

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

#40

CONTINUE UPON
RECEIPT OF ENTER

KEY IN ENTER

#50

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

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

#70

R3 TO NEAREST .01
SEC.

#80

RECORD THIS
TIME

•
•
•
•
•
EXIT

•
•
•
•
•
EXIT

R33/COLOSSUS
R33/SUNDANCE
R33/LUMINARY

CHANGE CONTROL NOTES

LOGIC REV 06 PCR MIT 66

SET TE=PRESENT TIME.

#40

EXTRAPOLATE CSM AND LM STATE VECTORS TO T USING COASTING INTEGRATION ROUTINE.

#50

IS AVERAGE G RUNNING?

.N .Y

#60

SET TE=PRESENT TIME.

EXTRAPOLATE LM AND CSM STATE VECTORS TO TE FROM T USING KEPLER SUBROUTINE.

#70

SET TE=AVERAGE G TIME.

#80

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

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

TURN ON OPERATOR
ERROR LIGHT

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

#30

EXIT

.Y .N
.
.

IN ORDER TO
USE THIS
ROUTINE KEY
IN V37E00E
AND THEN KEY
IN V79E

#40

EXIT

#50

HOLD .
.....
SNAP .

FLASH VERB-ACUN TO
REQUEST RESPONSE AND
DISPLAY T-LAT-LONG
V06N34
R1 00XXX
R2 000XX
R3 0XXXX
IN HOURS-MIN-SEC TO
THE NEAREST .01 SEC
NOTE: FIRST
DISPLAY WILL BE
PRESENT G.E.T.

.....

MONITOR DSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF T-LAT-LONG:

#60

T-LAT-LONG=G.E.T.
THIS IS THE TIME
WHICH THE
COMPUTER WILL DE-
FINE AS THE START OF
LMK TRACKING. IT
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
THE GROUND TRACK.

#70

#80

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.

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

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

.N .Y

KEY IN PROCEED

HAVE ALL 5 LANDMARKS
 BEEN DISPLAYED?

.N .Y

#250

#260

#270

#280

#290

HOLD
 SNAP
 FLASH VERB NOUN TO
 REQUEST RESPONSE AND
 DISPLAY TIME OF
 LANDMARK:
 V06N34
 R1- 00XXX
 R2- 000XX
 R3- 0XXXX
 IN HOURS-MIN-SEC TO
 THE NEAREST .01 SEC

MONITOR DSKY:
 OBSERVE VERB NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 TIME AT WHICH THE
 LANDMARK, JUST DIS-
 PLAYED, WILL PASS
 UNDER THE SPACE-
 CRAFT.

#350

WAIT FOR KEYBOARD
 ENTRY

HAVE ALL 5 LANDMARKS
 AND THEIR ASSOCIATED
 TIMES BEEN
 DISPLAYED?

#360

.N .Y

DO I WISH TO
 SEE THE NEXT
 LANDMARK?

#370

.N .Y

KEY IN
 PROCFED

#380

++
 +09
 ++
 PCR
 206
 EDIT

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR TERMINATE

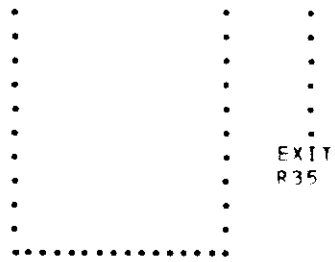
KEY IN TERMINATE
 V34E

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

EXIT
 R35

#390

539



R35/COLOSSUS

#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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#40

HOLD
.....
SNAP
++
+06
++
PCR
206
FDIT

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

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

#50

T(EVENT): TIME
(G.E.T.) FOR WHICH
OUT OF PLANE PARA-
METERS ARE DESIRED
IN HRS, MINS, AND
SECS TO NEAREST .01
SECONDS.

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

#60

A SPECIAL CASE IS
ALL ZERCS INDICA-
TING PRESENT TIME

.N .Y

AM I SATISFIED
WITH THE DIS-
PLAYED TIME?

#70

.N .Y

ARE ALL
THREE
REGISTERS
EQUAL TO
ZERO?

#80

.Y .N

543

R36/COLOSSUS
R36/SUNDANCE
R36/LUMINARY

++
+06
++
EDIT

WAIT FOR KEYBOARD
ENTRY:

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

KEY IN V25E AND LOAD
NEW DATA.

NEW DATA

STORE NEW DATA

DATA

D

P
R
C
C
E
E
D

IS T(EVENT) ZERO?

N Y
.
.

EXTRAPCLATE CSM
AND LM VECTORS
TO THE PRESENT
TIME USING
PRECISION
INTEGRATION

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

#90

#100

#110

#120

#130

R36/COLOSSUS
R36/SUNDANCE
R36/LUMINARY

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TURN OFF
TVC DAP

SET NARROW
DFADBAND
IN RCS DAP

DRIVE SPS ENGINE
BELL TO TRIM PC-
SITION.
NOTE: THE TRIM
POSITION IS THAT
LAST DEFINED BY
THE C.G. 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

TURN ON PRO-
GRAM ALARM
LIGHT AND
STOP ALARM
CODE 1703

MONITOR OSKY PROGRAM
ALARM LIGHT DURING
THE PERIOD FROM TIC
-40 SECONDS TO
BLANKING AT TIC-35;
IF LIGHT COMES ON
DURING THIS TIME IT
INDICATES THAT TIC
WILL BE SLIPPED AS
REQUIRED TO GET THE
STATE VECTOR INTEG-
RATED TO A NEW TIC
-30 SECONDS.

#30

SET TIC
FLAG

IF THIS ALARM
CONDITION OCCURS THE
TEI DISPLAY WILL
CONTINUE TO COUNT
BASED ON THE ORIGI-
NAL TIC UNTIL INTE-
GRATION IS COMPLETE
AND A NEW TIC IS
ESTABLISHED. THE
DISPLAY WILL NOT
BLANK HOWEVER UNTIL
THE NEW TIC HAS BEEN
ESTABLISHED AND TEI
IS REVISED.

#40

SET TDEC=TP PLUS
10 SECONDS

#50

IS INTEGRATION
FINISHED?

.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 TIC
FLAG SET?

OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT GOES OFF WHICH
INDICATES THAT THIS
ROUTINE IS COMPLETE

.N .Y

#80

++

+03

+

+

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552

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AUTOMATIC OPTICS POSITIONING ROUTINE (R52)

LCGIC 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 LCS 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
					

•
•
•
•
•

#40

SELFCY DESIRED IMU
INERTIAL ORIENTATION
FROM STORAGE (PRO-
VIDED BY CALLING
PROGRAM).

•
•

#50

CALCULATE REQUIRED
FINAL GIMBAL ANGLES
TO GIVE DESIRED IMU
INERTIAL ORIENTATION

•
•

#60

++
+03
++

IS ANY REQUIRED
GIMBAL ANGLE CHANGE
GREATER THAN 1
DEGREE?

•Y •N
• •
• •
• •••
• •
• EXIT
•
•

#70

SWITCH ISS TO CCARSE
ALIGN MODE. TERMINATE
ATTITUDE HOLD OF
VEHICLE

•
•

#80

COARSE ALIGN THE IMU

•
•
•
•
•
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•
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•
•
•

R56

007

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•

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 LCS 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
					

IS THE LM TARGET
FLAG SFT ?

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

#30

.YES .NO
. (LM) .

. .
. .
. .

RESFT
TERM-
INATE
FLAG

#40

GO TO
"B"
BELOW

#50

"A"
.SEE BELOW

#60

IS THE TRACK FLAG
SFT?

(SEE P20)

.YES .NO
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

#70

EXIT
RS2

561

IS THE PREFERRED
ATTITUDE FLAG SET?

.NO .YES

#80

IS UPDATE
FLAG SET?

.N .Y

#90

WAIT ABOUT 1.3
SECONDS

#100

. EXTRAPOLATE CSM AND
. LM STATE VECTORS TO
. THE PRESENT TIME
. +1.3 SECONDS USING
. CONIC EQUATIONS

++
+09
++
EDIT

#110

. READ PRESENT VEHICLE
. ATTITUDE FROM THE
. ICDU'S

#120

. COMPUTE TARGET VEC-
. TOR FROM CSM TO LM

++
+09
++
EDIT

· CALCULATE THE REQUI-
· RED OPTICS ANGLES
· TO POINT THE STAR
· LINE OF SIGHT AT
· THE LM.

#130

· IS A TRUNNION ANGLE
· GREATER THAN 50 DEG.
· REQUIRED TO POINT
· THE STAR LINE OF
· SIGHT AT THE
· LM ?

#140

· .N .YES
· .
· .

· SET THE RESET THE
· TRUNNION TRUNNION
· DRIVE DRIVE
· FLAG. FLAG

#150

· TURN ON PROGRAM
· ALARM LIGHT AND
· STORE ALARM
· CODE 407

· CHECK OPTICS MODE
· DISCRETE. IS THE
· DSS IN THE
· CMC MODE?

· .Y .NO
· .
· .

· IS THE TRUNNION
· DRIVE FLAG SET?

· .Y .N
· .
· .

· MONITOR PROGRAM
· ALARM LIGHT: IF THE
· PROGRAM ALARM LIGHT
· COMES ON AT THIS
· TIME THE ASTRONAUT
· SHOULD VERIFY ALARM
· (BY KEYING IN
· V05N09E) AND EITHER
· MANUALLY MANEUVER
· THE VEHICLE BACK TO
· THE PREFERRED TRACK-
· ING ATTITUDE
· (DESIRED GIMBAL
· ANGLES MAY BE DIS-
· PLAYED BY KEYING IN
· V16N22E AND DESIRED
· OPTICS BY KEYING IN
· V16N92E) OR ALLOW
· THE GNCS TO AUTOMA-
· TICALLY MANEUVER BY
· SWITCHING TO CMC
· AUTO CONTROL AND/OR
· BY KEYING IN V58E.

#160

#170

#180


```

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

```

```

-----
. DRIVE  CRIVE
. SHAFT  SHAFT
. AND    CDU
. TRUNNION ONLY
. CDU'S
-----

```

```

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

```

```

-----
DO THE TRACKING
ATTITUDE ROUTINE
R61.
-----

```

```

.
.
.
.
.
.
.

```

```

-----
WAIT 0.5 SEC
-----

```

```

.
.
.
.
.
.
.
GE TO
"WA"
ABOVE

```

#190

#200

#210

#220

```

"R" FROM
ABOVE

```

#230

```

.
.
.
.
.
.
.

```


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

++
+09
++
EDIT

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

++
+09
++
PCN
594

#370

GET LMK
COORDINATES
FROM CMC
STORAGE

#380

POSS
PRIO
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RESP-
ONSE AND DISPLAY
ALARM CODE:
V05N09
R1-
R2-
R3-
EXPECTED ALARM
ALARM CODE AT
THIS TIME IS 404

MONITOR DSKY:
DOES ALARM CODE
DISPLAY INDICATE
THAT THE TARGET IS
NOT WITHIN THE
HEMISPHERE OF
OPTICS VISIBILITY?

#440

.Y N.
.
.

FOR STAR/LANDMARK
SIGHTINGS THERE
ARE TWO OPTIONS:

#450

++
+09
++
EDIT
PCR
206

WAIT 2 SECONDS

(A) MANUALLY MA-
NEUVER VEHICLF
UNTIL OPTICS CAN
ACQUIRE THE DES-
IRED TARGET.

(B) TERMINATION
OF THE PRO-
GRAM AND
ROUTINE.

#460

.A B.
.
.
.

MANUALLY
MANEUVER VEH-
ICLE UNTIL IT
IS ESTIMATED
THAT OPTICS
CAN ACQUIRE
THE TARGET.
MONITOR FDAI
TO AVOID
GIMBAL LOCK.

#470

.
.

#480

WAIT FOR KEY-
BOARD ENTRY.

KEY IN
PROCEED

#490

SET TRUNNION
DRIVE FLAG

#550

RESET TRUNNION
DRIVE FLAG.

TURN ON PROGRAM
ALARM LIGHT AND
STORE ALARM CODE
407

MONITOR PROGRAM
ALARM LIGHT: IF THE
PROGRAM ALARM LIGHT
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
V16N92F. IF TRUNNION
(R2) IS GREATER THAN
49.775 THE ASTRONAUT
SHOULD MANUALLY
MANEUVER THE
VEHICLE.

#560

#570

#580

++
+09
++
EDIT

IS THE SIGHTING
MARK FLAG SET?

.Y .N

#590


```

++
POSS . DISPLAY CN DSKY:
..... VO6N92
MON . R1-SHAFT
+09 . R2-TRUNNION
++ . R3-BLANK
EDIT .
PCR . SHAFT-DESIRED
206 . 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. NCTE: THIS
. DISPLAY WILL NOT
. APPEAR IF R53 HAS
. ALREADY BEEN CALLED
. BY SWITCHING OPTICS
. MODE SWITCH TO
. MANUAL.
-----

```

#600

```

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

```

```

. Y . N
.
.
-----

```

#610

```

IS TRUNNION
DRIVE FLAG SET?
-----

```

```

. Y . N
.
.
-----

```

#620

```

DRIVE DRIVE
SHAFT SHAFT
AND CDU
TRUN- ONLY
NION
CDUS
-----

```

#630

```

-----
WAIT 0.5 SEC
-----

```

#640

```

.
.
.
.....

```

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)

LOGIC REV. NO. 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 SOT 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 LOCALS AND 2 GLOBALS) 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 ROUTINE) 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, DISTINGUISHABLE, 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 OFFSET 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)					

	.					
	.					
	.					
	.					
	.					
	.					
	.					
	.					

SET SIGHTING
MARK FLAG

ZERO MARK COUNTER

"A"

"A"

#20

#30

#40

#50

#60

HOLD .
.....
SNAP .

FLASH VERR-
TO REQUEST PLEASE
MARK:
V51 N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

.....

MONITOR DSKY:
OBSERVE FLASHING
VERR TO REQUEST
PLEASE MARK

SELECT MANUAL OPTICS
MODE

WAIT FOR KEYBOARD
ENTRY

.....

WHEN SIGHTING IS
SATISFACTORILY
ACCOMPLISHED PRESS
MARK BUTTON

WAS THE SIGHTING
SATISFACTORY?

Y. .N
.....
PRESS MARK
REJECT
BUTTON

.....

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

#180

GO TO
"A"
ABOVE

#190

HOLD
SNAP

FLASH VFR-MOUN TO
REQUEST PLEASE
PERFORM TERMINATE
MARK SEQUENCE:
V50-N25
P1-00016
P2-BLANK
P3-BLANK

MONITOR DSKY:
OBSERVE FLASHING
VFR-MOUN TO REQUEST
PLEASE PERFORM
TERMINATE MARK
SEQUENCE

#200

WAIT FOR KEYBOARD
ENTRY.

WAS LAST MARK
SATISFACTORY?

#210

Y N

KEY IN
PROCEED

#220

PRESS MARK
REJECT
BUTTON

GO TO
"A"
ABOVE

#230

TERMINATE FLASH
UPON RECEIPT OF
ENTER, OR MARK
REJECT

.MK .P
.REJ .P
.C
.C
.F
.F IS MARK
.D COUNTER
= 0?
.Y .N

#240

GO TO
MARK
ABOVE

#250

RESET MARK FLAG

.
.
.

#260

IS THE CALLING
PROGRAM P22 OR P23?

.N .Y
. .
. .

SET TERMINATE
FLAG
(FOR USE
BY P52).

#270

SET TERMINATE
FLAG (FOR USE
BY P52)

++
+00
+
+00
++
PCM
660

#280

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

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

STORE
NEW
DATA

IS CELESTIAL
BODY CODE 00?

.N .Y
.
.
.

IS THE CELESTIAL
BODY CODE 46, 47
OR 50?

.N .Y
.
.

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

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

#340

#350

#360

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

.N .Y
.
.
.

.....
EXIT

#370

#380

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	00600001
REV 09	PCR 669, EDITORIAL	00600002

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++
+07
HOLD . FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY SIGHTING AN-
+07 GLE DIFF:
++ V06 N05
PCR R1-SIGHTING ANGLE
206 DIFF
EDIT R2-BLANK
R3-BLANK

SIGHTING ANGLE DIFF-
ERENCE IN DEGREES TO
THE NEAREST .01
DEGREES.

MONITOR DSKY:
OBSERVE FLASHING
VERB-NOUN AND DIS-
PLAY OF SIGHTING
ANGLE DIFF

#40

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
ENTRY

KEY IN
PROCEED

EXIT "A"
FROM R54
CONTINUE
AS DEFINED
IN CALLING
PROGRAM/
ROUTINE

#80

R54/COLOSSUS
R54/SUNDANCE
R54/LUMINARY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE



KEY IN RECYCLE
V32E

.P .R
.R .E
.D .C
.C .Y
.E .C
.F .L
.D .F
. .
. .
. .
....

EXIT "A"
FROM R54
CONTINUE AS
DEFINED IN
CALLING PRO-
GRAM/ROUTINE

EXIT "B"
FROM R54
CONTINUE AS
DEFINED IN THE
CALLING PRO-
GRAM/ROUTINE

. .
. .
. .
. .
EXIT "B"
FROM R54
CONTINUE AS
DEFINED IN THE
CALLING PRO-
GRAM/ROUTINE

#90

#100

#110

CHANGE CONTROL NOTES

REV 07 EDITORIAL

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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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ARE THE DISPLAYED
ANGLES CORRECT FOR
THE CHOSEN LOS?

WAIT FOR KEYBOARD
ENTRY:

.Y .N

TERMINATE FLASH
UPON RECEIPT OF NEW
DATA OR PROCEED

KEY IN V24F
AND LOAD
ANGLES.

KEY IN
PROCEED

.NEW .PROCEED
.DATA

STOP
NEW DATA

HOLD
SNAP

FLASH VCR
TO REQUEST PLEASE
PERFORM ALTERNATE
LOS SIGHTING
MARK:

V53N-BLANK
01-BLANK
02-BLANK
03-BLANK

MONITOR DSKY:
RESERVE VCR
FLASH TO REQUEST
PLEASE PERFORM ALTE-
RNATE LOS SIGHTING
MARK:

USING THE ROTATIONAL
HAND CONTROLLER DO-
SITION THE SPACE-
CRAFT SO THAT THE
NAVIGATION STAR IS
PRECISELY ALONG THE

#40

#50

#60

#70

#80

LOS CHUSEN.

#90

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER

#100

.F
.N
.T
.E
.R

STOP THREE ICDU
ANGLES AND THE TWO
OPTICS ANGLES OF
NCUN 94

#110

HOLD
SNAP

FLASH VERB NOUN
TO REQUEST PLEASE
PERFORM TERMINATION
OF THIS ROUTINE
V50 N25
R1 00016
R2 BLANK
R3 BLANK

MONITOR DSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
PLEASE PERFORM TERM-
INATION OF THIS
ROUTINE.

#120

WAS THE SIGHTING
SATISFACTORY?

#130

.Y .N
. .
. .

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

#140

TERMINATE FLASH UDDN
RECEIPT OF ENTER OR
PROCEED

KEY IN PROCEED

.F .D
.N .D
.T .D
.E .C
.D .E
. .F
. .D

ERASE MARK
DATA

#150

#160

HOLD .
SNAP .

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OF CELESTIAL
BODY CODE

V01 N71
01-CELESTIAL BODY
CODE
02-PLANET
03-PLANET

01-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

#170

#180

#190

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

#200

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

KEY IN V21E AND
LOAD STAR CODE:

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

#210

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

STORE
NEW
DATA

#220

IS CELESTIAL BODY
CODE 00?

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

#230

.N .Y

.N .Y

IS CELESTIAL
BODY CODE 46,
47 OR 50?

EXIT

#240

.N .Y

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

#250

CALCULATE CEN-
TRAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE STAR
CODE.

#260

POSS
HOLD .
.....
SNAP .

FLASH VERR-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
PLANET POSI-
TION VECTOR;
V06ARR
R1-X PL
R2-Y PL
R3-Z PL

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

#270

++
+10
++
EDIT

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

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

#280

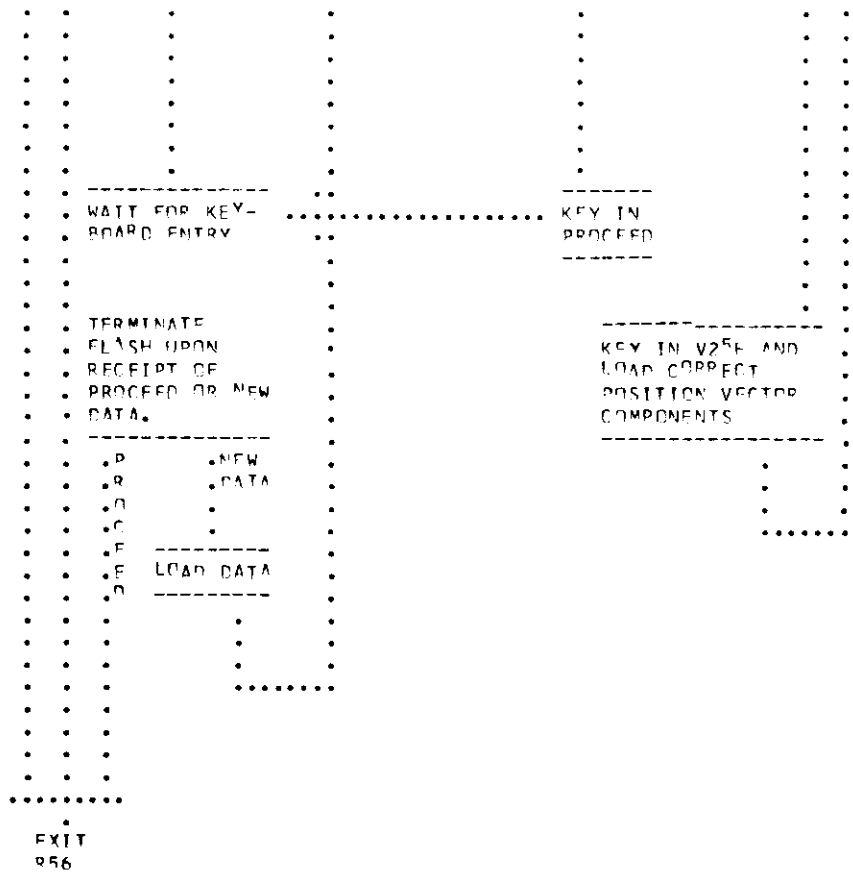
Y N

Y PL - SAME AS
X PL FOR Y
COMPONENT.

Z PL - SAME AS
Y PL FOR Z
COMPONENT.

#290

#300



#310

#320

#330

CHANGE CONTROL NOTES

REV 07 RCR MIT 66
 REV 02 RCR 487
 REV 00 RCR 206 EDITORIAL
 REV 00 CRITERIA

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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 CCNE 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.

PRG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
-------------	-----	--------	------	-----------	------	---------------

```

.CMC
.ROUTINE
.SELECTION
.
...
.
    
```

```

-----
START OPTICS CALI-
BRATION ROUTINE
(R57)
-----
    
```

#10



601

----- EXIT

STORE TRUN-
NION OCDB
ANGLE

#70

SNAP
HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY TRUNNION

BIAS ANGLE.
V06 N87
R1-BLANK
R2-XXXXX
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TRUNNION BIAS
ANGLE

#80

R2-ANGLE IN DEGREES
TO NEAREST .001 DEG

#90

WAIT FOR KEYBOARD
ENTRY

DO I WISH TO INCORP-
ORATE THE CALIBRA-
TION OR RECALIBRATE?
NOTE: THE SCALING OF
THIS NOUN IS SUCH
THAT A SMALL NEGA-
TIVE ANGLE WILL
APPEAR AS A POSI-
TIVE ANGLE APPROA-
CHING 90.000.
THE ACTUAL ANGLE
WOULD THEN BE EQUAL
THAT 90.000 MINUS
THE DISPLAYED VALUE.

#100

++
+09
+
+
+
+
+
+
+
+09
++

.I .R
.N .E
.C .C
.D .A
.R .L
.P .
. .
. .

#110

KFY IN
PROCEED

#120

EXIT

KEY IN
RECYCLE
V32F

#130

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE.

#140

.RECYCLE .PROCEED

ERASE MARK
DATA

#150

STORE CALIPRA-
TION ANGLE

#160

EXIT

CHANGE CONTROL NOTES

ATTITUDE MANEUVER ROUTINE (R6J)

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 DESCRIBED

PRG CONT	CMC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.CMC .ROUTINE .SELECTION					
	----- START ATTITUDE MANEUVER ROUTINE (R60) -----					#10
	. . .					
	----- OBTAIN DESIRED ATTITUDE SPECIFICA- TION FROM THE CALL- ING PROGRAM -----					#20
	. . .					
						R60/COLOSSUS R60/LUMINARY

.....

IS THE PRIORITY
DISPLAY IN R22
USING THE DSKY?

.N .Y
.
.

. WAIT
. UNTIL
. IT IS
. REMOV-
. ED.

.
.
.
.

#30

#40

IS THE 3 AXIS FLAG
SET?

.N .Y
.
.

#50

CALCULATE FINAL
VEHICLE ATTITUDE
TO MEET THE
DESIRED ATTITUDE
SPECIFICATION
(VECPPOINT ROU-
TINE). THIS FINAL
VEHICLE ATTITUDE
WILL BE CALCU-
LATED TO MEET THE
ATTITUDE SPECIFI-
CATION IN SUCH A
WAY AS TO CON-
SERVE RCS FUEL
AND NOT CONSTRAIN
ANY UNSPECI-
FIED DEGREE OF
FREEDOM.

#60

++
+11
++
EDIT
PCR
206

#70

.....

DESIRED
VECTOR?
(NOT POS-
SIBLE FOR
ALL CASES.
SEE ASSUMP-
TION 1)

#130

.N .Y

TERMINATE FLASH UPON
RECEIPT OF ENTER OR
PROCEED

KEY IN ENTER

#140

.P .F
.R .N
.Q .T
.C .F
.E .R
.E .
.D .

EXIT

#150

RESET 3-
AXIS FLAG.

EXIT

#160

SHALL I HAVE THE
GNCS PERFORM THE
MANEUVER AUTO-
MATICALLY?

.Y .N

#170

IS THE 3 AXIS FLAG
SET?

.N .Y

SELECT CMC
CONTROL AND
SELECT THE
AUTO MODE.

 . CALCULATE FINAL .
 . VEHICLE ATTITUDE .
 . TO MEET THE .
 . DESIRED ATTITUDE .
 . SPECIFICATION .
 . (VECPPOINT ROU- .
 . TINE). THIS FINAL .
 . VEHICLE ATTITUDE .
 . WILL BE CALCU- .
 . LATED TO MEET THE .
 . ATTITUDE SPECIFI- .
 . CATION IN SUCH A .
 . WAY AS TO CON- .
 . SERVE RCS FUEL .
 . AND NOT CONSTR- .
 . RAIN ANY UNSPEC- .
 . IFIED DEGREE OF .
 . FREEDOM. .
 . NOTE: GNCS CAP- .
 . ABILITY TO PER- .
 . FORM MANEUVER .
 . AUTOMATICALLY .
 . WILL BE COMPROM- .
 . ISED IF THE .
 . ATTITUDE IS .
 . CHANGED BY MANUAL .
 . INPUTS AFTER THIS .
 . TIME .

 . SELECT GIMBAL .
 . ANGLES CORRES- .
 . PONDING TO .
 . PREFERRED .
 . VEHICLE ATTIT- .
 . UDE AND PRES- .
 . ENT IMU ORIEN- .
 . TATION .

 . SHALL I HAVE .
 . THE GNCS .
 . RECOMPLTE THE .
 . DESIRED ATTI- .
 . TUDE WITHOUT .
 . PERFORMING .
 . THE AUTOMATIC .
 . MANEUVER? .
 . (NOT POSSIBLE .
 . FOR ALL .
 . CASES. SEE .
 . ASSUMPTION 1) .

. Y . N

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

..... KEY IN

 PROCEED

#180

#190

#200

#210

#220

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

IS S/C CONTROL CMC?

.N .Y

DID I DIRECT THE CMC
TO PERFORM THE MANE-
UVER AUTOMATICALLY?

.Y .N

#260

IS THE AUTO
MODE SELEC-
TED?

.N .Y

#270

608

609

R60/COLOSSUS
R60/LUMINARY

TFMP
HOLD.
.....
SNAP.

DISPLAY FINAL GIMBAL
ANGLES
V06N18
R1-CG ROLL
R2-IG PITCH
R3-MG YAW
ALL ANGLES IN
DEGREES TO THE NEAR-
EST .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 DE-
FINED TO THE
CMC BY DSKY
ENTRY. THIS
PROCESS WILL
INCLUDE A MON-
ITOR OF THE
RHC INPUTS TO
THE CMC. ANY
INPUT FROM THE
RHC WILL BE
INTERPRETED AS
A MANUAL OVER-
RIDE AND WILL
CAUSE IMMED-
IATE TERMINA-
TION OF THIS
MANUEVER CAL-
CULATION AND
ICDU DRIVE
ROUTINE.

MONITOR ATTITUDE
MANEUVER BY
REFERENCE TO FDAI
BALL AND ATTI-
TUDE ERROR
NEEDLES TO AVCID
GIMBAL LOCK.

#290

SHALL I OVERRIDE
THE GNC'S AND
COMPLETE THE MAN-
EUVER MANUALLY?

#300

.Y .N
.
.

WAIT FOR
AUTOMATIC
COMPLETION.

#310

#320

R60/COLOSSUS
R60/LUMINARY

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

.

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

#330

.
.....

#340

CHANGE CONTROL NOTES

REV 09 PCR NASA 09
REV 11 PCR 206 EDITORIAL

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:
- $$\text{UNIT (I)} = \text{UNIT (Z)} \cos 55 \text{ DEG} + \text{UNIT (X)} \sin 55 \text{ DEG}$$
- (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 BY KEYING IN V16N95F.
- (4) THE GIMBAL ANGLES REQUIRED TO POINT THE +X-AXIS LOS AT THE LM ARE AVAILABLE BY KEYING IN V16N96F.
- (5) IF THE SURFACE FLAG HAS BEEN SET (V44F) 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

PRG
CONT

CMC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.CMC
.ROUTINE
.SELECTION
.
...
.

START PREFERRED
TRACKING ATTITUDE
ROUTINE (R61)

.
.
.

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 LCS FROM
CSM TO LM). THIS
ATTITUDE WILL BE
COMPUTED (VECPNT)
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 NCOM 05

•
•
•

CALCULATE +X-AXIS
TRACKING ATTITUDE
FROM CSM TO LM (+X-
AXIS ALIGNED WITH
LCS FROM CSM TO
LM). THIS ATTITUDE
WILL BE COMPUTED
(VECPNT) TO
POINT THE +X-AXIS

0617001055US

#70

#80

#90

#100

#110

#120

1A

0617001055US

1A

#220

TURN ON
HRLINK ACTV
LIGHT

SET R61
COUNTER EQUAL
TO 3.

.....
EXIT

#230

#240

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

.Y .N

SET R61 COU-
NTER EQUAL
TO -1.

.....
EXIT

#250

#260

DO ATTITUDE MANEUVER
ROUTINE (R60).

.....
DO ATTITUDE MANEUVER
ROUTINE (R60).

#270

+14
++
DOP
606

SET P41 COUNTER
EQUAL TO 0.

EXIT

#280

IS CMC AUTO MODE
SELECTED?

.Y .N

#290

IS STICK FLAG
SET?

.N .Y

#300

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

#310

INPUT THE FOL-
LOWING QUANTITIES
TO THE RCS DAP:

(1) DESIRED BODY
ATTITUDE

#320

1A

1A

```

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

```

(3) AMOUNTS BY
    WHICH THE
    CPU-DESIGNED
    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 PCB # MIT 54
- REV 12 PCB MIT 64
- REV 13 PCB 206
- PCB 225
- REV 14 PCB 507
- REV 15 PCB 521
- REV 16 PCB 606

1/2

)

TURN ON OPER-
ATOR ERROR
LIGHT

KFY V37E00E
AND THEN KEY
V49E

EXIT

EXIT

#30

#40

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

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

#50

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE.

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

#60

WAIT FOR KEYBOARD
ENTRY

.N .Y

KFY IN V25E AND
LOAD NEW GIMBAL
ANGLES

#70

TERMINATE FLASH UPON
RECEIPT OF PROCED
OR NEW DATA

KFY IN PROCEED

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

STORE .E
NEW .F

#80

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++
+
+
+13
+
++
PCN
586

IS ANOTHER EX-
TENDE VERR
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 V37E00F
AND RESELECT THIS
ROUTINE

EXIT
R63

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)

#30

#40

#50

#60

#70

IS THE OPTION = 1?

#130

.NO .YES

RESET THE PREFERRED ATTITUDE FLAG. SET THE PREFERRED ATTITUDE FLAG.

#140

.....

EXTRAPOLATE LM AND CSM STATE VECTORS FORWARD TO THE PRESENT TIME +1 MIN USING CONIC EQUATIONS

PCN 531 ++ +12 ++

#150

CALCULATE THE PREFERRED TRACKING ATTITUDE FROM CSM TO LM. (PREFERRED UNIT VECTOR ALIGNED WITH LOS FROM CSM TO LM). THIS ATTITUDE WILL BE COMPUTED (VECPNT) TO POINT THE PREFERRED AXIS AT THE LM BUT WILL NOT CONSTRAIN THE NON-CRITICAL ORIENTATION ABOUT THAT VECTOR.

#160

#170

TRANSFER
CONTENTS
OF NOUN
96 INTO
NOUN 19

#230

STORE
ATTITUDE
SPECIFIC-
ACTION FOR
+X-AXIS
TRACKING
ATTITUDE
FOR USE
BY THE
ATTITUDE
MANEUVER
ROUTINE
(P60).

#240

·
·
·

#250

HOLD .. FLASH VERB-NOUN
..... TO REQUEST RESPONSE
SNAP .. AND DISPLAY COMPUTED
· GIMBAL ANGLES
· V06 N18
· R1-06
· R2-10
· R3-M0
· ALL GIMBAL ANGLES
· IN DEGREES TO THE
· NEAREST .01 DEGREES

MONITOR OSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
COMPUTED GIMBAL
ANGLES.

#260

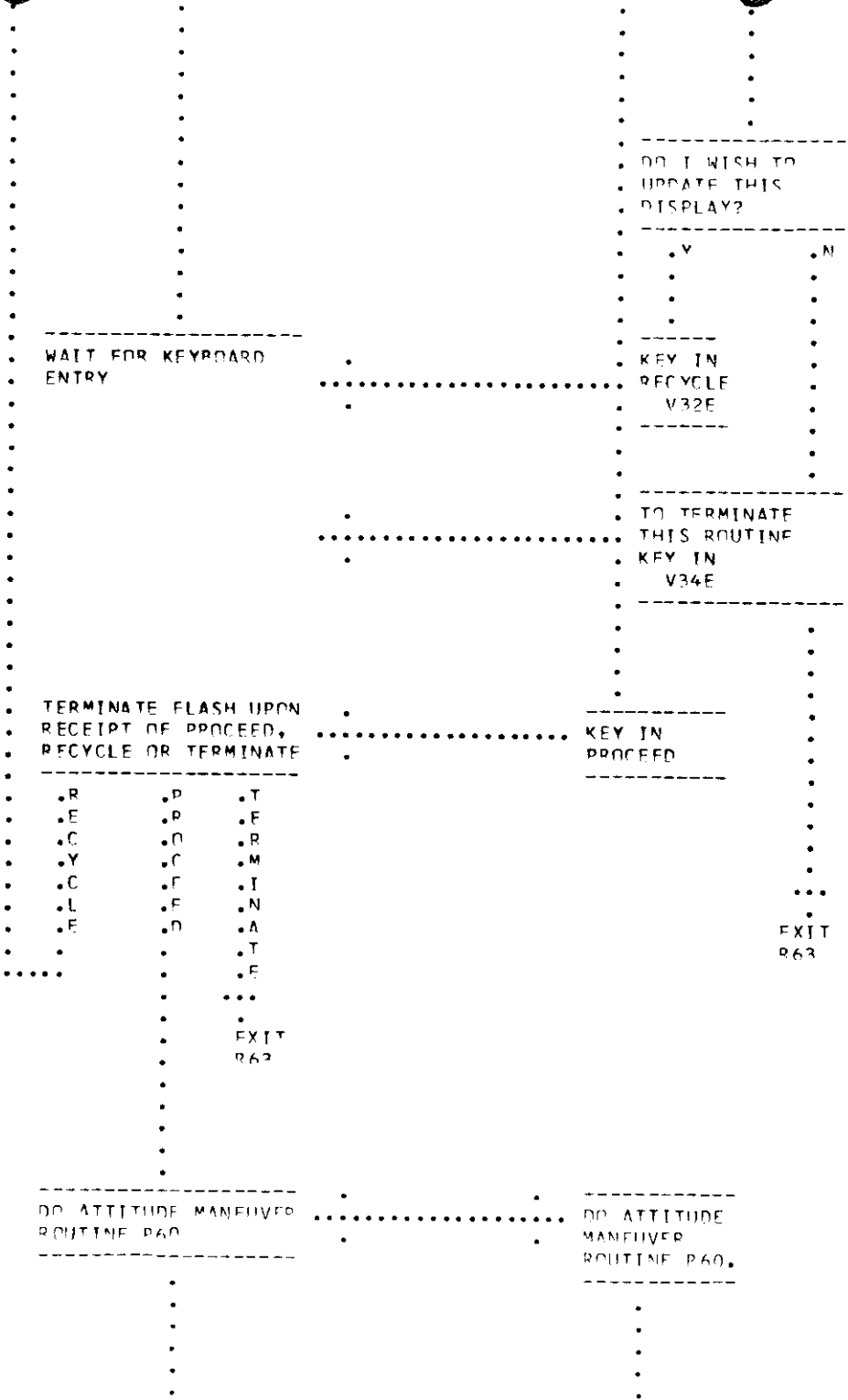
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#270

SHALL I ALLOW
THE CAM TO
ORBIT THE SPACE
CRAFT TO THE
DESIRED ATTIT-
TUD?

#280

· Y · N
·
·
·
·
·
·



#290

#300

#310

#320

#330

FRESH START VERB (V36)

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

++
+04
+
+04
++

PROG 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) -----					#20
	. . .					
	----- SET TIME 3 = 37777 TIME 4 = 37775 TIME 5 = 37774 -----					#30
					

++
+04
+04
++

.
 .
 .
 .

 ZERO OUTBIT CHAN-
 NELS: 11 (EXCEPT
 ENGINE ON, OFF AND
 ISS WARNING);
 12 (EXCEPT COARSE
 ALIGN ENABLE, ZERO
 IMU CDU'S, ENABLE
 IMU ERROR COUNTER;
 13 (EXCEPT TELEMETRY
 BITS, RESET TRAP
 BITS AND TRAPT
 BIT);
 14 (EXCEPT CYRO EN-
 ABLE).

++
 +04
 ++

#40

.
 .
 .

 TERMINATE WAITLISTED
 TASKS

#50

.
 .
 .

 CLEAR ALL EXECUTIVE
 REGISTER SPTS

#60

.
 .
 .

 INDICATE NO ACTIVE
 JOBS

#70

.
 .
 .

 MAKE ALL VAC AREAS
 AVAILABLE

.
 .
 .

 BLANK DSKY REGISTERS
 (PROGRAM, VERR,
 NCUN, R1, P2, R3.)

#80

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 .
 .
 .
 .
 .
 .
 .
 .
 .

 RESET DISPLAY/
 ASTRONAUT INTERFACE
 FLAGS

#90

.
 .
 .
 .

 TURN OFF DSKY
 DISCRETE LIGHTS.

.
 .
 .
 .

#100

 CLEAR FAIL REGIS-
 TERS, SELF CHECK
 ERROR COUNTER, AND
 RESTART COUNTER

.
 .
 .
 .

#110

++
 +04
 ++

 CLEAR SELF-CHECK
 ERROR REGISTERS,
 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

.
 .
 .
 .
 .
 .
 .
 .
 .
 .

435

CHANGE CONTROL NOTFS

LOGIC REV 04 PCR MIT 66

00231000

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639

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.
.
.
.
EXIT

V40N20/COLLOSSUS

CHANGE CONTROL NOTES

REV 03 PCB 206

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IS THE IMU
BEING
INITIALIZED?

.N .Y

TURN ON OPR
ERR LIGHT

EXIT

#30

#40

++
+04
+
+04
++
EDIT

#50

HOLD .
.....
.

FLASH VERB-NOUN TO
REQUEST LOAD OF
DESIRED CDU ANGLES.
V2IN22
R1-OG ROLL
R2-IG PITCH
R3-MG YAW

ALL REGISTERS
INITIALLY BLANK

ALL ANGLES IN DE-
GREES TO NEAREST .01
DEGREE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF CDU ANGLES

#60

SHALL I LOAD CDU
ANGLES?

.Y .N

#70

WAIT FOR KEYBOARD
ENTRY

.....
LOAD DESIRED
ANGLES

TERMINATE FLASH UPON
RECEIPT OF DATA OR
PROCEED

KEY IN
PROCEED

.DATA .P
. .R
. .O
. .C
. .E
. .E
. .D
. .
. .
.....
. .

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)

#80

#90

#100

#110

#120

WAIT 1.5 SECONDS

READ PRESENT IMU OR-
IENTATION W.R.T. THE
VEHICLE.
(GIMBAL ANGLES)

ARE THE GIMBALS
WITHIN 2 DEGREES OF
THE DESIRED ANGLES?

.Y .N
.
.
.

. TURN ON PROGRAM
. ALARM AND STORE
. ALARM CODE
. (00211)

.....
EXIT

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

.N .Y
.
.
...
EXIT

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

.Y .N
.
.
.
.
.
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.

#130

#140

#150

#160

#170

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+
+
+
+
+05
++
EDIT

IS OPTICS MODE
CMC?

.Y .N

.
.
.
.

TURN ON OPR
ERR LIGHT

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.
.
.

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00115)

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.
.

ARE OPTICS AVAIL-
ABLE?

.Y .N

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TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00117)

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MONITOR PROGRAM
ALARM LIGHT: IF THE
PROGRAM ALARM LIGHT
COMES ON AT THIS
TIME, THE ASTRONAUT
SHOULD KEY V05N09E
TO CHECK THE ALARM
CODE:

00115-SET OPTICS
MODE SW-CMC
RSET

00117-OPTICS NOT
AVAILABLE.
THE PROCESS
CANNOT BE
DONE AT THIS
TIME

#40

#50

#60

#70

#80

#90

648

