IN EITHER THE RATE COMMAND OR MINIMUM IMPULSE MODE DEPENDING UPON THE STATUS OF THE PULSES FLAG. HOWEVER IT IS STRONGLY RECOMMENDED THAT POWERED FLIGHT NOT BE ATTEMPTED IN THE MINIMUM IMPULSE MODE. THE PULSES FLAG IS SET OR RESET BY EXTENDED VERBS 76 (MINIMUM IMPULSE) AND 77 (RATE COMMAND) RESPECTIVELY. THE PULSES FLAG IS ALSO RESET BY P12, P40, P41, P42, P63, P70, P71, AND R40 AT MAIN ENGINE IGNITION; WITH THE EXCEPTION OF THESE CASES, MODE SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. DURING A THRUSTING MANEUVER IN THE PGNS/ATTITUDE HOLD MODE THE PGNS WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

(8) CONTROL OF THE LM RCS AND APS IS TRANSFERRED FROM THE PGNS TO THE ABORT GUIDANCE SYSTEM (AGS) BY PLACING THE GUID CONT SWITCH FROM PGNS TO AGS.
THE AGS WILL BE CAPABLE OF TAKING OVER CONTROL OF THE LM DURING ANY PORTION OF THE LUNAR ASCENT, THE AGS WILL GUIDE THE LM TO A SAFE CREIT.
THE AGS MAY BE INITIALIZED BY THE LGC AT ANY TIME BY MANUAL SELECTION OF THE AGS INITIALIZATION ROUTINE (R47), AND SHOULD HAVE BEEN PERFORMED PRIOR TO SELECTION OF P12.
IN THE EVENT THAT THE GUIDANCE CONTROL SWITCH IS CHANGED FROM PGNS TO AGS DURING A THRUSTING MANEUVER, THE LGC WILL CONTINUE COMPUTATION OF POSITION AND VELOCITY, THE DESIRED THRUST VECTOR AND THE DESIRED ATTITUDE ERRORS, HOWEVER THE PGNS WILL NOT BE RESPONSIBLE IF REGISTER OVERFLOWS OCCUR WITHIN THE LGC.

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+02
+EDIT
+
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+
+02
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(9) THE PGNS CAN GENERATE TWO TYPES OF ATTITUDE ERRORS FOR DISPLAY ON THE FDAI;
MODE I - SELECTED BY EXTENDED VERB 61. AUTOPILOT FOLLOWING ERRORS USED AS A MONITOR OF THE DAP'S ABILITY TO TRACK AUTOMATIC STEERING COMMANDS.
MODE II- SELECTED BY EXTENDED VERB 62. TOTAL ATTITUDE ERRORS USED TO ASSIST CREW IN MANUALLY MANEUVERING THE VEHICLE.
PGNS-DERIVED VEHICLE ATTITUDE RATES MAY ALSO BE DISPLAYED VIA SELECTION BY EXTENDED VERB 60.
MODE II ATTITUDE ERROR DISPLAYS ARE AUTOMATICALLY SELECTED AT THE BEGINNING OF R60. WITH THE EXCEPTIONS INDICATED IN ASSUMPTION (7) ABOVE, DISPLAY SELECTION IS ALWAYS BASED UPON THE LAST ENTRY MADE IN THE DSKY. FOR A MORE DETAILED DESCRIPTION OF THESE DISPLAYS REFER TO SECTION 3 OF R567, PARA. 3.2.6.

(10) THE RENDEZVOUS RADAR (RR) WAS ENERGIZED AND CHECKED OUT PRIOR TO SELECTION OF THIS PROGRAM.
(11) THE LANDING ANALOG DISPLAYS ROUTINE (R10) IS ENABLED AT TIG, HOWEVER R10 USE OF THE RR CDUS IS INHIBITED BY THIS PROGRAM. THE POWERED FLIGHT DESIGNATE ROUTINE (R29) IS ENABLED AFTER PITCHOVER. R10 AND R29 ARE TERMINATED UPON TERMINATION OF AVERAGE G.
(12) EITHER THE LOAD DAP DATA ROUTINE (R03) OR THE LANDING CONFIRMATION PROGRAM (P68) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.
(13) FOR EACH BURN AN IGNITION TOTAL ALLOWABLE TIME DELAY WILL BE SPECIFIED IN THE MISSION RULES. THIS DELAY TIME IS THE TOTAL TIME WHICH THE THRUSTING MANEUVER MAY BE DELAYED BEYOND THE LGC CALCULATED TIME OF IGNITION. IF ENGINE RESTARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.

(14) THE ASTRONAUT MAY MONITOR THE FOLLOWING ADDITIONAL PARAMETERS DURING THIS PROGRAM BY KEYING IN V16N77E :

V16N77
R1-TC
R2-V(Y)
R3-BLANK

WHERE :

TG- THE ESTIMATED TIME OF FLIGHT FROM THE PRESENT TIME TO THE ACCOMPLISHMENT OF THE ASCENT INJECTION CONDITIONS. POLARITY IS -. IN MINS AND SECS TO NEAREST SEC. MAX READING IS 59859. IF AN RCS INJECTION DECISION IS MADE AFTER AN LGC ASSUMED APS THRUST FAILURE (SEE R40), THE UPDATE OF TG IS NOT MEANINGFUL.

V(Y) - THE MAGNITUDE OF THE LM VELOCITY COMPONENT NORMAL TO THE CSM ORBITAL PLANE. IN FPS TO NEAREST .1 FPS.

(15) THE ASTRONAUT MAY MONITOR THE FOLLOWING ADDITIONAL PARAMETERS AT ANY TIME DURING THIS PROGRAM AFTER TIG, BY KEYING IN V16N85E:

V16N85
R1-VGX(LM)
R2-VGY(LM)
R3-VGZ(LM)

FOR DEFINITION, SEE LOGIC BELOW.

(16) THE DAP WILL BE ENERGIZED WHENEVER THE PGNS CONTROL MODE AND THE AUTO ATTITUDE OR ATTITUDE HOLD CONTROL MODE HAVE BEEN SELECTED. IF THIS OCCURS PRIOR TO THE PGNS AUTO CHECK IN THIS PROGRAM, THE ATTITUDE ERRORS WILL BE ZEROED AND THE ATTITUDE DEADBAND WILL BE SET TO THE LAST VALUE SPECIFIED BY R03 (ASTRONAUT DEFINED). IMMEDIATELY PRIOR TO THE PGNS AUTO CHECK, THIS PROGRAM WILL SET THE ATTITUDE DEADBAND TO 1 DEGREE.

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+02
+EDIT
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(17) THE FOLLOWING DISPLAY IS AVAILABLE DURING THIS PROGRAM PRIOR TO TIG BY KEYING IN V85E (SEE EXTENDED VERBS).

V16A56
R1 - RR LOS AZIMUTH
R2 - RR LOS ELEVATION
R3 - BLANK

WHERE:

RR LOS AZIMUTH - THE ANGLE BETWEEN THE LM X/Z PLANE AND THE RR LOS VECTOR. POSITIVE ROTATION IS FROM THE LM +Z AXIS TO THE LM +Y AXIS. IN DEGREES TO THE NEAREST 0.01 DEGREE.

RR LOS ELEVATION - THE ANGLE BETWEEN THE LM +Z AXIS AND THE PROJECTION OF THE RR LOS VECTOR ON THE LM X/Z PLANE. POSITIVE ROTATION IS POSITIVE ROTATION ABOUT THE LM +Y AXIS.

(18) LGC AND CREW PROCEDURES IN CASES OF LGC-ASSUMED THRUST FAILURE ARE DEFINED BY THE DPS/APS THRUST FAIL ROUTINE (R40). THIS ROUTINE IS CALLED AT APS IGNITION BY THIS PROGRAM.

(19) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 5 MINUTES BEFORE THE ESTIMATED TIME OF ASCENT IGNITION TIG(AS).

PROG

LGC

GROUND

CREW

LCNT

.CREW
.PROGRAM
.SELECTION

#10

START POWERED ASCENT
PROGRAM (P12)
DISPLAY P12

KEY IN POWERED
ASCENT PROGRAM (P12)
V37E12E

#20

. MONITOR DSKY:
OBSERVE DISPLAY OF
P12

#30

DO IMU STATUS CHECK
ROUTINE (R02)

DU IMU STATUS CHECK
ROUTINE (R02)

#40

++
+02
+EDIT
+C2
++

.....

RESET DESIGNATE FLAG

.....

#50

.....

RESET CONTINUOUS
DESIGNATE FLAG

.....

#60

.....

DISABLE RR
ERRCK COUNTERS

.....

++
+02
+EDIT
++

.....

SET APS DELTA V
THRESHOLD FOR USE BY
R40

.....

#70

.....

SET DELTA V COUNTER
= 4 FCR USE BY R40

.....

#80

.....

INVALIDATE R29 DATA

.....

#90

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.....

.....

OBTAIN CONTENTS OF
TIG REGISTER FOR
DISPLAY AS TIG(AS).
(NOTE: P57 MAY HAVE
STORED T(ALIGN) IN
TIG REGISTER - REFER
P57.)

#100

HOLD .
.....
SNAP .

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(AS):
V06 N33
R1-TIG(AS)-HRS
R2-TIG(AS)-MINS
R3-TIG(AS)-SECS

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG (AS)

#110

TIG(AS) - TIME OF
APS IGNITION FOR
ASCENT. (GET) IN
HRS, MINS, SECS, TO
NEAREST .01 SEC

AM I SATISFIED WITH
THIS VALUE?

#120

.Y .N
.
.
.
.

#130

RECORD THIS
VALUE

#140

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

KEY IN V25E
AND LOAD DE-
SIRED TIG(AS)

#150

.P .NEW
.R .DATA
.D
.C

.E STORE DATA

.D

#160

SET MUNFLAG

#170

SET 4-JET TRANSLA-
TION FLAG

#180

SET R10 FLAG

#190

RESET THE RENDEZVOUS
FLAG

INITIALIZE ENGINE
DATA AND TARGET DATA

++
+ 02
+ EDIT
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+ 02
++

COMPUTE CROSSRANGE
AND INITIALIZE DOWN-
RANGE SPEED TO
5509.5 FPS AND
RADIAL SPEED TO
19.5 FPS

#200

HOLD .
.....
SNAP .

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY CROSSRANGE,
DOWNRANGE VELOCITY,
AND RADIAL VELOCITY
VC6N76
R1-DOWNRANGE
VELOCITY (VHF)
R2-RADIAL VEL-
CITY (H DOT F)
R3-CROSSRANGE

MCNITCR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF DOWNRANGE VELO-
CITY (VHF), RADIAL
VELOCITY (H DOT F),
AND CROSSRANGE

#210

#220

DOWNRANGE VELOCITY-
THE VELOCITY ALONG
THE LM LOCAL HORIZ-
ONTAL DOWNRANGE AXIS
AT ASCENT INJECTION,
I.E: UNIT X UNIT
-L
(V X R)). THIS VALUE
-C -C
WILL ALWAYS BE POS-
ITIVE. IN FT-SEC TO
THE NEAREST 0.1
FT/SEC.

IS THE ANTICIPATED
TOTAL DELTA V EXPEN-
DITURE FOR THE
ASCENT AND RENDEZV-
OUS MANEUVERS SUCH
THAT I WISH TO RE-
DUCE THE AMOUNT OF
DELTA R FOR THE ASC-
ENT MANEUVER?

#230

(NOTE: THE INITIAL
VALUES OF DOWNRANGE
VELOCITY = 5509.5
FT/SEC AND RADIAL
VELOCITY =

#240

.N .Y

19.5 FT/SEC WILL
SATISFY AN ORBIT
WITH AN APOLONE
LF 30 N.M. (REFER
ASSUMPTION 1)
THE CREW SHOULD
CONFER WITH THE
GROUND TO DETERMINE
OVERLOAD VALUES IF
SUCH PROCEDURE IS
DESIRED.)

#250

RADIAL VELOCITY-THE
VELOCITY (UP) ALONG
THE LM LOCAL VERT-
ICAL AXIS AT ASCENT
INJECTION, I.E.;
ALONG UNIT R. THIS
-L
VALUE WILL ALWAYS BE
POSITIVE. IN FT-SEC
TO THE NEAREST
0.1 FT/SEC.

DO I WISH TO
CHANGE THE
PRESENTLY DE-
FINED DOWN-
RANGE VELOCITY
OR RADIAL
VELOCITY FOR
THE ASCENT
TRAJECTORY?

#260

CROSSRANGE-THE DIS-
TANCE BETWEEN THE LM
ORBITAL PLANE AFTER
ASCENT INJECTION AND
THE LM POSITION VEC-
TOR AT TIG(AS).
POLARITY INDICATES
THE LM POST-INJECT-
ION PLANE IS NORTH
(+) OR SOUTH (-) OF
THE POSITION VECTOR.
IN NAUTICAL MILES TO
NEAREST .1 NM.
(NOTE: THE LM WILL
INITIALLY DISPLAY
DELTA R EQUAL TO THE
DISTANCE BETWEEN THE
GSM ORBITAL PLANE
AND THE LM POSITION
VECTOR AT TIG(AS);
I.E.: THE TOTAL CUT-
OF-PLANE MANEUVER
VECTOR AT TIG(AS)

.N .Y

#270

#280

#290

CONTROL MODES BEEN
SELECTED?

.Y N.

IS THE APS FLAG
SET?

.Y N.

HAS THE AUTO
THRATTLE MODE
BEEN SELECTED?

.Y N.

POSS
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST
PLEASE PERFORM
PGNS CONTROL
AND AUTO ATT-
ITUDE CONTROL
MODE SELECTION:
V5C N25
R1-00203
R2-BLANK
R3-BLANK

CONTROL MODES BEEN
SELECTED?

.N Y.

MONITOR DSKY:
VERB-NOUN FLASH
TO REQUEST PLEASE
PERFORM PGNS
CONTROL AND AUTO
ATTITUDE CONTROL
MODE SELECTION

HAVE REQUESTED
MODES BEEN
SELECTED?

.N Y.

DO I WISH TO
HAVE THESE

#400

#410

#420

#430

MODES SELECTED
DURING THE
THRUSTING MAN-
EUVER?

#440

.Y N.

SET GUIDANCE
CONTROL SWI-
TCH TO PONS
AND ATTITUDE
CONTROL SWI-
TCH TO AUTO.

#450

WAIT FOR KEY-
BOARD ENTRY

KEY IN
PROCEED

#460

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR ENTER

KEY IN
ENTER

#470

.E .P
.N .R
.T .O
.E .C
.R .E
. .E
. .D

#480

PITCHOVER PHASE, IN
DEGREES TO NEAREST
.01 DEGREE.

REFERENCE DURING THE
INITIAL PHASES OF
THE ASCENT.

.
.
.
.
.
.
.

.
.

UPDATE EVENT TIMER
IF DESIRED.

#540

SET TDECI = TIG -30
SECONDS

.
.
.
.
.
.
.
.
.
.
.

#550

++
+02
+EDIT
+
++

EXTRAPCLATE CSM
STATE VECTOR TO
TDECI

.
.
.

#560

DC STATE VECTOR IN-
TEGRATION (MIDTAVE)
ROUTINE (R41)
(NOTE: ENTER R41
AT "A".)

DO STATE VECTOR IN-
TEGRATION (MIDTAVE)
ROUTINE (R41).
OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT IS ON UNTIL
COMPLETION OF R41

.NO TIG.
.TIG SLIP.
.SLIP

.
.
.
.

#570

ARM APS

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#580

.....
 CHECK STATUS OF C/W
 LAMPS

.....
 . (NOTE: R41 WILL
 . DEFINE TIG TO BE
 . THE TIME TO WHICH
 . R41 DID INTEGRATE
 . THE LM STATE
 . VECTOR PLUS 30
 . SECONDS.)

#590

++
 +02
 +EDIT
 ++

.....
 WAIT UNTIL TIG-35
 SECONDS

#600

.....
 BLANK THE DSKY DIS-
 PLAY (V,N,R1,R2, AND
 R3)

.....
 MONITOR DSKY:
 AT TFI = -00B35
 OBSERVE DSKY DISPLAY
 TO GO BLANK FOR 5
 SECONDS

#610

.....
 WAIT UNTIL TIG -30
 SECONDS

#620

.....

CALL VERB 59 DISPLAY
(SEE "A" BELOW)

.....

WAIT UNTIL TIG =0

.....

SET IGNITION FLAG

.....

IS ASTRONAUT FLAG
SET?

.Y	N.
.	.
.	.
...	...
.	.
GO TO	EXIT
"B"	(NOTE:
BELOW	THIS
	IS NOT
	A P12
	EXIT.
	REFER
	DIS-
	PLAY
	RESP-
	UNSE
	AT "A"
	BELOW).

#690

#700

#710

#720

"A"
FROM
ABLVE
.
.
.
.
.....

HOLD . CHANGE VERB BUT
MAINTAIN PRESENT
.....
MCN . NOUN AND DISPLAYS IN
R1, R2, R3, FLASH
VERB-NOUN TO REQUEST
PLEASE PERFORM
ENGINE ON ENABLE:
V55N74

"F"
FROM
R40
.
.
.
.....

MCNITCR DSKY:
OBSERVE AT TF1 =
-00B05 VERB NOUN
FLASH TO REQUEST
PLEASE PERFORM
ENGINE ON ENABLE

#730

#740

#750

SHALL I ATTEMPT TO
COMPLETE THE THRUS-
TING MANEUVER WITH
THE RCS?

.Y . N.
.
.

#760

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

.
.
.
.....
GL TC

#770

"C"
BELOW

SHALL I PERMIT
IGNITION?

#780

.N .Y

KEY IN PROCEED

#790

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
ENTER, OR TERMINATE

KEY IN
TERMINATE
V34E

#800

.P .J .E
.R .E .N
.D .R .T
.C .M .E
.E .I .R
.E .N .
.D .A .
. .T .
. .E .
. . . SC TC
. . . "C"
. . . BELOW
. . .
. . .

RESET CULLAGE FLAG

DO FINAL AUTO-
MATIC REQUEST
TERMINATE ROU-
TINE (ROO).

DO FINAL AUTO-
MATIC REQUEST
TERMINATE ROU-
TINE (ROO).

#810

#820

```

.
.
.
.
.
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.
.
.
.
EXIT P12
.
.

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.
.
.
.
.
.
.
.
.
.
EXIT P12
.
.

```

#830

SET ASTRONAUT FLAG

#840

IS IGNITION FLAG
SET?

MONITOR DSKY:
IS R1 DISPLAY CF TFI
NEGATIVE AND NON-
ZERO?

.Y .N

.Y .N

#850

RESUME STATIC
DISPLAY OF
VC6N74

MONITOR DSKY:
OBSERVE RE-
TURN OF STATIC
VERB-NCUN
(V06N74)

#860

```

.
.
.
.
.
EXIT
(NOTE: THIS IS
NOT A P12 EXIT.
REFER TIG -C
LOGIC ABOVE)
.
.

```

STANDBY FOR
THRUST CN
WHEN TFI =-00B00

#870

RESUME STATIC
DISPLAY OF VC6N74

"R"
FROM
ABOVE

#880

STANDBY FOR
THRUST ON
IMMEDIATELY

COMMAND APS ON

#890

RESET PULSES FLAG

#900

SET LANDING ANALOG
DISPLAYS FLAG

#910

RESET IDLE FLAG

#920

RESET IGNITION FLAG

RESET ASTRONAUT FLAG

.....

CALL FOR RESET OF
LLAGE FLAG IN 0.5
SEC (NOTE: THIS FLAG
WOULD ONLY BE SET IN
A RESTART CASE VIA
R40).

#930

.....

WHEN APS IGNITION IS
DETECTED VIA THE
PIPAS, RESET THE
SURFACE FLAG.

#940

.....

RESET RENDW FLAG

#950

.....

CALCULATE THE PRE-
SENT DESIRED THRUST
VECTOR TO ACCOMPLISH
ASCENT INSERTION

#960

.....

IS THE VERTICAL RISE
FLAG SET?

#970

.....

N Y.

#980

IS H GREATER THAN
25,000 FT?

.Y .N

#990

SET X-AXIS-OVER-
RIDE-INHIBIT FLAG

#1000

IS H DCT
GREATER THAN
40 FPS (LPI)?

.Y .N

#1010

++
+C2
+EDIT
+
++

RESET
ROTATION
FLAG

#1020

RESET VERTICAL
RISE FLAG

#1030

IS ROTATION FLAG
SET?

.Y .N

.....

SET TXC EQUAL
TO PRESENT TIME
+ APPROXIMATELY
12 SECCNDS.

.....

IS T PRESENT
GREATER THAN TXC?

N Y

IS THE ROTATION
FLAG SET?

N Y

IS THE LM
X-AXIS WITHIN
30 DEGREES OF
THE DESIRED
LM X-AXIS?

Y N

IS THE
PRESENT
LM X-AXIS
WITHIN 30
DEGREES OF

#1040

#1050

#1060

#1070

#1080

 . CALCULATE THE RE-
 . QUIRED ICCU/GIM-
 . BAL ANGLES AND
 . DRIVE THE ICCUS
 . (USING FINCCUW)
 . TO ALIGN THE LM
 . +X AXIS WITH THE
 . PRESENT LCCAL
 . VERTICAL (UP),
 . THE LM +Y AXIS
 . NORMAL TO THE
 . ANTICIPATED PITCH
 . MANEUVER PLANE
 . FOR THE ASCENT,
 . AND THE LM +Z
 . AXIS DOWNRANGE.

#1140

#1150

TEMP
 HOLD .

 MON .

 DISPLAY ON DSKY:
 VO6N63
 R1-VI
 R2-H DCT
 R3-H

 MONITOR DSKY:
 OBSERVE DISPLAY
 OF VI, H DCT, AND
 H

#1160

VI - MAGNITUDE OF
 LM INERTIAL VELOCITY
 WITH RESPECT TO THE
 REFERENCE COORDI-
 NATE SYSTEM. IN
 FPS TO NEAREST .1
 FPS.

#1170

H DCT - THE PRESENT
 RATE OF CHANGE OF
 ALTITUDE(+). POLAR-
 ITY INDICATES DES-
 CENT (-) OR ASCENT
 (+). IN FT/SEC TO
 NEAREST .1 FT/SEC.

#1180

H - THE PRESENT
 ALTITUDE OF THE LM

ABOVE THE LM POSI-
TION VECTOR AT TIG
(AS). POLARITY IS +
FOR ALTITUDES
GREATER THAN
THE ABOVE RADIUS.
IN FEET TO NEAREST
FOOT.

#1190

MONITOR FDI BALL,
LM WINDOW, AND DSKY:

#1200

(A) OBSERVE LM X
..... AXIS TO COME TO
LOCAL VERTICAL.

(B) OBSERVE LM
YAW MANEUVER TO FDI
BALL YAW ANGLE PRE-
VIOUSLY DISPLAYED
AND RECORDED.

#1210

(C) OBSERVE LM
PITCH MANEUVER TO
FDI BALL PITCH
ANGLE PREVIOUSLY
DISPLAYED AND RECOR-
DED.

Y N
* *
* *

#1220

GO TO BACKUP
PROCEDURES

THE X-AXIS OVERRIDE
OPTION IS RESTORED

#1230

APPROXIMATELY 12
SECONDS AFTER
H DOT REACHES +00400

.
. .
. . .
.

CONTINUE MONITOR OF
APS THRUSTING:

#1240

1. DSKY:
R1-VI SHOULD
BE INCREAS-
SING
R2-H DOT
SHOULD BE
INCREASING
AND THEN
DECREASE
R3-H SHOULD
BE INCREAS-
SING.

#1250

2. FDAI-ATT ERR-
ORS SHOULD BE
LESS THAN OR
EQUAL TO XX
DEGREES. ATT
RATES SHOULD
BE LESS THAN
OR EQUAL TO XX
DEGREES/SEC.

#1260

IDENTIFY EARLY,
NORMAL, OR LATE
ENGINE CUTOFF FROM
ASSESSMENT OF DSKY
DISPLAYS.

#1270

.E	.N	.L
.A	.O	.A
.R	.R	.T
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.	.	.
.	.	.

#1280

.L .M .E
.Y .C .C
.C .U .U
.U .T .T
.T .O .O
.D .F .F
.F .F .F
.F . .

PUSH EN-
GINE STOP
PUSH BUT-
TON.

#1290

GO TO
BACKUP
PROCEDURES

#1300

IS TG LESS THAN 4
SECONDS?

.Y N.
. .
. .
. .
.....

CALL ENGINE OFF COM-
MAND AT COMPUTED
REQUIRED TIME.

SET IDLE FLAG

SEE DPS/APS
THRUST FAIL
ROUTINE
(R40) FOR
REQUIRED
RESPONSE

#1310

#1320

.....

WAIT UNTIL COMPUTED
TIME OF CUTOFF.

#1330

.....

COMMAND ENGINE OFF

#1340

.....

COMMAND ZERO ATTITUDE
RATES

#1350

.....

SET DEADBAND TO
PREVIOUS VALUE
DEFINED BY R03.

.....

DISARM APS

#1360

MAINTAIN VG
COMPUTATIONS FOR
POSSIBLE NULLING BY
RCS TRIMMING
MANEUVER

.....
.....
"C"
FROM
ABOVE
.....
.....
.....
.....
.....
.....
.....
.....

#1370

COMMAND ZERO
ATTITUDE RATES

#1380

SET DEADBAND
TO PREVIOUS
VALUE DEFINED
BY RC3.

"C"
FROM
ABCDE

#1390

RESET ULLAGE
FLAG

#1400

HOLD .
.....
MON .

FLASH VERB-NCUN TC
REQUEST RESPONSE AND
MAINTAIN DISPLAY OF
VI, H DOT, AND H.
V16 N63
R1-VI
R2-H DOT
R3-H

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TC REQUEST
RESPONSE AND DISPLAY
OF VI, H DOT, AND H.

#1410

RECORD THESE VALUES
AS DESIRED.

#1420

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PRGCEEC,
RECYCLE, OR TER-
MINATE

KEY IN PROCEED

.P .T .R
.R .E .E

THE VC VECTOR WILL
BE UPDATED BY THE
STEERING LOOPS
DURING EACH COMPUTA-
TION CYCLE. IN FPS
TO NEAREST .1 FPS.

MANUAL TRANSLATIONS
AND ROTATIONS.
(NOTE: THIS MANEUVER
IS AT THE OPTION OF
THE CREW.)
(NOTE: TRANSLATION
WILL BE 4 JET UNLESS
R03 IS PERFORMED TO
SPECIFY 2 JET.)

#1480

THE ORBITAL PARA-
METER DISPLAY ROU-
TINE (R30) MAY BE
SELECTED AT THIS
TIME (V82E) TO MONI-
TOR CONTINUOUSLY UP-
DATED VALUES OF APD
ALT, PER ALT, AND
TFF.

#1490

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED,
RECYCLE, OR TER-
MINATE

KEY IN PROCEED

#1500

.P .T .R
.R .E .E
.O .R .C
.C .M .Y
.E .I .C
.E .N .L
.C .A .E
. .T .
. .E

#1510

#1520

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RENDEZVOUS NAVIGATION PROGRAM (P20)

REV 03 12/03/69

- PURPOSE:
- (1) TO CONTROL THE LM ATTITUDE AND THE RENDEZVOUS RADAR (RR) TO ACQUIRE AND TRACK THE CSM WITH THE RR WHILE THE LM IS IN FLIGHT.
 - (2) TO UPDATE EITHER THE LM OR CSM STATE VECTOR (AS SPECIFIED BY THE ASTRONAUT BY DSKY ENTRY) ON THE BASIS OF RR TRACKING DATA OR TO TRACK THE CSM WITHOUT UPDATING EITHER VEHICLE STATE VECTOR.
 - (3) TO POINT THE LM OPTICAL BEACON AT THE CSM.

ASSUMPTIONS:

- (1) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) OR THE LUNAR SURFACE ALIGN PROGRAM (P57) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM. NO PREFERRED ORIENTATION IS SPECIFIED OR REQUIRED FOR THIS PROGRAM AS THE ATTITUDE MANEUVER ROUTINE (R60) CAN ALWAYS CALCULATE A VEHICLE ORIENTATION ABOUT THE LM +Z AXIS THAT CAN AVOID GIMBAL LOCK FOR ANY IMU INERTIAL ORIENTATION. THE ISS THUS MAY BE:

++
+03
+EDIT
++

(A) OFF (STANDBY).

(B) ON, AND NOT ALIGNED SINCE TURN ON.

(C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E.: HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT HAVING DRIFTED FROM THE STORED ALIGNMENT.

(D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC.

IF (A) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
IF (B) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
IF (C) IS TRUE THE LGC MAY OR MAY NOT HAVE A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.
IF (D) IS TRUE THE LGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.

(2) THE CSM IS MAINTAINING A PREFERRED TRACKING ATTITUDE FOR RR TRACKING BY THE LM. THIS PREFERRED ATTITUDE CORRECTLY ORIENTS THE CSM RADAR TRANSPONDER.

(3) AT THE BEGINNING OF THE PROGRAM THE STATE VECTOR UPDATE OPTION IS AUTOMATICALLY SET TO THE LM. THIS OPTION MAY BE CHANGED AT ANY TIME LATER BY ONE OF THE FOLLOWING MANUAL ENTRIES:

V80E UPDATE LM STATE VECTOR
V81E UPDATE CSM STATE VECTOR
V95E NO STATE VECTOR UPDATE

NOTE: IF V95E IS ENTERED BEFORE P20 IS SELECTED, EITHER V80E OR V81E MUST BE PERFORMED TO ALLOW STATE VECTOR UPDATING.

++
+03
+EDIT
+

(4) THE RENDEZVOUS RADAR IS ON, AND PRELIMINARY CHECKOUT HAS BEEN COMPLETED.

(5) THE INITIALIZATION OF THE W MATRIX (SEE SECTION 5.2.4.2 OF R567) IS ENABLED BY:

(A) A MANUAL DSKY ENTRY (V53E).

(B) COMPUTER FRESH START (V36E).

(C) LM OR CSM IN-FLIGHT STATE VECTOR UPDATE FROM THE GROUND (P27) (EXCEPT FOR UPDATE OF LANDING SITE VECTOR WHEN THE LM IS ON THE LUNAR SURFACE).

(D) THE POWERED ASCENT PROGRAM (P12) INVALIDATES THE W-MATRIX USED BY P22 AND CAUSES P20 TO RE-INITIALIZE

THE W-MATRIX WHEN SELECTED.

(6) THE RR TRACKING MARK COUNTER COUNTS THE NUMBER OF RR MARKS PROCESSED BY THE LGC. THIS COUNTER IS ZEROED BY:

- (A) MANUAL SELECTION OF P20/22 (V37E20/22E).
- (B) COMPLETION OF THE TARGET DELTA V PROGRAM (P76).
- (C) SELECTION OF A NEW PROGRAM FROM A PROGRAM WHICH HAD TURNED ON AVERAGE G.
- (D) INITIALIZATION OF THE W MATRIX (SEE (5) ABOVE).
- (E) COMPLETION OF RR SEARCH ROUTINE (R24) IN P20.

(7) THE CREW MAY MANUALLY ADJUST THE LGC-STORED VALUES OF RR SHAFT AND TRUNNION BIAS BY A DIRECT LOAD OF FOUR REGISTERS TO BE SPECIFIED. HOWEVER, UNLESS THE RR HAS BEEN JARRED, THE LGC BIAS ESTIMATE SHOULD BE MORE ACCURATE THAN THAT FROM ANOTHER SOURCE.

(8) THE SELECTION AND TERMINATION OF P20, P22, AND P25 ARE SUBJECT TO SPECIAL OPERATING PROCEDURES DIFFERENT FROM ALL OTHER PROGRAMS;

(A) SELECTION

- (1) ALWAYS BY V37EXXE.
- (2) IF ANY OTHER PROGRAM IS RUNNING AT THE TIME OF P20/22/25 SELECTION THE NEW PROGRAM WILL REPLACE THE OLD. THIS INCLUDES P20/22/25 SELECTION WHENEVER EITHER P20, 22, OR 25 IS RUNNING.
- (3) IF P20 OR P25 IS RUNNING, SELECTION OF ANY PROGRAM OTHER THAN P00 OR P22 WILL RESULT IN P20 OR P25 CONTINUING AND THE NEW PROGRAM ALSO OPERATING WITH ITS NUMBER IN THE DSKY PROG LIGHTS.
- (4) IF P20 OR P25 IS RUNNING, SELECTION OF P00 OR P22 WILL RESULT IN THE TERMINATION OF THE OLD PROGRAM AND OPERATION OF THE NEW.

(B) TERMINATION

- (1) BY SELECTION OF P00, V56E OR BY V34E.
- (2) P00 SELECTION WILL TERMINATE P20, 22, AND 25 AND ANY OTHER PROGRAM IN PROCESS, AND ESTABLISH P00.
- (3) V56E SELECTION WILL SELECT THE TERMINATE TRACKING ROUTINE (R56) WHICH WILL TERMINATE ONLY P20 OR P25 IF EITHER OF THESE PROGRAMS IS RUNNING IN CONJUNCTION WITH ANOTHER PROGRAM. IN ALL OTHER CASES R56 WILL SELECT P00. V56E MAY BE PERFORMED ANY TIME DURING P20, 22, OR 25 OPERATION.
- (4) THE LGC WILL ACT UPON V34E ONLY IN RESPONSE TO A FLASHING VERB-NOUN. IF THIS DISPLAY WAS ORIGINATED BY P20, 22, OR 25, V34E WILL RESULT IN AN IDENTICAL LGC RESPONSE TO THAT OF V56E, THAT IS, SELECTION OF R56. IF THIS DISPLAY WAS NOT ORIGINATED BY P20, 22, OR 25 (SUCH AS P32, WHILE RUNNING WITH P20) THE LGC WILL GO TO P00, HOWEVER THE PROGRAM IN THE BACKGROUND WILL CONTINUE. THE NEW PROGRAM SELECTED FOLLOWS THE SELECTION RULES ABOVE, (A).
- (5) ALTHOUGH IT IS NOT CLEARLY SHOWN IN THE LOGIC BELOW, A V34E RESPONSE TO A PRIORITY DISPLAY MUST BE DELAYED 2 SECONDS FROM DISPLAY INITIATION WHEREAS THE DELAY IS NOT NECESSARY FOR A V56E RESPONSE.

(9) THE RR MANUAL ACQUISITION ROUTINE (R23) MAY ONLY BE SELECTED IF P20 IS NOT RUNNING IN CONJUNCTION WITH ANOTHER PROGRAM.

++
+03
+EDIT
+
+
+
+03
++

(10) WHEN P20 IS SELECTED ANYTIME PRIOR TO THE LANDING PHASE IN THE LUNAR MISSION, THIS PROGRAM MUST BE OPERATED IN THE NC UPDATE MODE. (REFER SECTION 5, PAGE 5.7-6 OF R567.)

(11) THE RMS POSITION AND VELOCITY ERRORS AND ANGLE BIAS ERRORS COMPUTED FROM THE W MATRIX ARE AVAILABLE BY EXTENDED VERB (V67E). BASED UPON VALUES IN THIS DISPLAY AND THE DETAILS OF THE MISSION, THE ASTRONAUT CAN ELECT TO STOP OR CONTINUE THE CURRENT NAVIGATION PROCEDURE OR TO RE-INITIALIZE THE W MATRIX AND CONTINUE NAVIGATING. THE CAPABILITY TO REINITIALIZE THE W MATRIX IS ALSO PROVIDED VIA V67E.

(12) TO MONITOR THE PROGRESS OF STATE VECTOR INTEGRATION, THE TIME ASSOCIATED WITH THE ADVANCING (REGRESSING) STATE IS AVAILABLE BY KEYING IN VC6N38E:

VCENBE
R1-TET-HRS
R2-TET-MINS
R3-TET-SECS

TET-THE TIME (GET) TO WHICH THE STATE VECTOR INTEGRATION PROCESS HAS PRESENTLY CALCULATED THE STATE VECTOR. IN HRS, MINS, AND SECS TO NEAREST .01 SEC.

(13) STATE VECTOR INTEGRATION MAY BE PERMANENTLY INHIBITED BY V96E. THIS ENTRY WILL TERMINATE ALL PRESENT PROGRAMS AND SELECT THE LGC IDLING PROGRAM (PCO) WITH THE PCO AUTOMATIC STATE VECTOR INTEGRATION PERMANENTLY INHIBITED UNTIL SELECTION OF ANOTHER PROGRAM. USE OF V96 CAN CAUSE INCORRECT W-MATRIX EXTRAPOLATION SINCE STATE VECTOR SYNCHRONIZATION IS NOT MAINTAINED.

PROG LGC GROUND CREW
CONT

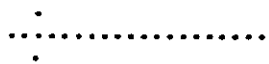
#10

#20

.CREW
.PROGRAM
.SELECTION
.
...
.

#30

START RENDEZVOUS
NAVIGATION PROGRAM
(P20).



KEY IN RENDEZVOUS
NAVIGATION PROGRAM
(P20)
V37E20E

DISPLAY P20

++
+03
+EDIT
++

NOTE: WHENEVER P20
IS SELECTED PRIOR TO
THE LANDING OPERA-
TION IN THE LUNAR
MISSION, IT MUST BE
ENTERED AND OPERATED
IN THE NO UPDATE
MODE (I.E.: - V95E
MUST BE EXECUTED BE-
FORE ENTRY INTO
P20.) (SEE FOOTNOTE
ON PAGE 5.7-6 OF
"ERASABLE MEMORY
PARAMETER LIST" IN
SECTION 5 OF R567.)

#40

#50

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MONITOR DSKY:
OBSERVE DISPLAY
OF P20

#60

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(NOTE: FROM THIS
POINT ON THE LGC
LOGIC DESCRIBES BOTH
THE RENDEZVOUS NAVI-
GATION PROGRAM (P20)
AND THE LUNAR SUR-
FACE NAVIGATION PRO-
GRAM (P22). ONLY
THAT LOGIC ASSOCIA-
TED WITH P20 IS PER-
TINENT HERE (CW-
EVER)).

(NOTE: ALL LOGIC IN
THE CREW COLUMN IS
ONLY THAT ASSOCIATED
WITH THE RENDEZVOUS
NAVIGATION PROGRAM
(P20)).

#70

#80

IS SURFACE FLAG SET?

.N Y.
. .
. .
. .
. .
. .
. .
. .
. .
. .

#90

121

RE SET VEHICLE
UPDATE FLAG.

SET VEHICLE UP-
DATE FLAG

SET LGC ASSUMED
CPTICN = 00001

PGSS
HOLD

SNAP

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
ASSUMED CSM
ORBIT CPTICN:
V04N06
R1-00012
R2-0000X
R3-BLANK

R1 IS CPTICN CCDE
FOR ASSUMED CSM
ORBIT CPTICN.

R2 IS THE LGC-
ASSLMED CPTICN:

00001 - CSM
WILL NCT CHANGE
ITS PRESENT
CREIT.

#100

#110

#120

#130

00002 - CSM
WILL CHANGE ITS
PRESENT ORBIT
TO GO OVER THE
PRESENT LM
POSITION ON THE
LUNAR SURFACE.

#140

WAIT FOR KEY-
BOARD ENTRY

#150

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

#160

.F .NEW
.K .DATA
.D .
.C .
.E
.E STORE DATA
.D

#170

IS LGC ASSUMED
OPTION = 00001?

.Y N.

#180

POSS
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
ESTIMATED LAUNCH

#190

TIME:
V06N33
R1-TIG(AS)-HRS
R2-TIG(AS)-MINS
R3-TIG(AS)-SECS

TIG(AS)- TIME
(ESTIMATED) OF
APS IGNITION FOR
ASCENT (GET). IN
HRS, MINS, SECS,
TO NEAREST .01
SEC.

#200

WAIT FOR KEYBOARD
ENTRY

#210

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

#220

.P .NEW
.R .DATA
.C .
.C .
.E
.E STCRE DATA
.D

#230

CALCULATE NEW GSM
GRET AND UPDATE
GSM STATE VECTOR

#240

(REFER SECTION
5.2.5.2 OF R567)

DG IMU STATUS CHECK
ROUTINE (R02)

DG IMU STATUS
CHECK ROUTINE (R02)

#250

SET UPDATE FLAG

#260

SET TRACK FLAG

#270

SET RENDEZVOLS FLAG

RESET SEARCH FLAG

#280

RESET MANUAL ACQUIRE
FLAG

RESET THE R04 FLAG

#290

125

RESET THE NO RR
MONITOR FLAG.

RESET LCSCM FLAG.

RESET DESIGNATE FLAG

RESET CONTINUOUS
DESIGNATE FLAG

DISABLE RR ERROR
COUNTERS

++
+03
+EDIT
++

MAN
ENTER HERE.
FRM RR
SEARCH
ROUTINE
(R24)

ZERO RR TRACKING
MARK COUNTER

300

310

320

330

340

350

EXTRAPLATE LM AND
CSM STATE VECTORS TO
PRESENT TIME USING
CCNIC EQUATIONS

#360

CALCULATE LCS VECTOR
FROM LM TO CSM.

#370

IS RANGE GREATER
THAN 400 NM?

.N Y.

.....
A
ENTER HERE
FROM RR
SEARCH
ROUTINE
(R24)
.
.
.....

380

PGSS
PRID
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
ALARM CODE 00526.

MONITOR DSKY:
DOES ALARM CODE
DISPLAY 00526 INDIC-
ATE THAT RANGE TO

V05N09
R1-XXXXX
R2-XXXXX
R3-XXXXX

WAIT 2 SECONDS

CSM IS GREATER THAN
400 NM?
(NOTE: ALARM
CODE DISPLAYS MAY
OCCUR IN R1, R2, OR
R3, DEPENDING ON
PRESENCE OR ABSENCE
OF OTHER ALARM CODE
DISPLAYS.)

.Y .N

WAIT 2 SECONDS

DO I WISH TO
WAIT UNTIL
RANGE TO CSM IS
LESS THAN
400 NM?

.Y .N

WAIT AS
DESIRED

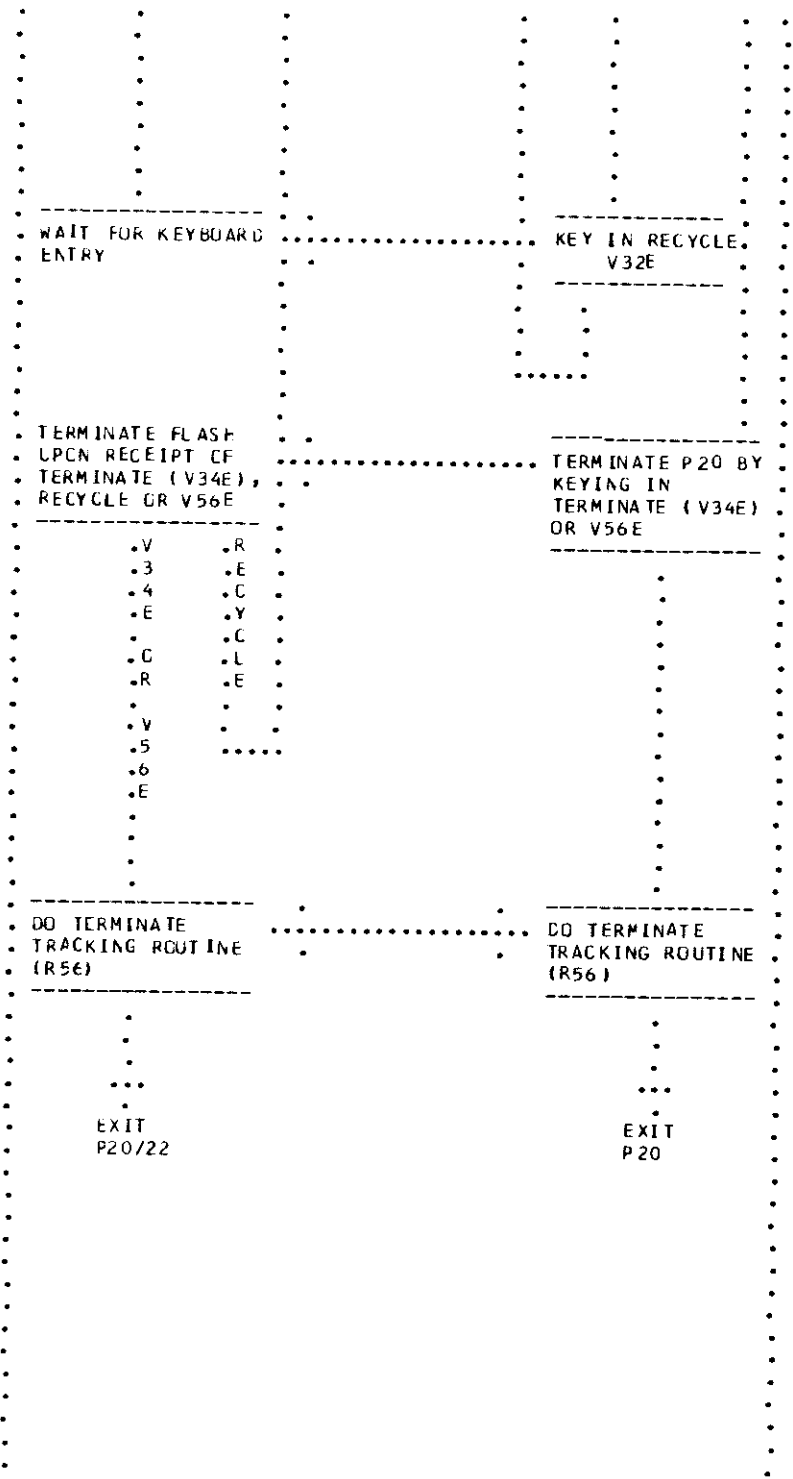
#390

#400

#410

#420

#430



#440

#450

#460

#470

#480

"B"
ENTER HERE
FROM RR
DATA READ
ROUTINE (R22)
OR FROM RR
DESIGNATE
ROUTINE
(R21).

#490

IS SURFACE FLAG SET?

Y N

#500

"B"
ENTER HERE
FROM RR
DATA READ
ROUTINE
(R22),
RR DE-
SIGNATE
ROUTINE
(R21)

#510

#520

DO PREFERRED
TRACKING ATTITUDE ROUTINE
(R61).

DO PREFERRED TRACKING ATTITUDE ROUTINE
(R61).

#530

#540

IS TRACK FLAG SET?

.Y .N

GC TO
"G"
BELOW

#550

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N

"C"
ENTER HERE
FROM RR
DATA READ
ROUTINE
(R22).

"C"
ENTER
HERE
FROM
RR DATA
READ
ROUTINE
(R22).

#570

IS P20 OR P22 THE
ONLY PROGRAM
RUNNING?

#580

NOTE: IF PRESENT
PROGRAM IS P22,
ANSWER IS ALWAYS
"YES".

.Y .N

POSS
PRIO
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DIS-
PLAY ALARM CODE
00514 INDICATING
IMPROPER REMOVAL
OF RR FROM AUTO
MODE.
VC5NCS
R1-XXXXX
R2-XXXXX
R3-XXXXX

WAIT 2 SECONDS

WAIT FOR KEY-
BOARD ENTRY

MONITGR DSKY:
DOES VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
ALARM CODE 00514
INDICATING THE RR
HAS BEEN IMPROPERLY
SWITCHED OUT OF AUTO
MODE?

(NOTE: ALARM CODE
DISPLAYS MAY APPEAR
IN R1, R2, OR R3,
DEPENDING ON PRES-
ENCE OR ABSENCE OF
OTHER ALARM CODE
DISPLAYS.)

.Y .N

WAIT 2 SECONDS

DO I WISH TO
RESELECT RR
AUTO MODE AND
CONTINUE WITH
AUTOMATIC P20

#590

#600

#610

#620

#630

#640

OPERATION?

.Y N.

PUT RR MODE
SWITCH TO
LGC

#650

KEY IN
PROCEED

#660

TERMINATE FLASH
UPON RECEIPT OF
PROCEED,
RECYCLE,
TERMINATE
(V34E), OR V56E

KEY IN TERM-
INATE (V34E)
OR V56E.

#670

.V .P
.3 .R
.4 .C
.E .C
. .E
.C .E
.R .D
.V .C
.5 .R
.6 .

#680

SWITCH MUST BE OUT
OF THE LGC POSITION
BEFORE THE LGC PRO-
GRAM CHECKS THE
AUTO MODE DISCRETE.

#740

(2) THE RR
MUST BE IN THE
AUTO MODE (LGC
POSITION) FOR AUTO-
MATIC P20 OPERAT-
ION.

(3) AS LONG
AS THE LGC IS ON IT
WILL CALL THE RR
MONITOR ROUTINE
(R25) EVERY 0.48
SECONDS AS DESCR-
IBED IN SECTION
5.2.4.3. OF R567).

#750

.Y .N
:

#760

DO I WISH TO
ATTEMPT A
MANUAL
ACQUISITION?

.N .Y
:

#770

PUT RR
MODE
SWITCH TO
LGC.

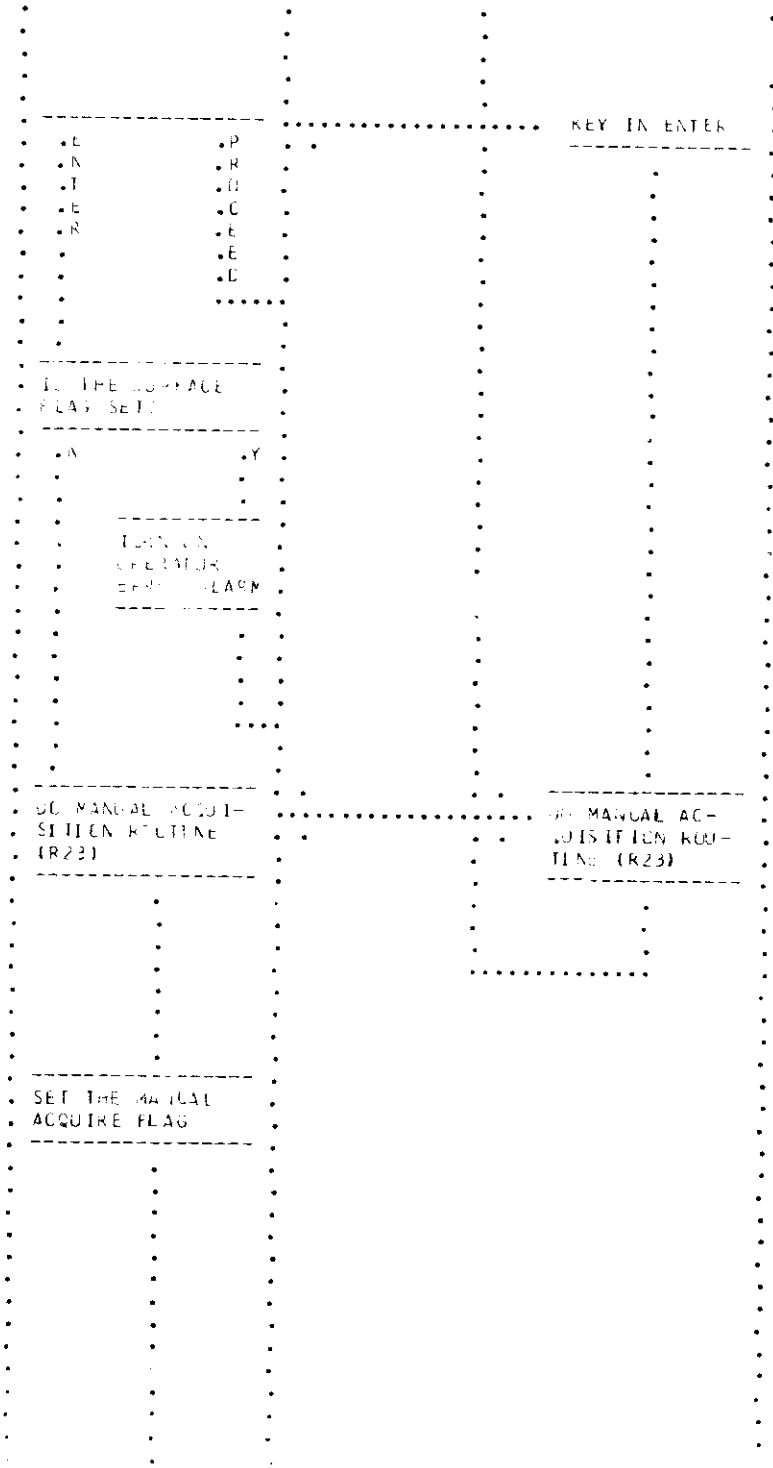
#780

WAIT FOR KEY-
BOARD ENTRY.

KEY IN
PROCEED

#790

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR ENTER



#800

#810

#820

#830

#840

UPDATE PER-
MANENT STATE
VECTORS TO THE
PRESENT TIME
USING PRE-
CISION INTE-
GRATION.

#900

"D"
ENTER
FROM
RK DATA
READ
ROUTINE
(R22)

#910

IS THE RENDEZ-
VOUS FLAG SET?

#920

Y. N.

.....
EXIT
P20/22

#930

"D"

IS THE TRACK
FLAG SET?

.Y .N

WAIT 15
SECCNDS

IS THE
TRACK FLAG
SET?

.Y .N

WAIT
15
SEC-
CNDS
INCTE:
IF
TRACK
FLAG
RE-
MAINS
RESET
P20/22
TERMI-
NATION
(BY
V37E-
OOE,-
CR

"H"
ENTER
HERE
FROM RR
DESIG-
NATE
ROUTINE
(R21)
CR RR
DATA
READ
ROUTINE
(R22).

#940

#950

#960

#970

#980

DISPLAY AND DIS-
PLAYS ALARM CODE
00503.

.
.
.

IS THE SURFACE
FLAG SET?

++
+C3
+EDIT
++

.N .Y
.
.
.
.
.
.
.
.

IS THE LM ON THE
LUNAR SURFACE?

#1040

.N
.
.
.
.
.
.

HOLD .
.....
SNAP .

FLASH VERB-NCUN
TO REQUEST RES-
PCNSE AND DIS-
PLAY RR CDU
ANGLES

++
+C3
+EDIT
+
+
+O3
++

V50N72
R1-TRUNNION
ANGLE
R2-SHAFT ANGLE
R3-BLANK

TRUNNION ANGLE-
360 DEGREES
MINUS THE RR CDU
ANGLE VALUE. IN
DEGREES TO NEAR-
EST .01 DEGREE.
(NOTE: PLUS IS
DEFINED AS A
NEGATIVE ROT-
ATION ABOUT THE
LM +X AXIS.)

SMALL ANGLE- RR
SHAFT ANGLE. IN
DEGREES TO NEAR-
EST .01 DEGREE.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
CONFIRMATION OF RR
MAIN-LOBE LOCK-ON
VIA THE FOLLOWING
INDICATORS:

#1050

(1) PRIOR TO THIS
DISPLAY, THE FOAI
ATTITUDE ERRORS
SHOULD HAVE BEEN
ZERCED BEFORE
TESTING INDICA-
TORS (2) AND (3).

#1060

(2) RR SHAFT AND
TRUNNION ANGLE
NOMINAL READINGS
ARE ZERO.
SMALL ANGLE OFF-
SETS FROM ZERC
MAY RESULT FROM
SEVERAL NORMAL
CAUSES.
LARGE ANGLE READ-
OUT IS INDICATIVE
OF SIDE-LOBE
LOCK-ON.

#1070

#1080

GO TO "G"
BELOW

(3) THE CCAS (IF
CALIBRATED) LOS
SHOULD BE OPTIC-
ALLY ON TARGET.
IF NOT, SIDE-LOBE
LOCK-ON IS INDIC-
ATED

(4) THE RR SIGNAL
STRENGTH METERS
ARE EXPRESSLY FOR
DETERMINING MAIN-
LOBE LOCK-ON.

#1090

WAIT FOR KEY-
BOARD ENTRY

HAS MAIN-LOBE LOCK-
ON BEEN ACHIEVED?

#1100

.Y N.
.
.
.
.

DO I WISH TO
ACHIEVE MAIN-LOBE
LOCK - ON
MANUALLY?

#1110

.Y N.
.
.
.
.

RE-ACQUIRE
CSM IN MAIN-
LOBE MAN-
UALLY

#1120

SET RR MODE
SWITCH TO LGC

#1130

WAIT FOR NO
TRACK LIGHT
TO GC OFF

#1140

KEY IN PROCEED.

TERMINATE FLASH
ON RECEIPT OF
PROCEED OR TERM-
INATE

#1150

KEY IN TERMINATE
V34E

P T
R E
D R
C M
E I
E N
C A
T
E

#1160

DO TERMINATE
TRACKING ROUT-
INE (R56)

DO TERMINATE
TRACKING ROUTINE
(R56)

#1170

EXIT

EXIT

#1180

P20/22

P20

++
+03
+EDIT

"GM"
FROM
ABOVE

WAIT 2-5 SEC.

IS THE RENDEZVOUS
FLAG SET?

.Y N.
.
.
.
.
.
.
.
EXIT P20/22

IS THE TRACK FLAG
SET?

.Y N.
.
.
.
.
GO TO "B"

MONITOR THE VEHICLE
ATTITUDE AND THE
DSKY:

THE ATTITUDE MAN-
EUVER/RR TRACK/RR
MARK/STATE VECTOR
UPDATE PROCESS IS
NOW AUTOMATIC.
THE LGC WILL ONLY
COMMUNICATE WITH THE
ASTRONAUT DURING
THIS PROGRAM.

(1) WHEN A DSKY
ENTRY OF V16N45E
IS MADE TO RE-
QUEST A DISPLAY
OF THE NUMBER OF
MARKS (M), THIS
DISPLAY WILL CON-
TAIN M IN R1.
THIS DISPLAY MAY
ALSO BE USED TO
OBTAIN THE MIDDLE
GIMBAL ANGLE
WHEN THE IMU IS
ON AND THE LM +X
AXIS IS ALIGNED
WITH THE INITIAL
THRUST VECTOR (R3
-MGA). IF NO PURN
HAS BEEN DEFINED
R3 WILL BE MEAN-
INGLESS. THE IN-
FORMATION IN R2
AT THIS TIME IS
NOT RELIABLE.
CONTROL OF
THE DSKY
DISPLAY IS
RETURNED TO THE
LGC BY PUSHING
KEY RELEASE.

#1190

#1200

#1210

#1220

#1230

IN R22

"E"
ENTER HERE
FROM RR
DATA READ
ROUTINE (R22)

WAIT 15 SECONDS.

"F"
ENTER HERE
FROM RR DATA
READ ROUTINE
(R22)

WAIT 2 SECONDS.

(2) WHEN THE DATA
GOOD DISCRETE
LAPSES DURING THE
DATA READ ROUTINE
(R22), A TRACKER
FAIL ALARM AND A
PROGRAM ALARM RE-
SULT. NO DISPLAY
INTERRUPTION OCC-
URS. AN ALARM
CODE (00521) IS
STORED WHICH MAY
BE IDENTIFIED BY
V05 N09.

#1240

(3) WHEN THE RR O
AUTO MODE DIS- O
CRETE IS NOT PRE-
SENT IMMEDIATELY
PRIOR TO A DATA
READ SEQUENCE
DURING THE DATA
READ ROUTINE
(R22) THE LGC
GRABS THE DISPLAY
AND REQUESTS THIS
DISCRETE.

#1250

#1260

(4) WHEN THE LGC
DETERMINES THAT
THE ACTUAL RR LOS
DIFFERS FROM THE
LGC CALCULATED
LOS BY MORE THAN
3 DEGREES AFTER
A DATA READ SE-
QUENCE THE LGC
GRABS THE DISPLAY
AND DISPLAYS AN
ALARM CODE
(00525).

#1270

(5) WHEN THE
MAGNITUDE OF A

#1330

.....

DU TERMINATE TRACK-
ING ROUTINE (R56)

.....
.....
.....
EXIT
P20/P22

.....

DC TERMINATE TRACK-
ING ROUTINE (R56)

.....
.....
.....
EXIT
P20

#1340

CHANGE CENTRCL NOTES

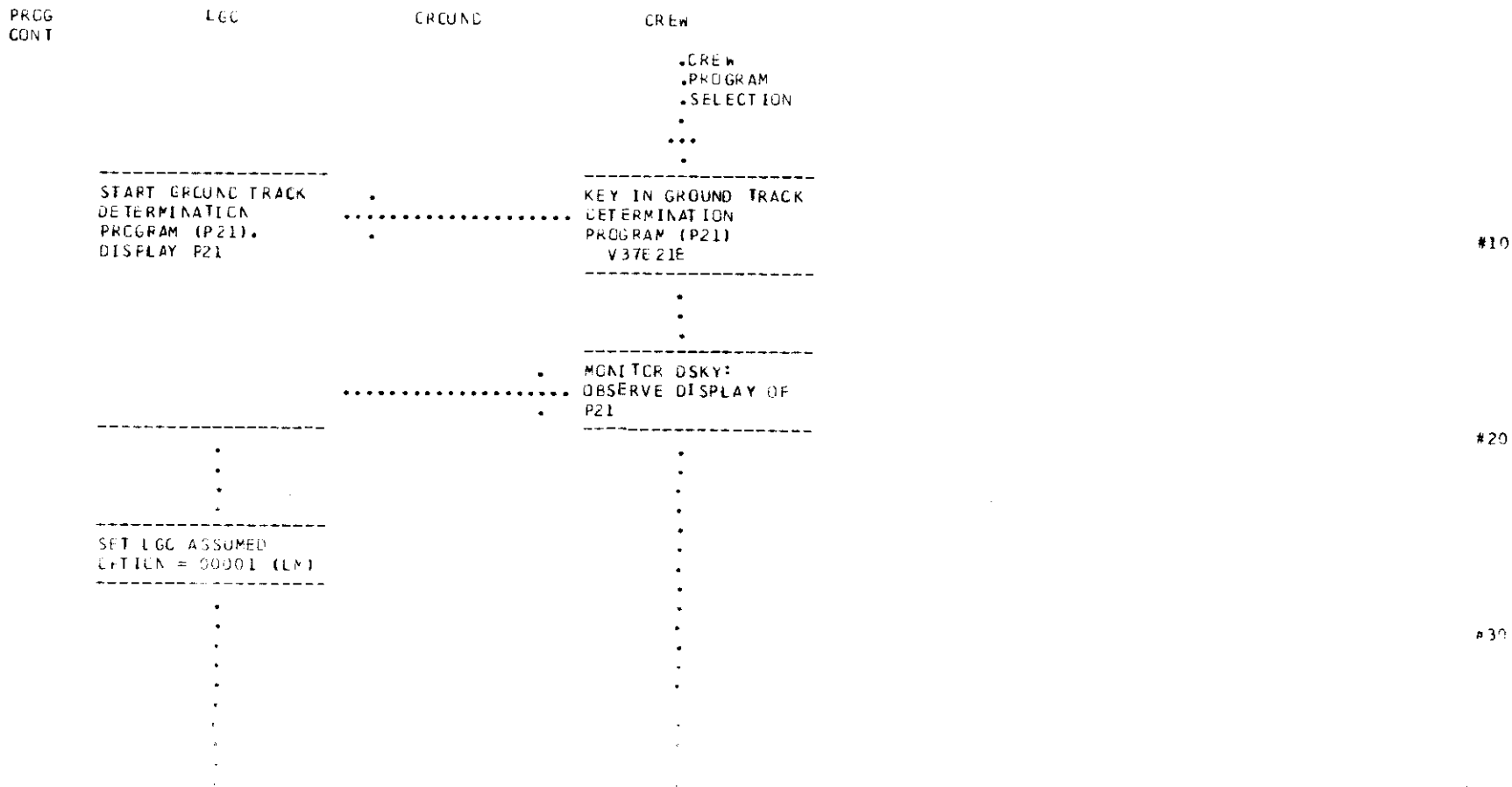
REV 01 PCR 146, 172, 226, 415, 451, 468, 537, 541, 549, 562, 614, 640
REVS 00, 01 (LUM 1A) PCR 646, 732, 757
REV 02 EDITORIAL
REV 03 EDITORIAL

GROUND TRACK DETERMINATION PROGRAM (P21)

REV F2 12/03/69

- PURPOSE: (1) TO PROVIDE THE ASTRONAUT DETAILS OF HIS GROUND TRACK WITHOUT THE NEED FOR GROUND COMMUNICATION.
- ASSUMPTIONS: (1) THIS PROGRAM MAY BE SELECTED WHILE THE LM IS EITHER IN EARTH OR LUNAR ORBIT, TO DEFINE THE GROUND TRACK OF EITHER THE LM OR THE CSM.
- (2) THIS PROGRAM ASSUMES THE VEHICLE WHOSE GROUND TRACK PARAMETERS ARE CALCULATED TO REMAIN IN FREE FALL FROM THE PRESENT TIME UNTIL T LAT LONG.
- (3) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

++
+C2
+EDIT
++



HGLD .
 SNAP . FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY OPTION CODE
 FOR ASSUMED VEHICLE
 (LM OR CSM):
 V04 N06
 R1-00002
 R2-0000X
 R3-ELANK

R1 IS THE OPTION
 CODE FOR ASSUMED
 VEHICLE (LM OR CSM).

R2 IS THE LGC ASSUM-
 ED OPTICN:
 00001 - THIS VEHICLE
 (LM)
 00002 - OTHER VEHI-
 CLE (CSM)

++
 +02 (NOTE: LGC WILL
 +EDIT ASSUME ALL OPTIONS
 ++ OTHER THAN 00001,
 00000, OR 77776 TO
 BE CSM)

MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF OPTICN CODE FOR
 ASSUMED VEHICLE (LM
 OR CSM)

#40

#50

#60

IS THE VEHICLE (LM
 OR CSM) ASSUMPTION
 CORRECT?

#70

.Y .N

WAIT FOR KEYBOARD
 ENTRY

KEY IN PROCEED

#80

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

- .P .NEW
- .R .CODE
- .C .DATA
- .C .
- .E .
- .E .
- .D .

STORE CODE DATA

ZERO T LAT LONG
DISPLAY REGISTERS.
R1, R2, AND R3 WILL
INITIALLY READ
CCCC.

KEY IN
V22E
AND LOAD
THE
DESIRED
VEHICLE
(LM OR
CSM)
CODE IN-
TO R2.

#90

#100

#110

#120

HOLD FLASH VERBODEN TO
 REQUEST RESPONSE AND
SNAP DISPLAY T LAT LONG
 V06 133
 R1-T LAT LONG-HRS
 R2-T LAT LONG-MINS
 R3-T LAT LONG-SECS

MONITOR DSKY:
OBSERVE VERBODEN ON
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF T LAT LONG

#130

++
+02 T LAT LONG - TIME
+EDIT (OBT) AT WHICH LAT

DO I WISH TO HAVE
THE ECC COMPUTE

AND LONG OF VEHICLE
POSITION IS DESIRED.
IN HRS, MINS, SEC TO
NEAREST .01 SEC.

PARAMETERS FOR THE
PRESENT TIME?

.Y .N

ARE ALL
3 REGIST-
ERS EQUAL
TO ZERO ?

.Y .N

AM I SAT-
ISFIED
WITH THE
DISPLAYED
TIME?

.N .Y

WAIT FOR KEYBOARD
ENTRY

KEY IN V25E
AND LOAD NEW
DATA

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

KEY IN PROCEED

.P .NEW
.R .DATA
.O .
.C .
.E -----
.E STORE DATA
.D -----

#140

#150

#160

#170

#180

HOLD
SNAP

FLASH VERB-NCUN TO
REQUEST RESPNSE AND
DISPLAY LATITUDE,
LONGITUDE AND
ALTITUDE:
V06 N43
R1-LAT
R2-LONG
R3-ALT

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF LATITUDE, LONGI-
TITUDE AND ALTITUDE.

LAT-LATITUDE OF
VEHICLE. + IS NORTH.
IN DEGREES TO NEAR-
EST .01 DEGREE.

LONG-LONGITUDE OF
VEHICLE. + IS EAST.
IN DEGREES TO NEAR-
EST .01 DEGREE.

ALT-ALTITUDE OF
VEHICLE ABOVE THE
LAUNCH PAD RADIUS
(EARTH ORBIT) OR
THE LUNAR RADIUS AT
THE LGC-STCRD
LANDING SITE (LLNAR
ORBIT). IN NAUTICAL
MILES TO NEAREST
.1 NM.

++
+02
+EDIT
++

DO I WISH TO OBTAIN
NEW PARAMETERS FOR
A T LAT LONG IC
MINUTES FROM NOW OR
ANY OTHER TIME THAN
THAT WHICH APPLIES
TO PRESENT DISPLAY?

.N .Y

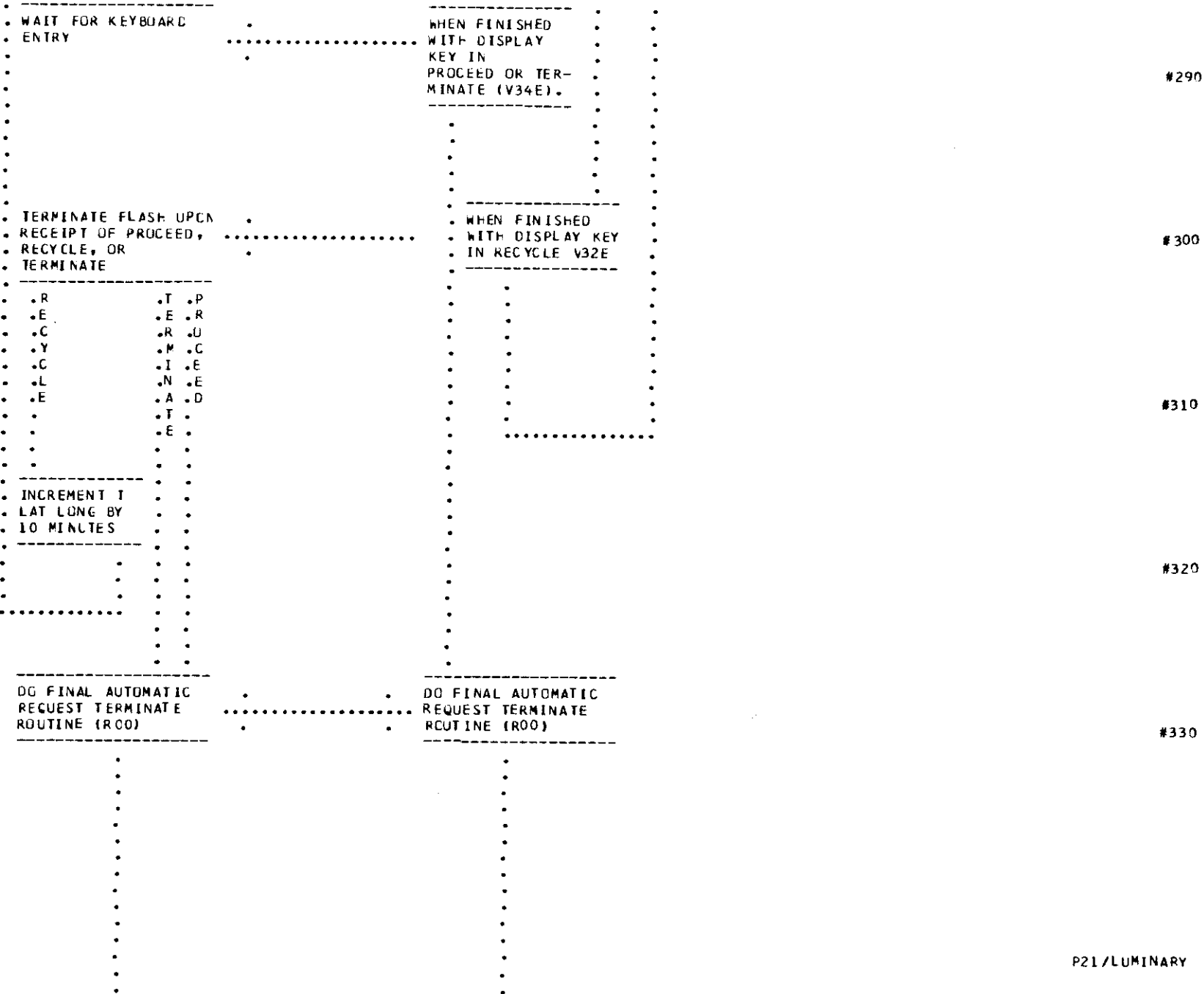
#240

#250

#260

#270

#280



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EXIT P21

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.
.
EXIT P21

CHANGE CONTROL NOTES

REV 01 EDITORIAL
REV CC(LUM 1A) PCR 738
REV 01(LUM 1B) PCR 807.2
REV 02 EDITORIAL

LUNAR SURFACE NAVIGATION PROGRAM (P22)

REV 03 12/03/69

- PURPOSE:
- (1) TO CONTROL THE RENDEZVOUS RADAR (RR) TO ACQUIRE AND TRACK THE CSM WHILE THE LM IS ON THE LUNAR SURFACE.
 - (2) TO UPDATE THE CSM STATE VECTOR ON THE BASIS OF RR TRACKING DATA.
 - (3) TO TRACK THE CSM WITHOUT UPDATING EITHER VEHICLE STATE VECTOR.

ASSUMPTIONS: (1) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE LUNAR SURFACE ALIGN PROGRAM (P57) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM. THE ISS THUS MAY BE:

- (A) OFF (STANDBY).
- (B) ON, AND NOT ALIGNED SINCE TURN ON.
- (C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT EITHER HAVING BEEN INACCURATELY ALIGNED OR HAVING DRIFTED FROM THE STORED ALIGNMENT.
- (D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC.

IF (A) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.

IF (B) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.

IF (C) IS TRUE THE LGC MAY OR MAY NOT HAVE A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.

IF (D) IS TRUE THE LGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.

(2) THE CSM MAY OR MAY NOT BE BELOW THE LUNAR HORIZON. ALTHOUGH ABOVE THE HORIZON IT MAY STILL BE OUTSIDE OF THE AVAILABLE RR COVERAGE SECTOR. ALTHOUGH WITHIN THE AVAILABLE RR COVERAGE SECTOR IT MAY BE OUTSIDE THE ALLOWABLE RR COVERAGE SECTOR (SEE RR MONITOR ROUTINE (R25)).

THIS PROGRAM WILL ALWAYS TRACK THE CSM WITH THE RADAR IN MODE 2 (SEE FIGURE 2.4-3 OF SECTION 5 OF R567). IN MODE 2 THE AVAILABLE COVERAGE IS ALWAYS LESS THAN HORIZON TO HORIZON.

(3) THE CSM IS MAINTAINING A PREFERRED TRACKING ATTITUDE FOR RR TRACKING BY THE LM. THIS PREFERRED ATTITUDE CORRECTLY ORIENTS THE CSM RADAR TRANSPONDER.

(4) AT THE BEGINNING OF THE PROGRAM THE STATE VECTOR UPDATE OPTION IS AUTOMATICALLY SET TO THE CSM. THIS OPTION MAY BE INHIBITED AT ANY TIME AND LATER RESTORED BY THE FOLLOWING MANUAL ENTRIES:

V81E UPDATE CSM STATE VECTOR

V95E NO STATE VECTOR UPDATE

(5) THE RENDEZVOUS RADAR IS ON, PRELIMINARY CHECKOUT HAS BEEN COMPLETED.

(6) THE FOLLOWING DISPLAY IS AVAILABLE DURING THIS PROGRAM UPON CREW REQUEST BY KEYING IN V85E (SEE EXTENDED VERBS):

V1E56

R1-RR LOS AZIMUTH

R2-RR LOS ELEVATION

R3-BLANK

WHERE: RR LOS AZIMUTH-THE ANGLE BETWEEN THE LM X/Z PLANE AND THE RR LOS VECTOR. POSITIVE ROTATION IS FROM THE LM +Z AXIS TO THE LM +Y AXIS. IN DEGREES TO NEAREST .01 DEGREE.

RR LOS ELEVATION-THE ANGLE BETWEEN THE LM +Z AXIS AND THE PROJECTION OF THE RR LOS VECTOR ON THE LM X/Z PLANE. POSITIVE ROTATION IS POSITIVE ROTATION ABOUT THE LM +Y AXIS.

- (7) THE INITIALIZATION OF THE W MATRIX (SEE SECTION 5.2.4.2 OF R567) IS ENABLED BY:
- (A) A MANUAL DSKY ENTRY (V93E).
 - (B) COMPUTER FRESH START (V36E).
 - (C) LM OR CSM IN-FLIGHT STATE VECTOR UPDATE FROM THE GROUND (P27) (EXCEPT FOR UPDATE OF LANDING SITE VECTOR WHEN THE LM IS ON THE LUNAR SURFACE).
- (8) THE RR TRACKING MARK COUNTER COUNTS THE NUMBER OF RR MARKS PROCESSED BY THE LGC. THIS COUNTER IS ZEROED BY:
- (A) MANUAL SELECTION OF P20/P22 (V37E20/22E).
 - (B) COMPLETION OF THE TARGET DELTA V PROGRAM (P76).
 - (C) SELECTION OF A NEW PROGRAM FROM A PROGRAM WHICH HAD TURNED ON AVERAGE G.
 - (C) INITIALIZATION OF THE W MATRIX (SEE (7) ABOVE).
 - (E) COMPLETION OF RR SEARCH ROUTINE (R24).
- (9) THE RMS POSITION AND VELOCITY ERRORS COMPUTED FROM THE W MATRIX ARE AVAILABLE BY EXTENDED VERB (V67E). BASED UPON VALUES IN THIS DISPLAY AND THE DETAILS OF THE MISSION, THE ASTRONAUT CAN ELECT TO STOP OR CONTINUE THE CURRENT NAVIGATION PROCEDURE OR TO RE-INITIALIZE THE W MATRIX AND CONTINUE NAVIGATING. THE CAPABILITY TO REINITIALIZE THE W MATRIX IS ALSO PROVIDED VIA V67E.
- (10) THE SELECTION AND TERMINATION OF P20, P22, AND P25 ARE SUBJECT TO SPECIAL OPERATING PROCEDURES DIFFERENT FROM ALL OTHER PROGRAMS;
- (A) SELECTION
 - (1) ALWAYS BY V37EXXE.
 - (2) IF ANY OTHER PROGRAM IS RUNNING AT THE TIME OF P20/22/25 SELECTION THE NEW PROGRAM WILL REPLACE THE OLD. THIS INCLUDES P20/22/25 SELECTION WHENEVER EITHER P20, 22, OR 25 IS RUNNING.
 - (3) IF P20 OR P25 IS RUNNING, SELECTION OF ANY PROGRAM OTHER THAN P00 OR P22 WILL RESULT IN P20 OR P25 CONTINUING AND THE NEW PROGRAM ALSO OPERATING WITH ITS NUMBER IN THE DSKY PRG LIGHTS.
 - (4) IF P20 OR P25 IS RUNNING, SELECTION OF P00 OR P22 WILL RESULT IN THE TERMINATION OF THE OLD PROGRAM AND OPERATION OF THE NEW.
 - (B) TERMINATION
 - (1) BY SELECTION OF P00, V56E, OR BY V34E.
 - (2) P00 SELECTION WILL TERMINATE P20, 22, AND 25 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH P00.
 - (3) V56E SELECTION WILL SELECT THE TERMINATE TRACKING ROUTINE (R56) WHICH WILL TERMINATE ONLY P20 OR P25 IF EITHER OF THESE PROGRAMS IS RUNNING IN CONJUNCTION WITH ANOTHER PROGRAM. IN ALL OTHER CASES R56 WILL SELECT R00. V56E MAY BE PERFORMED ANY TIME DURING P20, 22, OR 25 OPERATION.
 - (4) THE LGC WILL ACT UPON V34E ONLY IN RESPONSE TO A FLASHING VERB-NOUN. IF THIS DISPLAY WAS ORIGINATED BY P20, 22, OR 25, V34E WILL RESULT IN AN IDENTICAL LGC RESPONSE TO THAT OF V56E, THAT IS SELECTION OF R56. IF THIS DISPLAY WAS NOT ORIGINATED BY P20, 22, OR 25 (SUCH AS P32, WHILE RUNNING WITH P20) THE LGC WILL GO TO R00, HOWEVER THE PROGRAM IN THE BACKGROUND WILL CONTINUE. THE NEW PROGRAM SELECTED FOLLOWS THE SELECTION RULES ABOVE, (A).
 - (5) ALTHOUGH IT IS NOT CLEARLY SHOWN IN THE LOGIC BELOW, A V34E RESPONSE TO A PRIORITY DISPLAY MUST BE DELAYED 2 SECONDS FROM DISPLAY INITIATION WHEREAS THE DELAY IS NOT NECESSARY FOR A V56E RESPONSE.
- (11) TO MONITOR THE PROGRESS OF STATE VECTOR INTEGRATION, THE TIME ASSOCIATED WITH THE ADVANCING (REGRESSING) STATE IS AVAILABLE BY KEYING IN V06N38E:

VC6N38
R1-TET-FRS
R2-TET-MINS
R3-TET-SECS

TET - THE TIME (GET) TO WHICH THE STATE VECTOR INTEGRATION PROCESS HAS PRESENTLY CALCULATED THE STATE VECTOR. IN HRS, MINS, AND SECS TO NEAREST .01 SEC.

(12) STATE VECTOR INTEGRATION MAY BE PERMANENTLY INHIBITED BY V96E. THIS ENTRY WILL TERMINATE ALL PRESENT PROGRAMS AND SELECT THE LGC IDLING PROGRAM (P00) WITH THE P00 AUTOMATIC STATE VECTOR INTEGRATION PERMANENTLY INHIBITED UNTIL SELECTION OF ANOTHER PROGRAM. USE OF V96 CAN CAUSE INCORRECT W-MATRIX EXTRAPOLATION SINCE STATE VECTOR SYNCHRONIZATION IS NOT MAINTAINED.

PROG CONT	LGC	GROUND	CREW	
			.CREW .PROGRAM .SELECTION .	#10
			#20
----- START LUNAR SURFACE NAVIGATION PROGRAM (P22). DI SPLAY P22	----- KEY IN LUNAR SURFACE NAVIGATION PROGRAM (P22) V37E22E -----	#30

.....
MONITOR DSKY:
OBSERVE DISPLAY
OF P22

#40

(NOTE: FROM THIS POINT ON THE LGC LOGIC DESCRIBES BOTH THE RENDEZVOUS NAVIGATION PROGRAM (P20) AND THE LUNAR SURFACE NAVIGATION PROGRAM (P22). ONLY THAT LOGIC ASSOCIATED WITH P22 IS PERTINENT HERE HOWEVER).

(NOTE: ALL LOGIC IN THE CREW COLUMN IS ONLY THAT ASSOCIATED WITH THE LUNAR SURFACE NAVIGATION PROGRAM (P22)).

#50

IS SURFACE FLAG SET?

. N . Y .

#60

RESET VEHICLE UPDATE FLAG.

#70

. SET VEHICLE UPDATE FLAG .

#80

. SET LGC ASSUMED OPTION = 00001 .

POSS
HGLD
.....
SNAP

FLASH VERB-NOUN
TO REQUEST RE-
SPONSE AND DIS-
PLAY ASSUMED CSM
ORBIT OPTION;
V04N06
R1-00G12
R2-G000X
R3-ELANK

R1 IS OPTION CODE
FOR ASSLMED CSM
ORBIT OPTION.

R2 IS THE LGC-
ASSLMED OPTION:
00001-CSM
WILL NCT
CHANGE ITS
PRESENT ORBIT.

00002-CSM
WILL CHANGE
ITS PRESENT
ORBIT TO GO
OVER THE PRE-
SENT LM PCS-
ITION ON THE
LUNAR SURFACE.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

.P .NEW
.R .DATA

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
LGC ASSUMED CSM
ORBIT OPTION.

IS THIS ASSUMPTION
CCRRRECT?

.Y N.

KEY IN PROCEED

KEY IN V22E AND
LCAD DESIRED
OPTION CODE IN R2

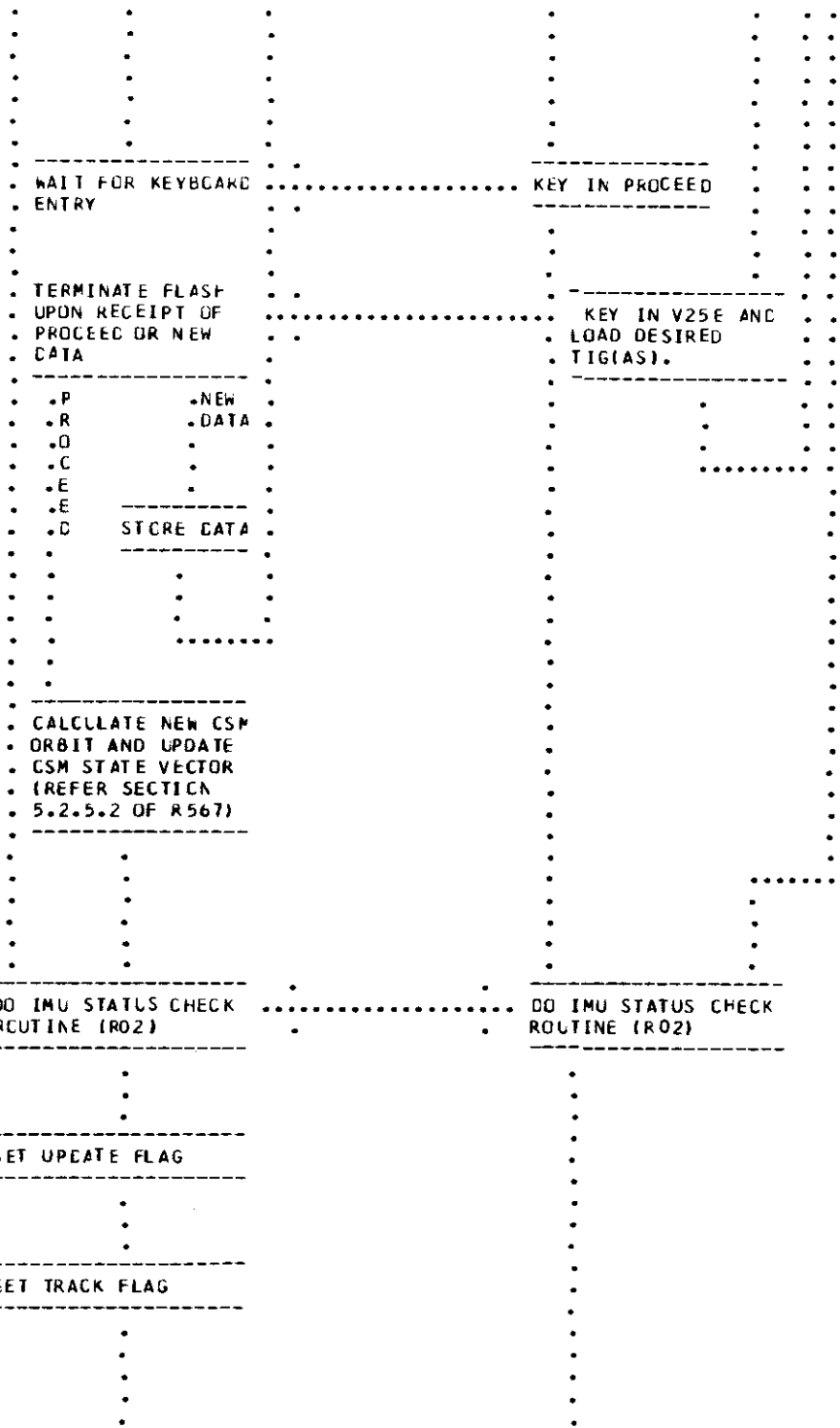
#90

#100

#110

#120

#130



#190

#200

#210

#220

#230

#240

•
•
•
•
•
•
•
•

SET RENDEZVOUS FLAG

#250

•
•
•
•
•
•
•
•

RESET SEARCH FLAG

•
•
•
•
•
•
•
•

RESET MANUAL ACQUIRE
FLAG

#260

•
•
•
•
•
•
•
•

RESET THE R04 FLAG

#270

•
•
•
•
•
•
•
•

RESET THE NO RR
MONITOR FLAG

•
•
•
•
•
•
•
•

RESET LCSCM FLAG

#280

•
•
•
•
•
•
•
•

RESET DESIGNATE FLAG

#290

•
•
•
•
•
•
•
•

RESET CONTINUOUS DE-
SIGNATE FLAG

162

DISABLE RR ERROR
COUNTERS

#300

 " A "
ENTER HERE
FROM RR
SEARCH
ROUTINE
(R24)

#310

ZERO RR TRACKING
MARK COUNTER

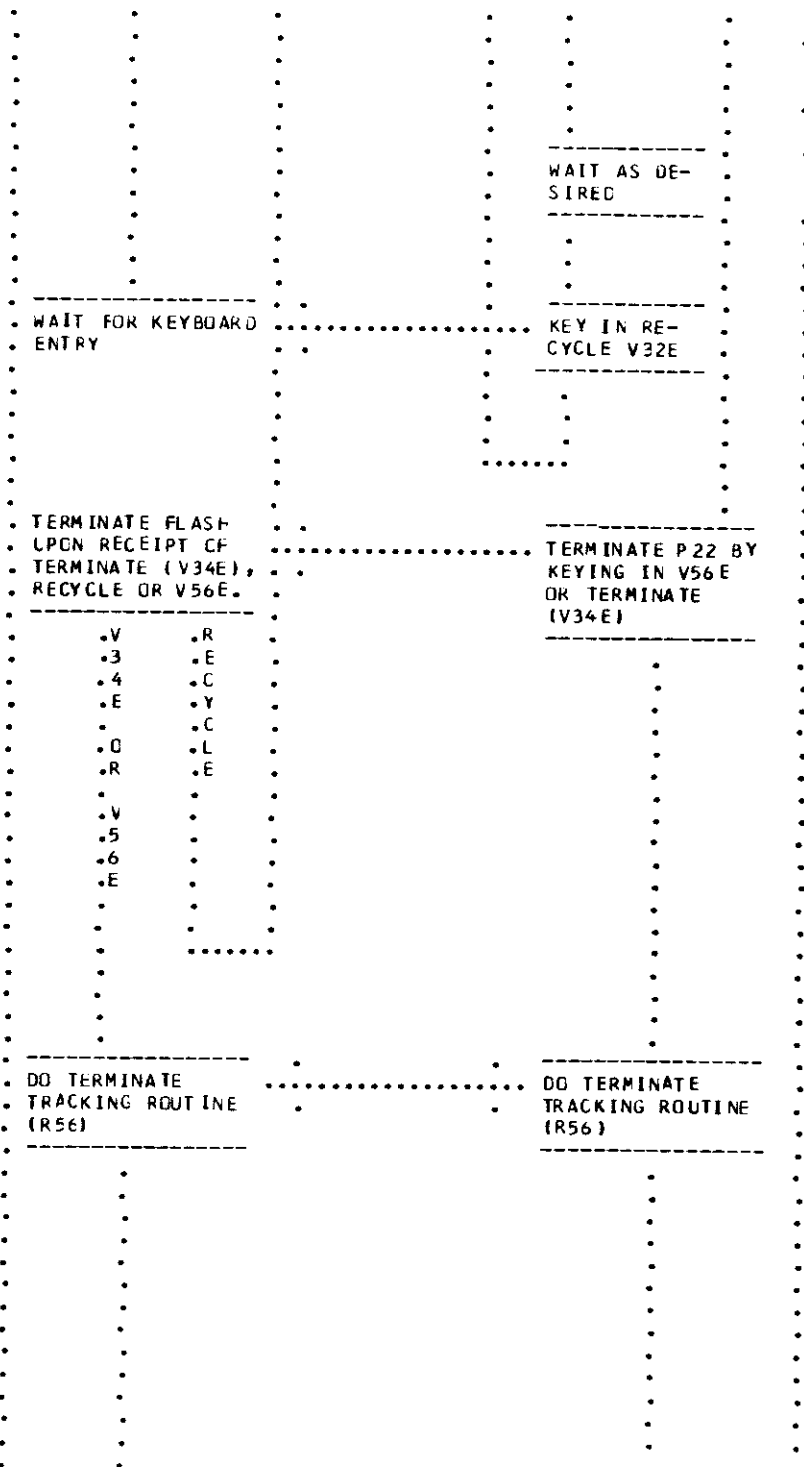
#320

++
+03
+EDIT
+
+
+
+
+
+
+
+03
++

UPDATE THE LM STATE
VECTOR TO T(LCS) =
PRESENT TIME USING
THE PLANETARY INER-
TIAL ORIENTATION
SUBROUTINE AND
UPDATE THE CSM STATE
VECTOR TO T(LCS) =
PRESENT TIME USING
THE KEPLER SUBROU-
TINE.

#330

#340



#400

#410

#420

#430

#440

EXIT P20/22

EXIT P22

"B"
ENTER HERE
FROM RR
DATA READ
ROUTINE
(R22).

#450

IS SURFACE FLAG SET?

.Y N.
.
.
.

#470

DO PREFERRED
TRACKING ATTITUDE
ROUTINE (R61).

#480

IS TRACK FLAG SET?

.Y N.
.
.
.
.
.
.
GO TO

#490

"G"
BELOW

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N

"C"
ENTER HERE
FRM RR
DATA READ
ROUTINE
(R22).

IS P20 OR P22 THE
ONLY PROGRAM
RUNNING?
(NOTE: IF PRESENT
PROGRAM IS P22,
ANSWER IS ALWAYS
"YES".)

.Y N.

POSS
PRIO
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PCNSE AND DIS-
PLAY ALARM CODE
00514 INDICAT-
ING IMPRCPER

#500

#510

#520

#530

#540

REMOVAL OF RR
FROM AUTO MODE.
V05N09
R1 XXXXX
R2 XXXXX
R3 XXXXX

WAIT 2 SECONDS

WAIT FOR KEY-
BOARD ENTRY

TERMINATE FLASH
UPON RECEIPT
OF PROCEED, RE-
CYCLE, OR TER-
MINATE (V34E),
OR V56E

.V	.P
.3	.R
.4	.C
.E	.C
	.E

#550

#560

#570

#580

#590

R1-00201
R2-BLANK
R3-BLANK

UAL ACQUISITION ROUT-
INE (R23) MAY BE
CALLED FROM THIS
DISPLAY (ENTER).
HOWEVER DURING THIS
PROGRAM (P22) AN
"ENTER" WILL CAUSE
AN OPERATOR ERROR.

#650

2) THE RR MUST BE IN
THE AUTO MODE (LGC
POSITION) FOR AUTO-
MATIC P20/22 OPERA-
TION.

3) AS LONG AS THE
LGC IS ON IT WILL
CALL THE RR MONITOR
ROUTINE (R25) EVERY
0.48 SECONDS AS DES-
CRIBED IN SECTION
5.2.4.3 OF R567).

#660

.Y .N

PUT RR ANTENNA
MODE SWITCH TO
LGC.

#670

WAIT FOR KEY-
BOARD ENTRY.

KEY IN PROCEED

#680

TERMINATE FLASH
LPCN RECEIPT OF
PROCEED OR ENTER

.E .P
.N .R

#690

.T
.E
.R

.D
.C
.E
.E
.D

IS THE SURFACE
FLAG SET?

.N Y.

TURN ON OPER-
ATOR ERROR
ALARM.

#700

#710

DO MANUAL ACQUI-
SITION ROUTINE
(R23).

#720

SET THE MANUAL
ACQUIRE FLAG

#730

WAIT FOR 2.5
SECONDS

#740

IS THE RR CDU ZERO
FLAG SET?

.N Y.

#750

IS MANUAL ACQUIRE OR
SEARCH FLAG SET?

.Y N.

#760

RE SET THIS
FLAG.

#770

"H"
ENTER
HERE
FROM RR
DESIGNATE
ROUTINE
(R21)

#780

UPDATE PER-
MANENT STATE
VECTORS TO THE

#790

112

PRESENT TIME
USING PRECIS-
ION INTEGRAT-
ION.

WCM
ENTER HERE
FROM RR
DATA READ
ROUTINE
(R22)
OR LUNAR
SURFACE
RR PRE-
DESIGNATE
ROUTINE
(R26)

IS THE RENDEZ-
VOUS FLAG SET?

.Y .N

EXIT
P20/22

IS THE TRACK
FLAG SET?

.Y .N

#800

#810

#820

#830

#840

WAIT 15
SECCNDS

IS THE
TRACK FLAG
SET?

.Y N.

WAIT 15
SECONDS
(NOTE:
IF
TRACK
FLAG
REMAINS
RESET
P20/22
TERMIN-
ATION
(V37E-
OOE OR
V56E)
WILL
TERMIN-
ATE
THIS
WAIT-
LIST
CALL
AND
EXIT
P2C/
22.)

#850

#860

#870

#880

#890

"C"
"H"
ENTER
HERE
FROM RR
DESIGNATE
ROUTINE
(R21) OR
RR DATA
READ
ROUTINE
(R22)
OR LUNAR
SURFACE RR
PRE-DESIGNATE
ROUTINE
(R26)

#900

#910

#920

DO RR DESIG-
NATE ROUTINE
(R21)

.TARGET
.ACQUIRED
.BY R21

MONITOR DSKY:
THE RR IS NOW
DESIGNATED TOWARD
THE CSM.
THE LGC WILL
ONLY COMMUNICATE
WITH THE ASTRONAUT
DURING THIS ROUTINE:

#930

(1) WHEN THE LGC
FAILS TO RECEIVE
THE DATA GOOD
DISCRETE FROM THE

RR WITHIN APPROX-
IMATELY 45 SEC-
ONDS OF THE IN-
ITIATION OF A DE-
SIGNATE SEQUENCE,
THE LGC GRABS THE
DISPLAY AND DIS-
PLAYS ALARM CODE
00503.

#940

(2) WHEN THE LGC
CALCULATES THAT
THE LOS TO THE
CSM IS OUTSIDE
THE ALLOWABLE
LIMITS FOR THE
RR DURING A
PRE-DESIGNATE ON
THE LUNAR SUR-
FACE, THE LGC
GRABS THE DISPLAY
AND DISPLAYS
ALARM CODE 00530.

#950

#960

IS THE SURFACE
FLAG SET?

#970

.N Y.
.
.
.

HOLD .
.....
SNAP .

FLASH VERB-NCUN
TO REQUEST RES-
PCNSE AND DIS-
PLAY RR CDU
ANGLES
V50N72
R1-TRUNNICH

#980

WAIT 15 SECONDS

"F"
ENTER HERE
FROM RR
DATA READ
ROUTINE (R22)

WAIT 2 SECONDS

CRETE IS NOT PRE-
SENT IMMEDIATELY
PRIOR TO A DATA
READ SEQUENCE
DURING THE DATA
READ ROUTINE
(R22) THE LGC
GRABS THE DISPLAY
AND REQUESTS THIS
DISCRETE.

(4) WHEN THE LGC
DETERMINES THAT
THE ACTUAL RR LCS
DIFFERS FROM THE
LGC CALCULATED
LOS BY MORE THAN
3 DEGREES AFTER
A DATA READ SE-
QUENCE THE LGC
GRABS THE DISPLAY
AND DISPLAY AN
ALARM CODE
{00525}.

(5) WHEN THE
MAGNITUDE OF A
STATE VECTOR COR-
RECTION IS GREAT-
ER THAN THE ALL-
OWABLE LIMITS (AS
DEFINED IN PARA-
GRAPH 5.2.4.2.2
OF R567) THE
LGC GRABS THE
DISPLAYS AND DIS-
PLAYS THE EXCESS-
IVE UPDATE PARA-
METERS.

#1130

#1140

#1150

#1160

#1170

PREFERRED TRACKING ATTITUDE PROGRAM (P25)

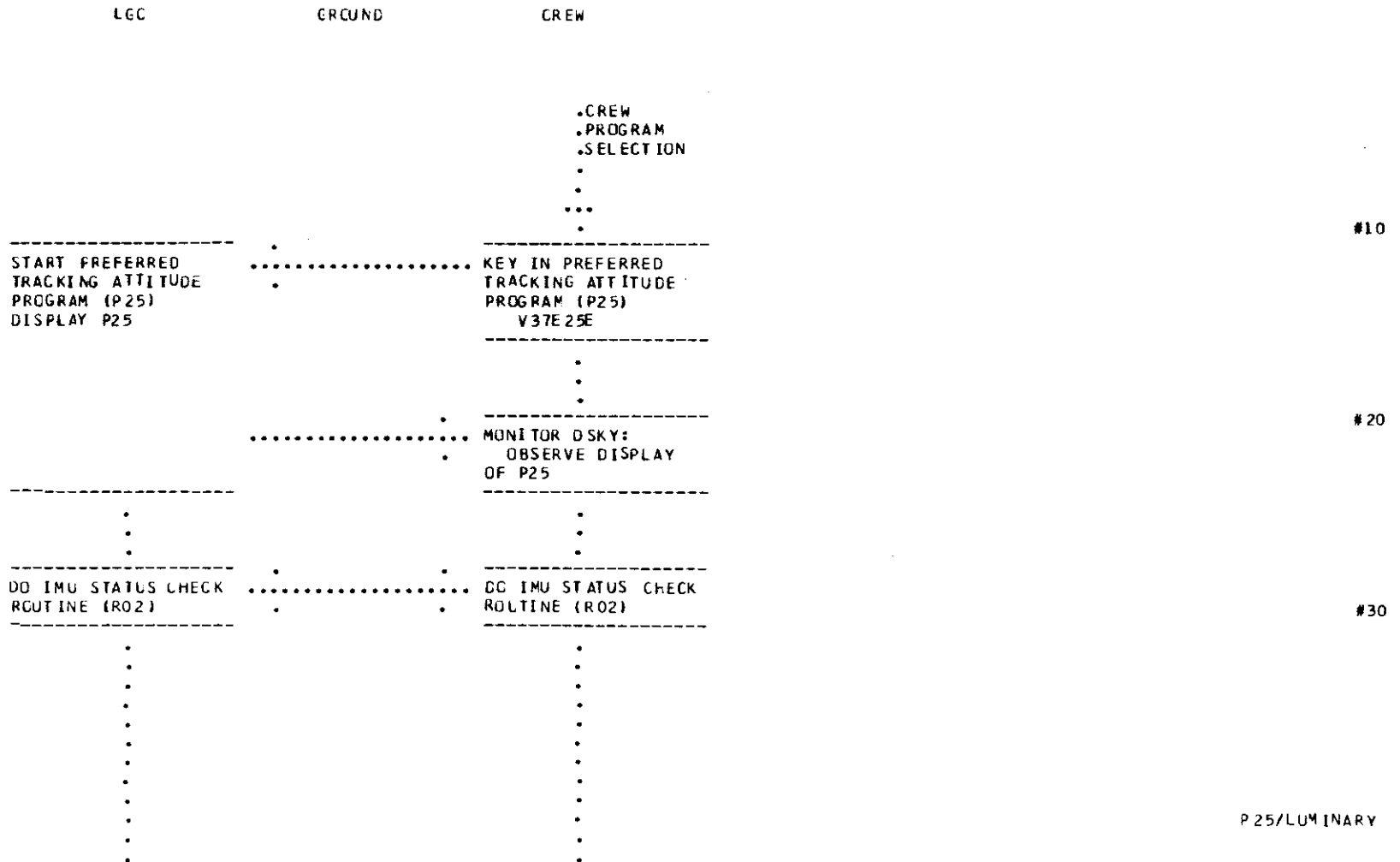
REV 03 12/03/69

- PURPOSE: (1) TO COMPLETE THE PREFERRED TRACKING ATTITUDE OF THE LM WHICH ENABLES CSM TRACKING OF THE LM BEACON.
 (2) TO PERFORM THE MANEUVER TO THE PREFERRED TRACKING ATTITUDE.
- ASSUMPTIONS: (1) DURING THE RENDEZVOUS NAVIGATION PROGRAM (P20) THE LM ATTITUDE CONTROL IS INTIMATELY ASSOCIATED WITH THE RENDEZVOUS RADAR (RR). SHOULD RR MALFUNCTION PRECLUDE CORRECT OPERATION OF P20, THIS PROGRAM (P25) SHOULD BE SELECTED TO PROVIDE A LM PREFERRED TRACKING ATTITUDE.
 (2) THE PREFERRED TRACKING ATTITUDE IS DEFINED AS FOLLOWS:
 (A) THE LM +Z AXIS IS ALIGNED ALONG THE LCS TO THE CSM.
 (B) THE ROLL ATTITUDE (ABOUT LM +Z AXIS) IS UNCONSTRAINED AND IS DEFINED AS NECESSARY TO AVOID GIMBAL LOCK.
 (3) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) OR THE LUNAR SURFACE ALIGN PROGRAM (P57) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM. NO PREFERRED ORIENTATION IS SPECIFIED OR REQUIRED FOR THIS PROGRAM AS THE FINE PREFERRED TRACKING ATTITUDE ROUTINE (R65) CAN ALWAYS CALCULATE A VEHICLE ORIENTATION ABOUT A SPECIFIED LM +Z VECTOR THAT CAN AVOID GIMBAL LOCK FOR ANY INERTIAL IMU ORIENTATION.
 THE ISS THUS MAY BE:
 (A) OFF (STANDBY).
 (B) ON, AND NOT ALIGNED SINCE TURN ON.
 (C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E.: HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN-ON BUT HAVING DRIFTED FROM THE STORED ALIGNMENT.
 (D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC.
 IF (A) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
 IF (B) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
 IF (C) IS TRUE THE LGC MAY OR MAY NOT HAVE A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.
 IF (D) IS TRUE THE LGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE PROGRAM.
- (4) THE LM TRACKING BEACON FIELD OF VIEW IS A 30 DEGREE HALF ANGLE CONE WITH THE CONE AXIS PARALLEL TO THE LM +Z AXIS.
- (5) THE SELECTION AND TERMINATION OF P20, P22, AND P25 ARE SUBJECT TO SPECIAL OPERATING PROCEDURES DIFFERENT FROM ALL OTHER PROGRAMS;
 (A) SELECTION
 (1) ALWAYS BY V37EXXE.
 (2) IF ANY OTHER PROGRAM IS RUNNING AT THE TIME OF P20/P22/P25 SELECTION THE NEW PROGRAM WILL REPLACE THE OLD. THIS INCLUDES P20/P22/P25 SELECTION WHENEVER EITHER P20, P22, OR P25 IS RUNNING.
 (3) IF P20 OR P25 IS RUNNING, SELECTION OF ANY PROGRAM OTHER THAN P00 OR P22 WILL RESULT IN P20 OR P25 CONTINUING AND THE NEW PROGRAM ALSO OPERATING WITH ITS NUMBER IN THE DSKY PROG LIGHTS.
 (4) IF P20 OR P25 IS RUNNING, SELECTION OF P00 OR P22 WILL RESULT IN THE TERMINATION OF THE OLD PROGRAM AND OPERATION OF THE NEW.
 (B) TERMINATION
 (1) BY SELECTION OF P00, V56E OR BY V34E.
 (2) P00 SELECTION WILL TERMINATE P20, P22, AND P25 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH

PCC.

- (3) V56E SELECTION WILL SELECT THE TERMINATE TRACKING ROUTINE (R56) WHICH WILL TERMINATE ONLY P20 OR P25 IF EITHER OF THESE PROGRAMS IS RUNNING IN CONJUNCTION WITH ANOTHER PROGRAM. IN ALL OTHER CASES R56 WILL SELECT R00. V56E MAY BE PERFORMED ANY TIME DURING P20, 22, OR 25 OPERATION.
- (4) THE LGC WILL ACT UPON V34E ONLY IN RESPONSE TO A FLASHING VERB-NDUN. IF THIS DISPLAY WAS ORIGINATED BY P20, 22, OR 25, V34E WILL RESULT IN AN IDENTICAL LGC RESPONSE TO THAT OF V56E, THAT IS, SELECTION OF R56. IF THIS DISPLAY WAS NOT ORIGINATED BY P20, 22, OR 25 (SUCH AS P32, WHILE RUNNING WITH P20) THE LGC WILL GO TO R00. HOWEVER THE PROGRAM IN THE BACKGROUND WILL CONTINUE. THE NEW PROGRAM SELECTED FOLLOWS THE SELECTION RULES ABOVE, (A).
- (5) ALTHOUGH IT IS NOT CLEARLY SHOWN IN THE LOGIC BELOW A V34E RESPONSE TO A PRIORITY DISPLAY MUST BE DELAYED 2 SECONDS FROM DISPLAY INITIATION WHEREAS THE DELAY IS NOT NECESSARY FOR A V56E RESPONSE.

PROG
CONT



SET TRACK FLAG

SET P25 FLAG.

IS P25 FLAG SET?

.Y .N.

EXIT
P25

IS THE TRACK FLAG
SET?

.Y .N

WAIT 60 SEC.

SET NZ = 7 FOR USE
BY R65

DC FINE PREFERRED
TRACKING ATTITUDE

THE LGC WILL MAIN-
TAIN THE LM/CSM LOS

#40

#50

#60

#70

#80

#90

ROUTINE (R65)

ALIGNED WITH THE
LM +Z AXIS WITHIN
THE DEADBAND LIMITS
OF THE RCS

DO I DESIRE TO
TERMINATE P25?

.Y .N

WAIT FOR KEYBOARD
ENTRY.

KEY IN V56E

RESPOND TO V56E
IMMEDIATELY.

.V
.5
.6
.E

DO TERMINATE TRAC-
KING ROUTINE (R56).

DO TERMINATE TRAC-
KING ROUTINE (R56).

EXIT P25

EXIT P25

#100

#110

#120

#130

#140

181

CHANGE CONTROL NOTES

LOGIC REV 00 PCR 39
REV 01 PCR 451,562
REV 02 EDITORIAL
REV 03 EDITORIAL

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LGC UPDATE PROGRAM (P27)

REV 03 12/03/69

PURPOSE: (1) TO INSERT INFORMATION INTO THE LGC VIA THE DIGITAL UPLINK BY TRANSMISSION FROM THE GROUND OR VIA THE DSKY KEYBOARD BY CREW MANUAL INPUT.

ASSUMPTIONS: (1) THE LGC MUST BE IN THE OPERATE CONDITION. THE ISS MAY BE IN STANDBY OR OPERATE CONDITION.

(2) LGC UPDATES ARE OF FOUR CATEGORIES:

(A) PROVIDE AN UPDATE FOR LGC LIFTOFF TIME (V70).

(B) PROVIDE LOAD CAPABILITY FOR A BLOCK OF SEQUENTIAL ERASABLE LOCATIONS (1-18 INCLUSIVE LOCATIONS WHOSE ADDRESS IS SPECIFIED) (V71).

(C) PROVIDE LOAD CAPABILITY FOR 1-9 INCLUSIVE INDIVIDUALLY SPECIFIED ERASABLE LOCATIONS (V72).

(D) PROVIDE AN OCTAL INCREMENT FOR THE LGC CLOCK ONLY (V73).

(3) A COMPLETE DESCRIPTION OF THE LGC UPLINK FORMAT IS INCLUDED IN SECTION 2 OF R567.

(4) THE UPLINK MAY BE BLOCKED BY PLACING THE VOICE/OFF/VOICE BU SWITCH TO VOICE BU.

(5) UPDATE IS ALLOWED IN THE LM ONLY WHEN THE LGC IS IN THE LGC IDLING PROGRAM (P00). P27 EXIT IS ALWAYS TO P00.

(6) THE PROGRAM IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR BY THE GROUND BY UPLINK TRANSMISSION.

PRG
CONT

LGC

GROUND

CREW

.CREW
.PROGRAM
.SELECTION
.
...
.

CONFIRM UPDATE
PARAMETERS AND
TRANSMISSION
TIME. PREPARE
PARAMETERS AT
NECESSARY GROUND
STATION.

REQUEST LGC UPDATE.
SPECIFY PARAMETERS
AND COORDINATE TIME
OF TRANSMISSION.
ENSURE LGC WILL BE
ABLE TO ACCEPT.

.
. .GROUND
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

.
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

#10

137

1. UPDATE LIFT OFF
TIME V70
2. LOAD DATA BLOCK
V71
3. LOAD SINGULAR
DATA V72
4. OCTAL TIME INCRE-
MENT V73

 2. 3. 1. 4.

 WAIT FOR KEYBOARD
 ENTRY OR UPLINK
 TRANSMISSION.

 . TRANS-
 MIT
 . V71E

 . TRANS-
 MIT
 . V72E

 . TRANS-
 MIT
 . V70E

 . TRAN-
 SMIT
 . V73E

GO TO "B"

GO TO "C"

#70

#80

#90

#100

#110

BELWA BELCW

KEY IN
V70E

#120

KEY IN
V71E

#130

KEY IN
V72E

KEY IN
V73E

#140

DO EXTENDED VERB
INTERLOCK ROUTINE
(R76).

DO EXTENDED VERB
INTERLOCK ROUTINE
(R76).

#150

IS THE PRESENT
PROGRAM THE LGC
IDLING PROGRAM

#160

(P00) OR ARE PROGRAM
LIGHTS BLANKED DUE
TO A FRESH START?

Y. N.
.
.

SET UPLINK
COMPONENT
COUNTER TO
ONE

CHANGE DOWN-
LINK LIST.

START LGC
UPDATE PRO-
GRAM (P27).
DISPLAY P27

MONITOR DSKY:
DOES DISPLAY OF
P27 INDICATE
THAT AN UPDATE IS
ALLOWED?

RESET
EXTEND-
ED VERB
ACTIVE
FLAG
AND NO
MARKS
ALLOWED
FLAG

TURN ON
OPERA-
TOR ER-
ROR

N Y

OBSERVE OPERATOR
ERROR LIGHT ON
AND UPLINK ACTI-
VITY LIGHT OFF

#170

#180

#190

#200

#210

LIGHT.
TURN
OFF UP-
LINK
ACTI-
VITY
LIGHT

TO INDICATE IN-
CORRECT PROGRAM
SELECTION.

EXIT

EXIT

#220

HOW WAS THIS PROGRAM
INITIATED?

WAS THIS PROGRAM
INITIATED BY V71
OR V72?

.V .V .V
.7 .7 .7
.1 .2 .C
. . .
. . .C
. . .R
. . .
. . .V
. . .7
. . .3

.N .Y
. . .
GO TO
"C"
BELOW

#230

#240

FLASH VERB/
NOUN TO RE-
QUEST LOAD
OF INDEX IN
MACHINE AD-
DRESS SPEC-
IFIED IN R3
AND DISPLAY:
V21 N01
R1-BLANK
R2-UN-
CHANGED
R3-LPBUFF
ADDRESS

"B"
FROM
ABOVE

MONITOR DSKY:
OBSERVE VERB/NOUN
FLASH TO REQUEST
LOAD OF INDEX AND
DISPLAY OF UPBUFF
ADDRESS

#250

POSS
HOLD ..
.....
SNAP ..

MONITOR DOWNLINK
OBSERVE VERB/
NOUN FLASH AND
DISPLAY OF LP-
BUFF ADDRESS.

UPBUFF ADD-
RESS - AN
ERASABLE
MEMORY LO-
CATION TC

#260

BE USED FOR
TEMPORARY
STORAGE OF
THE FIRST
COMPONENT
OF THE
UPDATE.

DO I WISH TO
TERMINATE?

DO I WISH TO
TERMINATE?

.Y N.

.Y N.

WAIT FOR
KEYCARD
ENTRY. DIS-
PLAY INDEX
IN RI AS IT
IS LOADED.

TRANSMIT
TERMINATE
V34E

GO TO
"A"
BELOW

TRANSMIT
INDEX WGRD

KEY IN
TERMIN-
ATE V34E

GO TO
"A"

#270

#280

#290

#300

#310

BELOW

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE
OR INDEX

KEY IN INDEX
WORD FOR UP-
DATE
XXXXXE
OBSERVE INDEX
WORD LOADED
TO BE DIS-
PLAYED IN R1

#320

.T .I
.E .N
.R .C
.M .E
.L .X
.N
.A
.T
.E

#330

GO TO
"A"
BELOW

#340

IS INDEX
LESS THAN
3 OR GREA-
TER THAN
20?

#350

Y. N.

SET
CUMP-
NUMB
EQUAL
TU 2

STORE
INDEX IN

#360

COMPNUMB

SET LP-
LINK
COMPO-
NENT
COUNTER
TO 2

#370

#380

CALCULATE
ADDRESS:
IUPBUFF AD-
DRESS +
CONTENTS OF
UPLINK COM-
PCNENT
COUNTER
MINUS 1)

#390

"C"
FRCM
ABOVE

#400

FLASH VERB/
NCUN TO RE-
QUEST LOAD
OF DATA IN-
TC CALCULA-
TED ADDRESS
SPECIFIED
IN R3 AND
DISPLAY:

"C"
FROM
ABOVE

MONITOR DSKY:
OBSERVE VERB/NOUN
FLASH TO REQUEST
DATA LOAD

#410

HOLD

SNAP

V21 NO1
R1 ELANK
R2 UN-
CHANGED
R3 AAAAA

MONITOR DOWNLINK
OBSERVE VERB/
NCUN FLASH TO
REQUEST DATA

AAAAA-CAL-
CULATED
MACHINE AD-
DRESS.

LOAD

#420

DO I WISH TO
TERMINATE?

DO I WISH TO
TERMINATE?

.Y N.

.Y N.

#430

WAIT FOR
KEYBOARD
ENTRY. DIS-
PLAY DATA
IN R1 AS IT
IS LOADED

TRANSMIT
TERMINATE
V34E

#440

GO TO
"A"
BELOW

#450

TRANSMIT
DATA

KEY IN
TERMINATE
V34E

#460

GC TO
"A"
BELOW

#470

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE
OR DATA.

KEY IN DATA
FOR UPDATE.
XXXXXE
OBSERVE DATA
LOADED TO BE
DISPLAYED IN
R1

#480

.T .C
.E .A
.R .T
.Y .A
.I
.N
.A
.T
.E

#490

GC TO
"A"
BELOW

#500

IS THIS THE
LAST COMPO-
NENT? (CP-
LINK COMPO-
NENT COUN-
TER = COMP-
NUMB)

IS THIS THE LAST
DATA COMPONENT TO BE
LOADED?

#510

.Y N.

Y.

N.

INCRE-
MENT UP-
LINK
COMPU-
NENT
COUNTER
BY ONE

#520

#530

FLASH VERB/NOUN
TO REQUEST LOAD
OF OCTAL IDENTI-
FIER IN MACHINE
ADDRESS SPECIFI-
ED IN R3 AND

MONITOR DSKY:
OBSERVE VERB/NOUN
FLASH TO REQUEST
LOAD OF OCTAL IDENTI-
FIER.

#540

HOLD

DISPLAY:
V21 NO2
R1 BLANK
R2 UNCHANGED
R3 UPTEMP
ADDRESS

MONITOR DOWN-
LINK: OBSERVE
VERB/NOUN FLASH
TO REQUEST LOAD
OF OCTAL IDENTI-
FIER.

SNAP

UPTEMP -
AN ERASABLE
LOCATION FOR
OCTAL IDENTIFIER

#550

DO I WISH TO
TERMINATE?

DO I WISH TO
TERMINATE?

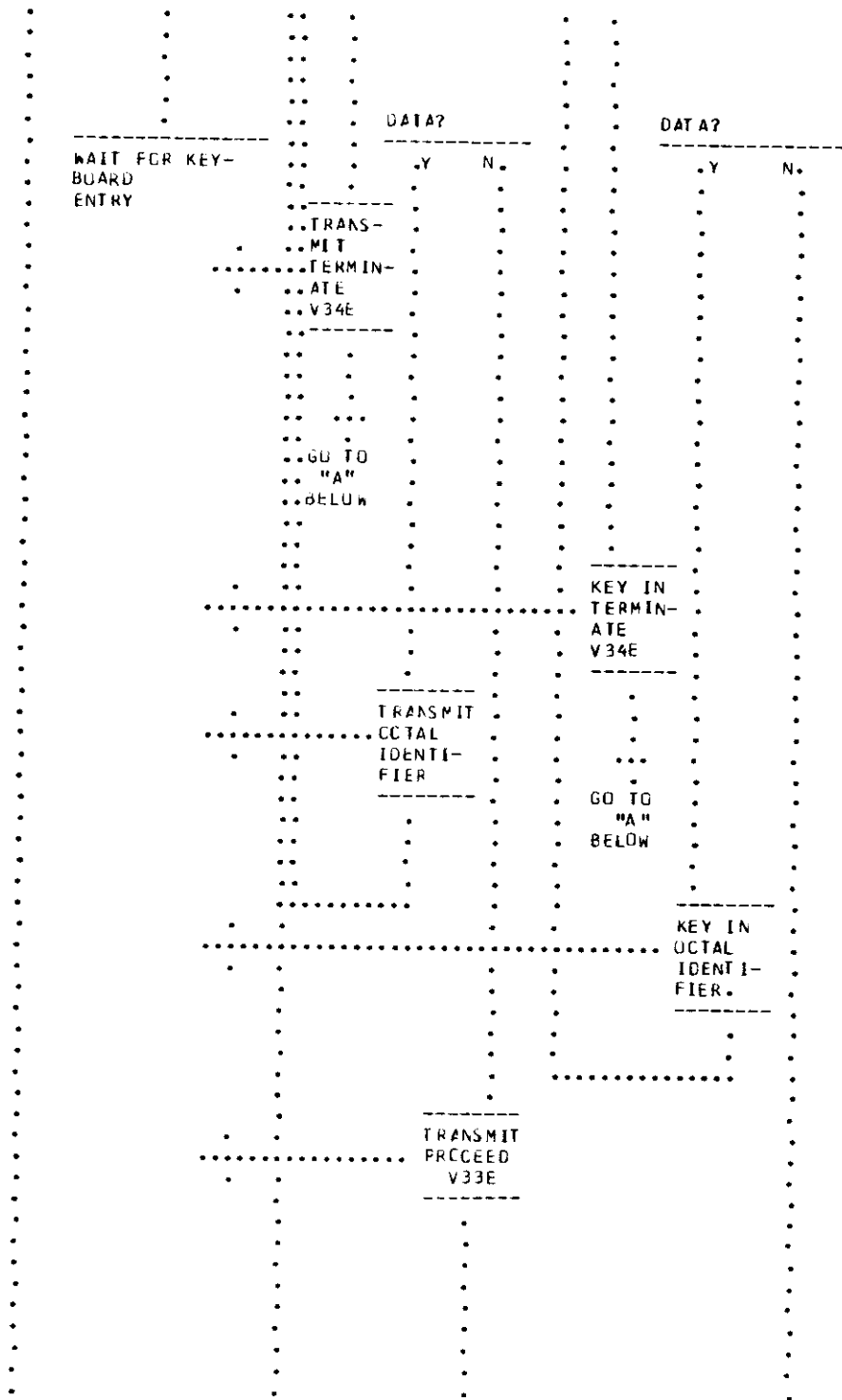
.Y N.

.Y N.

#560

DO I WISH TO
CORRECT ANY

DO I WISH TO
CORRECT ANY



#570

#580

#590

#600

#610

GL TC
"A"
BELOW

#620

++
+03
+EDIT
+
+
+
+
+
+
+03
++

TERMINATE FLASH
UPCN RECEIPT OF
TERMINATE,
V33E, OR XXE.

.T .V .X
.E .3 .X
.R .3 .E
.M .E -----
.I .S
.N .OCTAL
.A .IDENT-
.T .IFIER
.E .GREAT-
. TIVE?

.Y .N
GC TC
"A"
BELOW

.S
.OCTAL
.IDENT-
.IFIER
.GREAT-
.ER THAN
.ZERO
.AND
.EQUAL
.TO OR
.LESS
.THAN
.COMP-

KEY IN
V33E

#630

#640

#650

#660

TURN ON OPERATOR ERROR LIGHT

MONITOR DSKY:
IF OPERATOR ERROR LIGHT OCCURS UPDATE WAS NOT COMPLETED DUE TO POSSIBLE LGC CLOCK OVERFLOW

#720

INCREMENT LGC CLOCK

GO TO "A" BELOW

#730

IS ORBITAL INTEGRATION IN PROCESS?

.Y N.

#740

DELAY TRANSFER OF DATA LOADS UNTIL INTEGRATION COMPLETE.

STALL INTEGRATION UNTIL DATA TRANSFER

#750

IS THIS A LIFTOFF TIME UPDATE (V7C)?

.N Y.

#760

8-26

.
. . .
. . .
. . .

WOULD UPDATE
CAUSE THE LGC
CLOCK TO OVER-
FLOW?

.A Y.
. . .
. . .

TURN ON OPERA-
TOR ERROR
LIGHT

. . .
. . .
. . .

INCREMENT TE-
PHEN AND
DECREMENT
STATE VECTOR
TIME TAGS AND
LGC CLOCK

. . .
. . .
. . .

GO TO "A" BELOW

WHICH UPDATE
VERB INITIATED THIS
PROGRAM?

.V .V
.7 .7
.1 .2
. . .

IS UP- IS COMP-
BUFF+1 NOMB
A LEG- AN OCC

IS THIS AN OCTAL
TIME INCREMENT (V73)
OR LIFTOFF TIME
UPDATE (V70)?

.Y N.
. . .
. . .

GO TO
"A"
BELOW

#770

#780

#790

#800

#810

AL AD-
DRESS?
(NOTE
#1;
ALL A-
CCRES-
SES IN
BLOCK
MUST
BE IN
THE
SAME
EBANK.)

NUMBER?

.Y N.

.Y N.

TURN
ON
OPER-
ATOR
ER-
ROR
LIGHT

MONITOR DSKY:
IF OPERATOR ERROR
OCCURS UPDATE WAS
NOT COMPLETED DUE TO
ILLEGAL ADDRESSES.

GC
TC
"A"
BELOW

TURN ON
OPERATOR
ERROR
LIGHT

GC TC

#820

#830

#840

#850

COAST AND
ALIGN)

.
.

RESET EXTENDED
VERB ACTIVE
FLAG AND NO
MARKS ALLOWED
FLAG.

.
.

TERMINATE
P27 AND
GO TO P00

MONITOR DSKY:
OBSERVE TERMINATION
OF P27 AND DISPLAY
OF P00 (OR BLANK
DSKY IF STARTED FROM
FRESH START CONFIGU-
RATION)

.
.
..... MONITOR DOWN-
LINK: OBSERVE
TERMINATION OF
P27, THE RETURN
TO P00 (OR BLANK
DSKY IF STARTED
FROM FRESH START
CONFIGURATION),
AND REVERSION TO
ORIGINAL (I.E.:
COAST AND ALIGN)
DOWNLINK
FORMAT.

.

.....
EXIT P27

.....
EXIT P27

#920

#930

#940

#950

#960

CHANGE CONTROL NOTES

LOGIC REV C1 PCR 417
REV 02 EDITORIAL
REV 03 EDITORIAL

EXTERNAL DELTA V PROGRAM (P30)

REV 03 12/03/69

PURPOSE:

- (1) TO ACCEPT TARGETING PARAMETERS OBTAINED FROM A SOURCE(S) EXTERNAL TO THE LGC AND COMPUTE THEREFROM THE REQUIRED VELOCITY AND OTHER INITIAL CONDITIONS REQUIRED BY THE LGC FOR EXECUTION OF THE DESIRED MANEUVER. THE TARGETING PARAMETERS INSERTED INTO THE LGC ARE THE TIME OF IGNITION (TIG) AND THE IMPULSIVE DELTA V ALONG LM LOCAL VERTICAL AXES AT TIG.
- (2) TO DISPLAY TO THE ASTRONAUT AND THE GROUND CERTAIN SPECIFIC DEPENDENT VARIABLES ASSOCIATED WITH THE DESIRED MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.

ASSUMPTIONS-

- (1) THE TARGET PARAMETERS (TIG AND DELTA V(LV)) MAY HAVE BEEN LOADED FROM THE GROUND DURING A PRIOR EXECUTION OF P27.
- (2) THE EXTERNAL DELTA V FLAG IS SET DURING THIS PROGRAM TO DESIGNATE TO THE THRUSTING PROGRAM THAT EXTERNAL DELTA V STEERING IS TO BE USED.
- (3) THE ISS NEED NOT BE ON.
- (4) THE RENDEZVOUS RADAR MAY OR MAY NOT BE USED TO UPDATE THE LM OR CSM STATE VECTORS FOR THIS PROGRAM. IF RADAR USE IS DESIRED, THE ISS SHOULD BE IN OPERATION AND THE RADAR SHOULD HAVE BEEN TURNED ON AND LOCKED ON THE CSM BY PREVIOUS SELECTION OF F20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS.
- (5) THIS PROGRAM IS APPLICABLE IN EITHER EARTH OR LUNAR ORBIT.
- (6) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG CONT	LGC	GROUND	CREW
			• CREW • PROGRAM • SELECTION • • • • •
++ +03 +EDIT ++	----- START EXTERNAL DELTA V PROGRAM (P30) DISPLAY P30	• •	----- KEY IN EXTERNAL DELTA V PROGRAM (P30) V37E 30E -----

#10

MONITOR DSKY:
OBSERVE DISPLAY OF
P30

#20

SET UPDATE FLAG.

SET TRACK FLAG.

#30

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG:

HOLD .
.....
SNAP .

V06 N33
R1-TIG-HRS
R2-TIG-MIN
R3-TIG-SEC

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG.

#40

TIG-TIME OF
IGNITION (GET).
IN HRS, MIN, SEC
TO NEAREST .01 SEC.

AM I SATISFIED WITH
THIS VALUE?

#50

Y. .N

RECORD THIS
VALUE

#60

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

KEY IN V25E AND
LOAD THE DESIRED
FIG.

.P .T .NEW
.R .E .DATA
.D .R
.C .M
.E .I STORE DATA
.E .N
.D .A
. .T
. .E

GC TC
"A"
BELOW

HOLD . FLASH VERB-NCUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY THREE STORED
COMPONENTS OF DELTA
V (LV):
V06N81
R1-DELTA VX (LV)
R2-DELTA VY (LV)
R3-DELTA VZ (LV)

DELTA VX (LV):
COMPONENT OF
IMPLLSIVE DELTA V AT

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF THREE STORED
COMPONENTS OF
IMPULSIVE DELTA V
ALONG LM LOCAL
VERTICAL AXES AT
FIG.

70

#80

#90

#100

#110

TIG ALONG (RXV) XR. IN
FPS TO NEAREST .1
FPS.

DELTA VY (LV):
COMPONENT OF
IMPULSIVE DELTA V AT
TIG ALONG VXR, IN FPS
TO NEAREST .1 FPS.

DELTA VZ (LV):
COMPONENT OF
IMPULSIVE DELTA V AT
TIG ALONG -R- IN FPS
TO NEAREST .1 FPS

WHERE R IS LM GEC-
CENTRIC (EARTH ORBIT)
OR SELENOCENTRIC
(LUNAR ORBIT) RADIUS
VECTOR AND V IS LM
INERTIAL VELOCITY
VECTOR AT TIG.

AM I SATISFIED WITH
THESE VALUES?

.Y .N

#120

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#140

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

KEY IN V25E AND
LOAD THE DESIRED
COMPONENTS OF
DELTA V

#150

.P .T .NEW
.R .E .DATA
.C .R .
.C .M .
.E .I -----
.E .N STORE DATA
.D .A -----
. .T .
. .E .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CALCULATED
THRUSTING PARAMETERS:
VC6 N42
R1-APD ALT
R2-PER ALT
R3-DELTA V

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF CALCULATED
THRUSTING PARAMETERS

#210

APD ALT - ALTITUDE
OF APOGEE ABOVE THE
LAUNCH PAD RADIUS
(EARTH ORBIT) OR
ALTITUDE OF THE
APOLONE ABOVE THE
LUNAR RADIUS AT THE
MOST RECENTLY DE-
FINED LANDING SITE
(LUNAR ORBIT). IN
NAUTICAL MILES TO
NEAREST .1 NM.
(NOTE: 9999.9 WILL
BE DISPLAYED FOR
VALUES GREATER THAN
9999.9 NM.)

++
+03
+EDIT
++

PER ALT - ALTITUDE
OF PERIGEE ABOVE THE
LAUNCH PAD RADIUS
(EARTH ORBIT) OR
ALTITUDE OF THE
PERILUNE ABOVE THE
LUNAR RADIUS AT THE
MOST RECENTLY DE-
FINED LANDING SITE
(LUNAR ORBIT). IN
NAUTICAL MILES TO
NEAREST .1 NM.
(NOTE: 9999.9 WILL
BE DISPLAYED FOR
VALUES GREATER THAN
9999.9 NM.)

#220

#230

#240

#250

DELTA V - MAGNITUDE
OF IMPULSIVE DELTA V
VECTOR AT TIG. IN FPS.
TO NEAREST .1 FPS

IS A GROUND STATION
AVAILABLE FOR CON-
FIRMATION OF THESE
PARAMETERS?

Y. N

#260

MONITOR LGC COORDINATE
DOWNLINK EVALUATION OF
TELEMETRY OF THE LGC COMPU-
APD ALT, PER TED PARAMETERS
ALT AND DEL- WITH THE
TA V REQUIR- GROUND
ED. COORDIN-
ATE EVALUA-
TION OF LGC
COMPLETED
PARAMETERS
WITH ASTRONAUT

#270

SELECT ONE OF THE
FOLLOWING FIVE
ALTERNATIVES:

#280

(1) IF THE CALCULATED DATA IS
SATISFACTORY,
PERFORM THE THRUSTING MANEUVER
USING THE LGC CALCULATED PARAME-
METERS WITHOUT GROUND CONFIRMA-
TION.

#290

(2) IF THE CALCULATED DATA IS NOT
SATISFACTORY ADJUST THE CALCULA-
TED PARAMETERS.

#300

TERMINATE P30 AND
THEN RESELECT P30
AS NECESSARY AND
CHANGE THE
LOADED AIM PARA-
METERS UNTIL LGC
COMPUTED PARAMET-
ERS ARE SATISFAC-
TORY. THEN
PERFORM THE THRU-
STING MANEUVER.

#310

(3) REMAIN AT
THIS POINT IN THE
LGC PROGRAM UNTIL
GROUND CO-ORDINA-
TION IS AVAILABLE
(4) TERMINATE P30
AND THEN SELECT
A NEW PROGRAM AS
DESIRED UNTIL
GROUND CO-ORDINA-
TION IS AVAILABLE
THEN RESELECT
P30, LEAVE AIM
PARAMETERS
UNCHANGED ETC.

#320

(5) TERMINATE P30
AND SELECT A NEW
PROGRAM AS DE-
SIRED AND PERFORM
THRUSTING MANEU-
VER USING BACKUP
PROCEDURE.

#330

.....3 2.1.
..... 4.
..... 5.

#340

ARE THESE
PARAMETERS
SATISFACTORY
FOR USE BY THE
LGC FOR THE
THRUSTING

MANEUVER?

. N Y.

#350

SELECT ONE OF
THE FOLLOWING
FOUR ALTERNA-
TIVES:

#360

(1) ADJUST THE
CALCULATED PARA-
METERS. TERMIN-
ATE P30 AND THEN
RESELECT P30 AS
NECESSARY AND
CHANGE THE
LOADED AIM PARA-
METERS UNTIL LGC
COMPUTED PARA-
METERS ARE
SATISFACTORY.

#370

(2) TERMINATE
P30 AND
OBTAIN NEW
AIM PARAMETERS
FROM THE GROUND
BY VOICE LINK,
RESELECT P 30,
KEY IN NEW DATA,
ETC.

#380

(3) TERMINATE
P30 AND SELECT
THE LGC UPDATE
PROGRAM (P27).
LOAD NEW AIM
PARAMETERS FROM
THE GROUND VIA
THE LGC UPLINK,
OR BY CREW
DSKY INPUT.
OBSERVE NEW AIM
PARAMETERS, ETC.
(4) TERMINATE

#390

P30 AND PERFORM
THRUSTING
MANEUVER
USING BACKUP
PROCEDURES.

#400

- 1.
- 2.
- 3.
- 4.

WAIT FOR KEYBOARD
ENTRY.

KEY IN TERMIN-
ATE (V34E)

#410

GC TO
"A"
BELOW

#420

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR
RECYCLE.

KEY IN
PROCEED

#430

.P	.T	.R
.R	.E	.E
.O	.R	.C
.C	.M	.Y
.E	.I	.C

#440

212

.
.
.
.
E N L
. D . A . E
. . . T .
. . . E

.
GO TO
"A"
BELOW

#450

.

RESET UPDATE
FLAG

.
.
.

#460

IS REF SMMAT FLAG
SET?

. Y . N
.
.

#470

COMPUTE IMU MID-
DLE GIMBAL ANGLE
AT TIG FOR THE
PRESENT IMU OR-
IENTATION WITH
THE LM +X AXIS
ALIGNED WITH THE
INITIAL THRUST
VECTOR.

#480

.

SET MGA DISPLAY
IN R3 (BELOW) =
.

++
+03
+EDIT
+C3
++

-00002.

#490

HOLD FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 MON DISPLAY MANEUVER

. MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF MANEUVER DATA

#500

DATA:
 V16 N45
 R1-M
 R2-TFI
 R3-MGA

M-THE NUMBER OF
 MARKS MADE SINCE
 THE RR TRACKING MARK
 COUNTER WAS ZEROED
 (SEE ASSUMPTION 6
 OF P20).

#510

TFI - TIME FROM
 TIG. IN MIN AND SEC
 TO NEAREST SEC.
 MAXIMUM READING IS
 59859. (- BEFORE
 + AFTER TIG.)

MGA-MIDDLE GIMBAL
 ANGLE AT TIG IF
 +X LM AXIS IS
 ALIGNED WITH INITIAL
 THRUST DIRECTION.
 SIGN IS ALWAYS +
 EXCEPT WHEN THE IMU
 IS NOT ALIGNED THE
 VALUE IS -00002. IN
 DEGREES TO NEAREST
 .01 DEGREE

#520

#530

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED
(NOTE: CONSIDERING
VALUE OF DELTA V,
FUEL AVAILABLE,
STATUS OF PROPULSION
HARDWARE, AND TIME
AVAILABLE TO RE-AL-
IGN THE IMU TO AVOID
GIMBAL LOCK SELECT A
PROPULSION SYSTEM
AND THE APPROPRIATE
THRUSTING PROGRAM
(OPS-P40, APS-P42,
RCS-P41) TO PERFORM
THE MANEUVER. COOR-
DINATE WITH GROUND
IF REQUIRED.)

#540

IF TIME AND
LOCATION
PERMIT
ASSIST
ASTRONAUT IN
SELECTION OF
PROPULSION
SYSTEM. AT
THIS TIME,
OR EARLIER
IF POSSIBLE
THE ASTRONAUT
MUST LEARN
OF THE
SYSTEM USED
IN MCC COM-
PUTATIONS
OF DATA LOAD

#550

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
RECYCLE, OR TERMINATE.

.P .T .R
.R .E .E
.O .R .C
.C .M .Y
.E .I .C
.E .N .L
.C .A .E
. .T .
. .E .

#570

"A"
FROM
ABOVE

"A"
FROM
ABOVE

#580

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROO).

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROO).

#590

CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32)

REV 03 12/03/69

PURPOSE:

- (1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE FOLLOWING CONCENTRIC FLIGHT PLAN MANEUVERS: THE CO-ELLIPTIC SEQUENCE INITIATION (CSI) AND THE CONSTANT DELTA ALTITUDE MANEUVER (CDH), FOR DELTA V BURNS.
- (2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE LGC BY THE ASTRONAUT.
- (3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND DEPENDENT VARIABLES ASSOCIATED WITH THE CONCENTRIC FLIGHT PLAN MANEUVERS FOR APPROVAL BY THE ASTRONAUT/GROUND.
- (4) TO STORE THE CSI TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

- (1) AT A SELECTED TPI TIME THE LINE OF SIGHT BETWEEN THE LM AND THE CSM IS SELECTED TO BE A PRESCRIBED ANGLE (θ) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE POSITION.
- (2) THE TIME BETWEEN CSI IGNITION AND CDH IGNITION MUST BE COMPUTED TO BE GREATER THAN 10 MINUTES FOR SUCCESSFUL COMPLETION OF THE PROGRAM.
- (3) THE TIME BETWEEN CDH IGNITION AND TPI IGNITION MUST BE COMPUTED TO BE GREATER THAN 10 MINUTES FOR SUCCESSFUL COMPLETION OF THE PROGRAM.
- (4) CDH DELTA V IS SELECTED TO MINIMIZE THE VARIATION OF THE ALTITUDE DIFFERENCE BETWEEN THE ORBITS.
- (5) CSI BURN IS DEFINED SUCH THAT THE IMPULSIVE DELTA V IS IN THE LM HORIZONTAL PLANE AT CSI IGNITION.
- (6) THE PERICENTER ALTITUDE OF THE ORBIT FOLLOWING CSI AND CDH MUST BE GREATER THAN 35,000 FT (LUNAR ORBIT) OR 85 NM (EARTH ORBIT) FOR SUCCESSFUL COMPLETION OF THIS PROGRAM.
- (7) THE CSI AND CDH MANEUVERS ARE ORIGINALLY ASSUMED TO BE PARALLEL TO THE PLANE OF THE CSM ORBIT. HOWEVER CREW MODIFICATION OF DELTA V (LV) COMPONENTS MAY RESULT IN AN OUT-OF-PLANE CSI MANEUVER.
- (8) LGC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE NORMALLY LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.
- (9) THE RENDEZVOUS RADAR MAY OR MAY NOT BE USED TO UPDATE THE LM OR CSM STATE VECTORS FOR THIS PROGRAM. IF RADAR USE IS DESIRED THE RADAR SHOULD BE TURNED ON AND LOCKED ON THE CSM BY PREVIOUS SELECTION OF P20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS. THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.
- (10) THE ISS NEED NOT BE ON TO COMPLETE THIS PROGRAM UNLESS THE RENDEZVOUS RADAR IS TO BE USED FOR AUTOMATIC STATE VECTOR UPDATING BY THE RENDEZVOUS NAVIGATION PROGRAM (P20). P20 WILL DEFINE THE STATUS OF THE ISS.
- (11) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PRCG

LGC

GROUND

CREW

SET UPDATE FLAG

SET TRACK FLAG

SET TIG (CSI) TO:
+00000
+00000
+00000

HCLD FLASH VERB-NOUN TO
SNAP REQUEST RESPONSE AND
 DISPLAY STORED TIG
 (CSI):
 V06 N11
 R1-TIG(CSI)-HRS
 R2-TIG(CSI)-MINS
 R3-TIG(CSI)-SECS

TIG(CSI) - TIME OF
CSI IGNITION (GET)
IN HRS, MINS, SECS,
TC NEAREST .01 SEC

MONITOR CSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG (CSI)
(NOTE: INITIALLY
THIS VALUE WILL BE:
+00000
+00000
+00000)

DO I WISH TO DISPLAY
TIME OF APOAPSIS?
(I.E.: IS THIS AN

#50

#60

#70

#80

#90

++
+03
+
+EDIT
++

ABORT FROM LUNAR
LANDING?)
(NOTE: IF THIS OP-
TION IS CHOSEN FOR
THE NORMAL MISSION,
TIG(CSI) WILL BE
TARGETED TO OCCUR AT
APOAPSIS UNLESS THE
APOAPSIS TIME IS RE-
PLACED BY SOME OTHER
TIME.)

#100

.Y N.

AM I SATISFIED
WITH THIS VALUE?

#110

.Y .N

RECORD THIS
VALUE

#120

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#130

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

KEY IN V25E
AND LOAD DESIRED
TIG(CSI).

#140

.P .T .NEW
.R .E .DATA
.C .R .
.C .M .
.E .I
.E .N STORE DATA
.D .A

#150

226

GC TO
"A"
BELOW

IS THE VALUE OF TIG
(CSI) NOW STORED =
+00000
+00000
+00000
OR IS TIG(CSI) A
NEGATIVE NUMBER?

.N .Y.

COMPLETE
T(APDAPSIS)
AND STORE IN
TIG(CSI)

HAS A CALL BEEN MADE
FOR COMPUTATION OF
T(APDAPSIS)?
(NOTE: THE LGC WILL
RESPOND TO A NEGA-
TIVE LOAD IN THE
SAME FASHION THAT IT
WOULD RESPOND TO A
ZERO LOAD.)

.N .Y

#160

#170

HOLD . FLASH VERB-NCUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY STORED N
AND E;
V06 N55
R1-N
R2-E
R3-CENTANG

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF N, E, AND CENTANG

#180

#190

N - THE FUTURE
APICAL CROSSING
(APDCEE OR PERIGEE
(APOLUNE OR PERI-

AM I SATISFIED WITH
THESE VALUES?

++
+03
+
+
+
+
+
+
+
+
+
+
+
+
+
+

+
+
+
+
+
+EDIT
++

LUNE)) OF THE
ACTIVE VEHICLE AT
WHICH TIG(CDH)
SHOULD OCCUR.
00001=FIRST,
00002=SECCND, ETC.

E - ELEVATION ANGLE.
THE ANGLE BETWEEN
THE LM/CSM LOS AND
THE LM LOCAL HORIZ-
ONTAL PLANE AT TIG
(TPI) REFERENCED TO
THE DIRECTION OF
FLIGHT (SEE SECTION
5.4.2.2 OF R567
FOR DETAILED DE-
SCRIPTION). IN
DEGREES TO NEAREST
.01 DEG.

CENTANG - THE ORBIT-
AL CENTRAL ANGLE OF
THE PASSIVE VEHICLE
DURING TRANSFER FROM
TIG(TPI) TO TIME OF
INTERCEPT. IN DEGREES
TO NEAREST .01
DEGREE.

(NOTE: IN THIS CASE
CENTANG (R3) IS USED
ONLY AS AN OPTION
CCODE BY THE LGC. FOR
ANY VALUE OF CENTANG
OTHER THAN 00000 THE
LGC WILL CALCULATE
THE CDH PARAMETER
FOR A TIG(CDH) AT
N(180 DEGREES) FROM
THE CSI MANEUVER
WHERE N IS SPECIFIED
IN R1. REFER SECTION
5.4.2.2 OF R567.)

WAIT FOR KEYBOARD
ENTRY

(NOTE: R3 WILL BE
ORIGINALLY DISPLAYED
AS 00000. IF THE
CREW WISHES TO EXER-
CISE THE N(180 DEG-
REES) OPTION FOR CDH
MANEUVER DEFINITION,
LOAD ANY NUMBER
OTHER THAN 00000 IN
R3. REFER SECTION
5.4.2.2 OF R567.)

. Y . N

RECORD THESE
VALUES

#209

#210

#220

#230

#240

KEY IN PROCEED

229

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

.P .T .NEW
.R .E .DATA
.D .R .
.C .M .
.E .I .
.E .N .
.D .A STORE DATA
.T .
.E .

GC TO
"A"
BELOW

KEY IN V25E
AND LOAD THE
DESIRED PARAMET-
ERS

#250

#260

#270

HOLD . FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY STORED TIG
(TPI):
++ V06N37
+03 R1-TIG(TPI)-HRS
+EDIT R2-TIG(TPI)-MINS
++ R3-TIG(TPI)-SECS

TIG(TPI) - TIME OF
TPI IGNITION (GET).
IN HRS, MINS, SECS,
TO NEAREST .01 SEC

MONITOR DSKY:
OBSERVE FLASHING
VERB-NOUN TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG(TPI)
(TIME OF TPI
IGNITION).

#280

AM I SATISFIED
WITH THIS VALUE?

#290

.Y .N

RECORD THIS
VALUE

#300

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

KEY IN V25E
AND LOAD THE
DESIRED TIG (TPI)

#310

.P .T .NEW
.R .E .DATA
.D .R .
.C .M .
.E .I
.E .N STORE DATA
.D .A

#320

GO TO
"A"
BELOW

#330

RESET FINAL
FLAG

RESET UPDATE
FLAG

#340

SET EXTERNAL
DELTA V FLAG

#350

BASED ON THE STO-
RED TARGET PARA-

METERS, COMPUTE
THE PARAMETERS
ASSOCIATED WITH
CSI AND CDH AS
DESCRIBED IN SEC-
TION 5.4.2.2 OF
R567.

#360

ESTABLISH ALARM
IF:

(A) ON FIRST
ITERATION THERE
IS NO INTER-
SECTION OF
THE DESIRED LOS
AT TPI WITH THE
CIRCLE DESCRIBED
IN SECTION
5.4.2.2 OF R567.
(ALARM CODE
00600)

#370

(B) ON ANY TWO
CONSECUTIVE
ITERATIONS THE
MAGNITUDE OF
DELTA V(CSI) IS
GREATER THAN
1000 FPS.
(ALARM CODE
00606)

#380

(C) THE ITERA-
TION COUNTER
EXCEEDS 15
WITHOUT ARRIV-
ING AT A PRO-
BLEM SOLUTION.
(ALARM CODE
00605)

#390

(D) PERICENTER
ALT (POST CS1)
IS LESS THAN
35,000 FT.
(LUNAR ORBIT)
OR 85 NM (EARTH

#400

ORBIT).
(ALARM CODE
00601)

(E) PERICENTER
ALT (POST CDH)
IS LESS THAN
35,000 FT
(LUNAR ORBIT)
OR 85 NM (EARTH
ORBIT) (ALARM
CCCE 00602)

#410

(F) TIG(CDH) -
TIG(CSI) IS
LESS THAN 10
MIN. (ALARM
CCCE 00603)

#420

(G) TIG(TPI) -
TIG(CCH) IS
LESS THAN 10
MIN OR COM-
PLETED CCH
TIME IS
GREATER
THAN INPUT
TPI TIME.
(ALARM CODE
00604)

#430

.N .A
.C .L
. .A
.A .R
.L .M
.A .
.R .
.M .

#440

PGSS
HOLD
SNAP

FLASH VERE-
NOUN TO RE-
QUEST RESPON-
SE AND DIS-
PLAY ALARM
CODE:
V05 N09
R1-XXXXX

MONITOR DSKY:
GGES ALARM CODE
DISPLAY INDICATE
COMPUTATIONAL
DIFFICULTY?

#450

.Y N.

++
+03
+EDIT
+03
++

R2-XXXX
R3-XXXX

THE EXPECTED
ALARM CODES
AT THIS TIME
ARE 00600
THROUGH 00606

WAIT FOR
KEYBOARD
ENTRY

TERMINATE
UPON RECEIPT
OF PROCEED,
RECYCLE, OR
TERMINATE.

.T R. .P
.E E. .R
.R C. .G
.M Y. .C
.I C. .E
.N L. .E
.A E. .D
.T .
.E .

RETURN TO
START OF PRO-
GRAM AND
ADJUST INPUT
PARAMETERS.
KEY IN RECYCLE
V32E.

GO TO
"A"
BELOW

IS FINAL FLAG
SET?

.N Y.

SET UPDATE
FLAG

#460

#470

#480

#490

#500

#510

HOLD .

SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
DELTA ALT (CDH),
DELTA T (CSI/CDH),
AND DELTA T (CCH/
TPI);
V06 N75
R1-DELTA ALT
(CDH)
R2-DELTA T (CSI/
CDH)
R3-DELTA T (CDH/
TPI)

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA ALT (CDH)
DELTA T (CSI/CDH)
AND DELTA T (CDH/
TPI).

#520

DELTA ALT (CDH) -
THE ALTITUDE BE-
TWEEN THE ACTIVE
AND PASSIVE VE-
HICLE ORBITS AT
TIG (CDH). SIGN IS
+ WHEN THE ACTIVE
VEHICLE IS BELOW
THE PASSIVE
VEHICLE. IN NAUT-
ICAL MILES TO
NEAREST .1 NM.

#530

DELTA T (CSI/CDH)-
TIG (CDH) MINUS
TIG (CSI).
COMPLETED IN HRS,
MINS, SECS OF
WHICH ONLY THE
MINS AND SECS
ARE DISPLAYED. TO
NEAREST SEC.

#540

DELTA T (CCH/TPI)-
TIG (TPI) MINUS
TIG (CCH).
COMPLETED IN HRS,
MINS, SECS, OF

#550

WHICH ONLY THE
MINS AND SECS ARE
DISPLAYED. TG
NEAREST SEC.
(NOTE: R2 AND R3
ARE MODULARIZED
TO THE HOUR, I.E.,
63 MINS 22 SECS
IS DISPLAYED AS
C3B22)

#560

(NOTE: TIG(CDH)
IS AVAILABLE BY
KEYING IN V06N13.)

#570

RECORD THESE
VALUES

#580

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, TERMIN-
ATE, OR RECYCLE

#590

.P	.T	R.
.R	.E	E.
.C	.R	C.
.E	.M	Y.
.E	.I	C.
.E	.N	L.
.D	.A	E.
.	.T
.	.E	
.	.	
.	.	
.	...	
.	.	
.	GC TC	

#600

"A"
BELOW

#610

#620

#630

#640

#650

HOLD .
.....
SNAP .

FLASH VERB-NCUN
TO REQUEST RES-
PCNSE AND DISPLAY
CALCULATED COM-
PONENTS OF DELTA
V(LV) FOR CSI;
VC6 N81
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

DELTA VX(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CSI) ALONG
(RXV)XR. IN FPS
TC NEAREST .1
FPS.

DELTA VY(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CSI) ALONG
VXR. IN FPS TO
NEAREST .1 FPS.

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CSI) ALONG
-R. IN FPS TO
NEAREST .1 FPS

WHERE R IS LM
GEOCENTRIC (EARTH
CRBIT) OR SELCNC-
CENTRIC (LUNAR
CRBIT) RADIUS
VECTOR AND V IS

MONITOR USKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA V(LV) FOR
CSI

AM I SATISFIED
WITH THESE
VALUES?
(NOTE: CREW HAS
THE OPTION AT
THIS TIME TO RE-
DEFINE THE DELTA
V(LV) COMPONENTS
FOR THE SUBSEQ-
UENT THRUSTING
MANEUVER. THIS
CAPABILITY WILL
NORMALLY BE
EXERCISED TO
CORRECT OUT-OF-
PLANENESS BY
FIRST SELECTING
THE RENDEZVOUS
OUT-OF-PLANE DIS-
PLAY ROUTINE
(R36) (V90E) AND
THEN MODIFYING
DELTA VY(LV)).

.Y .N

LM INERTIAL VELO-
CITY VECTOR AT
TIG(CSI).

WAIT FOR KEYBOARD
ENTRY

KEY IN V25E
AND LOAD DE-
SIRED DELTA V
(LV) COMPONENT
VALUES

#660

RECORD THESE
VALUES

#670

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, TERMIN-
ATE, OR NEW DATA.

KEY IN PROCEED

#680

.P .T .NEW
.R .E .DATA
.C .R
.C .M STORE DATA
.E .I
.E .N
.D .A
.T
.E

#690

GC TC

700

"A"
BELOW

HOLD
.....
SNAP

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
CALCULATED COM-
PONENTS OF DELTA
V(LV) FOR CDH;
VCG NB2
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

DELTA VX(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH) ALONG
IRXVXR. IN FPS
TO NEAREST .1
FPS.

DELTA VY(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH) ALONG
VXR. IN FPS TO
NEAREST .1 FPS.

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH) ALONG
-R. IN FPS TO
NEAREST .1 FPS

WHERE R IS LM
GEOCENTRIC (EARTH
ORBIT) OR SELENE-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AND V IS

MONITGR CSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA V(LV) FOR
CDH.
(NOTE:
IF THE DELTA V
(LV) FOR CSI (SEE
ABOVE) HAS BEEN
MODIFIED BY THE
CREW, THE MODIF-
ICATION WILL NOT
BE REFLECTED IN
THE LGC COMPUTED
VALUES FOR DELTA
V (LV) FOR CDH
DISPLAYED HERE.)

#710

#720

#730

RECORD THESE
VALUES.
(NOTE: UNLIKE
DELTA V(LV) FOR
CSI ABOVE, THESE
VALUES CANNOT BE
WRITTEN OVER.)

#740

LM INERTIAL VELO-
CITY VECTOR AT
TIG(CCH).

#750

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, RECYCLE,
OR TERMINATE

#760

.P .T .R
.R .E .E
.D .R .C
.C .M .Y
.E .I .C
.E .N .L
.D .A .E
. .T
. .E

#770

GC TO
"A"
BELOW

#780

IS THE FINAL FLAG
SET?

.N .Y.

SET MGA DISPLAY
IN R3 (BELOW) =
-CCCC1.

#790

IS REFSMMAT FLAG
SET?

.Y N.

COMPLTE IMC
MIDDLE GIMBAL
ANGLE AT TIG
(CSI) FOR THE
PRESENT IMU
ORIENTATION
WITH THE LM
+X AXIS ALIG-
NED WITH THE
INITIAL
THRUST VECTOR

SET MGA DIS-
PLAY IN R3
(BELOW) =
-CCC02.

#800

#810

#820

HOLD . FLASH VERB-NOUN TO
REQUEST RESPONSE AND
MGN . DISPLAY M, TFI AND
MGA;

V16N45
R1-M
R2-TFI
R3-MGA

M - THE NUMBER OF
MARKS MADE SINCE THE
RR TRACKING MARK
COUNTER WAS ZEROED

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF M, TFI AND MGA.

#830

#840

(SEE ASSUMPTION 6
OF P20).

TFI - TIME FROM TIG
(CSI). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59859.
SIGN IS - BEFORE, +
AFTER TIG(CSI).

MGA - MIDDLE GIMBAL
ANGLE AT TIG(CSI)
IF LM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
IN DEGREES TO NEAR-
EST .01 DEGREE.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAY-
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE
VALUE IS -00001

(B) ON THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-CCCC2.

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y N.

#850

DO I WISH TO
TERMINATE THE
MARK PROCESS AND
GO THE FINAL PASS
THROUGH THE
PROGRAM?

.Y N.

#860

KEY IN PROCEED.

#880

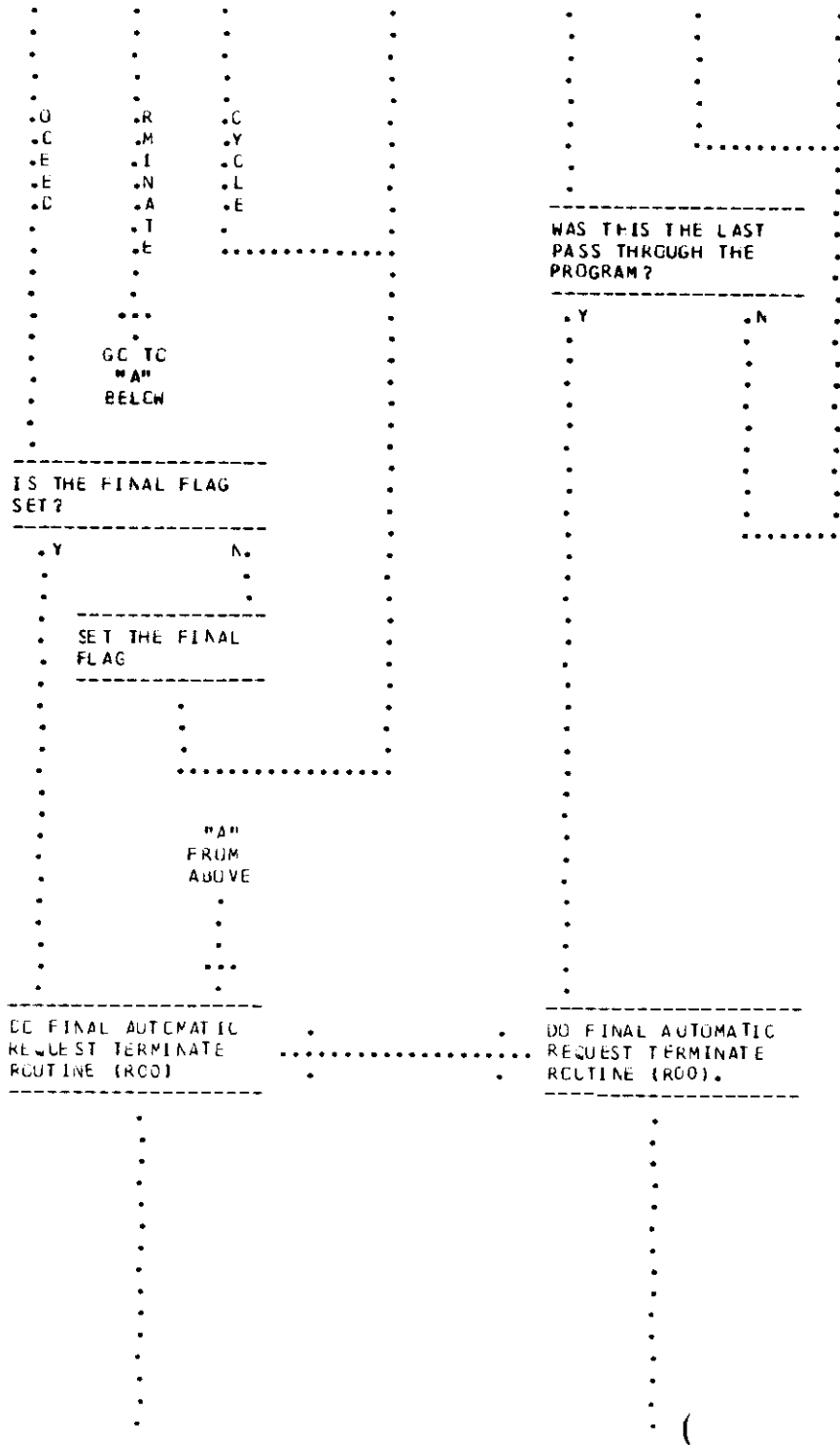
WAIT FOR KEYBOARD
ENTRY

KEY IN RECYCLE
V32E

#890

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR
RECYCLE

.P .T .R
.R .E .E



#900

#910

#920

#930

243

EXIT P32

EXIT P32

291
P32/LUMINARY

#940

CHANGE CONTROL NOTES

REV C1 PCR 254,540,623
REV 00 (LUM 1A) PCR 695, 752
REV 02 EDITORIAL
REV 03 EDITORIAL

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244

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(

CONSTANT DELTA ALTITUDE (CDH) PROGRAM (P33)

REV 03 12/03/69

PURPOSE:

- (1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE CONSTANT DELTA ALTITUDE MANEUVER (CDH), FOR DELTA V BURNS.
- (2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE LGC BY THE ASTRONAUT.
- (3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND DEPENDENT VARIABLES ASSOCIATED WITH THE CDH MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.
- (4) TO STORE THE CDH TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTION:

- (1) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32). THEREFORE:
 - (A) AT A SELECTED TPI TIME (NOW IN STORAGE) THE LINE OF SIGHT BETWEEN THE LM AND THE CSM WAS SELECTED TO BE A PRESCRIBED ANGLE (E) (NOW IN STORAGE) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE VEHICLE POSITION.
 - (B) THE TIME BETWEEN CSI IGNITION AND CDH IGNITION WAS COMPUTED TO BE GREATER THAN 10 MINUTES.
 - (C) THE TIME BETWEEN CDH IGNITION AND TPI IGNITION WAS COMPUTED TO BE GREATER THAN 10 MINUTES.
 - (D) THE VARIATION OF THE ALTITUDE DIFFERENCE BETWEEN THE ORBITS WAS MINIMIZED.
 - (E) CSI BURN WAS DEFINED SUCH THAT THE IMPULSIVE DELTA V WAS IN THE LM HORIZONTAL PLANE AT CSI IGNITION.
 - (F) THE PERICENTER ALTITUDES OF THE ORBITS FOLLOWING CSI AND CDH WERE COMPUTED TO BE GREATER THAN 35,000 FT (LUNAR ORBIT) OR 85 NM FOR EARTH ORBIT.
 - (G) THE CSI AND CDH MANEUVERS WERE ASSUMED TO BE PARALLEL TO THE PLANE OF THE CSM ORBIT. HOWEVER, CREW MODIFICATION OF DELTA V (LV) COMPONENTS MAY HAVE RESULTED IN AN OUT-OF-PLANE CSI MANEUVER.
- (2) LGC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE NORMALLY LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.
- (3) THE RENDEZVOUS RADAR MAY OR MAY NOT BE USED TO UPDATE THE LM OR CSM STATE VECTORS FOR THIS PROGRAM. IF RADAR USE IS DESIRED THE RADAR WAS TURNED ON AND LOCKED ON THE CSM BY PREVIOUS SELECTION OF P20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS (SEE P20). THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.
- (4) THERE IS NO REQUIREMENT FOR ISS OPERATION DURING THIS PROGRAM UNLESS AUTOMATIC STATE VECTOR UPDATING IS DESIRED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20). IF SELECTED, P20 WILL DEFINE THE STATUS OF THE ISS.
- (5) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG

LGC

GROUND

CREW

247

HOLD . FLASH VERB-NCUN TO
 REQUEST RESPONSE AND
 DISPLAY STORED TIG
 SNAP . (CDH):
 V06 N13
 R1-TIG(CDH)-HRS
 R2-TIG(CDH)-MIN
 R3-TIG(CDH)-SECS

TIG(CDH) - TIME OF
 CDH IGNITION (GET).
 IN HRS, MINS, SECS
 TO NEAREST .01 SEC.

MONITOR DSKY:
 OBSERVE VERB-NCUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF STORED TIG
 (CDH).

AM I SATISFIED WITH
 THIS VALUE?

 .Y .N

RECORD THIS
 VALUE

#60

#70

#80

#90

#100

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR NEW
DATA

KEY IN V25E
AND LOAD
DESIRED TIG
(GDH)

.P .T .NEW
.R .E .DATA
.D .R .
.C .M .
.E .I .
.E .N STORE DATA
.D .A .
. .T .
. .E .
. . . .
. . . .
. . . .
.GC TC
"A"
.BELOW
. . . .

RESET FINAL FLAG

RESET UPDATE FLAG

SET EXTERNAL
DELTA V FLAG

#110

#120

#130

#140

#150

249

#160

#170

#180

#190

++
+03
+EDIT
++

```

-----
. BASED ON THE STO-
. RED TARGET PARA-
. METERS, COMPUTE
. THE PARAMETERS
. ASSOCIATED WITH
. CDH, AS DES-
. CRIBED IN SEC-
. TION 5.4.2.3 OF
. R567.
. ESTABLISH ALARM
. IF NO SOLUTION
. CAN BE REACHED
-----

```

```

. N      .A
. O      .L
.        .A
. A      .R
. L      .M
. A
. R
. M

```

POSS
HOLD .
.....
SNAP .

```

-----
. FLASH VERB-
. NOUN TO RE-
. QUEST RESPON-
. SE AND DIS-
. PLAY ALARM
. CCDE 00611;
. VC5NC9
. R1-XXXXX
. R2-XXXXX
. R3-XXXXX
-----

```

```

-----
. MONITOR DSKY:
. DCES ALARM
. CODE DISPLAY IN-
. DICATE THAT NO
. SOLUTION CAN BE
. REACHED?
-----

```

.N Y.

```

-----
. IS IT POSSIBLE
. THAT READJUST-
-----

```

MENT OF TIG
(CCH) MIGHT
PROVIDE A SOL-
UTION? DO I
WISH TO ATT-
EMPT TO READ-
JUST TIG(CCH)?

.N .Y.

#200

WAIT FOR KEY-
BCARD ENTRY

KEY IN RE-
CYCLE
V32E

#210

DO I WISH TO
ATTEMPT TO DE-
FINE CDF
MANEUVER ANY-
WAY, REALIZING
THAT DELTA T
(CDH/TPI) AND
DELTA T (TPI/
TPI) ARE NOT
ACCURATE?

.Y .N.

#220

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED, RE-
CYCLE OR TER-
MINATE

KEY IN
PRGCEED

#230

KEY IN
TERMINATE
V34E

#240

P T R
R E E
D R C

251

.C .M .Y
.E .I .C
.E .N .L
.D .A .E
.T
.E

GO TO
"A"
BELOW

#250

GO TO
"A"
BELOW

#260

IS FINAL FLAG
SET?

.N .Y.

#270

SET UPDATE
FLAG.

#280

HOLD .
.....
SNAP .

FLASH VERB-NCUN
TO REQUEST RES-
PONSE AND DISPLAY
DELTA ALT (CDH),
DELTA TICD/TPI,
AND DELTA T(TPI/

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA ALT (CDH)

#290

TPI);
 V06 N75
 R1-DELTA ALT
 (CCH)
 R2-DELTA T(CDH/
 TPI)
 R3-DELTA T(TPI/
 TPI)

DELTA T (CDH/TPI)
 AND DELTA T (TPI/
 TPI).

DELTA ALT (CDH) -
 THE ALTITUDE BE-
 TWEEN THE ACTIVE
 AND PASSIVE VE-
 HICLE ORBITS AT
 TIG(CCH). SIGN IS
 + WHEN THE ACTIVE
 VEHICLE IS BELOW
 THE PASSIVE
 VEHICLE. IN NAUT-
 ICAL MILES TO THE
 NEAREST .1 NM

DELTA T(CCH/TPI)-
 TIG(TPI) AS DE-
 FINED BY THIS
 PROGRAM MINUS
 TIG(CDH). COM-
 PUTED IN HRS,
 MINS, AND SECS OF
 WHICH ONLY THE
 MINS AND SECS ARE
 DISPLAYED.

DELTA T(TPI/TPI)-
 TIG(TPI) AS DE-
 FINED BY THIS
 PROGRAM MINUS
 TIG(TPI) AS DE-
 FINED EARLIER BY
 P32. COMPUTED IN
 HRS, MINS, AND
 SECS OF WHICH
 ONLY THE MINS AND
 SECS ARE DIS-
 PLAYED.
 (NOTE: R2 AND R3
 ARE MODULARIZED)

#300

#310

#320

#330

#340

++
+03
+EDIT
++

TO THE HOUR, I.E.
63 MINS 22 SECS
IS DISPLAYED AS
038221.

RECORD THESE
VALUES

#350

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#360

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, TERMINATE,
OR RECYCLE

.P .T K.
.R .E E.
.C .R C.
.C .M Y.
.E .I C.
.E .N L.
.C .A E.....

#370

GO TO
"A"
BELOW

#380

HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RESPONSE
AND DISPLAY
CALCULATED COMPONENTS
OF DELTA
V(LV) FOR CDF;

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DELTA

VC6 N81
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

DELTA VX(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH)
ALONG (RXV)XR.
IN FPS TO NEAR-
EST .1 FPS

DELTA VY(LV) -
COMPONENT OF
IMPULSIVE DELTA
V AT TIG(CDH)
ALONG VXR. IN
FPS TO NEAREST
.1 FPS

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH)
ALONG -R.
WHERE R IS LM
GEOCENTRIC (EARTH
ORBIT) OR SELENU-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AND V IS
LM INERTIAL VELC-
CITY VECTOR AT
TIG(CDH). IN FPS
TO NEAREST .1 FPS

WAIT FOR KEYBOARD
ENTRY

V (LV) FOR CDH

AM I SATISFIED
WITH THESE
VALUES?
(NOTE: CREW HAS
THE OPTION AT
THIS TIME TO
REDEFINE THE
DELTA V (LV)
COMPONENTS FOR
THE SUBSEQUENT
THRUSTING MAN-
EUVER. THIS
CAPABILITY WILL
NORMALLY BE
EXERCISED TO
CORRECT OUT-OF-
PLANENESS BY
FIRST SELECTING
THE RENDEZVOUS
OUT-OF-PLANE
DISPLAY ROUTINE
(R36) (V90E)
AND THEN MODIF-
YING DELTA VY
(LV)).

.Y .N

KEY IN V25E
AND LOAD DE-
SIREL DELTA
V VALUES

#390

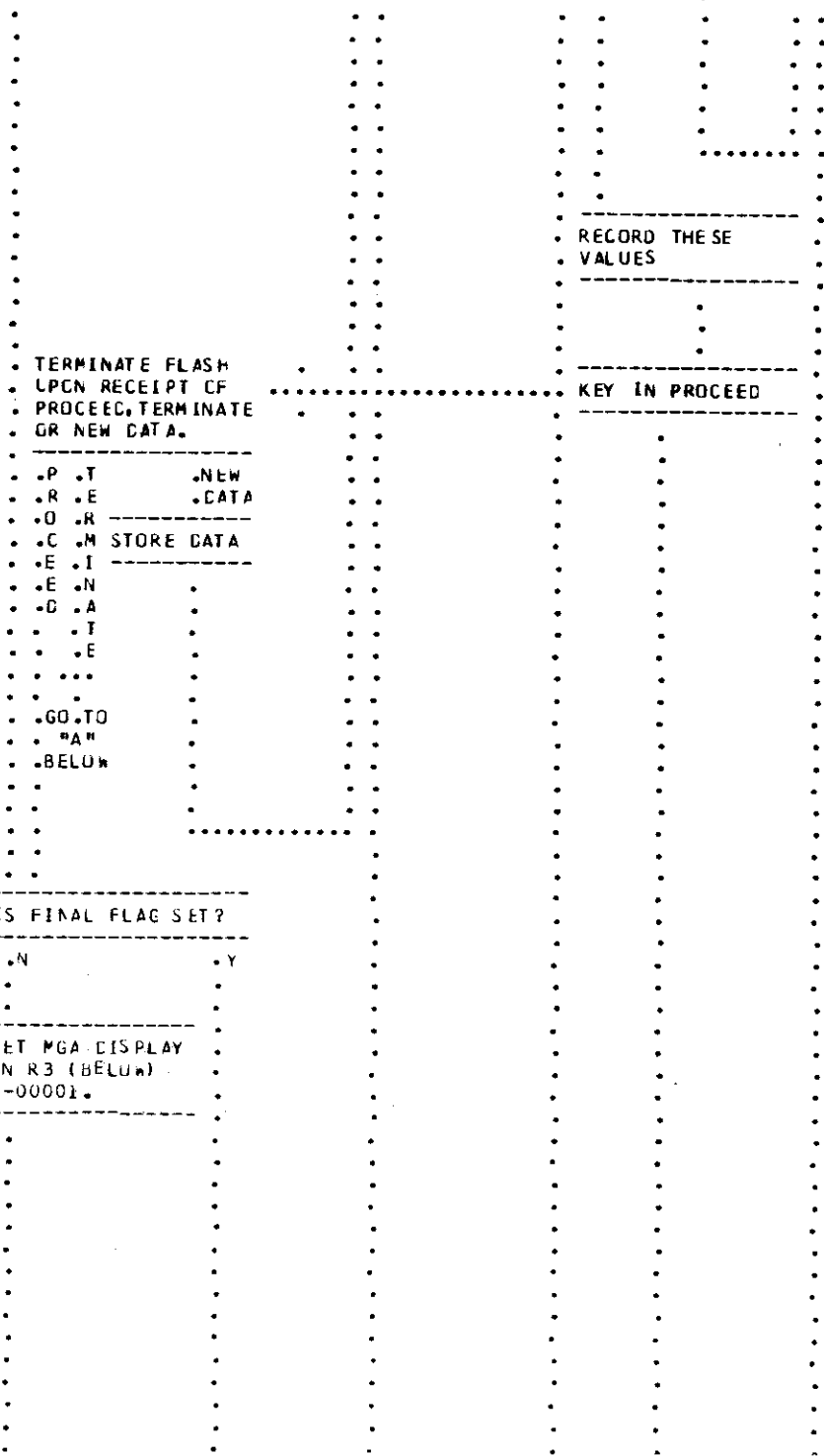
#400

#410

#420

#430

255



#440

#450

#460

#470

#480

.
.
.
.

IS REFSMAT FLAG
SET?

. Y N.
.
.

COMPUTE IMU
MIDDLE GIMBAL
ANGLE AT TIG
(CCF) FOR THE
PRESENT IMU
ORIENTATION
WITH THE LM *X
AXIS ALIGNED
WITH THE
INITIAL THRUST
VECTOR

.
.
.

SET MGA DIS-
PLAY IN R3
(BELOW) =
-00002.

.
.
.

#490

#500

#510

#520

#530

HOLD .

.....
MON .

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY M, TFI AND
MGA;

V16N45
R1-M
R2-TFI
R3-MGA

M - THE NUMBER OF
MARKS MADE SINCE
THE RR TRACKING MARK
COUNTER WAS ZEROED

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF M, TFI AND MGA.

(SEE ASSUMPTION 6
OF P2C)

TFI - TIME FROM TIG
(GDH). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59859.
SIGN IS - BEFORE +
AFTER TIG(GDH).

MGA - MIDDLE GIMBAL
ANGLE AT GETI(GDH)
IF LM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION. IN
DEGREES TO NEAREST
.01 DEGREE
SIGN IS ALWAYS +
EXCEPT;

(A) WHEN DISPLAY-
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE
VALUE IS -00001

(B) ON THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00002.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR
RECYCLE

.P .T .R
.R .E .E

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y N.

DO I WISH TO
TERMINATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE
PROGRAM?

.Y N.

KEY IN PROCEED.

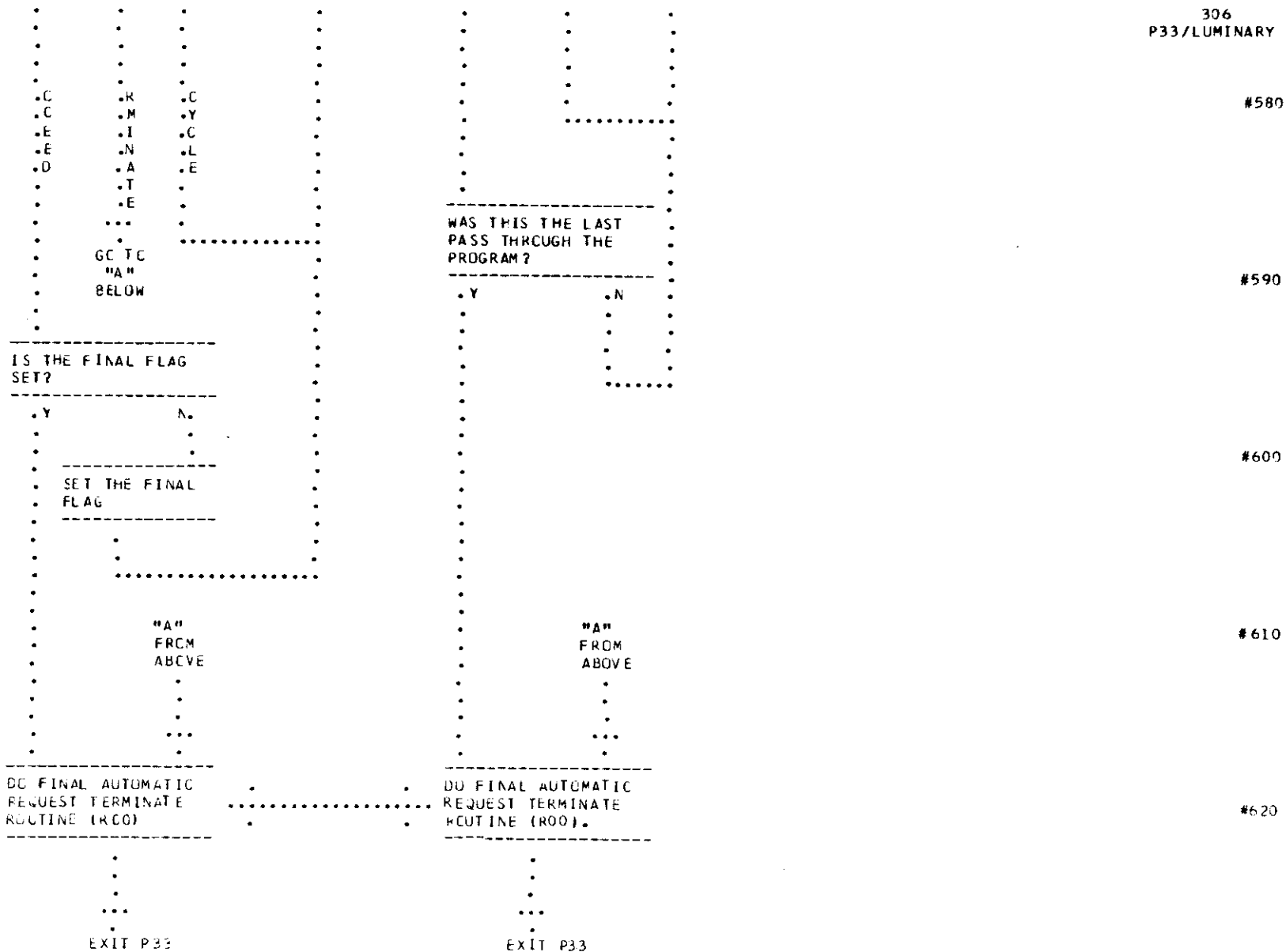
KEY IN RECYCLE
V32E

#540

#550

#560

#570



CHANGE CONTROL NOTES

LOGIC REV 01 PCR 540,623
REV 02 PCR 752, EDITORIAL
REV 03 EDITORIAL

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110

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(

TRANSFER PHASE INITIATION (TPI) PROGRAM (P34)

REV 02 12/03/69

PURPOSE:

(1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE LGC FOR LM EXECUTION OF THE TRANSFER PHASE INITIATION (TPI) MANEUVER, GIVEN:

(A) TIME OF IGNITION TIG(TPI) OR THE ELEVATION ANGLE (E) OF THE LM/CSM LOS AT TIG(TPI)

(E) CENTRAL ANGLE OF TRANSFER (CENTANG) FROM TIG(TPI) TO INTERCEPT TIME (TIG(TPF)).

(2) TO CALCULATE TIG(TPI) GIVEN E OR E GIVEN TIG(TPI).

(3) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE LGC BY THE ASTRONAUT.

(4) TO DISPLAY TO THE ASTRONAUT AND THE GROUND CERTAIN DEPENDENT VARIABLES ASSOCIATED WITH THE MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.

(5) TO STORE THE TPI TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

++ (1) LGC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME, EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.

+C2

+EDIT

++

(2) THE RENDEZVOUS RADAR MAY OR MAY NOT BE USED TO UPDATE THE LM OR CSM STATE VECTORS FOR THIS PROGRAM. IF RADAR USE IS DESIRED THE RADAR SHOULD BE TURNED ON AND LOCKED ON THE CSM BY PREVIOUS SELECTION OF P20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS. THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.

(3) THERE IS NO REQUIREMENT FOR ISS OPERATION DURING THIS PROGRAM UNLESS AUTOMATIC STATE VECTOR UPDATING IS DESIRED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20). IF SELECTED, P20 WILL DEFINE THE STATUS OF THE ISS.

(4) ONCE THE PARAMETERS REQUIRED FOR COMPUTATION OF THE MANEUVER HAVE BEEN COMPLETELY SPECIFIED, THE VALUE OF THE ACTIVE VEHICLE CENTRAL ANGLE OF TRANSFER IS COMPUTED AND STORED. THIS NUMBER WILL BE AVAILABLE FOR DISPLAY TO THE ASTRONAUT THROUGH THE USE OF VO6N52.

THE ASTRONAUT WOULD CALL THIS DISPLAY TO VERIFY THAT THE CENTRAL ANGLE OF TRANSFER OF THE ACTIVE VEHICLE IS NOT WITHIN 170 TO 190 DEGREES. IF THE ANGLE IS WITHIN THIS ZONE THE ASTRONAUT SHOULD REASSESS THE INPUT TARGETING PARAMETERS BASED UPON DELTA V AND EXPECTED MANEUVER TIME.

(5) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY USKY ENTRY.

PRCG
CNT

LGC

GROUND

CREW

.CREW
.PROGRAM
.SELECTION
.
.
.
.

START TRANSFER PHASE
INITIATION PROGRAM
(P34)
DISPLAY P34

KEY IN TRANSFER
PHASE INITIATION
PROGRAM (P34)
V37E 34E

#10

MONITOR DSKY:
OBSERVE DISPLAY OF
P34

#20

SET ACTIVE VEHICLE
FLAG

#30

SET UPDATE FLAG

#40

SET TRACK FLAG

#50

HOLD . FLASH VERB-NCUN TO
..... REQUEST RESPONSE AND

MONITOR DSKY:
OBSERVE VERB-NCUN

SNAP

DISPLAY STORED TIG
(TPI) CALCULATED
FROM PREVIOUS
PROGRAMS:
VC6 N37
R1-TIG(TPI)-HRS
R2-TIG(TPI)-MIN
R3-TIG(TPI)-SEC

FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TIG(TPI)
STORED FROM PREVIOUS
PROGRAMS.

#60

TIG(TPI)-TIME OF TPI
IGNITION (GETI).
IN HRS, MIN, SEC
TO NEAREST .01 SEC.

#70

AM I SATISFIED WITH
THIS VALUE?
(NOTE: THIS PROGRAM
ALWAYS REQUIRES AN
INITIAL VALUE OF
TIG(TPI) WHICH IS
WITHIN 30 MINUTES
OF THE ACTUAL VALUE
EVEN IF TIG(TPI) IS
TO BE CALCULATED
FROM A SPECIFIED E.)

#80

.Y N.

RECORD THIS
VALUE.

#90

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

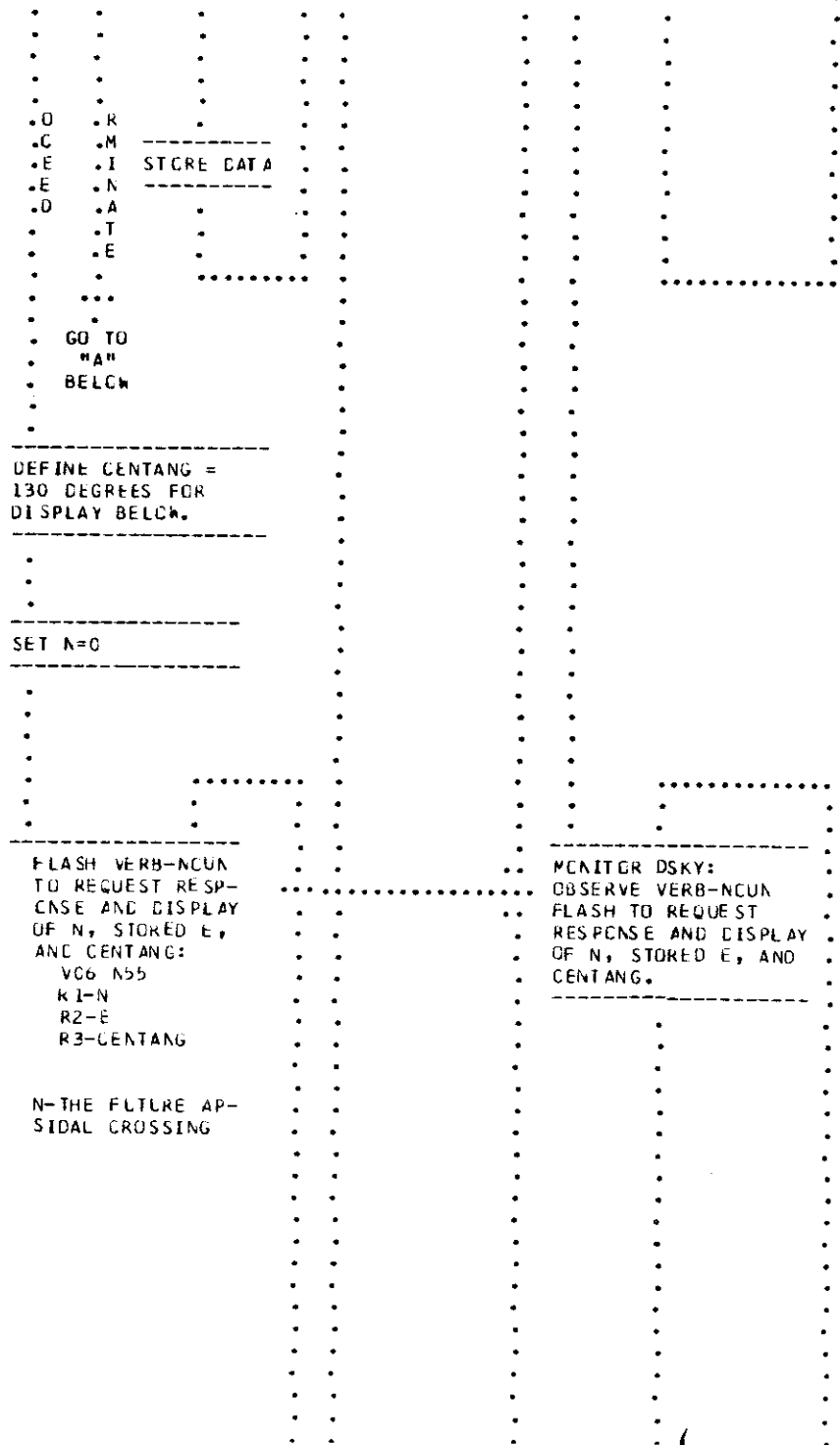
#100

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE,
OR NEW DATA

KEY IN V25E AND
LOAD THE DESIRED
TIG

#110

.P .T .NEW
.R .E .DATA



.O .R
.C .M
.E .I STORE DATA
.E .N
.D .A
.T
.E
. .

GO TO
"A"
BELCH

DEFINE CENTANG =
130 DEGREES FOR
DISPLAY BELCH.

SET N=0

HOLD . FLASH VERB-NCUN
..... TO REQUEST RESP-
SNAP . CNSE AND DISPLAY
OF N, STORED E,
AND CENTANG:
VC6 N55
K1-N
R2-E
R3-CENTANG

N-THE FUTURE AP-
SIDAL CROSSING

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF N, STORED E, AND
CENTANG.

#120

#130

#140

#150

249

205

(APGCENTER OR
PERICENTER) OF
THE ACTIVE
VEHICLE AT
WHICH TIG (CDH)
SHOULD OCCUR.

#160

00001=FIRST
00002=SECOND
ETC.

(NOTE:
IN THIS CASE, N IS
THE NUMBER OF TAR-
GET OFFSETS. WHEN
N IS ZERO, USE CO-
NIC INTEGRATION TO
DETERMINE THE IN-
ITIAL POSITION AND
VELOCITY OF THE
TARGET AT INTER-
CEPT TIME. WHEN N
IS NON-ZERO, USE
PRECISION INTEGRA-
TION AND THE INDI-
CATED NUMBER OF
OFFSETS.)

#170

00000-KEPLER CO-
NIC INTE-
GRATION
WITH NO
TARGET
OFFSET

#180

#190

00001-PRECISION
INTEGRA-
TION WITH
ONE TARGET
OFFSET

00002-PRECISION
INTEGRA-
TION WITH
TWO TARGET
OFFSETS

#200

ETC.)

E-ELEVATION ANGLE
BETWEEN THE LM/
CSM LOS AND THE
LM LOCAL HORI-
ZONTAL AT TIG
(TPI) REFERENCED
TO THE DIRECTION
OF FLIGHT (SEE
SECTION 5.4.2 OF
R567 FOR
DETAILED DESCRIPT-
ION). IN DEGREES
TO NEAREST .01
DEGREE.

#210

DO I WISH THE LGC TO
CALCULATE E?

.N .Y

#220

CENTANG-THE ORBIT-
AL CENTRAL ANGLE
OF THE PASSIVE
VEHICLE DURING
TRANSFER FROM
TIG(TPI) TO TIME
OF INTERCEPT. IN
DEGREES TO NEAREST
.01 DEGREE.

HAVE I SPECIFIED
N AS DESIRED, E
TO BE +00000,
AND CENTANG AS
DESIRED?

.Y .N

#230

RECORD THE
VALUES OF N
AND CENTANG.

WAIT FOR KEYBOARD
ENTRY

KEY IN
PRCCEED

#240

GC TO
"B"
BELOW

#250

267

 . KEY IN V25E AND
 . LCAD N AS DE-
 . SIRE D IN R1,
 . +00000 IN R2,
 . AND CENTANG AS
 . DESIRED IN R3

#260

 . AM I SAT ISFIED
 . WITH THE PRESENT
 . VALUES OF N, E
 . AND CENTANG?

#270

.Y N.

#280

 . KEY IN V25E
 . AND LCAD N AS
 . DESIRED IN
 . R1, E AS DE-
 . SIRE D IN R2,
 . AND CENTANG
 . AS DESIRED IN
 . R3

#290

 . RECCRD THESE VALUES

#300

++
 +02
 +EOIT
 ++

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE,
OR NEW DATA

KEY IN PROCEED

.P .T .NEW
.R .E .DATA
.Q .R
.C .M
.E .I STORE DATA
.E .N
.C .A
. .T
. .E

GC TC
"A"
BELOW

RESET COMP E FLAG

IS E SPECIFIED TO
BE #00000?

.Y .N.

SET COMP E FLAG

RESET FINAL FLAG

#310

#320

#330

#340

#350

240

#360

DID I SPECIFY E
TO BE +00000?

.Y N.

RESET UPDATE FLAG

#370

IS CCMP E FLAG
SET?

.Y N.

COMPUTE E FOR
SPECIFIED
TIG(TP1)

#380

#390

MONITOR DSKY:
OBSERVE
VERB-NGUN
FLASH TO RE-
QUEST RESPON-
SE AND DIS-
PLAY OF CAL-
CULATED E.

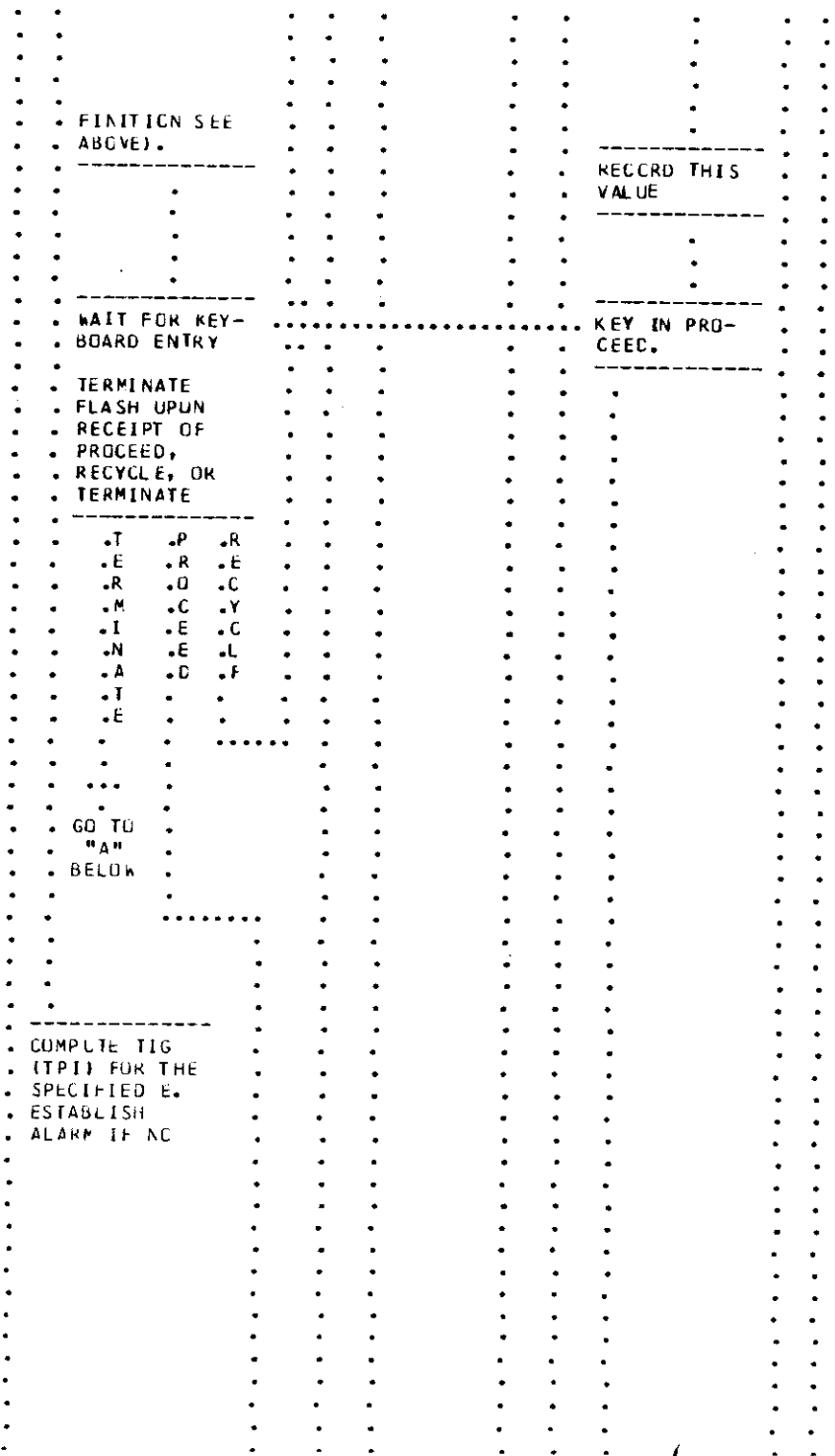
FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED E;
V06 N55
R1-N
R2-E
R3-CENTANG

(NOTE: FOR DE-

++
+02
+EDIT
+
+02
++

POSS
HOLD .
.....
SNAP .

++
+02
+EDIT
++



FINITION SEE ABOVE).

RECORD THIS VALUE

#400

WAIT FOR KEY-BOARD ENTRY

KEY IN PRO-CEED.

#410

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED,
RECYCLE, OR
TERMINATE

.T	.P	.R
.E	.R	.E
.R	.D	.C
.M	.C	.Y
.I	.E	.C
.N	.E	.L
.A	.D	.F
.T	.	.
.E	.	.

#420

GO TO "A" BELOW

#430

COMPLETE TIG (TPI) FOR THE SPECIFIED E. ESTABLISH ALARM IF NC

#440

SOLUTION CAN
BE REACHED

.N .A
.C .L
.A .A
.L .R
.A .M
.R
.M

FLASH VERB-
NOUN TO
REQUEST RE-
SPONSE AND
DISPLAY
ALARM CODE
CC611:
V05N09
R1-XXXXX
R2-XXXXX
R3-XXXXX

MONITOR DSKY:
DOES ALARM
CODE DISPLAY
INDICATE THAT
NO SOLUTION
CAN BE
REACHED?

.Y N.

WAIT FOR
KEYBOARD
ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED,
RECYCLE, CR
TERMINATE

RETURN TO
START OF
PROGRAM
AND ADJUST
INPUT PARA-
METERS.
KEY IN
PROCEED.

.T .P .R
.E .R .E

#450

#460

#470

#480

#490

POSS
HOLD
.....
SNAP

R . G . C
M . C . Y
I . E . C
N . E . L
A . D . E
T .
E .

GO TO
"A"
BELOW

#500

#510

POSS
HOLD .
.....
SNAP .

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED
TIG(TPI):
V06N37
R1-TIG(TPI)
-HRS
R2-TIG(TPI)
-MINS
R3-TIG(TPI)
-SECS.

(NOTE: FOR DE-
FINITION SEE
ABOVE).

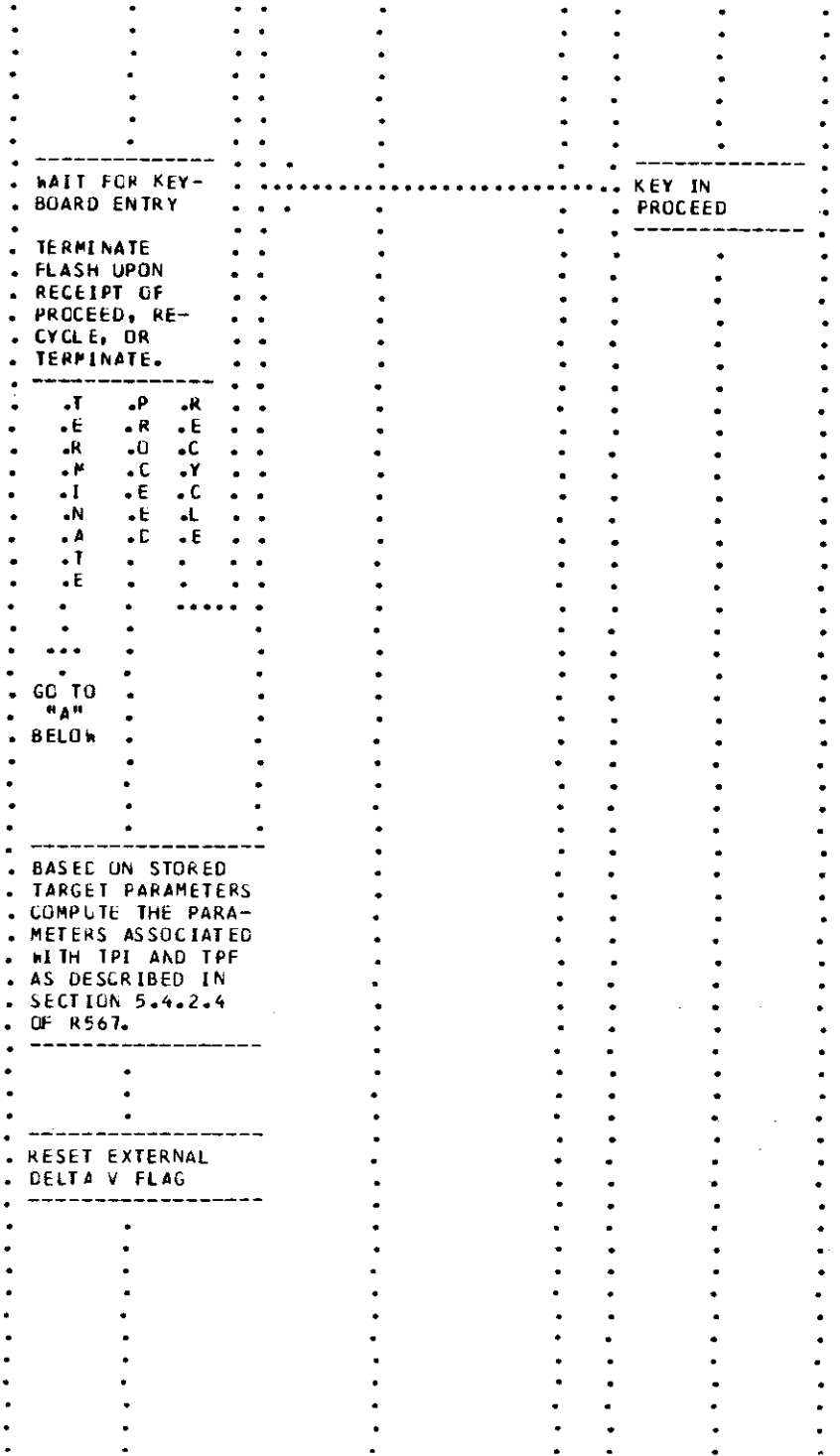
MONITOR DSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RE-
SPONSE AND
DISPLAY OF
CALCULATED
TIG(TPI).

RECGRD THIS
VALUE

#520

#530

#540



#550

#560

#570

#580

#590

#600

#610

#620

#630

#640

HOLD .
.....
SNAP .

FLASH VERB-NOUN
TG REQUEST RE-
SPONSE AND DIS-
PLAY CALCULATED
PER ALT, DELTA
V(TPI), AND DELTA
V(TPF):
VO6N58
R1-PER ALT
R2-DELTA V(TPI)
R3-DELTA V(TPF)

PER ALT-ALTITUDE
OF PCST TPI PERI-
GEE ABOVE
THE LAUNCH PAD
RADIALS (EARTH
ORBIT) OR ALTI-
TUDE OF PERILUNE
ABOVE THE LUNAR
RADIUS AT THE
MGST RECENTLY DE-
FINED LANDING
SITE (LUNAR
ORBIT). IN NAUTI-
CAL MILES TO
NEAREST .1 NM.

DELTA V(TPI)-RE-
QUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TPI MANEU-
VER AT TIG(TPI).
IN FPS TO NEAREST
.1 FPS.

DELTA V(TPF)-RE-
QUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TPF MANEU-
VER AT TIME OF
INTERCEPT. IN FPS
TO NEAREST .1 FPS.

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO
REQUEST RESPONSE
AND DISPLAY OF
CALCULATED PER
ALT, DELTA
V(TPI), AND
DELTA V(TPF).

RECORD THESE
VALUES

#700

POSS
HOLD
.....
SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED
COMPONENTS OF
DELTA V(LV)
FOR TPI;
V06N81
R1-DELTA
VX(LV)
R2-DELTA
VY(LV)
R3-DELTA
VZ(LV)

DELTA VX(LV)-
COMPONENT OF
IMPULSIVE
DELTA V AT
TIG(TPI) ALONG
(RXV)XR. IN
FPS TO NEAREST
.1 FPS.

DELTA VY(LV)-
COMPONENT OF
IMPULSIVE
DELTA V AT
TIG(TPI) ALONG
VXR. IN FPS TO
NEAREST .1 FPS

DELTA VZ(LV)-
COMPONENT OF
IMPULSIVE
DELTA V AT
TIG(TPI) ALONG
-R. IN FPS TO

MONITOR DSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RES-
PONSE AND
DISPLAY OF
DELTA V(LV)
FOR TPI

AM I SATIS-
FIED WITH
THESE VALUES?
(NOTE: CREW
HAS THE OP-
TION AT THIS
TIME TO RE-
DEFINE THE
DELTA V(LV)
COMPONENTS
FOR THE SUB-
SEQUENT THRU-
STING MANEU-
VER. THIS
CAPABILITY
WILL NORMALLY
BE EXERCISED
TO CORRECT
OUT-OF-PLANE-
NESS BY FIRST
SELECTING THE
RENDEZVOUS
OUT-OF-PLANE
DISPLAY RCU-
TINE (R36)

#710

#720

#730

#740

.C .M
.E .I
.E .N
.D .A
.T
.E
.
.
.
GC TO
"A"
BELOW
.

STCRE DATA

.
.

HAS NEW DATA
BEEN LOADED?
(IS THE SUM OF
ALL CHANGES TO
ALL COMPONENTS,
TREATING MOST
SIGNIFICANT
AND LEAST SIG-
NIFICANT
HALVES AS SEP-
ARATE QUANTIT-
IES, NOT EQUAL
TO "0"?)

.N Y.
.

SET NEW
TARGET FLAG

#800

#810

#820

#830

#840

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, RECYCLE,
OR TERMINATE

#900

.P	.T	.R
.R	.E	.E
.D	.R	.C
.C	.M	.Y
.E	.I	.C
.E	.N	.L
.D	.A	.E
	.T	
	.E	
	

#910

GO TO
"A"
BELOW

#920

IS THE FINAL FLAG
SET?

.N Y.

SET MGA DISPLAY
IN R3(BELOW)
= -00001.

#930

IS REFSMMAT FLAG
SET?

.Y N.

#940

MGA-MIDDLE GIMBAL
ANGLE AT TIG(TPI) IF
LM *X AXIS IS ALIGN-
ED WITH INITIAL
THRUST DIRECTION.
IN DEGREES TO NEAR-
EST .01 DEGREE.

SIGN IS ALWAYS +
EXCEPT
(A) WHEN DISPLAY-
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE
VALUE IS -00001

(B) ON THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00002.

DO I WISH TO
TERMINATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE
PROGRAM?

.Y .N.

#1000

#1010

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED.

#1020

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, TERMINATE,
OR RECYCLE

KEY IN RECYCLE
V32E

#1030

.P .T .R
.K .E .E
.C .R .C
.C .M .Y
.E .I .C
.E .N .L
.D .A .E
. .T .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
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. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .

TRANSFER PHASE MIDCOURSE (TPM) PROGRAM (P35)

REV 03 12/03/69

- PURPOSE:** (1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE LGC FOR LM EXECUTION OF THE NEXT MIDCOURSE CORRECTION OF THE TRANSFER PHASE OF AN ACTIVE LM RENDEZVOUS.
- ASSUMPTIONS:** (1) THERE IS NO REQUIREMENT FOR ISS OPERATION DURING THIS PROGRAM UNLESS AUTOMATIC STATE VECTOR UPDATING IS DESIRED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20). IF SELECTED, P20 WILL DEFINE THE STATUS OF THE ISS.
- (2) THE RENDEZVOUS RADAR IS ON AND IS LOCKED ON THE CSM. THIS WAS DONE DURING PREVIOUS SELECTION OF P20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS. THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.
- (3) THE TIME OF INTERCEPT (T(INT)) WAS DEFINED BY PREVIOUS COMPLETION OF THE TRANSFER PHASE INITIATION (TPI) PROGRAM (P34) AND IS PRESENTLY AVAILABLE IN LGC STORAGE.
- (4) ONCE THE PARAMETERS REQUIRED FOR COMPUTATION OF THE MANEUVER HAVE BEEN COMPLETELY SPECIFIED, THE VALUE OF THE ACTIVE VEHICLE CENTRAL ANGLE OF TRANSFER IS COMPUTED AND STORED. THIS NUMBER WILL BE AVAILABLE FOR DISPLAY TO THE ASTRONAUT THROUGH THE USE OF V06N52. THE ASTRONAUT WOULD CALL THIS DISPLAY TO VERIFY THAT THE CENTRAL ANGLE OF TRANSFER OF THE ACTIVE VEHICLE IS NOT WITHIN 170 TO 190 DEGREES. IF THE ANGLE IS WITHIN THIS ZONE THE ASTRONAUT SHOULD REASSESS THE INPUT TARGETING PARAMETERS BASED UPON DELTA V AND EXPECTED MANEUVER TIME.
- (5) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY PRIOR TO ANY ANTICIPATED RENDEZVOUS MIDCOURSE CORRECTION.

PROG
CNT

LGC

GROUND

CREW

.CREW
.PROGRAM
.SELECTION
.
...
.

START TRANSFER PHASE
MIDCOURSE (TPM) .
PROGRAM (P35). .
DISPLAY P35. .

..... KEY IN TRANSFER
PHASE MIDCOURSE
(TPM) PROGRAM (P35)
V37E 35E

.
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .


```

.
.
.
.
.
.
.
.
.
.
.-----
. DEFINE TIG(MID)=
. T + "ATIGINC"
. MIN.
. (NOTE: THE VALUE
. "ATIGINC" IS IN
. ERASABLE STORAGE,
. HAVING BEEN LOAD-
. ED PRIOR TO
. LALACH CR BY P27.)
.-----
.
.
.

```

#70

```

.-----
. EXTRAPOLATE LM
. STATE VECTOR TO
. TIG(MID)
.-----
.
.
.

```

#80

```

.-----
. EXTRAPOLATE CSM
. STATE VECTOR TO
. T(INT) (NOTE:
. REFER ASSUMPTION
. (3) ABOVE).
.-----
.
.
.

```

#90

```

.-----
. DO LAMBERT RCLT-
. INE TO CALCULATE
. THE REQUIRED VEL-
. OCITY FOR THE
. MIDCOURSE COR-
. RECTION.
.-----
.
.
.

```

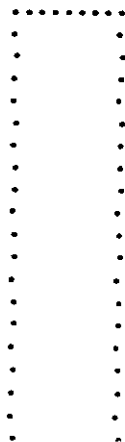
#100

```

.-----
. RESET EXTERNAL
. DELTA V FLAG
.-----
.
.
.

```

#110



IS THE FINAL FLAG
SET?

.N .Y.

SET LDATE
FLAG

RESET NEW
TARGET FLAG

IS THIS THE FINAL
PASS THROUGH THIS
PROGRAM?

.Y .N.

POSS
HOLD .
.....
SNAP .

FLASH VERB-
NOUN TO REQ-
UEST RESPONSE
AND DISPLAY
CALCULATED
COMPONENTS OF
DELTA V(LV)
FOR TPM;
VC6N81
R1-DELTA
VX(LV)
R2-DELTA
VY(LV)
R3-DELTA
VZ(LV)
DELTA VX(LV)-
COMPONENT OF
IMPULSIVE
DELTA V AT

MONITOR
DSKY:
OBSERVE
VERB-NOUN
FLASH TO
REQUEST RE-
SPONSE AND
DISPLAY OF
DELTA V(LV)
FOR TPM

AM I SATIS-
FIED WITH
THESE
VALUES?
(NOTE: CREW

#120

#130

#140

#150

289

<p>TIG(TPM) ALONG (RXV)XR IN FPS TO NEAREST .1 FPS.</p> <p>DELTA VY(LV)- COMPONENT OF IMPULSIVE DELTA V AT TIG(TPM) ALONG VXR. IN FPS TO NEAR- EST .1 FPS</p> <p>DELTA VZ(LV)- COMPONENT OF IMPULSIVE DELTA V AT TIG(TPM) ALONG -R. IN FPS TO NEAR- EST .1 FPS</p> <p>WHERE R IS THE LM GEC- CENTRIC (EARTH ORBIT) OR SELEND- CENTRIC (LUNAR ORBIT) RADIUS VECTOR AND V IS THE LM INERTIAL VELOCITY VECTOR AT TIG(TPM).</p> <p>-----</p> <p>WAIT FOR KEY- BOARD ENTRY</p>	<p>HAS THE OP- TION AT THIS TIME TO REDEFINE THE DELTA V (LV) COM- PONENTS FOR THE SUBSE- QUENT THRUSTING MANEUVER.</p> <p>THIS CAPA- BILITY WILL NORMALLY BE EXERCISED TO CORRECT OUT-OF- PLANENESS BY FIRST SE- LECTING THE RENDEZVOUS OUT-OF- PLANE DIS- PLAY ROU- TINE (R36) (V90E), AND THEN MODI- FYING DELTA VY(LV).</p> <p>-----</p> <p>.Y N.</p> <p>-----</p> <p>KEY IN V25E AND LGAD THE DE-</p>	<p>#160</p> <p>#170</p> <p>#180</p> <p>#190</p> <p>#200</p>
---	--	---

SI RED
DELTA V
VALUES

#210

RECORD
THESE
VALUES

#220

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED, TER-
MINATE, OR
NEW DATA

KEY IN
PROCEED.

#230

P T NEW
R E DATA
C R
C M
E I
E N STORE
D A DATA
T
E

#240

GO TO
"A"
BELOW

HAS NEW DATA
BEEN LOADED?
(IS THE SUM

#250

HOLD .
.....
SNAP .

FLASH VERB-NOUN
TC REQUEST RES-
PONSE AND DISPLAY
DELTA V(LCS) FOR
TPM:
VC6N59
R1-DELTA
V1(LCS)
R2-DELTA
V2(LCS)
R3-DELTA
V3(LCS)

++
+03
+EDIT
++

EACH COMPONENT IN
FPS TC NEAREST
.1 FPS. (NOTE:
FOR DEFINITION
SEE SECTION
5.4.2.5 OF R567).

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH
UPON RECEIPT OF
PROCEED, RECYCLE,
OR TERMINATE

.P	.T	.R
.R	.E	.E
.D	.R	.C
.C	.M	.Y
.E	.I	.C
.E	.N	.L
.D	.A	.E
	.T	
	.E	

GO TO

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA V(LCS).

#310

RECORD THESE
VALUES.
(NOTE: UNLIKE
DELTA V(LV) FOR
TPM ABOVE, THESE
VALUES CANNOT BE
WRITTEN OVER.)

#320

KEY IN PROCEED

#330

#340

#350

```

. .
. .
. .
. .
. . "A"
. . BELOW
. .

```

```

IS THE FINAL FLAG
SET?

```

```

. N . Y .
. .
. .

```

#360

```

SET MGA DISPLAY
IN R3 (BELOW)=
-COCC1.

```

```

. .
. .

```

#370

```

IS REFSMMAT FLAG
SET?

```

```

. Y . N .
. .
. .

```

```

COMPUTE IMU
MIDDLE GIMBAL
ANGLE AT TIG
(TPM) FOR THE
PRESENT IMU
ORIENTATION
WITH THE LM
X AXIS ALIG-
NED WITH THE
INITIAL
THRUST VECTOR

```

#380

```

. .
. .

```

#390

```

SET MGA DIS-
PLAY IN R3
(BELOW)=
-COCC2.

```

```

. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

```

#400

HOLD

MON

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OF M, TFI
AND MGA;
V16N45
R1-M
R2-TFI
R3-MGA

M-THE NUMBER OF
MARKS MADE SINCE THE
RR TRACKING MARK
COUNTER WAS ZEROED
(SEE ASSUMPTION 6
OF P20).

TFI-TIME FROM TIG
(TPM) IN MIN AND SEC
TO NEAREST SEC. MAX
READING IS 59859.
SIGN IS - BEFORE, +
AFTER TIG(TPM).

MGA-MIDDLE GIMBAL
ANGLE AT TIG(TPM) IF
LM + X AXIS IS ALIG-
NED WITH INITIAL
THRUST DIRECTION.
IN DEGREES TO NEAR-
EST .01 DEGREES.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAY-
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF M, TFI AND MGA.
NOTE: ON FIRST PASS
THROUGH, TFI WILL BE
TIME FROM PREVIOUS
TIG IF P41 WAS PER-
FORMED, OR TIME FROM
PREVIOUS CUTOFF IF
P40 OR P42 WAS PER-
FORMED.

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

. Y . N .

DO I WISH TO
TERMINATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE PRO-
GRAM?

. Y . N .

#410

#420

#430

#440

VALUE IS -00001

(B) ON THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00002.

#450

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED.

#460

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE, OR RECYCLE

KEY IN RECYCLE
V32E

#470

.P .T .R
.R .E .E
.O .R .C
.C .H .Y
.E .I .C
.E .N .L
.D .A .E
. .T
. .E

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

#480

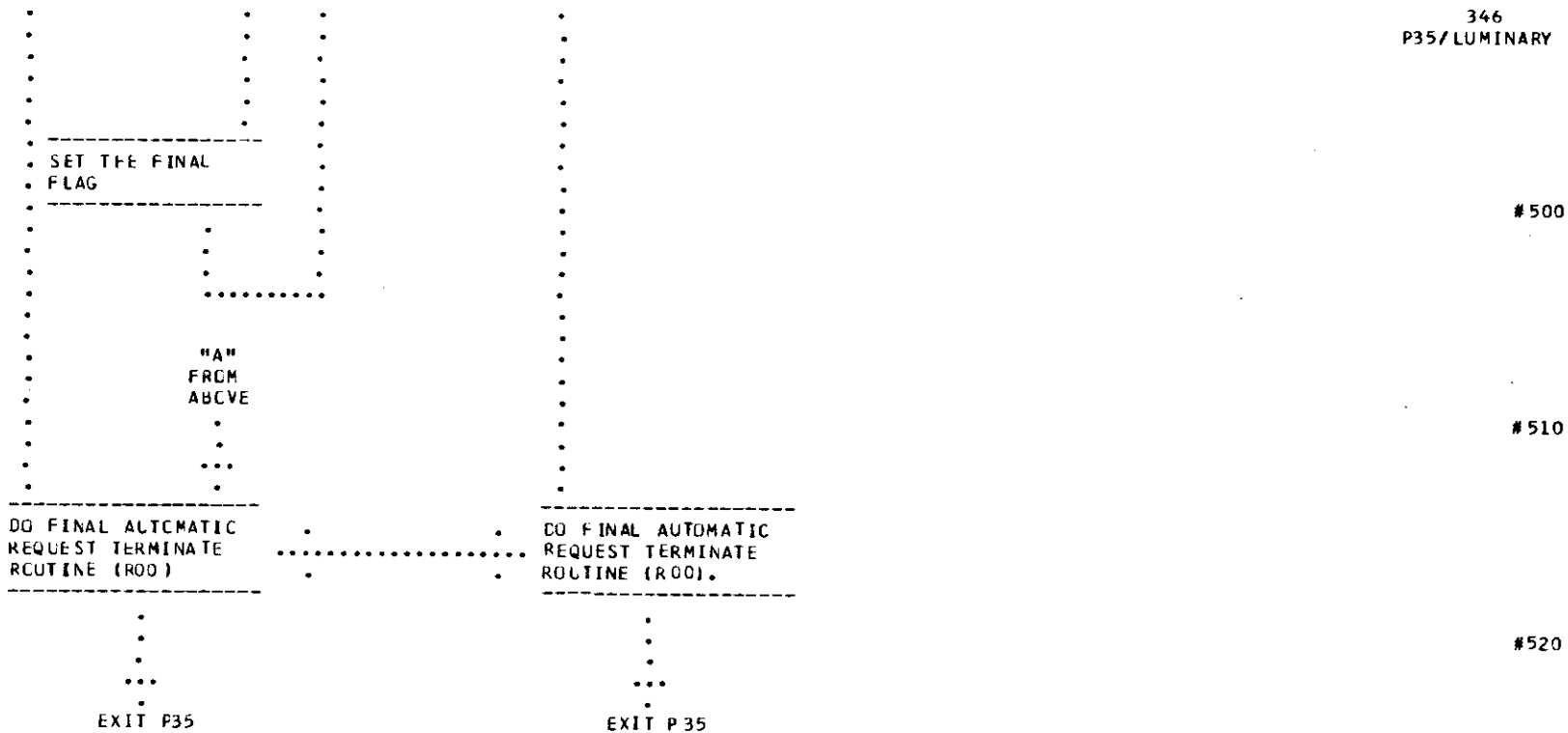
GO TO
"AM"
BELCH

.Y .N

IS THE FINAL FLAG
SET?

#490

.Y N.



CHANGE CONTROL NOTES

LOGIC REV C1 PCR 502,627
 REV 02 (LUM1B) PCR 812.2
 REV C3 EDITORIAL