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GUIDANCE, NAVIGATION AND CONTROL

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GUIDANCE SYSTEM OPERATIONS PLAN FOR MANNED LM EARTH ORBITAL AND LUNAR MISSIONS USING PROGRAM LUMINARY 1C (REV. 131)

SECTION 4 PGNCS OPERATIONAL MODES (Rev. 7)

DECEMBER 1969

MIT INSTRUMENTATION LABORATORY
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SECTION 4, PGNCS OPERATIONAL MODES

DECEMBER 1969

(REVISION 7)

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Preface

The Guidance System Operations Plan is published as six 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

This volume, Revision 7 of Section 4 of the GUIDANCE SYSTEM OPERATIONS PLAN FOR MANNED LM EARTH ORBITAL AND LUNAR MISSIONS USING PROGRAM LUMINARY describes the operational modes of the missions.

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

Revisions to this plan require NASA approval.

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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 PGNC 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 LGC Program Control

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

In primary PGNCS control modes the LGC 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 PGNCS control modes the astronauts and/or the ground must be capable of initiation or termination of LGC Programs. These procedures must be thoroughly defined for use in the design of the LGC Program logic for astronaut/ground participation.

4.1.1 LGC Program Initiation

4.1.1.1 LGC Programs

Because of the random time sequencing of many of the LGC tasks, the design of Programs which are capable of being 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/LGC communication procedures, ground/LGC communication procedures,and PGNCS and SCS Mode determination.

A logical sequence of these Programs has been prepared, supplemented by simpler Routines which do not require identification as Programs. The Programs, their associated Routines and the crew interfaces are outlined in Section 4.4.

Programs in process in the LGC are identified by the Program light on the keyboard and display panel with three exceptions, P20, P25, and P27 with P00 in background. These Programs may be in process simultaneously with another Program whose number is displayed.

The LGC is programmed to initiate a Program only in response to the start 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 LGC UPLINK command (ground). In certain cases Program initiation is automatically performed by a previous Program.

4.1.1.2 Special LGC Routines

In addition to the LGC Programs there are many Routines and subroutines not specifically identified with a Program. The majority of these are automatically

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

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

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

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

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

4.1.2 LGC Program Termination

Normally there are three ways by which an LGC Program in process is terminated:

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

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

1. Use the DSKY to select a new Program to operate.
2. Use the DSKY to select a Routine 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 LGC.

4.2 LGC/Astronaut/Ground Communications

4.2.1 LGC/Ground Communications

The LGC/Ground Communications are via the LGC UPLINK and LGC DOWNLINK and are described in detail in Section 2 of the GSOP.

4.2.2 LGC/Astronaut Communications

The display and keyboard logic in the LGC processes information exchanged between the LGC 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 LGC.

(b) Loading of external data -The process of inserting data into the LGC 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).

1. UPLINK ACTY Light - is energized by the first character of a digital UPLINK message received by the LGC. 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.

2. NO ATT Light - is energized when the LGC is in the Operate Mode and there is no inertial reference; i.e.: the ISS is off, caged, or in the Coarse Align Mode.

3. STBY Light - is energized when the LGC is in the Standby Mode and de-energized when the LGC is in the Operate Mode.

4. KEY REL LIGHT

   A. Energized when:

      (a) An internal display comes while the 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.)

B. De-energized when:

(a) Astronaut relinquishes the DSKY by operating the KEY REL button.

(b) Astronaut terminates his current sequence normally, e.g.:

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.

C. Some special DSKY cases 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 (4)(A.)(c) 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) If 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 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.

5. TEMP Light - the LGC 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.

6. GIMBAL LOCK Light - is energized when the middle gimbal angle exceeds $\pm 70^{\circ}$ from its zero position. When the middle gimbal angles exceeds $\pm 85^{\circ}$ from its zero position the LGC automatically commands the coarse align mode in the ISS to prevent gimbal oscillation. The NO ATT light will then be energized (see (2.) above).

7. PROG Light - under a variety of situations a program alarm is generated. The program alarm actuates the PROG lamp on the DSKY. For further information see section 4. 3. 3, and 4. 3. 4.

8. TRACKER Light - when the rendezvous or landing radars are on, the light is energized when:
   A. An RR CDU fine error signal greater than 1. 0 vrms occurs.*
   B. An RR CDU coarse error signal greater than 2. 5 vrms occurs.*
   C. The RR read counter limit-cycles at a rate greater than 160 cps.*
   D. An RR CDU analog-to-digital conversion fails, i. e.: cos $(\Theta - \phi)$ signal is less than 2 volts.
   E. The RR CDU +14 VDC supply decreases to 50% of nominal.*
   F. When the RR Data Good bar discrete occurs during an LGC data read sequence.

9. 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.

10. COMP ACTY Light - is energized when the LGC is occupied with an internal sequence. It is not an indication that the operator may or may not use the DSKY or that the LGC is incapable of handling further computation.

11. RESTART Light - in the event of a Restart during operation of a Program a latch is set in the LGC which illuminates the RESTART lamp on the DSKY until the latch is manually reset by RSET (see section 4. 3. 3).

12. ALT Light - when the landing radar is on, the light is energized (on steady or flashing) when:

    A. LR range data good discrete was not present before and after LR altitude sampling (STEADY).

    B. LR altitude reasonability test was failed (FLASHING).

13. VEL Light - when the landing radar is on, the light is energized (on steady or flashing) when:
    A. LR velocity data good discrete was not present before and after LR velocity sampling (STEADY).
    B. LR velocity reasonability test was failed (FLASHING).

14. Display Panel - consists of 24 electroluminescent sections arranged as in Fig. 4-1, page 4-18. Each section is capable of displaying a 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 0.50 second.

* And RR is in auto mode and RR CDU's are not being zeroed.

15. Keyboard - contains the following buttons:

VERB - pushing the button indicates that the next two numerical characters keyed 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 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 LGC is in the Standby Mode, pressing this button will put the LGC in the Operate Mode, turn off the STBY light (see 3.) and automatically select Routine 00 in the LGC, after restoring the clock.

2a. When the LGC is in the Operate Mode but Program 06 is not selected, pressing the button will provide the "Proceed" function. "Proceed" directs the LGC to continue to the next programmed event. In response to an LGC request it further indicates crew compliance with the request. If the PRO button is pressed when the VERB lights contain verb 21, 22 or 23, the button is rejected and the OPR ERR light is energized.

b. When the LGC is in the Operate Mode and Program 06 is selected, pressing the button will put the LGC in the Standby Mode and turn on the STBY light (see 3.).

ENTR - is used in three ways:

1. To direct the LGC to execute the Verb/Noun now appearing on the Verb/Noun lights.

2. To direct the LGC to accept a data word just loaded.

3. In response to a "Please Perform" request (see section 4.2.2.7).

RSET - turns off alarm indicator 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 the Verb and Noun. 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 LGC 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 are interpreted as the Verb Code. Each of these characters is displayed in the Verb lights on the display panel as it is keyed 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 shown 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 five 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 five 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 alarm 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 is turned off by: PRO, VERB 34 ENTR (terminate), and internal program initiation of the Keyboard and Display System Program, (if the DSKY is not busy) or by a Fresh Start of the LGC, or by a re-cycle verb, or a Restart.

Monitor action is suspended (but not ended) by the depression of any key, except RSET. This turns on the KEY RLSE 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 LGC Programs and Routines.

As outlined in the Mission Programs (sec. 4.4.9) 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 a "MARK" button for an optics sighting.

LGC 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 LGC Program or Routine is interrupted until the astronaut responds appropriately, (although the program may continue to update the display) 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 4.4.9.

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, noun, or program number, 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 alarm 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. Exceptions to this are in P40/P41/P42 when the DSKY is blanked at T-35 seconds. 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 4.4.9.

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 LGC 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 alarm 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 five 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. 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 the CLR is punched before the data ENTR. Once the ENTR is depressed, the 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 key performs the Clearing Function on whichever register is being loaded. (The CLR may be pressed after any character, but before its ENTR.) Consecutive depressions of CLR perform the Clearing Function on 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 attempts 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 LGC is prepared to accept optical sighting data upon the pushing of a "MARK" button. The logic associated with the "please mark" function is completely described in Section 4.4.9.

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) the Noun register to be blanked, 3) a request for the new Program to be entered, and 4) the new Program Code to be displayed (if allowed) in the Program display register.

4.2.2.11 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. (This does not apply to V21, V22, or V23 except for the specific components.)

(h) No input code other than those which are defined may be punched into the keyboard.

4.2.2.12 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 operator

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) All 3 words must loaded for the Hours, Minutes, Seconds scale.

(g) When loading with the Hours, Minutes, Seconds scale, the minutes must not exceed 59; the seconds must not exceed 59.99; and the total magnitude must not exceed 745 hours, 39 minutes, 14.55 seconds.

(h) Two numerical characters must be supplied for the Program Code under V37.

4.2.2.13 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 4.4.9).

(d) An attempt to call one extended verb on top of another without allowing proper termination of the first.

(e) The PRO button may not be pressed when the VERB lights contain verb 21, 22 or 23.

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

	DISPLAY OF INFORMATION		REQUEST FOR ASTRO ACTION	REQUEST FOR DATA LOAD	REQUEST FOR OPTICS MARK
	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), V97 (perform engine fail procedure), 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")
	LGC Awaiting ASTRO Response	LGC Not Awaiting ASTRO	LGC Always Awaiting ASTRO Response	LGC Always Awaiting ASTRO Response	LGC Always Awaiting ASTRO Response
ASTRONAUT RESPONSE	V__N__ Flashing	V__N__ Static	VXXN__ Flashing	V__N__ Flashing	V52, V53, or V54 Flashing
Key in "ENTR"	No LGC Action	No LGC Action	LGC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues.	AGC takes loaded data, terminates flashing Verb-Noun and continues.	Discard mark data on present target and return to earlier point in sequence
Key in "PRO"	LGC assumes displayed data is correct, terminates flashing Verb-Noun, and continues.	No LGC Action	LGC assumes ASTRO complied, terminates flashing Verb-Noun, and continues.	Incorrect Response	Marking sequence is terminated
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 (recycle)	LGC returns to earlier point in sequence.	No LGC Action	Incorrect Response.	Incorrect Response	Discard mark data on present target and return to earlier point in sequence
Press "MARK X" button or "MARK Y" button					LGC reads 3 CDU angles and time, terminates flashing Verb-Noun if a suitable number of marks have been made and continues.

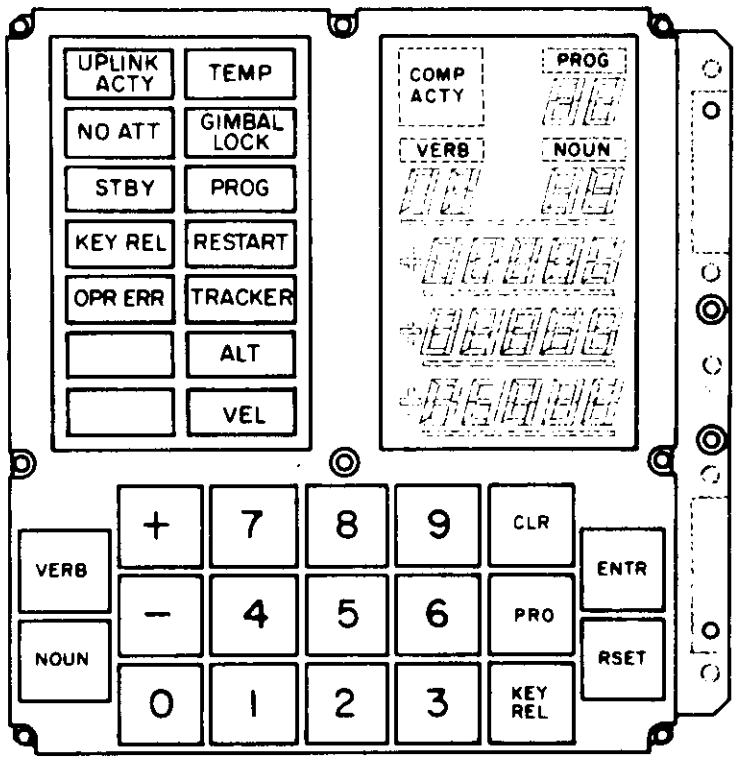

Fig. 4-1 Display and Control Panel

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: LGC Warning indicates computer failure; ISS warning indicates failure of the inertial subsystem. 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 LGC Warning

An LGC warning alarm is generated in the event of LGC power failure, scaler failure of either of two types, restart or counter fail during LGC 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 momentary transient disturbances from causing a warning alarm. In this subsection the various inputs and conditions associated with LGC 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 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 TC or TCF instructions are too infrequent. The criterion for "too many" varies from 5 ms to 15 ms duration. The criterion for "too infrequent" varies from 5 ms to 15 ms absence.

(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 LGC voltages (28, 14, 4)are out of limits. This signal produces STRT1 if it stays on for a period of between 157 and 470 μsec. If the computer is in the STANDBY mode, an input to the LGC 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 LGC 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 LGC alarms are inhibited during the Standby mode with the exception of LGC 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 after any of the following: RUPT LOCK, TC TRAP, NIGHT WATCHMAN, PARITY FAIL, STANDBY, VOLTAGE FAIL.

RESTART causes the computer to transfer control to address 4000 as soon as it disappears. It lights the RESTART lamp in the DSKY.

The RESTART lamp is turned off either by the ALARM RESET (RSET) key, or by setting outbit CH11 B10.

(k) WARNING FILTER - This circuit is used to operate the LGC WARNING output following repeated or prolonged occurrences of any of certain failure 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 LGC WARNING to turn on for

about 5 seconds. Non-consecutive stretched pulses may also cause LGC 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 LGC 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 LGC is in STANDBY because of loss of power to front end of circuit. This results in a 250-millisecond delay in starting when LGC comes out of STANDBY into OPERATE. Causes 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 - 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 LGC program control. The "FAIL" signal is inhibited by the LGC program when the PGNCS 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

Occurs if no pulses arrive from a PIPA during a 312.5 μsec 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 LGC and thus is completely under LGC program control. Its generation is enabled by the LGC only during LGC controlled translation or thrusting maneuvers.

(c) ISS CDU FAIL (Monitored for each of 3 CDUs)

(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 LGC program control. The "FAIL" signal is inhibited by the LGC program when the PGNCS is in the CDU Zero Mode and for 10 seconds afterwards. 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) LGC Restart during Operation. In the event of Restart during operate a latch is set in the LGC which maintains the PGNCS Caution alarm and the RESTART lamp on the DSKY until the latch is reset by the 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 LGC 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 LGC 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 LGC 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 the possible Rendezvous Radar CDU failures. (see paragraph 4.2.2.1-8)

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 4.4.7.

4.3.5 Restart Protection

With the exception of P06, all programs are restart protected. All routines which are called by a program are restart protected. The logic is designed such that significant information is not lost due to a restart. Extended verb routines and manually called displays are not restart protected.

4.4 LGC Logic/Ground/Crew Interface Diagrams

These diagrams outlined the detailed logic of the inter-relationship between the LGC/Crew/Ground. For ease of correction and reproduction the diagrams have been incorporated in a computer memory 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 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 LGC.

   d) POSS HOLD (Possible HOLD) - denotes that the display is a possible path taken by the LGC.

   e) MON (Monitor) - denotes that the displayed data is automatically updated and displayed by the LGC.

   f) SNAP - denotes that the displayed data is not automatically updated (monitored) by the LGC.

2) LGC
3) Ground
4) Crew

   } The sequence logic and interface relationships of the LGC logic, ground operations and crew activities.

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

6) The LGC Program (or Routine) number is printed on the lower right hand corner of each page eg.: P40/LUMINARY. In addition, the commonality of Programs and Routines contained in LUMINARY, COLOSSUS, and SUNDANCE is also designated eg.: P34/LUMINARY, P34/COLOSSUS, P34/SUNDANCE. This commonality is defined to be identical man-machine interface operation and identical intent. However, it should be clearly understood that commonality so defined does not imply identical logic flow either in the diagrams or the computer program.

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LUMINARY - GUIDANCE SYSTEM OPERATIONS PLAN - R567, PGNCS OPERATIONAL MODES, SECTION 4.4, LGC LOGIC/GROUND/CREW INTERFACE DIAGRAMS
08/01/69

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LL          UU      UU  MM      MM  II  NN      NN   AAAAAAAAAA   RRRRRRRRRR   YY      YY
LL          UU      UU  MM      MMM II  NN      NN  AAAAAAAAAAAA  RRRRRRRRRRR   YY    YY
LL          UU      UU  MMMM    MMMM II  NNNN    NN  AA      AA   RR      RR    YY   YY
LL          UU      UU  MM MM  MM MM II  NN NN   NN  AA      AA   RR      RR     YY YY
LL          UU      UU  MM  MMMM  MM II  NN  NN  NN  AA      AA   RR      RR      YYYY
LL          UU      UU  MM   MM   MM II  NN   NN NN  A LUMINARY A  RRRRRRRRRRR      YY
LL          UU      UU  MM        MM II  NN    NN NN  A LUMINARY A  RRRRRRRRRR       YY
LL          UU      UU  MM        MM II  NN     NN NN  AA      AA   RR    RR         YY
LL          UU      UU  MM        MM II  NN      NNNN  AA      AA   RR     RR        YY
LL          UU      UU  MM        MM II  NN       NNN  AA      AA   RR      RR       YY
LLLLLLLLLLL  UUUUUUUUU  MM        MM II  NN        NN  AA      AA   RR       RR      YY
LLLLLLLLLLL   UUUUUUU   MM        MM II  NN        NN  AA      AA   RR        RR     YY
```

4.4.1 PROGRAMS AND ROUTINES DIAGRAMMED IN SECTIONS 4.4.9 AND 4.4.10 FOR PROGRAM LUMINARY

REV 02 12/03/69

PHASE	PROGRAM NUMBER	PROGRAM TITLE	PCR
SERVICE	00	LGC IDLING	
	01	-----*	
	02	-----*	
	03	-----*	
	04	-----*	

	05	-----*
	06	LGC POWER DOWN
	07	IMU PERFORMANCE TEST (PRELAUNCH ONLY)
	08	-----*
	09	-----*
ASCENT	10	-----*
	11	-----*
	12	POWERED ASCENT
	13	-----*
	14	-----*
	15	-----*
	16	-----*
	17	-----*
	18	-----*
	19	-----*
COAST	20	RENDEZVOUS NAVIGATION
	21	GROUND TRACK DETERMINATION
	22	LUNAR SURFACE NAVIGATION
	23	-----*
	24	-----*
	25	PREFERRED TRACKING ATTITUDE
	26	-----*
	27	LGC 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	-----*
THRUSTING	40	DPS
	41	RCS
	42	APS
	43	-----*
	44	-----*
	45	-----*
	46	-----*
	47	THRUST MONITOR
	48	-----*
	49	-----*
ALIGNMENTS	50	-----*
	51	IMU ORIENTATION DETERMINATION
	52	IMU REALIGN
	53	-----*
	54	-----*
	55	-----*

	56	-----*	
	57	LUNAR SURFACE ALIGN	
	58	-----*	
	59	-----*	
DES-CENT	60	-----*	
	61	-----*	
	62	-----*	
	63	BRAKING PHASE	
	64	APPROACH PHASE	
	65	LANDING PHASE (AUTO)	
	66	LANDING PHASE (ROD)	
	67	-----*	285
	68	LANDING CONFIRMATION	
	69	-----*	
ABORTS AND BACKUPS	70	DPS ABORT	
	71	APS ABORT	
	72	CSM CO-ELLIPTIC SEQUENCE INITIATION (CSI) TARGETING	
	73	CSM CONSTANT DELTA ALTITUDE (CDH) TARGETING	
	74	CSM TRANSFER PHASE INITIATION (TPI) TARGETING	
	75	CSM TRANSFER PHASE MIDCOURSE(TPM) TARGETING	
	76	TARGET DELTA V	
	77	-----*	
	78	-----*	
	79	-----*	

ROUTINE	ROUTINE TITLE	
00	FINAL AUTOMATIC REQUEST TERMINATE	
01	ERASABLE AND CHANNEL MODIFICATION	2.5.2
02	IMU STATUS CHECK	
03	DAP DATA LOAD	
04	RR/LR SELF TEST	
05	S-BAND ANTENNA	
06	-----*	
07	-----*	
08	-----*	
09	R10/R11/R12 SERVICE	
10	LANDING ANALOG DISPLAYS	
11	ABORT DISCRETES MONITOR	
12	DESCENT STATE VECTOR UPDATE	
13	LANDING AUTO MODES MONITOR	
14	-----*	
15	-----*	
16	-----*	
17	-----*	
18	-----*	
19	-----*	
20	LR/RR READ	
21	RR DESIGNATE	
22	RR DATA READ	
23	RR MANUAL ACQUISITION	
24	RR SEARCH	

25 RR MONITOR
26 LUNAR SURFACE RR PRE-DESIGNATE
27 -----*
28 -----*
29 POWERED FLIGHT RR DESIGNATE
30 ORBIT PARAMETER DISPLAY
31 RENDEZVOUS PARAMETER DISPLAY
32 -----*
33 LGC/CMC CLOCK SYNCHRONIZATION
34 -----*
35 -----*
36 RENDEZVOUS OUT-OF-PLANE DISPLAY
37 -----*
38 -----*
39 -----*
40 DPS/APS THRUST FAIL
41 STATE VECTOR INTEGRATION (MID TO AVE)
42 -----*
43 -----*
44 -----*
45 -----*
46 -----*
47 AGS INITIALIZATION
48 -----*
49 -----*
50 COARSE ALIGN
51 INFLIGHT FINE ALIGN
52 ALTE OPTICS POSITIONING
53 ALT MARK

54	VIEWING DATA DISPLAY
55	GYRO TORQUING
56	TERMINATE TRACKING
57	MARK/RUPT
58	CELESTIAL BODY DEFINITION
59	LUNAR SURFACE SIGHTING MARK
60	ATTITUDE MANEUVER
61	PREFERRED TRACKING ATTITUDE
62	CREW-DEFINED MANEUVER
63	RENDEZVOUS FINAL ATTITUDE
64	-----*
65	FINE PREFERRED TRACKING ATTITUDE
66	-----*
67	-----*
68	-----*
69	-----*
70	-----*
71	-----*
72	-----*
73	-----*
74	-----*
75	-----*
76	EXTENDED VERB INTERLOCK
77	LM SERVICES TEST

* THIS PROGRAM OR ROUTINE DOES NOT EXIST FOR ASSEMBLY LUMINARY

CHANGE CONTROL NOTES

```
LOGIC REV 00    PCR 39
LOGIC REV 01    PCR 79,105,106,138,229,468,470,562
      REV 00(LUM 1A)  PCR 722
      REV 01(LUM 1B)  PCR 279,823
      REV 02(LUM 1C)  PCR 285,806.2
```

4.4.2 LUMINARY PCR CHANGE RECORD

CODE OF STATUS ABBREVIATIONS
- A - APPLICABLE TO LUMINARY
- NA - NOT APPLICABLE TO LUMINARY
- S(XX) - SUPERSEDED BY PCR (XX)
- C - CANCELLED OR WITHDRAWN
- A(D) - APPLICABLE TO LUMINARY, BUT DISAPPROVED
- OPEN - DISPOSITION NOT ESTABLISHED AND/OR NOT INCORPORATED IN THIS EDITION OF SECTION 4.
- UNAS - UNASSIGNED, PCR NUMBER NOT IN USE AT THIS TIME

PCR NUMBER	STATUS	DISPOSITION, SEC. 4	NOTES	SUBJECT TITLE (IF APPLICABLE TO SECTION 4)
1	NA	-		
2	A	-	SEC. 2 ONLY	
3	NA	-		
4	A	-	LUM II	
5	NA	-		
6	NA	-		
7	A	P51,R53		IMU ALIGNMENT PROGRAM CHANGE
8	A	V/N LIST,R40		MODIFICATION TO DELTA V MONITOR

9	A	V/N LIST,R60		SIMPLIFY CREW PROCEDURES IN R60 (ATTITUDE MANEUVER ROUTINE)
10-12	C	-		
13	A	P12,P63,P70,P71,R12,R29		MODE II RENDEZVOUS RADAR DESIGNATE
14	A	-	SEC 2 ONLY	
15	A	R05		S-BAND ANTENNA
16-17	NA	-		
18	C	-		
19-25	NA	-		
26	C	-		
27	A(D)	-		
28,29	C	-		
30	A	P40,P63		DPS TRIMMING TIME
31	A	P12,P40,P42,P63,P64,P65, P66,P67,P70,P71		LGC REQUIREMENTS DURING AGC SWITCHOVER
32	S(85)	-		
33	A(C)	-		
34	C	-		
35	NA	-		

36	S(36)	-		
37-38	NA	-		
39	A	INDEX,P25,R22,R29,R61,R65		Z AXIS TRACK (ONLY)
40,41	C	-		
42	NA	-		
43	A(D)	-		
44-52	NA	-		
53-61	A(D)	-		
62-69	NA	-		
70	A	P70,P71	SEC. 5	CHANGES TO P12, P70, P71
71	A(D)	-		
72-76	NA	-		
77	A(D)	-		
78	NA	-		
79	A	V/N LIST, R01		FLAGBIT UPDATE VERB
80	A	PCU,RCO		STATE VECTOR SYNCHRONIZATION
81	NA	-		
82	A(D)	-		

83,84	NA	-		
85	A	P12,P40,P41,P42,P63,P64, P65,P66,P67,P70,P71		RATE COMMAND/ATTITUDE HOLD DURING X-AXIS OVERRIDE
86	A	P12,P40,P41,P42,P63,P70, P71,R00,R23,R60.		DEADBAND SELECTION CHANGES
87	NA	-		
88	A	-	SEC 5 ONLY	
89-92	NA	-		
93	A	-	SEC 2 ONLY	
94	NA	-		
95	A	R04		SIGN CHANGE TO NOUN 72
96	A	V41N72		CHANGE TO RR COARSE ALIGN EXTENDED VERB
97	A	R25		RR MONITOR ROUTINE CHANGE
98	A(D)	-		
99	A	V/N LIST,V85,P12,P22,P68		DSKY DISPLAY OF RR POSITION IN MODE II
100-104	NA	-		
105	A	INDEX, OPTION LIST.		DELETION OF LM/CSM SEPARATION MONITOR
106	A	INDEX,V/N LIST,ALARM LIST, P12,P57		DELETION OF DIRECT TRANSFER ASCENT TARGETING
107	UNAS	-		

108-113	NA	-		
114	A	P42		DELETE MINIMUM DEADBAND SETTING DURING MINIMUM IMPULSE BURN
115-117	A(D)	-		
118	A	V/N LIST,P63,ROC,R12		REDEFINITION OF R12 PROCEED AND INHIBIT
119	C	-		
120	NA	-		
121	A	R40		NEW ENGINE FAIL ROUTINE
122	S(144)	-		
123	NA	-		
124	A	R24		ATTITUDE MANEUVER DURING RR SEARCH ROUTINE
125	S(184)	-		
126	NA	-		
127	C	-		
128-132	NA	-		
133	A	-	SEC. 5 AND CODING	
134	A	CHECKLIST,P52,R51		PULSE TORQUING TO ACHIEVE IMU REALIGNMENT
135,136	NA	-		

137	A	R00,R12		R12 FLAG CHANGE
138	A	INDEX,V/N LIST, ALARM LIST, P12,P57		DELETION OF PREDICTED LAUNCH TIME PROGRAM
139	A(D)	-		
140,141	A	-	SEC. 3 ONLY	
142	NA	-		
143	S(499)	-		
144	A	P12,P40,P42,P63,R40		REDUCTION OF ULLAGE DURATION AND DELTA V THRESHOLD
145	NA	-		
146	A	P00,P20,P22		EMERGENCY TERMINATION OF INTEGRATION FUNCTION
147-158	NA	-		
159	A(D)	-		
160-162	NA	-		
163	A	-	SEC 2 ONLY	
164	A	V/N LIST, P12,P40,P41,P42, P63,P64,P65,P70,P71,R60		MODE II ATTITUDE ERROR DISPLAY
165	UNAS	-		
166-170	NA	-		
171	A	-	SEC 5 ONLY	
172	NA	-		

173	A	V/N LIST,P20,P22,V67		RMS POSITION AND VELOCITY ERROR DISPLAY
174-180	NA	-		
181	A	-	SEC 5 ONLY	
182,183	NA	-		
184	A	RC3,R47		STANDARDIZE TERMINATION OF EXTENDED VERBS V47 AND V48
185	A	V41N72		SIGN CHANGE TO NOUN 73
186	A	P40,P42,P63		ELIMINATION OF ULLAGE FOLLOWING AN ENTER OR TERMINATE
187-189	NA	-		
190	A	R31		CLARIFICATION OF R31'S OPERATION
191	A	-	SEC. 5 ONLY	
192-196	NA	-		
197	A(D)	-		
198-201	NA	-		
202	C	-		
203,204	NA	-		
205	A(D)	-		
206	NA	-		

207	A	-	SEC 2 ONLY	
208,209	NA	-		
210	A	P66		INCREASE DPS THROTTLE RECOVERY LIMIT
211-213	NA	-		
214	A	R00,R09,R12,R20		DSKY LIGHT UTILIZATION FOR LR
215	NA	-		
216	A	R12		INITIATION OF LR ANTENNA POSITION CHANGE
217-219	A(D)	-		
220,221	NA	-		
222	A(D)	-		
223	NA	-		
224	A(D)	-		
225	NA	-		
226	A	P20,P22,R12,R21,R22,R23,R60		CHANGE PRIORITY DISPLAYS FROM 5 SEC TO 2 SEC
227	A(D)	-		
228	A(D)	-		
229	A	INDEX,V/N LIST,R77		ADDITION OF R77 TO LUMINARY
230	A	-	SEC 2 ONLY	

231	NA	-		
232	A(L)	-		
233	A	-	SEC 5 ONLY	
234	A	MANY PROG/ROUT.		UPDATE LUMINARY CSDP SECTION 4 (NASA COMMENTS)
235	UNAS	-		
236-240	NA	-		
241	A(D)	-		
242	A(D)	-		
243	A	-	SEC. 2 ONLY	
244	A	R12		DELAY
245	NA	-		
246	A	VERB LIST,P63,P64		IMPLEMENTATION OF ONE-PHASE DESCENT GUIDANCE LOGIC
247	A(D)	-		
248	A	R12		LR REASONABILITY TEST
249	A(D)	-		
250-251	NA	-		
252	A	-	SEC. 5 ONLY	
253	A	P63,R12		LANDING RADAR READ INITIATION

254	A	NOUN LIST,P32,P72		MODIFICATION OF COH TIME COMPUTATION LOGIC
255-256	NA	-		
257	A(C)			
258	A	P12,P70,P71		REDEFINITION OF VERTICAL RISE VELOCITY CUTOFF
259	A	P70,P71		OMIT ZONE 1 FROM DESCENT LOGIC
260	NA	-		
261	NA	-		
262	A	-	SEC. 1 ONLY	
263	C	-		
264	A	-	SEC. 2 ONLY	
265	A	-	SEC. 2 ONLY	
266-267	NA	-		
268-399	UNAS	-		
400	A	R22		PROVIDE RR DOWNLINK DATA ON LUNAR SURFACE IN P22
401	A	P12,P40,P41,P42,P47,P63		CORRECTION OF IMU WARM UP TIME
402	NA	-		

403	C	-	
404	NA	-	
405	A	R30	GSOP UPDATE SECTION 4
406	A	R04	CORRECTION TO R04 IN GSOP SECTION 4
407	A	V/N LIST,R36	GSOP CHANGE TO NOUN 90 R1 SCALE
408	A	R47	R47 CHANGES TO SECTION 4
409	A	R23,R24	TRANSFER OF RR FROM AUTO TRACK TO LGC MODE
410	A	R25	PREVENT PROBLEMS ARISING FROM RR CONTROL MODE CHANGES
411,412	NA	-	
413	A	R02	GSOP SECTION 4 R02 IMUSE FLAG
414	NA	-	
415	A	P20,P22	PREVENT DISPLAY CONFLICTS WHEN RR GOES OUT OF AUTO MODE
416	NA	-	
417	A	P27	DELETION OF ENDSAFE
418	A(C)	-	
419	A	P12,P40,P42,P63,P68,P70, P71,R03	STAGE-VERIFY DISCRETE

420	A	R04,V/N LIST		REARRANGEMENT OF EXTENDED VERBS
421	C	-		
422-430	NA	-		
431	C	-	(NOTE:MIT/IL	WILL PROPOSE CANCELLATION OF THIS PCR.)
432	A	R21		GSOP SECTION 4 R21 REPOSITIONING CHECK
433	A	R60		GSOP SECTION 4 R60 CLARIFICATION
434	C	-		
435,436	NA	-		
437	A	ALARM LIST,P12,P47,P63,R41		MID-TO-AVE FOR P47, P12, P63
438	NA	-		
439	A	P52,P57		DOWNGRADE THE AUTHORITY OF THE PREFERRED ATTITUDE FLAG
440-443	NA	-		
444	A	P06		P06 IMUSE FLAG
445	A	P39,P79		USE OF N34 IN P39
446	A	R60		R60 BALL ANGLE DISPLAY
447-450	NA	-		

451	[illegible]	[illegible],R23, [illegible]		[illegible] IN [illegible]
452	A	R03		ROUTINE 03 [illegible] LIMITS
453	A	R00		ALARM 01520 AND IMUSE FLAG
454-456	NA	-		
457	A	R20		CORRECTION TO R22
458-467	NA	-		
468	A	INDEX,V/N LIST,P20,P22,P76		CHANGE R32 INTO PROGRAM P76
469	A	V/N LIST,P57		NOUN CHANGE IN P57
470	A	INDEX,V/N LIST,CHECKLIST, P65,P66,P67,P68		ADDITION OF P68 PROGRAM
471	A	-	CODING ONLY	
472	A	V/N LIST,P70,P71,R40		SIMPLIFICATION OF P71
473	C	-		
474	NA	-		
475	A	P12,P70,P71,R10		EXTENSION OF [illegible] CAPABILITY
476	A	P12,P70,P71	SEC 5	FINDCDUW - GIMBAL DRIVE
477	NA	-		

478	A		SEC 5 ONLY	
479	C	-		
480,481	NA	-		
482	C	-		
483-485	NA	-		
486	S(490)	-		
487	NA	-		
488	S(468)	-		
489	A	P57		BYPASS R54 AND NOUN 93 DURING INITIAL ALIGNMENT
490	A	V/N LIST,OPTION LIST,R04, R20,R63,V41N72		NEW NOUN FOR OPTION CODE IN EXTENDED VERBS
491-493	NA	-		
494	A	-	SEC 2 ONLY	
495	NA	-		
496	A	ALL EXTENDED VERBS		INCORPORATION OF EXTENDED VERBS
497	A	P63		DO NOT DELAY P63 THROTTLE-UP TIME
498	A	P63		GSOP CHANGE R63
499	A	R10	SEC 5	R10 COMPUTATION FREQUENCY

500,501	NA	-		
502	A	P35,P75		CLARIFY FIRST TEL DISPLAY IN P35/P75
503-506	NA	-		
507	A	PCC,VSC		TERMINATION OF INTEGRATION
508-512	NA	-		
513	A	R33		CORRECT EXIT OF R33
514	A	P12		P12 GSOP CHANGE
515-517	NA	-		
518	A	R30		CORRECTION TO R30
519-526	NA	-		
527	A	R53		MARK VERB FOR R53
528-530	NA	-		
531	A	R63		ADD 1 MINUTE TO R63 EXTRAPOLATION
532	A	-	SEC 2 ONLY	
533	NA	-		
534	A(L)	-		
535	NA	-		

536	A	ALARM LIST,P70,P71	P70, P71 SELECTION VIA V37
537	A	P20,P22	SURFACE NAVIGATION FLAG CHECK IN P20 AND P22
538	NA	-	
539	A	VERB LIST,P40,P63,P70	PROVIDE OPTION TO DISABLE THE PITCH-ROLL RCS AUTOPILOT
540	A	V/N LIST,P32,P33,P72,P73	ACTIVE VEHICLE CENTRAL ANGLE IN CSI-CDH
541	A	P20,P22	DECREASE FREQUENCY OF MARKS IN P22
542	A	P63,P64,P65,P66,P67,P70,P71	ASSURE RATE COMMAND/ATTITUDE HOLD MODE DURING P66 AND P67
543	A(C)	-	
544	UNAS	-	
545	A	P38,P78	P38/P78 UPDATE INHIBIT FOR T(FINAL) CALCULATION
546	A	P68	P68 DELETION OF PLEASE PERFORM ATTITUDE STORAGE DISPLAY
547	A	P68	P68 TERMINATES IN GOTOPOOH
548	C	-	
549	A	P20,P22	RR SHAFT/TRUNNION BIAS MODIFICATION BY CREW

550	C	-		
551	S(618)	OPEN		
552-553	NA	-		
554	A	-	SEC. 2 AND CODING	
555	A	-	SEC 5 ONLY	
556-558	NA	-		
559	A	R29,R41		R29 HINDRANCE BY MID-TO-AVE TIG SLIP IN P12
560	UNAS	-		
561	A	P12		RESET OF RENDWFLAG IN P12
562	A	INDEX,P20,P22,P25,R21,R22, R23,R24		SELECTION AND TERMINATION OF P20/22/25
563	UNAS	-		
564	A	-	SEC 5 ONLY	
565	A	-	SEC 5 ONLY	
566	NA	-		
567	A(C)	-		
568	A	P63,P70,P71,R12,R29		DELETE USE OF R29 DURING P63
569	A(C)	-		
570-572	NA	-		

573	A	-	SEC 5 ONLY	
574-575	NA	-		
576	A	-	SEC 5 ONLY	
577-586	NA	-		
587	A	-	SEC 6 ONLY	
588	NA	-		
589	A	-	SEC 2 ONLY	
590	NA	-		
591	A(D)	-		
592	NA	-		
593	A	ALARM LIST		MODIFY ARCSIN-ARCCOS ALARM (01301) ACTION TO AVOID HARDWARE RESTART
594-598	NA	-		
599	A	-	SEC 3 ONLY	RESCALE ATTITUDE ERROR DISPLAY
600	A(D)	-		
601-603	NA	-		
604	A	P30,P31,R30		PROVIDE MAXIMUM DISPLAY FOR PERIGEE AND APOGEE IN P30,P31,R30.
605-606	NA	-		
607	A	ALARM LIST		UPDATE ALARM CODE LIST

608	A	P57		SIMPLIFICATION OF PREFERRED ORIENTATION SELECTION (P57)
609	A	P40,P41,P42		PREFERRED IMU ORIENTATION WHEN THRUST IS ALONG LOCAL VERTICAL
610-611	NA	-		
612	A	R40		RAISE THRESHOLDS FOR DELTA V MONITOR
613	A	P12,P70,P71		AUTOMATIC 4-JET TRANSLATION CAPABILITY IN P12,70,71
614	A	P00,P20,P22,R30 R31,R36,R41		ADD NOUN 38 FOR TIME OF STATE VECTOR
615	A	R04		REDUCE RESTRICTIONS ON RUNNING R04 TO A MINIMUM
616	A	-	SEC 2 ONLY	
617	A	P12,P70,P71,R10		PREVENT R10 FROM DESIGNATING THE RP
618	A	R03		MAKE THE DAP RATE COMMAND A NON-LINEAR FUNCTION OF LM HAND CONTROLLER DEFLECTION
619-621	NA	-		
622	A	R31		CORRECTION TO V-2, R DOT, THETA, ON LUNAR SURFACE
623	A	NOUN LIST,P12,P22,P32 P33,R08,R72,R73,V45		USE SAME NOUN NUMBER FOR P32 AND P33 IN LUMINARY AND COLOSSUS II

624-626	NA	-		
627	A	P34,P35,P74,P75		[illegible] DATA [illegible] PROBLEM IN P34/74, P35/75
628-629	NA	-		
630	A	-	SEC 5,6 ONLY	
631	A	-	SEC 5 ONLY	
632	A	R12		ALLOW ASTRONAUT TO CONTINUE LANDING DISPLAY WHEN RALAR DOES NOT ACHIEVE POSITION #2
633	A(D)	-		
634	A	R61,R65		CORRECT DESIGN FLAW IN R61,R65 FOR HIGH LOS RATES
635	A	-	SEC 5 ONLY	
636	A	-	SEC 5 ONLY	
637	A	P40,P41,P42,P63,R60		DELETE X-AXIS OVERRIDE INHIBIT FROM R60
638	NA	-		
639	A	R12		ALTITUDE REASONABILITY TEST PARAMETERS IN ERASABLE MEMORY
640	A	P20,P22,R21		REMOVE THE INSTABILITIES AND EXCESSIVE OVERSHOOTS FROM THE RR DESIGNATE ROUTINE R21
641	A(D)	-		

642	NA	-	
643	NA	-	
644	A	-	SEC 2 ONLY
645	C	-	
646-651	NA	-	
652	A	-	SEC 5 ONLY
653-659	NA	-	

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4.4.2 LUMINARY PCR CHANGE RECORD
4.4.2.1 LUMINARY 1A PCR CHANGE RECORD

REV 02 10/31/69

THE LUMINARY 1A GSOP USES THE LUMINARY 1 GSOP AS A REFERENCE BASELINE, AND THE FOLLOWING TABULATION OF PCRS IS DESCRIPTIVE OF THE CHANGES MADE TO R567, SECTION 4, REVISION 1, (ASSEMBLY REVISION 069) IN ORDER TO UPDATE THE GSOP SECTION 4 TO THE LUMINARY 1A CONFIGURATION (ASSEMBLY REVISION C99).

ONLY THOSE PCRS WHICH ARE APPLICABLE TO LUM 1A SECTION 4 ARE TABULATED BELOW. THIS LIST SUPPLEMENTS PREVIOUS PCR CHANGE RECORDS WHICH SHOULD ALSO BE RETAINED FOR REFERENCE PURPOSES.

PCR NUMBER	EFFECTIVE LOCATION	SUBJECT TITLE
260	FLAGS, P12,P70,P71	PREFERRED ORIENTATION DURING LM ABORTS
268.2	NOUNS, P34, P74	REDUCTION OF P34/P35 RUN TIME
270	NOUNS, P12,P70,P71	PLACEMENT OF DESIRED INSERTION RADIAL VELOCITY COMPONENT INTO ERASABLE FOR P70/P71/P12
642	R61,R65	PROVIDE "WINGS LEVEL" HEADS UP, FINE Z-AXIS TRACKING
646	P20,P22	GIVE ASTRONAUT THE OPTION TO CONFIRM MAIN-LOBE LOCK-ON AFTER R21 ACQUISITION
647	P31,P40,P41,P42	REPLACE LAMBERT WITH "A" STEER IN P40,P41, AND P42
648	P40,P42	MODIFY P42 TO PERMIT STAGING BETWEEN TIG-30 AND TIG
654	R31	LESSEN DELAYS IN R31
670	FLAGS, P63,P64	SIMPLIFICATION OF LANDING PROGRAMS
695	NOUNS, P32, P72	PROVIDE OPTION FOR CSI PROGRAM TO COMPUTE T(APOAPSIS)
696	P57	VOEN22 DISPLAY IN P57
697	P70,P71	LIMITATION OF LM ABORT ORBIT INSERTION TO 1/2 DEGREE PLANE CHANGE
698	P57	ADD LM POSITION DETERMINATION CAPABILITY TO P57
699	R52,R53,R59	PAD LOAD AOT BACK DETENT AZ AND EL ANGLES
700	P66,R13	IMPROVE THE RATE-OF-DESCENT MODE (P66) PERFORMANCE
702	R52	ADD COAS CALIBRATION OPTION TO R52
708	P12,P70,P71	PROVIDE CONTINUOUSLY VARIABLE ABORT ORBIT INSERTION TARGETING
716	R61,R65	ASCENT POWERED FLIGHT RCS CONTROL

720	ALARMS	ABORT COASTING INTEGRATION WHEN IN INFINITE ACCELERATION OVERFLOW LOOP
721	ALARMS	TIME-THETA AND TIME-RADIUS ALARM ABORT
722	INDEX,ALARMS,FLAGS, R21,R26	IMPROVE PERFORMANCE OF RR DESIGNATE PROCEDURE ON LUNAR SURFACE
732	NOUNS, P20,V67	PERMIT THE CREW TO MODIFY W-MATRIX BIAS ERROR IN V67 ROUTINE
736	NOUNS, R22	ADD SOURCE CODE TO NOUN 49 IN P20/P22
737	P63,P64,P65,P66, R13	PERMIT ATT HOLD MODE IN P63,P64,P65
738	NOUNS, P21	H,V, GAMMA DISPLAY WITH P21
740	P52	DISPLAY TLAND IN P52, OPTION 4
744	R24	CHANGE EPSILON TO 1.5 SECONDS IN R24
751	ALARMS, P63,P64	MAKE 1406 ALARM NON-ABORTIVE
752	P32,P33,P72,P73	CLARIFY DESCRIPTION OF TCDH-TCSI AND TTPI-TCDH DISPLAYS
754	P57	PROVIDE IMU ORIENTATION SELECTION OPTION CODE IN P57
755	P57	CHANGE IMU GIMBAL ANGLES IN GRAVITY VECTOR DETERMINATION
757	P12,P20,P22,P70,P71	INITIALIZE RADMODES FOR P20,P22 AND R29
758	R41	ALLOW 15 SECONDS FOR AN INTEGRATION TIME STEP IN R41
761.1	R41	R-2 LUNAR POTENTIAL MODEL
762	VERBS	DELETE V68

4.4.2 LUMINARY PCR CHANGE RECORD REV 04 09/16/69
4.4.2.2 LUMINARY 1B PCR CHANGE RECORD

THE FOLLOWING TABULATION OF PCRS IS DESCRIPTIVE OF THE CHANGES MADE TO R-567 SECTION 4, PGNCS OPERATIONAL MODES, REVISION 4 (ASSEMBLY REVISION 099) IN ORDER TO UPDATE THE GSOP SECTION 4 FROM THE LUMINARY 1A TO THE LUMINARY 1B CONFIGURATION (ASSEMBLY REVISION 116). ONLY THOSE PCRS APPLICABLE TO LUMINARY 1B HAVE BEEN TABULATED BELOW. THIS LIST SUPPLEMENTS PREVIOUS PCR CHANGE RECORDS WHICH SHOULD ALSO BE RETAINED FOR REFERENCE PURPOSES.

PCR NUMBER	EFFECTIVE LOCATION	SUBJECT TITLE
277	V74	A FIXED DUMPCNT
279	INDEX,P38,P39,P70,P71, P78,P79	VARIABLE INSERTION COMPUTATION
779	R29	LEAVE TRACK ENABLE SET WHEN R29 IS TERMINATED
780	NOUNS,R04,R05	PROVIDE PURE RR RANGE, RANGE RATE, AND TIME TAG DURING P20, P22, AND P25
791.2	SECTION 4.0 TEXT	DO NOT ALLOW A PROCEED RESPONSE TO A V21, V22, OR V23
798.2	FLAGS,R00	RESET GLOCKFAIL IN R00
801.2	ALARMS,R53	MAKE BAILOUT ALARMS START WITH 3XXXX AND P00D00 ALARMS START WITH 2XXXX
802.2	ALARMS	SAVE ALARM DATA AFTER "ERROR RESET"
805	V66	DON'T ALLOW V66 ON THE SURFACE
807.2	P21	ADD PRESENT TIME OPTION TO P21
812.2	P30,P34,P35,P74,P75	RESETTING AND SETTING OF THE EXTERNAL DELTA V FLAG
814	V57	REDUCE KEYSTROKES REQUIRED TO CHECK AND APPROVE LR DATA
816	R03	MODIFY R03 TO PERMIT ASTRONAUT SETTING OF 1 DEGREE DEADBAND
817	ALARMS,R04,R12,R20	ELIMINATE UNDESIRABLE LR POSITION ALARMS FROM R12
818	R22	PERMIT REJECTION OF INDIVIDUAL MEASUREMENT INCORPORATIONS IN P20
820	R12,R20	ELIMINATE LIGHTING OF ALT LIGHT WHEN LOW SCALE DISCRETE IS ABSENT
823	P31	DELETE P31(LAMBERT AIM POINT GUIDANCE PROGRAM)
825.2	P52	DISPLAY OPTION 3 IN P52/P54
826.2	P76	REVERSE P76 DISPLAY

832.2	R05	REMOVE RESTRICTION OF RUNNING R05 ONLY IN P00
838	P12,P40,P41,P42,P63,P64, P65,P66,P67,P68,P70,P71, R40	PREVENT RCS JET FIRINGS ON LUNAR SURFACE
839	R12	R12 AND LR RE-POSITION ROUTINE IMPROVEMENTS
840	P64,P70,P71	REDUCE ATTITUDE OSCILLATIONS IN P64 AND P65
841	VERBS,FLAGS,P12,P40,P41, P42,P63,P64,P65,P66,P67 P70,P71,R60,V59,V60,V61 V62	PGNCS DERIVED VEHICLE ATTITUDE RATES ON FDAI ERROR NEEDLES
*844	INDEX,NOUNS,OPTICAL CODES, FLAGS,P38,P39,P78,P79	DELETION OF P38/P78 AND P39/P79
*845	P70,P71	DO NOT TURN ON R29 DURING P70/P71
847	P12,P70,P71	ELIMINATE POSSIBLE LOCK-OUT OF PITCH-OVER FROM P12,P70,P71
848	R25	PREVENT RR ECDUS FROM STEALING LGC MEMORY CYCLES
853	VERBS	RESTRICT V35 TO P00
854	NOUNS,P63	PROVIDE A FLEXIBLE METHOD FOR CREW TO MODIFY RLS
855	R12	BEGIN READING LR VELOCITY AS SOON AS VELOCITY DATA GOOD APPEARS
856	ALARMS	CHANGE 1502/1206 FROM P00D00'S TO BAILOUTS

* ALSO REFER TO PCR 279

4.4.2 LUMINARY PCR CHANGE RECORD
4.4.2.3 LUMINARY 1C PCR CHANGE RECORD

REV 01 12/03/69

THE FOLLOWING TABULATION OF PCRS IS DESCRIPTIVE OF THE CHANGES MADE TO R-567 SECTION 4, PGNCS OPERATIONAL MODES, REVISION 6 IN ORDER TO UPDATE THE SECTION 4 GSOP FROM LUMINARY 1B TO LUMINARY 1C CONFIGURATION. THIS LIST SUPPLEMENTS PREVIOUS PCR CHANGE RECORDS WHICH SHOULD ALSO BE RETAINED FOR REFERENCE PURPOSES.

PCR NUMBER	EFFECTIVE LOCATION	SUBJECT TITLE
285(REV 1)	INDEX,NOUNS,FLAGS,P63, P64,P65,P66,P67,P68,P70, P71,R10,R11,R12,R13,R40	REMOVE CHECK OF AUTO THROTTLE DISCRETE
806.2	INDEX,NOUNS,R01	ALLOW N07 TO ADDRESS OUTPUT CHANNELS
863.2	FLAGS, P76	MAKE P76 SET NOCO FLAG
882	NOUNS,P65,P66	REPLACE VHORIZ WITH SOMETHING BETTER
893	FLAGS, P70, P71, R00	ABORT TARGETING FLAGBIT
895	FLAGS,V59	LR REPOSITION BY V59E IN P63
936.2	R36	INITIALIZE V90 TIME TO TIG
943	R12	VELOCITY REASONABILITY TEST
968	P64	LPD BIAS CORRECTION
972	R54	DISPLAY POLARITY OF SIGHTING ANGLE DIFFERENCE IN R-54

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4.4.3 VERBS USED IN PROGRAM LUMINARY

4.4.3.1 REGULAR VERBS

REV 02 09/16/69

PCR

00 NOT IN USE

01 DISPLAY OCTAL COMP 1 IN R1

02 DISPLAY OCTAL COMP 2 IN R1

03 DISPLAY OCTAL COMP 3 IN R1

04 DISPLAY OCTAL COMP 1,2 IN R1,R2

05 DISPLAY OCTAL COMP 1,2,3 IN R1,R2,R3

06 DISPLAY DECIMAL IN R1 OR R1,R2 OR R1,R2,R3

07 DISPLAY DP DECIMAL IN R1,R2

08 SPARE

09 SPARE

10 SPARE

11 MONITOR OCTAL COMP 1 IN R1

12 MONITOR OCTAL COMP 2 IN R1

13 MONITOR OCTAL COMP 3 IN R1

14 MONITOR OCTAL COMP 1,2 IN R1,R2

15 MONITOR OCTAL COMP 1,2,3 IN R1,R2,R3

16 MONITOR DECIMAL IN R1 OR R1,R2 OR R1,R2,R3

17 MONITOR DP DECIMAL IN R1,R2

18 SPARE

19 SPARE

20 SPARE

21 LOAD COMPONENT 1 INTO R1

22 LOAD COMPONENT 2 INTO R2

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

28 SPARE

29 SPARE

30 REQUEST EXECUTIVE

31 REQUEST WAITLIST

32 RECYCLE

33 PROCEED

34 TERMINATE

35 TEST LIGHTS (USAGE RESTRICTED TO P00) 853

36 REQUEST FRESH START (#)

37 CHANGE PROGRAM

38 SPARE

39 SPARE

# DENOTES THAT LOGIC FLOW IS DESCRIBED IN SEC 4.4.11

4.4.3.2	EXTENDED VERBS	WHEN USED	PCR

40	ZERO CDUS (SPECIFY N20 OR N72)	#	(N20 AND N72)
41	COARSE ALIGN CDUS (SPECIFY N20 OR N72)	#	(N20 AND N72)
42	FINE ALIGN IMU	#	
43	LOAD FDAI ERROR NEEDLES (TEST ONLY)	#	
44	TERMINATE RR CONTINUOUS DESIGNATE	#	
45	SPARE		
46	SPARE		
47	INITIALIZE AGS (R47)		
48	START DAP DATA LOAD (R03)		
49	START CREW DEFINED MANEUVER (R62)		P00
50	PLEASE PERFORM		
51	SPARE		
52	MARK X-RETICLE		R53
53	MARK Y-RETICLE		R53
54	MARK X-OR Y-RETICLE		R53
55	INCREMENT LGC TIME (DECIMAL)	#	R33
56	REQUEST TERMINATE TRACKING ROUTINE (R56)		P20,P22,P25
57	PERMIT LANDING RADAR UPDATE	#	P63
58	INHIBIT LANDING RADAR UPDATE	#	
59	COMMAND LR TO POSITION 2	#	
60	DISPLAY VEHICLE RATES	#	
61	DISPLAY DAP ATTITUDE ERROR	#	
62	DISPLAY TOTAL ATTITUDE ERROR	#	
63	START RR/LR SELF TEST ROUTINE (R04)		
64	START S-BAND ANT. ROUTINE(R05)		P00
65	DISABLE U,V JETS DURING DPS BURNS	#	
66	VEHICLE ATTACHED. MOVE THIS VEHICLE STATE VECTOR TO OTHER VEHICLE	#	
67	W MATRIX RMS ERROR DISPLAY	#	P20,P22

68	SPARE		
69	RESTART	#	
70	START LGC UPDATE; LIFTOFF TIME		P27
71	START LGC UPDATE; BLOCK ADR		P27
72	START LGC UPDATE; SINGLE ADR		P27
73	START LGC UPDATE: LGC TIME (OCTAL)		P27
74	INITIALIZE ERASABLE DUMP VIA DOWNLINK	#	
75	ENABLE U,V JETS DURING DPS BURNS	#	
76	MINIMUM IMPULSE COMMAND MODE	#	
77	RATE COMMAND AND ATTITUDE HOLD MODE	#	
78	START LR SPURIOUS TEST (R77)		
79	STOP LR SPURIOUS TEST (R77)		
80	ENABLE LM STATE VECTOR UPDATE	#	P20
81	ENABLE CSM STATE VECTOR UPDATE	#	P20,P22
82	REQUEST ORBIT PARAM DISPLAY (R30)		ANYTIME(P12, P40,P41,P42,P47)
83	REQUEST RENDZ PARAM DISPLAY (R31)		ANYTIME(P47)
84	SPARE		
85	DISPLAY RR LOS AZIMUTH AND ELEVATION	#	V85,P12, P22,P57,P68
86	SPARE		
87	SPARE		
88	SPARE		
89	START RENDZ FINAL ATTITUDE MANEUVER (R63)		P00
90	REQUEST RENDZ OUT OF PLANE DISPLAY (R36)		P32,P33,P34,P35, P72,P73,P74,P75
91	DISPLAY BANKSUM	#	
92	START IMU PERFORMANCE TESTS (GRD USE)		
93	ENABLE W MATRIX INITIALIZATION	#	P20,P22
94	SPARE		
95	NO UPDATE OF EITHER STATE VECTOR	#	P20,P22

96	INTERRUPT INTEGRATION AND GO TO PCC	# ANYTIME	
97	PERFORM ENGINE FAIL PROCEDURE	R40	
98	SPARE		
99	ENABLE ENGINE IGNITION	P12,P40,P42 P63,R40	

DESIGNATES THOSE EXTENDED VERBS FOR WHICH
LOGIC FLOW IS DESCRIBED IN SECTION 4.4.11

CHANGE CONTROL NOTES

REV 01 PCR 8,99,118,164,173,225,246,420,468,470,539,623
REV 00(LUM 1A) PCR 762
REV 01(LUM 1B) PCR 841, EDITORIAL
REV 02(LUM 1B) PCR 853

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4.4.4 NOUNS USED IN PROGRAM LUMINARY.

REV 03 12/03/69

NOUNS SPECIFIED AS BEING LOADABLE IN THIS DOCUMENT ARE MARKED (L). ALTHOUGH OTHER NOUNS MAY BE LOADABLE, WHETHER NEWLY LOADED DATA IS USED BY THE PROGRAM IS SUBJECT TO THE PARTICULAR CODING ASSOCIATED WITH THE USE OF THE NOUN.

NOUNS				WHEN USED	PCR
00 NOT IN USE					
01 SPECIFY ADDRESS (FRAC)		(L)	.XXXXX FRAC .XXXXX FRAC .XXXXX FRAC	P27	
02 SPECIFY ADDRESS (WHOLE)		(L)	XXXXX. INTEG XXXXX. INTEG XXXXX. INTEG	P27	
03 SPECIFY ADDRESS (DEGREE)		(L)	XXX.XX DEG XXX.XX DEG XXX.XX DEG		
04 GRAVITY ERROR ANGLE			XXX.XX DEG	P57	
05 SIGHTING ANGLE DIFFERENCE			XXX.XX DEG	R22, R54	
06 OPTION CODE IC OPTION CODE DATCODE (P57)		(L,R2 ONLY)	OCT OCT OCT		
07 CHANNEL/FLAGWORD/ ERASABLE OPERATOR	ECADR BIT ID ACTION	(L)	OCT OCT OCT	ANYTIME WITH V25	806.2
08 ALARM DATA	ADRES BBCON ERCOUNT		OCT OCT OCT	ANYTIME WITH V05	
09 ALARM CODES	FIRST SECOND LAST		OCT OCT OCT	ANYTIME WITH V05	
10 CHANNEL TO BE SPECIFIED (L,EXCEPT CHANNEL 7)			OCT	ANYTIME WITH V01,V11, OR V21	
11 TIG(CSI)		(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P32,P72	EDIT

12	OPTION CODE ID(USED BY EXT VERBS ONLY)		OCT	R04,R30,R63,V41N72
	OPTION CODE		OCT	
13	TIG(CDH)	(L)	CCXXX. HRS	P33,P73
			000XX. MIN	
			0XX.XX SEC	
14	CHECKLIST (USED INTERNALLY BY EXTENDED VERBS ONLY) (N25 IS PASTED AFTER DISPLAY. N14 IS NEVER VISIBLE TO THE CREW.)		XXXXX.	
			XXXXX.	
			XXXXX.	
15	INCREMENT ADDRESS	(L,WITH N01,02,03)	OCT	
16	TIME OF EVENT (USED BY EXTENDED VERBS ONLY)	(L)	COXXX. HRS	R36,R47
			000XX. MIN	
			0XX.XX SEC	
17	SPARE			
18	DESIRED AUTO MANEUVER FDAI BALL ANGLES		R XXX.XX DEG	R60,R63
			P XXX.XX DEG	
			Y XXX.XX DEG	
19	SPARE			
20	PRESENT ICDU ANGLES		OG XXX.XX DEG	ANYTIME WITH V06
			IG XXX.XX DEG	
			MG XXX.XX DEG	
21	PIPAS		X XXXXX. PULSES	ANYTIME WITH V06
			Y XXXXX. PULSES	
			Z XXXXX. PULSES	
22	DESIRED ICDU ANGLES	(L)	OG XXX.XX DEG	P51,P52,P57,R62,V41N20,V43
			IG XXX.XX DEG	
			MG XXX.XX DEG	
23	SPARE			
24	DELTA TIME FOR LGC CLOCK	(L)	00XXX. HRS	V55
			000XX. MIN	
			CXX.XX SEC	
25	CHECKLIST (USED WITH V50)		XXXXX.	
26	PRIO/DELAY,ADRES,BBCON	(L,WITH V30,31)	OCT	
			OCT	
			OCT	
27	SELF TEST ON/OFF SWITCH	(L)	XXXXX.	
28	SPARE			
29	SPARE			

30	SPARE			
31	SPARE			
32	TIME FROM PERIGEE		00XXX. HRS 000XX. MIN 0XX.XX SEC	R30
33	TIG	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P12,P22,P30,P76
34	TIME OF EVENT	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P21,P52,P57
35	TFI		00XXX. HRS 000XX. MIN 0XX.XX SEC	
36	TIME OF LGC CLOCK		00XXX. HRS 000XX. MIN 0XX.XX SEC	
37	TIG (TPI)	(L)	00XXX. HRS 000XX. MIN 0XX.XX SEC	P32,P34,P72,P74
38	SV INTEGRATION TIME (TET)		00XXX. HRS 000XX. MIN 0XX.XX SEC	ANY TIME
39	SPARE			
40	TIME FROM IGNITION/CUTOFF VG DELTA V (MEASURED)		XXBXX MIN/SEC XXXX.X FPS XXXX.X FPS	P40,P42
41	NAV BASE AZIMUTH NAV BASE LATITUDE	(L)	XXX.XX DEG XX.XXX DEG	SYSTEM TEST
42	APO ALT PER ALT DELTA V		XXXX.X NM XXXX.X NM XXXX.X FPS	P30
43	LATITUDE LONGITUDE ALTITUDE		XXX.XX DEG (+ NORTH) XXX.XX DEG (+ EAST) XXXX.X NM	P21,P68
44	APO ALT PER ALT TFF		XXXX.X NM XXXX.X NM XXBXX MIN/SEC	R30
45	MARKS (M) TFI MGA		XXXXX. XXBXX MIN/SEC XXX.XX DEG	P30,P32,P33,P34,P35 P72,P73,P74,P75

46	DAP CONFIG	(L)	CCT	R03	
47	THIS VEHICLE WT OTHER VEHICLE WT	(L)	XXXXX. LBS XXXXX. LBS	R03	
48	GIMBAL PITCH TRIM GIMBAL ROLL TRIM	(L)	XXX.XX DEG XXX.XX DEG	R03 (LOAD POSITIVE NON-ZERO ONLY)	
49	DELTA R DELTA V SOURCE CODE		XXXX.X NM XXXX.X FPS XXXXX.	R22	
50	SPARE				
51	S BAND ANT PITCH (ALPHA) S BAND ANT YAW (BETA)		XXX.XX DEG XXX.XX DEG	R05	
52	CENTRAL ANGLE OF ACTIVE VEHICLE		XXX.XX DEG	P34,P35,P74,P75	
53	SPARE				
54	RANGE RANGE RATE THETA		XXX.XX NM XXXX.X FPS XXX.XX DEG	R31	
55	NO OF APSIDAL CROSSINGS (N) ELEVATION ANGLE (E) CENTRAL ANGLE (CENTANG)	(L)	XXXXX. XXX.XX DEG XXX.XX DEG	P32,P34,P72,P74	
56	RR LOS AZIMUTH RR LOS ELEVATION		XXX.XX DEG XXX.XX DEG	V85,P12,P22,P57,P68	
57	SPARE				EDIT
58	PERIGEE ALTITUDE (POST TPI OR SOR) DELTA V (TPI OR SOR) DELTA V (TPF OR SOR FINAL)		XXXX.X NM XXXX.X FPS XXXX.X FPS	P34,P74	
59	DELTA V LOS		XXXX.X FPS XXXX.X FPS XXXX.X FPS	P34,P35,P74,P75	
60	FORVEL H DOT H		XXXX.X FPS XXXX.X FPS XXXXX. FT	P65,P66	285,882
61	TG TFI CROSSRANGE		XXBXX MIN/SEC XXBXX MIN/SEC XXXX.X NM	P63	
62	VI TFI DELTA V (MEASURED)		XXXX.X FPS XXBXX MIN/SEC XXXX.X FPS	P63	
63	VI H DOT		XXXX.X FPS XXXX.X FPS	P12,P63	

46

	H	XXXXX. FT		
64	TIME LEFT FOR REDESIGNATIONS (TR)/LPD H DOT H	XXBXX SEC/DEG XXXX.X FPS XXXXX. FT	P64	
65	SAMPLED LGC TIME (FETCHED IN INTERRUPT)	00XXX. HRS CCOXX. MIN 0XX.XX SEC	R33, ANYTIME WITH V16 OR V06	
66	LR SLANT RANGE LR POSITION	XXXXX. FT 0000X.	R04 (LR POSITION ANYTIME WITH V06 OR V16)	
67	LR VX LR VY LR VZ	XXXXX. FPS XXXXX. FPS XXXXX. FPS	R04	
68	SLANT RANGE TO LS TG DELTA H	XXXX.X NM XXBXX MIN/SEC XXXXX. FT	P63,V57	EDIT
69	LAND DELTA Z COMPONENT (L) LAND DELTA Y COMPONENT LAND DELTA X COMPONENT	XXXXX. FT XXXXX. FT XXXXX. FT	P63	
70	ACT DETENT CODE/STAR CODE (L)	OCT	R52,R59	
71	AOT DETENT CODE/STAR CODE (L)	CCT	R53,R59	
72	RR TRUNNION ANGLE RR SHAFT ANGLE	XXX.XX DEG XXX.XX DEG	RC4,R21, ANYTIME WITH V06 OR V16	EDIT
73	DESIRED RR TRUNNION ANGLE (L) DESIRED RR SHAFT ANGLE	XXX.XX DEG XXX.XX DEG	V41N72	
74	TFI YAW PITCH	XXBXX MIN/SEC XXX.XX DEG XXX.XX DEG	P12	
75	DELTA ALTITUDE CDH DELTA TIME (CDH-CSI OR TPI-CDH) DELTA TIME (TPI-CDH OR TPI-NOMTPI) (NOTE: R2 AND R3 ARE MODULARIZED TO THE HOUR; I.E. 63 MINS 22 SECS IS DISPLAYED AS 03822)	XXXX.X NM XXBXX MIN/SEC XXBXX MIN/SEC	P32,P33,P72,P73	
76	DOWNRANGE VELOCITY (VHF) (L) RADIAL VELOCITY (H DOT F) CROSSRANGE	XXXX.X FPS XXXX.X FPS XXXX.X NM	P12,P70,P71	
77	TG VELOCITY NORMAL TO CSM PLANE	XXBXX MIN/SEC XXXX.X FPS	P12,P70,P71	
78	RR RANGE RR RANGE RATE TFI	XXX.XX NM XXXXX. FPS XXBXX MIN/SEC.	R04	EDIT

79	CURSOR ANGLE	(L)		XXX.XX DEG	R57,R59
	SPIRAL ANGLE			XXX.XX DEG	
	POSITION CODE			XXXXX.	
80	DATA INDICATOR			XXXXX.	R24
	OMEGA			XXX.XX DEG	
81	DELTA VX(LV)	(L)		XXXX.X FPS	P30,P32,P33,P34,P35,P40,P41,P42,
	DELTA VY(LV)			XXXX.X FPS	P72,P73,P74,P75
	DELTA VZ(LV)			XXXX.X FPS	
82	DELTA VX(LV)	(L)		XXXX.X FPS	P32,P72
	DELTA VY(LV)			XXXX.X FPS	
	DELTA VZ(LV)			XXXX.X FPS	
83	DELTA VX(LM)			XXXX.X FPS	P47
	DELTA VY(LM)			XXXX.X FPS	
	DELTA VZ(LM)			XXXX.X FPS	
84	DELTA VX(OV)	(L)		XXXX.X FPS	P76
	DELTA VY(OV)			XXXX.X FPS	
	DELTA VZ(OV)			XXXX.X FPS	
85	VGX(LM)			XXXX.X FPS	P12,P40,P41,P42,P70,P71
	VGY(LM)			XXXX.X FPS	
	VGZ(LM)			XXXX.X FPS	
86	VGX(LV)			XXXX.X FPS	P40,P41,P42
	VGY(LV)			XXXX.X FPS	
	VGZ(LV)			XXXX.X FPS	
87	BACKUP OPTICS LOS AZIMUTH	(L)		XXX.XX DEG	R52,R53,R59
	BACKUP OPTICS LOS ELEVATION			XXX.XX DEG	
88	CELESTIAL BODY 1/2 UNIT VECT COMP	(L)	X	.XXXXX	R58
			Y	.XXXXX	
			Z	.XXXXX	
89	LATITUDE	(L)		XX.XXX DEG	P52,P57
	LONG/2			XX.XXX DEG	
	ALTITUDE			XXX.XX NM	
90	REND CUT OF PLANE PARAMETERS		Y	XXX.XX NM	R36
			Y DOT	XXXX.X FPS	
			PSI	XXX.XX DEG	
91	ALTITUDE	(L)		XXXXX. NMX10	P21
	VELOCITY			XXXXX. FPS	
	FLIGHT PATH ANGLE			XXX.XX DEG	
92	THRCMD			XXXXX. PCT	P63,P64,P65,P66
	H DOT			XXXX.X FPS	
	H			XXXXX. FT	
93	DELTA GYRO ANGLES		X	XX.XXX DEG	P57,R55,V42
			Y	XX.XXX DEG	

285

Z XX.XXX DEG

94 SPARE

95 SPARE

96 SPARE

97 SYSTEM TEST INPUTS (L) XXXXX.
XXXXX.
XXXXX.

98 SYSTEM TEST RESULTS AND INPUT (L) XXXXX.
.XXXXX
XXXXX.

99 RMS IN POSITION XXXXX. FT V67
RMS IN VELOCITY XXXX.X FPS
RMS IN BIAS XXXXX. MILLIRADIANS

CHANGE CONTROL NOTES

LOGIC REV 00 PCR 79
LOGIC REV 01 PCR 9,99,106,138,173,254,407,469,472,490,540,614,623
LOGIC REV 00(LUM 1A) PCR 268,270,695,732,736,738
REVS 01,02(LUM 1B) PCR 279,752,780,823,854,EDITORIAL
REV 03(LUM 1C) PCR 285,806.2,882, EDITORIAL

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4.4.5 CHECKLIST REFERENCE CODES USED WITH THE "PLEASE PERFORM CHECKLIST" REQUEST (VERB 50 NOUN 25)

REV 02 08/05/69

R1 CODE	ACTION TO BE EFFECTED	WHEN USED	PCR
00013	KEY IN NORMAL OR GYRO TORQUE COARSE ALIGN	P52	
00014	KEY IN FINE ALIGNMENT OPTION	P57,P63,R51	
00015	PERFORM CELESTIAL BODY ACQUISITION	P51,R51,R59	
00062	SWITCH LGC POWER DOWN	P06	
00200	-	-	408
00201	SWITCH RR MODE TO AUTOMATIC	P20,P22,R04	
00203	SWITCH GUIDANCE CONT TO PGNS, MODE TO AUTO, THR CONT TO AUTO	P12,P40,P42,P63,P70,P71	
00205	PERFORM MANUAL ACQUISITION OF CSM WITH RR	R23	
00500	SWITCH LR ANTENNA TO POSITION 1	P63	
00501	-	-	470

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

REV 01 PCR 134,470
REV 02 EDITORIAL

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OPTION CODES/LUM

REV 03 12/03/69

4.4.6 THIS LIST STATES THE OPTION CODES DISPLAYED IN R1 IN
++ CONJUNCTION WITH VERB 04 NOUN 06 (OR V04N12 FOR EXTENDED VERBS
+03 OR V05 FOR P57) TO REQUEST THE ASTRONAUT TO LOAD INTO R2 THE
+EDIT OPTION HE DESIRES FOR PROGRAM LUMINARY. THE SPECIFIED OPTION
++ CODES WILL BE DISPLAYED IN R1 IN CONJUNCTION WITH FLASHING V04-
N06 (OR V04N12 FOR EXTENDED VERBS OR V05 FOR P57) TO REQUEST
THE ASTRONAUT TO LOAD INTO R2 THE OPTION HE DESIRES.

R1

OPTION CODE	PURPOSE	INPUT FOR R2	WHEN USED	PCR
00001	SPECIFY IMU ORIENTATION	1=PREF, 2=NOM, 3=REFSMMAT, 4=LAND SITE	P52,P57	
00002	SPECIFY VEHICLE	1=THIS, 2=OTHER	P21,R30	
00003	SPECIFY TRACKING ATTITUDE	1=PREFERRED, 2=OTHER	R63	
00004	SPECIFY RADAR	1=RR, 2=LR	R04	
00006	SPECIFY RR COARSE ALIGN OPTION	1=LOCKON, 2=CONTINUOUS DESIG	V41N72	
00010	SPECIFY ALIGNMENT MODE	0=ANYTIME, 1=REFSMMAT +G, 2=TWO BODIES, 3=ONE BODY +G	P57	
00012	SPECIFY CSM ORBIT OPTION	1=NO ORBIT CHANGE, 2=CHANGE ORBIT TO PASS OVER LM	P22	

CHANGE CONTROL NOTES

REV 01 PCR 105,490
REV 02(LUM 1B) PCR 279
REV 03 EDITORIAL

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4.4.7 ALARM CODES USED WITH VERB 05 NOUN 09

REV 03 12/03/69

R1 CODE		PURPOSE	SET BY	PCR
20105		** AUT MARK SYSTEM IN USE	R53	
00107		MORE THAN 5 MARK PAIRS INFLIGHT, 5 MARKS ON LUNAR SURFACE	R57	
00111		MARK MISSING	R53	
00112		MARK OR MARK REJECT NOT BEING ACCEPTED	R57	
00113		NO INBITS	R57	
00114		MARK MADE BUT NOT DESIRED	R57	
00115		NO MARKS IN LAST PAIR TO REJECT	R57	
00206		ZERO ENCODE NOT ALLOWED WITH COARSE ALIGN + GIMBAL LOCK	IMU MODE SWITCH V40N20	
00207		ISS TURN-ON REQUEST NOT PRESENT FOR 90 SEC	# T4RUPT	
00210		IMU NOT OPERATING	IMU MODE SWITCH, R02	
00211		COARSE ALIGN ERROR	IMU MODE SWITCH, P51, P57,R50	
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	
00217		BAD RETURN FROM IMUSTALL	P51,P57,R50	
00220		BAD REFSMMAT	R02,R47	
00401		DESIRED GIMBAL ANGLES GREATER THAN "X" DEG	INF ALIGN ("X"=60), FINDCDUW ("X"=70) KALCMANU	
00402		FINDCDUW ROUTINE NOT CONTROLLING ATTITUDE BECAUSE OF INADEQUATE POINTING VECTORS.	FINDCDUW	
00404	M	SPECIFIED STAR NOT AVAILABLE IN ANY DETENT	R59	EDIT

00405	M	TWO STARS NOT AVAILABLE	R51
00421		W-MATRIX OVER FLOW	INTEGPV
20430		** ACCELERATION OVERFLOW IN INTEGRATION	# ORBITAL INTEGRATION
00501	MP	RADAR ANTENNA OUT OF LIMITS	R23
00502		BAD RADAR GIMBAL ANGLE INPUT	V41N72
00503	MP	RADAR ANTENNA DESIGNATE FAIL	R21,V41N72(NON MP)
00510		RADAR AUTO DISCRETE NOT PRESENT	R25,V40N72
00511		LR NOT IN POSITION 2 OR REPOSITIONING	R12
00514	MP	RR GOES OUT OF AUTO MODE WHILE IN USE	P20,P22
00515		RR CDU FAIL DISCRETE PRESENT	R25
00520		RADARUPT NOT EXPECTED AT THIS TIME	P20,P22,R12
00521		COULD NOT READ RADAR	R22,R12
00522		LR POSITION CHANGE	R04
00523	MP	LR DID NOT ACHIEVE POSITION 2	R12,V60(NON MP)
00525	MP	DELTA THETA GREATER THAN 3 DEG	R22
00526	MP	RANGE GREATER THAN 400 MILES	P20,P22
00527		LOS NOT IN MODE 2 COVERAGE WHILE ON LUNAR SURFACE OR VEHICLE MANEUVER REQUIRED	R24
00530	P	LOS NOT IN MODE 2 COVERAGE ON LUNAR SURFACE AFTER 600 SEC	R21
00600	M	IMAGINARY ROOTS ON FIRST ITERATION	P32,P72
00601	M	PERIGEE ALTITUDE CSI LESS THAN 35K FT (LUNAR ORBIT) OR 85 NM (EARTH ORBIT).	P32,P72
00602	M	PERIGEE ALTITUDE CDH LESS THAN 35K FT (LUNAR ORBIT) OR 85NM (EARTH ORBIT).	P32,P72
00603	M	CSI TO CDH TIME LESS THAN 10 MIN	P32,P72
00604	M	CDH TO TPI TIME LESS THAN 10 MIN OR COMPUTED CDH TIME IS GREATER THAN INPUT TPI TIME.	P32,P72
00605	M	NUMBER OF ITERATIONS EXCEEDS P32/72 LOOP MAXIMUM	P32,P72
00606	M	DELTA V EXCEEDS MAXIMUM	P32,P72

20607		**	NO SOLUTION FROM TIME-THETA OR TIME-RADIUS	# TIMETHET, TIMERAD
00611	M		NO TIG FOR GIVEN ELEV ANGLE	P33,P34,P73,P74
00701	M		ILLEGAL OPTION CODE SELECTED	P57
00777			PIPA FAIL CAUSED ISS WARNING	# T4RUPT
01102			LGC SELF TEST ERROR	# SELF CHECK
21103		**	UNUSED CCS BRANCH EXECUTED	# ABORT
31104		*	DELAY ROUTINE BUSY	# EXECUTIVE
01105			DOWNLINK TOO FAST	# T4RUPT
01106			UPLINK TOO FAST	# T4RUPT
01107			PHASE TABLE FAILURE. ASSUME ERASABLE MEMORY IS DESTROYED	# RESTART
31201		*	EXECUTIVE OVERFLOW - NO VAC AREAS	# EXECUTIVE
31202		*	EXECUTIVE OVERFLOW-NO CORE SETS	# EXECUTIVE
31203		*	WAITLIST OVERFLOW - TOO MANY TASKS	# WAITLIST
21204		**	WAITLIST, VARDELAY, FIXDELAY, LONGCALL OR DELAYJOB CALLED WITH ZERO OR NEGATIVE DELTA TIME	# WAITLIST
31206		*	SECOND JOB ATTEMPTS TO GO TO SLEEP VIA KEYBOARD AND DISPLAY PROGRAM	# PINBALL
31207		*	NO VAC AREA FOR MARKS	R53
31210		*	TWO PROGRAMS USING DEVICE AT THE SAME TIME	# IMU MODE SWITCH
31211		*	ILLEGAL INTERRUPT OF EXTENDED VERB	R53
01301			ARCSIN-ARCCOS ARGUMENT TOO LARGE	# INTERPRETER
21302		**	SQRT CALLED WITH NEGATIVE ARGUMENT	# INTERPRETER
21406		**	BAD RETURN FROM ROOTPSRS (DURING IGNITION ALGORITHM)	# P63 EDIT
01406			BAD RETURN FROM ROOTPSRS (DURING POWERED FLIGHT)	# P63,P64 EDIT
01407			VG INCREASING (DELTA-V ACCUMULATED AT 90 DEGREES FROM DESIRED THRUST VECTOR).	P40,P42
01410			UNINTENTIONAL OVERFLOW IN GUIDANCE	# P63,P64,P65

01412		DESCENT IGNITION ALGORITHM NOT CONVERGING	# P63
21501	**	KEYBOARD AND DISPLAY ALARM DURING INTERVAL USE (NVSUB). ABORT	# PINBALL
31502	*	ILLEGAL FLASHING DISPLAY	# GOPLAY
01520		V37 REQUEST NOT PERMITTED AT THIS TIME	R00
01600		OVERFLOW IN DRIFT TEST	# GROUND TEST
01601		BAD IMU TORQUE	# GROUND TEST
01703		TOO CLOSE TO IGNITION, SLIP TIG	R41
01706	M	INCORRECT PROGRAM SELECTED FOR VEH CONFIG	P40,P42
32000	*	DAP STILL IN PROCESS AT NEXT TIME 5 RUPT	# DAP
02001		JET FAILURES HAVE DISABLED Y-Z TRANSLATION	# DAP
02002		JET FAILURES HAVE DISABLED X TRANSLATION	# DAP
02003		JET FAILURES HAVE DISABLED P ROTATIONS	# DAP
02004		JET FAILURES HAVE DISABLED Q-V ROTATIONS	# 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, ICDU FAILS CAUSED THE ISS WARNING	# T4RUPT
14777		IMU, ICDU, PIPA FAILS CAUSED THE ISS WARNING	# T4RUPT

SECTION 4 OF THE GSOP DOES NOT DESCRIBE LOGIC OF ALARM GENERATION. CONSULT PROGRAM LISTING

* GENERATES SOFTWARE RESTART (BAILOUT ALARM)
** RESULTS IN PROGRAM GOING TO R00 (POODOO ALARM)
M INDICATES MAIN ALARM
P INDICATES PRIORITY ALARM

NOTE: FOR V05 N09 DISPLAYS:
R1-XXXXX (FIRST ALARM FOLLOWING ERROR RESET).
R2-XXXXX (SECOND ALARM FOLLOWING ERROR RESET).
R3-XXXXX (MOST RECENT ALARM).

ERROR RESET WILL SET R1 AND R2 TO
ZERO, BUT NOT AFFECT R3.

CHANGE CONTROL NOTES

LOGIC REV 01 PCR 105,106,138,437,536,593
LOGIC REV 00(LUM 1A) PCR 720,721,722,751
REVS 01,02(LUM 1B) PCR 801.2,802.2,817,856,EDITORIAL
REV 03 EDITORIAL

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4.4.8 FLAGS REFERENCED IN SECTION 4 OF R567 REV 04 12/03/69

FLAG	PCR	IF FLAG SET	IF FLAG RESET	TESTED	SET	RESET
ABORT ENABLE FLAG		ABORT PROGRAMS ENABLED	ABORT PROGRAMS NOT ENABLED	P70,P71,R11	P63	P12,P68,P70,P71
ABORT TARGETING FLAG	893	J2,K2 PARAMETERS USED FOR ABORT TARGETING	J1,K1 PARAMETERS USED FOR ABORT TARGETING		P70,P71	R00
ACTIVE FLAG VEHICLE		LM IS ACTIVE VEHICLE	CSM IS ACTIVE VEHICLE	TARGETING COMPUTATIONS	P32,P33,P34,P35	P72,P73,P74, P75
APS ABORT CONTINUATION FLAG		APS CONTINUED ABORT AFTER DPS ABORT	APS ABORT NOT A CONTINUATION OF DPS ABORT	P71	P70	FRESH START (V36E)
APS FLAG	EDIT	CREW HAS SPECIFIED THAT DPS HAS BEEN STAGED	CREW HAS SPECIFIED THAT DPS HAS NOT BEEN STAGED	P12,P40,P42,P63 P70,P71,R03,R40	P42,P68,P71,R03	R03
ASTRONAUT FLAG		CREW HAS APPROVED IGNITION	CREW HAS NOT APPROVED IGNITION	P12,P40,P41,P42,P63, R40	P12,P40,P42,P63,R40	P12,P40,P41,P42, P63,R40
ATTITUDE FLAG		LGC HAS STORED LM ATTITUDE IN MOON-FIXED CO-ORD	LGC HAS NOT STORED LM ATTITUDE IN MOON-FIXED CO-ORD	P57	P57,P68	FRESH START (V36E)
AUX FLAG		IF IDLE FLAG RESET SERVICER WILL EXERCISE DVMON	IF IDLE FLAG RESET SERVICER WILL SKIP DVMON AND SET AUX FLAG	R40	R40	R40
AVERAGE G FLAG	895	AVERAGE G (SERVICER) DESIRED	AVERAGE G (SERVICER) NOT DESIRED	P70,P71,R25,R30,R31, AVERAGE G, V59	AVERAGE G	R00, FRESH START (V36E)
COMP E FLAG		ELEV. ANGLE SUPPLIED FOR P34/74	ELEV. ANGLE NOT SUPPLIED FOR P34/74	P34,P74	P34,P74	P34,P74
CONTINUOUS DESIGNATE FLAG	EDIT	LGC COMMANDS RR WITHOUT LOCK ON	LGC CHECKS FOR LOCK ON	V41N72,V44	V41N72	P12,P20,P22,R00 R25,R26,R56, V41N72,V44
DESIGNATE FLAG	EDIT	RR DESIGNATE	RR DESIGNATE NOT	R29,V41N72	R29,V41N72	P12,P20,P22,R00,

		REQUESTED OR IN PROGRESS	REQUESTED OR IN PROGRESS.			R29,R56, V41N72,V44, FRESH START (V36E)
DID FLAG		INERTIAL DATA AVAIL-ABLE	PERFORM DATA DISPLAY INITIAL-IZATION	R10	R10	R10
DRIFT FLAG		GYRO COM-PENSATION	NO GYRO COMPEN-SATION	T3RUPT	P51,P52,P57,R00,R50	P06,P51,P52,P57, R50
EXTENDED VERB ACTIVE FLAG		EXTENDED VERB IN PROGRESS	NO EXTENDED VERB PROGRESS	R05,R30,R31,R76,V85	R76	P27,R03,R04,R05, R30,R31,R36,R47, R62,R63,V41,V42, V43,V55,V67,V85, V91,V92
EXTERNAL DELTA V FLAG		EXTERNAL DELTA V VG COMP	LAMBERT VG COMP	TVC COMPUTATIONS	P30,P32,P33,P72,P73	P34,P35,P74,P75
FINAL FLAG	EDIT	LAST PASS THROUGH REND. COMP.	INTERIM PASS THROUGH REN-DEZVOUS COMP	P32,P33,P34,P35,P72, P73,P74,P75	P30,P32,P33,P34,P35, P72,P73,P74,P75	P32,P33,P34, P35,P72,P73, P74,P75
FIRST PASS FLAG		FIRST PASS OF R26	SUCCEEDING PASS OF R26	R26	R26	R26
GIMBAL LOCK FLAG		GIMBAL LOCK	NOT GIMBAL LOCK			R00
H FLASH FLAG		FLASH LR ALTITUDE FAIL LAMP	DO NOT FLASH LR ALTITUDE FAIL LAMP	R09	R12	R00,R12
HIGATE FLAG		AFTER HIGATE	BEFORE HIGATE	R12	R12	R00
IDLE FLAG	EDIT	NO DV MONITOR	CONNECT DV MONITOR	R40	P12,P40,P42,P70,P71, R00,R40, FRESH START (V36E)	P12,P40,P42,P63, P70,P71,R40
IGNITION FLAG		TIG HAS ARRIVED	TIG HAS NOT ARRIVED	P12,P40,P42,P63,R40	P12,P40,P41,P42,P63, R40	P12,P40,P41,P42, P63,R40
IMPULSE FLAG		MINIMUM IMPULSE BURN (C/C SET)	STEERING BURN (C/C NOT SET)	P40,P42,P63,R40	P40,P42	P40,P42
IMUSE FLAG		IMU IN USE	IMU NOT IN USE	R47	P51,P57,R02	P06,R00,R56
INERTIAL DATA DISCRETE FLAG		RR CDUS IN USE FOR INERTIAL DATA DISPLAY	RR CDUS NOT IN USE FOR INERTIAL DATA DISPLAY	R10	R10	R10
INITIAL ALIGN FLAG		INITIAL PASS	SECOND PASS OF P57	P57	P57	P57
LANDING ANALOG DISPLAYS		LANDING ANALOG	LANDING ANALOG	R10	P12,P63	P68,R00

FLAG		DISPLAYS ENABLED	DISPLAYS NOT ENABLED			
LOCK-ON FLAG	EDIT	RADAR LOCK-ON DESIRED	RADAR LOCK-ON NOT DESIRED	V41N72	R21,V41N72	R21,R26,V41N72
LOSCM		LOS BEING COMPUTED	LOS NOT BEING COMPUTED	R21,R29	R21,R29	P20,P22,R21,R24, R29,V41N72
LPOS2 FLAG		USE LR POSITION 2 TRANSFORMATION	USE LR POSITION 1 TRANSFORMATION	R12	R12	R00
LR BYPASS FLAG	EDIT	BYPASS LR UPDATES	DO NOT BYPASS LR UPDATES	R04,R12,R20,R77,V59, V40N72,V41N72	P68,P70,P71,R00, FRESH START (V36E)	P63
LR PERMIT FLAG		LR UPDATES PERMITTED BY ASTRONAUT	LR UPDATES NOT PERMITTED BY ASTRONAUT	R12	V57	R00,V57,V58
LR POSITION DATA FAIL FLAG		LR ALTITUDE DATA FAIL	NO LR ALTITUDE DATA FAIL	R12	R20	R20
LR POSITION FLAG		LR POSITION #2 DESIRED	LR POSITION #1 DESIRED	R20	R04,R12,R77,V60	R04,R77
LR VELOCITY DATA FAIL FLAG		LR VELOCITY DATA FAIL	NO LR VELOCITY DATA FAIL	R12	R20	R20
MANUAL ACQUIRE FLAG		MANUAL ACQUIRE BY REND. RADAR	AUTO ACQUIRE BY REND. RADAR	P20,P22	P20	P20,P22
MARK IN PROGRESS FLAG		MARK IN PROGRESS	NO MARK IN PROGRESS	R53,R76	R53	R53
MARK INPUT INHIBIT FLAG		MARK PROCESSING INHIBITED	MARK PROCESSING ALLOWED	R57	R53	R53
MARK PAIR FLAG		PAIR COMPLETE, NEXT MARK STARTS NEW PAIR	PAIR IN PROCESS, MARKS NOW WILL BE REJECTED	R57	R57	R53,R57
MARK REJECT FLAG		MARK MADE AND WILL BE CLEARED BY REJECT	BOTH MARKS WILL BE CLEARED BY REJECT	R57	R57	R53,R57
MID 1 FLAG	EDIT	INTEGRATE STATE TO TDEC1	INTEGRATE STATE TO PRESENT TIME	R41	R41	R41
MUNFLAG		SERVICER CALLS MUNRVG	SERVICER CALLS CALC RVG	R25	P12,P63	R00
NEEDLE FLAG		TOTAL ATTITUDE ERROR DISPLAYED	A/P FOLLOWING ERROR DISPLAYED	DAP	R60,V62	V61,FRESH START (V36E)
NEED2FLG	EDIT	VEHICLE ATTITUDE RATES DISPLAYED	VEHICLE ATTITUDE RATES NOT DISPLAYED	DAP	V60	R60,V61,V62, FRESH START (V36E)

NEW TARGET FLAG		ASTRONAUT OVER-WROTE DELTA V AT TPI OR TPM	ASTRONAUT DID NOT OVERWRITE DELTA V	P34,P35,P74,P75	P34,P35,P74,P75	P34,P35,P74,P75
NO SIT FLAG		DO NOT TEST LR ANTENNA POSITION AFTER HIGATE IN R12	TEST LR ANTENNA POSITION AFTER HI-GATE IN R12	R12	R12	FRESH START (V36E)
NO DO VERB 37 FLAG	663 EDIT	V37 NOT ALLOWED	V37 ALLOWED	R00	P06,P76,R47	P06,P76,R00,R47
NO MARKS ALLOWED FLAG		MARKS NOT ALLOWED (EXTENDED VERB ACTIVE)	MARKS ALLOWED	R53,R76	R76	P27,R03,R04,R05, R30,R31,R36,R47, R62,R63,V41,V42, V43,V55,V67,V85, V91,V92
NO LR REAL FLAG		LR REPOSI-TIONING	LR NOT REPOSI-TIONING	R12	R12	R00,R12
NO RR MONITOR FLAG	EDIT	BYPASS RR MONITOR	PERFORM RR MONITOR	R25	R23,R26,V41N72	P20,P22,R21,R23, V44, FRESH START (V36E)
NO R-29 FLAG	EDIT	R29 NOT ALLOWED	R29 ALLOWED	R04,R29,R77,V59, V40N72,V41N72, FRESH START (V36E)	R00, FRESH START (V36E)	P12
NO THROTTLE FLAG		INHIBIT FULL THROTTLE	ALLOW FULL THROTTLE	P40	P40	P40,P63
NO UPDATE FLAG		NEITHER VEHICLE MAY BE UPDATED	EITHER VEHICLE MAY BE UPDATED	R22	V95	V80,V81
OLDES FLAG		R29 GYRO CMD LOOP REQUESTED	R29 GYRO CMD LOOP NOT REQUESTED	R29	R29	R29
PREFERRED-ATTITUDE-COMPUTED FLAG		PREFERRED ATTI-TUDE COMPUTED	PREFERRED ATTITUDE NOT COMPUTED	P52	P40,P41,P42	P52
PRIORITY DISPLAY AWAITING KEY RELEASE FLAG		ASTRONAUT USING KEYBOARD WHEN PRIORITY DISPLAY INITIATED	ASTRONAUT NOT USING (KEYBOARD FREE)	R76	DSKY DISPLAY PROGRAM	DSKY DISPLAY PROGRAM
PRIORITY DISPLAY FLAG		P20 PRIORITY DISPLAY	P20 NORMAL DISPLAY	R76	P61,R65	R61,R65
PRIORITY IDLE FLAG		PRIORITY DISPLAY AWAITING ASTRO-NAUT RESPONSE	PRIORITY DISPLAY NOT WAITING (KEYBOARD FREE)	R76	DSKY DISPLAY PROGRAM	DSKY DISPLAY PROGRAM
PULSES FLAG	EDIT	MINIMUM IMPULSE COMMAND MODE	NOT IN MINIMUM IMPULSE COMMAND MODE	DAP	P63, V76	P12,P40,P41,P42, P63,P70,P71,R40, V77

P25 FLAG		P25 RUNNING	P25 NOT RUNNING	P25,R00,R56,R61,R65	P25	P63,R00,R56
QUIT FLAG		STOP INTE-GRATION	CONTINUE INTE-GRATION	P00	V96	P00
RANGE DATA FLAG		LR ALTITUDE MEASUREMENT MADE	NO LR ALTITUDE MEASUREMENT MADE	R12	R12	R00,R12
RANGE SCALE FLAG		SCALE CHANGE DURING RR/LR READ	NO SCALE CHANGE DURING RR/LR READ	R12,R22,R29	R20	R12,R22,R29
RCS FLAG	EDIT	RCS INJECTION MODE	MAIN ENGINE MODE	P12	P12,P70,P71	P70,P71
READ R FLAG	EDIT	READING RR FOR R29	NOT READING RR FOR R29	R29	R29	R29, FRESH START (V36E)
READ VELOCITY FLAG		READ LR VELOCITY DATA	DO NOT READ LR VELOCITY DATA	R12	R12	R00
REDESIGNATION FLAG		LANDING SITE REDESIGNATION ALLOWED	LANDING SITE REDESIGNATION PROHIBITED	P64	P64	P63,P64
REFSMMAT FLAG		REFSMMAT GOOD	REFSMMAT BAD	P30,P32,P33,P34, P35,P57,R02,R47	P51,P52,P57	P06,P51,P52,P57, R50,V41N20
REMODE FLAG	EDIT	CHANGE IN ANTENNA MODE REQUESTED	NO CHANGE IN ANTENNA MODE REQUESTED	R24,R25,R29, V41N72	R21,R29,V41N72	R21,R25,R29, V41N72, FRESH START (V36E)
RENDEZVOUS FLAG	EDIT	P20 OR P22 RUNNING	NEITHER P20 NOR P22 RUNNING	P20,P22,R00,R22, R24,R25,R56,R61,R65, R77,V59,V40N72,V41N72	P20,P22,	P06,P12,P63,R00, R56
REND W FLAG		W MATRIX VALID	W MATRIX INVALID	NAVIGATION COMPUTATIONS	NAVIGATION COMPUTATIONS	P12,V67,V93
REPOSITION FLAG	EDIT	REPOSITION IN PROGRESS	NO REPOSITION IN PROGRESS	R20,R21,R25,R29, V40N72,V41N72	R25,R29	R25,R29,V41N72, FRESH START (V36E)
ROTATION FLAG		FORCE VEHICLE ROTATION IN PRE-FERRED DIRECTION	DO NOT FORCE VEHICLE ROTATION	P12,P70,P71	P70,P71	P70,P71, FRESH START (V36E)
RR ANTENNA MODE FLAG		RR IN MODE #2	RR IN MODE #1	R29	R25,V40N72	R25,V40N72
RR AUTO MODE FLAG	EDIT	RR NOT IN AUTO MODE	RR IN AUTO MODE	R29,V40N72	R25, FRESH START (V36E)	R25

RR CDU NOT FAILED FLAG	EDIT	NO RR CDU FAIL	RR CDU FAILED	R20,R25	R25, FRESH START (V36E)	R25
RR CDU ZERO FLAG	EDIT	RR CDUS BEING ZEROED	RR CDUS NOT BEING ZEROED	P20,P22,R22,R25,P29	R25,V40N72	R25,V40N72, FRESH START (V36E)
RR DATA FAIL FLAG		RR DATA FAIL	NO RR DATA FAIL	R25	R20	R20
RR TURN ON FLAG	EDIT	RR TURN ON SEQUENCE IN PROGRESS	NO RR TURN ON SEQUENCE	V40N72	R25	R25, FRESH START (V36E)
R04 FLAG		ALARM 00521 SUPPRESSED	ALARM 00521 ALLOWED	R20,R77	R04,R65	P20,P22,R00,R04, R65
R10 FLAG		R10 OUTPUTS ONLY TO H AND F DOT METERS	R10 OUTPUTS TO H AND HDOT METERS AND FORWARD AND LATERAL CROSSPOINTERS	R10	P12,P70,P71	FRESH START (V36E)
R-12 X-AXIS OVERRIDE FLAG		INHIBIT OVERRIDE	DO NOT INHIBIT OVERRIDE	R12	R12	R00
R61 FLAG		RUN R61 LM	RUN R65 LM	R61,R65	R61	R65
R77 FLAG	EDIT	R77 ON (SUPPRESS RADAR ALARMS AND TRACKER FAILS)	R77 OFF	R04,R20,R77,V59, V40N72,V41N72	R77	V79, FRESH START (V36E)
SEARCH FLAG		RADAR IN AUTO SEARCH OPTION	RADAR NOT IN AUTO SEARCH OPTION	P20,P22,R24	R24	P20,P22
SNUFFER FLAG		U, V JETS DISABLED DURING DPS BURN	U, V JETS ENABLED DURING DPS BURN	DAP	V65	V75, FRESH START (V36E)
STEER FLAG		SUFFICIENT THRUST	NOT SUFFICIENT THRUST	TVC	R40	R40
SURFACE FLAG		LM ON MOON	LM NOT ON MOON	P20,P22,R21,R22,R24, R31,R57,V67	P68	P12
TRACK FLAG	EDIT	TRACKING ALLOWED	TRACKING NOT ALLOWED	P20,P22,P25,R04,R22, R56,R61,R65,R77,V59, V40N72,V41N72	P20,P22,P25,P30, P32,P33,P34,P35, P72,P73,P74,P75,P76, R00	P06,P51,P57,R00, R50,R56,V41N20
ULLAGE FLAG		ULLAGE REQUEST	NO ULLAGE REQUEST	DAP	P40,P42,P63,R40	P40,P42,P63,P70, P71,R00,R40
UPDATE FLAG		SV UPDATING BY RR MARKS ALLOWED	SV UPDATING BY RR MARKS NOT ALLOWED	R22	P20,P22,P30,P32, P33,P34,P35, P72,P73,P74,P75,	P30,P32, P33,P34,P35, P72,

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				R00	P73,P74,P75, R00,R56
USE-QR-JETS FLAG	TRIM GIMBAL UN-USABLE-USE JETS ONLY	TRIM GIMBAL MAY BE USED	DAP	R40	R40
VEHICLE UPDATE FLAG	CSM BEING UPDATED	LM BEING UPDATED	NAVIGATION COMPUTATIONS	P22,V81	P20,V80
VELOCITY DATA FLAG	LR VELOCITY MEASUREMENT MADE	LR VELOCITY MEASUREMENT NOT MADE	R12	R12	R00,R12
VERIFLG	INVERTED BY V33 AT END OF P27		GROUND CONTROLLERS	P27	P27
VERTICAL RISE FLAG	VERTICAL RISE	NON VERTICAL RISE	P12,P70,P71	P12,P70,P71	P12,P70,P71
V FLASH FLAG	LR VELOCITY LAMP FLASHING	LR VELOCITY LAMP NOT FLASHING	R09	R12	R00,R12
VX INHIBIT FLAG	IF Z-VELOCITY BAD, BYPASS X-VELOCITY UPDATE	UPDATE X-VELOCITY	R12	R12	R00,R12
V37 FLAG EDIT	SERVICER IS RUNNING	SERVICER IS NOT RUNNING	R00,R03,R04,R77, V59,V40N72,V41N72	AVERAGE G	R00
V67 FLAG	ASTRONAUT OVER-WROTE INITIAL W-MATRIX	ASTRONAUT HAS NOT OVERWRITTEN W-MATRIX	V67	V67	V67
X-AXIS OVERRIDE INHIBIT FLAG 285	BELOW LIMIT IN-HIBIT OVERRIDE	ABOVE LIMIT-DO NOT INHIBIT	DAP	P12,P70,P71,R12	P12,P65,P66,P70, P71,R00
X MARK FLAG	X MARK AC-CEPTED	X MARK NOT ACCEPTED	R53,R57	R57	R53,R57
Y MARK FLAG	Y MARK AC-CEPTED	Y MARK NOT ACCEPTED	R53,R57	R57	R53,R57
3-AXIS FLAG	3-AXIS MANEUVER	1-AXIS MANEUVER (VECPOINT)	R60	R62	P40,P41,P42,R00, R52,R60,R61,R63, R65
4-JET TRANSLATION FLAG	4-JET X-AXIS TRANSLATION	2-JET X-AXIS TRANSLATION	DAP	P12,P70,P71,CREW OPTION IN R03	FRESH START (V36E) OR CREW OPTION IN R03

CHANGE CONTROL NOTES

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REV 01   EDITORIAL
REVS 00,01 (LUM 1A)  PCR 260,648,670,722,EDITORIAL
REVS 02,03 (LUM 1B)  PCR 279,780,798,814,820,823,838,
                         839,841,845,EDITORIAL
REV 04 (LUM 1C)   PCR 285,863.2,893,895,EDITORIAL
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4.4.9 LUMINARY PROGRAMS

	TITLE
P00	LGC IDLING
P06	LGC POWER DOWN
P12	POWERED ASCENT
P20	RENDEZVOUS NAVIGATION
P21	GROUND TRACK DETERMINATION
P22	LUNAR SURFACE NAVIGATION
P25	PREFERRED TRACKING ATTITUDE
P27	LGC UPDATE
P30	EXTERNAL DELTA V
P32	CO-ELLIPTIC SEQUENCE INITIATION (CSI)
P33	CONSTANT DELTA ALTITUDE (CDH)
P34	TRANSFER PHASE INITIATION (TPI)
P35	TRANSFER PHASE MIDCOURSE (TPM)
P40	DPS
P41	RCS
P42	APS
P47	THRUST MONITOR
P51	IMU ORIENTATION DETERMINATION
P52	IMU REALIGN
P57	LUNAR SURFACE ALIGN
P63	BRAKING PHASE
P64	APPROACH PHASE
P65	LANDING PHASE (AUTO)
P66	LANDING PHASE (RCS)
P68	LANDING CONFIRMATION
P70	DPS ABORT
P71	APS ABORT
P72	CSM CO-ELLIPTIC SEQUENCE INITIATION (CSI) TARGETING
P73	CSM CONSTANT DELTA ALTITUDE (CDH) TARGETING
P74	CSM TRANSFER PHASE INITIATION (TPI) TARGETING
P75	CSM TRANSFER PHASE MIDCOURSE (TPM) TARGETING
P76	TARGET DELTA V

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