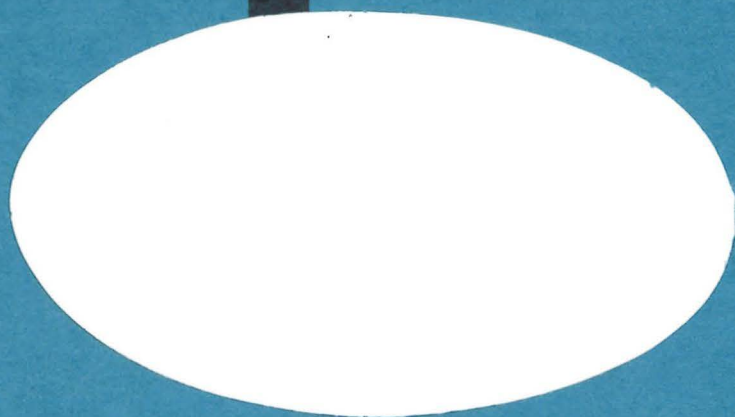


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R-557

GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED LM EARTH ORBITAL
MISSIONS USING
PROGRAM SUNDANCE (REV. 306)

SECTION 4 PGNCS OPERATIONAL MODES
(Rev. 3)

JANUARY 1969

**MIT INSTRUMENTATION
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R-557

GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED LM EARTH ORBITAL MISSIONS
USING
PROGRAM SUNDANCE
Rev. 306
SECTION 4 PGNC OPERATIONAL MODES

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REVISION INDEX COVER SHEET

GUIDANCE SYSTEM OPERATION PLAN

GSOP # R-557 Title: For Manned Earth Orbital Mission Using Program
SUNDANCE
Section # 4 Title: PGNCS Operational Modes (Rev. 2)

Date	Rev.			
2/20/68	1	Remove Pages	Add Pages	PCR Ref.
		All of R-53 (ppgs. 399-416 inclusive)	New R-53 (16 pages numbered R53-1 to R53-16), last page of R-52, and first page of R-54 included in order to permit neat insertion. Title Page, Index Sheet	PCR #7
		Title Page		
7/1/68	2	Revision 2 incorporates the following NASA/MSC approved changes and is published as a complete new document.		
		MIT No.	NASA PCR	
		15.1	146.1 *	Emergency termination of integration function
		27.2	80.1 *	State Vector synchronization
		30	145 *R	GSOP Change R63
		39.1	85.1 *R	Attitude hold during X axis over ride
		40.1	86.1 *	Deadband selection changes
		44.1	124.1 *	Attitude maneuver during search routine
		47.1	405.1 *	GSOP update (sect. 4) R30
		49	177 *	GSOP update (section 4) P 40
		50.2	148.2 *	IMU ON check in P51
		52.1	406.1 *	Correction to R04 in GSOP section 4.
		56	178 *	P30 displays and section 4 of update flag changes
		57.1	449 *	Noun 78 scaling in V/Noun list of sect. 4
		58.1	450 *	Noun 78 scaling in R04
		60.1	251 *	GSOP update section 4
		65	126 *	GSOP update section 4
		71	179 *	New alarm code (1711) for P40, P41, P42
		74	180 *	R77 restriction
		85.1	184.1 *	Standardize termination of extended verbs 47 and 48

* Indicates an MIT Program Change Notice (PCN)

Date: July 1, 1968

REVISION INDEX COVER SHEET (cont.)

GUIDANCE SYSTEM OPERATION PLAN

GSOP #R-577 Title: For Manned Earth Orbital Mission Using Program
SUNDANCE

Section #4 Title: PGNCS Operational Modes (Rev. 2)

MIT No.	NASA PCR		
86	142	*	Rescale attitude error display
88.1	185.1	*	Sign change to Noun 73
90.1	186.1	*	Elimination of ullage following an enter or terminate
92.1	144.1	*	Reduction of ullage duration of delta threshold
94.2	407.2	*	GSOP change to Noun 90 R1 scale
95.1	451.1	*	P20 display terminates in GSOP
96.1	452.1	*	Routine 03 mass limits
102.1	408.1	*	R47 changes to section 4
103.2	173.2	*	RMS position and velocity display
104.1	409.1	*	Transfer of RR from auto track to LGC Mode
106.2	453.1	*	Alarm 1520 and IMUSE flag
109.1	410.1	*	Prevent problems arising from RR control mode changes
110.1	415.1	*	Prevent display conflicts when RR goes out of auto mode
118	426	*	V43 Reconciliation
119	454	*	Noun list corrections
120	455	*	Verb list corrections
121	456	*	Correction to V36
122	427	*	V74 reconciliation
123	428	*	V55 reconciliation
124	429	*	V69 reconciliation
125.1	457.1	*	Correction to R22
130	430	*	V61 Reconciliation
131	458	*	V41N72 addition of assumption
132	459	*	RDR check
133	443	*	Checklist code reconciliation
134	411	*	Option code reconciliation
135	460	*	IMU check
136	412	*	Delete N89 in P52
137	461	*	Update of alarm code list
138.1	431.1	*	R24/1261 Interface
139.1	444.2	*	P06 IMUSE flag
143.1	432.1	*	GSOP section 4 R21 repositioning check
144.1	413.1	*	GSOP section 4 R02 IMUSE flag
145.1	433.1	*	GSOP section 4 R60 clarification

* Indicates an MIT Program Change Notice (PCN)

Date: July 1, 1968

REVISION INDEX COVER SHEET (cont.)

GUIDANCE SYSTEM OPERATION PLAN

GSOP # R-557

Title: For Manned Earth Orbital Mission Using Program

SUNDANCE

Section #4

Title: PGNCS Operational Modes (Rev. 2)

MIT No.	NASA PCR	
	30	DPS trimming time
	31	LGC Req. during AGC switchover
	79	Flagbit update verb
	95	Sign change to N72
	96	Change to RR coarse align extended verb
	97	RR monitor routine change
	103	Delete programs P72, P73, P74, & P75
	114	Delete minimum deadband setting during min impulse burn

Date	Rev.	Revision 3 incorporates the following NASA/MSC approved changes:		
Jan, 1969	3	PCR/PCN	Remove	Add
			Title Page (Rev. 2)	Title Page (Rev. 3)
			Revision Index	Revision Index
			Cover Sheet,	Cover Sheet,
			Page vii	Page vii
		658	P20, Rev. 13	P20, Rev. 14
		401.3*	P30, Rev. 10	P30, Rev. 11
		401.3*, 540.2*	P32, Rev. 10	P32, Rev. 11
		401.3*, 540.2*	P33, Rev. 14	P33, Rev. 15
		401.3*	P40, Rev. 20	P40, Rev. 21
		401.3*	P41, Rev. 16	P41, Rev. 17
		401.3*	P42, Rev. 19	P42, Rev. 20
		603.1*	P52, Rev. 18	P52, Rev. 19
		512*	R00, Rev. 04	R00, Rev. 05
		592	R04, Rev. 11	R04, Rev. 12
		Edit	R23, Rev. 16	R23, Rev. 17
		500*	R24, Rev. 12	R24, Rev. 13
		Edit	R25, Rev. 13	R25, Rev. 14
		518.1*	R30, Rev. 10	R30, Rev. 11
		513.2*	R33, Rev. 07	R33, Rev. 08
		603.1*	R55, Rev. 07	R55, Rev. 08
		446.1*	R60, Rev. 09	R60, Rev. 10
		Edit	V41N20, Rev. 05	V41N20, Rev. 06
		Edit	V41N72, Rev. 04	V41N72, Rev. 05
		601*	V61, Rev. 03	V61, Rev. 04
		164, 483*	Verb List, Rev. 05	Verb List, Rev. 06
		449*	Noun List, Rev. 06	Noun List, Rev. 07
		593.1	Alarm Codes	Alarm Codes
			List, Rev. 03	List, Rev. 04

* Indicates an MIT Program Change Notice (PCN)

Preface

The Guidance System Operations Plan is published as seven separate volumes (sections) as follows:

Section 1	Pre-Launch
Section 2	Data Links
Section 3	Digital Autopilots
Section 4	Operational Modes
Section 5	Guidance Equations
Section 6	Control Data
Section 7	Error Analyses

This volume, Section 4 of the Guidance System Operations Plan for Manned LM Earth Orbital Missions using Program SUNDANCE describes the operational modes of the mission.

It constitutes a Control Document to govern the structure of these missions, including PGNC interfaces with the flight crew and MCC.

Revisions to this plan require NASA approval.

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NOTE: The reproduction of IBM print-outs in Section 4.4 is deliberately not paginated. Reference to the material on these pages is accomplished by using title and line numbers of Section 4.4.

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4.9	List of Alarm Codes

4. PGNCS OPERATIONAL MODES

4.0 Introduction

Preparation of the PGNCS for any mission involves the generation of computer programs, flight and ground crew procedures, and the provision of hardware to meet interface, accuracy, and instrumentation requirements. All of these mission-related items are specified in the Guidance System Operations Plan.

The guidance operational concept is designed to comprise a set of manually-initiated programs and functions which may be arranged by the flight crew to implement a large class of flight plans. This concept of operation will permit both a late flight-plan definition and a capability for real-time flight-plan changes.

The PGNCS system is designed to perform the LM guidance and navigation functions required on lunar landing missions in a self-contained mode within specified accuracy and maneuver propellant constraints. The System is also designed to accept navigation data from earth-based facilities whenever required to improve accuracy, to reduce maneuver propellant requirements, or to gain some other operational advantage. It is essential on Earth Orbital Missions to demonstrate to the maximum possible extent both the self-contained and earth-cooperative modes of operation, since either mode may be required on lunar missions.

4.1 AGC Program Control

To efficiently coordinate the design of the AGC*Programs, as well as define the astronaut and ground control procedures with respect to the PGNCs system, it is necessary to define the operating inter-relationships between the PGNCs system, other S/C systems, the astronauts and the ground.

In primary PGNCs control modes the AGC can automatically compute required mission parameters and automatically command both PGNCs and LM subsystems. Complete automation of this control throughout a mission is neither feasible nor desirable. For primary as well as secondary control modes of the PGNCs the astronauts and/or the ground must be capable of initiation or termination of AGC Programs. These procedures must be thoroughly defined to design the AGC Program logic for astronaut/ground participation.

4.1.1 AGC Program Initiation

4.1.1.1 AGC Programs

Due to the random time sequencing of many of the AGC tasks the design of Programs which can be utilized at varied times and in varied circumstances offers the best method of accomplishing these tasks. These Programs must incorporate sufficient logic to clearly define the particular time and/or application for which they are used. They must also standardize astronaut/AGC communication procedures, ground/AGC communication procedures and PGNCs and SCS Mode determination.

A logical establishment of these Programs has been made, supplemented by simpler routines not requiring identification as a Program. The Programs, their associated routines and the crew interface are outlined in detail in Section 4.4.

Programs in process in the AGC are identified by the Program light on the keyboard and display panels with two exceptions, P20 and P25. These Programs may be in process at the same time as another Program whose number is displayed.

The AGC is programmed to initiate a Program only in response to the initiation of a specific mission task and will continue the programmed sequence of computations and displays for the specific task until Program completion or termination.

Programs are generally initiated by manual keyboard entry (astronaut) or by AGC UPLINK command (ground). In certain cases Program initiation is automatically done by the previous Program. The diagrams of Section 4.4 show Program selection as it should occur normally.

4.1.1.2 Special AGC Routines

In addition to the AGC Programs there are many routines and subroutines not specifically identified with a Program. The majority of these are automatically performed in a particular computation or control sequence and involve no notification to the "outside world" that they are in process. While they may occasionally

* AGC is an acronym for Apollo Guidance Computer. In the LM, this computer is officially designated as the LGC (LM Guidance Computer).

be referred to in this document their large number alone requires that detailed descriptions be restricted to special AGC program documents.

Several special routines are described in detail herein because of one or more of the following characteristics:

- (a) The routine involves AGC communication with the astronaut.
- (b) The routine is of importance in understanding the Programs.
- (c) The routine involves significant sequences of AGC/ astronaut action but could be performed while certain programs are in process.

These routines include those automatically called by the AGC as well as those manually called. If the routine requires AGC/ astronaut communication, it will start with a particular display which acts as a key to the astronaut that the AGC has automatically entered the routine.

4.1.2 AGC Program Termination

Normally there are two ways by which an AGC Program in process is terminated:

- 1. At completion, the program in process will transfer control to the Final Automatic Request Terminate routine (R00).
- 2. Via a terminate response by the astronaut to an AGC-generated flashing display on the DSKY (usually results in transferring control to R00).

In addition to the above the astronaut may terminate a particular AGC program as follows:

- 1. Select a new Program to operate via the DSKY.
- 2. Select a routine via the DSKY which has been specifically designed to terminate a particular program or activity (e.g. state vector integration).
- 3. Select the FRESH START routine which essentially initializes the AGC.

4.2 AGC/Astronaut/Ground Communications

4.2.1 AGC/Ground Communications

The AGC/Ground Communications are via the AGC UPLINK and AGC DOWN-LINK and are described in detail in Section 2 of this GSOP.

4.2.2 AGC/Astronaut Communications

The display and keyboard logic in the AGC processes information exchanged between the AGC and the computer operator. This information is exchanged via the Display and Keyboard (DSKY).

The modes of operation are basically:

- (a) Display of internal data - This includes simple displays and periodically updated displays of data; and displays of requests for operator action required by the AGC.
- (b) Loading of external data - the process of inserting data into the AGC via the DSKY.
- (c) Program or Routine calling - Initiated by operator action via the DSKY.

The following paragraphs and Table 4-1 (page 4-17) provide a limited description of the DSKY, and the crew/DSKY operating procedures. They are included herein to facilitate understanding of the Program logic in Section 4.4 and do not comprise a complete instruction manual for the use of the DSKY. For detailed DSKY operating instructions refer to other MIT documents.

4.2.2.1 The DSKY (refer to Fig. 4-1, page 4-18).

- (a) UPLINK ACTY Light - is energized by the first character of a digital UPLINK message received by the AGC. If the light is not extinguished by the UPLINK transmission it should be extinguished by crew use of the RSET or KEY REL buttons when the UPLINK transmission is complete.
- (b) NO ATT Light - is energized when the AGC is in operate mode and there is no inertial reference; i.e. the ISS is off, caged, or in the coarse align mode.
- (c) STBY Light - is energized when the AGC is in standby mode and deenergized when the AGC is in operate mode.
- (d) KEY REL LIGHT
 - (1) Energized when:
 - a) An internal display comes up while astronaut has the DSKY.
 - b) An astronaut keystroke is made when an internal flashing display is currently on the DSKY. (Note three exceptions: PRO (proceed), RSET (reset) and ENTR (enter) if ENTR is a single button response.

- c) The astronaut makes a keystroke on top of (his own) Monitor Verb display. This is the so-called "suspended monitor" case. (Monitor Verbs display data updated every one second.)
- (2) De-energized when:
 - a) Astronaut relinquishes DSKY by hitting KEY REL button.
 - b) Astronaut terminates his current sequence normally, eg.
 - i) with final ENTR of a load sequence.
 - ii) the ENTR of a response to a flashing display.
 - iii) the ENTR of an extended verb request,
- (3) Some special DSKY cases that may not be universally appreciated are:
 - a) The astronaut may select a non-Monitor Verb display on top of his own previously selected Monitor Verb. This will cause KEY REL light to flash (See 1c above). Hitting the KEY REL button will bring back (unsuspend) the monitor and extinguish the light. However, if these sequences are selected on top of an internal display, the KEY REL light will not go out as the monitor is unsuspended. It requires one more KEY REL button operation to extinguish the light and bring back the internal display.
 - b) Suppose the astronaut selects another verb-noun combination (e.g. a V16 monitor) on top of an internal flashing display. That internal display can still be answered with an ENTR, PRO or VERB 34 ENTR (terminate), which wipes everything from the DSKY till the next internal display. Therefore, an astronaut selected monitor should, as a rule, never be terminated with VERB 34 ENTR, because that may not be the desired response to the flashing display. The KEY REL button should be used instead.
- (e) TEMP Light - the AGC receives a signal from the IMU when the stable member temperature is in the range 126.3°F to 134.3°F . In the absence of this signal, the TEMP lamp on the DSKY is actuated.
- (f) GIMBAL LOCK Light - is energized when the middle gimbal angle exceeds $\pm 70^{\circ}$ from its zero position. When the middle gimbal exceeds $\pm 85^{\circ}$ from its zero position the AGC automatically commands the coarse align mode in the ISS to prevent gimbal oscillation. The NO ATT light will then be energized (see (b)).

- (g) PROG Light - The program alarm actuates the PROG light on the DSKY. A program alarm is generated under a variety of situations. Under program control the AGC inhibits this alarm for 10 sec after system turn-on. For further information see section 4.3.3.
- (h) TRACKER Light - when the rendezvous or landing radars are on, the light is energized when:
 - (1) An RR CDU fine error greater than 1.0 vrms occurs.
 - (2) An RR CDU coarse error greater than 2.5 vrms occurs.
 - (3) The RR read counter limit cycles at a rate greater than 160 cps.
 - (4) An RR CDU analog to digital conversion fails ($\cos\theta - \phi$) is less than 2 volts.
 - (5) The RR CDU + 14 VDC supply decreases to 50% of nominal.
 - (6) When the RR Data Good Bar discrete occurs during an AGC data read sequence.
 - (7) When an LR Altitude Data Good Bar discrete or LR Velocity Data Good Bar discrete occurs during an AGC data read sequence.
- (i) OPR ERR Light - is energized when the DSKY operator performs an improper sequence of key depressions. The light is de-energized by pressing the RSET button.
- (j) COMP ACTY Light - is energized when the AGC is occupied with an internal sequence. It is not an indicator of whether the operator may use the DSKY or whether the AGC is not capable of handling further computation.
- (k) RESTART Light - in the event of Restart during operate a latch is set in the AGC which maintains the RESTART lamp on the DSKY until the latch is manually reset by pressing the RSET button. For further detail see section 4.3.3.
- (l) Display Panel - consists of 24 electroluminescent sections arranged as in Fig. 4-1, page 4-18. Each section is capable of displaying any decimal character or remaining blank, except the 3 sign sections (R1S, R2S, R3S). These display a plus sign, a minus sign, or a blank. The numerical sections are grouped to form 3 data display registers, each of 5 numerical characters; and 3 control display registers, each of 2 numerical characters. The data display registers are referred to as R1, R2, R3. The control display registers are known as VERB, NOUN, and PROGRAM. At maximum activity, the complete display panel may be updated in 1/4 second.

(m) Keyboard - contains the following buttons:

VERB - pushing the button indicates that the next two numerical characters keyed in are to be interpreted as the Verb Code.

NOUN - pushing the button indicates that the next two numerical characters keyed are to be interpreted as the Noun Code.

+ and - - sign keys used for sign convention and to identify decimal data.

0 - 9 - numerical keys.

CLR - used during a data loading sequence to clear or blank the data display register (R1, R2, R3) being used. It allows the operator to reload the data word.

PRO - this pushbutton performs two functions:

1. When the AGC is in a standby mode, pressing this button will put the AGC in the operate mode, turn off the STBY light (see(c)), and automatically select Program 00 in the AGC.
2. When the AGC is in the operate mode but Program 06 is not selected, pressing the button will provide the proceed function. Proceed directs the AGC to continue to the next programmed event. In response to an AGC request it further indicates crew compliance with the request.
- 2a. When the AGC is in the operate mode and Program 06 is selected, pressing the button will put the AGC in the standby mode and turn on the STBY light (see (c)).

ENTR - is used in three ways:

1. To direct the AGC to accept a data word just loaded.
2. In response to a "please perform" request (see section 4.2.2.7).

RSET - turns off alarm conditions on the DSKY providing the alarm condition has been corrected.

4.2.2.2 Verbs and Nouns

The basic language of communication between the astronaut and the DSKY consists of Verb and Noun codes. The Verb Code indicates what action is to be taken. The Noun Code indicates to what this action is applied.

Verb Noun codes may be originated either by manual operation or by the AGC Program in process.

The standard procedure for a manual keyboard operation consists of a sequence of 7 key depressions:

VERB	V ₁	V ₂	NOUN	N ₁	N ₂	ENTR
------	----------------	----------------	------	----------------	----------------	------

The VERB key depression blanks the Verb lights on the display panel and clears the Verb Code register within the computer. The next two numerical characters punched in are interpreted as the Verb Code. Each of these characters is displayed in the Verb lights on the display panel as it is punched in. The NOUN key operates similarly for the Noun lights and Noun Code register.

The depression of the ENTR key causes the performance of the Verb-Noun combination appearing in the lights at the time of depression. Thus it is not necessary to follow any order in punching in the Verb or Noun Code. They may be done in reverse order, or an old Verb or old Noun may be used without repunching it.

No action is ever taken in performing the Verb-Noun combination until ENTR is pressed. If an error is noticed in either the Verb Code or the Noun Code before the ENTR is pressed, correction is simple. Merely press the VERB or NOUN key and repunch the originally intended code, without necessarily changing the other. Only when the astronaut has verified that the desired Verb and Noun Codes are in the lights, should he press the ENTR key to execute the Verb-Noun combination.

A Noun Code can refer to a group of computer erasable registers, a group of counter registers, or may serve merely as a label. A label Noun refers to no particular computer register, but conveys information by its Noun Code number only. The group of registers to which a Noun Code refers may be a group of 1, 2 or 3 members. These are generally referred to as 1, 2, or 3 component Nouns. The component is understood as a component member of the register group to which the Noun refers. The machine addresses for the registers to which a Noun refers are stored within the computer in Noun tables.

A single Noun Code refers to a group of 1, 2, or 3 component members. It is the Verb Code that determines which component member of the Noun group is operated on. Thus, for instance, there are 5 different Load Verbs. Verb 21 is

required for loading the first component of whatever Noun is used therewith; Verb 22 loads the second component of the Noun; Verb 23, the third component; Verb 24, the first and second components of the Noun; and Verb 25 loads all three components of the Noun. A similar component format is used in the Display and Monitor Verbs.

When the decimal Display Verb is employed, all the component members of the Noun being used are scaled as appropriate, converted to decimal, and displayed in the data display registers.

Decimal data is identified by a + or - sign preceding the 5 numerical characters. If decimal is used for loading data of any component members of a multi-component Load Verb, it must be used for all components of the Verb. Thus no mixture of decimal and octal data is permitted for different components of the same Load Verb. (If this is violated, the OPR ERR light is turned on.)

There is a class of verbs called Monitor Verbs which display data every one second. Once a Monitor Verb is executed, the data on the display panel continues to be updated until the Monitor is turned off.

The Monitor may be turned off by keying in: PRO, VERB 34 ENTR (terminate), by internal program initiation of the Keyboard and Display System Program, (if the DSKY is not busy) or by a Fresh Start of the AGC.

Monitor action is suspended (but not ended) by the depression of any key, except RSET. This turns on the KEY REL light immediately. Monitor action continues after the Keyboard and Display System is released. Thus it is possible to suspend a monitor while the astronaut loads some data (or requests another display) and to return to the original monitor when his intervention is concluded.

After any use of the DSKY, the numerical characters (verb, noun and data words) remain visible until the next use of the DSKY. If a particular use of the DSKY involves fewer than 3 data words, the data display registers (R1, R2, R3) not used remain unchanged, unless blanked by deliberate program action.

The DSKY procedures above were described for manual operation; however, the principles described remain the same for DSKY operation by the AGC Programs and routines.

As outlined in the Mission Programs (section 4.4) the majority of DSKY operations are of the following categories:

- a) Display - to display data to the operator. Display Verbs present data computed by the mission program.
- b) Load - to request a data load as described in detail below.

- c) Please Perform - to request an action from the astronaut.
(see section 4.2.2.7)
- d) Please Mark - to request the astronaut to push the "MARK" button
for an optics sighting.

AGC initiated Verb/ Noun combinations are either statically displayed or flashed. If static they identify data displayed only for astronaut information requiring no response from him. If the Verb/Noun is flashing, appropriate astronaut response is required as dictated by the Verb/Noun combination. In this case the AGC Program or Routine is interrupted until the astronaut responds appropriately, then the Verb/ Noun flash is terminated and the Program or Routine is resumed.

An appropriate astronaut response to a flashing Verb/Noun should be a data load and ENTR, VERB 32 ENTR (recycle), PRO, or VERB 34 ENTR (terminate). The internal program response to any one of these astronaut responses varies according to the Verb/Noun flashing and the Program in process as described below and in Section 4.4.

4.2.2.3 Acceptance of Keys

The numerical keys, the CLR key, and the sign keys are rejected if struck after completion (final ENTR) of a data display or data load Verb. At such time, only the VERB, NOUN, ENTR, RSET, or KEY REL are accepted. Thus the data keys are accepted only after the control keys have instructed the program to accept them.

Similarly the plus (+) and minus (-) keys are accepted just before the first numerical character of R1, R2, R3 is punched in, and at no other time.

The 8 or 9 key is accepted only while defining a verb or noun, or when loading a data word into R1, R2, or R3 which was preceded by a plus or minus sign. (If this is violated, the OPR ERR light is turned on.)

If more than two numerical characters are punched in while loading the Verb, Noun, or Program code, or more than five numerical characters while loading a data word, the excess characters are not accepted.

4.2.2.4 Release of Keyboard and Display System

The Keyboard and Display System Program can be used by internal computer programs. However, any operator keyboard action (except RSET) makes the Keyboard and Display System Program busy to internal routines. The operator has control of the Keyboard and Display System until he wishes to release it. Thus he is assured that data he wishes to observe will not be replaced by internally initiated data displays. In general, it is recommended that the operator release the Keyboard and Display System for internal use when he has temporarily finished with it. This is done by pressing the KEY REL button.

If an internal program attempts to use the Keyboard and Display System, but finds that the astronaut has used it and not yet released it, the KEY REL light is turned on. When the astronaut finds it convenient, he should strike the KEY REL button to allow the internal program to use the keyboard and display panel.

4.2.2.5 Display - Verb/Noun Flashing

This is an internally initiated action. The appropriate astronaut response to a flashing display Verb/Noun combination is:

- (a) Correct the data (see Section 4.2.2.6 below). Perform the appropriate Load Verb sequence. Upon the final ENTR, the program proceeds normally.
- (b) VERB 32 ENTR (recycle). This causes the program to return to a previous location.
- (c) PRO. This indicates acceptance of the displayed data, and a desire for the internal sequence to continue normally.
- (d) VERB 34 ENTR (terminate). The astronaut wishes to terminate the operation.

NOTE: Uncommon responses are defined in the program logic of Section 4.4

4.2.2.6 Load - Verb/Noun Flashing

Whenever any data is to be loaded the Verb/Noun flashes. The flash occurs whether the data load is initiated by the AGC or by the astronaut. The appropriate data display register (R1, R2, or R3) is blanked in anticipation of the data load. Data is loaded in 5-character words and is displayed character-by-character in one of the 5-position data display registers as it is keyed in.

Numerical data is considered decimal if the 5-character data word is preceded by a plus or minus sign; if no sign is supplied it is considered octal. The plus and minus keys are accepted only when they precede the first numerical character of the data word; they are ignored at any other time. Decimal data must be loaded in full 5-numerical-character words (no zeros may be suppressed); octal data may be loaded with high order zeros suppressed. If decimal is used for any component of a multi-component Load Verb, it must be used for all components of that Verb. No mixing of octal and decimal data is permitted for different components of the same Load Verb. (If this principle is violated, the OPR ERR light is turned on.)

The ENTR key must be pressed after each data word. This tells the program that the numerical word punched in is complete. The flash is turned off after the last ENTR of a loading sequence.

As data is loaded, it is temporarily stored in buffers. It is not placed into its final destination, as specified by the Noun Code, until the final ENTR of the load sequence.

If an attempt is made to key in more than 5 numerical characters in sequence, the sixth and subsequent characters are simply rejected. If the 8 or 9 key is punched during octal load (as identified by lack of a sign entry), it is rejected and the OPR ERR light is turned on.

In multi-component load situations, the appropriate single component Load Verbs are flashed one at a time. The computer always instructs the astronaut through a loading sequence. For example: the astronaut (or the internal program) initiates the sequence by selecting VERB 25, "load 3 components of: "(any 3-component noun will do). The Verb Code is changed to 21, "load first component of:" and the flash is turned on. VERB 21 continues to be flashed as the astronaut punches in the first word of data. When the ENTR is pressed, the Verb Code is changed to 22. Flashing continues while the astronaut punches the second data word. When ENTR is pressed, the Verb Code is changed to 23, "load third component," and again the flash continues while the third data word is punched in. When ENTR is pressed, the flash is turned off, and all three data words are placed in the locations specified by the Noun. Throughout the changing of the Verb Codes, the Noun Code is left unchanged.

The CLR button is used during data loading to remove errors in R1, R2, or R3. It allows the astronaut to begin loading the data word again. It does not clear the Program, Noun, or Verb lights. (The Noun lights are blanked by the NOUN key; the Verb lights, by the VERB key.) In the following discussions, the term Clearing Function will be used to mean blanking the data display register.

For single component Load Verbs, the CLR button depression performs the Clearing Function on whichever register is being loaded, provided that CLR is punched before data ENTR. Once ENTR is depressed, CLR does nothing. The only way to correct an error after the data ENTR for a single component Load Verb is to begin the Load Verb again.

For the 2- or 3- component Load Verbs, there is a backing-up feature of CLR. The first depression of the CLR buttons performs the Clearing Function on whichever register is being loaded. (CLR may be pressed after any character, but before its ENTR.) Consecutive depressions of CLR perform the Clearing Function of the data display register above the current one, and also changes the VERB light to indicate the register being acted upon until R1 is cleared. Any attempt to back up beyond R1 are simply ignored.

The backing-up of CLR operates only on whatever data is pertinent to the Load Verb which initiated the loading sequence. For example, if the initiating Load Verb was a load second component only, no backing-up action is possible.

4.2.2.7 Please Perform - Verb/Noun Flashing

This is always an internally initiated action, as astronaut response is always required to the "please perform" request; the Verb-Noun is always flashed, and the Program is interrupted. The "please perform" verb (50) is usually used with the "Checklist" noun (25) with an appropriate "checklist code" number in R1. The appropriate response is:

- (a) PRO to indicate an affirmative response to the request.
- (b) ENTR to indicate a negative response to the request.

4.2.2.8 Please Mark

The "please mark" verbs (52, 53 or 54) are flashed when the AGC is prepared to accept optical sighting data upon the pushing of the "MARK" button. The logic associated with the "please mark" function is completely described in Section 4.4.

4.2.2.9 Machine Address to be Specified

There is a class of Noun available to allow any machine address to be used. These are called "Machine Address to be Specified" Nouns. When the ENTR which causes the Verb-Noun combination to be executed senses a noun of this type, R3 is blanked and the flash is immediately turned on. The Verb Code is left unchanged. The astronaut should load the 5-octal-character complete machine address of interest. It is displayed in R3 as it is punched in. If an error is made in loading the address, the CLR may be used to remove it. Pressing ENTR causes the verb to be executed.

4.2.2.10 Program Selection

VERB 37 ENTR is used to select a Program. This causes the Noun display register to be blanked and the Verb Code to be flashed. The 2-character Program Code would then be loaded. For verification purposes, it is displayed as it is loaded in the Noun display register. The ENTR causes 1) the flash to be turned off, 2) a request for the new Program to be entered, and 3) the new Program Code to be displayed in the Program display register.

4.2.2.11 Alarm Philosophy

The OPR ERR light is turned on when the astronaut performs some improper sequence of key depressions.

4.2.2.12 Illegal Verbs, Nouns and Combinations

The simplest alarm situation is an attempt to use an undefined (or spare) Verb Code or Noun Code. The OPR ERR light is turned on when the ENTR that attempts to execute the Verb/Noun combination is pressed. No further action is taken.

It is possible to choose a Verb that is defined and a Noun that is defined, but have the combination of Verb and Noun be illegal (for example, the "decimal display" Verb used with a Noun which is restricted to be "octal only"). The OPR ERR light is turned on at the ENTR that attempts to execute the Verb/Noun combination. No further action is taken.

Violation of the following principles causes the OPR ERR light to be turned on. No further action is taken.

- (a) An undefined (or spare) verb must not be used.
- (b) An undefined (or spare) noun must not be used.
- (c) In octal Display and Monitor Verbs and all Load verbs, the components number of the verb must not exceed the number of components in the noun. (Note, all "machine address to be specified" nouns are considered 3-component.)
- (d) The octal display and Monitor Verbs must not be used with a "decimal only" noun.
- (e) The decimal Display and Monitor Verbs must not be used with an "octal only" noun.
- (f) The double precision decimal Display and Monitor Verbs (07, 17) must not be used with mixed nouns (codes 40-99).
- (g) No Load Verb may be used with a noun restricted to be "no load". All nouns having split MIN/SEC scale or 2 integers for any component are "no load" for the entire noun.
- (h) An input code other than those which are defined is received from the keyboard.
- (i) The contents of the register used to determine which display panel character is to be lighted has exceeded its limit.

4.2.2.13 Illegal Data and Recycle

Many legal Verb/Noun combinations require the loading of additional data (either numerical or machine address). It is possible that the data supplied may itself be improper for the Noun selected. Examples are: (1) the numerical data exceeds the maximum value allowed by the scale factor associated with the Noun, and (2) decimal data is loaded into an "octal only" noun.

In general the offense is detected at the final ENTR of the loading sequence. The alarm is turned on and a recycle is performed back to the beginning of the loading sequence. The flash is left on, and the data display register associated with the first data word in the sequence is blanked again. It is necessary for the astronaut

only to supply the data again; he need not attempt to re-execute the Verb/Noun combination. (Note, if decimal data is supplied for the address of a "machine address to be specified" noun, the alarm and recycle are performed at the ENTR immediately following the address keyed in.)

Violation of the following principles causes the OPR ERR light to be turned on, and a recycle to be performed.

- (a) The address keyed in for a "machine address to be specified" noun must be octal.
- (b) In multicomponent load verbs, no mixing of octal and decimal data is permitted. All the data words loaded for a given noun must either be all octal or all decimal.
- (c) Octal data must not be loaded into a "decimal only" noun.
- (d) Decimal data must not be loaded into an "octal only" noun.
- (e) Decimal data loaded must not numerically exceed the maximum permitted by the scale factor associated with the appropriate component of the noun.
- (f) Negative decimal data must not be loaded using the Y optics scale.
- (g) All 3 words must be loaded for the Hours, Minutes, Seconds scale.
- (h) When loading with the Hours, Minutes, Seconds scale, the minutes must not exceed 59; the seconds must not exceed 59.99; and the total number must not exceed 745 hours, 39 minutes, 14.55 seconds.
- (i) Two numerical characters must be supplied for the Program Code under V37.

4.2.2.14 Operator Error and Key Rejection

There are four situations which cause the OPR ERR light to be turned on and the offending key depression to be simply rejected. These are:

- (a) An attempt to ENTR a decimal data word having fewer than 5 numerical characters. The ENTR is simply rejected. The flash is left on and the Verb Code is not advanced. Thus it is possible to supply the remaining characters and to press the ENTR again for the same data word. Or the CLR key may be used if the operator wishes to begin loading the offending data word again.
- (b) An 8 or 9 is punched while loading a word which was not preceded by a plus or minus sign. The 8 or 9 is simply rejected. The remaining characters may then be supplied or the offending word removed and its loading begun again.

- (c) Certain program controlled cases (see Section 4.4).
- (d) An attempt to call one extended verb on top of another without allowing proper termination of the first.

TABLE 4-1 Astronaut Response to DSKY Displays and AGC Resultant Action.

	DISPLAY OF INFORMATION		REQUEST FOR ASTRO ACTION	REQUEST FOR DATA LOAD	REQUEST FOR OPTICS MARK
ASTRONAUT RESPONSE	Type of information identified by V__N__ followed by up to three available registers of information, R1, R2, R3		Request identified by V99 (please enable engine on), V37 (please select program) or V50 (please perform checklist) identifying a function to be performed or a checklist, one register R1 identifying function on that checklist.	Request identified by V__ and type of data by N___. Loaded data appears in registers R1, R2, R3. At completion key in "ENTR".	Request identified by V52, V53 or V54. At completion of "MARKs" identify target (final entry is "ENTR")
	AGC Awaiting ASTRO Response	AGC Not Awaiting ASTRO	AGC always Awaiting ASTRO Response	AGC Always Awaiting ASTRO Response	AGC Always Awaiting ASTRO Response
	V__N__ Flashing	V__N__ Static	V50N__ Flashing	V__N__ Flashing	V52, V53, or V54 Flashing
	Key in "ENTR"	No AGC Action	No AGC Action	AGC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues.	AGC takes loaded data, terminates flashing Verb-Noun and continues.	No AGC Action
Key in "PRO"	AGC assumes displayed data is correct, terminates flashing Verb-Noun, and continues.	No AGC Action	AGC assumes ASTRO complied, terminates flashing Verb-Noun, and continues.	AGC assumes no data available, terminates flashing Verb-Noun, and continues if possible.	No AGC Action
Key in VERB 34 ENTR (terminate)	Varies with program in progress.	Varies with program in progress.	Varies with program in process.	Varies with program in process.	Program in progress is terminated.
Key in VERB 32 ENTR (re-cycle)	AGC returns to earlier point in sequence.	No AGC Action	Incorrect Response.	Incorrect	No AGC Action
Press "MARK X" button or "MARK Y" button					AGC reads time, terminates flashing Verb-Noun if a suitable number of marks have been made and continues.

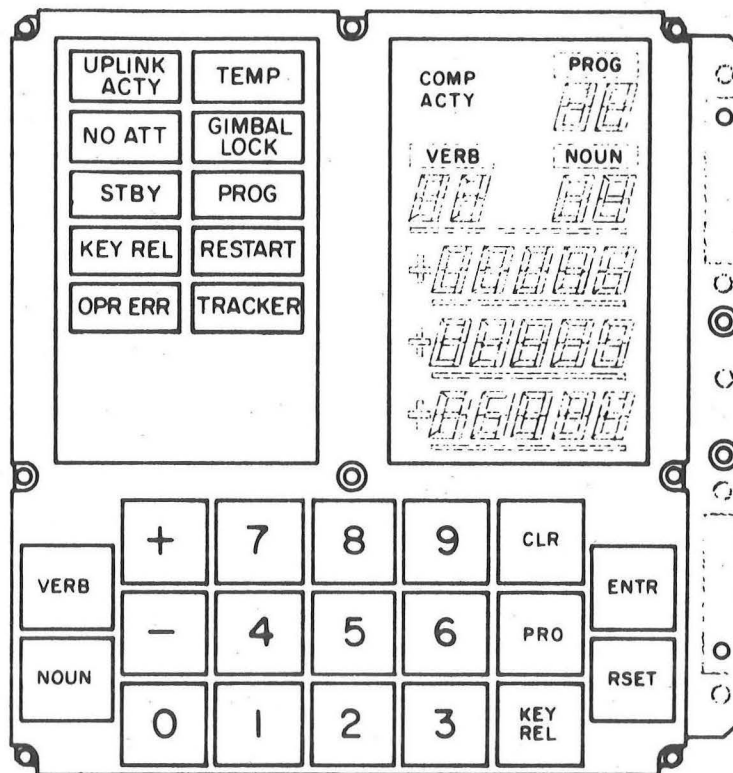


Fig. 4-1 Display and Control Panel

4.3 PGNCS Failure Monitor

The PGNCS performance and operational readiness are self-monitored and caution and warning information are displayed to the crew. Two warning (red) lamps are actuated by the PGNCS on the Caution/Warning Panel: AGC Warning indicates computer failure; ISS warning indicates failure of the inertial subsystem. Also a PGNCS Caution (amber) light is actuated to indicate non-critical problems in the system. Further detail regarding the caution items is displayed by means of the DSKY event lamps and the DSKY data registers (in the event of a program alarm).

4.3.1 AGC Warning

An AGC warning alarm is generated in the event of AGC power failure, scaler failure of either of two types, restart or counter fail during AGC operate, or in response to an alarm test program. A scaler fail or prime power fail result in an immediate alarm indication whereas the other inputs are buffered by a filter so as to prevent transient disturbances from causing a warning alarm. In this subsection the various inputs and conditions associated with AGC warning are defined.

- (a) SCAFAL - Occurs if scaler stage 17 (1.28-sec period) fails to produce pulses. This provides a check on the timing for all logic alarms.
- (b) COUNTER FAIL - Occurs if counter increments happen too frequently or else fail to happen following an increment request. "Too frequently" means continuous counter requests and/or incrementing for from 0.625 to 1.875 ms.
- (c) SCADBL - Occurs if the 100 pps scaler stage operates at a pulse rate of 200 pps or more.
- (d) PARITY FAIL - Occurs if any accessed word in fixed or erasable memory whose address is octal 10 or greater contains an even number of "ones".
- (e) RUPT LOCK - Occurs if interrupt is either too long or too infrequent. The criterion for "too long" is phase dependent, varying in duration from 140 ms to 300 ms. Likewise the criterion for "too infrequent" varies from 140 ms to 300 ms.
- (f) TC TRAP - Occurs if too many consecutive TC or TCF instructions are run or TCF instructions are too infrequent. The criterion for "too many" varies in duration from 5 ms to 15 ms. The criterion for "too infrequent" varies in absence from 5ms to 15ms.
- (g) NIGHT WATCHMAN - Occurs if the computer should fail to access address 67 within a period whose duration varies from 0.64 sec to 1.92 sec.

- (h) V FAIL - Occurs if the AGC voltages (28, 14, 4) are out of limits. This signal produces STRT1 if it stays on for a period of between 157 and 470 μ sec. If the computer is in the STANDBY mode, an input to the AGC WARNING FILTER is generated simultaneously with STRT1. The following criteria apply for V FAIL:

4 V Supply > 4.4 V	14 V Supply > 16 V
4 V Supply < 3.65 V	14 V Supply < 12.5 V
	28 V Supply < ~22.6V

- (i) STANDBY - This is a signal which turns on RESTART and turns off the switchable +4 and +14 voltage, thus putting the AGC into a low power mode where only the scaler, timing signal, and a few auxiliary signals are operative. STANDBY is initiated by first setting the ENABLE STANDBY outbit (CH13 B11), and then pressing the PRO button on the DSKY for a time which varies from 0.64 sec to 1.92 sec. at the end of which time the STANDBY light is turned on. (All AGC alarms are inhibited during the Standby mode with the exception of AGC WARNING, which can be caused by VOLTAGE FAIL or SCALER FAIL; and TEMPERATURE CAUTION, which can be caused by TEMP ALARM.) Normal operation is resumed by pressing the PRO Button on the DSKY again. Time of depression same as above.
- (j) RESTART - RESTART occurs at next time 12 following occurrence of any one or more of the following parameters: RUPT LOCK, TC TRAP, NIGHT WATCHMAN parity fail, and standby as described above.

RESTART occurs immediately and forces time counter to 12 upon occurrence of OSCILLATOR FAIL. (See paragraph (1) below.)

RESTART causes the computer to transfer control to address 4000 as soon as it disappears. It sets a flip-flop which lights the RESTART CAUTION lamp in the DSKY.

The Flip-flop is reset either by the ALARM RESET hard-wired signal or by the CAUTION RESET outbit CH11 B10. ALARM TEST operates the lamp but not the flip-flop.

- (k) WARNING FILTER - This circuit is used to operate the AGC WARNING output following repeated or prolonged occurrences of any of certain parameters. All occurrences of these signals are stretched so that no more than one input to the filter is generated in each 160-millisecond period. Approximately six consecutive stretched pulses cause AGC WARNING to turn on for

about 5 seconds. Non-consecutive stretched pulses may also cause AGC WARNING after an interval dependent on the frequency of the pulses. The output will not occur if input pulses occur at a frequency of less than 0.9 pps; and the output will remain on if pulses occur at a frequency of 0.6 pps or more. The threshold of the filter resumes its normal level with a time constant of many seconds after the filter has received inputs. An immediate reset of the AGC FAIL due to a WARNING FILTER output is therefore not possible.

- (1) OSCILLATOR FAIL - Occurs if the oscillator stops. Has nominal 250-millisecond delay to keep signal present after the oscillator starts. Also occurs when AGC is in STANDBY because of loss of power to front end of circuit. This results in a 250-millisecond delay in starting when AGC comes out of STANDBY into OPERATE, and causes an immediate restart without waiting for time pulse 12.

4.3.2 ISS Warning

The ISS Warning signal is the logical "OR" of the following parameters, any one of which will cause an ISS Warning under the following conditions:

(a) IMU Fail

- (1) IG Servo Error - greater than 2.9 mr for 2 sec
- (2) MG Servo Error - greater than 2.9 mr for 2 sec
- (3) OG Servo Error - greater than 2.9 mr for 2 sec
- (4) 3200 cps supply-decrease to 50% of normal voltage level
- (5) 800 cps wheel supply - decrease to 50% of normal voltage level

These parameters are generated in the Inertial Subsystem. However, the "FAIL" signal itself is under AGC program control. It is ignored by the AGC program when the G&N System is in the Coarse Align Mode and during the 5-second interval following Coarse Align. During this mode the servo errors normally exceed the above criteria.

(b) PIPA FAIL

Pipa fail occurs if no pulses arrive from a PIPA during a 312.5-sec period, or else if both plus and minus pulses occur, or if a "long time" elapses without at least one plus pulse and at least one minus pulse arriving. By "long time" is meant a period of between 1.28 sec and 3.84 sec.

This FAIL signal is generated totally within the AGC and thus is completely under AGC program control. Its generation is enabled by the AGC only during AGC controlled translation or thrusting maneuvers.

- (c) ISS CDU FAIL (Monitored for each of 3 CDU's)
 - (1) CDU fine error - in excess of 1.0 V rms
 - (2) CDU coarse error - in excess of 2.5 V rms
 - (3) READ COUNTER limit cycle - in excess of 160 cps
 - (4) $\cos(\Theta - \phi)$ - below 2.0 V
 - (5) +14 VDC Supply - decrease to 50% of normal level

These parameters are generated in the Inertial Subsystem. However, the "FAIL" signal itself is under AGC program control. It is ignored by the AGC program when the G & N System is in the CDU Zero Mode. During this Mode the CDU errors normally exceed the above criteria.

4.3.3 PGNCS Caution

The PGNCS Caution lamp is actuated by the following undesirable but non-critical events:

- (a) AGC Restart during Operation. In the event of Restart during operate a latch is set in the AGC which maintains the PGNCS Caution alarm and the RESTART lamp on the DSKY until the latch is reset by program or until the latch is manually reset by ALARM RESET. For further detail see section 4.3.4.
- (b) Temperature out of Limits. The AGC receives a signal from the IMU when the stable member temperature is in the range 126.3°F to 134.3°F. In the absence of this signal, the Caution alarm and the TEMP lamp on the DSKY are actuated.
- (c) Gimbal Lock. When the AGC determines that the middle gimbal angle (MGA) of the IMU is greater than 70°, the Caution alarm and the Gimbal Lock lamp on the DSKY are actuated. When MGA exceeds 85° the ISS is downmoded to Coarse Align and the No Attitude lamp on the DSKY is actuated.
- (d) Program Alarm. Under a variety of situations a program alarm is generated. One example is that of a PIPA fail when the vehicle is not in a thrusting mode. Under program control the LMC inhibits this alarm for 10 sec after system turn-on. The program alarm actuates

the Caution alarm and the Program lamp on the DSKY. For further information see section 4.3.4.

- (e) Tracker Alarm indicates one of five possible Rendezvous Radar CDU failures. (see paragraph 4.2.2. (h))

4.3.4 Restart and Program Alarms

When the Restart or Program Alarm lamps are illuminated on the DSKY, either V05N09 will automatically appear on the DSKY with the alarm code displayed in R1, R2, R3, or this information can be displayed by astronaut call up from the DSKY. This allows the astronaut to identify and normally correct the alarm condition. The listing of program alarms is included in Section 4.4.

4.4 AGC Logic/Ground/Crew Interface Diagrams

These diagrams outlined the detailed logic of the inter-relationship the AGC/Crew/Ground. For ease of correction and reproduction the diagrams have been incorporated on IBM cards and are presented as a computer printout.

The diagrams contain the following:

- 1) Program Control - Indication of sequence interruptions and the following display notation:
 - a) PRIO (Priority) - denotes a priority display
 - b) HOLD - denotes that the flashing verb-noun and data will continue to be displayed until the astronaut takes DSKY action.
 - c) TEMP HOLD (Temporary HOLD) - denotes that the duration of the display on the DSKY (non-flashing) is controlled by the AGC.
 - d) POSS HOLD (Possible HOLD) - denotes that the display is a possible path taken by the AGC.
 - e) MON (Monitor) - denotes that the displayed data is automatically updated and displayed by the AGC.
 - f) SNAP - denotes that the displayed data is not automatically updated (monitored) by the AGC.
- 2) AGC The sequence logic and interface relationships of the
- 3) Ground AGC logic, ground operations and crew activities.
- 4) Crew

5) A line count is provided on the far right hand side of the page.

The reproductions of IBM print-outs in Section 4.4 is deliberately not paginated. Reference to the material on these pages is accomplished by using title and line numbers,

	04	-----*
	05	-----*
	06	LSC POWER DOWN
	07	-----*
	08	-----*
	09	-----*
ASCENT	10	-----*
	11	-----*
	12	-----*
	13	-----*
	14	-----*
	15	-----*
	16	-----*
	17	-----*
	18	-----*
	19	-----*
COAST	20	RENDEZVOUS NAVIGATION
	21	GROUND TRACK DETERMINATION
	22	-----*
	23	-----*
	24	-----*
	25	PREFERRED TRACKING ATTITUDE
	26	-----*
	27	LSC UPDATE
	28	-----*
	29	-----*

PRE-THRUSTING	30	EXTERNAL DELTA V
	31	-----*
	32	CO-ELLIPTIC SEQUENCE INITIATION (CSI)
	33	CONSTANT DELTA ALTITUDE (CDH)
	34	TRANSFER PHASE INITIATION (TPI)
	35	TRANSFER PHASE MIDCOURSE (TPM)
	36	-----*
	37	-----*
	38	-----*
	39	-----*
THRUST-ING	40	DPS
	41	RCS
	42	APS
	43	-----*
	44	-----*
	45	-----*
	46	-----*
	47	THRUST MONITOR
	48	-----*
	49	-----*
ALIGN-MENT	50	-----*
	51	IMU ORIENTATION DETERMINATION
	52	IMU REALIGN
	53	-----*
	54	-----*
	55	-----*

56	---	*
57	---	*
58	---	*
59	---	*
DESCENT 60	---	*
61	---	*
62	---	*
63	---	*
64	---	*
65	---	*
66	---	*
67	---	*
68	---	*
69	---	*
ABORTS 70	---	*
AND	---	*
BACKUPS 71	---	*
++	---	*
+23	---	*
+	---	*
+	---	*
+	---	*
+	---	*
+23	---	*
++	---	*
76	---	*
77	---	*
78	---	*
79	---	*

ROUTINE TITLE

ROUTINE

FINAL AUTOMATIC REQUEST TERMINATE

-----*

IMJ STATUS CHECK

DAP DATA LOAD

RR/LP SELF TEST

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RP DESIGNATE

RP DATA READ

RP MANUAL ACQUISITION

RR SEARCH

RR MONITOR

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25

26

27

27 -----*
28 -----*
29 -----*
30 ORBIT PARAMETER DISPLAY
31 RENDEZVOUS PARAMETER DISPLAY
32 TARGET DELTA V
33 LGC/CMC CLOCK SYNCHRONIZATION
34 -----*
35 -----*
36 RENDEZVOUS OUT-OF-PLANE DISPLAY
37 -----*
38 -----*
39 -----*
40 -----*
41 -----*
42 -----*
43 -----*
44 -----*
45 -----*
46 -----*
47 AGS INITIALIZATION
48 -----*
49 -----*
50 COARSE ALIGN
51 INFIGHT FINE ALIGN
52 AUTO OPTICS POSITIONING
53 INFIGHT SIGHTING MARK

54	SIGHTING DATA DISPLAY
55	GYRO TOPQUING
56	-----*
57	-----*
58	-----*
59	-----*
60	ATTITUDE MANEUVER
61	PREFERRED TRACKING ATTITUDE
62	CPWM-DEFINED MANEUVER
63	RENDEZVOUS FINAL ATTITUDE
64	-----*
65	-----*
66	-----*
67	-----*
68	-----*
69	-----*
70	-----*
71	-----*
72	-----*
73	-----*
74	-----*
75	-----*
76	-----*
77	LR SPOUTIOUS TEST

* THIS PROGRAM OF ROUTINE DOES NOT EXIST FOR ASSEMBLY SDN

CHANGE CONTROL NOTES:
LOGIC REV 23 PCP NASA 103

[illegible]

4.4.4.2 LGC LOGIC/GROUND/CREW INTERFACE DIAGRAMS FOR PROGRAM SUNDANCE.

[illegible]

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LGC IDLING PROGRAM (POO)

LOGIC REV 05 04/16/68

PURPOSE:

(1) TO PROVIDE A PROGRAM TO FULFILL THE FOLLOWING REQUIREMENTS:

(A) PROVIDE AN INDICATION TO THE CREW THAT THE LGC IS ENGAGED IN NO CONTROL OR COMPUTATIONAL OPERATIONS WHICH MIGHT REQUIRE CONSIDERATION FOR COORDINATION WITH OTHER CREW TASKS IN PROGRESS.

(B) MAINTAIN THE LGC IN A CONDITION OF READINESS FOR ENTRY INTO ANY OTHER PROGRAM.

ASSUMPTIONS: (1) THE LGC IS ON.

(2) THE IMU MAY OR MAY NOT BE ON. IF ON THE IMU IS INERTIALLY STABILIZED BUT NOT NECESSARILY ALIGNED TO AN ORIENTATION WHICH IS KNOWN TO THE LGC.

(3) THE DAP IS AVAILABLE FOR MANUALLY CONTROLLED ATTITUDE MANEUVERS IF THE IMU IS ON. IF ATTITUDE MANEUVERS ARE MADE BY THE CREW CARE MUST BE TAKEN TO AVOID IMU GIMBAL LOCK BY OBSERVING THE ICDUS (V16 V20) OR BY MONITORING THE FDAI BALL (THE BALL REPEATS IMU GIMBAL ANGLES ONLY WHEN PGNCIS IS SELECTED).

(4) DURING THIS PROGRAM THE LGC ERASABLE STORAGE MAY BE INITIALIZED BY KEYING IN V36F (FRESH START). THIS WOULD BE DONE ONLY WHEN THE CONTENT OF THE LGC ERASABLE STORAGE IS IN QUESTION. IF THIS ENTRY IS PERFORMED THE LGC KNOWLEDGE OF THE PRESENT IMU ORIENTATION (REFSMAT) IS INVALIDATED.

(5) DURING THIS PROGRAM THE COASTING INTEGRATION ROUTINE WILL UPDATE THE LM AND CSM STATE VECTORS TO APPROXIMATELY THE CURRENT TIME AS DESCRIBED IN SECTION 5.6.11 OF 3557.

++
+06
++
(6) STATE VECTOR INTEGRATION IS INHIBITED FOR 10 MINUTES FOLLOWING V96E. JSEAGE OF V96 CAN CAUSE INCORRECT W MATRIX EXTRAPOLATION SINCE STATE VECTOR SYNCHRONIZATION IS NOT MAINTAINED.

(7) THE PROGRAM IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

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

• CREW PRG
• SELECTION
•
•
•
•
•

START LGC IDLING
PROGRAM (POO)
DISPLAY PROGRAM 00

KEY IN LGC IDLING
PROGRAM (POO)
V37E 00E

#10

POO/SUNDANCE

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LGC POWER DOWN PROGRAM (P06)

LOGIC REV 09 06/13/68

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

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

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

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

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

(5) ONCE THE PROGRAM HAS BEEN SELECTED THE LGC MUST BE SHUTDOWN. AFTER P06 SELECTION THE LGC WILL NOT HONOR A NEW PROGRAM REQUEST (V37E--E), A TERMINATE (V34E) OR AN ENTER IN RESPONSE TO THE LGC REQUEST FOR LGC STANDBY.

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

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------

START LGC
POWER DOWN
PROGRAM (P06)
DISPLAY PROGRAM 06

KEY IN LGC POWER
DOWN PROGRAM (P06)
V37E 05E

• CREW PROG
• SELECTION
•
•
•

#10

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 06

#20

RESET REFSMELAG

RESET RENDEZVOUS
FLAG

#30

RESET IMUSE FLAG

#40

HOLD . FLASH VERB-NOJN TO
..... REQUEST PLEASE PUT
SNAP . LGC IN STANDBY:
V50 N25
R1-00062
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASHING TO REQUEST
PLEASE PUT LGC IN
STANDBY:

#50

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED
(STANDBY) BUTTON

#60

EXIT P06

39

TERMINATE FLASH UPON
RECEIPT OF STANDBY
ENTRY

.STANDRY .ENTER
ENTRY .OR
.(PROCFED) .TERM-
INATE
.
.
.
.
.
.
.

PUT LGC IN STANDBY

.
.
.
.
.
EXIT P06

CHANGE CONTROL NOTES
LOGIC REV 08 PCN MIT - 65
LOGIC REV 09 PCN-MIT - 139

P06/SUNDANCE

#70

#80

#90

1
(4)
APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RENDEZVOUS NAVIGATION PROGRAM (P20)

LOGIC REV 14 01/17/69

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

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

(A) OFF (STANDBY).

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

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

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

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

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

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

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

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

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

V80E UPDATE LM STATE VECTOR

V81E UPDATE CSM STATE VECTOR

V95E NO STATE VECTOR UPDATE

(4) THE RENDEZVOUS RADAR IS ON, PRELIMINARY CHECKOUT HAS BEEN COMPLETED AND THE RADAR IS UNDER PGNC'S CONTROL.

(5) THE OPERATION OF THE PROGRAM INCLUDES THE FOLLOWING FLAGS:

RENDEZVOUS FLAG- CONTROLS THE PERMANENT TERMINATION OF THE TOTAL RENDEZVOUS NAVIGATION PROCESS. THIS PROGRAM WILL ONLY RUN OR RESUME RUNNING WHEN THIS FLAG IS SET. SET BY P20 SELECTION. RESET BY SELECTION OF LGC IDLING PROGRAM (P00) OR BY V56F.

TRACK FLAG- CONTROLS THE TEMPORARY TERMINATION OF THE TOTAL RENDEZVOUS NAVIGATION PROCESS. RESET OF THIS FLAG INTERRUPTS THE AUTOMATIC ATTITUDE MANEUVER/RADAR DESIGNATE/TRACK PROCESS, AS WELL AS THE STATE VECTOR UPDATE PROCESS. THE SET OF THIS FLAG ENABLES ALL THESE PROCESSES.

UPDATE FLAG- CONTROLS THE TEMPORARY TERMINATION OF THE STATE VECTOR UPDATE PROCESS ONLY.

STATE VECTOR FLAGS (LM AND CSM) - DEFINES THE STATE VECTOR TO BE UPDATED BY THIS PROGRAM. SEE ASSUMPTION(3).

MANUAL ACQUIRE FLAG - BYPASSES RR DESIGNATE ROUTINE (R21) IF CSM HAD BEEN ACQUIRED BY MANUAL ACQUISITION ROUTINE (R23).

SEARCH FLAG - BYPASSES RR DESIGNATE ROUTINE (R21) IF CSM HAD BEEN ACQUIRED BY RR SEARCH ROUTINE (R24).

NO UPDATE FLAG - WHEN SET TERMINATES STATE VECTOR UPDATING. SET BY V84F SELECTION OF TARGET DELTA V ROUTINE (R32) OR BY KEYING IN V95E. RESET BY KEYING IN V80E (UPDATE LM STATE VECTOR) OR V81E (UPDATE CSM STATE VECTOR).

SURFACE NAVIGATION FLAG - SET BY SELECTION OF P22, RESET BY SELECTION OF P20.

(6) THE INITIALIZATION OF THE W MATRIX (SEE SECTION 5.2.4.2 OF R557) IS ENABLED BY:

(A) A MANUAL DSKY ENTRY (V93E).

(B) COMPUTER FRESH START (V36E).

(C) STATE VECTOR UPDATE FROM THE GROUND (P27).

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

(A) MANUAL SELECTION OF P20 (V37E20E).

(B) COMPLETION OF THE TARGET DELTA V ROUTINE (R32).

(C) SELECTION OF A NEW PROGRAM FROM A PROGRAM WHICH HAD TURNED ON AVERAGE G.

(D) INITIALIZATION OF THE W MATRIX (SEE (6) ABOVE).

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

(9) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY. IT MAY BE TERMINATED BY THE SELECTION OF THE LGC IDLING PROGRAM (P00), TERMINATION OF RR SEARCH ROUTINE (R24), V56E OR BY A V34E RESPONSE TO A FLASHING P20 DISPLAY. P00 SELECTION WILL TERMINATE P20 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH P00. ALL OTHER PROGRAMS SELECTED WILL CHANGE THE PROGRAM NUMBER DISPLAYED ON THE DSKY BUT WILL NOT TERMINATE P20. THIS PROGRAM IS THEREFORE DESIGNED TO OPERATE AUTOMATICALLY AND SIMULTANEOUSLY WITH ANOTHER PROGRAM WITHOUT REQUIRING USE OF THE DSKY UNLESS NON-NOMINAL CIRCUMSTANCES REQUIRE LGC COMMUNICATION WITH THE ASTRONAUT. IF V56 OR V34 IS KEYED INTO THE DSKY AND P20 IS THE ONLY PROGRAM IN PROCESS, THE FINAL AUTOMATIC REQUEST TERMINATE ROUTINE (R00) WILL BE INITIATED.

++
+14
+658
+14
++

3
(43)

PRCG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

START RENDEZVOUS
NAVIGATION PROGRAM
(P20).
DISPLAY P20

KEY IN RENDEZVOUS
NAVIGATION PROGRAM
(P20)
V37E20E

MONITOR DSKY:
OBSERVE DISPLAY
OF P20

RESET SURFACE
NAVIGATION FLAG.

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

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

#10

#20

#30

#40

#50

P20/SUNDANCE

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
CHECK ROUTINE (R02)

SET RENDEZVUS FLAG

#60

SET TRACK FLAG

#70

SET UPDATE FLAG

RESET MANUAL ACQUIRE
FLAG

#80

RESET SEARCH FLAG

#90

ZERO RR TRACKING
MARK COUNTER

RESET NC ANGLE
MONITOR FLAG.

#100

5
(4s)

IS SURFACE NAVIGATION FLAG SET?

.N .Y

SET STATE VECTOR
UPDATE OPTION TO
CSM.

SET STATE VECTOR
UPDATE OPTION TO
LM.

++
+14
+EDIT
+14
++

INTEGRATE BOTH PERMANENT STATE VECTORS TO PRESENT TIME USING PRECISION INTEGRATION.

"A"
ENTER
HERE
FROM
RR
SEARCH
ROUT-
INE
(R24).

P20/SUNDANCE

#110

#120

#130

#140

#150

P20/SUNDANCE

++
+14
+EDIT
+
++

EXTRAPCLATE LM AND
CSM STATE VECTORS TO
PRESENT TIME USING
KEPLER (CONIC)
INTEGRATION.

CALCULATE LCS VECTOR
FROM LM TO CSM. IS
RANGE GREATER THAN
400 NM?

POSS
PRIO
HOLD .
.....
SNAP

.N .Y

FLASH VERB-NCUN
REQUEST RESPONSE
AND DISPLAY ALARM
CODE.
VC5N09
R1-00526
R2-XXXXX
R3-XXXXX

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

MONITOR DSKY:
DOES ALARM CODE
DISPLAY 00526 INDIC-
ATE THAT RANGE TO
CSM IS GREATER THAN
400 NM?

.Y .N

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

.Y .N

WAIT AS
DESIRED

#160

#170

#180

#190

#200

#210

7
(47)

P20/SUNDANCE

WAIT FOR KEYBOARD
ENTRY

KEY IN RECYCLE
(V32E)

TERMINATE FLASH
UPON RECEIPT OF
RECYCLE CR V56E

TERMINATE P20 BY
V56E. LGC WILL
DISPLAY ANY
OTHER PROGRAM
IN PROCESS. IF
NO OTHER PRO-
GRAM IS IN PRO-
CESS LGC WILL
EXIT TO AND DIS-
PLAY P00.

.V .R
.5 .E
.6 .C
.E .Y
. .C
. .L
. .E

EXIT P20
(NOTE: IF NO
OTHER PROGRAM
IS IN PROCESS
EXIT WILL BE
TO LGC IDLING
PROGRAM(P00).

EXIT P2C

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

#220

#230

#240

#250

#260

P20/SUNDANCE

IS SURFACE NAVIG-
ATION FLAG SET?

.N .Y

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

DO PREFERRED
TRACKING ATTIT-
UDE ROUTINE
(R61).

DO PREFERRED TRACK-
ING ATTITUDE ROUTINE
(R61).

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N

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

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

#270

#280

#290

#300

#310

#320

POSS
HOLD
.....
SNAP

TERMINATE FLASH-
UPCN RECEIPT
OF PROCEED OR
TERMINATE

.T	.P
.E	.R
.R	.O
.W	.C
.I	.E
.N	.E
.A	.D
.T	
.E	

EXIT
P20/P22

FLASH VERB-NCUN
TO REQUEST PLEASE
PERFORM SELEC-
TION OF RR AUTO
MODE:

V50N25
R1-00201
R2-BLANK
R3-BLANK

KEY IN TER-
MINATE
(V34E)

EXIT
P20/P22

MONITOR DSKY:
IS VERB-NCUN
FLASHING TO REQUEST
SELECTION OF RR AUTO
MODE?

(NOTE: (1) THE MAN-
UAL ACQUISITION
ROUTINE (R23) MAY
ONLY BE CALLED FROM
THIS DISPLAY (EN-
TER). THIS DISPLAY
IS NOT CALLED IF
THE RR MODE SWITCH
IS IN LGC. THERE-
FORE IF R23 IS DES-
IRED THE RR MODE
SWITCH MUST BE CUT
OF THE LGC POSITION
BEFORE THE LGC PRO-
GRAM CHECKS THE
AUTO MODE DISCRETE.

#380

#390

#400

#410

#420

#430

11
(51)

P20/SUNDANCE

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

(3) WHENEVER
THE RP AUTO MODE
DISCRETE IS PRESENT
THE LGC WILL CALL
THE RP MONITOR ROU-
TINE (R25) AS DES-
CRIBED IN SECTION
5.2.4.3 OF R557).

Y N

DO I WISH TO
ATTEMPT A
MANUAL
ACQUISITION?

N Y

PUT RP
MODE
SWITCH TO
LGC.

WAIT FOR KEY-
BOARD ENTRY.

KEY IN
PROCEED

#440

#450

#460

#470

#480

P20/SUNDANCE

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR ENTER

KEY IN ENTER

.E
.N
.T
.E
.R

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

IS THE SURFACE
NAVIGATION FLAG
SET?

.N

.Y

TURN ON
OPERATOR
ERRCR LIGHT

DC MANUAL ACQUI-
SITION ROUTINE
(R23)

SET THE MANUAL
ACQUIRE FLAG.

#490

#500

#510

#520

#530

13
(53)

P20/SUNDANCE

WAIT 2.5
SECONDS

ARE CDUS BEING
ZERCED?

.N

Y.

IS MANUAL ACQUIRE,
OR SEARCH FLAG SET?

.Y

.N

RESET THIS
FLAG.

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

++
+14
+EDIT

IS THE RENDEZ-
VOUS FLAG SET

.Y

.N

#540

#550

#560

#570

#580

P20/SUNDANCE

#590

EXIT
P20/22

IS TRACK FLAG
SET?

Y N

WAIT 15
SEC.

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

#600

#610

DO RR DESIG-
NATE ROUTINE
(R21)

MONITOR THE VEHICLE
ATTITUDE AND THE
DSKY.

#620

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

#630

WAIT 2.5 SEC.

DO RR DATA READ
ROUTINE (R22)

(1) WHEN A DSKY
ENTRY OF V16N45F
IS MADE TO RE-
QUEST A DISPLAY
OF THE NUMBER OF
MARKS (M). THIS
DISPLAY WILL CON-
TAIN M IN R1.
THIS DISPLAY MAY
ALSO BE USED TO
OBTAIN THE TIME
FROM IGNITION FOR

#640

15
(55)

P20/SUNDANCE

THE NEXT BURN
(R2-TFI) AND THE
MIDDLE GIMBAL
ANGLE WHEN THE
IMU IS CN AND THE
+X LM AXIS IS
ALIGNED WITH THE
INITIAL THRUST
VECTOR (R3-MGA).
IF NO BURN HAS
BEEN DEFINED R2
AND R3 WILL BE
MEANINGLESS.
CONTROL OF THE
DSKY DISPLAY IS
RETURNED TO THE
LGC BY PUSHING
KEY RELEASE.

#650

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

#670

(3) WHEN THE RR
AUTO MODE DIS-
CRETE IS NOT PRE-
SENT IMMEDIATELY
PRIOR TO RR DES-
IGNATION THE LGC
GRABS THE DISPLAY
AND REQUESTS THIS
DISCRETE.

#680

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

#690

P20/SUNDANCE

DISCRETE.

#700

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

#710

(6) WHENEVER AN ATTITUDE MANEUVER TO THE PREFERRED ATTITUDE IS REQUIRED THE LGC GRABS THE DISPLAY AND DISPLAYS THE FINAL BALL ANGLES (N18) (SEE ATTITUDE MANEUVER ROUTINE R60).

#720

(7) WHEN THE LGC FAILS TO RECEIVE THE DATA GOOD DISCRETE FROM THE THE RR WITHIN APPROXIMATELY 45 SECONDS OF THE INITIATION OF A DESIGNATE SEQUENCE THE LGC GRABS THE DISPLAY AND DISPLAYS AN ALARM CODE (00503).

#730

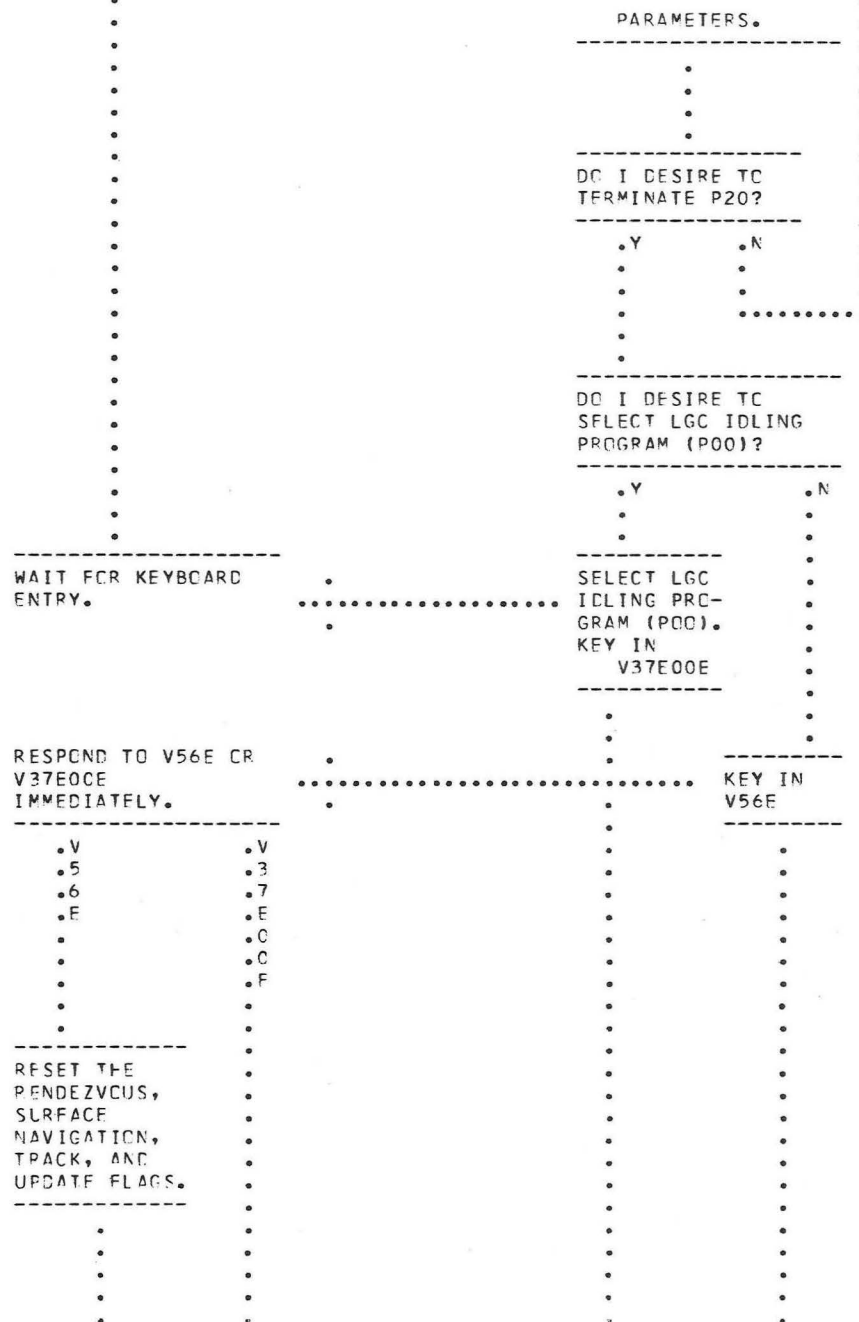
(8) WHEN THE MAGNITUDE OF A STATE VECTOR CORRECTION IS GREATER THAN THE ALLOWABLE LIMITS (AS DEFINED IN SECTION 5.2.4.2.2 OF R557) THE LGC GRABS THE DISPLAY AND DISPLAYS THE EXCESSIVE UPDATE

#740

#750

17
(57)

P20/SUNDANCE



#760

#770

#780

#790

#800

P20/SUNDANCE

```

.Y          N.
.           .
.           .
.           .
.           .
.           .
.           .
.           .
EXIT
P20/P22

```

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROO).
(NOTE: ENTRY INTO
ROO DIFFERS FOR CREW
PROGRAM SELECTION
AND LGC ROUTINE
SELECTION).

EXIT P20/P22

- IS P20 THE ONLY
- PROGRAM RUNNING?

```

      .N      Y.
      .
     . . .
      .
EXIT P20      .

```

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROO).
(NOTE: ENTRY INTO
ROO DIFFERS FOR CREW
PROGRAM SELECTION
AND LGC ROUTINE
SELECTION).

EXIT P20

#820

4830

#840

LOGIC REV 12 PCN MIT - 65
LOGIC REV 13 PCN - MIT - 95 + PCN MIT - 110, PCR 97.1
LOGIC REV 14 PCN 658, EDITORIAL CORRECTIONS

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

GROUND TRACK DETERMINATION PROGRAM (P21)

LOGIC REV 09 11/27/67

PURPOSE: (1) TO PROVIDE THE ASTRONAUT DETAILS OF HIS GROUND TRACK WITHOUT THE NEED FOR GROUND COMMUNICATION.

ASSUMPTIONS: (1) THIS PROGRAM MAY BE SELECTED WHILE THE LM IS EITHER IN EARTH OR LUNAR ORBIT TO DEFINE THE GROUND TRACK OF EITHER THE LM OR THE SSM.

(2) THIS PROGRAM ASSUMES THE VEHICLE WHOSE GRID TRACK PARAMETERS ARE CALCULATED TO REMAIN IN FREE FALL FROM THE PRESENT TIME UNTIL T LAT LONG.

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

P.POG
CONT

LGC

GROUND

CREN

CHECKLIST

TIME

TOTAL
TIME

START GROUND TRACK
DETERMINATION
PROGRAM (P21).
DISPLAY PROGRAM 21

KEY IN GROUND TRACK
DETERMINATION
PROGRAM (P21)
V37E21F

#10

MONITOR DISK:
OBSERVE DISPLAY OF
PROGRAM 21

#20

P21/SUNDANCE

HOLD

FLASH VERT-HUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED VEHICLE
(LM OR CSM):

VC4 NO6
R1-00002
R2-0000X
R3-BLANK

F1 IS THE OPTION
CODE FOR ASSUMED
VEHICLE (LM OR CSM).

P2 IS THE LGC ASSUMED
OPTION:

00001 - THIS VEHICLE
(LM)

00002 - OTHER VEHICLE
(CSM)

(NOTE: LGC WILL
ASSUME ALL OPTIONS
OTHER THAN 00001 TO
BE CSM)

#30

#40

#50

#50

#70

61

P21/SUNDANCE

(LM DR
CSM)
CODE IN-
TO P2.

#80

SIDE CODE DATA

#90

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

#100

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY T LAT LONG:
Y06 N34
31-T LAT LONG-HRS
32-T LAT LONG-MINS
33-T LAT LONG-SECS

#110

T LAT LONG - TIME
(GET) AT WHICH LAT
AND LONG OF VEHICLE
POSITION IS DESIRED.
IN HRS, MINS, SEC TO
NEAREST .01 SEC.

#120

IS THIS THE T LAT
LONG I DESIRE?

Y
N

#130

P21/SUNDANCE

KEY IN DESIRED

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

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

KEY IN VREF
AND LOAD
DESIRED T
LAT LONG

#140

EXTRAPOLATE STATE
VECTOR OF SELECTED
VEHICLE TO T LAT
LONG. CALCULATE
LATITUDE, LONGITUDE
AND ALTITUDE OF
VEHICLE AT T LAT
LONG.

#150

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

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

#150

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

#170

#180

43

P21/SUNDANCE

++
+06
++

ALT-ALTITUDE OF
VEHICLE ABOVE THE
LAUNCH PAD RADIUS
(EARTH ORBIT) OR
THE LUNAR RADIUS AT
THE MOST RECENTLY
DEFINED (SEE SECTION
5 OF R557) LANDING
SITE (LUNAR ORBIT).
IN NAUTICAL MILES
TO NEAREST .1 NM.

#190

DO I WISH TO OBTAIN
NEW PARAMETERS FOR
A T LAT LONG 10
MINUTES FROM NOW OR
ANY OTHER TIME THAN
THAT WHICH APPLIES
TO PRESENT DISPLAY?

#200

.N .Y

++
+09

WAIT FOR KEYBOARD
ENTRY

WHEN FINISHED
WITH DISPLAY
KEY IN
PROCEED

#210

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE V32E

#220

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

+09
++

#230

P21/SUNDANCE

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

```

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

```

#250

65

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PREFERRED TRACKING ATTITUDE PROGRAM (P25)

LOGIC REV 11 06/13/68

PURPOSE: (1) TO COMPUTE THE PREFERRED TRACKING ATTITUDE OF THE LM WHICH ENABLES CSM TRACKING OF THE LM BEACON.
(2) TO PERFORM THE MANEUVER TO THE PREFERRED TRACKING ATTITUDE.

ASSUMPTIONS: (1) DURING THE RENDEZVOUS NAVIGATION PROGRAM (P20) THE LM ATTITUDE CONTROL IS INTIMATELY ASSOCIATED WITH THE RENDEZVOUS RADAR (RR). SHOULD RR MALFUNCTION PRECLUDE CORRECT OPERATION OF P20, THIS PROGRAM (P25) SHOULD BE SELECTED TO PROVIDE A LM PREFERRED TRACKING ATTITUDE.

(2) THE PREFERRED TRACKING ATTITUDE IS DEFINED AS FOLLOWS:

(A) THE LM +Z AXIS IS ALIGNED ALONG THE LOS TO THE CSM.

(B) THE ROLL ATTITUDE (ABOUT LM +Z AXIS) IS UNCONSTRAINED AND IS DEFINED IN R50 AS NECESSARY TO AVOID GIMBAL LOCK.

(3) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM. NO PREFERRED ORIENTATION IS SPECIFIED OR REQUIRED FOR THIS PROGRAM AS THE PREFERRED TRACKING ATTITUDE ROUTINE (R61) CAN ALWAYS CALCULATE A VEHICLE ORIENTATION ABOUT A SPECIFIED +Z LM VECTOR THAT CAN AVOID GIMBAL LOCK FOR ANY INERTIAL IMU ORIENTATION.
THE ISS THUS MAY BE:

(A) OFF (STANDBY).

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

(C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT NOT WITHIN THE LAST 3 HRS.

(D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED WITHIN THE LAST 3 HRS.

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

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

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

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

(4) THE LM TRACKING BEACON FIELD OF VIEW IS A 30 DEGREE HALF ANGLE CONE WITH THE CONE AXIS PARALLEL TO THE LM +Z AXIS.

++
+11
+

(5) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY. IT MAY BE TERMINATED BY THE SELECTION OF THE LGC IDLING PROGRAM (P00) V34E OR BY V56E. P00 SELECTION WILL TERMINATE P25 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH P00. ALL OTHER PROGRAMS SELECTED WILL CHANGE THE PROGRAM NUMBER DISPLAYED ON THE DSKY BUT WILL NOT TERMINATE P25.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

CREW
PROGRAM
SELECTION

START PREFERRED
TRACKING ATTITUDE
PROGRAM (P25)
DISPLAY P25

KEY IN PREFERRED
TRACKING ATTITUDE
PROGRAM (P25)
V37E25E

#10

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 25.

#20

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)

#30

SET TRACK FLAG
(SEE P20)

#40

SET P25 FLAG

#50

P25/SUNDANCE

++
+10
+
+
+
+
+10
++

66

P25/SUNDANCE

DO PREFERRED TRACK-
ING ATTITUDE ROUTINE
(R61)

DO PREFERRED TRACK-
ING ATTITUDE ROUTINE
(R61)
(NOTE: WHENEVER THE

LOS TO THE
CSM IS NOT
WITHIN 30
DEGREES OF
THE LM +Z
AXIS THE -CC
WILL CALL
R51.)

#50

#70

#80

#90

#100

IS THE P25 FLAG SET?

Y. N

EXIT
P25

IS TRACK FLAG SET?

Y. N

WAIT 60
SECONDS

CALCULATE LOS TO CSM

P25/SUNDANCE

IS LOS MORE THAN 30
DEGREES FROM THE
LM+Z AXIS?

.Y

.N

WAIT 60
SECONDS

DO I DESIRE TO
TERMINATE P25?

.Y

.N

DO I DESIRE TO
SELECT LGC IDLING
PROGRAM (P00)?

.Y

.N

WAIT FOR KEYBOARD
ENTRY.

SELECT LGC
IDLING PROGRAM
(P00).
KEY IN
V37E00E

#110

#120

#130

#140

#150

CHANGE CONTROL NOTES

LOGIC REV 10 PCN MIT - 65
LOGIC REV 11 PCN-MIT-96

71

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LGC UPDATE PROGRAM (P27)

LOGIC REV 06 11/21/67

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

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

(2) LGC UPDATES ARE OF FOUR CATEGORIES:

(A) PROVIDE A DECREMENT FOR THE LGC CLOCK AND THE ORBITAL INTEGRATION STATE VECTOR TIME TAGS, AND AN INCREMENT FOR TEPHEM (V70).

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

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

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

(3) A COMPLETE DESCRIPTION OF THE LGC UPLINK FORMAT IS INCLUDED IN SECTION 2 OF R557.

++
+03
++

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

++
+03
++

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

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

PRG
CNT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

. CREW
. PRG
. SELECTION
. .
. .
. .

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

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

#10

P27/SUNDANCE

GROUND
 PROG
 SELECTION

#20

NOTIFY CREW OF . VERIFY THAT UP-
 INTENTION TO DATE WILL BE
 UPDATE. SPECIFY . SATISFACTORY
 PARAMETERS AND . A.P.T. TIME,
 COORDINATE TIME. WORK IN PRO-
 GRESS, AND LGC
 ACTIVITY.

#30

WILL UPDATE BE
 DONE AUTOMATI-
 CALLY BY LGC UP-
 LINK FROM GROUND
 OR MANUALLY BY
 CREW DSKY INPUT

WILL UPDATE BE DONE
 AUTOMATICALLY BY LGC
 UPLINK FROM GROUND
 OR MANUALLY BY CREW
 DSKY INPUT

#40

AUTO . MAN

AUTO . MAN

GO TO
 "A"
 BELOW

#50

TRANSMIT UP- . RECEIVE AND
 DATE BY VOICE RECORD UPDATE
 LINK TO CREW .

#50

73

P27/SUNDANCE

```

SELECT THE DESIRED
TYPE OF UPDATE:
1. UPDATE LIFT OFF
   TIME V70
2. LOAD DATA BLOCK
   V71
3. LOAD SINGULAR
   DATA V72
4. OCTAL TIME INCRE-
   MENT V73

```

1. 2. 3. 4.

WAIT FOR KEYBOARD
ENTRY OR UPLINK
TRANSMISSTION.

TRANS-
MIT
V70F

```

.....MIT .
. V70F .
----- .
. -----
. . TRANS-
.....MIT
. . V71E

```

```

SELECT THE DESIRED
TYPE OF UPDATE:
1. UPDATE LIFT OFF
   TIME V70
2. LOAD DATA BLOCK
   V71
3. LOAD SINGULAR
   DATA V72
4. OCTAL TIME INCRE-
   MENT V73

```

1. 2. 3. 4.

TRANS-
MIT
V72E

TRAN-
SMIT
V73E

GO TO "B" BELOW

#70

#80

#90

#100

#110

P27/SUNDANCE

74

75

P27/SUNDANCE

 CHANGE DOWN-
 LINK LIST.

TURN ON
 OPERA-
 TOR ER-
 ROR
 LITE.

 OBSERVE OPERATOR
 ERROR LIGHT TO
 INDICATE INCOR-
 RECT PROGRAM SE-
 LECTION.

 START LGC
 UPDATE PRO-
 GRAM (P27).
 DISPLAY PRO-
 GRAM 27

EXIT

EXIT

 HOW WAS THIS PROGRAM
 INITIATED?

.V	.V	.V
.7	.7	.7
.2	.1	.0
.	.	.
.	.	.0
.	.	R
.	.	.
.	.	.V
.	.	.7
.	.	.3

 FLASH VERB/
 NOUN TO RE-
 QUEST LOAD
 OF INDEX IN
 MACHINE AD-
 DRESS SPEC-
 IFIED IN F3
 AND DISPLAY:
 V21 NO1
 R1-BLANK
 R2-UN-
 CHANGED
 R3-UPBUFF

"B"
 FROM
 ABOVE

 MONITOR DSKY:
 OBSERVE VERB/NOU
 FLASH TO REQUEST
 LOAD OF INDEX AND
 DISPLAY OF JPRUFF

 MONITOR DOWNLINK

HOLD ..

 SNAP ..

#180

#190

#200

#210

#220

P27/SUNDANCE

```

ADDRESS ..... OBSERVE VERB/
                NOJN FLASH AND
                DISPLAY OF UP-
                BUFF.
                -----
                .
                .
                .
                -----
                DO I WISH TO
                TERMINATE?
                Y.      N.
                .
                .
                .
                -----
                WAIT FOR
                KEYBOARD
                ENTRY. DIS-
                PLAY INDEX .....
                IN R1 AS IT
                IS LOADED.
                -----
                TRANSMIT
                TERMINATE
                V34F
                -----
                .
                .
                .
                GO TO
                "A"
                BELOW
                -----
                TRANSMIT
                INDEX WORD
                -----
                .
                .
                .
                -----
                KEY IN
                TERMIN-
                ATE V34F
                -----
                .
                .
                .
                GO TO
                "A"
                BELOW

```

#230

#240

#250

#260

#270

#280

KEY IN INDEX
WORD FOR UP-
DATE
XXXXX
OBSERVE INDEX
WORD LOADED
TO OF DIS-
PLAYED IN R1

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE
OR INDEX

I
N
D
E
X
N
A
T
E

CO TO
"A"
FLOU

IS INDEX
LESS THAN
A OR GRE-
TER THAN
20?

V. N.

SFT
COMP-
NUMR
EQJAI
TO 2

STRE
INDEX IN
COMPJAP

#290

#300

#310

#320

#330

SET UP-
LINK
COMPO-
NENT
COUNTER
TO 2

#340

++
+03
++

CALCULATE
ADDRESS:
(UPBUFF AD-
DRESS +
CONTENTS OF
UPLINK COM-
PONENT
COUNTER
MINUS 1)

#350

#360

FLASH VERB/
NOUN TO RE-
QUEST LOAD
OF DATA IN-
TO CALCULA-
TED ADDRESS
SPECIFIED
IN R3 AND

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

#370

HOLD
.....
SNAP

DISPLAY:
V21 NO1
P1 BLANK
R2 UN-
CHANGED
R3 AAAAA

MONITOR DOWNLINK
OBSERVE VERB/
NOUN FLASH TO
REQUEST DATA
LOAD

#380

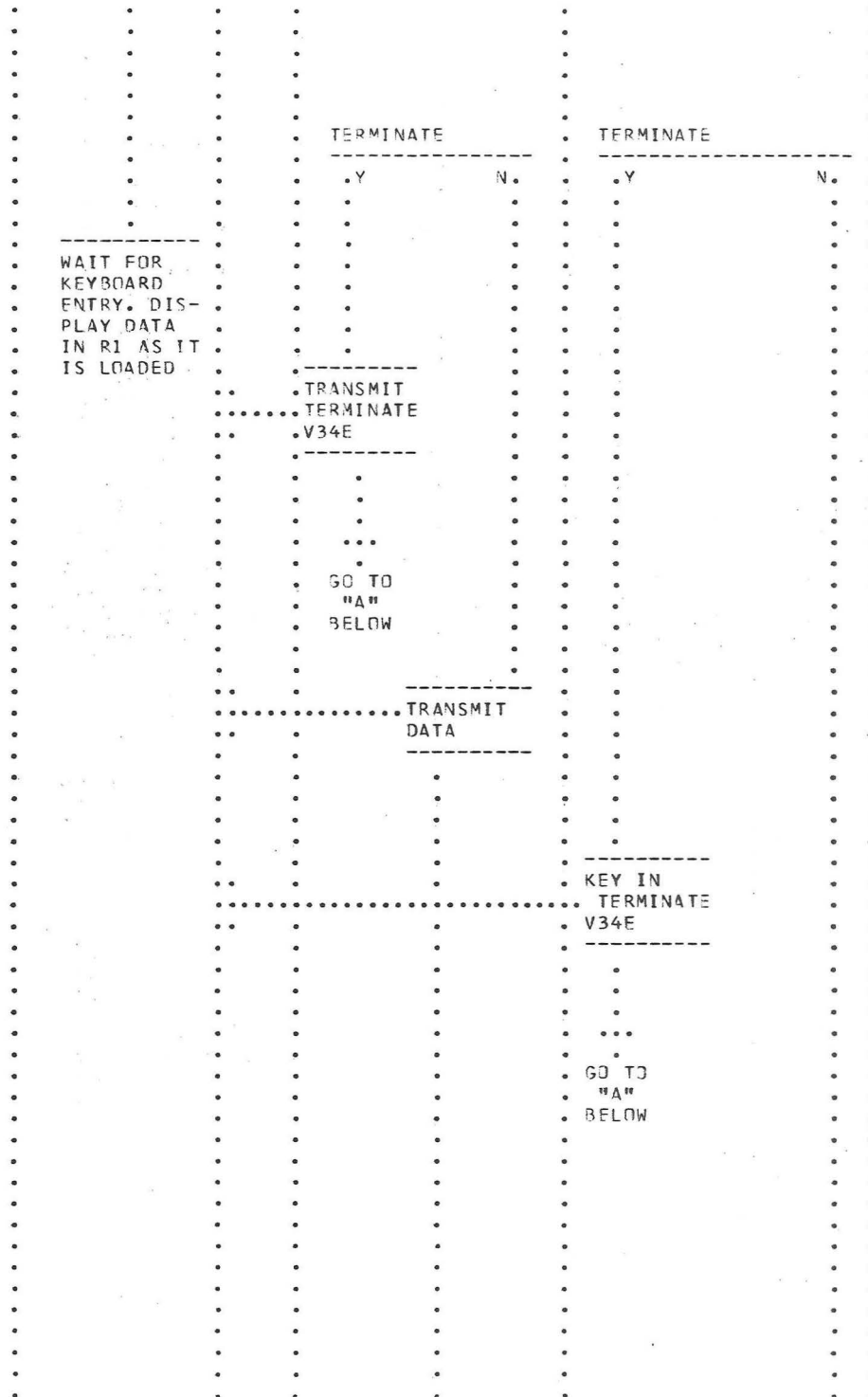
AAAAA-CAL-
CULATED
MACHINE AD-
DRESS.

DO I WISH TO

DO I WISH TO

79

P27/SUNDANCE



#390

#400

#410

#420

#430

P27/SUNDANCE

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE
OR DATA.

.T .D
.E .A
.R .T
.M .A
.I
.N
.A
.T
.E

GO TO
"A"
BELOW

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

.Y N.

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

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

#440

#450

#460

#470

#480

#490

81

P27/SUNDANCE

HOLD
.....
SNAP

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

DISPLAY:
V21 NO2
R1 BLANK
R2 UNCHANGED
R3 UTEMP
ADDRESS

UTEMP -
AN ERASABLE
LOCATION FOR
OCTAL IDENTIFIER

WAIT FOR KEY-
BOARD
ENTRY

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

DO I WISH TO
TERMINATE?

.Y N.

DO I WISH TO
CORRECT ANY
DATA?

.Y N.

TRANS-
MIT
TERMIN-
ATE
V34F

GO TO
"A"
PROM

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

DO I WISH TO
TERMINATE?

.Y N.

DO I WISH TO
CORRECT ANY
DATA?

.Y N.

#500

#510

#520

#530

#540

P27/SUNDANCE

#550

#550

#570

#580

#590

KEY IN
TERMIN-
ATE
V345

TRANSMIT
OCTAL
IDENTI-
FIER

GO TO
"A"
BELOW

KEY IN
OCTAL
IDENTI-
FIER

TRANSMIT
PROCEED

GO TO
"A"
BELOW

KEY IN
PROCEED

TERMINATE FLASH
UPON RECEIPT OF
TERMINATE, PRO-
CEED, OR YXE.

T . P . X
E . R . X
R . D .
A . C .
I . F IS

GO TO
"A"
BELOW

.. OCTAI
.. IDENT-
.. IFIER
.. POSI-
.. TIVE?

7.

MO 738
"V"
01 03

IS OCTAL IDENTIFIER GREAT-ER THAN ZERO AND EQUAL TO OR LESS THAN COMP-NUMB?

Y
N

CALCULATE
ADDRESS OF
COMPONENT
TO BE COR-
RECTED.
(UPRUFF
ADDRESS +
SOCIAL
IDENTIFIER
MINUS ONE)

#600

#610

#620

#630

049#

#650

EXP 7 / SURDANCE

INVERT VEP FLAG

WHICH UPDATE
WAS INITIATED THIS
PROGRAM

#650

$\begin{matrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{matrix}$

019#

#1;	ES L-	IN-
ALL A-	EGAL,	CRE-
DDRES-	AND	MENT
SES IN	IS C-	LGC
BLOCK	OMP-	CLOCK
MUST	NUMB	----

#680

069#

700

227/SUNDANCE

#710

#720

#730

#740

#750

227/SUNDANCE

GO TO
"A"
BELOW

TURN
ON
OPER-
ATOR
ER-
ROR
LITE

GO
TO
"A"
BELOW

TURN
ON
OPER-
RAT-
OR
ER-
ROR
LITE

GO
TO
"A"
BELOW

TRANS-
FER
DATA
TO
SPECI-
FIED
BLOCK

#750

170#

081番

061 著

0C8#

#810

027/SUNDANCE

86

TERMINATE
P27 AND
GO TO P00

MONITOR DSKY:
OBSERVE TERMINATION
OF P27 AND DISPLAY
OF PROGRAM 00

MONITOR DOWN-
LINK: OBSERVE
TERMINATION OF
227, THE RETURN
TO POO, AND
REVERSION TO
ORIGINAL (I.E.,
COAST AND ALIGN
DOWNLINK
FORMAT).

EXIT p27

EXIT P27

820

*830

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

EXTERNAL DELTA V PROGRAM (P30)

LOGIC REV 11 01/17/69

PURPOSE:

(1) TO ACCEPT TARGETING PARAMETERS OBTAINED FROM A SOURCE(S) EXTERNAL TO THE LGC AND COMPUTE THEREFROM THE REQUIRED VELOCITY AND OTHER INITIAL CONDITIONS REQUIRED BY THE LGC FOR EXECUTION OF THE DESIRED MANEUVER. THE TARGETING PARAMETERS INSERTED INTO THE LGC ARE THE TIME OF IGNITION(TIG) AND THE IMPULSIVE DELTA V ALONG LM LOCAL VERTICAL AXES AT TIG.

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

ASSUMPTIONS-

(1) THE TARGET PARAMETERS (TIG AND DELTA V(LV)) MAY HAVE BEEN LOADED FROM THE GROUND DURING A PRIOR EXECUTION OF P27.

(2) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM UNLESS THIS PROGRAM IS SELECTED ONLY FOR DATA LOADING AND THRUSTING PARAMETER COMPUTATION. TIME AND RCS FUEL MAY BE SAVED AND SUBSEQUENT IMU ALIGNMENT DECISIONS GREATLY SIMPLIFIED IF P51 IS PERFORMED IN SUCH A WAY AS TO LEAVE THE IMU INERTIALLY STABILIZED AT AN ORIENTATION CLOSE TO THE PREFERRED ORIENTATION. THIS PROGRAM GENERATES THE MANEUVER INITIAL CONDITIONS FROM WHICH THE PREFERRED IMU ORIENTATION CAN BE DETERMINED IN PROGRAM 40, 41, OR 42.
THE ISS THUS MAY BE:

(A) OFF (STANDBY).

(B) ON, AND NOT ALIGNED SINCE TURN ON

(C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT NOT WITHIN THE LAST 3 HRS.

(D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED WITHIN THE LAST 3 HRS.

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

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

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

IF (D) IS TRUE THE LGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE MANEUVER. CASES (B), (C) AND (D) HOWEVER ARE FURTHER SUBJECT TO THE CONSTRAINT OF LARGE MIDDLE GIMBAL ANGLE, I.E. THE EXISTING INERTIAL ORIENTATION MAY CAUSE A MIDDLE GIMBAL ANGLE GREATER THAN 45 DEGREES AT THE THRUSTING ORIENTATION OF THE LM, WHICH IS UNSATISFACTORY.

++

+11

+401

++

(3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANEUVER.

(4) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 15 MIN BEFORE THE TIME OF IGNITION.

PROG
CONT

LCC

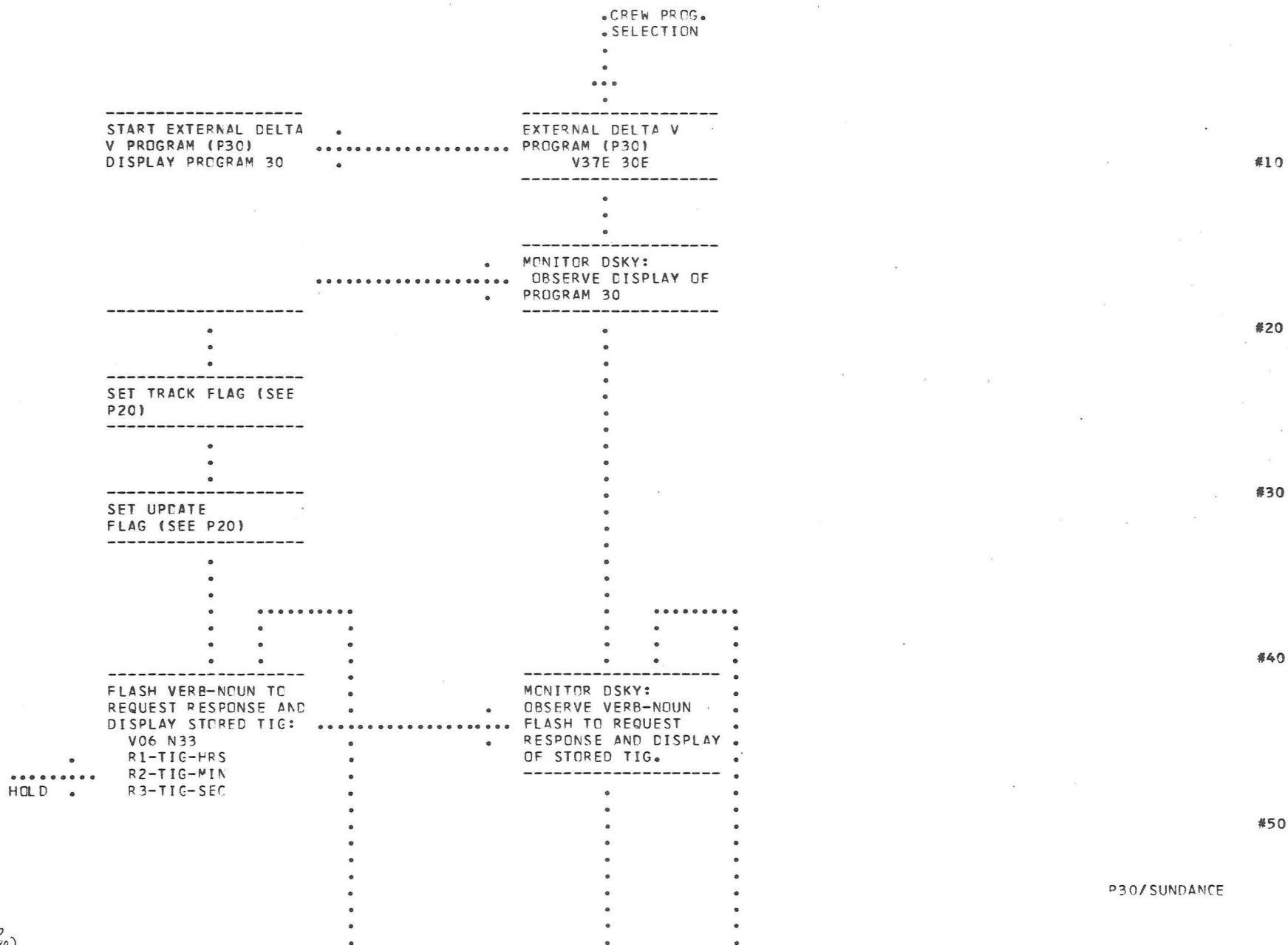
GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME



TIG-TIME CF
IGNITION (GET).
IN HPS, MIN, SEC
TO NEAREST .01 SEC.

AM I SATISFIED WITH
THIS VALUE?

$$Y_{\bullet} \quad \bullet N$$
RECORD THIS
VALUE

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPCN
RECEIPT OF PROCEED
OR NEW DATA

- KEY IN V25E AND
- LOAD THE DESIRED
- TIG.

```

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

```

STORE DATA

.....
HOLD . FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY THRE STOREC
CCMPONENTS CF DELTA
(LV):

V06N82
R1-DELTA VX (LV)
R2-DELTA VY (LV)
R3-DELTA VZ (LV)

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

#60

#70

#80

#90

#100

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

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

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

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

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

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

TIG.

AM I SATISFIED WITH
THESE VALUES?

.Y .N

KEY IN
PROCEED

. KEY IN V25E AND
. LOAD THE DESIRED
. COMPONENTS OF
. DELTA V

#110

#120

#130

#140

#150

#160

23
(93)

P30/SUNDANCE

RESET UPDATE FLAG
(SEE P20)

BASED ON THE STORED
TARGET PARAMETERS
COMPUTE NECESSARY
DEPENDENT VARIABLES
FOR EVALUATION OF THE
THRUSTING MANEUVER
INCLUDING PERILUNE
ALTITUDE, APOCLUNE
ALTITUDE AND DELTA V
REQUIRED (SEE SECT-
ION 5.3.3.3.1 OF
R557)

SET UPDATE FLAG
(SEE P20)

.....
HOLD

.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CALCULATED
THRUSTING PARAMETERS:
V06 N42
R1-APO ALT
R2-PER ALT
R3-DELTA V

APC ALT - ALTITUDE
OF APOGEE ABOVE THE
LAUNCH PAD RADIUS
(EARTH ORBIT) OR
ALTITUDE OF THE
APOCLUNE ABOVE THE
LUNAR RADIUS AT THE
MOST RECENTLY DE-
FINED LANDING SITE
(LUNAR ORBIT). IN
NAUTICAL MILES TO
NEAREST .1 NM.

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

#170

#180

#190

#200

#210

P30/SUNDANCE

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

MONITOR LGC
DOWNLINK TELE-
METRY CF APO
ALT, PER ALT
AND DELTA V RE-
QUIRED. COORDI-
NATE EVALUATION
OF LGC COMPUTED
PARAMETERS WITH
ASTRONAUT

- ...COORDINATE
- EVALUATION OF
- THE LGC COMPU-
- TED PARAMETERS
- ... WITH THE
- ...GROUND

. (1) IF THE CALCULATED DATA IS
 . SATISFACTORY, PERFORM THE THRU-
 . STING MANEUVER USING THE LGC
 . CALCULATED PARAMETERS WITHOUT
 . GROUND CONFIRMATION.
 . (2) IF THE CALCULATED DATA IS NOT

#270

#280

#290

¥300

#310

P30/SUNDANCE

 SELECT ONE OF
 THE FOLLOWING
 FOUR ALTERNA-
 TIVES:

(1) ADJUST THE
 CALCULATED PARA-
 METERS BY RESEL-
 ECTING P 30 AS
 NECESSARY AND
 CHANGING THE
 LOADED AIM PARA-
 METERS UNTIL LGC
 COMPUTED PARA-
 METERS ARE
 SATISFACTORY.

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

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

OBSERVE NEW AIM
 PARAMETERS, ETC.

(4) TERMINATE
 P 30 BY SELECT-
 ING A NEW PRO-
 GRAM AS DESIRED
 AND PERFORM THR-
 USTING MANEUVER
 USING BACKUP
 PROCEDURES.

1.

2.

3.

4.

.....

#330

#340

#350

#360

#370

$27_{(97)}$

P30/SUNDANCE

WAIT FOR KEYBOARD
ENTRY.

KEY IN PROGRAM
SELECTION AS
DESIRED
V37E--E

#380

GO TO PROGRAM
SELECTED.

EXIT P3C

#390

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW PROGRAM.

KEY IN
PROCEED

#400

```

.P      . NEW
.R      . PROGRAM
.C      .
.C      .
.E      -----
.E      GO TO PROGRAM
.D      SELECTED.

```

EXIT P30

IS REFSMFLAG SET?

• Y • A

030/SUNDANCE

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

#430

 SET MGA DISPLAY
 IN R3 (BELOW) =
 -00002.

#440

.....
 HOLD . FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY MANEUVER
 DATA:

V16 N45
 R1-M
 R2-TFI
 R3-MGA

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

#450

M-THE NUMBER OF
 MARKS MADE SINCE
 THE LAST THRUSTING
 MANEUVER OR INITIAT-
 ION OF P20. (NOTE-
 NORMALLY RP TRACKING
 DATA IS NOT BEING
 TAKEN DURING THIS
 PROGRAM AND THIS
 REGISTER WILL BE 00000.)

#460

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

#470

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

#480

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#500

TERMINATE FLASH UPON
RECEIPT OF PROCEED

SET EXTERNAL DELTA V
STEERING FLAG FOR
USE BY THRUSTING
PROGRAM

#510

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

#520

EXIT P30

IF TIME AND
LOCATION
PERMIT
ASSIST
ASTRONAUT IN
SELECTION OF
PROPULSION
SYSTEM. AT
THIS TIME,
OR EARLIER
IF POSSIBLE
THE ASTRONAUT

(NOTE: CONSIDERING
VALUE OF DELTA V,
FUEL AVAILABLE,
STATUS OF PROPULSION
HARDWARE, AND TIME
AVAILABLE TO RE-AL-
IGN THE IMU TO AVOID
GIMBAL LOCK SELECT A
PROPULSION SYSTEM
AND THE APPROPRIATE
THRUSTING PROGRAM
(DPS-P40, APS-P42,
RCS-P41) TO PERFORM

#530

MUST LEARN
OF THE
SYSTEM USED
IN MCC COM-
PUTATIONS
OF DATA LOAD

THE MANEUVER. COOR-
DINATE WITH GROUND
IF REQUIRED.)

.
.
.
.
.
EXIT P30

#540

CHANGE CONTROL NOTES:
LOGIC REV 10 PCN-MIT-56
LOGIC REV 11 PCN 401.3

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32) LOGIC REV 11 01/17/69

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

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

ACTIVE VEHICLE FLAG-DESIGNATES THE VEHICLE WHICH IS DOING RENDEZVOUS THRUSTING MANEUVERS TO THE PROGRAM WHICH CALCULATES THE MANEUVER PARAMETERS. SET AT THE START OF EACH RENDEZVOUS PRE-THRUSTING PROGRAM.

FINAL FLAG - SELECTS FINAL PROGRAM DISPLAYS AFTER CREW HAS COMPLETED THE FINAL MANEUVER COMPUTATION AND DISPLAY CYCLE.

```

++
+11      (12) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANEUVER.
+
+11      (13) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

```

++
+11
+
+11
++
401
540

PROG CONT	LCC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			. CREW PROG. . SELECTION 			
----- START CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32) DISPLAY P32 -----	----- KEY IN CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32) V37E 32E -----			#10
			. . .			
	----- MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 32 -----			#20
-----			
----- SET ACTIVE VEHICLE FLAG TO LM. -----						#30
.					
----- RESET FINAL FLAG -----					
. . . .						#40
				P32/SUNDANCE		

33
(103)

P32/SUNDANCE

SET TRACK FLAG (SFE
P20)

SET UPDATE FLAG
(SEE P2C)

HOLD .
.....
SNAP .

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(CSI):

V06 N30
R1-TIG(CSI)-HRS
R2-TIG(CSI)-MINS
R3-TIG(CSI)-SECS

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

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

AM I SATISFIED
WITH THIS VALUE?

.Y .N

RECORD THIS
VALUE

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#50

#60

#70

#80

#90

P32/SUNDANCE

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

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

KEY IN V25E
AND LOAD DESIRED
TIG(CSI).

#100

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

N - THE FUTURE
APSIDAL CROSSING
(APCLUNE OR
PERILUNE) OF THE
ACTIVE VEHICLE AT
WHICH TIG(CDF)
SHOULD OCCUR.
00001=FIRST,
00002=SECOND, ETC.

E - ELEVATION ANGLE.
THE ANGLE BETWEEN
THE LM/CSM LOS AND
THE LM LOCAL HORIZ-
ONTAL PLANE AT TIG
(TPI) REFERENCED TO
THE DIRECTION OF
FLIGHT (SEE SECTION
5.4.4 OF R557
FOR DETAILED DE-
SCRIPTION). IN
DEGREES TO NEAREST
.01 DEG.

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

#110

AM I SATISFIED WITH
THESE VALUES?

.Y .N

#130

RECORD THESE
VALUES

#140

35
(105)

P32/SUNDANCE

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#150

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

KEY IN V25E
AND LOAD THE
DESIRED PARAMET-
ERS

#160

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

STORE DATA

#170

HOLD . FLASH VERB-NCUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY STORED TIG
(TPI):
V06 N37
R1-TIG(TPI)-HRS
R2-TIG(TPI)-MINS
R3-TIG(TPI)-SECS

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

#180

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

AM I SATISFIED
WITH THIS VALUE?

#190

.Y .N

RECORD THIS
VALUE

#200

P32/SUNDANCE

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

KEY IN V25E
AND LOAD THE
DESIRED TIG (TPI)

#210

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

#220

RESET UPDATE
FLAG.

#230

BASED ON THE STC-
RED TARGET PARA-
METERS, COMPUTE
THE PARAMETERS
ASSOCIATED WITH
CSI AND CDH AS
DESCRIBED IN SEC-
TION 5.4.4 OF
R557.
ESTABLISH ALARM
IF;

#240

(A) CN FIRST
ITERATION THERE
IS NO INTER-
SECTION OF
THE DESIRED LOS
AT TPI WITH THE
CIRCLE DESCRI-
BED IN SECTION
5.4.4.2 OF R557.
(ALARM CODE
00600)

#250

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

#260

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

#270

(D) PERICENTER
ALT (PCST CSI)
IS LESS THAN
35,000 FT.
(LUNAR ORBIT)
OR 85 NM (EARTH
ORBIT).
(ALARM CODE
00601)

#280

(F) PERICENTER
ALT (PCST CDH)
IS LESS THAN
35,000 FT
(LUNAR ORBIT)
OR 85 NM (EARTH
ORBIT) (ALARM
CODE 00602)

#290

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

#300

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

#310

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

#320

POSS
HOLD
.....
SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPON-
SE AND DIS-
PLAY ALARM
CODE:

VC5 N09
R1-XXXXX
R2-XXXXX
R3-XXXXX

(NOTE: UP TO
THREE ALARM
CODES CAN BE
DISPLAYED
SIMULTANEOUS-
LY. THOSE
REGISTERS NOT
CONTAINING AN
ALARM CODE
WILL BE
BLANK.)

MONITOR DSKY:
DOES ALARM CODE
DISPLAY INDICATE
COMPUTATIONAL
DIFFICULTY?

.Y N.

#330

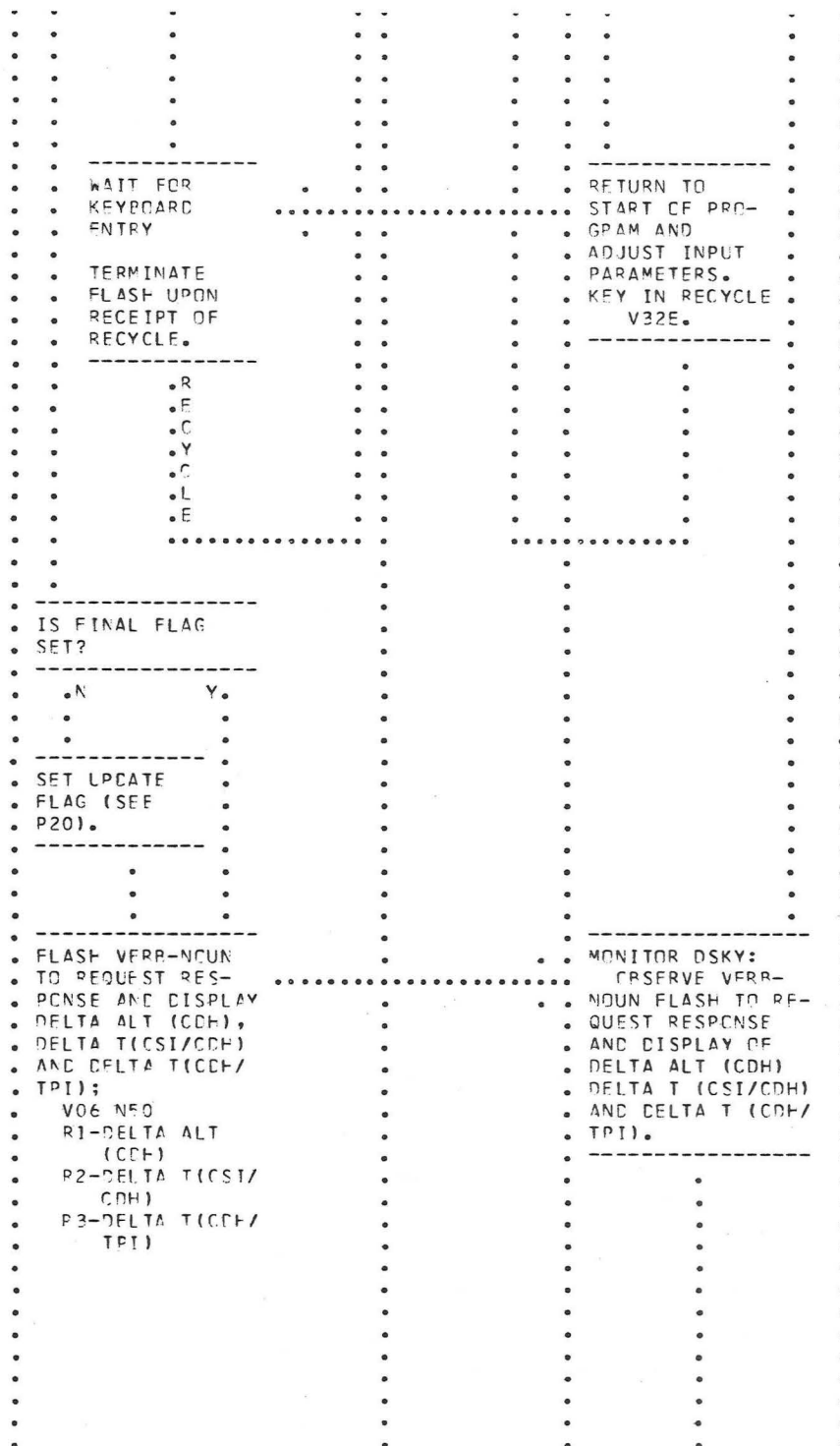
#340

#350

39(09)

P32/SUNDANCE

HOLD .
.....
SNAP .



#360

#370

#380

#390

#400

P32/SUNDANCE

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

#410

DELTA T(CSI/CDH)-
 TIG(CCH) MINUS
 TIG(CSI).
 COMPUTED IN HRS,
 MINS, SECS OF
 WHICH ONLY THE
 MINS AND SECS
 ARE DISPLAYED. TO
 NEAREST SEC. MAX
 READING IS 59859.

#420

DELTA T(CDH/TPI)-
 TIG(TPI) MINUS
 TIG(CCH).
 COMPUTED IN HRS,
 MINS SECS OF
 WHICH ONLY THE
 MINS AND SECS ARE
 DISPLAYED. TO
 NEAREST SEC. MAX
 READING IS 59859.

#430

#440

RECORD THESE
 VALUES

#450

WAIT FOR KEYBOARD
 ENTRY

KEY IN PROCEED

TERMINATE FLASH
 UPON RECEIPT OF
 PROCEED

P
 P

#460

#470

#480

#490

#500

#510

WAIT FOR KEYBOARD
ENTRY

KEY IN V25F
AND LOAD DE-
SIRED DELTA V
VALUES

#520

RECORD THESE
VALUES

#530

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

KEY IN PROCEED

#540

P NEW
R DATA
C
E STORE DATA
E
D

#550

HOLD
SNAP

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
CALCULATED COM-
PONENTS OF DELTA
V(LV) FOR CDH;
V06 NR2
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA V(LV) FOR
CDH.
(NOTE:
IF THE DELTA V
(LV) FOR CSI (SEE
ABOVE) HAS BEEN

#560

43
(113)

P32/SUNDANCE

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

MODIFIED BY THE
CREW, THE MODIF-
ICATION WILL NOT
BE REFLECTED IN
THE LGC COMPUTED
VALUES FOR DELTA
V (LV) FOR CDH
DISPLAYED HERE.)

#570

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

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

#580

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

#590

WHERE R IS LM
GEOCENTRIC (EARTH
ORBIT) OR SELENC-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AND V IS
LM INERTIAL VELC-
CITY VECTOR AT
TIG(CDH).

#600

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#610

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

P
R
C
C
E
F
C

#620

P32/SUNDANCE

IS THE FINAL FLAG
SET?

.N Y.

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

IS REFSMFLAG
SET?

.Y N.

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

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

#630

#640

#650

#660

#670

43
(113)

P32/SUNDANCE

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

MODIFIED BY THE
CREW, THE MODIF-
ICATION WILL NOT
BE REFLECTED IN
THE LGC COMPUTED
VALUES FOR DELTA
V (LV) FOR CDH
DISPLAYED HERE.)

#570

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

#580

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

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

#590

WHERE R IS LM
GECCENTRIC (EARTH
ORBIT) OR SELENC-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AND V IS
LM INERTIAL VELC-
CITY VECTOR AT
TIG(CDH).

#600

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#610

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

P
R
C
C
E
F
C

#620

P32/SUNDANCE

IS THE FINAL FLAG
SET?

.N .Y.

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

IS REFSMFLAG
SET?

.Y .N.

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

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

#630

#640

#650

#660

#670

45
(115)

P32/SUNDANCE

HOLD . FLASH VERR-NOUN TO
..... REQUEST RESPONSE AND
MON . DISPLAY M, TFI AND
MCA;
V16A45
R1-W
R2-TFI
R3-MCA

M - THE NUMBER OF
MARKS MADE SINCE THE
LAST THRUSTING MAN-
EUVER OR INITIATION
OF P20.

TFI - TIME FROM TIG
(CSI). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59P59.
SIGN IS - BEFORE +
AFTER TIG(CSI).

MCA - MIDDLE GIMBAL
ANGLE AT TIG(CSI)
IF LM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
SIGN IS ALWAYS +
EXCEPT:

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

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

WAIT FOR KEYBOARD
ENTRY

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

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y N.

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

.Y N.

KEY IN PROCEED.

#680

#690

#700

#710

#720

P32/SUNDANCE

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

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

IS THE FINAL FLAG
SET?

.Y .N

SET THE FINAL
FLAG

SET THE EXTERNAL
DELTA V FLAG.

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (RCO)

EXIT P32

KEY IN RECYCLE
V32E

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y .N

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (RCO).

EXIT P32

#730

#740

#750

#760

#770

4-7
(163)

P32/SUNDANCE

CHANGE CONTRCL NOTES
LOGIC REV 10 PCN MIT - 65
LOGIC REV 11 PCN MIT - 401.3,540.2

#780

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

CONSTANT DELTA ALTITUDE (CDH) PROGRAM (P33)

LOGIC REV 15 01/17/69

PURPOSE:

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

ASSUMPTION:

- (1) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE CO-ELLIPTIC SEQUENCE INITIATION (CSI) PROGRAM (P32). THEREFORE:
 - (A) AT A SELECTED TPI TIME (NOW IN STORAGE) THE LINE OF SIGHT BETWEEN THE LM AND THE CSM WAS SELECTED TO BE A PRESCRIBED ANGLE (E) (NOW IN STORAGE) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE POSITION.
 - (B) THE TIME BETWEEN CSI IGNITION AND CDH IGNITION WAS COMPUTED TO BE GREATER THAN 10 MINUTES.
 - (C) THE TIME BETWEEN CDH IGNITION AND TPI IGNITION WAS COMPUTED TO BE GREATER THAN 10 MINUTES.
 - (D) THE VARIATION OF THE ALTITUDE DIFFERENCE BETWEEN THE ORBITS WAS MINIMIZED.
 - (E) CSI BURN WAS DEFINED SUCH THAT THE IMPULSIVE DELTA V WAS IN THE LM HORIZONTAL PLANE AT CSI IGNITION.
 - (F) THE PERICENTER ALTITUDES OF THE ORBITS FOLLOWING CSI AND CDH WERE COMPUTED TO BE GREATER THAN 35,000 FT (LUNAR ORBIT) OR 85 NM FOR EARTH ORBIT.
 - (G) THE CSI AND CDH MANEUVERS WERE ASSUMED TO BE PARALLEL TO THE PLANE OF THE CSM ORBIT. HOWEVER, CREW MODIFICATION OF DELTA V (LV) COMPONENTS MAY HAVE RESULTED IN AN OUT-OF-PLANE CSI MANEUVER.
- (2) LGC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE NORMALLY LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.
- (3) THE RENDEZVOUS RADAR MAY OR MAY NOT BE USED TO UPDATE THE LM OR CSM STATE VECTORS FOR THIS PROGRAM. IF RADAR USE IS DESIRED THE RADAR WAS TURNED ON AND LOCKED ON THE CSM BY PREVIOUS SELECTION OF P20. RADAR SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS (SEE P20). THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.
- (4) THIS ISS NEED NOT BE ON TO COMPLETE THIS PROGRAM.
- (5) THE OPERATION OF THE PROGRAM UTILIZES THE FOLLOWING FLAGS:

ACTIVE VEHICLE FLAG - DESIGNATES THE VEHICLE WHICH IS DOING RENDEZVOUS THRUSTING MANEUVERS TO THE PROGRAM WHICH CALCULATES THE MANEUVER PARAMETERS. SET AT THE START OF EACH RENDEZVOUS PRE-THRUSTING PROGRAM.

FINAL FLAG - SELECTS FINAL PROGRAM DISPLAYS AFTER CREW HAS COMPLETED THE FINAL MANEUVER COMPUTATION AND DISPLAY CYCLE.

02

4

0

4

40

0.2

40

51(119)

P33/SUNDANCE

HOLD
.....
SNAP

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(CCH):
V06 N31
R1-TIG(CCH)-HRS
R2-TIG(CCH)-MIN
R3-TIG(CCH)-SECS

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

WAIT FOR KEYBOARD
ENTRY

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

AM I SATISFIED WITH
THIS VALUE?

.Y .N
.
.

RECORD THIS
VALUE

KEY IN PROCEED

#50

#60

#70

#80

#90

P33/SUNDANCE

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P
.R
.C
.C
.E
.E
.D

.NEW
.DATA

STORE DATA

RESET UPDATE FLAG.

.BASED ON THE STO-
.RED TARGET PARA-
.METERS, COMPUTE
.THE PARAMETERS
.ASSOCIATED WITH
.CDH, AS DES-
.CRIED IN SEC-
.TION 5.4.4 OF
.R557.
.ESTABLISH ALARM
.IF NO SOLUTION
.CAN BE REACHED

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

.A
.L
.A
.R
.M

KEY IN V25F
AND LCAD
DESIRED TIG
(CDH)

#100

#110

#120

#130

#140

#150

#160

#170

#180

#190

#200

53
(121)

POSS
HOLD
.....
SNAP

FLASH VERB-
NOJN TO RE-
QUEST RESPON-
SE AND DIS-
PLAY ALARM
CODE;
V05N09
R1-00611
R2-XXXXX
R3-XXXXX

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

.N Y.

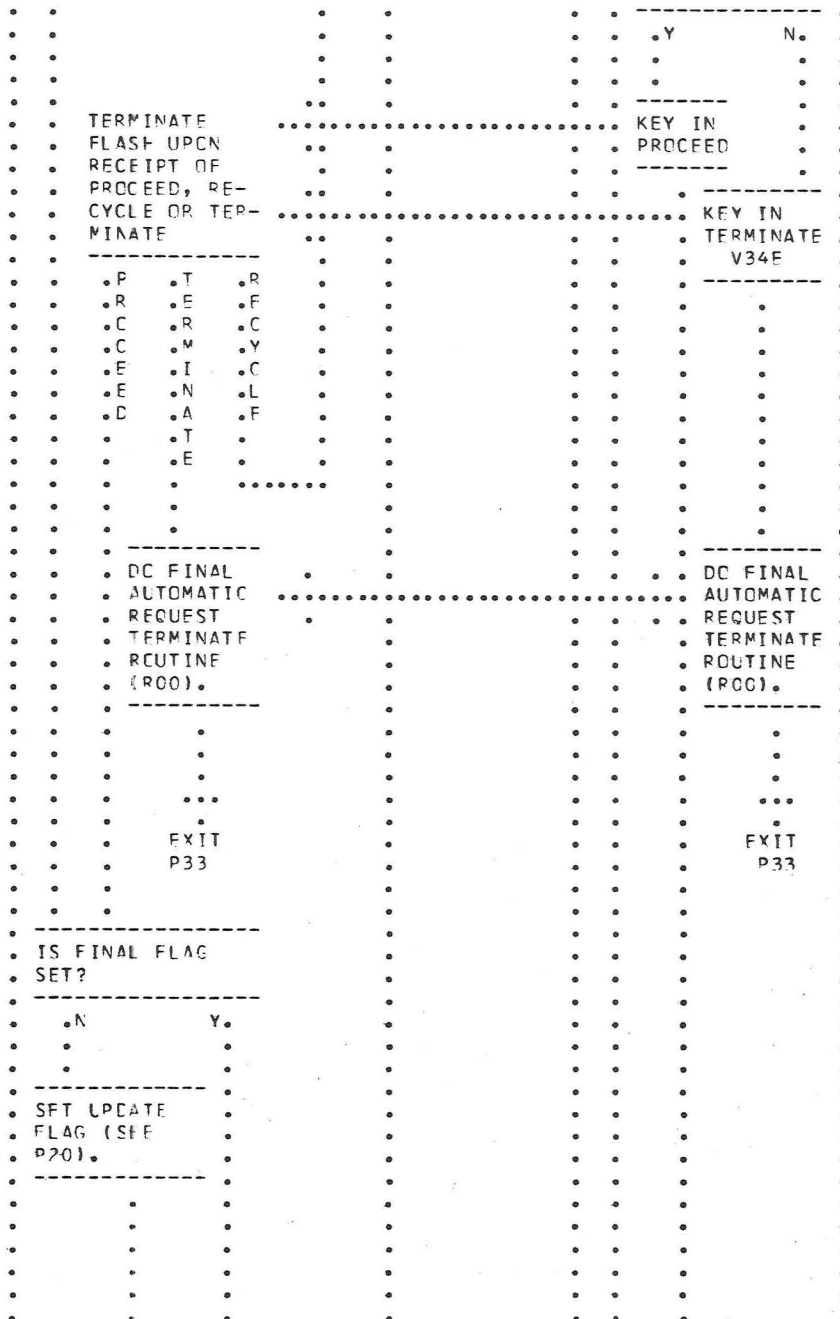
IS IT POSSIBLE
THAT READJUST-
MENT OF TIG
(CDH) MIGHT
PROVIDE A SOL-
UTION. DO I
WISH TO ATT-
EMPT TO READ-
JUST TIG(CDH)

.N Y.

WAIT FOR KEY-
BOARD ENTRY

KEY IN RE-
CYCLE
V32E

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



#210

#220

#230

#240

#250

#260

85-
(123)

P33/SUNDANCE

HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST RES-
PCNSE AND DISPLAY
DELTA ALT (CDH),
DELTA T(CDH/TPI)
AND DELTA T(TPI/
TPI);
V06 N5C
R1-DELTA ALT
(CDH)
R2-DELTA T(CDH/
TPI)
R3-DELTA T(TPI/
TPI)

DELTA ALT(CDH) -
THE ALTITUDE RE-
TWEEN THE ACTIVE
AND PASSIVE VE-
HICLE ORBITS AT
TIG(CDH). SIGN IS
+ WHEN THE ACTIVE
VEHICLE IS BELOW
THE PASSIVE
VEHICLE.

DELTA T(CDH/TPI)-
TIG(TPI) AS CE-
FINED BY THIS
PROGRAM MINUS
TIG(CDH). COM-
PUTED IN HRS,
MINS, AND SECS OF
WHICH ONLY THE
MINS AND SECS ARE
DISPLAYED. MAX
READING IS 59859.

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

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

#270

#280

#290

#300

#310

P33/SUNDANCE

MAX. READING IS
59R59.

RECORD THESE
VALUES

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

P
R
C
C
E
E
D

HOLD
.....
SNAP

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

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

DELTA VX(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CDH)
ALCAG (FXV)XR.

DELTA VY(LV) -
COMPONENT OF
IMPULSIVE DELTA
V AT TIG(CDH)

AM I SATISFIED
WITH THESE
VALUES?
(NOTE: CREW HAS
THE OPTION AT
THIS TIME TO
REDEFINE THE
DELTA V (LV)
COMPONENTS FOR

#320

#330

#340

#350

#360

57 (125)

P33/SUNDANCE

ALONG VXP.

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(CSH)
ALONG -R.

WHERE R IS LM
GECCENTRIC (EARTH
ORBIT) OR SELENC-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AND V IS
LM INERTIAL VELC-
CITY VECTOR AT
TIG(CDH).

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

P NEW
R DATA
D
C STORE DATA
E
E
D

THE SURSEQUENT
THRUSTING MAN-
EUVER. THIS
CAPABILITY WILL
NORMALLY BE
EXERCISED TO
CORRECT OUT-OF-
PLANENESS BY
FIRST SELECTING
THE RENDEZVOUS
OUT-OF-PLANE
DISPLAY ROUTINE
(R36) (V90E)
AND THEN MODIF-
YING DELTA VY
(LV)).

Y N
KEY IN V25E
AND LOAD DE-
SIRED DELTA
V VALUES

RECORD THESE
VALUES

KEY IN PROCEED

#370

#380

#390

#400

#410

#420

P33/SUNDANCE

IS FINAL FLAG SET?

.N .V
 .
 .
 SET
 MGA
 DIS-
 PLAY
 IN R3
 (BELCW)
 =
 -00001.

#430

IS REFSMFLAG SET?

.Y .N

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

#450

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

#470

#480

HOLD

MON

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

V16N45
R1-M
R2-TFI
R3-MGA

M - THE NUMBER OF
MARKS MADE SINCE THE
LAST THRUSTING MAN-
EUVER OR INITIATION
OF P20.

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

MGA - MIDDLE GIMBAL
ANGLE AT GETI(CCH)
IF LM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
SIGN IS ALWAYS +
EXCEPT;

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

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

WAIT FOR KEYBOARD
ENTRY

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

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y N.

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

.Y N.

KEY IN PROCEED.

#490

#500

#510

#520

#530

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

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

IS THE FINAL FLAG
SET?

.Y .N

SET THE FINAL
FLAG

SET EXTERNAL
DELTA V FLAG

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (RCC)

EXIT P33

KEY IN RECYCLE
V32E

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

.Y .N

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (ROO)

EXIT P33

#540

#550

#560

#570

#580

P33/SUNDANCE

CHANGE CONTROL NOTES
LOGIC REV 14 PCN WIT - 65
LOGIC REV 15 PCN WIT 401.3,540.2

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

TRANSFER PHASE INITIATION (TPI) PROGRAM (P34)

LOGIC REV 12 06/13/68

PURPOSE:

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

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

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

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

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

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

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

ASSUMPTIONS:

(1) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE CONSTANT DELTA ALTITUDE (CDH) PROGRAM (P33). THEREFORE:

(A) AT A SELECTED TPI TIME (NOW IN STORAGE) THE LINE

OF SIGHT BETWEEN THE LM AND THE CSM WAS SELECTED TO BE A PRESCRIBED ANGLE (E) (NOW IN STORAGE) FROM THE HORIZONTAL PLANE DEFINED AT THE LM POSITION.

(B) THE TIME BETWEEN CDH IGNITION AND TPI IGNITION WAS COMPUTED TO BE GREATER THAN 10 MINUTES.

(C) THE VARIATION OF THE ALTITUDE DIFFERENCE BETWEEN THE ORBITS WAS MINIMIZED.

(D) THE PERICENTER ALTITUDES OF THE ORBITS FOLLOWING CSI AND CDH WERE COMPUTED TO BE GREATER THAN 35,000 FT. (LUNAR ORBIT) OR 85 NM (EARTH ORBIT)

(F) THE CSI AND CDH MANEUVERS WERE ASSUMED TO BE PARALLEL TO THE PLANE OF THE CSM ORBIT HOWEVER CREW MODIFICATION OF DELTA V(LV) COMPONENTS MAY HAVE RESULTED IN AN OUT-OF-PLANE CDH MANEUVER.

++

+12

++

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

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

(4) THE ISS NEED NOT BE ON TO COMPLETE THIS PROGRAM.

(5) THE OPERATION OF THE PROGRAM UTILIZES THE FOLLOWING FLAGS:

ACTIVE VEHICLE FLAG - DESIGNATES THE VEHICLE WHICH IS DOING RENDEZVOUS THRUSTING MANEUVERS TO THE PROGRAM WHICH CALCULATES THE MANEUVER PARAMETERS. SET AT THE START OF EACH RENDEZVOUS PRE-THRUSTING PROGRAM.

EXTERNAL DELTA V FLAG - RESET BY THIS PROGRAM WHICH DESIGNATES THAT LAMPERT STEERING IS REQUIRED FOR EXECUTION OF THIS MANEUVER BY THE THRUSTING PROGRAM SELECTED AFTER COMPLETION OF THIS PROGRAM.

$$\begin{array}{r} ++ \\ +12 \\ +12 \\ ++ \end{array}$$

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

(7) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

[illegible]

133

P34/SUNDANCE

 RESET FINAL
 FLAG

 RESET COMP E FLAG

 SET TRACK FLAG
 (SEE P20)

 SET UPDATE FLAG
 (SEE P20)

HOLD FLASH VERB-NDJN TO
 REQUEST RESPONSE AND
 SNAP DISPLAY STORED TIG
 (TPI) CALCULATED
 FROM PREVIOUS
 PROGRAMS:
 V06 N37
 R1-TIG (TPI)-HRS
 R2-TIG (TPI)-MIN
 R3-TIG (TPI)-SEC

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

 MONITOR DSKY:
 OBSERVE VERB-NDJN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF TIG (TPI)
 STORED FROM PREVIOUS
 PROGRAMS.

#40

#50

#50

#70

#80

P34/SUNDANCE

#90

#100

#110

#120

#130

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

.Y N.

RECORD THIS
VALUE.

KEY IN PROCEED

KEY IN V25E AND
LOAD THE DESIRED
TIG

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P NEW
.R DATA
.J
.C
.E STORE DATA
.E
.D

135

P34/SUNDANCE

HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST PRO-
CEED AND DISPLAY
STORED E AND
CENTANG:
V06 N55
R1-BLANK
R2-E
R3-CENTANG

E-ELEVATION ANGLE.
BETWEEN THE LM/
CSM LOS AND THE
LM LOCAL HORI-
ZONTAL AT TIG
(TPI) REFERENCED
TO THE DIRECTION
OF FLIGHT (SEE
SECTION 5.4.4 OF
R557 FOR
DETAILED DESCRIPT-
ION). IN DEGREES
TO NEAREST .01
DEGREE.

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

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF STORED E AND
CENTANG:

DO I WISH THE LSC TO
CALCULATE E?

.N .Y

KEY IN V25E AND
LOAD +00000 IN
R2 AND CENTANG
AS DESIRED IN R3

#140

#150

#150

#170

#180

P34/SUNDANCE

 AM I SATISFIED
 WITH THE PRESENT
 VALUE OF E?

.Y .N.

#190

 KEY IN V25E
 AND LOAD THE
 DESIRED F IN
 R2 AND GEN-
 TANG AS DE-
 SIRED IN R3

#200

 RECORD THIS VALUE

#210

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA

 KEY IN PROCEED

#220

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

 STORE DATA

#230

 IS E SPECIFIED TO
 BE +00000?

.N .Y.

#240

137

P34/SUNDANCE

SET COMP E FLAG

RESET NEW TARGET
FLAG

RESET UPDATE FLAG

IS COMP E FLAG
SET?

N Y

COMPUTE E FOR
SPECIFIED
TIG(TPI)

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

DID I SPECIFY E
TO BE +00000?

Y N

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

#250

#260

#270

#280

#290

POSS
HOLD
.....
SNAP

P34/SUNDANCE

(NOTE: FOR DEFINITION SEE ABOVE).

RECORD THIS
VALUE

#300

WAIT FOR KEY-
BOARD ENTRY

KEY IN PRO-
CEED.

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED

#310

COMPUTE TIG
(TPI) FOR THE
SPECIFIED F.
ESTABLISH
ALARM IF NO
SOLUTION CAN
BE REACHED

#320

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

POSS
HOLD
.....
SNAP

.M FLASH VERB-
NOUN TO
REQUEST RE-
SPONSE AND
DISPLAY
ALARM CODE:
V05N79
R1-00611
R2-XXXXX
R3-XXXXX

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

#330

.Y N.

#340

139

P34/SUNDANCE

HOLD .
.....
SNAP .

<p>-----</p> <p>WAIT FOR KEYBOARD ENTRY</p> <p>-----</p> <p>TERMINATE FLASH UPON RECEIPT OF PROCEED</p> <p>-----</p>		<p>-----</p> <p>RETURN TO START OF PROGRAM AND ADJUST INPUT PARA- METERS. KEY IN PROCEED.</p> <p>-----</p>
<p>-----</p> <p>FLASH VERB- NOUN TO RE- QUEST RESPONSE AND DISPLAY CALCULATED TIG(TPI): V06N37 R1-TIG(TPI) -HRS R2-TIG(TPI -MINS R3-TIG(TPI) -SECS.</p> <p>(NOTE: FOR DE- FINITION SEE ABOVE).</p> <p>-----</p>		<p>-----</p> <p>MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO RE- QUEST RE- SPONSE AND DISPLAY OF CALCULATED TIG(TPI).</p> <p>-----</p>
		<p>-----</p> <p>RECORD THIS VALUE</p> <p>-----</p>
<p>-----</p> <p>WAIT FOR KEY- BOARD ENTRY</p> <p>-----</p> <p>TERMINATE FLASH UPON RECEIPT OF PROCEED.</p> <p>-----</p>		<p>-----</p> <p>KEY IN PROCEED</p> <p>-----</p>

#350

#360

#370

#380

#390

P34/SUNDANCE

 . BASED ON STORED
 . TARGET PARAMETERS
 . COMPUTE THE PARA-
 . METERS ASSOCIATED
 . WITH TPI AND
 . TPF AS DESCRIBED
 . IN SECTION 5.4.4
 . OF R557.

#400

 . IS FINAL FLAG
 . SET?

#410

. N Y.

 . SET UPDATE
 . FLAG (SEE
 . P20)

#420

HOLD .

 SNAP .

 . FLASH VERB-NOUN
 . TO REQUEST RE-
 . SPONSE AND DIS-
 . PLAY CALCULATED
 . PER ALT, DELTA
 . V(TPI), AND DELTA
 . V(TPF):
 . V06N58
 . R1-PER ALT
 . R2-DELTA V(TPI)
 . R3-DELTA V(TPF)

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

#430

 . PER ALT-ALTITUDE
 . OF POST TPI PERI-
 . GEE ABOVE
 . THE LAUNCH PAD
 . RADIUS (EARTH
 . ORBIT) OR ALTI-
 . TUDE OF PERILUNE
 . ABOVE THE LUNAR
 . RADIUS AT THE
 . MOST RECENTLY DE-
 . FINED LANDING
 . SITE (LUNAR
 . ORBIT). IN NAUTI-

#440

141

P34/SUNDANCE

#450

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

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

RECORD THESE
VALUES

#460

. WAIT FOR KEYBOARD
. ENTRY

KEY IN PROCEED

#470

. TERMINATE FLASH
. UPON RECEIPT OF
. PROCEED

#480

. IS THE FINAL FLAG
. SET?

. IS THIS THE
. FINAL PASS
. THROUGH THIS
. PROGRAM?

. N . Y .

. Y . N .

#490

HOLD .
.....
SNAP .

. FLASH VERB-
. NOUN TO RE-
. QUEST RESPONSE
. AND DISPLAY
. CALCULATED
. COMPONENTS OF
. DELTA V(LV)
. FOR TPI;

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

#500

P34/SUNDANCE

V06NR1
 R1-DELTA
 VX(LV)
 R2-DELTA
 VY(LV)
 R3-DELTA
 VZ(LV)

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

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

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

 WHERE R IS THE
 LM GEOCENTRIC
 (EARTH ORBIT)
 OR SELENOGEN-
 TRIC (LUNAR
 ORBIT) RADIUS
 VECTOR AND V
 IS THE LM IN-
 ERTIAL VELO-
 CITY VECTOR AT
 TIG(TPI).

FOR TPI

AM I SATIS-
 FIED WITH
 THESE VALUES?
 (NOTE: CREW
 HAS THE OP-
 TION AT THIS
 TIME TO RE-
 DEFINE THE
 DELTA V(LV)
 COMPONENTS
 FOR THE SUB-
 SEQUENT THRU-
 STING MANEU-
 VER. THIS
 CAPABILITY
 WILL NORMALLY
 BE EXERCISED
 TO CORRECT
 OUT-OF-PLANE-
 NESS BY FIRST
 SELECTING THE
 RENDEZVOUS
 OUT-OF-PLANE
 DISPLAY ROU-
 TINE (R36)
 (V90E), AND
 THEN MODIFY-
 ING DELTA
 VY(LV).

.Y N.

#510

#520

#530

#540

059#

[illegible]

145

++
+12
+
+12
++

SET MGA DISP AY
IN R3(BELOW)
= -00001.

IS REFSMFLAG SET?

.Y N.

COMPUTE IMU
MIDDLE GIMBAL
ANGLE AT TIG
(TPI) FOR THE
PRESENT IMU
ORIENTATION
WITH THE LM
+X AXIS ALIGN-
ED WITH THE
INITIAL
THRUST VECTOR

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

++
+12
++

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

M-THE NUMBER OF
MARKS MADE SINCE THE
LAST THRUSTING MAN-
EUVER OR INITIATION
OF P20.

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

P34/SUNDANCE

#660

#670

#680

#690

#700

#710

P34/SUNDANCE

147

P34/SUNDANCE

SET?

Y N

SET THE FINAL
FLAG

RESET THE EXTERNAL
DELTA V FLAG.

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

EXIT P34

CHANGE CONTROL NOTES
LOGIC PEV 12 PCN HIT - 65

#770

#780

#790

#800

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

EXIT P34

149

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

TRANSFER PHASE MIDCOURSE (TPM) PROGRAM (P35)

LOGIC REV 11 05/13/68

PURPOSE: (1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE LGC FOR LM EXECUTION OF THE NEXT MIDCOURSE CORRECTION OF THE TRANSFER PHASE OF AN ACTIVE LM RENDEZVOUS.

ASSUMPTIONS: (1) THE ISS NEED NOT BE ON TO COMPLETE THIS PROGRAM.

++

+11 (2) THE RENDEZVOUS RADAR IS ON AND IS LOCKED ON THE CSM. THIS WAS DONE DURING PREVIOUS SELECTION OF P20. RADAR
++ SIGHTING MARKS WILL BE MADE AUTOMATICALLY APPROXIMATELY ONCE A MINUTE WHEN ENABLED BY THE TRACK AND UPDATE FLAGS (SEE P20). THE RENDEZVOUS TRACKING MARK COUNTER IS ZEROED BY THE SELECTION OF P20 AND AFTER EACH THRUSTING MANEUVER.

(3) THE OPERATION OF THIS PROGRAM UTILIZES THE FOLLOWING FLAGS:

ACTIVE VEHICLE FLAG - DESIGNATES THE VEHICLE WHICH IS DOING RENDEZVOUS THRUSTING MANEUVERS TO THE PROGRAM WHICH CALCULATES THE MANEUVER PARAMETERS. SET AT THE START OF EACH RENDEZVOUS PRE-THRUSTING PROGRAM.

FINAL FLAG - SELECTS FINAL PROGRAM DISPLAYS AFTER CREW HAS SELECTED THE FINAL MANEUVER COMPUTATION CYCLE.

EXTERNAL DELTA V FLAG - RESET BY THIS PROGRAM WHICH DESIGNATES THAT LAMBERT STEERING IS REQUIRED FOR EXECUTION OF THIS MANEUVER BY THE THRUSTING PROGRAM SELECTED AFTER AFTER COMPLETION OF THIS PROGRAM.

(4) THE TIME OF INTERCEPT (T(INT)) WAS DEFINED BY PREVIOUS COMPLETION OF THE TRANSFER PHASE INITIATION (TPI) PROGRAM (P34) AND IS PRESENTLY AVAILABLE IN LGC STORAGE.

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

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

(6) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY PRIOR TO ANY ANTICIPATED RENDEZVOUS MIDCOURSE CORRECTION.

PL G
CONT

140

STEP

OPER

CHECKLIST

TIME

TOTAL
TIME

		.CPRN .PRDG .SELECTION	
----- START TRANSFER PHASE MIDCOURSE (TPM) PROGRAM (P35). DISPLAY PROGRAM 35. -----	. ..... .	----- KEY IN TRANSFER PHASE MIDCOURSE (TPM) PROGRAM (P35) V37E 35E ----- . . .	#10
-----		----- MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 35 -----	#20
----- . : .		----- . : .	
----- SET ACTIVE VEHICLE FLAG TO LM -----		----- . : .	
----- . : .		----- . : .	#30
----- RESET FINAL FLAG. -----		----- . : .	
----- . : .		----- . : .	
----- SET TRACK FLAG (SEE P20) -----		----- . : .	#40
----- . : .		----- . : .	
----- SET UPDATE FLAG (SEE P20) -----		----- . : .	
----- . : . . . . . . . .	..... . . . . . . . . .	----- . : . . . . . . . .	#50

P35/SUNDANCE

150

151

P35/SUNDANCE

 . RESET NEW TARGET
 . FLAG
 .-----

 . RESET UPDATE FLAG
 .-----

 . DEFINE TIG(MID)=
 . T + "A" MIN.
 . WHERE:
 . "A" WILL BE
 . STORED IN ERAS-
 . ABLE STORAGE AND
 . MAY BE CHANGED BY
 . PRELAUNCH ERAS-
 . ABLE LOAD OR LGC
 . UPDATE BY P27.
 .-----

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

 . EXTRAPOLATE CSM
 . STATE VECTOR TO
 . T(INT) (NOTE:
 . REFER ASSJPTION
 . (4) ABOVE).
 .-----

#50

#70

#80

#90

#100

P35/SUNDANCE

```

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

```

```

IS THE FINAL FLAG
SET?

```

```

.N      Y.

```

```

SET UPDATE
FLAG

```

```

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

```

```

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

```

```

IS THIS THE FINAL
PASS THROUGH THIS
PROGRAM?

```

```

.Y      N.

```

```

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

```

```

AM I SATIS-
FIED WITH
THESE
VALUES?
(NOTE: CREW
HAS THE OP-
TION AT
THIS TIME
TO REDEFINE

```

#110

#120

#130

#140

#150

HOLD

SNAP

153

P35/SUNDANCE

FPS.

DELTA VY(LV)-
 COMPONENT OF
 IMPULSIVE
 DELTA V AT
 TIG(TPM)
 ALONG VXR. IN
 FPS TO NEAR-
 EST .1 FPS

DELTA VZ(LV)-
 COMPONENT OF
 IMPULSIVE
 DELTA V AT
 TIG(TPM)
 ALONG -R. IN
 FPS TO NEAR-
 EST .1 FPS

WHERE R IS
 THE LM GEO-
 CENTRIC
 (EARTH ORBIT)
 OR SELENO-
 CENTRIC
 (LUNAR ORBIT)
 RADIUS VECTOR
 AND V IS THE
 LM INERTIAL
 VELOCITY
 VECTOR AT
 TIG(TPM).

 WAIT FOR KEY-
 BOARD ENTRY

THE DELTA V
 (LV) COM-
 PONENTS FOR
 THE SUBSF-
 QUENT
 THRUSTING
 MANEUVER.
 THIS CAPA-
 BILITY WILL
 NORMALLY BE
 EXERCISED
 TO CORRECT
 OUT-OF-
 PLANENESS
 BY FIRST SE-
 LECTING THE
 RENDEZVOUS
 OUT-OF-
 PLANE DIS-
 PLAY RDU-
 TIME (R36)
 (V90E), AND
 THEN MODI-
 FY(LV).

 .Y V.

 KEY IN
 V25E
 AND
 LOAD
 THE DE-
 Sired
 DELTA V
 VALUES.

#160

#170

#180

#190

#200

P35/SUNDANCE

#210

#220

#230

#240

#250

#260

REC'D
THESE
VALUES

KEY IN
PROCEED

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR
NEW DATA

P NEW
R DATA
O
C
E
F STORE
D DATA

SET NEW
TARGET
FLAG

IS NEW TAR-
GET FLAG
SET?

N Y

CALCULATE
NEW TAR-
GET VEC-
TOR BASED
ON NEWLY
LOADED
DELTA V
(LV) FOR
TDM

++
+11

451

 IS REFSMFLAG SET?

.Y N.

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

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

++
 +11
 +11
 ++

HOLD

MON

..... FLASH VERB-NJUN TO
 REQUEST RESPONSE AND
 DISPLAY OF M, TFI
 AND MGA;

V16N45
 R1-M
 R2-TFI
 R3-MGA

M-THE NUMBER OF
 MARKS MADE SINCE THE
 LAST THRUSTING MAN-
 EUVER OR INITIATION
 OF P20.

++
 +11
 +
 +
 +
 +
 +11
 ++

 MONITOR DSKY:
 OBSERVE VERB-NJUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF M, TFI AND MGA.
 NOTE: ON FIRST PASS
 THROUGH TFI WILL BE
 TIME FROM TIG (TPI)
 UNTIL THE FIRST RE-
 CYCLE DEFINES TIG
 (MID).

#320

#330

#340

#350

#360

157

P35/SUNDANCE

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

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

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

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

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

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

WAS THIS THE LAST
PASS THRUJGH THE
PROGRAM?

.Y	.N
----	----

DO I WISH TO
TERMINATE THE
MARK PROCFSS AND
DO THE FINAL PASS
THROJGH THE PRO-
GRAM?

.Y	.N
----	----

KEY IN PROCEED.

KEY IN RECYCLE
V32E

WAS THIS THE LAST
PASS THROUGH THE

#370

#380

#390

#400

#410

P35/SUNDANCE

++
+11
+11
++

IS THE FINAL FLAG
SET?

.Y .N.

SET THE FINAL
FLAG

RESET THE EXTERNAL
DELTA V FLAG

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

EXIT P35

PROGRAM?

.Y .N

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

EXIT P35

#420

#430

#440

#450

CHANGE CONTROL NOTES
LOGIC REV. 11 PCN-MIT-65

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

DPS PROGRAM (P40)

LOGIC REV 21 01/17/69

- PURPOSE:
- (1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A VEHICLE ATTITUDE FOR A LM DPS THRUSTING MANUEVER.
 - (2) TO DO THE VEHICLE MANUEVER TO THE THRUSTING ATTITUDE.
 - (3) TO CONTROL THE PGNC'S DURING COUNTDOWN, IGNITION, THRUSTING, AND THRUST TERMINATION OF A PGNC'S CONTROLLED DPS MANUEVER.
- ASSUMPTIONS:
- (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE LGC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
 - (2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER SET (EXT DELTA V) OR RESET (LAMBERT) THE EXTERNAL DELTA V FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE LGC THAT DPS AND RCS TRIM THRUSTING HAS BEEN COMPLETED, THE LGC UPDATES VG ONLY AS A RESULT OF ACCELEROMETER INPUTS.
FOR LAMBERT STEERING VG IS CALCULATED AND UPDATED SIMILARLY, HOWEVER IT IS ALSO UPDATED PERIODICALLY BY LAMBERT SOLUTIONS TO CORRECT FOR CHANGES IN THE LM STATE VECTOR.
 - (3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANUEVER.
 - (4) THE EVENT TIMER IS SET TO COUNT ZERO AT TIG.
 - (5) ENGINE IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW.
 - (6) IN THE EVENT THAT THE GUIDANCE CONTROL SWITCH IS CHANGED FROM PGNC'S TO AGS DURING A THRUSTING MANUEVER, THE LGC WILL CONTINUE COMPUTATION OF POSITION AND VELOCITY, THE DESIRED THRUST VECTOR AND THE DESIRED ATTITUDE ERRORS, BUT IS NO LONGER RESPONSIBLE FOR THE MANUEVER.
 - (7) THE X-AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNC'S ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNC'S DAMPS THE YAW RATE TO APPROXIMATELY 1 DEGREE/SECOND, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS DAMPED, AND THEN MAINTAINS THAT ATTITUDE.
THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE. THUS THE OPTION IS INHIBITED BY THIS PROGRAM ONLY DURING THE ATTITUDE MANUEVER TO THE THRUSTING ATTITUDE (SEE R6C).
- WHEN THE ATTITUDE MODE CONTROL SWITCH IS SET TO AUTO AND X-AXIS OVERRIDE IS PERMITTED THE YAW ATTITUDE CONTROL SUB MODE IS RATE COMMAND/ATTITUDE HOLD.
- (8) THE DOCKED CONFIGURATION OF THE VEHICLE(S) HAS BEEN PREVIOUSLY ENTERED IN THE LGC.
 - (9) WHEN THE THOLST/TRANSLATION CONTROLLER IS SET TO MINIMUM THRUST POSITION AND THE LGC THROTTLE COMMAND IS ZERO THE DPS WILL START AT 10 PER CENT THRUST.
 - (10) THE LOAD CAP DATA ROUTINE (R03) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM AND THE DPS ENGINE GIMBAL HAS BEEN PREVIOUSLY DRIVEN TO THE CORRECT TRIM POSITION. IF THIS BURN IS OF SUFFICIENT DURATION THAT VEHICLE TRANSIENTS AT IGNITION DUE TO CG/THRUST DOES NOT AFFECT ACCOMPLISHMENT OF MANUEVER AIM CONDITIONS, THEN GIMBAL DRIVE TO TRIM POSITION NEED NOT BE DONE BEFORE TIG. GIMBAL DRIVE TO TRIM POSITION IN WORST CASE COULD REQUIRE 2 MINUTES.

(11) FOR EACH BURN AN IGNITION TOTAL ALLOWABLE TIME DELAY WILL BE SPECIFIED IN THE MISSION RULES. THIS DELAY TIME IS THE TOTAL TIME WHICH THE THRUSTING MANEUVER MAY BE DELAYED BEYOND THE LGC CALCULATED TIME OF IGNITION. IF ENGINE RESTARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.

(12) THIS PROGRAM SHOULD BE SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 5 MIN. BEFORE THE ESTIMATED TIME OF IGNITION.

(13) FLAGS USED IN THIS PROGRAM:

NO THROTTLE FLAG - INHIBITS THROTTLING BEYOND 10 PERCENT IF TFC IS LESS THAN 95 SECONDS.

[illegible]

HOLD .
.....
SNAP .

EXIT P40

DO IMU STATUS CHECK
ROUTINE (R02)

RESET NC THRCT FLAG

DOES VERB-NCUN FLASH
TO REQUEST RESPONSE
AND DISPLAY OF ALARM
CODE INDICATE THAT
THE STAGE VERIFIED
DISCRETE INDICATES
THAT DPS HAS BEEN
STAGED?

KEY IN TERMINATE
V34F

DO FINAL AUTO-
MATIC REQUEST
TERMINATE
ROUTINE (RCO)

EXIT P40

DO IML STATUS CHECK
ROUTINE (RC2)

#40

#50

#60

#70

¥80

P40/SUNDANCE

 COMPUTE INITIAL
 THRUST DIRECTION
 AND INITIAL VALUE OF
 VG VECTOR AND STORE
 VG(LV) IN N86 FOR
 POSSIBLE MANUAL
 SELECTION:

R1-VGX(LV)
 R2-VGY(LV)
 R3-VGZ(LV)

VGX(LV)-COMPONENT OF
 VG AT TIG ALONG
 (RXV)XR. IN FPS TO
 NEAREST .1 FPS.

VGY(LV)-COMPONENT OF
 VG AT TIG ALONG VXR.
 IN FPS TO NEAREST
 .1 FPS.

VGZ(LV)-COMPONENT OF
 VG AT TIG ALONG -R.
 IN FPS TO NEAREST
 .1 FPS.

WHERE R IS GEO-
 CENTRIC (EARTH
 ORBIT) OR SELENC-
 CENTRIC (LUNAR
 ORBIT) RADIUS VECTOR
 AND V IS VEHICLE
 INERTIAL VELOCITY
 VECTOR AT TIG.

 COMPUTE PREFERRED
 IMU ORIENTATION:

X = UNIT (T)
 -SM -

Y = UNIT (T X R)
 -SM - -

Z = UNIT(X X Y)
 -SM -SM -SM

#90

#100

#110

#120

#130

#140

67
(163)

P40/SUNDANCE

WHERE:

T = THE INITIAL
- THRUST VECTOR
AT TIG

R = THE GEOCENTRIC
- (EARTH ORBIT)
OR SELENO-
CENTRIC (LUNAR
ORBIT) RADIUS
VECTOR AT TIG.

#150

.
.
.

SET PREFERRED
ORIENTATION FLAG

#160

.
.
.

STORE DESIRED ATTITUDE SPECIFICATION
FOR USE BY ATTITUDE
MANEUVER ROUTINE
(R60). THE FINAL
ATTITUDE WILL BE
COMPUTED DURING R60
AND WILL POINT THE
LM +X AXIS IN THE
INITIAL THRUST
DIRECTION. HOWEVER,
IN ORDER TO CONSERVE
RCS FUEL AND NOT
CONSTRAIN THE NON-
CRITICAL ATTITUDE
ABOUT THE THRUST
VECTOR, WINGS MAY
NOT BE LEVEL IN THE
COMPUTED FINAL
ATTITUDE.

#170

.
.
.

ZERO ATTITUDE ERROR
AND SET 1 DEGREE
DEADBAND IN RCS CAP.

#180

#190

P40/SUNDANCE

#200

RESET 3 AXIS FLAG
FOR USE BY THE ATTITUDE MANEUVER
ROUTINE (R6C).

#210

DO ATTITUDE MANEUVER
ROUTINE (R60)

DO ATTITUDE MANEUVER
ROUTINE (R60)

#220

HAVE PGNC'S CONTRCL,
AUTO ATTITUDE
CONTROL AND AUTO
THROTTLE MODES
BEEN SELECTED?

.Y .N

POSS
HOLD .
.....
SNAP .

FLASH VERB-NOUN
TO REQUEST
PLEASE PERFORM
PGNC'S CONTROL,
AUTO ATTITUDE
CONTROL AND AUTO
THROTTLE MODE
SELECTION:
V50 N25
R1-00203
R2-BLANK
R3-BLANK

#230

MONITOR DSKY:
DOES VERB-NCUN
FLASH TO REQUEST
PLEASE PERFORM
PGNC'S CONTROL, AUTO
ATTITUDE CONTROL
AND AUTO THROTTLE
MODE SELECTION IN-
DICATION THAT MODE
SELECTION IS
INCORRECT?

.Y .N

#240

DO I DESIRE
AUTO CONTRCL?

.Y .N

#250

#260

#270

#280

#290

#300

POSS
HOLD .
.....
SNAP .

IS TIME FROM
IGNITION NEG-
ATIVE, LESS
THAN 35 AND
GREATER THAN
30 SECONDS?

.Y .N

FLASH
VEPB-NCUN
TO REQUEST
RESPONSE
AND DIS-
PLAY ALARM
CODE TO
INDICATE
THAT STATE
VECTOR IN-
TEGRATION
HAS OVER-
LAPPED
AVERAGE G
TURN ON
TIME:
V05NCS
R1-01711
R2-XXXXX
R3-XXXXX

WAIT FOR
KEYBOARD
ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE

MONITOR DSKY:
DOES VEPB-NCUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
ALARM CODE INDICAT-
ING THAT INTEGRATION
HAS OVERLAPPED AVER-
AGE G TURN ON TIME?

.Y .N

KEY IN
TERMIN-
ATE

V34E

#420

#430

#440

#450

#460

DO FIN-
AL AUT-
OMATIC
REQUEST
TERMIN-
ATE
ROUTINE
(ROO)

EXIT P40

EXIT
P40

DISPLAY
ON DSKY:
V06 N40
R1-TFI
R2-VG
R3-DELTA
VM
TFI-TIME
FROM DPS
IGNIT-
IGN. IN
MIN. SEC
TC NEAR-
EST SEC.
MAX
READING
IS
59059.
SIGN IS
- BEFORE
NORMAL
TIG, +
THERE-
AFTER.

VG-MAGN-
ITUDE OF
THE VEL-
OCITY TO
BE GAIN-

MONITOR DSKY:
OBSERVE DISPLAY OF
TFI AND VG.

UPDATE EVENT TIMER
IF DESIRED. TIMER
WILL NOT AGREE WITH
DSKY R1 IF IGNITION
HAS BEEN SLIPPED AS
R1 WILL DISPLAY TFI
TO NEW TIC.

VERIFY/SET THRUST/
TRANSLATION CONTROL-
LER TO MINIMUM
THRUST POSITION.

APM DPS. (AUTC

#470

480

#490

#500

#510

ED BY
THRUST-
ING MAN-
EUVER.
IN FPS
TC NEAR-
EST .1
FPS

DELTA
VM-MEAS-
URED
DELTA V
MAGNIT-
UCE. IN
FPS TO
NEAREST
.1 FPS.
THIS
DISPLAY
WILL BE
OCCOO
UNTIL
TIG-30
SEC AND
THEN
SHOULD
CHANGE
ONLY DUE
TO PIPA
BIAS UN-
TIL ULL-
AGE IS
STARTED.

BLANK
DSKY IM-
MEDIATELY

AT TIG-35 SEC
BLANK THE
DSKY DISPLAY
(V,N,R1,R2,
AND R3) FOR 5
SECONDS.

THROTTLE SIGNAL IS
ENABLED TO DPS AND
THRUST INDICATOR.)

CHECK THRUST INDICA-
TOR (RIGHT SIDE) TO
ENSURE AUTO THROTTLE
COMMAND IS ZEROED (0
PERCENT INDICATION).

.Y .N
GO TO BACKUP
PROCEDURES.

CHECK STATUS OF C/W
LAMPS

MONITOR DSKY:
AT TIG-35 SEC
OBSERVE DSKY DISPLAY
TO GO BLANK FOR 5
SECONDS. (NOTE: IF
STATE VECTOR INTEG-
RATION HAS RUN INTO
THE TIME PERIOD TIG
-35 TO TIG-30 THE
BEGINNING AND DURA-
TION OF BLANKING
CANNOT BE DEFINED

#520

#530

#540

#550

#560

#570

75
(177)

P40/SUNDANCE



WAIT UNTIL
TFI = -5 SEC.

CALCULATE DURATION
OF BURN

IS BURN DURATION
LESS THAN 95
SECONDS?

N

Y

SET NC THROT
FLAG TO
INHIBIT THROT-
TLE COMMAND TO
MAXIMUM
AT TIG + XX (A
PAD LOADED
ERASABLE
MEMORY
CONSTANT)

#630

#640

#650

#660

77
(173)

P40/SUNDANCE

.....
HOLD .
CHANGE VERB BUT
RETAIN PRESENT NCUN
AND DISPLAYS IN R1,
R2, R3, FLASH VERB-
NCUN TO REQUEST
PLEASE PERFORM
ENGINE CN ENABLE:
V99N40

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
PLEASE PERFORM
ENGINE CN ENABLE

#670

IS THIS AN ATTEMPTED
ENGINE RESTART?

.N .Y

#680

MONITOR START OF
+X TRANSLATION

#690

MONITOR DSKY:
WAIT FOR INCREASE OF
DELTA VM INDICATING
SUFFICIENT ULLAGE.
REQUIRED ULLAGE
DELTA V IS A
FUNCTION OF VEHICLE
WEIGHT.

#700

WAIT FOR KEYBOARD
ENTRY

SHALL I PERMIT
IGNITION OF
REIGNITION?

.N .Y

#710

KEY IN PROCEED

#720

P40/SUNDANCE

#730

SHALL I ATTEMPT
TO COMPLETE
THIS THRUSTING
MANEUVER WITH
THE RCS?

Y N

KEY IN
ENTER

#740

GO TO
"A"
BELOW

#750

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMINATE.

KEY IN
TERMINATE
V34E

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

TURN
OFF
ULLAGE

TURN
OFF
ULLAGE

GO TO
"A"
BELOW

#760

#770

79
(175)



P40/SUNDANCE

#780

#790

#800

#810

#820

#830

P40/SUNDANCE

WAIT 0.5 SEC.

TURN OFF LLLAGE

TURN ON CAP TVC
FUNCTIONS

CHANGE TFI DISPLAY
TO TFC IN R1:

V06 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

TFC - TIME FROM
ENGINE CUTOFF. IN
MIN AND SEC TO NEAR-
EST SEC. SIGN IS
- BEFORE + AFTER
CUTOFF.

MONITOR DSKY:
OBSERVE CHANGE OF
TFI DISPLAY TO TFC
IN R1

HAS ENGINE IGNITED?
CHECK THRUST INDI-
CATOR (LEFT SIDE) TO
INDICATE 10 PERCENT
CHAMBER PRESSURE
(CORRESPONDING TO
THRUST/TRANSLATION
CONTROLLER SETTING).

ESTABLISH DELTA V
MONITOR (REFER
SECTION 5.3.3.4 OF
R557).
(NOTE: IF THE DELTA

.N

.Y

#840

#850

#860

#870

#880

81(177)

V MONITOR DOES NOT
DETECT THRUST IN 8-
10 SECONDS FROM REC-
EPT OF ENGINE ON
COMMAND IT IS CON-
SIDERED THRUST FAIL.
IF THE DELTA V MONI-
TOR DOES NOT DETECT
THRUST FOR 2-4 SEC-
ONDS DURING NORMAL
THRUSTING PERIODS IT
IS CONSIDERED A
THRUST FAIL. IN THE
EVENT OF A THRUST
FAIL, THE PROGRAM
WILL RETURN TO THE
TIG-5 SEC POINT).

THRUST .NO
CK .THRUST

COMMAND ENGINE
OFF

TURN OFF DAP TWO
FUNCTIONS

MAINTAIN VG COM-
PUTATIONS FOR
POSSIBLE FURTHER
THRUSTING.

COMMAND +X
ULLAGE TRANS-
LATION (2 JFT)

P40/SUNDANCE

#890

#900

#910

#920

#930

#940

P40/SUNDANCE

RESET TFC DIS-
PLAY IN R1 TO
59B59.

AT TIG +XX SEC (A
PAD LOADED ERASABLE
MEMORY CONSTANT.)
COMMAND THROTTLE
TO MAXIMUM.
IF NO THRCT FLAG IS
RESET. (I.E. BURN
DURATION WAS CALCU-
LATED TO BE GREATER
THAN 95 SEC).

THROUGHOUT THE
THRUSTING MANEUVER
THE LGC WILL MONITOR
THE ANGLE BETWEEN
THE DESIRED THRUST
VECTOR AND THE
MEASURED THRUST
VECTOR. IF THIS
ANGLE BECOMES
GREATER THAN 45 DE-
GREES TURN ON PRO-
GRAM ALARM PUT DO
NOT CHANGE THE DSKY

AFTER XX SECONDS
OBSERVE THRUST INDI-
CATOR TO INDICATE
PERCENT AUTO
THROTTLE COMMAND
(RIGHT SIDE) AND 100
PERCENT CHAMBER
PRESSURE (LEFT SIDE)
ALSO AT THIS TIME
TFC WILL START
COUNTING DOWN.

.Y N.

BURN DURATION WAS
CALCULATED TO BE
LESS THAN 95
SECONDS.
THEREFORE MAXI-
MUM THROTTLE WILL
NOT BE COMMANDED.

MONITOR DPS
THRUSTING:
1. DSKY:
R1-TFC
SHOULD BE
DECREASING
R2-VG SHOULD BE
DECREASING
R3-DELTA VM
SHOULD INCREASE

#950

#960

#970

#980

#990

DISPLAY. STORE ALARM
CODE (1407). (REFER
SECTION 5.3.3.4 OF
R557).

2. FDAI-ATT. ERRORS
SHOULD BE LESS THAN
DEGREE.

ATT RATES SHOULD BE
LESS THAN OR EQUAL
TO DEGREE/SEC.

3. THRUST INDICATOR
LEFT SIDE: PERCENT
MAX CHAMBER PRESSURE
RIGHT SIDE: LGC
THROTTLE COMMAND
PERCENT FULL THRUST.

(NOTE: A PROGRAM
ALARM WILL OCCUR IF
THE ANGLE BETWEEN
THE DESIRED THRUST
VECTOR AND THE MEAS-
URED THRUST VECTOR
BECOMES GREATER THAN
45 DEGREES. TO
IDENTIFY THE ALARM
KEY IN VC5NOSE.
EXPECTED ALARM CODE
IS 01407.)

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

#1000

#1010

#1020

#1030

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

#1040

PUSH ENGINE
STOP PUSH-
BUTTON

#1050

P40/SUNDANCE

P40/SUNDANCE

GC TC
BACKUP
PROCEDURES.

#1060

LGC COMMANDS ENGINE
OFF WHEN INDICATED
BY CUTOFF EQUATION

#1070

REMOVE CAP TVC
FUNCTIONS

TERMINATE DELTA V

#1080

MAINTAIN VG
COMPUTATIONS AFTER
CUTOFF FOR POSSIBLE
NULLING BY PCS
TRIMMING MANEUVER
(NOTE: SEE ASSUMP-
TION (2) ABOVE).

#1090

DISARM DPS

#1100

"A"
FROM
ABOVE

"A"
FROM
ABOVE

85
(187)

P40/SUNDANCE

#1110

HOLD

FLASH VERB-NOUN TO
REQUEST PROCEED.
HOLD DISPLAY OF TFC
AT ITS FINAL VALUE:
V16 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

NOTE: SEE ASSUMP-
TION (2) ABOVE).

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF TFC, VG AND DELTA
VM.

#1120

RECORD THESE VALUES
AS DESIRED.

#1130

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED

KEY IN PROCEED

#1140

ZERO ATTITUDE ERROR
AND SET .3 DEGREE
DEADBAND IN FCS CAP

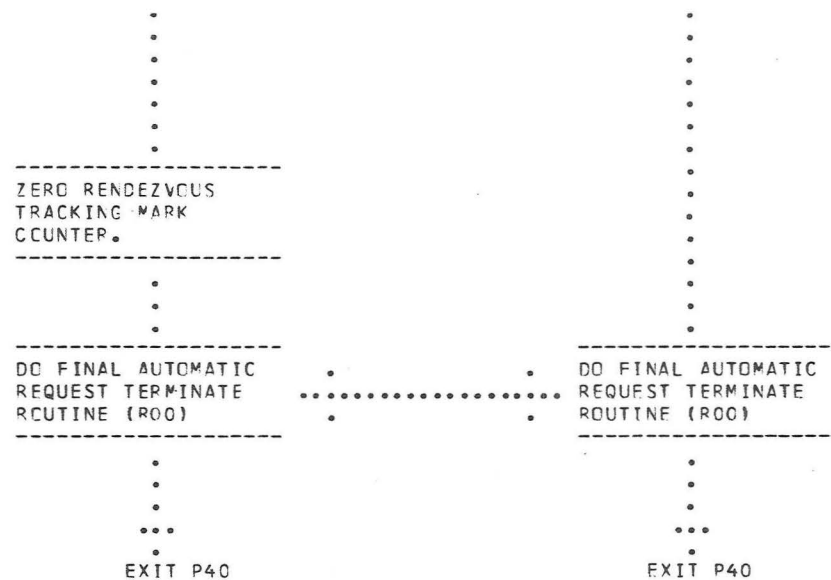
#1150

#1160

P40/SUNDANCE

87
(183)

P40/SUNDANCE



#1220

#1230

CHANGE CONTROL NOTES

LOGIC REV 19 PCN # MIT 49
 LOGIC REV 20 PCR - NASA - 86 + PCN-MIT-71 + PCN-MIT-79 + PCN MIT 92
 PCR-NASA-85
 LOGIC REV 21 PCN MIT 401.3

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RCS PROGRAM (P41)

LOGIC REV 17 01/17/69

- PURPOSE:
- (1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A VEHICLE ATTITUDE FOR AN RCS THRUSTING MANEUVER.
 - (2) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
 - (3) TO PROVIDE FLITABLE DISPLAYS FOR MANUAL EXECUTION OF THE THRUSTING MANEUVER IN THE ATTITUDE HOLD MODE.
- ASSUMPTIONS:
- (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE LGC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
 - (2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER SET (EXT DELTA V) OR RESET (LAMBERT) THE EXTERNAL DELTA V FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE LGC THAT RCS THRUSTING HAS BEEN COMPLETED, THE LGC UPDATES VG ONLY AS A RESULT OF ACCELEROMETER INPUTS.
FOR LAMBERT STEERING VG IS CALCULATED AND UPDATED SIMILARLY, HOWEVER IT IS ALSO UPDATED PERIODICALLY BY LAMBERT SOLUTIONS TO CORRECT FOR CHANGES IN THE LM STATE VECTOR.
 - (3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO THRUSTING MANEUVER.
 - (4) THE EVENT TIMER IS SET TO COUNT TO ZERO AT TIG.
 - (5) THE IMU IS ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) HAS BEEN COMPLETED BEFORE SELECTION OF THIS PROGRAM.
 - (6) RCS IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW.
 - (7) THE X - AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNC'S ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNC'S CAMPS THE YAW RATE TO APPROXIMATELY 1 DEGREE/SECOND, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS CAMPED, AND THEN MAINTAINS THAT ATTITUDE.
THE X - AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE. THUS THE OPTION IS INHIBITED BY THIS PROGRAM ONLY DURING THE ATTITUDE MANEUVER TO THE THRUSTING ATTITUDE (SEE R6C)
 - (8) THE DOCKED CONFIGURATION OF THE VEHICLE(S) HAS BEEN PREVIOUSLY ENTERED IN THE LGC.
 - (9) THE LOAD DATA ROUTINE (R03) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.
 - (10) THIS PROGRAM SHOULD BE SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 5 MIN. BEFORE THE ESTIMATED TIME OF IGNITION.

TOTAL
TIME

#40

90.
(186)

91
(187)

VGX(LV)-COMPONENT OF
VC AT TIG ALONG
(RXV)XP. IN FPS TO
NEAREST .1 FPS.

VGY(LV)-COMPONENT OF
VC AT TIG ALONG VXR.
IN FPS TO NEAREST
.1 FPS.

VGZ(LV)-COMPONENT OF
VC AT TIG ALONG -R.
IN FPS TO NEAREST
.1 FPS.

WHERE R IS GEOCENT-
RIC (EARTH ORBIT) OR
SELENCENTRIC (LUNAR
ORBIT) RADIUS VECTOR
AND V IS VEHICLE
INERTIAL VELOCITY
VECTOR AT TIG.

•
•
•

COMPUTE PREFERRED
IMU ORIENTATION:

X = UNIT T
-SM -

Y = UNIT (T X R)
-SM - -

Z > UNIT (X X Y)
-SM -SM -SM

WHERE:

T = THE INITIAL
-
THRUST VECTOR.

R = THE GEOCENTRIC
-
(EARTH ORBIT) OR
SELENCENTRIC
(LUNAR ORBIT)
RADIUS VECTOR AT
TIG.

P41/SUNDANCE

#50

#60

#70

#80

#90

#100

P41/SUNDANCE

 SET PREFERRED ORIEN-
 TATION FLAG.

#110

 STORE DESIRED ATTITUDE SPECIFICATION FOR USE BY ATTITUDE MANEUVER ROUTINE (R60). THE FINAL ATTITUDE WILL BE COMPUTED DURING R60 AND WILL POINT THE LM +X AXIS IN THE INITIAL THRUST DIRECTION. HOWEVER, IN ORDER TO CONSERVE RCS FUEL AND NOT CONSTRAIN THE NON-CRITICAL ATTITUDE ABOUT THE THRUST VECTOR, WINGS MAY NOT BE LEVEL IN THE COMPUTED FINAL ATTITUDE.

#120

#130

 ZERO ATTITUDE ERROR AND SET .3 DEGREES DEADBAND IN RCS DAP

#140

 RESET 3 AXIS FLAG FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60)

#150

.....

 WAIT UNTIL TFI =
 -00800

#320

.....

 FLASH PRESENT VEPB-
 NCUN (V16N85) TO RE-
 HOLD QUEST RESPONSE.
 MAINTAIN DISPLAY OF
 VG (LM) COMPONENTS.
 (NOTE: SEE ASSUMP-
 TION (2) ABOVE).

.....

 MONITOR DSKY:
 OBSERVE VEPB-NCUN
 FLASH TO REQUEST
 RESPONSE AT LGC
 ASSUMED TIG.

#330

.....

 COMMAND MANUAL
 ROTATIONS AND
 TRANSLATIONS TO NULL
 VG COMPONENTS

#340

.....

 THE ORBITAL PARAMET-
 ER DISPLAY ROUTINE
 (R30) MAY BE SELECT-
 ED AT THIS TIME
 (V82E) TO MONITOR
 CONTINUOUSLY UPDATED
 VALUES OF APO ALT,
 PER ALT, AND TFE.

#350

.....

 WAIT FOR KEYBOARD
 ENTRY

.....

 WHEN MANEUVER IS
 COMPLETE KEY IN
 PROCEED

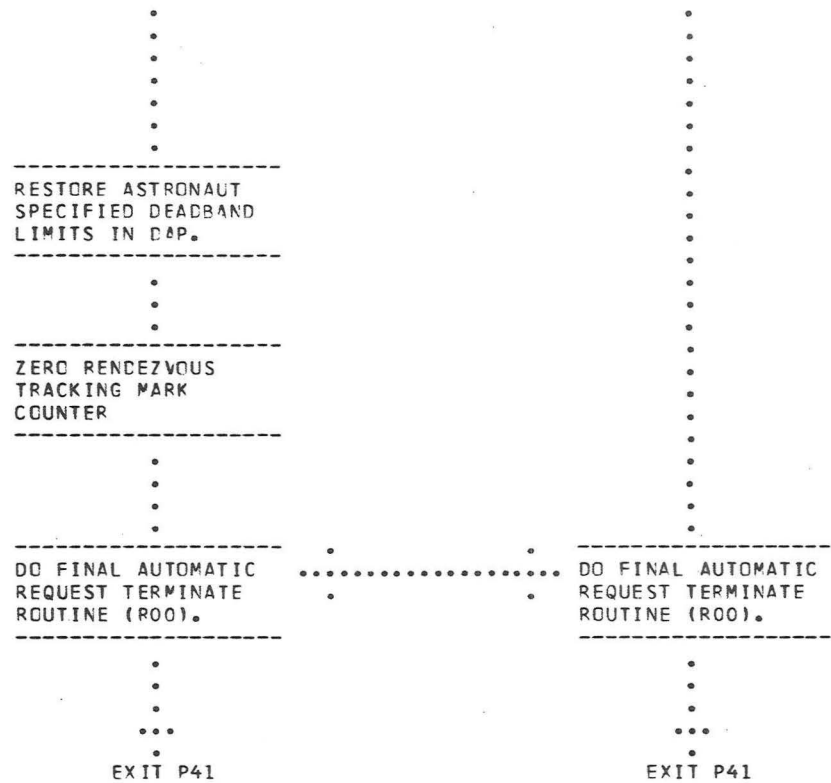
#360

.....

 TERMINATE VEPB-NCUN
 FLASH UPON RECEIPT
 OF PROCEED

#370

97 (193)



P41/SUNDANCE

#380

#390

#400

CHANGE CONTROL NOTES:
LOGIC REV 16 PCR - NASA 86 + PCN-MIT-71
LOGIC REV 17 PCN MIT 401.3

99
(195)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

APS PROGRAM (P42)

LCGIC REV 20 01/17/69

- PURPOSE: (1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A VEHICLE ATTITUDE FOR A LM APS THRUSTING MANEUVER.
- (2) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
- (3) TO CONTROL THE PGNC'S DURING COUNTDOWN, IGNITION, THRUSTING, AND THRUST TERMINATION OF A PGNC'S CONTROLLED APS MANEUVER.
- ASSUMPTIONS: (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE LGC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
- (2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER SET (EXT DELTA V) OR RESET (LAMBERT) THE EXTERNAL DELTA V FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE LGC THAT APS AND RCS TRIM THRUSTING HAS BEEN COMPLETED, THE LGC UPDATES VG ONLY AS A RESULT OF ACCELEROMETER INPUTS.
- FOR LAMBERT STEERING VG IS CALCULATED AND UPDATED SIMILARLY, HOWEVER IT IS ALSO UPDATED PERIODICALLY BY LAMBERT SOLUTIONS TO CORRECT FOR CHANGES IN THE LM STATE VECTOR.
- ++
+20
+401
++
- (3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR A MINIMUM OF 15 MINUTES PRIOR TO A THRUSTING MANEUVER.
- (4) THE EVENT TIMER IS SET TO COUNT TO ZERO AT TIG.
- (5) ENGINE IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW.
- (6) IN THE EVENT THAT THE GUIDANCE CONTROL SWITCH IS CHANGED FROM PGNC'S TO AGS DURING A THRUSTING MANEUVER, THE LGC WILL CONTINUE COMPUTATION OF POSITION AND VELOCITY, THE DESIRED THRUST VECTOR AND THE DESIRED ATTITUDE ERRORS, BUT IS NO LONGER RESPONSIBLE FOR THE MANEUVER.
- ++
+20
+EDIT
++
- (7) THE X-AXIS OVERRIDE OPTION PROVIDES THE CREW WITH THE ABILITY TO EXERCISE MANUAL CONTROL ABOUT THE LM X AXIS WITH THE ATTITUDE CONTROLLER EVEN THOUGH THE PGNC'S ATTITUDE CONTROL MODE IS AUTO. WHEN THE CONTROLLER IS RETURNED TO DETENT THE PGNC'S DAMPS THE YAW RATE TO APPROXIMATELY 1 DEGREE/SECOND, STORES THE YAW ATTITUDE WHEN THE YAW RATE IS DAMPED, AND THEN MAINTAINS THAT ATTITUDE.
- THE X-AXIS OVERRIDE OPTION IS ALWAYS AVAILABLE TO THE CREW EXCEPT WHEN THE LGC IS SPECIFYING A DESIRED YAW ATTITUDE. THUS THE OPTION IS INHIBITED BY THIS PROGRAM ONLY DURING THE ATTITUDE MANEUVER TO THE THRUSTING ATTITUDE (SEE P60).
- WHEN THE ATTITUDE MODE CONTROL SWITCH IS SET TO AUTO AND X-AXIS OVERRIDE IS PERMITTED THE YAW ATTITUDE CONTROL SUB MODE IS RATE COMMAND/ATTITUDE HOLD.
- (8) THE DOCKED CONFIGURATION OF THE VEHICLE(S) HAS BEEN PREVIOUSLY ENTERED IN THE LGC.
- (9) FOR EACH BURN AN IGNITION TOTAL ALLOWABLE TIME DELAY WILL BE SPECIFIED IN THE MISSION RULES. THIS DELAY TIME IS THE TOTAL TIME WHICH THE THRUSTING MANEUVER MAY BE DELAYED BEYOND THE LGC CALCULATED TIME OF IGNITION. IF ENGINE RE-STARTS ARE INVOLVED, THE ACCOUNTING OF THIS TOTAL TIME DELAY IS UP TO THE CREW.
- (10) THE LOAD CAP DATA ROUTINE (R03) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM.
- (11) THIS PROGRAM SHOULD BE SELECTED BY THE ASTRONAUT BY DSKY ENTRY AT LEAST 5 MIN. BEFORE THE ESTIMATED TIME OF IGNITION.

TOTAL
TIME

¥50

100
(196)

VGX(LV)-COMPONENT OF
VG AT TIG ALONG VXR.
IN FPS TO NEAREST
.1 FPS.

VGZ(LV)-COMPONENT OF
VG AT TIG ALONG -R.
IN FPS TO NEAREST
.1 FPS.

WHERE R IS GECCENT-
RIC (EARTH CRBIT)
OR SELENOCENTRIC
(LUNAR CRBIT) RADIUS
VECTOR, AND V IS
VEHICLE INERTIAL
VELOCITY VECTOR AT
TIG.

COMPUTE PREFERRED
IMU ORIENTATION:

X = UNIT(T)
-SM -

Y = UNIT(T X R)
-SM - -

Z = UNIT(X X Y)
-SM -SM -SM

WHERE:

T = THE INITIAL
- THRUST VECTOR
AT IGNITION

R = THE GECCENTRIC
(EARTH ORBIT)
OR SELENOCENT-
RIC (LUNAR
CRBIT) RADIUS
VECTOR AT TIG.

#110

#120

#130

#140

#150

103
(199)

.....
SET PREFERRED
ORIENTATION FLAG
.....

.....
STORE DESIRED ATTITUDE SPECIFICATION
FOR USE BY ATTITUDE
MANEUVER ROUTINE
(R60). THE FINAL
ATTITUDE WILL BE
COMPUTED DURING R60
AND WILL POINT THE
LM +X AXIS IN THE
INITIAL THRUST
DIRECTION. HOWEVER,
IN ORDER TO CONSERVE
RCS FUEL AND NOT
CONSTRAIN THE NON-
CRITICAL ATTITUDE
ABOUT THE THRUST
VECTOR, WINGS MAY
NOT BE LEVEL IN THE
COMPUTED FINAL
ATTITUDE.
.....

.....
ZERO ATTITUDE ERROR
AND SET 1 DEGREE
DEADBAND IN RCS DAP.
.....

.....
RESET 3 AXIS FLAG
FOR USE BY THE ATTITUDE MANEUVER ROUTINE
(R60)
.....

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

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

P42/SUNDANCE

#160

#170

#180

#190

#200

#210

P42/SUNDANCE

POSS
HOLD
.....
SNAP

HAS PGNC'S A/P AND
AUTO MODE BEEN SE-
LECTED?

.Y .N

FLASH VERB-NCUN
TO REQUEST
PLEASE PERFORM
PGNC'S A/P AND
AUTO MODE SELEC-
TION:
V50 N25
P1-00203
R2-BLANK
R3-BLANK

WAIT FOR KEY-
BOARD ENTRY

MONITOR DSKY:
DOES VERB-NCUN FLASH
TO REQUEST PLEASE
PERFORM PGNC'S A/P
AND AUTO MODE SELEC-
TION INDICATE THAT
MODE SELECTION IS
INCORRECT?

.Y .N

DO I DESIRE AUTO
CONTROL?

.Y .N

SFT GUIDANCE
CONTROL SWITCH
TO PGNC'S, AT-
TITUDE CONTROL
SWITCH TO
AUTO.

KEY IN PROCEED

#220

#230

#240

#250

#260

#320

 WAIT FOR KEY-
 BOARD ENTRY

 KEY IN PROCFED

#330

 TERMINATE FLASH
 UPON RECEIPT OF
 PROCFED OR
 TERMINATE

 KEY IN TERMINATE
 V34F

#340

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

++
 +20
 +EDIT
 ++

 DO FINAL AUTC-
 MATIC REQUEST
 TERMINATE
 ROUTINE(R00).

 DO FINAL AUTOMA-
 TIC REQUEST
 TERMINATE
 ROUTINE(R00).

#350

EXIT P42

EXIT P42

#360

 ESTABLISH NEW
 TIG EQUAL TO
 PRESENT TIME
 PLUS 45 SECONDS

#370

 COMMAND AFS CFF

107
(203)

P42/SUNDANCE

 . EXTRAPOLATE STATE
 . VECTOR TO TIG-30
 . SEC. USING PRE-
 . CISION INTEGRA-
 . TION

#380

 . IS TIME FROM IG-
 . NITION NEGATIVE
 . AND GREATER THAN
 . 35 SECONDS?

#390

.Y .N

 . IS TIME FROM
 . IGNITION NEG-
 . ATIVE, LESS
 . THAN 35 AND,
 . GREATER THAN
 . 30 SECONDS?

#400

.Y .N

POSS
 HOLD .

 SNAP .

 . FLASH
 . VERB-NOUN
 . TO REQUEST
 . RESPONSE
 . AND DIS-
 . PLAY ALARM
 . CODE TO
 . INDICATE
 . THAT STATE
 . VECTOR IN-
 . TEGRATION
 . HAS OVER-
 . LAPPED
 . AVERAGE G
 . TURN ON
 . TIME:
 . V05N09
 . R1-01711
 . R2-XXXXX
 . R3-XXXXX

 MONITOR DSKY:
 DOES VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 ALARM CODE INDICAT-
 ING THAT INTEGRATION
 HAS OVERLAPPED AVER-
 AGE G TURN ON TIME?

#410

.Y .N

#420

P42/SUNDANCE

#430

WAIT FOR
KEYBOARD
ENTRY

KEY IN
TERMIN-
ATE

V34E

TERMINATE
FLASH UPON
RECEIPT OF
TERMINATE

#440

T
F
R
M
I
N
A
T
E

DO FINAL
AUTOMATIC
REQUEST
TERMINATE
ROUTINE
(R00)

DO FIN-
AL AUT-
OMATIC
REQUEST
TERMIN-
ATE
ROUTINE
(R00)

#450

EXIT P42

EXIT
P42

#460

#470

MON DISPLAY
ON DSKY:
VC6 N40
R1-TFI
R2-VG
R3-DELTA
VM

MONITOR DSKY:
OBSERVE DISPLAY OF
TFI AND VG.

#480

109
(205)

TFI-TIME
FROM APS
IGNITION
IN MIN,
SEC TO
NEAREST
SEC. MAX
READING
IS 59859
SIGN IS
- BEFORE
NOMINAL
TIG, +
THERE-
AFTER.

VG-MAG-
NITUDE
OF THE
VELOCITY
TO BE
GAINED
BY THRU-
TING
MANEUVER
IN FPS
TO NEAR-
EST .1
FPS

DELTA VM-
MEASURED
DELTA V
MAGNITUDE
IN FPS TO
NEAREST
.1 FPS.
THIS DIS-
PLAY WILL
BE 0000
UNTIL
TIG-30
SEC AND
THEN
SHOULD
CHANGE
ONLY DUE
TO PIPA
BIAS UN-
TIL ULL-
AGE IS
STARTED.

UPDATE EVENT TIMER
IF DESIRED. TIMER
WILL NOT AGREE WITH
DSKY R1 IF IGNITION
HAS BEEN SLIPPED
AS R1 WILL DISPLAY
TFI TO NEW TIG

ARM APS

BLANK
DSKY IM-
MEDIATELY

P42/SUNDANCE

#490

#500

#510

#520

#530

P42/SUNDANCE

#540

CHECK STATUS OF C/W
LAMPS

AT TIG-35 SEC
BLANK THE
DSKY DISPLAY
(V,N,R1,R2,
AND R3) FOR
5 SECONDS.

MONITOR DSKY:
AT TIG -35 SEC OR-
SERVE DSKY DISPLAY
TO GO BLANK FOR 5
SECONDS. (NOTE: IF
STATE VECTOR INTEG-
RATION HAS RUN INTO
THE TIME PERIOD TIG
-35 TO TIG-30 THE
BEGINNING AND DURA-
TION OF BLANKING
CANNOT BE DEFINED.)

#550

AT TIG-30 SEC RETURN
VO6N40 DISPLAYS

MONITOR DSKY:
AT TIG -30 SEC OR-
SERVE RETURN OF
VO6N40 DISPLAYS TO
INDICATE THAT AVER-
AGE G INTEGRATION
HAS STARTED.

#570

CALL AVERAGE G
INTEGRATION ON AT
TIG - 30 SEC

#580

P42/SUNDANCE

#590

MONITOR DSKY:
IN THE PERIOD FROM
TFI =-00R30 UNTIL
TFI =-00B15
DOES DELTA VM BECOME
GREATER THAN .5 FPS
INDICATING EXCESSIVE
PIPA BIAS ERROR?

#600

.N .Y
GO TO RACKUP
PROCEDURES

#610

WAIT UNTIL TFI=
-5 SEC.

#620

HOLD
MON

CHANGE VEPR BUT RE-
TAIN PRESENT NOUN
AND DISPLAYS IN R1,
R2, P3, FLASH VERB-
NCUN TO REQUEST
PLEASE PERFORM ENG-
INE CN ENABLE:
V99N40

#630

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
ENGINE CN ENABLE

#640

P42/SUNDANCE

 WAIT FOR KEYBOARD
 ENTRY

 AT TFI = -3.5 SEC
 COMMAND 2 JET +X
 TRANSLATION

++
 +20
 +EDIT
 ++

 IS THIS AN ATTEMPTED
 ENGINE RESTART?

.N .Y.

 AT TFI = -00B03
 MONITOR START OF
 +X TRANSLATION.

 MONITOR START
 OF +X
 TRANSLATION.

 MONITOR DSKY:
 WAIT FOR INCREASE OF
 DELTA VM INDICATING
 SUFFICIENT ULLAGE.
 REQUIRED ULLAGE
 DELTA V IS A
 FUNCTION OF VEHICLE
 WEIGHT.

 SHALL I PERMIT
 IGNITION OR REIGNI-
 TION?

.N .Y.

 KEY IN PROCEED

#650

#660

#670

#680

#690

113
(209)

P42/SUNDANCE

#700

#710

#720

#730

#740

#750

P42/SUNDANCE

SHALL I ATTEMPT
TO COMPLETE
THIS THRUSTING
MANEUVER WITH
THE RCS?

.Y .N

KEY IN
ENTER

GO TO
"A"
BELOW

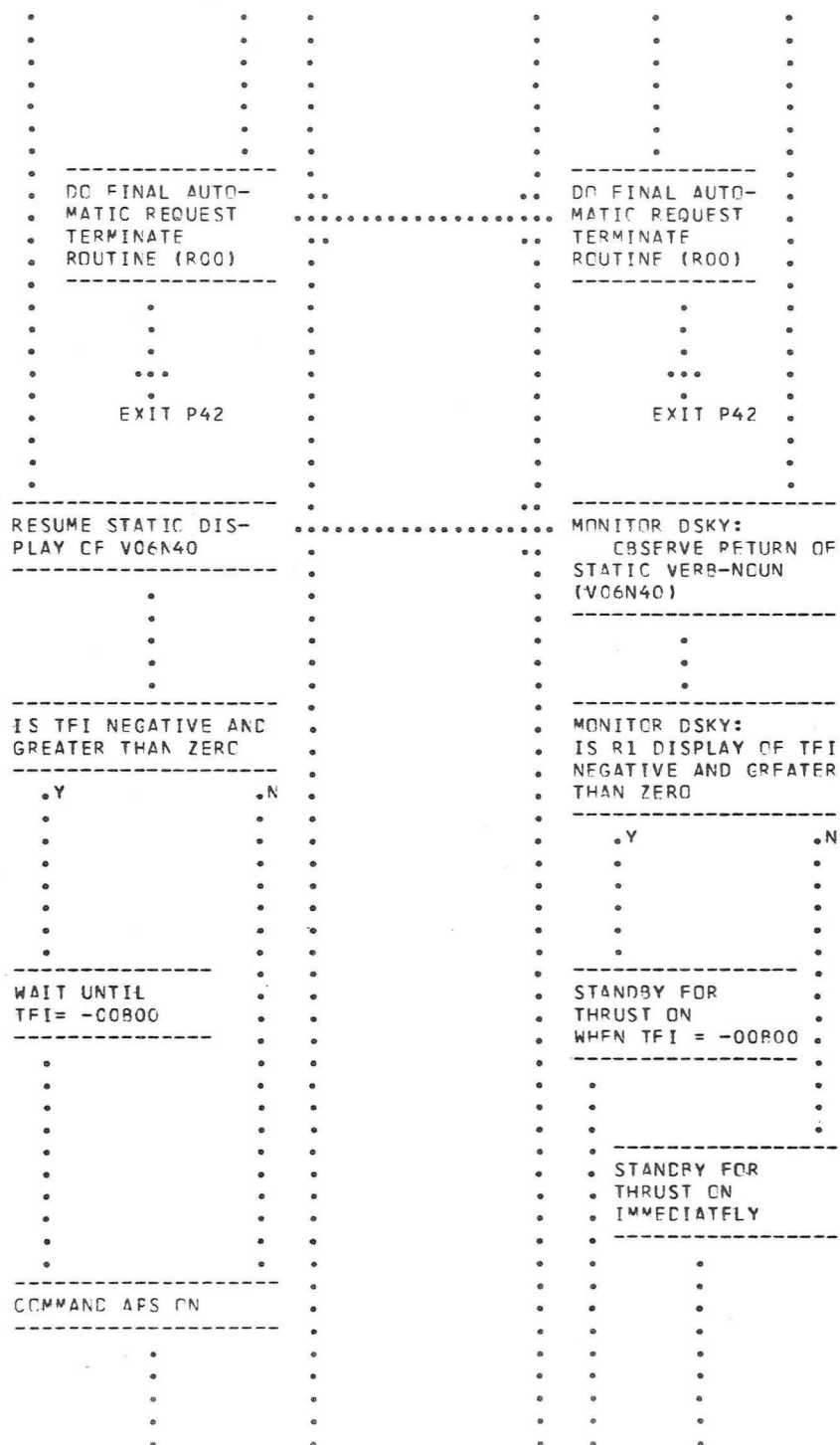
TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMI-
NATE.

KEY IN
TERMINATE
V34E

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

TURN	TURN
OFF	OFF
ULLAGE	ULLAGE

GO TO
"A"
BELOW



#760

#770

#780

#790

#800

115
(211)

P42/SUNDANCE

WAIT 0.5 SEC

TURN OFF LLLAGE

TURN ON CAP TVC
FUNCTIONS

.....
MON . CHANGE TFI DISPLAY
TO TFC IN R1
V06 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

TFC - TIME FROM
ENGINE CUTOFF.
IN MIN AND SEC TO
NEAREST SEC. SIGN IS
- BEFORE + AFTER
CUTOFF.

MONITOR DSKY:
OBSERVE CHANGE OF
TFI DISPLAY TO TFC
IN R1

HAS ENGINE IGNITED?
CHAMBER PRESSURE
SHOULD INDICATE
NORMAL.

.N

.Y

#810

#820

#830

#840

#850

P42/SUNDANCE

 ESTABLISH DELTA V
 MONITOR (REFER SEC-
 TION 5.3.3.4 OF
 R557). (NOTE: IF THE

DELTA V ROUTINE
 DOES NOT DETECT
 THRUST IN 8-10 SEC-
 ONDS FROM RECEIPT OF
 ENGINE ON COMMAND,
 IT IS CONSIDERED A
 THRUST FAIL.

IF THE DELTA V
 MONITOR DOES NOT
 DETECT THRUST FOR
 2-4 SECONDS DURING
 NORMAL THRUSTING,
 IT IS CONSIDERED A
 THRUST FAIL.

IN THE EVENT A
 THRUST FAIL, THE
 PROGRAM WILL RETURN
 TO THE TIG-5 SEC.
 POINT).

 .THRUST .NO
 .CK .THRUST

 . COMMAND ENGINE
 . OFF.

 . TURN OFF CAP. TVC
 . FUNCTIONS

 . MAINTAIN VG COM-
 . PUTATION FOR
 . POSSIBLE FURTHER
 . THRUSTING

#860

#870

#880

#890

#900

117
(213)

 . COMMAND + X
 . ULLAGE TRANSLA-
 . TION (2 JET).
 .-----

 . RESET TFC DISPLAY
 . IN R1 TO 59 B 59
 .-----

 THROUGHOUT THE
 THRUSTING MANEUVER
 THE LGC WILL MONITOR
 THE ANGLE BETWEEN
 THE DESIRED THRUST
 VECTOR AND THE MEAS-
 URED THRUST VECTOR.
 IF THIS ANGLE
 BECOMES GREATER THAN
 45 DEGREES TURN ON
 PROGRAM ALARM BUT
 DO NOT CHANGE THE
 DSKY DISPLAY. STORE
 ALARM CODE (1407).
 (REFER SECTION
 5.3.3.4 OF R557).

 . MONITOR APS
 . THRUSTING:
 . 1. DSKY:
 . R1-TFC
 . SHOULD BE
 . DECREASING.
 .-----

P42/SUNDANCE

#910

#920

#930

#940

#950

#960

P42/SUNDANCE

R3-DELTA VM
SHOULD INCREASE.

2. FDAI-ATT. ERROR
SHOULD BE LESS THAN
OR EQUAL TO
DEGREE.

ATT RATES SHOULD BE
LESS THAN OR EQUAL
TO DEGREE/SEC.

3. APS CHAMBER PRESSURE (PC) SHOULD BE NORMAL.

(NOTE: A PROGRAM ALARM WILL OCCUR IF THE ANGLE BETWEEN THE DESIRED THRUST VECTOR AND THE MEASURED THRUST VECTOR BECOMES GREATER THAN 45 DEGREES. TO IDENTIFY THE ALARM KEY IN V05N09E. EXPECTED ALARM CODE IS 01407.)

IDENTIFY EARLY,
NORMAL, OR LATE EN-
GINE CUTOFF FROM AS-
SESSMENT OF DSKY
DISPLAYS.

.E	.N	.L
.A	.C	.A
.R	.R	.T
.L	.M	.E
.Y	.	.
.	.C	.C
.C	.U	.U
.U	.T	.T
.T	.C	.C
.O	.F	.F
.F	.F	.F
.E	.	.

#970

#980

#990

#1000

1010

119
(215)

P42/SUNDANCE

LGC COMMANDS ENGINE
OFF WHEN INDICATED
BY CUTOFF EQUATION

REMOVE CAP TVC
FUNCTIONS

TERMINATE DELTA V
MONITOR

MAINTAIN VG
COMPUTATIONS AFTER
CUTOFF FOR POSSIBLE
NULLING BY RCS
TRIMMING MANEUVER
(NOTE: SEE ASSUMP-
TION (2) ABOVE).

PUSH ENGINE
STOP PUSH-
BUTTON

GO TO BACK-
UP PROCES-
DURES

DISARM APS

#1020

#1030

#1040

#1050

#1060

#1070

P42/SUNDANCE

HOLD .

MON .

FLASH VERB-NOUN TO
REQUEST PROCEED.
HOLD DISPLAY OF TFC
AT ITS FINAL VALUE:
V16 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

(NOTE: SEE ASSUMP-
TION (2) ABOVE).

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED

ZERO ATTITUDE ERROR
AND SET 3 DEGREES
DEADBAND IN RCS CAP

"A"
FROM
ABOVE

"A"
FROM
ABOVE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF TFC, VG AND DELTA
VM

RECORD THESE VALUES
AS DESIRED.

KEY IN PROCEED

#1080

#1090

#1100

#1110

#1120

121
(217)

P42/SUNDANCE

HOLD . FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
MON . DISPLAY COMPONENTS
OF VG(LM):
V16 N85
R1-VGX(LM)
R2-VGY(LM)
R3-VGZ(LM)

COMPONENTS OF THE VG
VECTOR RESOLVED
ALONG THE PRESENT
X, Y, AND Z AXES.
THE VG VECTOR WILL
BE UPDATED BY THE
STEERING LOOPS
DURING EACH COMPUTA-
TION CYCLE. IN FPS
TO NEAREST .1 FPS.
(NOTE: SEE ASSUMP-
TION (2) ABOVE).

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF VG(LM) COMPONENTS

#1130

TO NULL OUT VG
COMPONENTS COMMAND
MANUAL TRANSLATIONS
AND ROTATIONS.
(NOTE: THIS MANEUVER
IS AT THE OPTION OF
THE CREW.)

#1140

THE ORBITAL PARAME-
TER DISPLAY ROUTINE
(R30) MAY BE SELECT-
ED AT THIS TIME
(V82E) TO MONITOR
CONTINUOUSLY UPDATED
VALUES OF APC ALT,
PER ALT, AND TFF.

#1160

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED

KEY IN PROCEED

#1170

P42/SUNDANCE

 RESTORE ASTRONAUT
 LIMITS IN CAP
 SPECIFIED DEADRANG

 ZERO RENDEZVOUS
 TRACKING MARK
 CCOUNTER

 DO FINAL AUTOMATIC
 REQUEST TERMINATE
 ROUTINE (ROO)

EXIT P42

 DO FINAL AUTOMATIC
 REQUEST TERMINATE
 ROUTINE (ROO)

EXIT P42

#1180

#1190

#1200

CHANGE CONTRL NOTES:

LOGIC REV 18 PCN # MIT 49
 LOGIC REV 19 PCR NASA 86,+ PCN-MIT-71,+ PCN-MIT-79,+ PCN MIT 92,
 PCR-NASA-85
 LOGIC REV 20 PCN MIT 401.3

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

THRUST MONITOR PROGRAM (P47)

LOGIC REV 09 04/15/68

PURPOSE: (1) TO MONITOR VEHICLE ACCELERATION DURING A NON PGNC CONTROLLED THRUSTING MANEUVER.
 (2) TO DISPLAY THE DELTA V APPLIED TO THE VEHICLE BY THIS THRUSTING MANEUVER.

ASSUMPTIONS: (1) THE ISS MAY BE IN STANDBY OR OPERATE. THE IMU WOULD NORMALLY BE ON AND THE IMU ORIENTATION DETERMINATION PROGRAM (P51) COMPLETED BEFORE THE SELECTION OF THIS PROGRAM.
 THE ISS THUS MAY BE:

(A) OFF (STANDBY).

(B) ON, AND NOT ALIGNED SINCE TURN ON

(C) ON AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT NOT WITHIN THE LAST 3 HRS

(D) ON AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE LGC, I.E. HAVING BEEN ALIGNED WITHIN THE LAST 3 HRS

IF (A) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
 IF (B) IS TRUE A PROGRAM ALARM WILL BE MADE BY THIS PROGRAM.
 IF (C) IS TRUE THE LGC MAY OR MAY NOT HAVE A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE MANEUVER.
 IF (D) IS TRUE THE LGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCURATELY COMPLETE THE MANEUVER. CASES (B), (C) AND (D) HOWEVER ARE FURTHER SUBJECT TO THE CONSTRAINT OF LARGE MIDDLE GIMBAL ANGLE, I.E. THE EXISTING INERTIAL ORIENTATION MAY CAUSE A MIDDLE GIMBAL ANGLE GREATER THAN 45 DEGREES AT THE THRUSTING ORIENTATION OF THE LM, WHICH IS UNSATISFACTORY.

(2) THE LGC IDLING PROGRAM (P00), THE RENDEZVOUS NAVIGATION PROGRAM (P20) AND THE RENDEZVOUS DISPLAY ROUTINE (R31) WILL AUTOMATICALLY UPDATE THE LM AND CSM STATE VECTORS. THIS PROGRAM ASSUMES THE LM AND CSM STATE VECTORS TO HAVE BEEN UPDATED TO WITHIN -- MINUTES OF THE PRESENT TIME.

(3) THE RESPONSIBILITY OF AVOIDING GIMBAL LOCK DURING EXECUTION OF THIS PROGRAM IS UPON THE ASTRONAUT.

(4) THIS PROGRAM IS NORMALLY USED DURING RENDEZVOUS FINAL PHASE. IF THE CREW DESIRED TO DO ANY FINAL PHASE THRUSTING MANEUVERS AUTOMATICALLY UNDER PGNC CONTROL THEY MUST BE ACCOMPLISHED VIA SELECTION OF TRANSFER PHASE INITIATION (TPI) PROGRAM (P34) AND THEN THE OPS THRUSTING PROGRAM (P40).

(5) RANGE, RANGE RATE, AND THETA MAY BE DISPLAYED DURING THIS PROGRAM BY CALLING THE RENDEZVOUS PARAMETER DISPLAY ROUTINE (P31).

(6) THIS PROGRAM SHOULD BE TURNED ON JUST PRIOR TO THE PLANNED THRUSTING MANEUVER AND TERMINATED AS SOON AS POSSIBLE AFTER THE MANEUVER IN ORDER TO KEEP ERRORS ASSOCIATED WITH AVERAGE G INTEGRATION AT A MINIMUM.

PRG
CONT

LOG

SPENDING

CPM

CHECKLIST

TIME

TOTAL
TIME

.CREW
.PROGRAM
.SELECTION

.
...

START THRUST
MONITOR PROGRAM
(P47).
DISPLAY P47.

.
.....
.

KEY IN THRUST
MONITOR PROGRAM
(P47)
V37F47F

#10

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.
.

.
.....
.

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 47.

#20

.
.
.

.
.
.

DO IMU STATUS
CHECK ROUTINE
(R02)

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.....
.

DO IMU STATUS
CHECK ROUTINE
(R02)

#30

++
+09
++

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.
.
.

.
.
.
.

BRING PERMANENT
STATE VECTORS TO
PRESENT TIME PLUS
60 SECONDS USING
PRECISION INTEGRA-
TION (REFER TO SEC-
TION 5.2.2 OF R557).

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.
.

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.
.

#40

CALL FOR AVERAGE G
ROUTINE AT PRESENT
TIME PLUS 60 SECONDS.
(REFER SECTION 5.3.2
OF R557).

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.
.

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.
.
.
.

#50

P47/SUNDANCE

220

221

P47/SUNDANCE

 WAIT 60 SECONDS

 WAIT 60 SECONDS

HOLD FLASH VERB-NDUN TO
 MON REQUEST RESPONSE AND
 DISPLAY DELTA V
 (LM):

VI6NP3
 R1-DELTA VX(LM)
 R2-DELTA VY(LM)
 R3-DELTA VZ(LM)

DELTA VX(LM) - COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 LM +X AXIS. IN FPS
 TO NEAREST .1 FPS.

DELTA VY(LM) - COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 LM +Y AXIS. IN FPS
 TO NEAREST .1 FPS.

DELTA VZ(LM) - COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 LM +Z AXIS. IN FPS
 TO NEAREST .1 FPS.

NOTE: R1,2, AND 3
 WILL READ 0000 IN-
 ITIALLY AND WILL RE-
 MAIN SO EXCEPT FOR
 12A BIAS ACCUMULAT-
 IONS UNTIL A THRUST-
 ING MANEUVER IS
 STARTED. THEY WILL
 BE UPDATED EVERY
 2 SEC.

MONITOR DSKY:
 OBSERVE FLASHING
 VERB-NDUN TO REQUEST
 RESPONSE AND DISPLAY
 OF EACH COMPONENT OF
 DELTA V(LM).

PERFORM THRUSTING
 MANEUVER(S) AS
 DESIRED.
 MONITOR FOOT BALL
 TO AVOID GIMBAL
 LOCK

THE ORBITAL PARAMET-
 ER DISPLAY ROUTINE
 (R30) MAY BE SELECT-
 ED AT THIS TIME
 (V82E) TO MONITOR
 CONTINUOUSLY UPDATED
 VALUES OF APD ALT,
 PER ALT AND TFF.

#60

#70

#80

#90

#100

P47/SUNDANCE

 WAIT FOR KEYBOARD
 ENTRY

 SHALL I TERMINATE
 THIS PROGRAM?

#110

.Y .N

 SHALL I ZERO
 THE DISPLAY IN
 ORDER TO MONIT-
 OR ANOTHER
 BURN?

#120

.Y .N

 KEY IN RECY-
 CLE V32F

#130

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED,
 TERMINATE OR RECYCLE.

 KEY IN PROCEED OR
 TERMINATE (V34F)

#140

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

#150

#150

223

P47/SUNDANCE

RFINIT-
IALIZE
ACCELERO-
METER IN-
TEGRATION

#170

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

#180

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

#190

LOGIC REV 09 PCN # MIT 49

EXIT P47

225

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

IMU ORIENTATION DETERMINATION PROGRAM (P51)

LOGIC REV 15 05/23/68

PURPOSE: (1) TO DETERMINE THE INERTIAL ORIENTATION OF THE IMU USING SIGHTINGS ON TWO CELESTIAL BODIES WITH THE ADT OR A BACKUP OPTICAL SYSTEM.

ASSUMPTIONS: (1) THIS PROGRAM MAY ONLY BE PERFORMED WHILE THE LM IS IN FLIGHT.

(2) THE ISS MAY BE:

(A) OFF (STANDBY)

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

IF (A) IS TRUE, THE IMU MUST BE TURNED ON BEFORE THIS PROGRAM CAN BE PERFORMED.

IF (B) IS TRUE THIS PROGRAM CAN BE COMPLETED.

(3) THERE ARE NO RESTRAINTS UPON THE LM ATTITUDE CONTROL MODES UNTIL A PGNC'S CONTROLLED MANEUVER IS CALLED BY A PROGRAM OR THE CREW WISHES TO MANUALLY MANEUVER THE VEHICLE. THE AUTOPILOT CONTROL MAY BE PGNC'S OR AGS AND IF PGNC'S, MAY BE AUTO OR ATTITUDE HOLD. PRIOR TO PGNC'S CONTROLLED MANEUVERS THE LGC WILL REQUEST THE CORRECT MODE IF IT IS NOT IN EFFECT. FOR MANUALLY CONTROLLED MANEUVERS THE CREW MUST SELECT THE CORRECT MODES.

(4) TIME AND RCS FUEL MAY BE SAVED, AND SUBSEQUENT IMU ALIGNMENT DECISIONS GREATLY SIMPLIFIED IF THIS PROGRAM IS PERFORMED IN SUCH A WAY AS TO LEAVE THE IMU INERTIALLY STABILIZED AT AN ORIENTATION AS CLOSE AS POSSIBLE TO THE OPTIMUM ORIENTATION REQUIRED BY FUTURE LGC PROGRAMS.

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

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.CREW PRG
.SELECTION

.

.

.

.

START IMU ORIENTATION
DETERMINATION
PROGRAM (P51)
DISPLAY PROGRAM 51

KEY IN IMU
ORIENTATION DETERMI-
NATION PROGRAM (P51)
V37F 51F

#10

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.

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.

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.

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.

.

.

.

P51/SUNDANCE

227

FLASH VERR-NDUN TO
REQUEST PLEASE PER-
FORM CELESTIAL BODY
ACQUISITION:
V50 N25
R1-00015
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERR-NDUN
FLASH TO REQUEST
PLEASE PERFORM
CELESTIAL BODY
ACQUISITION

SHALL I MANEUVER (OR
CONTINUE TO MANEJ-
VER) THE LM TO POSI-
TION THE IMJ INNER
GIMBAL AXIS IN A
PREFERRED DIRECTION?

.N .Y
.
.

WITH THE ROTATION
CONTROL ROTATE
THE LM UNTIL THE
PITCH AXIS IS IN
THE PREFERRED
DIRECTION

ARE 2 CELESTIAL
BODIES VISIBLE IN
THE OPTICAL SYS-
TEM FIELD OF
VIEW ?

.Y .N
.
.

WITH THE ROTA-
TION CONTROL
ORIENT THE LM
UNTIL 2 CELES-
TIAL BODIES
ARE VISIBLE IN
THE OPTICAL
SYSTEM

P51/SUNDANCE

#70

#80

#90

#100

#110

#120

P51/SUNDANCE

SHALL I COARSE
ALIGN IMU TO
0,0,0 GIMBAL
ANGLES?

N. Y

MONITOR FOAI BALL
IS GIMBAL LOCK
IMPENDING?

Y N

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR ENTER

KEY IN PROCEED

P E
R N
D T
C E
E R
E
D

#130

#140

#150

#160

229

P51/SUNDANCE

#170

MONITOR DSKY:
OBSERVE DISPLAY
OF COARSE ALIGN
VEEB AND ICOW
ANGLES (ALL
00000) FOR COARSE
ALIGNMENT

#180

WHERE R1, R2,
AND R3 REPRESENT
ICOW/GIMBAL ANG-
LES TO BE COARSE
ALIGNED TO (OG,
IG, MG, RESPEC-
TIVELY).

#190

RESET RE=SWFLAG

#200

COMMAND ISS TO
COARSE ALIGN
MODE

#210

TURN ON "NO ATT"
LIGHT ON

#220

COARSE ALIGN ISS

TERMINATE COARSE
ALIGN MODE IN
ISS. RESUME
ATTITUDE HOLD OF
VEHICLE.

P51/SUNDANCE

TURN OFF "NO
ATT" LIGHT

WAIT FOR "NO ATT"
LIGHT OFF

#230

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#1

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#1

#240

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#2

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#2

#250

#250

DO SIGHTING DATA
DISPLAY ROUTINE
(R 54)

DO SIGHTING DATA
DISPLAY ROUTINE
(R 54)

#270

.F .E
.Y .X
.I .I
.T .T
."A" .B"
.....

.E .F
.X .X
.I .I
.T .T
."A" .B"
.....

• • • • •

280

CALCULATE IMJ INERTIAL
ORIENTATION # 3.1.
CELESTIAL COORDIN-
ATES AS DEFINED BY
CELESTIAL BODIES # 1
AND # 2 • STORE AS
PRESENT PLATFORM
ORIENTATION
(PRESMMAT)

062 著

SET PF5MFLAS

300

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

ADD FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

EXIT P51

EXIT 51

CHANGE CONTROL NOTES

LOGIC 2FV 15 DCI - MIT - 57

123
(233)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

IMU REALIGN PROGRAM (P52)

LOGIC REV 19 01/17/69

PURPOSE: (1) TO ALIGN THE IMU FROM A "KNOWN" (SEE ASSUMPTION 5) ORIENTATION TO ONE OF THREE ORIENTATIONS SELECTED BY THE ASTRONAUT USING SIGHTINGS ON TWO CELESTIAL BODIES WITH THE AOT OR A BACKUP OPTICAL SYSTEM.

(A) PREFERRED ORIENTATION

AN OPTIMUM ORIENTATION FOR A PREVIOUSLY CALCULATED MANEUVER. THIS ORIENTATION MUST BE CALCULATED AND STORED BY A PREVIOUSLY SELECTED PROGRAM.

(B) NOMINAL ORIENTATION

X = UNIT(R)

-SM -

Y = UNIT(V X R)

-SM - -

Z = UNIT(X X Y)

-SM -SM -SM

WHERE:

R = THE GEOCENTRIC (EARTH ORBIT) OR SELENOCENTRIC (LUNAR ORBIT) RADIUS VECTOR AT TIME T(ALIGN)
-
SELECTED BY THE ASTRONAUT.

V = THE INERTIAL VELOCITY VECTOR AT TIME T(ALIGN) SELECTED BY THE ASTRONAUT.
-

(C) REFSMMAT

SEE ASSUMPTION (5)

ASSUMPTIONS: (1) THIS PROGRAM MAY ONLY BE PERFORMED WHILE THE LM IS IN FLIGHT.

(2) THE DOCKED CONFIGURATION MAY BE LM/CSM OR LM ALONE. THE PRESENT CONFIGURATION SHOULD HAVE BEEN ENTERED INTO THE LGC BY COMPLETION OF THE CAP DATA LOAD ROUTINE (R03).

(3) THERE ARE NO RESTRAINTS UPON THE LM ATTITUDE CONTROL MODES UNTIL A PGNC'S CONTROLLED MANEUVER IS CALLED BY A PROGRAM OR THE CREW WISHES TO MANUALLY MANEUVER THE VEHICLE. THE GUIDANCE CONTROL SWITCH MAY BE PGNC'S OR AGS AND IF PGNC'S THE MODE MAY BE AUTO OR ATTITUDE HOLD. PRIOR TO PGNC'S CONTROLLED MANEUVERS THE LGC WILL REQUEST THE CORRECT MODE IF IT IS NOT IN EFFECT. FOR MANUALLY CONTROLLED MANEUVERS THE CREW MUST SELECT THE CORRECT MODES.

(4) THIS PROGRAM MAKES NO PROVISION FOR AN ATTITUDE MANEUVER TO RETURN THE VEHICLE TO A SPECIFIC ATTITUDE. SUCH A MANEUVER, IF DESIRED, MUST BE DONE MANUALLY. AN OPTION IS PROVIDED HOWEVER TO ALLOW POINTING OF THE AOT AT ASTRONAUT OR LGC SELECTED STARS EITHER MANUALLY BY THE CREW OR AUTOMATICALLY BY AN LGC CONTROLLED ATTITUDE MANEUVER.

(5) THE ISS IS ON AND HAS BEEN ALIGNED TO A "KNOWN" ORIENTATION WHICH IS STORED IN THE LGC (REFSMMAT). THE PRESENT IMU ORIENTATION DIFFERS FROM THAT TO WHICH IT WAS LAST ALIGNED ONLY DUE TO GYRO DRIFT (I.E. NEITHER GIMBAL LOCK NOR IMU POWER INTERRUPTION HAS OCCURRED SINCE THE LAST ALIGNMENT).

(16) IF THE DAP IS ON AND THE CONTROL MODE IS RATE COMMAND/ATTITUDE HOLD (V77E) WHEN THE ASTRONAUT KEYS IN "PROCEED" TO FLV06N93, THE DAP MAY FIRE RCS JETS WHEN THE STABLE MEMBER IS REORIENTED BY MEANS OF GYRO TORQUING. THESE JET FIRINGS CAN BE SUPPRESSED BY TURNING OFF THE DAP (GUIDE CONTROL SWITCH TO AGS OR THE MODE CONTROL SWITCH TO OFF), OR BY KEYING IN V76E (MINIMUM IMPULSE CONTROL MODE).

•

 $12^4 (234)$

125
(235)

P52/SUNDANCE

SET LGC ASSUMED
OPTICN TO 00001.

SET LGC ASSUMED
OPTICN TO 00002.

HOLD . FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY OPTICN CODE
FOR ASSUMED IMU OR-
IENTATION SELECTION:
V04 NC6
R1-00001
R2-0000X
R3-BLANK

R1 IS THE
OPTICN CODE
FOR ASSUMED
IMU ORIENTATION
SELECTION.

R2 IS THE
LGC ASSUMED OPTION:
00001-PREFERRED
00002-NOMINAL
00003-REFSMAT

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTICN CODE FOR
ASSUMED IMU ORIE-
TION SELECTION

IS THIS THE IMU
ORIENTATION I
DESIRE?

.Y .N

KEY IN
PROCEED

#40

#50

#60

#70

#80

#90

P52/SUNDANCE

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .CODE
.C
.E
.E STORE CODE
.D

KEY IN V22E
AND LOAD THE
DESIRED ORIEN-
TATION CODE IN
R2

#100

IS STORED ORIENTA-
TION CODE 00001?

.N .Y
. (NCM) . (PREF)
. (REFSM)

WAS PREFERRED IMU
ORIENTATION SELECT-
ED?

.Y .N
. (PREF) . (NOM)
. (REFSM)

#110

IS PREFERRED
ORIENTATION
FLAG SET?

.Y N

SELECT PRE-
FERRED IMU
ORIENTATION
FOR GIMBAL
ANGLE CCMPU-
TATION

GO TO
"A"
BELOW

#120

#130

#140

127 (237)

P52/SUNDANCE

POSS
HOLD .
.....
SNAP .

FLASH VERB-NCUN
TO REQUEST RE-
SPCNSE AND DIS-
PLAY ALARM CODE:
V05N09
R1-00215
R2-XXXXX
R3-XXXXX

MONITOR DSKY:
DOES ALARM
CODE DISPLAY
INDICATE THAT
A PREFERRED IMU
ORIENTATION
HAS NOT BEEN
SPECIFIED?

.Y .N

GO TO
"A"
BELOW

IS THE NOMINAL
OR RFFSMAT IMU
ORIENTATION
SATISFACTORY OR
DO I WANT A
PREFERRED IMU
ORIENTATION?

.NOM .PREF
.OR
.PRES

WAIT FOR KEY-
BOARD ENTRY

KEY IN
RECY-
CLE
V32E

#150

#160

#170

#180

#190

P52/SUNDANCE

TERMINATE UPCN
RECEIPT OF RE-
CYCLE OR NEW
PROGRAM

.NEW .R
.PRCG. .E
.C
.Y
.C
.L
.E

GO TO PROGRAM
SELECTED

EXIT P52

IS STORED ORIENTATION
CCODE 00002?

.Y .N
(NCM) (REFSM)
.C
.C
GC TO
"B"
BELOW

STORE C00C0,
0C00C, 00000 FOR
DISPLAY AS
T(ALIGN)

SELECT DESIRED
PROGRAM TO DE-
FINE A PREFERRED
IMU ORIENTATION
AND THEN RESEL-
ECT THIS PRO-
GRAM. KEY IN
V37--E

GO TO PROGRAM
SELECTED

EXIT P52

WAS NCNINAL ORIEN-
TATION SELECTED?

.Y .N
(NCM) (REFSM)
.C
.C
GC TO
"B"
BELOW

#200

#210

#220

#230

#240

129 (239)

P52/SUNDANCE

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY T(ALIGN);
V06N34
R1- T(ALIGN)-HRS
R2- T(ALIGN)-MINS
R3- T(ALIGN)-SECS

T(ALIGN)- TIME(GET)
AT WHICH LM POSITION
VECTOR AND LM VEL-
OCITY VECTOR OR CSM
ANGULAR MOMENTUM
VECTOR ARE TO BE
DEFINED FOR A NOMI-
NAL IMU ORIENTATION.
IN HRS, MINS, SEC,
TO NEAREST .01 SEC.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF T(ALIGN).

T(ALIGN) WILL APPEAR
HERE AS 00000,
00000, 00000, WHICH
IF ACCEPTED WILL
INDICATE THAT THE
NOMINAL ORIENTATION
WILL BE DEFINED FOR
A T(ALIGN) AUTOMAT-
ICALLY SELECTED BY
THE PRESENT TIME.

DO I WISH TO ALIGN
THE IMU TO AN
ORIENTATION DEFINED
BY THE T(ALIGN)
PRESENTLY DISPLAYED?

.Y .N

#250

#260

#270

#280

#290

#300

P52/SUNDANCE

 WAIT FOR KEYBOARD
 ENTRY

 KEY IN PROCEED

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA

 KEY IN V25E AND
 LOAD THE DESIRED
 T(ALIGN) IN R1,
 R2, AND R3.

 .PROCEED .NEW
 .DATA

 STORE DATA

 IS T(ALIGN) DEFINED
 TO BE = 0?

 .Y N.

 DEFINE T(ALIGN)
 = T PRESENT

 COMPUTE NOMINAL
 ORIENTATION FOR THE
 PREVIOUSLY DEFINED
 T(ALIGN). SELECT
 THIS ORIENTATION FOR
 GIMBAL ANGLES COM-
 PUTATION. (NOTE: AT
 THIS TIME ANY PRE-
 FERRED ORIENTATION
 STORED IN THE LGC IS
 LCST).

#310

#320

#330

#340

#350

"A"
FROM
ABOVE

#360

- READ VEHICLE ATTITUDE FROM GIMBAL ANGLES

- COMPUTE GIMBAL
- ANGLES AT SELECTED
- IMU ORIENTATION AND
- PRESENT VEHICLE
- ATTITUDE

"A"
 FROM
 ABOVE

#370

第380

```

      . FLASH VERB-NCUN TO
HOLD  . REQUEST RESPONSE AND
      .
..... DISPLAY THE RESULT-
SNAP  . ING ICDD/GIMBAL
      . ANGLES:
      .   V06 N22
      .   R1-CG
      .   R2-IG
      .   R3-MG
      .

```

- ALL GIMBAL ANGLES IN
- DEGREES TC NEAREST
- .01 DEGREE

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TC REQUEST
RESPONSE AND DISPLAY
OF ICCU/GIMBAL
ANGLES AFTER PRO-
POSED LM/IMU ALIGN-
MENT

IS MIDDLE GIMBAL
ANGLE SATISFACTORY?

• Y • M

#390

#400

P52/SUNDANCE

BY SUITABLE
MODE SELECTION
INSURE THAT
VEHICLE IS AS
INERTIALLY
STABLE AS POSSI-
BLE TO ENSURE
ACCURACY OF IMU
COARSE ALIGN-
MENT.

#410

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

#420

DO I WISH TO
MANEUVER VEHICLE
TO AN ATTITUDE
WHICH WILL PRO-
VIDE A MORE
SUITABLE MGA?

#430

.N .Y

#440

MANEUVER VEH-
ICLE WITH
ROTATION
CONTROLLER

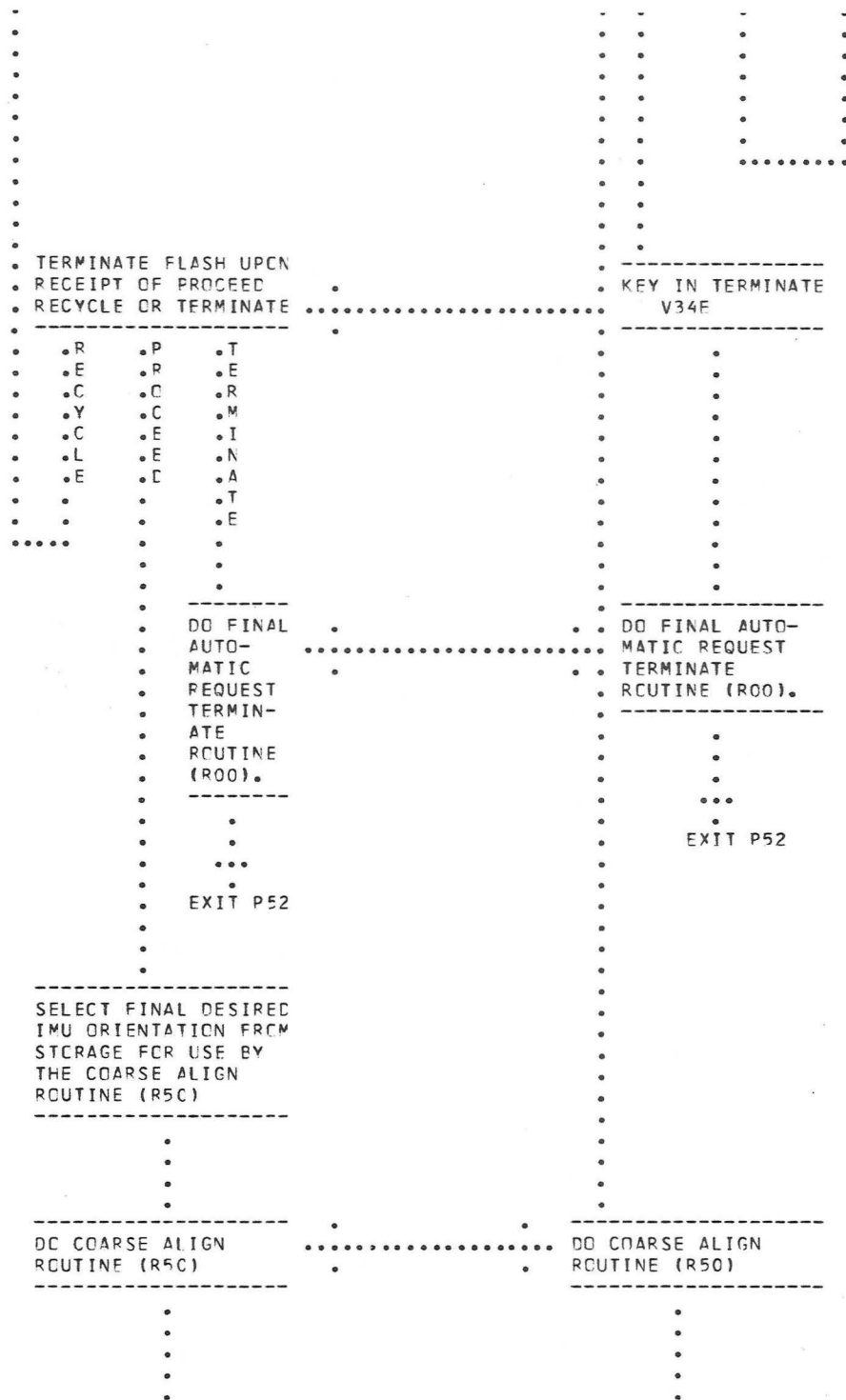
UPDATE THE
DISPLAY OF
RESULTING
GIMBAL
ANGLES:
KEY IN
RFCYCLE
V32F

#450

#460

133
(243)

P52/SUNDANCE



#470

#480

#490

#500

#510

P52/SUNDANCE

STORE THE PRESENT
IMU ORIENTATION
IN REFSMMAT AND SET
REFSM FLAG

#520

RESET PREFERRED
ORIENTATION FLAG

#530

"B"
FROM
ABOVE

"B"
FROM
ABOVE

#540

DO FINE ALIGN
ROUTINE (R51)

DO FINE ALIGN
ROUTINE (R51)

#550

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)

EXIT P52

EXIT P52

#560

CHANGE CONTROL NOTES

LOGIC REV 18 PCN-MIT-136
LOGIC REV 19 PCN 603.1

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

FINAL AUTOMATIC REQUEST TERMINATE
ROUTINE (R00)

LOGIC REV 05 01/17/69

PURPOSE:

- (1) TO PROVIDE A STANDARD EXIT FOR PROGRAMS, AND AN OPTION TO SELECT ANY PROGRAM DESIRED.
- (2) TO PROVIDE A GENERAL DESCRIPTION OF THE COMPUTER ACTIVITY FOLLOWING ANY V37EXXE.

ASSUMPTIONS:

- (1) THE CALLING PROGRAM HAS SUCCESSFULLY COMPLETED ALL ITS FUNCTIONS OR THE OPERATOR HAS PREMATURELY TERMINATED THE PROGRAM.
- (2) THE COMPUTER CHECKS ON THE RENDEZVOUS OR LUNAR SURFACE NAVIGATION PROCESS FOLLOWING ANY V37EXXE IN THE FOLLOWING WAYS:
 - (A) IF P20, OR P25 IS THE NEW PROGRAM KEYED IN AND IT IS NOT PRESENTLY RUNNING AND WAS NOT RUNNING IN THE BACKGROUND IT WILL BE STARTED AS A NEW PROGRAM.
 - (B) IF P20, OR P25 IS THE NEW PROGRAM KEYED IN AND IT IS THE ONLY PROGRAM PRESENTLY RUNNING (I.E. 20 OR 25 DISPLAYED IN THE PROG LIGHTS) IT WILL BE STARTED AS A NEW PROGRAM (I.E. RE-INITIALIZED).
 - (C) IF P20 OR P25 IS THE NEW PROGRAM KEYED IN BUT A PROGRAM OTHER THAN P20 OR P25 IS DISPLAYED IN THE PROG LIGHTS THE PROG LIGHTS WILL BE CHANGED TO 20 OR 25 AND P20 OR P25 WILL EITHER BE STARTED AS A NEW PROGRAM (IF IT WAS NOT RUNNING AT ALL) OR MERELY CONTINUED (IF IT WAS ALREADY RUNNING).
 - (D) IF PCC IS SELECTED, THE RENDEZVOUS FLAG AND P25 FLAGS ARE RESET (SHUTS OFF P20 OR P25) AND P00 IS STARTED.
 - (E) IF A PROGRAM OTHER THAN P20, OR P25 OR P00 IS KEYED IN, THE NEW PROGRAM WILL BE STARTED AND THE PROG LIGHTS WILL DISPLAY THE NEW PROGRAM. IF P20, OR P25 WAS RUNNING IT WILL CONTINUE IN THE BACKGROUND.
- (3) THIS ROUTINE RESTORES THE DEADBAND SPECIFIED IN R03 BY THE ASTRONAUT.
- (4) FLAGS USED BY THIS ROUTINE:
NODO V37 FLAG - INHIBITS PROGRAM SELECTION OTHER THAN LGC IDLING PROGRAM P00. SET BY R47 STATE VECTOR INTEGRATION, AND P06. RESET BY R47, STATE VECTOR INTEGRATION, AND RECOVERY FROM STAND BY.

PROG
CONT

LCC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- LGC
- ROUTINE
- SELECTION

- CREW
- PROGRAM
- SELECTION

++
+05
+512

ROO/SUNDANCE

#10

HOLD.

SNAP

FLASH VERB 37 TO
REQUEST PLEASE PER-
FORM CHANGE OF
PROGRAM:

V37 N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB
37 FLASH TO RE-
QUEST PLEASE
PERFORM CHANGE
OF PROGRAM.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH ON
RECEIPT OF XXE

KEY IN DESIRED
PROGRAM:
XXE

RECEIVE V37EXXE
TO REQUEST NEW
PROGRAM.

KEY IN DESIRED
PROGRAM
V37EXXE

"A"
ENTRY FROM
V96 WITH
PROGRAM PCO
SPECIFIED

IS THE IMU BEING
INITIALIZED?

N

Y

#20

#30

#40

#50

#60

'31
(247)+

IS THE NEW PRO-
GRAM PCC?

.Y N.

IS THE NCDD
V37 FLAG
SET?

.N Y.

TURN ON
PROGRAM
ALARM LIGHT
AND STORE
ALARM CODE
01520

EXIT
RCD

MONITOR DSKY:
DOES PROGRAM
ALARM LIGHT COME
ON INDICATING
ABNORMALITY?

.Y N.

KEY IN V05N09E
TO DISPLAY
ALARM CODE. EX-
PECTED ALARM AT
THIS TIME IS
01520

INDICATING:

- (1) THE IMU IS
BEING IN-
ITIALIZED
- (2) A PROGRAM
OTHER THAN
POC HAS
BEEN SEL-
ECTED AND
A CHANGE
OF PROGRAM
IS DIS-
ALLOWED AT
THIS TIME
(SEE R47
AND DES-
CRIPTION
OF STATE
VECTOR IN-
TEGRATION

R00/SUNDANCE

#70

#80

#90

#100

#110

R00/SUNDANCE

SECTION
5.6.11 OF
R557.)

DOES THE NEW
PROGRAM EXIST?

.Y. N.

EXIT
ROO

#120

TURN ON
OPERATOR
ERROR LIGHT

MONITOR DSKY:
DOES OPERATOR
ERROR LIGHT COME
ON INDICATING THAT
I HAVE SELECTED A
PROGRAM THAT DOES
NOT EXIST?

#130

EXIT
ROO

.N .Y.

#140

IS SERVICER
RUNNING?

.N .Y.

TERMINATE AVER-
AGE G CALCULA-
TION

#150

WAIT FOR INTEGRATION
TO FINISH

#160

RESET 3 AXIS FLAG

#170

'39
(249)

IS NEW PROGRAM PCC?

.Y N.

RESET RADMODES
BITS 10 & 15

RESET NCCCV37,
RENDEZVCUS, P25,
AND IMUSE FLAGS.

IS NEW PROGRAM
P20 OR P25?

.Y N.

RESET IMUSE
FLAG

TURN OFF ULLAGE

TURN OFF ENGINE

DC STOPRATE

ROO/SUNDANCE

#180

#190

#200

#210

#220

ROO/SUNDANCE

RESET THE TRACK FLAG

RESET THE UPDATE
FLAG.

RESTORE ASTRONAUT
SPECIFIED DEADBAND.

IS NEW PROGRAM P00?

.N .Y

RESET THE REN-
DEZVOLS AND P25
FLAGS.

IS NEW PROGRAM P20
OR P25?

.Y .N

IS THE CURRENT
PROGRAM P20 OR P25?

.N .Y

#230

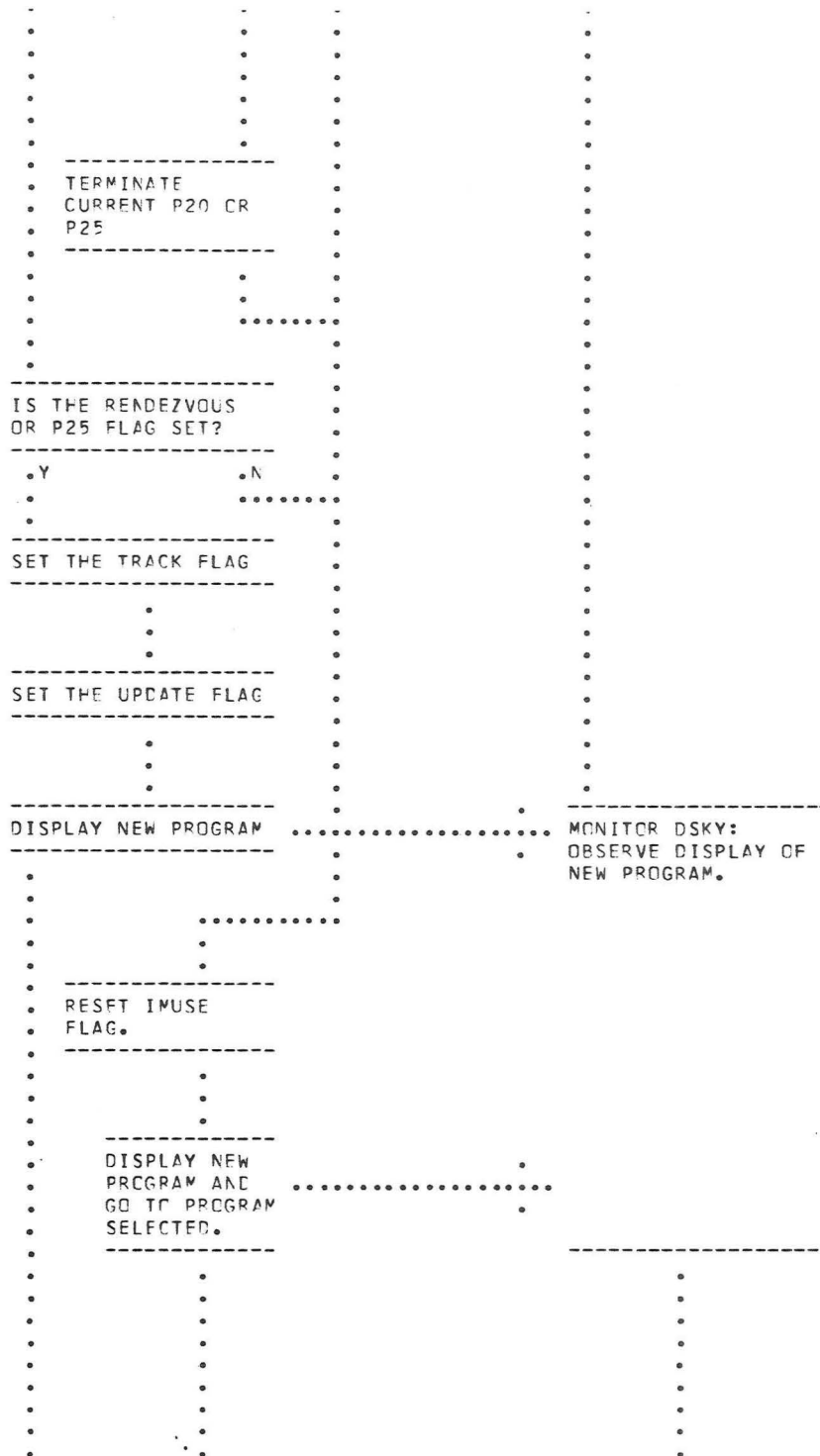
#240

#250

#260

#270

#1
(251)



ROO/SUNDANCE

#280

#290

#300

#310

#320

#330

ROO/SUNDANCE

RELEASE DISPLAY
SYSTEM.

EXIT ROO

GO TO PROGRAM
SELECTED

EXIT
ROO/P--

#340

CHANGE CONTROL NOTES

REV C4 PCN NC. 86 + PCR-NASA-88 + PCN-MIT-15 + PCN-MIT-106.
REV C5 PCN-512

LOGIC REV 05 05/23/68

ASSUMPTIONS: (1) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE PROGRAM IN PROCESS.

- .LGC
- .ROUTINE
- .SELECTION
- .
- ...
- .

#10

#20

[illegible]

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PAP DATA LOAD ROUTINE (R03)

LOGIC REV 13 04/16/68

PURPOSE: (1) TO LOAD AND VERIFY LGC DIGITAL AUTOPILOT (DAP) DATA, AND DPS ENGINE GIMBAL TRIM ANGLES.

(2) TO PROVIDE THE CREW A MEANS FOR SELECTING THE DESIRED DAP RESPONSE.

(3) TO PERFORM ENGINE GIMBAL TRIM.

ASSUMPTIONS: (1) THIS ROUTINE IS MANUALLY SELECTED BY THE CREW.

[illegible]

SYSTEM A
ALIGN)
R=1 2 JFT TRANS-
LATION (RCS
SYSTEM R
ALIGN)
R=2 4 JFT TRANS-
LATION (RCS
SYSTEM A AND
R).
C=0 FINE SCALING
ACA
C=1 NORMAL SCALING
ACA
D=0 ATT DEADBAND,
.3 DEGREES
D=1 ATT DEADBAND,
5.0 DEGREES.
E= KALCMANU RATE
0= .2 DEG/SEC
1= .5 DEG/SEC
2= 2 DEG/SEC
3= 10 DEG/SEC

WAIT FOR KEYBOARD
ENTRY

KEY IN PRO-
CEED

KEY IN V21F AND
LOAD DESIRED
DATA CODE IN R1

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

PROCEED NEW DATA

STORE DATA

#40

#50

#50

#70

#80

259

R03/SUNDANCE

#90

IS A=1 IN THE DAP
CONFIGURATION/RESP-
ONSE DATA CODE (SEE
ABOVE)?

.N .Y.

DOES STAGE VERIF-
IED DISCRETE IND-
ICATE THAT THE
DPS HAS BEEN
STAGED?

.N .Y

POSS
HOLD .

FLASH VERB-NOUN
TO REQUEST
RESPONSE AND
DISPLAY ALARM
CODE TO INDIC-
ATE THAT AN
A/P DOES NOT
EXIST FOR THE
ASCENT STAGE
DOCKED WITH THE
CSM:

V05N09
R1-01706
R2-XXXXX
R3-XXXXX

WAIT FOR KEY-
BOARD ENTRY.

MONITOR DSKY:
DOES VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF ALARM CODE
INDICATE THAT AN A/P
DOES NOT EXIST FOR
THE ASCENT STAGE
DOCKED WITH THE CSM.

.Y .N.

DO I WISH TO CHA-
NGE DATA CODE?

.Y .N.

KEY IN
PROCEED

#100

#110

#120

#130

#140

R03/SUNDANCE

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR
TERMINATE.

KEY IN TERM-
INATE V34F

#150

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

EXIT R03

EXIT R03

#160

TRANSFER DATA
TO DAP

#170

#180

HOLD . FLASH VERB-NDUN TO
..... REQUEST RESPONSE AND
DISPLAY STORED LM
WEIGHT AND CSM
WEIGHT;

V06 N47
R1- THIS VEHICLE
(LM) WEIGHT
R2- OTHER VEHICLE
(CSM) WEIGHT
R3- BLANK

MONITOR DSKY:
OBSERVE VERB-NDUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF VEHICLE WEIGHTS.

#190

261

WEIGHTS IN POUNDS TO
NEAREST POUND.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

.P .NEW
.R .DATA
.J
.C STORE DATA
.E
.E
.D

IS LM WEIGHT GREATER
THAN (ASCENT ONLY
4850, DESCENT ATTAC-
HED 11,120) POUNDS?
(NOTE: THE LSC WILL
CHECK THE STAGE VER-
IFIED DISCRETE TO
SELECT THE WEIGHT
CRITERIA FOR EITHER
THE DPS/APS OR APS
ALONE. THE CREW
DEFINED WEIGHT MUST
EXCEED THE EMPTY

AM I SATISFIED WITH
THESE VALUES?

.Y .N

KEY IN PROCEED
(NOTE: IF LM
AND/OR CSM
WEIGHTS DO NOT
EXCEED EMPTY
WEIGHT OF THE
RESPECTIVE
VEHICLE THIS
DISPLAY WILL
NOT TERMINATE).

KEY IN V24F
AND LOAD
THE DESIRED
PARAMETERS.

R03/SUNDANCE

#200

#210

#220

#230

#240

#250

R03/SUNDANCE

#470

DO I WISH TO
CONTINUE WITH
THE INTERRUPT-
ED PROGRAM.

.Y .N.

WAIT FOR KEYBOARD
ENTRY

#480

KEY IN
PROCEED.

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR TERMINATE.

KEY IN
TERMINATE

#490

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

.T
.E
.R
.M
.I
.N
.A

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EXIT
R03

EXIT
R03

LOGIC REV 12 PCN NO. MIT 60
LOGIC REV 13 PCN MIT 85 + PCN-MIT-96.

#510

43
(247)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RR/LR SELF TEST ROUTINE (R04)

LCGIC REV 12 01/17/69

PURPOSE: (1) TO PROVIDE SUITABLE DSKY DISPLAYS AND LGC DOWNLINK INFORMATION TO SUPPORT THE SELF TESTS OF THE RENDEZVOUS RADAR (RR) CP THE LANDING RADAR (LR).

++
+12
+592
++

(2) TO ALLOW CREW MONITORING OF RAW RADAR DATA DURING PROGRAMS OTHER THAN P00, PARTICULARLY DURING P47 IN TERMINAL BRAKING.

++

ASSUMPTIONS: (1) THIS ROUTINE IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY IN CONJUNCTION WITH MANUAL SELECTION OF THE APPROPRIATE RADAR SELF TEST AT THE LM CONSOLE (RADAR TEST SWITCH-PNDZ/OFF/LDG).

++
+12
+592
+
+
+12
++

(2) THE ROUTINE MAY BE CALLED DURING THE LGC IDLING PROGRAM (P00) AND ANY OTHER PROGRAM/ROUTINE WHEN P20 IS NOT RUNNING IN THE BACKGROUND.

(3) THE ROUTINE MAY ALSO BE CALLED DURING THOSE EXTENDED VERBS WHICH DO NOT RESTRICT OTHER EXTENDED VERB ACTIVITY.

(4) THE RR HEATERS HAVE BEEN IN THE OPERATE POSITION AT LEAST 1 HOUR.

PRCG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

				.CREW .ROUTINE .SELECTION	
	-----	.....	-----		#10
	START RR/LR SELF TEST ROUTINE (R04)		KEY IN V62E		
	-----		-----		
	.		.		
	.		.		
	.		.		
++	-----		-----		
+12	IS THE RENDEZVOUS				
+592	FLAG SET? (IS				
+	P20 RUNNING?)				#20
+	-----				
+	.N	.Y			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			
+	.	.			

P04/SUNDANCE

IS THE EXTENDED
VIRE ACTIVITY
INTERLOCK SET?

• **2**

• Y

TURN ON
OPERATOR
ERROR LIGHT

EXIT
RC4

MONITOR DSKY:
DOES OPERATOR
ERROR LIGHT CCME ON
INDICATING THAT THIS
ROUTINE CANNOT BE
SELECTED AT THIS
TIME?

• Y

• N

KEY IN V37E00E
THEN RESELECT
THIS ROUTINE
BY KEYING IN
V62E.

EXIT
R04

HOLD .
.....
SNAP .

FLASH VERB-NOUN TO
REQUEST RESPONSE
AND DISPLAY OPTION
CODE FOR ASSUMED
RADAR

W04 N06
P1-00004
R2-0000X
R3-PLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
RADAR

#30

#40

#50

#60

#70

145(269)

R04/SUNDANCE

R1 IS THE OPTION
CODE FOR ASSUMED
RADAR

R2 IS THE LGC
ASSUMED RADAR
OPTICN:
00001-RR
00002-LR

IS THE RADAR
ASSUMPTION CORRECT?

.Y .N

#80

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#90

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW CODE

KEY IN V22E AND
LOAD THE DESIR-
ED RADAR CODE
IN R2

#100

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

STCRE NEW
CODE

#110

IS RADAR OPTICN CODE
LR?

.Y .N

#120

#130

R04/SUNDANCE

#140

DID I SPECIFY RR OR
LR?

.RR .LR

GC TO
"C"
BELOW

#150

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N

SEND ALTC
TRACK ENABLE
TO THE RR.

#160

POSS
HOLD
SNAP

FLASH VERB-
NCUN TO RE-
QUEST PLEASE
PERFORM SELEC-
TION OF RR
AUTO MODE:
V5CN25
R1-C0201
R2-BLANK
R3-BLANK

MONITOR DSKY:
IS VERB-NCUN
FLASHING TO REQUEST
SELECTION OF AUTO
MODE?

.Y .N

PUT RR MODE
SWITCH TO LGC

#170

WAIT FOR KEY-
BOARD ENTRY.

KEY IN PROCEED

#180

R04/SUNDANCE

#190

#200

#210

#220

#230

R04/SUNDANCE

147
(271)

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED.

P
R
C
E
E
D

READ RR CDU
ANGLES EVERY
SECCND, AND RANGE
AND RANGE RATE
ON ALTERNATE
SECCNDS. TRANSMIT
THESE QUANTITIES
ON THE DOWNLINK

"A"
FROM
BELOW

"A"
FROM
BELOW

POSS
HOLD
MON

FLASH VERB-NCUN
TO REQUEST RES-
PCNSE AND MONITOR
RR CDU ANGLES:
V16 N72
R1-TRUNNION
R2-SHAFT
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND MONITOR
OF RR CDU ANGLES.

TRUNNICN-360
 MINUS RR TRUNNICN
 CDU VALUE.
 IN DEGREES TO
 NEAREST .01 DEG-
 REE.
 (PLUS IS DEFINED
 AS A NEGATIVE
 ROTATION ABOUT
 LM X AXIS.)

SHAFT-RR SHAFT
 ANGLE. IN DEGREES
 TO NEAREST .01
 DEGREE.

DO I WISH TO MONITOR
 RANGE AND RANGE
 RATE?

.Y .N

DO I WISH TO
 TERMINATE THIS
 ROUTINE?

.Y .N

WAIT FOR KEYCARD
 ENTRY.

KEY IN
 PROCEED

KEY IN
 TERMINATE
 (V34E)

#240

#250

#260

#270

#280

49 (273)

R04/SUNDANCE

POSS
HOLD
.....
MON

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR TERM-
INATE

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

EXIT
R04

FLASH VERB-NCUN
TO REQUEST RES-
PONSE AND MONITOR
RR RANGE AND
RANGE RATE:
V16 N78
R1-RANGE
R2-RANGE RATE
R3-BLANK

RANGE- RANGE
(SIMULATED) TC
CSM IN NAUTICAL
MILES TO NEAR-
EST .01 NM.

RANGE RATE-
RANGE RATE
(SIMULATED)
BETWEEN LM AND
CSM. IN FPS TC
NEAREST FPS.

(NOTE: WHENEVER A
RANGE OR RANGE
RATE MEASUREMENT
IS OBTAINED FROM
THE RR THE RR
DATA GOOD DIS-

EXIT
R04

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND MONITOR
OF RR RANGE AND
RANGE RATE.
(NOTE: WHENEVER A
RANGE OR RANGE RATE
MEASUREMENT IS OB-
TAINED FROM THE RR
THE RR DATA GOOD
DISCRETE IS ALSO
CHECKED BY THE LGC.
IF IT IS MISSING THE
TRACKER FAIL ALARM
IS ACTUATED)

DO I WISH TO TERM-
INATE RADAR SELF
TESTING?

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

#290

#300

#310

#320

#330

R04/SUNDANCE

WAIT FOR KEYBOARD
ENTRY

KEY IN
TERMINATE
(V34E)

DO I WISH
TO PER-
FORM LR
SELF
TEST?

• Y • N

• DO I
• WISH
• TO MC-
• NITOR
• SHAFT
• AND
• TRUNN-
• ION
• AN-
• GLES?

• Y • N

EXIT
R04

- KEY IN
- RECY-
- CLF
- (V32E)

¥390

[illegible]

R04/SUNDANCE

HOLD
MON

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
MONITOR THE LR
RANGE AND ANTENNA
POSITION:

V16 N66
R1-RANGE
R2-POSITION
R3-BLANK

RANGE- SIMULATED
SLANT RANGE. IN
FEET TO NEAREST
FOOT

POSITION-PRESENT
LANDING RADAR
ANTENNA POSITION
(00001 OR 00002)

WAIT FOR KEYBOARD
ENTRY.

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR TERM-
INATE

P
R
O
C
E
E
D

T
E
R
M
I
N
A
T
E

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND MONITOR
THE LR RANGE AND
ANTENNA POSITION:
NOTE: POSSIBLE TRAC-
KER FAIL IF ALTITUDE
DATA GOOD DISCRETE
IS MISSING.

DO I WISH TO MONITOR
V(X), V(Y) AND V(Z)?

Y. N

KEY IN
PROCEED

DO I WISH
TO TERM-
INATE
THIS ROU-
TINE?

Y N

KEY IN
TERMINATE
(V34E)

EXIT
R04

#450

#460

#470

#480

#490

R04/SUNDANCE

#500

#510

#520

#530

#540

#550

R04/SUNDANCE

53(277)

HOLD
MON

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
MONITOR LR
V(X), V(Y), AND V(Z):
V16 N67
R1-V(X)
R2-V(Y)
R3-V(Z)

V(X), V(Y) AND V(Z)-
SIMULATED VELOCIT-
IES. IN FPS TO NEAR-
EST FPS

(NOTE: WHEN EACH
VELOCITY COMPONENT
IS OBTAINED FROM THE
LR THE VELOCITY
DATA GOOD DISCRETE
IS ALSO CHECKED. IF
IT IS MISSING THE
TRACKER FAIL ALARM
IS ACTUATED)

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
RESPONSE AND MONITOR
OF LR V(X), V(Y) AND
V(Z)
(NOTE: WHEN EACH
VELOCITY COMPONENT
IS OBTAINED FROM THE
LR THE ASSOCIATED
DATA GOOD DISCRETE
IS ALSO CHECKED. IF
IT IS MISSING THE
TRACKER FAIL ALARM
IS ACTUATED)

DO I WISH TO TERM-
INATE RADAR SELF
TESTING?

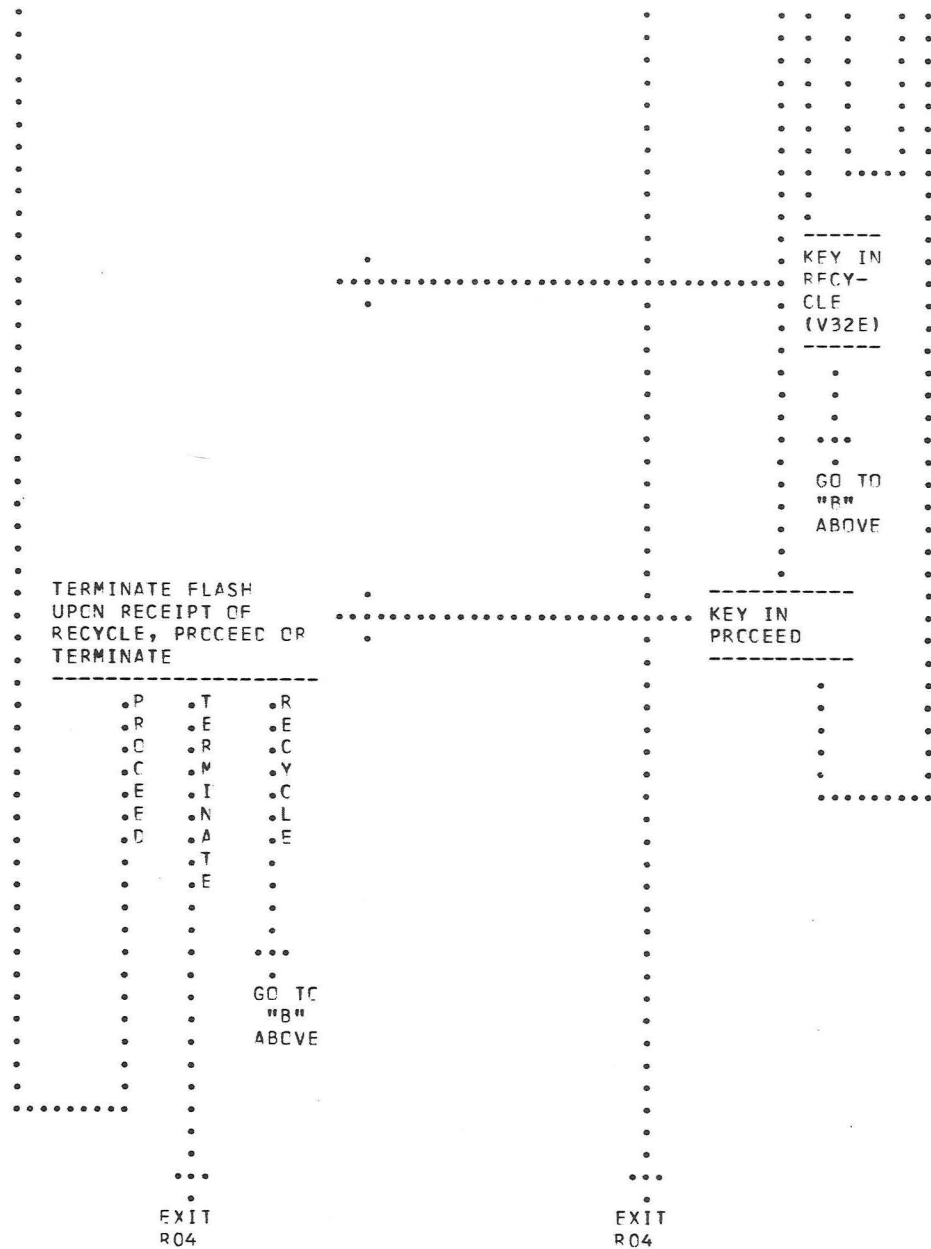
Y. N

KEY IN DO I WISH
TERMINATE TO PER-
(V34E) FORM RR
SELF
TEST?

Y. N

DO I
WISH
TO MO-
NITOR
RANGE?

Y. N



#560

#570

#580

#590

#600

155
(278-A)

CHANGE CONTROL NOTES

LOGIC REV 10 PCN MIT - 58.65
LOGIC REV 11 PCN - MIT - 52. + PCR - 95.1
LOGIC REV 12 PCR 592

00771000
00772000
00772001

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RR DESIGNATE ROUTINE (R21)

LOGIC REV 15 05/28/68

PURPOSE: (1) TO POINT THE RENDEZVOUS RADAR (RR) AT THE CSM UNTIL AUTOMATIC ACQUISITION OF THE CSM IS ACCOMPLISHED BY THE RADAR WHILE THE LM IS IN ORBIT OR ON THE LUNAR SURFACE.

ASSUMPTIONS: (1) THIS ROUTINE IS AUTOMATICALLY CALLED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20) AND THE LUNAR SURFACE NAVIGATION PROGRAM (P22).

(2) THE RR SERVCS MAY BE COMMANDED BY THE LGC AFTER THE LGC ISSUES THE TRACK ENABLE DISCRETE UNTIL RANGE RATE LOCKDN IS ACHIEVED BY THE RR.

PROG CONT	I GC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	------	--------	------	-----------	------	---------------

- LGC
- PROGRAM
- SELECTION

START RR
DESIGNATE ROUTINE
(R21)

#10

++
+16

+16

+

+

 \oplus

+

+

 $+$

+

+

+

+

+

+

+

+

+

+

 $+$

+

+

+

+

+

 \div

REMOVE TRACK ENABLE
DISCRETE TO THE PR.

SET THE PR DESIGNATE
COUNTER (SET K = 60)

第20

第30

R21/SUNDANCE

#150

WAIT FOR CSW TO
RISE TOWARDS
ZENITH.

#160

KEY IN PROCEED

#170

WAIT FOR KEY-
BOARD ENTRY
TERMINATE
FLASH UPON
RECEIPT OF
PROCEED.

#180

IS REMODE FLAG SET?

N . Y
.

COMMAND R3 CDU,S
TO PLACE ANTENNA
IN THE OTHER
MODE.

#190

RESET REMODE
FLAG.

283

++
+16
+
+
+
+
+
+
+
+16
++

IS REPOSITIONING
FLAG SET?

.N .Y

GO TO
"A"
BELOW

IS N = 0?

.Y .N

DECREMENT N BY
ONE.

IS THE RR DESIGNATE
COUNTER = 0 (K=0)?

.Y .N

DECREMENT K BY
ONE.

IS THE PRESENT
RR LOS WITHIN
1/2 DEGREE OF
THE PRESENT LOS
FROM THE LM TO
THE CSM?

.N .Y

R21/SUNDANCE

#200

#210

#220

#230

#240

#250

R21/SUNDANCE


```

-----
SEND AJTQ
TRACK ENABLE
TO THE RR.
-----

```

#250

```

-----
IS DATA GOOD
DISCRETE RECEIVED
FROM THE RR?
-----

```

```

.N      .Y

```

#270

```

EXIT R21

```

```

-----
ISSUE RATE COM-
MANDS TO THE RR
PROPORTIONAL TO
THE ANGULAR DIFF-
ERENCE BETWEEN
RR LOS AND THE
LOS TO THE CSM
ONE SECOND FROM
NOW.
-----

```

#280

```

-----
WAIT .5 SECONDS.
-----

```

#290

```

-----
TERMINATE PERIODIC
LOS DETERMINATION
CALCULATION.
-----

```

#300

 GO TO RR SEARCH
 ROUTINE (R24)

#360

EXIT R21

 DO I WISH TO ATTEMPT
 TO DESIGNATE THE RR
 AGAIN?

#370

.Y .N

 KEY IN RECYCLE
 V32F

#380

 KEY IN TERMINATE
 V34E

#390

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 TERMINATE, OR
 RECYCLE

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

#400

 GO TO RR SEARCH
 ROUTINE (R24)

#410

```
.
.
.
.
EXIT P21
.
-----
IS ANOTHER PROGRAM
OTHER THAN P20/P22
IN PROCFS?
-----
.Y.N
.
.
.
.
.
.
.
.
.
.
.
..
EXIT R21
AND P20/P22
.
.
.
-----
DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)
-----
.
.
.
...
.
EXIT R21
```

```

      .
      .
      .
      .
      .
      .
      .
      .
      .
-----
IS ANOTHER PROGRAM
OTHER THAN P20/P22
IN PROCESS?
-----
      .Y                                .N
      .
      .
      .
-----
OBSERVE DISPLAY
OF OTHER
PROGRAM
-----
      .
      .
      .
      .
      .
      .
      .
      .
      .
EXIT R21
AND P20/P22
      .
      .
      .
-----
DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00)
-----
      .
      .
      .
      .
      .
      .
      .
      .
      .
EXIT R21

```

#440

LOGIC REV 16 PCN-MIT-143

#40

IS THE TRACK FLAG
SET? (SEE P20/P22)

.Y .N

WAIT 15 SEC

IS THE RR TRACK
ENABLE DISCRETE
ISSUED?

.Y .N

GO TO "B"
IN P20/P22

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N

GO TO "C"
IN P20/P22

IS THE LM ON THE
LUNAR SURFACE?

.N .Y

(NOTE: IF THE RR
HAS BEEN PULLED
OFF THE CSM BY AN
ATTITUDE MANEUVER
THE RR MONITOR
ROUTINE (R25)
WILL HAVE DETECT-
ED THE LARGE RR
CDU ANGLES AND
WILL HAVE REMOVED
THE RR TRACK
ENABLE DISCRETE.

.Y .N

GO TO "B"
IN P20/P22

IS RR MODE SWITCH
IN LGC

.Y .N

GO TO "C"
IN P20/P22

#50

#60

#70

#80

#90

391

ARE CDUS BEING
ZEROED?

.Y .N.

WAIT 15 SECONDS

STORE RR
RANGE SCALE

IS RR DATA
GOOD PRESENT?

.Y .N

READ RANGE RATE

IS RR CDU FAIL ON?

.N .Y

R22/SUNDANCE

#100

#110

#120

#130

#140

R22/SUNDANCE

 IS RP DATA GOOD
 PRESENT?

.Y .N

#150

 READ 5 CDUS
 (ISS-3 AND R3-2)
 AND TIME (TM)

#160

 IS RP DATA
 GOOD PRESENT?

.Y .N

#170

 READ RANGE

#180

 IS RR CDU FAIL ON?

.N .Y

#190

 IS THE RR RANGE
 SCALE THE SAME
 AS BEFORE?

.N .Y

293

IS RR DATA
GOOD PRESENT?

.Y .N

TURN ON TRACKER
FAIL ALARM. TURN
ON PROGRAM ALARM
LIGHT BUT DO NOT
CHANGE PRESENT
DISPLAY.
(PROGRAM ALARM
DISPLAY IF CALL-
ED IS
V05N09
R1-00521
R2-XXXXX
R3-XXXXX

(NOTE: THIS DIS-
PLAY WHEN CALLED
WILL SUSPEND
CURRENT DISPLAY
AND TURN ON THE
KEY RELEASE
LIGHT).

GO TO "D"
IN P20/P22

MONITOR DSKY:
DOES TRACKER
FAIL ALARM AND
PROGRAM ALARM LIGHT
INDICATE ABNORMA-
LITY?

.Y N.

CALL PROGRAM
ALARM DISPLAY
(V05N09) TO
IDENTIFY ABNORM-
ALITY. WHEN
FINISHED, PUSH
KEY RELEASE TO
RECALL PREVIOUS
DISPLAY

PRESS ALARM
RESET TO RESET
PROGRAM ALARM.

GO TO "D"
IN P20/P22

R22/SUNDANCE

#200

#210

#220

#230

#240

R22/SUNDANCE

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR
RECYCLE.

KEY IN
RECYCLE
V32F

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

GO TO "D"
IN P20/P22

GO TO "D"
IN P20/P22

IS THE SURFACE
NAVIGATION FLAG
SET?

.N .Y

IS THE TRACK
FLAG SET?

.N .Y

WAIT 15 SEC

IS RR LOS WITHIN
30 DEGREES OF
THE LM +Z AXIS?

.N .Y

#350

#360

#370

#380

#390

297

DO PREFERRED
TRACKING
ATTITUDE
ROUTINE
(R61)

WAIT 15 SEC

IS THE UPDATE FLAG
SET?

N

Y

WAIT 15 SEC

IS THE NO
UPDATE FLAG
SET? (SEE P20)

N

Y

GO TO
"B"
BELOW

R22/SUNDANCE

#400

#410

#420

#430

#440

R22/SUNDANCE

TERMINATE FLASH
UPON RECEIPT OF
PROCEED RECYCLE OR
TERMINATE

KEY IN TERMINATE
V34E

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

IS ANOTHER
PROGRAM
OTHER THAN
P20/P22 IN
PROCESS?

.Y N.

EXIT R22
AND P20/
22

DO FINAL
AUTOMATIC
REQUEST
TERMINATE
ROUTINE
(R00).

EXIT R22

IS ANOTHER PROGRAM
OTHER THAN P20/P22
IN PROCESS?

.Y N.

OBSERVE DISPLAY
OF OTHER PROGRAM

EXIT R22
AND P20/22

DO FINAL AUTOMATIC
REQUEST TERMINATE
ROUTINE (R00).

EXIT R22

#560

#570

#580

#590

#600

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PR MANUAL ACQUISITION ROUTINE (R23)

LCCIC RFV 17 01/17/69

PURPOSE: (1) TO ACQUIRE THE CSM BY MANUAL OPERATION OF THE RENDEZVOUS RADAR(RR) WHILE THE LM IS IN FLIGHT.

ASSUMPTIONS: (1) THE PCLTIME IS AUTOMATICALLY CALLED BY THE PENDEZVOUS NAVIGATION PROGRAM (P20) IN RESPONSE TO AN ASTRONAUT REQUEST FOR A MANUAL ACQUISITION.

PRCG
CONT

LGC

GRUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- LGC
- ROUTINE
- SELECTION

START RR MANUAL
ACQUISITION ROUTINE
(R23)

#10

SELECT MIN. DEACBAND

```

SET NC ANGLE MONITOR
FLAG FOR USE BY RR
MONITOR ROUTINE
(R25).

```

#20

#30.

INITIAL
ENTRY

R23/SUNDANCE

HOLD
SNAP

DO PREFERRED
TRACKING
ATTITUDE
ROUTINE (R61)

SEND AUTO TRACK
ENABLE TO RENDEZVOUS
RADAR

FLASH VERB-NCUN TO
REQUEST PLEASE
PERFORM MANUAL
ACQUISITION OF CSM.
V50N25
R1-00205
R2-BLANK
R3-BLANK

DO PREFERRED
TRACKING ATTIT-
UDE ROUTINE
(R61)

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
PLEASE PERFORM
MANUAL ACQUISITION
OF THE CSM.

PUT RR CONTROL
SWITCH FROM LGC TO
SLEW

#40

#50

#60

#70

#80

#90

59
(305)

R23/SUNDANCE

SEARCH FOR CSM
MANUALLY

#100

HAS THE CSM BEEN
ACQUIRED?

#110

.N .Y

VERIFY THAT
ACQUISITION HAS
NOT BEEN BY SIDE
LOBE

#120

PUT RR MODE
SWITCH TO LGC.

#130

WAIT FOR THE NO
TRACK LIGHT TO
GO OFF.

WAIT FOR KEYBOARD
ENTRY.

KEY IN PROCEED

#140

R23/SUNDANCE

61
(307)

R23/SUNDANCE

++
+17
+EDIT

RESTORE ASTRO-
NAUT SPECIFIED
DEADEND

ARE THE RR GIMBAL
ANGLES WITHIN PRE-
SENT MODE LIMITS?
(REFER FIGURE 5.2.4-
3 OF R557).

.N .Y.

RESET NC
ANGLE
MONITOR
FLAG FOR
USE BY RR
MONITOR
ROUTINE
(R25).

EXIT R23

POSS
HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY ALARM CODE:
V05NC9
R1-00501
R2-XXXXX
R3-XXXXX

MONITOR DSKY:
DOES VERB-NOUN
FLASH AND DISPLAY
OF ALARM CODE INDI-
CATE THAT CSM IS
PRESENTLY OUTSIDE
ALLOWABLE LIMITS OF
THE PRESENT RR AN-
TENNA MODE?

.Y .N

#210

#220

#230

#240

#250

R23/SUNDANCE

EXIT R23

#260

DO I WISH TO
MANEUVER AGAIN TO
THE PREFERRED
TRACKING ATTITUDE?
(THE CSM AND/OR LM
STATE VECTORS PROB-
ABLY ARE INCORRECT
IN THE LGC BECAUSE
THE PREFERRED
ATTITUDE ROUTINE
(R61) IS NOT POINT-
ING THE LM +Z AXIS
NEAR THE CSM)

#270

.Y .N

#280

WAIT FOR KEYBOARD
ENTRY

KEY IN RECYCLE
(V32E)

#290

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR TERMINATE

KEY IN TERMINATE
(V34E)

.RECYCLE .TERMINATE

#300

"A"
FROM
ABOVE

"A"
FROM
ABOVE

•

•

•

—

.....

•

•

• • •

```
EXIT R23
AND P20
```

#330

LOGIC REV 15 PCR #86 & PCN MIT - 65
LOGIC REV 16 PCN - MIT - 104
LOGIC REV 17 EDITORIAL CORRECTIONS

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165
(311)

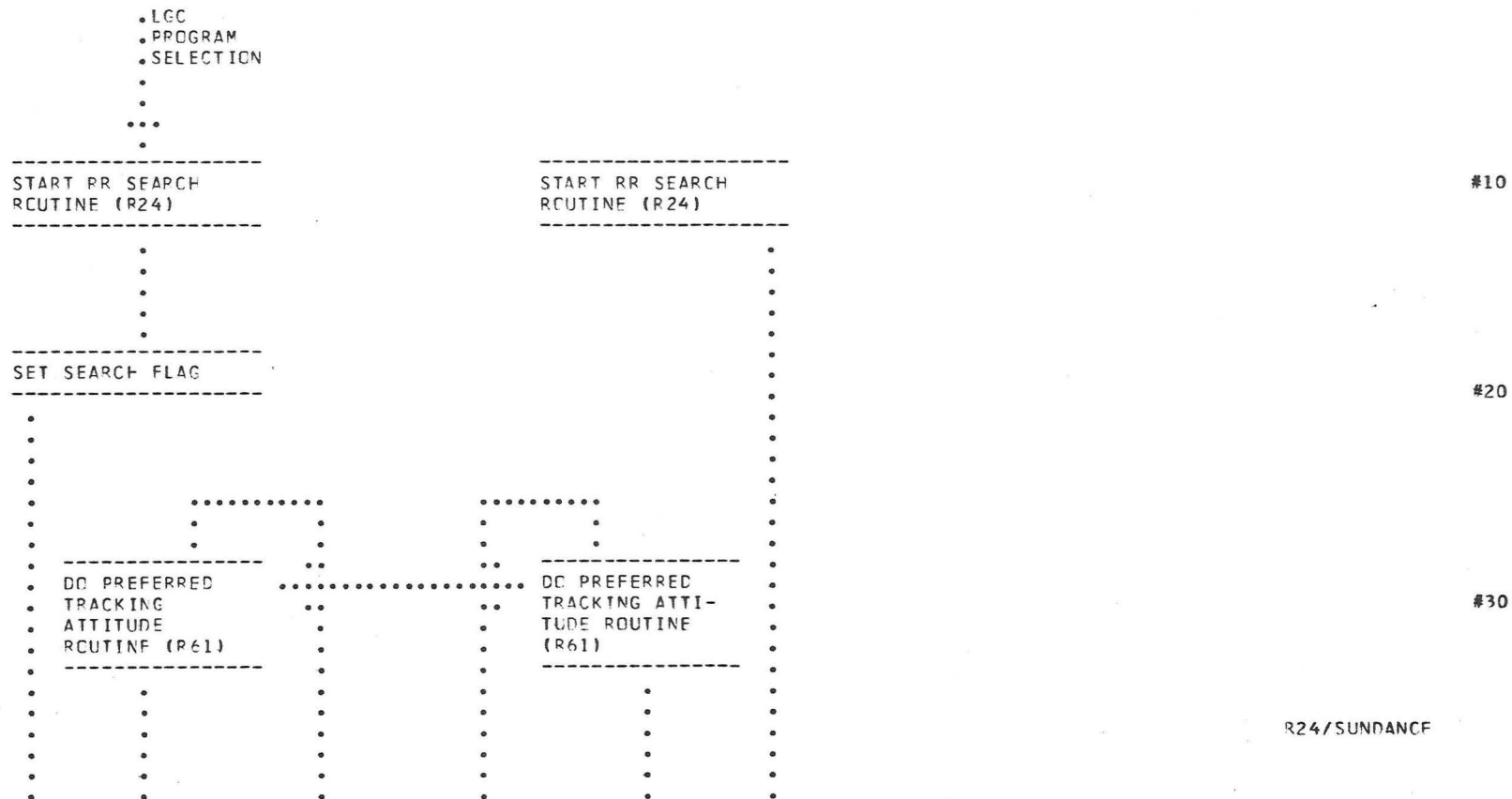
APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RR SEARCH ROUTINE (R24)

LCGIC REV 13 01/17/69

- PURPOSE: (1) TO ACQUIRE THE CSM BY A SEARCH PATTERN WHEN THE RENDEZVUS RADAR HAS FAILED TO ACQUIRE THE CSM IN THE AUTOMATIC TRACKING MODE.
- (2) TO ALLOW THE ASTRONAUT TO CONFIRM THAT REACQUISITION HAS NOT BEEN BY SIDELobe.
- ASSUMPTION: (1) THE ROUTINE IS AUTOMATICALLY CALLED BY THE RR DESIGNATE ROUTINE (R21) IN RESPONSE TO AN ASTRONAUT REQUEST FOR A SEARCH ACQUISITION.

PRCG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------



PRIO

MON

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY RR SEARCH
PARAMETERS:
V16N80
R1-C0000
R2-CMEGA
R3-BLANK

R1 WILL DISPLAY
11111 IF THE
DISCRETE IS RECEIVED
FROM THE RR INDICAT-
ING THAT THE SEARCH
HAS BEEN SUCCESSFUL

OMEGA- THE ANGLE BE-
TWEEN THE RR LOS AND
THE LM +Z AXIS. IN
DEGREES TO NEAREST
.01 DEGREE.

SEND AUTO TRACK
ENABLE TO RR

IS R61 OPERATING?

.N .Y

MONITOR DSKY:
OBSERVE FLASHING
VERB-NOUN TO REQUEST
RESPONSE AND TO
INDICATE THAT AN LGC
CONTROLLED SEARCH
PATTERN IS IN PRO-
CESS.

CONFIRM BY VOICE
THAT CSM IS IN PRE-
FERRED ATTITUDE AND
TRANSPONDER IS
OPERABLE.

#40

#50

#60

#70

#80

167
(313)

R24/SUNDANCE

#90

STCP 6 SEC-
OND SEARCH
PATTERN UN-
TIL R61 IS
COMPLETE

EXIT

#100

IS THE LCS WITHIN
THE LIMITS OF THE
PRESENT RR ANTENNA
MCDE?

.Y N.

#110

IS THE LUNAR
SURFACE FLAG SET?

.N Y.

IS THE LM ON THE
LUNAR SURFACE?

.Y N.

#120

TURN ON PRO-
GRAM ALARM
LIGHT BUT DO
NOT CHANGE
PRESENT DIS-
PLAY. STORE
ALARM CODE
0C527.

MONITOR DSKY:
DOES PROGRAM
ALARM LIGHT COME
ON INDICATING THAT
THE CSM IS PRES-
ENTLY OUTSIDE THE
ALLOWABLE LIMIT OF
THE CORRECT ANTEN-
NA MODE?

.Y N.

#130

R24/SUNDANCE

STOP 6 SECOND
SEARCH PATTERN

GC TO
"B"
BELOW

IS THE LCS WITHIN
THE LIMITS OF THE
OTHER RR ANTENNA
MODE?

.Y .N

SET REMODE FLAG

IS THE REMODE FLAG
SET?

.N .Y

COMMAND RR CDUS
TO PLACE ANTENNA
IN THE OTHER MODE.

IS THE LM CN
THE LUNAR SUR-
FACE?

.Y .N

GO TO GO TO
"C" "B"
BELOW BELOW

IF THE LCS IS NOT
WITHIN THE LIMITS OF
EITHER RR ANTENNA
MODE THE LGC WILL
TURN ON THE PROGRAM
ALARM LIGHT.

.Y N

#140

#150

#160

#170

#180

#190

DOES 11111 IN R1
INDICATE THAT
CSM HAS BEEN
ACQUIRED?

• N • Y

SHALL I CONTINUE
SEARCH?

•Y •N

IS THE LM
ON THE LU-
NAR SUR-
FACE?

• Y • N

- IS OME-
- GA
- GREATER
- THAN 30
- DEG-
- REES?

• N • Y

"B"
FROM
ABCVE

"B"	"C"
FROM	FROM
ABOVE	ABOVE

171 (317)

WAIT FOR KEYBOARD
ENTRY

KEY IN RE-
CYCLE
(V32E)

KEY IN TERMINATE
(V34E)

HAS CSM BEEN
ACQUIRED BY
SIDELOBE?

.Y .N

SET RR
MODE
SWITCH TO
LGC

WAIT FOR
NO TRACK
LIGHT TO
GO OFF.

REACQUIRE
CSM IN
CENTER
LCBE
MANUALLY

R24/SUNDANCE

#300

#310

#320

#330

#340

#350

R24/SUNDANCE

TERMINATE FLASH
UPON RECEIPT OF
TERMINATE, PROCEED
OR RECYCLE

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

++
+13
+500
+
+13
++

TERMIN-
ATE HALF
SECCND

DESIGN- IS SURFACE
ATE LOCP. NAVIGATION
FLAG SET?

.Y .N

TURN
OFF 6
SECCND
SEARCH
PAT-
TERN.

GO TO
"A" IN
P20/P22

GO TO
"A"
ABOVE

IS ANOTHER PROGRAM
OTHER THAN P20/22 IN
PROCESS?

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

KEY IN PROCEED

GO TO
"A" IN
P20/P22

IS ANOTHER PROGRAM
OTHER THAN P20/22 IN
PROCESS?

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

#360

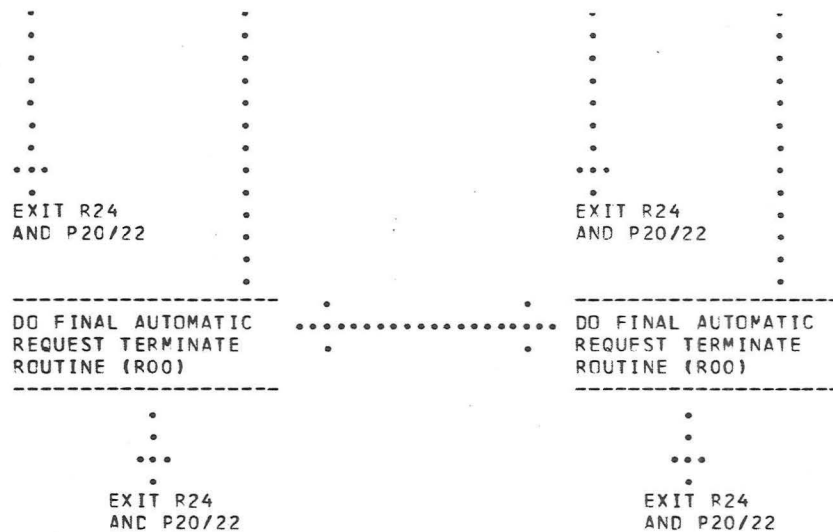
#370

#380

#390

#400

173₍₃₁₉₎



R24/SUNDANCE

#410

#420

CHANGE CCNTRCL NOTES

LOGIC REV 11 PCN MIT 44
 LOGIC REV 12 PCN - MIT - 138, PCN - MIT - 104
 LOGIC REV 13 PCN 500

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APCLLC COMPUTER LOGIC CHECKLIST INTERFACE

R R MCNITOR ROUTINE (R25)

LOGIC REV 14 01/17/69

```
PURPOSE:      (1)  TO MONITOR THE RR STATUS WITH RESPECT TO MODE CHANGES, RR CDU FAILURE, AND RR GIMBAL POSITIONS.
++
+14           (2)  TO COMMAND THE RR GIMBALS TO ONE OF TWO REFERENCE POSITIONS (DEPENDENT UPON RR ANTENNA MODE) IF THE RR GIMBAL
+EDIT        ANGLES EXCEED PREDEFINED LIMITS (AS DESCRIBED IN FIG 2.4-3 OF SECTION 5 OF R-557).
+
+14           (3)  TO ZERO THE RR CDUS WHEN THE RR IS FIRST PLT IN AUTO MODE.
++
```

ASSUMPTIONS: (1) THE PREDEFINED LIMITS OF PURPOSE (2) ARCVE ALLOW THE ANGLE BETWEEN THE LM +Z AXIS AND THE RR LOS TO BE GREATER THAN 30 DEGREES DURING NORMAL RR TRACKING UNDER CONTROL OF THE RENDEZVOUS NAVIGATION PROGRAM (P20) OR THE LUNAR SURFACE NAVIGATION PROGRAM (P22).

WHILE IN FLIGHT, THE 30 DEGREE LIMIT DEFINED IN THE RR DATA READ ROUTINE (R22) WILL ACT TO KEEP THE RR LOS WITHIN THIS LIMIT W.R.T. THE LM +7 AXIS. THIS WILL BE ACCOMPLISHED BY LM ATTITUDE MANEUVERS UNDER THE CONTROL OF THE PREFERRED TRACKING ATTITUDE ROUTINE (R61). THEREFORE, IN FLIGHT, WHEN THE TRACK FLAG (SEE P20) IS SET, THE LIMITS DEFINED BY THIS ROUTINE SHOULD NEVER BE EXCEEDED AND IT SHOULD ONLY BE NECESSARY FOR THIS ROUTINE TO CONTROL THE RR GIMBALS WHEN THE TRACK FLAG IS RESET (AS DURING MANEUVERS FOR THRUSTING, ETC).

WHILE ON THE LUNAR SURFACE RR DESIGNATION IS INHIBITED IF THE LOS TO THE CSM IS NOT WITHIN THE ALLOWABLE RR GIMBAL LIMITS OF MODE # 2.

(2) THIS ROUTINE IS AUTOMATICALLY CALLED EVERY 0.48 SECONDS WHENEVER THE LGC IS ON.

PRCG
CONT

LGC

GRUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- LGC
- ROUTINE
- SELECTION
- • •
-

START RR MONITOR
ROUTINE (R25)

第10

[illegible]
$$\begin{array}{ccc} \bullet N & & Y \bullet \\ \bullet & & \bullet \\ \bullet & & \bullet \end{array}$$

• •

• •

• •

• •

$$\begin{array}{ccc} \bullet & \bullet N & Y \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \end{array}$$

#60

[illegible]

#110

R25/SUNDANCE

#120

IS A DSKY LAMP
TEST IN
PROGRESS?

.Y N.

ARE RR CDUS
BEING
ZERDED?

.Y N.

HAVE ANY
OF THE
CDUS
FAILED?

.N Y.

IS
THE
RR
AUTO
MODE
DIS-
CRETE
PRE-
SENT?

.N Y.

IS THE NO
RR DATA
FLAG SET?

.N Y.

#130

#140

#150

#160

$$\begin{pmatrix} + \\ + \end{pmatrix}$$

#170

DOES TRACKER FAIL
LIGHT INDICATE
ABNORMALITY?

• Y

No.

CONSULT BACKUP PROCEDURES

#180

WAIT 1 SECOND

RESET TURN ON
FLAG

EXIT
R25

#190

¥200

#210

HAS THE RR CDU FAIL
DISCRETE CHANGED
STATE?

N. Y.

第220

R25/SUNDANCE

IS THE RR AUTC
MCDE DISCRETE
PRESENT?

N. Y.

EXIT
R25

UPDATE RR CDU
FAIL FLAG

IS RR CDU FAIL
CN?

N. Y.

IS THE REND-
EZVUS FLAG
SET?

N. Y.

TURN ON
PROGRAM
ALARM LIGHT
BUT DO NOT
CHANGE PRE-
SENT DIS-
PLAY.
STORE
ALARM CODE
00515.

MONITOR DSKY:
DOES PROGRAM
ALARM LIGHT INDICATE
ABNORMALITY?

Y. N.

CALL PROGRAM
ALARM DISPLAY.
(V05N09) TO
IDENTIFY ABNORM-
ALITY. WHEN FIN-
ISHED, PUSH KEY

#230

#240

#250

#260

#270

+

IS A DSKY LAMP
TEST IN PROGRESS?

•Y N•

ARE RR CCUS
BEING ZEROED?

Y N.

- HAVE ANY
- OF THE
- CDUS
- FAILED?

• N Y •

•

•

•

•

•

EXIT
R25

#280

#290

#300

#310

井320

R25/SUNDANCE

#330

IS THE
RR AUTO
MODE
DIS-
CRETE
PRE-
SENT?

N Y.

IS THE NO
RR DATA
FLAG SET?

N Y.

TURN ON
TRACKER
FAIL LIGHT

DOES TRACKER FAIL
LIGHT INDICATE
ABNORMALITY?

#350

TURN OFF
TRACKER
FAIL LIGHT

Y

N

#360

CONSULT BACKUP
PROCEDURES

#370

IS THE NO RR
MONITOR FLAG SET?

Y

N

#380

[illegible]

#440

ARE THE RR GIMBAL
ANGLES WITHIN PRESENT
MODE LIMITS (REFER
FIGURE 2.4-3 OF
SECTION 5 OF R-557)?

#450

```

.Y                               .N
.
.
.
...
.
EXIT
R25

```

#460

REMOVE RR TRACK
ENABLE DISCRETE TC
THE RR AND RESET THE
RR ERROR COUNTER.

#470

SET REPOSITION FLAG

#480

COMMAND RR GIMBALS
TO REFERENCE POSI-
TION FOR THE PRESENT
RR ANTENNA MODE.

#490

[illegible]EXIT
R25

#500

LOGIC REV 13 PCR 97,410
LOGIC REV 14 EDITORIAL CORRECTIONS

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

ORBIT PARAMETER DISPLAY ROUTINE (R30)

LCGIC REV 11 01/17/69

PURPOSE: (1) TO PROVIDE THE ASTRONAUT PERTINENT ORBITAL PARAMETERS COMPUTED BY THE LGC TO SUPPLEMENT ORBITAL INFORMATION PROVIDED HIM BY THE GROUND.

ASSUMPTIONS: (1) THE COMPUTATIONS MADE DURING THIS ROUTINE ARE UPDATED ABOUT EVERY TWO SECONDS ONLY IF THE AVERAGE G ROUTINE IS ON WHEN THIS ROUTINE IS CALLED.

(2) THE VALUE OF TFF OR TF PER WILL BE MADE TO COUNT DOWN IF THE AVERAGE G ROUTINE IS NOT ON WHEN THIS ROUTINE IS CALLED.

++ (3) IF TFF IS NOT COMPUTABLE (PER ALT IS GREATER THAN 300,000 FT IN EARTH ORBIT OR GREATER THAN 35,000 FT IN LUNAR
+11 ORBIT) THE LGC WILL SET TFF EQUAL TO -59859 AND COMPUTE TF PEP AND STORE IT IN N32. THE ASTRONAUT MAY CALL IT BY
+518 KEYING IN N32E.

(4) THIS ROUTINE MAY BE SELECTED WHILE THE LM IS EITHER IN EARTH OR LUNAR ORBIT.

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

PROG
CONT

LCC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- CREW
- ROUTINE
- SELECTION

START ORBIT PARAMETER.
DISPLAY ROUTINE (R30)

KEY IN V82E

IS AVERAGE G ROUTINE
ON?

IS AVERAGE G ROUTINE
ON?

•Y •N

• Y • N

#10

¥20

R30/SUNDANCE

HOLD

SNAP

SET LGC ASSUMED
OPTION TO 00001.

FLASH VERB-NCUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED VEHICLE;
V04 N06
R1-000C2
R2-000CX
R3-BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
VEHICLE.

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

WAIT FOR KEYBOARD
ENTRY

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

IS THE VEHICLE (LM
OR CSM) ASSUMPTION
CORRECT?

.Y .N

KEY IN PRO-
CEED

#30

#40

#50

#60

#70

189(329)

R30/SUNDANCE

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

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

STORE CODE
DATA

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

EXTRAPOLATE SELECTED
VEHICLE STATE VECTOR
TO PRESENT TIME
USING PRECISION
INTEGRATION.

COMPUTE APO ALT. PER
ALT AND TFF.

IS TFF COMPTABLE
(I.E. IS PER ALT
LESS THAN 300,000 FT
IN EARTH ORBIT OR
35,000 FT IN LUNAR
ORBIT)?

.Y .N

#80

#90

#100

#110

#120

R30/SUNDANCE

++
+11
+518
++

```

. SET TF      SET TFF
. PER EQUAL   EQUAL TC
. TO ZERO     -59859
. AND CCM-    AND COMP-
. PUTE TFF.   UTE TF
. -----    PER.

```

POSS

HOLD

MON

```

. FLASH VERB-NCUN TC
. REQUEST RESPONSE AND
. DISPLAY ORBIT PARA-
. METERS:
.   V16 N44
.   R1-APC ALT
.   R2-PER ALT
.   R3-TFF

```

```

. APC ALT-ALTITUDE
. OF APCGEE ABOVE
. THE LAUNCH PAD
. RADIUS (EARTH OR-
. BIT) OR ALTITUDE
. OF THE APCLUNE
. ABOVE THE LUNAR
. RADIUS AT THE MOST
. RECENTLY DEFINED
. LANDING SITE (LUN-
. AR ORBIT). IN NAU-
. TICAL MILES TO
. NEAREST .1 NM.

```

```

. PER ALT-ALTITUDE
. OF PERIGEE ABOVE
. THE LAUNCH PAD
. RADIUS (EARTH OR-
. BIT) OR ALTITUDE
. OF THE PERILUNE
. ABOVE THE LUNAR
. RADIUS AT THE MOST
. RECENTLY DEFINED
. LANDING SITE (LU-
. AR ORBIT). IN
. NAUTICAL MILES TO
. NEAREST .1 NM.

```

```

. MONITOR DSKY:
. OBSERVE VERB-NCUN
. FLASH TO REQUEST
. RESPONSE AND DIS-
. PLAYS OF APO
. ALT, PER ALT
. AND TFF

```

```

. IS AVERAGE G ROUTINE
. ON?

```

```

. N      .Y

```

```

. DO I WISH TO
. HAVE THE CAL-
. CULATION RE-
. PEATED? (SEE
. ASSUMPTION 1)

```

```

. Y      N

```

#130

#140

#150

#160

#170

191 (331)

R30/SUNDANCE

```

. TFF-TIME OF FREE
. FALL TO 300,000 FT
. FOR EARTH ORBIT
. OR 35,000 FT FOR
. LUNAR ORBIT.
. ALTITUDE DEFINED
. ABOVE THE LAUNCH
. PAD RADIUS (EARTH
. ORBIT) AND ABOVE
. THE LUNAR RADIUS
. AT THE MOST RECENT-
. TLY DEFINED LAND-
. ING SITE (LUNAR
. ORBIT).
. IN MIN, SEC TO
. NEAREST SEC. MAX
++ READING IS -59859.
+11 (IF PER ALT IS
+518 GREATER THAN
+ 300,000/35,000
+ FT THE TFF DISPLAY
+11 WILL READ -59859.)
++

```

#180

#190

```

.-----
. WAIT FOR KEYBOARD
. ENTRY

```

```

.-----
. KEY IN
. RECYCLE
. V32E
.-----

```

#200

```

. TERMINATE FLASH UPON
. RECEIPT OF PROCEED
. OR RECYCLE

```

```

.-----
. NOTE: REFER TO
. ASSUMPTIONS FOR
. DEFINITION OF
. ADDITIONAL DISPLAYS
. AVAILABLE IN THIS
. ROUTINE.
. WHEN FINISHED WITH
. THIS ROUTINE
. KEY IN PROCEED
.-----

```

#210

```

.-----
. .RECYCLE .PROCEED
. .CR AVE G
. .AUTOMATIC
. .RECYCLE
. ....

```

#220

R30/SUNDANCE

EXIT R30

EXIT R30

CHANGE CONTROL NOTES

LOGIC REV 09	PCN # MIT 47
LOGIC REV 10	REVISION NUMBER INCREMENTED IN ERROR
LOGIC REV 11	PCN #518

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RENDEZVOJS PARAMETER DISPLAY ROUTINE (R31)

LOGIC REV 08 05/23/68

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST LGC CALCULATED RENDEZVOJS PARAMETERS (RANGE, RANGE RATE, THETA)

ASSUMPTIONS: (1) RANGE AND RANGE RATE ARE CALCULATED BY THE LGC 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 IF A CORRECT DISPLAY OF THETA IS DESIRED. THE RANGE/RANGE RATE/THETA DISPLAY IS NOT INHIBITED HOWEVER IF THE ISS IS NOT ON AND ALIGNED. THE RENDEZVOJS RADAR IS NOT REQUIRED TO BE OPERATING.

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

++
+08 (3) IF NAVIGATION MARKS ARE MADE AFTER THIS ROUTINE IS SELECTED AND RUNNING, THE EFFECT OF THE MARKS ON THE STATE VECTOR WILL NOT BE EXHIBITED IN THE DISPLAY OF RANGE AND RANGE RATE. TO SEE THE EFFECT OF THE NAVIGATION MARKS ON THE RANGE AND RANGE RATE IN N 54, THE ASTRONAUT MUST TERMINATE THIS ROUTINE (PROCEED) AND RE-SELECT IT (V83E).

+
+ (4) IF R31 IS RUN FOR A LONG TIME IN COASTING FLIGHT THE RANGE AND RANGE RATE INFORMATION IN N54 WILL BEGIN TO DEGENERATE BECAUSE OF THE CONIC EXTRAPOLATIONS OF THE STATE VECTORS.
+08
++

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.CREW
.ROUTINE
.SELECTION
.
...

START RENDEZVOJS
PARAMETER DISPLAY
ROUTINE (R31)

KEY IN V83E

#10

EXTRAPOLATE LM AND
CSM STATE VECTORS TO
PRESENT TIME BY PRE-
CISION INTEGRATION
(DESCRIBED IN SECT-
ION 5.6.7.1 OF R557)
TO ESTABLISH A BASE
STATE VECTOR FOR THE
SUBSEQUENT CONIC
(KEPLER SUBROUTINE)

++
+08
+
+
+
+
+08

#20

R31/SUNDANCE

```

HOLD  ..  FLASH VERB-NJUN TO
.....  REQUEST RESPONSE AND
MON    ..  DISPLAY RENDEZVOUS
        ..  PARAMETERS :
        ..  V06 N54
        ..  R1-RANGE
        ..  R2-RANGE  RATE
        ..  R3-THETA

```

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RENDEZVOUS
PARAMETERS.
(NOTE: THESE PARA-
METERS ARE UPDATED
EVERY .5 SECOND).

#80

R31/SUNDANCE

EXIT
R31

EXIT
R31

CHANGE CONTROL NOTES

LOGIC REV 07 PCN MIT - 65
LOGIC REV 08 PCN-MIT-129

337

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

TARGET DELTA V ROUTINE (R32)

LOGIC REV 05 03/06/68

PURPOSE:

(1) TO PROVIDE A MEANS OF NOTIFYING THE LGC THAT THE CSM HAS CHANGED ITS ORBITAL PARAMETERS BY THE EXECUTION OF A THRUSTING MANEUVER.

(2) TO PROVIDE TO THE LGC THE DELTA V APPLIED TO THE CSM TO ENABLE AN UPDATING OF THE CSM STATE VECTOR.

ASSUMPTIONS:

(1) THE LM CREW HAS THE DELTA V TO BE APPLIED TO THE CSM IN LOCAL VERTICAL AXES AT A SPECIFIED TIG. THESE VALUES ARE DISPLAYED PRIOR TO TIG BY THE THRUSTING PROGRAMS (P40 AND P41 IN THE CMC). NO PROVISION IS MADE IN THESE THRUSTING PROGRAMS TO DISPLAY THE RESULTS OF THE MANEUVER IN A FORM USABLE BY THIS ROUTINE. IF THE BURN IS NOT NOMINAL AND THIS DELTA V IS NOT AS SPECIFIED OR IF TIG IS NOT AS ORIGINALLY SPECIFIED CONSULT BACKUP PROCEDURES.

++
+06
++

(2) IF THE RENDEZVOUS NAVIGATION PROGRAM (P20) OR THE LUNAR SURFACE NAVIGATION PROGRAM (P22), IS IN PROCESS THIS ROUTINE MUST BE SELECTED PRIOR TO THE CSM THRUSTING MANEUVER. THIS CAN BE ASSURED BY VOICE COMMUNICATION BETWEEN THE LM AND CSM.

++
+04
+04
++

(3) THIS ROUTINE WILL TERMINATE STATE VECTOR UPDATING BY SETTING THE NO UPDATING FLAG (SET ALSO BY MANUAL V95E AS IN P20). UPDATING WILL ONLY RESUME BY MANUAL V80E (JDATE LM STATE VECTOR) OR V81E (UPDATE CSM STATE VECTOR) AS IN P20.

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

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.CREW
.ROUTINE
.SELECTION
...

START TARGET
DELTA V
ROUTINE (R32)

KEY IN V84E

#10

++
+04
++

R32/SUNDANCE

HOLD . FLASH VERB-NOUN
 TO REQUEST RESPONSE
 SNAP . AND DISPLAY THREE
 STORED COMPONENTS OF
 DELTA V(OV).

V06N84
 R1-DELTA VX(OV)
 R2-DELTA VY(OV)
 R3-DELTA VZ(OV)

DELTA VX(OV)-
 COMPONENT OF DELTA V
 APPLIED TO THE OTHER
 VEHICLE AT TIG(OV)
 ALONG (RXV)XR. IN
 FPS TO NEAREST .1
 FPS.

DELTA VY(OV)-
 COMPONENT OF DELTA V
 APPLIED TO THE OTHER
 VEHICLE AT TIG(OV)
 ALONG VXR. IN FPS TO
 NEAREST .1 FPS.

DELTA VZ(OV)-
 COMPONENT OF DELTA V
 APPLIED TO THE OTHER
 VEHICLE AT TIG(OV)
 ALONG -R. IN FPS TO
 NEAREST .1 FPS.

WHERE R IS GEOCEN-
 TRIC (EARTH ORBIT)
 OR SELENOCENTRIC
 (LUNAR ORBIT) RADIUS
 VECTOR AND V IS THE
 CSM INERTIAL VEL-
 OCITY VECTOR AT
 TIG(OV).

WAIT FOR KEYBOARD
 ENTRY

MONITOR DSKY
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF THREE STORED
 COMPONENTS OF DELTA
 V APPLIED TO THE
 OTHER VEHICLE (OV)
 ALONG LOCAL VERTICAL
 AXES AT TIG(OV).

WAIT UNTIL THE CSM
 CREW HAS TRANSMITTED
 THE VALUES OF THE
 DELTA V TO BE AP-
 PLIED AND THE TIME
 OF IGNITION AND
 THE THRUSTING MAN-
 EUVER HAS BEEN
 SUCCESSFULLY COM-
 PLETED.

ARE THE VALUES
 DISPLAYED THE
 CORRECT ONES
 EXECUTED BY THE CSM?

.Y .N

#20

#30

#40

#50

#50

#70

 WAIT FOR KEYBOARD
 ENTRY.

 IS THE VALUE
 DISPLAYED THE
 CORRECT TIME AT
 WHICH THE CSM EXECU-
 TED THE MANFJVER

.Y .N

 KEY IN PROCEED

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA

 KEY IN V25E
 AND LOAD THE
 CORRECT TIG(JV).

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

 SET NO UPDATE FLAG
 (SEE ASSUMPTION (4)
 ABOVE).

 UPDATE CSM STATE
 VECTOR TO REFLECT
 THE DELTA V ADDED.

 ZERO RR TRACKING
 MARK COUNTER

++
 +06
 +
 +
 +
 +
 +
 +06
 ++

#130

#140

#150

#150

#170

341

•
•
•
•
•
•
EXIT R32

•
•
•
•
•
•
EXIT R32

R32/SUNDANCE

CHANGE CONTROL NOTES
LOGIC REV 06 PCN #11 - 65

#180

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193
(3+3)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LGC/CMC CLOCK SYNCHRONIZATION ROUTINE (P33)

LCGIC REV 08 01/17/69

++

+08

+EDIT

PURPOSE:

(1) TO DETERMINE THE TIME DIFFERENTIAL BETWEEN THE LGC CLOCK AND 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 LGC IS ON. THE CMC MUST ONLY BE ON UNTIL SATISFACTORY COMPARATIVE READINGS HAVE BEEN MADE BY THE CREW OR GROUND.

++

+08

+EDIT

++

(3) CORRECTION OF THE LGC CLOCK MAY BE MADE VIA V55 AFTER THE TIME DIFFERENTIAL HAS BEEN DETERMINED.

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

PRG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

DO I HAVE A PRECISE
VALUE FOR THE DIFF-
ERENCE BETWEEN THE
CMC AND LGC CLOCKS
SUPPLIED FROM THE
GROUND?

#10

.N

.Y

++

+08

+513

+EDIT

+

+

+

+

+

+

+

+

+

+

+

+

+

WAIT FOR KEYBOARD
ENTRY

KEY IN VO6N65

#20

CONFIRM SELECTION OF THIS ROUTINE (R33) IN THE OTHER VEHICLE.

#30

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 LGC CLOCK AT TIME OF ENTER

#60

DISPLAY LGC CLOCK TIME ON DSKY:
V06 N65
R1-HRS
R2-MINS
R3-SECS

MONITOR DSKY: OBSERVE DISPLAY OF LGC CLOCK AT TIME OF ENTER.

#70

195
(345)

R3 TO NEAREST .01
SEC.

RECORD THIS
TIME

OBTAIN FROM
THE CMC THE
CMC CLOCK TIME
OF SIMULTANE-
OUS ENTER INTO
THE CMC (VIA
VOICE LINK).

COMPUTE TIME
DIFFERENCE BE-
TWEEN COMPU-
TER CLOCK
TIMES.

DO I WISH TO
TAKE MORE DATA
POINTS?

.Y .N

OBTAIN AVER-
AGE OF ALL
TIME DIFFER-
ENCES

R33/SUNDANCE

#80

#90

#100

#110

#120

R33/SUNDANCE

#130

041#

DO I WISH TO MAKE
THIS CORRECTION TO
THE LGC CLOCK?

[illegible]

CHANGE CCNTRCL NOTES

REV C8 PCN - 513.2, EDITORIAL CORRECTIONS

196 (346)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RENDEZVOUS HOT-DE-PLANE DISPLAY ROUTINE (R36)

LOGIC REV 07 05/23/68

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST LGC CALCULATED RENDEZVOUS OUT-OF-PLANE PARAMETERS (Y, Y DOT, PSI)

ASSUMPTIONS: (1) THESE PARAMETERS ARE CALCULATED BY THE LGC 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.

[illegible]

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

• Y V.

 $\bullet Y \quad \bullet Y$

• Y • Y

KEY IN V25E
AND LOAD
NEW DATA

KEY IN PROCEED

• P

• • •

• 7.

.9

•

•

•

•

•

•

•

•

•

#90

349

R36/SUNDANCE

IS T(EVENT) ZERO?

.N .Y

EXTRAPOLATE LM
AND CSM STATE
VECTORS TO THE
PRESENT TIME
USING PRECISION
INTEGRATION.

EXTRAPOLATE LM
AND CSM STATE
VECTORS TO THE
TIME DEFINED BY
T(EVENT) USING
PRECISION INTE-
GRATION.

CALCULATE OUT-OF-
PLANE PARAMETERS:

Y
Y DOT
PSI

FLASH VERR NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
OUT-OF-PLANE PARA-
METERS:
V06N90
R1-Y
R2-Y DOT
R3-PSI

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

#100

#110

#120

#130

#140

R36/SUNDANCE

(NOTE: FOR DEFINITIONS REFER TO SECTION 5.6.7.3 OF R557).

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

Y-IN NAUTICAL
MILES TO NEAREST
.01 NM.

.N .Y

Y DOT-IN FPS TO
TO NEAREST .1 FPS

PSI-IN DEGREES
TO NEAREST .01
DEGREE.

WAIT FOR KEYBOARD
ENTRY:

KEY IN RECYCLE
V32F

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

KEY IN PROCEED

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

EXIT
R35

EXIT
R36

#150

#150

#170

#180

#190

351

CHANGE CONTROL NOTES

LOGIC REV 07 PCN-MIT-94.

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353

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

AGS INITIALIZATION ROUTINE (R47)

LOGIC REV 13 05/23/68

- PURPOSE: (1) TO PROVIDE THE AGS ADAPT ELECTRONICS ASSEMBLY (AEA) WITH THE LM AND CSM STATE VECTORS (POSITION, VELOCITY, TIME) IN LM IMU COORDINATES BY MEANS OF THE LGC DIGITAL DOWNLINK.
- (2) TO ZERO THE ICDU, LGC, AND AEA GIMBAL ANGLE COUNTERS SIMULTANEOUSLY IN ORDER TO ESTABLISH A COMMON ZERO REFERENCE FOR THE MEASUREMENT OF GIMBAL (EULER) ANGLES WHICH DEFINE LM ATTITUDE WITH RESPECT TO THE IMU STABLE MEMBER.
- (3) TO ESTABLISH THE GROUND ELAPSED TIME OF AEA CLOCK ZERO IF THE AEA CLOCK IS ZEROED DURING THIS ROUTINE.
- ASSUMPTIONS: (1) THE LGC DOWNLINK DATA FORMAT AND SCALING ARE DEFINED IN SECTION 2 OF R557.
- (2) THE CAPABILITY TO SELECT AN LGC PROGRAM (V37E--E OTHER THAN P00) IS INHIBITED BY THE LGC DURING THIS ROUTINE. RESTORATION OF PROGRAM SELECTION CAPABILITY REQUIRES COMPLETION OF THIS ROUTINE OR SELECTION OF P00.
- (3) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY AND IS COORDINATED WITH THE PARALLEL AEA PROGRAM BY ASTRONAUT PROCEDURE. THIS ROUTINE MAY BE CALLED AT ANY TIME THAT ANOTHER EXTENDED VERB IS NOT IN PROCESS.
- ++ (4) ZEROING OF THE ICDU, LGC, AND AEA GIMBAL ANGLE COUNTERS OCCURS ONLY WHEN THE IMU IS NOT BEING USED (P00,P3X WITH-
+13 OUT P20).
+13
++
- (5) THE DAP IS TURNED OFF DURING CDU ZERO.

PRPG
CUNT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME-----
START AGS INITIALI-
ZATION ROUTINE (R47)

KEY IN V47E

PREPARE AGS FOR
INITIALIZATION

#10

#20

R47/SUNDANCE

IS THE REFSMAT
FLAG SFT?

.Y .N

TURN ON PROGRAM
ALARM BUT DO NOT
CHANGE CURRENT
DISPLAY (PROGRAM
ALARM IF CALLED

WILL BE
V05 N09
R1-00220
R2-XXXXX
R3-XXXXX

NOTE: WHEN CALLED
THIS DISPLAY WILL
SUSPEND THE
CURRENT DISPLAY
AND TURN ON THE
KEY RELEASE LIGHT

EXIT R47

RECORD G.E.T.
OF ENTER KEY
DEPRESSION AND
STORE AS K.

DOES PROGRAM ALARM
LIGHT INDICATE THAT
THE IMU IS NOT
ALIGNED?

.Y .N

THIS ROUTINE MAY
NOT BE PERFORMED
WITHOUT AN AL-
IGNED IMU.

EXIT R47

#30

#40

#50

#60

#70

++
+13

354

355

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED

G.E.T. OF AEA CLOCK
ZERO (K):

V06 N16

R1-K-HRS

R2-K-MIN

R3-K-SEC

K- G.E.T. OF AEA
CLOCK ZERO IN HRS.,
MIN., SEC. TO NEAR-
EST .01 SEC.

WAIT FOR KEYBOARD
ENTRY

+13

++

MONITOR DSKY:

OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF G.E.T. OF AEA
CLOCK ZERO (K).

DO I WISH TO PERFORM
AEA CLOCK ZERO?

.Y.

N.

KEY IN V32

KEY IN ENTP
SIMULTANEOUSLY
ON DSKY AND DECA

DO I HAVE A MORE
PRECISE VALUE OF K
TRANSMITTED FROM
GROUND AFTER COMPAR-
ISON OF AEA AND LOC
DOWNLINK DATA FOL-
LOWING THE LAST AEA
CLOCK ZERO?

.N.

.Y.

247/SUNDANCE

#80

#90

#100

#110

#120

247/SUNDANCE

IS THE DISPLAYED
VALUE OF K THE
CORRECT G.E.T.
OF LAST AEA
CLOCK ZERO?

#130

.Y .N

REFER TO K RE-
CORDED DURING
LAST EXECUTION
OF R47

#140

REFER TO K
OBTAINED FROM
GROUND

#150

KEY IN V25E AND
LOAD NEW VALUE
OF K

#160

RECORD K

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
V32 OR NEW DATA

KEY IN PROCEED

#170

.P	.V	.NEW
.R	.3	.DATA
.O	.2	.
.C	.E	.
.E	.	.
.E	.	NEW DATA

 PLACE EACH COMPONENT
 (OR COMPONENT/4)
 OF CSM AND LM POSI-
 TION AND VELOCITY
 AND CSM AND LM STATE
 VECTOR TIMES (EACH
 REDUCED BY K) ON THE
 AGS INITIALIZATION
 DOWNLINK LIST.
 TRANSMIT THIS LIST
 TEN TIMES. FFORMAT
 FOR STATE VECTORS IS
 TWOS COMPLEMENT,
 ROUNDED OFF. (SEE
 SECTION 2 OF R557.)

#240

++
 +13
 +
 +
 +13
 ++

 IS IMU PRESENTLY
 BEING USED BY ANY
 LGC PROGRAM?

#250

.N Y.
 .
 .

 ZERO ICDU COJN-
 TERS (IN LGC)
 AND TRANSMIT CDU
 ZERO DISCRETES
 TO THE AEA AND
 THE ICDUS. HOLD
 DISCRETES FOR
 .32 SEC. (NOTE:
 DURING CDU ZERO
 THE DAP IS TURN-
 ED OFF.)

#260

++
 +13
 +
 +
 +
 +
 +
 +
 +
 +13
 ++

 WAIT APPROXIMATE-
 LY 12 SECONDS TO
 ACCUMULATE TOTAL
 GIMBAL ANGLES

#270

#280

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361

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

COARSE ALIGN ROUTINE (R50)

LOGIC REV 05 03/27/68

PURPOSE: (1) TO COARSE ALIGN THE IMU TO A DESIRED INERTIAL ORIENTATION.

ASSUMPTIONS: (1) THE DESIRED IMU INERTIAL ORIENTATION HAS BEEN SPECIFIED BY THE CALLING PROGRAM.

(2) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (P52).

PRGG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.LGC
.ROUTINE
.SELECTION
...
.

START COARSE ALIGN
ROUTINE (R50)

#10

.
.
.

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

#20

.
.
.

SELECT PRESENT IMU
INERTIAL ORIENTATION
FROM STORAGE

#30

.
.
.

CALCULATE THE
INERTIAL ORIENTATION
OF THE VEHICLE

.
.
.
.
.
.
.

R50/SUNDANCE

#50

#60

#70

#80

#90

R50/SUNDANCE

OBSERVE TERMINATION
OF NO ATT LIGHT TO
INDICATE THAT IMU IS
NOW INERTIAL.

T

L

X

F

EXIT 050

CHANGE CONTROL NOTES
LOGIC REV C6 PCN MIT - 65

СЗД 11X3

350/SUNDANCE

第100

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365

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

INFLIGHT FINE ALIGN ROUTINE (R51)

LOGIC REV 09 11/21/67
CHECKLIST REV 06 01/19/68

PURPOSE: (1) TO OBTAIN THE NECESSARY STAR, PLANET OR SUN SIGHTINGS AND THEN TO FINE ALIGN THE IMU TO A DESIRED INERTIAL ORIENTATION WHILE THE LM IS IN FLIGHT.

ASSUMPTIONS: (1) THE DESIRED IMU INERTIAL ORIENTATION HAS BEEN SPECIFIED BY THE CALLING PROGRAM.

(2) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (P52), AND THE BRAKING PHASE PROGRAM (P63).

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------

.LGC ROUTINE
.SELECTION

...

START INFLIGHT FINE
ALIGN ROUTINE (R51)

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

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM CELESTIAL BODY
ACQUISITION:
V50 N25
R1-00015
R2-BLANK
R3-BLANK

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

.....
.....

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
CELESTIAL BODY AC-
QUISITION

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

#10

#20

#30

 DO I WISH LSC ASSIS-
 TANCE IN SELECTING
 2 STARS SUITABLE FOR
 ALIGNMENT?

NOTE: IF ANY LOS
 OTHER THAN THE ADT
 CENTER DETENT IS TO
 BE USED THE STAR
 SELECTION ROUTINE
 MAY POSSIBLY BE USED
 BY THE CREW TO

#40

ASSIST IN SPATIAL
 ORIENTATION OF THE
 VEHICLE ATTITUDE.
 HOWEVER IT MUST BE
 REMEMBERED THAT THE
 ROUTINE ONLY CONSID-
 ERS STARS WITHIN THE
 ADT CENTER DETENT
 FIELD OF VIEW.

#50

ALLOWANCE MUST BE
 MADE BY THE CREW FOR
 ANY DIFFERENT DETENT
 OF THE ADT OR THE
 BACKUP OPTICAL
 SYSTEM. IF USE OF
 THIS ROUTINE IS CON-
 SIDERED IMPRACTICAL
 IT MAY BE EASILY BY-
 PASSED (SEE BELOW)).

#60

 .Y .N
 .
 .
 .

 WAIT FOR KEYBOARD
 ENTRY

 KEY IN
 ENTER
 .
 .
 .

#70

 MANEUVER VEHICLE
 UNTIL 2 SUITABLE
 STARS MAY BE AC-
 QUIRED. MONITOR
 FOAT BALL TO
 AVOID GIMBAL
 LOCK. (NOTE:
 ASTRONAUT MAY
 USE OPTICS TO
 ASSIST ATTITUDE
 CHOICE OR MAY

#80

367

251/SUNDANCE

MANEUVER AT
RANDOM).

KEY IN PROCEED

#90

TERMINATE FLASH UPON
RECEIPT OF ENTER OR
PROCEED

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

#100

DO STAP SELECTION
ROUTINE (REFER TO
SECTION 5.6.4 OF
P557).

.TWO
.STARS
.AVAIL
.NOT
.AVAIL

#110

FLASH VERR-
NOUN TO RE-
QUEST RES-
PONSE AND
DISPLAY ALARM

CODE:
V05403
51-20405
02-XXXXX
03-XXXXX

#120

MONITOR DSKY:
DOES ALARM
CODE DISPLAY IN-
DICATION THAT TWO
STARS ARE NOT
AVAILABLE IN THE
ART CENTER DE-
TENT FIELD OF
VIEW.

.Y .N

#130

251/SUNDANCE

SHALL I BY-
PASS STAR
SELECTION
ROUTINE, SE-
LECT MY OWN
CELESTIAL
BODIES, AND
MANUALLY AC-
QUIRE THEM?

.N .Y.

MANEUVER
VEHICLE
UNTIL A
SUITABLE
CELESTIAL
BODY IS
ACQUIRED

WAIT FOR KEY-
BOARD ENTRY

KEY IN
RECYCLE
V32E

TERMINATE
FLASH UPON RE-
CEIPT OF PRO-
CEED OR RE-
CYCLE

KEY IN
PROCEED

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

#140

#150

#160

#170

#180

#190

DO AUTO OPTICS (LM)
POSITIONING ROUTINE
(R52) FOR CELESTIAL
BODY #2

DO AUTO OPTICS (LM)
POSITIONING ROUTINE
(R52) FOR CELESTIAL
BODY #2

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#2

DO INFLIGHT SIGHTING
MARK ROUTINE (R53)
FOR CELESTIAL BODY
#2

DO SIGHTING DATA
DISPLAY ROUTINE
(R54)

DO SIGHTING DATA
DISPLAY ROUTINE
(R54)

.E .E
.X .X
.I .I
.T .T

.E .E
.X .X
.I .I
.T .T

"B" "A"

"A" "3"

DO GYRO TORQUING
ROUTINE (R55)

DO GYRO TORQUING
ROUTINE (R55)

FLASH VERB-NDUN TO
REQUEST PLEASE
PERFORM FINE ALIGN:
V50 N25
R1-00014
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NDUN
FLASH TO REQUEST
PLEASE PERFORM FINE
ALIGN

#250

#260

#270

#280

#290

R51/SUNDANCE

• 第300

#310

#320

#330

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER
OR PROCEED

KEY IN PROCEED

- E
- N
- T
- M
- R

• P
• R
• O
• C
• E
• E
• D

EXIT R51

EXIT P51

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AUTOMATIC OPTICS(LM) POSITIONING ROUTINE(R52)

LOGIC REV 13 02/12/68

PURPOSE: (1) TO POINT THE LOS OF ANY ADT DETENT OR THE LOS OF A BACKUP OPTICAL SYSTEM AT A SPECIFIED CELESTIAL BODY BY MANEUVERING THE LM.

ASSUMPTION: (1) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE INFLIGHT FINE ALIGN ROUTINE (R51).

R52/SUNDANCE

AOI DETENT- THE AOI
DETENT POSITION USED
FOR SIGHTING; 1
(LEFT), 2 (CENTER),
3 (RIGHT), OR 4 (ANY
OF THE THREE REAR
DETENTS); 5 IF A
BACKUP OPTICAL SYS-
TEM IS USED.

STAR CODE-THE
DESIGNATION OF THE
CELESTIAL BODY TO BE
USED. ALL DESIGNA-
TIONS IN OCTAL.

00-PLANET

01/45-STAR (FROM
STAR CODE LIST)

46-SUN

47-EARTH

50-MOON

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
PROCEED OR NEW DATA

.PROCEED .NEW
.DATA

STORE DATA

ARE THE AOI DETENT
AND STAR CODE
DISPLAYS CORRECT FOR
THE DESIRED SIGHT-
INGS?

.Y .N

KEY IN PROCEED

KEY IN V21E
AND LOAD DESIRED
STAR AND DETENT
CODES IN R1.

#40

#50

#60

#70

#80

#90

++
+13

374+

R52/SUNDANCE

IS AOT DETENT 00004
OR 00005?

• Y

IS THE PRESENT
DETENT IN USE ONE OF
THE THREE REAR
DETENTS?

Y

- IS THE BACKUP
- OPTICAL SYSTEM
- BEING USED?

Y V.

POSS
HOLD

SNAP

- FLASH VERB-NOUN
- TO REQUEST RESPON-
- NSE AND DISPLAY
- PRESENT AJT DET-
- ENT OR BACKJUP
- OPTICAL SYSTEM
- LOS DEFINITION:
- VO6N87
- R1-OPT AZ
- P2-OPT EL
- R3-BLANK

- . OPT AZ-THE
- . AZIMUTH OF THE
- . PRESENT DETENT
- . OR OPTICAL SYS-
- . TEM IN USE. THE
- . ANGLE IN THE LM
- . Y/Z PLANE MEAS-
- . URED FROM THE LM
- . +Z AXIS TO THE
- . PROJECTION OF THE
- . LOS ON THE Y/Z
- . PLANE. POLARITY
- . IS + FOR NEGATIVE
- . ROTATION ABOUT
- . THE LM +X AXIS.
- . IN DEGREES TO
- . NEAREST .01
- . DEGREE.

MONITOR DISK:
OBSERVE VERB-
NOUN FLASH TO
REQUEST RESPON-
SE AND DISPLAY
OF PRESENT AOT
DETENT OR BACK-
UP OPTICAL SYS-
TEM LOS DEFINI-
TION.

ARE THE CALI-
BRATIONS PRES-
ENTLY DISPLAYED
CORRECT?

 γ γ

#100

#110

#120

#130

#140

R52/SUNDANCE

.N Y.

• Y • N

#200

377

R52/SUNDANCE

OBTAIN STAR
VECTOR FROM
STORED EPHEM-
ERIS.

USING GET AND
TIME OF LAUNCH
COMPUTE EPHEM-
ERIS TIME OF
MARK. CONSULT
ON BOARD TA-
BLES TO DETER-
MINE PLANET
POSITION VEC-
TOR AT THE
PRESENT TIME.

CALCULATE CE-
LESTIAL BODY
VECTOR FOR
THE BODY DE-
FINED BY THE
STAR CODE.

#210

#220

#230

POSS
HOLD

SNAP

FLASH VERB-NOUN
TO REQUEST RE-
SPONSE AND
DISPLAY LGC-
ASSUMED PLANET
POSITION
VECTOR.

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

X PL - THE
X COMPONENT OF
THE LGC-ASSUMED
UNIT POSITION
VECTOR OF THE

MONITOR DSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RE-
SPONSE AND
DISPLAY OF
LGC-ASSUMED
PLANET
POSITION
VECTOR.

ARE THE
POSITION

#240

#250

R52/SUNDANCE

PLANET AT GET.
IN REFERENCE
COORDINATES. TO
THE FIFTH PLACE
(.XXXXX).

Y PL - SAME
AS X FOR Y
COMPONENT.

Z PL - SAME
AS X FOR Z
COMPONENT.

WAIT FOR KEY-
BOARD ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

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

DEFINE THE SPECIFIED
LOS WITH RESPECT TO
THE LM TO BE ALONG
THE LOS TO THE CELE-
STIAL BODY SELECTED
FOR USE BY THE ATTITUDE
MANEUVER ROUTINE
(R60). THE
TOTAL VEHICLE ATTITUDE
WILL BE COMPUTED DURING
R60(VECPPOINT).
IN ORDER TO CONSERVE

VECTOR COM-
PONENTS COR-
RECT?

.Y .N

KEY IN
PROCEED

KEY IN
V25E
AND LOAD
CORRECT
POSITION
VECTOR
COMPONENTS.

#260

#270

#280

#290

#300

+ + + + +
+ 13
+ +

EXIT R52

EXIT R52

#340

CHANGE CONTROL NOTES
LOGIC REV 13 PCN MIT - 65

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

INFLIGHT SIGHTING MARK ROUTINE (R53)

LOGIC REV 19 02/13/68

PURPOSE: (1) TO PERFORM THE REQUIRED OPTICAL SYSTEM (AOT OR BACKUP OPTICS) SIGHTING MARKS ON CELESTIAL BODIES FOR USE BY THE INFIGHT ALIGNMENT PROGRAMS TO ALIGN THE IMU.

ASSUMPTIONS: (1) THE ROUTINE IS ONLY USED DURING FLIGHT.

(2) THE ROUTINE IS AUTOMATICALLY CALLED BY THE IMJ ORIENTATION DETERMINATION PROGRAM (P51) OR THE INFLIGHT FINE ALIGN ROUTINE (R51).

(3) MULTIPLE PAIRS OF SIGHTINGS UP TO A MAXIMUM OF FIVE MAY BE USED TO DETERMINE THE AVERAGE LOS VECTOR TO THE CELESTIAL BODY.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- LGC
- ROUTINE
- SELECTION

START INFLIGHT
SIGHTING MARK
ROUTINE (R53)

#10

RESET X MARK, AND Y
MARK, FLAGS; ZERO
THE MARK PAIR
COUNTER AND CLEAR
MARK DATA STORAGE.

#20

¥30

R53/SUNDANCE

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE
AND DISPLAY AOT
DETENT AND STAR
CODE:

V01N71
R1-ABCD
R2-BLANK
R3-BLANK

R1 IS AOT DETENT
CODE AND STAR
CODE:

A, B - BLANK
C - AOT DETENT
D, E - STAR CODE

WHERE:

AOT DETENT- THE AOT
DETENT POSITION USED
FOR SIGHTING; 1
(LEFT), 2 (CENTER),
3 (RIGHT), OR 4 (ANY
OF THE THREE REAR
DETENTS); 5 IF A
BACKUP OPTICAL SYS-
TEM IS USED.

STAR CODE-THE
DESIGNATION OF THE
CELESTIAL BODY TO BE
USED. ALL DESIGN-
ATIONS IN OCTAL.

00-PLANET

01/45-STAR (FROM
STAR CODE LIST)

46-SUN

47-EARTH

50-MOON

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:

OBSERVE FLASHING
VERB-NOUN TO REQUEST
RESPONSE AND DISPLAY
OF AOT DETENT AND
STAR CODE.

ARE THE AOT DETENT
AND STAR CODE
DISPLAYS CORRECT FOR
THE PRESENT SIGHT-
INGS?

.Y

.N

KEY IN PROCEED

#40

#50

#60

#70

#80

383

R53/SUNDANCE

TERMINATE FLASH UPON
PROCEED OR NEW DATA

PROCEED NEW
DATA

STORE DATA

IS AOT DETENT 004XX
OR 005XX?

N Y

KEY IN V21E
AND LOAD DESIRED
STAR AND DETENT
CODES IN R1.

IS THE PRESENT
DETENT IN USE ONE OF
THE THREE REAR
DETENTS?

Y N

IS THE BACKUP
OPTICAL SYSTEM
BEING USED?

Y N

POSS
HOLD
.....
SNAP

FLASH VERB-NOUN
TO REQUEST RESPON-
NSE AND DISPLAY
PRESENT AOT DET-
ENT OR BACKUP
OPTICAL SYSTEM
LOS DEFINITION:
V06N87
R1-OPT AZ

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO
REQUEST RESPONSE
AND DISPLAY OF
PRESENT AOT
DETENT OR BACKUP
OPTICAL SYSTEM
LOS DEFINITION.

#90

#100

#110

#120

#130

#140

R53/SUNDANCE

R2-OPT EL
R3-BLANK

OPT AZ-THE
AZIMUTH OF THE
PRESENT DETENT
OR OPTICAL SYS-
STEM IN USE. THE
ANGLE IN THE LM
Y/Z PLANE MEAS-
URED FROM THE LM
+Z AXIS TO THE
PROJECTION OF THE
LOS ON THE Y/Z
PLANE. POLARITY
IS + FOR NEGATIVE
ROTATION ABOUT
THE LM +X AXIS.
IN DEGREES TO
NEAREST .01
DEGREE.

OPT EL-THE ELE-
VATION OF THE LOS
OF THE PRESENT
DETENT OR OPTICAL
SYSTEM IN USE.
THE ANGLE FROM
THE LOS TO LM Y/Z
PLANE. POLARITY
IS + FOR A LOS
IN THE SAME HEMI-
SPHERE AS THE LM
+X AXIS. IN DE-
GREE TO NEAREST
.01 DEGREE.

WAIT FOR KEYBOARD
ENTRY

ARE THE CALIBRA-
TIONS PRESENTLY
DISPLAYED
CORRECT?

.Y N.

#150

#150

#170

#180

KEY IN PROCEED

385

R53/SUNDANCE

#190

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

KEY IN V24F
AND LOAD THE
CORRECT CAL-
IBRATIONS

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

#200

#210

++
+16
+

HOLD . FLASH VERB-NOJN TO
REQUEST MARK X
OR MARK Y RETICLE
LINE/STAR INTER-
SECTION; V54 N71

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
MARK X OR MARK Y RE-
TICLE LINE/STAR
INTERSECTION;
V54 N71

#220

+16
++

WAIT FOR KEYBOARD
ENTRY

COMPLETE SIGHTING
MARK PROCEDURE
ADHERING TO THE
FOLLOWING PRINCI-
PLES;

#230

+19
++

TERMINATE FLASH UPON
RECEIPT OF MARK X,
MARK Y, MARK REJECT,
ENTER, PROCEED OR
TERMINATE

(1) ADJUST ADT
RETICLE TO ZERO
BEFORE PERFORMING
ANY MARKS.

(2) MARKS MUST
BE MADE IN X AND
Y PAIRS.

#240

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

(3) SEQUENCE OF

R53/SUNDANCE

E D A
J T
E E
C
T

DO
FINAL
AUTO-
MATIC
REQUEST
TERMIN-
ATE ROU-
TINE
(R00)

EXIT
R53

THROW AWAY
ANY UNPAIRED
X OR Y MARK
DATA AND DE-
CREMENT MARK
PAIR COUNTER

HAVE AT
LEAST ONE
PAIR OF X
AND Y MARKS
BEEN MADE
TO DEFINE
THE STAR
VECTOR?

.Y .N

MARKS IN EACH
PAIR(X, OR Y,X)
IS IRRELEVANT.

(4) MARK REJECTS
MAY BE MADE TO
THE DEPTH OF ONE
PAIR OR PARTIAL
PAIR.

(5) THE LGC CAN
PROCESS UP TO AND
INCLUDING 5 MARK
PAIRS FOR EACH
STAR. THE LGC
WILL AVERAGE ALL
OF THE LOSS TO
DEFINE A FINAL
LOS.

(6) AFTER EACH
PAIR THE CREW
MAY TERMINATE THE
MARKING (KEY IN
"PROCEED");
CONTINUE MARKING
ON THE SAME STAR
(IF LESS THAN 5
PAIRS ARE ALREADY
STORED IN THE
LGC) (USE APPROP-
RIATE MARK BUT-
TONS); OR THROW
AWAY ALL DATA ON
PRESENT STAR,
SELECT A NEW STAR
AND CONTINUE MAR-
KING (KEY IN
"ENTER", DEFINE
NEW STAR AND CON-
TINUE MARKING).

(7) THIS ROUTINE
AND THE PRESENT
ALIGNMENT PROGRAM
MAY BE TERMINATED
AT ANY TIME BY
KEYING IN TERMIN-
ATE (V34E).

A PROGRAM ALARM
WILL OCCUR IN THE
FOLLOWING CASES
(TO IDENTIFY

#250

#260

#270

#280

#290

387*

R53/SUNDANCE

```

-----
TJPN ON
PROGRAM
ALARM AND
STORE
CODE
(00111)
-----

```

ALARM KEY IN
V05N09E AND
OBSERVE ALARM
CODES IN R1, R2,
AND R3).

#300

(1) A MARK IS
MADE WHEN 5 PAIRS
ARE ALREADY STOR-
ED IN THE LGC
(CODE 00107)

(2) A "PROCEED"
WHEN NO COMPLETE
PAIR OF MARKS IS
STORED IN THE LGC
(CODE 00111).

#310

(3) A "MARK X",
OR "MARK REJECT"
WHEN NO MARKS ARE
BEING REQUESTED
BY THE LGC. I.E.
NO FLASHING V52,
V53 OR V54. (CODE
00112)

#320

(4) A "MARK X"
WHEN THE LGC IS
REQUESTING A
"MARK Y" OR VICE
VERSA (CODE
00114).

#330

(5) A "MARK RE-
JECT" WHEN A PAIR
OR PARTIAL PAIR
HAS ALREADY BEEN
REJECTED OR WHEN
NO UNREJECTED
MARKS ARE STORED
IN THE LGC. (CODE
00115).

#340

```

-----
IS MARK PAIR
COUNTER =
0?
-----

```

```

.Y      .N

```

```

-----
DECREMENT
MARK PAIR
COUNTER
-----

```

#350

R53/SUNDANCE

#360

#370

#380

#390

#400

GO TO
"A"
BELOW

ARE MARKS BE-
ING REQUESTED
BY LGC?
V52, 53 OR 54

.Y N.

TURN ON
PROGRAM
ALARM
AND
STORE
CODE
(00112)

ARE X MARK OR
Y MARK OR BOTH
X AND Y MARK
FLAGS SET?

.Y N.

TURN ON
PROGRAM
ALARM
AND
STORE
CODE
(00115)

[illegible][illegible]

#460

R53/SUNDANCE

```

-----
TURN ON
PROGRAM
ALARM
AND
STORE
CODE
(00112)
-----

```

```

-----
SET MARK ID REGIS-
TER TO Y MARK
-----

```

```

-----
IS MARK PAIR FLAG
SET?
-----

```

```

.N .Y

```

```

-----
IS MARK PAIR
COUNTER = 4?
-----

```

```

.N .Y

```

```

-----
TURN ON PRO-
GRAM ALARM
AND STORE
CODE (00107)
-----

```

```

-----
INCRFMENT MARK
PAIR COUNTER
-----

```

#470

#480

#490

#500

#510

[illegible][illegible]

R53/SUNDANCE

第560

#570

#580

#590

#600

#610

#620

DISP_LAY V52

SET MARK
PAIR FLAG

ARE MARKS BEING RE-
QUESTED BY LGC?
V52, 53, 54

.Y . N.

TURN ON PROGRAM
ALARM AND STORE
CODE (00112)

SET MARK ID REGISTER
TO X MARK.

IS MARK PAIR FLAG
SET?

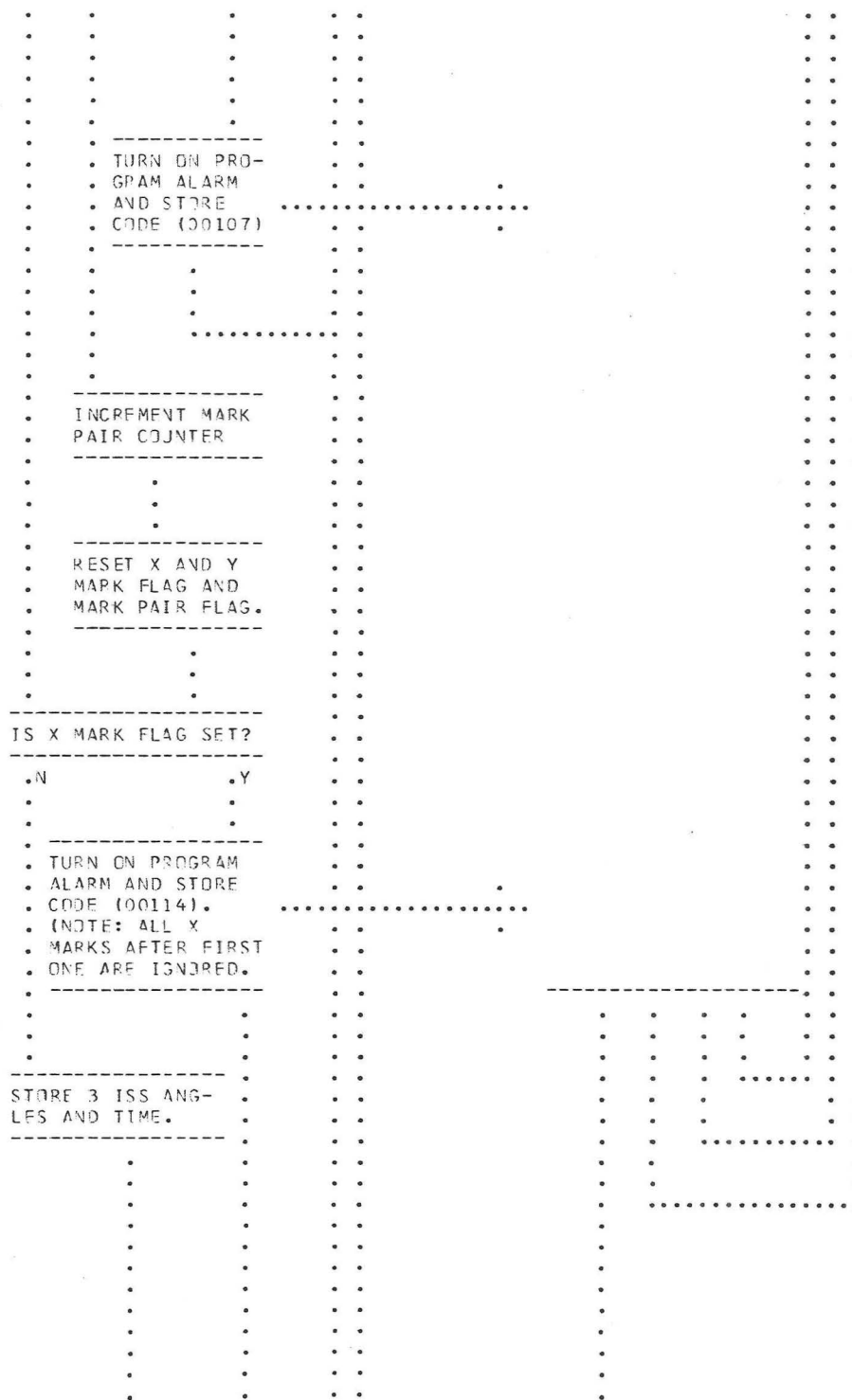
.N .Y

IS MARK PAIR
COUNTER = 4?

.N .Y

393

R53/SUNDANCE



#630

#640

#650

#650

#670

R53/SUNDANCE

```

-----
RESET MARK REJECT
FLAG.
-----

```

```

-----
SET X MARK FLAG
-----

```

```

-----
IS X AND Y MARK
FLAG SET?
-----

```

```

.Y      N.

```

```

-----
DISPLAY V53
-----

```

```

-----
SET MARK
PAIR FLAG
-----

```

```

    "A"
FROM ABOVE

```

```

-----
IS STAR CODE 00?
-----

```

```

.N      Y.

```

```

-----
IS THE TARGET A
PLANET
-----

```

```

.Y      N.

```

#680

#690

#700

#710

#720

395

R53/SUNDANCE

IS THE STAR CODE
46, 47, OR 50?

.N . Y.

OBTAIN STAR
VECTOR FROM
STORED EPHEMERIS.

CALCULATE CELE-
STIAL BODY VEC-
TOR FOR THE
BODY DEFINED BY
THE STAR CODE.

POSS
HOLD

SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
LGC-ASSUMED
PLANET POSI-
TION VECTOR;
V06 V88
R1-X PL
R2-Y PL
R3-Z PL

X PL - THE X
COMPONENT OF
THE LGC
ASSUMED UNIT
POSITION
VECTOR AT GET.
IN REFERENCE
COORDINATES
TO THE FIFTH

USING GET AND TIME
OF LAUNCH COMPJTE
EPHEMERIS TIME
OF MARK. CONSULT
ON BOARD TABLES
TO DETERMINE
PLANET POSITION
VECTOR AT THE
PRESENT TIME.

MONITOR DSKY:
OBSERVE
VERB-N0JN
FLASH TO
REQUEST RESPONSE
AND DISPLAY OF
LGC-ASSUMED
PLANET POSITION
VECTOR.

ARE THE
POSITION VECTOR
COMPONENTS
CORRECT?

.Y . N.

#730

#740

#750

#760

#770

#780

R53/SUNDANCE

```

. . . PLACE
. . . (.XXXXX).
. . .
. . . Y PL - SAME AS
. . . X PL FOR Y
. . . COMPONENT.
. . .
. . . Z PL - SAME AS
. . . X PL FOR Z
. . . COMPONENT.

```

WAIT FOR KEY-
BOARD ENTRY.

KEY IN
PROCEED

TERMINATE
FLASH JPON
RECEIPT OF
PROCEED, OR
NEW DATA.

KEY IN
V25E
AND LOAD
CORRECT
POSITION
VECTOR
COMPONENTS

```

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

```

EXIT
R53

EXIT
253

```
EXIT .
R53  EXIT
      R53
```

CHANGE CONTROL NOTES
LOGIC REV'S 16, 17, 18 PCR #7
LOGIC REV 19 PCN MIT - 65

#790

第800

#810

#820

#830

397

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

SIGHTING DATA DISPLAY ROUTINE (R54)

LOGIC REV 07 02/12/68

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

ASSUMPTIONS: (1) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU ORIENTATION DETERMINATION PROGRAM (P51) OR THE FINE ALIGN ROUTINE (R51).

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.LGC .ROUTINE .SELECTION ...					
++ +07 ++	----- STAR SIGHTING DATA DISPLAY ROUTINE (R54) -----					#10
	. . .					
	----- CALCULATE ANGLE BE- TWEEN TWO CELESTIAL BODIES USING FROM STORED EPHEMERIS DATA (ACTUAL) -----					#20
	. . .					
	----- CALCULATE ANGLE BE- TWEEN TWO CELESTIAL BODIES USING VECTORS DERIVED FROM MARK ANGLES (INDICATED) -----					#30
					

R54/SUNDANCE

 HOLD . FLASH VERB-NOUN TO . MONITOR DSKY:
 REQUEST RESPONSE AND OBSERVE VERB-NOUN
 SNAP . DISPLAY SIGHTING . FLASH AND DISPLAY OF
 ANGLE DIFF: SIGHTING ANGLE DIFF

V06 N05
 R1-SIGHTING ANGLE
 DIFF
 R2-BLANK
 R3-BLANK

SIGHTING ANGLE DIFF-
 DIFFERENCE BETWEEN
 ACTUAL AND INDICATED
 ANGLES BETWEEN CELE-
 STIAL BODY VECTOR
 #1 AND CELESTIAL
 BODY VECTOR #2. IN
 DEGREES TO NEAREST
 .01 DEGREES.

 DOES THE SIGHTING
 ANGLE DIFFERENCE
 EXCEED THE ACCEPT-
 ABLE TOLERANCE?

.N .Y

 . SHALL I PROCEED
 . WITH OUT OF
 . TOLERANCE DATA?

.Y .N

 WAIT FOR KEYBOARD
 ENTRY

 KEY IN PRO-
 CEED

#40

#50

#50

#70

#80

399

254/SUNDANCE

TERMINATE FLASH UPON RECEIPT OF PROOFED OR RECYCLE		KEY IN RECYCLE V32F	
P.	.P	.	.
P.	.E	.	.
D.	.C	.	.
C.	.Y	.	.
E.	.C	.	.
E.	.L	.	.
D.	.E	.	.
.	.	.	.
.	.	.	.
...
EXIT "A"	EXIT "B"	EXIT "A"	EXIT "B"
FROM	FROM	FROM	FROM
R54.	R54.	R54.	R54.
CONTINUE	CONTINUE	CONTINUE	CONTINUE
AS DEFINED	AS DEFINED	AS DE-	AS DEFINED
IN CALLING	IN CALLING	FINED IN	IN CALLING
PROGRAM/	PROGRAM/	CALLING	PROGRAM/
ROUTINE	ROUTINE	PROGRAM/	ROUTINE
		ROUTINE	

#90

#100

CHANGE CONTROL NOTES
LOGIC REV 07 PCN MIT - 65

#110

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

GYRC TORQUING ROUTINE (R55)

LOGIC REV 08 01/17/69

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 INFLIGHT FINE ALIGN ROUTINE (R51).

++ (2) IF THE DAP IS ON AND THE CONTROL MODE IS RATE COMMAND/ATTITUDE HOLD (V77E) WHEN THE ASTRONAUT KEYS IN "PROCEED"
+08 TO FLV06N93, THE DAP MAY FIRE RCS JETS WHEN THE STABLE MEMBER IS REORIENTED BY MEANS OF GYRO TORQUING.
+603 THESE JET FIRINGS CAN BE SUPPRESSED BY TURNING OFF THE DAP (GUIDE CONTROL SWITCH TO AGS OR THE MODE CONTROL
+08 SWITCH TO CFF), OR BY KEYING IN V76E (MINIMUM IMPULSE CONTROL MODE).

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.LGC .RCUTINE .SELECTION					
	----- START GYRO TORQUING RCUTINE (R55) ----- . . .					#10
	----- CALCULATE REQUIRED TORQUING ANGLES FOR EACH GYRO ----- . . .					#20
POSS HOLD .	FLASH VERB-NOUN TO REQUEST RES- PCNSE AND DISPLAY GYRO TORQUING ANGLES: VO6 N93 R1-X GYRO R2-Y GYRO R3-Z GYRO			----- MCNITOR DSKY: OBSERVE FLASHING VERB-NOUN AND DISPLAY OF GYRO TORQUING ANGLES ----- . . .		#30

GYRO TORQUING
 ANGLES-THE ANGLE
 THRU WHICH EACH
 GYRO MUST BE
 TORQUED TO COM-
 PLETE THE FINE
 ALIGNMENT. ALL
 ANGLES IN DEGREES
 TO NEAREST .001
 DEGREE.

WAIT FOR KEYBOARD
 ENTRY

TERMINATE FLASH
 UPON RECEIPT OF
 PROCEED OR RECYCLE

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

PULSE IRIGS
 THROUGH DESIRED
 ANGLES

EXIT
 R55

EXIT
 R55

SHALL I PERMIT
 TORQUING?
 CONSIDER MAG-
 NITUDE OF
 TORQUING ANGLES.

.N Y.

KEY IN
 RECYCLE
 (V32E)

KEY IN PROCEED

EXIT
 R55

EXIT
 R55

#40

#50

#60

#70

#80

149 (402-A)

CHANGE CONTROL NOTES

LOGIC REV 08 PCN 603.1

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201
(#03)

APCLLC COMPUTER LOGIC CHECKLIST INTERFACE

ATTITUDE MANEUVER ROUTINE (R60)

LCGIC REV 10 01/17/69

PURPOSE: (1) TO MANEUVER THE ASCENT STAGE ALONE, THE COMPLETE LM, OR THE LM/CSM 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 AXES ARE TO BE ALIGNED (THE THREE AXIS FLAG IS SET).

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

(3) THE DOCKED CONFIGURATION OF THE VEHICLE(S) HAS BEEN DEFINED TO THE LGC.

(4) THE ATTITUDE MANEUVER RATE DESIRED FOR CAP CONTROLLED MANEUVERS HAS BEEN DEFINED TO THE LGC.

(5) THE X-AXIS OVERRIDE OPTION IS INHIBITED BY THIS ROUTINE DURING A PGNC'S CONTROLLED MANEUVER.

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

(7) IF THIS ROUTINE WAS SELECTED BY THE PREFERRED TRACKING ATTITUDE ROUTINE (R61) THE THREE DISPLAYS (V50N18, V06N18 AND V50N19) IN THIS ROUTINE ARE PRIORITY DISPLAYS AND WILL REMAIN UP A MINIMUM OF 5 SECONDS. RESPONSE AFTER 5 SECONDS WILL CAUSE THE PROGRAM TO CONTINUE AS DESCRIBED.

(8) WHEN THIS ROUTINE IS SELECTED BY A PROGRAM OTHER THAN P20, ALL DISPLAYS ARE NORMAL.

PROG
CONT

LCC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.LGC
.ROUTINE
.SELECTION

.
.
.
.
.

START ATTITUDE
MANEUVER ROUTINE
(R60)

.
.
.
.
.
.

#10

R60/SUNDANCE

•

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•

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•

• N • Y

•

•

•

•

•

•

•

•

•

#50

R60/SUNDANCE

203 (#03)

R60/SUNDANCE

#70

TRANSFORM FINAL IMU
ANGLES TO FINAL FCAI
BALL ANGLES.

#80

HOLD.
.....
SNAP.

FLASH VERB-NCUN TO
REQUEST PLEASE
PERFORM AUTO
MANEUVER AND DISPLAY
FINAL FCAI BALL
ANGLES:
V50 N18
R1-ROLL
R2-PITCH
R3-YAW

MONITOR DSKY:
OBSERVE VERB-NCUN
FLASH TO REQUEST
PLEASE PERFORM AUTO
MANEUVER AND DISPLAY
OF FINAL FCAI BALL
ANGLES.

#90

ROLL, PITCH, YAW-
FINAL FCAI BALL
ANGLES. IN DEGREES
TO NEAREST .01
DEGREE.
(NOTE: IF THE FINAL
FCAI BALL ANGLES
COMPUTED RESULT IN
+ CR - 90 DEGREES
YAW, THE TRANSFORM-
ATION FROM IMU TO
FCAI IN ROLL AND
PITCH IS INCER-
MINATE, AND R1 AND
R2 WILL BE SET TO
ZERO. FOR YAW ANGLES
NEAR + CR - 90 DEG-
REES THE VALUES OF
R1 AND R2 MAY NOT BE
RELIABLE.)

++
+10
+446
+
+
+
+
+10
++

#100

#110

R60/SUNDANCE

SHALL I PROVIDE THE
PGNCS WITH THE
CAPABILITY TO
PERFORM THE MANEUVER
AUTOMATICALLY?

#120

.Y .N
.
.

SELECT
PGNCS
CONTRCL
AND
PLACE
MODE
SWITCH IN
AUTO

#130

WAIT FOR KEYBOARD
ENTRY

DO I WISH TO
TERMINATE
THIS
ROUTINE?

#140

.Y .N
.
.

KEY IN
TERMINATE
V34E

#150

EXIT

#160

205(407)

R60/SUNDANCE

 SELECT PGNC'S
 CONTROL AND
 PLACE MODE
 SWITCH TO
 ATTITUDE
 HOLD CP
 SELECT BACK-
 UP A/P.

#170

 KEY IN ENTER

#180

TERMINATE FLASH UPON
 RECEIPT OF ENTER,
 PROCEED OR TERMINATE

 KEY IN
 PROCEED

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

#190

 IS THE CURR-
 ENT PROGRAM
 PC0?

#200

.Y	.N
.	.
.	.

 RESET THE
 3 AXIS
 FLAG

#210

EXIT
 R6C

R60/SUNDANCE

#220

R60/SUNDANCE

#230

#240

#250

#260

#270

R60/SUNDANCE

IS THIS AN
R61 INITIAT-
ED MANEUVER?

.Y .N

EXIT
R60/
P20

DC FINAL
AUTOMATIC
REQUEST
TERMINATE
RCUTINE
R00

EXIT

SET MANUAL
FLAG

IS THE 3 AXIS FLAG
SET?

.Y .N

207(409)

CALCULATE FINAL
VEHICLE ATTITUDE
TO MEET THE
DESIRED ATTITUDE
SPECIFICATION
(VECPINT 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 UNSPEC-
IFIED DEGREE OF
FREEDOM.
NOTE: PGNC'S CAP-
ABILITY TO PER-
FORM MANEUVER
AUTOMATICALLY
WILL BE COMPROM-
ISED IF THE
VEHICLE
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

TRANSFORM FINAL IMU
ANGLES TO FINAL FCAI
BALL ANGLES.

R60/SUNDANCE

#280

#290

#300

#310

#320

R60/SUNDANCE

TEMP
HOLD.
.....
SNAP.

IS PGNC'S AUTO MODE
SELECTED?

.Y .N

IS MANUAL FLAG
SET?

.N .Y

DISPLAY FINAL
FDAI BALL

ANGLES:

V06N18

R1-RCLL

R2-PITCH

R3-YAW

(NOTE: FOR
DEFINITION SEE
ABOVE.)

INHIBIT X-AXIS
OVERRIDE
OPTION IN THE
DAP.

IS THE PGNC'S AUTO
MODE SELECTED AND
DID I DIRECT THE LGC
TO PERFORM THE MANE-
UVER AUTOMATICALLY?

.Y .N

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

THE X-AXIS OVER-
RIDE OPTION IS
INHIBITED IN THE
DAP UNTIL COM-
PLETION OF THE
AUTOMATIC
MANEUVER.

#330

#340

#350

#360

#370

#380

209 (411)

R60/SUNDANCE

DC MANEUVER
CALCULATION
(KALCMANU).
TURN ON PRO-
GRAM ALARM AND
STORE ALARM
CODE (00401)
IF FINAL VEH-
ICLE ATTITUDE
RESULTS IN A
MIDDLE GIMBAL
ANGLE GREATER
THAN 70 DEG-
REES WITH THE
PRESENT IMU
ORIENTATION.
(NOTE-NO LGC
CHECK IS MADE
FOR POSSIBLE
GIMBAL LOCK
DURING THE
ATTITUDE
MANEUVER
SEQUENCE WHICH
IS DEFINED BY
KALCMANU).

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

MCNITOR DSKY:
DOES PROGRAM
ALARM INDICATE
POSSIBILITY THAT
THE FINAL MIDDLE
GIMBAL ANGLE
EXCEEDS 70 DEG-
REES?

.N .Y

KEY IN VC5N09
TO VERIFY
ALARM CODE
00401?

.Y .N

CONSULT
BACKUP
PROCEDURES

GO TO
"A"
BELOW

PROGRAM ALARM
IS NOT DUE TO
IMPENDING
GIMBAL LOCK.

PRESS KEY
RELEASE AND
ALARM RESFT

#390

#400

#410

#420

#430

R60/SUNDANCE

DRIVE ICCUS
TO GIMBAL
ANGLES DE-
FINED BY
KALCMANU.
(NOTE:
KALCMANU
MONITORS
THE ATTIT-
UDE MODE
CENTRCL
SWITCH. IF
ATTITUDE
HOLD IS
SELECTED
DURING THE
EXECUTION
OF
KALCMANU,
THE PROGRAM
WILL GO TO
THE V5CN19
DISPLAY
POINT.)

ENABLE X-AXIS
OVERRIDE
OPTION IN THE
DAP

MONITOR ATTITUDE
MANEUVER BY REF-
ERENCE TO FDAI
BALL AND ERROR
NEEDLES. IS GIM-
BAL LOCK IMPEND-
ING OR DO I WISH
TO COMPLETE THE
MANEUVER MANUAL-
LY FOR ANY OTHER
REASON?

.N .Y

PLACE MODE
SWITCH TO
ATTITUDE HOLD

PERFORM/COMPLETE
THE ATTITUDE MAN-
EUVER MANUALLY
USING ACA BY RE-
REFERENCE TO THE
OUT-THE-WINDOW-
CUES AND/OR THE
FDAI BALL AND
ATTITUDE ERROR
NEEDLES. THIS
OPERATION MAY IN-
CLUDE ESTABLISH-
MENT OF A PREFER-
RED ORIENTATION
ABOUT THE LGC
DEFINED BODY-FIX-
ED VECTOR

#440

#450

#460

#470

#480

211 (413)

R60/SUNDANCE

IS THE PGNC IN AUTO
MODE AND DID I DI-
RECT THE LGC TO PER-
FORM THE MANEUVER
AUTOMATICALLY?

N Y.

#490

WAIT FOR CCM-
PLETION OF ICDU
DRIVE AND RELEASE
OF X-AXIS CVER-
RIDE OPTION
INHIBIT AS INDI-
CATED BY NEXT
DISPLAY.

#500

"A"
FROM
ABOVE

#510

HOLD.
.....
SNAP.
FLASH VERB-NOUN TO
REQUEST PLEASE
PERFORM BYPASS OF
ATTITUDE TRIM MAN-
EUVER AND DISPLAY
FINAL FCAI BALL
ANGLES:
V50 N19
R1-RCLL
R2-PITCH
R3-YAW

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH AND DISPLAY OF
FINAL FCAI BALL ANG-
LES TO REQUEST PLEA-
SE PERFORM BYPASS OF
ATTITUDE TRIM MAN-
EUVER

#520

(NOTE: FOR DEF-
INITIATION SEE
ABOVE).

#530

R60/SUNDANCE

 WAIT FOR KEYBOARD
 ENTRY

#540

 REVIEW THE PRESENTLY
 DISPLAYED FINAL FDI
 BALL ANGLES AND THE
 PRESENT ATTITUDE. AM
 I WITHIN THE PRESENT
 RCS DAP DEADBAND
 LIMITS IN EACH AXIS?

#550

.N .Y

 DO I WISH
 TO FURTHER
 ADJUST THE
 VEHICLE
 ATTITUDE
 ABOUT THE
 DESIRED
 VECTOR?

#560

.N .Y

#570

 SHALL I
 PROVIDE
 THE
 PGNC
 WITH THE
 CAPABIL-
 ITY TO
 PERFORM
 A TRIM
 MANEUVER
 AUTOMAT-
 ICALLY?

#580

.Y .N

#690

[illegible]

#700

#710

LOGIC REV 08 PCN-MIT - 65
LOGIC REV 09 PCN-MIT-145
LOGIC REV 10 PCN-446

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PREFERRED TRACKING ATTITUDE ROUTINE (R61)

LOGIC REV 07 11/01/67

- PURPOSE
- (1) TO NOTIFY THE CREW THAT AN ATTITUDE MANEUVER TO THE PREFERRED TRACKING ATTITUDE IS REQUIRED.
 - (2) TO COMPUTE THE PREFERRED TRACKING ATTITUDE OF THE LM WHICH ENABLES RR TRACKING OF THE CSM AND CSM TRACKING OF THE LM BEACON.
 - (3) TO PERFORM THE MANEUVER TO THE PREFERRED TRACKING ATTITUDE.
- ASSUMPTIONS:
- (1) THE PREFERRED TRACKING ATTITUDE IS DEFINED AS FOLLOWS:
 - (A) THE LM +Z AXIS IS ALIGNED ALONG THE LOS TO THE CSM.
 - (B) THE ROLL ATTITUDE (ABOUT LM +Z AXIS) IS UNCONSTRAINED AND IS DEFINED IN R60 AS NECESSARY TO AVOID GIMBAL LOCK.
 - (2) THE MANEUVER MAY BE PERFORMED AUTOMATICALLY BY THE PGNC'S OR PERFORMED MANUALLY WITH AN OPTIONAL FINAL AUTOMATIC PGNC'S-CONTROLLED TRIM MANEUVER.
 - (3) THE ROUTINE IS AUTOMATICALLY CALLED BY THE RENDEZVOUS NAVIGATION PROGRAM (P20) AND THE PREFERRED TRACKING ATTITUDE PROGRAM (P25).

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
	.LGC .PROGRAM .SELECTION					
	----- START PREFERRED TRACKING ATTITUDE ROUTINE (R61) ----- . . .					#10
++ +07 + + + + + + + +	----- IS TRACK FLAG SET? ----- .Y					#20

261/SUNDANCE

```

++          .
+07         .
+           .
+           .
+-----+
+ RESET R AXIS FLAG
+ FOR USE BY R60 (SEE
+ BELOW)
+-----+
+           .
+           .
+           .
+-----+
+ SET PRIORITY DIS-
+ PLAYS FLAG FOR USE
+ BY R60 (SEE BELOW)
+-----+
+07         .
++          .

```

CALCULATE LOS FROM
LM TO CSM.

DEFINE THE DESIRED
VEHICLE ATTITUDE TO
BE THE +Z L/M AXIS
ALONG THE LOS TO
THE CSM.

RESET 3 AXIS FLAG
FOR USE BY R30 (SEE
BELOW)

SET PRIORITY DIS-
PLAYS FLAG FOR USE
BY R60 (SEE BELOW)

#70

420

421

R61/SUNDANCE

++
+04
+
+
+
+
+
+
+
+
+
+
+04
++

DO ATTITUDE MANUEVER
ROUTINE (R60)

++
+07
+
+
+
+07
++

RESET PRIORITY DIS-
PLAYS FLAG (REFER
R60 ABOVE)

.....
EXIT
R61

DO ATTITUDE MANEJVER
ROUTINE (R60)

.....
EXIT
R61

#80

#90

#100

#110

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

CREW-DEFINED MANEUVER ROUTINE(R62)

LOGIC REV 07 02/12/68

PURPOSE: (1) TO PROVIDE THE CREW WITH THE ABILITY TO SPECIFY A FINAL VEHICLE ATTITUDE FOR USE BY AN LG2-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 DAP DATA LOAD ROUTINE (R03).

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

[illegible]

EXIT
R62

#40

HOLD
.....
SNAP

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

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.NEW .P
.DATA .R

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

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

.N .Y

KEY IN V25E AND
LOAD NEW GIMBAL
ANGLES

KEY IN PROCEED

#50

#60

#70

#80

```

. . . . . D
. . . . . C
. . . . . E
. . . . . E
. . . . . D
. . . . .
-----
STORE
DATA
-----
. . . . .
. . . . .
. . . . .
. . . . .
. . . . .

```

STORE
DATA

SET 3 AXIS FLAG FOR
USE BY ATTITUDE
MANEUVER ROUTINE
(R60)

DO ATTITUDE MANEUVER
ROUTINE (R60)

EXIT R62

DD ATTITUDE MANEJVER
ROUTINE (R60)

EXIT R52

#90

解130

#110

120

CHANGE CONTROL NOTES
LOGIC REV 07 PCN NO. MIT - 65

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RENDEZVOJS FINAL ATTITUDE ROUTINE (R63)

LOGIC REV 07 04/02/68

PURPOSE: (1) TO CALCULATE AND DISPLAY THE FINAL FDAI BALL ANGLES REQUIRED TO POINT THE LM +Z OR +X AXIS AT THE CSM.

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

ASSUMPTIONS: (1) TO SAVE TIME THE LM ATTITUDE CONTROL MODE SHOULD BE PRESELECTED (FOR AUTOMATIC MANEUVERS R03 SHOULD HAVE BEEN DONE AND THE AUTO MODE SELECTED).

(2) THIS ROUTINE CAN ONLY BE SELECTED DURING THE LGC IDLING PROGRAM (POO).

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

PPQG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- CREW
- ROUTINE
- SELECTION

START RENDEZVOUS
FINAL ATTITUDE
ROUTINE (R63)

KEY IN V89E

#10

IS THE LGC IDLING
PROGRAM (POO) IN
PROCESS?

• Y

.N

第20

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 (NOTE: TO EN-
ABLE SELECTION OF
THIS ROUTINE THE LGC
IDLING PROGRAM (P00)
MUST BE IN PROCESS.)

.Y N.

PRESS ALARM
RFSET

EXIT R63

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)

HOLD .. FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
SNAP .. DISPLAY OPTION CODE
FOR ASSUMED TRACKING
ATTITUDE:
++ VC4 N06
+07 R1-00003
++ R2-00001
R3-BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
TRACKING ATTITUDE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OPTION CODE FOR
ASSUMED TRACKING
ATTITUDE.

#30

#40

#50

#60

#70

```

R2 IS THE LGC
ASSUMED OPTION:
00001=PREFERRED(+Z)
00002=OTHER(+X)
-----
.
.
.
-----
WAIT FOR KEYBOARD
ENTRY
-----
IS THE OPTION IN
R2 CORRECT?
-----
.Y                               .N
.                               .
.                               .
-----
KEY IN
PROCEED
-----
.
.
.
-----
TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA
-----
.NEW      .PROCEED
.DATA
-----
STORE
DATA
-----
.
.
.
-----
EXTRAPOLATE LM AND
CSM STATE VECTORS
FORWARD TO THE
PRESENT TIME USING
CONIC EQUATIONS
-----

```

#80

#90

解 100

110

120

#130

R63 / SUNDANCE

++
+07

CALCULATE THE LINE
OF SIGHT VECTOR LOS
FROM LM TO CSM

#140

IS THE TRACKING
ATTITUDE OPTION =
00001?

NO YES

#150

SELECT SFLECT
+X AXIS +Z AXIS
(PREFERRED)

#160

CALCULATE THE SELEC-
TED AXIS TRACKING
ATTITUDE (LM +Z OR
+X) ALIGNED WITH LOS
FROM LM TO CSM).
NOTE: THIS ATTITUDE
WILL BE COMPUTED
(VECPPOINT) TO POINT
THE SELECTED AXIS
(+Z OR +X) AT THE
CSM BUT WILL NOT
CONSTRAIN THE NON-
CRITICAL (X OR Z) OR
Y AXES.

#170

COMPUTE REQUIRED
FOAI BALL ANGLES AT
THE SELECTED AXIS
(+Z OR +X) TRACKING
ATTITUDE IF THE
PRESENT IMU ORIENTA-
TION IS HFLD AND
STORE IN NOUN 18

#180

 WAIT FOR KEYBOARD
 ENTRY

 KEY IN
 RECYCLE
 V32E

#250

 KEY IN TERMINATE
 V34E

#250

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED,
 RECYCLE OR TERMINATE

 KEY IN
 PROCEED

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

EXIT
 R63

#270

EXIT
 R63

#280

 RESET 3 AXIS FLAG
 FOR USE BY THE
 ATTITUDE MANEUVER
 ROUTINE (R60).

#290

 DO ATTITUDE MANEUVER
 ROUTINE R60

 DO ATTITUDE MANEUVER
 ROUTINE R60.

433

.....
EXIT
P63

.....
EXIT
R63

R63/SUNDANCE

#300

CHANGE CONTROL NOTES:
LOGIC REV 07 PCN-MIT-30

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435

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LR SPURIOUS TEST ROUTINE (R77)

LOGIC REV 03 04/16/68

PURPOSE: (1) TO READ OUT THE RANGE AND VELOCITY DATA FROM THE LANDING RADAR (LR) AND PUT IT ON THE LGC DOWNLINK DURING LR SPURIOUS RETURN TESTS.

ASSUMPTIONS: (1) THIS ROUTINE IS ONLY USED FOR LR TESTING DURING EARTH ORBITAL MISSIONS.

(2) THE LR DATA IS PLACED ON THE DOWNLINK REGARDLESS OF THE STATUS OF THE LR RANGE DATA GOOD AND VELOCITY DATA GOOD DISCRETES.

(3) THIS ROUTINE IS MANUALLY SELECTED BY DSKY ENTRY (V78E) AND MAY BE CALLED ONLY WHEN NO OTHER EXTENDED VERB IS IN PROCESS. THE ROUTINE MUST BE TERMINATED BY MANUAL DSKY ENTRY (V79E).

++
+03
+03
++

PRPG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------

•
•
•
• CREW
• PROGRAM
• SELECTION
•
•

START LR SPURIOUS
TEST ROUTINE (R77)

•
.....
•

KEY IN V78E

#10

•
•
•

SAMPLE EACH LR
VELOCITY BEAM AND
THE RANGE BEAM
ONCE EACH SECOND
AND PUT THIS DATA
ON THE LGC DOWNLINK

#20

CHANGE CONTROL NOTES
LOGIC REV 03 PCN-MIT-74

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APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

FRESH START VERB (V36)

LOGIC REV 03 06/13/68

PURPOSE: (1). TO INITIATE A COMPUTER FRESH START

ASSUMPTION: (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 FRESH START INTERRUPTS STATE VECTOR INTEGRATION, THE STATE VECTOR MAY BE INVALIDATED.

(5) THIS PROCESS MAY BE SELECTED AT ANYTIME.

PRNG
CONT

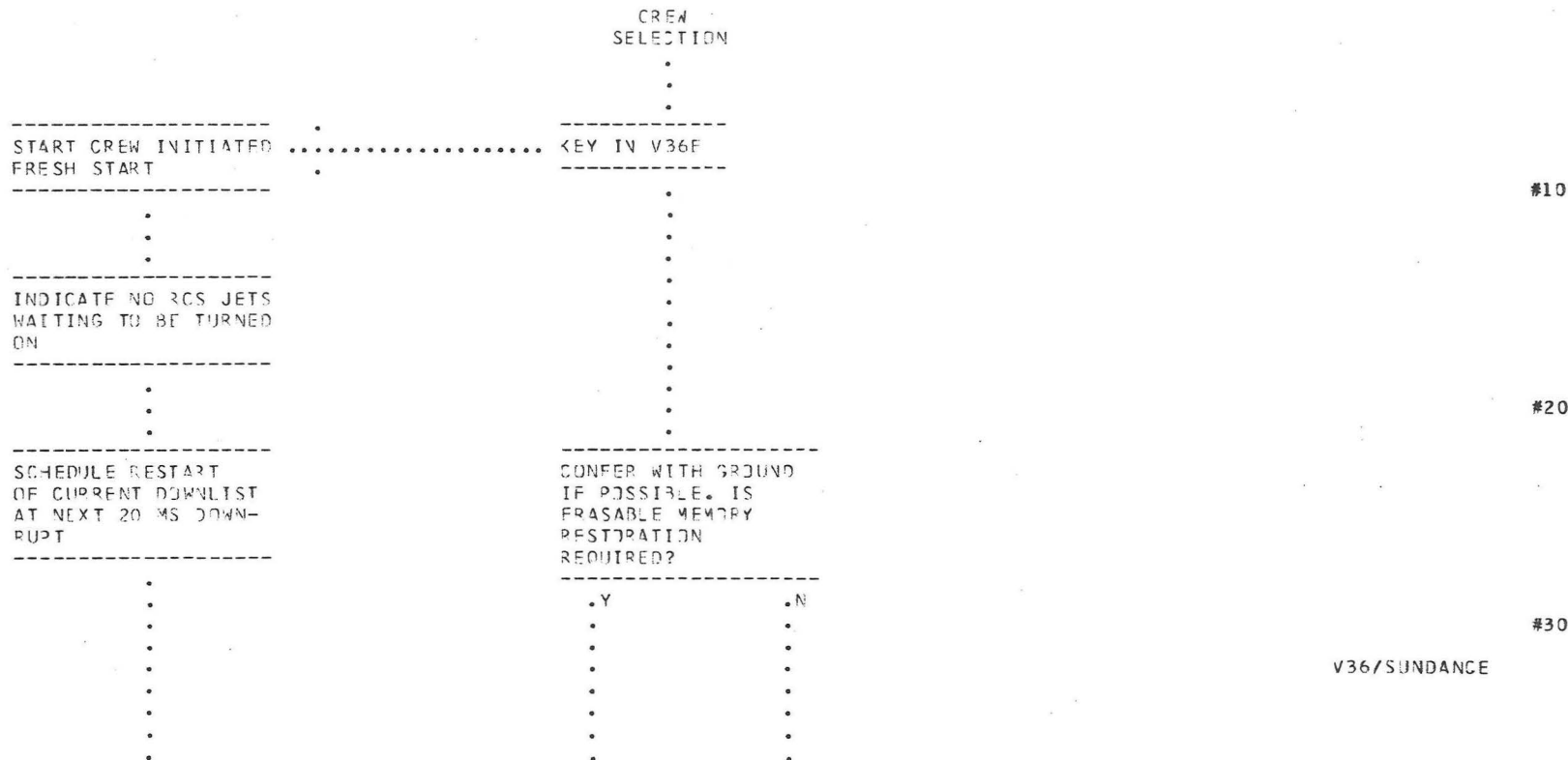
LGC

G² RUND

CREW

CHECKLIST

TIME

TOTAL
TIME

```

-----
INITIALIZE RADAR
FLAGS
-----

```

```

-----
SET TIME 3 = 37777
   TIME 4 = 37775
   TIME 5 = 37774
-----

```

```

-----
SET TRAPT FOR
DAPIOLER PROGRAM.
-----

```

```

-----
ZERO OUTBIT CHAN-
NELS: 11 (EXCEPT
ENGINE ON, OFF AND
ISS WARNING);
13 (EXCEPT TELEMETRY
BITS, RESET TRAP
BITS AND T6RJPT
BIT);
14 (EXCEPT GYRO EN-
ABLE).
-----

```

```

-----
TERMINATE WAITLISTED
TASKS
-----

```

```

-----
CLEAR ALL EXECUTIVE
REGISTER SETS
-----

```

```

-----
EXIT
-----

```

```

-----
SELECT P27 TO
RESTORE ERASABLE
MEMORY, THEN SELECT
P51 AND P52 TO RE-
ESTABLISH REFSMMAT
-----

```

```

-----
EXIT
-----

```

#40

#50

#60

#70

#80

439

V36/SUNDANCE

INDICATE NO ACTIVE
JOBS

#90

MAKE ALL VAC AREAS
AVAILABLE

SET DIDFLG FOR
T4RUPT

#100

BLANK DSKY REGISTERS
(PROGRAM, VERB,
NOUN, R1, R2, R3.)

#110

RESET EXTENDED VERB
ACTIVITY INTERLOCK

#120

INITIALIZE TMU FLAGS

#130

TURN OFF DSKY
DISCRETE LIGHTS.

V36/SUNDANCE

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

#140

++
 +03
 +
 +03
 ++

 CLEAR SELF CHECK
 ERROR REGISTERS AND
 MODE REGISTER.

#150

 INITIALIZE ATTITUDE
 ERROR DISPLAY FLAGS

 INITIALIZE DOWNLINK
 WITH POO DOWNLIST

#160

++
 +03
 ++

 RESET UPSVFLAG

#170

 ZERO OUTBIT CHANNELS
 5 (RCS PITCH AND
 YAW), 6 (RCS ROLL),
 12 (GN AND C), 13
 (RADAR AND ASC) AND
 14 (IMU)

#180

441

V36/SUNDANCE

SET ENGINE OFF
(CHANNEL 11 BIT 14)

#190

CLEAR PHASE TABLE

INITIALIZE IMU
(INHIBIT IMU FAIL)

#200

INITIALIZE DAP

#210

++
+03
+03
++

SELECT 5 DEGREE
DEADBAND

#220

INHIBIT DAP TURN ON
AND ERROR NEEDLE
DISPLAY UNTIL ICPU'S
ARE ZEROED

#230

RESET ALL FLAGWORDS
(EXCEPT IDLE FLAG-
BIT 7 FLAGWORD 7 AND
R31 FLG-BIT 4 FLAG-
WORD 9)

V36/SUNDANCE

++
+03
++

WAIT 10 SECONDS

#240

CLEAR IMU FAIL AND
ICDU FAIL INHIBIT

#250

SET DRIFT FLAG AND
INITIALIZE
COMPENSATION

#260

....
EXIT

CHANGE CONTROL NOTES

LOGIC REV 03 PCN-MIT-121

442

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

LOGIC REV 03 06/13/68

IMU CDU - ZERO EXTENDED VERB (V40N20)

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.

√40N20/SDN

++
+03
++

EXIT

EXIT

IS ISS IN COARSE
ALIGN MODE AND IN
GIMBAL LOCK?

.N .Y

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00206)

EXIT

ENTER CDU ZERO
MODE

TURN OFF NO ATT
LAMP

COMMAND DAP OFF.

SET ICPU ZERO
DISCRETE

#40

#50

#60

#70

#80

#90

#100

#110

#120

#130

445

SFT INHIBIT ICDU
FAIL DISCRETE.

CLEAR ISS COJ
READ COUNTERS

WAIT 320 MS

REMOVE ICDU ZERO
DISCRETE

WAIT 10 SEC

REMOVE INHIBIT ICDU
FAIL DISCRETE

COMMAND DAP ON.

ENTER FINE
ALIGN MODE

.....

+03
++

EXIT

CHANGE CONTROL NOTES

LOGIC REV 03 PCN-MIT-135

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PR CDD ZERO EXTENDED VERB (V40N72)

LOGIC REV 04 06/13/68

PURPOSE: (1) TO ZERO THE RP CDS'S.

(2) TO DETERMINE THE RR ANTENNA MODE.

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

(2) THIS PROCESS MAY BE SELECTED AT ANY TIME EXCEPT WHEN A DESIGNATE OR READ SEQUENCE IS IN PROGRESS.

PRDG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

CREW
PROGRAM
SELECTION

•
•
•
• • •
•

START CREW INITIATED KEY IN V4DN72E
RR CDU ZERO -----

#10

•

[illegible]

IS A DESIGNATE OR
READ SEQUENCE IN
PROGRESS?

#20

.N Y.

• •

• •

- TURN ON OPER-
- ATOR ERROR
- LIGHT

```

      .
      .
      .
    . . .
      .
EXIT

```

第30

V40N72/SDN

IS RR TURN ON FLAG
SET?

.N .Y

IS REPOSITION
FLAG SET?

.N .Y

EXIT EXIT

SET RR CDU ZERO
FLAG

SET RR CDU ZERO
DISCRETE

WAIT 20 MILLISECONDS

ZERO LGC RR CDJ
COUNTERS

REMOVE RR CDJ ZERO
DISCRETE

#40

#50

#60

#70

#80

#90

++
+04
++

WAIT 10 SECONDS

RESET RR CPU ZERO
FLAG

#100

IS TRUNNION ANGLE
LESS THAN 90
DEGREES?

.Y .N
. .
. .

#110

SET RR SET RR
ANTENNA ANTENNA
MODE TO 1 MODE TO 2

. .
. .
. .

UPDATE TRACKER FAIL
LIGHT

#120

MONITOR JSKY:
1. TRACKER FAIL
LIGHT WILL BE TURNED
ON IF:
A. THE RR MODE
IS AUTO AND
THE TRACKER'S
FAILED

#130

IS RR AUTO MODE
DISCRETE PRESENT?

.Y .N
. .
. .
. .

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00510)

#140

2. PROGRAM ALARM
LIGHT WILL BE
TURNED ON IF RR
AUTO MODE NOT
SELECTED

217
(451)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

COARSE ALIGN ISS EXTENDED VERB (V41N20)

LOGIC REV 06 01/17/69

PURPOSE:

++

+06

+EDIT

ASSUMPTIONS:

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++

- (1) TO ALIGN THE IMU TO GIMBAL ANGLES SPECIFIED BY THE ASTRONAUT.
- (2) TO COARSE ALIGN TO 0,0,0 WHEN IN GIMBAL LOCK.
- (3) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
- (4) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.
- (5) 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.
- (6) V41 MAY ONLY BE USED WITH N20 OR N72. REFER TO RR COARSE ALIGN EXTENDED VERB (V41N72).
- (7) V4CN20 MAY BE ENTERED TO TERMINATE THE COARSE ALIGN MODE.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

START CREW INITIATED
ISS COARSE ALIGN

KEY IN V41N20E

IS A MODE SWITCH OR
GYRC TORQUING IN
PROGRESS?

N Y

TURN ON CPER-
ATOR ERROR
LIGHT

OBSERVE OPERATOR
ERROR LIGHT FOR IN-
DICTION OF IMPROPER
PROCEDURE

#10

#20

V41N20/SDN

[illegible]

219(453)

V41N20/SDN

WAIT FOR KEYBOARD
ENTRY

#80

LOAD DESIRED
ANGLES

++
+06
+EDIT
+
+
+
+
+
+
+
+
+
+
+
+
+
+06
++

DO I WISH TO
TERMINATE?

#90

N. Y

KEY IN
TERMINATE
(V34E)

#100

EXIT

TERMINATE FLASH UPON
RECEIPT OF DATA,
PROCEED OR TERMINATE

KEY IN
PROCEED

#110

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

STORE
DATA

E

EXIT
V41

#120

#130

V41N20/SDN

.....
 DISPLAY COARSE ALIGN
 VERB
 V41

.....
 MONITOR DSKY:
 OBSERVE DISPLAY OF
 COARSE ALIGN VERB

.....
 IS ISS IN COARSE
 ALIGN MCDE?

.....
 .N .Y

.....
 ZERO ISS ERROR
 CCOUNTERS

.....
 ENTER COARSE
 ALIGN MCDE

.....
 TURN ON NO ATT
 LIGHT

.....
 DISABLE DAP AUTO
 AND FCLC MCDES

.....
 INHIBIT IMU FAIL

.....
 RESET TRACK FLAG,
 DRIFT FLAG AND
 REFSMMAT FLAG

#140

#150

#160

#170

#180

221(455)

COARSE ALIGN IMU TO
STORED ANGLES (15
SECS MAX)

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)

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

V41N20/SDN

#190

#200

#210

#220

#230

V41N20/SDN

RESET EXTENDED
VERB ACTIVITY
INTERLOCK

RESELECT COARSE
ALIGN

EXIT

CHANGE CONTROL NOTES

LOGIC REV 05 PCN-MIT-135
LOGIC REV 06 EDITORIAL CORRECTIONS

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RENDEZVOUS RADAR COAPSE ALIGN EXTENDED VERB
(V41N72)

LOGIC REV 05 01/17/69

PURPOSE: (1) TO DRIVE THE PENDZVCUS RADAR SHAFT AND TRUNNION TO 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.

(3) THE PROCESS MAY NOT BE SELECTED IF P20 OR P22 IS RUNNING.

(4) THE CONTINUOUS DESIGNATE MODE MUST BE TERMINATED BY DSKY ENTRY (V44F).

(5) THE CONTINUOUS DESIGNATE MCDE INHIBITS RR GIMBAL MONITOR ROUTINE (R25).

(6) THE RR SHAFT AND TRUNNION LIMITS ARE:

(A) MCDE 1: SHAFT -70 DEG TO +59 DEG, TPLANNICN -55 DEG TO +55 DEG.

(B) MCDE 2: SHAFT -25 DEG TO -139 DEG, TRUNNION -125 DEG TO -235 DEG.

(C) MODE 1, CONTINUOUS DESIGNATE ONLY: SHAFT -85 DEG. TO +59 DEG., TRUNNION -55 DEG. TO +55 DEG.

PROG
CONT

LGC

GRUND

CREW

CHECKLIST

TIME

TOTAL
TIME

- CREW
- PROGRAM
- SELECTION

START CREW INITIATED
RF COARSE ALIGN

KEY IN V41N72F

IS A DESIGNATE OR
READ SEQUENCE IN
PROGRESS?

●

BY

V41N72/SDN

#10

#20

++
+05
+EDIT

++
+05
+EDIT
++

++
+05
+EDIT
++

++
+05
+EDIT
++

TURN ON OPER-
ATOR ERROR
LIGHT

EXIT

IS ANOTHER EXTENDED
VERB ACTIVE?

N Y

IS RENDEZVOUS
FLAG SET? (SEE
P20/P22)

N Y

TURN ON OPER-
ATOR ERROR
LIGHT

EXIT

SET EXTENDED VERB
ACTIVITY INTERLOCK

CLEAR CONTINUOUS
DESIGNATE AND
DESIGNATE IN
PROGRESS FLACS.

OBSERVE OPERATOR
ERROR LIGHT FOR IN-
DICATION OF IMPROPER
PROCEDURE

#30

#40

#50

#60

#70

$$225^{-(459)}$$

V41N72/SDN

++
+05
+EDIT

```

+-----+
+      FLASH VERR-NCUN TC
+ HOLD . REQUEST LCAD OF NEW
+ ..... RR SHAFT AND TRUNN-
+ SNAP . ICN ANGLES
+      V21N73
+      R1-TRUNNION
+      R2-SHAFT
+      R3-BLANK
+-----+

```

```

+      TRUNNION-360 MINUS
+      RR TRUNNION CDU VAL
+      UE. IN DEGREES TO
+      NEAREST .01 DEGREE.
+      (PLUS IS DEFINED AS
+      A NEGATIVE ROTATION
+      ABOUT LM +X AXIS) IN
+      MODE I.

```

+ SHAFT-RR SHAFT
+ ANGLE. IN DEGREES TO
+ NEAREST .01 DEGREE.

```

+      WAIT FOR KEYBOARD
+      ENTRY

```

```

+      TERMINATE FLASH UPCN
+      RECEIPT OF TERMINATE
+      OR DATA

```

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

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF NEW RR SHAFT
AND TRUNNION ANGLES

DO I WISH TO LOAD
NEW SHAFT AND
TRUNNION ANGLES?

Age Group	Y Group	N Group
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10

LOAD DESIRED
ANGLES

KEY IN
TERMINATE
(V34F)

EXIT

#80

#90

#100

#110

第120

130

V41N72/SDN

KEY IN
PROCEED

V41N72/SDN

¥250

★260

MONITOR DSKY:
OBSERVE DISPLAY OF
COARSE ALIGN VERR

#270

#280

229 (463)

V41N72/SDN

+++
+05
+EDIT

- TURN ON PRC-
- GRAM ALARM AND
- STORE ALARM
- CODE (00502)

EXIT

SET REMODE FLAG

SET DESIGNATE FLAG

MONITOR DSKY:
PROGRAM ALARM LIGHT
WILL BE LIT IF THE
DESIRED LOS IS NOT
WITHIN THE LIMITS OF
EITHER RR MODE.
DO I WISH TO OBSERVE
THE PROGRAM ALARM
CODE?

• Y • N
• •
• •
• •

CALL PROGRAM
ALARM CODE DIS-
PLAY (V05N09) TO
IDENTIFY FAILURE.
ALARM 00502 INDI-
CATES A BAD RADAR
GIMBAL ANGLE IN-
PUT. WHEN FINISH-
ED, PUSH KEY RE-
LEASE TO RECALL
PREVIOUS DISPLAY.

PRESS ALARM RESET
TO RESET PROGRAM
ALARM

EXIT

#290

#300

#310

#320

#330

V41N72/SDN

V41N72/SDN

• Y • N

#450

 COMPLTE RR SHAFT AND
 TRUNNION DRIVE CCM-
 MANDS

 IS CCNTINUOUS DESIG-
 NATE FLAG SET?

.Y .N

 IS DESIGNATE FLAG
 SET

.Y .N

 IS RRCDU
 FAIL DISCRETE
 PRESENT?

.Y .N

EXIT

 TURN ON PRO-
 GRAM ALARM
 AND STORE
 ALARM CODE
 (00503)

EXIT

 MONITOR DSKY:
 PROGRAM ALARM LIGHT
 WILL BE LIT IF THERE
 HAS BEEN A RACAR
 ANTENNA DESIGNATE
 FAIL. DO I WISH TO
 OBSERVE THE PROGRAM
 ALARM CODE?

.Y .N

#470

#480

#490

V41N72/SDN

#500

#510

#520

#530

#540

V41N72/SDN

#550

TURN ON PRO-
GRAM ALARM AND
STORE ALARM
CODE (00503)

MONITOR DSKY:
PROGRAM ALARM LIGHT
WILL BE LIT IF THERE
HAS BEEN A RADAR
ANTENNA DESIGNATE
FAIL. DO I WISH TO
OBSERVE THE PROGRAM
ALARM CODE?

EXIT

.Y .N

#560

DECREMENT DESIG-
NATE CCOUNTER

CALL PROGRAM
ALARM CODE DIS-
PLAY (V05N09) TO
IDENTIFY FAILURE
(ALARM CODE
00503). WHEN FIN-
ISHED, PUSH KEY
RELEASE TO RECALL
THE PREVIOUS
DISPLAY.

#570

IS RR WITHIN .5
DEG. OF LOS DEF-
INED BY DESIRED
SHAFT AND TRUN-
NION ANGLES?

PRESS ALARM RESET
TO RESET PROGRAM
ALARM.

#580

.N .Y

EXIT EXIT

#590

#600

V4 1N72/SDN

#610

#620

#630

#640

#650

V41N72/SDN

CHANGE CONTRCL NOTES

LOGIC REV 04 PCR 96 + PCR 95 + PCN-MIT-131 + PCN-MIT-132
LOGIC REV 05 EDITORIAL CORRECTIONS

469.

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

TORQUE GYROS EXTENDED VERB (V42)

LOGIC REV 05 06/13/68

PURPOSE: (1) TO FINE ALIGN THE STABLE MEMBER BY TORQUING THE GYROS.

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

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

PPDG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------

DO I DESIRE TO LOAD
A DELTA GYRO ANGLE
GREATER THAN +99.999
DEGREES? -

.Y	.N
.	.
.	.

#10

THE ASTRONAUT
MUST LOAD THE
THREE DOUBLE PRE-
CISION LGC
REGISTERS:
KEY V21N02E
02500E
XXXXXE
N15E
XXXXXE
YYYYYE
YYYYYE
ZZZZZE
ZZZZE

#20

BIT 14 OF THE
HIGH ORDER RE-
PRESENTS 190
DEGREES; BIT
13, 90 DEGREES;
ETC.
THE MAXIMUM NE-
GATIVE GYRO
TORQUING ANGLE
IS 37777,
37743; THE MAX-
IMUM POSITIVE

#30

V42/SUNDANCE

GYRO TORQUING
 ANGLE IS 40000,
 40034. ANY
 ANGLE OF GREAT-
 ER MAGNITUDE
 THAN THE GIVEN
 MAXIMUM WILL
 RESULT IN A
 COMMANDED TOR-
 QUING ANGLE OF
 ZERO.

(NOTE: THE
 LOADING OF TOR-
 QUING ANGLES
 GREATER THAN 90
 DEGREES SHOULD
 NOT BE PERFORM-
 ED DURING
 FLIGHT. THIS
 PROCEDURE IS
 INTENDED FOR
 USE ON THE
 GROUND.)

#40

#50

#50

START CREW INITIATED
 FINE ALIGN

KEY V42E

#70

IS A MODE SWITCH OR
 GYRO TORQUING IN
 PROGRESS?

.N Y.

TURN ON OPER-
 ERROR LIGHT

#80

#90

$$\begin{array}{c} + \\ + \\ + \\ + \\ + \\ + \\ + 0.5 \\ ++ \end{array}$$

EXIT

IS ANOTHER EXTENDED
VERB ACTIVE?

```

.N          .Y
.           .
.           .
.           .
.  -----
.  TURN ON
.  OPR ERR LIGHT

```

SET EXTENDED
VERB ACTIVITY
INTERLOCK

EXIT

HOLD .
.....
SNAP .

FLASH VERB-NDUN TO
REQUEST LOAD OF
DELTA GYRO ANGLES
V21N93
R1-XGYRO
R2-YGYRO
R3-ZGYRO

DELTA GYRO ANGLES -
THE ANGLES THROUGH
WHICH EACH GYRO MUST
BE TORQUED TO COM-
PLETE THE FINE
ALIGNMENT. ALL ANG-
LES IN DEGREES TO
NEAREST .001 DEGREES

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

DID I LOAD THE D3C
REGISTERS BEFORE
KEYING V42F?

.Y .N

V42/SUNDANCE

130

110

第120

130

#140

V42 / SUNDANCE

#190

472

473

•
•
•
•
•

TURN OFF NO ATT
LAMP

•
•
•

LEAVE IMU FAIL INHI-
BIT ON FOR 5 SEC

•
•
•

PULSE IRIGS THROUGH
DESIRED ANGLES

•
•
•

RESET EXTENDED VERB
ACTIVITY INTERLOCK

•
•
•
•••
•
EXIT

V42/SUNDANCE

#200

#210

#220

CHANGE CONTROL NOTES

LOGIC REV 05 PCN-MIT-135

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475

LOGIC REV 03 05/28/68

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

(2) THE PROCESS MAY NOT BE SELECTED IF THE IMU IS IN THE COARSE ALIGN OR ZERO ICPU MODE.

```

++      (3) THE MAXIMUM ANGLE WHICH MAY BE LOADED IS +/-16.88 DEGREES. ANY VALUE GREATER THAN THIS MAXIMUM WILL BE
+03     INTERPRETED AS =16.88 DEGREES. THE MAXIMUM ERROR WHICH MAY BE DISPLAYED IS 5 DEGREES.

```

(4) THIS PROCESS MAY BE SELECTED ONLY IN P00.

PRDG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
--------------	-----	--------	------	-----------	------	---------------

CREW
PROGRAM
SELECTION

START CREW INITIATED
LOAD OF IMU ATTITUDE
ERROR METERS

KEY IN V43F

解10

IS MODE CONTROL IN
OFF POSITION?

Y. N.

TURN ON THE
OPERATOR ERROR
LIGHT

#20

#30

V43/SUNDANCE

+03
++

EXIT

IS THE COARSE ALIGN
ENABLE BIT SET?

.N .Y

IS PROGRAM 03
OPERATING?

.Y .N

IS ANOTHER
EXTENDED
VERB ACTIVE?

.N .Y

TURN ON
OPR ERR
LAMP

EXIT

SET EXTENDED VERB
ACTIVITY INTERLOCK

CLEAR ERROR COUNTED
ENABLE

V43/SUNDANCE

#40

#50

#50

#70

#80

V43/SUNDANCE

477

V43/SUNDANCE

HOLD . FLASH VERB-NOUN TO
 REQUEST LOAD OF
 SNAP . ERROR ANGLES
 V21 N22
 R1 - CG
 R2 - IG
 R3 - MG

ALL ANGLES IN
 DEGREES TO NEAREST
 .01 DEG

WAIT FOR KEYBOARD
 ENTRY

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

DO I WANT TO LOAD
 ERROR ANGLES?

.Y .N

LOAD DESIRED
 ANGLES

TERMINATE FLASH UPON
 RECEIPT OF DATA OR
 TERMINATE (V34E)

KEY IN
 V34F

.DATA .V34E

RESET EXTENDED
 VERB ACTIVITY
 INTERLOCK

EXIT

EXIT

#90

#100

#110

#120

#130

V43/SUNDANCE

479

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

W MATRIX RMS ERROR DISPLAY
(V45)

LOGIC REV 00 06/13/68

PURPOSE: (1) TO PROVIDE A MEANS OF DISPLAYING W MATRIX INFORMATION AND REINITIALIZING THE W MATRIX IF DESIRED.

ASSUMPTIONS: (1) NO OTHER EXTENDED VERBS ARE ACTIVE.

(2) THIS PROCESS IS CREW SELECTED BY DSKY ENTRY.

(3) IF NEW VALUES OF RMS POSITION AND VELOCITY ERRORS ARE LOADED IN THIS ROUTINE, W MATRIX INITIALIZATION OCCURS THE NEXT TIME A MEASUREMENT IS MADE.

PRDG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW .EXTENDED .VERR .SELECTION			
----- START EXTENDED VERB 45 ROUTINE -----	----- KEY IN V45E -----				#10
.....				
----- IS EXTENDED VERR ACTIVITY FLAG SET? -----		----- MONITOR DSKY: DOES OPERATOR ERR- OR LIGHT COME ON INDICATING ANOTHER EXTENDED VERR IS IN PROCESS? -----				#20
.N .Y...		.N .Y . . .				
----- . TURN ON OPERATOR ERROR LIGHT -----		----- . COMPLETE OR TERMINATE THE ACTIVE EXTENDED VERR ROUTINE, RESET OPERATOR ERROR LIGHT, -----				#30
..... EXIT					
.....				

V45/SUNDANCE

SET EXTENDED VERB
ACTIVITY INTERLOCK

RESET V45 FLAG

CALCULATE RMS POSI-
TION AND VELOCITY
ERRORS.

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY:
V06 N99
R1 POS ERR
R2 VEL ERR
R3 BLANK

R1 - POS ERR - RMS
VALUE OF POSITION
ERROR IN NM TO NEAR-
EST .01 NM.

R2 - VEL ERR - RMS
VALUE OF VELOCITY
ERROR IN F.P.S. TO
NEAREST .1 F.P.S.

THEN RESELECT
THIS ROUTINE
BY KEYING IN
V45F

EXIT

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF W MATRIX RMS
VALUES OF POSITION
AND VELOCITY ERRORS.

AM I SATISFIED WITH
THESE VALUES?

.Y .N

DO I WISH TO
LOAD NEW VALUES
AND REINITIALIZE
THE W-MATRIX?

.N .Y

#40

#50

#60

#70

#80

481

V45/SUNDANCE

WAIT FOR KEYBOARD
ENTRY.

KEY IN
PROCEED

#90

EXIT

KEY IN
TERMINATE
V34E

#100

EXIT

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
TERMINATE OR NEW
DATA

KEY IN V24E AND
LOAD NEW DATA

#110

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

GO TO
"A"
BELOW

SET V45 FLAG

#120

IS THE V45 FLAG SET?

N. Y.
.
.
.
.
.
.
.

#130

#140

V45/SUNDANCE

GO TO
"A"
RFLOW

COMPUTE NEW W MATRIX
INITIALIZATION VALUES
BASED ON THE NEW RMS
POSITION AND VELO-
CITY ERRORS.

RESET RENDWFLAG.

"A"
FROM
ABOVE

RESET EXTENDED VERB
ACTIVITY FLAG

EXIT

#150

#160

#170

#180

CHANGE CONTROL NOTES

LOGIC REV 00 PCN-MIT-103

482

483

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

INCREMENT LGC TIME EXTENDED VERB (V55)

LOGIC REV 04 06/13/68

- PURPOSE: (1) TO CHANGE THE LGC CLOCK TIME USING INCREMENTS (OR DECREMENTS) LOADED BY THE ASTRONAUT.
- ASSUMPTIONS: (1) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.
- (2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PRDG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			.CREW .PROGRAM .SELECTION ...			
	START CREW INITIATED CHANGE OF LGC CLOCK		KEY IN V55E			#10
++	.		.			
+04	.		.			
+	IS ANOTHER EXTENDED VERB ACTIVE?		.			
+04	.		.			
++	.N .Y		.			
	.		.			
	.		.			
	TURN ON OPR ERR LAMP		.			#20
	.		.			
	.		.			
	.		.			
	.		.			
	.		.			
	.		.			
	EXIT		.			
	.		.			
	SET EXTENDED VERB ACTIVITY INTERLOCK		.			#30
	.		.			
	.		.			
	.		.			
	.		.			
	.		.			
	.		.			
	.		.			

V55/SUNDANCE

HOLD . FLASH VERB-NOUN TO
 REQUEST LOAD OF
 SNAP . DELTA TIME
 V21 N24
 R1-HOURS
 R2-MINUTES
 R3-SECONDS

TIME TO NEAREST .01
 SECONDS

WAIT FOR KEYBOARD
 ENTRY

TERMINATE FLASH UPON
 RECEIPT OF DATA V34E
 OR PROCEED

.PRJ .D
 .OR .A
 .V34E .T
 . .A
 .
 .
 .

RESET EXTENDED
 VERB ACTIVITY
 INTERLOCK

EXIT

MONITOR DSKY:
 OBSERVE FLASH OF
 VERB-NOUN REQUESTING
 LOAD OF DELTA CLOCK
 TIME

DO I DESIRE TO LOAD
 DELTA CLOCK TIME?

.Y .N

LOAD DESIRED
 TIME INCREMENTS

KEY IN
 PRD OR
 V34E

EXIT

EXIT

#40

#50

#60

#70

#80

485

V55/SUNDANCE

ADD LOADED DELTA
TIME TO LOG CLOCK
TIME

#90

RESET EXTENDED VERB
ACTIVITY INTERLOCK

#100

.....
EXIT

CHANGE CONTROL NOTES

LOGIC REV 04 PCN-MIT-123

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237
(487)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

COMMAND LR TO POSITION 2 EXTENDED VERR (V61)

LOGIC REV 04 01/17/69

PURPOSE (1) TO DRIVE THE LANDING RADAR TO POSITION 2 (FINAL APPROACH).

ASSUMPTIONS: (1) THE PROCESS MAY BE SELECTED ANY TIME ANOTHER PROGRAM IS NOT USING EITHER LR OR RR.

(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

CREW
PROGRAM
SELECTION

•
•
•
•
•
•

START CREW INITIATED
COMMAND LR TO POS-
TICN 2

•
•

KEY IN V61E

#10

•
•
•

IS ANOTHER PROGRAM
USING EITHER RADAR?

•N

•Y

•
•

•
•

TURN ON
CPR ERR
LAMP

•

•

•

•

•

•

•

•

•

•

•

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•

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•

•

•

•

•

•

•

•

•

•

EXIT

#20

#30

V61/SUNDANCE

#40

#50

#60

#70

#80

238 (488)

239
(489)

V61/SUNDANCE

++
+04
+EDIT
++

WAIT 1
SECCND
FCR LR
TC SET-
TLE

DECRE-
MENT
SCAN
CCUN-
TER

#90

++
+04
+EDIT
+04
++

REMOVE
CCM-
MAND
CF LR
TC PC-
SITION
2

WAIT 1
SECCND

#100

#110

TURN ON
PROGRAM
ALARM
AND
STORE
ALARM
CODE
(00523)

#120

EXIT

EXIT

CHANGE CONTRCL NOTES

LOGIC REV 03 PCN-MIT-130
LOGIC REV 04 PCN 601, EDITORIAL CORRECTIONS

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491

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RESTART EXTENDED VERB (V69)

LOGIC RFV 03 06/13/68

PURPOSE: (1) TO CAUSE A COMPUTER RESTART.

ASSUMPTIONS: (1) THE RESTART IS CREW INITIATED BY DSKY ENTRY.

(2) V69E DOES NOT DIRECTLY SELECT RESTART PROCESSING. IT CAUSES A SITUATION WHICH SATISFIES ONE OF THE CONDITIONS FOR AN AUTOMATIC RESTART, I.E. TOO MANY CONSECUTIVE TC INSTRUCTIONS.

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW PROG SELECTION			
			.			
			.			
			.			
					
			.			
----- START CREW INITIATED COMPUTER RESTART -----			..... KEY IN V69E -----			#10
.			
----- BRANCH (TC) TO SELF -----			MONITOR DSKY: DOES PROGRAM ALARM LIGHT COME ON INDICATING RESTART DIFFICULTIES? -----			#20
			.Y .N			
			.			
			.			
NOTE: THE LOGIC FROM THIS POINT IS NOT UNIQUELY ASSOCIATED WITH V69. IT IS THE PROCESSING WHICH TAKES PLACE WITH ANY HARDWARE INITIATED RESTART. THE CONDI-			----- KEY VOENVO9E TO DISPLAY A LARM CODE: O1107-BAD PHASE TABLE -----			#30
			.			
			.			
			.			
			.			
			.			
			.			
			.			
			.			

V69/SUNDANCE

SCHEDULE RESTART OF
CURRENT DOWNLIST AT
NEXT 20MS DOWNRUPT

```
SELECT P27 TO
RESTORE ERASABLE
MEMORY, THEN SELECT
P51 AND P52 TO
REESTABLISH REFSMMAT
```

EXIT

#90

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

492

493

•
•
•
•
•

INITIALIZE RADAR
FLAGS

•
•
•

SET TIME 3 = 37777
TIME 4 = 37775
TIME 5 = 37774

•
•
•

SCHEDULE T5RJPT FOR
DAP IDLER PROGRAM

•
•
•

ZERO OUTBIT CHANNELS
11 (EXCEPT ENGINE
ON, OFF AND ISS
WARNING); 13 (EXCEPT
TELEMETRY BITS, RESET
TRAP BITS AND T6RUPT
BIT); AND 14 (EXCEPT
GYRO ENABLE)

•
•
•

TERMINATE
WAITLISTED TASKS

•
•
•

CLEAR ALL EXECUTIVE
REGISTER SETS

•
•
•

INDICATE NO ACTIVE
JOBS

•
•
•
•
•
•
•

V69/SUNDANCE

#100

#110

#120

#130

#140

V69/SUNDANCE

MAKE ALL VAC AREAS
AVAILABLE

#150

SET DIDFLG FOR
T4RUPT

#160

BLANK DSKY REGISTERS
(PROGRAM, VERB,
NOUN, R1, R2, R3)

#170

RESET EXTENDED VERB
ACTIVITY INTERLOCK

RESET DISPLAY/ASTRO-
NAUT INTERFACE FLAGS

#180

INITIALIZE IMU
FLAGS

#190

WAS AN ERASABLE
MEMORY CHECK IN
PROCESS WHEN THE
RESTART OCCURRED?

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

495

V69/SUNDANCE

HAS THERE BEEN
AN OSCILLATOR
FAIL?

#200

.Y .N

IS THE AGC
WARNING ON?

#210

.Y .N

HAVE BOTH THE
MARK REJECT
AND ERROR
RESET BUTTONS
BEEN PRESSED?

#220

.Y .N

CLEAR SELF CHECK
ERROR REGISTERS
AND MODE REGISTER

#230

INITIALIZE DOWN-
LINK WITH POD
DOWNLIST

#240

RESET UPSVFLAG

V69/SUNDANCE

++
+03
++

 ZERO OUTBIT
 CHANNELS 5 (RCS
 PITCH AND YAW), 6
 (RCS ROLL), 12
 (GN AND C), 13
 (RADAR), AND 14
 (IMU)

#250

 SET ENGINE OFF
 (CHANNEL 11
 BIT 4)

#260

 CLEAR PHASE TABLE

#270

 INITIALIZE IMU
 FLAGS (INHIBIT
 IMU FAIL)

#280

 WAIT 10 SECONDS

 CLEAR IMU FAIL
 INHIBIT

#290

 INITIALIZE DAP

#300

++
 +03
 ++

496

497

V69/SUNDANCE

++
+03
+03
++

SELECT 5 DEGREE
DEADEND

INHIRT DAP TURN
ON AND ERROR
NEEDLE DISPLAY
UNTIL ICDS ARE
ZEROED

RESET ALL FLAG-
WORDS (EXCEPT
IDLEFLAG - BIT
7 FLAGWORD 7 AND
R31 FLG - BIT
4 FLAGWORD 9

EXIT

CLEAR HIGH ORDER
STALL FLAG BITS

TURN OFF DISK DIS-
CRETE LIGHTS EXCEPT
PRG, GIMBAL LOCK
AND NO ATT.

++
+03
++

INITIALIZE IMU FLAGS

310

320

330

340

350

V59/SUNDANCE

(INHIBIT IMU FAIL)

#360

RESET IMU FAILURE
CODES

INITIALIZE DAP

#370

TURN ON THROTTLE
COUNTER

#380

IS ENGONFLG SET?

.N .Y

#390

TURN ENGINE ON
(BIT 13 CHANNEL
11)

TEST PHASE TABLE.
IS IT CORRECT?

.N .Y

#400

TURN ON PROG
ALARM AND
STORE ALARM
CODE 1107

#410

DISPLAY PROGRAM

WERE ANY GROUPS
RUNNING?

.Y	.N
.	.
.	.
...	...
.	.
EXIT	EXIT
VIA	TO
SWRETURN	IDLELOOP

#420

#430

LOGIC REV 03 PCN-MIT-124

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501

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

INITIALIZE ERASABLE DUMP VIA DOWNLINK EXTENDED VERB (V74) LOGIC REV 04 05/28/68

PURPOSE: (1) TO DUMP ALL EIGHT BANKS OF ERASABLE MEMORY VIA DOWNLINK.

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) 4, 2, OR 1 COMPLETE DUMPS MAY BE CALLED BY THE ASTRONAUT BY LOADING 20000, 10000, OR 04000 RESPECTIVELY IN LOCATION (DUMPCNT). THIS MAY BE DONE BEFORE OR AFTER KEYING V74E.

(4) THE DUMP OF EACH BANK IS PRECEDED BY AN ID WORD, SYNCH BITS, ECADR AND TIME.

(5) THE E BANKS ARE DUMPED IN ORDER, STARTING WITH E BANK ZERO.

(6) THE TIME REQUIRED FOR 4 COMPLETE DUMPS IS 83.2 SECONDS.

PRG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME-----
START CREW INITIATED
DOWNLINK ERASABLE
DUMP

KEY IN V74E

IS ANOTHER EXTENDED
VERB ACTIVE?

.N .Y

TURN ON OPR
ERR LAMP

SPECIFY NUMBER
OF DUMPS DESIRED BY
LOADING THE FOUR
HIGH ORDER BITS OF
LOCATION DUMPCNT
KEY V21V01E
XXXXE
XX000E

#10

#20

V74/SUNDANCE

XX-20 FOR 4 DUMPS
10 FOR 2 DUMPS
04 FOR 1 DUMP

EXIT

++
+04
+04
++

SET EXTENDED VERR
ACTIVITY INTERLOCK

TERMINATE CURRENT
DOWNLIST

SET E BANK COUNTER,
WORD COUNTER, AND
DUMP COUNTER=0

INITIALIZE E BANK
DUMP. DUMP ID, SYNCH
BITS, ECADR AND
TIME1.

DUMP E BANK

INCREMENT E BANK
COUNTER AND SET WORD
COUNTER=0.

#30

#40

#50

#60

#70

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506

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

MINIMUM IMPULSE MODE EXTENDED VFRB (V76)

LOGIC REV 03 01/29/68

PURPOSE: (1) TO ENABLE THE MINIMUM IMPULSE MODE OF THE DAP.

ASSUMPTIONS: (1) TO OBTAIN THE MINIMUM IMPULSE MODE, THE GJID CONT SWITCH MUST BE AT PGNS AND THE MODE CONTROL SWITCH AT ATT HOLD.

(2) THE MINIMUM IMPULSE MODE WILL REMAIN ENABLED UNTIL CANCELLED BY RATE MODE SELECTION (SEE V77) OR A FRESH START.

(3) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(4) THE PROCESS MAY BE SELECTED AT ANY TIME.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIMECREW
PROGRAM
SELECTION.
.
.
.
.-----
START CREW INITIATED
MINIMUM IMPULSE MODE
SELECTION
-----..... KEY IN V76F

#10

SET MINIMUM IMPULSE
ACA MODE FLAG
-----.
.
.
.
.
EXIT

#20

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507

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

RATE COMMAND EXTENDED VERB (V77)

LOGIC REV 03 01/29/68

PURPOSE: (1) TO ENABLE THE RATE COMMAND MODE OF THE DAP.

(2) TO SET DESIRED CDU ANGLES EQUAL TO ACTUAL CDU ANGLES.

ASSUMPTIONS: (1) TO OBTAIN THE RATE COMMAND MODE, THE GUID CONT SWITCH MUST BE AT PGNS AND THE MODE CONTROL SWITCH AT ATT HOLD.

(2) THE RATE COMMAND MODE WILL REMAIN ENABLED UNTIL CANCELLED BY MINIMUM IMPULSE MODE SELECTION (SEE V76).

(3) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(4) THE PROCESS MAY BE SELECTED ANY TIME.

PROG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW PROGRAM SELECTION			
				START CREW INITIATED RATE COMMAND MODE SELECTION	.....	KEY IN V77E
				RESET MINIMUM IM- PULSE ACA MODE FLAG		
				SET DESIRED CDU ANGLES = CURRENT CDU ANGLES		

#10

#20

#30

V77/SUNDANCE

V77/SUNDANCE

EXIT

528

509

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

ENABLE W MATRIX INITIALIZATION EXTENDED
VERB (V93)

LOGIC REV 02 01/19/68

PURPOSE: (1) TO REQUEST REINITIALIZATION OF THE RENDEZVOUS W MATRIX.

ASSUMPTIONS: (1) THIS PROCESS RESETS THE RENWFLAG INDICATING THAT THE RENDEZVOUS W MATRIX IS NOT VALID AND MUST BE REINITIALIZED BEFORE BEING USED. THE RENWFLAG IS AUTOMATICALLY SET FOLLOWING W MATRIX INITIALIZATION OR REINITIALIZATION.

(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(3) THIS PROCESS MAY BE SELECTED AT ANY TIME.

PRG CONT	LGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
			CREW PROGRAM SELECTION			
				----- START CREW INITIATED RENDEZVOUS W MATRIX INITIALIZATION -----	----- KEY IN V93E -----
				----- RESET RENWFLAG -----		
				EXIT		

#10

#20

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571.

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

EXTENDED VERB 26

LOGIC REV 00 05/28/68

PURPOSE: (1) TO PROVIDE A MEANS OF SUSPENDING STATE VECTOR INTEGRATION.

ASSUMPTIONS: (1) IF THE COASTING INTEGRATION ROUTINE IS IN OPERATION, IT IS TERMINATED AT THE END OF THE CURRENT TIME STEP.

(2) THE CURRENT PROGRAM IS TERMINATED

(3) THE LGC IDLING PROGRAM (POO) IS ACTIVATED.

(4) THE FIRST POO STATE VECTOR TEST IS BYPASSED SO THAT NO STATE VECTOR INTEGRATION OCCURS FOR TEN MINUTES, UNLESS A NEW PROGRAM IS SELECTED.

(5) THIS ROUTINE DOES NOT MAINTAIN STATE VECTOR SYNCHRONIZATION THEREFORE INCORRECT W MATRIX EXTRAPOLATION MAY RESULT.

PROG
CONT

LGC

GROUND

CREW

CHECKLIST

TIME

TOTAL
TIME

.CREW
.EXTENDED
.VERB
.SELECTION
.
.
.
.

START STATE VECTOR
TERMINATION ROUTINE.

..... KEY IN V95E

#10

SET QUIT FLAG

#20

GO TO IDLING PROGRAM
(POO) VIA ROUTINE
(POO)

.
.
.
.
.
.
.
.

V96/SUNDANCE

GO TO
"A"
IN R00

CHANGE CONTROL NOTES

LOGIC REV 00 PCN-MIT-15

512

513

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

PROCEDURAL ROUTINE ONE (PR1)

LOGIC REV 00 04/16/68

PURPOSE: (1) TO PROVIDE MANUAL CAPABILITY OF CHANGING FLAG WORD BITS.

ASSUMPTIONS: (1) THIS PROCEDURE CAN BE PERFORMED AT ANY TIME.

(2) THIS PROCEDURE IS NOT RESTRICTED TO FLAG WORDS BUT CAN MODIFY ANY LEGITIMATE ERASABLE LOCATION.

DESCRIPTION: (1) NOUN 7 WILL BE LOADED BY STANDARD PINBALL TECHNIQUES, E.G. V25 N7E

(2) NOUN 7 IS A THREE COMPONENT OCTAL NOUN WITH THE FOLLOWING DEFINITION.

R1 = ECADR OF AN ERASABLE LOCATION (E.G. FOR FLAGWORD 8 R1 = 104).

R2 = UP TO FIVE OCTAL DIGITS REPRESENTING BITS IN THE WORD TO BE SET
(E.G. 200 IS BIT 8).

R3 = NON-ZERO (OR NON-BLANK) INDICATES A 1 IS TO BE SET INTO BIT POSITIONS SPECIFIED IN R2. ZERO
OR BLANK INDICATES A 0.

(3) AS AN EXAMPLE, SETTING OF BITS 1, 3 AND 13 TO 1 IN FLAGWORD 8 REQUIRES THE FOLLOWING SEQUENCE:

V25N7E
104F
10005E
1E

SETTING THE SAME BITS TO 0 REQUIRES THE SEQUENCE:

V25N7E
104F
10005E
0E

CHANGE CONTROL NOTES.
LOGIC REV 00 PCR - 79

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241
(515)

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

REV 06 01/17/69

4.5 THIS LIST REPRESENTS THE VERBS USED IN PROGRAM SUNDANCE.

4.5.1 REGULAR VERBS

- 00 NCT IN USE
- 01 DISPLAY OCTAL CCMP 1 IN R1
- 02 DISPLAY OCTAL CCMP 2 IN R1
- 03 DISPLAY OCTAL CCMP 3 IN R1
- 04 DISPLAY OCTAL CCMP 1,2 IN R1,R2
- 05 DISPLAY OCTAL CCMP 1,2,3 IN R1,R2,P3
- 06 DISPLAY DECIMAL IN R1 OR R1,R2 OR R1,R2,P3
- 07 DISPLAY DP DECIMAL IN R1,R2 (TEST ONLY)
- 08 SPARE
- 09 SPARE
- 10 SPARE
- 11 MONITOR OCTAL CCMP 1 IN R1
- 12 MONITOR OCTAL CCMP 2 IN R1
- 13 MONITOR OCTAL CCMP 3 IN R1
- 14 MONITOR OCTAL CCMP 1,2 IN R1,R2
- 15 MONITOR OCTAL CCMP 1,2,3 IN R1,R2,P3
- 16 MONITOR DECIMAL IN R1 OR R1,R2 OR R1,R2,P3
- 17 MONITOR DP DECIMAL IN R1,R2 (TEST ONLY) (GRD USE)
- 18 SPARE
- 19 SPARE
- 20 SPARE
- 21 LOAD COMPONENT 1 INTO R1
- 22 LOAD COMPONENT 2 INTO R2

VERBS/SUNDANCE

23 LOAD COMPONENT 3 INTO R3
 24 LOAD COMPONENT 1,2 INTO R1,R2
 25 LOAD COMPONENT 1,2,3 INTO R1,R2,R3
 26 SPARE
 27 DISPLAY FIXED MEMORY (GRD USE)
 28 SPARE
 29 SPARE
 30 REQUEST EXECUTIVE (GRD USE)
 31 REQUEST WAITLIST (GRD USE)
 32 RECYCLE
 33 PROCEED
 34 TERMINATE
 35 TEST LIGHTS
 36 REQUEST FRESH START
 37 CHANGE PROGRAM
 38 SPARE
 39 SPARE

4.5.2 EXTENDED VERBS

40 ZERO CDU (SPECIFY N20 OR N72)
 41 COARSE ALIGN CDU (SPECIFY N20 OR N72)
 42 FINE ALIGN IMU
 43 LOAD FDAI ERROR NEEDLES (TEST ONLY)
 44 TERMINATE CONTINUOUS DESIGNATE
 45 DISPLAY W-MATRIX RMS ERRORS
 46 SPARE
 47 INITIALIZE AGS (R47)
 48 LOAD CAP DATA (R03)

(C)

(C)

CALLABLE IN PROGRAM
 (C) - CALLABLE WITH ANOTHER EXTENDED VERB IN USE.

ALL

ALL (SEE V41 DESCRIPTION)

ALL

00

ALL

ALL

ALL

ALL

49	START CREW DEFINED MANEUVER (R62)		00
50	PLEASE PERFORM		NCNF
51	SPARE		
52	MARK X-RETICLE		NONE
53	MARK Y-RETICLE		NONE
54	MARK X OR Y-RETICLE		NCNF
55	INCREMENT LGC TIME (DECIMAL)		ALL
56	TERMINATE TRACKING (P20 AND P25)	(C)	20, 25
57	SPARE		
58	SPARE		
59	SPARE		
++	60	DISPLAY DAP FOLLOWING ATTITUDE ERRORS	(C) ALL
+	61	CCMMAND LR TO POSITION 2	ALL
+	62	START RR/LR SELF TEST (R04)	(SEE R04 DESCRIPTION)
+	63	DISPLAY TCTAL ATTITUDE ERRORS WITH RESPECT TO N22	(C) ALL
++		PCR-164, EDIT	
	64	SPARE	
++	65	DISABLE U, V JETS DURING CSM DOCKED BURNS	(C) ALL
++		PCN-483	
	66	SET LM STATE VECTOR INTO CSM STATE VECTOR	(C) ALL
	67	SPARE	
	68	SPARE	
	69	RESTART	(C) ALL
	70	UPDATE LIFTOFF TIME (P27)	00
	71	UNIVERSAL UPDATE-BLOCK ADR (P27)	00
	72	UNIVERSAL UPDATE-SINGLE ADR (P27)	00
	73	UPDATE LGC TIME (CCTAL) (P27)	00
	74	INITIALIZE ERASABLE DUMP VIA COWALINK	ALL
++	75	ENABLE U, V JETS DURING CSM DOCKED BURNS	(C) ALL
++		PCN-483	

76	MINIMUM IMPULSE COMMAND MODE	(C)	ALL
77	RATE COMMAND AND ATTITUDE HOLD MODE	(C)	ALL
78	START LR SPURIOUS TEST (R77)		ALL
79	STOP LR SPURIOUS TEST (R77)	(C)	ALL
80	UPDATE LM STATE VECTOR	(C)	ALL EXCEPT R32
81	UPDATE CSM STATE VECTOR	(C)	ALL EXCEPT R32
82	REQUEST ORBIT PARAM DISPLAY (R30)		ALL
83	REQUEST REND PARAM DISPLAY (R31)		ALL
84	START TARGET DELTA V (R32)		ALL
85	SPARE		
86	SPARE		
87	SPARE		
88	SPARE		
89	START REND FINAL ATTITUDE MANEUVER (R63)		00
90	REQUEST REND CUT OF PLANE DISPLAY (R36)		ALL
91	BANKSUM		00
92	START IMU PERFORMANCE TESTS (GRD USE)		00
93	ENABLE W MATRIX INITIALIZATION	(C)	ALL
94	SPARE		
95	NO UPDATE OF EITHER STATE VECTOR	(C)	ALL
96	TERMINATE STATE VECTOR INTEGRATION	(C)	ALL
97	SPARE		
98	SPARE		
99	ENABLE ENGINE IGNITION		NONE

245 (5/83)

CHANGE CONTROL NOTES

REV C5 PCN-MIT-120
REV 06 PCR-164, PCN-483 , EDITORIAL CORRECTIONS

00261000
00261001

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APCLLC COMPUTER LOGIC CHECKLIST INTERFACE

RFV 07 01/17/69

4.6 THIS LIST REPRESENTS THE NOUNS USED IN PROGRAM SUNDANCE.

CALLABLE IN:

CODE:

(L) - NOUNS WHICH MAY BE LOADED IN LGC

* - ALSO P40, P41, P42 OR P52 IF SELECTED
IN SEQUENCE AFTER THIS PRETHRUST
PROGRAMP20(L280+) - INDICATES NOUN MAY BE CALLED
IN P20 AFTER LINE COUNT #180
(APPROX) AND IN ANY SUB-
SEQUENT PROGRAM UNTIL
RECALCULATED.(W R30) - WITH, OR BY MEANS OF,
ROUTINE 30P00(R62) - NOUN MAY BE CALLED IN P00
DURING ROUTINE 62

00	NCT IN USE			
01	SPECIFY ADDRESS (FRAC)	(L)	.XXXXX FRAC .XXXXX FRAC .XXXXX FRAC	ALL
02	SPECIFY ADDRESS (WHOLE)	(L)	XXXXX. INTEG XXXXX. INTEG XXXXX. INTEG	ALL
03	SPECIFY ADDRESS (DEGREE)	(L)	XXX.XX DEG XXX.XX DEG XXX.XX DEG	ALL
04	SPARE			
05	ANGULAR ERROR/DIFFERENCE		XXX.XX DEG	NONE
06	OPTICN CODE	(L)	CCT CCT	NONE
07	FLAGWORD OPERATOR	FOADR BIT ID ACTION	CCT CCT CCT	
08	ALARM DATA		CCT CCT CCT	ALL

NOUNS/SUNDANCE

09	ALARM CODES		OCT OCT OCT	ALL
10	CHANNEL TO BE SPECIFIED (L-EXCEPT CHANNEL 7)		OCT	ALL
11	SPARE			
12	SPARE			
13	SPARE			
14	CHECKLIST (USED INTERNALLY BY EXTENDED VERBS ONLY) (N25 IS PASTED AFTER DISPLAY)		XXXXX.	NONE
15	INCREMENT ADDRESS (L-W N01,N02,N03,N10)		OCT	ALL
16	TIME OF EVENT (USED BY EXTENDED VERBS ONLY) (L)		00XXX. HRS 000XX. MIN 0XX.XX SEC	R32* R36, R47
17	SPARE			
18	DESIRED AUTO MANEUVER FCAI BALL ANGLES (L)	P XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG		P00(R62,R63) P20(L280+) P25(L130+) P40(L220+) P41(L160+) P42(L210+)
19	BYPASS ATTITUDE TRIM MANEUVER (L) (DESIRED FCAI BALL ANGLES)	R XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG		NONE
20	ICDU ANGLES (L)	CG XXX.XX DEG IG XXX.XX DEG MG XXX.XX DEG		ALL
21	PIPAS (L)	X XXXXX. PULSES Y XXXXX. PULSES Z XXXXX. PULSES		ALL
22	DESIRED ICDU ANGLES (L)	CG XXX.XX DEG IG XXX.XX DEG MG XXX.XX DEG		SAME AS N18
23	SPARE			
24	DELTA TIME FOR LGC CLOCK (L)	00XXX. HRS 000XX. MIN 0XX.XX SEC		V55
25	CHECKLIST (USED WITH V50)		XXXXX.	NONE

26	PRIQ/DELAY, ADRES, BBON (L-W V3C, V31)		CCT OCT CCT	GRD. USE
27	SELF TEST ON/OFF SWITCH	(L)	XXXXX.	ALL
28	SPARE			
29	SPARE			
30	GETI (CSI)	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P32(L70+)* P72(L70+)
31	GETI (CDH)	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P33(L80+)* P73(L80+)
32	TIME FROM PERIGEE		00XXX. HRS 000XX. MIN 0XX.XX SEC	ALL (EXCEPT P06, P21, P27, R30)
33	GETI	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P30*
34	TIME OF EVENT	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P21, P52, P51, (R53)
35	TIME TO GC TO EVENT		00XXX. HRS 000XX. MIN 0XX.XX SEC	
36	TIME OF LGC CLOCK		00XXX. HRS 000XX. MIN 0XX.XX SEC	ALL
37	GETI (TPI)	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P32(L180+)* P34(L80+)* P72(L180+) P74(L80+)
38	SPARE			
39	SPARE			
40	TIME FROM IGNITION/CUTOFF VG DELTA V (ACCUMULATED)		XXBXX M-S XXXX.X FPS XXXX.X FPS	P40(L400+) P42(L400+)
41	TARGET AZIMUTH ELEVATION - LAT/2	(L)	XXX.XX DEG XX.XXX DEG	GRD USE

42	APOGEE PERIGEE DELTA V (REQUIRED)	XXXX.X NM XXXX.X NM XXXX.X FPS	P30(L200+)*
43	LATITUDE LCNGITUDE ALTITUDE	XXX.XX DEG (+ NCRTH) XXX.XX DEG (+ EAST) XXXX.X NM	P21(L100+)
44	APOGEE PERIGEE TFF	XXXX.X NM XXXX.X NM XXBXX M-S	ALL P27, (R30)
45	MARKS (M) TF GETI OF NEXT BURN MGA	XXXXX. XXBXX M-S XXX.XX DEG	P30(L450+)* P32(L700+)* P33(L510+)* P34(L710+)* P35(L360+)*
46	DAP CONFIG (L)	OCT	P00, P20, P3X, P4X, P5X, (R03)
47	THIS VEHICLE WT (L) OTHER VEHICLE WT	XXXXX. LBS XXXXX. LBS	P00, P20, P3X, P4X, P5X, (R03)
48	GIMBAL PITCH TRIM (L) GIMBAL ROLL TRIM	XXX.XX DEG XXX.XX DEG	P00, P20, P3X, P4X, P5X, (R03)
49	DELTA R DELTA V	XXXX.X NM XXXX.X FPS	NONE
50	DELTA ALTITUDE CDH DELTA TIME (CCH-CSI OR TPI-CDH) DELTA TIME (TPI-CCH OR TPI-NOM TPI)	XXXX.X NM XXBXX M-S XXBXX M-S	P32(L400+)* P33(L280+)*
51	SPARE		
52	CENTRAL ANGLE OF ACTIVE VEH	XXX.XX DEG	P34, P35
53	SPARE		
54	RANGE RANGE RATE THETA	XXX.XX NM XXXX.X FPS XXX.XX DEG	ALL (R31)
55	NC OF APSIDAL CROSSINGS (N) (L) ELEVATION ANGLE (E) CENTRAL ANGLE	XXXXX. XXX.XX DEG XXX.XX DEG	P32(L120+)* P34(L150+)*
56	SPARE		
57	DELTA R	XXXX.X NM	LUMINARY ONLY
58	PERIGEE ALTITUDE (POST TPI) DELTA V (TPI) DELTA V (TPF)	XXXX.X NM XXXX.X FPS XXXX.X FPS	P34(L430+)*

59	DELTA V LOS		XXXX.X FPS XXXX.X FPS XXXX.X FPS	P34(L630+)* P35(L280+)*
60	SPARE			LUMINARY ONLY
61	SPARE			
62	SPARE			LUMINARY ONLY
63	SPARE			LUMINARY ONLY
64	SPARE			LUMINARY ONLY
65	SAMPLED LGC TIME (FETCHED IN INTERRUPT)		COXXX. HRS 000XX. MIN 0XX.XX SEC	ALL
66	LR SLANT RANGE LR POSITION		XXXXX. FT 00001/00002	ALL EXCEPT P20 (R04) R2(ALL)
67	LR VX VY VZ		XXXXX. FPS XXXXX. FPS XXXXX. FPS	ALL EXCEPT P20 (R04)
68	SPARE			LUMINARY ONLY
69	SPARE			
70	AOT DETENT CODE/STAR CODE (BEFORE MARK)	(L)	OCT	P52 (R52)
71	AOT DETENT CODE/STAR CODE (AFTER MARK)	(L)	OCT	P51,P52 (R53)
72	RR TRUNNION ANGLE RR SHAFT ANGLE		XXX.XX DEG XXX.XX DEG	ALL
73	DESIRED RR TRUNNION ANGLE DESIRED RR SHAFT ANGLE	(L)	XXX.XX DEG XXX.XX DEG	W V41 N72
74	SPARE			
75	SPARE			
76	SPARE			
77	SPARE			
++				
+ 78	RR RANGE		XXX.XX NM	ALL EXCEPT P20 (R04)
+ 79	RR RANGE RATE		XXXXX. FPS	
++	PCN 449			
79	SPARE			

80	DATA INDICATOR OMEGA		XXXXX. XXX.XX DEG	NCNE
81	DELTA VX(LV) DELTA VY(LV) DELTA VZ(LV)	(L)	XXXX.X FPS XXXX.X FPS XXXX.X FPS	P32(L480+AFTER RECYCLE)* P33(L350+AFTER RECYCLE)* P34(L500+AFTER FINAL CALC)* P35(L140+AFTER FINAL CALC)*
82	DELTA VX(LV) DELTA VY(LV) DELTA VZ(LV)	(L)	XXXX.X FPS XXXX.X FPS XXXX.X FPS	P30(L100+)* P32(L590+AFTER RECYCLE)*
83	DELTA VX(LM) DELTA VY(LM) DELTA VZ(LM)		XXXX.X FPS XXXX.X FPS XXXX.X FPS	P47(L90+)
84	DELTA VX(O VEH) (RXV)XR DELTA VY(O VEH) (VXR) DELTA VZ(O VEH) (-R)	(L)	XXXX.X FPS XXXX.X FPS XXXX.X FPS	P00,P20(R32)
85	VGX (LM) VGY (LM) VGZ (LM)		XXXX.X FPS XXXX.X FPS XXXX.X FPS	P40(L1030+) P41(L170+) P42(L960+)
86	VGX(LV) VGY(LV) VGZ(LV)		XXXX.X FPS XXXX.X FPS XXXX.X FPS	P40,P41,P42
87	BACKUP OPTICS LOS AZIMUTH ELEVATION	(L)	XXX.XX DEG XXX.XX DEG	P51,P52,(R52,R53)
88	CELESTIAL BODY 1/2 UNIT VECTOR	(L)	X .XXXXX Y .XXXXX Z .XXXXX	P51,P52,(R52,R53)
89	SPARE			
90	REND OUT OF PLANE PARAMETERS Y Y DCT PSI		XXX.XX NM XXXX.X FPS XXX.XX DEG	R36(IN P32,P33,P34,P35)
91	SPARE			
92	SPARE			
93	DELTA GYRC ANGLES	(L)	X XX.XXX DEG Y XX.XXX DEG Z XX.XXX DEG	P52 (R55)
94	SPARE			
95	SPARE			
96	SPARE			

253 (525)

NOUNS/SUNDANCE

97	SYSTEM TEST INPUTS	(L)	XXXXX. XXXXX. XXXXX.	GRD USE
98	SYSTEM TEST RESULTS AND INPUTS	(L)	XXXXX. XXXXX. XXXXX.	GRD USE
99	RMS PCS. ERR W MAT RMS VEL ERR W MAT		XXX.XX NM XXXX.X FPS	ALL (V45)

CHANGE CONTROL NOTES

REV 06 PCN-MIT-119 + PCN-MIT-136
REV 07 PCN 449

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527

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

REV 03

06/13/68

4.7 THIS LIST REPRESENTS THE CHECKLIST REFERENCE CODES USED WITH
THE "PLEASE PERFORM CHECKLIST" REQUEST (VERB 50 NOUN 25)

RI CODE	ACTION TO BE EFFECTED
00011	KEY IN AUTO OPTICS POSITIONING OPTION
00012	KEY IN TARGET DATA
00014	KEY IN FINE ALIGNMENT OPTION
00015	PERFORM STAR ACQUISITION
00016	KEY IN TERMINATE MARK OPTION
00017	PERFORM ADDITIONAL SIGHTINGS
00031	KEY IN ENGINE ON OPTION
00035	PERFORM LGC PREPARATION
00036	PERFORM THRUST TERMINATION
00062	SWITCH LGC POWER DOWN
00201	SWITCH RR MODE TO AUTOMATIC
00202	KEY IN SIGHTING CHECK OPTION
00203	SWITCH GUIDANCE CONT TO GNC, MODE TO AUTO, THR CONT TO AUTO
00204	KEY IN ENABLE GIMBAL TRIM OPTION
00205	PERFORM MANUAL ACQUISITION OF CSM WITH RR

SWITCH-DENOTES CHANGE POSITION OF A CONSOLE SWITCH
PERFORM-DENOTES START OR END OF A TASK
KEY IN-DENOTES KEY IN OF DATA THRU THE DSKY

CHANGE CONTROL NOTES

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529 APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

REV 13

06/13/68

4.8 THIS LIST REPRESENT THE OPTION CODES DISPLAYED IN R1 IN CONJUNCTION WITH VERB 04 NOJN 06 TO REQUEST THE ASTRONAUT TO LOAD INTO R2 THE OPTION HE DESIRES FOR PROGRAM SUNDANCE.

THE SPECIFIED OPTION CODES WILL BE DISPLAYED IN R1 IN CONJUNCTION WITH FL V04 N06 TO REQUEST THE ASTRONAUT TO LOAD INTO R2 THE OPTION HE DESIRES.

R1

OPTION

CODE	PURPOSE	INPUT FOR R2
00001	SPECIFY IMJ ORIENTATION	1=PREF, 2=NOM, 3=REFSMMAT, 4=LAND SITE
00002	SPECIFY VEHICLE	1=THIS, 2=OTHER (P21, R30)
00003	SPECIFY TRACKING ATTITUDE	1=PERFERRED, 2=OTHER (R63)
00004	SPECIFY RADAR	1=RR, 2=LR(R04)
00006	SPECIFY RR COARSE ALIGN	1=LOCK, 2=CONT. DESIG. (V41N72)

CHANGE CONTROL NOTES

REV 03 PCN-MIT-134

530

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

REV 04

01/17/69

4.9 THIS LIST REPRESENTS THE ALARM CODES USED WITH VERB 05 NOUN 09 FOR PROGRAM SUNDANCE.

R1

CODE	PURPOSE	SET BY
00105	AOT MARK SYSTEM IN USE	ACTMARK
00107	MORE THAN 5 MARK PAIRS	ACTMARK
00111	MARK MISSING	ACTMARK
00112	MARK OR MARK REJECT NOT BEING ACCEPTED	ACTMARK
00113	NO INBITS	ACTMARK
00114	MARK MADE BUT NOT DESIRED	ACTMARK
00115	NO MARKS IN LAST PAIR TO REJECT	ACTMARK
00206	ZERO ENCODE NOT ALLOWED WITH COARSE ALIGN + GIMBAL LOCK	IMU MODE SWITCH
00207	ISS TURNON REQUEST NOT PRESENT FOR 90 SEC	T4RUPT
00210	IMU NOT OPERATING	IMU MODE SWITCH, IMU 2, R02, P51
00211	COARSE ALIGN ERROR	IMU MODE SWITCH
00212	PIPA FAIL BUT PIPA IS NOT BEING USED	IMU MODE SWITCH, T4RUPT
00213	IMU NOT OPERATING WITH TURN-ON REQUEST	T4RUPT
00214	PROGRAM USING IMU WHEN TURNED OFF	T4RUPT
00215	PREFERRED ORIENTATION SELECTED BUT NOT SPECIFIED	P52
00217	BAD RETURN FROM STALL ROUTINES	CURTAINS
00220	IMU NOT ALIGNED (BAD REFSMMAT)	R47, PC2
00401	* DESIRED GIMBAL ANGLES YIELD GIMBAL LOCK	INF ALIGN, IMU2, R60
00405	TWO STARS NOT AVAILABLE	P52
00421	W-MATRIX OVER FLOW	INTEGRV
00501	RADAR ANTENNA BEYOND PRESENT MODE LIMITS	R23

00502	LCS OUTSIDE OF LIMITS OF BOTH RR ANTENNA MODES	V41N72
00503	RADAR ANTENNA DESIGNATE FAIL	R21,V41N72
00510	RADAR AUTO DISCRETE NCT PRESENT	R25
00514	RADAR GOES OUT OF AUTO MODE WHILE IN USE	R25
00515	RR CDU FAIL DISCRETE PRESENT	R25
00520	RADARUPT NOT EXPECTED AT THIS TIME	P20
00521	RR DATA CDDC NCT PRESENT	P20
00522	LANDING RADAR POSITION CHANGE	RADAR READ
00523	LR ANTENNA DIDN'T ACHIEVE POSITION 2	V61
00525	DELTA THETA GREATER THAN 3 DEG	R22
00526	RANGE GREATER THAN 400 MILES	P20
00527	LCS OUTSIDE OF ANTENNA MODE LIMITS	R24
++		
+00600	IMAGINARY ROOTS ON FIRST ITERATION	P32
++ EDIT		
00601	PERICTR ALTITUDE (POST CSI) LESS THAN 85 NM	P32
00602	PERICTR ALTITUDE (POST CDH) LESS THAN 85 NM	P32
00603	CSI TO CDH TIME LESS THAN 10 MIN	P32
00604	CDH TO TPI TIME LESS THAN 10 MIN	P32
00605	NUMBER OF ITERATIONS EXCEEDS LOCP MAXIMUM	P32
00606	DV EXCEEDS MAXIMUM	P32
00611	NO GETI FOR GIVEN ELEV ANGLE	P33,P34
00777	PIPA FAIL CAUSED THE ISS WARNING	T4RUPT
01102	LGC SELF TEST ERROR	SELF CHECK
01103	* UNUSED CCS BRANCH EXECUTED	ABORT
01104	* DELAY ROUTINE BUSY	EXEC
01105	DOWNLINK TOO FAST	T4RUPT
01106	UPLINK TOO FAST	T4RUPT

01107	PHASE TABLE FAILURE. ASSUME ERASABLE MEMORY IS DESTROYED	RESTART
01201	* EXECUTIVE OVERFLOW-NO VAC AREAS	EXEC
01202	* EXECUTIVE OVERFLOW-NO CORE SETS	EXEC
01203	* WAITLIST OVERFLOW-TOO MANY TASKS	WAITLIST
01206	* SECOND JOB ATTEMPTS TO GO TO SLEEP VIA KEYBOARD AND DISPLAY PROGRAM	PINBALL
01207	* NO VAC AREA FOR MARKS	AOTMARK
01210	* TWO PROGRAMS USING DEVICE AT SAME TIME	IMU MODE SWITCH
01211	* ILLEGAL INTERRUPT OF EXTENDED VERB	ACTMARK
++		
+01301	ARCSIN-ARCCOS ARGUMENT TOO LARGE.	INTERPRETER
++ PCR 593.		
01302	* SQRT CALLED WITH NEGATIVE ARGUMENT. ABORT	INTERPRETER
01407	VG INCREASING	S40.8
01501	* KEYBOARD AND DISPLAY ALARM DURING INTERNAL USE (NVSUB). ABORT	PINBALL
01502	* ILLEGAL FLASHING DISPLAY	GOPLAY
01520	V37 REQUEST NOT PERMITTED AT THIS TIME	V37
01600	OVERFLOW IN DRIFT TEST	CPT PRE ALIGN CALIB IMU 4 (LEM)
++		
+01601	BAD IMU TORQUE.	OPT PRE ALIGN CALIB. IMU 4 (LEM)
++ EDIT		
01703	LESS THAN 45 SECS TO IGNITION	P41, P42
01706	CSM DOCKED BIT SET IN ASCENT (NO SUCH DAP) P40 SELECTED WITH DESCENT UNIT STAGED P42 SELECTED WITHOUT DESCENT UNIT STAGED	R03
01711	STATE VECTOR INTEGRATION NOT FINISHED PRIOR TO TIG - 30 SECONDS.	P40,P41,P42
02000	* DAP STILL IN PROGRESS AT NEXT TIME5 RUPT	DAP
02001	JET FAILURES HAVE DISABLED Y-Z TRANS.	DAP
02002	JET FAILURES HAVE DISABLED X TRANSLATION	DAP
02003	JET FAILURES HAVE DISABLED P-ROTATION	DAP

02004	JET FAILURES HAVE DISABLED U-V ROTATION	DAP
03777	ICDU FAIL CAUSED THE ISS WARNING	T4RUPT
04777	ICDU, PIPA FAILS CAUSED THE ISS WARNING	T4RUPT
07777	IMU FAIL CAUSED THE ISS WARNING	T4RUPT
10777	IMU, PIPA FAILS CAUSED THE ISS WARNING	T4RUPT
13777	IMU, ICCU FAILS CAUSED THE ISS WARNING	T4RUPT
14777	IMU, ICCU, PIPA FAILS CAUSED THE ISS WRNING	T4RUPT

* INDICATES ABORT TYPE. ALL OTHERS ARE NON-ABORTIVE EXCEPT 401 WHICH IS BCTF.

NOTE: FOR V05 N09 DISPLAYS:
 R1-OXXXX (FIRST ALARM TO OCCUR AFTER LAST RESET).
 R2-OXXXX (SECND ALARM TO OCCUR AFTER LAST RESET).
 R3-OXXXX (ALARM WHICH OCCURRED LAST).

CHANGE CONTRCL NOTES

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 REV 04 PCR 593.1, EDITORIAL CORRECTIONS

Section 4 SUNDANCE (Rev. 306)

Rev. 3, January 1969

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