CMC/LGC CLOCK SYNCHRONIZATION ROUTINE (R33) LOGIC REV 06 04/11/68

PURPOSE: (1) TO SYNCHRONIZE THE LGC CLOCK WITH THE CMC CLOCK.

ASSUMPTIONS: (1) SYNCHRONIZATION REQUIRES THE VALUE OF THE DIFFERENCE BETWEEN THE TWO CLOCKS. THIS VALUE MAY BE OBTAINED DIRECTLY FROM CO-ORDINATED READING OF THE TWO CLOCKS OR MAY BE PROVIDED BY THE GROUND FROM DOWNLINK MONITORING OF THE CLOCKS.

(2) THE CMC IS ON. THE LGC MUST ONLY BE ON UNTIL SATISFACTORY COMPARATIVE READINGS HAVE BEEN MADE BY THE CREW OR GROUND.

(3) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			DO I HAVE A PRECISE VALUE FOR THE DIFFERENCE BETWEEN THE CMC AND LGC CLOCKS SUPPLIED FROM THE GROUND?			#10
++ +06 ++	WAIT FOR KEYBOARD ENTRY.		KEY IN V06N65			#20
			CONFIRM SELECTION OF THIS ROUTINE (R33) IN THE OTHER VEHICLE.			#30
					R33/COLOSSUS R33/SUNDANCE	

PERFORM COUNT-DOWN WITH CREW MEMBER IN OTHER VEHICLE TO INSURE SIMULTANEOUS DEPRESSION OF BOTH ENTER KEYS. #40

#50

CONTINUE UPON RECEIPT OF ENTER

KEY IN ENTER

RECORD CONTENTS OF CMC CLOCK AT TIME OF ENTER #60

HOLD SNAP

DISPLAY CMC CLOCK TIME ON DSKY:
V06 N65
R1-HRS
R2-MIN
R3-SECS

R3 TO NEAREST .01 SEC.

MONITOR DSKY: OBSERVE DIS-PLAY OF CMC CLOCK AT TIME OF ENTER #70

#80

RECORD THIS TIME

R33/COLOSSUS
R33/SUNDANCE
R33/LUMINARY

WAIT FOR KEYBOARD ENTRY

OBTAIN FROM THE LGC THE LGC CLOCK TIME OF SIMULTANEOUS ENTER INTO THE LGC (VIA VOICE LINK). #90

#100

COMPUTE TIME DIFFERENCE BETWEEN COMPUTER CLOCK TIMES.

#110

DO I WISH TO TAKE MORE DATA POINTS?

Y N

#120

OBTAIN AVERAGE OF ALL TIME DIFFERENCES AND TRANSMIT TO LM CREW.

#130

TERMINATE DISPLAY UPON RECEIPT OF KEY RELEASE

PUSH KEY RELEASE BUTTON

#140

R33/COLOSSUS
R33/SUNDANCE
R33/LUMINARY

```
        .                    .
        .                    .
        .                    .
        .                    .
        .                    .
      EXIT                 EXIT
```

CHANGE CONTROL NOTES

LOGIC REV 06 PCR MIT 66

RENDEZVOUS PARAMETER DISPLAY ROUTINE NO 2 (R34) LOGIC REV 07 11/27/68

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED RENDEZVOUS PARAMETERS (RANGE, RANGE RATE, PHI)

ASSUMPTIONS: (1) RANGE AND RANGE RATE ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED LM AND CSM STATE VECTORS AND DO NOT
++ REQUIRE THAT THE ISS BE ON. THE ISS MUST BE ON AND ALIGNED TO A "KNOWN" ORIENTATION AND THE OPTICAL SUBSYSTEM
+06 MUST BE ON AND OPERATIONAL, IF A CORRECT DISPLAY OF PHI IS DESIRED. THE RANGE/RANGE RATE/PHI DISPLAY IS NOT
++ INHIBITED HOWEVER IF THE IMU IS NOT ON AND ALIGNED.
PCR
519 (2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW .ROUTINE .SELECTION			
	START RENDEZVOUS PARAMETER DISPLAY ROUTINE NO 2 (R34)	.....	KEY IN V85E			#10
++ +07 + + + + + + + + + + +07 ++ PCN 586	IS ANOTHER EXTENDED VERB ACTIVE? N. Y. TURN ON OPERATOR ERROR LIGHT ... EXIT					#20 #30
					R34/COLOSSUS	

```
                                                                  #40
  SET T=PRESENT TIME.
  -------------------
            .
            .
            .
  -------------------
  EXTRAPOLATE CSM AND
  LM STATE VECTORS TO
  T USING COASTING
  INTEGRATION ROUTINE.
  -------------------
            .
            .                                                     #50
            .
.....       .
.   .       .
.   .       .
. -------------------
. IS AVERAGE G
. RUNNING?
. -------------------
.   .N              .Y
.   .               .                                             #60
.   .               .
. -----------------  .
. SET TF=PRESENT     .
. TIME.              .
. -----------------  .
.   .               .
.   .               .
.   .               .
. -----------------  .
. EXTRAPOLATE LM     .                                             #70
. AND CSM STATE      .
. VECTORS TO TF FROM.
. T USING KEPLER     .
. SUBROUTINE.        .
. -----------------  .
.   .               .
.   .               .
.   .               .
.   . ----------------
.   . SET TF=AVERAGE G                                            #80
.   . TIME.
.   . ----------------
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
.   .               .
```

```
          .   .               .                    .
          .   .               .                    .
          .   .               .                    .
          .   .               .                    .
          .   .               .                    .
          .   .               .                    .
          .   . ---------------                    .
          .   . EXTRAPOLATE LM                     .
          .   . STATE VECTOR TO                    .
          .   . TE FROM T USING                    .
          .   . COASTING INTEG-                    .                                  #90
          .   . RATION ROUTINE.                    .
          .   . ---------------                    .
          .   .       .                            .
          .   .       .                            .
          .   .       .                            .
++        .   .       .                            .
+07       .   .       .                            .
++        .   .       .                            .
EDIT      .   .       .                            .
          .   .       .                            .                                  #100
          .   .       .                            .
          . --------------------                   .
          . CALCULATE RANGE,                       .
          . RANGE RATE AND                         .
          . PHI                                    .
          . --------------------                   .
          .           .                            .
          .           .                            .
          .           .                            .
          .           .                            .                                  #110
HOLD  . . . --------------------                   . --------------------
......... . FLASH VERB-NOUN TO                     . . MONITOR DSKY:
MON   . . . REQUEST RESPONSE AND ................... . OBSERVE VERB-NOUN
          . DISPLAY RENDEZVOUS                     . . FLASH TO REQUEST
          . PARAMETERS:                            . . RESPONSE AND DISPLAY
          .   V16 N53                              . . OF RENDEZVOUS
          .   R1-RANGE                             . . PARAMETERS.
          .   R2-RANGE RATE                        . . (NOTE: THESE PARA-
          .   R3-PHI                               . . METERS WILL BE
          .                                        . . UPDATED EVERY TWO              #120
          . RANGE-CALCULATED                       . . SECONDS.
          . RANGE TO LM, IN                        . . --------------------
          . NAUTICAL MILES TO                      .
          . NEAREST .01 NM.                        .
          .                                        .
          . RANGE RATE-                            .
          . CALCULATED RANGE                       .
          . RATE BETWEEN CSM AND                   .
          . LM. NEGATIVE SIGN                      .
          . INDICATES CLOSING                      .                                  #130
          . IN FPS TO NEAREST                      .
          . .1 FPS                                 .
          . PHI-ANGLE BETWEEN                      .
          . OPTICS STAR LINE OF                    .
          . SIGHT AND THE LOCAL                    .
          . HORIZONTAL PLANE AT                    .
          . THE PRESENT TIME.                      .
++        . ANGLE IS ALWAYS                        .
+07       . POSITIVE.                              .
++        . FROM 0 TO 360                          .                                  #140
          .                                        .
          .                                        .
          .                                        .
```

```
EDIT     DEGREES IN DEGREES
         TO NEAREST .01
         DEGREE
         --------------------
         .   .       .
         .   .       .
         .   .       .
++       .   .       .
+06      .   .       .                                          #150
++       .   .       .
PCR      .   .       .
511      .   .       .
         .   .       .
         .   .       .
         .....       .
                     .
                     .
         --------------------
         WAIT FOR KEYBOARD
         ENTRY                                                  #160
                                                 .
         TERMINATE FLASH UPON    .               --------------------
         RECEIPT OF PROCEED      ................ WHEN FINISHED WITH
         --------------------    .               THIS DISPLAY KEY IN
                   .PROCEED                      PROCEED
                   .                             --------------------
                   .                                     .
                   .                                     .                #170
                   .                                     .
                  ...                                   ...
                   .                                     .
                EXIT R34                              EXIT R34
```

CHANGE CONTROL NOTES

```
LOGIC REV 04   PCR MIT 66
      REV 05   PCR 206
               PCR 485
       REV 06  PCR 510
               PCR 511
      REV 07   PCN 586
```

LUNAR LANDMARK SELECTION ROUTINE (R35) LOGIC REV 09 11/27/68

PURPOSE: (1) TO DISPLAY TO THE ASTRONAUT THE TIME AT WHICH THE SPACECRAFT WILL PASS OVER THE LANDING SITE.

(2) TO CALCULATE AND DISPLAY FIVE LANDMARKS WHICH WILL BE SUITABLE FOR NAVIGATION.

(3) TO CALCULATE AND DISPLAY THE TIME AT WHICH THE SPACECRAFT WILL PASS OVER EACH LANDMARK.

ASSUMPTIONS: (1) THIS ROUTINE SHOULD BE SELECTED BY THE NAVIGATOR IN LUNAR ORBIT PRIOR TO SELECTION OF THE ORBITAL NAVIGATION PROGRAM (P22).

(2) THIS ROUTINE MAY BE SELECTED ONLY DURING THE CMC IDLING PROGRAM (P00).

++
+09 (3) THE SELECTED LANDMARKS ARE NOT NECESSARILY DISPLAYED IN CHRONOLOGICAL ORDER.
++
EDIT

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW ROUTINE .SELECTION			
	START LUNAR LMK SELECTION ROUTINE		KEY IN V79E			
	. . .					#10
	IS CURRENT PROGRAM P00?					
	.Y .N					
++ +09 ++ PCN 586	IS ANOTHER EXTENDED VERB ACTIVE?					#20
	N. .Y					

R35/COLOSSUS

```
                                                                    #30
TURN ON OPERATOR ..................... MONITOR DSKY: DOES
ERROR LIGHT                            OPERATOR ERROR LIGHT
                                       COME ON INDICATING
                                       THAT THIS ROUTINE
                                       CAN NOT BE SELECTED
                                       AT THIS TIME?
                                        .Y            .N
      EXIT                              IN ORDER TO
                                        USE THIS                    #40
                                        ROUTINE KEY
                                        IN V37E00E
                                        AND THEN KEY
                                        IN V79E
                                                                    #50
                                        EXIT
                                                                    #60
HOLD .   FLASH VERB-NOUN TO             MONITOR DSKY:
........ REQUEST RESPONSE AND ......... OBSERVE VERB NOUN
SNAP .   DISPLAY T-LAT-LONG             FLASH TO REQUEST
             V06N34                     RESPONSE AND DISPLAY
             R1 00XXX                   OF T-LAT-LONG:
             R2 000XX
             R3 0XXXX                   T-LAT-LONG=G.E.T.
         IN HOURS-MIN-SEC TO              THIS IS THE TIME
         THE NEAREST .01 SEC            WHICH THE
            NOTE: FIRST                 COMPUTER WILL DE-
            DISPLAY WILL BE             FINE AS THE START OF
            PRESENT G.E.T.              LMK TRACKING. IT        #70
                                        WILL DETERMINE THE
                                        NEXT TIME THE LAND-
                                        ING SITE WILL PASS
                                        UNDER THE SPACECRAFT
                                        AND IT WILL DETER-
                                        MINE 5 LANDMARKS
                                        WHICH WILL PASS
                                        UNDER THE SPACECRAFT
                                        AFTER T-LAT-LONG AND
                                        WHICH WILL BE ALONG     #80
                                        THE GROUND TRACK.
```

```
                                                  ------------------
                                                          .
                                                          .
                                                          .
                                                  ------------------
                                                  AM I SATISFIED WITH
                                                  THIS VALUE?
                                                  ------------------
                                                    .Y            .N
                                                    .             .
                                                    . ---------------
                                                    . KEY IN VERB 25E
                                                    . AND LOAD A NEW
                                                    . TIME.
                                                    . ---------------
                                                    .             .
                                                    .             .
                                                    .             .
                                                    .             ......
                                                    .
                                                    .
                                                  ---------------
                                                  KEY IN PROCEED
                                                  ---------------
------------------
WAIT FOR KEYBOARD
ENTRY
                                  .
                                .........
                                  .
------------------
TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA
                                  .
                                .........
                                  .
------------------
          .P    .NEW
          .R    .DATA
          .C    .
          .C -------
          .E STORE
          .E NEW
          .D DATA
           -------
             .
             .
             .........
------------------
CALCULATE THE NEXT
TIME AFTER T-LAT-
LONG AT WHICH THE
LANDING SITE, STORED
IN ERASABLE MEMORY,
WILL PASS UNDER THE
SPACECRAFT
------------------
```

#90

#100

#110

#120

#130

```
                 .
                 .
                 .
                 .
          -------------------                    -------------------
          FLASH VERB-NOUN TO                     MONITOR DSKY:
HOLD  .   REQUEST RESPONSE AND                .  OBSERVE VERB NOUN
......... DISPLAY TIME OF       ................ FLASH TO REQUEST
SNAP  .   LANDING SITE:                       .  RESPONSE AND DISPLAY                    #140
              V06N31                             THE NEXT TIME AFTER
              R1 00XXX                           T-LAT-LONG AT WHICH
              R2 000XX                           THE LANDING SITE
              R3 0XXXX                           WILL PASS UNDER THE
          IN HOURS-MIN-SEC TO                    SPACECRAFT.
          THE NEAREST .01 SEC                    -------------------
          -------------------                           .
                   .                                    .
                   .                                    .
                   .                                    .
          -------------------                    -------------------                        #150
          WAIT FOR KEYBOARD                      RECORD THIS TIME. DO
          ENTRY                                  I WISH TO CONTINUE
                                                 WITH THIS ROUTINE
                                                 TO OBTAIN LANDMARK
                                                 INFORMATION?
                                                 -------------------
                                                   .N            .Y
                                                   .             .
                                                   .             .
                                                   .             .                          #160
                                 .               ------          .
                               ................  KEY IN          .
                                 .               TERMI-          .
                                                 NATE,           .
                                                 V34E            .
                                                 ------          .
                                 .                 .         -------
                               ................    .         KEY IN
                                 .                 .         PROCEED
                                                   .         -------                        #170
                                                  ...
          TERMINATE FLASH UPON                     .
          RECEIPT OF PROCEED                     EXIT R35
          OR TERMINATE
          -------------------
            .P              .T
            .R              .E
            .O              .R
            .C              .M
            .E              .I                                                               #180
            .F              .N
            .D              .A
            .               .T
            .               .E
            .               .
            .              ...
            .               .
            .         EXIT R35
            .
            .
            .
            .
            .
```

```
        .
        .
        .
        .
        .
        .
        .
    -------------------
    BASED ON THE
    COMPUTED GROUND
    TRACK AND STORED
    LANDMARKS, SELECT
    THE NEXT 5 LANDMARKS
    THAT WILL PASS UNDER
    THE SPACECRAFT AFTER
    T-LAT-LONG.
    -------------------
              .
              .
              .
       ------------
       SELECT THE
       LANDMARK
       ASSOCIATED
       WITH THE +60
       DEGREE LONGI-
       TUDE LINE
       ------------
              .
              .
              .
.......       .
.     .       .
.     .       .
.    --------- .
.    HAVE ALL  .
.    5 LAND-   .
.    MARKS     .
.    BEEN DIS- .
.    PLAYED?   .
.    --------- .
.    .N     .Y .
.    .      .  .
.    .      .  .
.    .     ... .
.    .      .  .
.    .    EXIT .
.    .    R35  .
.    .         .
.    --------- .
.    SELECT    .
.    THE NEXT  .
.    LANDMARK  .
.    --------- .
.    .         .
.    .         .
.    .         .
.    .         .                    ......
.    .         .                    .    .
.    .         .                    .    .
.    .         .                    .    .
.    .         .                    .    .
.    .         .                    .    .
```

#190

#200

#210

#220

#230

#240

```
HOLD
SNAP
```

FLASH VERB NOUN
TO REQUEST RESPONSE
AND DISPLAY LAND-
MARK CODE:
V05N70
R1 BLANK
R2-000XX
R3-BLANK

R2 LMK ID NO

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
THE LANDMARK CODE. #250

NOTE: THE COMPUTER
WILL CALCULATE 5
LMKS SUITABLE FOR
NAVIGATION AND WILL
DISPLAY THEN
SEQUENTIALLY ON
COMMAND STARTING
WITH THE LANDMARK
ASSOCIATED WITH THE #260
+60 DEGREE LONGITUDE
LINE AND CONTINUING
THROUGH TO THE LAND-
MARK ASSOCIATED WITH
THE -60 DEGREE
LONGITUDE LINE.

#270

RECORD DATA. DO I
WISH DISPLAY OF THE
TIME AT WHICH THIS
LMK WILL PASS UNDER
THE SPACECRAFT? #280

N Y

KEY IN PROCEED

HAVE ALL 5 LANDMARKS #290
BEEN DISPLAYED?

N Y

```
                                   DO I WISH TO
                                   SEE THE LAND-
                                   MARK CODE FOR
                                   THE NEXT LAND-                    #300
                                   MARK ON MY
                                   GROUND TRACK?
                                   ---------------
                                     .Y          .N
                                                 -------
                                                 KEY IN
                                                 TERM-
                                                 INATE                #310
                                                 V34E
                                                 -------
                                                 ...
                                                 EXIT
                                                 R35
                                                                      #320
                                   --------------
                                   KEY IN RECYCLE
                                   V32E
                                   --------------
                                   ......

TERMINATE FLASH UPON
RECEIPT OF RECYCLE,
TERMINATE OR PROCEED
-------------------
.R        .P      .T
.E        .R      .F
.C        .C      .R
.Y        .C      .M
.C        .E      .I                                                  #330
.L        .E      .N
.E        .D      .A
                  .T
                  .F
                  ...
                  EXIT
                  R35                                                 #340
```

```
        .                 .
        .                 .
        .                 .
        .                 .
        .   -------------------                   .   -------------------
HOLD    .   FLASH VERB NOUN TO   ..................... MONITOR DSKY:
........    REQUEST RESPONSE AND                  .   OBSERVE VERB NOUN
SNAP    .   DISPLAY TIME OF                           FLASH TO REQUEST
        .   LANDMARK:                                 RESPONSE AND DISPLAY
        .      V06N34                                 TIME AT WHICH THE
        .      R1- 00XXX                              LANDMARK, JUST DIS-        #350
        .      R2- 000XX                              PLAYED, WILL PASS
        .      R3- 0XXXX                              UNDER THE SPACE-
        .   IN HOURS-MIN-SEC TO                       CRAFT.
        .   THE NEAREST .01 SEC                       -------------------
        .   -------------------                               .
        .             .                                       .
        .             .                                       .
        .             .                                       .
        .   -------------------                               .
        .   WAIT FOR KEYBOARD                         -------------------      #360
        .   ENTRY                                     HAVE ALL 5 LANDMARKS
        .                                             AND THEIR ASSOCIATED
        .                                             TIMES BEEN
        .                                             DISPLAYED?
        .                                             -------------------
        .                                               .N             .Y
        .                                               .              .
        .                                               .              .
        .                                             --------------   .
        .                                             DO I WISH TO     .       #370
        .                                             SEE THE NEXT     .
        .                                             LANDMARK?        .
        .                                             --------------   .
        .                                               .N       .Y    .
        .                                               .        .     .
        .                                               .        .     .
        .                          .                    .      -----------
        .                       ...................     .      KEY IN
        .                          .                    .      PROCEED
        .                                               .      -----------      #380
        .                                               .
        .                                               .
++      .   TERMINATE FLASH UPON   .                  -------------------
+09     .   RECEIPT OF PROCEED  ...................... KEY IN TERMINATE
++      .   OR TERMINATE           .                  V34E
PCR     .   -------------------                       -------------------
206     .             .P    .T                                .
EDIT    .             .R    .E                                .
        .             .O    .R                                .
        .             .C    .M                               ...              #390
        .             .E    .I                                .
        .             .E    .N                             EXIT
        .             .D    .A                             R35
        .             .     .T
        .             .     .E
        .             .     .
        .             .    ...
        .             .     .
        .             .     .
        .             .     .
        .             .     .
```

```
EXIT
R35
```

#400

CHANGE CONTROL NOTES

LOGIC REV 07 PCR MIT 66
LOGIC REV 08 PCR MIT 116
LOGIC REV 09 PCR 206 EDITORIAL
PCN 586

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RENDEZVOUS OUT OF PLANE DISPLAY ROUTINE (R36) LOGIC REV 06 11/27/68

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED RENDEZVOUS OUT OF PLANE PARAMETERS (Y,YDOT,PSI)

ASSUMPTIONS: (1) THESE PARAMETERS ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED LM AND CSM STATE VECTORS AND DO NOT REQUIRE THAT THE ISS BE ON.

(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

```
 PROG                CMC                GROUND              CREW                              CHECKLIST              TIME       TOTAL
 CONT                                                                                                                            TIME

                                                                .CREW
                                                                .ROUTINE
                                                                .SELECTION
                                                                .
                                                                .
          --------------------   .                  --------------
          START THE RENDEZVOUS ..................... KEY IN V90E
          OUT OF PLANE ROUTINE   .                  --------------                                                          #10
          --------------------
                    .
                    .
                    .
++        --------------------
+06       IS ANOTHER EXTENDED
+         VERB ACTIVE?
+         --------------------
+                 .N       Y.
+                 .         .                                                                                               #20
+                 .         .
+                 . -----------
+                 . TURN ON
+                 . OPERATOR
+06               . ERROR LIGHT
++                . -----------
 PCN              .   .
 586              .   .
                  .   .
                  .  ...                                                                                                    #30
                  .   .
                  . EXIT
                  .
                  .
     .........    .
     .       .    .
     .       .    .                                                                                   R36/COLOSSUS
     .       .    .                                                                                   R36/SUNDANCE
     .       .    .                                                                                   R36/LUMINARY
```

HOLD
SNAP
++
+06
++
PCR
206
EDIT

FLASH VERB NOUN TO
REQUEST RESPONSE AND
DISPLAY T(EVENT) IN
G.E.T.:
V06 N16
R1-T(EVENT)-HRS
R2-T(EVENT)-MINS
R3-T(EVENT)-SECS

T(EVENT): TIME
(G.E.T.) FOR WHICH
OUT OF PLANE PARA-
METERS ARE DESIRED
IN HRS, MINS, AND
SECS TO NEAREST .01
SECONDS.
A SPECIAL CASE IS
ALL ZEROES INDICA-
TING PRESENT TIME

MONITOR DSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TIME AT WHICH
OUT OF PLANE PARA-
METERS ARE DESIRED.

DO I WISH TO HAVE
THE CMC COMPUTE
PARAMETERS FOR THE
PRESENT TIME?

N Y

AM I SATISFIED
WITH THE DIS-
PLAYED TIME?

N Y

ARE ALL
THREE
REGISTERS
EQUAL TO
ZERO?

Y N

```
                                                                                R36/COLOSSUS
                                                                                R36/SUNDANCE
                                                                                R36/LUMINARY
 ++
 +06
 ++
 EDIT

 WAIT FOR KEYBOARD
 ENTRY:                                                                         #90

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA.

 NEW
 DATA
 STORE NEW
 DATA                                                                           #100

 IS T(EVENT) ZERO?                                                              #110

 N                Y

 EXTRAPOLATE CSM
 AND LM VECTORS
 TO THE PRESENT
 TIME USING
 PRECISION
 INTEGRATION                                                                    #120

 EXTRAPOLATE CSM
 AND LM STATE
 VECTORS TO THE
 TIME DEFINED BY
 T(EVENT) USING
 PRECISION
 INTEGRATION                                                                    #130

 KEY IN
 PROCEED

 KEY IN V25E AND LOAD
 NEW DATA.

                                                                                R36/COLOSSUS
                                                                                R36/SUNDANCE
                                                                                R36/LUMINARY
```

R36/COLOSSUS
R36/SUNDANCE
R36/LUMINARY

CALCULATE OUT-OF-PLANE PARAMETERS:
Y
Y DOT
PSI

#140

HOLD
SNAP

FLASH VERB NOUN TO REQUEST RESPONSE AND DISPLAY RENDEZVOUS OUT OF PLANE PARAMETERS:
V06 N90
R1 Y
R2 Y DOT
R3 PSI

Y-(NOTE: FOR DEFINITION OF PARAMETERS REFER TO SECTION 5.6.7.4 OF THIS DOCUMENT.) IN NAUTICAL MILES TO THE NEAREST .01 NM.

Y DOT-RATE OF CHANGE OF Y (+ IS INCREASING AND - IS DECREASING) IN FPS TO THE NEAREST .1 FPS.

PSI-ANGLE BETWEEN THE CSM ORBITAL PLANE AND THE LOS TO THE LM PROJECTED INTO THE HORIZONTAL PLANE. IN DEGREES TO THE NEAREST .01 DEGREES.

MONITOR DSKY:
OBSERVE VERB NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF RENDEZVOUS OUT OF PLANE PARAMETERS

#150

#160

DO I WISH TO RECEIVE ANOTHER DATA POINT FOR A DIFFERENT TIME?

.N .Y

#170

#180

R36/COLOSSUS
R36/SUNDANCE
R36/LUMINARY

```
                                                                          R36/COLOSSUS
                                                                          R36/SUNDANCE
                                                                          R36/LUMINARY
 ------------------
 WAIT FOR KEYBOARD                                                                #190
 ENTRY:                  ...............   ---------------
                                           KEY IN RECYCLE
                                             V32E
                                           ---------------

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED      ................. -------------------
 OR RECYCLE                                KEY IN PROCEED
 ------------------                        -------------------
    .R        .P                                                             #200
    .E        .R
    .C        .O
    .Y        .C
    .C        .E
    .L        .E
    .F        .D
    .         .
    .        ...
    .         .
    .       EXIT                                                             #210
    .       R36
 .........
```

CHANGE CONTROL NOTES

LOGIC REV 04 PCR MIT 66
LOGIC REV 05 PCR 436
REV 06 PCR 206 EDITORIAL
PCN 586

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SPS THRUST FAIL ROUTINE (R40) LOGIC REV 02 07/11/68

PURPOSE: (1) TO INDICATE TO THE ASTRONAUT THAT THE GNCS HAS DETECTED A THRUST FAILURE.

(2) TO PROVIDE THE ASTRONAUT A FLASHING DISPLAY TO WHICH HE CAN RESPOND AS DESCRIBED IN THE FLOW.

ASSUMPTION: (1) THE GNCS HAS DETECTED A THRUST FAILURE AND HAS SHUT OFF CROSS PRODUCT STEERING AND HAS STOPPED THE CALCULATIONS OF TIME FROM CUTOFF AND HAS STOPPED C.G. TRACKING.

(2) IF THE ASTRONAUT KEYS IN PROCEED ON THIS DISPLAY THRUST FAILURE DETECTION WILL BE INHIBITED FOR 2 SECONDS TO PREVENT A PREMATURE THRUST FAIL INDICATION.

(3) THIS ROUTINE IS SELECTED BY THE SPS THRUSTING PROGRAM (P40)

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
HOLD MON	FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF THRUSTING PARAMETERS V97N40 R1 59859 R2 VC R3 DELTA VM		MONITOR DSKY: OBSERVE VERB NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF THRUSTING PARAMETERS.			#10
					R40/COLOSSUS R40/LUMINARY	#20

```
                                        .                 .
                                        .                 .
                                        .                 .
                                        .                 .
                                        .                 .
                                        ------------------- .
                                        SHALL I TERMINATE   .
                                        THE ENGINE ON COMM- .
                                        AND AND RETURN TO   .
                                        THE V99 FLASH WHICH .
                                        WILL ALLOW ME TO    .
                                        EITHER REISSUE THE  .
                                        ENGINE ON COMMAND OR .
                                        CONTINUE ON TO THE  .
                                        DISPLAY OF VGX, VGY, .
                                        VGZ FOR RCS         .
                                        THRUSTING?          .
                                        ------------------- .
--------------------                    .Y              .N  .
WAIT FOR KEYBOARD                       .                .  .
ENTRY                                   .                .  .
                                        ------------     .  .
                                        KEY IN ENTER     .  .
                                        ------------     .  .
                                                         .  .
                                                         .  .
                                           ---------------- .
                                           HAS THRUST COME  .
                                           BACK ON?         .
                                           ---------------- .
                                             .Y          .N .
                                             .           . .
                                             .           . .
                                        -------------    . .
                                        KEY IN PROCEED   . .
                                        -------------    . .
                                                         . .
                                                         . .
                                        ------------------- .
                                        SHALL I TERMINATE   .
                                        THE ENGINE ON COM-  .
                                        MAND AND THE SPS    .
                                        THRUSTING PROGRAM   .
                                        (P40)?              .
                                        ------------------- .
                                        .Y              .N  .
                                        .               . .
                                        .               . .
                                                        .....
```

#30

#40

#50

#60

#70

```
                                                  .
                                                  .
                                                  .
                                                  .
                                                  .
                                                  .
TERMINATE FLASH UPON                              ---------------
RECEIPT OF PROCEED,                               KEY IN TERMINATE
ENTER OR TERMINATE                                   V34E
-------------------                               ---------------
 .P        .E      .T                                  .
 .R        .N      .E                                  .
 .O        .T      .R                                  .
 .C        .E      .M                                  .
 .E        .R      .I                                  .                    #80
 .E        .       .N                                  .
 .D        .       .A                                  .
 .         .       .T                                  .
 .         .       .E                                  .
 .         .       .                                   .
 .         .       .                                   .
++         .     -------                               .
+02        .     COMMAND                               .
+          .     ENGINE                                .
+          .     OFF                                   .                    #90
+02        .     -------                               .
++         .       .                                   .
 .         .       .                                   .
...        .       .                                   .
 .         .       .                                   .
GO TO      .     -------                           --------
"B"        .     DO                 .     .        DO
IN P40     .     ROUTINE          ...........        ROUTINE
           .     R00                .     .        R00
           .     -------                           --------
           .       .                                   .                    #100
           .       .                                   .
           .       .                                   .
           .      ...                                 ...
           .       .                                   .
           .     EXIT                                EXIT
           .    R40 AND                             R40 AND
           .      P40                                 P40
           .
           .
  -------------                                                             #110
  TERMINATE THE
  ENGINE ON
  COMMAND
  -------------
       .
       .
       .
++ -------------
+02 WAIT ABOUT
++ 2.5 SEC                                                                  #120
  -------------
       .
       .
       .
       .
       .
       .
       .
```

```
     .
     .
     .
     .
     .
----------
TURN OFF
TVC DAP
----------
     .
     .
     .
----------
SET NARROW
DEADBAND
IN RCS DAP
----------
     .
     .
     .
-----------------
DRIVE SPS ENGINE
BELL TO TRIM PO-
SITION.
NOTE: THE TRIM
POSITION IS THAT
LAST DEFINED BY
THE C.C. TRACKING
COMPUTATION.
-----------------
     .
     .
     .
----------
TURN ON RCS
DAP IN .6
SEC
----------
     .
     .
     .
    ...
     .
   GO TO
    "A"
  IN P40
```

#130

#140

#150

#160

CHANGE CONTROL NOTES

REV 01 PCR MIT 98
REV 02 PCR 206

STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41) LOGIC REV 02 11/29/68

PURPOSE: (1) TO INTEGRATE THE STATE VECTOR OF THIS VEHICLE TO THE TIME AT WHICH THE AVERAGE G ROUTINE WILL BE TURNED ON BY THE CALLING PROGRAM.

(2) TO DEFINE A NEW TIG FOR PROGRAMS 40 OR 41 IN THE EVENT THE STATE VECTOR CAN NOT BE INTEGRATED TO THE TIME DEFINED BY PROGRAMS 40 OR 41 AND TO LIGHT THE ALARM LIGHT TO INFORM THE CREW THAT TIG HAS BEEN SLIPPED.

ASSUMPTIONS: (1) THERE IS A SIGNIFICANT AMOUNT OF TIME REQUIRED BY THE CMC TO TURN ON THE AVERAGE G ROUTINE. THIS TIME IS VARIABLE ACCORDING TO THE FOLLOWING CONSIDERATIONS REGARDING THE CSM STATE VECTOR:
1.4 SECONDS PER TIME STEP IN EARTH ORBIT
2.5 SECONDS PER TIME STEP IN LUNAR ORBIT
WHERE TIME STEP IS EQUAL TO:
240 SECONDS IN EARTH ORBIT
350 SECONDS IN LUNAR ORBIT

(2) THE ROUTINE IS ONLY AUTOMATICALLY SELECTED.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	CMC ROUTINE SELECTION					
	READ PRESENT TIME, TP					#10
	IS THE TIG FLAG SET?					
	IS TDEC-10 SEC GREATER THAN OR EQUAL TO TP?					#20
				R41/COLOSSUS R41/LUMINARY		

```
        .  .       .        .                                                  R41/COLOSSUS
        .  .       .        .                                                  R41/LUMINARY
        .  .       .        .
        .  .       .        .
        .  . -------------  .                    .    --------------------
        .  . TURN ON PRO-   .     ................    MONITOR OSKY PROGRAM                    #30
        .  . GRAM ALARM     .                    .    ALARM LIGHT DURING
        .  . LIGHT AND      .                         THE PERIOD FROM TIG
        .  . STORE ALARM    .                         -40 SECONDS TO
        .  . CODE 1703      .                         BLANKING AT TIG-35:
        .  . -------------  .                         IF LIGHT COMES ON
        .  .       .        .                         DURING THIS TIME IT
        .  .       .        .                         INDICATES THAT TIG
        .  .       .        .                         WILL BE SLIPPED AS
        .  . ----------     .                         REQUIRED TO GET THE
        .  . SET TIG        .                         STATE VECTOR INTEG-     #40
        .  . FLAG           .                         RATED TO A NEW TIG
        .  . ----------     .                         -30 SECONDS.
        .  .       .        .                            IF THIS ALARM
        .  .       .        .                         CONDITION OCCURS THE
        .  .       .        .                         TFI DISPLAY WILL
        .  . -----------------                       CONTINUE TO COUNT
        .  . SET TDEC=TP PLUS                        BASED ON THE ORIGIN-
        .  . 10 SECONDS                              AL TIG UNTIL INTE-
        .  . -----------------                       GRATION IS COMPLETE
        .  .     .                                   AND A NEW TIG IS        #50
        .  .     .                                   ESTABLISHED. THE
        .  .     .                                   DISPLAY WILL NOT
++      . --------------                             BLANK HOWEVER UNTIL
+03     . IS INTEGRATION                             THE NEW TIG HAS BEEN
+       . FINISHED?                                  ESTABLISHED AND TFI
+       . --------------                             IS REVISED.
+       .  .N      .Y                                --------------------
+       .  .       .                                        .
+       .  .       .                                        .
+       .  .       ................                         .      #60
+       .  .                      .                         .
+       .  .                      .                         .
+       . --------------------    .                         .
+       . INTEGRATE THIS          .                         .
+       . VEHICLES STATE          .                         .
+       . VECTOR ONE TIME STEP    .                         .
+       . OR TO TDEC IF LESS      .                         .
+       . THAN ONE TIME STEP      .                         .
+       . USING PRECISION         .                         .
+       . INTEGRATION.            .                         .      #70
+       . --------------------    .                         .
+       .          .              .                         .
+       .          .              .                         .
+       .          .              .                         .
+       .    -----------          .                         .
+       .    IS THE TIG           .                         .
+       .    FLAG SET?            .                         .
+       .    -----------          .                         .
+       .      .N     .Y          .                         .      #80
+       .      .      .           .                         .
+       .      .      .           .                         .
+       ........      .           .                         .
+       .             .           .                        ...
+       .             .           .                         .
+       .             .           .                         .
+       .             .           .                         .
+       .             .           .                         .
+ 552   .             .           .                         .
```

```
+ 553
+
+
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+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+
+03
++
PCN
650
```

```
IS INTEGRATION
FINISHED?
N
Y
EXIT
```

#90

```
WAS TIG SLIPPED?
N
Y
SET TIG=TPFC
PLUS 30 SECONDS
EXIT
EXIT
```

#100

#110

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PURPOSE: (1) TO POINT THE STAR LOS OF THE OPTICS AT A STAR OR LANDMARK DEFINED BY THE PROGRAM OR BY DSKY INPUT (ASTRONAUT).
PCR
206 (2) TO POINT THE STAR LOS OF THE OPTICS AT THE LM DURING RENDEZVOUS TRACKING OPERATIONS.

++
+09 (3) TO DO THE TRACKING ATTITUDE ROUTINE (R61) APPROXIMATELY EVERY 2 SECONDS DURING RENDEZVOUS TRACKING OPERATIONS.
++
EDIT

ASSUMPTIONS- (1) THE ROUTINE IS AUTOMATICALLY SELECTED DURING IMU REALIGN PROGRAM (P52) BY THE RENDEZVOUS NAVIGATION PROGRAM (P20), BY THE ORBITAL NAVIGATION PROGRAM (P22), OR BY THE CISLUNAR NAVIGATION PROGRAM (P23).

(2) THIS ROUTINE IS SELF PERPETUATING AND IS TERMINATED BY THE SIGHTING MARK ROUTINE (R53) FOR STAR OR LMK AND BY RESETTING THE TRACK FLAG FOR LM.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC ROUTINE .SELECTION					
	---------- START AUTO OPTICS POSITIONING ROUTINE (R 52) ----------					#10
++ +09 ++ EDIT	. . . .					
	---------- SET TRUNNION DRIVE FLAG ----------					#20
	. . . . . .				R52/COLOSSUS	

```
                 .
                 .
                 .
                 .
                 .
                 .
                 .
      -------------------
      SELECT DESIRED IMU
      INERTIAL ORIENTATION
      FROM STORAGE (PRO-
      VIDED BY CALLING
      PROGRAM).
      -------------------
                 .
                 .
                 .
      -------------------
      CALCULATE REQUIRED
      FINAL GIMBAL ANGLES
      TO GIVE DESIRED IMU
      INERTIAL ORIENTATION
      -------------------
                .
                .
                .
      -------------------
      IS ANY REQUIRED
++    GIMBAL ANGLE CHANGE
+03   GREATER THAN 1
++    DEGREE?
      -------------------
                 .Y     .N
                 .      .
                 .      .
                 .     ...
                 .      .
                 .    EXIT
                 .
                 .
      -------------------
      SWITCH ISS TO COARSE
      ALIGN MODE. TERMINATE
      ATTITUDE HOLD OF
      VEHICLE
      -------------------
                 .
                 .
                 .
      -------------------
      COARSE ALIGN THE IMU
      -------------------
                 .
                 .
                 .
                 .
                 .
                 .
                 .
                 .
                 .
                 .
                 .
                 .
```

```
                .
                .
                .
                .
                .
                .
      -------------------
      TERMINATE COARSE
      ALIGN MODE IN ISS.
      RESUME ATTITUDE
      HOLD OF VEHICLE
      -------------------
                .
                .
                .
               ...
                .
          EXIT R50
```

R50/COLOSSUS
R50/SUNDANCE
R50/LUMINARY

#90

#100

CHANGE CONTROL NOTES

LOGIC REV 03 PCR 464

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AUTOMATIC OPTICS POSITIONING ROUTINE (R52) LOGIC REV 09 11/27/68

PURPOSE: (1) TO POINT THE STAR LOS OF THE OPTICS AT A STAR OR LANDMARK DEFINED BY THE PROGRAM OR BY DSKY INPUT (ASTRONAUT).
PCR
206 (2) TO POINT THE STAR LOS OF THE OPTICS AT THE LM DURING RENDEZVOUS TRACKING OPERATIONS.

++
+09 (3) TO DO THE TRACKING ATTITUDE ROUTINE (R61) APPROXIMATELY EVERY 2 SECONDS DURING RENDEZVOUS TRACKING OPERATIONS.
++
EDIT
ASSUMPTIONS- (1) THE ROUTINE IS AUTOMATICALLY SELECTED DURING IMU REALIGN PROGRAM (P52) BY THE RENDEZVOUS NAVIGATION PROGRAM (P20), BY THE ORBITAL NAVIGATION PROGRAM (P22), OR BY THE CISLUNAR NAVIGATION PROGRAM (P23).

(2) THIS ROUTINE IS SELF PERPETUATING AND IS TERMINATED BY THE SIGHTING MARK ROUTINE (R53) FOR STAR OR LMK AND BY RESETTING THE TRACK FLAG FOR LM.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC ROUTINE .SELECTION					
	START AUTO OPTICS POSITIONING ROUTINE (R 52)					#10
++ +09 ++ EDIT	.					
	SET TRUNNION DRIVE FLAG					#20
	.				R52/COLOSSUS	

```
          .
          .
          .
          .
--------------------
IS THE LM TARGET
FLAG SET ?
--------------------
          .YES    .NO
          .(LM)   .
          .       .
          .       .
          .    ------
          .    RESET
          .    TERM-
          .    INATE
          .    FLAG
          .    ------
          .       .
          .       .
          .       .
          .      ...
          .       .
          .     GO TO
          .      "B"
          .     BELOW
          .
          .
          .
          .
          .
          .
          .
          .
          .
          .
          .   "A"
          .SEE BELOW
          .    .
          .    .
          .   ...
          .    .
--------------------
IS THE TRACK FLAG
SET?
     (SEE P20)
--------------------
          .YES    .NO
          .       .
          .      ...
          .       .
          .     EXIT
          .     R52
          .
          .
          .
          .
          .
          .
          .
          .
          .
          .
          .
```

```
--------------------
THE LOGIC FROM THIS
POINT TO "B" BELOW
IS FOR THE LM TARGET
CASE ONLY.
--------------------
```

#30

#40

#50

#60

#70

```
                     .
                     .
                     .
                     .
                     .
                     .
         ------------------
         IS THE PREFERRED
         ATTITUDE FLAG SET?
         ------------------
          .NO        .YES
          .          .
          .          .
          .          .
          .        ---------
          .        IS UPDATE
          .        FLAG SET?
          .        ---------
          .         .N    .Y
          .         .     .
          .         .     .
         -------------    .
         WAIT ABOUT 1.3   .
         SECONDS          .
         -------------    .
          .               .
          .               .
          .               .
       ....               .
       .                  .
       .                  .
       .                  .
       . ------------------
       . EXTRAPOLATE CSM AND
       . LM STATE VECTORS TO
++     . THE PRESENT TIME
+09    . +1.3 SECONDS USING
++     . CONIC EQUATIONS
EDIT   . ------------------
       .          .
       .          .
       .          .
       . ------------------
       . READ PRESENT VEHICLE
       . ATTITUDE FROM THE
       . ICDU'S
       . ------------------
       .          .
       .          .
       .          .
       . ------------------
       . COMPUTE TARGET VEC-
       . TOR FROM CSM TO LM
       . ------------------
       .          .
       .          .
       .          .
       .          .
       .          .
       .          .
       .          .
       .          .
       .          .
```

```
          .                 .
          .                 .
          .                 .
          .                 .
          .                 .
          . -------------------
          . CALCULATE THE REQUI-
          . RED OPTICS ANGLES                                          #130
          . TO POINT THE STAR
++        . LINE OF SIGHT AT
+09       . THE LM.
++        . -------------------
EDIT      .                 .
          .                 .
          .                 .
          . -------------------
          . IS A TRUNNION ANGLE
          . GREATER THAN 50 DEG.                                       #140
          . REQUIRED TO POINT
          . THE STAR LINE OF
          . SIGHT AT THE
          . LM    ?
          . -------------------
          .    .N           .YES
          .    .            .
          .    .            .
          . --------    ---------
          . SET THE     RESET THE                                      #150
          . TRUNNION    TRUNNION
          . DRIVE       DRIVE
          . FLAG.       FLAG
          . --------    ---------
          .    .            .
          .    .            .
          .    .            .
          .    . ---------------                   --------------------
          .    . TURN ON PROGRAM                .  MONITOR PROGRAM
          .    . ALARM LIGHT AND ................... ALARM LIGHT: IF THE  #160
          .    . STORE ALARM                    .  PROGRAM ALARM LIGHT
          .    . CODE 407                          COMES ON AT THIS
          .    . ---------------                   TIME THE ASTRONAUT
          .    .            .                      SHOULD VERIFY ALARM
          .    .            .                      (BY KEYING IN
          .    .            .                      V05N09E) AND EITHER
          . -------------------                    MANUALLY MANEUVER
          . CHECK OPTICS MODE                      THE VEHICLE BACK TO
          . DISCRETE. IS THE                       THE PREFERRED TRACK-
          . OSS IN THE                             ING ATTITUDE         #170
          . CMC MODE?                              (DESIRED GIMBAL
          . -------------------                    ANGLES MAY BE DIS-
          .           .Y      .NO                  PLAYED BY KEYING IN
          .           .       .                    V16N22E AND DESIRED
          .           .       .                    OPTICS BY KEYING IN
          . ---------------   .                    V16N92E) OR ALLOW
          . IS THE TRUNNION   .                    THE GNCS TO AUTOMA-
          . DRIVE FLAG SET?   .                    TICALLY MANEUVER BY
          . ---------------   .                    SWITCHING TO CMC
          .    .Y        .N   .                    AUTO CONTROL AND/OR  #180
          .    .         .    .                    BY KEYING IN V58E.
          .    .         .    .                    --------------------
          .    .         .    .
          .    .         .    .
          .    .         .    .
          .    .         .    .
```

```
 .    .        .    .
 .    .        .    .
 .    .        .    .
 .    .        .    .
 .    .        .    .
 .    .        .    .
 . -------- -----    .
 . DRIVE    DRIVE    .
 . SHAFT    SHAFT    .
 . AND      CDU      .
 . TRUNNION ONLY     .
 . CDU'S             .
 . -------- -----    .
 .    .        .    .
 .    .        .    .
 .... .        .    .
    . .        .    .
    . .        .    .
   -------------------
   DO THE TRACKING
   ATTITUDE ROUTINE
   R61.
   -------------------
             .
             .
             .
             .
             .
             .
             .
        ---------------
        WAIT 0.5 SEC
        ---------------
             .
             .
             .
            ...
             .
          GO TO
           "A"
          ABOVE
```

#190

#200

#210

#220

#230

```
"B" FROM
ABOVE
 .
 .
 .
 .
 .
 .
 .
 .
 .
```

"B"
FROM ABOVE

THE LOGIC FROM THIS POINT TO THE END OF THE ROUTINE IS FOR THE LMK, ADVANCED GROUND TRACK, OR STAR TARGETS ONLY

IS TERMINATE FLAG SET?

.Y .N

EXIT R52

CHECK OPTICS MODE DISCRETE. IS THE OSS IN THE CMC MODE?

.Y .N

THE AUTOMATIC OPTICS POSITIONING IS NOW RUNNING. TO MARK ON THE TARGET, SWITCH THE OPTICS MODE SWITCH TO MAN-UAL. THIS WILL CALL THE SIGHTING MARK ROUTINE R53. IF R53 IS TERMINATED THIS ROUTINE WILL ALSO TERMINATE. IF THE ASTRONAUT SWITCHES BACK TO CMC MODE PRIOR TO TERMINATION OF R53 V51 WILL REMAIN FLASHING AND THE ASTRONAUT MAY CONTINUE WITH R53 BUT THE OPTICS WILL BE POINTED AT THE TARGET AUTOMATICALLY

```
                 .              .      .
                 .              .      .
                 .              .      .
                 .              .      .
                 .              .      .
                 .              .      .
                 .--------------       .
                 .CALL SIGHTING        .
                 .MARK ROUTINE         .                                  #290
                 .(R53) IF NOT         .
                 .ALREADY CALLED       .
                 .--------------       .
                 .              .      .
                 .              .      .
                 .              .      .
++               .   -----------       .
+09              .   WAIT .5 SEC       .
++               .   -----------       .
EDIT             .              .      .                                  #300
                 .              .      .
                 .              .      .
                 .              .......
                 .                     .
                 .                     .
            --------------------       .
            GET PRESENT IMU            .
            ORIENTATION FROM           .
            STORAGE (REFSMMAT)         .
            --------------------       .                                  #310
                       .               .
                       .               .
                       .               .
            --------------------       .
            READ PRESENT VEHI-         .
            CLE ATTITUDE FROM          .
            ICDUS                      .
            --------------------       .
                       .               .
                       .               .                                  #320
                       .               .
            --------------------       .
            IS THE TARGET FLAG         .
            STAR OR LANDMARK           .
            --------------------       .
            .(STAR)        .(LMK)      .
            .              .           .
            .              .           .
++          -------------  .           .
+09         GET STAR DATA  .           .                                  #330
++          FROM CMC       .           .
EDIT        STORAGE        .           .
            -------------  .           .
            .              .           .
            .              .           .
            .              
```

```
++
+09
+
+
+09
++
PCN
594

++
+09
++
EDIT
++
+09
++
PCN
594
```

```
IS LANDMARK
CODE GREATER
THAN 32?
NO    YES
```

#340

```
COMPUTE TARGET
VECTOR TO A
POINT ON THE
SURFACE OF THE
MOON 60 DEG FOR-
WARD OF PRESENT
LOCATION AND ON
THE GROUND TRACK
OF THE DESIRED
ORBIT (DESIRED
ORBIT IS DEFINED
AS THAT NUMBER
OF ORBITS AHEAD
OF THE PRESENT
ORBIT INDICATED
BY THE LEAST
SIGNIFICANT DI-
GIT IN THE LAND-
MARK CODE)
```

#350

#360

#370

```
GET LMK
COORDINATES
FROM CMC
STORAGE
```

#380

```
COMPUTE
TARGET
VECTOR
FROM CSM
TO DES-
IGNATED
LAND-
MARK.
```

#390

#400

```
COMPUTE TAR-
GET VECTOR
FROM CSM TO
DESIGNATED
STAR.
```

#410

```
CALCULATE THE RE-
QUIRED OPTICS ANGLES
TO POINT THE STAR
LOS OF THE OPTICS
ALONG THE TARGET
VECTOR.
```

#420

```
IS A TRUNNION ANGLE
REQUIRED TO POINT
THE STAR LOS OF THE
OPTICS AT THE TARGET
GREATER THAN 90 DEG?
```

#430

N Y

```
          .   .                .
          .   .                .
          .   .                .
          .   .                .
POSS      .   .                .
PRIO      .   ---------------- .             -------------------
HOLD .    .   FLASH VERB-NOUN  .             MONITOR DSKY:
........  .   TO REQUEST RESP- .                DOES ALARM CODE
SNAP .    .   ONSE AND DISPLAY .           . DISPLAY INDICATE
          .   ALARM CODE:      ............. THAT THE TARGET IS
          .      V05N09        .           . NOT WITHIN THE
          .      R1-           .             HEMISPHERE OF
          .      R2-           .             OPTICS VISIBILITY?
          .      R3-           .             -------------------
          .   EXPECTED ALARM   .               .Y              N.
          .   ALARM CODE AT    .               .                .
          .   THIS TIME IS 404 .               .                .
          .   ---------------- .             -----------------  .
          .          .         .             FOR STAR/LANDMARK  .
          .          .         .             SIGHTINGS THERE    .
          .          .         .             ARE TWO OPTIONS:   .
          .          .         .                                .
++        .   ---------------- .               (A) MANUALLY MA- .
+09       .   WAIT 2 SECONDS   .               NEUVER VEHICLE   .
++        .   ---------------- .               UNTIL OPTICS CAN .
EDIT      .          .         .               ACQUIRE THE DES- .
PCR       .          .         .               IRED TARGET.     .
206       .          .         .                                .
          .          .         .               (B) TERMINATION  .
          .          .         .                   OF THE PRO-  .
          .          .         .                   GRAM AND     .
          .          .         .                   ROUTINE.     .
          .          .         .             -----------------  .
          .          .         .                .A           B. .
          .          .         .                .            .  .
          .          .         .                .            .  .
          .          .         .                .            .  .
          .          .         .             ------------    .  .
          .          .         .             MANUALLY        .  .
          .          .         .             MANEUVER VEH-   .  .
          .          .         .             ICLE UNTIL IT   .  .
          .          .         .             IS ESTIMATED    .  .
          .          .         .             THAT OPTICS     .  .
          .          .         .             CAN ACQUIRE     .  .
          .          .         .             THE TARGET.     .  .
          .          .         .             MONITOR FDAI    .  .
          .          .         .             TO AVOID        .  .
          .          .         .             GIMBAL LOCK.    .  .
          .          .         .             ------------    .  .
          .          .         .                .            .  .
          .          .         .                .            .  .
          .   ---------------- .             ------------    .  .
          .   WAIT FOR KEY-    .             KEY IN          .  .
          .   BOARD ENTRY.     ............. PROCEED         .  .
          .                    .             ------------    .  .
          .                    .                             .  .
          .                    .                             .  .
          .                    .                             .  .
          .                    .                             .  .
          .                    .                             .  .
          .                    .                             .  .
          .                    .                             .  .
```

```
                                                                    #500
  TERMINATE FLASH                          ------------
  UPON RECEIPT OF  ......................  KEY IN TERMIN-
  PROCEED, OR                              ATE.
  TERMINATE.                                  V34E
  ----------------                         ------------
  .T            .P                               .
  .E            .R                               .
  .M            .O                               .
  .I            .C                               .
  .N            .E                               .
  .A            .E                               .
  .T            .D                               .
  .E            .                                .
++        ----------                           .
+09       WAIT .5 SEC                          .                    #510
++        ----------                           .
EDIT                                           .
                .                              .
                .                              .
                .                              .
                ......                         .
                                               .
                                               .
                                               .
                                               .
  ----------                                   .
  DO ROUTINE                               ------------             #520
     R00   ......................          DO ROUTINE
  ----------                                  R00
                                           ------------
      .                                        .
      .                                        .
      .                                        .
     ...                                      ...
      .                                        .
   EXIT R52                                 EXIT R52
   AND CALLING                              AND CALLING.             #530
   PROGRAM                                  PROGRAM
                                                                    #540
--------------------
IS THE TRUNNION
ANGLE REQUIRED TO
POINT THE STAR LOS
OF THE OPTICS AT THE
TARGET GREATER THAN
50 DEGREES?
--------------------
 .N             .Y
```

```
SET TRUNNION
DRIVE FLAG

RESET TRUNNION
DRIVE FLAG.

TURN ON PROGRAM          MONITOR PROGRAM
ALARM LIGHT AND          ALARM LIGHT: IF THE
STORE ALARM CODE         PROGRAM ALARM LIGHT
407                      COMES ON AT THIS
                         TIME THE ASTRONAUT
                         SHOULD VERIFY THE
                         ALARM BY KEYING
                         IN V05N09E AND
                         THEN REVIEW THE
                         OPTICS ANGLES IF
                         THEY ARE BEING
                         DISPLAYED (THEY WILL
                         BE UNLESS R53 HAS
                         BEEN PREVIOUSLY
                         SELECTED). IF THEY
                         ARE NOT BEING
                         DISPLAYED KEY IN
++                       V16N92E. IF TRUNNION
+09                      (R2) IS GREATER THAN
++                       49.775 THE ASTRONAUT
EDIT                     SHOULD MANUALLY
                         MANEUVER THE
                         VEHICLE.

IS THE SIGHTING
MARK FLAG SET?
 Y        N
```

```
++
POSS
MON
+09
++
EDIT
PCR
206

DISPLAY CN DSKY:
   V06N92
   R1-SHAFT
   R2-TRUNNION
   R3-BLANK

SHAFT-DESIRED
SHAFT ANGLE. IN
DEGREES TO NEAR-
EST .01 DEGREE.

TRUNNION-DESIRED
TRUNNION ANGLE.
IN DEGREES TO
NEAREST .001
DEGREE.

MONITOR DSKY:
  OBSERVE DISPLAY
OF DESIRED OPTICS
ANGLES. NOTE: THIS
DISPLAY WILL NOT
APPEAR IF R53 HAS
ALREADY BEEN CALLED
BY SWITCHING OPTICS
MODE SWITCH TO
MANUAL.

CHECK OPTICS MODE
DISCRETE. IS THE
OSS IN CMC MODE?
   .Y          .N

IS TRUNNION
DRIVE FLAG SET?
   .Y      .N

DRIVE   DRIVE
SHAFT   SHAFT
AND     CDU
TRUN-   ONLY
NION
CDUS

WAIT 0.5 SEC
```

#600

#610

#620

#630

#640

CHANGE CONTROL NOTES

```
LOGIC REV 07   PCR # MIT 54
LOGIC REV 08   PCN  503
LOGIC REV 09   PCR 206 EDITORIAL
          09   PCN 594
```

115

SIGHTING MARK ROUTINE (R53) LEGIC REV 00 12/26/68

PURPOSE: (1) TO PERFORM A SATISFACTORY NUMBER OF OPTICAL SIGHTING MARKS FOR THE REQUESTING PROGRAM (OR ROUTINE).

ASSUMPTIONS: (1) SIGHTINGS ARE MADE WITH EITHER SCT OR SXT AS REQUIRED.

(2) SIGHTINGS MAY BE MADE ON A STAR OR LANDMARK.

(3) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORES 5 ANGLES (3 ICDUS AND 2 RCDUS) AND THE TIME OF THE MARK.

(4) MAXIMUM UNREJECTED-MARK THRESHOLDS ARE ESTABLISHED UTILIZING A MARK COUNTER. THIS MARK COUNTER WILL INCREMENT EACH TIME A MARK IS MADE AND DECREMENT EACH TIME A MARK REJECT IS MADE. THE MARK COUNTER WILL BE COMPARED AGAINST A MARK INDEX. THE MAGNITUDE OF THIS INDEX WILL BE SELECTED BY THE PROGRAM (OR ROUTINES) SELECTING THE SIGHTING MARK AS FOLLOWS:

(A) STAR - 1

(B) LANDMARK - 5

THE ROUTINE REQUIRES THAT AT LEAST ONE MARK BE TAKEN FOR NORMAL TERMINATION. IF FOR SOME REASON (TARGET NOT VISIBLE, INDISTINGUISHABLE, ETC), THE ASTRONAUT GETS INTO THIS ROUTINE AND ELECTS NOT TO MARK HE SHOULD EITHER KEY IN V34E WHICH WILL CALL R00 OR CALL A NEW PROGRAM BY KEYING IN V37EXXE.

(5) THE ROTATION OR MINIMUM IMPULSE CONTROLLER MAY BE USED AS REQUIRED TO REDUCE THE S/C DRIFT RATE.

(6) THE ROUTINE IS SELECTED IN THE AUTO OPTICS POSITIONING ROUTINE (R52) BY CREW SELECTION OF MANUAL OPTICS MODE.

(7) THE ROUTINE MAY ALSO BE ENTERED DIRECTLY FROM R51 OR R23.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC ROUTINE .SELECTION					
	START SIGHTING MARK ROUTINE (R 53)					
	. . . .					#10

```
                 .
                 .
                 .
                 .
                 .
                 .
        -------------------
        SET SIGHTING
        MARK FLAG
        -------------------
                 .
                 .
                 .
        -------------------                                          #20
        ZERO MARK COUNTER
        -------------------
                 .
                 .
                 .
            "A"  .                          "A"
             .   .                           .
             .   .                           .
             .   .                           .
            ...  .                          ...                      #30
             .   .                           .
          -----------------              -------------------
HOLD .       FLASH VERB-          .       MONITOR DSKY:
........     TO REQUEST PLEASE     .......OBSERVE FLASHING
SNAP .       MARK:                 .       VERB TO REQUEST
               V51 N BLANK                 PLEASE MARK
               R1-BLANK                  -------------------
               R2-BLANK                          .
               R3-BLANK                          .
          -----------------                      .                  #40
                 .                           -------------------
                 .                           SELECT MANUAL OPTICS
                 .                           MODE
                 .                           -------------------
                 .                                   .
        -------------------              -------------------
        WAIT FOR KEYBOARD        .       WHEN SIGHTING IS
        ENTRY                    .......SATISFACTORILY
                                 .       ACCOMPLISHED PRESS
                                         MARK BUTTON                #50
                                         -------------------
                                                 .
                                                 .
                                                 .
                                         -------------------
                                         WAS THE SIGHTING
                                         SATISFACTORY?
                                         -------------------
                                         Y.          .N
                                          .          .                #60
                                          .          .
                                          . -----------
                                          .  PRESS MARK
                                         .  REJECT
                                         .  BUTTON
                                          . -----------
                                          .          .
                                          .          .
                                          .          .
```

```
                                                                    #70
                                  GO TO
                                   "A"
                                  ABOVE

                        -------------------
                        IS THE TARGET A
                        CELESTIAL BODY?
                        -------------------
                                                                    #80
                        Y           N

                                  ---------------
                                  DO I WISH TO
                                  MAKE MORE
                                  MARKS?
                                  ---------------
                                  N           Y
                                                                    #90
                                                 ...
                                                 ..
                                               GO TO
                                                 "A"
                                               ABOVE

                        -----------
                        KEY IN
                        PROCEED
                        -----------
                                                                    #100
TERMINATE FLASH OF
V51 UPON RECEIPT
OF MARK, MARK
REJECT, OR PROCEED
-----------------
MARK
REJECT
                  M
                  A
                  R
                  K
                                                                    #110
-----------------
IS MARK FLAG
SET?
-----------------
        N       Y
                                                                    #120
                                                                    253/COLOSSUS
```

```
                    GO TO
                     "A"
                    ABOVE

  ----------------
  ERASE LAST SET
  OF MARK DATA AND
  DECREMENT MARK
  COUNTER BY ONE.
  ----------------
          .
          .
          .
  ----------------
  RESET MARK FLAG
  ----------------
          .
          .
          .
         ...
          .
                    GO TO
                     "A"
                    ABOVE

                 .....
                 .
                 .
  ----------------
      SET MARK
      FLAG
  ----------------
          .
          .
          .
  ------------------
  STORE FIVE ANGLES
  AND TIME AND
  INCREMENT MARK
  COUNTER BY ONE.
  ------------------
          .
          .
          .
  ------------------
  IS MARK COUNTER
  STILL LESS THAN
  MARK INDEX?
  ------------------
    .Y            .N
    .             .
    .             .
   ...            .
    .             .
    .             .
    .             .
    .             .
```

```
                    GO TO
                     "A"
                    ABOVE

  ----------------
  ERASE LAST SET
  OF MARK DATA AND
  DECREMENT MARK
  COUNTER BY ONE.
  ----------------
                                                        #130
          .
          .
          .
  ----------------
  RESET MARK FLAG
  ----------------
          .
          .
          .
         ...
          .
                                                        #140
                    GO TO
                     "A"
                    ABOVE

                 .....
                 .
                 .
  ----------------
                                                        #150
      SET MARK
      FLAG
  ----------------
          .
          .
          .
  ------------------
  STORE FIVE ANGLES
  AND TIME AND
  INCREMENT MARK
  COUNTER BY ONE.
  ------------------
                                                        #160
          .
          .
          .
  ------------------
  IS MARK COUNTER
  STILL LESS THAN
  MARK INDEX?
  ------------------
                                                        #170
    .Y            .N
    .             .
    .             .
   ...            .
    .             .
    .             .
    .             .
    .             .
```

```
                                                                                  #180
GO TO
 "A"
ABOVE

                                                                                  #190
HOLD..  ----------------  ----------------------
        FLASH VERB NOUN TO  MONITOR DSKY:
        REQUEST PLEASE      OBSERVE FLASHING
        PERFORM TERMINATE ..... VERB-NOUN TO REQUEST
SNAP..  MARK SEQUENCE:      PLEASE PERFORM
         V50 N25            TERMINATE MARK
         R1-00016           SEQUENCE
         R2-BLANK           ----------------------
         R3-BLANK
        ----------------
                                                                                  #200
        ----------------  ----------------------
        WAIT FOR KEYBOARD   WAS LAST MARK
        ENTRY.              SATISFACTORY?
                            ----------------------
                             .Y            .N
                                                                                  #210
                            --------
                            KEY IN
                            PROCEED
                            --------
                                          ------------
                                          PRESS MARK
                                          REJECT
                                          BUTTON
                                          ------------
                                                                                  #220
                                              GO TO
                                               "A"
                                              ABOVE

                                                                                  #230
```

```
                                                                    #240
      TERMINATE FLASH
      UPON RECEIPT OF
      ENTER, OR MARK
      REJECT
      ------------------
            .MK .P
            .REJ.P
            .   .C
            .   .C
            .   .F -------
            .   .E IS MARK
            .   .D COUNTER
            .   .  = 02
            .   .  -------
            .   .   .Y  .N
            .   .   .   .
            .   .   .   .
            .   .   ...  .
            .   .   .    .
            .   . GO TO  .                                          #250
            .   .  "A"   .
            .   . ABOVE  .
            .   .        .
            .   .        .
      --------------------
      RESET MARK FLAG
      --------------------
                .
                .
                .                                                   #260
      --------------------
      IS THE CALLING
      PROGRAM P22 OR P23?
      --------------------
       .N             .Y
       .              .
       .              .
       .        ------------
       .        SET TERMI-
       .        NATE FLAG                                          #270
       .        (FOR USE
       .        BY P52).
       .        ------------
       .              .
       .              .
++     --------------  .
+09    SET TERMINATE   .
+      FLAG (FOR USE   .
+09    BY P52)         .
++     ---------------  .                                          #280
PCN    .              .
E69    .              .
       .              .
       .             ...
       .              .
```

EXIT 253

#290

HOLD .
SNAP .

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF CELESTIAL BODY CODE
V01 N71
R1-00XXX
R2-BLANK
R3-BLANK

R1-CELESTIAL BODY CODE-THE DESIGNATION OF THE CELESTIAL BODY WHICH WAS MARKED (IN OCTAL).

00 - PLANET (ANY PLANET)
01/45 - STAR (FROM CELESTIAL BODY CODE LIST)
46 - SUN
47 - EARTH
50 - MOON

WAIT FOR KEYBOARD ENTRY

MONITOR DSKY:
OBSERVE FLASHING VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF CELESTIAL BODY CODE.

#300

AM I SATISFIED WITH THIS CODE?

Y N

#310

KEY IN
PROCEED

KEY IN V21E AND LOAD CELESTIAL BODY CODE:

#320

#330

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

PROCEED

NEW DATA

STORE NEW DATA

IS CELESTIAL BODY CODE 00?

N

IS THE CELESTIAL BODY CODE 46, 47 OR 50?

N

OBTAIN STAR VECTOR FROM STORED EPHEMERIS

Y

Y

CELESTIAL BODY CODE - CELESTIAL BODY DESIGNATION FROM CARRY ON DATA.

IS THE TARGET A STAR OR THE EARTH MOON OR SUN?

N

Y

EXIT

CALCULATE CEL-
ESTIAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE STAR
CODE.

#390

POSS
HOLD
SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
PLANET POSI-
TION VECTOR:
VOEXPR
R1-X PL
R2-Y PL
R3-Z PL

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

#400

++
+09
++
EDIT

X PL - THE X
COMPONENT OF 1/2
UNIT POSITION
VECTOR OF THE
PLANET AT GET.
IN REFERENCE
COORDINATES.
TO THE FIFTH
PLACE
(.XXXXX).

Y PL - SAME AS
RECEIPT OF
PROCEED OR NEW
X PL FOR Y
COMPONENT.

Z PL - SAME AS
Y PL FOR Z
COMPONENT.

#410

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

Y

N

#420

#430

```
 . .       .          .                 .               . .
 . .       .          .                 .               . .
 . .       .          .                 .               . .
 . .       .          .                 .               . .
 . .       .          .                 .               . .
 . . -------------    .   .         -------            . .
 . . WAIT FOR KEY-    . ..........  KEY IN            . .
 . . BOARD ENTRY      .   .         PROCEED            . .
 . .                  .             -------            . .
 . .                  .                                . .
 . .                  .                                . .
 . . TERMINATE        .   .            -------------   .
 . . FLASH UPON       . ...........    KEY IN V25E AND .
 . . RECEIPT OF       .   .            LOAD CORRECT    .
 . . PROCEED OR NEW   .                POSITION VECTOR .
 . . DATA.            .                COMPONENTS      .
 . . -------------    .                ---------------.
 . .  .P      .NEW    .                          .     .
 . .  .R      .DATA   .                          .     .
 . .  .O      .       .                          .     .
 . .  .C      .       .                          .     .
 . .  .E  ---------   .                          .......
 . .  .E  STORE NEW   .
 . .  .D  DATA        .
 . .  .   ---------   .
 . .  .          .    .
 . .  .          .    .
 . .  .          .    .
 . .  .          .....
 . .  .
 . .  .
-------------------
RESET SIGHTING MARK
FLAG.
-------------------
          .
          .
          .
++        .
+09       .
++        .
PCN       .
669       .
          .
          .
          .
         ...
          .
        EXIT
        R53
```

#440

#450

#460

#470

CHANGE CONTROL NOTES

REV 06	PCR MIT 66	00597000
	PCR MIT 67	00598000
REV 07	PCR 206	00599000
	PCR 448	00600000
REV 08	PCR 206 EDITORIAL	00601001
REV 09	PCN 669, EDITORIAL	00600002

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SIGHTING DATA DISPLAY ROUTINE (R54) LOGIC REV 07 11/27/68

PURPOSE: (1) TO TEST THE ACCURACY OF A PAIR OF CELESTIAL BODY SIGHTINGS.

ASSUMPTIONS: (1) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU ORIENTATION DETERMINATION PROGRAM (P51), BY THE IMU REALIGN PROGRAM (P52), BY THE BACK-UP IMU ORIENTATION DETERMINATION PROGRAM (P53), OR BY THE BACK-UP IMU REALIGN PROGRAM (P54).

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	START SIGHTING DATA DISPLAY ROUTINE (R54).					
	.					#10
	CALCULATE ANGLE BETWEEN TWO CELESTIAL BODIES USING STORED EPHEMERIS DATA (ACTUAL)					
	.					#20
	CALCULATE ANGLE BETWEEN TWO CELESTIAL BODIES USING CELESTIAL BODY VECTORS DERIVED FROM MARK ANGLES (INDICATED)					
	.					#30
	.			R54/COLOSSUS R54/SUNDANCE		

```
                 .
                 .
                 .
                 .
                 .
                 .
++               .
+07      -------------------                  -------------------
HOLD  .  FLASH VERB-NOUN TO                .  MONITOR DSKY:
......... REQUEST RESPONSE AND ................ OBSERVE FLASHING
SNAP  .  DISPLAY SIGHTING AN-              .  VERB-NOUN AND DIS-
+07      GLE DIFF:                            PLAY OF SIGHTING
++         V06 N05                            ANGLE DIFF                #40
 PCR       R1-SIGHTING ANGLE                  -------------------
 206          DIFF                                   .
 EDIT      R2-BLANK                                   .
           R3-BLANK                                   .
                                                      .
         SIGHTING ANGLE DIFF-                         .
         ERENCE IN DEGREES TO                         .
         THE NEAREST .01                              .
         DEGREES.                                     .
         -------------------                          .                #50
                 .                                    .
                 .                                    .
                 .                                    .
                 .                                    .
                 .                            -------------------
                 .                            DOES THE SIGHTING
                 .                            ANGLE DIFFERENCE
                 .                            EXCEED THE ACCEPT-
                 .                            ABLE TOLERANCE?
                 .                            -------------------
                 .                             .N              .Y      #60
                 .                             .               .
                 .                             .               .
                 .                             . ----------------
                 .                             . SHALL I PROCEED
                 .                             . WITH BAD DATA?
                 .                             . ----------------
                 .                             .  .Y           .N
                 .                             .  .            .
                 .                             .  .            .
         -------------------                   -------          .      #70
         WAIT FOR KEYBOARD      .              KEY IN           .
         ENTRY                 ................ PROCEED          .
                                .              -------          .
                                                  .             .
                                                  .             .
                                                 ...            .
                                                  .             .
                                                EXIT "A"        .
                                                FROM R54        .
                                                CONTINUE        .      #80
                                                AS DEFINED      .
                                                IN CALLING      .
                                                PROGRAM/        .
                                                ROUTINE         .
                                                                .
                                                                .
                                                                .
                                                                .
                                                                .
                                                                .
                                                                .
                                                                .
```

```
                                                                                R54/COLOSSUS
                                                                                R54/SUNDANCE
                                                                                R54/LUMINARY
TERMINATE FLASH UPON                  ------------------                                #90
RECEIPT OF PROCEED   ................ KEY IN RECYCLE
OR RECYCLE                            V32E
-------------------                   ------------------
  .P            .R                          .
  .R            .E                          .
  .O            .C                         ...
  .C            .Y                          .
  .E            .C                       EXIT "B"
  .F            .L                       FROM R54
  .D            .F                       CONTINUE AS                                  #100
  .             .                        DEFINED IN THE
  .             .                        CALLING PRO-
  .             .                        GRAM/ROUTINE
 ...           ...
  .             .
EXIT "A"      EXIT "B"
FROM R54      FROM R54
CONTINUE AS   CONTINUE AS
DEFINED IN    DEFINED IN THE
CALLING PRO-  CALLING PRO-                                                            #110
GRAM/ROUTINE  GRAM/ROUTINE
```

CHANGE CONTROL NOTES

REV 07 EDITORIAL

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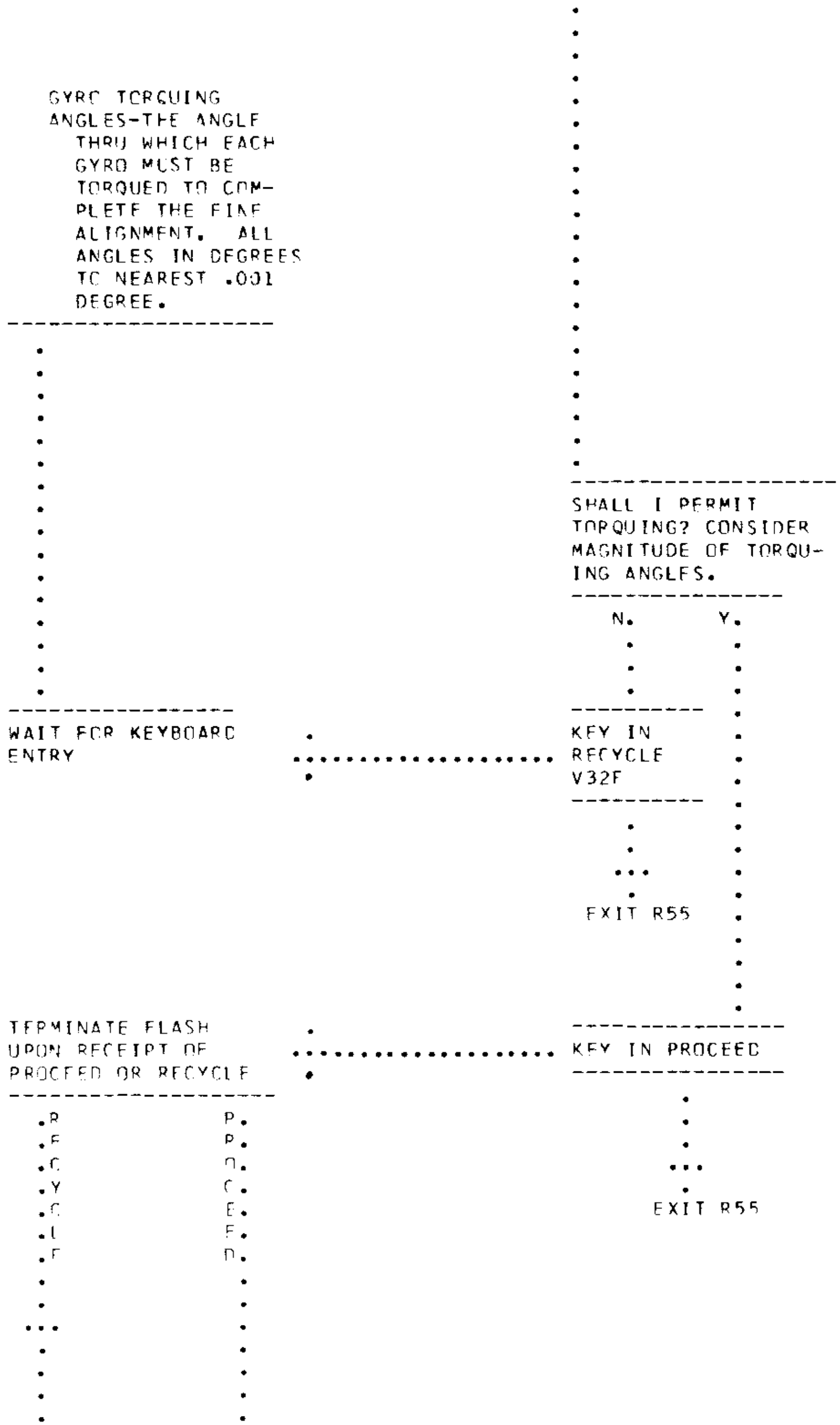
GYRO TORQUING ROUTINE (R55) LOGIC REV 03 04/10/68

PURPOSE: (1) TO CALCULATE GYRO TORQUING ANGLES FOR FINAL (FINE) ALIGNMENT OF THE INERTIAL PLATFORM DURING AN INFLIGHT ALIGNMENT, TO DISPLAY THESE ANGLES AND TO TORQUE THE GYROS.

ASSUMPTIONS: (1) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (P52), OR BY THE BACKUP IMU REALIGN PROGRAM (P54).

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	START GYRO TORQUING ROUTINE (R55)					
	. . .					#10
	CALCULATE REQUIRED TORQUING ANGLES FOR EACH GYRO					
	. . .					#20
HOLD . ..... SNAP .	FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY V06 N93 R1-X GYRO R2-Y GYRO R3-Z GYRO	.....	MONITOR DSKY: OBSERVE VERB-NOUN FLASH AND DISPLAY OF GYRO TORQUING ANGLES		R55/COLOSSUS R55/SUNDANCE R55/LUMINARY	


GYRO TORQUING ANGLES-THE ANGLE THRU WHICH EACH GYRO MUST BE TORQUED TO COMPLETE THE FINE ALIGNMENT. ALL ANGLES IN DEGREES TO NEAREST .001 DEGREE.
SHALL I PERMIT TORQUING? CONSIDER MAGNITUDE OF TORQUING ANGLES.
N.
Y.
WAIT FOR KEYBOARD ENTRY
KEY IN RECYCLE V32F
EXIT R55
TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE
KEY IN PROCEED
EXIT R55
RECYCLE
PROCEED

589

```
.                 .
.                 .
.                 .
.                 .
.                 .
.                 .
.                 .
EXIT R55          .
                  .
                  .
                  .
-------------------
PULSE IRIGS THROUGH
DESIRED ANGLES
-------------------
          .
          .
          .
          .
          .
          .
         ...
          .
        EXIT R55
```

R55/COLOSSUS
R55/SUNDANCE
R55/LUMINARY

#90

#100

CHANGE CONTROL NOTES

LOGIC REV 03 PCR MIT 66

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ALTERNATE LOS SIGHTING MARK ROUTINE (P56) LOGIC REV 10 12/22/69

PURPOSE: (1) TO PERFORM SIGHTING MARKS FOR THE BACK-UP ALIGNMENT PROGRAMS (P53, P54).

ASSUMPTIONS: (1) THE ASTRONAUT KNOWS THE COORDINATES (OPTICS) OF THE ALTERNATE LINE OF SIGHT HE MUST USE FOR THIS ROUTINE.

(2) WHEN THE ASTRONAUT KEYS IN ENTR IN RESPONSE TO FLASHING V53 THE CMC STORES THE THREE IMU ANGLES AND TWO ANGLES DISPLAYED IN N94.

(3) THE RHC IS USED TO POSITION THE SPACECRAFT SO THAT THE ALTERNATE LOS POINTS TOWARD THE CHOSEN STAR.

(4) THIS ROUTINE IS AUTOMATICALLY CALLED BY P53 AND P54.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE					
						#10
HOLD SNAP	FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY ALTERNATE LOS COORDINATES V06 N94 01 SHAFT 02 TRUNNION 23 BLANK SHAFT-OPTICS SHAFT ANGLE IN DEGREES TO NEAREST .01 DEGREES TRUNNION-OPTICS TRUNNION ANGLE IN DEGREES TO NEAREST .001 DEGREES		MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY NEW IMU ANGLES. NOTE: THE VALUE OF THESE REGISTERS SHOULD CORRESPOND TO THE CHOSEN ALTERNATE LOS. (THE NOMINAL ANGLES TO BE USED FOR COAS SIGHTINGS ARE: 01-00033 02-57470			#20 #30
				P56/COLOSSUS		

```
                                                                  ARE THE DISPLAYED
                                                                  ANGLES CORRECT FOR
                                                                  THE CHOSEN LOS?
          --------------------                                    --------------------
          WAIT FOR KEYBOARD                                         .Y            .N      #40
          ENTRY:                                                    .             .
                                                                    .             .
                                                                    .        -----------
          TERMINATE FLASH                .                          .        KEY IN V24E
          UPON RECEIPT OF NEW  ..........................           .        AND LOAD
          DATA OR PROCEED                .                          .        ANGLES.
                                                                    .        -----------
                                                                    .             .
                                                                    .             ......
                                                                    .                      #50
                                                                    .
                                                                  ------
                                         .                        KEY IN
                                   ......................         PROCEED
                                         .                        ------
          --------------------
            .NEW        .PROCEED
            .DATA       .
          --------      .
          STORE         .                                                                  #60
          NEW DATA      .
          --------      .
            .           .
            .           .
            .           .
          ......        .
                        .
                        .
                        .
          ......        .                                                                  #70
            .           .
            .           .
          --------------------                                    --------------------
HOLD  ..  FLASH VERB                                .             MONITOR DSKY:
........  TO REQUEST PLEASE    ......................              OBSERVE VERB
SNAP  ..  PERFORM ALTERNATE                         .             FLASH TO REQUEST
          LOS SIGHTING                                            PLEASE PERFORM ALTE-
          MARK:                                                   RNATE LOS SIGHTING
             V53N-BLANK                                           MARK:
             R1-BLANK                                             --------------------                                    #80
             R2-BLANK                                                   .
             R3-BLANK                                                   .
          --------------------                                    --------------------
                                                                  USING THE ROTATIONAL
                                                                  HAND CONTROLLER PO-
                                                                  SITION THE SPACE-
                                                                  CRAFT SO THAT THE
                                                                  NAVIGATION STAR IS
                                                                  PRECISELY ALONG THE
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```
                                                   LOS CHOSEN.                                  #90
                                                   --------------------
                                                           .
                                                           .
                                                           .
 --------------------   .                          --------------
 WAIT FOR KEYBOARD     ..................... KEY IN ENTER
 ENTRY                  .                         ---------------

 TERMINATE FLASH UPON
 RECEIPT OF ENTER                                                                               #100
 --------------------
            .E
            .N
            .T
            .E
            .R
            .
            .
 --------------------
 STORE THREE ICDU
 ANGLES AND THE TWO                                                                             #110
 OPTICS ANGLES OF
 NOUN 94
 --------------------
            .
            .
            .
 --------------------                             --------------------
HOLD  ..  FLASH VERB NOUN                      .   MONITOR DSKY:
........  TO REQUEST PLEASE     ..................     OBSERVE VERB NOUN                        #120
SNAP  ..  PERFORM TERMINATION                  .   FLASH TO REQUEST
          OF THIS ROUTINE                          PLEASE PERFORM TERM-
             V50 N25                               INATION OF THIS
             R1 00016                              ROUTINE.
             R2 BLANK                              --------------------
             R3 BLANK                                      .
 --------------------                                      .
            .                                      --------------------
            .                                      WAS THE SIGHTING
            .                                      SATISFACTORY?                                #130
            .                                      --------------------
            .                                        .Y            .N
            .                                        .             .
            .                                        .             .
 --------------------   .                           .   --------------
 WAIT FOR KEYBOARD     ........................     .   KEY IN ENTER
 ENTRY                  .                           .   ---------------
                                                    .
                                                    .                                           #140
                                                    .
                                                    .
                                                    .
                                                    .
                                                    .
                                                    .
```

TERMINATE FLASH UPON RECEIPT OF ENTER OR PROCEED

KEY IN PROCEED

ENTER

PROCEED

ERASE MARK DATA

HOLD

SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF CELESTIAL BODY CODE
V01 N71
R1-CELESTIAL BODY CODE
R2-BLANK
R3-BLANK

R1-CELESTIAL BODY CODE-THE DESIGNATION OF THE CELESTIAL BODY WHICH WAS MARKED (IN OCTAL).

00 - PLANET (ANY PLANET)
01/45 - STAR (FROM CELESTIAL BODY CODE LIST)
46 - SUN
47 - EARTH
50 - MOON

MONITOR DSKY:
OBSERVE FLASHING VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF CELESTIAL BODY CODE.

AM I SATISFIED WITH THIS CODE?

Y

N

```
                                                                  #200
WAIT FOR KEYBOARD                  KEY IN
ENTRY                              PROCEED

                                   KEY IN V21E AND
                                   LOAD STAR CODE:

                                   CELESTIAL BODY
TERMINATE FLASH UPON               CODE - CELESTIAL
RECEIPT OF PROCEED                 BODY DESIGNATION                #210
OR NEW DATA.                       FROM CARRY ON
                                   DATA.

  .P          .NEW
  .R          .DATA
  .O
  .C
  .E
  .E
  .D
                                                                  #220
            STORE
            NEW
            DATA

                                                                  #230
IS CELESTIAL BODY                  IS THE TARGET A STAR
CODE 002                           OR THE EARTH MOON OR
                                   SUN?

  .N          .Y                     .N          .Y
IS CELESTIAL                                                      #240
BODY CODE 46,                                     EXIT
47 OR 50?

  .N          .Y
```

OBTAIN STAR VECTOR FROM STORED EPHEMERIS

CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE STAR CODE.

POSS HOLD

SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR:

V06N88
R1-X PL
R2-Y PL
R3-Z PL

++
+10
++
EDIT

X PL - THE X COMPONENT OF 1/2 UNIT POSITION VECTOR OF THE PLANET AT GET, IN REFERENCE COORDINATES, TO THE FIFTH PLACE (.XXXXX).

Y PL - SAME AS X PL FOR Y COMPONENT.

Z PL - SAME AS X PL FOR Z COMPONENT.

MONITOR DSKY:
OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF PLANET POSITION VECTOR.

ARE THE POSITION VECTOR COMPONENTS CORRECT?

Y

N

```
WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

P
R
O
C
E
E
D

NEW
DATA

LOAD DATA

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

EXIT
R56
```

#310

#320

#330

CHANGE CONTROL NOTES

REV 07 RCR MIT 66
REV 03 RCR 487
REV 02 RCR 206 EDITORIAL

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OPTICS CALIBRATION ROUTINE (R57) LOGIC REV 09 04/12/68

PURPOSE: (1) TO MEASURE THE EFFECT OF SOLAR RADIATION ON THE SXT TRUNNION ANGLE.

(2) TO STORE THE MEASURED TRUNNION BIAS FOR USE BY THE CISLUNAR NAVIGATION PROGRAM (P23).

ASSUMPTIONS: (1) TRUNNION BIAS IS MEASURABLE ONLY IN SPACE (VACUUM) .

(2) TRUNNION BIAS IS A FUNCTION OF THE ANGLE BETWEEN THE LANDMARK LINE OF SIGHT AND THE SUN AND IS CONSTANT OUTSIDE THE CONE FROM PLUS OR MINUS 15 DEGREES FROM THE LANDMARK LINE OF SIGHT.

(3) AFTER THE FIRST TIME THIS ROUTINE IS PERFORMED DURING A MISSION IT SHOULD NOT BE NECESSARY TO REPEAT IT IF THE SUN ANGLE WAS OUTSIDE THE CONE OF ASSUMPTION 2 AND WILL BE OUTSIDE THE CONE DURING THE NAVIGATION MARKS TO BE TAKEN DURING P23. IF THE SUN ANGLE IS WITHIN THIS CONE THIS ROUTINE SHOULD BE REPEATED EACH TIME THROUGH P23.

(4) THE OPTICS SHOULD "SOAK" IN AN ATTITUDE WITHIN THE REGION THAT WILL BE USED FOR P23 FOR AT LEAST A HALF HOUR PRIOR TO CALIBRATION AND MARKING ON THE NAVIGATION TARGETS OF P23.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	START OPTICS CALI-BRATION ROUTINE (R57)					#10
				R57/COLOSSUS		

```
                                                                          #20
HOLD  FLASH VERB TO RE-      ..... MONITOR DSKY:
.....QUEST PLEASE PERFORM          OBSERVE VERB 59
SNAP  CALIBRATION MARK             FLASH TO REQUEST
         V59N-BLANK                PLEASE PERFORM
         R1-BLANK                  CALIBRATION MARK
         R2-BLANK
         R3-BLANK
                                                                          #30
WAIT FOR KEYBOARD                  HAVE I PREVIOUSLY
ENTRY                              CALIBRATED THE
                                   OPTICS?
                                     .Y              .N
                                                                          #40
                                   WILL THE OPTICS
                                   BE USED IN THE
                                   SAME REGION THAT
                                   I CALIBRATED
                                   THEM FOR PRE-
                                   VIOUSLY? (REFER

                                   TO ASSUMPTIONS
                                   3 AND 4)
                                                                          #50
                                     .Y          .N
                                   KEY IN ENTER
                                                                          #60
TERMINATE FLASH UPON         ..... PERFORM OPTICS CALI-
RECEIPT OF MARK OR                 BRATION PER CHECK-
ENTER                              LIST AND MARK
      .MARK     .ENTER
```

```
                                                                                  #70
 ----------- EXIT
 STORE TRUN-
 NION OCDU
 ANGLE
 -----------

 -------------------                  -------------------
 FLASH VERB-NOUN TO                   MONITOR DSKY:
 REQUEST RESPONSE AND ................  OBSERVE VERB-NOUN                        #80
 DISPLAY TRUNNION                     FLASH TO REQUEST
SNAP BIAS ANGLE.                      RESPONSE AND DISPLAY
HOLD   V06 N87                        OF TRUNNION BIAS
       R1-BLANK                       ANGLE
       R2-XXXXX                       -------------------
       R3-BLANK

 R2-ANGLE IN DEGREES
 TO NEAREST .001 DEG
 -------------------                                                              #90

 -------------------                  -------------------
 WAIT FOR KEYBOARD                    DO I WISH TO INCORP-
 ENTRY                                ORATE THE CALIBRA-
                                      TION OR RECALIBRATE?
++                                    NOTE: THE SCALING OF
+09                                   THIS NOUN IS SUCH
+                                     THAT A SMALL NEGA-                           #100
+                                     TIVE ANGLE WILL
+                                     APPEAR AS A POSI-
+                                     TIVE ANGLE APPROA-
+                                     CHING 90.000.
+                                     THE ACTUAL ANGLE
+                                     WOULD THEN BE EQUAL
+                                     THAT 90.000 MINUS
+09                                   THE DISPLAYED VALUE.
++                                    -------------------
                                       .I     .R                                   #110
                                       .N     .E
                                       .C     .C
                                       .O     .A
                                       .R     .L
                                       .P     .
                                       .      .
                                       .      .
                                       .      .
                                      --------.
                                      KEY IN  .                                   #120
                                 ..... PROCEED .
                                      --------.
                                         .    .
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                                         .    .
                                         .    .
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                                                  .    .          .
                                               EXIT    .          .
                                                       .          .
                                                       .          .
                                                     -------      .
                                 .                   KEY IN       .
                            ........................ RECYCLE      .
                                 .                      V32F      .
                                                     -------      .
                                                       .          .
                                                       .          .
                                                       .          .
  TERMINATE FLASH UPON                                 ............
  RECEIPT OF PROCEED
  OR RECYCLE.
  --------------------
   .RECYCLE  .PROCEED
   .         .
   .         .
  ----------.
  ERASE MARK .
  DATA       .
  ----------.
   .         .
   .         .
   .         .
 .....       .
             .
             .
             .
  ---------------
  STORE CALIBRA-
  TION ANGLE
  ---------------
         .
         .
         .
        ...
         .
       EXIT
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#130

#140

#150

#160

CHANGE CONTROL NOTES

ATTITUDE MANEUVER ROUTINE (R60) LOGIC REV 11 11/27/68

PURPOSE: (1) TO MANEUVER THE LM/CSM OR CSM ALONE TO AN ATTITUDE SPECIFIED BY THE PROGRAM IN PROGRESS.

ASSUMPTIONS: (1) THE FINAL ATTITUDE DESIRED, DEFINED AS FOLLOWS, HAS BEEN STORED BY THE CALLING PROGRAM:
(A) A SPECIFIC BODY FIXED VECTOR AND A DIRECTION IN SPACE TO WHICH THIS VECTOR IS TO BE ALIGNED (THE 3-AXIS FLAG IS RESET).

(B) A THREE AXIS (ORTHOGONAL) INERTIAL ORIENTATION TO WHICH THE THREE BODY AXIS ARE TO BE ALIGNED (THE THREE AXIS FLAG IS SET).

(2) THE MANEUVER MAY BE PERFORMED AUTOMATICALLY BY THE GNCS OR PERFORMED MANUALLY WITH AN OPTIONAL FINAL AUTOMATIC GNCS CONTROLLED TRIM MANEUVER. THIS OPTIONAL TRIM MANEUVER SHOULD BE CONSIDERED ESSENTIAL FOR MANEUVERS TO SPS THRUSTING ATTITUDES.

(3) THE DAP DATA LOAD ROUTINE (R03) HAS BEEN PERFORMED PRIOR TO THIS ROUTINE.

(4) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE PROGRAM OR ROUTINE REQUIRING THE ATTITUDE MANEUVER.

(5) IF THIS ROUTINE WAS SELECTED BY THE TRACKING ATTITUDE ROUTINE (R61) THE V50N18 AND THE V06N18 IN THIS ROUTINE ARE PRIORITY DISPLAYS. THE V50N18 DISPLAY WILL REMAIN UP A MINIMUM OF 2 SECONDS. RESPONSE AFTER 2 SECONDS WILL CAUSE THE PROGRAM TO CONTINUE AS DISCRIBED

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	START ATTITUDE MANEUVER ROUTINE (R60)					#10
	. . .					
	OBTAIN DESIRED ATTITUDE SPECIFICATION FROM THE CALLING PROGRAM					#20
	.			R60/COLOSSUS R60/LUMINARY		

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                 .
                 .
                 .
                 .
                 .
                 .
        ----------------
        IS THE PRIORITY
        DISPLAY IN R22
        USING THE DSKY?
        ----------------
                 .N     .Y                                          #30
                 .      .
                 .      .
                 . ------
                 . WAIT
                 . UNTIL
                 . IT IS
                 . REMOV-
                 . ED.
                 . ------
                 .      .                                          #40
                 .      .
                 .      .
      --------------------
      IS THE 3 AXIS FLAG
      SET?
      --------------------
           .N            .Y
           .             .
           .             .
      ----------------   .                                         #50
      CALCULATE FINAL    .
      VEHICLE ATTITUDE   .
      TO MEET THE        .
      DESIRED ATTITUDE   .
      SPECIFICATION      .
      (VECPOINT ROU-     .
      TINE). THIS FINAL  .
      VEHICLE ATTITUDE   .
      WILL BE CALCU-     .
      LATED TO MEET THE  .                                         #60
      ATTITUDE SPECIFI-  .
      CATION IN SUCH A   .
      WAY AS TO CON-     .
++    SERVE RCS FUEL     .
+11   AND NOT CONSTRAIN  .
++    ANY UNSPECI-       .
EDIT  FIED DEGREE OF     .
PCR   FREEDOM.           .
206   --------------------
           .                                                       #70
           .
           .
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                 .
                 . --------------
                 . SELECT GIMBAL
                 . ANGLES CORRES-
                 . PONDING TO
                 . PREFERRED
                 . VEHICLE ATTI-
                 . TUDE AND PRES-
                 . ENT IMU ORIEN-                                          #80
                 . TATION
                 . --------------
                 .       .                          .............
                 .       .                          .           .
                 .       .                          .           .
        ......   .       .                          .           .
        .    .   .       .                          .           .
        .    .   .       .                          .           .
        .   -------------------                    -------------------.
HOLD.   .   FLASH VERB-NOUN TO            .         MONITOR DSKY:      .                                          #90
.......     REQUEST PLEASE          .........       OBSERVE VERB-NOUN   .
SNAP.   .   PERFORM AUTO                  .         FLASH TO REQUEST    .
        .   MANEUVER:                               PLEASE PERFORM AUTO .
        .      V50 N18                              MANEUVER AND DISPLAY .
        .      R1-CG ROLL                           OF DESIRED GIMBAL   .
        .      R2-IG PITCH                          ANGLES.             .
        .      R3-MG YAW                            -------------------.
        .                                                   .           .
        .   OG - FINAL DESIRED                              .           .
        .   OUTER GIMBAL ANGLE                              .           .                                          #100
        .   IN DEGREES TO                                   .           .
        .   NEAREST .01 DEGREES.                            .           .
        .                                                   .           .
        .   IG - FINAL DESIRED                              .           .
        .   INNER GIMBAL ANGLE                              .           .
        .   IN DEGREES TO                                   .           .
        .   NEAREST .01 DEGREES                             .           .
        .                                                   .           .
        .                                                   .           .
        .   MG - FINAL DESIRED                              -------------------.                                  #110
        .   MIDDLE GIMBAL ANGLE                             REVIEW THE PRESENTLY .
        .   IN DEGREES TO                                   DISPLAYED GIMBAL    .
        .   NEAREST .01 DEGREES.                            ANGLES AND THE      .
        .   -------------------                             PRESENT ATTITUDE. AM .
        .             .                                     I WITHIN THE PRESENT .
        .             .                                     RCS DAP DEADBAND    .
        .             .                                     LIMITS IN EACH AXIS? .
        .   -------------------                             -------------------.
        .   WAIT FOR KEYBOARD                                .N          .Y      .
        .   ENTRY                                            .           .       .                                  #120
        .                                                    .       -----------.
        .                                                    .       DO I WISH   .
        .                                                    .       TO FURTHER  .
        .                                                    .       ADJUST THE  .
        .                                                    .       VEHICLE     .
        .                                                    .       ATTITUDE    .
        .                                                    .       ABOUT THE   .
        .                                                    .                   .
        .                                                    .                   .
```

#130

DESIRED VECTOR? (NOT POSSIBLE FOR ALL CASES. SEE ASSUMPTION 1)

N Y

#140

KEY IN ENTER

...

EXIT

#150

TERMINATE FLASH UPON RECEIPT OF ENTER OR PROCEED

P R O C E E D

F N T F R

RESET 3-AXIS FLAG.

...

EXIT

#160

SHALL I HAVE THE GNCS PERFORM THE MANEUVER AUTOMATICALLY?

Y N

#170

SELECT CMC CONTROL AND SELECT THE AUTO MODE.

IS THE 3 AXIS FLAG SET?

N Y

#180

SHALL I HAVE THE GNCS RECOMPUTE THE DESIRED ATTITUDE WITHOUT PERFORMING THE AUTOMATIC MANEUVER? (NOT POSSIBLE FOR ALL CASES. SEE ASSUMPTION 1)

#190

.Y .N

#200

EITHER SELECT SCS CONTROL OR PLACE MODE SWITCH NOT IN AUTO.

KEY IN PROCEED

#210

CALCULATE FINAL VEHICLE ATTITUDE TO MEET THE DESIRED ATTITUDE SPECIFICATION (VECPOINT ROUTINE). THIS FINAL VEHICLE ATTITUDE WILL BE CALCULATED TO MEET THE ATTITUDE SPECIFICATION IN SUCH A WAY AS TO CONSERVE RCS FUEL AND NOT CONSTRAIN ANY UNSPECIFIED DEGREE OF FREEDOM.
NOTE: GNCS CAPABILITY TO PERFORM MANEUVER AUTOMATICALLY WILL BE COMPROMISED IF THE ATTITUDE IS CHANGED BY MANUAL INPUTS AFTER THIS TIME

#220

SELECT GIMBAL ANGLES CORRESPONDING TO PREFERRED VEHICLE ATTITUDE AND PRESENT IMU ORIENTATION

PERFORM ATTITUDE MANEUVER MANUALLY USING RHC AND BY REFERENCE TO THE OUT THE WINDOW VIEW AND/OR THE FDAI BALL AND ATTITUDE ERROR NEEDLES.

#230

#240

#250

DID I DIRECT THE CMC TO PERFORM THE MANEUVER AUTOMATICALLY?

.Y .N

#260

IS S/C CONTROL CMC?

.N .Y

IS THE AUTO MODE SELECTED?

.N .Y

#270

R60/COLOSSUS
R60/LUMINARY

TEMP HOLD. SNAP.

DISPLAY FINAL GIMBAL ANGLES
V06N18
R1-CG ROLL
R2-IG PITCH
R3-MG YAW
ALL ANGLES IN DEGREES TO THE NEAREST .01 DEGREES

MONITOR DSKY: OBSERVE NON-FLASHING VERB-NOUN DISPLAY OF FINAL GIMBAL ANGLES UNTIL COMPLETION OF THE AUTOMATIC MANEUVER.

#280

DC MANEUVER CALCULATION (KALCMANU) AND ICDU DRIVE ROUTINE TO ACHIEVE FINAL GIMBAL ANGLES. THE MANEUVER RATE WILL BE THAT LAST DEFINED TO THE CMC BY DSKY ENTRY. THIS PROCESS WILL INCLUDE A MONITOR OF THE RHC INPUTS TO THE CMC. ANY INPUT FROM THE RHC WILL BE INTERPRETED AS A MANUAL OVERRIDE AND WILL CAUSE IMMEDIATE TERMINATION OF THIS MANUEVER CALCULATION AND ICDU DRIVE ROUTINE.

#290

MONITOR ATTITUDE MANEUVER BY REFERENCE TO FDAI BALL AND ATTITUDE ERROR NEEDLES TO AVOID GIMBAL LOCK.

#300

SHALL I OVERRIDE THE GNCS AND COMPLETE THE MANEUVER MANUALLY?

.Y .N

#310

WAIT FOR AUTOMATIC COMPLETION.

#320

R60/COLOSSUS
R60/LUMINARY

R60/COLOSSUS
R60/LUMINARY

```
PERFORM ATTITUDE
MANEUVER MANUALLY
USING RHC AND BY
REFERENCE TO THE
OUT-THE-WINDOW-
VIEW AND/OR THE
FDAI BALL AND ATT-
ITUDE ERROR NEED-
LES.
```

#330

#340

CHANGE CONTROL NOTES

REV 09 PCR NASA 09
REV 11 PCR 206 EDITORIAL

/3)

TRACKING ATTITUDE ROUTINE (R61) — LOGIC — REV 16 — 12/26/68

PURPOSE: (1) TO COMPUTE THE PREFERRED TRACKING ATTITUDE OF THE CSM WHICH ENABLES OPTICS TRACKING OF THE LM AND LM TRACKING OF THE CSM RADAR TRANSPONDER AND TO COMPUTE THE +X-AXIS TRACKING ATTITUDE OF THE CSM WHICH ENABLES COAS TRACKING OF THE LM.

PCR 606 ++ +16 ++

(2) TO PERFORM THE MANEUVER TO THE SELECTED TRACKING ATTITUDE IF THE MANEUVER IS LESS THAN 10 DEGREES BUT TO CALL R60 IF THE MANEUVER IS GREATER THAN 10 DEGREES.

ASSUMPTIONS: (1) THE PREFERRED TRACKING ATTITUDE IS DEFINED AS FOLLOWS:

(A) THE TRACK AXIS (I) IS ALIGNED ALONG THE LOS TO THE LM. THE TRACK AXIS (I) IS DEFINED AS:

$$\text{UNIT}(\bar{I}) = \text{UNIT}(\bar{Z}_{SC}) \cos 55\ \text{DEG} + \text{UNIT}(\bar{X}_{SC}) \sin 55\ \text{DEG}$$

(B) THE CSM ORIENTATION ABOUT THE TRACK AXIS (I) IS A FUNCTION OF THE EXISTING ATTITUDE AT THE TIME OF THE CALCULATION AND IS CALCULATED SO AS TO YIELD A MINIMUM ATTITUDE MANEUVER.

(2) THE ROUTINE IS AUTOMATICALLY CALLED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20).

(3) THE GIMBAL ANGLES REQUIRED TO POINT THE PREFERRED LOS AT THE LM ARE AVAILABLE BE KEYING IN V16N95E.

(4) THE GIMBAL ANGLES REQUIRED TO POINT THE +X-AXIS LOS AT THE LM ARE AVAILABLE BE KEYING IN V16N96E.

(5) IF THE SURFACE FLAG HAS BEEN SET (V44E) THIS ROUTINE WILL ASSUME THE LM TO BE AT THE MOST RECENTLY DEFINED LANDING SITE. THE LANDING SITE CAN BE PLACED INTO THE CMC DURING THE ORBIT NAVIGATION PROGRAM (P22), OR BY UPLINK

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	START PREFERRED TRACKING ATTITUDE ROUTINE (R61)					#10
	. . . .					

1A

R61/COLOSSUS

1A

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                .
                .
                .
                .
                .
                .
-----------------
IS THE R61 COUNTER
EQUAL TO ZERO?
-------------------                                  #20
 .Y              .N
 .               .
 .               .
 .   ---------------
 .   IS R61 COUNTER
 .   NEGATIVE?
 .   ---------------
 .      .N       .Y
 .      .        .
 .      .        .                                   #30
 .      .       ...
 .      .        .
 .      .      EXIT
 .      .
 .      .
 . ----------------
 . DECREMENT R61
 . COUNTER BY ONE.
 . ----------------
 .               .                                   #40
 .               .
 .               .
 .              ...
 .               .
 .             EXIT
 .
 .
------------------
IS THE SURFACE FLAG
SET?
------------------                                   #50
 .N              .Y
 .               .
 .               .
 . ----------------
 . EXTRAPOLATE CSM
 . STATE VECTOR TO
 . THE PRESENT TIME
 . USING CONIC
 . EQUATIONS AND SET
 . POSITION OF THE                                   #60
 . LM EQUAL TO THE
 . LANDING SITE.
 . ----------------
 .               .
 .               .
 .               .
 .               .
 .               .
 .               .
 .               .
 .               .
 .               .
 .               .
```

137


```
.                 .
.                 .
.                 .
.                 .
.                 .
.                 .
----------------  .
EXTRAPOLATE LM    .
AND CSM STATE     .
VECTORS TO        .
PRESENT TIME      .
USING CONIC       .
EQUATIONS         .
----------------  .
          .       .
          .       .
          .       .
--------------------
CALCULATE THE PRE-
FERRED TRACKING
ATTITUDE FROM CSM
TO LM. (PREFERRED
UNIT VECTOR ALIGN-
ED WITH LOS FROM
CSM TO LM). THIS
ATTITUDE WILL BE
COMPUTED (VECPOINT)
TO POINT THE PRE-
FERRED AXIS AT THE
LM BUT WILL NOT
CONSTRAIN THE NON-
CRITICAL ORIENTA-
TION ABOUT THAT
VECTOR.
--------------------
          .
          .
          .
------------------
COMPUTE REQUIRED
GIMBAL ANGLES, AT
THE PREFERRED
TRACKING ATTITUDE
IF THE PRESENT IMU
ORIENTATION IS
HELD AND STORED
IN NOUN 95
------------------
          .
          .
          .
------------------
CALCULATE +X-AXIS
TRACKING ATTITUDE
FROM CSM TO LM (+X-
AXIS ALIGNED WITH
LOS FROM CSM TO
LM). THIS ATTITUDE
WILL BE COMPUTED
(VECPOINT) TO
POINT THE +X-AXIS
```

#70

#80

#90

#100

#110

#120

1A

1A

```
AT THE LM PLT WILL
NOT CONSTRAIN THE
NON-CRITICAL OR-
IENTATION ABOUT
THAT VECTOR (ROLL)
------------------
          .
          .
          .
------------------
COMPUTE REQUIRED
GIMBAL ANGLES AT
THE +X-AXIS TRACK-
ING ATTITUDE IF
THE PRESENT IMU
ORIENTATION IS
HELD AND
STORE IN NOUN 96
------------------
          .
          .
          .
------------------
IS THE PREFERRED
ATTITUDE FLAG
SET (SEE P20)?
------------------
 .N             .Y
 .              .
 .              .
 . --------------
 . TRANSFER CON-
 . TENTS OF NOUN
 . 95 INTO NOUN 18
 . ---------------
 .              .
 .              .
 .              .
--------------- .
TRANSFER CON-   .
TENTS OF NOUN   .
96 INTO NOUN 18 .
--------------- .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
 .              .
```

#130

#140

#150

#160

STORE ATTITUDE SPECIFICATION FOR +X-AXIS TRACKING ATTITUDE FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60).

STORE ATTITUDE SPECIFICATION FOR PREFERRED TRACKING ATTITUDE FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60).

++
+16

SHUT OFF UPLINK ACTY LIGHT

COMPARE PRESENT AND REQUIRED GIMBAL ANGLES. IS ANY REQUIRED GIMBAL ANGLE CHANGE GREATER THAN 10 DEGREES?

N

Y

IS THE STICK FLAG SET?

Y

N

1A

TURN ON
UPLINK ACTY
LIGHT

SET R61
COUNTER EQUAL
TO 3.

EXIT

+16
++
PCR
606

IS THE PRIORITY
DISPLAY IN ROU-
TINE 22 USING
THE DSKY?

Y

N

SET R61 COU-
NTER EQUAL
TO -1.

EXIT

DO ATTITUDE MANEUVER
ROUTINE (R60).

DO ATTITUDE MANEUVER
ROUTINE (R60).

SET R61 COUNTER
EQUAL TO 0.

EXIT

IS CMC AUTO MODE
SELECTED?

Y / N

IS STICK FLAG
SET?

N / Y

CALCULATE THE
ANGULAR VELOCITY
OF THE LOS AND
RESOLVE INTO
RCS DAP CONTROL
AXIS.

INPUT THE FOL-
LOWING QUANTITIES
TO THE RCS DAP:

(1) DESIRED BODY
ATTITUDE

1A

```
(2) RATE BODY
    RATE EQUAL TO
    COMPUTED LOS
    RATE (IN
    CONTROL AXIS
    COMPONENTS).

(3) AMOUNTS BY
    WHICH THE
    CDU-DESIRED
    REGISTERS
    SHOULD BE
    INCREMENTED
    AT 0.1 SECOND
    INTERVALS.
----------------
        .
        .
        .
--------------------
SET R61 COUNTER
EQUAL TO 3.
--------------------
        .
        .
        .
       ...
        .
     EXIT R61
```

#330

#340

#350

CHANGE CONTROL NOTES

LOGIC REV 11 PCR 4 MIT 54
REV 12 PCR MIT 66
REV 13 PCR 206
PCR 325
REV 14 PCR 503
REV 15 PCR 521
REV 16 PCR 606

1-2

CREW-DEFINED MANEUVER ROUTINE (R62) LOGIC REV 05 11/27/68

PURPOSE: (1) TO PROVIDE THE CREW WITH THE ABILITY TO SPECIFY A FINAL VEHICLE ATTITUDE FOR USE BY A CMC-CONTROLLED ATTITUDE MANEUVER.

ASSUMPTIONS: (1) THE ROUTINE IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

(2) THE DAP DEADBAND DURING THIS ROUTINE IS AS DEFINED BY THE LOAD DAP DATA ROUTINE (R03).

(3) THIS ROUTINE CAN ONLY BE ENTERED FROM THE CMC IDLING PROGRAM (P00).

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW PROGRAM SELECTION			
	START CREW-DEFINED MANEUVER ROUTINE (R62)		KEY IN V49E			
						#10
	IS CURRENT PROGRAM P00?		MONITOR DSKY: DOES OPERATOR ERROR LIGHT COME ON INDICATING THAT THIS ROUTINE CANNOT BE SELECTED AT THIS TIME?			
						#20
++ + +05 + ++ PCN 586	IS ANOTHER EXTENDED VERB ACTIVE?					
				R62/COLOSSUS		

#30

TURN ON OPER-
ATOR ERROR
LIGHT

KEY V37E00E
AND THEN KEY
V49E

EXIT

EXIT

#40

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY FINAL GIMBAL
ANGLES:
V06 N22
R1- CG ROLL
R2- IG PITCH
R3- MG YAW

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF FINAL GIMBAL
ANGLES.

#50

DO I WISH TO KEY IN
NEW GIMBAL ANGLES TO
BE USED BY ROUTINE
R60?

#60

N

Y

WAIT FOR KEYBOARD
ENTRY

KEY IN V25E AND
LOAD NEW GIMBAL
ANGLES

#70

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

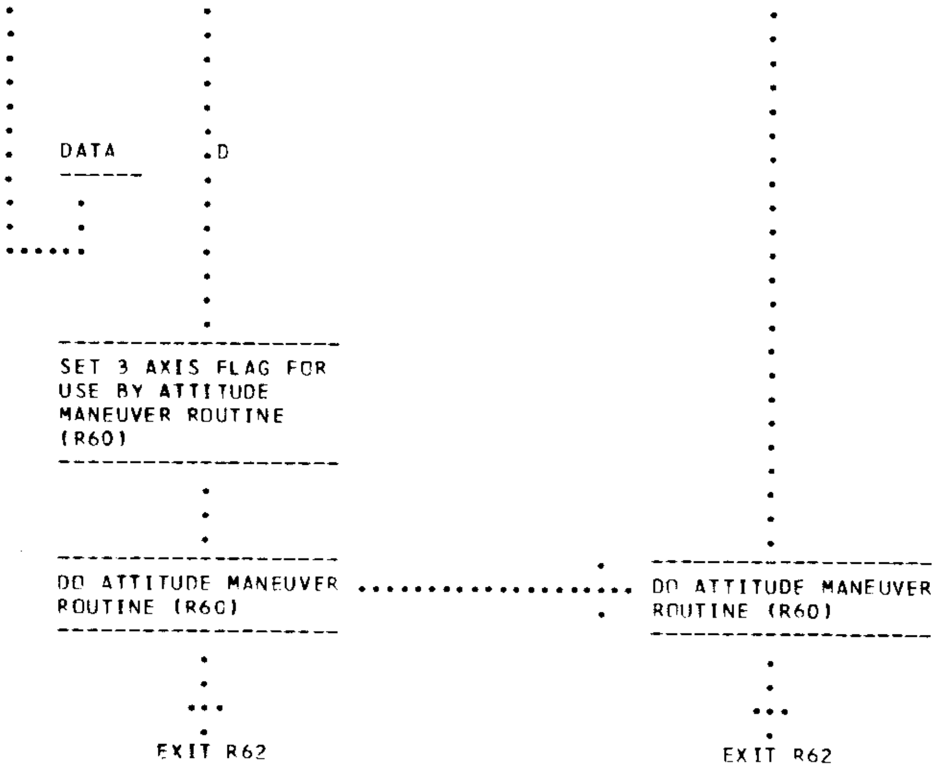
KEY IN PROCEED

NEW
DATA

STORE
NEW

P
R
C
E
F

#80



CHANGE CONTROL NOTES

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PURPOSE: (1) TO CALCULATE THE FINAL GIMBAL ANGLES REQUIRED TO POINT THE CSM +X AXIS AT THE LM AND TO CALCULATE THE FINAL GIMBAL ANGLES REQUIRED TO POINT THE PREFERRED TRACKING AXIS AT THE LM.

(2) TO DISPLAY THE GIMBAL ANGLES CORRESPONDING TO THE ATTITUDE OPTION SELECTED BY THE ASTRONAUT.

(3) TO CALL THE ATTITUDE MANEUVER ROUTINE (R60) FOR AUTOMATIC MANEUVER CAPABILITY.

ASSUMPTIONS: (1) THE PREFERRED TRACKING ATTITUDE IS DEFINED AS FOLLOWS:

(A) THE TRACK AXIS ($\bar{I}$) IS ALIGNED ALONG THE LOS TO THE LM. THE TRACK AXIS ($\bar{I}$) IS DEFINED AS:

++
+13
++
EDIT
PCR 206

$$\text{UNIT}(\bar{I}) = \text{UNIT}(\bar{Z}_{SC}) \cos 55 \text{ DEG} + \text{UNIT}(\bar{X}_{SC}) \sin 55 \text{ DEG}$$

(B) THE CSM ORIENTATION ABOUT THE TRACK AXIS ($\bar{I}$) IS A FUNCTION OF THE EXISTING ATTITUDE AT THE TIME OF THE CALCULATION SO AS TO YIELD A MINIMUM ATTITUDE MANEUVER.

(2) TO SAVE TIME THE CSM ATTITUDE CONTROL MODE SHOULD BE PRESELECTED (FOR AUTOMATIC MANEUVERS R03 SHOULD HAVE BEEN DONE AND THE CMC AUTO MODE SELECTED).

(3) THIS ROUTINE MAY BE SELECTED IN P00 ONLY.

(4) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW .ROUTINE .SELECTION			
	START RENDEZVOUS FINAL ATTITUDE ROUTINE R63	. ...	KEY IN V89E			#10
	. . .					
	IS THE CURRENT PROGRAM P00?					
	YES. . . .	.NO . . .				#20

```
++
+
+
+13
+
++
PCN
586

IS ANOTHER EX-
TENDED VERB
ACTIVE?
N.          Y.

TURN ON
OPERATOR ERROR
LIGHT

EXIT
R63

MONITOR DSKY:
  DOES OPERATOR
ERROR LIGHT COME ON,
INDICATING THAT THIS
ROUTINE CAN NOT BE
SELECTED AT THIS
TIME?
Y          N

IN ORDER TO TURN
THIS ROUTINE ON
SELECT CMC IDLING
PROGRAM (P00) BY
KEYING V37E00E
AND RESELECT THIS
ROUTINE

EXIT
R63

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)
```

#30

#40

#50

#60

#70

```
HOLD  ..  FLASH VERB-NOUN TO                      MONITOR DSKY:
......    REQUEST RESPONSE AND ................... OBSERVE VERB-NOUN
SNAP  ..  DISPLAY OPTION CODE                     FLASH TO REQUEST
          FOR ASSUMED TRACKING                    RESPONSE AND DISPLAY
          ATTITUDE:                               OPTION CODE FOR
             V04 N06                              ASSUMED TRACKING                #80
             R1-00003                             ATTITUDE.
             R2-0000X
             R3-BLANK

          R1 IS THE OPTION
          CODE FOR ASSUMED
          TRACKING ATTITUDE

          R2 IS THE CMC
          ASSUMED OPTION:
          00001 = PREFERRED                                                       #90
          00002 = OTHER (+X-
                  AXIS)
          ------------------
                    .
                    .
                    .
          ------------------
          WAIT FOR KEYBOARD
          ENTRY                                                                   #100
                                                  ------------------
                                                  IS THE OPTION IN
                                                  R2 CORRECT?
                                                  ------------------
                                                     .YES         .NO
                                                     .            .
                                                     .            .
                                                  -------         .
                                ................. KEY IN          .
                                                  PROCEED         .              #110
                                                  -------         .
                                                                  .
                                                                  .
          TERMINATE FLASH UPON                      ----------------
          RECEIPT OF PROCEED                    ... KEY IN V22E AND
          OR NEW DATA                               LOAD OTHER OPTION
          ------------------                        ----------------
           .NEW      .PROCEED                                     .
           .DATA     .                                            .
          ------     .                                            ......
          STORE      .                                                           #120
          DATA       .
          ------     .
           .         .
           .         .
           .         .
          .....      .
                     .
                     .
                     .
```

```
                 .
                 .
                 .
                 .
                 .
                 .
            -------------------
            IS THE OPTION = 1?                                          #130
            -------------------
                .NO        .YES
                .          .
                .          .
            ---------  ---------
            RESET THE  SET THE
            PREFERRED  PREFERRED
            ATTITUDE   ATTITUDE
            FLAG.      FLAG.                                            #140
            ---------  ---------
                .          .
                .          .
                .          .
        .....   .          .
        .   .   .          .
        .   .   .          .
        .   -------------------
        .   EXTRAPOLATE LM AND
PCN     .   CSM STATE VECTORS                                           #150
531     .   FORWARD TO THE
++      .   PRESENT TIME +1 MIN
+12     .   USING CONIC EQUATIONS
++      .   -------------------
        .           .
        .           .
        .           .
        .   -------------------
        .   CALCULATE THE
        .   PREFERRED TRACKING                                          #160
        .   ATTITUDE FROM CSM
        .   TO LM. (PREFERRED
        .   UNIT VECTOR ALIGNED
        .   WITH LOS FROM CSM TO
        .   LM). THIS ATTITUDE
        .   WILL BE COMPUTED
        .   (VECPOINT) TO POINT
        .   THE PREFERRED AXIS
        .   AT THE LM BUT WILL
        .   NOT CONSTRAIN THE                                           #170
        .   NON-CRITICAL ORIENT-
        .   ATION ABOUT THAT
        .   VECTOR.
        .   -------------------
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
        .           .
```

```
.          .
.          .
.          .
.          .
.          .
.          .
.  -------------------
.  COMPUTE REQUIRED
.  GIMBAL ANGLES AT THE                                          #180
.  PREFERRED TRACKING
.  ATTITUDE IF THE
.  PRESENT IMU ORIEN-
.  TATION IS HELD AND
.  STORE IN NOUN 95.
.  -------------------
.          .
.          .
.          .
.  -------------------                                           #190
.  CALCULATE THE +X-
.  AXIS TRACKING ATT-
.  ITUDE FROM CSM TO LM
.  (+X-AXIS ALIGNED
.  WITH LOS FROM CSM TO
.  LM). THIS ATTITUDE
.  WILL BE COMPUTED
.  (VECPOINT) TO POINT
.  THE +X-AXIS AT THE
.  LM BUT WILL NOT CON-                                          #200
.  STRAIN THE NON-CRIT-
.  ICAL ORIENTATION
.  ABOUT THAT VECTOR
.  (ROLL).
.  -------------------
.          .
.          .
.          .
.  -------------------
.  COMPUTE REQUIRED                                              #210
.  GIMBAL ANGLES AT
.  THE +X-AXIS TRACKING
.  ATTITUDE IF THE
.  PRESENT IMU ORIEN-
.  TATION IS HELD AND
.  STORE IN NOUN 96.
.  -------------------
.          .
.          .
.          .                                                     #220
.  -------------------
.  IS THE PREFERRED
.  ATTITUDE FLAG SET
.  (SEE P20)?
.  -------------------
.     .NO        .YES
.     .          .
.     .          .
.     .          .
.     .          .
.     .          .
.     .          .
.     .          .
.     .          .
```

```
    .          .            .
    .          .            .
    .          .            .
    .          .            .
    .          .            .
    .  ---------  ---------
    .  TRANSFER   TRANSFER
    .  CONTENTS   CONTENTS
    .  OF NOUN    OF NOUN
    .  96 INTO    95 INTO
    .  NOUN 18    NOUN 18
    .  ---------  ---------
    .      .          .
    .      .          .
    .      .          .
    .  ---------  ---------
    .  STORE      STORE
    .  ATTITUDE   ATTITUDE
    .  SPECIFIC-  SPECIFIC-
    .  ATION FOR  ATION FOR
    .  +X-AXIS    PREFERRED
    .  TRACKING   TRACKING
    .  ATTITUDE   ATTITUDE
    .  FOR USE    FOR USE
    .  BY THE     BY THE
    .  ATTITUDE   ATTITUDE
    .  MANEUVER   MANEUVER
    .  ROUTINE    ROUTINE
    .  (P60).     (P60).
    .  ---------  ---------
    .      .          .
    .      .          .
    .      .          .
    .  -------------------                   -------------------
HOLD ..  FLASH VERB-NOUN                     MONITOR DSKY:
.........TO REQUEST RESPONSE                  OBSERVE VERB-NOUN
SNAP ..  AND DISPLAY COMPUTED                FLASH TO REQUEST
    .  GIMBAL ANGLES                         RESPONSE AND DISPLAY
    .     V06 N18                            COMPUTED GIMBAL
    .     R1-OG                              ANGLES.
    .     R2-IG                              -------------------
    .     R3-MG                                      .
    .  ALL GIMBAL ANGLES                             .
    .  IN DEGREES TO THE                             .
    .  NEAREST .01 DEGREES                           .
    .  -------------------                           .
    .         .                                      .
    .         .                                      .
    .         .                                      .
    .         .                              ---------------
    .         .                              SHALL I ALLOW
    .         .                              THE CSM TO
    .         .                              DRIVE THE SPACE
    .         .                              CRAFT TO THE
    .         .                              DESIRED ATTI-
    .         .                              TUDE?
    .         .                              ---------------
    .         .                                .Y        .N
    .         .                                .         .
    .         .                                .         .
    .         .                                .         .
    .         .                                .         .
    .         .                                .         .
```

R63/COLOSSUS

```
                                                  ---------------
                                                  DO I WISH TO
                                                  UPDATE THIS
                                                  DISPLAY?
                                                  ---------------
                                                     .Y         .N
                                                                                #290
 --------------------                             ------
 WAIT FOR KEYBOARD                                KEY IN
 ENTRY                                            RECYCLE
                                                    V32E
                                                  -------

                                                  ---------------
                                                  TO TERMINATE                  #300
                                                  THIS ROUTINE
                                                  KEY IN
                                                    V34E
                                                  ---------------

 TERMINATE FLASH UPON                           -----------
 RECEIPT OF PROCEED,                            KEY IN                         #310
 RECYCLE OR TERMINATE                           PROCEED
 --------------------                           -----------
  .R      .P     .T
  .E      .R     .E
  .C      .O     .R
  .Y      .C     .M
  .C      .E     .I
  .L      .E     .N
  .E      .D     .A
                 .T                                                             #320
                 .E
                ...
                 .
                EXIT
                R63

 --------------------                                                           #330
 DO ATTITUDE MANEUVER                           -----------
 ROUTINE R60                                    DO ATTITUDE
 --------------------                           MANEUVER
                                                ROUTINE R60.
                                                -----------
```

#340

```
.
.
.
.
.
.
...
.
EXIT
 R63
```

```
.
.
.
.
.
.
...
.
EXIT
R63
```

CHANGE CONTROL NOTES

REV 10 PCR MIT 66
REV 11 PCR MIT 206
REV 12 PCN 531
REV 13 PCR 206 EDITORIAL
PCN 586

FRESH START VERB (V36) LOGIC REV 04 04/10/68

PURPOSE: (1) TO INITIATE A COMPUTER FRESH START

ASSUMPTIONS: (1) FRESH START IS CREW INITIATED BY DSKY ENTRY.

(2) ALTHOUGH THE REFSMMAT FLAG IS RESET BY A FRESH START INDICATING THAT THE REFSMMAT IS NOT GOOD, THE ACTUAL REFSMMAT IS NOT CHANGED.

(3) FRESH START RESETS THE CSM MOON FLAG AND THE LM MOON FLAG INDICATING EARTH ORBIT FOR STATE VECTOR INTEGRATION.

++
+04 (4) IF A FRESH START INTERRUPTS STATE VECTOR INTEGRATION, THE STATE VECTOR MAY BE INVALIDATED.
+
+04 (5) THIS PROCESS MAY BE SELECTED AT ANY TIME.
++

PROC CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW SELECTION			
	START CREW INITIATED FRESH START		KEY IN V36E			#10
	ZERO OUTBIT CHANNELS 5 (RCS PITCH AND YAW) AND 6 (RCS ROLL)					
++ +04 +04 ++						#20
	SET TIME 3 = 37777 TIME 4 = 37775 TIME 5 = 37774					
						#30
				V36/COLOSSUS		

```
                .
                .
                .
                .
                .
          -------------------
          ZERO OUTBIT CHAN-
          NELS: 11 (EXCEPT
          ENGINE ON, OFF AND
          ISS WARNING);
          12 (EXCEPT COARSE
          ALIGN ENABLE, ZERO
++        IMU CDU'S, ENABLE
+04       IMU ERROR COUNTER;
++        13 (EXCEPT TELEMETRY                                    #40
          BITS, RESET TRAP
          BITS AND T6RUPT
          BIT);
          14 (EXCEPT GYRO EN-
          ABLE).
          -------------------
                .
                .
                .
          -------------------                                     #50
          TERMINATE WAITLISTED
          TASKS
          -------------------
                .
                .
                .
          -------------------
          CLEAR ALL EXECUTIVE
          REGISTER SETS
          -------------------                                     #60
                .
                .
                .
          -------------------
          INDICATE NO ACTIVE
          JOBS
          -------------------
                .
                .
                .                                                 #70
          -------------------
          MAKE ALL VAC AREAS
          AVAILABLE
          -------------------
                .
                .
                .
          -------------------
          BLANK DSKY REGISTERS
          (PROGRAM, VERB,                                         #80
          NOUN, R1, R2, R3.)
          -------------------
                .
                .
                .
                .
                .
                .
                .
```

```
                .
                .
                .
                .
                .
                .
          --------------------
          RESET DISPLAY/
          ASTRONAUT INTERFACE
          FLAGS
          --------------------                                        #90
                .
                .
                .
          --------------------
          TURN OFF DSKY
          DISCRETE LIGHTS.
          --------------------
                .
                .
                .                                                     #100
          --------------------
          CLEAR FAIL REGIS-
          TERS, SELF CHECK
          ERROR COUNTER, AND
          RESTART COUNTER
          --------------------
                .
                .
                .
          --------------------                                        #110
          CLEAR SELF-CHECK
++        ERROR REGISTERS,
+04       MODE REGISTER.
++        --------------------
                .
                .
                .
          --------------------
          INITIALIZE PIPA AND
          TELEMETRY FAIL FLAGS                                        #120
          --------------------
                .
                .
                .
          --------------------
          ZERO OUTBIT CHAN-
          NELS: 11( "A"
          RELAYS); 12 (GNC);
          13 (AGC); AND
          14 (ISS)                                                    #130
          --------------------
                .
                .
                .
          --------------------
          INITIALIZE DOWNLINK
          WITH P00 DOWNLIST
          --------------------
                .
                .
                .                                                     #140
                .
                .
```

```
          .
          .
          .
          .
          .
          .
--------------------
CLEAR PHASE TABLE
--------------------
          .
          .
          .
--------------------
INITIALIZE IMU
(INHIBIT IMU FAIL                                                  #150
FOR 5 SECONDS)
--------------------
          .
          .
          .
--------------------
INITIALIZE OPTICS
--------------------
          .
          .                                                        #160
          .
--------------------
RESET EXTENDED VERB
ACTIVITY INTERLOCK
--------------------
          .
          .
          .
--------------------
RESET ALL FLAGWORDS                                                #170
(EXCEPT IDLEFLAG-
BIT 7 FLAGWORD 7
AND COMPUTER FLAG-
BIT 8 FLAGWORD 5)
--------------------
          .
          .
          .
--------------------
RESET UPSVFLAG                                                     #180
--------------------
          .
          .
          .
          .
         ...
          .
        EXIT
```

635

CHANGE CONTROL NOTES

LOGIC REV 04 PCR MIT 66 00231000

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ZERO ICDU EXTENDED VER3 (V40N20) LOGIC REV 03 07/09/68

PURPOSE: (1) TO INSURE SYNCHRONIZATION BETWEEN THE ISS CDU COUNTERS AND THE CDU COUNTERS IN THE COMPUTER.

(2) TO TERMINATE THE IMU COARSE ALIGN MODE AND ENTER THE FINE ALIGN MODE (INERTIAL IMU).

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(2) THE PROCESS MAY NOT BE SELECTED IF THE ISS IS IN THE COARSE ALIGN MODE AND IN GIMBAL LOCK.

(3) THE PROCESS IS INTENDED PRIMARILY FOR USE ON THE GROUND.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW PROG. SELECTION			
	START CREW INITIATED CDU ZERO		KEY IN V40N20E			#10
	IS ISS IN COARSE ALIGN MODE WITH GIMBAL LOCK?		EXIT			#20
++ +03	IS THE IMU BEING INITIAL-IZED?					#30

V40N20/COLDSSUS

```
+
+
+
+
+
+
+
+03
++
```

```
.          .   .
.          .   .
.          .   .
.          .   .
.          .   .
.  --------------
.  TURN ON OPER-
.  ATOR ERROR
.  LIGHT
.  --------------
.             .
.             .
.            ...
.             .
.           EXIT
.
.
--------------------
ENTER COU ZERO
MODE
--------------------
          .
          .
          .
--------------------
TURN OFF NO ATT
LIGHT
--------------------
          .
          .
          .
--------------------
WAIT 320 MSEC
--------------------
          .
          .
          .
--------------------
CLEAR ISS COU
READ COUNTERS
--------------------
          .
          .
          .
--------------------
ENTER FINE
ALIGN MODE
--------------------
          .
          .
          .
--------------------
WAIT APPROXIMATELY
10 SEC
--------------------
          .
          .
          .
         ...
          .
          .
          .
          .
          .
```

#40

#50

#60

#70

#80

```
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.
.
EXIT
```

CHANGE CONTROL NOTES

REV 03 PCR 206

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COARSE ALIGN ICDU EXTENDED VERB (V41N20) LOGIC REV 04 11/27/68

PURPOSE: (1) TO ALIGN THE IMU TO GIMBAL ANGLES SPECIFIED BY THE ASTRONAUT.

(2) TO COARSE ALIGN TO 0,0,0 WHEN IN GIMBAL LOCK AND COARSE ALIGN.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(2) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.

(3) THE ACCURACY OF THE ALIGNMENT IS TESTED TO A TOLERANCE OF ±2 DEGREES. IF THIS TOLERANCE IS EXCEEDED, THE ASTRONAUT WILL BE NOTIFIED VIA A PROGRAM ALARM.

(4) V41 MAY ONLY BE USED WITH N20 OR N91. REFER TO OPTICS COARSE ALIGN EXTENDED VERB (V41N91).

(5) THE PROCESS SHOULD NEVER BE USED DURING A PROGRAM WHICH REQUIRES THAT THE IMU BE ON AND ALIGNED.

PROG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW .PROG .SELECTION			
	START CREW INITIATED ICDU COARSE ALIGN		KEY IN V41N20E			#10
	IS ANOTHER EXTENDED VERB ACTIVE?					
	.N					#20
					V41N20/COL	

```
                                                                          #30
          ---------------
          IS THE IMU
          BEING
          INITIALIZED?
          ---------------
             .N      .Y
             .       .
             .       .
             .       .
             .       .
             .    -------------
             .    TURN ON OPR
             .    ERR LIGHT
             .    -------------
             .            .
             .            .
             .           ...                                              #40
             .            .
             .           EXIT
             .
             .
++           .
+04          .
+            .
+04          .
++           .
 EDIT        .                                                            #50
             .
             .
          --------------------                 --------------------
          FLASH VERB-NOUN TO                .  MONITOR DSKY:
HOLD .    REQUEST LOAD OF      ................ OBSERVE VERB-NOUN
........  DESIRED CDU ANGLES.                .  FLASH REQUESTING
     .       V21N22                            LOAD OF CDU ANGLES
             R1-OG ROLL                        --------------------
             R2-IG PITCH                              .
             R3-MG YAW                                .                   #60
                                                      .
          ALL REGISTERS                               .
          INITIALLY BLANK                             .
                                                      .
          ALL ANGLES IN DE-                        --------------------
          GREES TO NEAREST .01                     SHALL I LOAD CDU
          DEGREE                                   ANGLES?
          --------------------                     --------------------
                   .                                 .Y          .N
                   .                                 .           .       #70
                   .                                 .           .
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```

WAIT FOR KEYBOARD ENTRY

LOAD DESIRED ANGLES

TERMINATE FLASH UPON RECEIPT OF DATA OR PROCEED

KEY IN PROCEED

DATA

PROCEED

DISPLAY COARSE ALIGN VERB V41

MONITOR DSKY: OBSERVE DISPLAY OF COARSE ALIGN VERB

ENTER COARSE ALIGN MODE

TURN ON NO ATT LIGHT

COARSE ALIGN IMU TO STORED ANGLES (15 SECS MAX)

WAIT 1.5 SECONDS

READ PRESENT IMU ORIENTATION W.R.T. THE VEHICLE. (GIMBAL ANGLES)

ARE THE GIMBALS WITHIN 2 DEGREES OF THE DESIRED ANGLES?

Y: EXIT

N: TURN ON PROGRAM ALARM AND STORE ALARM CODE (00211)

MONITOR DSKY: DOES PROGRAM ALARM INDICATE THAT THE IMU GIMBALS DID NOT DRIVE TO WITHIN 2 DEGREES OF THE DESIRED ANGLES?

N: EXIT

Y: CHECK STATUS OF CW PANEL. IS AN ISS MALFUNCTION INDICATED?

Y / N

```
 .                          .            .
 .                          .            .
 .                          .            .
 .                          .            .
 .                          .            .
 .                          .            .
 .                          .  --------------
 .                          .  DO I DESIRE TO
 .                          .  RESELECT THE
 .                          .  COARSE ALIGN                          #180
 .                          .  PROCESS?
 .                          .  NOTE: THE
 .                         ...  DEGREE OF
 .                          .  FAILURE MAY BE
 .                        EXIT CHECKED BY
 .                             COMPARING THE
 .                             SPECIFIED
 .                             GIMBAL ANGLES
 .                             (V16N22E) WITH
 .                             THE CURRENT                            #190
 .                             ANGLES
 .                             (V16N20E).
 .                             --------------
 .                              .N         .Y
 .                              .           .
 .                              .           .
 .                              .  ---------
 .                              .  RESELECT
 .                              .  COARSE
 .                             ...  ALIGN KEY                         #200
 .                              .  V41N20E
EXIT                           EXIT ----------
```

CHANGE CONTROL NOTES

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04 EDITORIAL

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COARSE ALIGN OCDU EXTENDED VERB (V41N91) LOGIC REV 05 11/27/68

PURPOSE: (1) TO DRIVE THE OPTICS TO SHAFT AND TRUNNION ANGLES SPECIFIED BY THE ASTRONAUT

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(2) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.

```
PROG                CMC                 GROUND              CREW                                CHECKLIST          TIME      TOTAL
CONT                                                                                                                          TIME

                                                            CREW PROG.
                                                            SELECTION
                                                                .
                                                                .
                                                                .
                                                                ...
                                                                .
          -------------------   .                 -------------------
          START CREW INITIATED ..................... KEY IN V41N91E
          OSS COARSE ALIGN      .                 -------------------                                                   #10
          -------------------                             .
                    .                                     .
                    .                                     .
                    .                                     .
          -------------------                             .
          IS ANOTHER EXTENDED                             .
          VERB ACTIVE?                                    .
          -------------------                             .
             .N            .Y                             .
             .             .                              .
             .             .                              .                                                             #20
             .   -------------                            .
             .   TURN ON CPR                              .
             .   ERR LIGHT                                .
             .   -------------                            .
             .               .                            .
             .               .                            .
             .              ...                           .
             .               .                            .
             .             EXIT                           .                                                             #30
             .                                            .
++           .                                            .
+05          .                                            .
+            .                                            .
+            .                                            .
+            .                                            .                                  V41N91/COL
+            .                                            .
+            .                                            .
```

```
+
+
+
+
+
+05
++
 EDIT

                                                                    #40
IS OPTICS MODE
CMC?

.Y        .N

TURN ON OPR  ..................  MONITOR PROGRAM                   #50
ERR LIGHT                        ALARM LIGHT: IF THE
                                 PROGRAM ALARM LIGHT
                                 COMES ON AT THIS
                                 TIME, THE ASTRONAUT
                                 SHOULD KEY V05N09E
                                 TO CHECK THE ALARM
TURN ON PROGRAM                  CODE:
ALARM AND STORE ..............     00115-SET OPTICS
ALARM CODE                                MODE SW-CMC
(00115)                                   RSET                      #60
                                   00117-OPTICS NOT
                                          AVAILABLE.
                                          THE PROCESS
                                          CANNOT BE
                                          DONE AT THIS
ARE OPTICS AVAIL-                         TIME
ABLE?

.Y       .N                                                         #70

TURN ON PROGRAM
ALARM AND STORE ..............
ALARM CODE
(00117)

                                                                    #80
++
+05
+
+05
++
 EDIT

                                                                    #90
```

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                 .       EXIT                         .
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                 .                                    .
                 --------------------                 --------------------
HOLD  .          FLASH VERB-NOUN TO                   MONITOR DSKY:
......... .      REQUEST LOAD OF DE-          .       OBSERVE VERB-NOUN
        .        SIRED OPTICS ANGLES  ................ FLASH REQUESTING
                    V21 N92                   .       LOAD OF DESIRED
                    R1 - SHAFT                        OPTICS ANGLES
                    R2 - TRUNNION                     --------------------
                    R3 - BLANK                                .
                                                              .
                 ALL REGISTERS                                .
                 INITIALLY BLANK                              .
                                                              .
                 SHAFT ANGLE IN DE-                           .
                 GREES TO NEAREST                             .
                 .01 DEGREE                                   .
                                                              .
                 TRUNNION ANGLE IN                            .
                 DEGREES TO NEAREST                           --------------------
                 .001 DEGREE                                  SHALL I LOAD OPTICS
                 --------------------                         ANGLES?
                                                              --------------------
                           .                                    .Y            .N
                           .                                    .             .
                           .                                    .             .
                 --------------------   .                     --------------  .
                 WAIT FOR KEYBOARD    ..................... LOAD DESIRED     .
                 ENTRY                 .                      ANGLES          .
                                                              --------------  .
                                                              .             .
                                                              .             .
                                                              .             .
                 TERMINATE FLASH UPON   .                     .           -------
                 RECEIPT OF DATA      ................................... KEY IN
                 OR PROCEED             .                     .           PROCEED
                 --------------------                         .           -------
                    .DATA         .P                          .             .
                    .             .R                          .             .
                    .             .O                          .             .
                    .             .C                          .             .
                    .             .E                          .             .
                    .             .E                          .             .
                    .             .D                          .             .
                    .             .                           .             .
                    .   -------------                         .             .
                    .   USE ANGLES                            .             .
                    .   IN SAC, PAC                           .             .
                    .   -------------                         .             .
                    .             .                           .             .
                    .             .                           .             .
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#100

#110

#120

#130

#140

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          .            .                 .            .
   -------------------                  -------------------
   DISPLAY COARSE                     .  MONITOR DSKY:
   ALIGN VERB                ..................  OBSERVE DISPLAY
      V41                             .  OF COARSE ALIGN
   -------------------                  VERB
                                        -------------------
            .                                   .                          #150
            .                                   .
            .                                   .
   -------------------                          .
   ENABLE CMC POSITION-                         .
   ING OF OPTICS TO                             .
   DESIRED ANGLES                               .
   -------------------                          .
            .                                   .
            .                                   .
            .                                   .
++          .                                  ...                         #160
+05         .                                   .
++          .                                 EXIT
 EDIT       .
            .
            .
           ...
            .
          EXIT
```

CHANGE CONTROL NOTES

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REV 03 PCR MIT 66
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