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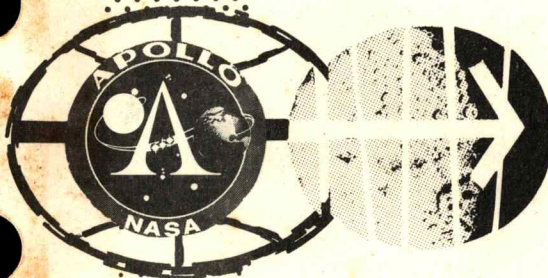
VOLUME II

APOLLO OPERATIONS HANDBOOK

**LUNAR
MODULE**

2

Prepared Under Direction of:
**SPACECRAFT SYSTEMS BRANCH
FLIGHT CREW SUPPORT DIVISION**



**MANNED SPACECRAFT CENTER
HOUSTON, TEXAS**

LMA790-3-LM 2

APOLLO OPERATIONS HANDBOOK

LUNAR MODULE

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SECTION 4
OPERATIONAL DATA

INTRODUCTION.

This section contains information concerning instrument markings, LM subsystem consumables, and operational limitations. The markings for LM-2 meters and indicators are shown in figures 4-1 through 4-9. The limitations shown on the instruments and noted in the illustrations are not necessary repeated in the text of this section.

4.1 GUIDANCE, NAVIGATION, AND CONTROL SUBSYSTEM.

The markings of the Guidance Navigation, and Control Subsystem (GN&CS) indicators are shown in figure 4-1.

4.1.1 INDICATORS.

The indicators for the GN&CS are: the THRUST indicator; T/W indicator; and SIGNAL STRENGTH indicator.

4.1.1.1 THRUST Indicator.

The left needle of the THRUST indicator displays descent engine chamber pressure; the right needle, manual thrust commands (systems engineer's or commander's thrust/translation controller) or LGC thrust commands, as selected with the THR CONT switch. The display range is 0% to 100% thrust.

4.1.1.2 T/W Indicator.

The T/W indicator displays instantaneous X-axis acceleration in lunar g units ($1g = 5.32 \text{ ft/sec}^2$). The indicator may be used to provide a gross check of engine performance, because any given throttle setting provides a specific acceleration when the vehicle has a given mass.

4.1.1.3 SIGNAL STRENGTH Indicator.

The SIGNAL STRENGTH indicator displays the magnitude of landing-radar or rendezvous-radar received signals.

4.2 MAIN PROPULSION SUBSYSTEM.

The markings of the Main Propulsion Subsystem (MPS) indicators are shown in figure 4-2.

4.2.1 INDICATORS.

The MPS indicators display helium temperatures and pressures, and propellant-tank temperatures and pressures, as shown in table 4-1. The quantity of MPS fuel and oxidizer remaining aboard the LM is displayed on the FUEL and OXIDIZER QUANTITY indicators, as selected with the PRPLNT QTY MON switch.

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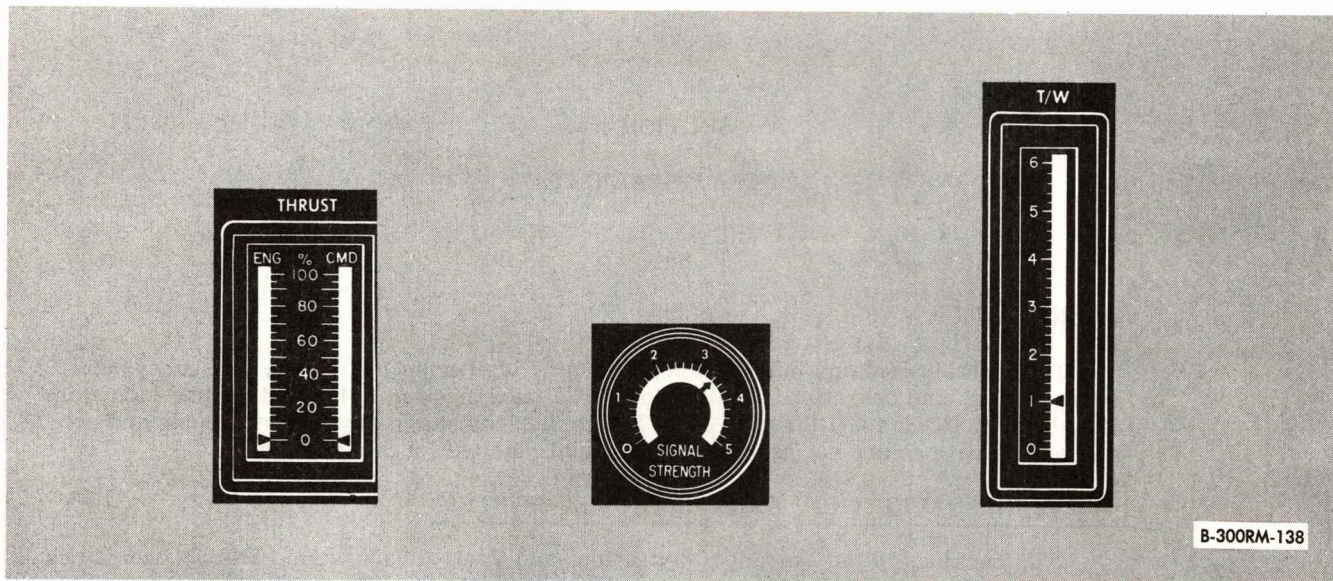


Figure 4-1. Guidance, Navigation, and Control Subsystem Indicators

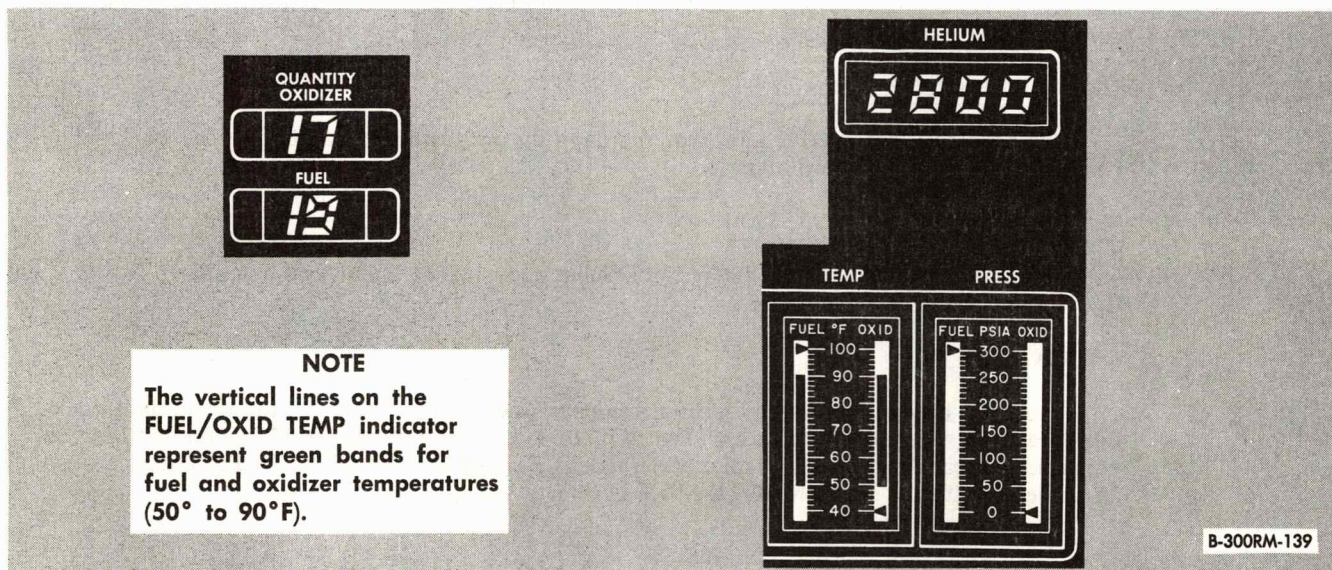


Figure 4-2. Main Propulsion Subsystem Indicators

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4.2.2 MPS OPERATING LIMITATIONS.

The operating limitations for the MPS are given in table 4-1.

Table 4-1.

Main Propulsion Subsystem Operating Limitations

| Indicator | Prelaunch | Ascent | Space Flight |
|--------------------------------|---------------------|---------------------|---------------------|
| HELIUM | | | |
| Descent supercritical pressure | 400 to 1,750 psia | 400 to 1,750 psia | 400 to 1,750 psia |
| Descent ambient pressure | 400 to 1,750 psia | 400 to 1,750 psia | 400 to 1,750 psia |
| Ascent Temperature 1 | 30° to 130° F | 30° to 130° F | 30° to 130° F |
| Ascent Temperature 2 | 30° to 130° F | 30° to 130° F | 30° to 130° F |
| Ascent Pressure 1 | 2,900 to 3,500 psia | 2,900 to 3,500 psia | 2,900 to 3,500 psia |
| Ascent Pressure 2 | 2,900 to 3,500 psia | 2,900 to 3,500 psia | 2,900 to 3,500 psia |
| TEMP (Fuel) | | | |
| Ascent | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| Descent 1 | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| Descent 2 | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| TEMP (Oxidizer) | | | |
| Ascent | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| Descent 1 | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| Descent 2 | 50° to 90° F | 50° to 90° F | 50° to 90° F |
| PRESS | | | |
| Ascent | 100 to 190 psia | 100 to 190 psia | 100 to 190 psia |
| Descent | 130 to 230 psia | 130 to 230 psia | 130 to 230 psia |
| Descent | 130 to 230 psia | 130 to 230 psia | 130 to 230 psia |

4.2.3 CONSUMABLES.

The consumables for the MPS are given in table 4-2.

Table 4-2.

Main Propulsion Subsystem Consumables

| Consumables | Number of Tanks | Total Weight (pounds) | | Delivery Rate to Engine (lb/sec) |
|----------------|-----------------|-----------------------|----------|----------------------------------|
| | | Filled | Usable | |
| Descent engine | | | | |
| Oxidizer | 2 | 11,016.9 | 10,777.2 | 2.5 to 21.3 |
| Fuel | 2 | 6,969.9 | 6,735.8 | 11.5 to 13.3 |
| Helium | 1 | 49.7 | 49.7 | NA |
| Ascent engine | | | | |
| Oxidizer | 1 | 3,203.9 | 3,120 | 7.1 |
| Fuel | 1 | 1,996.4 | 1,950 | 4.4 |
| Helium | 2 | 13 | 13 | NA |

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4.3 REACTION CONTROL SUBSYSTEM.

The markings of the Reaction Control Subsystem (RCS) indicators are shown in figure 4-3.

4.3.1 INDICATORS.

The RCS indicators display temperatures and pressures, as shown in table 4-3. The percentage of RCS propellant quantity remaining is displayed on the QUANTITY indicator.

4.3.2 RCS OPERATING LIMITATIONS.

The operating limitations for the RCS are given in table 4-3.

Table 4-3.
Reaction Control Subsystem Operating Limitations

| Indicator | Prelaunch | Ascent | Space Flight |
|-------------------|------------|------------|--------------|
| TEMP | | | |
| Helium | 70° F | 70° F | 70° F |
| Propellant | 70° F | 70° F | 70° F |
| PRESS | | | |
| Helium | 3,000 psia | 2,000 psia | 3,000 psia |
| Propellant | 50 psia | 180 psia | 50 psia |
| Oxidizer Manifold | 0 psia | 180 psia | 0 psia |
| Fuel Manifold | 0 psia | 180 psia | 0 psia |

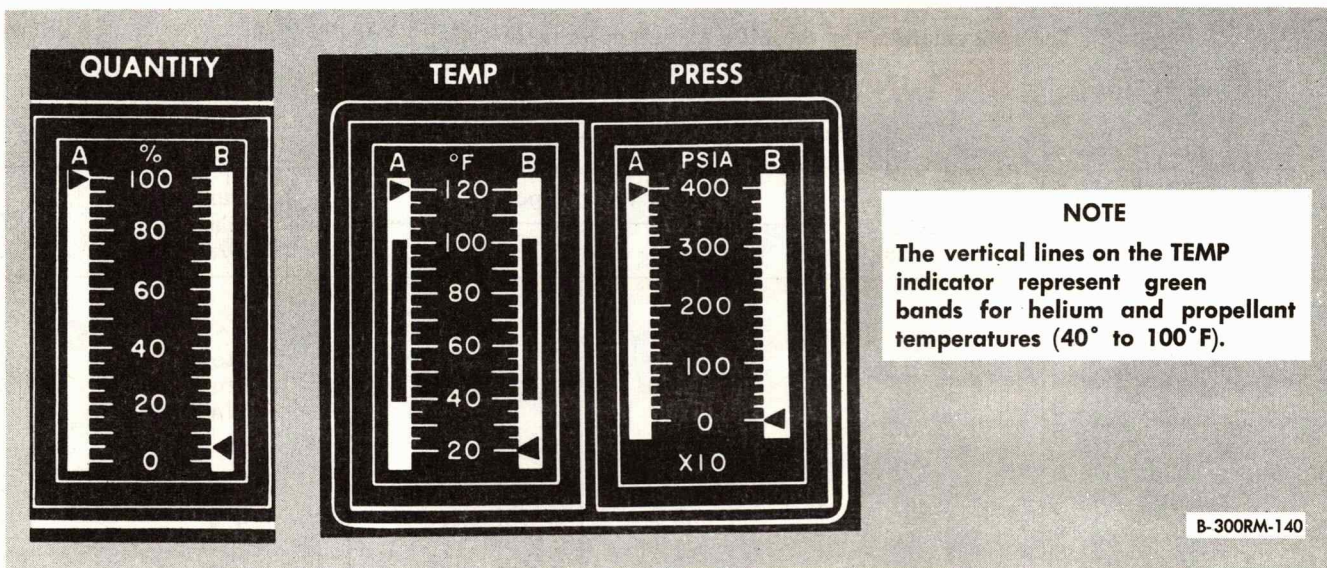


Figure 4-3. Reaction Control Subsystem Indicators

4.3.3 CONSUMABLES.

The consumables for the RCS are given in table 4-4.

Table 4-4.

Reaction Control Subsystem Consumables

| Consumables | Number of Tanks | Total Weight (pounds) | | Steady-State Delivery Rate to Engine (lb/sec) |
|-------------|-----------------|-----------------------|--------|---|
| | | Filled | Usable | |
| Oxidizer | 2 | 388.4 | 353.4 | 0.245 |
| Fuel | 2 | 207 | 186 | 0.121 |
| Helium | 2 | 2.1 | 2.1 | NA |

4.4 ELECTRICAL POWER SUBSYSTEM.

The markings of the Electrical Power Subsystem (EPS) indicators are shown in figure 4-4.

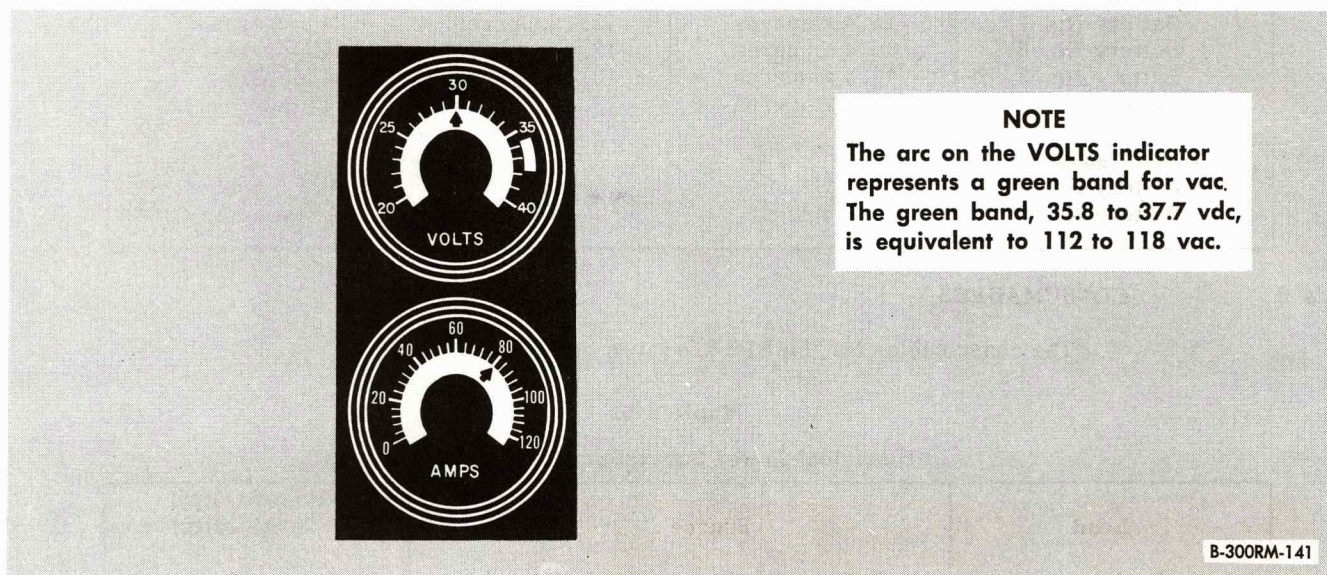


Figure 4-4. Electrical Power Subsystem Indicators

4.4.1 INDICATORS.

The EPS indicators display voltages and currents, as shown in table 4-5.

4.4.2 EPS OPERATING LIMITATIONS.

The operating limitations for the EPS are given in table 4-5.

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Table 4-5.
Electrical Power Subsystem Operating Limitations

| Indicator | Prelaunch | Ascent | Space Flight |
|---------------|------------------|------------------|------------------|
| VOLTS | | | |
| Descent stage | | | |
| Battery No. 1 | 28 to 32.5 vdc | 28 to 32.5 vdc | 28 to 32.5 vdc |
| Battery No. 2 | 28 to 32.5 vdc | 28 to 32.5 vdc | 28 to 32.5 vdc |
| Battery No. 3 | 28 to 32.5 vdc | 28 to 32.5 vdc | 28 to 32.5 vdc |
| Battery No. 4 | 28 to 32.5 vdc | 28 to 32.5 vdc | 28 to 32.5 vdc |
| Ascent stage | | | |
| Battery No. 5 | NA | NA | 28 to 32.5 vdc |
| Battery No. 6 | NA | NA | 28 to 32.5 vdc |
| CDR bus | 26.5 to 32.5 vdc | 26.5 to 32.5 vdc | 26.5 to 32.5 vdc |
| SE bus | 26.5 to 32.5 vdc | 26.5 to 32.5 vdc | 26.5 to 32.5 vdc |
| AC bus | 115±3 vac | 115±3 vac | 115±3 vac |
| AMPS | | | |
| Descent stage | | | |
| Battery No. 1 | 13.4 amperes | 13.4 amperes | 24 amperes |
| Battery No. 2 | 13.4 amperes | 13.4 amperes | 24 amperes |
| Battery No. 3 | 13.4 amperes | 13.4 amperes | 24 amperes |
| Battery No. 4 | 13.4 amperes | 13.4 amperes | 24 amperes |
| Ascent stage | | | |
| Battery No. 5 | NA | NA | 48.1 amperes |
| Battery No. 6 | NA | NA | 48.1 amperes |

4.4.3 CONSUMABLES.

The consumables for the EPS are given in table 4-6.

Table 4-6.
Electrical Power Subsystem Consumables

| Load | Source | Power Output (total watts) |
|------------------|---|-------------------------------|
| Peak | Two ascent batteries and four descent batteries | 3,988 |
| Normal | Two ascent batteries and four descent batteries | 2,695 |
| Emergency | TBD | TBD |
| | | |
| Electrical Power | Descent Stage | Ascent Stage |
| Available | 46.9 kwh | 17.8 kwh |
| Required | TBD | TBD |

4.5

ENVIRONMENTAL CONTROL SUBSYSTEM.

The markings of the Environmental Control Subsystem (ECS) indicators are shown in figures 4-5 through 4-7.

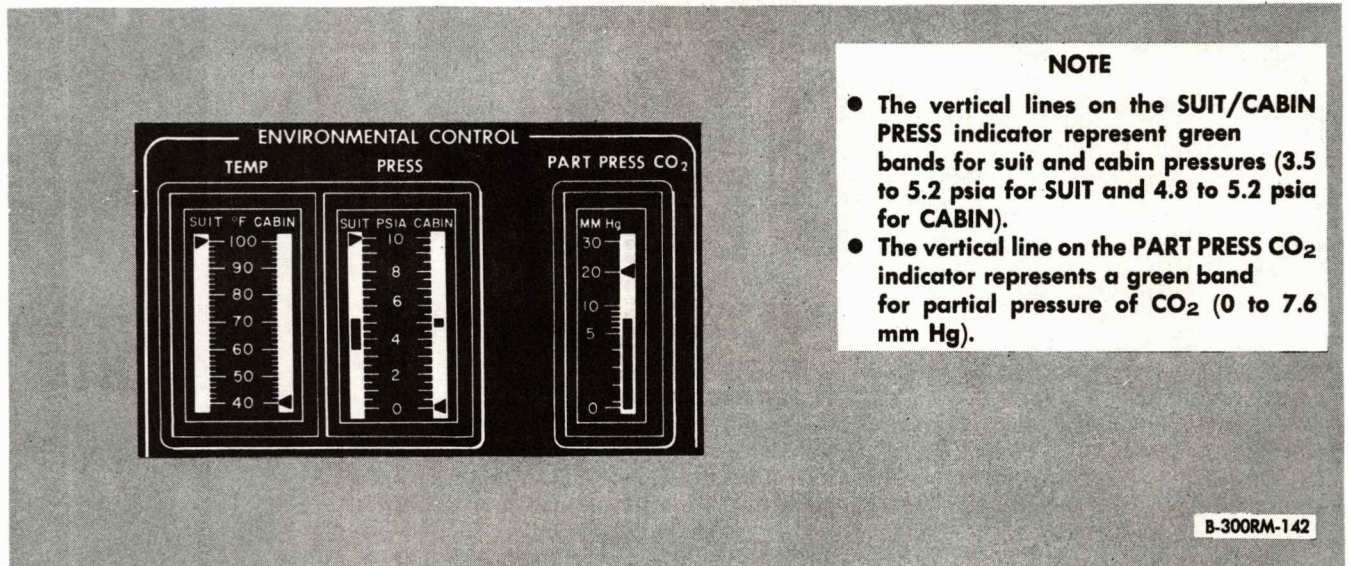


Figure 4-5. Environmental Control Subsystem Suit and Cabin Temperature/Pressure Indicators

4.5.1

INDICATORS.

The ECS indicators display temperatures, pressures, and quantities. The oxygen and water QUANTITY indicator displays the quantity of oxygen and water remaining in the descent tanks or in either of the two ascent tanks.

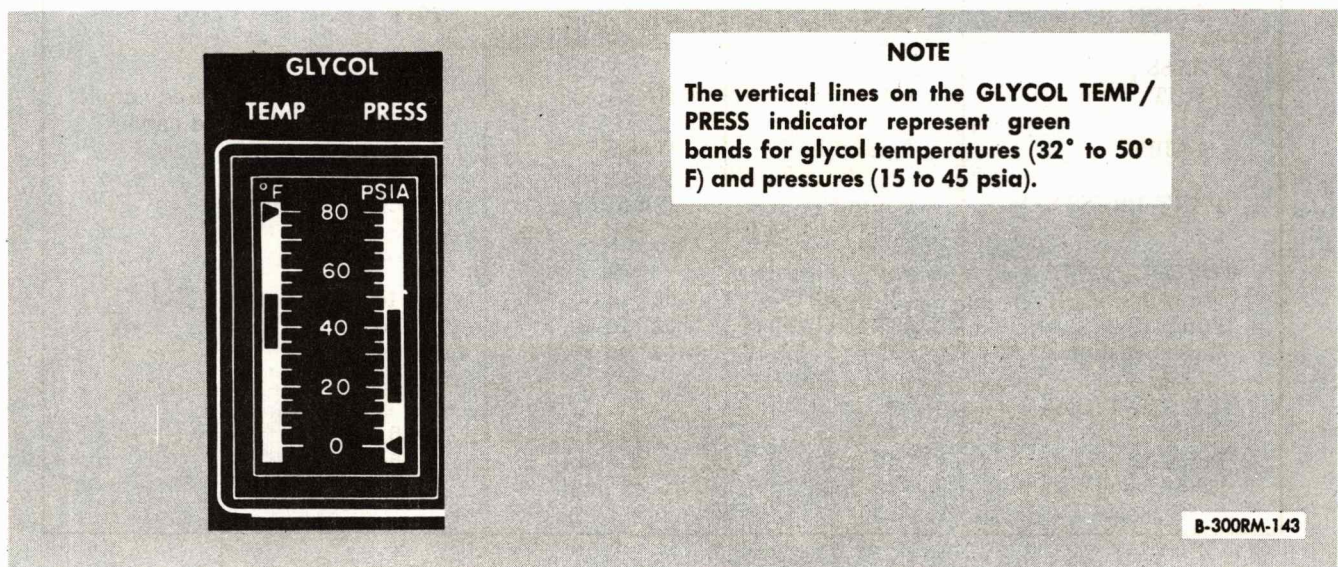


Figure 4-6. Environmental Control Subsystem Glycol Temperature/Pressure Indicator

ENVIRONMENTAL CONTROL SUBSYSTEM

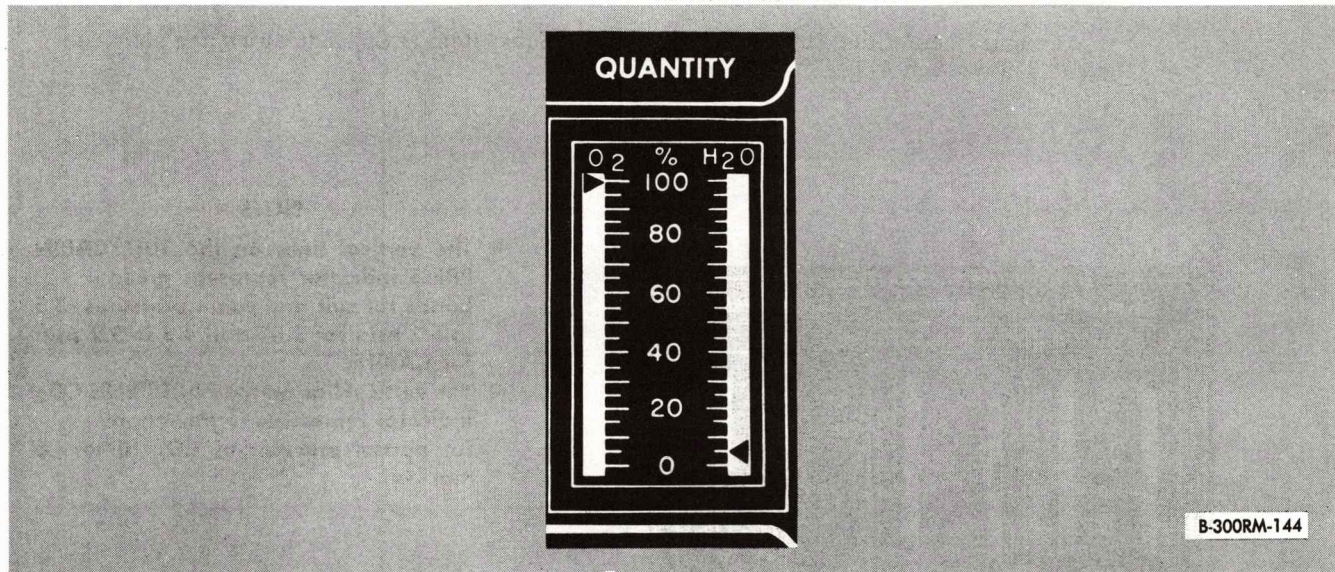


Figure 4-7. Environmental Control Subsystem Oxygen and Water Quantity Indicator

4.5.2 ECS OPERATING LIMITATIONS.

The operating limitations for the ECS are given in table 4-7.

Table 4-7.

Environmental Control Subsystem Operating Limitations

| Indicator | Prelaunch | Ascent | Space Flight |
|---|--|--|---|
| TEMP SUIT CABIN | NA 70° F | NA 40° F | 40° to 70° F 70° F |
| PRESS SUIT CABIN | NA 0 psia | NA 0 psia | 3.8 psia (unpressurized cabin) 4.8±0.2 (pressurized cabin) 4.8 psia |
| PART PRESS CO ₂ | 0 mm Hg | 0 mm Hg | 0 to 7.6 mm Hg |
| GLYCOL-TEMP Pump 1 Pump 2 Emergency | 32° to 50° F 32° to 50° F 32° to 50° F | 32° to 50° F 32° to 50° F 32° to 50° F | 32° to 50° F 32° to 50° F 32° to 50° F |
| GLYCOL-PRESS Pump 1 Pump 2 Emergency | 45 psia 45 psia 45 psia | 45 psia 45 psia 45 psia | 45 psia 45 psia 45 psia |

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4.5.3 CONSUMABLES.

The consumables for the ECS are given in table 4-8.

Table 4-8.
Environmental Control Subsystem Consumables

| Consumables | Number of Tanks | Weight Per Tank (pounds) | |
|---------------|-----------------|--------------------------|--------|
| | | Filled | Usable |
| Descent stage | | | |
| Water | 1 | 333.5 | 326.3 |
| Oxygen | 1 | 48.01 | 47.01 |
| Ascent stage | | | |
| Water | 2 | 41.8 | 41.8 |
| Oxygen | 2 | 2.41 | 2.17 |

Note

The heat transport section of the ECS contains 44 pounds of a water-glycol solution.

4.6 COMMUNICATIONS SUBSYSTEM.

The markings of the Communications Subsystem (CS) indicators are shown in figure 4-8.

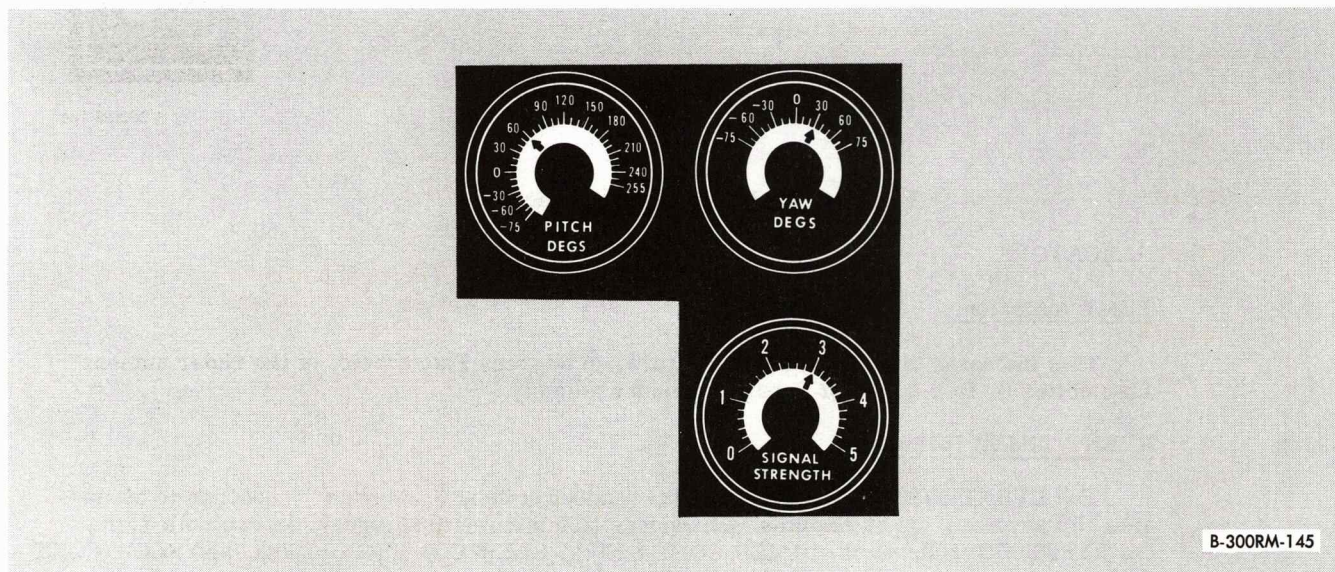


Figure 4-8. Communications Subsystem Indicators

4.6.1 INDICATORS.

4.6.1.1 SIGNAL STRENGTH Indicator.

The SIGNAL STRENGTH indicator displays the magnitude of the automatic gain control (AGC) signal in the operational S-band receiver.

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4.6.1.2 Antenna PITCH Indicator.

The antenna PITCH indicator displays the pitch angles of the S-band dish antenna. The antenna pitch limits are 225° above and 75° below a plane parallel to the LM X-Z plane.

4.6.1.3 Antenna YAW Indicator.

The antenna YAW indicator displays the yaw angles of the S-band dish antenna. The antenna yaw limits are 75° to the left and 75° to the right of a plane parallel to the LM X-Y plane.

4.7 MISCELLANEOUS INDICATORS.

The markings of the miscellaneous indicators, such as the heater TEMP indicator, the EVENT TIMER, and the MISSION TIMER, are shown in figure 4-9.

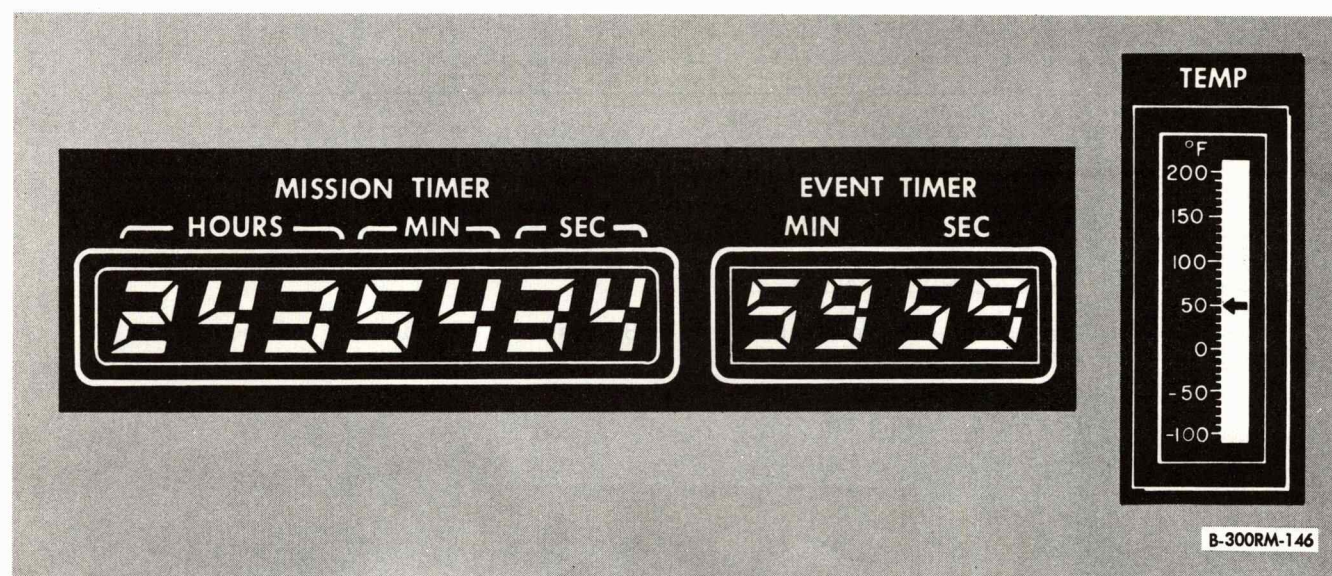


Figure 4-9. Miscellaneous Indicators

4.7.1 INDICATORS.

4.7.1.1 TEMP Indicator.

This indicator displays the temperature, in degrees Fahrenheit, of the radar antenna assemblies or RCS quads or S-band antenna assembly.

4.7.1.2 EVENT TIMER Indicator.

The EVENT TIMER provides a digital readout of time (0 minutes 0 seconds to 59 minutes 59 seconds, or 59 minutes 59 seconds to 0 minutes 0 seconds), as controlled with the RESET/COUNT switch, TIMER CONT switch, SLEW CONT MIN switch, and SLEW CONT SEC switch.

4.7.1.3 MISSION TIMER Indicator

The MISSION TIMER provides a digital readout of mission elapsed time in hours, minutes, and seconds. This indicator is controlled by the TIMER CONT switch and SLEW CONT switches.

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4.7.2

TEMP INDICATOR OPERATING LIMITATIONS.

The operating limitations for the radar and RCS quadrants are given in table 4-9.

Table 4-9.

TEMP Indicator Operating Limitations

| Indicator | Prelaunch | Ascent | Space Flight |
|--|---|---|--|
| TEMP Landing radar* Rendezvous radar RCS quad 1 RCS quad 2 RCS quad 3 RCS quad 4 S-band | <div> }</div> Ambient temper- ature | <div> }</div> Ambient temper- ature | +50° to +145° F +10° to +145° F +130° F +130° F +130° F +130° F -40° F |
| *Before equipment operation, the landing radar antenna must be at a minimum of +50° F. | | | |

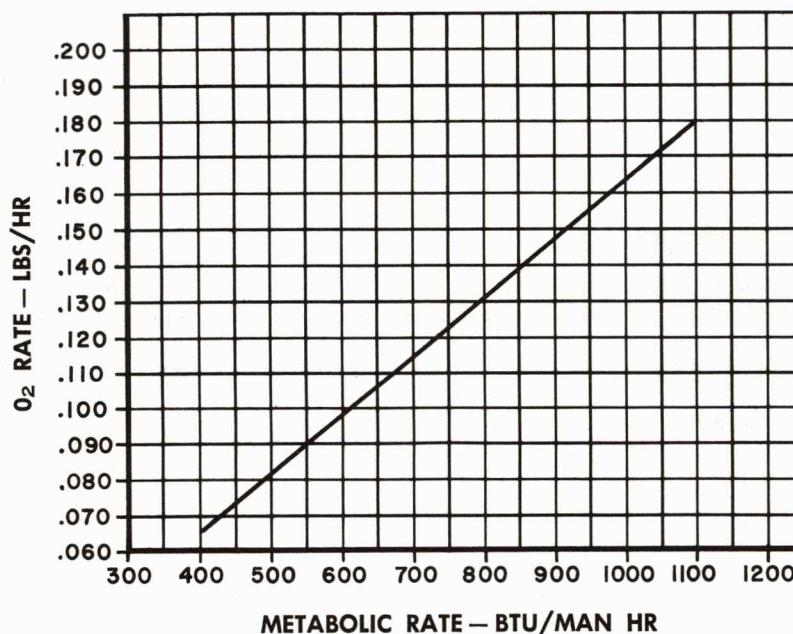
4.8

LM-2 CONSUMABLES.

4.8.1

METABOLIC OXYGEN CONSUMPTION.

Metabolic oxygen consumption is directly proportional to the crew metabolic rate (BTU/man-hour). Using the crew metabolic rate, the oxygen consumption rate can be determined from figure 4-10. The total oxygen consumption per man multiplying the time duration at each activity level by the oxygen consumption rate and by the number of men.



300RM-197

Figure 4-10. Oxygen Rate Versus Metabolic Rate

LM-2 CONSUMABLES

Mission 207/208A

Basic Date 1 January 1967

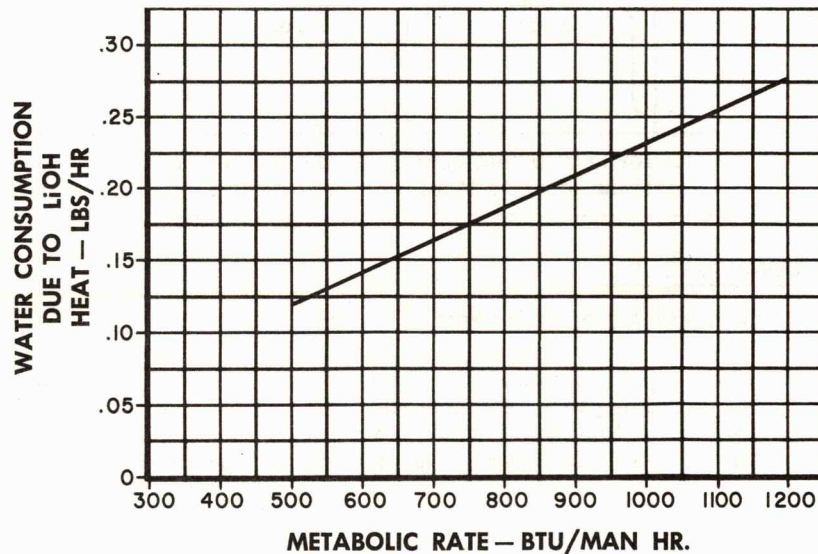
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4.8.2

WATER CONSUMPTION.

The water consumption rate (lb/hr) for the lithium hydroxide (LiOH) reaction, as a function of crew metabolic rate is shown in figure 4-11. If two astronauts are on board, the metabolic rates of the two astronauts should be added before using figure 4-11. The water consumption is then obtained by multiplying the rate by the time of activity.



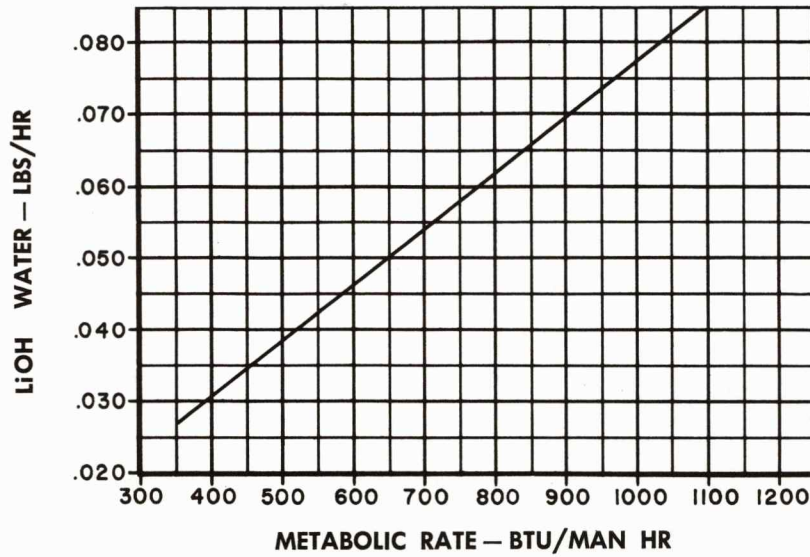
300RM-199

Figure 4-11. Water Consumption Due to LiOH Heat Versus Metabolic Rate

4.8.3

WATER PRODUCTION.

Water consumption is offset by production of water by the LiOH reaction. This water production should be subtracted from the water consumption to give the total water consumption. Figure 4-12 gives the LiOH water production rate (lb/hr) as a function of metabolic rate. If two astronauts are active, the metabolic rates of both should be added before using figure 4-12. The total water production is obtained by multiplying the rate by the time of activity.



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Figure 4-12. Lithium Hydroxide Water Production
Versus Metabolic Rate

SECTION 8
NORMAL/BACKUP PROCEDURES

INTRODUCTION.

This section contains normal/backup procedures for the first manned LM mission. The procedures are arranged in a block format and sequence which coincides with that used in the Mission Modular Data Book for LM-2. The block number and title identify the block type and the mission event being performed. Blocks designated by an L (e.g. L1-2) are LM only blocks and do not require CSM interface, while blocks designated by a JL require actions on the part of the CSM crewman as well as the LM astronauts.

Preceding the procedures in this section is general information concerning the Display Keyboard (DSKY) and the Data Entry and Display Assembly (DEDA). The information comprises brief familiarization data, verb lists, noun lists, reference codes, option codes, alarm codes, and DEDA operating procedures and codes.

8.1 DISPLAY KEYBOARD SYMBOLS.

| | |
|-------|--|
| V | Depress Verb button |
| N | Depress Noun button |
| E | Depress Enter button |
| ENTER | Depress sequence of numeric pushbuttons for input of program numbers or parameters |
| FL | Observe flashing of numeric lamps which indicates that the LGC requires input. |

8.2 DATA ENTRY AND DISPLAY ASSEMBLY SYMBOLS.

| | |
|-----|------------------------|
| C | Depress Clear button |
| R | Depress Readout button |
| E | Depress Enter button |
| VCE | Verify correct entry |

8.3 DSKY MODES OF OPERATION.

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:

- 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.
- Loading of External Data - the process of inserting data into the LGC via the DSKY.
- PROGRAM or ROUTINE calling - Initiated by operator action via the DSKY.

8.4

DSKY DESCRIPTION AND OPERATION.

The following paragraphs and table 8-1 provide a limited description of the DSKY and the crew/DSKY operating procedures. See figure 3-2.

- 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 should be extinguished by crew use of the RSET or KEY REL buttons when the UPLINK transmission is complete.
- NO ATT LIGHT - Is energized when the LGC is in operate mode and there is no inertial reference; i. e. the ISS is off, caged, as in the coarse align mode.
- STBY LIGHT - Is energized when the LGC is in standby mode. Is deenergized when the LGC is in operate mode.
- KEY REL LIGHT - Is energized when an internal sequence attempts to use the DSKY, but finds it busy due to independent operator action (any keyboard depression except RSET). Until the operator releases the DSKY (by pressing the KEY REL button) the internal sequence may be forced to hold.
- TEMP LIGHT - Is energized when the stable member temperature is outside the design limits (126.3°F to 134.3°F).
- GIMBAL LOCK LIGHT - Is energized when the middle gimbal angle exceeds $\pm 70^\circ$ from its zero position. When the middle gimbal angle 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.
- PROG LIGHT - Is energized when a PROGRAM ALARM occurs.
- RESTART LIGHT - Is energized when a RESTART occurs.
- TRACKER LIGHT - When the rendezvous or landing radars are on the light is energized when:

An RR CDU fine error greater than 1.0 vrms occurs.

An RR CDU coarse error greater than 2.5 vrms occurs.

The RR read counter limit cycles at a rate greater than 160 cps.

An RR CDU analog to digital conversion fails (Cos ($\theta - \emptyset$) is less than 2 volts).

The RR CDU +14VDC supply decreases to 50% of nominal.

When the RR Data Good Bar discrete occurs during an LGC data read sequence.

When an LR Altitude Data Good Bar discrete or LR Velocity Data Good Bar discrete occurs during an LGC data read sequence.

- OPR ERROR LIGHT - Is energized when the DSKY operator performs an improper sequence of key depressions. The light is deenergized by pressing the RSET button.
- CMPTR ACTIVITY LIGHT - Is energized when the LGC is occupied with any internal sequence. It is not an indicator of whether the operator may use the DSKY or whether the LGC is not capable of handling further computation.

Table 8-1

Astronaut Response to DSKY Displays and LGC Resultant Action

| ASTRONAUT RESPONSE | 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 V50 ("Please Perform"), N___ identifying a function to be performed or a check list, one register R1 identifying function on that check list. | Request identified by V___ and type of data by N___. Loaded data appears in registers R1, R2, R3. At completion key in "ENTER" | Request identified by V51. At completion of "MARK"s identify target (final entry is "ENTER") |
| | LGC Awaiting ASTRO Response | LGC Not Awaiting ASTRO | LGC Awaiting ASTRO Response | LGC Always Awaiting ASTRO Response | LGC Always Awaiting ASTRO Response |
| | V_ N_ Flashing | V_ N_ Static | V50N_ Flashing | V_ N_ Flashing | V51 Flashing |
| Key in "ENTER" (E) | No LGC Action | No LGC Action | LGC assumes ASTRO complied, terminates flashing Verb-Noun, and continues. | LGC takes loaded data, terminates flashing Verb-Noun and continues. | No LGC action |
| Key in "PROCEED/ PROCEED w/o DATA" (V33E) | LGC assumes displayed data is correct, terminates flashing Verb-Noun, and continues. | No LGC Action | LGC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues. | LGC assumes no data available, terminates flashing Verb-Noun, and continues if possible. | No LGC Action |
| Key in "TERMI- NATE" (V34E) | Varies with program in progress | No LGC Action | Varies with program in process. | Varies with program in process. | Program in progress is terminated. |
| Key in "RECYCLE" (V32E) | LGC returns to earlier point in sequence. | No LGC Action | Incorrect Response. | Incorrect response. | No LGC Action |
| Press "MARK X" button or "MARK Y" button | | | | | LGC reads time, terminates flashing Verb-Noun if a suitable number of marks have been made and continues. |

- **DISPLAY PANEL** - Consists of 24 electroluminescent sections arranged as in figure 3-1. Each section is capable of displaying any decimal character or remaining blank, except the 3 sign sections. 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 placarded VERB, NOUN, and PROG.

At maximum activity, two display characters and a sign may be updated on the Display Panel approximately every 0.1 second.

- **KEYBOARD** - Contains the following buttons:

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

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

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

NUMERICAL keys (0 thru 9) - Self explanatory.

CLR (CLEAR) - Used during a data loading sequence to blank the data display register (R1, R2, R3) being used. It allows the operator to begin loading the data word again.

STBY - Used to put the LGC in standby or operate mode. Pushing button always changes set mode. **STBY LIGHT**, (when lit) indicates standby mode.

KEY REL - Gives the operator's permission for internal sequences to use the DSKY. It is recommended that the operator release the DSKY by pushing this button whenever he is temporarily finished with the DSKY.

ENTR (ENTER) - Is used in two ways:

To execute the Verb/Noun now appearing on the Verb and Noun lights.

To accept a data word just loaded.

RSET (RESET) - Turns off alarm conditions on the DSKY providing the alarm condition has been corrected.

8.4.1

VERBS AND NOUNS.

The basic language of communication between the operator and the DSKY consists of the Verb and Noun. The Verb Code indicates what action is to be taken (operation). The Noun Code indicates to what this action is applied (operand).

Verb Noun codes may be originated either by the operator or by internal LGC sequence.

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

VERB V₁ V₂ NOUN N₁ N₂ ENTER

The VERB key depression blanks the Verb lights on the Display Panel (VD1 and VD2), and clears the Verb Code register within the computer. The next two numerical characters punched in are interpreted as in the Verb Code (V₁, V₂). Each of these characters is displayed in the Verb lights on the Display Panel as it is punched in. The NOUN key operates similarly for the NOUN lights and Noun Code register.

DSKY DESCRIPTION AND OPERATION

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The depression of the ENTER 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 ENTER is pressed. If an error is noticed in either the Verb Code or the Noun Code before the ENTER 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 operator has verified that the desired Verb and Noun Codes are in the lights, should he press the ENTER key and execute the Verb-Noun combination.

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

A single Noun Code refers to a group of 1-, 2-, or 3-component members. It is the Verb Code that determines which component member of the Noun group is operated on. Thus, for instance, there are 5 different Load Verbs. Verb 21 is required for loading the first component of whatever Noun is used therewith; Verb 22 loads the second component of Noun; Verb 23, the third component; Verb 24, the first and second components of the Noun; and Verb 25 loads all three components of the Noun. A similar component format is used in the Display and Monitor Verbs.

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

Decimal data is identified by a + or - sign preceding the 5 numerical characters. If decimal is used for loading data of any component members of a multi-component Load Verb, it must be used for all components of the Verb. Thus no mixture of decimal and octal data is permitted for different components of the same Load Verb. (If this is violated, the Operator Error 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; Proceed/Proceed without data (V33E), Terminate (V34E), and internal program initiation of the Keyboard and Display System Program, or by a Fresh Start of the LGC.

Monitor action is suspended (but not ended) by the depression of any key, except Reset. This turns on the KEY REL light immediately. Monitor action continues after the Keyboard and Display System is released. Thus it is possible to suspend a monitor while the operator 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 internal LGC sequences.

The majority of DSKY operations are of the following categories:

- DISPLAY - To display data to the operator. DISPLAY verbs present data computed by the mission program.
- LOAD - To request a data load as described in detail below.
- PLEASE PERFORM - To request an action from the operator who then notifies the LGC that he has complied as described in detail below.
- PLEASE MARK - To request the operator to push the "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 operator information requiring no response from him. If the Verb/Noun is flashing, appropriate operator response is required as dictated by the Verb/Noun combination. In this case the internal sequence is interrupted until the operator responds appropriately, then the Verb/Noun flash is terminated and the internal sequence is resumed.

It is important to respond to a flashing Verb/Noun with only one of the proper responses or else the internal sequence that called the display may never be resumed.

An appropriate operator response to a flashing Verb/Noun should be an ENTER, Recycle (V32E), Proceed/Proceed without Data (V33E), or a Terminate (V34E). The internal sequence response to any one of these operator responses varies according to the Verb/Noun flashing and the PROGRAM in process.

8.4.2

ACCEPTANCE OF KEYS.

The numerical keys, the CLR key, and the sign keys are rejected if struck after completion (final ENTER) of a data display or data load Verb. At such time, only the Verb, Noun, Enter, Reset, or Key Release 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, or R3 is punched in, and at no other time.

The 8 or 9 key is accepted only while loading a data word into R1, R2, or R3 which was preceded by a plus or minus sign. (If this is violated, the Operator Error 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.

8.4.3

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

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

8.4.4

DISPLAY - VERB/NOUN FLASHING.

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

- Correct the data. Perform the appropriate load verb sequence. Upon the final ENTER, the internal sequence proceeds normally.
- Recycle (V32E). This causes the program to return to a previous location.
- "Proceed/Proceed Without Data" (V33E). This indicates acceptance of the displayed data, and a desire for the internal sequence to continue normally.
- "Terminate" (V34E). The operator wishes the internal sequence to cease operation.

Note that only three responses are legal for any given Verb/Noun flash.

8. 4. 5 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 LGC or by the operator. 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 a 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 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 Operator Error alarm is turned on.)

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

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

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

In multi-component load situations, the appropriate single component Load Verbs are flashed one at a time. The computer always instructs the operator through a loading sequence. The operator (or the internal program) initiates the sequence by selecting VERB 25, "load 3 components of:" (any noun will do) E. 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 operator punched in the first word of data. When the ENTR is pressed, the Verb Code is changed to 22. Flashing continues while the operator 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 was left unchanged.

The CLR Button is used during data loading to remove errors in R1, R2, or R3. It allows the operator to begin loading the data word again. It does nothing to the PROG, 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 of interest and placing +0 into the buffer storage register associated with that display register.

For single component Load Verbs, the CLEAR button depression performs the Clearing Function on whichever register is being loaded, provided that the CLEAR is punched before the data ENTER. Once the ENTER is depressed, the CLEAR does nothing. The only way to correct an error after the data ENTER 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 CLEAR. The first depression of the CLEAR key performs the Clearing Function on whichever register is being loaded. (The CLEAR may be pressed after any character, but before its ENTER.) Consecutive depressions of CLEAR perform the Clearing Function on the data display register above the current one, until R1 is cleared. Any attempts to back-up beyond R1 are simply ignored.

The backing-up of CLEAR 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.

The appropriate operator response to an internally initiated Verb/Noun for LOAD therefore becomes:

- The final ENTER of the Loading sequence, after which internal sequence proceeds normally.
- "Proceed/Proceed Without Data" (V33E). This indicates the operator will not load the requested data and desires the internal sequence to continue as best it can.
- "Terminate" (V34E). The operator wishes the internal sequence to cease operation.

8.4.6 PLEASE PERFORM - VERB/NOUN FLASHING.

This is always an internally initiated action, as operator response is always required to the "please perform" request, the verb-noun is always flashed, and the internal sequence is interrupted. The "please perform" verb (50) is usually used with the "checklist" noun (25) with an appropriate "checklist code" number R1. The appropriate response is:

- ENTER to indicate that the requested action has been performed. The internal sequence continues normally.
- "Proceed Without Data" (V33E). The operator chooses not to perform the requested action, but desires the internal sequence to proceed as best it can.
- "Terminate" (V34E). The operator chooses not to perform the requested action and desires the internal program to cease operation.

The "please perform" verb (50) is also used with "Change of PROGRAM" noun (07) and "Engine on Enable" noun (11). Its use in these cases is subject to the PROGRAM in process.

8.4.7 PLEASE MARK.

The "please mark" verb (51) is flashed when the LGC is prepared to accept optical sighting data upon the pushing of the "MARK" buttons.

8.4.8 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 ENTER which causes the Verb-Noun combination to be executed senses a Noun of this type, the flash is immediately turned on. The Verb Code is left unchanged. The operator 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 CLEAR may be used to remove it.

Pressing the ENTER causes continuation in executing the Verb

8. 4. 9 PROGRAM SELECTION.

To change the PROGRAM the sequence is VERB 37 ENTER. This causes the Noun display register to be blanked and the Verb Code to be flashed. The 2 character PROGRAM Code should then be loaded. For verification purposes, it is displayed as it is loaded in the Noun display register. The ENTER causes 1) the flash is to be turned off, 2) a request for the new PROGRAM to be entered, and 3) a new PROGRAM Code to be displayed in the PROGRAM display register.

8. 4. 10 ALARM PHILOSOPHY.

The Operator Error light is turned on when the operator performs some improper sequence of key depressions.

8. 4. 10. 1 Illegal Verbs, Nouns and Combinations.

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

Violation of the following principle causes the Operator Error to be turned on. No further action is taken.

- An undefined (or spare) Verb must not be used.
- An undefined (or spare) Noun must not be used.
- In octal display and monitor verbs and all load verbs, the component number of the verb must not exceed the number of components in the noun. (Note, all "machine address to be specified" nouns are considered 1 component, except noun 01 which may be used with any verb.)
- The octal display and monitor verbs must not be used with a "decimal only" noun.
- The decimal display and monitor verbs must not be used with an "octal only" noun.
- The dp decimal display and monitor verbs (07, 17) must not be used with mixed nouns (codes 55-77).
- No load verb may be used with a noun restricted to be "no load". All nouns having split MIN/SEC scale for any component are "no load" for the entire noun.
- An input code other than those which are defined is received from the Keyboard.
- The contents of the register used to determine which Display Panel character is to be lighted has exceeded its limit.

8. 4. 10. 2 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

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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 ENTER 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 ENTER immediately following the address word.)

Violation of the following principles causes the Operator Error to be turned on, and a recycle to be performed.

- The address keyed in for a "machine address to be specified" noun must be octal.
- In multi-component 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.
- Octal data must not be loaded into a "decimal only" noun.
- Decimal data must not be loaded into an "octal only" noun.
- Decimal data loaded must not numerically exceed the maximum permitted by the scale factor associated with the appropriate component of the noun.
- Negative decimal data must not be loaded using the Y optics scale.
- All 3 words must be loaded for the Hours, Minutes, Seconds scale.
- When loading with the Hours, Minutes, Seconds scale, the minutes must not exceed 59; the seconds must not exceed 59.99; and the total number must not exceed 745 hours, 39 minutes, 14.55 seconds.
- Two numerical characters must be supplied for the PROGRAM Code under V37.

8.4.10.3

Operator Error and Key Rejection.

There are two situations which cause the Operator Error light to be turned on and the offending key depression to be simply rejected. These are:

- An attempt to ENTER a decimal data word having fewer than 5 numerical characters. The ENTER 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 ENTER again for the same data word. Or the CLEAR key may be used if the operator wishes to begin loading the offending data word again.
- 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.

VERB LIST

ALLOWABLE REGULAR VERBS

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

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 (TEST ONLY)

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

27 DISPLAY FIXED MEMORY

30 REQUEST EXECUTIVE
31 REQUEST WAITLIST
32 RECYCLE PROGRAM
33 PROCEED WITHOUT DSKY INPUTS
34 TERMINATE FUNCTION
35 TEST LIGHTS
36 REQUEST FRESH START
37 CHANGE PROGRAM (MAJOR MODE)

ALLOWABLE EXTENDED VERBS

40 ZERO CDU-S
41 COARSE ALIGN CDU-S
42 FINE ALIGN IMU-S
43 LOAD IMU ATT ERROR METERS
44 PULSE TORQUE GYROS

46 SPECIFY VEHICLE CONFIGURATION
47 INITIALIZE AGS (LM)

50 PLEASE PERFORM
51 MARK X-RETICLE (LM)
52 MARK Y-RETICLE (LM)
53 MARK X OR Y-RETICLE (LM)

56 TERMINATE TRACKING (P20)

60 SET LEM DAP (LM)
61 COMMAND LR TO POSITION 2 (LM)
62 SAMPLE RADAR ONCE PER SEC (LM)
63 START LEM FCS TEST

70 UPDATE LIFTOFF TIME
71 UNIVERSAL UPDATE-BLOCK ADR
72 UNIVERSAL UPDATE-SINGLE ADR

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80 UPDATE LEM STATE VECTOR
81 UPDATE CSM STATE VECTOR
82 REQUEST ORBIT PARAM DISPLAY (R30)
83 REQUEST REND PARAM DISPLAY (R31)
84 START TARGET DELTA V (R32)

91 COMPUTE BANKSUM
92 OPERATE SELECTED SYSTEM TEST
93 SCAN INBITS

NOUN LIST

ALLOWABLE NORMAL NOUNS

01 SPECIFY ADDRESS (FRAC)
02 SPECIFY ADDRESS (WHOLE)
03 SPECIFY ADDRESS (DEGREE)

05 ANGULAR ERROR/DIFFERENCE
06 OPTION CODE (R1)
07 CHANGE OF PROGRAM

09 ALARMS
10 CHANNEL TO BE SPECIFIED
11 ENGINE ENABLE

15 INCREMENT ADDRESS

19 BALL ANGLES (LM)
20 ICDU ANGLES
21 PIPAS
22 NEW ICDU ANGLES
23 DELTA ICDU ANGLES
24 DELTA TIME OF AGC CLOCK
25 CHECKLIST
26 PRIORITY/DELAY, ADRES, BBCON
27 SELF TEST SWITCH

30 TIG-CSI (LM)
31 TIG-CDH (LM)

33 TIME OF IGNITION
34 TIME OF EVENT
35 TIME TO GO TO EVENT
36 TIME OF AGC CLOCK
37 TIG-TPI
38 TIG-MID
39 DELTA TIME TO TRANSFER

MIXED NOUNS

41 TARGET AZIMUTH, ELEVATION
42 APOGEE, PERIGEE, DELTA V
43 LAT, LONG, ALT
44 APOGEE, PERIGEE, TFF
45 MARKS, TTI-NEXT BURN, MGA
46 IX, IY/IZ, W
47 PITCH, YAW TRIM, THRUST
48 DELTA R, V, BYPASS/MARK CTR

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54 RANGE, RANGE RATE, THETA
55 CDH APSIS, ELEV, POST CDH ALT
56 DELTA V-CDH, PERIGEE
57 DELTA V-CDH, ALT, DELTA ALT
58 DELTA V-TPI, PER, DELTA V-TPF
59 DELTA V-MID, TTIG, DELTA V-TPF

70 STAR OR AOT DETENT CODE
71 AOT ROTATION ANGLES (LM)
72 RR SHAFT, TRUNION ANGLES (LM)
73 NEW RR SHAFT, TRUNION ANGLES (LM)
74 LANDING RADAR ALT, TIME
75 LANDING RADAR VX, TIME (LM)
76 LANDING RADAR VY, TIME (LM)
77 LANDING RADAR VZ, TIME (LM)
78 RR RANGE, TRUNION, SHAFT (LM)
79 RR RANGE RATE, TRUNION, SHAFT (LM)

82 DELTA V (LV)
83 DELTA V (IMU)
84 DELTA V (OTHER VEHICLE)
85 VG (BODY)
86 VG (LV)

90 COMPUTED GIMBAL ANGLES

93 DELTA GYRO ANGLES

98 SYSTEM TEST

CHECKLIST REFERENCE NOUNS (NOUN 25)

| R1 CODE | | ACTION TO BE EFFECTED |
|---------|---------|---|
| 00007 | PERFORM | MANUAL ATTITUDE MANEUVER |
| 00011 | KEY IN | AUTO OPTICS POSITIONING OPTION |
| 00012 | KEY IN | TARGET DATA |
| 00013 | SWITCH | OSS TO COMPUTER CONTROL |
| 00014 | KEY IN | FINE ALIGNMENT OPTION |
| 00015 | PERFORM | STAR ACQUISITION |
| 00016 | KEY IN | TERMINATE MARK OPTION |
| 00050 | PERFORM | FINAL IMU ORIENT, STAR SIGHT AT PRESENT ATT |
| 00051 | PERFORM | FINAL IMU ORIENT, STAR SIGHT AT FINAL ATT |
| 00052 | PERFORM | INT IMU ORIENT, STAR SIGHT AT FINAL ATT |
| 00053 | PERFORM | FINAL IMU ORIENT, STAR SIGHT AT INT ATT |
| 00054 | PERFORM | INT IMU ORIENT, STAR SIGHT AT INT ATT |
| 00060 | SWITCH | ISS TO ON |
| 00061 | SWITCH | IMU POWER DOWN |
| 00062 | SWITCH | LGC POWER DOWN |
| 00200 | KEY IN | ZERO AEA CLOCK OPTION |
| 00201 | SWITCH | RR MODE TO AUTOMATIC |
| 00202 | KEY IN | SIGHTING CHECK OPTION |
| 00203 | SWITCH | GUID CONTROL - PGNS MODE CONTROL - AUTO |
| 00204 | KEY IN | ENABLE GIMBALS OPTION |
| 00205 | PERFORM | MANUAL ACQUISITION OF RR |
| 00206 | PERFORM | ATTITUDE TRIM |

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| R1 CODE | ACTION TO BE EFFECTED (cont) | |
|---------|------------------------------|--------------------------|
| 00401 | SWITCH | S/C CONTROL TO G/N |
| 00403 | SWITCH | OPTICS TO MANUAL OR ZERO |

NOTE

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.

OPTION CODES

THE SPECIFIED OPTION CODES WILL BE FLASHED IN COMPONENT R1 IN CONJUNCTION WITH VERBO6NOUNO6 TO REQUEST THE ASTRONAUT TO LOAD INTO COMPONENT R2 THE OPTION HE DESIRES.

| OPTION CODE | PURPOSE | INPUT FOR COMPONENT 2 |
|-------------|------------------------------------|--|
| 00001 | SPECIFY STATE VECTOR TO BE UPDATED | 1 = LM 2 = CSM |
| 00002 | SPECIFY ACQUISITION MODE | 1 = AUTO 2 = MANUAL |
| 00003 | SPECIFY TIG OR ELEV ANGLE INPUT | 1 = TIG 2 = ELEV ANGLE |
| 00004 | SPECIFY TRANSLATION AXIS | 1 = +X 2 = -X 3 = +Y 4 = -Y 5 = +Z 6 = -Z |
| 00005 | SPECIFY IMU ORIENTATION | 1 = PREF 2 = NOM 3 = REF SMMAT |
| 00006 | SPECIFY IMU ORIENTATION | 1 = PREF 2 = NOM |
| 00007 | SPECIFY CSM/LM VEH ATT | 1 = PREF 2 = NOM |
| 00010 | WILL ATT MANEUVER BE PERFORMED | 1 = YES 2 = NO |

ALARM CODES

| CODE | * TYPE | SET BY |
|-------|---|-------------------------|
| 00105 | MARK BUTTONS NOT AVAILABLE | SXTMARK |
| 00110 | NO MARK SINCE LAST MARK REJECT | SXTMARK |
| 00112 | MARK NOT BEING ACCEPTED | SXTMARK |
| 00113 | NO INBITS | SXTMARK |
| 00114 | MARK MADE BUT NOT DESIRED | SXTMARK |
| 00115 | OPTICS TORQUE REQUEST WITH SWITCH NOT AT CGC | EXT VERB OPTICS CDU |
| 00116 | OPTICS SWITCH ALTERED BEFORE 15 SEC ZERO TIME ELAPSED | T4RUPT |
| 00117 | OPTICS TORQUE REQUEST WITH OPTICS NOT AVAILABLE (OPTIND = -0) | EXT VERB OPTICS CDU |
| 00120 | OPTICS TORQUE REQUEST WITH OPTICS NOT ZEROED | T4RUPT |
| 00121 | INSUFFICIENT MARKS | P22 |
| 00206 | ZERO ENCODE NOT ALLOWED WITH COARSE ALIGN + GIMBAL LOCK | IMU MODE SWITCHING |
| 00207 | ISS TURNON REQUEST NOT PRESENT FOR 90 SEC | T4RUPT |
| 00210 | IMU NOT OPERATING | IMU MODE SWITCH, IMU S2 |
| 00211 | COARSE ALIGN ERROR | IMU MODE SWITCH |
| 00212 | PIPA FAIL BUT PIPA IS NOT BEING USED | IMU MODE SWITCH, T4RPT |
| 00213 | IMU NOT OPERATING WITH TURN-ON REQUEST | T4RUPT |

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| CODE | * TYPE | SET BY |
|-------|---|---------------------|
| 00214 | PROGRAM USING IMU WHEN TURNED OFF | T4RUPT |
| 00215 | ORIENTATION NOT SPECIFIED | P52, P53 |
| 00401 | * DESIRED GIMBAL ANGLES YIELD GIMBAL LOCK | INF ALIGN, IMU S2 |
| 00404 | TARGET OUT OF VIEW | R52 |
| 00405 | TWO STARS NOT AVAILABLE | P52 |
| 00406 | REND NAVIGATION NOT OPERATING | R22 |
| 00410 | ATTITUDE NOT SPECIFIED | P53 |
| 00501 | RADAR ANTENNA OUT OF LIMITS | R25 |
| 00503 | RADAR ANTENNA DESIGNATE FAIL | R21 |
| 00510 | RADAR AUTO DESCRETE NOT PRESENT | R25 |
| 00514 | RADAR GOES OUT OF AUTO MODE WHILE BEING USED | R25 |
| 00525 | DELTA THETA GREATER THAN 3 DEG | R22 |
| 00526 | RANGE GREATER THAN 400 MILES | P20 |
| 00600 | IMAGINARY ROOTS ON FIRST ITERATION | P32, P72 |
| 00601 | PERIGEE ALTITUDE CSI LT PMIN1 | P32, P72 |
| 00602 | PERIGEE ALTITUDE CDH LT PMIN2 | P32, P72 |
| 00603 | CSI TO CDH TIME LT TMIN21 | P32, P72, P33, P73 |
| 00604 | CDH TO TPI TIME LT TMIN23 | P32, P72 |
| 00605 | NUMBER OF ITERATIONS EXCEEDS LOOP MAXIMUM | P32, P72 |
| 00606 | DV EXCEEDS MAXIMUM | P32, P72 |
| 00607 | NO SOLUTION FROM LAMBERT | P32, P72, P33, P73 |
| 00610 | COMPUTED CDH TIME GT INPUT TPI TIME | P32, P72 |
| 00611 | NO TIG FOR GIVEN ELEV ANGLE | P34, P74 |
| 01102 | AGC SELF TEST ERROR | SELF CHECK |
| 01103 | * UNUSED CCS BRANCH EXECUTED | ABORT |
| 01105 | DOWNLINK TOO FAST | T4RUPT |
| 01106 | UPLINK TOO FAST | T4RUPT |
| 01201 | * EXECUTIVE OVERFLOW-NO VAC AREAS | EXEC |
| 01202 | * EXECUTIVE OVERFLOW-NO CORE SETS | EXEC |
| 01203 | * WAITLIST OVERFLOW-TOO MANY TASKS | WAITLIST |
| 01206 | * KEYBOARD AND DISPLAY WAITING LINE O-FLOW | PINBALL |
| 01207 | * NO VAC AREA FOR MARKS | SXTMARK |
| 01210 | * TWO PROGRAMS USING DEVICE AT SAME TIME | IMU MODE SWITCH |
| 01301 | * ARCSIN-ARCCOS INPUT ANGLE TOO LARGE. ABORT | INTERPRETER |
| 01302 | * SQRT CALLED WITH NEGATIVE ARGUMENT. ABORT | INTERPRETER |
| 01406 | THRUST MISALGN EXCEEDS 90 DEGREES | P40MC |
| 01411 | CDU DOES NOT AGREE WITH COMMAND TO 1 DEG | IMU S2 |
| 01501 | * KEYBOARD AND DISPLAY ALARM DURING INTERNAL USE (NVSUB).ABORT | PINBALL |
| 01600 | DRIFT/GYROCOMPSS MISSED TIME STEP-TEST STILL RUNNING-OPT CHOICE | OPT PRE ALIGN CALIB |
| 01601 | DRIFT TEST INTEGRATION OVERFLOW | OPT PRE ALIGN CALIB |
| 01602 | DRIFT TEST ERR IN GYRO TORQUING. END TEST | OPT PRE ALIGN CALIB |
| 01700 | PITCH ATTITUDE ERROR LIMIT EXCEEDED | CSM DAP |
| 01701 | YAW ATTITUDE ERROR LIMIT EXCEEDED | CSM DAP |
| 01702 | ENGINE IS NOT ON 1 SEC.AFTER ENGINE-ON SIGNAL | CSM DAP |
| 01703 | LESS THAN 45 SECS TO IGNITION | P40, P41, P42 |

* INDICATES ABORT TYPE,ALL OTHERS ARE NON-ABORTIVE EXCEPT 4Q1 WHICH IS BOTH.

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8.5

DEDA DATA.

The DEDA front panel (see figure 3-23) contains ten digit pushbuttons, two sign push-buttons, four control pushbuttons, and three digit address display, a sign plus five digit data display, and an operator error indicator.

DEDA operation is initiated by depression of the CLEAR pushbutton which enables entry with the digit pushbuttons. To display the contents of a computer memory cell, its three digit octal address is entered followed by depression of the READOUT pushbutton. After each digit is entered, it appears on the address display. When the computer senses the READOUT command, the display will go blank. After half a second, and at succeeding half second intervals, the computer will read out the address and its contents. Data will be either octal or decimal.

To enter data, a three digit address followed by a sign, five digits of data, and the ENTER pushbutton must be depressed. The computer blanks the panel display upon reading in the data.

If at any time the ENTER or READOUT is depressed without the right sequence of digits, the Operator Error Light will be turned on and the computer will discard the data. The same is true if an 8 or 9 is entered for an address, or a sign is omitted after punching an address. The DEDA processing software in the AEA limits the AGS to 1 DEDA operator request in a 2 sec period.

Depression of the HOLD pushbutton, after a readout is accomplished, will hold the last value displayed rather than update the display every half second. The display is returned to the normal readout mode, where the data is updated every half second, by depressing the READOUT pushbutton.

DEDA CODE

DEDA INPUT INSTRUCTION

| <u>SYMBOL</u> | <u>CODE(7)</u> | <u>DEFINITION</u> |
|---------------|----------------|--|
| *S00 = 0 | +00000 | Attitude Hold |
| * = 1 | +10000 | Guidance Steering |
| * = 2 | +20000 | Acquisition |
| * = 3 | +30000 | IMU Align |
| * = 4 | +40000 | Lunar Align |
| = 5 | +50000 | Body Axis Align |
| = 6 | +60000 | Inflight Calibrate |
| S07 = 0 | +00000 | Equations Utilize Rotating External ΔV Reference Frame |
| = 1 | +10000 | Freezes the External ΔV Reference into an Inertial Reference Frame |
| *S10 = 0 | +00000 | Orbit Insertion |
| * = 1 | +10000 | Coelliptic Sequence Initiate |
| * = 2 | +20000 | Constant delta "h" |
| * = 3 | +30000 | Direct Transfer-Time Increment T Δ Constant |

(7) If the value of the multistate switches is inserted wrong, the computer will treat the number as the closest state which is less than the number loaded.

DEDA DATA

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| <u>SYMBOL</u> | <u>CODE(7)</u> | <u>DEFINITION</u> |
|----------------------|----------------|---|
| * = 4 | +40000 | Direct Transfer-Fixed Time of Ignition |
| = 5 | +50000 | External ΔV |
| *S ₁₁ = 0 | +00000 | DPS or RCS Burn |
| = 1 | +10000 | APS Burn |
| S ₁₂ = 0 | +00000 | Reset Error Indicators or Re-initiate Testing |
| = 1 | +10000 | Test Successfully Completed |
| = 3 | +30000 | Logic Test Failure |
| = 4 | +40000 | Memory Test Failure |
| = 7 | +70000 | Logic and Memory Test Failures |
| *S ₁₃ = 0 | +00000 | Normal Position |
| * = 1 | +10000 | Store Lunar Azimuth |
| *S ₁₄ = 0 | +00000 | Initialization Complete Indication |
| * = 1 | +10000 | Initialize IM and CSM via Downlink |
| * = 2 | +20000 | Initialize LM via DEDA |
| * = 3 | +30000 | Initialize CSM via DEDA |
| *S ₁₅ = 0 | +00000 | Normal Position |
| * = 1 | +10000 | Store z axis Direction Cosines |
| S ₁₆ = 0 | +00000 | CDH at First Crossing of LM Orbit Line of Apsides |
| = 1 | +10000 | CDH at Second Crossing of LM Orbit Line of Apsides |
| S ₁₇ = 0 | +00000 | Normal Position |
| = 1 | +10000 | Select CDH at (S ₂ + 1) π Radians after CS1 for Near Circular Orbits |
| S ₅₅ = 0 | +00000 | Normal Position (Lunar Scaling) |
| = 1 | +10000 | Change Altitude Rate Scaling for Earth Orbits |

(7) If the value of the multistate switches is inserted wrong, the computer will treat the number as the closest correct state which is /ESS than the number loaded.

DEDA OUTPUTS

| <u>SYMBOL</u> | <u>QUANTIZATION</u> | <u>RANGE</u> | <u>ADDRESS</u> | <u>DEFINITION</u> |
|----------------|---------------------|--------------------|----------------|----------------------------|
| r _x | 100 ft | $\pm 8,388,500$ ft | H340 | X component of LM Position |
| r _y | 100 ft | $\pm 8,388,500$ ft | H341 | Y component of LM Position |
| r _z | 100 ft | $\pm 8,388,500$ ft | H342 | Z component of LM Position |

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| <u>SYMBOL</u> | <u>QUANTIZATION</u> | <u>RANGE</u> | <u>ADDRESS</u> | <u>DEFINITION</u> |
|--------------------|---------------------|-----------------|----------------|--|
| V _x | . 1 ft/sec | ±8191. 9 ft/sec | H360 | X component of LM Velocity |
| V _y | . 1 ft/sec | ±8191. 9 ft/sec | H361 | Y component of LM Velocity |
| V _z | . 1 ft/sec | ±8191. 9 ft/sec | H362 | Z component of LM Velocity |
| V | . 1 ft/sec | 8191. 9 ft/sec | H433 | LM Velocity Magnitude |
| r _{cx} | 100 ft | ±8, 388, 500 ft | H344 | X component of CSM Position |
| r _{cy} | 100 ft | ±8, 388, 500 ft | H345 | Y component of CSM Position |
| r _{cz} | 100 ft | ±8, 388, 500 ft | H346 | Z component of CSM Position |
| V _{cx} | . 1 ft/sec | ±8191. 9 ft/sec | H364 | X component of CSM Velocity |
| V _{cy} | . 1 ft/sec | ±8191. 9 ft/sec | H365 | Y component of CSM Velocity |
| V _{cz} | . 1 ft/sec | ±8191. 9 ft/sec | H366 | Z component of CSM Velocity |
| T _{A1} | . 1 min | 4369 min | H377 | Absolute Time |
| q | . 1 NM | ±1379. 7 NM | H343 | Pericynthion Altitude of Present LM Trajectory |
| *q ₁ | . 1 NM | ±1379. 7 NM | TBD | Pericynthion Altitude of Predicted LM Transfer Trajectory (Direct Intercept Transfer Routine Only) |
| * ΔV _{gx} | . 1 ft/sec | ±8191. 9 ft/sec | TBD | Body Axis Components of Velocity-to-be-Gained to Engine Shutdown |
| ΔV _{gy} | . 1 ft/sec | ±8191. 9 ft/sec | TBD | |
| ΔV _{gz} | . 1 ft/sec | ±8191. 9 ft/sec | TBD | |
| *V _{dx} | . 1 ft/sec | ±8191. 9 ft/sec | H473 | Minus Descent Stage Capability plus Δ V Expended |
| *V _o | . 1 ft/sec | ±8191. 9 ft/sec | TBD | Δ V for CS1 Maneuver |
| *V _{po} | . 1 ft/sec | 8191. 9 ft/sec | TBD | Δ V for CDH Maneuver |
| *Δ r _o | . 1 NM | ±1379. 7 NM | TBD | Differential Attitude |
| ξ | . 01 deg | ±90 deg | TBD | Angle between Local Horizon and Z-body axis |
| *T _{Ao} | . 01 min | 136. 5 min | TBD | Coast Time from CSI to CDH |
| R | . 1 NM | 1379. 7 NM | TBD | Range from LM to CSM |
| \dot{R} | . 1 ft/sec | ±8191. 9 ft/sec | TBD | Range Rate |
| \dot{r} | . 1 ft/sec | ±8191. 9 ft/sec | H367 | LM Altitude Rate |
| h | 100 ft | 8, 388, 500 ft | H337 | LM Altitude |
| *T _{Co} | . 1 min | 4369 min | TBD | Best Predicted Time from CDH to TPI |
| *C' _o | . 01 deg | 360 deg | TBD | Best Cost for DEDA Output |
| *V _G | . 1 ft/sec | 8191. 1 ft/sec | H370 | Magnitude of LM Velocity-to-be-Gained |
| *t _{igB} | . 1 min | 4369 min | TBD | Predicted Absolute Time of CDH Maneuver |
| *θ LOS | . 01 deg | 360 deg | TBD | Predicted LOS Angle at t _{igC} |

DEDA DATA

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| <u>SYMBOL</u> | <u>QUANTIZATION</u> | <u>RANGE</u> | <u>ADDRESS</u> | <u>DEFINITION</u> |
|---|---------------------|---------------------|----------------|---|
| * r_5 | . 1 ft/sec | ± 8191.9 ft/sec | TBD | Radial Velocity at CSI (Predicted) |
| * V_T | . 1 ft/sec | 8191.9 ft/sec | TBD | Direct Transfer plus Braking Impulse ΔV |
| r_f | 100 ft | 8,388,500 ft | TBD | Predicted Orbit Insertion Burnout Altitude |
| y | 100 ft | 8,388,500 ft | TBD | Out of CSM Orbit Plane Dis- placement in Orbit Insertion |
| V_y | . 1 ft/sec | ± 8191.9 ft/sec | TBD | LM Velocity Normal to CSM Orbit Plane |
| * $\Delta \gamma i$ | N. A. | N. A. | TBD | Lunar Align Status |
| * $\delta 21$ | N. A. | N. A. | TBD | Lunar Surface Flag |
| 1K1 | .01 deg/hr | ± 10 deg/hr | H540 | Gyro Drift Compensation Coefficient |
| 1K6 | .01 deg/hr | ± 10 deg/hr | H541 | Gyro Drift Compensation Coefficient |
| 1K11 | .01 deg/hr | ± 10 deg/hr | H542 | Gyro Drift Compensation Coefficient |
| S00, S10, S11, S12, S13, S14, S16, S17, S55 | (See DEDA Inputs) | | | |

8.6 NORMAL/BACKUP PROCEDURES.

The following procedures are presented in a manner that cuts across subsystem lines. That is, the procedures are oriented to the performance of mission tasks rather than subsystem operations. If, during the performance of a block of procedures, it is necessary to perform the whole, or a portion of another block of procedures, reference is made to the second set of procedures.

8.6.1 DEFINITIONS.

Table 8-2 contains the definitions of all terms used in the procedures.

Table 8-2.
Definitions of Terms Used in Procedures

| TERM | DEFINITION |
|-----------------|---|
| APSYS | Trajectory intersection of orbital plane and ephemeral plane - Apogee and Perigee |
| ALT (CDH) | Altitude of active vehicle above the launch pad radius at TIG (CDH) |
| Apogee Alt | Altitude of apogee above launch pad radius |
| CDH | Constant Delta Altitude Maneuver |
| CSI | Coelliptic Sequence Initiation Maneuver |
| DELTA ALT (CDH) | Altitude between LM and CSM orbits at TIG (CDH) |

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Table 8-2.
Definitions of Terms Used in Procedures (cont)

| TERM | DEFINITION |
|--------------------------------|--|
| DELTA H (CDH) | Altitude between LM and CSM orbits at TIG (CDH) |
| DELTA T TRANSFER | Time required for transfer from TIG (TPI) to time of intercept |
| DELTA v | Magnitude of Δv vector at TIG |
| DELTA v (CDH) | Required impulsive Δv to accomplish CDH maneuver at TIG (CDH) |
| DELTA V (CDH) | Impulsive Δv at TIG (CDH) to accomplish CDH |
| DELTA V (CSI) | Required impulsive Δv at TIG (CSI) to accomplish CSI |
| DELTA VM | Measured Δv magnitude |
| DELTA V (MID) | Required impulsive Δv to accomplish next midcourse maneuver at TIG (MID) |
| DELTA V (TPF) | Required impulsive Δv to accomplish intercept (TPF) maneuver at calculated time of intercept |
| DELTA V (TPI) | Required impulsive Δv at TIG (TPI) to accomplish TPI maneuver |
| DELTA V _X (IMU) | Component of integrated acceleration along IMU + X axis |
| DELTA V _Y (IMU) | Component of integrated acceleration along IMU + Y axis |
| DELTA V _Z (IMU) | Component of integrated acceleration along IMU + Z axis |
| E | Elevation angle between LM/CSM LOS and LM local horizontal at TIG (TPI) measured from direction of flight |
| E (TPI) | Elevation angle; angle between LM/CSM and LM local horizontal plane at TIG (TPI) measured from direction of flight |
| External Delta v | Program to accept targeting parameters from a source external to the LGC |
| g | Predicted perigee TPI [DEDA] |
| GET | Ground elapsed time |
| GETI (CDH) | TIG (CDH) - Time of CDH ignition |
| GETI (CSI) | TIG (CSI) Time of CSI ignition (GET) |
| GETI (TPI) | TIG (TPI) Time of ignition in ground elapsed time |
| H (CDH) | Altitude of active vehicle above launch pad radius at TIG (CDH) |
| HP (CDH) | Post CDH altitude of perigee above launch pad radius |
| HP (TPI) | Post TPI altitude of perigee above launch pad radius |
| H _A | Altitude of apogee above launch pad radius |
| H _P | Altitude of perigee above launch pad radius |
| IG | Pitch |
| I _X | Moment of inertia above LM x axis |
| I _Y /I _Z | Average moments of inertia about LM _Y and z axes |
| MG | Yaw |
| MGA | Middle gimbal angle at TIG if +X LM axis is aligned with initial thrust direction |
| N | Number of state vector updates since last thrusting maneuver or initiation of program 20 |
| N CDH APSIS | Future Apisidal crossing at which TIG (CDH) should occur |

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Table 8-2.
Definitions of Terms Used in Procedures (cont)

| TERM | DEFINITION |
|--------------------------|--|
| OG | Roll |
| Perigee Alt | Altitude of perigee above launch pad radius |
| { Pitch Trim Yaw Trim | DPS Engine-Bell trim angles at ignition from data taken from fuel loading charts and vehicle fuel gauges |
| R | Geocentric radius vector |
| RANGE | Calculated range to CSM |
| RANGE RATE | Calculated range rate between LM and CSM (minus sign indicates closing) |
| TFF | Time of free fall to 300,000 feet altitude above the launch pad radius |
| TFI | Transfer phase final maneuver |
| TG | Time to go to engine cutoff |
| THETA | Angle between LM + Z axis and local horizontal plane at present time. Plus sign indicates +Z axis is above the plane |
| TIG | Time of engine ignition (Ground elapsed time) |
| Tige | Fixed absolute time of TPI [DEDA] |
| TLX | DPS maximum thrust times CG to hinge point distance at TIG |
| T Perigee | Time to perigee |
| TPI | Transfer phase initiation maneuver |
| TTI | Time to go to APS ignition |
| TTI | Time to go to DPS ignition (Plus sign is before and minus is after ignition) |
| TTI NT | Time to go to intercept |
| TTI (CDH) | Time to go to TIG (CDH) |
| TTI (CSI) | Time to go to TIG (CSI) |
| TTI (MID) | Time to go to TIG (MID) |
| TTI (TPI) | Time to go to TIG (TPI) |
| v | LM inertial velocity vector at TIG |
| V | Inertial velocity vector at TIG |
| V ₀ | Delta V CSI (DEDA) |
| VG | Magnitude of velocity to be gained by thrust maneuver |
| VG _X (LV) | Component of VG at TIG along (R x V) x R |
| VG _Y (LV) | Component of VG at TIG along V x R |
| VG _Z (LV) | Component of VG at TIG along R |
| VP ₀ | Delta V (CDH) (DEDA) |
| W | Total weight |
| Yaw Trim | (See Pitch Trim) |
| Δ V ₀ | Differential altitude (DEDA) |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|--|
| <u>LI-2 IN-FLIGHT UNDOCKED IMU ALIGNMENT</u> | | |
| <p>1. <u>LM-IMU REALIGN PROGRAM (P52)</u></p> <p>1. Key V37E 52E</p> <p>2. POSS FL V50 N07 R1-00005 (PGNCS startup) V37E 05E</p> <p>3. FL V06 N - -</p> <p>R1-000 -- option code for assumed IMU orientation R2-0000X assumed option: 00001 preferred 00002 nominal 00003 REFSMMAT</p> <p>Accept: V33E Reject: Load desired option. Select: Nominal V32E</p> <p>or</p> <p>Preferred V37E --E (Program to define IMU orientation)</p> <p>4. POSS FL V06 N-- (nominal selected)</p> <p>T (align) 00XXX. hrs 000XX. min 0XX. XX sec</p> <p>Accept: V33E Reject: Load desired T (Align)</p> <p>5. FL V06 N17 (Gimbal angles)</p> <p>ROLL, PITCH, YAW XXX. XX deg</p> <p>Check MGA</p> | | <p>NOTE</p> <p>POSS FL V05 N31 R1-000-- (Preferred IMU not specified)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>ACCEPT: V33E</p> <p>Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>REJECT: Maneuver using attitude controller or select new program</p> <p>R50 - Coarse align)</p> <p>6. Wait -- seconds for completion of coarse alignment</p> <p>7. PGNS/AOT LAMP (AC) CB-PRESS.</p> <p>8. Ascend floor-mounted BACKPACK.</p> <p>9. AOT azimuth control - F detent.</p> <p>10. Operate AOT reticle illumination control for desired illumination.</p> <p>11. Operate AOT reticle control until AOT counter indicates 000.0°.</p> <p>12. POSS FL V05 N31 (two stars not available in AOT).</p> <p>R1-000--</p> <p>Bypass R56</p> <p>Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> | <p>12. Monitor FDAI to avoid gimbal lock.</p> | <p style="text-align: center;">NOTE</p> <p>If the RR antenna blocks the center AOT detent, RR antenna be slewed:</p> <p>Radar/Rendezvous Radar slew switch - SLEW.</p> <p>RADAR/SLEW switch - as desired</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Maneuver to acquire stars, V33E. or Repeat R56 Verify STAB/CONT/MODE CONTROL switch - ATT HOLD. Maneuver to possible star acquisition, V32E. (R51 - fine align).</p> <p>13. FL V06 N30 R1 000XX (Star code) R2 0000X (Detent code) Accept: V33E Reject: Repeat steps 6 through 12.</p> <p>14. AOT azimuth control - appropriate detent position.</p> <p>15. FL V50 (please perform checklist item number - -. GUID CONT switch - PGNS. STAB/CONT/MODE CONTROL switch - AUTO. enter or STAB/CONT/MODE CONTROL switch - ATT HOLD. V33E Proceed to step 18.</p> <p>16. FL V06 N17 (gimbal angles) R1 XXX.XX R2 XXX.XX R3 XXX.XX</p> | | <p style="text-align: center;">NOTE</p> <p>If under control of preferred tracking attitude routine proceed to step 17.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>17. Proceed to step 19.</p> <p>18. Maneuver using attitude controller.</p> <p>19. FL V50 N25 R100007 (Attitude trim maneuver) Accept: Proceed to step 20. Reject: Maneuver using attitude controller</p> <p>20. a. Auto trim (option) GUID CONT switch - PGNS STAB/CONT/MODE control switch - AUTO b. No auto trim (option) V33E Repeat sequence from step 18.</p> <p>21. FL V21 N - -</p> <p>22. Load - - star code and AOT detent.</p> <p>23. FL V53 (please mark). Verify AOT reticle counter - 000.0°.</p> <p>24. Load V - - E (DAP pulse mode). Verify STAB/CONT MODE CONTROL switch - ATT HOLD.</p> <p>25. Maneuver using attitude controller.</p> <p>26. Mark X or Y. Accept: Enter Reject: Mark reject , repeat steps 24 and 25.</p> <p>27. FL V51 or FL 52. Verify AOT reticle counter - 000.0°.</p> <p>28. Maneuver using attitude controller.</p> | <p>18. Monitor FDAI to avoid gimbal lock.</p> | <div>NOTE</div> <p>An unsatisfactory mark may be rejected by pressing mark reject (R) any time prior to terminating the marking sequence.</p> <p>Possible program alarm if mark reject is depressed without prior mark or if a surplus mark is entered.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>29. Mark Y or X Accept: Enter Reject: Mark reject Repeat: Steps 27 and 28 above</p> <p>30. FL V50 N25 R1-000 16 (Terminate marks) Accept: Enter Reject: V33E Repeat sequence from step 22.</p> <p>31. FL V06 N30 R1 - 000XX (star code) R2 - 0000X (Detent code) Accept: V33E Reject: V21E Repeat step 31.</p> <p>32. AOT azimuth control - appropriate detent position, if under control of preferred tracking attitude routine, proceed to step 35.</p> <p>33. FL V50 N25 R - 000--- GUID CONT switch - PGNS STAB/CONT/MODE CONTROL switch - AUTO enter or STAB/CONT/MODE CONTROL switch - ATT HOLD, V33E (proceed to step 36)</p> <p>34. FL V06 N17 (gimbal angles) R1 - XXX.XX R2 - XXX.XX R3 - XXX.XX</p> <p>35. Observe attitude maneuver on FDAI.</p> <p>36. Maneuver using attitude controller.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>37. FL V50 N25 R1 00007 (attitude trim maneuver)</p> <p>Accept: V33E Reject: Repeat steps 33 through 37.</p> <p>38. FL V21 N - -</p> <p>Load star code, AOT detent.</p> <p>39. FL V53</p> <p>Verify AOT reticle counter - 000.0°. V - - E (DAP pulse mode)</p> <p>Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>40. Maneuver using attitude controller.</p> <p>Mark X or Y. Accept: Enter Reject: Mark reject, repeat step 34 above.</p> <p>41. FL V51 or V52</p> <p>Verify AOT reticle counter - 000.0°.</p> <p>42. Maneuver using attitude controller.</p> <p>Mark Y or X Accept: Enter Reject: Mark reject, repeat step 8.</p> <p>43. FL V50 N25 R1 00016</p> <p>Terminate enter.</p> <p>Continue V33E. Proceed to step 38.</p> <p>44. V06 N05 (10 seconds)</p> <p>R1 - Star angle difference 000.0X deg (Good Data, angle 0.05 deg)</p> <p>or</p> <p>FL V06 N05</p> <p>R1 - Star angle difference XXX.XX deg (Bad Data, angle 0.05 deg)</p> <p>Accept: V33E Reject: V37E--E (Select new program)</p> <p>(R55 - Gyro torquing) (Optional)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>45. V06 N67 (10 seconds)</p> <p>Delta gyro angles X, Y, Z XX.XXX deg. All angles < 5 deg (Gyros are torqued)</p> <p>or</p> <p>FL V06 N67</p> <p>Delta gyro angles X, Y, Z XX.XXX deg. If any angle > 5 deg</p> <p>Accept: V33E (Gyros are torqued) Reject: V34E (LDC displays P00)</p> <p>46. FL V50 N25 R1-00014 (Fine align check)</p> <p>Accept: Enter (return to step 13) Reject: V33E</p> <p>47. P00</p> <p>48. Set controls:</p> <p>AOT azimuth control - CL</p> <p>Descend from back pack</p> <p>PGNS/AOT LAMP CB (AC) - Pull out.</p> <p>2. <u>IMU ORIENTATION DETERMINATION (P51)</u></p> | | |
| <p>1. Key V37E 51E.</p> <p>2. FL V50 N25 R1-00015 (star acquisition).</p> <p>3. Communicate with CSM to determine attitude compatible with separation or SPS backup to avoid gimbal lock in LM or CSM.</p> <p>4. Communicate and request CSM to relinquish attitude control.</p> | | <p>If docked, CSM may re-acquire attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. MODE CONTROL switch - ATT HOLD.</p> <p>6. AOT azimuth control - desired position.</p> <p>7. PGNS/AOT LAMP CB(AC) - Press.</p> <p>8. Step onto floor-mounted PLSS.</p> <p>9. Operate AOT reticle illumination control for desired light intensity.</p> <p>10. Operate AOT recticle control switch until AOT counter indicates 000.0°.</p> <p>11. Orient LM to desired attitude (based on AOT data) with attitude controller.</p> <p>12. Two navigation stars are in AOT field-of-view.</p> <p>13. Key V33E</p> <p>14. FL V41 N20 R1 00000 R2 00000 R3 00000</p> <p>15. (R50-coarse align CDU and IMU to body axes.)</p> <p>16. Verify that DSKY NO ATT light is illuminated during coarse align.</p> <p>17. Coarse align completed, DSKY NO ATT light out.</p> <p>18. FL V21 N -- (Load star and AOT detent codes in R1 and R2, respectively).</p> <p>19. Refer to star map (flight data kit); identify star in AOT (Obtain star code number from star catalog)</p> | | <p>13. This step is optional, but desirable. If not used, key ENTR in place of V33E.</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>20. KEY star code number E.</p> <p>21. KEY AOT detent code E.</p> <p>22. Verify V21 N -- stops flashing.</p> <p>23. FL V53.</p> <p>24. Verify AOT counter is still 000.0°.</p> <p>25. Key V -- (DAP pulse mode).</p> <p>26. Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>27. Operate attitude controller bringing the selected star across the X or Y reticle.</p> <p>28. Selected star crosses X or Y reticle.</p> <p>29. Mark X or Y pushbutton - depress.</p> <p>30. FL V51 (Mark X) or V52 (Mark Y).</p> <p>31. Verify AOT counter is 000.0°.</p> <p>32. Operate attitude controller bringing the selected star across the X or Y reticle.</p> <p>33. Selected star crosses X or Y reticle.</p> <p>34. Mark X or Y pushbutton - depress.</p> <p>35. FL V50 N25 R1-00016 (Terminate marks request)</p> <p>36. a. Decide to terminate marks, depress ENTR.</p> <p>36. b. Decide to continue pairs of marks D, key V33E and repeat steps 23 through 35.</p> | | <p style="text-align: center;">NOTE</p> <p>If mark is not satisfactorily executed depress R pushbutton (rejects marked position), Repeat steps 27, 28, and 29.</p> <p>34. See above note.</p> <p style="text-align: center;">NOTE</p> <p>If at any time a better star marking is desirable, Key V32E and repeat steps 18 through 35.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>37. First star sighting completed.</p> <p>38. Repeat steps 18 through 36 for second star sighting.</p> <p>39. Second star sighting completed.</p> <p>40. FL V06 N05 R1- XXX.XX (Star angle difference).</p> <p>41. a. FL V06 (10 seconds) (Good data, angle < 0.05°).</p> <p>41. b. FL V06 N05 (Bad data, angle > 0.05°).</p> <p>Accept: V33E Reject: V37E (Select new program).</p> <p>42. P 00.</p> <p>43. Rotate AOT azimuth control to CL detent.</p> <p>44. Descend from floor-mounted PLSS.</p> <p>45. STAB/CONT/MODE CONTROL switch - OFF.</p> <p>46. Communicate with CSM requesting CSM resume attitude control.</p> <p>47. PGNS/AOT LAMP (AC) CB - OPEN.</p> <p>48. IMU orientation determination completed.</p> | | <p>41a. Good data LGC returns to previous program or routine.</p> <p>41b. LGC determines present IMU angles referenced to LM, then determines IMU inertial angles referenced to celestial coordinates. These data are stored as the Reference Stable Member Matrix (REFSMAT) and the LGC internally sets the "orientation known" flag and terminates program 51.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. <u>LM/IMU ALIGN PROGRAM (P53)</u></p> <p>1. Set controls to nominal positions, except as follows:</p> <p style="padding-left: 40px;">PGNS/AOT LAMP CB (AC) - pressed HEATERS/AOT CB-pressed IMU OPR CB - pressed</p> <p>2. Key V37E 53E (R02 - IMU status check)</p> <p>3. POSS FL V50 N07</p> <p style="padding-left: 40px;">(R1 00005 V37E 05E POSS FL V50 N07 R1 00051 V37E 51E</p> <p>4. V06 N - -</p> <p style="padding-left: 40px;">R1 000 -- option code, assumed IMU orientation selection R2 0000X LGC assumed option 00001 = Pref 00002 = Nom</p> <p>Accept: V33E Reject: V22E Load desired code in R2</p> <p>Choose nominal orientation: V32E</p> <p>Select new program: V37E XXE (to specify orientation)</p> <p>For preferred IMU orientation, proceed to step 8.</p> | | <div style="border: 1px solid black; padding: 2px; text-align: center; margin-bottom: 10px;">NOTE</div> <p>LM/IMU Align program (P53) may be deleted at a later date.</p> <div style="border: 1px solid black; padding: 2px; text-align: center; margin-top: 100px;">NOTE</div> <p>POSS FL V05 N31 R1 000XX (IMU orientation not specified)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N - -</p> <p style="margin-left: 40px;">T (Align) 00XXX. hrs 000XX. min 0XX. XX sec</p> <p style="margin-left: 40px;">Accept: V33E Reject: V25 E Load desired T (Align)</p> <p>6. FL V06 N - -</p> <p style="margin-left: 40px;">R1 000XX option code, for assumed LM attitude selection</p> <p style="margin-left: 40px;">R2 0000X LGC assumed option 00001 = Pref 00002 = Nom</p> <p style="margin-left: 40px;">Accept: V33E Reject: V22E Load desired code in R2</p> <p style="margin-left: 40px;">Choose nominal attitude: V32E</p> <p>or</p> <p style="margin-left: 40px;">Select new program: V37E XXE (to specify orientation)</p> <p>7. FL V06 N17</p> <p style="margin-left: 40px;">OG, IG, MG, XXX. XX deg</p> <p style="margin-left: 40px;">If MG < 45 deg: V33E</p> <p style="margin-left: 40px;">If MG > 45 deg: V32E - (Restart program)</p> <p>8. V01 N25</p> <p style="margin-left: 40px;">R1 0005 (SC attitude, IMU orientation 00051 = Final IMU and final vehicle. 00052 = Final IMU and interim vehicle.</p> | | <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">NOTE</div> <p>POSS FL V05 N31 R1 000XX (LM attitude not specified)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>00053 = Interim IMU and final vehicle</p> <p>00054 = Interim IMU and interim vehicle</p> <p>Record Value</p> <p>(R60 - attitude maneuver routine)</p> <p>9. FL V50 N25</p> <p>R1 000XX (auto mode control)</p> <p>Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS</p> <p>Reject: Set GUID CONT AND STAB/CONT/MODE switches as desired.</p> <p>V33E</p> <p>Maneuver vehicle as desired</p> <p>10. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX deg</p> <p>Monitor maneuver on FDAI</p> <p>11. POSS FL V50 N25</p> <p>R1 00007 (attitude trim maneuver)</p> <p>Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS</p> <p>Enter</p> <p>or</p> <p>Reject: Set GUID CONT AND CONT switches as desired.</p> <p>V33E</p> <p>Maneuver vehicle as desired.</p> <p>(51 - fine align)</p> <p>12. FL V06 N30</p> <p>R1 000XX (star code)</p> <p>R2 XXXX (AOT detent)</p> <p>Accept: V33E</p> <p>Reject: V21E load desired star code</p> <p>(R60 - attitude maneuver)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. FL V50 N25</p> <p>R1 000XX (auto mode control)</p> <p>Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS Enter</p> <p>Reject: Set GUID CONT and STAB/ CONT/MODE CONT switches as desired. V33E Maneuver vehicle as desired.</p> <p>14. POSS FL V06 N17</p> <p>OG, IGN, MG XXX. XX deg</p> <p>Monitor maneuver on FDAI</p> <p>15. POSS FL V50 N25</p> <p>R1 00007 - PERFORM (ATT trim maneuver)</p> <p>Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS Enter</p> <p>Reject: Set GUID CONT and STAB/ CONT/MODE CONTROL switches as desired. V33E</p> <p>(R53 - Maneuver vehicle sighting mark as desired.)</p> <p>16. FL V21 N - - (request load)</p> <p>Load star code in R1 Load AOT detent in R2</p> <p>17. FL V53</p> <p>Ascend floor-mounted back pack. AOT reticle to zero, AOT detent - to above load position. Key in V--E (minimum impulse).</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>STAB/CONT/MODE CONTROL switch - ATT HOLD - Maneuver LM so star crosses X or Y reticle line and press appropriate mark button.</p> <p>18. POSS FL V51 (Y mark) or V52 (X mark) If necessary, maneuver LM so star crosses X or Y reticle line and press appropriate mark button.</p> <p>19. FL V50 N25 R1 00016 (terminate marks) Accept: Enter Reject for recycle: New star - V32E same star - V33E</p> <p>20. Repeat steps 12 through 19 for second star. (R54 - star data test)</p> <p>21. V06 N05 (static or flashing) Star angle difference XXX.XX deg Static indication automatically exits R54. Flashing indication = angle > 0.5 deg Key in new program: V37E --E Proceed on bad data: V33E (R55 - gyro torquing)</p> <p>22. FL V06 N67 (static or flashing) Gyro X, Y, Z XX.XXX deg</p> | | <p>NOTE</p> <p>To reselect star: V32E</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Flashing indication = any angle > 5 deg, static indication automatically proceeds to next step.</p> <p>Accept: V33E Reject (for termination): V34E</p> <p>23. FL V50 N25</p> <p style="padding-left: 40px;">R1 00014 (fine align check)</p> <p>Accept: Enter Return to step 11</p> <p>or</p> <p>Reject: V33E Final vehicle attitude (R60 - attitude maneuver)</p> <p>24. POSS FL V50 V25</p> <p style="padding-left: 40px;">R1 000XX (auto mode control)</p> <p>Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS Enter</p> <p>or</p> <p>Reject: Set GUID CONT and STAB/CONT/MODE CONTROL switches as desired. V33E</p> <p>25. POSS FL V06 N17</p> <p style="padding-left: 40px;">OG, IG, MG XXX.XX deg</p> <p style="padding-left: 40px;">Monitor maneuver on FDAI</p> <p>26. POSS FL V50 N25</p> <p style="padding-left: 40px;">R1 00007 (attitude trim maneuver)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p> Accept: STAB/CONT/MODE CONTROL switch - AUTO GUID CONT switch - PGNS Enter Reject: Set GUID CONT and STAB/ CONT/MODE CONTROL switches as desired. V33E </p> <p>27. FL V50 N07</p> <p> R1 000XX (Original program calling for alignment) </p> <p> V37E --E </p> <p> AOT detent - CL Step down from backpack. PGNS/AOT LAMP CB (AC) - Pull open. </p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p><u>L3-2 PRIMARY GUIDANCE NAVIGATION AND CONTROL SYSTEM UPDATE</u></p> | | |
| <p><u>1. P01 LGC INITIALIZATION</u></p> <p>1. Key V06 N65 (Display sample time) enter</p> <p>2. FL V06 N65</p> <p>XXXXX HOURS XXXXX MIN. XXXXX centi-seconds</p> <p>3. Obtain value displayed on CMC DSKY. Compute CMC Minus LGC time difference and record.</p> <p>Reject: Repeat steps 1 thru 3 above to obtain average with desired variance.</p> <p>Accept: V55E (average time diff) 00XXX E (HRS) 000XX E (MIN) 0XXXX E (CS)</p> <p>4. Key V37E 01E (LAC initialization program)</p> | | <p>1. Participate in countdown with CSM. Navigator to attempt simultaneous depression of LGC and CMC ENTR keys.</p> <p>4. This sequence loads 3 double precision (DP) octal words for each of the following quantities:</p> <p>CSM Position Vector CSM Velocity Vector CSM State Vector Time Lunar Landing Site Vector Time for Lunar Landing Vector Time between Zero Ground Elapsed Time and 1 July of the reference Besselian year.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V04 N01</p> <p>XXXXXX (Most significant part of dp word) XXXXXX (Least significant part of dp word) XXXXXX (Address of dp word)</p> <p>6. Obtain DP data word by voice from CMC address displayed on DSKY and record.</p> <p>ACCEPT: V33E</p> <p>REJECT: Go to step 4 or If V50 N07 R1 00000, go to step 11.</p> <p>7. Key V6 - E</p> <p>FL V21 N01</p> <p>Blank Unchanged AAAA</p> <p>8. Key - Most significant part of DP word.</p> <p>Read back to CM</p> <p>ENTER.</p> <p>9. FL V22 N01</p> <p>MSP Blank AAAA</p> <p>10. Key least significant part of DP word.</p> <p>Read back to CM ENTER.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. FL V50 N07</p> <p>00000</p> <p>Accept: Continue sequence Reject: Return to step 4</p> <p>12. Key V37E 00E</p> <p><u>2. LM RENDEZVOUS NAVIGATION PROGRAM (P20)</u></p> <p>1. Key V37E 20E</p> <p>(R02 - IMU status check)</p> <p>2. POSS FL V50 N07</p> <p>R1-00005 (PGNCS startup request) V37E 05E</p> <p>OR</p> <p>POSS FL V50 N07</p> <p>R1-00051 IMU orientation determination request</p> <p>V37E 51E</p> <p>3. FL V06N--</p> <p>R1 000XX Option code for assumed State Vector to be updated</p> <p>R2 0000X LGC assumed option 00001 - LM 00002 - CSM</p> <p>Accept: (State Vector improvement assumption): V33E</p> <p>Reject: V22E Load desired State Vector Code in R2</p> | | <p>11. V50 N07, R1 00000 (Please perform selection of idling. Program P00).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. FL V06 N--</p> <p>R1 000XX Option code for assumed acquisition mode employment</p> <p>R2 0000X LGC assumed option 00001 - AUTO 00002 - MANUAL</p> <p>Accept: (Assumed acquisition mode): V33E</p> <p>Reject: V22E Load desired acquisition mode code in R2</p> <p>CONFIRM CSM at preferred Attitude and transponder operable. Verify RR AC DC CB's CLOSED.</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX</p> <p>(R23 - RR manual acquisition routine)</p> <p>FL V50 N25 XXXXXX (Perform manual acquisition)</p> <p>Set:</p> <p>RNDZ RADAR mode selector to SLEW</p> <p>Verify RATE/ERR MON to RNDZ RADAR</p> <p>Search for CSM manually and upon acquisition verify that acquisition is not side lobe. Then set RNDZ RADAR mode selector to LGC and key ENTR</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX</p> | | <p>Recommend LM in preferred tracking attitude for manual acquisition.</p> <p>SHFT/TRUN ±5° or ±50° as required.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>NOTE:</p> <p>POSS FL V05 N31 R1 000XX (CSM > 400 NM)</p> <p>If desired to wait until CSM < 400 NM, rendezvous parameter display routine (R31) may be used to monitor range by keying in V--E and return to this display is made by keying KEY REL. Key V32E for recycle.</p> <p>OR</p> <p>Terminate P20 by V--E</p> <p>(R61 - Preferred tracking attitude routine)</p> <p>5. POSS FL V50 N25</p> <p>R1-000XX - Perform auto mode selection</p> <p>Set MODE CONTROL to AUTO V33E</p> <p>(R60 - Attitude maneuver routine)</p> <p>Monitor maneuver on FDAI</p> <p>(R21 - RR Designate routine)</p> <p>NOTE:</p> <p>POSS FL V05 N31</p> <p>R1-XXXXX</p> <p>If ALARM code indicates CSM is not being acquired, key RESET and perform one of the following:</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>V33E for R24 RR search routine</p> <p>OR</p> <p>V--E to terminate P20</p> <p>OR</p> <p>V--E to terminate P20, then reselect P20</p> <p>(R20 - RR Data READ routine)</p> <p>POSS FL V05 N31 (Delta Theta ALARM)</p> <p>R1-XXXXXX</p> <p>V33E</p> <p>6. POSS FL V06 N--</p> <p>Delta Theta XXX. XX DEG</p> <p>Accept: V33E</p> <p>Reject: V32E (Recycle to step 5)</p> <p>7. POSS FL V06 N75</p> <p>Delta P XXXX. X NM</p> <p>Delta V XXXXX. FPS</p> <p>Accept: V33E</p> <p>Reject: V32E (Recycle to step 6)</p> <p>or</p> <p>V37E 20E and select manual acquisition runs until terminated by crew</p> <p>VARIABLE TIME</p> <p>8. V37E 00E (No other program in process)</p> <p>OR</p> <p>V--E (Another program beside P20 in process)</p> | | <p>NOTE</p> <p>Once CSM acquired P20 runs in the background until terminated.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---|
| <p>3. <u>LM LGC UPDATE PROGRAM (P27)</u></p> <p>AUTO update:</p> <ol style="list-style-type: none"> 1. Coordinate with ground regarding parameters and time of update. 2. Observe display of P27 and uplink ACTY light ON. 3. Observe uplink ACTY light out after update 4. LGC displays P00 <p>Voice transmission update:</p> <ol style="list-style-type: none"> 1. Key V72E - EXT Delta V or V70E - LM RVT or V76E - CSM RVT 2. FL V21 N01 BLANK UNCHANGED UPADR 000XX. <p>NOTE: V34E to terminate program when desired.</p> <ol style="list-style-type: none"> 3. Key in update data (Data displayed in R1) | | <div>NOTE</div> <p>Purpose is to enter data in LGC via Uplink or by crew input.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. FL V21 N02 (Load complete)</p> <p>BLANK UNCHANGED UPADR</p> <p>Review Data: V01 N01E Key octal address at first word R1 displays first word Key N15E to see next word Key enter for each succeeding word</p> <p>Accept: V33E Change Data: Key in octal identifier of register to be changed (Data loaded displayed in R1) Load new data V33E</p> <p>5. P00</p> <p>4. <u>THRUST MONITOR (P47)</u></p> <p>1. Key V37E 47E R2 - IMU status check</p> <p>2. Poss FL V50 N07 R1 - 00005 (PGNCS start up) V37E 05E</p> <p>or</p> <p>Poss F1 V50 N07 R1 - 00005</p> | | <p>4. MCC may also review data on Downlink.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>R1 - 00051 (IMU orientation determination)</p> <p>V37E 51E</p> <p>3. V16 N--</p> <p>Delta VX (IMU) XXXX. X FPS Delta VY (IMU) XXXX. X FPS Delta VZ (IMU) XXXX. X FPS</p> <p>Perform thrusting maneuver as desired Monitor maneuver on FDAI to avoid gimbal lock.</p> <p>4. When maneuvers are completed:</p> <p>V37E 00E</p> <p>5. <u>ROUTINE NO. 32 TARGET DELTA V.</u></p> <p>1. Key V--E (Target Delta V routine (R32))</p> <p>2. FL V06 N--</p> <p>Delta VX XXXXXX Delta VY XXXXXX Delta VZ XXXXXX</p> <p>3. Receive and record actual CSM Delta V after CSM Thrusting</p> <p>Accept: V33E Reject: V25E</p> <p>Delta VX E Delta VY E Delta VZ E</p> <p>Return to step 2</p> | | <p style="text-align: center;">NOTE</p> <p>This action stops automatic state Vector updating by P20 if in progress, and should be done before the maneuver is started. This will prevent erroneous update of the LM state Vector if in fact the CSM State Vector has changed.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>6. <u>USE LGC PROGRAM NO. 2</u> <u>AGS INITIALIZATION</u></p> <ol style="list-style-type: none"> 1. Refer to Flight Data Kit for procedure checklist. 2. Key into Deda UPDATE LM AND CSM STATE VECTORS, CLR, 414+10000, E 3. Key into DSKY V, 37, E, 02, E 4. FL V50, N25, R1 00xxx, ZERO AEA Clock Accept: Go to step 5 Reject: V33E go to step 7 5. Key into Deda CLR 377+00000. 6. Attempt to press DSKY and Deda ENTR buttons simultaneously. 7. FL V06, N , R1 HRS, R2 MIN, R3 CENTI SECONDS (Get at which DSKY ENTR interrupt was processed) 8. Obtain from MCC actual difference (K) between GET and AGS absolute time. 9. If obtained K is different from DSKY key into DSKY V23E CORRECTED CENTI SECONDS, E OTHERWISE OMIT STEP. 10. Key into DSKY V33E 11. P20 (End of sequence) <p>FL V50 N07, R1 00000 V37E 00E (End of sequence)</p> | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>7.</p> <p>1. Key into Deda</p> <p>CLR, 400 + 30000, VCE, E (Align AGS to DGNS)</p> <p>2. Key into Deda:</p> <p>CLR, 400 + 0000, VCE, E (Attitude hold)</p> <p>8. <u>ENTER RENDEZVOUS RADAR DATA INTO AGS.</u></p> <p>1. Verify DEADBAND switch - MIN. MODE CONTROL switch - ATT HOLD.</p> <p>2. Key into Deda</p> <p>C, *415 + 00000*, VCE (Store 2 AXIS direction Cosines).</p> <p>3. Perform attitude maneuver with Atti- tude Controller to obtain precise Antenna Angle Null.</p> <p>4. Depress Deda ENTR at null.</p> <p>5. Communicate MARK at null note range at null</p> <p>6. Key into Deda</p> <p>C, * + *, VCE, E</p> <p>7. Operate EVENT TIMER - RESET/ COUNT switch to RESET and release.</p> <p>8. STAB/CONT - DEADBAND switch - MAX</p> | <p>Within 5 minutes of Burn.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>9. Monitor EVENT TIMER</p> <p>* * MIN * 50 * SEC</p> <p>10. Verify that criteria for performing an update are met:</p> <p>RANGE * * TO * *</p> <p>RANGE RATE * NEGATIVE *</p> <p>No. of updates performed in present series is * *</p> <p>9. <u>INITIALIZE LM AND CSM STATE VECTORS VIA DEDA</u></p> <p>1. Enter CSM position, velocity, and time data.</p> <p>C, * Z44 + CSM X POSITION *, VCE, E</p> <p>C, * Z45 + CSM Y POSITION *, VCE, E</p> <p>C, * Z46 + CSM Z POSITION *, VCE, E</p> <p>C, * Z64 + CSM X VELOCITY *, VCE, E</p> <p>C, * Z65 + CSM Y VELOCITY *, VCE, E</p> <p>C, * Z66 + CSM Z VELOCITY *, VCE, E</p> <p>C, * Z72 + CSM EPOCH TIME *, VCE, E</p> <p>C, * 414 + 30,000 *, VCE, E</p> | <p>NOTE</p> <p>In certain cases RANGE RATE may go from negative to positive and back to negative between burn-out and docking if using the direct guidance option.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>2. Request LM state Vector from MCC</p> <p>3. Enter LM Position, Velocity, and Time Data.</p> <p style="padding-left: 40px;">C, * 240 + LM X POSITION *, VCE, E</p> <p style="padding-left: 40px;">C, * 241 + LM Y POSITION *, VCE, E</p> <p style="padding-left: 40px;">C, * 242 + LM Z POSITION *, VCE, E</p> <p style="padding-left: 40px;">C, * 260 + LM X VELOCITY *, VCE, E</p> <p style="padding-left: 40px;">C, * 261 + LM Y VELOCITY *, VCE, E</p> <p style="padding-left: 40px;">C, * 262 + LM Z VELOCITY *, VCE, E</p> <p style="padding-left: 40px;">C, * 254 + LM EPOCH TIME *, VCE, E</p> <p style="padding-left: 40px;">C, * 414 + 20,000 *, VCE, E</p> <p style="padding-left: 40px;">10. <u>AGS MANUAL EXTERNAL DELTA V MODE RCS BURNS</u></p> <p>1. Record components of Delta V and time for maneuver as obtained from MSFN.</p> <p>2. Verify GUID CONT switch - AGS</p> <p style="padding-left: 40px;">Verify X-TRANSL switch - 4 JETS</p> <p>3. Key into Deda X, Y, AND Z Delta V components.</p> <p style="padding-left: 40px;">C, address and value, VCE, E</p> <p style="padding-left: 40px;">External Delta V option</p> <p style="padding-left: 40px;">C, 410 + 50,000, VCE, E</p> <p>4. Communicate that EVENT TIMER has reached Zero</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>5. Set SSUB 07 to 1</p> <p>C, 407 + 10,000, VCE, E</p> <p>6. STAB/CONT-DEADBAND switch - MIN.</p> <p>11. <u>INSERT ORBIT INSERTION TARGETING DATA IN AEA.</u></p> <p>1. Key into Deda orbit insertion, Targeted Injection Altitude, Radius RATE, Horizontal Velocity, Delta Two.</p> <p>Desired Absolute Time of CSI Maneuver, and of Transfer Phase Initiate (TPI) as received from CSM or MGG.</p> <p>C, address and value, E</p> <p>12. <u>SET UP AEA FOR DIRECT TRANSFER</u></p> <p>1. Key into Deda values of Delta Time for direct transfer intercept prediction, for Absolute Time of Transfer Phase Initiate (TPI) and for duration of Transfer Phase as received from MSFN.</p> <p>C, address and value, E</p> <p>C, address and value, E</p> <p>C, address and value, E</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. <u>GROUND TRACK DETERMINATION (P21).</u></p> <p>1. Verify 00 in DSKY program display</p> <p>2. Key V37 E 21 E (Ground Track determination program).</p> <p>3. FL V25 N34</p> <p> XXXX XX HOURS XXXXXX MIN XXXXXX SEC </p> <p>4. KEY HOURS, E MIN, E SEC, E</p> <p>5. FL V06 N44</p> <p> XXXXXX LATITUDE XXXXXX LONGITUDE XXXXXX ALTITUDE </p> <p>6. Update 10 min later</p> <p>KEY V32E (Recycle)</p> <p>Return to step 6</p> <p>7. After 10 sec</p> <p>KEY V34E (Terminate)</p> <p>8. FL 00</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>14.</p> <p>1. Key V64E (Start orbit parameter display routine (R30))</p> <p>2. FL V06 N43</p> <p>XXXX. X APOGEE ALT N. M XXXX. X PERIGEE ALT N. M XXXX X TIME OF FREE FALL IN MIN. SEC.</p> <p>V33E</p> <p>Accept: Perigee < 300,001 ft LGC exits from R30 Reject: V06 N35</p> <p>XXXXXX HRS XXXXXX MIN XXXXXX CENTI SEC</p> <p>Response to time to Perigee</p> <p>3. Key V33E</p> <p>4. LGC exits from R30</p> <p>15. <u>ROUTINE R31 RENDEZVOUS PARAMETER DISPLAY</u></p> <p>1. FL V06 N--</p> <p>XXX. XX RANGE TO CSM (N. M) XXXX. X RANGE RATE TO ESM (FPS) XXX. XX THETA</p> <p>2. To cancel display (and R31) key KEY REL.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>16.</p> <p>1. Monitor FDAI error needles for a Zero + or - * indication in PITCH and ROLL and * * in YAW.</p> <p>17. <u>LM2 LANDING RADAR TEST DURING DPS FIRING.</u></p> <p>1. PGNS/LDG RDR CB - PRESS</p> <p>2. TEST MONITOR switch - LDG RADAR PWR/VEL XMTR</p> <p>3. SIGNAL STRENGTH meter > PWR check mark</p> <p>4. TEST MONITOR switch - LDG RADAR PWR/ALT XMTR</p> <p>5. SIGNAL STRENGTH meter > PWR check mark</p> <p>6. MSFN CONFIRMS RADAR OPERATION</p> <p>7. LDG ANT switch - HOVER AFTER * * SEC OF DPS FIRING</p> <p>8. MSFN CONFIRMS RADAR OPERATION</p> <p>9. LDG ANT switch - DES AFTER * * SEC OF DPS FIRING</p> <p>10. MSFN CONFIRMS RADAR OPERATION</p> <p>11. LDG ANT switch - AUTO AFTER DPS SHUTDOWN</p> <p>12. PGNS/LDG RDR CB - PULL</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>18.</p> <ol style="list-style-type: none"> 1. Cross check Rendezvous Radar parameters using DSKY 2. Routine 31 (Display Range and Rate to CSM). <p>V--E</p> <ol style="list-style-type: none"> 3. Crosscheck Range and Rate from Rendezvous Radar with DSKY 4. Key REL on DSKY - PRESS 5. Monitor Rendezvous Radar Parameters 6. Monitor Range and Range Rate. 7. Monitor LOS angles and rates 8. Cross check primary against Abort Guidance System by FDAI readings. | <ol style="list-style-type: none"> 8. Listen to Attitude Angles and respond according to agreement. | |

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| <u>L5-2 RCS PRETHRUSTING SETUP</u> | | | | | | | | | | | | | | | | | | | | | | | |
| <p>1. <u>INTRODUCTION.</u></p> <p>1. Receive directive from MCC that an RCS thrust maneuver will satisfy the Delta V requirements.</p> <p>2. Prepare PGNCS for a specific maneuver to be performed.</p> <p>Choices are:</p> <table><tr><th>Program No.</th><th>Program Title</th><th>Task No.</th></tr><tr><td>30</td><td>External Delta V</td><td>23530</td></tr><tr><td>32</td><td>Co-elliptic sequence initiation</td><td>23532</td></tr><tr><td>33</td><td>Constant Delta altitude</td><td>23533</td></tr><tr><td>34</td><td>Transfer phase initiation</td><td>23534</td></tr><tr><td>35</td><td>Transfer phase midcourse</td><td>23535</td></tr><tr><td>36</td><td>Transfer phase final</td><td>23536</td></tr></table> <p>2. <u>EXTERNAL DELTA V (P30).</u></p> | Program No. | Program Title | Task No. | 30 | External Delta V | 23530 | 32 | Co-elliptic sequence initiation | 23532 | 33 | Constant Delta altitude | 23533 | 34 | Transfer phase initiation | 23534 | 35 | Transfer phase midcourse | 23535 | 36 | Transfer phase final | 23536 | <p>2. Prepare AGS for backup mode to PGNCS for the specified maneuver.</p> | <p>2. AGS procedures will be included in a revised edition of this block.</p> <div>NOTE</div> <p>The purpose of this program is to accept targeting parameters (TIG and impulsive Delta V along LM local vertical axes at TIG) from sources external to LGC; calculate Delta V required and other initial conditions for the maneuver.</p> |
| Program No. | Program Title | Task No. | | | | | | | | | | | | | | | | | | | | | |
| 30 | External Delta V | 23530 | | | | | | | | | | | | | | | | | | | | | |
| 32 | Co-elliptic sequence initiation | 23532 | | | | | | | | | | | | | | | | | | | | | |
| 33 | Constant Delta altitude | 23533 | | | | | | | | | | | | | | | | | | | | | |
| 34 | Transfer phase initiation | 23534 | | | | | | | | | | | | | | | | | | | | | |
| 35 | Transfer phase midcourse | 23535 | | | | | | | | | | | | | | | | | | | | | |
| 36 | Transfer phase final | 23536 | | | | | | | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>1. Key into DSKY V37E30E</p> <p>2. FL V06 N34 TIG</p> <p>00XXX. hrs (GET) 000XX. min 0XX.XX sec Accept: V33E Reject: Reload Data</p> <p>3. FL V06 N</p> <p>XXXX.X DELTA V_X XXXX.X DELTA V_Y XXXX.X DELTA V_Z Accept: V33E Reject: Reload Data</p> <p>4. FL V06 N45</p> <p>H_A XXXX.X NM H_P XXXX.X NM Delta V XXXX.X FPS</p> <p>Accept: V33E Reject:</p> <p>a. Reselect V37E 30E and adjust aim parameters.</p> <p>b. Select V37E 27E and load new aim parameters.</p> <p>c. Select new program.</p> <p>d. Perform manually using PGNCs/AGS data.</p> | <p>1. Receive from MCC/CSM and record: TIG DELTA V_X DELTA V_Y DELTA V_Z APOGEE ALT. (H_A) PERIGEE ALT. (H_P) DELTA V (TIG)</p> <p>2. Record TIG used if different from MCC/CSM value.</p> <p>3. Record Delta V_X, V_Y, V_Z used if different from MCC/CSM value.</p> <p>4. Compare DSKY values with MCC.</p> | <p>1. Delta V may already be available from LGC update program P27. Oxibital parameters are optional output information.</p> <p>a. Reselect P30 and adjust aim parameters.</p> <p>b. Select P27 and load new aim parameters; reselect P30.</p> <p>c. Decide alternatives.</p> <p>d. See Block ----</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 5. FL V06 N35 TTI 00XXX. hrs 000XX. mins 0XX.XX secs Accept: V33E Reject: Select desired program 6. (R02 - IMU Status check) 7. FL V06 N BLANK TTI XXBXX min - sec MGA XXX.XX deg V33E 8. FL V50 N07 R1 000 40 (Select program) Select Propulsion System DPS V37E 40E RCS V37E 41E APS V37E 42E 3. <u>LM PRETHRUST CSI PROGRAM (P32).</u> | 7. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * MINS; release. SLEW CONT/MIN - UNITS Hold till * * MINS; release. SLEW CONT/SECS - TENS Hold till * * MIN; release. SLEW CONT/SECS - UNITS Hold till * * SECS; release. TIMER CONT - START 8. Verify maneuver with MCC. Receive MCC go ahead. | 6. Done automatically. 7. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start). 8. Consider in maneuver decision with MCC/CSM: a. Delta V magnitude b. Propellant available c. Status of propulsion hardware d. TIME/NEED for IMU realignment <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">NOTE</div> Purpose of this program is to calculate parameters for CSI, CDH, TPI AND TPF. Delta V (TPI) and Delta V (TPF) are computed Delta V (TPF) assumed to be single impulse. Midcourse and final corrections are not allowed for. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>1. Key V37E 32E</p> | <p>1. Receive from MCC/CSM and record</p> <p>TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) DELTA T TRANS</p> | |
| <p>2. FL V06 N</p> <p>GETI (CSI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>2. Record TIG (CSI) if different from MCC value</p> | <p>2. Compare DSKY and MCC values</p> |
| <p>3. FL V06 N</p> <p>N CDH APSIS 0000X. E (TPI) XXX.XX DEG</p> <p>Accept: V33E Reject: Reload data</p> | <p>3. Record N CDH APSIS if different from MCC value</p> | <p>3. Compare DSKY and MCC values</p> |
| <p>4. FL V06 N</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>4. Record TIG (TPI) if different from MCC value</p> | <p>4. Compare DSKY and MCC values</p> |
| <p>5. FL V06 N</p> <p>Delta T transfer 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data NOTE: If FL V05N31 R1 (Computation difficulty)</p> <p>Reselect P32 and adjust parameters or select new program.</p> | <p>5. Record Delta T Trans if different from MCC value</p> <p>If alarm flashes communicate which alarm to MCC</p> | <p>5. Compare DSKY and MCC values</p> <p>ALARMS</p> <p>No intersection of desired LOS at TPI with CSM. Magnitude of delta V (CSI) > 1000 fps. Computer cycles for solution excessive. Perigee altitude (CSI) < 80 nm. Perigee altitude (CDH) < 80 nm. Time (CSI to CDH) < 10 MINUTES. Time (CDH to TPI) < 10 MINUTES. Hyperbolic velocity achieved at TPI using orbital parameters planned.</p> |

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| <p>6. FL V06 N</p> <p>Delta V (CSI) XXXX.X FPS</p> <p>V33E</p> | <p>6. Record value of Delta V (CSI) key into DEDA</p> <p>CLR TBD, Readout (Delta V C51, V_O Compare PENCs and AGS Delta V C1</p> | |
| <p>7. FL V06 N</p> <p>GETI (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>V33E</p> | <p>7. Key into DEDA</p> <p>CLR, TBD, Readout (COAST TIME CSI to CDH T_A).</p> <p>Record value.</p> | |
| <p>8. FL V06 N</p> <p>Delta V (CDH) XXXX.X FPS H (CDH) XXXX.X NM Delta H (CDH) XXXX.X NM</p> <p>V33E</p> | <p>8. Subtract GETI (CSI) from GETI (CDH). Compare result with AGS key into Key into Deda</p> <p>CLR TBD Readout (Delta V CDH, V_{PO})</p> <p>Compare PGNS and AGS Delta V CDH Key into Deda</p> <p>CLR TBD, Readout (Differential altitude, v_o)</p> <p>Compare PCNS and AGS Delta H.)</p> | |
| <p>9. FL V06 N</p> <p>Delta V (TPI) XXXX.X FPS HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X FPS</p> <p>V33E</p> | <p>9. Record values</p> | |
| <p>10. FL V16 N35</p> <p>TTI (CSI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>V33E</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 11. FL V16N N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC Check N increases 1/MIN Accept: V33E Reject: a. V32E b. V37E 32E | 11. Check maneuver parameters with MCC. | 11. Accept if TTI \geq 10 MINUTES. Reject if TTI < 10 MINUTES or data is unsatisfactory. a. Recycle to step 02. b. Adjust input data. |
| 12. (R02 - IMU status check) | | 12. No crew action required. |
| 13. FL V06 N N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC MGA XXX.XX DEG V33E | 13. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * MINS; release. SLEW CONT/MIN - UNITS Hold till * * MIN; release. SLEW CONT/SECS - TENS Hold till * * SECS; release. SLEW CONT/SECS - UNITS Hold till * * SECS; release. TIMER CONT - START Record MGA value. | 13. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start). |
| 14. FL V50 N07 (Select program) Select propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42 | | 14. Consider in maneuver decision with MCC/CSM: a. Magnitude of Delta V. b. Status of propulsion hardware. c. Time/Need to realign IMU. Select P02 AGS initialization first. |

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| <p>4. <u>LM PRETHRUST CDH PROGRAM (P33)</u></p> | | <div>NOTE</div> <p>The purpose of this program is to calculate parameters for CDH, TPI and TPF. Delta V (TPI) and Delta V (TPF) are computed. Delta V (TPF) assumed to be single impulse. Midcourse and final correction are not allowed for.</p> |
| <p>1. Key V37E 33E</p> | <p>1. Receive from MCC/CSM and record</p> <p>TIG (CDH) N CDH APSIS E TIG (TPI) DELTA T TRANS</p> | |
| <p>2. FL V06 N</p> <p>GETI (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>2. Record TIG (CDH) if different from MCC value.</p> | |
| <p>3. FL V06 N</p> <p>Delta T transfer 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>3. Record Delta T TRANS if different from MCC value.</p> | |
| <p>4. FL V06 N</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>4. Record TIG (TPI) if different from MCC value.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| FL V05 N31 ALARM V32E Recycle | If ALARM flashes, communicate to MCC which alarm. | <div>NOTE</div> <p>If GETI (TPI) - GETI (CDH) < 10 MIN. FL V05 N31 R1</p> <p>Program ALARM, Reset, recycle V32E and define GETI (TPI)</p> <div>NOTE</div> <p>If Hyperbolic LM velocity results: FL V05 N31 R1</p> <p>Program ALARM. Reset, recycle V32E and adjust parameters.</p> |
| 5. FL V06 N Delta V (CDH) XXXX.X FPS Alt (CDH) XXXX.X NM Delta alt (CDH) XXXX.X NM V33E | 5. Record values. | |
| 6. FL V06 N Blank Blank HP (CDH) XXXX.X NM V33E | 6. Record values. | |
| 7. FL V06 N Delta V (TPI) XXXX.X FPS HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X FPS V33E | 7. Record values. | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>8. FL V16 N35</p> <p>TTI (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> | | |
| <p>9. FL V16 N</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC Blank</p> <p>Check N increase 1/Minute</p> <p>Accept: Reject:</p> <p>a. V32E b. V37E 33E</p> | <p>9. Check maneuver parameters with MCC.</p> | <p>9. Accept if TTI \geq 8 minutes. Reject if TTI < 8 minutes or data unsatisfactory.</p> <p>a. Recycle to step 02.</p> <p>b. Adjust input data.</p> |
| <p>10. FL V16 N</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC MGA XXX.XX DEG</p> <p>V33E</p> | <p>10. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MINS - TENS Hold till * * MINS; release. SLEW CONT/MINS - UNITS Hold till * * MINS; release. SLEW CONT/SECS - TENS Hold till * * SECS; release. SLEW CONT/SECS - UNITS Hold till * * SECS; release. TIMER CONT - START.</p> <p>Record MGA value.</p> | <p>10. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER start).</p> |
| <p>11. FL V50 N07</p> <p>R1 00040 (Select Program)</p> <p>Select propulsion system</p> <p>DPS - Select P40 RCS - Select P41 APS - Select P42</p> | <p>Key into Deda CLR, 410 + 20,000 E (CDH BURN)</p> | <p>Consider in maneuver, decision with MCC/CSM:</p> <p>a. Magnitude of delta V</p> <p>b. Status of propulsion hardware</p> <p>c. Time/Need to realign IMU</p> <p>Select P02 AGS initialization first. Exact time <u>TBD</u>.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>5. <u>LM PRETHRUST TPI PROGRAM (P34).</u></p> <p>1. Key V307E 34E</p> <p>2. FL V06 N</p> <p>R1-0000X (TPI load option) R2-00001 - Load GETI (LGC computes E) OR 00002 - Load E (LGC computes GETI)</p> <p>Accept: V33E Reject: Load data</p> <p>3. If 00001 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> <p>OR If 00002 Accepted:</p> <p>FL V06 N</p> <p>R2-E (TPI) XXX.XX DEG</p> <p>Accept: V33E Reject: Load data</p> | <p>1. Receive from MCC/CSM and record:</p> <p>TIG (TPI) E Delta T TRANS</p> | <div>NOTE</div> <p>Purpose of this program is to calculate Delta V required and initial conditions for TPI given GETI (TPI) or E (TPI) and transfer duration.</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| 4. POSS FL V05 N31 R1 (GETI impossible) V32E - Load NEW E (TPI) or reselect P34 - Load new GETI 5. FL V06 N Delta T TRANS 00XXX. HRS 000XX. MIN 0XX.XX SEC Accept: V33E Reject: Load data 6. POSS: FL V05 N31 R1 (Delta V too great) V32E - Load new Delta T TRANS 7. IF 00001 accepted: FL V06 N R2 - E (TPI) XXX.XX DEG V33E OR If 00002 accepted: FL V06 N34 GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC V33E 8. FL V06 N Delta V (TPI) XXXX.X FPS HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X FPS V33E | 5. Key into Deda CLR, TBD +XXXXXX (TIG C1/MIN DESIRED FIXED ABSOLUTE TIME OR TPI) CLR TBD +XXXXXX (60 .01 MIN Record Delta T TRANS used if different from MCC value 6. Tell MCC if ALARM flashes. 7. Record value(s) used if different from MCC value(s). 8. Record values. CLR, TBD, READOUT Key into DEDa (q, 1000 ft, Predicted Perigee TPI) Compare (q, with HP) | 6. Use of MCC values should prevent this alarm. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>9. FL V06 N</p> <p>TTI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> <p>10. FL V16 N</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC</p> <p>Check data with ground</p> <p>Check N increases 1/MIN.</p> <p>Accept: V33E (No later than TTI = 8 MIN) Reject: If time permits recycle V32E</p> <p>(R02-IMU Status check)</p> <p>11. FL V06 N</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC MGA XXX. XX DEG</p> <p>V33E</p> | <p>11. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * MINS on EVENT TIMER; release. SLEW CONT/MIN - UNITS Hold till * * MINS on EVENT TIMER; release. SLEW CONT/SECS - TENS Hold till * * SEC on EVENT TIMER; release. SLEW CONT/SECS - UNITS Hold till * * SECS on EVENT TIMER; release. TIMER CONT - START</p> | <p>Must convert between NM and thousands of feet.</p> <p>10. RR active.</p> <p>11. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER start.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|--|---|
| <p>12. FL V50 N07 R1 00040 (SELECT PROGRAM)</p> <p>Select propulsion system</p> <p>DPS - V37E 40E RCS - V37E 41E APS - V37E 42E</p> <p>6. <u>LM PRETHRUST TPM PROGRAM (P35).</u></p> <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p>TT INT 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>V33E</p> | <p>12. Record N and MGA used.</p> <p>1. Verify RR actively tracking CSM. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till ** MIN; release. SLEW CONT/MIN - UNITS Hold till ** MIN; release. SLEW CONT/SECS - TENS Hold till ** SECS; release. SLEW CONT/SECS - UNITS Hold till ** SECS; release. TIMER CONT - START</p> | <p>12. Consider in maneuver decision with MCC/ CSM:</p> <p>a. Value of Delta V</p> <p>b. Status of propulsion hardware</p> <p>c. Time available for IMU realignment.</p> <p>Select P02 AGS initialization first.</p> <p>NOTE</p> <p>Purpose of this program is to calculate Delta V required and initial conditions for next MCC during active LM Rendezvous to display data for CREW to enter P36 at correct time to complete thrust maneuver at first Range Gate.</p> <p>Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER start.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| <p>3. FL V16 N</p> <p>N 000XX. MARKS TT INT XXBXX MIN-SEC</p> <p>NOTE: IF TT INT < 20 MIN select P36.</p> <p>Check N increases 1/MIN when ready: V33E</p> <p>Note time on mission timer add 7 MIN result TIG (MID) communicate to SE</p> | | |
| <p>4. FL V16 N</p> <p>N 000XX. MARKS TTI (MID) XXBXX MIN-SEC MGA</p> <p>V33E</p> | <p>4. Key into Deda CLR, TBD +XXXX. X (TIG C .1 MIN desired fixed absolute time mid-course Record values</p> | <p>4. This assumes additional state vector updates not required.</p> |
| <p>5. FL V16 N</p> <p>Delta V (MID) XXXX.X FPS TTI (MID) XXBXX MIN-SEC Delta V (TPF) XXXX.X FPS</p> <p>If MCC burn not required: V32E recycle to step 1. If MCC burn required: V33E</p> | <p>5. Record values.</p> | <p>5. Consider in maneuver decision:</p> <p>a. Magnitude of DELTA V.</p> <p>b. Status of propulsion hardware.</p> <p>c. Time/Need to realign IMU.</p> |
| <p>6. FL V50 N07 R1-00040 (Select program)</p> <p>Select propulsion system</p> <p>DPS - Select P40 RCS - Select P41 APS - Select P42</p> | | |
| <p>7. <u>LM TRANSFER PHASE (P36) FINAL.</u></p> | | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| 1. Key V37E 36E 2. FL V06 N (Rendezvous Data) Range XXX.XX NM Range Rate XXXX.X FPS Theta XXX.XX DEG 3. SHFT/TRUN $\pm 5^\circ$ MODE CONTROL - ATT HOLD RNG ALT MON - RNG/RNG RT 4. Drive pilot roll angle to zero using ATCA. Maintain attitude. 5. Drive LOS Azimuth and elevation angles to null on FDAI using ATCA. Maintain null. 6. Drive azimuth and elevation angular rates to null using TTCA. Maintain null. 7. RANGE * * RANGE RATE * * DRIVE RANGE RATE to * * using TTCA. 8. 9. Repeat step 7 as required. V33E 10. 11. FL V50 N07 00000 V37E 00E 12. P00 | 1. Receive from MCC/CSM and record: a. Range/Range Rate Schedule at each check point b. Angle between +Z LM axis and local horizontal plane per check point. 7. Communicate Range/Range Rate data at each check point to MCC. Receive new Range/Range Rate schedule from MCC as required. 8. Monitor DSKY TRACKER. 10. Verify FL V06 N Stops | 1. RR is active. Program 20 (Rendezvous Navi- gation) points LM +Z axis to CSM within $\pm 30^\circ$. FDAI Pointer needles display LOS angles. Pointer meters display LOS azimuth and elevation angle rates. 5. FLY TO X-Pointer needles on FDAI. 6. FLY TO X-Pointer needles on X-Pointer meters. TTCA LEFT/RIGHT &/OR UP/DOWN. 7. Follow MCC schedule. Correct all NON-NULL deviations immediately rather than allow devia- tion buildup TTCA IN/OUT. 8. RR data lost. Malfunction or CSM ≤ 0.02 NM away. All maneuvers complete. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>8. <u>RCS MANEUVER (23541).</u></p> <p>2. Key V37E 41E (R02 - IMU status)</p> <p>3. FL V06 N (Mass parameters)</p> <p>IX XXXXX. SLUG-FT SQ IY/IZ XXXXX. SLUG-FT SQ W XXXXX. LB</p> <p>Accept: V37E Reject: V25E</p> <p>Reload data.</p> <p>4. FL V06 N</p> <p>Assumed TRANS. axis code 000 LM assumed axis option code 0000X Blank</p> <p>Accept: V33E Reject: V22E</p> <p>Reload axis option code in R2</p> | <p>1. Observe on FDAI</p> <p>PITCH ANGLE * * ROLL ANGLE * * YAW ANGLE * *</p> <p>ATTITUDE MON switch - PGNS</p> <p>Verify on FDAI:</p> <p>PITCH ANGLE * * ROLL ANGLE * * YAW ANGLE * * to be within ±5 DEGS of previous readings.</p> <p>ATTITUDE MON switch - AGS</p> <p>Communicate to CDR that PGNS and AGS agree.</p> <p>3. Request from MCC and/or CSM data on estimated thrust parameters. Record information; transmit information to CDR.</p> <p>4. Set EVENT TIMER to * * MIN * * SEC.</p> <p>EVENT TIMER/TIMER CONT switch - STOP (MOMENTARY) RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT/switch/MIN - TENS Hold until * * MINS on EVENT TIMER; release</p> | <p>3. MCC Data</p> <p>I_x I_y/I_z W VGX (LM) VGY (LM) VGZ (LM) PILOT PITCH } PILOT ROLL } for maneuver PILOT YAW }</p> <p>4. Reset EVENT TIMER only if update required (ignition time slipped etc.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>5. FL V06 N (VG AT IGNITION)</p> <p>VGX (LM) XXXX.X FPS VGY (LM) XXXX.X FPS VGZ (LM) XXXX.X FPS</p> <p>Estimate approx. thrust direction and attitude for various axes. Accept: V33E Reject: V32E</p> <p>Recycle to step 4</p> <p>6. FL V06 N17 (RESULTING GIMBAL ANGLES).</p> <p>ROLL, PITCH, YAW XXX.XX DEG</p> <p>Accept: V33E Reject: V32E</p> <p>Recycle to step 4 or V37E 53E (or 52E) Reselect P41 at completion of P53 (or P52)</p> <p>7. FL V06 N (Velocity to be gained local vertical).</p> <p>VGX (LV) .I FPS VGY (LV) .I FPS VGZ (LV) .I FPS</p> <p>V33E</p> | <p>SLEW CONT/switch/SEC - TENS Hold until * * SEC on EVENT TIMER; release. SLEW CONT switch/SEC - UNITS Hold till * * SEC on EVENT TIMER; release.</p> <p>6. Record values.</p> <p>Record values. Transmit to CSM for R32, target Delta V. Key to Deda CLR, CLR, 400 +30,000 E (Align AGS to PGNCs) CLR, 400 +10,000 E (Auto Submode)</p> | <p>6. Consider if YAW > 45° if ±X axis translation used, in decision to accept or reject.</p> <p>May also select P52 or P53 based on time since last alignment. TIME AVAILABLE RCS fuel available and ground concurrence.</p> <p>Time Constraint TIG - 5 minutes</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>12. Verify these CDR/WARNING lights are extinguished:</p> <p>AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT/FAN MASTER ALARM</p> <p>13. Verify SE's TONE-OFF and MASTER ALARM, and CAUTION lights are extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O₂ QTY GLYCOL WATER QTY MASTER ALARM TONE</p> <p>14. Verify the following:</p> <p>MAIN PROPULSION/FUEL and OXID - TEMP meter pointers in Green Band</p> | <p>NOTE</p> <p>Do not scan propulsion parameters after last ascent burn.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|--|---|
| <p>15. Communicate count down to thrust maneuver from Minus 10 seconds to SE, CSM, MSFN.</p> <p>16. FL V50 N11 (Please perform ENGINE ON).</p> <p>17. Key into DSKY ENTR</p> <p>18. Experience RCS firing by vibration and acceleration.</p> <p>Observe V06 N51</p> <p>R1 T6 (Time to go to shutdown) R2 VG R3 Delta VM</p> <p>19. Monitor FDAI for Attitude Error indication.</p> | <p>MAIN PROPULSION/FUEL and OXID - PRESS meter pointers aligned REACTION CONTROL/SYS A and B TEMP meter pointers in Green Band Communication links to CSM/MCC are usable ENVIRONMENTAL CONTROL - SUIT and CABIN/PRESS meter pointers in Green Band ENVIRONMENTAL CONTROL/PART PRESS CO₂ meter in Green Band ENVIRONMENTAL CONTROL/GLYCOL TEMP and PRESS meter pointers in Green Band</p> <p>18. Experience RCS firing by vibration and acceleration.</p> <p>Verify RCS firing to CSM) MCC.</p> <p>Monitor FDAI</p> <p>FDAI: ATT ERR < - - DEG ATT RATES < - - DEG/SEC</p> | <p>16. Option to inhibit thrust here Key V34E FL V50 N07 R1 00000 Key V37E 00E</p> <p>18. At TTI = O, TTI becomes TG.</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>20. Monitor DSKY AS engine shutdown occurs.</p> <p>FL V06 N51</p> <p>R1 TG (NO) R2 VG R3 DELTA VM</p> <p>(No trim maneuver.) V33E</p> | <p>Compare VG on DSKY with VG on Deda.</p> <p>21. Record final VG and Δ VM Key into Deda (Readout Perigee) CLR, 343 Readout, Record Perigee Transmit final values to MSFN</p> <p>22. Observe PITCH, ROLL AND YAW angles in FDAI. ATTITUDE MON - PGNS Verify PITCH, ROLL and YAW angles on FDAI are within 5 degrees or previous readings. ATTITUDE MON - AGS</p> | |
| <p>23. Do orbital parameter routine (R30).</p> <p>9. <u>POST THRUST EVALUATION.</u></p> <p>1. MODE CONTROL - AUTO</p> <p>2. (R30 orbital parameter routine)</p> | <p>2. Receive trajectory data from</p> <p>MCC Perigee Apogee Time to free fall TOTAL SENSED Velocity---- Time to Perigee</p> | <p>2. The orbital parameter routine may also be entered by Key V64E, though it is normally entered automatically after a thrust program.</p> <p>Time to free fall to 300,000 ft above Launch pad radius.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | |
|--|---|---|--|-----------------|--------------------|-----|---------------------------------------|---------------|-----------|--|---------------|
| <p>3. FL V06 N43</p> <p>Apogee ALT XXXX.X NM Perigee ALT XXXX.X NM TFF XXBXX MIN-SEC V33E</p> <p>4. POSS FL V06 N35</p> <p>T Perigee 00XXX. HRS 000XX. MIN 0XX.XX SECS</p> <p>V33E</p> <p>5. FL V50 N07 R1 00000 V37 E00E</p> <p>6. Key V37 E 00E</p> <p>7. Monitor FDAI</p> <p>PITCH * * ROLL * * YAW * *</p> <p>8. AZ RT * * MRAD/SEC ELEV RT * * MRAD/SEC FDAI Attitude Error - in deadband Attitude rates - *ZERO ± * DEG/SEC FDAI PITCH - * * DEG FDAI ROLL and YAW - STABLE</p> <p>9.</p> | <p>3. Record values if different from MCC values.</p> <p>4. Record value of T Perigee.</p> <p>5. Verify LM safe orbit</p> <p>6. Receive request from CSM for tracking attitude.</p> <p>Tracking Light * *</p> <p>9. Verify CDR/WARNING lights extinguished:</p> <p>ASC PRESS DES REG DES QTY</p> | <p>7.</p> <table> <tr> <td></td><td><u>R to CSM</u></td><td><u>Beacon Mode</u></td></tr> <tr> <td>Eye</td><td>1500 ft <R< 10 NM 10 NM <R< 130 NM</td><td>DIM BRIGHT</td></tr> <tr> <td>Telescope</td><td>1500 ft <R< 30 NM 30 NM <R< 130 NM 130 NM <R< 400 NM</td><td>DIM BRIGHT</td></tr> </table> | | <u>R to CSM</u> | <u>Beacon Mode</u> | Eye | 1500 ft <R< 10 NM 10 NM <R< 130 NM | DIM BRIGHT | Telescope | 1500 ft <R< 30 NM 30 NM <R< 130 NM 130 NM <R< 400 NM | DIM BRIGHT |
| | <u>R to CSM</u> | <u>Beacon Mode</u> | | | | | | | | | |
| Eye | 1500 ft <R< 10 NM 10 NM <R< 130 NM | DIM BRIGHT | | | | | | | | | |
| Telescope | 1500 ft <R< 30 NM 30 NM <R< 130 NM 130 NM <R< 400 NM | DIM BRIGHT | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | CES AC CES DC AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT/FAN Verify SE/CAUTION lights extinguished: ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O ₂ QTY GLYCOL WATER QTY 11. Monitor the following: MAIN PROPULSION/FUEL TEMP * * MAIN PROPULSION/OXID TEMP * * MAIN PROPULSION/FUEL } PRESS } ALIGNED MAIN PROPULSION/OXID } PRESS } REACTION CONTROL/SYSTEM A TEMP - in Green Band REACTION CONTROL/SYSTEM B TEMP - in Green Band | |

11.

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>12. Receive optical tracking trajectory data from CSM.</p> <p>13. R/D TLM CALIBRATE ON. Hold for 12 seconds.</p> <p>14. Prepare for next maneuver.</p> | <p>REACTION CONTROL/ SYSTEM A PRESS REACTION CONTROL/] ALIGNED SYSTEM B PRESS ENVIRONMENTAL CONTROL/ PRESS SUIT - in Green Band ENVIRONMENTAL CONTROL/ PRESS CABIN - in Green Band ENVIRONMENTAL CONTROL/ PART PRESS CO₂ - in Green Band ENVIRONMENTAL CONTROL/ GLYCOL TEMP - in Green Band ENVIRONMENTAL CONTROL/ GLYCOL PRESS - in Green Band</p> <p>12. Record. Compare MCC, CSM, DEDA, and DSKY trajectory values.</p> | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | | | | | |
|--|---------------------------------|----------|----------|----|------------------|-------|----|---------------------------------|-------|----|-------------------------|-------|----|---------------------------|-------|----|---------------------------|-------|--|---|
| <u>L8-2 DPS BURN PRE-THRUSTING SETUP</u> | | | | | | | | | | | | | | | | | | | | |
| <p>1. <u>INTRODUCTION</u></p> <p>1. Receive directive from MCC that a DPS BURN maneuver will satisfy the Delta V requirements.</p> <p>2. Prepare PGNS setup for specific maneuver to be performed. The choices are as follows:</p> <table> <thead> <tr> <th>Program No.</th><th>Title</th><th>Task No.</th></tr> </thead> <tbody> <tr> <td>30</td><td>External Delta V</td><td>23530</td></tr> <tr> <td>32</td><td>Co-elliptic Sequence Initiation</td><td>23532</td></tr> <tr> <td>33</td><td>Constant Delta Altitude</td><td>23533</td></tr> <tr> <td>34</td><td>Transfer Phase Initiation</td><td>23534</td></tr> <tr> <td>35</td><td>Transfer Phase Mid-course</td><td>23535</td></tr> </tbody> </table> <p>2. <u>SELECT ELECTRICAL POWER SYSTEM MODES FOR POWERED DESCENT</u></p> | Program No. | Title | Task No. | 30 | External Delta V | 23530 | 32 | Co-elliptic Sequence Initiation | 23532 | 33 | Constant Delta Altitude | 23533 | 34 | Transfer Phase Initiation | 23534 | 35 | Transfer Phase Mid-course | 23535 | <p>1. Verify CDR BUS on VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/AC</p> <p>VOLTS indicator - GREEN BAND</p> <p>POWER/TEMP MON switch BAT/1 thru 4</p> | <p>1. The 28.0 volts indications in this step are nominal readings.</p> |
| Program No. | Title | Task No. | | | | | | | | | | | | | | | | | | |
| 30 | External Delta V | 23530 | | | | | | | | | | | | | | | | | | |
| 32 | Co-elliptic Sequence Initiation | 23532 | | | | | | | | | | | | | | | | | | |
| 33 | Constant Delta Altitude | 23533 | | | | | | | | | | | | | | | | | | |
| 34 | Transfer Phase Initiation | 23534 | | | | | | | | | | | | | | | | | | |
| 35 | Transfer Phase Mid-course | 23535 | | | | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| | <p>VOLTS indicator: AMPS indicator, each position:</p> <p>VOLTS - 28.0 AMPS - TBD</p> <p>POWER/TEM MON switch - BAT/5</p> <p>BAT/5 NORMAL FEED switch - ON</p> <p>BAT/5 NORMAL FEED indicator - GRAY FLAG</p> <p>VOLTS indicator - 28.0</p> <p>AMPS indicator - TBD</p> <p>POWER/TEMP MON switch - BAT/6</p> <p>BAT/6 NORMAL FEED switch - ON</p> <p>BAT/6 NORMAL FEED indicator - GRAY FLAG</p> <p>VOLTS indicator - 28.0</p> <p>AMPS indicator - TBD</p> <p>POWER/TEMP MON switch - BUS/CDR</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/AC</p> <p>VOLTS indicator - GREEN BAND</p> <p>AC PWR switch - INV-1</p> <p>VOLTS indicator - GREEN BAND</p> <p>EPS/INV 2 - pull out</p> | |
| <p>EPS/INV 1 - press</p> <p>EPS/CROSS TIE/BAT LOADS - pullout</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>2. CALIBRATE DFI TELEMETRY.</p> <p>Calibrate DFI telemetry by positioning R/D TLM CALIBRATE switch to ON, and hold switch position for 12 seconds.</p> <p>3. <u>EXTERNAL DELTA V (P30)</u></p> <p>1. Key into DSKY V37E 30E</p> | <p>EPS/CROSSTIE/BAT LOADS - pullout</p> <p>VOLTS indicator - GREEN BAND</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/CDR</p> <p>3. Prepare AGS for backup mode to PGNCS for the specified maneuver.</p> <p>1. Receive from MCC/CSM and Record:</p> <p>TIG</p> <p>Delta VX</p> <p>Delta VY</p> <p>Delta VZ</p> <p>Apogee ALT (H_A)</p> <p>Perigee ALT (H_P)</p> <p>Delta V (TIG)</p> | <p>NOTE</p> <p>AGS procedures will be included in a revised edition of this block.</p> <p>NOTE</p> <p>The purpose of this program is to accept targeting parameters (TIG and impulsive Delta V along LM local vertical axes at TIG) from sources external to LGC; calculate Delta V required and other initial conditions for maneuver.</p> <p>1. Delta V may already be available from LGC update program P27. Orbital parameters are optional output information.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>2. FL V06 N34 TIG</p> <p>00XXX. HRS (GET) 000XX. MIN 0XX. XX SEC</p> <p>Accept: V33E Reject: ReLoad Data</p> <p>3. FL V06 N--</p> <p>XXXX. X Delta V_X XXXX. X Delta V_Y XXXX. X Delta V_Z</p> <p>Accept: V33E Reject: ReLoad Data</p> <p>4. FL V06 N45</p> <p>HA XXXX. X NM Hp XXXX. X NM Delta V XXXX. X FPS</p> <p>Accept: V33E Reject:</p> <p>a. Reselect V37E30E and adjust aim parameters.</p> <p>b. Select V37E27E and load new aim parameters.</p> <p>c. Select new program.</p> <p>d. Perform manually using PGNCs/AGS data.</p> | <p>2. Record TIG used if different from MCC/CSM value.</p> <p>3. Record Delta V_X, V_Y, V_Z used if different from MCC/CSM value.</p> <p>4. Compare DSKY values with MCC.</p> | <p>a. Reselect P30 and adjust aim parameters.</p> <p>b. Select P27 and load new aim parameters; reselect P30.</p> <p>c. Decide alternatives.</p> <p>d. See Block</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 5. FL V06 N35 TTI 00XXX. HRS 000XX. MINS 0XX.XX SECS Accept: V33E Reject: Select Desired Program 6. (R02 - IMU status check) 7. FL V06 N-- BLANK TTI XXBXX MIN-SEC MGA XXX.XX DEG V33E 8. FL V50 N07 R1 00040 (Select program) Select propulsion system DPS V37E40E RCS V37E41E APS V37E42E | 7. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * MINS release. SLEW CONT/MIN - UNITS Hold till * * MINS release. SLEW CONT/SECS - TENS Hold till * * MIN; release. SLEW CONT/SECS - UNITS Hold till * * SECS; release. TIMER CONTROL - START 8. Verify maneuver with MCC. Receive MCC go ahead. | 6. Done automatically. 7. Set EVENT TIMER to future DSKY time (TIME OF EVENT TIMER START). 8. Consider in maneuver decision with MCC/CSM: a. Delta V magnitude. b. Propellant available. c. Status of propulsion hardware. d. Time I need for IMU realignment. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| 4. <u>LM PRETHRUST CSI PROGRAM (P32)</u> | | <div>NOTE</div> <p>The purpose of this program is to calculate parameters for CSI, CDH, TPI, and TPF, Delta V (TPI) and Delta V (TPF) are computed Delta V (TPF) assumed to be single impulse Midcourse and final corrections are not allowed for.</p> |
| 1. Key V37E 32E | 1. Receive from MCC/CSM and record TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) DELTA T TRANS | |
| 2. FL V06 N-- GETI (CSI) 00XXX. HRS 000XX. MIN 0XX. XX SEC Accept: V33E Reject: Reload data | 2. Record TIG (CSI) if different from MCC value. | 2. Compare DSKY and MCC values |
| 3. FL V06 N-- N CDH APSIS 0000X. E (TPI) XXX. XX DEG Accept: V33E Reject: Reload data | 3. Record N CDH APSIS if different from MCC value | 3. Compare DSKY and MCC values |
| 4. FL V06 N-- GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC Accept: V33E Reject: Reload data | 4. Record TIG (TPI) if different from MCC value | 4. Compare DSKY and MCC values |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>5. FL V06 N--</p> <p>Delta T Trans-fer 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>Accept: V33E Reject: Reload data</p> <p>NOTE: If FL V05N31 R1 ----- (computation difficulty) Reselect P32 and ad- just parameters or select new program.</p> <p>6. FL V06 N--</p> <p>Delta V (CSI) XXXX. X FPS V33E</p> <p>7. FL V06 N--</p> <p>GETI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> | <p>5. Record Delta T Trans if different from MCC value.</p> <p>If alarm flashes communicate which alarm to MCC</p> <p>6. Record value of Delta V (CSI)</p> <p>Key into Deda:</p> <p>CLR, TBD, READOUT (Delta V CSI, V_0)</p> <p>Compare PGNCS and AGS Delta V CSI</p> <p>7. Key into Deda:</p> <p>CLR, TBD, READOUT (Coast time CSI to CDH, T_{A_0})</p> <p>Record value</p> <p>Subtract GETI (CSI) from GETI (CDH) Compare result with AGS</p> <p>Key into Deda:</p> <p>CLR, TBD, READOUT (Delta V CDH, V_{P_0})</p> <p>Compare PGNCS and AGS Delta V CDH</p> | <p>5. Compare DSKY and MCC values</p> <p>ALARMS</p> <p>No intersection of desired LOS at TPI will CSM. Magnitude of Delta V (CSI) > 1000 fps. Computer cycles for solution excessive. Perigee altitude (CSI) < 80 NM. Perigee altitude (CDH) < 80 NM. Time (CSI to CDH) < 10 minutes. Time (CDH to TPI) < 10 minutes. Hyperbolic velocity achieved at TPI. using orbital parameters planned.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. FL V06 N--</p> <p>Delta V (CDH) XXXX. X FPS H (CDH) XXXX. X NM Delta H (CDH) XXXX. X NM</p> <p>V33E</p> <p>9. FL V06 N--</p> <p>Delta V (TPI) XXXX. X FPS HP (TPI) XXXX. X NM Delta V (TPF) XXXX. X FPS</p> <p>V33E</p> <p>10. FL V16 N35</p> <p>TTI (CSI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> | <p>Key into Deda:</p> <p>CLR, TBD, READOUT (DIFFERENTIAL ALTITUDE, Ar_0)</p> <p>Compare PGNCS and AGS Delta H</p> <p>9. Record values</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>11. FL V16 N--</p> <p>N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC</p> <p>Check N increases 1/MIN</p> <p>Accept: V33E Reject: a) V32E b) V37E32E</p> <p>12. (R02 - IMU STATUS CHECK)</p> <p>13. FL V06 N--</p> <p>N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC MGA XXX.XX DEG</p> <p>V33E</p> <p>14. FL V50 N07</p> <p> (SELECT PROGRAM) SELECT PROPULSION SYSTEM</p> <p>DPS - SELECT P40 RCS - SELECT P41 APS - SELECT P42</p> | <p>11. Check maneuver parameters with MCC.</p> <p>13. EVENT TIMER/TIMER CONT switch - STOP (momentary)</p> <p>RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * mins; release SLEW CONT/MIN - UNITS Hold till * * min; release SLEW CONT/SEC - TENS Hold till * * secs; release SLEW CONT/SECS - UNITS Hold till * * secs; release TIMER CONT - START</p> <p>Record MGA value</p> | <p>11. Accept if TTI \geq 10 MINUTES Reject if TTI $<$ 10 MINUTES or data is unsatisfactory.</p> <p> a. Recycle to step 02 b. Adjust input data</p> <p>12. No crew action required.</p> <p>13. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> <p>14. Consider in maneuver decision with MCC/ CSM:</p> <p> a. Magnitude of DELTA V b. Status of propulsion hardware c. Time/need to realign IMU</p> <p>Select P02 AC3 initialization first.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| 5. <u>LM-PRE-THRUST CDH PROGRAM (P33)</u> | | <div>NOTE</div> <p>The purpose of this program is to calculate parameters for CDH, TPI and TPF. Delta V (TPI) and Delta V (TPF) are computed. Delta V (TPF) assumed to be single impulse. Midcourse and final correction are not allowed for.</p> |
| 1. Key V37E 33E | 1. Receive from MCC/CSM and record: TIG (CDH) N CDH APSIS E TIG (TPI) DELTA T TRANS | |
| 2. FL V06 N-- GETI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC Accept: V33E Reject: Reload data | 2. Record TIG (CDH) if different from MCC value. | |
| 3. FL V06 N-- DELTA T 00XXX. HRS TRANSFER 000XX. MIN 0XX. XX SEC Accept: V33E Reject: Reload data | 3. Record DELTA T TRANS if different from MCC value. | |
| 4. FL V06 N-- GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC Accept: V33E Reject: Reload data FL V05 N31 ALARM V32E Recycle | 4. Record TIG (TPI) if different from MCC value. If alarm flashes, communicate to MCC which alarm. | <div>NOTE</div> <p>If GETI (TPI) - GETI (CDH) < 10 min. FL V05 N31 R1----- Program alarm, Reset, recycle V32E and define GETI (TPI)</p> <div>NOTE</div> <p>If hyperbolic LM velocity results: FL V05 N31 R1----- Program alarm. Reset, recycle V32E and adjust parameters.</p> |

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| 5. FL V06 N-- DELTA V XXX. X FPS (CDH) ALT (CDH) XXXX. X NM DELTA ALT XXXX. X NM (CDH) V33E | 5. Record values. | |
| 6. FL V06 N-- BLANK BLANK HP (CDH) XXXX. X NM V33E | 6. Record value. | |
| 7. FL V06 N-- DELTA V XXXX. X FPS (TPI) HP (TPI) XXXX. X NM DELTA V XXXX. X FPS (TPF) V33E | 7. Record value. | |
| 8. FL V16 N35 TTI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>9. FL V16 N--</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC BLANK</p> <p>Check N increase 1/minute</p> <p>Accept: V33E Reject: a) V32E b) V37E33E</p> <p>10. FL V16 N--</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC MGA XXX.XX DEG</p> <p>V33E</p> <p>11. FL V50 N07</p> <p> R1 00040 (Select Program)</p> <p>Select Propulsion System</p> <p>DPS - Select P40 RCS - Select P41 APS - Select P42</p> | <p>9. Check maneuver parameters with MCC.</p> <p>10. EVENT TIMER/TIMER CONT - STOP (momentary)</p> <p>RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MINS - TENS Hold till * * mins; release SLEW CONT/MINS - UNITS Hold till * * mins; release SLEW CONT/SECS - TENS Hold till * * secs; release SLEW CONT/SECS - UNITS Hold till * * secs; release TIMER CONTROL - START Record MGA value</p> <p>Key into Deda</p> <p>CLR, 410 + 20000, E (CDH BURN)</p> | <p>9. Accept if TTI \geq 8 minutes Reject if TTI $<$ 8 minutes or data unsatisfactory.</p> <p> a. Recycle to step 02. b. Adjust input data.</p> <p>10. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> <p>11. Consider in maneuver decision with MCC/ CSM:</p> <p> a. Magnitude of delta V. b. Status of propulsion hardware. c. Time/need to realign IMU.</p> <p>Select P02 AGS initialization first</p> <p>Exact time TBD.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>6. <u>LM-PRETHRUST TPI PROGRAM (P34)</u></p> <p>1. Key V37E 34E</p> <p>2. FL V06 N--</p> <p style="padding-left: 40px;">R1-0000X (TPI LOAD OPTION) R2-00001 - LOAD GETI (LGC COMPUTES E) OR 00002 - LOAD E (LGC COMPUTES GETI)</p> <p style="padding-left: 40px;">Accept: V33E Reject: Load Data</p> <p>3. If 00001 accepted:</p> <p style="padding-left: 40px;">FL V06 N34</p> <p style="padding-left: 80px;">GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p style="padding-left: 40px;">Accept: V33E Reject: Reload Data</p> <p>OR If 00002 accepted:</p> <p style="padding-left: 40px;">FL V06 N--</p> <p style="padding-left: 80px;">R2-E (TPI) XXX.XX DEG</p> <p style="padding-left: 40px;">Accept: V33E Reject: Load data</p> | <p>1. Receive from MCC/CSM and record:</p> <p style="padding-left: 40px;">TIG (TPI) E DELTA T TRANS</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">NOTE</div> <p>The purpose of this program is to calculate Delta V required and initial conditions for TPI given GETI (TPI) or E (TPI) and transfer duration.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>4. POSS FL V05 N31</p> <p>R1----- (GETI impossible)</p> <p>V32E - Load New E (TPI) or reselect P34 - Load New GETI</p> <p>5. FL V06 N--</p> <p>DELTA T 00XXX. HRS TRANS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Load Data</p> <p>6. POSS FL V05 N31</p> <p>R1----- (DELTA V TOO GREAT)</p> <p>V32E - LOAD NEW DELTA T TRANS</p> <p>7. If 00001 accepted:</p> <p>FL V06 N--</p> <p>R2 - E (TPI) XXX.XX DEG</p> <p>V33E</p> <p>OR If 00002 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>V33E</p> | <p>5. Key into Deda</p> <p>CLR, TBD + XXXX.X (TigC 1/min, de- sired fixed absolute time of TPI) CLR, TBD + XXX.XX (60 .01 min.</p> <p>Record DELTA T TRANS used if different from MCC value.</p> <p>6. Tell MCC if ALARM flashes.</p> <p>7. Record value(s) used if different from MCC value(s).</p> | <p>6. Use of MCC values should prevent this alarm.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>8. FL V06 N--</p> <p>DELTA V XXXX. X FPS (TPI)</p> <p>HP (TPI) XXXX. X NM DELTA V XXXX. X FPS (TPF)</p> <p>V33E</p> <p>9. FL V06 N--</p> <p>TTI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> <p>10. FL V16 N--</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC</p> <p>CHECK DATA WITH GROUND</p> <p>CHECK N INCREASES 1/MIN.</p> <p>Accept: V33E (No later than TTI=8 min)</p> <p>Reject: If time permits re- cycle V32E</p> <p>(R02-IMU status check)</p> <p>11. FL V06 N--</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC MGA XXX. XX DEG</p> <p>V33E</p> | <p>8. Record values.</p> <p>Key into Deda</p> <p>CLR, TBD, READOUT (q, 1000 ft, PREDICTED PERI- GEE TPI) COMPARE (q, with HP)</p> <p>11. EVENT TIMER/TIMER CONT - STOP (momentary)</p> <p>RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * mins on EVENT TIMER; release</p> | <p>Must convert between N. M. and thousands of feet.</p> <p>RR active.</p> <p>11. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. FL V50 N07</p> <p>R1 00040 (Select Program)</p> <p>Select Propulsion System</p> <p>DPS - V37E40E RCS - V37E41E APS - V37E42E</p> | <p>SLEW CONT/MIN - UNITS Hold till * * MINS on EVENT TIMER; release SLEW CONT/SECS - TENS Hold till * * SEC on EVENT TIMER; release SLEW CONT/SECS - UNITS Hold till * * SECS on EVENT TIMER; release TIMER CONT - START</p> <p>12. Record N and MGA used.</p> | <p>12. Consider in maneuver decision with MCC/CSM:</p> <p>a. Value of Delta V. b. Status of propulsion hardware. c. Time available for IMU realignment.</p> <p>Select P02 AGS Initialization first.</p> |
| <p>7. <u>LM - PRETHRUST TPM PROGRAM (P35)</u></p> <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p>TT INT 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> | <p>1. Verify RR actively tracking CSM</p> <p>2. EVENT TIMER/TIMER CONT - STOP (momentary)</p> <p>RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold till * * MIN; release SLEW CONT/MIN - UNITS Hold till * * MIN; release SLEW CONT/SECS - TENS Hold till * * SECS; release SLEW CONT/SECS - UNITS Hold till * * SECS; release TIMER CONT - START</p> | <p style="text-align: center;">NOTE</p> <p>The purpose of this program is to calculate Delta v required and initial conditions.</p> <p>2. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER start).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. FL V16 N--</p> <p>N 00XXX. MARKS TT INT XXBXX MIN-SEC</p> <p>NOTE: If TT INT < 20 MIN select P36.</p> <p>CHECK N INCREASES 1/MIN</p> <p>When ready: V33E</p> <p>Note Time on Mission Timer Add 7 MIN, Result TIG (MID) Communicate to SE</p> | <p>Key into Deda</p> <p>CLR, TBD + XXXX. X (TigC .1 MIN, desired fixed absolute time mid course)</p> | <p>This assumes additional State Vector updates not required.</p> |
| <p>4. FL V16 N--</p> <p>N 000XX. MARKS TTI (MID) XXBXX MIN-SEC MGA</p> <p>V33E</p> | <p>Record values.</p> | |
| <p>5. FL V16 N--</p> <p>DELTA V XXXX. X FPS (MID) TTI (MID) XXBXX MIN-SEC DELTA V XXXX. X FPS (TPF)</p> <p>If MCC BURN not required: V32E Recycle to step 1. If MCC BURN required: V33E</p> | <p>Record values.</p> | <p>Consider in maneuver decision:</p> <ul style="list-style-type: none"> a. Magnitude of DELTA V b. Status of propulsion hardware c. Time/need to realign IMU. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V50 N07</p> <p>R1-00040 (Select Program)</p> <p>Select Propulsion System</p> <p>DPS - Select P40 RCS - Select P41 APS - Select P42</p> <p>8. <u>LM - OPS PROGRAM (P40)</u></p> <p>1. Key V37E 40E</p> <p>(R02 - IMU status check)</p> <p>2. POSS FL V50 N07</p> <p>R1 00005</p> <p>V37E 05E</p> <p>3. POSS FL V50 N07</p> <p>R1 00051</p> <p>V37E 51E</p> <p>4. FL V06 N--</p> <p>IX XXXXX. SLUG- FT SQ</p> <p>IY/IZ XXXXX. SLUG- FT SQ</p> <p>W XXXXX. LB</p> | <p>1. Receive from MCC/CSM and record</p> <p>IX IY/IZ YAW TRIM PITCH TRIM TLX VGX (LV) VGY (LV) VGZ (LV)</p> <p>4. Record IX, IY, IZ and W if different from MCC values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Accept: V33E Reject: Load Desired Parameters</p> <p>5. V06 N70</p> <p>PITCH TRIM XXX.XX DEG YAW TRIM XXX.XX DEG TLX XXXXX. 100 LB</p> <p>Accept: V33E Reject: Load Desired Parameters</p> <p>6. FL V06 N--</p> <p>VGX (LV) XXXX. X FPS VGY (LV) XXXX. X FPS VGZ (LV) XXXX. X FPS</p> <p>V33E</p> <p>7. FL V06 N17</p> <p>OG XXX.XX DEG IG XXX.XX DEG MG XXX.XX DEG</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>IF IMU ORIENTATION UNSATISFACTORY, SELECT P52 OR P53, UPON COMPLETION RESELECT P40</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>IMU ORIENTATION IS SATISFACTORY:</p> <p>V33E</p> <p>(R60 - ATTITUDE MANEUVER).</p> | <p>5. Record VGX, VGY, VGZ if different from MCC values.</p> <p>Communicate values to CSM.</p> <p>7. Observe PITCH, ROLL, and YAW angles on FDAI</p> <p>ATTITUDE MON - PGNS Observe PITCH, ROLL, and YAW angles on FDAI ATTITUDE MON - AGS</p> <p>COMPARE MANEUVER REQUIRE- MENTS AND ON BOARD PROPELLANT SUPPLIES.</p> <p>Communicate with MCC/CSM on maneuver Attitude Propellant Quantities, and Ground Station Coverage.</p> <p>Key into Deda</p> | <p>7. Assumes angles are in FDAI coordinates. SE angles should be within $\pm 5^\circ$ of former values. If not, see LI TASK 23552.</p> <p>Consider in decision on IMU orientation:</p> <p>a. Is $MGA > 45^\circ$?</p> <p>b. Is reorientation required?</p> <p>c. Is alignment required ?</p> <p>d. Impact of Manual Thrust control</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. POSS FL V50 N25</p> <p>R1 000-- (CMC MODE - AUTO)</p> <p>Accept: MODE CONT SW - AUTO ENTER</p> <p>Reject: SELECT GUID CONT AND MODE CONT AS DESIRED V33E</p> <p>9. POSS FL V06 N17</p> <p>OG XXX. XX DEG IG XXX. XX DEG MG XXX. XX DEG</p> <p>MONITOR MANEUVER ON FDAI</p> <p>10. FL V50 N25</p> <p>R1XXXXX -(ENGINE GIMBAL DRIVE ENABLE)</p> <p>Accept: ENTR Reject: V33E</p> <p>11. POSS FL V05 N31</p> <p>R1 XXXXX (IGNITION TIME > 45 SEC)</p> <p>SLIP ENGINE IGNITION - V33E</p> <p>12. Verify restraint cables attached and secure cabin.</p> | <p>CLR, 400 + 30000 E (ALIGN AGS to PGNCS) CLR, 400 + 10000 E (AUTO SUBMODE)</p> <p>8. Verify the following:</p> <p>MODE CONTROL - AUTO GUID CONT - PGNS</p> <p>Observe EVENT TIMER and communi- cate time to CDR.</p> <p>Verify ENG GMBL - ENABLE ENG GMBL - EXT (CWEA)</p> <p>12. Verify restraint cables attached and secure cabin.</p> | <p>NO thrusting without GROUND STATION coverage.</p> <p>8. Time Constraint TIG - 5 minutes.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. Verify the following:</p> <p>STAB/CONT-DEAD BAND switch-MIN ATTITUDE CONTROL/MODE CONTROL switch - AUTO MODE SEL switch - PGNS RATE/ERR MON switch - LDG RDR/ CMPTR</p> <p>Verify Angle Error needles are within DEADBAND, and ATTITUDE on FDAI is approximately as follows:</p> <p>PITCH * -77 DEG* ROLL * 0 DEG* YAW * 180 DEG*</p> <p>Verify the following:</p> <p>ENGINE THRUST CONT/THR CONT switch - AUTO ENGINE THRUST CONT/MAN THROT switch - CDR</p> <p>14. FL V06 N51</p> <p>TTI XXBXX MIN-SEC VG XXXX. X FPS DELTA VM XXXX. X FPS</p> <p>UPDATE TTE CLOCK CHECK C/W LAMPS DELTA VM > 0.5 FPS FOR TTI BETWEEN 15 AND 30 SEC</p> | <p>13. RCS/QTY MON SW - SYS A</p> <p>Verify REACTION CONTROL-TEMP/ PRESS MON switch - He</p> <p>Verify HE MON SW - DESC/PRESS PRPLNT TEMP/PRESS MON switch - DES 1 PRPLNT/QTY MON switch - DES 1</p> <p>Verify O₂/H₂O QTY MON switch - DES</p> <p>Verify RATE/ERR MON switch - LDG RDR/CMPTR</p> | <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;">NOTE</div> <p>If DELTA VM is greater than 0.5 FPS consider:</p> <ol style="list-style-type: none"> a. Switching to AGS CONTROL b. Manual firing of the Engine. c. Firing with LGC anyway. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>15. When DELTA VM > FPS position ENGINE THRUST CONT/ENG ARM - DES</p> <p>16. Monitor EVENT TIMER.</p> <p>Monitor X-POINTER for AZ RT in the interval * + OR - 0.7 * M RAD/SEC and ELEV RT in the interval * + OR - 5.0 * M RAD/SEC as per Flight Plan.</p> <p>Monitor FDAI Attitude Error Display - within DEADBAND..</p> <p>Monitor FDAI for Zero ATTITUDE RATES * + OR - DEGREES PER SEC *</p> <p>Monitor FDAI PITCH angle is in appropriate interval for Mission Phase * to Degrees *</p> <p>Monitor FDAI ROLL and YAW angles for stability.</p> | <p>15. Verify the following CDR's WARNING lights:</p> <p>ASC PRESS - EXT DES REG - EXT DES QTY - EXT CES AC - EXT CES DC - EXT AGS - EXT LGC - EXT ISS - EXT RCS TCA - EXT RCS A REG - EXT RCS B REG - EXT DC BUS - EXT CABIN - EXT SUIT/FAN - EXT</p> <p>Verify the following SE's CAUTION lights:</p> <p>ASC HI REG - EXT ASC QTY - EXT ENG GMBL - EXT PGNS - EXT INVERTER - EXT BATTERY - EXT RNDZ RDR - EXT LDG RDR - EXT PRE AMPS - EXT RCS - EXT HEATER - EXT C/W PWR - EXT ECS - EXT O2 QTY - EXT GLYCOL - EXT WATER QTY - EXT</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>17. Communicate Countdown to Engine Ignition from - 10 SEC.</p> <p>Verify RCS ULLAGE IGNITION by sound, vibration and acceleration at -7.5 SEC.</p> <p>Monitor Error Needles on FDAI for within DEADBAND.</p> <p>Monitor FDAI for constant Attitude of:</p> <p>PITCH * *</p> <p>ROLL * *</p> <p>YAW * *</p> | <p>Verify the following:</p> <p>MAIN PROPULSION-FUEL/OXID TEMP meter -in Green band.</p> <p>MAIN PROPULSION-FUEL/OXID PRESS meters aligned</p> <p>REACTION CONTROL/TEMP A andB in Green Band</p> <p>REACTION CONTROL/PRESS A and B meter aligned</p> <p>ENVIRONMENTAL CONTROL / SUIT and CABIN PRESS meter in Green Band</p> <p>ENVIRONMENTAL CONTROL/PART PRESS CO2 meter in Green Band</p> <p>ENVIRONMENTAL CONTROL/GLYCOL TEMP and PRESS meter in Green Band</p> <p>17. Monitor ENG GMBL CWEA light for malfunction indication.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>18. FL V50 N11 (ENGINE ENABLE)</p> <p>TTI XX XX MIN-SEC VG XXXX.X FPS DELTA VM XXXX.X FPS</p> <p>Accept: ENTR Reject: -V34E</p> <p>(THRUST ON AT TTI = 0)</p> <p>19. Monitor Descent Engine Ignition * 5.5 * SEC after RCS Ignition by vibration, sound, and acceleration.</p> <p>Verify that both thrust needles are aligned and indicate * * PC Thrust for * * SEC and then * * PC Thrust for * * SEC.</p> <p>Verify Error Needles Stabilize at the Error Signal required to offset thrust misalignment.</p> <p>Verify that Position Error decreases as Engine Gimbaling decreases Vehicle moment unbalance.</p> <p>Verify that thrust increases to * * PC after Error Needles move to within DEADBAND and that both needles are aligned.</p> <p>Monitor EVENT TIMER.</p> | <p>19. Monitor REACTION CONTROL/ QUANTITY System A and B quantities for about * * PC. Usage during Gimbal alignment with decreased propellant expenditure as a function of decreasing Vehicle moment of unbalance.</p> <p>Monitor MAIN PROPULSION/QUANTITY - descent-OXIDIZER * * % descent-FUEL * * %</p> <p>Communicate DELTA V to CDR.</p> | <p>NOTE</p> <p>The option of inhibiting Engine Ignition EXITS AT THIS TIME. It has been assumed that the option will not be exercised during Nominal Sequences.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Monitor X-POINTER for Zero LAT VEL * + - FPS * and * * FWD VEL indication.</p> <p>Monitor THRUST meter for ENG and CMD needles aligned * + OR - * %</p> <p>Monitor FDAI Attitude Error Display for within DEADBAND.</p> <p>Monitor FDAI for Zero ATTITUDE RATES * + or - DEG PER SECOND*</p> <p>Monitor FDAI PITCH Angle is in appropriate interval for Mission Phase * to DEGREES*.</p> <p>Monitor FDAI ROLL and YAW Angles for Zero Degrees * + or - DEGREES*.</p> <p>Monitor T/W is in the appropriate interval for mission Phase * to LUNAR G's*</p> | <p>Verify CDR's Warning Lights are:</p> <p>ASC PRESS - EXT DEC REG - EXT DES QTY - EXT CES AC - EXT CES DC - EXT AGS - EXT LGC - EXT ISS - EXT RCS TCA - EXT RCS A REG - EXT RCS B REG - EXT DC BUS - EXT CABIN - EXT SUIT/FAN - EXT</p> <p>Verify SE's Caution Lights are:</p> <p>ASC HI REG - EXT ASC QTY - EXT ENG GIMBAL - EXT PGNS - EXT INVERTER - EXT BATTERY - EXT RNDZ RDR - EXT LDG RDR - EXT PRE AMPS - EXT RCS - EXT HEATER - EXT C/W PWR - EXT ECS - EXT O2 QTY - EXT GLYCOL - EXT WATER QTY - EXT</p> <p>Verify the following:</p> <p>MAIN PROPULSION-FUEL/OXID TEMP - meter in Green Band.</p> <p>MAIN PROPULSION-FUEL/OXID PRESS meters - aligned</p> | <p style="text-align: center;">NOTE</p> <p>The forward Velocity indication depends upon whether the MODE SEL switch was set to PGNS or AGS in a previous Task. In AGS it always reads Zero, but in PGNS it reads correctly up to full scale.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>REACTION CONTROL/TEMP A and B meter in Green Band.</p> <p>REACTION CONTROL/PRESS A and B meters aligned</p> <p>ENVIRONMENTAL CONTROL/SUIT and CABIN PRESS meters in Green Band.</p> <p>ENVIRONMENTAL CONTROL/PART PRESS CO2 meter in Green Band.</p> <p>ENVIRONMENTAL CONTROL/GLYCOL TEMP and PRESS meters in Green Band.</p> <p>Read MAIN PROPULSION/QUANTITY-OXIDIZER and FUEL for * * to * * % remaining.</p> <p>Read MAIN PROPULSION/HELIUM pressure as * * to * * PSIA</p> <p>Read REACTION CONTROL/QUANTITY systems A and B for about * * to * * % remaining.</p> <p>20. Verify POWER/TEMP MON switch-BUS/CDR reading is * * VOLTS.</p> <p>Operate POWER/TEMP MON switch to BUS/SE and BUS/AC positions and verify voltages.</p> <p>Operate POWER/TEMP MON switch to BAT 1-6 and verify following parameters:</p> <p style="text-align: center;">BAT1 BAT2 BAT3 BAT4 BAT5 BAT6</p> <p>VOLTS</p> <p>AMPS</p> <p>POWER/TEMP MON switch-BUS/CDR</p> | |

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| <p>21. V06 N51</p> <p>TG XXBXX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS</p> <p>When TG and VG = 0, position ENG ARM - OFF</p> <p>22. Verify engine shutdown by displays and cessation of noise, vibration and acceleration.</p> <p>MASTER ARM - OFF</p> <p>23. V06 N51</p> <p>TG XXBXX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS</p> <p>V33E - No trim maneuver</p> <p>Key V37E 41E for final trim - RCS</p> <p>Receive orbital data from MSFN (R30 - orbital parameter display)</p> <p>9. <u>POST THRUST EVALUATION.</u></p> <p>1. MODE CONTROL - AUTO</p> <p>2. (R30 orbital parameter routine.)</p> <p>3. FL V06 N43</p> <p>Apogee Alt. XXXX. X NM Perigee Alt. XXXX. X NM TFF XXBXX MIN-SEC V33E</p> | <p>Compare VG on DSKY with VG on DEDA. Record final VG & Delta VM. Key into DEDA (readout perigee) CLR, 343, READOUT. Record perigee. Key into DEDA CLR, 400 + 10000 E (AUTO SUBMODE)</p> <p>23. Transmit to MCC terminal values of DELTA VM and VG. Receive opinion from MCC on need for final RCS trim. Compare DELTA VM value on DSKY against VG value on DEDA. Call up perigee on DEDA. Record VG & perigee from DEDA and DELTA VM from DSKY. Transmit DEDA values to MCC.</p> <p>2. Receive trajectory data from MCC</p> <p>Perigee Apogee Time to freefall TOTAL sensed velocity Time to go to perigee</p> <p>3. Record values if different from MCC values.</p> | <p>Flash starts at TG = 0.</p> <p>2. The orbital parameter routine may also be ensured by Key V64E, though it is normally entered automatically after a thrust program. Time to freefall to 300,000 ft above launch pad radius.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | | |
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| <p>4. POSS FL V06 N35 T Perigee 00XXX. HRS 000XX. MIN 0XX.XX SECS V33E</p> <p>5. FL V50 N07 R1 00000 V37E 00E</p> <p>6. Key V37E 25E</p> <p>7. Monitor FDAI Pitch * * Roll * * Yaw * *</p> <p>8. X-POINTER/AZ RT - * * MRAD/ SEC X-POINTER/ELEV RT - * * MRAD/SEC FDAI Attitude Error - In Deadband Attitude Rates - * ZERO ± * DEG/SEC FDAI PITCH - * * DEG FDAI Roll and Yaw - STABLE</p> | <p>4. Record value of T Perigee.</p> <p>5. Verify LM safe orbit.</p> <p>6. Receive request from CSM for tracking attitude.</p> <p>Tracking light - * *</p> <p>8. Communication from CSM locked and tracking.</p> <p>9. Verify the following CDR/CWEA lights are extinguished: ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC ISS RCS TCA</p> | <p>7. R to CSM Beacon Mode</p> <table> <tr> <td>Eye</td><td>1500 ft < R < 10^{nm}</td><td>DIM</td></tr> <tr> <td></td><td>10^{nm} < R < 130^{nm}</td><td>BRIGHT</td></tr> <tr> <td>Telescope</td><td>1500 ft < R < 30^{nm}</td><td>DIM</td></tr> <tr> <td></td><td>30^{nm} < R < 130^{nm}</td><td></td></tr> <tr> <td></td><td>130^{nm} < R < 400^{nm}</td><td>BRIGHT</td></tr> </table> | Eye | 1500 ft < R < 10 ^{nm} | DIM | | 10 ^{nm} < R < 130 ^{nm} | BRIGHT | Telescope | 1500 ft < R < 30 ^{nm} | DIM | | 30 ^{nm} < R < 130 ^{nm} | | | 130 ^{nm} < R < 400 ^{nm} | BRIGHT |
| Eye | 1500 ft < R < 10 ^{nm} | DIM | | | | | | | | | | | | | | | |
| | 10 ^{nm} < R < 130 ^{nm} | BRIGHT | | | | | | | | | | | | | | | |
| Telescope | 1500 ft < R < 30 ^{nm} | DIM | | | | | | | | | | | | | | | |
| | 30 ^{nm} < R < 130 ^{nm} | | | | | | | | | | | | | | | | |
| | 130 ^{nm} < R < 400 ^{nm} | BRIGHT | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>RCS A REG RCS B REG DC BUS CABIN SUIT/FAN</p> <p>10. Verify the following SE/CWEA lights are extinguished: ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O₂ QTY GLYCOL WATER QTY</p> <p>11. Monitor the following: MAIN PROPULSION/FUEL TEMP * * MAIN PROPULSION/OXID TEMP * * MAIN PROPULSION/FUEL PRESS } ALIGNED MAIN PROPULSION/OXID PRESS } REACTION CONTROL/SYSTEM A TEMP - In Green Band REACTION CONTROL/SYSTEM B TEMP - In Green Band REACTION CONTROL/SYSTEM A PRESS } ALIGNED REACTION CONTROL/SYSTEM B PRESS ENVIRONMENTAL CONTROL/PRESS SUIT - In Green Band</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Receive optical tracking trajectory data from CSM.</p> <p>13. R/D TLM CALIBRATE - ON Hold for 12 seconds.</p> <p>14. Prepare for next maneuver.</p> | <p>ENVIRONMENTAL CONTROL/PRESS CABIN - In Green Band ENVIRONMENTAL CONTROL/PART PRESS CO₂ - In Green Band ENVIRONMENTAL CONTROL/GLYCOL TEMP - In Green Band ENVIRONMENTAL CONTROL/GLYCOL PRESS - In Green Band</p> <p>Record: Compare MCC, CSM, DEDA, and DSKY trajectory values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>L9-2 APS BURNS</u> | | |
| <p>1. <u>INTRODUCTION.</u></p> <p>1. Communicate with MCC and verify APS burn maneuver will satisfy delta V requirements.</p> <p>2. Prepare PGNCs for one of the following maneuver operations:</p> <ul style="list-style-type: none"> a. External delta V, Program 30 b. Coelliptic sequence initiation, Program 32 c. Constant delta Altitude, Program 33 d. Transfer Phase initiation, Program 34 e. Transfer Phase (Midcourse), Program 35 <p>3. Calibrate DF1 telemetry;</p> <p>R/D TLM CALIBRATE switch - ON (hold for 12 seconds)</p> <p>2. <u>EXTERNAL DELTA V (P30).</u></p> | <p>2. Prepare AGS to backup PGNCs during APS burns.</p> | <p>2. AGS operation procedure to be provided at a later date.</p> <div style="border: 1px solid black; padding: 2px; text-align: center; margin: 10px 0;">NOTE</div> <p>The 5 maneuver operations listed in step 2 are followed by an APS thrusting maneuver (program 42) and a post thrust evaluation operation.</p> <div style="border: 1px solid black; padding: 2px; text-align: center; margin: 10px 0;">NOTE</div> <p>The purposes of this program are to accept targeting parameters (TIG and impulsive delta V along LM local vertical axes at TIG) from sources external to the LGC and to calculate delta V required and other initial conditions for the maneuver.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 1. Key into DSKY V37E 30E 2. FL V06 N34 TIG 00XXX. hrs (GET) 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data 3. FL V06 N ____ XXXX.X Delta V _X XXXX.X Delta V _Y XXXX.X Delta V _Z Accept: V33E Reject: Reload data 4. FL V06 N45 HA XXXX.X NM Hp XXXX.X NM Delta V XXXX.X fps Accept: V33E Reject: a. Reselect V37E 30E and adjust aim parameters. b. Select V37E 27E and load new aim parameters. c. Select new program. d. Perform manually using PGNCS/AGS data. | 2. Receive from MCC/CSM and record TIG Delta V _X Delta V _Y Delta V _Z APOGEE ALT. (H _A) PERIGEE ALT (H _p) Delta V (TIG) Record TIG readout if different from MCC/CSM value. 3. Record Delta V _X , V _Y , V _Z readout if different from MCC/CSM value. 4. Compare DSKY values with MCC. | 2. Delta V may be available from LGC update program P27. Orbital parameters are optional output information. 4. a. Reselect P30 and adjust aim parameters. b. Select P27 and load new aim parameters; reselect P30. c. Decide alternatives. d. See block _____. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N35</p> <p>TTI 00XXX. hrs 000XX. mins 0XX.XX secs</p> <p>Accept: V33E Reject: Select desired program</p> <p>6. (R02 - IMU status check)</p> <p>7. FL V06 N _____</p> <p>Blank TTI XXBXX min-sec MGA XXX.XX deg</p> <p>V33E</p> <p>8. FL V50 N07 R1 00040 (Select program)</p> <p>Select Propulsion System</p> <p>DPS V37E 40E RCS V37E 41E APS V37E 42E</p> | <p>7. EVENT TIMER/TIME CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS Hold until * * minutes, then release. SLEW CONT/MIN/UNITS - Hold until * * minutes, then release. SLEW CONT/SECS/TENS Hold until * * minutes, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONTROL - START</p> <p>8. Verify maneuver with MCC.</p> <p>Receive MCC go ahead.</p> | <p>7. Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> <p>8. Consider in maneuver decision with MCC/ CSM:</p> <p>a. Delta V magnitude.</p> <p>b. Propellant available.</p> <p>c. Status of propulsion equipment.</p> <p>d. Time needed for IMU realignment.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <div>3. <u>LM PRETHRUST CSI PROGRAM (P31).</u></div> | | |
| <div>1. Key V37E 32E</div> <div>2. FL V06 N - -</div> <div>GETI (CSI) 00XXX. hrs 000XX. min 0XX. XX sec</div> <div>Accept: V33E Reject: Reload data</div> <div>3. FL V06 N - -</div> <div>N CDH APSIS 0000X. E (TPI) XXX. XX deg</div> <div>Accept: V33E Reject: Reload data</div> <div>4. FL V06 N - -</div> <div>GETI (TPI) 00XXX. hrs 000XX. min 0XX. XX sec</div> <div>Accept: V33E Reject: Reload data</div> | <div>2. Receive from MCC/CSM and record:</div> <div>TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) Delta T Transfer</div> <div>Record TIG (CSI) if different from MCC value.</div> <div>3. Record N CDH APSIS if different from MCC value.</div> <div>4. Record TIG (TPI) if different from MCC value.</div> | <div>NOTE</div> <div>Purpose to calculate parameters for CSI, CDH, TPI and TPF. Delta V (TPI) and delta V (TPF) are computed. Delta V (TPF) is assumed to be single impulse. Midcourse and final corrections are not allowed for.</div> <div>2. Compare DSKY and MCC values.</div> <div>3. Compare DSKY and MCC values.</div> <div>4. Compare DSKY and MCC values.</div> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N _ _</p> <p>Delta T transfer 00XXX. hrs 000XX. min 0XX. XX sec</p> <p>Accept: V33E Reject: Reload data</p> | <p>5. Record Delta T Transfer if different from MCC value.</p> <p>If alarm flashes, inform MCC.</p> | <p>5. Compare DSKY and MCC values.</p> <p>Alarms:</p> <p>No intersection of desired LOS at TPI with CSM. Magnitude of delta V (CSI) > 1000 fps. Computer cycles for solution excessive. Perigee altitude (CSI) < 80 NM. Perigee altitude (CDH) < 80 NM. Time (CSI to CDH) < 10 minutes. Time (CDH to TPI) < 10 minutes. Hyperbolic velocity achieved at TPI using orbital parameters planned.</p> <div style="border: 1px solid black; padding: 2px; text-align: center;">NOTE</div> <p>If FL V05 N31 - - - - - (computation difficulty)</p> <p>Reselect P32 and adjust parameters or select new program.</p> |
| <p>6. FL V06 N _ _</p> <p>Delta V (CSI) XXXX.X fps</p> <p>V33E</p> | <p>6. Record value of Delta V (CSI) key into DEDA CLR, <u>TBD</u>, READOUT (DELTA V CSI, V_O) Compare PGNCs with AGS delta V (CSI)</p> | |
| <p>7. FL V06 N _ _</p> <p>GETI (CDH) 00XXX. hrs 000XX. min 0XX. XX sec</p> <p>V33E</p> | <p>7. Key into DEDA CLR, <u>TBD</u>, READOUT (COAST TIME ESI to EDH, T_A) Record value. Subtract GETI (CSI) from GETI (CDH). Compare result with AGS, Key into DEDA CLR, <u>TBD</u>, READOUT (delta V CDH, V_O). Compare PGNCs and AGS delta V CDH. Key into DEDA CLR, <u>TBD</u>, READOUT (Differential altitude, A_V). Compare PGNCs and AGS delta H.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. FL V06 N - -</p> <p>Delta V (CDH) XXXX.X fps H (CDH) XXXX.X NM Delta H (CDH) XXXX.X NM</p> <p>V33E</p> <p>9. FL V06 N - -</p> <p>Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps</p> <p>V33E</p> <p>10. FL V16 N35</p> <p>TTI (CSI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> <p>11. FL V16 N - -</p> <p>N 000XX. marks TTI (CSI) XXBXX min-sec</p> <p>Check N increases 1/MIN.</p> <p>Accept: V33E Reject: a. V32E b. V37E 32E</p> <p>12. (R02 - IMU status check)</p> <p>13. FL V06 N - -</p> <p>N 000XX. marks TTI (CSI) XXBXX min-sec MGA XXX.XX deg</p> <p>V33E</p> | <p>9. Record values.</p> <p>11. Verify maneuver parameters with MCC.</p> <p>13. EVENT TIMER/EVENT TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes, then release.</p> | <p>11. Accept if TTI > 10 minutes. Reject if TTI < 10 minutes or if data are unsatisfactory:</p> <p>a. Recycle to step 02.</p> <p>b. Adjust input data.</p> <p>13. Set EVENT TIMER to future DSKY TIME (Time of EVENT TIMER START).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>14. FL V50 N07</p> <p style="text-align: center;">(Select program)</p> <p>Select propulsion system</p> <p>DPS - Select P40</p> <p>RCS - Select P41</p> <p>APS - Select P42</p> <p>4. <u>LM PRETHRUST CDH PROGRAM (P33).</u></p> <p>1. Key V37E 33E</p> <p>2. FL V06 N _ _</p> <p>GETI (CDH) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> | <p>SLEW CONT/MIN/UNITS - Hold until * * minutes, then release.</p> <p>SLEW CONT/SECS/TENS Hold until * * seconds, then release.</p> <p>SLEW CONT/SECS/UNITS - Hold until * * seconds, then release.</p> <p>TIMER CONT - START Record MGA value</p> <p>1. Receive from MCC/CSM and record:</p> <p>TIG (CDH) N CDH APSIS E TIG (TPI) Delta T Transfer</p> <p>2. Record TIG (CDH) if different from MCC value.</p> | <p>14. Consider in maneuver decision with MCC/ CSM:</p> <p>Magnitude of delta V. Status of propulsion equipment. Time needed to realign IMU.</p> <p style="text-align: center;">NOTE</p> <p>Purpose to calculate parameters for CDH, TPI and TPF. Delta V (TPI) and Delta V (TPF) are computed. Delta V (TPF) is assumed to be single impulse. Midcourse and final correction are not allowed for.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 3. FL V06 N - - Delta T transfer 00XXX. hrs 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data | 3. Record Delta T Transfer if different from MCC value. | |
| 4. FL V06 N - - GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data FL V05 N31 (Alarm) V32E Recycle. | 4. Record TIG (TPI) if different from MCC value. If Alarm flashes inform MCC. | <div>NOTE</div> <p>If GETI (TPI) - GETI (CDH) min. FL V05 N31 R1</p> <p>Program ALARM, reset, Recycle V32E and define GETI (TPI)</p> <p>If hyperbolic LM velocity results: FL V05 N31 R1</p> <p>Program alarm reset, Recycle V32E and adjust parameters.</p> |
| 5. FL V06 N - - Delta V (CDH) XXXX.X fps ALT (CDH) XXXX.X NM Delta ALT (CDH) XXXX.X NM V33E | 5. Record values. | |
| 6. FL V06 N - - Blank Blank HP (CDH) XXXX.X NM V33E | 6. Record values. | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. FL V06 N - -</p> <p>Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps</p> <p>V33E</p> <p>8. FL V16 N35</p> <p>TTI (CDH) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>9. FL V16 N - -</p> <p>N 000XX. marks TTI (CDH) XXBXX min-sec Blank</p> <p>Check N increase 1/minute.</p> <p>Accept: V33E Reject: a. V32E b. V37E 33E</p> <p>10. FL V16 N - -</p> <p>N 000XX. marks TTI (CDH) XXBXX min-sec MGA XXX.XX deg</p> <p>V33E</p> | <p>7. Record values.</p> <p>9. Check maneuver parameters with MCC.</p> <p>EVENT TIMER/TIMER CONT - STOP (MOMENTARY EVENT) RESET/COUNT-RESET RESET/COUNT-DOWN SLEW CONT/MINS/TENS - Hold until * * minutes, then release. SLEW CONT/MINS/UNITS - Hold until * * minutes, then release. SLEW CONT/SECS/TENS - Hold until * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONT/START. Record MGA value.</p> | <p>9. Accept if TTI > 8 minutes. Reject if TTI < 8 minutes or data are unsatisfactory:</p> <p>a. Recycle to step 02. b. Adjust input data.</p> <p>10. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER START).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>11. FL V50 N07</p> <p>R1 00040 (Select program) Select propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42</p> <p>5. <u>LM PRETHRUST TPI PROGRAM(P34).</u></p> <p>1. Key V07E 34E</p> <p>2. FL V06 N _ _</p> <p>R1-0000X (TPI load option) R2-00001 - Load GETI (LGC computes E) R3-00002 - Load E (LGC computes GETI)</p> <p>Accept: V33E Reject: Load data</p> <p>3. If 00001 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> | <p>12. Key into DEDA CLR, 410 + 20000 E (CDH Burn)</p> <p>1. Receive from MCC/CSM and record:</p> <p>TIG (TPI) E Delta T transfer</p> | <p>11. Consider in maneuver decision with MCC/CSM:</p> <p>a. Magnitude of delta V.</p> <p>b. Status of propulsion equipment.</p> <p>c. Time or need to realign IMU.</p> <p>NOTE</p> <p>Purpose to calculate delta V required and for TPI given GETI (TPI) or E (TPI) and transfer duration.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>OR if 00002 accepted:</p> <p>FL V06 N - -</p> <p>R2-E (TPI) XXX.XX deg</p> <p>Accept: V33E Reject: Load data</p> <p>4. POSS FL V05 N31</p> <p>R1 ____ (GETI impossible)</p> <p>V32E - Load new E (TPI) or reselect P34 - Load new GETI</p> <p>5. FL V06 N - -</p> <p>Delta T transfer 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Load data</p> <p>6. POSS FL V05 N31</p> <p>R1 ____ (Delta V too great)</p> <p>V32E - Load new delta T transfer</p> <p>7. If 00001 accepted:</p> <p>FL V06 N - -</p> <p>R2 - E (TPI) XXX.XX deg V33E</p> <p>OR if 00002 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> | <p>5. Key into DEDA CLR, <u>TBD + XXXXX</u> (TIG within .1 min of desired fixed absolute time of TPI) CLR, <u>TBD +</u> <u>XXX.XX</u> (60 < .03 min delta T transfer) Record delta T transfer USE) If different from MCC value.</p> <p>6. If alarm flashes, inform MCC.</p> <p>7. Record value readout if different from MCC values.</p> | <p>6. Using MCC values should prevent this alarm.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 8. FL V06 N _ _ Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps V33E | 8. Record values. Key into DEDA CLR, TBD, READOUT (q1 1000 ft, predicted perigee TPI) Compare (q1 with HP) | 8. NM must be converted into thousands of feet. |
| 9. FL V06 N _ _ TTI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec V33E | | |
| 10. FL V16 N _ _ N 000XX. marks TTI (TPI) XXBXX min-sec Check data with MCC Check N increases 1/MIN. Accept: V33E (no later than TTI = 8 min) Reject: If time permits recycle V32E (R02 - IMU status check) | | 10. RR is active. |
| 11. FL V06 N _ _ N 000XX. marks TTI (TPI) XXBXX min-sec MGA XXX.XX deg V33E | 11. EVENT TIMER/TIMER CONTROL - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes on EVENT TIMER, then release. SLEW CONT/MIN/UNITS - Hold until * * minutes on EVENT TIMER, then release. SLEW CONT/SECS/TENS - Hold until * * seconds on EVENT TIMER, then release. | 11. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start). |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>12. FL V50 N07 R1 00040 (Select program)</p> <p>Select propulsion system DPS - V37E 40E RCS - V37E 41E APS - V37E 42E</p> <p>6. <u>LM PRETHRUST TPM PROGRAM (P35).</u></p> | <p>SLEW CONT/SECS/UNITS - Hold until * * seconds on EVENT TIMER, then release. TIMER CONTROL - START</p> <p>Record N and MGA value used.</p> | <p>12. Consider in maneuver decision with MCC/ CSM:</p> <p>a. Value of delta V. b. Status of propulsion equipment. c. Time available for IMU realignment.</p> |
| <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p>TT INT 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> | <p>2. Verify RR actively tracking CSM. EVENT TIMER/TIMER CONT - STOP (MOMENTARY) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes, then release. SLEW CONT/MIN/UNITS - Hold until * * minutes, then release. SLEW CONT/SECS/TENS - Hold until * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONTROL - START</p> | <p style="text-align: center;">NOTE</p> <p>Purpose to calculate delta V required and initial conditions for next midcourse corrections during active LM rendezvous. To display data for crew to enter P36 at correct time to complete thrust maneuver at first range gate.</p> <p>2. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER START).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. FL V16 N _ _</p> <p>N 000XX. marks TT INT XXBXX min-sec</p> <p>Check N increases 1/MIN When ready: V33E</p> <p>Note time on MISSION TIMER, add 7 minutes. Result is TIG (MID), com- municate to SE.</p> | | <p>3. If TT INT < 20 minutes select P36.</p> |
| <p>4. FL V16 N _ _</p> <p>N 000XX. marks TTI (MID) XXBXX min-sec MGA</p> <p>V33E</p> | <p>4. Key into DEDA. CLR, TBD + <u>XXXX.X</u> (TIG within .1 minute of desired fixed absolute midcourse)</p> <p>Record values</p> | <p>4. This assumes that no additional state vector updates are required.</p> |
| <p>5. FL V16 N _ _</p> <p>Delta V (MID) XXXX.X fps TTI (MID) XXBXX min-sec Delta V (TPF) XXXX.X fps</p> <p>If midcourse corrections burn is not required: V32E recycle to step 1. If midcourse corrections burn required: V33E</p> | <p>5. Record values.</p> | |
| <p>6. FL V50 N07 R1-00040 (Select program)</p> <p>Select propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42</p> | | <p>6. Consider in maneuver decision:</p> <p>a. Magnitude of delta V.</p> <p>b. Status of propulsion equipment.</p> <p>c. Time needed to realign IMU.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. <u>LH-APS THRUSTING PROGRAM (P42).</u></p> <p>1. Key V37E 42E (R02 - IMU status check)</p> <p>2. POSS FL V50 N07 R1 00051 (PGNCS start up) V37E 05E OR R1 00051 (IMU orientation determination) V37E 51E</p> <p>3. FL V06 N _ _ IX XXXXX. 100 IY/IZ XXXXX. 100 W XXXXX. LB Accept: V33E Reject: V25E Load desired parameters</p> <p>4. FL V06 N _ _ VGX (LV) XXXX.X fps VGY (LV) XXXX.X fps VGZ (LV) XXXX.X fps V33E</p> | <p>1. Receive from MCC the following data: IX IY/IZ W VGX (LV) VGY (LV) VGZ (LV)</p> <p>2. Cross check PGNCS against AGS via SE's FDAI ATTITUDE MON switch - PGNCS Verify pitch, roll, and yaw angles are $\pm 5^\circ$ of previous readings ATTITUDE MON switch - AGS.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>5. FL V06 N17</p> <p>OG XXX.XX deg IG XXX.XX deg MG XXX.XX deg</p> <p>Record angles and confirm with MCC.</p> <p>7. IMU orientation is satisfactory - V33E (R60 - attitude maneuver)</p> <p>8. POSS FL V50 N25</p> <p>R1 00007 (Attitude trim maneuver)</p> <p>Accept: Mode cont ROL switch - AUTO enter</p> <p>Reject: Set GUIDE CONT AND MODE CONTROL switches as desired.</p> <p>V33E</p> <p>9. POSS FL V50 N25</p> <p>R1 000XX (ignition time < 45 sec) Slip engine ignition: V33E</p> <p>OR</p> <p>Terminate: V34E</p> <p>10. Secure self and cabin.</p> | <p>5. Transmit DSKY values to MCC.</p> <p>6. Communicate with MCC concerning maneuver attitude, propellant quantities, and MSFN coverage.</p> <p>Key into Deda CLR, 400 +30,000 E (Align AGS to PGNCS) CLR, 400 +10,000 E (Auto sub- mode)</p> <p>8. Verify</p> <p>GUID CONT switch - PGNCS MODE CONT ROL switch - AUTO ENG GMBL switch - ENABLE ENG GMBL (CWEA) - extinguished</p> <p>9. Observe EVENT TIMER and trans- mit time to CDR.</p> <p>10. Secure self and cabin.</p> | <p>5. If IMU orientation is unsatisfactory (MGA > 45 deg), select P52 or P53. On completion reselect P42.</p> <p>6. Time constraint: TIG-5 minutes.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. FL V06 N51</p> <p>TTI XXBXX min-sec VG XXXX.X fps DELTA VM XXXX.X cps</p> <p>Check delta VM < 0.5 fps for TTI between 30 and 15 seconds.</p> <p>12. RATE/ERR MON switch - LDG RDR/ CMPTR ATTITUDE MON switch - PGNS SHFT/TRUN < switch - $\pm 50^\circ$ X-POINTER SCALE switch - HI MULT GUID CONT switch - PGNS MODE SEL switch - AGS RNG/ALT MON switch - ALT/ALT RT X-TRANSL switch - 2 JETS BAL CPL switch - ON DEAD BAND switch - MIN ROLL switch - MODE CONT PITCH switch - MODE CONT YAW switch - MODE CONT MODE CONTROL switch - AUTO</p> <p>(+X translation: TTI = 12.5 seconds) When delta VM > fps, ENG ARM switch ASC</p> <p>13. FL V50 N11</p> <p>TTI XXBXX min-sec VG XXXX.X fps Delta VM XXXX.X fps</p> <p>Engine ignition enable: Enter</p> <p>OR</p> <p>Terminate: V34E (Thrust on at TTI = 0)</p> <p>14. Monitor ascent engine ignition via vib- ration, sound, and acceleration.</p> | <p>11. Update EVENT TIMER if ignition slipped.</p> <p>12. RATE/ERR MON switch - LDG RDR/ CMPTR ATTITUDE MON switch AGS X-POINTER SCALE switch - HI MULT O₂/H₂O QTY MON switch - ASC 1 REACTION CONTROL/TEMP/PRESS MON switch - HC PRPLNT TEMP/PRESS MON switch - ASC HELIUM MON switch - ASC/PRESS 1</p> <p>Verify all caution and warning lamps are extinguished.</p> <p>14. Notify MCC/CSM of ascent engine firing.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>15. Monitor T/W indicator increase from 0 to * * g's.</p> <p>Monitor Zero attitude rates. Monitor termination of +X translation 0.5 seconds after engine ignition. Monitor change from TTI to TG on DSKY.</p> <p>16. BAL CPL switch - OFF (after approximately 8 seconds of ascent thrust).</p> <p>18. Observe pitch, roll, and yaw on FDAI.</p> <p>ATTITUDE MON switch - AGS Verify pitch, roll, and yaw are within ± 5 degrees of previous reading. ATTITUDE MON switch - PGNS</p> <p>19. Monitor EVENT TIMER and DSKY TG.</p> <p>Monitor Zero lateral velocity *+* fps, and * * fps forward velocity. Monitor attitude error within deadband. Monitor for zero attitude rates or *+ deg/sec* Monitor pitch angle is * * to * * degrees. Verify roll and yaw angles are zero or * * to * * degrees verify T/W indicator is * * g's.</p> | <p>17. Enable supply of ascent propellant to RCS thrusters and disable RCS propellants.</p> <p>REACTION CONTROL/SYSTEM A/ ASC FEED switch - OPEN REACTION CONTROL/SYSTEM A/ MAIN SOV switch - CLOSE REACTION CONTROL/SYSTEM B/ ASC FEED switch - OPEN REACTION CONTROL/SYSTEM B/ MAIN SOV switch - CLOSE CRSFD switch - OPEN</p> <p>19. Monitor EVENT TIMER and DSKY TG.</p> <p>Monitor zero lateral velocity *+* fps, and * * fps forward velocity. Monitor attitude error within deadband. Monitor for zero attitude rates or *+ deg/sec*. Monitor pitch angle is * * to * * degrees. Verify roll and yaw angles are zero or * * to * * deg. Verify T/W indicator is * * g's.</p> | <p>15. If LM CG unbalance occurs, pitch and/or roll rates will decrease as RCS fires to correct recurrence of CG. Offset can result in varying pitch and/or roll rates during this task.</p> <p>17. This task is intended to be used shortly after engine ignition.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>21. Communicate countdown to thrust termination from minus 10 seconds.</p> | <p>20. Verify MAIN PROPULSION/PRESS/METER/FUEL AND OXID pointers - aligned Verify HELIUM MON switch - ASC/PRESS 1 OR ASC/PRESS 2. HELIUM indicator - * * to * * psia. Verify REACTION CONTROL/QUANTITY indicator - * * to * *</p> <p>21. Disable supply of ascent propellant to RCS thrusters and enable RCS propellants:</p> <p>CRSFD switch - CLOSE REACTION CONTROL/SYSTEM B/ MAIN SOV switch - OPEN REACTION CONTROL/SYSTEM B/ ASC FEED switch - CLOSE REACTION CONTROL/SYSTEM A/ MAIN SOV switch - OPEN REACTION CONTROL/SYSTEM A/ ASC FEED switch - CLOSE</p> <p>22. Compare VG on DSKY with VG on DEDA. Record final VG and DELTA VM. Key into DEDA (readout perigee) CLR, 343, READOUT. Record perigee. Key into DEDA CLR, 400 + 10,000 (AUTO sub-mode)</p> | <p>21. This task is intended to be used just prior to completion of nominal ascent engine burn.</p> <p>22. Flash starts at TG = 0.</p> |
| <p>22. FL V06 N51</p> <p>TG XXBXX min-sec VG XXXX.X fps Delta VM XXXX.X fps</p> <p>When TG and VG = 0, ENG ARM switch - OFF Reset EVENT TIMER to zero. Verify T/W indicator - 0; verify engine vibration and acceleration have ceased. EVENT TIMER/RESET/COUNT switch - RESET (TOO) BAL CPL switch - ON</p> | <p>23. Monitor change in LM orientation via FDAI:</p> <p>Pitch * * Roll * * Yaw * *</p> | |
| <p>23. Observe pitch, roll, and yaw on FDAI ATTITUDE MON switch - AGS Verify pitch, roll, and yaw on FDAI are within $\pm 5^\circ$ of previous values. ATTITUDE MON switch - PGNS</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>24. Monitor EVENT TIMER monitor X - pointer for azimuth LOS rate in the interval $\pm 0.7^{\circ}$ MRAD/second Monitor FDAI attitude error display is within deadband. Monitor FDAI for zero attitude rates $\pm \text{deg/sec}$ Monitor FDAI pitch angle is in appropriate interval for mission phase (* to * degrees) Monitor FDAI roll and yaw angles for stability.</p> <p>25. Verify warning lights following warning lights are extinguished:</p> <p>ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT FAN</p> <p>Verify following caution lights are extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>C/W PWR ECS O₂ QTY GLYCOL WATER QTY</p> <p>26. Verify MAIN PROPULSION/TEMP/ FUEL OXID POINTERS - within green band. Verify MAIN PROPULSION/PRESS/ FUEL OXID POINTERS - aligned. Verify REACTION CONTROL/TEMP/ A/B POINTERS - within green band. Verify REACTION CONTROL/PRESS/ A/B POINTERS - Aligned. Verify ENVIRONMENTAL CONTROL/ PRESS/SUIT CABIN POINTERS - within green band. Verify ENVIRONMENTAL CONTROL/ PART PRESS CO₂ meter - within green band. Verify GLYCOL TEMP PRESS meter - within green band. Verify MAIN PROPULSION/PRESS/ FUEL/OXID POINTERS - Aligned. Verify HELIUM MON switch - ASC/ PRESS 1 OR ASC/PRESS 2. HELIUM indicator - * * to * * psia. REACTION CONTROL QUANTITY indi- cator * * to * *.</p> <p>27. REACTION CONTROL/TEMP/ PRESS MON switch - Hce REACTION CONTROL/TEMP indicator - A at 70 ±30°F REACTION CONTROL/TEMP indicator - B at 70 ±30°F REACTION CONTROL/PRESS indicator - A at * * psia REACTION CONTROL/PRESS indicator - B at * * psia REACTION CONTROL/TEMP/PRESS MON switch - PRPLNT</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>REACTION CONTROL/TEMP indicator - A at 70 \pm30° F REACTION CONTROL/TEMP indicator - B at 70 \pm30° F REACTION CONTROL/PRESS indicator - A at 180 +25, -15 psia REACTION CONTROL/PRESS indicator - B at 180 +25, -15 psia REACTION CONTROL/TEMP/PRESS MON switch - FUEL MANF REACTION CONTROL/PRESS indicator - A at 175 +25, -15 psia REACTION CONTROL/PRESS indicator - B at 175 +25, -15 psia REACTION CONTROL/TEMP/PRESS MON switch - OXID MANF REACTION CONTROL/PRESS indicator - A at 175 +25, -15 psia REACTION CONTROL/PRESS indicator - B at 175 +25, -15 psia</p> <p>28. HELIUM MON switch - ASC/TEMP 1 HELIUM indicator - 70 \pm20 (°F) HELIUM MON switch - ASC/TEMP 2 HELIUM indicator - 70 \pm20 (°F) HELIUM MON switch - ASC/PRESS 1 HELIUM indicator - * * (psia) HELIUM MON switch - ASC/PRESS 2 HELIUM indicator - * * (psia)</p> <p>29. PRPLNT TEMP/PRESS MON switch - ASC MAIN PROPULSION/TEMP indicator - FUEL at 70 \pm20° F MAIN PROPULSION/TEMP indicator - OXID at 70 \pm20° F MAIN PROPULSION/PRESS indicator - FUEL at * * psia MAIN PROPULSION/PRESS indicator - OXID at * * psia</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>30. O₂/H₂O QTY MON switch - ASC 1 ENVIRONMENTAL CONTROL/QUANTITY indicator - O₂ at * *% ENVIRONMENTAL CONTROL/QUANTITY indicator - H₂O at * *% O₂/H₂O QTY MON switch - ASC 2 ENVIRONMENTAL CONTROL/QUANTITY indicator - O₂ at 100% ENVIRONMENTAL CONTROL/QUANTITY indicator - H₂O at 100%</p> <p>31. O₂/H₂O QTY MON switch - ASC 1</p> <p>32. Verify following glycol parameters on ENVIRONMENTAL CONTROL/GLYCOL/ TEMP/PRESS indicator - Temp 45 ±20° F Press 30 ±10 psia Verify PART PRESS CO₂ > 7.6 mm Hg</p> <p>33. Verify RCS flag/VLV status: SYSTEM A/MAIN SOV - Gray SYSTEM A/ASC FEED - Barber pole SYSTEM A/THRUSTER PAIR/QUAD 1 - Gray SYSTEM B/THRUSTER PAIR/QUAD 2 - Gray SYSTEM A/THRUSTER PAIR/QUAD 3 - Gray SYSTEM A/THRUSTER PAIR/QUAD 4 - Gray SYSTEM B/MAIN SOV - Gray SYSTEM B/ASC FEED - Barber pole SYSTEM B/THRUSTER PAIR/QUAD 1 - Gray SYSTEM B/THRUSTER PAIR/QUAD 2 - Gray SYSTEM B/THRUSTER PAIR/QUAD 3 - Gray SYSTEM B/THRUSTER PAIR/QUAD 4 - Gray CRSFD - Barber pole</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 34. EPS/CROSS TIE/BAL LOADS circuit breaker - Press 1A. | 34. EPS/CROSS TIE BAL LOADS circuit breaker - Press 1A. | |
| 35. Monitor FDAI for stable attitude. | Verify CDR BUS voltage is > 26.5 vdc. | |
| 36. FL V06 N51 | 36. Transmit to MCC terminal values of delta VM and VG. Receive opinion from MCC on need for RCS trim maneuver. Compare delta VM value on DSKY against VG on DEDA. Record VG and Perigee from DEDA. Transmit DEDA values to MCC. Record DELTA V _M from DSKY. | |
| TG XXBXX min-sec | | |
| VG XXXX.X fps | | |
| Delta VM XXXX.X fps | | |
| Accept VG: V33E | | |
| Reject VG: V37E 41E | | |
| 8. <u>POST THRUST EVALUATION.</u> | | |
| 1. Mode Control switch - AUTO. | | |
| 2. R30 (Orbital parameter routine) | 2. Receive following trajectory data from MCC: | 2. The orbital parameter routine may also be entered by Key V64E, through it is normally entered automatically after a thrust program. |
| | Perigee | |
| | Apogee | |
| | Time to free fall | |
| | TOTAL SENSED VELOCITY () | |
| | Time to go to Perigee | Time to free fall to 300,000 ft above launch pad radius. |
| 3. FL V06 N43 | 3. Record values if different from MCC values. | |
| Apogee alt XXXX.X NM | | |
| Perigee alt XXXX.X NM | | |
| TFF XXBXX min-sec | | |
| V33E | | |
| 4. POSS FL V06 N35 | 4. Record value of T perigee. | |
| T Perigee 00XXX. hrs | | |
| 000XX. min | | |
| 0XX.XX secs | | |
| V33E | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | |
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| <p>5. FL V50 N07</p> <p>R1 00000 V37E 00E</p> <p>6. Key V37E 25E</p> <p>7. Monitor FDAI</p> <p>Pitch * * Roll * * Yaw * *</p> <p>8. Azimuth LOS rate - * * <u>MRAD/SEC</u> Elevation rate - * * <u>MRAD/SEC</u> FDAI attitude error - within deadband Attitude rates - *zero ±* deg/sec FDAI pitch - * * deg FDAI roll and yaw - stable</p> | <p>5. Verify LM safe orbit.</p> <p>6. Receive request from CSM for tracking attitude.</p> <p>8. Verify the CSM is locked and tracking the LM.</p> <p>9. Verify the following warning lights are extinguished:</p> <p>ASC PRESS DES REG DES QTY CES AC CES DC</p> | <p>7. EXTERIOR LTG switch</p> <p>a. When the LM is tracked by CSM without the use of the Scanning Telescope, the following applies:</p> <table><tr><th><u>LM-CSM Range</u></th><th><u>EXTERIOR LTG switch</u></th></tr><tr><td>1500 ft to 10 NM</td><td>DIM</td></tr><tr><td>10 NM to 30 NM</td><td>BRIGHT</td></tr></table> <p>b. The CSM crewman using the Scanning Telescope, the following applies:</p> <table><tr><th><u>LM-CSM Range</u></th><th><u>EXTERIOR LTG switch</u></th></tr><tr><td>1500 ft to 30 NM</td><td>DIM</td></tr><tr><td>130 NM to 400 NM</td><td>BRIGHT</td></tr></table> | <u>LM-CSM Range</u> | <u>EXTERIOR LTG switch</u> | 1500 ft to 10 NM | DIM | 10 NM to 30 NM | BRIGHT | <u>LM-CSM Range</u> | <u>EXTERIOR LTG switch</u> | 1500 ft to 30 NM | DIM | 130 NM to 400 NM | BRIGHT |
| <u>LM-CSM Range</u> | <u>EXTERIOR LTG switch</u> | | | | | | | | | | | | | |
| 1500 ft to 10 NM | DIM | | | | | | | | | | | | | |
| 10 NM to 30 NM | BRIGHT | | | | | | | | | | | | | |
| <u>LM-CSM Range</u> | <u>EXTERIOR LTG switch</u> | | | | | | | | | | | | | |
| 1500 ft to 30 NM | DIM | | | | | | | | | | | | | |
| 130 NM to 400 NM | BRIGHT | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p> AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT/FAN </p> <p>10. Verify the following caution lights are extinguished:</p> <p> ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O₂ QTY GLYCOL WATER QTY </p> <p> 11. Verify the following meter indications MAIN PROPULSION/TEMP - FUEL at * * °F MAIN PROPULSION/TEMP - OXID at * * °F MAIN PROPULSION/PRESS - FUEL OXID, aligned REACTION CONTROL/TEMP - A and B, within green band REACTION CONTROL/PRESS - A/B, aligned ENVIRONMENTAL CONTROL/PRESS - SUIT and CABIN, within green band ENVIRONMENTAL CONTROL/PART PRESS CO₂ - within green band </p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Receive optical tracking trajectory data from CSM.</p> <p>13. R/D TLM CALIBRATE switch - ON (hold for 12 seconds)</p> <p>14. Prepare for next maneuver.</p> | <p>ENVIRONMENTAL CONTROL/GLYCOL/TEMP - within green band</p> <p>ENVIRONMENTAL CONTROL/GLYCOL/PRESS - within green band</p> <p>12. Record optical tracking data. Compare MCC, CSM, DEDA, and LGC trajectory values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>L15-2 CREW MAINTENANCE</u> | | |
| <p>1. <u>PREPARATION FOR URINE WASTE MANAGEMENT (PRIMARY MODE).</u></p> <p>1. Remove a primary waste collector bag from stowage.</p> <p>2. Remove two secondary LiOH cartridges from waste management.</p> <p>3. Stow two secondary LiOH cartridges behind the TMG webbing.</p> <p>4. Disconnect short fluid transfer hose from waste management stowage connector.</p> <p>5. Remove waste management stowage connector from cover.</p> <p>6. Connect short fluid transfer hose to waste management cover connector.</p> <p>7. Install primary waste collector bag in waste management stowage.</p> <p>8. Connect primary waste collector bag to short waste fluid transfer hose.</p> <p>9. Secure waste management stowage.</p> <p>10. Disconnect long waste fluid transfer hose from stowage connector.</p> <p>11. Remove PGA waste management connector cover.</p> <p>12. Connect long waste fluid transfer hose to PGA waste management connector.</p> <p>13. Urinate.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>TRANSFER URINE.</u></p> <ol style="list-style-type: none"> 1. Open waste control valve. 2. Place forearms and elbows at groin. 3. Bend forward. 4. Press in on PGA urine collector. 5. Urine transfer completed. 6. Disconnect long waste fluid transfer hose from PGA waste management connector. 7. Replace PGA waste management connector cover. 8. Connect long waste fluid transfer hose to stowage connector. <p>3. <u>PREPARATION FOR URINE WASTE MANAGEMENT (BACKUP MODE).</u></p> <ol style="list-style-type: none"> 1. Remove a secondary waste collector bag from stowage. 2. Remove cap from secondary waste collector bag. 3. Remove PGA waste management connector cover. 4. Connect secondary waste collector bag to PGA. 5. Urinate. | | <p>NOTE</p> <p>An alternate procedure for urine transfer (primary and backup modes) is available, steps 1 through 4.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. <u>TRANSFER URINE.</u></p> <ol style="list-style-type: none"> 1. Place forearms and elbows at groin. 2. Bend forward. 3. Press in on PGA urine collector. 4. Urine transfer completed. 5. Disconnect secondary waste collector bag from PGA. 6. Replace PGA waste management connector cover. 7. Stow secondary waste collector bag in waste management stowage. <p>5. <u>WASTE MANAGEMENT OF FECES.</u></p> <ol style="list-style-type: none"> 1. Remove fecal stowage bag and fecal wiping glove/bag from beneath TMG area. 2. Open fecal-emesis bag and unfold flap. 3. Set aside. (Under zero G condition bag must be restrained). 4. Insert hand into wiping glove/bag. 5. Defecate onto wiping glove/bag. 6. Strip wiping glove/bag from hand, turning wiping glove/bag inside out enclosing feces. 7. Remove germicide from stowage. 8. Place germicide in wiping glove/bag. | | <div>NOTE</div> <p>An alternate procedure for urine transfer (primary and backup modes) is available, steps 1 through 4.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>9. Roll up wiping glove/bag.</p> <p>10. Insert wiping glove/bag into fecal- emesis bag.</p> <p>11. Remove teflon strip from fecal- emesis bag sealant.</p> <p>12. Press sides of fecal-emesis bag together at the sealant point.</p> <p>13. Fold fecal-emesis bag flaps and close.</p> <p>14. Knead fecal-emesis bag to distribute germicide.</p> <p>15. Stow fecal-emesis bag in waste management stowage.</p> <p>6. <u>MEAL PREPARATION.</u></p> <p>1. Remove helmet and PGA gloves.</p> <p>2. Place helmet and PGA gloves on ascent engine cover.</p> <p>3. CDR SUIT FLOW valve - TORSO.</p> <p>4. Remove desired food packages from food stowage.</p> <p>5. Remove water dispenser and H₂O recharge hose from stowage.</p> <p>6. Attach water dispenser to H₂O recharge hose.</p> <p>7. Insert water dispenser into first food bag entry port.</p> | <p>1. Remove helmet and PGA gloves.</p> <p>2. Place helmet and PGA gloves on ascent engine cover.</p> <p>3. SE SUIT FLOW valve - TORSO.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. PLSS/DRINK valve - OPEN.</p> <p>9. Set lockout counter on water dispenser to appropriate amount.</p> <p>10. Depress water dispenser trigger until water transfer is completed.</p> <p>11. Water transfer completed.</p> <p>12. Remove water dispenser from food bag.</p> <p>13. Insert water dispenser into second food bag entry port.</p> <p>14. Repeat steps 9 through 12.</p> <p>16. PLSS/DRINK valve - CLOSE.</p> <p>17. Disconnect water dispenser from H₂O recharge hose.</p> <p>18. Stow water dispenser and H₂O recharge hose.</p> <p>19. Knead food bag.</p> <p>20. Food reconstitution completed.</p> <p>21. Unfold feeder tube, insert in mouth, squeeze bag, commence eating.</p> <p>22. Stow empty food bag in waste management stowage.</p> | <p>12. Take food bag from CDR.</p> <p>13. Knead food bag.</p> <p>14. Food reconstitution completed.</p> <p>15. Unfold feeder tube, insert in mouth, squeeze bag, commence eating.</p> <p>22. Stow empty food bag in waste management stowage.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>23. Remove personal hygiene items from stowage and use.</p> <p>24. Stow used personal hygiene items in waste management stowage.</p> <p>7. <u>DRINK MODE.</u></p> <p>1. Remove water dispenser and H₂O recharge hose from stowage.</p> <p>2. Attach water dispenser to H₂O recharge hose.</p> <p>3. Set lockout counter on water dispenser to desired amount.</p> <p>4. Insert water probe through helmet aperture into mouth.</p> <p>5. PLSS DRINK valve - OPEN.</p> <p>6. Depress water dispenser trigger, ingest desired amount of water.</p> <p>7. Release water dispenser trigger.</p> <p>8. Remove water dispenser from helmet.</p> <p>9. PLSS DRINK valve - CLOSE.</p> <p>10. Disconnect water dispenser from H₂O recharge hose.</p> <p>11. Stow water dispenser and H₂O recharge hose.</p> | <p>23. Remove personal hygiene items from stowage and use.</p> <p>24. Stow used personal hygiene items in waste management stowage.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. <u>PRIMARY LiOH CARTRIDGE REPLACEMENT.</u></p> <ol style="list-style-type: none"> 1. Verify PART PRESS CO₂ indicator - 7.6 mm Hg, minimum. 2. CO₂ CANISTER SEL valve - SEC. 3. Depress PRIMARY CO₂ VENT pushbutton. 4. PRIMARY CO₂ CANISTER cover - OPEN. 5. Remove and retain PRIMARY CO₂ CANISTER cover. 6. Remove expended primary LiOH cartridge. 7. Primary LiOH cartridge stowage cover - OPEN. 8. Remove and retain cartridge stowage cover. 9. Remove replacement primary LiOH cartridge. 10. Stow expended primary LiOH cartridge in primary LiOH cartridge stowage. 11. Replace primary LiOH cartridge stowage cover. 12. Primary LiOH cartridge stowage cover - CLOSE. | | <p>NOTE</p> <p>Task performed by available crew man.</p> <p>WARNING</p> <p>Step 3 required when cabin unpressurized.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. Insert replacement primary LiOH cartridge in PRIMARY CO₂ CANISTER.</p> <p>14. Replace PRIMARY CO₂ CANISTER cover.</p> <p>15. PRIMARY CO₂ CANISTER cover - CLOSE.</p> <p>16. CO₂ CANISTER SEL valve - PRIM.</p> <p>17. Verify PART PRESS CO₂ indicator - decays from 7.6 mm Hg.</p> | | |
| <p>9. <u>DON THERMAL METEROID GARMET (TMG) (BOTH CREWMEMBERS).</u></p> | | |
| <p>1. Remove TMG jacket from stowage.</p> <p>2. Remove dosimeter from PGA.</p> <p>3. Insert dosimeter into TMG jacket right sleeve pocket.</p> <p>4. Stow TMG jacket.</p> <p>5. Remove TMG trousers from stowage.</p> <p>6. Open slide fastener on each leg, secure slide-loop Velcro fasteners to trouser leg Velcro fasteners.</p> <p>7. Place left then right leg into trouser.</p> <p>8. Wrap trouser around waist.</p> <p>9. Close slide fastener on left leg, cover with flap.</p> | | <p style="text-align: center;">NOTE</p> <p>TMG jackets are stowed until PLSS is donned.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>10. Close slide fastener on right leg, cover with flap.</p> <p>11. Adjust trouser over PGA.</p> <p>12. Position PGA "D" rings in TMG holes at front of trouser.</p> <p>13. TMG trouser donned.</p> <p>10. <u>ERECT DONNING RIG.</u></p> <p>1. Remove donning rig from stowage.</p> <p>2. Attach top end clips to ceiling connectors forward of the docking hatch.</p> <p>3. Attach low end clips to connectors on step forward of the ascent engine cover.</p> <p>11. <u>EMU CHECKOUT, SYSTEMS ENGINEER.</u></p> <p>1. Assist SE as required.</p> | <p>1. Prepare PLSS for donning.</p> <p>2. Remove PLSS No. 2 from floor mount.</p> <p>3. Position PLSS back against donning rig, secure Velcro mounts.</p> <p>4. Open PLSS thermal cover.</p> <p>5. Unlock and remove LiOH cartridge.</p> | <p>NOTE</p> <p>Either crew man can perform this task.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>1. Assist SE as required.</p> | <p>6. Inspect LiOH cartridge for damage.</p> <p>7. Replace LiOH cartridge in PLSS.</p> <p>8. Lock LiOH cartridge in PLSS.</p> <p>9. Verify lock.</p> <p>10. Remove PLSS straps and umbilicals from stowage.</p> <p>11. Remove TMG jacket from stowage.</p> <p>12. Open TMG jacket slid fastener.</p> <p>13. Disconnect draw string slides.</p> <p>14. Open TMG jacket sleeve buttons.</p> <p>15. Position TMG jacket over PLSS.</p> <p>16. Thread PLSS upper support straps through TMG jacket holes.</p> <p>17. PLSS for SE donning completed.</p> | |
| | <p><u>12. PREPARE PLSS NO. 2 FOR CHECKOUT</u></p> <p>1. Prepare PLSS No. 2 for checkout.</p> <p>2. Disconnect LM r-f line from stowage on +Z 27 bulkhead.</p> <p>3. Open PLSS thermal cover exposing r-f receptacle.</p> <p>4. Connect LM r-f line to PLSS r-f receptacle.</p> <p>5. PLSS No. 2 checkout preparation completed.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 13. <u>PLSS NO. 2 PARTIAL CHECKOUT.</u> | | |
| 1. Move to SE's crew station for PLSS No. 2 partial checkout. | 1. Move to CDR's crew station for PLSS No. 2 partial checkout. | |
| 2. At COMMUNICATIONS ANTENNAS panel: VHF antenna switch - 1 | 2. At CDR's AUDIO panel: a. VHF A switch - T/R b. VHF B switch - OFF c. S-BAND switch - OFF d. RELAY switch - ON | |
| 3. At COMMUNICATIONS panel: a. VHF B XMTR switch - VOICE b. VHF B RCVR switch - OFF c. VHF A RCVR switch - ON d. VHF A XMTR switch - OFF e. BIOMED switch - RIGHT | 3. Disconnect PLSS communications lead from PLSS stowage. | |
| 4. At SE's AUDIO panel: a. VHF A switch - RCV b. VHF B switch - T/R | 4. Remove dust cap from PLSS SSC receptacle and stow PLSS stowage connector. 5. Connect PLSS communication lead (SSC end) to PLSS SSC receptacle. 6. Disconnect LM communication lead from PGA communication receptacle. 7. Connect PLSS communication lead (PGA end) to PGA communication receptacle. | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| | <p>14. On PLSS:</p> <p>SSC MODE SELECTOR switch - 1</p> <p>15. Verify voice and data communication with MSFN.</p> | <p>14. Measurements are the same as in step 13 with the exception that battery current instead of voltage is telemetered.</p> |
| 14. <u>ATTACH REMAINING PLSS UMBILICALS AND CONTINUE PARTIAL PLSS CHECKOUT.</u> | <p>1. Pull PLSS H₂O umbilical through TMG opening.</p> <p>2. Connect PLSS H₂O umbilical to PGA H₂O receptacle.</p> <p>3. Monitor PLSS accumulator fill condition.</p> <p>4. Verify PLSS full.</p> <p>5. Pull lower PLSS harness straps through TMG jacket.</p> <p>6. Route O₂/H₂O indicator through TMG.</p> <p>7. Attach O₂/H₂O indicator to TMG jacket arm.</p> <p>8. Pull EDS probe from PLSS through hole at left side of TMG jacket.</p> <p>9. Momentarily open PLSS OXYGEN SHUTOFF valve.</p> <p>10. Verify high O₂ flow sensor actuated (audible signal).</p> <p>11. Close PLSS OXYGEN SHUTOFF valve.</p> <p>12. PLSS SSC MODE SELECTOR switch - 3 (off).</p> | <p>4. If not full, system must be tapped.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>4. Insert one arm, then other arm partially into sleeves of TMG jacket.</p> <p>5. Push both arms through sleeves of the TMG jacket.</p> <p>6. Attach PLSS upper straps to PGM upper "D" rings.</p> <p>7. Attach PLSS lower straps to PGA lower "D" rings protruding through TMG waist.</p> <p>8. Adjust TMG jacket over PGA.</p> <p>9. Attach EOS probe to helmet.</p> <p>10. Release donned PLSS from donning rig.</p> <p>12. Return to SE's crew station.</p> | |
| <p>11. Return to CDR's crew station.</p> <p>17. <u>EMU CHECKOUT, COMMANDER.</u></p> <p>1. Identical to task 11.</p> <p>18. <u>EMU GROSS LEAKAGE CHECKOUT.</u></p> <p>1. CDR SUIT FLOW valve - HELMET.</p> <p>2. Don helmet and secure.</p> <p>3. PGA wrist disconnects - ENGAGE.</p> <p>4. Don PGA gloves.</p> | <p>1. SE SUIT FLOW valve - HELMET.</p> <p>2. Don helmet and secure.</p> <p>3. PGA wrist disconnects - ENGAGE.</p> <p>4. Don PGA gloves.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 5. PGA wrist disconnects - LOCK. 6. Adjust PGA glove palm restraints. 7. Don EV gloves, secure to PGA. | 5. PGA wrist disconnects - LOCK. 6. Adjust PGA glove palm restraints. 7. Don EV gloves, secure to PGA. 8. SUIT CIRCUIT RELIEF valve - OPEN. 9. CABIN GAS RETURN valve - EGRESS. 10. Verify O ₂ /H ₂ O QTY MON switch - DES. 11. Monitor O ₂ on O ₂ /H ₂ O QUANTITY. 12. Convert quantity reading to pressure using on-board data dit, or from MSFN. 13. Pressurize LM suit circuit. <ul style="list-style-type: none"> a. Descent O₂ supply pressure > 800 psi, PRESS REG A valve - DIRECT O₂. b. Descent O₂ supply pressure < 800 psi, PRESS REG A valve DIRECT O₂ and PRESS REG B valve - DIRECT O₂. 14. Monitor SUIT/CABIN PRESS indicator until SUIT reads 8.7 ± .2 psia, 3.7 ± .2 psia of CABIN. 15. SUIT/CABIN PRESS indicator SUIT 8.7 ± .2 psia. 16. PRESS REG A - CABIN. (If PRESS REG B used: PRESS REG B - CABIN). | <div style="border: 1px dashed black; padding: 5px; text-align: center; margin: 10px auto; width: fit-content;">CAUTION</div> <p>Maximum suit circuit operation at pressure 5.2 psia is five minutes.</p> <p>16. Immediately on reaching suit pressure of 8.7 ± .2 psia.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | 17. Monitor SUIT/CABIN PRESS indicator for one minute. 18. Verify suit pressure does not exceed <u>TBD</u> psia/minute. 19. If suit pressure decay is <u>TBD</u> psia/minute, repeat steps 14 through 18. | |
| 19. <u>DOFF THERMAL MITTENS, EV GLOVES, AND EV VISOR.</u> | 1. Remove thermal mittens. 2. Stow thermal mittens in TMG bag. 3. Remove EV gloves. 4. Stow in helmet stowage. 5. Unfasten and loosen TMG jacket collar draw string slides. 6. Disengage draw string slides. 7. Uncover TMG jacket slide fastener. 8. Undo and disengage slide fastener. 9. Unfasten and remove EV visor from helmet. 10. Stow visor in helmet stowage. | <div>NOTE</div> <p>Commander is in CSM.</p> |
| 20. <u>CONNECT TO LM ECS.</u> | 1. Open TMG jacket, expose PGA O ₂ receptacles. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>21. <u>DEACTIVATE PLSS.</u></p> | <ol style="list-style-type: none"> 2. Remove ECS umbilical from stowage. 3. Remove PGA O₂ plugs from O₂ receptacles. 4. Stow plugs on stowage connectors. 5. Connect O₂ inlet and exhaust hoses to PGA receptacles. 6. SE SUIT FLOW valve - HELMET. 1. PLSS FLOW SELECTOR valve-INTRAVEHICULAR. 2. PLSS FAN switch - OFF. 3. PLSS O₂ SHUT OFF valve - CLOSE. 4. PLSS FEEDWATER SHUT OFF valve - OFF. 5. PLSS PUMP switch - OFF. 6. Deactivate PLSS ELAPSED TIME INDICATOR. 7. Close forward hatch. 8. Cabin relief and dump valve - AUTO. 9. SSC MODE SELECTOR switch - 3. 10. Disconnect LM r-f line from PLSS. 11. Stow LM r-f line. 12. Disconnect PLSS communication lead from PGA. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 22. <u>DOFF PLSS.</u> | <p>13. Connect LM communication lead to PGA.</p> <p>14. Verify CSM and MSFN communication.</p> <p>15. Disconnect PLSS O₂ and H₂O hoses from PGA.</p> <p>16. Disconnect EOS probe from helmet.</p> <p>1. Stand with back to donning rig.</p> <p>2. Move back into donning rig with sufficient force to mate donning rig Velcro webbing to PLSS Velcro on thermal cover.</p> <p>3. PLSS mated to donning rig.</p> <p>4. Loosen PLSS harness straps.</p> <p>5. Disconnect PLSS from PGA.</p> <p>6. Withdraw arms from the jacket.</p> <p>7. Turn and face PLSS-TMG jacket on donning rig.</p> <p>8. Remove WATER-OXYGEN indicator from TMG jacket.</p> <p>9. Remove dosimeter from right sleeve pocket of TMG jacket.</p> <p>10. Install dosimeter on PGA.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ol style="list-style-type: none"> 11. Remove TMG jacket from PLSS. 12. Stow TMG jacket. 13. Open PLSS thermal cover. 14. Remove H₂O plug from stowage connector. 15. Connect H₂O plug to PGA receptacle. 16. Stow WATER-OXYGEN indicator in PLSS. 17. Stow O₂ and H₂O hoses, and EOS probe in PLSS. 18. Open top of PLSS thermal cover. 19. Disconnect PLSS communications lead, from SSC communication receptacle. 20. Remove SSC receptacle dust cap from stowage connector. 21. Connect dust cap to SSC receptacle. 22. Connect PLSS communications lead to stowage receptacles in PLSS. 23. Verify PLSS antenna is properly restrained. 24. Open PLSS cover exposing EOS. 25. Remove EOS lanyard from PLSS. 26. Remove EOS from PLSS. 27. Remove EOS arming pin from stowage on EOS. 28. Insert EOS arming pin into EOS acutation prevent position. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>23. <u>DOFF TMG</u></p> | <p>29. Stow EOS.</p> <p>30. Secure PLSS thermal cover.</p> <p>31. Remove PLSS from donning rig.</p> <p>32. Stow PLSS in recharge station.</p> <p>1. Place PGA "D" rings through TMG holes at front of trouser.</p> <p>2. Open right leg slide fastener flap.</p> <p>3. Open right leg slide fastener.</p> <p>4. Open left leg slide fastener flap.</p> <p>5. Open left leg slide fastener.</p> <p>6. Unwrap TMG trouser from around waist.</p> <p>7. Remove right then left leg from TMG trouser.</p> <p>8. Close slide fasteners on each TMG trouser leg.</p> <p>9. Fold trouser and stow in TMG bag.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>24. <u>STOW DONNING RIG.</u></p> | <ol style="list-style-type: none"> 1. Remove donning rig lower end clips from connectors forward of ascent engine cover. 2. Remove donning rig top end clips from ceiling connectors forward of docking hatch. 3. Roll up donning rig. 4. Stow donning rig. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p style="text-align: center;"><u>L15-2 CREW MAINTENANCE (ALTERNATE PROCEDURES)</u></p> <p>1. <u>URINE TRANSFER.</u></p> <p>1. SUIT GAS DIVERTER valve - PULL-EGRESS.</p> <p>2. SUIT CIRCUIT RELIEF valve - CLOSE.</p> <p>3. PRESS REG A and B - DIRECT O₂.</p> <p>4. Monitor suit pressure - PRESS/SUIT/CABIN.</p> <p>5. When suit pressure is 0.5 psia greater than cabin, PRESS REG A and B - CLOSE.</p> <p>6. Urine transfer (primary or backup mode) completed.</p> <p>7. SUIT CIRCUIT RELIEF valve - AUTO.</p> <p>8. SUIT GAS DIVERTER valve - PUSH-CABIN.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p align="center"><u>L15-2 CONTINGENCY PROCEDURES</u></p> <p><u>1. SECONDARY LiOH CARTRIDGE REPLACEMENT</u></p> <ol style="list-style-type: none"> 1. Verify PART PRESS CO₂ indicator - 7.6 mm Hg, minimum. 2. CO₂ CANISTER SEL valve - PRIM. 3. Depress SECONDARY CO₂ VENT pushbutton. 4. SECONDARY CO₂ CANISTER cover - OPEN. 5. Remove and retain SECONDARY CO₂ CANISTER cover. 6. Remove expended secondary LiOH cartridge. 7. Open waste management stowage cover. 8. Remove and retain waste management stowage cover. 9. Remove replacement secondary LiOH cartridge. 10. Stow expended secondary LiOH cartridge in waste management stowage. 11. Replace waste management stowage cover. | | <p align="center">NOTE</p> <p>Task performed by available crew man.</p> <p align="center">WARNING</p> <p>Step 3 required when cabin unpressurized. Not required in pressurized cabin.</p> <p align="center">NOTE</p> <p>Replacement cartridges will be stored behind TMG webbing when waste management stowage is in use.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Close waste management stowage cover.</p> <p>13. Insert replacement secondary LiOH cartridge in SECONDARY CO₂ CANISTER.</p> <p>14. Replace SECONDARY CO₂ CANISTER cover.</p> <p>15. SECONDARY CO₂ CANISTER cover - CLOSE.</p> <p>16. CO₂ CANISTER SEL valve - SEC.</p> <p>17. Verify PART PRESS CO₂ indicator - decays from 7.6 mm Hg.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <u>L19-2 ATTITUDE CONTROL</u> | |
| 1. <u>HARDOVER ATTITUDE MANEUVER IN PGNS - AUTO MODE OR AGS - AUTO MODE.</u> | | <div>NOTE</div> <p>Hardover is the only type of manual attitude maneuver that can be performed while in PGNS-AUTO MODE. If the MODE CONTROL switch is turned to ATT HOLD, it cannot be returned to AUTO except as indicated in the flight operations plan. Should a real-time decision require switching to ATT HOLD, the remainder of that mission phase must be completed manually.</p> <div>NOTE</div> <p>Hardover is a non-nominal emergency capability.</p> |
| 1. Verify the following: GUID CONT switch - PGNS (or AGS) MODE CONT switch - AUTO ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT | | |
| 2. Displace Attitude Controller to hardover | | |
| 3. Monitor FDAI Roll * * Pitch * * Yaw * * | | |
| 4. Return Attitude Controller to detent position when desired attitude is attained. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>HARDOVER ATTITUDE MANEUVERS IN PGNS - MODE CONTROL - OFF OR AGS - MODE CONTROL - OFF.</u></p> | | |
| <p>1. Verify the following:</p> <p>GUID CONT switch - PGNS (or AGS) MODE CONTROL switch - OFF ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT</p> <p>2. Displace Attitude Controller to hardover.</p> <p>3. Monitor FDAI</p> <p>Roll * * Pitch * * Yaw * *</p> <p>4. Return Attitude Controller to detent position when desired attitude is attained.</p> | | |
| <p>3. <u>DIRECT ATTITUDE MANEUVERS IN MODE SEL- PGNS OR MODE SEL - AGS</u></p> | | |
| <p>1. Verify the following:</p> <p>GUID CONT switch - PGNS (or AGS) MODE CONTROL switch - OFF ATTITUDE CONTROL/DIR, (for particular axis) others - MODE CONT</p> <p>2. Displace Attitude Controller to one- quarter of full throw.</p> <p>3. Monitor FDAI</p> <p>Roll * * Pitch * * Yaw * *</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. Return Attitude Controller to detent position when desired attitude is attained.</p> <p>5. MODE CONTROL switches to ATT HOLD.</p> | | |
| <p>4. <u>PULSE MODE ATTITUDE MANEUVER IN AGS - AUTO MODE</u></p> | | |
| <p>1. Verify the following:</p> <p>GUID CONT switch - AGS MODE CONTROL switch - AUTO ATTITUDE CONTROL - PULSE (for particular axis only), other to MODE CONT</p> <p>2. Displace Attitude Controller to one-quarter of full throw.</p> <p>3. Monitor FDAI</p> <p>Roll * * Pitch * * Yaw * *</p> <p>4. Return Attitude Controller to detent position when desired attitude is attained.</p> <p>5. ATTITUDE CONTROL - MODE CONT</p> | | <p>NOTE</p> <p>Rotation is manually commanded in a given axis by placing the corresponding ATTITUDE CONTROL switch to PULSE and displacing the Attitude Controller one-quarter of full throw. The other two ATTITUDE CONTROL switches remain in MODE CONT.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 5. <u>PROPORTIONAL MODE ATTITUDE MANEUVER IN GUID CONT/PGNS - MODE CONTROL/ATT HOLD OR GUID CONT/AGS - MODE CONTROL/ATT HOLD</u> | | |
| 1. Verify the following: GUID CONT - PGNS (or AGS) MODE CONTROL - ATT HOLD ATTITUDE CONTROL switch in ROLL/PITCH/YAW and MODE CONT 2. Displace Attitude Controller to out of detent position. 3. Monitor FDAI Roll * * Pitch * * Yaw * * 4. Return Attitude Controller to detent position when desired attitude is attained. | | |
| 6. <u>MINIMUM IMPULSE MODE MANEUVER IN GUID CONT/PGNS - MODE CONTROL/ATT HOLD</u> | | <div>NOTE</div> <p>Do not use this mode to command moderate rather than very small attitude maneuvers. Operating the Attitude Controller at more than 2 or 3 pulses per second is inefficient. Use proportional mode for faster rate of change.</p> |
| 1. Verify the following: GUID CONT - PGNS MODE CONTROL - ATT HOLD ATTITUDE CONTROL switches in ROLL/PITCH/YAW - MODE CONTROL 2. Key V73E | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. Displace Attitude Controller 2.5° out of detent.</p> <p>4. Return Attitude Controller to detent.</p> <p>5. Monitor FDAI</p> <p>Roll * *</p> <p>Pitch * *</p> <p>Yaw * *</p> <p>6. Displace Attitude Controller as frequently as required to accomplish attitude maneuver. Each Attitude Controller displacement causes one RCS pulse to be commanded.</p> <p>7. Key V75E for wide DEADBAND (5.0 degrees) or Key V76E for narrow DEADBAND (0.3 degrees)</p> | | |
| <p>7. <u>HARDOVER ATTITUDE MANEUVER IN PGNS - MODE CONTROL/ATT HOLD OR AGS - MODE CONTROL/ATT HOLD</u></p> <p>1. Verify the following:</p> <p>GUID CONT switch - PGNS (or AGS)</p> <p>MODE CONTROL switch - ATT HOLD</p> <p>ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT</p> <p>2. Displace Attitude Controller to hardover.</p> <p>3. Monitor FDAI</p> <p>Roll * *</p> <p>Pitch * *</p> <p>Yaw * *</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---------|
| <p>4. Return Attitude Controller to detent position when desired attitude is attained.</p> | | |
| <p>8. <u>PULSE OR DIRECT MODE MANEUVER IN AGS - MODE CONTROL/ATT HOLD</u></p> | | |
| <p>1. Verify the following:</p> <p>GUID CONT switch - AGS MODE CONTROL switch - ATT HOLD ATTITUDE CONTROL switch - PULSE or DIR (for particular axis - all others in MODE CONT)</p> <p>2. Displace Attitude Controller to one-quarter of full throw.</p> <p>3. Monitor FDAI</p> <p>Roll * * Pitch * * Yaw * *</p> <p>4. Return Attitude Controller to detent position when desired attitude is attained.</p> <p>5. ATTITUDE CONTROL - MODE CONT</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|------------------|---|
| <p>9. <u>BALANCED COUPLES SWITCH</u></p> <p>1. Verify the following:</p> <p style="padding-left: 40px;">GUID CONT - AGS MODE CONTROL - AUTO ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT BAL CPL switch - ON</p> <p>2. After * * seconds of APS burn - BAL CPL switch - OFF.</p> | | <div> <p>NOTE</p> </div> <p>BAL CPL switch is used only during APS under AGS control. After first few seconds (exact length of time TBD) the switch is set to OFF.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p align="center"><u>L21-2 SUBSYSTEM DEACTIVATION</u></p> <p>1. <u>SUBSYSTEM STATUS CHECKOUT PRIOR TO ECS WATER BOILER SHUTDOWN.</u></p> | | <p align="center">NOTE</p> <p>This block should be performed during the latter part of Block JL8-2.</p> |
| | <p>1. Verify following CDR's circuit breakers pulled out:</p> <ul style="list-style-type: none"> a. COMM/S-BD ANT b. STAB/CONT/DECA GMBL c. PGNS/AOT LAMP RNDZ RDR d. INST/TAPE RCDR e. PROPUL/DES He Reg f. RCS SYS A/ QUAD 4 TCA QUAD 3 TCA QUAD 2 TCA QUAD 1 TCA ISOL VLV ASC FEED MAIN SOV g. STAB/CONT/AELD ATT DIR CONT DES ENG CONT DECA PWR ENG START OVRD ABORT STAGE h. ED/ LDG GEAR FLAG LOGIC PWR A j. COMM/VHF B XMTR | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <ul style="list-style-type: none"> k. HEATERS/ RNDZ RDR-OPR DOCK WINDOW m. FLIGHT DISPLAYS/ THRUST DISP n. PGNS/ RNDZ RDR LDG RDR o. HEATERS RCS SYS A/B-1/ QUAD 1 QUAD 2 QUAD 3 QUAD 4 2. Verify switch positions as follows: <ul style="list-style-type: none"> a. LDG GEAR DEPLOY status flag - BARBER POLE b. ASC He SEL switch - BOTH c. CDR's VHFB T/R-RCV switch - OFF d. Engine START pushbutton - extinguished e. +X TRANSL switch - extinguished f. THR CONT switch - MAN g. ENG ARM switch - OFF h. PRPLNT QTY MON switch - OFF j. ABORT pushbutton - extinguished k. ABORT STAGE pushbutton - extinguished | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <ul style="list-style-type: none"> m. SYSTEM A/B MAIN SOV and ASC FEED status flags - BARBER POLE n. LDG ANT switch - AUTO o. ENG GMBL switch - OFF p. Rendezvous radar mode switch - LGC q. ATTITUDE CONTROL ROLL, PITCH and YAW switches - MODE CONT r. MODE CONTROL switches - OFF s. EXTERIOR LTG switch - DOCK 3. Verify following SE's circuit breakers pulled out: <ul style="list-style-type: none"> a. LTG/TRACK b. ED/LOGIC PWR B c. STAB/CONT/ ABORT STAGE ENG ARM AELD d. RCS SYS B/ MAIN SOV ASC FEED ISOL VLV QUAD 1 TCA QUAD 2 TCA QUAD 3 TCA QUAD 4 TCA e. RCS/CRSFD | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <ul style="list-style-type: none"> f. PROPUL/ ASC He REG PQGS g. COMM/ VHF B RCVR S-BD ANT TV h. CAMR/SEQ j. HEATERS-RCS SYS A/B-2/ QUAD 1 QUAD 2 QUAD 3 QUAD 4 4. Verify following switch positions: <ul style="list-style-type: none"> a. SE's VHF B T/R/RCV switch - OFF b. S-BAND MODULATE switch - PM c. FUNCTIONS/RANGE/TV switch - OFF d. VHF B XMTR switch - OFF e. VHF B RCVR switch - OFF f. TELEMETRY BIOMED switch - OFF g. TELEMETRY PCM switch - OFF h. RECORDER switch - OFF j. TRACK MODE switch - OFF k. VHF selector - 2 | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>m. PITCH selector - 0</p> <p>n. YAW selector - 0</p> <p>p. S-BAND selector - 1</p> <p>5. Verify CDR's circuit breakers pushed in:</p> <p>a. HEATERS/ WINDOWS-SE WINDOWS-CDR</p> <p>b. PROPUL/He PQGS DISP</p> <p>c. FLIGHT DISPLAYS/RNG/RNG RT-ALT/ALT RT GASTA SE FDAI CDR FDAI</p> <p>d. LTG/ NUM INTGL</p> <p>e. STAB/CONT/ ATCA (PGNS)</p> <p>f. COMM/ SEC S-BD XMTR/RCVR SEC S-BD PWR AMPL VHF A RCVR CDR AUDIO</p> <p>g. INST/SIG CONDR 1</p> <p>h. FLIGHT DISPLAYS/ RNG/RNG RT-ALT/ALT RT MISSION TIMER X PNTR GASTA CDR FDAI</p> <p>j. ECS/GLYCOL PUMP 1</p> <p>k. R/D INST</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>6. Verify CDR AUDIO panel switch positions as follows:</p> <ul style="list-style-type: none"> a. ICS T/R switch - ICS RCV b. RELAY ON/OFF switch - RELAY ON c. VOX switch - PTT d. AUDIO CONT switch - BO <p>7. SE attitude controller PTT switch - OUT</p> <p>8. SE communications umbilical PTT/KEYER switch - OUT</p> <p>9. +X TRANSLATION pushbutton - OUT</p> <p>10. MISSION TIMER CONT switch - STOP</p> <p>11. On CDR's center panel:</p> <ul style="list-style-type: none"> a. MASTER ALARM pushbutton - extinguished b. GUID CONT switch - PGNS <p>12. On SE's center panel:</p> <ul style="list-style-type: none"> a. MASTER ALARM pushbutton - extinguished b. GLYCOL PUMP switch - 1 <p>13. CDR X-POINTER SCALE switch - HI MULT</p> <p>14. On STAB/CONT panel:</p> <ul style="list-style-type: none"> a. DEAD BAND switch - MIN | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <ul style="list-style-type: none"> b. GYRO TEST ROLL/PITCH/ YAW switch - ROLL c. GYRO TEST POS RT/NEG RT switch - OFF d. ATTITUDE CONTROL ROLL, PITCH, and YAW switches - MODE CONT e. MODE CONTROL switch - OFF 15. SE X-POINTER scale switch - HI MULT 16. On SE LIGHTING panel: <ul style="list-style-type: none"> a. LAMP/TONE TEST switch - OFF 17. Verify following SE's circuit breakers pushed in: <ul style="list-style-type: none"> a. LTG/ FLOOD MASTER ALARM b. STAB/CONT/ATCA c. FLIGHT DISPLAYS/ EVENT TIMER/SE FDAI X/PNTR d. INST/ PCM/TE CWEA SIG SENSOR SIG CONDR 2 e. HEATERS/DISP f. RCS/PQGS g. PROPUL/ TEMP/PRESS DISP-FLAGS | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>h. COMM/ SE AUDIO VHF XMTR PRIM S-BD PWR AMPL PRIM S-BD XMTR/RCVR PMP</p> <p>18. Verify SE AUDIO panel switch positions:</p> <p>a. ICS T/R switch - ICS T/R</p> <p>b. RELAY ON/OFF switch - RELAY ON</p> <p>c. AUDIO CONT switch - BO</p> <p>d. VOX switch - PTT</p> <p>19. Verify following COMMUNICATIONS panel switch positions:</p> <p>a. S-BAND MODULATE switch - PM</p> <p>b. XMTR/RCVR switch - PRIM</p> <p>c. PWR AMPL switch - PRIM</p> <p>d. FUNCTIONS/VOICE switch - VOICE</p> <p>e. FUNCTIONS/PCM switch - PCM</p> <p>f. FUNCTIONS/RANGE switch - RANGE</p> <p>g. VHF A XMTR switch - ON</p> <p>h. VHF A RCVR switch - ON</p> <p>j. TELEMETRY PCM switch - LO</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>DEACTIVATE LM TEMPERATURE - CRITICAL EQUIPMENT AND SHUT OFF WATER SUPPLY TO ECS WATER BOILERS.</u></p> | <p>1. Verify following CDR's circuit breakers pulled out:</p> <ul style="list-style-type: none"> a. STAB/CONT/AGS b. ECS/ SUIT FAN 1 CABIN FAN 1 c. PGNS/ SIG STR DISP IMU STBY IMU OPR LGC DSKY <p>2. Verify following switch positions:</p> <ul style="list-style-type: none"> a. SYSTEM A/B MAIN SOV and ASC FEED status flags - BARBER POLE b. SYSTEM A/B THRUSTER PAIR QUAD 1 and QUAD 2 status flags - GRAY c. SYSTEM A/B THRUSTER PAIR QUAD 3 and QUAD 4 status flags - GRAY d. CRSFD status flag - BARBER POLE e. TEMP/PRESS MON switch - He f. SUIT FAN switch - OFF g. O₂/H₂O QTY MON switch - C/W RESET | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>h. RADAR/TEST MONITOR switch - LDG RADAR PWR/ VEL XMTR</p> <p>3. Verify following SE's circuit breakers pulled out:</p> <p>a. STAB/CONT/AEA</p> <p>b. RCS/TEMP/PRESS DISP- FLAGS</p> <p>c. COMM/DISP</p> <p>d. ECS/ SUIT FAN AP DISP</p> <p>e. ECS/ CO₂ SENSOR CABIN FAN 2</p> <p>f. EPS/DISP</p> <p>4. Verify switch positions and status flags as follows:</p> <p>a. POWER/TEMP MON switch - OFF</p> <p>b. DESCENT POWER BAT 1, 2, 3, 4, and DES BATS status flags - LO</p> <p>c. ASCENT POWER BAT 5 NORMAL FEED and BACK UP FEED status flag - BARBER POLE</p> <p>d. ASCENT POWER BAT 6 NORMAL FEED and BACK UP FEED status flags - BARBER POLE</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 3. <u>DEACTIVATE AND CHECKOUT SUBSYSTEMS STATUS AFTER ECS WATER BOILER DRYOUT PERIOD.</u> | <p>e. AGS STATUS switch - OFF</p> <p>5. Throughout the dryout period:</p> <p>a. GLYCOL TEMP/PRESS indicator - Monitor for steady increase of temperature to 50°F</p> <p>6. Crew member start task 3 immediately.</p> | <div>NOTE</div> <p>The water boiler dryout period should take approximately 1/2 hour to one hour.</p> |
| | <p>1. Pull out the following CDR's circuit breakers:</p> <p>a. HEATERS/ WINDOWS-SE WINDOWS-CDR</p> <p>b. PROPUL/He/PQGS DISP</p> <p>c. FLIGHT DISPLAYS/ RNG/RNG RT-ALT/ALT RT GASTA SE FDAI CDR FDAI</p> <p>d. LTG/ NUM INTGL</p> <p>e. STAB/CONT/ ATCA (PGNS)</p> <p>f. COMM/ SEC S-BD XMTR/RCVR SEC S-BD PWR AMPL VHF A RCVR CDR AUDIO</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ul style="list-style-type: none"> g. INST/SIG CONDR 1 h. FLIGHT DISPLAYS/ RNG/RNG RT-ALT/ALT RT MISSION TIMER X/PNTR GASTA CDR FDAI j. ECS/GLYCOL PUMP 1 2. Verify switch positions as follows: <ul style="list-style-type: none"> a. C-BAND PWR switch - ON b. R/D TLM CALIBRATE switch - ON 3. Verify CDR AUDIO panel switches: <ul style="list-style-type: none"> a. S-BAND T/R switch - OFF b. ICS T/R switch - OFF c. VOX switch - PTT d. AUDIO CONT switch - NORM e. VHF A switch - OFF f. Attitude Controller PTT switch - OUT g. Communications umbilical PTT/ KEYER switch - OUT 4. Verify switch positions as follows: <ul style="list-style-type: none"> a. MISSION TIMER CONT switch - STOP b. LIGHTING, OVERRIDE ANUN switch - OFF | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <ul style="list-style-type: none"> c. LIGHTING, OVERRIDE INTEGRAL switch - OFF d. LIGHTING, ANUN/NUM switch - DIM e. LIGHTING, INTEGRAL switch - DIM <p>5. Verify CDR's center panel switches:</p> <ul style="list-style-type: none"> a. PRPLNT QTY MON switch - OFF b. TEMP/PRESS MON switch - DES 1 c. HELIUM MON switch - OFF <p>6. Verify SE's center panel switch:</p> <ul style="list-style-type: none"> a. GLYCOL PUMP switch - 1 <p>7. On HTR CONT panel:</p> <ul style="list-style-type: none"> a. TEMP MONITOR switch - RADAR/RNDZ <p>8. On LIGHTING panel:</p> <ul style="list-style-type: none"> a. FLOOD switch - OFF b. LAMP/TONE TEST switch - OFF <p>9. Pull out the following SE circuit breakers:</p> <ul style="list-style-type: none"> a. LTG/ FLOOD MASTER ALARM b. STAB/CONT/ATCA | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <ul style="list-style-type: none"> c. FLIGHT DISPLAYS/ EVENT TIMER/SE FDAI X-PNTR d. INST/ PCM/TE CWEA SIG SENSOR SIG CONDR 2 e. HEATERS/DISP f. RCS/PQGS g. PROPUL/TEMP/PRESS DISP/FLAGS h. COMM/ SE AUDIO VHF A XMTR PRIM S-BD PWR AMPL PRIM S-BD XMTR/RCVR PMP 10. On SE's AUDIO panel: <ul style="list-style-type: none"> a. S-BAND T/R switch - OFF b. ICS T/R switch - OFF c. RELAY ON/OFF switch - RELAY OFF d. AUDIO CONT switch - NORM e. VOX switch - PTT f. VHF A switch - OFF 11. On COMMUNICATIONS panel: <ul style="list-style-type: none"> a. S-BAND MODULATE switch - PM | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | b. S-BAND XMTR/RCVR switch - OFF c. S-BAND PWR AMPL switch - OFF d. FUNCTIONS VOICE switch - OFF e. FUNCTIONS PCM switch - OFF f. FUNCTIONS RANGE switch - OFF g. VHF A switch - OFF h. UHF B switch - ON j. TELEMETRY PCM switch - LO 12. Verify CDR circuit breakers pushed in: a. EPS/ AC BUS-FEED TIE- AC BUS-FEED TIE- b. LTG/ ANUN DOCK/COMPNT c. HEATERS/ -RNDZ RDR-STBY LDG RDR AOT d. EPS/ BAT-FEED TIE- BAT-FEED TIE- -CROSS TIE-BAL LOADS DES ECA CONT DES ECA DC BUS VOLT | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>e. ECS/ GLYCOL PUMP 2 GLYCOL PUMP 1</p> <p>13. Verify SE's circuit breakers pushed in:</p> <p>a. HEATERS/S-BD ANT</p> <p>b. EPS/ DISP DC BUS VOLT DES ECA DES ECA CONT -CROSS TIE-BUS -CROSS TIE-BAL LOADS BAT-FEED TIE- BAT-FEED TIE-</p> <p>14. Verify ELECTRICAL POWER panel switches and status flags:</p> <p>a. OVER TEMP component light - extinguished</p> <p>b. POWER/TEMP MON switch - OFF</p> <p>c. AC PWR switch - OFF</p> <p>d. DESCENT POWER BAT 1, 2, 3, and 4 status flags - LO</p> <p>e. DESCENT POWER DES BATS status flag - GRAY</p> <p>f. ASCENT POWER BAT 5 NORMAL FEED and BACK UP FEED status flags - BARBER POLE</p> <p>g. ASCENT POWER BAT 6 NORMAL FEED and BACK UP FEED status flags - BARBER POLE</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 4. <u>TRANSFER CM ELECTRICAL POWER SOURCE TO LM.</u> | <div>1. Verify AC PWR switch - OFF</div> <div>2. Request CM to transfer electrical power to LM batteries and to verify that switching has occurred.</div> <div>3. CM verifies after power transfer.</div> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>L22-2 SUBSYSTEM STATUS CHECK</u> | | |
| 1. <u>CHECK STATUS OF PROPELLANTS, GASES AND FLUIDS OF ASCENT AND DESCENT STAGES.</u> | 1. RCS QUANTITY indicator - monitor 2. RCS TEMP/PRESS MON switch - He 3. RCS SYS A and SYS B PRESS indicator PSIA 4. RCS TEMP/PRESS MON switch - PRPLNT 5. RCS SYS A and SYS B TEMP indicator - $70^{\circ} \pm 30^{\circ}$ F 6. RCS SYS A and SYS B PRESS indicator - 180+25-15 PSIA 7. RCS TEMP/PRESS MON switch - FUEL MANF 8. RCS SYS A and SYS B PRESS indicator - 175+25-15 PSIA 9. RCS TEMP/PRESS MON switch - OXID MANF 10. RCS SYS A and SYS B PRESS indicator - 175+25-15 PSIA 11. RCS TEMP/PRESS MON switch - He 12. HEATER TEMP MONITOR switch - RCS QUAD 1, QUAD 2, QUAD 3, and QUAD 4 13. RCS SYS A and SYS B TEMP indicator - monitor each quad $140^{\circ} + 50^{\circ} - 20^{\circ}$ F | 2. The times ten (x 10) multiplier will illuminate when RCS TEMP/PRESS MON switch is in He. |

[illegible]

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | 30. PRPLNT TEMP/PRESS MON switch - DES 1 31. O ₂ /H ₂ O QTY MON switch - DES 32. O ₂ and H ₂ O QUANTITY indicator - ____ % 33. O ₂ /H ₂ O QTY MON switch - ASC-1 34. O ₂ and H ₂ O QUANTITY indicator - 100 % 35. O ₂ /H ₂ O QTY MON switch - ASC 2 36. O ₂ and H ₂ O QUANTITY indicator - 100% 37. O ₂ /H ₂ O QTY MON switch - DES 38. GLYCOL TEMP indicator - 45° ±20° F 39. GLYCOL PRESS indicator - 30±10 PSIA 40. PART PRESS CO ₂ indicator - less than 7.6mm Hg 41. CO ₂ component light - extinguished | |
| 2. <u>CHECKOUT STATUS OF PROPELLANTS, GASES AND FLUIDS AFTER STAGING</u> | 1. RCS QUANTITY indicator - monitor 2. RCS TEMP/PRESS MON switch - He 3. RCS SYS A and SYS B PRESS in- dicator - ____ PSIA 4. RCS TEMP/PRESS MON switch - PRPLNT | 2. The times ten (x 10) multiplier will illuminate when RCS TEMP/PRESS MON switch is in the He position. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---|
| | <p>5. RCS SYS A and SYS B TEMP indicator - $70^{\circ} \pm 30^{\circ}$ F</p> <p>6. RCS SYS A and SYS B PRESS indicator - 180+25-15 PSIA</p> <p>7. RCS TEMP/PRESS MON switch - FUEL MANF</p> <p>8. RCS SYS A and SYS B PRESS indicator 175+25-15 PSIA</p> <p>9. RCS TEMP/PRES MON switch - OXID MANF</p> <p>10. RCS SYS A and SYS B PRESS indicator - 175+25-15 PSIA</p> <p>11. RCS TEMP/PRESS MON switch - He</p> <p>12. HELIUM MON switch - ASC TEMP 1 and TEMP 2</p> <p>13. HELIUM indicator - $70^{\circ} \pm 20^{\circ}$ F</p> <p>14. HELIUM MON switch - ASC PRESS 1 and PRESS 2</p> <p>15. HELIUM indicator - _____ PSIA</p> <p>16. PRPLNT TEMP/PRESS MON switch - ASC</p> <p>17. FUEL and OXID TEMP indicator - $70^{\circ} \pm 20^{\circ}$ F</p> <p>18. FUEL and OXID PRESS indicator - _____ PSIA</p> <p>19. O₂/H₂O QTY MON switch - ASC 1</p> <p>20. O₂ and H₂O QUANTITY indicator - _____ %</p> <p>21. O₂/H₂O QTY MON switch - ASC 2</p> | <p>13. Compare displayed values with TEMP/PRESS curve values</p> <div style="border: 1px solid black; padding: 2px; text-align: center; margin: 10px 0;">NOTE</div> <p>If the HELIUM MON switch is initially in the ASC PRESS 2 position, read ascent helium parameter in sequence of PRESS 2, PRESS 1, TEMP 2, TEMP 1.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | 22. O ₂ and H ₂ O QUANTITY indicator - 100% 23. O ₂ /H ₂ O QTY MON switch - ASC 1 24. GLYCOL TEMP indicator -45°±20° F 25. GLYCOL PRESS indicator - 30±10 PSIA 26. PART PRESS CO ₂ indicator - less than 7.6mm Hg 27. CO ₂ component light - extinguished. | |
| 3. <u>PERFORM PERIODIC CHECK OF ELECTRICAL POWER SYSTEM</u> | | |
| | 1. POWER/TEMP MON switch - BUS CDR 2. VOLTS meter - ____VDC 3. POWER/TEMP MON switch - BUS SE 4. VOLTS meter - ____VDC 5. POWER/TEMP MON switch - BUS AC 6. VOLTS meter - GREEN BAND 7. POWER/TEMP MON switch - BAT 1 through 6 8. VOLTS meter - ____VDC ____VDC ____VDC ____VDC ____VDC ____VDC | 6. The AC BUS green band, 35.8 to 37.7 VDC, is equivalent to 112 to 118 VAC. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---------|
| | 9. AMPS meter - ____AMPS ____AMPS ____AMPS ____AMPS 0 AMPS 0 AMPS 10. POWER/TEMP MON switch - BUS CDR | |
| 4. <u>PERFORM PERIODIC CHECK OF ASCENT BATS PRIOR TO STAGING</u> | 1. BAT 5 NORMAL FEED switch - ON 2. BAT 5 NORMAL FEED status flag - GRAY 3. BAT 5 BACK UP FEED switch - ON 4. BAT 5 BACK UP FEED status flag - GRAY 5. BAT 6 NORMAL FEED switch - ON 6. BAT 6 NORMAL FEED status flag - GRAY 7. BAT 6 BACK UP FEED switch - ON 8. BAT 6 BACK UP FEED status flag - GRAY 9. POWER/TEMP MON switch - BAT 5 and BAT 6 10. VOLTS meter - ____VDC ____VDC 11. AMPS meter - 0 AMPS 0 AMPS 12. DES BATS switch - DEAD FACE | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | 13. DES BATS status flag - BARBER POLE 14. POWER/TEMP MON switch - BAT 5 and BAT 6 15. VOLTS meter - ___VDC ___VDC 16. AMPS meter - ___AMPS ___AMPS 17. POWER/TEMP MON switch - BUS CDR 18. VOLTS meter - ___VDC 19. POWER/TEMP MON switch - BUS SE 20. VOLTS meter - ___VDC 21. POWER/TEMP MON switch - BUS AC 22. VOLTS meter - GREEN BAND 23. EPS/CROSS TIE/BAL LOADS circuit breaker - pull out 24. POWER/TEMP MON switch - BUS CDR 25. VOLTS meter - ___VDC 26. POWER/TEMP MON switch - BUS SE 27. VOLTS meter - ___VDC 28. POWER/TEMP MON switch - BUS AC 29. VOLTS meter - GREEN BAND 30. EPS/CROSS TIE/BAL LOADS - press 31. DES BATS swtich - CONNECT | 22. The AC BUS green band, 35.8 to 37.7 VDC is equivalent to 112 to 118 VAC 29. The AC BUS green band, 35.8 to 37.7 VDC, is equivalent to 112 to 118 VAC. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>32. DES BATS status flag - GRAY</p> <p>33. BAT 5 NORMAL FEED switch - OFF/RESET</p> <p>34. BAT 5 NORMAL FEED status flag - BARBER POLE</p> <p>35. BAT 5 BACK UP FEED switch - OFF/RESET</p> <p>36. BAT 5 BACK UP FEED status flag - BARBER POLE</p> <p>37. BAT 6 NORMAL FEED switch - OFF/RESET</p> <p>38. BAT 6 NORMAL FEED status flag - BARBER POLE</p> <p>39. BAT 6 BACK UP FEED switch - OFF/RESET</p> <p>40. BAT 6 BACK UP FEED status flag - BARBER POLE</p> <p>41. POWER/TEMP MON switch - BUS CDR</p> <p>42. VOLTS meter - ____VDC</p> <p>43. POWER/TEMP MON switch - BUS SE</p> <p>44. VOLTS meter - ____VDC</p> <p>45. POWER/TEMP MON switch - BUS AC</p> <p>46. VOLTS meter - GREEN BAND</p> <p>47. POWER/TEMP MON switch - BAT 1 through 4</p> | <p>46. The AC BUS green band, 35.8 to 37.7 VDC, is equivalent to 112 to 118 VAC.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| | 48. VOLTS meter - _____ VDC _____ VDC _____ VDC _____ VDC 49. AMPS meter - _____ AMPS _____ AMPS _____ AMPS _____ AMPS 50. POWER/TEMP MON switch - BUS CDR | |
| 5. <u>CHECK AC INVERTER BACKUP CAPABILITY</u> | 1. POWER/TEMP MON switch - BUS AC 2. VOLTS meter - GREEN BAND 3. EPS/INV 1 circuit breaker - press 4. AC PWR switch - INV 1 5. VOLTS meter - GREEN BAND 6. AC PWR switch - INV 2 7. EPS/INV 1 circuit breaker - pull out 8. VOLTS meter - GREEN BAND 9. POWER/TEMP MON switch - BUS CDR | 2. The AC BUS green band, 35.8 to 37.7 VDC, is equivalent to 112 to 118 VAC 8. The AC BUS green band 35.8 to 37.7 VDC, is equivalent to 112 to 118 VDC. |
| 6. <u>PERFORM PERIODIC CHECK OF ASCENT ELECTRICAL POWER SYSTEM</u> | 1. POWER/TEMP MON switch - BUS CDR | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| | 2. VOLTS meter - ____VDC 3. POWER/TEMP MON switch - BUS SE 4. VOLTS meter - ____VDC 5. POWER/TEMP MON switch - BUS AC 6. VOLTS meter - GREEN BAND 7. POWER/TEMP MON switch - BAT 5 and 6 8. VOLTS METER - ____VDC ____VDC 9. AMPS meter - ____AMPS ____AMPS 10. POWER/TEMP MON switch - BUS CDR | 6. The AC BUS green band, 35.8 to 37.7 VDC, is equivalent to 112 to 118 VAC. |
| 7. <u>CHECK STATUS OF CAUTION AND WARNING SYSTEM</u> | | |
| | 1. LAMP/TONE TEST switch - ALARM TONE 2. Audio tone - audible 3. CDR's MASTER ALARM pushbutton - indicator - lit 4. SE's MASTER ALARM pushbutton - indicator - lit 5. LAMP/TONE TEST switch - C/W 1 6. CDR's MASTER ALARM pushbutton - extinguished 7. SE's MASTER ALARM pushbutton - extinguished | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>8. Warning lights - lit</p> <ul style="list-style-type: none"> a. ASC PRESS b. DES REG c. DES QTY d. CES AC e. CES DC f. AGS g. LGC h. ISS <p>9. LAMP/TONE TEST switch - ENG PB -C/W 2</p> <p>10. Warning lights in step 8. - extinguished</p> <p>11. Engine START pushbutton-indicator - lit</p> <p>12. CDR engine STOP pushbutton-indicator - lit</p> <p>13. SE engine STOP pushbutton-indicator - lit</p> <p>14. Warning lights - lit</p> <ul style="list-style-type: none"> a. RCS TCA b. RCS A REG c. RCS B REG d. DC BUS e. CABIN f. SUIT/FAN | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>15. LAMP/TONE TEST switch - C/W 3</p> <p>16. Engine START pushbutton-indicator - extinguished</p> <p>17. CDR engine STOP pushbutton- indicator - extinguished</p> <p>18. SE engine STOP pushbutton-indicator - extinguished</p> <p>19. Warning lights in step 14 - extinguished</p> <p>20. Caution Lights - lit</p> <ul style="list-style-type: none"> a. ASC HI REG b. ASC QTY c. ENG GIMBAL d. PGNS e. INVERTER f. BATTERY g. RNDZ RDR h. LDG RDR i. PRE AMPS <p>21. LAMP/TONE TEST switch - C/W 4</p> <p>22. Caution lights in step 20 - extinguished</p> <p>23. Caution lights - lit</p> <ul style="list-style-type: none"> a. RCS b. HEATER c. C/W PWR | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| | <p>d. ECS</p> <p>e. O₂ QTY</p> <p>f. GLYCOL</p> <p>g. WATER QTY</p> <p>24. LAMP/TONE TEST switch - COMPNT</p> <p>25. All caution lights in step 23. - extinguished</p> <p>26. Component caution and LUNAR CONTACT lights - lit</p> <p>a. CDR's LUNAR CONTACT</p> <p>b. SE's LUNAR CONTACT</p> <p>c. BAT FAULT</p> <p>d. SUIT FAN</p> <p>e. GLYCOL PUMP</p> <p>f. CO₂</p> <p>g. H₂O SEP</p> <p>h. NO TRACK</p> <p>26. LAMP/TONE TEST switch - OFF</p> <p>27. Component caution and LUNAR CONTACT lights in step 26 - extinguished</p> | |
| 8. <u>CHECK STATUS OF VHF B TRANSMITTER/RECEIVER (SIMPLEX) COMMUNICATIONS</u> | 1. Advise CM of readiness to check out VHF B XMTR/RCVR | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|--|---|
| <p>9. At AUDIO panel:</p> <p>a. VHF A switch - OFF</p> <p>b. VHF B switch - T/R</p> <p>c. VOX switch - PTT</p> <p>10. Press push-to-talk switch (attitude controller) - TRANSMIT TO CM</p> | <p>2. At COMMUNICATIONS panel:</p> <p>a. VHF A/XMTR switch - OFF</p> <p>b. VHF A/RCVR switch - OFF</p> <p>c. VHF B/XMTR switch - VOICE</p> <p>d. VHF B/RCVR switch - ON</p> <p>3. At AUDIO panel:</p> <p>a. VHF A switch - OFF</p> <p>b. VHF B switch - T/R</p> <p>c. VOX switch - PTT</p> <p>4. Press push-to-talk switch (attitude controller) - TRANSMIT TO CM</p> <p>5. Release push-to-talk switch (attitude controller) - RECEIVE FROM CM</p> <p>6. VHF B/VOLUME thumbwheel - adjust volume</p> <p>7. Press push-to-talk/keyer switch (LM communications umbilical lead) - TRANSMIT TO CM</p> <p>8. Release push-to-talk/Keyer switch (LM communications umbilical lead) - RECEIVE FROM CM</p> | <p>2. CM switch to VHF secondary mode (VHF B simplex)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>11. Release push-to-talk switch (attitude controller) - RECEIVE FROM CM</p> <p>12. VHF B/VOLUME thumbwheel - adjust volume</p> <p>13. Press push-to-talk/keyer switch (LM communications umbilical lead) - TRANSMIT TO CM</p> <p>14. Release push-to-talk/keyer switch (LM communications umbilical lead) - RECEIVE FROM CM</p> <p>18. At AUDIO panel:</p> <p>a. VHF A switch - ON</p> <p>b. VHF B switch - OFF</p> <p>c. VOX switch - ICS/XMTR</p> | <p>15. Press push-to-talk switch (attitude controller) - ACKNOWLEDGE END OF CHECKOUT</p> <p>16. Request CM switch-over to Simplex A.</p> <p>17. Release push-to-talk switch (attitude controller)</p> <p>18. At AUDIO panel:</p> <p>a. VHF A switch - ON</p> <p>b. VHF B switch - OFF</p> <p>c. VOX switch - ICS/XMTR</p> <p>19. At COMMUNICATIONS panel:</p> <p>a. VHF B/XMTR switch - OFF</p> <p>b. VHF B/RCVR switch - OFF</p> <p>c. VHF A/XMTR switch - ON</p> <p>d. VHF A/RCVR switch - ON</p> | <p>16. CM acknowledge end of checkout. Inform LM of switch-over to Simplex A</p> <p>18. CM switch to VHF primary mode (VHF A Simplex)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>9. <u>CHECK BACKUP VOICE AND KEYING CAPABILITY</u></p> | <p>1. S-BAND FUNCTIONS PCM/KEY switch - OFF</p> <p>2. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE BU</p> <p>3. S-BAND MODULATE switch - PM</p> <p>4. Voice communication with MCC - verify</p> <p>5. S-BAND FUNCTIONS PCM/KEY switch - PCM</p> <p>6. TELEMETRY PCM switch - LO</p> <p>7. Voice and PCM communication with MCC - verify</p> <p>8. S-BAND FUNCTION PCM/KEY switch - KEY</p> <p>9. Operate keyer on LM communications umbilical lead to transmit morse code to MCC - verify</p> <p>11. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE</p> <p>12. S-BAND FUNCTIONS PCM/KEY switch - OFF</p> <p>13. S-BAND FUNCTIONS RANGE/TV switch - OFF</p> <p>14. TELEMETRY PCM switch - HI</p> | |
| <p>10. Operate keyer on LM communications umbilical lead to transmit morse code to MCC - verify</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| 10. <u>CHECK BACKUP VOICE AND KEYING CAPABILITY (ONE MAN)</u> | 1. S-BAND FUNCTIONS PCM/KEY switch - OFF | |
| | 2. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE BU | |
| | 3. S-BAND MODULATE switch - PM | |
| | 4. Voice communication with MCC - verify | |
| | 5. S-BAND FUNCTIONS PCM/KEY switch - PCM | |
| | 6. TELEMETRY PCM switch - LO | |
| | 7. Voice and PCM communications with MCC - verify | |
| | 8. S-BAND FUNCTIONS PCM/KEY switch - KEY | |
| | 9. Operate keyer on umbilical to transmit morse code to MCC - verify | |
| | 10. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE | |
| | 11. S-BAND FUNCTIONS PCM/KEY switch - OFF | |
| | 12. S-BAND FUNCTIONS RANGE/TV switch - OFF | |
| | 13. TELEMETRY PCM switch - HI | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p>11. <u>CHECKOUT OPERATION OF SUIT FANS</u></p> <p>2. ECS/SUIT FAN 1 circuit breaker - pull out</p> <p>16. ECS/SUIT FAN 1 circuit breaker - press</p> | <p>1. ECS/SUIT FAN 2 circuit breaker - press</p> <p>3. Master alarm tone - audible</p> <p>4. CDR MASTER ALARM pushbutton- indicator - lit</p> <p>5. SE MASTER ALARM pushbutton- indicator - lit</p> <p>6. SUIT FAN component caution light - lit</p> <p>7. ECS caution light - lit</p> <p>8. SE MASTER ALARM pushbutton- indicator - press</p> <p>9. SE's MASTER ALARM pushbutton- indicator - extinguished</p> <p>10. CDR MASTER ALARM pushbutton- indicator - extinguished</p> <p>11. Master alarm tone - Inaudible</p> <p>12. SUIT FAN switch - 2</p> <p>13. O₂ flow in suit - verify</p> <p>14. SUIT FAN component caution light - extinguished</p> <p>15. ECS caution light - extinguished</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>17. ECS/SUIT FAN 2 circuit breaker - pull out</p> <p>18. O₂ flow in suit - stops flowing</p> <p>19. Master alarm tone - audible</p> <p>20. CDR MASTER ALARM pushbutton- indicator - lit</p> <p>21. SE MASTER ALARM pushbutton- indicator - lit</p> <p>22. SUIT FAN component caution light - lit</p> <p>23. SUIT/FAN warning light - lit</p> <p>24. SE MASTER ALARM pushbutton- indicator - press</p> <p>25. SE MASTER ALARM pushbutton- indicator - extinguished</p> <p>26. CDR MASTER ALARM pushbutton- indicator - extinguished</p> <p>27. Master alarm tone - inaudible</p> <p>28. SUIT FAN switch -1</p> <p>29. O₂ flow in suit - verify</p> <p>30. SUIT FAN component caution light - extinguished</p> <p>31. SUIT/FAN warning light - extinguished</p> <p>32. ECS/SUIT FAN 2 circuit breaker - press</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>12. <u>CHECK HEAT TRANSPORT SECTION</u></p> <p>3. ECS/GLYCOL PUMP 2 circuit breaker - press</p> <p>4. ECS/GLYCOL PUMP 1 circuit breaker - pull out</p> | <p>1. GLYCOL TEMP indicator - $45^{\circ} \pm 20^{\circ}$ F</p> <p>2. GLYCOL PRESS indicator - 30 ± 10 PSIA</p> <p>5. Master alarm tone - audible</p> <p>6. CDR MASTER ALARM pushbutton-indicator - lit</p> <p>7. SE MASTER ALARM pushbutton-indicator - lit</p> <p>8. GLYCOL PUMP component caution light - lit</p> <p>9. ECS caution light - lit</p> <p>10. SE MASTER ALARM pushbutton-indicator - press</p> <p>11. CDR and SE MASTER ALARM pushbutton-indicators - extinguished</p> <p>12. Master alarm tone - inaudible</p> <p>13. GLYCOL PUMP switch -2</p> <p>14. ECS caution light - extinguished immediately</p> <p>15. GLYCOL PUMP component caution light - extinguished when pump 2 attains speed</p> <p>16. GLYCOL TEMP and PRESS indicators - stable</p> | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| 1. <u>PREPARE FOR RENDEZVOUS.</u> | <u>L23-2 MANUAL DPS BURNS</u> | <div style="border: 1px solid black; padding: 2px; display: inline-block;">NOTE</div> The purpose of this program is to demonstrate capability and to prepare for subsequent rendezvous maneuvers. |
| 1. Receive direction from MCC - Manual DPS BURN | 2. Verify the following: CDR BUS - * * Volts POWER/TEMP MON - BUS/SE VOLTS - * * POWER/TEMP MON - BUS/AC VOLTS - * * POWER/TEMP MON - BAT/1-6 VOLTS - * * AMPS - * * POWER/TEMP MON - BAT/5 BAT 5/NORMAL FEED - ON BAT 5 FLAG - GRAY BAT 6/NORMAL FEED - ON BAT 6 FLAG - GRAY BAT 5 VOLTS - * * BAT 5 AMPS - * * POWER/TEMP MON - BAT/6 BAT 6 VOLTS - * * BAT 6 AMPS - * * POWER/TEMP MON - BUS/CDR VOLTS - * * POWER/TEMP MON - BUS/SE VOLTS - * * POWER/TEMP MON - BUS/AC AC BUS VOLT - in Green Band | 2. Choices EXT DELTA P30 T23530 CSI P32 T23532 CDH P33 T23533 TPI P34 T23534 TPM P35 T23535 |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>4. EPS/INV 1 CB - in EPS/CROSS TIE/BAL LOADS - out</p> <p>2. <u>EXTERNAL DELTA V (P30)</u></p> <p>1. Key into DSKY V37E30E</p> | <p>4. AC PWR - INV 1 AC BUS VOLT - in Green Band EPS/INV 2 - out EPS/CROSS TIE/BAL LOADS - out AC BUS VOLTS - in Green Band POWER/TEMP MON - BUS/SE VOLTS - * * POWER/TEMP MON - BUS/CDR VOLTS - * *</p> <p>5. Set up AGS</p> <p>1. Receive from MCC/CSM and record TIG DELTA VX DELTA VY DELTA VZ APOGEE ALT. (H_A) PERIGEE ALT. (H_p) DELTA V (TIG)</p> <p>Record TIG used if different from MCC/CSM value.</p> <p>Record DELTA V_x, V_y, V_z used if different from MCC/CSM value.</p> <p>Compare DSKY values with MCC.</p> | <p>AGS procedures included in revision.</p> <p style="text-align: center;">NOTE</p> <p>Purpose of this program is to accept targeting parameters (TIG and impulsive Delta V along LM local vertical axes at TIG) from a sourcer external to LGC; calculate Delta V required and other initial conditions for maneuver.</p> <p>Delta V may already be available from LGC update program P27. Orbital parameters are optional output information.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. FL V06 N34 TIG</p> <p>00XXX. HRS (GET) 000XX. MIN 0XX. XX SEC</p> <p>ACCEPT: V33E REJECT: RELOAD DATA</p> <p>3. FL V06 N--</p> <p>XXXX. X DELTA V_X XXXX. X DELTA V_Y XXXX. X DELTA V_Z</p> <p>ACCEPT: V33E REJECT: RELOAD DELTA</p> <p>4. FL V06 N45</p> <p>H_A XXXX. X NM H_p XXXX. X NM DELTA V XXXX. X FPS</p> <p>ACCEPT: V33E REJECT:</p> <p>a. Reselect V37E 30E and adjust aim parameters.</p> <p>b. Select V37E 27E and load new aim parameters.</p> <p>c. Select new program.</p> <p>d. Perform manually using PGNCS/AGS DATA.</p> <p>5. FL V06 N35 TTI</p> <p>00XXX. HRS 000XX. MINS 0XX. XX SECS</p> <p>ACCEPT: V33E REJECT: SELECT DESIRED PRO- GRAM</p> | | <p>a. Reselect P30 and adjust aim parameters.</p> <p>b. Select P27 and load new aim parameters; reselect P30.</p> <p>c. Decide alternatives.</p> <p>d. See block TBD</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>6. (ROZ - IMU STATUS CHECK)</p> <p>7. FL V06 N--</p> <p style="margin-left: 40px;">BLANK TTI XXBXX MIN-SEC MGA XXX.XX DEG V33E</p> <p>8. FL V50 N07</p> <p style="margin-left: 40px;">R1 000 40 (SELECT PROGRAM</p> <p>9. Select Propulsion System</p> <p style="margin-left: 40px;">DPS V37E 40E RCS V37E 41E APS V37E 42E</p> <p>4. LM PRETHRUST CSI PROGRAM</p> | <p>7. EVENT TIMER - TIMER CONT/ STOP (momentarily) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold for * * MINS; release SLEW CONT/MIN - UNITS Hold for * * MINS; release SLEW CONT/SECS - TENS Hold for * * MINS; release SLEW CONT/SECS - UNITS Hold for * * SECS; release TIMER CONTROL - START</p> <p>8. Verify maneuver with MCC.</p> <p>Receive MCC go ahead</p> | <p>6. Done automatically.</p> <p>7. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> <p>8. Consider in maneuver decision with MCC/CSM:</p> <p style="margin-left: 40px;">a. Delta V magnitude</p> <p style="margin-left: 40px;">b. Propellant available</p> <p style="margin-left: 40px;">c. Status of propulsion hardware</p> <p style="margin-left: 40px;">d. Time/need for IMU realignment.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 20px;"> <p>NOTE</p> <p>Purpose of this program is to calculate parameters for CSI, CDH, TPI and TPF. Delta V (TPI) and Delta V (TPF) are computed Delta V (TPF) assumed to be single impulse. Midcourse and final corrections are not allowed for.</p> </div> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|--|---|
| 1. Key V37E 32E | 1. Receive from MCC/CSM and record TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) DELTA T TRANS | |
| 2. FL V06 N _ _ GETI (CSI) 00XXX. HRS 000XX. MIN 0XX. XX SEC ACCEPT: V33E REJECT: RELOAD DATA | | 2. Compare DSKY and MCC values. |
| 3. FL V06 N _ _ N CDH APSIS 0000X. E (TPI) XXX. XX DEG ACCEPT: V33E REJECT: RELOAD DATA | 3. Record TIG (CSI) if different from MCC valve . Record N CDH APSIS if different from MCC value. | 3. Compare DSKY and MCC values. |
| 4. FL V06 N _ _ GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC ACCEPT: V33E REJECT: RELOAD DATA | 4. Record TIG (TPI) if different from MCC value. | 4. Compare DSKY and MCC values. |
| 5. FL V06 N _ _ DELTA T 00XXX. HRS TRANS- 000XX. MIN FER 0XX. XX SEC | 5. Record Delta T Trans if different from MCC value. If alarm flashes communicate which alarm to MCC. | 5. Compare DSKY and MCC values <u>ALARMS</u> No intersection of desired LOS at TPI with CSM magnitude of Delta V (CSI) 1000 fps Computer cycles for solution excessive Perigee altitude (CSI) 80 nm Perigee altitude (CDH) 80 nm |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>ACCEPT: V33E REJECT: RELOAD DATA NOTE: If FL V05 N31 R1 ____ (Computation difficulty) -- Reselect P32 and adjust parameters or select new program.</p> <p>6. FL V06 N __ DELTA V XXXX. X FPS (CSI) V33E</p> <p>7. FL V06 N __ GETI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC V33E</p> <p>8. FL V06 N __ DELTA V XXXX. X FPS (CDH) H (CDH) XXXX. X NM DELTA H XXXX. X NM (CDH)</p> <p>9. FL V06 N __ DELTA V XXXX. X FPS (TPI) HP (TPI) XXXX. X NM DELTA V XXXX. X FPS (TPF)</p> | <p>6. Record value of Delta V (CSI) Key into DEDA CLR, TBD, READOUT (DELTA V CSI, V_O) Compare PGNS and AGS Delta V CSI</p> <p>7. Key into DEDA CLR, TBD, READOUT (COAST TIME CSI to CDH, TA) Record value Subtract GETI (CSI) from GETI (CDH) Compare result with AGS. Key into DEDA CLR TBD READOUT (DELTA V CDH, V_{PO}) compare PGNS and AGS DELTA V CDH Key into DEDA CLR TBD READOUT (DIFFERENTIAL ALTITUDE, Ar₀) Compare PGNS and AGS DELTA H</p> <p>9. Record values</p> | <p>Time (CSI to CDH) 10 minutes Time (CDH to TPI) 10 minutes Hyperbolic Velocity achieved at TPI using orbital parameters planned.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>10. FL V16 N35</p> <p>TTI (CSI) 00XXX. HRS 000XX. MIN V33E 0XX. XX SEC</p> | | |
| <p>11. FL V16 N__</p> <p>N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC</p> <p>CHECK N INCREASES 1/MIN ACCEPT: V33E REJECT: a) V32E b) V37E 32E</p> | <p>11. Check maneuver parameters with MCC.</p> | <p>11. Accept if TTI 10 minutes Reject if TTI 10 minutes or data is unsatisfactory.</p> <p>a. Recycle to step 02.</p> <p>b. Adjust input data.</p> |
| <p>12. (R02- IMU STATUS CHECK)</p> | | <p>12. No crew action required.</p> |
| <p>13. FL V06 N__</p> <p>N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC MGA XXX. XX DEG V33E</p> | <p>13. EVENT TIMER/TIMER CONT - STOP (momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold for * * MINS; release SLEW CONT/MIN - UNITS Hold for * * MIN.; release SLEW CONT/SECS - TENS Hold for * * SECS; release SLEW CONT/SECS - UNITS Hold for * * SECS; release TIMER CONT - START Record MGA value</p> | <p>Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> |
| <p>14. FL V50 N07</p> <p>(SELECT PROGRAM) SELECT PROPULSION SYSTEM DPS - SELECT P40 RCS - SELECT P41 APS - SELECT P42</p> | | <p>Consider in maneuver decision with MCC/CSM</p> <p>a. Magnitude of DELTA V</p> <p>b. Status of propulsion hardware</p> <p>c. Time/need to realign IMU</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>5. LM-PRETHRUST CDH PROGRAM (P33)</p> <p>1. Key V37E 33E</p> <p>2. FL V06 N__ GETI 00XXX. HRS (CDH) 000XX. MIN 0XX. XX SEC</p> <p>3. FL V06 N__ DELTA T 00XXX. HRS TRANS- 000XX. MIN FER 0XX. XX SEC ACCEPT: V33E REJECT: RELOAD DATA</p> <p>4. FL V06 N__ GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC ACCEPT: V33E REJECT: RELOAD DATA</p> <p>FL V05 N31 ALARM V32E Recycle</p> | <p>1. Receive from MCC/CSM and record. TIG (CDH) N CDH APSIS E TIG (TPI) DELTA T TRANS</p> <p>2. Record TIG (CDH) if different from MCC value.</p> <p>3. Record DELTA T TRANS if different from MCC value.</p> <p>4. Record TIG (TPI) if different from MCC value.</p> <p>If ALARM flashes, communicate to MCC which alarm.</p> | <p>NOTE</p> <p>Purpose of this program is to calculate parameters for CDH, TPI and TPF. Delta V (TPI) and Delta V (TPF) are computed. Delta V (TPF) assumed to be single impulse. Midcourse and final correction are not allowed for.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | | <div>NOTE</div> <p>If GETI (TPI) - GETI (CDH) 10 MIN. FL V05 N31 R1 Program ALARM, RESET, RECYCLE V32E and define GETI (TPI)</p> <div>NOTE</div> <p>If HYPERBOLIC LM VELOCITY Results: FL V05 N31 R1</p> <p>Program ALARM, RESET, RECYCLE V32E and adjust para- meters.</p> |
| 5. FL V06 N__ DELTA V XXXX. X FPS (CDH) ALT XXXX. X NM (CDH) DELTA XXXX. X NM ALT (CDH) V33E 6. FL V06 N__ BLANK BLANK HP (CDH) XXXX. X NM V33E 7. FL V06 N__ DELTA V XXXX. X FPS (TPI) HP (TPI) XXXX. X NM DELTA V XXXX. X FPS (TPF) V33E | 5. Record values 6. Record value 7. Record value | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 8. FL V16 N35 TTI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC | | |
| 9. FL V16 N__ N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC BLANK CHECK N INCREASE 1/MINUTE ACCEPT: V33E REJECT: a) V32E b) V37E 33E | 9. Check maneuver parameters with MCC. | 9. Accept if TTI 8 minutes Reject if TTI 8 minutes or data unsatisfactory. a. Recycle to step 02. b. Adjust input data. |
| 10. FL V16 N__ N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC MGA XXX. XX DEG V33E | 10. EVENT TIMER/TIMER CONT - STOP (momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MINS - TENS Hold for * * MINS; release SLEW CONT/MINS - UNITS Hold for * * MINS; release SLEW CONT/SECS - TENS Hold for * * SECS; release SLEW CONT/SECS - UNITS Hold for * * SECS; release TIMER CONT - START Record MGA value | 10. Set EVENT TIMER to future DSKY time. (Time of EVENT TIMER start). |
| 11. FL V50 N07 R1 00040 (Select Program) Select Propulsion System DPS - Select P40 RCS - Select P41 APS - Select P42 | 12. Key into DEDA, CLR, 410 + 20,000 E (CDH Burn) | 11. Consider in maneuver decision with MCC/CSM a. Magnitude of delta v b. Status of propulsion hardware c. Time/need to realign IMU Select P02 AGS initialization first Exact time TBD |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. LM PRETHRUST TPI PROGRAM (P34)</p> <p>1. Key V37E 34E</p> <p>2. FL V06 N__</p> <p style="margin-left: 40px;">R1-0000X (TPI LOAD OPTION) R2-00001 - LOAD GETI (LGC COMPUTES E) OR 00002 - LOAD E (LGC COMPUTES GETI)</p> <p style="margin-left: 40px;">ACCEPT: V33E REJECT: LOAD DATA</p> <p>3. If 00001 Accepted:</p> <p style="margin-left: 40px;">FL V06 N34</p> <p style="margin-left: 80px;">GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p style="margin-left: 40px;">ACCEPT: V33E REJECT: RELOAD DATA</p> <p>OR IF 00002 ACCEPTED:</p> <p style="margin-left: 40px;">FL V06 N__</p> <p style="margin-left: 40px;">R2-E (TPI) XXX. XX DEG</p> <p style="margin-left: 40px;">ACCEPT: V33E REJECT: LOAD DATA</p> | <p>1. Receive from MCC/CSM and record; TIG (TPI) E DELTA T TRANS</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">NOTE</div> <p>Purpose of this program is to calculate Delta V required and initial conditions for TPI given GETI (TPI) or E (TPI) and transfer duration.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. POSS FL V05 N31 R1 _____ (GETI IMPOSSIBLE)</p> <p>V32E - LOAD NEW E (TPI) OR RESELECT P34 - LOAD NEW GETI</p> <p>5. FL V06 N__</p> <p>DELTA T TRANS 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>ACCEPT: V33E REJECT: LOAD DATA</p> <p>6. POSS: FL V05 N31 R1 _____ (DELTA V TOO GREAT) V32E - LOAD NEW DELTA T TRANS</p> <p>7. IF 00001 ACCEPTED:</p> <p>FL V06 N__</p> <p>R2 - E (TPI) XXX. XX DEG V33E</p> <p>OR IF 00002 ACCEPTED:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> | <p>5. Key into DEDA</p> <p>CLR, TBD + XXXXXX (TIG . 1 MIN desired fixed absolute time of TPI) CLR, TBD + XXXXXX (63 . 01 MIN DELTA T TRANS) Record DELTA T TRANS used if different from MCC value.</p> <p>6. Tell MCC if ALARM flashes.</p> <p>7. Record value(s) used if different from MCC value(s).</p> | <p>Use of MCC values should prevent this alarm.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. FL V06 N__</p> <p>DELTA V XXXX.X FPS (TPI) HP (TPI) XXXX.X NM DELTA V XXXX.X FPS (TPF) V33E</p> <p>9. FL V06 N__</p> <p>TTI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC V33E</p> <p>10. FL V16 N__</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC</p> <p>CHECK DATA WITH GROUND</p> <p>CHECK N INCREASES 1/MIN.</p> <p>ACCEPT: V33E (NO LATER THAN TTI = 8 MIN) REJECT: IF TIME PERMITS RECYCLE V32E</p> <p>(R02-IMU STATUS CHECK)</p> <p>11. FL V06 N__</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC MGA XXX.XX DEG V33E</p> | <p>8. Record values</p> <p>Key into DEDA CLR, TBD, READOUT (q, 1000 ft, predicted Perigee TPI) Compare (q, with HP)</p> <p>11. EVENT TIMER/TIMER CONT - STOP (Momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold for * * MINS on EVENT TIMER; release SLEW CONT/MIN - UNITS Hold for * * MINS on EVENT TIMER; release SLEW CONT/SECS - TENS Hold for * * SEC on EVENT TIMER; release</p> | <p>8. Must convert between NM and thousands of feet.</p> <p>10. RR active</p> <p>11. Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. FL V50 N07</p> <p>R1 00040 (Select Program)</p> <p>Select Propulsion System</p> <p>DPS - V37E40E RCS - V37E41E APS - V37E42E</p> <p>7. <u>LM PRETHRUST TPM PROGRAM (P35)</u></p> <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p>TT INT 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> | <p>SLEW CONT/SECS - UNITS Hold for * * SECS on EVENT TIMER; release TIMER CONTROL - START Record N and MGA used.</p> <p>2. Verify RR actively tracking CSM EVENT TIMER/TIMER CONT - STOP (Momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN - TENS Hold for * * MIN; release SLEW CONT/MIN - UNITS Hold for * * MIN; release SLEW CONT/SECS - TENS Hold for * * SECS; release SLEW CONT/SECS - UNITS Hold for * * SECS; release TIMER CONTROL - START</p> | <p>12. Consider in maneuver decision with MCC/CSM:</p> <p>a. Value of Delta V</p> <p>b. Status of propulsion hardware</p> <p>c. Time available for IMU realignment</p> <p>NOTE</p> <p>Purpose of this program is to calculate DELTA V required and I. C. for next MCC during active LM rendezvous. To display data for crew to enter P36 at correct time to complete thrust maneuver at first range gate.</p> <p>2. Set EVENT TIMER to future DSKY time. (time of EVENT TIMER start)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. FL V16 N__</p> <p>N 000XX. MARKS TT INT XXBXX MIN-SEC</p> <p>NOTE</p> <p>If TT INT 20 MIN select P36.</p> <p>Check N increases 1/MIN when ready: V33E</p> <p>Note time on Mission Timer add 7 MIN, result TIG (MIG) communicate to SE</p> | | |
| <p>4. FL V16 N__</p> <p>N 000XX. MARKS TTI (MID) XXBXX MIN-SEC MGA V33E</p> | <p>4. Key into DEDA CLR, TBD + XXXX. X (TIGC . 1 MIN desired fixed absolute mid course) Record values</p> | <p>4. This assumes additional state vector updates not required.</p> |
| <p>5. FL V16 N__</p> <p>DELTA V XXXX. X FPS (MID) TTI (MID) XXBXX MIN-SEC DELTA V XXXX. X FPS (TPF)</p> <p>If MCC burn not required: V32E recycle to step 1. If MCC burn required: V33E</p> | <p>5. Record values</p> | <p>5. Consider in maneuver decision:</p> <p>a. Magnitude of DELTA V</p> <p>b. Status of propulsion hardware</p> <p>c. Time used to realign 1 Mo</p> |
| <p>6. FL V50 N07</p> <p>R1-00040 (Select Program)</p> <p>Select Propulsion System</p> <p>DPS - SELECT P40 RCS - SELECT P41 APS - SELECT P42</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. <u>LM OPS PROGRAM (P40)</u></p> <p>1. Key V37E 40E (R2 - IMU STATUS CHECK)</p> <p>2. POSS FL V50 N07 R1 00005 V37E 05E</p> <p>3. POSS FL V50 N07 R1 00051 V37E 51E</p> <p>4. FL V06 N__ IX XXXXX. SLUG-FT SQ IY/IZ XXXXX. SLUG-FT SQ W XXXXX. LB ACCEPT: V33E REJECT: LOAD DESIRED PARAMETERS</p> <p>5. V06 N70 PITCH TRIM XXX.XX DEG YAW TRIM XXX.XX DEG TLX XXXXX. 100 LB ACCEPT: V33E REJECT: LOAD DESIRED PARAMETERS</p> | <p>1. Receive from MCC/CSM and record IX IY/IZ W Yaw trim Pitch trim TLX VGX (LV) VGY (LV) VGZ (LV)</p> <p>4. Record IX, IY, IZ and W if different from MCC values.</p> <p>5. Record Pitch and Yaw from TLX if different from MCC values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V06 N__</p> <p>VGX (LV) XXXX.X FPS VGY (LV) XXXX.X FPS VGZ (LV) XXXX.X FPS</p> <p>V33E</p> <p>7. FL V06 N17</p> <p>OG XXX.XX DEG IG XXX.XX DEG MG XXX.XX DEG</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>If IMU orientation unsatisfactory, select P52 or P53, upon completion reselect P40</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>IMU orientation is satisfactory:</p> <p>V33E (R60 - Attitude Maneuver)</p> <p>8. POSS FL V50 N25</p> <p>R1 000__ (Mode Control)</p> <p>MODE CONTROL - AUTO</p> <p>GUID CONT - PGNC</p> <p>ACCEPT: ENTER</p> | <p>6. Record VGX, VGY, VGZ if different from MCC values. Communicate values to CSM.</p> <p>7. Observe pitch, roll and yaw angles on FDAI.</p> <p>ATTITUDE MON - PGNC</p> <p>Observe pitch, roll and yaw angles on FDAI.</p> <p>ATTITUDE MON - AGS</p> <p>Compare maneuver requirements and onboard propellant supplies</p> <p>Communicate with MCC/CSM on maneuver attitude, propellant quantities, and ground station coverage.</p> <p>Key into DEDA CLR, 400 + 30,000 E (Align AGS to PGNC) CLR, 480 + 10,000 E (AUTO Submode)</p> <p>8. Verify the following:</p> <p>MODE CONTROL - AUTO</p> <p>GUID CONT - PGNS</p> | <p>7. Assumes angles are in FDAI coordinates.</p> <p>S. E. angles should be within $\pm 5^\circ$ of former values, if not, see L1 task 23552.</p> <p>Consider in decision on IMU orientation:</p> <ul style="list-style-type: none"> a. Is MGA 45° b. Is reorientation required c. Is alignment required d. Impact of manual thrust control <p>No thrusting without ground station coverage.</p> <p>Time constraint TIG - 6 MIN</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>9. POSS FL V06 N17</p> <p>OG XXXX.XX DEG IG XXXX.XX DEG MG XXXX.XX DEG</p> <p>10. Monitor change in LM attitude on FDAI</p> <p>Pitch * * Roll * * Yaw * *</p> <p>11. FL V50 N25</p> <p>R1XXXXXX - (ENGINE GIMBAL DRIVE ENABLE)</p> <p>ACCEPT: ENTR REJECT: V33E</p> <p>12. POSS FL V05 N31</p> <p>R1XXXXXX (IGNITION TIME 45 SEC)</p> <p>SLIP ENGINE IGNITION - V33E</p> <p>13. FL V06 N51</p> <p>TTI XXBXX MIN-SEC VG XXXX.X FPS DELTA XXXX.X FPS VM</p> <p>14. SHFT/TRUN - $\pm 50^\circ$ RNG/ALT MON - RNG/RNG RT MODE CONTROL - ATT HOLD DEAD/BAND - MIN ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT MODE SEL - PGNS RATE/ERR MON - LDG RDR CMPTR Angle Error in Dead Band</p> | <p>10. Observe EVENT TIMER and advise COR.</p> <p>11. Verify the following:</p> <p>RADAR/ENG GMBL - ENABLE ENG GMBL - OUT (CWEA)</p> <p>13. Secure self and cabin for thrust. Verify restraint cables on CDR and SELF properly attached.</p> <p>Record VG Communicate TTI value to CSM.</p> <p>14. Update EVENT TIMER if required. RCS/QTY MON - SYS A TEMP/PRESS MON - He HELIUM MON - DES PRPLNT TEMP/PRESS-MON - DES 1 PRPLNT QTY MON - DES 1 O₂/H₂O QTY MON - DES RATE/ERR MON LDG RDR/CMPTR THROTTLE/JETS select lever/ THROTTLE</p> | <p>14. RR inactive during thrust, reactivate once LOS to CSM established after thrust. LGC doesn't control maneuver. Maintains LM position and velocity data during maneuver.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p> FDAI PITCH * * ROLL * * YAW * * ENGINE THRUST CONT - MON MAN THROT - CDR THROT/JETS - THROTTLE MASTER ARM - ON ENG ARM - DES </p> <p>15. Key V__ N__ EXXX__ E</p> <p>16. Drive Pitch, Roll and Yaw angles from present values. Drive pitch, roll, yaw angles to thrust attitude maintain attitude.</p> <p>17. Verify final attitude with MCC.</p> <p>18. Key V37E 47E</p> <p>19. Poss FL V50 N07 R1 00005 (PGNGC START UP) V37E 05E OR Poss FL V50 N07 R1 00005 R1 00051 (IMU ORIENTATION DETERMIN.) V37E 51E FL V16N__ DELTA VX DELTA VY DELTA VZ</p> | <p>16. Observe EVENT TIMER and communicate time to CDR.</p> <p>17. Receive attitude verification from MCC.</p> | <p>DPS Pressurization was performed for Block JL9. DEADBAND - 0.3 DEGREES.</p> <p>Thrust attitude was automatically attained. Enables pilot control of thrust attitude.</p> <p>18. Non PGNCs controlled thrust monitor must be chosen at least one minute before maneuver.</p> <p>19. R₁, R₂, R₃ initially zero. During maneuver updated every TBD seconds.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>20. Verify TIG, TTI, and TG with MCC.</p> <p>21. Receive MCC verification.</p> <p>22. Verify the following: ED/MASTER ARM - ON ENG ARM - DES</p> <p>23. AZ RT * * ELEV RT * * FDAI ATTITUDE ERROR - IN DEADBAND FDAI ATTITUDE RATES - * * DEG/SEC FDAI PITCH - * * DEG FDAI ROLL and YAW - STABLE</p> <p>24. Receive values of DELTA V_X, V_Y, and V_Z at end of maneuver from MCC.</p> | <p>20. Communicate EVENT TIMER time to CDR.</p> <p>21. Update EVENT TIMER as required.</p> <p>23. Verify the following CWEA-CDR: ASC PRESS - EXT DES REG - EXT DES QTY - EXT CES AC - EXT CES DC - EXT AGS - EXT LGS - EXT ISS - EXT RCA TCA - EXT RCS A REG - EXT RCS B REG - EXT DC BUS - EXT CABIN - EXT SUIT FAN - EXT</p> <p>24. Verify the following CWEA-S. E. ASC HI REG - EXT ASC QTY - EXT ENG GMBL - EXT PGNS - EXT INVERTER - EXT BATTERY - EXT RNDZ RDR - EXT LDG RDR - EXT PRE AMPS - EXT RCS - EXT HEATER - EXT C/W PWR - EXT ECS - EXT OZ QTY - EXT GLYCOL - EXT WATER QTY - EXT</p> | <p>21. Update required only if MCC differs with EVENT TIMER value.</p> <p>24. If IMU oriented to body axes and thrust attitude held constant, all velocity changes will be along LM X body axis.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 25. Communicate to MCC going ahead with maneuver. | 25. Verify the following: MAIN PROPULSION - FUEL/OXID TEMP meter - in Green Band MAIN PROPULSION - FUEL/OXID PRESS meter - Aligned REACTION CONTROL/TEMP A and B meter in Green Band REACTION CONTROL/PRESS A and B meter Aligned ENVIRONMENTAL CONTROL/SUIT and CABIN PRESS meter in Green Band ENVIRONMENTAL CONTROL/ PART PRESS COZ - in Green Band ENVIRONMENTAL CONTROL/ GLYCOL TEMP and PRESS meter in Green Band | |
| 26. Monitor EVENT TIMER | 26. Monitor EVENT TIMER COUNT DOWN from TIG - 10 SECS. | |
| 27. +X AXIS TRANSLATION - IN and HOLD at TIG - 7.5 SECS. | 27. Verify RCS Jets firing V19 sound, vibration, and acceleration. | |
| 28. V16 N__ DELTA VX DELTA VY DELTA VZ | | 28. DELTA V should read more than + zero. |
| 29. ENGINE START - IN/RED +X TRANS - OUT Verify ENGINE START by sound, vibration, and acceleration T/W - * * ATTITUDE RATES - ZERO ATTITUDE (FDAI) - CONSTANT TTCA - * 10 * PC for * * SECS TTCA - * 90 * PC for * * SECS FDAI ERROR NEEDLES - STABLE | 29. Communicate MARK when EVENT TIMER reaches zero. EVENT TIMER - upcount. Communicate Engine Firing to MCC. ENG GMBL (CWEA) - EXT REACTION CONTROL/QUANTITY - System A and B * * % MAIN PROPULSION/QUANTITY - descent - OXIDIZER * * % descent - FUEL * * % Repeat steps 23, 24 and 25, periodically. | 29. a. Lock gimbal in position and compensate for trim manually if ENG GMBL (CWEA) illuminates. b. RCS OXID and FUEL used during gimbal alignment decreases as vehicle moment unbalance decreases. c. Position error decreases as vehicle moment unbalance decreases. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>30. V16 N__</p> <p>DELTA V_X DELTA V_Y DELTA V_Z</p> <p>31. Observe PITCH, ROLL, YAW on FDAI ATTITUDE MON - AGS Observe PITCH, ROLL, YAW on FDAI ATTITUDE MON - PGNS</p> <p>32. PGNS/AGS Difference check Select quantity to check, information source(s) check time.</p> <p>33. Monitor EVENT TIMER cross pointer</p> <p>LAT VEL * * FWD VEL * * MAIN PROPULSION/THRUST meter - ENG and CMD needles aligned FDAI ATTITUDE ERROR - IN DEADBAND FDAI ATTITUDE/RATES - * * DEG/SEC FDAI ROLL and YAW - * Deg ± * DEG T/W - * *</p> | <p>32. Communicate quantity to check, information source(s), and check time to MCC/CSM.</p> <p>33. Receive difference check data from MCC. Perform difference check.</p> <p>34. Repeat steps 23, 24, 25 ADD MAIN PROPULSION/QUANTITY - OXIDIZER * * % FUEL HELIUM - * * PSIA REACTION CONTROL/QUANTITY - System A * * System B * * CDR EPS BUS - * * VDC POWER/TEMP MON - BUS/SE VOLTAGE - * * POWER/TEMP MON - BUS/AC VOLTAGE - * *</p> | <p>31. Attitude should agree to within ±5 degrees. If not see L1, Task 23552.</p> <p>32. Consider duration of check before selecting.</p> <p>33. FWD VEL reads accurately only, when MODE SEL switch is in PGNS position.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>35. EVENT TIMER - * *</p> <p>MIN - SEC</p> <p>V16N __</p> <p>DELTA V_X - * *</p> <p>DELTA V_Y - * *</p> <p>DELTA V_Z - * *</p> <p>ENG/STOP switch - IN</p> <p>36. T/W - Zero</p> <p>ENGINE sound, vibration - Stop</p> <p>ENG ARM - OFF</p> <p>MASTER ARM OFF</p> <p>V16N __</p> <p>DELTA V_X</p> <p>DELTA V_Y</p> <p>DELTA V_Z</p> <p>Terminal Values</p> <p>37. Consider RCS trim maneuver</p> <p>ACCEPT - Step 38</p> <p>REJECT - V37E 00E</p> | <p>POWER/TEMP MON - BAT 1-6</p> <p>VOLTS - * *</p> <p>AMP - * *</p> <p>POWER/TEMP MON - BUS/CDR</p> <p>35. Count down from 10 seconds to engine shutdown.</p> <p>At EVENT TIMER * * communicate "mark"</p> <p>ENG/STOP - IN</p> <p>EVENT TIMER RESET/COUNT - RESET (momentary)</p> <p>COMMUNICATE DELTA V values to MCC.</p> <p>37. Observe PITCH, ROLL and YAW on FDAI ATTITUDE MON - PGNS</p> <p>Observe PITCH, ROLL, and YAW on FDAI with $\pm 5^\circ$ of former values</p> <p>ATTITUDE MON - AGS</p> | <p>S. E. only if required.</p> <p>37. CONSIDER:</p> <p>a. IMU alignment and orientation</p> <p>b. Magnitude at Delta V on DSKY</p> <p>c. VG</p> <p>d. Duration of burns</p> <p>TTCA Left or right for V_Y, fore or aft for V_Z</p> |

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| <p>38. Drive to Zero</p> <p style="padding-left: 40px;">Delta V_Y Delta V_Z using TTCA</p> <p style="padding-left: 40px;">V16 N --</p> <p style="padding-left: 40px;">Delta V_X * Delta V_Y * 0 * Delta V_Z * 0 *</p> <p>Satisfied - V37E00E Unsatisfied - Step 38 repeat</p> | <p>39. Communication from MCC orbital data available. Compare Delta V_X on DSKY with VG on DEDA. Record final Delta V_X and VG values. Key into DEDA (read out perigee)</p> <p style="padding-left: 40px;">CLR, 343, READOUT Record Perigee Key into DEDA CLR, 400 + 10,000 E (AUTO Submode)</p> | <p>38. Delta V_X should change * ± *.</p> |
| <p>9. <u>POST THRUST EVALUATION (2354a)</u></p> <p>1. Mode Control - AUTO</p> <p>2. (R30 orbital parameter routine)</p> <p>3. FL V06 N43</p> <p style="padding-left: 40px;">Appogee ALT XXXX.X NM Perigee ALT XXXX.X NM TFF XXBXX MIN-SEC V33E</p> | <p>2. Receive trajectory data from MCC Perigee Apogee Time to free fall Total SENSED VELOCITY (?) Time to go to Perigee</p> <p>3. Record values if different from MCC values.</p> | <p>2. The orbital parameter routine may also be entered by Key V64E, though it is normally entered automatically after a thrust program.</p> <p>Time to free fall to 300,000 ft above Launch pad radius</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | | |
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| <p>4. Poss FL V06 N35 T Perigee 00XXX. HRS 000XX. MIN 0XX. XX SECS V33E</p> <p>5. FL V50 N07 R1 00000 V37E 00E</p> <p>6. Key V37E 25E</p> <p>7. Monitor FDAI: PITCH * * ROLL * * YAW * *</p> <p>8. X-POINTER: AZ RATE - * * MRAD/SEC ELEV RATE - * * MRAD/SEC FDAI ATTITUDE ERROR - IN DEADBAND ATTITUDE RATES - * Zero ± * DEG/SEC FDAI PITCH - * * DEG FDAI Roll and Yaw - STABLE</p> | <p>4. Record value of T Perigee.</p> <p>5. Verify LM Safe orbit</p> <p>6. Receive request from CSM for tracking attitude</p> <p>7. Tracking Light - * *</p> <p>8. Communication from CSM locked and tracking.</p> <p>9. Verify the following (CWEA-CDR) extinguished: ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS</p> | <p>R to CSM Beacon Mode</p> <table> <tr> <td>Eye</td><td>1500 ft < R < 10NM</td><td>Dim</td></tr> <tr> <td></td><td>10NM < R < 130NM</td><td>Bright</td></tr> <tr> <td>Telescope</td><td>1500 ft < R < 30NM</td><td>Dim</td></tr> <tr> <td></td><td>30NM < R < 130NM</td><td></td></tr> <tr> <td></td><td>130NM < R < 400NM</td><td>Bright</td></tr> </table> | Eye | 1500 ft < R < 10NM | Dim | | 10NM < R < 130NM | Bright | Telescope | 1500 ft < R < 30NM | Dim | | 30NM < R < 130NM | | | 130NM < R < 400NM | Bright |
| Eye | 1500 ft < R < 10NM | Dim | | | | | | | | | | | | | | | |
| | 10NM < R < 130NM | Bright | | | | | | | | | | | | | | | |
| Telescope | 1500 ft < R < 30NM | Dim | | | | | | | | | | | | | | | |
| | 30NM < R < 130NM | | | | | | | | | | | | | | | | |
| | 130NM < R < 400NM | Bright | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>CABIN SUIT/FAN</p> <p>10. Verify the following (CWEA-SE) extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS OZ COL WATER QTY</p> <p>11. Verify the following:</p> <p>MAIN PROPULSION/FUEL - TEMP * * MAIN PROPULSION/OXID - TEMP * * MAIN PROPULSION/FUEL - Press Aligned MAIN PROPULSION/OXID - Press Aligned REACTION CONTROL SYS A TEMP - in Green Band REACTION CONTROL SYS B TEMP - in Green Band REACTION CONTROL RCS SYS A - Press Aligned REACTION CONTROL RCS SYS B - Press Aligned ENVIRONMENTAL CONTROL/PRESS - SUIT - in Green Band ENVIRONMENTAL CONTROL/PRESS- CABIN - in Green Band ENVIRONMENTAL CONTROL/PART PRESS COZ - in Green Band ENVIRONMENTAL CONTROL GLY- COL/TEMP - in Green Band</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Receive optical tracking trajectory data from CSM</p> <p>13. R/D TLM CALIBRATE ON HOLD for 12 Secs.</p> <p>14. Prepare for next maneuver.</p> | <p>ENVIRONMENTAL CONTROL GLY-COL/PRESS - in Green Band</p> <p>12. Record Compare MCC, CSM, DEDA, and DSKY trajectory values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>L24-2 MANUAL APS BURNS</u> | | |
| <p>1. <u>INTRODUCTION.</u></p> <p>1. Communicate with MCC and verify APS burn maneuver will satisfy delta V requirements.</p> <p>2. Prepare PGNCs for one of the following maneuver operations:</p> <ul style="list-style-type: none"> a. External delta V, Program 30 b. Co-elliptic Sequence Initiation, Program 32 c. Constant delta Altitude, Program 33 d. Transfer Phase Initiation, Program 34 e. Transfer Phase (Midcourse), Program 35. <p>3. Calibrate DFI telemetry:</p> <p>R/D TLM CALIBRATE switch - ON (hold for 12 seconds). DFI telemetry calibration completed.</p> <p>2. <u>EXTERNAL DELTA V (P30).</u></p> | <p>2. Prepare AGS to backup PGNCs during APS burns.</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">NOTE</div> <p>2. AGS preparation procedure to be provided at a later date.</p> <p>The 5 maneuver operations listed in step 2 are followed by an APS thrusting maneuver (program 42) and a post thrust evaluation operation.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">NOTE</div> <p>The purposes of this program are to accept targeting parameters (TIG and impulsive delta V along LM local vertical axes at TIG) from sources external to the LGC and to calculate delta V required and other initial conditions for the maneuver.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>1. Key into DSKY V37E30E</p> <p>2. FL V06 N34 (TIG)</p> <p>00XXX. hrs (GET)</p> <p>000XX. min</p> <p>0XX.XX sec</p> <p>Accept: V33E</p> <p>Reject: Reload data</p> <p>3. FL V06 N--</p> <p>XXXX. X Delta V_x</p> <p>XXXX. X Delta V_y</p> <p>XXXX. X Delta V_z</p> <p>Accept: V33E</p> <p>Reject: Reload data</p> <p>4. FL V06 N 45</p> <p>H_A XXXX. X (NM)</p> <p>H_p XXXX. X (NM)</p> <p>Delta V XXXX. X (fps)</p> <p>Accept: V33E</p> <p>Reject:</p> <p>a. Reselect V37E30E and adjust aim parameters</p> <p>b. Select V37E27E and load new aim parameters</p> <p>c. Select new program</p> <p>d. Perform manually using PGNC/AGS data.</p> | <p>2. Receive from MCC/CSM and record</p> <p>TIG</p> <p>Delta VX</p> <p>Delta VY</p> <p>Delta VZ</p> <p>Apogee Alt (H_A)</p> <p>Perigee Alt (H_p)</p> <p>Delta V (TIG)</p> <p>Record TIG readout if different from MCC/CSM value.</p> <p>3. Record delta V_x, V_y, V_z readout if different from MCC/CSM value.</p> <p>Compare DSKY values with MCC.</p> | <p>NOTE</p> <p>2. Delta V may be available from LGC update program P27. Orbital parameters are optional output information.</p> <p>NOTE</p> <p>4. a. Reselect P30 and adjust aim parameters.</p> <p>b. Select P27 and load new aim parameters; reselect P30.</p> <p>c. Decide alternatives.</p> <p>d. See block</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N35 TTI</p> <p>00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Select desired program.</p> <p>6. (R02 - IMU status check)</p> <p>7. FL V06 N__</p> <p>Blank TTI XXBXX min-sec MGA XXX.XX deg V33E</p> <p>8. FL V50 N07 R1 000 40 (select program) Select propulsion system</p> <p>DPS V37E40E RCS V37E41E APS V37E42E</p> | <p>7. EVENT TIMER/TIME CONT - STOP (Momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes then release. SLEW CONT/MIN/UNITS - Hold till * * minutes, then release. SLEW CONT/SECS/TENS Hold till * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONT - START</p> <p>8. Verify maneuver with MCC.</p> <p>Receive MCC go ahead.</p> | <p>NOTE</p> <p>7. Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> <p>NOTE</p> <p>8. Consider in maneuver decision with MCC/CSM:</p> <ul style="list-style-type: none"> a. Delta V magnitude b. Propellant available c. Status of propulsion equipment d. Time needed for IMU realignment. <p>NOTE</p> <p>Calculate parameters for CSI, CDH, TPI and TPF. Delta V (TPI) and delta V (TPF) are computed. Delta V (TPF) is assumed to be single impulse. Midcourse and final corrections are not allowed for.</p> |
| <p>3. <u>LM PRETHRUST CSI PROGRAM (P32)</u></p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 1. Key V37 32E 2. FL V06 N__ GETI (CSI) 00XXX. hrs 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data 3. FL V06 N__ N CDH APSIS 0000X. E (TPI) XXX.XX deg Accept: V33E Reject: Reload data 4. FL V06 N__ GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data 5. FL V06 N__ Delta T transfer 00XXX. hrs 000XX. min 0XX.XX sec Accept: V33E Reject: Reload data 6. FL V06 N__ Delta V (CSI) XXXX.X fps V33E | 2. Receive from MCC/CSM and record: TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) Delta T transfer Record TIG (CSI) if different from MCC value. 3. Record N CDH APSIS, if different from MCC value. 4. Record TIG (TPI) if different from MCC value. 5. Record delta T transfer if different from MCC value. If alarm flashes, inform MCC. 6. Record value of delta V (CSI) Key into DEDA CLR, <u>TBD</u> , READ OUT (Delta V CSI, V _O) Compare PGNCs with AGS (Delta V CSI) | 2. Compare DSKY and MCC values. 3. Compare DSKY and MCC values. 4. Compare DSKY and MCC values. <div style="border: 1px solid black; padding: 2px; text-align: center;">NOTE</div> 5. Compare DSKY and MCC values. Alarms: No intersection of desired LOS at TPI with CSM. Magnitude of delta V (CSI) 1000 fps. Computer cycles for solution excessive. Perigee altitude (CSI) 80 NM. Perigee altitude (CDH) 80 NM. Time (CSI to CDH) 10 minutes. Time (CDH to TPI) 10 minutes. Hyperbolic velocity achieved at TPI using orbital planned parameters. If FL V06N31 R1 --- (computation difficulty) Reselect P32 and adjust parameters or select new program. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. FL V06 N--</p> <p>GETI (CDH) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> <p>8. FL V06 N--</p> <p>Delta V (CDH) XXXX.X fps H (CDH) XXXX.X NM Delta H (CDH) XXXX.X NM</p> <p>V33E</p> <p>9. FL V06 N--</p> <p>Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps</p> <p>V33E</p> <p>10. FL V16 N35</p> <p>TTI (CSI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> <p>11. FL V16 N--</p> <p>N 000XX. marks TTI (CSI) XXBXX min-sec</p> <p>Check N increases, 1/MIN. Accept: V33E Reject: a. V32E b. V37E32E</p> <p>12. (R02 - IMU status check)</p> | <p>7. Key into DEDA CLR, <u>TBD</u>, READ OUT (Coast time CSI to CDH, T_{Ao})</p> <p>Record value. Subtract GETI (CSI) from GETI (CDH). Compare result with AGS Key into DEDA CLR, <u>TBD</u>, READ OUT (Delta V CDH, V_o) Compare PGNCs and AGS delta V, CDH Key into DEDA CLR, <u>TBD</u>, READ OUT differential altitude, A_{vo} Compare PGNCs and AGS delta H.</p> <p>9. Record values.</p> <p>Verify maneuver parameters with MCC.</p> | <p style="text-align: center;">NOTE</p> <p>11. Accept if TTI \geq 10 minutes. Reject if TTI $<$ 10 minutes or if data are unsatisfactory:</p> <p>a. Recycle to step 02</p> <p>b. Adjust input data.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. FL V06 N--</p> <p>N 000XX. marks TTI (CSI) XXBXX min- sec MGA XXX.XX deg V33E</p> <p>14. FL V50 N07 (Select program) Select propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42</p> <p>4. <u>LM-PRETHRUST CDH PROGRAM (P33)</u></p> <p>1. Key V37E 33E</p> | <p>13. EVENT TIMER/TIME CONT - STOP (momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold till * * minutes then release. SLEW CONT/MIN/UNITS - Hold till * * minutes then release. SLEW CONT/SECS/TENS - Hold till * * seconds then release. SLEW CONT/SECS/UNITS - Hold till * * seconds then release. TIMER CONT - START Record MGA value</p> <p>14. Consider in maneuver decision with MCC/CSM:</p> <p>a. Magnitude of delta V</p> <p>b. Status of propulsion equipment</p> <p>c. Time needed to realign IMU.</p> <p>NOTE</p> <p>Calculate parameters for CDH, TPI and TPF. Delta V (TPI) and delta V (TPF) are computed. Delta V (TPI) is assumed to be single impulse. Midcourse and final correction are not allowed for.</p> <p>1. Receive from MCC/CSM and record:</p> <p>TIG (CDH) N CDH APSIS E TIG (TPI) Delta T transfer</p> | <p>13. Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> <p>14. Consider in maneuver decision with MCC/CSM:</p> <p>a. Magnitude of delta V</p> <p>b. Status of propulsion equipment</p> <p>c. Time needed to realign IMU.</p> <p>NOTE</p> <p>Calculate parameters for CDH, TPI and TPF. Delta V (TPI) and delta V (TPF) are computed. Delta V (TPI) is assumed to be single impulse. Midcourse and final correction are not allowed for.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. FL V06 N--</p> <p>GETI (CDH) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> <p>3. FL V06 N--</p> <p>Delta T transfer 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> <p>4. FL V06 N--</p> <p>GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> <p>FL V05N31 (Alarm)</p> <p>V32E Recyle.</p> <p>5. FL V06 N</p> <p>Delta V (CDH) XXXX.X fps ALT (CDH) XXXX.X NM Delta ALT (CDH) XXXX.X NM V33E</p> | <p>2. Record TIG (CDH) if different from MCC value.</p> <p>3. Record delta T transfer if different from MCC value.</p> <p>4. Record TIG (TPI) if different from MCC value.</p> <p>If alarm flashes, inform MCC.</p> <p>5. Record values.</p> | <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">NOTE</div> <p>4. If GETI (TPI) - GETI (CDH) < 10 minutes. FL V05 N31 R1 -----</p> <p>Program alarm, reset, Recycle V32E and define GETI (TPI)</p> <p>If hyperbolic LM velocity results, FL V05 N31 R1-----</p> <p>Program alarm reset, Recycle V32E and adjust parameters.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V06 N__</p> <p>Blank Blank HP (CDH) XXXX.X MN V33E</p> <p>7. FL V06 N__</p> <p>Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps V33E</p> <p>8. FL V16 N35</p> <p>TTI (CDH) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>9. FL V16 N__</p> <p>N 000XX. marks TTI (CDH) XXBXX min - sec</p> <p>Blank Check N increase 1/minute. Accept: V33E Reject: a. V32E</p> <p> b. V37E33E</p> <p>10. FL V16 N__</p> <p>N 000XX. marks TTI (CDH) XXBXX min - sec</p> <p>MGA XXX.XX deg V33E</p> | <p>6. Record value.</p> <p>7. Record value.</p> <p>9. Check maneuver parameters with MCC.</p> <p>10. EVENT TIMER/TIME CONT - STOP (momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MINS/TENS - Hold until * * minutes, then release. SLEW CONT/MINS/UNITS - Hold until * * minutes, then release. SLEW CONT/SECS/TENS - Hold until * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release.</p> | <p style="text-align: center;">NOTE</p> <p>9. Accept if TTI \geq 8 minutes. Reject if TTI < 8 minutes or if data are unsatisfactory:</p> <p>a. Recycle to step 02.</p> <p>b. Adjust input data.</p> <p style="text-align: center;">NOTE</p> <p>10. Set EVENT TIMER to future DSKY time. (time of EVENT TIMER start)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. FL V50 N07</p> <p>R1 00040 (Select Program) Select Propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42</p> | <p>TIMER CONT - START Record MGA value.</p> <p>Key into DEDA CLR, 410 + 20000, E (CDH Burn).</p> | <p>NOTE</p> <p>11. Consider in maneuver decision with MCC/CSM:</p> <ul style="list-style-type: none"> a. Magnitude of delta V. b. Status of propulsion equipment. c. Time or need to realign IMU. |
| <p>5. <u>LM-PRETHRUST TPI PROGRAM (P34).</u></p> | | |
| <p>1. Key V37E 34E</p> <p>2. FL V06 N--</p> <p>R1-0000X (TPI load option) R2-00001 - Load GETI (LGC com- puts E) or 00002 - Load E (LGC computes GETI) Accept: V33E Reject: Load data</p> | <p>1. Receive from MCC/CSM and record:</p> <p>TIG (TPI) E Delta T transfer</p> | <p>Calculate delta V required and other initial conditions for TPI given GETI (TPI) or E (TPI) and transfer duration.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. If 00001 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Reload data</p> <p>or if 00002 accepted:</p> <p>FL V06 N--</p> <p>R2-E (TPI) XXX.XX deg Accept: V33E Reject: Load data</p> <p>4. POSS FL V05 N31</p> <p>R1----- (GETI impossible)</p> <p>V32E - Load new E (TPI) or re-select P34 - Load new GETI</p> <p>5. FL V06 N--</p> <p>Delta T transfer 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Load data</p> <p>6. POSS FL V05 N31</p> <p>R1 ---- (Delta V too great)</p> <p>V32E - Load new delta T transfer</p> <p>7. If 00001 accepted:</p> <p>FL V06 N--</p> | <p>5. Key into DEDA CLR, <u>TBD</u> + XXXXXE (TIG within .1 minute desired fixed absolute time of TPI). CLR, <u>TBD</u> + XXX.XX (60 + .03 minute delta T transfer) Record delta T transfer readout if different from MCC value.</p> <p>6. If alarm flashes, communicate ALARM to MCC.</p> <p>7. Record value read out if different from MCC values.</p> | <p style="text-align: center;">NOTE</p> <p>6. Using MCC values should prevent this alarm.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>R2 - E (TPI) XXX.XX deg</p> <p>or if 00002 accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> <p>8. FL V06 N--</p> <p>Delta V (TPI) XXXX.X fps HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X fps</p> <p>V33E</p> <p>9. FL V06 N--</p> <p>TTI (TPI) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> <p>10. FL V16 N--</p> <p>N 000XX. marks TTI (TPI) XXBXX min - sec</p> <p>Check data with MCC. Check N increases 1/min. Accept: V33E (no later than TTI = 8 min.) Reject: If time permits recycle V32E (R02-IMU status check)</p> <p>11. FL V06 N--</p> <p>N 000XX. marks TTI (TPI) XXBXX min - sec</p> <p>MGA XXX.XX deg</p> <p>V33E</p> | <p>8. Record values.</p> <p>Key into DEDA CLR, <u>TBD</u>, READOUT (q1 1000 ft, predicted perigee TPI) Compare (q1 with HP)</p> | <p style="text-align: center;">NOTE</p> <p>8. NM must be converted into thousands of feet.</p> <p style="text-align: center;">NOTE</p> <p>10. RR is active.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. FL V50 N07</p> <p>R1 00040 (select program) Select propulsion system</p> <p>DPS - V37E40E RCS - V37E41E APS - V37E42E</p> <p>6. <u>LM - PRETHRUST TPM PROGRAM (P35).</u></p> | <p>11. EVENT TIMER/TIME CONT - STOP (momentary) RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes, then release. SLEW CONT/MIN/UNITS - Hold until * * minutes, then release. SLEW CONT/SECS/TENS - Hold until * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONT - START. Record N and MGA value used.</p> | <p>11. Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> <p>NOTE</p> <p>12. Consider in maneuver decision with MCC/CMS:</p> <p>a. Value of delta V. b. Status of propulsion equipment. c. Time available for IMU realignment.</p> <p>NOTE</p> <p>Calculate delta V required and initial conditions for next midcourse correction during active LM rendezvous. Display data for crew to enter P36 at correct time to complete thrust maneuver at first range gate.</p> |
| <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p>TT INT 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>V33E</p> | <p>2. Verify RR actively tracking CSM. EVENT TIMER/TIMER CONT - STOP (momentary). RESET/COUNT - RESET RESET/COUNT - DOWN SLEW CONT/MIN/TENS - Hold until * * minutes, then release. SLEW CONT/MIN/UNITS - Hold until * * minutes, then release.</p> | |

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| <p>3. FL V16 N _ _</p> <p>N 000XX. marks TT INT XXBXX min - sec</p> <p>Note time on MISSION TIMER, add 7 minutes. Result is TIG (MID), communicate to SE.</p> <p>4. FL V16 N _ _</p> <p>N 000XX. marks TTI (MID) XXBXX min - sec</p> <p>MGA V33E</p> <p>5. FL V16 N _ _</p> <p>Delta V (MID) XXXX.X fps TTI (MID) XXBXX min - sec Delta V (TPF) XXXX.X fps</p> <p>If midcourse correction is not required: V32E recycle to step 1. If midcourse correction burn is required: V33E</p> <p>6. FL V50 N07</p> <p>R1-00040 (Select program) Select propulsion system</p> <p>DPS - Select P40 RCS - Select P41 APS - Select P42</p> | <p>SLEW CONT/SECS/TENS - Hold until * * seconds, then release. SLEW CONT/SECS/UNITS - Hold until * * seconds, then release. TIMER CONT - START.</p> <p>4. Key into DEDA CLR, <u>TBD</u> + XXXX.X (TIG within .1 minutes of desired fixed absolute mid- course)</p> <p>Record values.</p> <p>5. Record values.</p> | <p>NOTE</p> <p>3. If TT INT < 20 minutes select P36.</p> <p>NOTE</p> <p>4. This assumes that no additional state vector updates are required.</p> <p>NOTE</p> <p>6. Consider in maneuver decision:</p> <p>a. Magnitude of delta V.</p> <p>b. Status of propulsion equipment.</p> <p>c. Time needed to realign IMU.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. <u>LM-APS PROGRAM (P42)</u></p> <p>1. Key V37E 42E.</p> <p>2. FL V06 N _____ R1 - IX R2 - IY/IZ R3 - W</p> <p>3. Verify DSKY values agree with MCC - supplied values Agree: V33E Disagree: V25E (enter desired values, V33E).</p> <p>4. FL V05 N _____ R1 - VGX (LV) R2 - VGY (LV) R3 - VGZ (LV)</p> <p>5. V33E</p> | <p>2. Communicate with MCC and receive the following data:</p> <p>(a) IX (b) IY/IZ (c) W (d) VGX (LV) (e) VGY (LV) (f) VGZ (LV)</p> <p>3. Verify PGNCs values agree with AGS on FDAI</p> <p>(a) FDAI - Observe pitch, roll, yaw angles (b) ATTITUDE MON switch - PGNS (c) FDAI - Observe pitch, roll, yaw angles (d) Values agree within 5°, ATTITUDE MON switch - AGS (e) Values do not agree within 5° (see Block L1-2, Task 23552)</p> | <p>NOTE</p> <p>2. (a) IX - moment of inertia about LM X axis (slug-ft sq) (b) IY/IZ - average moment of inertia about LM Y and Z axis (slug-ft sq) (c) W - total weight (lbs) (d) Geocentric velocity vector (e) Components (f ps). (f)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V06 N17</p> <p>R1 - Roll R2 - Pitch R3 - Yaw</p> <p>7. Compare propellant quantity with available supply.</p> <p>8. Evaluate for following:</p> <p>(a) is middle gimbal $< 45^\circ$ (b) is IMU alignment required (c) is IMU reorientation required</p> <p>9. Attitude requirements are</p> <p>(a) Acceptable (V33E) (b) IMU alignment required (V37E 51E) (c) IMU reorientation required (V37E 53E).</p> <p>10. If P51 or P53 (step 9(b) or 9(c) required, on completion V37E 42E.</p> <p>11. Attitude requirements acceptable.</p> <p>12. Monitor FDAI for LM orientation change:</p> <p>Pitch * Roll * Yaw *</p> | <p>6. Record displayed DSKY values. Communicate with MCC.</p> <p>(a) Maneuver attitude (b) Propellant quantities (c) MSFN coverage</p> <p>7. Communicate with MCC and verify propellant quantities.</p> <p>8. Communicate with MCC and determine</p> <p>(a) Need for IMU alignment (b) Need for IMU reorientation</p> <p>MCC determines that</p> <p>(a) Attitude requirements acceptable (proceed to step 9) (b) IMU alignment required (c) IMU reorientation required</p> <p>12. Key into DEDA</p> <p>CLR, 400 + 30,000 E (Align AGS to PGNCs) CLR, 400 + 10,000 E (Auto Submode)</p> | <p>12. NOTE</p> <p>Time constraint TIG -5 minutes</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 13. FL V50 N25 R1 - 000XX (Auto mode control) | 13. Verify following: GUID CONT switch - PGNS MODE CONTROL switch - AUTO | |
| 14. Key V33E | | |
| 15. FL V05 N31 R1 000XX (Ignition time) | 15. Inform CDR of time displayed on EVENT TIMER. | |
| 16. If ignition time = < 45 secs, V34E Key V37E 00E. | | 16. NOTE If ignition time is < 45 seconds, this still may be acceptable. |
| 17. If ignition time is acceptable Key V33E. | | |
| 18. Secure self and cabin for thrust. | 18. Secure self and cabin for thrust. Verify restrain cables on self and CDR are secured. | |
| 19. FL V06 N51 R1 - Time to ignition (TTI) R2 - Velocity gain magnitude from thrust (VG) R3 - Velocity measured magnitude (Δ VM) | 19. Update EVENT TIMER if required. Record VG. | |
| 20. MODE CONTROL switch - ATT HOLD. | | 20. NOTE On selecting ATT HOLD, the LGC does not control the thrust maneuver. The LGC is continually updated with position and velocity data. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>21. Verify the following switch positions:</p> <p>GUID CONT switch - PGNS DEAD BAND switch - MIN ATTITUDE CONTROL/ROLL switch - MODE CONT ATTITUDE CONTROL/PITCH switch - MODE CONT ATTITUDE CONTROL/YAW switch - MODE CONT SHFT/TRUN χ switch - $\pm 50^\circ$ RNG/ALT MON switch - RNG/RNG RT</p> <p>22. Set deadband to 0.3°</p> <p>Key V <u> </u> E N <u> </u> E</p> <p>XX <u> </u> <u> </u> E</p> <p>23. RATE/ERR MON switch - LDG RDR/CMPTR.</p> <p>24. Verify the following switch positions:</p> <p>ATTITUDE MON switch - PGNS SHFT/TRUN χ switch - $\pm 50^\circ$ X-POINTER SCALE switch - HI MULT HI MULT GUID CONT switch - PGNS MODE SEL switch - AGS RNG/ALT MON switch - RNG/RNG RT X-TRANSL switch - 4 JETS BAL CPL switch - ON DEAD BAND switch - MIN</p> | <p>23. RATE/ERR MON switch - LDG RDR/CMPTR.</p> <p>24. Verify the following switch positions:</p> <p>ATTITUDE MON switch - AGS X-POINTER SCALE switch - HI MULT O₂/H₂O QTY MON switch - ASC 1 RES TEMP/PRESS MON switch - ASC HELIUM MON switch - ASC/PRESS POWER/TEMP MON switch - CDR BUS Throttle/Jets Select Control Lever - Jets</p> | <p>NOTE</p> <p>RR use during APS thrusting depends on LM position relative to the CSM. Nominally, it is suggested RR be turned off and actuated after APS thrusting when a LOS with CSM transponder is re-established.</p> <p>NOTE</p> <p>It is assumed that APS was pressurized during the FITH Block (L25-2). A manual pressurization capability is available.</p> <p>Exact DSKY operation to be provided at a later date.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>24. (cont)</p> <p>ATTITUDE CONTROL/ROLL switch - MODE CONT ATTITUDE CONTROL/PITCH switch - MODE CONT ATTITUDE CONTROL/YAW switch - MODE CONT. MODE CONTROL switch - ATT HOLD Throttle/Jets select control lever - Jets</p> <p>25. Key V37E 47E POSS FL V50 N07 R1 00005 (PGNCS start up) V37E 05E POSS FL V50 N07 R1 00005 R1 00051 (IMU orientation determination) V37E 51E</p> <p>26. FL V16 N __ Delta VX Delta VY Delta VZ</p> <p>27. Verify TIG, TTI, and TG with MCC.</p> <p>28. Receive MCC verification.</p> <p>29. Verify MASTER ARM switch - ON ENG ARM - DES</p> | <p>27. Communicate event time to CDR.</p> <p>28. Update EVENT TIMER as required.</p> | <p style="text-align: center;">NOTE</p> <p>Non PGNCS controlled thrust monitor must be chosen at least one minute before maneuver.</p> <p>R_1, R_2, R_3, initially zero. During maneuver updated every 8 seconds.</p> <p>Update required only if MCC differs with EVENT TIMER value.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>30. Azimuth Los rate * *</p> <p>Elevation Los rate * *</p> <p>FDAI attitude error - iu deadband</p> <p>FDAI attitude Rates -</p> <p>* * deg/sec</p> <p>FDAI pitch - * * deg</p> <p>FDAI roll and Yaw - stable.</p> <p>31. Receive values of delta VX, VY, and VZ at end of maneuver from MCC.</p> | <p>30. Verify following warning lights are extinguished:</p> <p>ADC PRESS</p> <p>DES REG</p> <p>DES QTY</p> <p>CES AC</p> <p>CES DC</p> <p>AGS</p> <p>LGC</p> <p>ISS</p> <p>RCS TCA</p> <p>RCS A REG</p> <p>RCS B REG</p> <p>DC BUS</p> <p>CABIN</p> <p>SUIT/FAN</p> <p>31. Verify the following caution lights are extinguished:</p> <p>ASC HI REG</p> <p>ASC QTY</p> <p>ENG GMBL</p> <p>PGNS</p> <p>INVERTER</p> <p>BATTERY</p> <p>RNDZ RDR</p> <p>LDG RDR</p> <p>PRE AMPS</p> <p>RCS</p> <p>HEATER</p> <p>C/W PWR</p> <p>ECS</p> <p>O₂ QTY</p> <p>GLYCOL</p> <p>WATER QTY</p> | <p>NOTE</p> <p>If IMU is oriented to body axes and thrust attitude is held constant, all velocity changes will be along LM X-body axis.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>32. Communicate to MCC go ahead of maneuver.</p> <p>33. Monitor Event Timer.</p> <p>34. +X AXIS translation switch - press IN and HOLD TIG - 7.5 SECS</p> <p>35. V16 N __ Delta VX Delta VY Delta VZ</p> | <p>32. Verify MAIN PROPULSION/FUEL/OXID/TEMP meter - In green band MAIN PROPULSION/OXID PRESS METER - Aligned REACTION CONTROL A/B TEMP METER - In green band REACTION CONTROL A/B PRESS Meter - Aligned CONTROL ENVIRONMENTAL SUIT/CABIN PRESS meter - In green band CONTROL ENVIRONMENTAL PART PRESS CO₂ meter - In green band CONTROL ENVIRONMENTAL GLYCOL/TEMP/PRESS meter - In green band</p> <p>33. Monitor EVENT TIMER count down from TIG -10 seconds. Verify RCS Jets firing via sound, vibration, and acceleration.</p> | <p>NOTE Delta V should read greater than + zero.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>42. EVENT TIMER - * minutes, * seconds</p> <p>V 16 N _ _</p> <p>Delta VX - * *</p> <p>Delta VY - * *</p> <p>Delta VZ - * *</p> <p>Eng Stop - Press in</p> <p>43. T/W meters - 0 determine engine/shut off via sound and vibration.</p> <p>ENG ARM switch - OFF</p> <p>MASTER ARM switch - OFF</p> <p>V16 N _ _</p> <p>Delta VX</p> <p>Delta VY</p> <p>Delta VZ</p> | <p>41. Repeat steps 30, 31, and 32 - Add</p> <p>DES OXID - * * %</p> <p>DES FUEL - * * %</p> <p>DES HEL - * * PSIA</p> <p>Verify the following:</p> <p>REACTION/CONTROL/QUANTITY meter - XX %</p> <p>ELECTRICAL POWER/POWER/ TEMP MON switch - CDR BUS</p> <p>VOLTS/meter - > 26.5 vdc</p> <p>ELECTRICAL POWER/POWER/TEMP MON switch - SE BUS</p> <p>VOLTS meter - > 26.5 vdc</p> <p>ELECTRICAL POWER/POWER/TEMP MON switch - AC BUS</p> <p>VOLTS meter - In green band</p> <p>ELECTRICAL POWER/POWER/TEMP MON switch - BASS 1-6</p> <p>VOLTS meter - 28 vdc</p> <p>AMPS meter - ** amps</p> <p>ELECTRICAL POWER/POWER/TEMP MON switch - CDR BUS</p> <p>42. Count down from 10 seconds to engine shutdown.</p> <p>When EVENT TIMER - * minutes, seconds, COMMUNICATE "mark"</p> <p>Eng Stop - Press in</p> <p>43. EVENT TIMER RESET/COUNT - RESET (Momentary)</p> <p>Communicate Delta V values to MCC.</p> | <p style="text-align: center;">NOTE</p> <p>42. S. E. only if possible.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>44. Consider RCS trim maneuver.</p> <p>Accept - Proceed to step 45. Reject - V37E00E</p> <p>45. Drive to Zero</p> <p>Delta VY Delta VZ</p> <p>Using TTCH</p> <p>V16 N--</p> <p>Delta VX * *</p> <p>Delta VY * 0 *</p> <p>Delta VZ * 0 *</p> <p>Satisfied - V37E00E Unsatisfied - Repeat step 45.</p> | <p>44. Observe pitch, roll and yaw on FDAI.</p> <p>ATTITUDE MON switch - PGNCS.</p> <p>Observe pitch, roll and yaw on FDAI within $\pm 5^\circ$ of former</p> <p>ATTITUDE MON switch - AGS.</p> <p>46. Orbital data available from MCC.</p> <p>Compare DELTA VX on DSKY with VG on DEDA. Record final delta VX and VG values. Key into Deda (Read out Perigee) CLR, 343, READOUT. Record Perigee. Key into Deda CLR, 400 + 10,000 E (AUTO Submode).</p> | <p style="text-align: center;">NOTE</p> <p>44. Consider the following:</p> <p>(a) IMU alignment and orientation</p> <p>(b) Magnitude of delta V on DSKY</p> <p>(c) VG</p> <p>(d) Duration of burn.</p> <p style="text-align: center;">NOTE</p> <p>45. TTCA left or right for VY; fore or aft for VZ.</p> <p>DELTA VX should change * \pm *.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. <u>POST THRUST EVALUATION</u></p> <p>1. Mode Control switch - AUTO.</p> <p>2. R30 (Orbital parameter routine)</p> <p>3. FL V06 N43</p> <p>Apogee alt XXXX. X NM Perigee alt XXXX. X NM TFF XXBXX min-sec</p> <p>V33E</p> <p>4. Poss FL V06 N35</p> <p>T Perigee</p> <p>00XXX. hrs 000XX. min 0XX. XX secs</p> <p>V33E</p> <p>5. FL V50 N07</p> <p>R1 00000</p> <p>V37E00E</p> <p>6.</p> <p>Key V37E25E</p> | <p>2. Receive following trajectory data from MCC:</p> <p>Perigee Apogee Time to free fall Total (Sensed Velocity) Time to go to perigee</p> <p>3. Record values if different from MCC values.</p> <p>4. Record value of T perigee.</p> <p>5. Verify LM safe orbit.</p> <p>6. Receive request from CSM for tracking attitude.</p> | <p>NOTE</p> <p>2. The orbital parameter routine may also be entered by Key V64E, though it is normally entered automatically after a thrust program.</p> <p>Time to free fall to 300,000 ft above launch pad radius.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | | | |
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| <p>7. Monitor FDAI</p> <p>Pitch * *</p> <p>Roll * *</p> <p>Yaw * *</p> | <p>7. EXTERIOR LTG switch - (See note)</p> | <div>NOTE</div> <p>7. (a) When the LM is tracked by CSM without the use of the Scanning Telescope, the following applies:</p> <table><tr><td></td><td>EXTERIOR LTG</td></tr><tr><td>LM-CBM Range</td><td>Switch -</td></tr><tr><td>1500 ft to < 10 NM</td><td>DIM</td></tr><tr><td>10 NM to < 130 NM</td><td>BRIGHT</td></tr></table> <p>(b) The CSM Crewman using the Scanning Telescope, the following applies:</p> <table><tr><td></td><td>EXTERIOR LTG</td></tr><tr><td>LM-CSM Range</td><td>Switch -</td></tr><tr><td>1500 ft to < 130 NM</td><td>DIM</td></tr><tr><td>130 NM to < 400 NM</td><td>BRIGHT</td></tr></table> | | EXTERIOR LTG | LM-CBM Range | Switch - | 1500 ft to < 10 NM | DIM | 10 NM to < 130 NM | BRIGHT | | EXTERIOR LTG | LM-CSM Range | Switch - | 1500 ft to < 130 NM | DIM | 130 NM to < 400 NM | BRIGHT |
| | EXTERIOR LTG | | | | | | | | | | | | | | | | | |
| LM-CBM Range | Switch - | | | | | | | | | | | | | | | | | |
| 1500 ft to < 10 NM | DIM | | | | | | | | | | | | | | | | | |
| 10 NM to < 130 NM | BRIGHT | | | | | | | | | | | | | | | | | |
| | EXTERIOR LTG | | | | | | | | | | | | | | | | | |
| LM-CSM Range | Switch - | | | | | | | | | | | | | | | | | |
| 1500 ft to < 130 NM | DIM | | | | | | | | | | | | | | | | | |
| 130 NM to < 400 NM | BRIGHT | | | | | | | | | | | | | | | | | |
| <p>8. Azimuth LOS rate - * * MRAD/SEC</p> <p>Elevation rate - * * MRAD/SEC</p> <p>FDAI attitude error - Within deadband</p> <p>ATTITUDE RATES - *Zero ± * deg/sec.</p> <p>FDAI pitch - * * deg.</p> <p>FDAI roll and yaw - STABLE.</p> | <p>8. Verify CSM is locked and tracking the LM,</p> <p>9. Verify the following warning lights are extinguished:</p> <p>ASC PRESS</p> <p>DES REG</p> <p>DES QTY</p> <p>CES AC</p> <p>CES DC</p> <p>AGS</p> <p>LGC</p> <p>ISS</p> <p>RCS TCA</p> <p>RCS A REG</p> <p>RCS B REG</p> <p>DC BUS</p> <p>CABIN</p> <p>SUIT/FAN</p> | | | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>Verify the following caution lights are extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O2 QTY GLYCOL WATER QTY</p> <p>11. Verify the following meter indications:</p> <p>MAIN PROPULSION/TEMP - FUEL at **°F MAIN PROPULSION/TEMP - OXID at **°F MAIN PROPULSION/PRESS - FUEL/ OXID, aligned REACTION CONTROL/TEMP - A and B, within green band REACTION CONTROL/PRESS - B/B, aligned ENVIRONMENTAL CONTROL/PRESS - SUIT and CABIN within green band ENVIRONMENTAL CONTROL/PART PRESS CO2 - Within green band ENVIRONMENTAL CONTROL/GLYCOL /TEMP - Within green band ENVIRONMENTAL CONTROL/GLYCOL /PRESS - Within green band</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Receive optical tracking trajector data from CSM.</p> <p>13. R/D TLM CALIB RATE switch - ON (hold for 12 seconds).</p> <p>14. Prepare for next maneuver.</p> | <p>12. Record optical tracking data. Compare MCC, CSM, DEDA, and LGC trajector values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>4. SLEW CONT/MIN - TENS/UNITS (until minutes displayed on EVENT TIMER)</p> <p>5. SLEW CONT/SEC - TENS/UNITS (until seconds displayed on EVENT TIMER)</p> <p>6. TIMER CONT - START</p> | |
| 3. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATE VECTORS.</u> | <p>1. Key into DEDA - CLR, 414 + 10000, E</p> <p>2. Key into DSKY - V37E02E</p> <p>3. FL V05 N25 R1 00 XXX</p> <p>REJECT: V33E</p> <p>4. FL V06 N--</p> <p>R1 HRS, R2 MIN, R3 CENTI SECS (K CORRECTION)</p> <p>V 33E</p> <p>5. P20 (END)</p> <p>OR</p> <p>FL V50 N07 R1 00000</p> <p>V37E 00E (END)</p> <p>6. Load orbit insertion targeting data in DEDA.</p> <p>Load orbit insertion targeted insertion altitude, radius rate, horizontal velocity, Delta two desired time of CSE maneuver, TPI.</p> | 6. Addresses to be determined. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. Communicate attitude angles from FDAI</p> <p>12. Key into DSKY</p> <p style="padding-left: 20px;">V37E 47E</p> <p style="padding-left: 20px;">FL V16 N - -</p> <p style="padding-left: 20px;">R1 XXXX. X</p> <p style="padding-left: 20px;">R2 XXXX. X</p> <p style="padding-left: 20px;">R3 XXXX. X</p> <p>13. DEADBAND switch - MIN</p> <p>14. Monitor EVENT TIMER - two minutes</p> <p>15. GUID CONT switch - AGS</p> <p>17. ABORT STAGE switch (approx 60 SEC prior to desired thrust time).</p> <p style="padding-left: 20px;">Verify throttle/jets control - jets</p> <p style="padding-left: 20px;">Verify X TRANSL SW - 4 JETS</p> <p style="padding-left: 20px;">Monitor FDAI - no rotation</p> <p style="padding-left: 20px;">Monitor EVENT TIMER - 6 JETS before thrusting time.</p> | <p>7. CLR, 410 + 00000, VCE, E</p> <p>8. CLR, 400 + 10000, VCE, E monitor EVENT TIMER for .05 min-00 SEC</p> <p>9. CLR, 400 + 30000, VCE, E key into DEDA</p> <p>10. CLR 400 + 0000, VCE, E</p> <p>11. Listen to attitude angles and respond according to agreement</p> <p>16. Key into DEDA; CLR, ADDRESS, VCE, R (DELTA V SUB GX)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. <u>AGS FITH WITH RCS/APS PROPELLANT INTERCONNECTED.</u></p> <p>1. +X Thrust/Translation Controller Maneuver</p> <p>2. Verify engine ignition</p> <p>3. Verify staging</p> <p>4. ENGINE THRUST COND switch BAL CPL - OFF (after *10* SEC of APS ring)</p> | <p>2. EVENT TIMER/RESET/COUNT-UP</p> <p>5. Ten seconds after ignition, set the following REACTION CONTROL switches:</p> <p>SYSTEM A/ASC FEED switch - OPEN</p> <p>SYSTEM A/ ASC FEED status flag - GREY</p> <p>SYSTEM A/ MAIN SOV switch - CLOSE</p> <p>SYSTEM A/ MAIN SOV status flag - BARBER POLE</p> <p>SYSTEM B/ ASC FEED switch - OPEN</p> <p>SYSTEM B/ ASC FEED status flag - GREY</p> <p>SYSTEM B/ MAIN SOV switch - CLOSE</p> <p>SYSTEM B/ MAIN SOV status flag - BARBER POLE CRSFD switch - OPEN CRSFD status flag - GREY</p> <p>6. Communicate and notify MSFN/CSM of FITH and staging.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 9. Verify - stable. | 7. Monitor delta V sub GX | |
| 10. Monitor EVENT TIMER. | 8. FL V16 N - - R1 XXXXX R2 XXXXX R3 XXXXX | |
| 11. Monitor X-pointer for zero lateral velocity, * + - * fps and * * forward velocity. | | NOTE |
| 12. Monitor FDAI attitude error - within deadband. | | Forward velocity is measured only if the mode SEL switch is set to PGNS. |
| 13. Monitor FDAI for zero attitude rates or * + or - deg/sec. | | |
| 14. Monitor FDAI pitch angle is * * to * * deg. | | |
| 15. Monitor FDAI roll and yaw angles are ZERO or * * to * * deg. | | |
| 16. Monitor T/W indicator is * * lunar G'S. | | |
| | 17. Monitor EVENT TIMER. | |
| | 18. Monitor X-poiinter for zero lateral velocity, * + * fps and * * forward velocity. | NOTE |
| | 19. Monitor for attitude error - within deadband. | Forward velocity is measured only if the mode SEL switch is in PGNS. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>20. Monitor FDAI for zero attitude rates or * + or - deg/sec.</p> <p>21. Monitor FDAI pitch angle is * * to * * deg.</p> <p>22. Monitor FDAI roll and yaw angles are zero or * * to * * deg.</p> <p>23. Monitor T/W indicator is * * lunar G'S.</p> <p>24. Twenty seconds before engine burn-out, set the following REACTION CONTROL switches:</p> <p>CRSFD switch - CLOSE.</p> <p>CRSFD status flag - BARBER POLE</p> <p>SYSTEM B/MAIN SOV switch - OPEN</p> <p>SYSTEM B/MAIN SOV status flag - GREY</p> <p>SYSTEM B/ASC FEED switch - CLOSE</p> <p>SYSTEM B/ASC FEED status flag - BARBER POLE</p> <p>SYSTEM A/MAIN SOV switch - OPEN</p> <p>SYSTEM A/MAIN SOV status flag - GREY</p> <p>SYSTEM A/ASC FEED switch - CLOSE</p> <p>SYSTEM A/ASC FEED status flag - BARBER POLE</p> | <p>NOTE</p> <p>Repeat steps 5, 6, 7, 8 until 10 seconds to engine burn out.</p> <p>NOTE</p> <p>Precalculate delta V sub GX 20-second valve.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 25. ENGINE THRUST CONT/BAL CPL switch - ON. | <p>26. STAB/CONT/ MODE CONTROL switch ATT HOLD.</p> <p>27. Verify throttle/jets control select lever - jets.</p> <p>Null out delta V residuals for each axis (Y, Z, and X in sequence).</p> <p>Read out respective delta V sub G - component and address, VCE, R.</p> <p>28. Operate translation controller until delta V displayed is nulled out.</p> <p>29. STAB/CONT/DEAD BAND switch - MAX.</p> <p>30. Proceed event 6, POST AGS FITH.</p> | Burnout completed. |
| 5. <u>AGS FITH WITHOUT RCS/APS PROPELLANT INTERCONNECTED</u> | | |
| <p>1. +X Thrust/Translation Controller - Maneuver</p> <p>2. Verify engine ignition</p> <p>3. Verify staging</p> <p>4. ENGINE THRUST CONT/BAL CPL switch - OFF (After * 10 * sec of APS firing.</p> | <p>2. EVENT TIMER/RESET/COUNT-UP</p> <p>5. Communicate and notify MSFN/CSM of FITH and staging.</p> <p>6. Monitor delta V sub GX</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. Verify FDAI - stable.</p> <p>9. Monitor EVENT TIMER.</p> <p>10. Monitor X-pointer for zero lateral velocity, * + - * fps and * * forward velocity.</p> <p>11. Monitor FDAI attitude error ____ within deadband.</p> <p>12. Monitor FDAI for zero attitude rates or * + or - deg/sec *.</p> <p>13. Monitor FDAI pitch angle is * * to * * deg.</p> <p>14. Monitor FDAI roll and yaw angles are zero or * * to * * deg.</p> <p>15. Monitor T/W indicator is * * lunar G'S.</p> | <p>7. FL V16 N - -</p> <p>R1 XXXXX</p> <p>R2 XXXXX</p> <p>R3 XXXXX</p> <p>16. MONITOR EVENT TIMER.</p> <p>17. Monitor X-pointer for zero lateral velocity, *+ - * fps and * * forward velocity.</p> <p>18. Monitor for attitude error-within deadband.</p> <p>19. Monitor FDAI for zero attitude rates or * + or - deg/sec *.</p> <p>20. Monitor FDAI pitch angle is * * to * * deg.</p> | <p>NOTE</p> <p>Forward velocity is measured only if the MODE SEL switch is set to PGNS.</p> <p>NOTE</p> <p>Forward velocity is measured only if the MODE SEL switch set to PGNS.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>23. ENGINE THRUST CONT/BAL CPL switch - ON.</p> <p>6. <u>POST AGS FITH.</u></p> <p>1. STAB/CONT/DEAD BAND switch - MAX.</p> <p>2. V37E 00E.</p> | <p>21. Monitor FDAI roll and yaw angles are zero or * * to * * deg.</p> <p>22. Monitor T/W indicator is * * lunar G'S.</p> <p>24. STAB/CONT/MODE CONTROL - switch ATT HOLD.</p> <p>25. Verify throttle/jets control select lever-jets.</p> <p>Null out delta V residuals for each axis (Y, Z, AND X in sequence).</p> <p>Read out respective delta V SUB T - component CLR, address, VCE, R.</p> <p>26. Operate translation controller until displayed delta is nulled out.</p> <p>27. STAB/CONT/DEAD BAND switch - MAX.</p> <p>28. Proceed event 6, to POST AGS FITH.</p> | <p style="text-align: center;">NOTE</p> <p>Repeat steps 4, 5, 6, 7 until 10 seconds to engine burn out.</p> <p>Burnout completed.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 8. ABORT STAGE switch - depress (to reset). | <p>3. Monitor EVENT TIMER.</p> <p>4. Monitor X-pointer - azimuth LOS * + or - 0.7*. M rad/sec and elevation LOS rate * or - 5.0 * M rad/sec (PER FLIGHT PLAN).</p> <p>5. Monitor FDAI attitude error - within dead band.</p> <p>6. Monitor FDAI - zero attitude rates * + or - degrees/sec*.</p> <p>7. Monitor FDAI pitch angle - appropriate interval for mission phase * to degrees *. Verify FDAI roll and yaw angles - stable.</p> <p>9. Verify following warning lights are extinguished.</p> <p>ASC PRESS</p> <p>DES REG</p> <p>DES QTY</p> <p>CES AC</p> <p>CES DC</p> <p>AGS</p> <p>LGC</p> <p>ISS</p> <p>RCS TCA</p> <p>RCS A REG</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>RCS B REG</p> <p>DC BUS</p> <p>CABIN</p> <p>SUIT/FAN</p> <p>10. Verify following caution lights are extinguished:</p> <p>ASC HI REG</p> <p>ASC QTY</p> <p>ENG GMBL</p> <p>PGNS</p> <p>INVERTER</p> <p>BATTERY</p> <p>RNDZ RDR</p> <p>LDG RDR</p> <p>PRE AMPS</p> <p>RCS</p> <p>HEATER</p> <p>C/W PWR</p> <p>ECS</p> <p>O₂ QTY</p> <p>GLYCOL</p> <p>WATER QTY</p> <p>11. Verify TEMP meter (FUEL and OXID) - within green bands.</p> <p>12. Verify PRESS meter (FUEL and OXID) - pointers aligned.</p> <p>13. Verify REACTION CONTROL/TEMP meter (A and B) - within green bands.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 18. GUID CONT switch - PGNS. | <p>14. Verify REACTION CONTROL/PRESS meter (A and B) - pointers aligned.</p> <p>15. Verify ENVIRONMENTAL CONTROL PRESS meter (SUIT and CABIN) - within green band.</p> <p>16. Verify ENVIRONMENTAL CONTROL/PART PRESS CO₂ meter - within green band.</p> <p>17. Verify ENVIRONMENTAL CONTROL/GLYCOL/TEMP and PRESS meter - within green band.</p> <p>19. Verify REACTION CONTROL status flags as follows:</p> <p>SYSTEM A</p> <p>MAIN SOV - GRAY</p> <p>ASC FEED - BARBER POLE</p> <p>THRUSTER PAIR</p> <p>QUAD 1 - GRAY</p> <p>QUAD 2 - GRAY</p> <p>QUAD 3 - GRAY</p> <p>QUAD 4 - GRAY</p> <p>SYSTEM B</p> <p>MAIN SOV - GRAY</p> <p>ASC FEED - BARBER POLE</p> <p>THRUSTER PAIR</p> <p>QUAD 1 - GRAY</p> <p>QUAD 2 - GRAY</p> <p>QUAD 3 - GRAY</p> <p>QUAD 4 - GRAY</p> <p>CRSFD - BARBER POLE</p> | |
| 20. Monitor FDAI - Stable. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p><u>JL1-2 DOCKED IMU ALIGNMENT</u></p> <p>1. <u>IMU ORIENTATION DETERMINATION (P51)</u></p> <p>1. Key V37E 51E.</p> <p>2. FL V50 N25 R1-00015 (Star Acquisition).</p> <p>3. Communicate with CSM to determine altitude compatible with separation or SPS back-up to avoid gimbal lock in LM or CSM.</p> <p>4. Communicate and request CSM to relinquish altitude control.</p> <p>5. MODE CONTROL switch - position.</p> <p>6. AOT azimuth control - Desired detent position.</p> <p>7. PENS/AOT LAMP CB (AC) - press.</p> <p>8. Step onto floor-mounted PLSS.</p> <p>9. Operate AOT reticle illumination control for desired light intensity.</p> <p>10. Operate AOT reticle control until AOT counter indicates 000.0°.</p> <p>11. Orient LM to desired altitude (based on CSM and AOT data) with Altitude Controller.</p> <p>12. Two navigation stars are in AOT field-of-view.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. Key V33E</p> <p>14. FL V41 N20</p> <p style="padding-left: 40px;">R1 00000 R2 00000 R3 00000</p> <p>15. (R50 - Coarse align CDU and IMU to body axes)</p> <p>16. Verify that DSKY NO ATT light is on during coarse align.</p> <p>17. Coarse align completed, DSKY NO ATT light out.</p> <p>18. FL V21 N . (Load star and AOT detent codes in R1 and R2, respectively).</p> <p>19. Refer to star map (flight data kit); identify star in AOT (obtain star code number from star catalog).</p> <p>20. KEY star code number, E.</p> <p>21. KEY AOT detent code E.</p> <p>22. Verify V21 N stops flashing.</p> <p>23. FL V53.</p> <p>24. Verify AOT counter is still 000.0°.</p> <p>25. Key V (DAP pulse mode).</p> <p>26. Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>27. Operate Altitude Controller bringing the selected star across the X or Y reticle.</p> | | <p>13. This step is optional, but desirable, if not used, KEY ENTR in place of V33E.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>28. Selected star crosses X or Y reticle.</p> <p>29. Mark X or Y pushbutton - depress.</p> <p>30. FL V51 (Mark X) or V52 (Mark Y).</p> <p>31. Verify AOT counter is 000.0°.</p> <p>32. Operate Attitude Controller bringing the selected star across the X or Y reticle.</p> <p>33. Selected star crosses X or Y reticle.</p> <p>34. Mark X or Y pushbutton - depress.</p> <p>35. FL V50 N25 R1-00016 (terminate marks request).</p> <p>36. a. Decide to terminate marks, depress ENTR.</p> <p>b. Decide to continue pairs of marks, Key V33E and repeat steps 23 through 35.</p> <p>37. First star sighting completed.</p> <p>38. Repeat steps 18 through 36 for second star sighting.</p> <p>39. Second star sighting completed.</p> <p>40. FL V06 N05</p> <p>R1 - XXX.XX (Star angle difference).</p> | | <p>29. NOTE</p> <p>If mark is not satisfactorily executed, depress Mark R pushbutton (rejects marked position). Repeat steps 27, 28, and 29.</p> <p>34. See above NOTE</p> <p>NOTE</p> <p>If, at any time, a better star marking is desirable, Key V32E and repeat steps 18 through 35.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>41. a. FL V06 (10 seconds) (Good data, angle $> 0.05^\circ$).</p> <p>b. FL V06 N 05 (Bad data, angle $> 0.05^\circ$).</p> <p>42. P 00.</p> <p>43. Rotate AOT azimuth control to CL detent.</p> <p>44. Descend from floor-mounted PS SS.</p> <p>45. STAB/CONT/MODE CONTROL switch - OFF.</p> <p>46. Communicate with CSM requesting CSM resume attitude control.</p> <p>47. PGNS/AOT LAMP (AC) CB - OPEN.</p> <p>48. IMU orientation completed.</p> | | <p>NOTE</p> <p>41. Good data, LGC returns to previous program on routine.</p> <p>NOTE</p> <p>LGC determines present IMU angles referenced to LM, then determines IMU inertial angles referenced to celestial coordinates. These data are stored as the Reference Stable Member Matrix (REFSMAT) and the LGC internally sets the "orientation known" flag and terminates Program 51.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>LM-IMU REALIGN PROGRAM (P52)</u></p> | | |
| <p>1. Key V37E 52E.</p> <p>2. POSS FL V50 N07 R1-00005 (PGNCS startup) V37E 05E</p> <p>3. FL V06 N-- R1-000--option code for assumed IMU orientation R2-000X LGC assumed option: 00001 preferred 00002 nominal 00003 REFSMMAT</p> <p>Accept: V33E Reject: Load desired option. Select: Nominal V32E or Preferred V37E --E (Program to define preferred IMU orientation).</p> <p>4. POSS FL V06 N-- (Nominal selected) T (Align) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: Load desired T (Align)</p> <p>5. FL V06 N 17 (Gimbal Angles) Roll, Pitch, Yaw XXX.XX Deg Check MGA Accept: V33E Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> | | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">NOTE</div> <p>POSS FL V05 N31 R1-000--- (preferred IMU not specified)</p> <p>5. Request CSM relinquish attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. (cont)</p> <p>Reject: Maneuver using attitude controller or select new program.</p> <p>(R50 - Coarse Align)</p> <p>6. Wait -- seconds for completion of coarse alignment.</p> <p>7. PGNS/AOT LAMP (AC) CB - press.</p> <p>8. Ascend floor-mounted PLSS.</p> <p>9. AOT azimuth control - To desired detent.</p> <p>10. Operate AOT reticle illumination control for desired light intensity.</p> <p>11. Operate AOT reticle control until AOT counter indicates 000.0°.</p> <p>12. POSS FL V05 N31 (two stars not available in AOT).</p> <p>R1-000--</p> <p>Bypass R56</p> <p>Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>Maneuver to acquire stars, V33E.</p> <p>or</p> <p>Repeat R56</p> <p>Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>(R51 - fine align.)</p> | <p>12. Monitor FDAI to avoid gimbal lock.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>13. FL V06 N30</p> <p>R1 00XX (Star Code) R2 0000X (Detent Code)</p> <p>Accept: V33E</p> <p>Reject: Repeat steps 6 through 12.</p> <p>14. AOT Azimuth Control - Appropriate detent position.</p> <p>15. FL V50 (please perform) checklist item number --.</p> <p>GUID CONTROL switch - PGNS. STAB/CONT/MODE control switch - AUTO.</p> <p>enter</p> <p>or</p> <p>STAB/CONT/MODE control switch - ATT HOLD. V33E</p> <p>Proceed to step 18.</p> <p>16. FL V06 N17 (gimbal angles)</p> <p>R1 XXX.XX R2 XXX.XX R3 XXX.XX</p> <p>17. Proceed to step 19.</p> <p>18. Maneuver using attitude controller.</p> <p>19. FL V50 N25 R1 00007 (Attitude trim maneuver)</p> <p>Accept: Proceed to step 20. Reject: Maneuver using attitude controller.</p> | <p>18. Monitor FDAI to avoid gimbal lock.</p> | <p>NOTE</p> <p>If under control of preferred tracking attitude routine proceed to step 17.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>20.</p> <p>a. AUTO TRIM (option) GUID CONT switch - PGNS. STAB/CONT/MODE CONTROL switch - AUTO.</p> <p>b. No AUTO TRIM (option) V33E Repeat sequence from step 18.</p> <p>21. FL V21 N--</p> <p>22. Load -- star code and AOT detent.</p> <p>23. FL V53 (please mark). Verify AOT reticle counter - 000.0°.</p> <p>24. Load V--E (DAP pulse mode) Verify STAB/CONT/MODE CONTROL switch - ATT HOLD.</p> <p>25. Maneuver using attitude controller.</p> <p>26. Mark X or Y. Accept: Enter. Reject: Mark reject, repeat steps 24 and 25.</p> <p>27. FL V51 or FL 52 Verify: AOT reticle counter - 000.0°.</p> <p>28. Maneuver using attitude controller.</p> <p>29. Mark Y or X. Accept: Center Reject: Mark reject Repeat steps 27 and 28.</p> | | <p>26. NOTE</p> <p>An unsatisfactory mark may be rejected by pressing mark reject (R) any time prior to terminating the marking sequence. Possible program alarm is mark reject is depressed without prior mark or if a surplus mark is entered.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>30. FL V50 H25 R1-000 16 (Terminate Marks)</p> <p>Accept: Enter Reject: V33E</p> <p>Repeat sequence from step 22.</p> <p>31. FL V06 N30</p> <p>R1 - 000.XX (star code) R2 - 000.0X (Detent Code)</p> <p>Accept: V33E Reject: V21E</p> <p>Repeat step 31.</p> <p>32. AOT azimuth control - appropriate detent position. If under control of preferred tracking attitude routine, proceed to step 35.</p> <p>33. FL V50 N 25 R1-00-- GUID CONT switch - PGNS. STAB/CONT/MODE CONTROL switch - AUTO.</p> <p>enter</p> <p>or</p> <p>STAB/CONT/MODE control switch - ATT HOLD.</p> <p>V33E (proceed to step 36).</p> <p>34. FL V06 N17 (gimbal angles)</p> <p>R1 - XXX.XX R2 - XXX.XX R3 - XXX.XX</p> <p>35. Observe attitude maneuvers on FDAI.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>36. Maneuver using attitude controller.</p> <p>37. FL V50 N25 R1-00007 (Attitude Trim maneuver)</p> <p>Accept: V33E Reject: Repeat steps 33 through 37.</p> <p>38. FL V21 N __</p> <p>Load star code, AOT detent.</p> <p>39. FL V53</p> <p>Verify AOT reticle counter - 000.0° V __ E (DAP pulse mode) Verify STAB/CONT/MODE control switch - ATT HOLD.</p> <p>40. Maneuver using attitude controller.</p> <p>Mark X or Y. Accept: Enter Reject: Mark reject. Repeat step 39 above.</p> <p>41. FL V51 or V52</p> <p>Verify AOT reticle counter - 000.0°</p> <p>42. Maneuver using attitude controller</p> <p>Mark Y or X Accept: Enter Reject: Mark reject. Repeat step 41.</p> <p>43. FL V50 N25 R1 00016. Terminate ENTER. Continue V33E. Proceed to step 38.</p> <p>44. VOG N05 (10 seconds) R1 - Star angle difference 000.0X deg. (Good data, angle < 0.05 deg) or</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>FL V06 N05</p> <p>R1 - Star angle difference XXX.XX deg. (Bad data, angle > 0.05 deg)</p> <p>Accept: V33E Reject: V37E E (Select new program) (R55 - Gyro torquing) (Optional)</p> <p>45. V06 N67 (10 seconds)</p> <p>Delta gyro angles X, Y, Z XX.XXX deg. All angles < 5 deg (Gyros are torqued)</p> <p>or</p> <p>FL V06 N67</p> <p>Delta gyro angles X, Y, Z XX.XXX deg. If any angle > 5 deg. Accept: V33E (Gyros are torqued) Reject: V34E (LGC displays P00)</p> <p>46. FL V50 N25 R1-00014 (Fine align check)</p> <p>Accept: Enter (return to step 13) Reject: V33E</p> <p>47. P00</p> <p>48. Set controls:</p> <p>AOT azimuth control - CL. Descend from back pack - PGONS/AOT lamp CB (AC) - pull out.</p> | | <p>CSM may re-acquire attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. LM/IMU ALIGN PROGRAM (P53)</p> <p>1. Set controls to nominal positions, except as follows:</p> <p>PGNS/AOT lamp CB (AC) - pressed HEATERS/AOT CB - pressed PGNS/IMU OPR CB - pressed</p> <p>2. Key V37E 53E</p> <p>(R02 - IMU status check)</p> <p>3. POSS FL V50 N07</p> <p>R1 00005 V37E 05E</p> <p>or</p> <p>POSS FL V50 N07 R1 00051 V37E 51E</p> <p>4. FL V06 N __</p> <p>R1 000--option code, assumed IMU orientation selection. R2 0000X LGC assumed option 00001 = Pref 00002 = Nom</p> <p>Accept: V33E Reject: V22E load desired code in R2</p> <p>Choose nominal orientation: V32E</p> <p>or</p> <p>Select new program: V37E XXE (to specify orientation) for preferred IMU orientation, proceed to step 8.</p> | | <p>1. NOTE</p> <p>LM/IMU Align Program (P53) may be deleted at a later date.</p> <p>4. NOTE</p> <p>POSS FL V05 N31 R1 000XX (IMU orientation not specified)</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N __</p> <p>T (align) 00XXX. hrs 000XX. min 0XX.XX sec</p> <p>Accept: V33E Reject: V25 E Load desired T (align)</p> <p>6. FL V06 N __</p> <p>R1 000XX option code, for assumed LM attitude selection R2 0000X LGC assumed option 00001 = Pref 00002 = Nom</p> <p>Accept: V33E Reject: V22E load desired code in R2</p> <p>Choose nominal attitude: V32E or Select new program: V37E XXE (to specify orientation)</p> <p>7. FL V06 N17</p> <p>OG, IG, MG, XXX.XX deg If MG < 45 deg: V33E If MG > 45 deg: V32E - (restart program)</p> <p>8. V01 N25</p> <p>R1 0005X (SC attitude, IMU orien- tation)</p> <p>00051 = Final IMU and final vehicle 00052 = Final IMU and interim vehicle 00053 = Interim IMU and final vehicle 00054 = Interim IMU and interim vehicle</p> <p>Record value (R60 - attitude maneuver routine)</p> | | <p>6. NOTE</p> <p>POSS FL V05 N31 R1 000XX (LM attitude not specified)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>9. FL V50 N25</p> <p>R1 000XX (auto mode control)</p> <p>Accept: Set STAB/CONT mode control switch - AUTO GUID CONT - PGNS</p> <p>Reject: Set GUID CONTROL and MODE CONT switches as desired V33E Maneuver vehicle as desired.</p> <p>10. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX deg Monitor maneuver on FDAI.</p> <p>11. POSS FL V50 N25</p> <p>R1 00007 (attitude trim maneuver)</p> <p>Accept: Set STAB/CONT/MODE CONTROL switch AUTO, GUID CONT switch - PGNS Enter</p> <p>or</p> <p>Reject: Set GUID CONTROL and MODE CONT switches as desired. V33E Maneuver vehicle as desired. (51 - fine align)</p> <p>12. FL V06 N30</p> <p>R1 000XX (star code) R2 XXXXXX (AOT detent) Accept: V33E Reject: V21E load desired star code. (R60 - attitude maneuver)</p> | | <p>9. Request CSM to relinquish attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. FL V50 N25</p> <p>R1 000XX (auto mode control) Accept: Set STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS Enter</p> <p>Reject: Set GUID CONTROL and MODE CONT switches as desired V33E Maneuver vehicle as desired</p> <p>14. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX deg Monitor maneuver on FDAI</p> <p>15. POSS FL V50 N25</p> <p>R1 00007 - Perform (Att trim maneuver) Accept: STAB/CONT/MODE CONTROL switch - AUTO, GUID CONTROL switch - PGNS ENTER</p> <p>Reject: GUID CONTROL and MODE CONT switches as desired V33E Maneuver vehicle as desired. (R53 - sighting mark)</p> <p>16. FL V21 N __ (request load)</p> <p>Load star code in R1 Load AOT detent in R2</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>17. FL V53</p> <p>Ascend floor-mounted backpack AOT reticle to zero. AOT detent - at above load position Key in V - - E (minimum impulse). STAB/CONT/MODE CONTROL - ATT HOLD. Maneuver LM so star crosses X or Y reticle line and press appropriate mark button.</p> <p>18. POSS FL V51 (Y mark) or V52 (X mark)</p> <p>If necessary, maneuver LM so star crosses X or Y reticle line and press appropriate mark button.</p> <p>19. FL V50 N25</p> <p>R1 00016 (terminate marks)</p> <p>Accept: Enter Reject for recycle: New star - V32E Same star - V33E</p> <p>20. Repeat steps 12 through 19 for second star.</p> <p>(R54 - star data test)</p> <p>21. V06 N05 (static or flashing) Star angle difference XXX.XX deg Static indication automatically exits R54 Flashing indication = angle ≥ 0.5 deg. Key in new program: V37E - - E or Proceed on bad data: V33E</p> <p>(R55 - gyro torquing)</p> | | <p style="text-align: center;">NOTE</p> <p>To reselect star: V32E</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>22. FL V06 N67 (static or flashing)</p> <p>Gyro X, Y, Z XX.XXX deg</p> <p>Flashing indication = any angle $> 5^\circ$</p> <p>Static indication automatically proceeds to next step.</p> <p>Accept: V33E Reject (for termination): V34E</p> <p>23. FL V50 N25</p> <p>R1 00014 (fine align check)</p> <p>Accept: Entr Return to step 11.</p> <p>or</p> <p>Reject: V33E Final vehicle attitude (R60 - attitude maneuver)</p> <p>24. POSS FL V50 N25</p> <p>R1 000XX (auto mode control)</p> <p>Accept: Set STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - PGNS Enter</p> <p>or</p> <p>Reject: Set STAB/CONT CONTROL switch and GUID CONT switch as desired. V33E</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>25. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX deg</p> <p>(Monitor maneuver on FDAI)</p> <p>26. POSS FL V50 N25</p> <p>R1 00007 (attitude trim maneuver)</p> <p>Accept: Set STAB/CONT/MODE CONTROL switch - AUTO, GUID CONT switch - Entr</p> <p>Reject: Set GUID CONT and STAB/CONT/MODE CONTROL switch as desired. V33E</p> <p>27. FL V50 N07</p> <p>R1 000XX (Original program calling for alignment)</p> <p>V37E - - E</p> <p>AOT detent - CL.</p> <p>Step down from backpack.</p> <p>PGNS/AOT lamp CB (AC) - pull open.</p> | | <p>CSM may reacquire attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>JL3-2 INTRAVEHICULAR CREW TRANSFER TO CSM</u> | | |
| <p>1. <u>PREPARE EQUIPMENT FOR TRANSFER INTO CSM.</u></p> <p>1. Place in helmet stowage container:</p> <ul style="list-style-type: none"> a. One EV visor b. One pair EV gloves c. One EMU spare parts kit d. One EOS <p>2. Place in second helmet stowage container:</p> <ul style="list-style-type: none"> a. One EV visor b. One pair EV gloves c. One EOS d. One sequence camera film magazine. <p>3. Place in either or both helmet stowage containers:</p> <ul style="list-style-type: none"> a. One DSEA b. One LM Flight Plan c. One Mission Log Data Book <p>4. Verify Radiation Survey Meter in stowage</p> <p>5. Verify PLSS (complete and unused) in recharge station.</p> | <p>1. Assist CDR</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>CONNECT TO TRANSFER UMBILICAL.</u></p> <p>1. Request Navigator to pass transfer umbilical (CM long umbilical) through tunnel to LM.</p> <p>2. Mount step on open docking hatch and reach into docking tunnel.</p> <p>3. Receive transfer umbilical and verify no O₂ flow.</p> <p>4. Remove purge valve from left side PGA O₂ inlet receptacle and stow on LM CDR's umbilical stowage plate.</p> <p>5. Remove relief valve from left PGA O₂ exhaust receptacle and stow on LM CDR's umbilical stowage plate.</p> <p>6. Connect O₂ hoses to PGA receptacles (left side).</p> <p>7. Request Navigator to activate communication lead on transfer umbilical.</p> <p>8. Disconnect LM umbilical communication lead from PGA.</p> <p>9. Connect transfer umbilical communication lead to PGA.</p> <p>10. Verify voice communication with CSM and request O₂ flow through transfer umbilical hose.</p> <p>11. CDR SUIT FLOW valve - SUIT DISCONNECT.</p> <p>12. Verify O₂ flow through transfer umbilical hose.</p> | | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. Disconnect LM O₂ hoses from PGA.</p> <p>14. Remove purge and relief valves from LM CDR's umbilical stowage plate.</p> <p>15. Insert purge valve into PGA O₂ inlet receptacle (right side).</p> <p>16. Insert relief valve into PGA O₂ exhaust receptacle (right side).</p> <p>17. Stow LM umbilical on LM CDR's umbilical stowage plate.</p> <p>3. <u>CDR ENTER CSM</u></p> <p>1. Enter docking tunnel feet first.</p> <p>2. Push self through tunnel to firm foot-hold in CM.</p> <p>4. <u>TRANSFER OF EQUIPMENT TO CM</u></p> | <p>1. Transfer one helmet stowage container, containing:</p> <ul style="list-style-type: none"> a. One EV visor b. One pair EV gloves c. One EMU spare parts kit d. One EO. e. One DSEA <p>2. Transfer one helmet stowage container, containing:</p> <ul style="list-style-type: none"> a. One EV visor | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">NOTE</div> <p>The equipment listed will be passed by the SE into the docking tunnel to the CDR.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | b. One pair EV gloves c. One EOS d. One sequence camera film magazine. e. One LM flight plan f. One mission log data book 3. One radiation survey meter. 4. One PLSS (complete, unused). | |
| 5. <u>SE PREPARE TO TRANSFER TO CM</u> | | <div>NOTE</div> <p>Prior to initiation of this task, it is assumed that transfer of equipment from CSM TO LM will have been completed.</p> |
| 1. While in the CM, connect to CM standard umbilical; disconnect from long (transfer) umbilical. | | |
| 3. While in CM, pass long (transfer) umbilical thru docking tunnel to SE. | 2. Request CDR pass long (transfer) umbilical thru tunnel to LM. | |
| | 4. Receive long (transfer) umbilical from CM and verify no O ₂ flow. | |
| | 5. Request CM to activate communications lead on long (transfer) umbilical. | |
| 6. While in CM, activate long (transfer) umbilical communications lead. | 7. Remove purge valve from left side PGA O ₂ inlet receptacle and stow on LM SE umbilical stowage plate. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>8. Remove relief valve from left side of PGA O₂ exhaust receptacle and stow on LM CDR umbilical stowage plate.</p> <p>9. Connect long (transfer) umbilical O₂ hoses to PGA.</p> <p>10. Disconnect LM umbilical communications lead from PGA and connect CM long (transfer) umbilical communications lead to PGA.</p> <p>11. Verify voice communication with CM and request O₂ flow thru CM long (transfer) umbilical.</p> <p>12. SE SUIT FLOW valve - SUIT DISCONNECT.</p> <p>13. Verify suit flow continues.</p> <p>14. Disconnect LM O₂ hoses from PGA.</p> <p>15. Remove purge and relief valves from LM SE umbilical stowage plate.</p> <p>16. Insert purge valve into PGA O₂ inlet receptacle (right side).</p> <p>17. Insert relief valve into PGA O₂ exhaust receptacle (right side).</p> <p>18. Stow LM umbilical on SE umbilical stowage plate.</p> <p>19. Perform Subsystem Deactivation (L21-2).</p> <p>20. Verify all LM compartments and equipment are secure.</p> <p>21. Transfer into docking tunnel:</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ul style="list-style-type: none"> a. Enter docking tunnel feet first. b. Push self into docking tunnel and grasp steps on top hatch. <p>22. Close LM top hatch from tunnel.</p> <ul style="list-style-type: none"> a. Brace self in tunnel and pull LM hatch to close. b. Lock hatch. c. Verify cabin dump valve - AUTO. <p>23. Complete transfer into CM.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>JL4-2 EARTH ORBITAL CHECKOUT</u> | | |
| 1. <u>DEACTIVATE SLA/LM ANTENNAS.</u> | <p>1. At the left side center console, pull out the following circuit breakers:</p> <ul style="list-style-type: none"> a. SLA/LEM ANT TRNFR A b. SLA/LEM ANT TRNFR B | <p>NOTE</p> <p>The following sequences are time constrained and if necessary may be performed during one astronaut occupancy of the LM; concurrently with block JC3-2.</p> |
| 2. <u>ACTIVATE RCS QUAD HEATERS AND CHECK QUAD TEMPERATURES.</u> | <p>1. At the left side center console, push in the following circuit breakers:</p> <ul style="list-style-type: none"> a. HEATERS RCS SYS A/B-1 QUAD 1 b. HEATERS RCS SYS A/B-1 QUAD 2 c. HEATERS RCS SYS A/B-1 QUAD 3 d. HEATERS RCS SYS A/B-1 QUAD 4 | <p>NOTE</p> <p>If any RCS burn is required, this task should be performed at least three hours prior to that burn.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>2. At the S. E. 's circuit breaker panel, push in the following circuit breakers:</p> <ul style="list-style-type: none"> a. HEATERS RCS SYS A/B-2 QUAD 1 b. HEATERS RCS SYS A/B-2 QUAD 2 c. HEATERS RCS SYS A/B-2 QUAD 3 d. HEATERS RCS SYS A/B-2 QUAD 4 e. HEATERS/DISP <p>3. At lower center panel:</p> <ul style="list-style-type: none"> a. HTR CONT/TEMP MONITOR select switch - RCS QUAD 1, QUAD 2, QUAD 3 and QUAD 4 b. HTR CONT/TEMP indicator - Monitor each quad - 140° +50° -20° F | |
| 3. <u>ENABLE S-BAND COMMUNICATION WITH MCC USING DATA FROM CSM.</u> | <p>1. At the S. E. 's circuit breaker panel, push in the following circuit breakers:</p> <ul style="list-style-type: none"> a. COMM PRIM S-BD PWR AMPL b. COMM PRIM S-BD XMTR/RCVR c. COMM S-BD ANT d. COMM PMP e. COMM DISP | <p style="text-align: center;">NOTE</p> <p>This task should be performed at the first opportunity in LOS with MCC for each application of the block.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>2. At the CDR's circuit breaker panel, push in the following circuit breakers:</p> <ul style="list-style-type: none"> a. COMM S-BD ANT b. COMM SEC S-BD XMTR/RCVR c. COMM SEC S-BD PWR AMPL <p>3. At Audio panel:</p> <ul style="list-style-type: none"> a. S-BD switch - S-BD T/R b. S-BD VOLUME control thumb-wheel - Adjust <p>4. At Communications Antennas panel:</p> <ul style="list-style-type: none"> a. S-BD antenna select switch - SLEW <p>5. At Communications panel:</p> <ul style="list-style-type: none"> a. S-BAND XMTR/RCVR switch - PRIM b. S-BAND PWR AMPL switch - PRIM c. S-BAND FUNCTIONS switch - VOICE d. S-BAND PCM/KEY FUNCTIONS switch - PCM e. S-BAND TELEMETRY/PCM switch - HI f. S-BAND MODULATE switch - PM - verify <p>6. At Communications Antennas panel:</p> <ul style="list-style-type: none"> a. TRACK MODE switch - SLEW | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 4. <u>CHECKOUT RANGING FUNCTION.</u> | <ul style="list-style-type: none"> b. PITCH rotary - rotate to pitch angle obtained from CSM c. PITCH indicator - Verify angle d. YAW rotary - rotate to yaw angle obtained from CSM e. YAW indicator - Verify angle f. SIGNAL STRENGTH indicator - rotate to peak g. PITCH and YAW rotary - Operate h. TRACK MODE switch - AUTO j. SIGNAL STRENGTH indicator - Verify remains peaked <p>7. Verify voice and data communications with CSM</p> <ul style="list-style-type: none"> 1. At Communications panel: <ul style="list-style-type: none"> a. S-BAND FUNCTIONS RANGE/TV switch - RANGE 2. Communicate preparedness to receive ranging signal with MCC 3. Verify phase lock and ranging fix on LM position - MCC 4. At Communications panel: <ul style="list-style-type: none"> a. S-BAND FUNCTIONS RANGE/TV switch - OFF when directed by MCC | <div style="border: 1px solid black; padding: 5px; text-align: center;">NOTE</div> <p>This task should be performed at the first opportunity in LOS with MCC for each application of the block.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 5. <u>CHECKOUT S-BAND REDUNDANT EQUIPMENT.</u> | <ol style="list-style-type: none"> 1. At Communications panel: <ol style="list-style-type: none"> a. S-BAND XMTR/RCVR switch - SEC 2. Voice and Data communications with MCC - Verify 3. At Communications panel: <ol style="list-style-type: none"> a. S-BAND PWR AMPL switch - SEC 4. Communication with MCC - Verify 5. At Communications panel: <ol style="list-style-type: none"> a. S-BAND XMTR/RCVR switch - PRIM 6. Communication with MCC - Verify | <div style="border: 1px solid black; padding: 2px; text-align: center;">NOTE</div> <p>This task should be performed at the first opportunity in LOS with MCC for each application of the block.</p> |
| 6. <u>PERFORM FM MODE CHECKOUT.</u> | <ol style="list-style-type: none"> 1. At Communications panel: <ol style="list-style-type: none"> a. S-BAND FUNCTIONS RANGE/. TV switch - Verify either in OFF or TV position b. S-BAND MODULATE SW. - FM c. S-BAND TELEMETRY PCM SW. - LO 2. VOICE and Data reception by MCC - Verify | <div style="border: 1px solid black; padding: 2px; text-align: center;">NOTE</div> <p>This task will be performed only once in order to checkout the TV camera operation.</p> <div style="border: 1px solid black; padding: 2px; text-align: center;">NOTE</div> <p>TV position does not enable TV transmission.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ol style="list-style-type: none"> 3. At Communications panel: <ol style="list-style-type: none"> a. S-BAND TELEMETRY PCM SW. - HI 4. Crew member receive TV camera, lens, and cable from CSM 5. At lower left side console, connect TV cable to TV CAMERA CONNECT receptacle 6. At S. E. 's circuit breaker panel, push in the COMM TV circuit breaker 7. Operate TV camera and scan LM cabin 8. Voice, Data, and TV reception by MCC - Verify 9. At S. E. 's circuit breaker panel, pull out COMM TV circuit breaker 10. At lower left side console, disconnect TV cable from TV CAMERA CONNECT receptacle 11. Crew member pass TV camera lens, and cable to CSM. | |
| 7. <u>CHECKOUT BACKUP VOICE AND KEYING CAPABILITY (ONE - MAN).</u> | <ol style="list-style-type: none"> 1. S-BAND FUNCTIONS PCM/KEY switch - OFF 2. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE BU 3. S-BAND MODULATE switch - PM 4. Voice communication with MCC - VERIFY | <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-bottom: 10px;">NOTE</div> <p>This task should be performed at the first opportunity in LOS with MCC for each application of the block.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. <u>CHECKOUT S-BAND OMNI ANTENNA.</u></p> | <p>5. S-BAND FUNCTIONS PCM/KEY switch - PCM</p> <p>6. TELEMETRY PCM switch - LO</p> <p>7. Voice and PCM communications with MCC - VERIFY</p> <p>8. S-BAND FUNCTIONS PCM/KEY switch - KEY</p> <p>9. Operate keyer on umbilical to transmit morse code to MCC.</p> <p>10. Code transmission with MCC - VERIFY</p> <p>11. S-BAND FUNCTIONS VOICE/VOICE BU switch - VOICE</p> <p>12. S-BAND FUNCTIONS PCM/KEY switch - OFF</p> <p>13. S-BAND FUNCTIONS RANGE/TV switch - OFF</p> <p>14. TELEMETRY PCM switch - HI</p> | |
| | <p>1. At Communications panel:</p> <p>a. S-BAND XMTR/RCVR switch - OFF</p> <p>b. S-BAND PWR AMPL switch - OFF</p> | <p>NOTE</p> <p>This task should be performed at the first opportunity in LOS with MCC for each application of the block.</p> <p>NOTE</p> <p>The power amplifiers must be turned off prior to changing antennas to prevent possible equipment damage.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>2. At Communications Antennas panel:</p> <p>a. S-BAND antenna select switch - 2</p> <p>3. At Communications panel:</p> <p>a. S-BAND XMTR/RCVR switch - PRIM</p> <p>b. S-BAND PWR AMPL switch - PRIM</p> <p>4. Voice communication with MCC - Verify</p> <p>5. At Communications panel:</p> <p>a. S-BAND FUNCTIONS PCM/KEY switch - PCM</p> <p>6. Transmission of PCM with MCC - Verify</p> <p>7. Establish normal communications capability at the Communications and Communications Antennas panels by performing the following steps:</p> <p>a. S-BAND XMTR/RCVR switch - OFF</p> <p>b. S-BAND PWR AMPL switch - OFF</p> <p>c. S-BAND antenna select switch - SLEW</p> <p>d. S-BAND XMTR/RCVR switch - PRIM</p> <p>e. S-BAND PWR AMPL switch - PRIM</p> <p>8. Voice and Data communication with MCC - Verify</p> | <p>NOTE</p> <p>Vehicle attitudes may require selection of S-BAND Omni 1 to communicate with MCC.</p> <p>NOTE</p> <p>Equipment limitations may result in transmission of degraded telemetry data.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 9. <u>ACTIVATE FRONT AND OVERHEAD WINDOW HEATERS.</u> | <p>1. At the CDR's circuit breaker panel, push in the following circuit breakers:</p> <ul style="list-style-type: none"> a. HEATERS/WINDOWS/SE b. HEATERS/WINDOWS/CDR c. HEATERS/DOCK WINDOW | <p>NOTE</p> <p>This task should be performed at least ninety minutes prior to any required observations. In addition, tasks 3 through 8 above should be performed again before crew member returns to the CSM through the tunnel.</p> <p>1. Do not push in both ac circuit breakers simultaneously.</p> |
| 10. <u>SWITCH ALL DESCENT BATTERIES FROM PARTIAL TO COMPLETE ACTIVATION.</u> | <p>1. At Electrical Power panel:</p> <ul style="list-style-type: none"> a. POWER/TEMP MON switch - CDR BUS b. VOLTS meter - ____VDC c. POWER/TEMP MON switch - ____VDC d. POWER/TEMP MON switch - BAT 1 through 6 e. VOLTS meter - ____VDC ____VDC ____VDC ____VDC ____VDC ____VDC | <p>NOTE</p> <p>This task is to be performed only once during this block and then, only when the voltage drops to the proper value for switchover. In addition, tasks 3 through 8 above should be performed again.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>f. AMPS meter - ____AMPS ____AMPS ____AMPS ____AMPS ____AMPS ____AMPS</p> <p>g. ASCENT POWER BAT 5 NORMAL FEED SW. (momentarily) - ON</p> <p>h. ASCENT POWER BAT 5 NORMAL FEED status flag - GRAY</p> <p>j. ASCENT POWER BAT 6 NORMAL FEED SW. (momentarily) - ON</p> <p>k. ASCENT POWER BAT 6 NORMAL FEED status flag - GRAY</p> <p>m. POWER/TEMP MON SW. - BAT 5 and BAT 6</p> <p>n. VOLTS meter - ____VDC ____VDC</p> <p>p. AMPS meter - ____AMPS ____AMPS</p> <p>q. DESCENT POWER DES BATS SW. - DEAD FACE</p> <p>r. DESCENT POWER DES BATS status flag - BARBER POLE</p> <p>s. POWER/TEMP MON SW. - BUS CDR</p> <p>t. VOLTS meter - ____VDC</p> <p>u. POWER/TEMP MON SW. - BUS SE</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>v. VOLTS meter - ____VDC</p> <p>w. POWER/TEMP MON SW. - BUS AC</p> <p>x. VOLTS meter - GREEN BAND</p> <p>y. DESCENT POWER LOW VOLT- AGE switches (momentarily) - OFF/RESET</p> <p>z. DESCENT POWER BAT 1 to BAT 4 status flag - BARBER POLE</p> <p>aa. DESCENT POWER HI VOLTAGE switches (momentarily) - ON</p> <p>ab. DESCENT POWER BAT 1 to BAT 4 status flag - GRAY</p> <p>ac. POWER/TEMP MON SW. - BAT 1 through 4</p> <p>ad. VOLTS meter - ____VDC ____VDC ____VDC ____VDC</p> <p>ae. DESCENT POWER DES BATS SW. - CONNECT</p> <p>af. DESCENT POWER DES BATS status flag - GRAY</p> <p>ag. ASCENT POWER BAT 5 NORMAL FEED SW. (momentarily) - OFF/ RESET</p> <p>ah. ASCENT POWER BAT 5 NORMAL FEED status flag - BARBER POLE</p> | <p>x. The AC BUS green band, 35.8 -37.8 VDC, is equivalent to 112 to 118 VAC.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>aj. ASCENT POWER BAT 6 NORMAL FEED SW. (momentarily) - OFF/RESET</p> <p>ak. ASCENT POWER BAT 6 NORMAL FEED status flag - BARBER POLE</p> <p>am. POWER/TEMP MON SW - BUS CDR</p> <p>an. VOLTS meter - ____VDC</p> <p>ap. POWER/TEMP MON SW. - BUS SE</p> <p>aq. VOLTS meter - ____VDC</p> <p>ar. POWER/TEMP MON SW. - BUS AC</p> <p>as. VOLTS meter - GREEN BAND</p> <p>at. POWER/TEMP MON SW. - BAT 1 through 4</p> <p>au. VOLTS meter - ____VDC ____VDC ____VDC ____VDC</p> <p>av. AMPS meter - ____AMPS ____AMPS ____AMPS ____AMPS</p> <p>aw. POWER/TEMP MON SW. - BUS CDR</p> | <p>as. The AC BUS green band, 35.8 -37.8 VDC, is equivalent to 112 to 118 VAC.</p> <p>NOTE</p> <p>The following sequences assume two astronauts in the LM and is performed after LM activation and completion of block JC3-2.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. <u>CALIBRATE AND CHECKOUT DFI OPERATION.</u></p> <p>1. At the left side center console:</p> <p style="padding-left: 20px;">a. R/D TLM CALIBRATE SW. - ON</p> <p>2. Observe MISSION TIMER for at least twelve seconds.</p> <p>3. Return R/D TLM CALIBRATE SW. - OFF</p> <p>12. <u>CHECKOUT SEQUENCE CAMERA</u></p> <p style="padding-left: 20px;">To be provided.</p> <p>13. <u>CHECKOUT STATUS OF PROPELLANTS AND HELIUM PRIOR TO PRESSURIZATION.</u></p> | <p>1. RCS QUANTITY indicator - MONITOR</p> <p>2. RCS TEMP/PRESS MON SW. - He</p> <p>3. RCS SYS A and SYS B PRESS indicator - 3000 \pm100 PSIA</p> <p>4. RCS TEMP/PRESS MON SW. - PRPLNT</p> <p>5. RCS SYS A and SYS B TEMP indicator - 70 \pm30° F</p> <p>6. RCS SYS A and SYS B PRESS indicator - 15 \pm5 PSIA</p> <p>7. RCS TEMP/PRESS MON SW. - FULL MANF</p> | <p style="text-align: center;">NOTE</p> <p>DFI telemetry should be calibrated before and after each major event. After one calibration cycle the system returns to data transmission regardless of the switch being held down.</p> <p>2. The times ten (x10) multiplier will illuminate when RCS TEMP/PRESS MON switch is in the He position.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>8. RCS SYS A and SYS B PRESS indicator - 15 ±5 PSIA</p> <p>9. RCS TEMP/PRESS MON SW. - OXID MANF</p> <p>10. RCS SYS A and SYS B PRESS indicator - 15 ±5 PSIA</p> <p>11. HELIUM MON SW. - DES AMP PRESS and DES SUPCRIT PRESS</p> <p>12. HELIUM indicator - _____RSIA _____RSIA</p> <p>13. PRPLNT TEMP/PRESS MON SW. - DES 1</p> <p>14. FUEL and OXID TEMP indicator - 70 ±20° F</p> <p>15. FUEL and OXID PRESS indicator - 120 - 230 PSIA</p> <p>16. PRPLNT TEMP/PRESS SW. - DES 2</p> <p>17. FUEL and OXID TEMP indicator - 70 ±20F</p> <p>18. FUEL and OXID PRESS indicator - 120 - 230 PSIA</p> <p>19. PRPLNT QTY MON SW. - DES 1</p> <p>20. DESCENT PROPULSION QUANTITY indicator - MONITOR 0/0</p> <p>21. PRPLNT QTY MON SW. - DES 2</p> <p>22. DESCENT PROPULSION QUANTITY indicator - MONITOR 0/0</p> <p>23. PRPLNT QTY MON SW. - OFF</p> | <p>13. Compare displayed values with TEMP/PRESS curve values</p> <p>20. Prior to ullage maneuver, descent propulsion Propellant Quantity Gaging System values cannot be predetermined.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | 24. DESCENT PROPULSION QUANTITY indicator - Verify extinguished 25. HELIUM MON SW. - ASC TEMP 1 and TEMP 2 26. HELIUM indicator - $70 \pm 20^{\circ}\text{F}$ 27. HELIUM MON SW. - ASC PRESS 1 and PRESS 2 28. HELIUM indicator - 3200 to 3500 PSIA | 25. Compare displayed values with TEMP/PRESS curve values |
| 14. <u>CHECKOUT WASTE MANAGEMENT SECTION.</u> | | |
| 1. At the right rear: a. Disconnect Waste Management hose from stowage plate b. Connect to PGA Waste Management Connector c. Urinate into PGA Urine Collection Bag d. Transfer Urine to LM Waste Management System e. Disconnect Waste Management hose from PGA Connector f. Stow hose | | |
| 15. <u>CHECKOUT ATMOSPHERE REVITALIZATION SECTION PRESSURE INTEGRITY AND ARS BACK-UP EQUIPMENT.</u> | 1. At the right rear: a. CDR's and SE's suits open to the cabin oxygen - Verify | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ul style="list-style-type: none"> b. CDR SUIT FLOW and SE SUIT FLOW VALVES - SUIT DIS-CONNECT c. SUIT CIRCUIT RELIEF VALVE - CLOSE d. SUIT GAS DIVERTER VALVE - PULL - EGRESS e. CABIN GAS RETURN VALVE - CLOSE 2. At the Environment Control panel: <ul style="list-style-type: none"> a. SUIT FAN select SW. - OFF 3. At the right rear: <ul style="list-style-type: none"> a. PRESS REG "A" - DIRECT O₂ 4. At the Environment Control panel: <ul style="list-style-type: none"> a. PRESS indicator - MONITOR increase to 7.0 PSIA 5. At the right rear: <ul style="list-style-type: none"> a. PRESS REG "A" - CLOSE b. PRESS REG "B" - DIRECT O₂ 6. At the Environmental Control panel: <ul style="list-style-type: none"> a. PRESS indicator - MONITOR increase to 9.0 PSIA 7. At the right rear: <ul style="list-style-type: none"> a. PRESS REG "B" - CLOSE b. CO₂ CANISTER SEL valve - SEC | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ol style="list-style-type: none"> 8. At the Environmental Control panel: <ol style="list-style-type: none"> a. PRESS indicator - MONITOR for stable pressure 9. At the right rear: <ol style="list-style-type: none"> a. CO₂ CANISTER SEL valve - PRIM b. SUIT CIRCUIT RELIEF VALVE - AUTO 10. At the Environmental Control panel: <ol style="list-style-type: none"> a. PRESS indicator - MONITOR decay to 5.0 PSIA 11. At the right rear: <ol style="list-style-type: none"> a. CABIN GAS RETURN VALVE - AUTO b. SUIT GAS DIVERTER VALVE - PUSH - CABIN c. SUIT FAN SW. - 1 d. CDR SUIT FLOW and SE SUIT FLOW valves - HELMUT 12. At the right front: <ol style="list-style-type: none"> a. H₂O SEP SEL valve - Pull out b. Alarm tone - Audible c. CDR MASTER ALARM - LIT d. SE MASTER ALARM - LIT e. H₂O SEP component caution light - LIT f. ECS caution light - LIT | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ul style="list-style-type: none"> g. SE MASTER ALARM - depress h. CDR's and SE's MASTER ALARM lights - Ext j. MASTER ALARM TONE - Inaudible k. H₂O SEP component caution light and ECS caution light - Verify Ext when SEP 2 attains speed m. H₂O SEP SEL valve - push in n. ALARM TONE - AUDIBLE p. CDR MASTER ALARM light - LIT q. SE MASTER ALARM light - LIT r. H₂O SEP component caution light - LIT s. ECS caution light - LIT t. H₂O SEP component caution light and ECS caution light - Verify EXT when SEP 1 attains speed | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>16. <u>CHECKOUT OPERATION OF SUIT FANS.</u></p> <p>2. SUIT FAN 1 circuit breaker - pull out</p> <p>7. Depress SUIT FAN 1 circuit breaker</p> | <p>1. SUIT FAN 2 circuit breaker - to press</p> <p>3. Verify MASTER ALARM tone audible and the following lights lit: -</p> <p style="padding-left: 40px;">CDR MASTER ALARM SE MASTER ALARM SUIT/FAN component caution ECS caution</p> <p>4. Depress SE MASTER ALARM and verify CDR's and SE's MASTER ALARM lights ext. and MASTER ALARM tone is inaudible.</p> <p>5. SUIT FAN switch - 2, verify O₂ flow in suit.</p> <p>6. Verify SUIT/FAN component caution and ECS caution lights ext.</p> <p>8. Pull out SUIT FAN 2 CB and verify O₂ flow in suit stops.</p> <p>9. Verify MASTER ALARM tone audible and the following lights lit: -</p> <p style="padding-left: 40px;">CDR MASTER ALARM SE MASTER ALARM SUIT/FAN component caution SUIT/FAN warning</p> <p>10. Depress SE MASTER ALARM switch and verify CDR's and SE's MASTER ALARM lights ext. and MASTER ALARM tone is inaudible.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>17. <u>CHECKOUT HEAT TRANSPORT SECTION.</u></p> <p>2. Depress GLYCOL PUMP 2 CB and pull out GLYCOL PUMP 1 CB.</p> | <p>11. Set SUIT FAN switch to 1 and verify O_2 flow in suit.</p> <p>12. Verify SUIT/FAN component caution and SUIT/FAN warning lights ext.</p> <p>13. Depress SUIT FAN 2 CB</p> <p>1. Verify following GLYCOL parameters</p> <p>TEMP $45 \pm 20^\circ F$ PRESS 30 ± 10 psia</p> <p>3. Verify MASTER ALARM tone audible and following lights lit: -</p> <p>CDR MASTER ALARM SE MASTER ALARM GLYCOL component caution ECS caution</p> <p>4. Depress SE MASTER ALARM switch and verify CDR's and SE's MASTER ALARM lights ext. and MASTER ALARM tone is inaudible.</p> <p>5. Set GLYCOL PUMP switch to 2, verify ECS caution light ext. immediately and GLYCOL component caution light ext. when pump 2 attains speed.</p> <p>6. Verify GLYCOL TEMP and PRESS remain stable.</p> <p>7. Depress GLYCOL PUMP EMER CB.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p>8. Pull out GLYCOL PUMP 2 CB and depress GLYCOL PUMP 1 CB.</p> | <p>9. Verify MASTER ALARM tone audible and following lights lit: -</p> <p style="margin-left: 40px;">CDR MASTER ALARM SE MASTER ALARM GLYCOL component caution ECS caution</p> <p>10. Depress SE MASTER ALARM switch and verify CDR's and SE's MASTER ALARM lights ext. and MASTER ALARM tone is inaudible.</p> <p>11. Set GLYCOL PUMP switch to EMER and verify ECS and GLYCOL component caution light ext.</p> <p>12. Verify GLYCOL TEMP fluctuates and PRESS decreases and varies.</p> <p>13. Set GLYCOL PUMP switch to 1 and verify GLYCOL component caution light lit, then ext. when pump 1 attains speed.</p> | |
| <p>14. Depress GLYCOL PUMP 2 CB.</p> <p>18. <u>CHECKOUT WATER MANAGEMENT SECTION.</u></p> | <p>1. Operate O₂/H₂O QTY MON switch and read H₂O quantities as follows:</p> <p style="margin-left: 40px;">DES - 95 ± 5% ASC 1 - 100% ASC 2 - 100%</p> <p>2. O₂/H₂O QTY MON switch des.</p> <p>3. Operate SEC GLYCOL EVAP FLOW valve from CLOSE to OPEN to CLOSE.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>19. <u>DEPLOY LANDING GEAR.</u></p> <p>1. Set EXPLOSIVE DEVICES/MASTER ARM switch to ON.</p> <p>2. Set LDG GEAR DEPLOY switch to FIRE.</p> <p>3. Verify LDG GEAR DEPLOY flag is GREY.</p> <p>4. Observe front ldg gear visible through window.</p> <p>5. Set EXPLOSIVE DEVICES/MASTER ARM sw to OFF.</p> <p>20. <u>ACTIVATE SUBSYSTEMS OF DESCENT AND ASCENT STAGES USING CHECK LIST.</u></p> | <p>4. Operate SEC SUIT EVAP FLOW valve from CLOSE to OPEN to CLOSE.</p> <p>5. Operate DRINK valve from CLOSE to OPEN to CLOSE.</p> <p>6. Operate WATER TANK SEL valve from DES to ASC to DES.</p> <p>7. Operate PLSS FILL valve from CLOSE to OPEN to CLOSE.</p> | <p>6. Do not set WATER TANK SEL valve to SEC.</p> <p>NOTE</p> <p>The following sequences are performed prior to any LM separation from the CSM and would normally be omitted if separation is not anticipated.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>1. At the CDR's circuit breaker panel, push in the following circuit breakers:</p> <p>PROPUL/HE TEMP/PRESS RCS/PQGS DISP</p> <p>STAB/CONT/DECA GIMBAL AGS</p> <p>FLIGHT DISPLAYS/ RNG/RNG RT ALT/ALT RT GASTA SE FDAI</p> <p>PROPUL/DES HE REG</p> <p>RCS SYS A/ QUAD 4 TCA QUAD 3 TCA QUAD 2 TCA QUAD 1 TCA ISOL VLV ASC FEED MAIN SOV</p> <p>STAB/CONT/ AELD ATCA (PGNS) DES ENG CONT DECA PWR ENG FIRE OVRD ABORT STAGE</p> <p>FLIGHT DISPLAYS/ RNG/RNG RT ALT/ALT RT THRUST DISP EVENT TIMER X-PNTR GASTA FDAI</p> <p>LTG/TRACK</p> <p>STAB/CONT/ ABORT STAGE</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---------|
| <p>21. <u>INSTALL DROGUE ON LM.</u></p> <ol style="list-style-type: none"> 1. Using all-purpose tool, open top hatch and secure in open position. 2. Mount step into aft equipment bay and receive drogue from CM. 3. Insert drogue into mounting flanges and lock into position. 4. Confirm that drogue has engaged probe latches. 5. Step down into cockpit and release top hatch from secured open position. | <p> ENG ARM ATCA AELD RCS SYS B/ MAIN SOV ISOL VLV QUAD 1 TCA QUAD 2 TCA QUAD 3 TCA QUAD 4 TCA FLIGHT DISPLAYS/ FDAI X-PNTR RCS/CRSFD TEMP/PRESS DISP-FLAGS PROPUL/ASC HE REG TEMP/PRESS DISP PQGS 2. Move to SE's flight station. 3. Verify PRE AMPS caution light-ext. </p> <p>1. Assist fellow crew member</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---------|
| <p>6. Verify CABIN RELIEF and DUMP valve.</p> <p>22. <u>ACTIVATE CABIN FANS.</u></p> <p>23. <u>ACTIVATE ABORT SENSOR ASSEMBLY.</u></p> <p>24. <u>VERIFY RCS FLAG/VALVE STATUS BEFORE PRESSURIZATION.</u></p> | <p>1. Depress CABIN FAN CONT and CABIN FAN 2 CB's and verify operation of fan 2.</p> <p>2. Pull out CABIN FAN 2 CB.</p> <p>3. Go to CDR's side and depress CABIN FAN 1 CB.</p> <p>4. Go to SE's side, verify operation of fan 1 and depress CABIN FAN 2 CB.</p> <p>1. AGS STATUS switch - STANDBY.</p> <p>2. STAB/CONT AEA CB - PRESS</p> <p>1. VERIFY ALL SYS A AND SYS B FLAG/VALVE POSITIONS AS FOLLOWS:</p> <p>SYS A/MAIN SOV - BARBERPOLE ASC FEED - BARBERPOLE THRUSTER PAIR/ QUAD 1 - GRAY QUAD 2 - GRAY QUAD 3 - GRAY QUAD 4 - GRAY</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>SYS B/MAIN SOV - BARBERPOLE ASC FEED - BARBERPOLE THRUSTER PAIR/ QUAD 1 - GRAY QUAD 2 - GRAY QUAD 3 - GRAY QUAD 4 - GRAY</p> <p>CRSFD- BARBERPOLE</p> | |
| <p>25. <u>VENT RCS MANIFOLDS AND CHECKOUT TRANSLATION CONTROL FUNCTION OF PRIMARY COILS, COLD FIRING.</u></p> | | |
| <p>1. Verify THROTTLE/JETS lever - JETS</p> <p>3. Set X-TRANSL switch - 4 JETS.</p> <p>4. Operate Translation Controller to UP, +X.</p> <p>5. Observe MISSION TIMER and maintain +x translation command for 45 seconds.</p> <p>8. Observe MISSION TIMER and determine that 45 seconds have elapsed since +x translation command was initiated.</p> | <p>2. Verify THROTTLE/JETS lever - JETS</p> <p>6. Depress MASTER ALARM switch.</p> <p>7. Verify the following:</p> <p>Audio tone - inaudible MASTER ALARM switch - ext</p> <p>QUAD FLAGS - SYS A - Quads 2 & 4 SYS B - Quads 1 & 3</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>19. Observe MISSION TIMER and determine that 45 seconds have elapsed since -x translation was initiated.</p> <p>20. Release translation controller.</p> | <p>QUAD flags - red as follows:</p> <p>SYS A - QUADS 1 & 3 SYS B - QUADS 2 & 4</p> <p>21. Perform the following sequence:</p> <p>Set QUAD switches - CLOSE</p> <p>Verify the following:</p> <p>QUAD flags - BARBER POLE</p> <p>22. RCS TCA warning light - ext. Set QUAD switches - OPEN Verify QUAD flags - GRAY SYS A - QUADS 1 & 3 SYS B - QUADS 2 & 4</p> <p>23. Verify that SYS A and SYS B FUEL MANF pressures are 0 psia.</p> <p>24. Set TEMP/PRESS MON switch - OXID MANF</p> <p>25. Verify that SYS A and SYS B FUEL MANF pressures are 0 psia.</p> <p>26. Assist fellow crew member</p> | |
| <p>26. <u>CHECKOUT Y AND Z TRANSLATION CONTROL FUNCTION OF RCS PRIMARY COILS, COLD FIRING.</u></p> <p>1. Operate Translation Controller</p> | | <p>NOTE</p> <p>Perform following sequence for each translation controller position.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---------|
| <p>2. Verify the following:</p> <p>Audio tone - audible MASTER ALARM switch - lit RCS TCA warning light - lit</p> <p>3. Depress master alarm PB</p> <p>4. Verify the following:</p> <p>Audio tone - inaudible MASTER ALARM switch - ext. QUAD flags - red</p> <p>5. Set quad switches - CLOSE</p> <p>6. Verify the following:</p> <p>QUAD flags - BARBER POLE RCS TCA warning light - ext.</p> <p>7. Set QUAD switches - OPEN</p> <p>8. Verify QUAD flags - GRAY</p> <p>9. Perform steps 1 through 8 for the following controller positions:</p> <p>Right +Y - SYS B - QUADS 1 & 2 Forward +Z - SYS A - QUAD 2 SYS B - QUAD 3</p> <p>10. Perform steps 1 through 8 for the following controller positions:</p> <p>Depress SE's MASTER ALARM to deactivate CWEA tone and to extinguish switch light. Left -Y - SYS A - QUADS 3 & 4 Back -Z - SYS A - QUAD 1 SYS B - QUAD 4</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|------------------|---------|
| <p>27. <u>CHECKOUT ATTITUDE CONTROL FUNCTION OF RCS PRIMARY COILS, COLD FIRING.</u></p> <ol style="list-style-type: none"> Verify the following: MODE CONTROL SWITCH - ATT HOLD ATTITUDE CONTROL/ROLL - MODE CONT ATTITUDE CONTROL/PITCH - MODE CONT ATTITUDE CONTROL/YAW - MODE CONT GUID CONT SW - AGS BAL CPL SW - ON Perform following sequence for each attitude controller position. Verify the following: Audio tone - audible MASTER ALARM - lit RCS TCA warning light - lit Depress MASTER ALARM Verify the following: Audio tone - inaudible MASTER ALARM - ext. QUAD flags - red Set quad switches - CLOSE Verify the following: QUAD flags - BARBER POLE RCS TCA warning light - ext. Set QUAD switches - open Verify QUAD flags - GRAY | | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p>10. Perform steps 2 through 9 for each controller operation:</p> <p style="padding-left: 40px;">Right, + Roll - SYS A - QUADS 2 & 3 Back, + Pitch - SYS B - QUADS 1 & 2 Left Twist + Yaw - SYS A - QUADS 1 & 2 SYS B - QUADS 2 & 3</p> | | |
| <p>28. <u>CHECKOUT RCS PRIOR TO PRESSURIZATION.</u></p> | <ol style="list-style-type: none"> 1. Operate TEMP/PRESS MON switch through each position and verify the following SYS A and SYS B parameters on the TEMP and PRESS indicators. <ol style="list-style-type: none"> a. He - TEMP - $70 \pm 20^{\circ}\text{F}$ (A & B) PRESS - 3000 ± 100 PSIA (A & B) b. PRPLNT - TEMP - $70 \pm 20^{\circ}\text{F}$ (A & B) PRESS - 15 ± 5 PSIA (A & B) c. FUEL MANF - PRESS - O PSIA (A & B) d. OXID MANF - PRESS - O PSIA (A & B) 2. Operate TEMP MONITOR switch to RCS/QUAD 1-4 positions and verify each quad temperature is $70 \pm 30^{\circ}\text{F}$ on HTR CONT/TEMP indicator. 3. Perform steps 2 through 9 of task 27 for the following controller operations: <p style="margin-left: 40px;">Depress SE's MASTER ALARM to deactivate CWEA tone and to ext. MASTER ALARM.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>Operate Attitude Controller as follows:</p> <ul style="list-style-type: none"> a. Left, +Roll SYS B - QUADS 2 & 3 b. Forward + Pitch SYS A - QUADS 1 & 2 c. Right Twist, +Yaw SYS A - QUADS 2 & 3 SYS B - QUADS 1 & 4 | |
| 29. <u>PRESSURIZE RCS.</u> | | |
| 1. Assist fellow crew member. | <ul style="list-style-type: none"> 1. System A MAIN SOL switch - OPEN, verify flag - GRAY. 2. System B MAIN SOV switch - OPEN, verify flag - gray. 3. Operate TEMP/PRESS MON switch to FUEL MANF and OXID MANF positions. Verify following SYS A and SYS B parameters on TEMP and PRESS indicators. <ul style="list-style-type: none"> a. FUEL MANF - PRESS 30 ± 10 PSIA (SYS A and B) b. OXID MANF - PRESS 30 ± 10 PSIA (SYS A and B) | |
| 4. MASTER ARM switch - on. | | |
| 5. RCS PRESS switch - fire. | | |
| 6. MASTER ARM switch - off. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| 30. <u>CHECKOUT RCS AFTER PRESSURIZATION.</u> | <ol style="list-style-type: none"> 1. Verify SYS A and SYS B OXID MANF pressures are 175 + 25 - 15 psia. 2. TEMP/PRESS MON switch to FUEL MANF. 3. Verify SYS A and SYS B FUEL MANF pressures are 175 + 25 - 15 psia. 4. Operate TEMP/PRESS MON switch to PRPLNT and He positions. Verify following SYS A and SYS B parameters: <ol style="list-style-type: none"> a. PRPLNT - TEMP 70 ± 30 PSIA (SYS A and B) b. He - TEMP 70 ± 30 PSIA (SYS A and B) c. PRPLNT - PRESS 180 + 25 - 15 PSIA (SYS A and B) d. He - PRESS 2800 ± 100 PSIA (SYS A and B) | |
| 31. <u>VERIFY RCS FLAG/VALVE STATUS.</u> | <ol style="list-style-type: none"> 1. Verify SYS A and SYS B flag/valve positions as follows: SYS A/MAIN SOV - Gray ASC FEED - BARBERPOLE Thruster pair QUAD 1 - Gray QUAD 2 - Gray QUAD 3 - Gray QUAD 4 - Gray | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | SYS B/MAIN SOV - Gray ASC FEED - BARBERPOLE Thruster pair QUAD 1 - Gray QUAD 2 - Gray QUAD 3 - Gray CRSFD - Barberpole CRSFD - Barberpole | |
| 32. <u>CHECKOUT RATE GYRO ASSEMBLY.</u> | 1. GYRO TEST SELECT switch to roll. 2. Hold GYRO TEST CONTROL switch to pos rt. 3. Verify ROLL RATE Needles indicate +4.9° to +5.1°. | |
| 4. Verify ROLL RATE needles indicate +4.9° to +5.1°. | 5. Hold GYRO TEST CONTROL switch to NEG RT. 6. Verify ROLL RATE needles indicate -4.9° to -5.1°. | |
| 7. Verify ROLL RATE needles indicate -4.9° to -5.1°. | 8. Release GYRO TEST CONTROL switch. 9. GYRO TEST SELECT switch to PITCH. 10. Hold GYRO TEST CONTROL switch to POS RT. 11. Verify PITCH RATE needles indicate +4.9° to +5.1°. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---------|
| <p>12. Verify PITCH RATE needles indicate +4.9° to +5.1°.</p> <p>15. Verify PITCH RATE needles -4.9° to -5.1°.</p> <p>20. Verify YAW RATE needles indicate +4.9° to +5.1°.</p> <p>23. Verify YAW RATE needles indicate -4.9° to -5.1°.</p> | <p>13. Hold GYRO TEST CONTROL switch to NEG RT.</p> <p>14. Verify PITCH RATE needles -4.9° to -5.1°.</p> <p>16. Release GYRO TEST CONTROL switch.</p> <p>17. GYRO TEST SELECT switch to YAW.</p> <p>18. Hold GYRO TEST CONTROL switch to POS RT.</p> <p>19. Verify YAW RATE needles indicate +4.9° to +5.1°.</p> <p>21. Hold GYRO TEST CONTROL switch to NEG RT.</p> <p>22. Verify YAW RATE needles indicate -4.9° to -5.1°.</p> <p>24. Release GYRO TEST CONTROL switch.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>33. <u>START UP AND CHECKOUT DSKY AND LGC.</u></p> <ol style="list-style-type: none"> 1. Refer to Flight Data Kit for codes. 2. Depress LGC/DSKY CB. 3. DSKY operations, change program to check out DSKY and LGC and checkout as follows: <ol style="list-style-type: none"> a. V, *37*, VCE, E, OF, *01*, VCE, E, Verify COMPTR ACTY light comes on. b. Verify the following ON or OFF for 10 seconds in sequence: All NUMERICS light up 9, 8, 7, 6, 5, 4, 3, 2, 1, 0. All characters blank, all minus signs on, all plus signs and ten status and caution lights on. (two remain on), 4. Verify COMPTR ACTY light OFF. Depress RSET to reset OPR ERR light. 5. Depress KEY REL to reset KEY REL light. 6. Verify all caution lights do not re-light as result of programmed LGC checkout steps. Program reads 00 indicates end checkout. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>34. <u>INITIALIZE SYNCHRONIZATION IN LGC AND AGS FROM CMC.</u></p> | | |
| <p>1. Communicate with CSM to prepare to send synchronization time.</p> <p>2. Refer to Flight Data Kit for Codes.</p> <p>3. DSKY Operations change program to initialize Synchronization Time. V, 37, VCE, E, OF, 02, VCE, E.</p> <p>4. Verify display of VERB, NOUN, and Code No's 50, for 'please perform' check list, and TIME MARK function on check-list, with VERB and NOUN Displays flashing.</p> <p>5. Communicate request to CSM for TIME MARK.</p> <p>6. Depress MARK X button at CSM MARK, E.</p> <p>7. Verify display of VERB and NOUN No's 2116 for load first component of time.</p> <p>9. Communicate request for hours at MARK.</p> | <p>8. Refer to Flight Data Kit for codes</p> <p>10. DEDA operations, enter absolute TIME and MARK, C,* + 'HOURS', VCE, E C * + 'MINUTES', VCE, E. C,* + 'SECONDS', VCE, Request TIME MARK for time entered in DEDA (seconds diff. from DSKY entry). Depress ENTER button at MARK.</p> | <div>NOTE</div> <p>MARK X and MARK Y buttons are on the AOT, choice is arbitrary.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. Enter HOURS, VCE, READ BACK, E.</p> <p>12. Verify display of VERB and NOUN No's 2216 for load second component of time.</p> <p>13. Communicate request for minutes at MARK.</p> <p>14. Enter MINUTES, VCE, READ BACK, E.</p> <p>15. Verify display of VERB and NOUN No's 2216 for load third component of time.</p> <p>16. Communicate request for SECONDS at MARK.</p> <p>17. Enter SECONDS, VCE, READ BACK, E. Observe flash termination.</p> <p>35. <u>SET MISSION ELAPSED TIMER.</u></p> <p>1. Depress MISSION TIMER START/STOP PB to stop timer.</p> <p>2. Operate MISSION timer set rotary controles to set elapsed timer to time received via voice from CSM.</p> <p>3. Depress MISSION TIMER START/STOP PB to start timer.</p> | <p>18. DEDA operations readout absolute time. C, _____ VCE, R, readback, C, _____ VCE, R, readback, C, _____ VCE, R, readback.</p> | <p>NOTE</p> <p>Zero point for LM elapsed time is arbitrary. One hour prior to final translunar midcourse correction is zero point that corresponds to time of awakening prior to lunar orbit insertion and is used where applicable, for planning.</p> |

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| <p>36. <u>UPDATE NAVIGATIONAL PARAMETERS IN LGC.</u></p> <ol style="list-style-type: none"> 1. Communicate CSM to prepare send Navigational information. 2. Refer to Flight Data Kit for Codes. 3. DSKY operations change program V, 37, VCE, E, OF. 4. DSKY operations, update navigational state vectors enter VCE, E. 5. Refer to Flight Data Kit. Verify display of verb NOUN numbers 51 for please mark time value, and VERB/NOUN flash. 6. Communicate request to CSM for TIME MARK. 7. Depress MARK button on CSM command, E. 8. Refer to Flight Data Kit. Verify display of VERB and NOUN numbers. For load three components of landing site Vector after initial updating. 9. Communicate request for landing site Vector from CSM. 10. Enter three components of landing site Vector as received from CSM. <ol style="list-style-type: none"> a. Enter first component value, VCE, and read back, E. b. Enter second component value, VCE, and read back, E. c. Enter third component value, VCE, and read back, E. | | <p>NOTE</p> <p>Program code appears in NOUN number display for verification.</p> <p>NOTE</p> <p>If no change in landing site has occurred use landing site Vector from FLIGHT PLAN.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. Refer to Flight Data Kit. Verify display of VERB and NOUN numbers for load three components of LM Velocity Vector.</p> <p>12. Communicate request for Velocity Vector from CSM.</p> <p>13. Refer to Flight Data Kit for combined vectors.</p> <p>14. DSKY operations combined LM/CSM Velocity Vector N, VCE, E.</p> <p>15. Enter three components of LM/CSM Velocity Vector received from CSM.</p> <ul style="list-style-type: none"> a. Enter first component value, VCE, and read back, E. b. Enter second component value, VCE, and read back, E. c. Enter third component value, VCE, and read back, E. <p>16. DSKY operations combined LM/CSM N, VCE, E.</p> <p>17. Enter three components of LM/CSM position Vector received from CSM.</p> <ul style="list-style-type: none"> a. Enter first component value, VCE, and read back, E. b. Enter second component value, VCE, and read back, E. c. Enter third component value, VCE, and read back, E. d. DSKY operations proceed as follows: V, 33, VCE, E. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>18. Refer to Flight Data Kit and verify display of VERB and NOUN numbers, for load first three components of ABORT TIME polynomial.</p> <p>19. Communicate request for first three components of ABORT TIME polynomial.</p> <p>20. Enter first three components of ABORT TIME polynomial received from CSM.</p> <ul style="list-style-type: none"> a. Enter first component value, VCE, and read back, E. b. Enter second component value, VCE, and read back, E. c. Enter third component value, VCE, and read back, E. <p>21. Refer to Flight Data Kit and verify display of VERB and NOUN numbers, for load second three components of ABORT TIME polynomial.</p> <p>22. Communicate request for second three components of ABORT TIME polynomial.</p> <p>23. Enter second three components of ABORT TIME polynomial received from CSM.</p> <ul style="list-style-type: none"> a. Enter first component value, VCE, and read back, E. b. Enter second component value, VCE, and read back, E. c. Enter third component value, VCE, and read back, E. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>24. Refer to Flight Data Kit. Verify display of VERB and NOUN numbers, for load one component of ABORT TIME polynomial.</p> <p>25. Communicate request for seventh component of ABORT TIME polynomial.</p> <p>26. Enter seventh component, VCE, and read back, E.</p> <p>27. Observe flash termination.</p> <p>37. <u>ENABLE INERTIAL MEASUREMENT UNIT FOR WARMUP.</u></p> <p>1. At CDR's circuit breaker panel, push in the following circuit breaker:</p> <p>a. IMU OPR</p> <p>38. <u>CHECKOUT RCS, HOT FIRING, USING DSKY.</u></p> <p>39. <u>CHECK RADAR INITIAL SWITCH POSITIONS.</u></p> | <p>1. Verify Radar initial switch positions are as follows:</p> <p>LDG ANT - AUTO RADAR TEST - OFF TEST MONITOR - ARBITRARY RNDZ RADAR MODE - LGC SLEW RATE - LOW SLEW - CENTER OFF</p> | <p>NOTE</p> <p>This task will be applicable when the necessary software program has been incorporated into the LM Guidance Computer.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>40. <u>ACTIVATE, SELF TEST, AND DEACTIVATE LANDING RADAR.</u></p> <p>9. RATE/ERR MON switch LDG RDR/CMPTR.</p> <p>11. X-POINTER switch to LO MULT.</p> | <p>1. Depress PGNS/LDG RDR CB.</p> <p>2. TEST MONITOR switch to LDG RADAR PWR/VEL XMTR.</p> <p>3. Verify SIGNAL STRENGTH meter pointer indicates power level is above power check mark on SIGNAL STRENGTH meter as partial indication of warmup.</p> <p>4. TEST MONITOR switch to LDG RADAR PWR/ALT XMTR.</p> <p>5. Verify SIGNAL STRENGTH meter power level is above power check mark on meter face.</p> <p>6. RADAR TEST switch to LDG.</p> <p>7. ALT/RNG MON switch to ALT/ALT RT.</p> <p>8. RATE/ERR MON switch to LDG RDR/CMPTR.</p> <p>10. X-POINTER switch to LO MULT.</p> <p>12. Allow about 1 minute for TRACKER circuit lockup.</p> <p>13. Verify _____ altitude reading per LM Systems Data Book.</p> <p>14. Verify _____ altitude rate reading per LM Systems Data Book.</p> | <p>NOTE</p> <p>Location of this mark currently being evaluated.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>16. Verify _____ forward Velocity Reading per LM Systems Data Book.</p> <p>18. Verify _____ lateral velocity reading per LM systems data book.</p> | <p>15. Verify _____ Forward Velocity reading per LM Systems Data Book.</p> <p>17. Verify _____ lateral Velocity reading per LM Systems Data Book.</p> <p>19. Refer to Flight Data Kit for codes.</p> <p>20. DSKY operations monitor Altitude, Altitude Rate, V, VCE, N, VCE, E.</p> <p>21. Observe DSKY and determine displayed self test values of _____ and _____ indicate proper functioning of landing radar LGC interface for altitude and altitude rate and agree with displays.</p> <p>22. DSKY operations, forward and lateral velocities, N, VCE, E.</p> <p>23. Observe DSKY and determine displayed self test values of _____, indicate proper functioning of landing radar LGC interface for Forward and Lateral Velocities and agree with panel display.</p> <p>24. DSKY operations, enter request to executive to checkout Landing Radar Antenna positioning V, VCE, N, VCE, E.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | |
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| | <p>25. Verify display of code on DSKY indicating that landing radar antenna has moved to appropriate position chosen by LGC or manual override as indicated below, and in LM Systems Data Book.</p> <table><tr><td><u>LDG ANT switch</u></td><td><u>DSKY CODE</u></td></tr><tr><td><u>POSITION</u></td><td><u>FOR</u></td></tr><tr><td>AUTO</td><td>HOVER</td></tr><tr><td>DES</td><td>DESCENT</td></tr><tr><td>HOVER</td><td>HOVER</td></tr><tr><td>DES</td><td>DESCENT</td></tr><tr><td>AUTO</td><td>DESCENT</td></tr></table> | <u>LDG ANT switch</u> | <u>DSKY CODE</u> | <u>POSITION</u> | <u>FOR</u> | AUTO | HOVER | DES | DESCENT | HOVER | HOVER | DES | DESCENT | AUTO | DESCENT | |
| <u>LDG ANT switch</u> | <u>DSKY CODE</u> | | | | | | | | | | | | | | | |
| <u>POSITION</u> | <u>FOR</u> | | | | | | | | | | | | | | | |
| AUTO | HOVER | | | | | | | | | | | | | | | |
| DES | DESCENT | | | | | | | | | | | | | | | |
| HOVER | HOVER | | | | | | | | | | | | | | | |
| DES | DESCENT | | | | | | | | | | | | | | | |
| AUTO | DESCENT | | | | | | | | | | | | | | | |
| 27. X-POINTER switch to HI MULT. | <p>26. X-POINTER switch to HI MULT.</p> <p>28. Radar test switch to OFF.</p> <p>29. Verify alarm tone - audible and LDG RDR caution light is lit.</p> <p>30. Depress CDR's MASTER ALARM PB and verify light out and audio tone is inaudible.</p> <p>31. Pullout PGNS/LDG RDR CB.</p> <p>32. Verify LDG RDR caution light is out.</p> | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>41. <u>STARTUP AND CHECKOUT ABORT GUIDANCE SYSTEM.</u></p> <p>1. AGS STATUS switch to - OPERATE.</p> <p>2. Refer to Flight Data Kit for codes.</p> <p>3. DEDA operations, illuminate and check all EL NUMERIC lamps and OPR ERR light. C, 8 (verify OPR ERR light lights) 88+88888, verify all EL lamp segments illuminate, C.</p> <p>4. DEDA operations, reset error indicators, initiate AGS self test, and readout results of self test, C, 412+00000, VCE, E, C, 412, VCE, R, verify display of +10000 for TEST SUCCESSFULLY COMPLETED.</p> | | |
| <p>42. <u>UPDATE ABORT GUIDANCE SYSTEM NAVIGATIONAL PARAMETERS TO PRIMARY GUIDANCE NAVIGATION AND CONTROL SUBSYSTEM.</u></p> <p>1. Refer to Flight Data Kit for codes.</p> <p>2. DSKY operation, request executive to transform PGNS Downlink state vector information to AGS Computational Coordinate System V, VCE, N, VCE, E.</p> <p>3. DEDA operations, update LM and CSM Status Vectors C, 414+10000, VCE, E.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>JL5-2 LM SEPARATION FROM CSM</u> | | |
| 1. <u>ESTABLISH INDEPENDENT MAINTENANCE OF LM CABIN ENVIRONMENT.</u> | | |
| 1. Cabin dump valve on top hatch - AUTO. | | |
| 2. PRESS REG A and PRESS REG B valve controls - CABIN. | | |
| 3. Verify cabin and suit pressure remain at 4.8 + -.2 PSIA. | | 3. Cabin and suit pressure should be monitored over a period of approximately 2 minutes. |
| 2. <u>SET EVENT TIMER TO COUNTDOWN TO SEPARATION.</u> | | <div>NOTE</div> |
| 1. Set EVENT TIMER to countdown time displayed on DSKY or based on difference between previously recorded scheduled time of event and time on MISSION TIMER. | | Prior to initiation of the LM countdown, it is assumed: |
| 2. EVENT TIMER CONT switch - STOP (momentarily). | | a. All manual docking latches from the CSM end of the docking tunnel have been released. |
| 3. Event timer RESET/COUNT switch - RESET. | | b. CM thermal and pressure hatches have been installed. |
| 4. Event timer RESET/COUNT switch - DOWN. | | |
| 5. Event timer SLEW CONT/MIN switch - TENS and/or UNITS (hold until desired MIN value appears on EVENT TIMER and then release). | | |
| 6. Event timer SLEW CONT/SEC switch - TENS and/or UNITS (hold until desired SEC value appears on EVENT TIMER and then release). | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. Observe DSKY display of countdown time as it approaches ____ MIN and ____ SEC or observe MISSION TIMER as it approaches the scheduled time for event ____ HRS, ____ MIN, ____ SEC, minus ____ MIN, and ____ SEC as set on EVENT TIMER.</p> <p>8. Event timer TIMER CONT switch - START (momentarily as countdown time reaches pre-set value).</p> <p>3. <u>CROSS CHECK FDAIS.</u></p> <p>1. ATTITUDE MON switch - AGS.</p> <p>3. Communicate attitude angles from FDAI.</p> <p>5. ATTITUDE MON switch - PGNS.</p> <p>7. Communicate attitude angles from FDAI.</p> | <p>2. ATTITUDE MON switch - PGNS.</p> <p>4. Listen to attitude angles and respond according to agreement with SE's FDAI.</p> <p>6. ATTITUDE MON switch - AGS.</p> <p>8. Listen to attitude angles and respond according to agreement with SE's FDAI.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>4A. <u>VERIFY LM/CSM SOFT DOCKED CONFIGURATION.</u></p> <p>4B. <u>ACTIVATE DOCKING LIGHTS.</u></p> <p>1. Communicate with CSM to verify that an indication of the establishment of soft docked configuration has been received.</p> <p>5. <u>SECURE SELF AND CABIN FOR SEPARATION.</u></p> <p>1. Remove optical alignment sight (OAS) from storage.</p> <p>2. Install docking reticle device in overhead window for use during separation.</p> <p>3. LTG/OAS circuit breaker - PRESS.</p> <p>6. Remove restraint cables from stowed position on lighting panel and attach to front of harness.</p> <p>8. Remove restraint cables from +Z27 bulkhead and attach to rear of harness.</p> | <p>1. EXTERIOR LTG switch - DOCK.</p> <p>4. Verify all equipment is secure.</p> <p>5. Remove restraint cables from stowed position on AGS panel and attach to front of harness.</p> <p>7. Remove restraint cables from +Z27 bulkhead and attach to rear of harness.</p> | <p>NOTE</p> <p>Prior to initiation of this task, it is assumed:</p> <p>a. LM pressurization valve in CM is set to pressurize the CM tunnel from the LM.</p> <p>b. CM optics are installed.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. <u>SELECT CONTROL MODES FOR SEPARATION USING CHECK LIST AND COUNTDOWN TO MANUAL SEPARATION.</u></p> <ol style="list-style-type: none"> 1. Refer to Flight Data Kit for codes. 2. DSKY operation, Thrust Monitor Program. <ol style="list-style-type: none"> a. VERB pushbutton - PRESS. b. Keyboard entry - 37 - PRESS. c. VERB display - 37. d. ENTER pushbutton - DEPRESS. e. Observe flashing VERB light. f. Keyboard entry - 47 - DEPRESS. g. NOUN display - 47. h. ENTER pushbutton - DEPRESS. j. Observe flashing light terminates. k. PROG display - 47. 3. Verify BAL CPL switch - ON. 4. Verify X-TRANSL switch - 2 JETS. 5. Verify MODE CONTROL switch - OFF. 6. Verify ATTITUDE CONTROL/ROLL, PITCH, and YAW switches - MODE CONT. | | <div>NOTE</div> <p>Prior to initiation of the manual separation check, it is assumed:</p> <ol style="list-style-type: none"> a. CM tunnel illumination switch is off. b. CM docking target and CM external lights on. c. Confirm that spacecraft has obtained proper attitude for separation and minimum deadband attitude hold mode. Crosscheck with LM and MCC. d. CMC programmed for post-separation program attitude and for station keeping. |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---------|
| 7. Verify DEAD BAND switch - MIN. 8. Verify GUID CONT switch - PGNS. 9. Verify RATE/ERR MON switch - LDG RDR/CMPTR. 10. Refer to Flight Data Kit for codes. 11. DSKY operation, Select Minimum Dead Band. <ul style="list-style-type: none"> a. VERB pushbutton - DEPRESS. b. Keyboard entry - 76 - DEPRESS. c. VERB display - 76. d. ENTER pushbutton - DEPRESS. | | |
| 7. <u>COUNT DOWN TO SEPARATION AND SELECT ATTITUDE HOLD.</u> | | |
| 1. Communicate count down to thrust maneuver from minus 20 seconds. 2. At 0 seconds, MODE CONT switch - ATT HOLD. | | |
| 8. <u>PERFORM LM-CSM SEPARATION MANEUVER.</u> | | |
| 1. Operate translation controller in -X for approximately 2.5 seconds to accelerate away from CSM with about .5 FPS delta V. | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>4. Monitor separation using Docking Reticle:</p> <ul style="list-style-type: none"> a. Observe CSM docking target through top window. b. Verify separation without rotation. c. Estimate separation distance. <p>7. Refer to Flight Data Kit for codes.</p> | <ul style="list-style-type: none"> 2. Refer to Flight Data Kit for codes. 3. Monitor DSKY <ul style="list-style-type: none"> a. VERB display - 16 b. NOUN display - _____ c. R₁ upper register display - _____ (Delta V along X - axis). d. R₂ middle register display - _____ (Delta V along Y - axis). e. R₃ lower register display - _____ (Delta V along Z - axis). f. Communicate all delta V values to MCC. 5. Monitor FDAI for stable attitude. 6. Communicate time-from-separation at about 80 seconds. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. DSKY operation, Terminate thrust monitor program.</p> <ul style="list-style-type: none"> a. Thrust terminated b. Separation clearance approximately 40 feet. c. VERB pushbutton - PRESS d. Keyboard entry - 37 - PRESS e. VERB display - 37 f. ENTER pushbutton - PRESS g. Observe flashing VERB light. h. Keyboard entry - 00 - PRESS j. NOUN display - 00 k. ENTER pushbutton - PRESS l. Observe flashing light terminates. m. PROG display - 00 <p>9. MODE CONT switch - AUTO</p> <p>10. DSKY operation, Notify LGC of undocked condition.</p> <ul style="list-style-type: none"> a. VERB pushbutton - PRESS b. Keyboard entry - ____ - PRESS c. VERB display - ____ d. ENTER pushbutton - PRESS | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. LTG/OAS circuit breaker - PULL OUT.</p> <p>9. <u>VERIFY CABIN PRESSURE MAINTAINS 4.8 + -.2 PSIA AFTER SEPARATION.</u></p> <p>10. <u>STOP EVENT TIMER.</u></p> <p>1. Event timer TIMER CONT switch - STOP.</p> | <p>1. Monitor cabin pressure meter and verify cabin pressure remains at 4.8 + -.2 PSIA.</p> | <p>1. Cabin pressure should be monitored over a period of approximately 30 seconds.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>JL6-2 TWO MAN LM PGNCs EARTH ORBITAL RENDEZVOUS</u> | | |
| <p>1. <u>P52/LM-IMU REALIGN PROGRAM</u></p> <p>1. Key into DSKY: V37E, 52E</p> <p>2. POSS FL V50, N07, R1-00005 (PGNCs startup) V37E, 05E</p> <p>3. FL V06 N06</p> <p>R1 - 00005 - Option Code for assumed IMU orientation.</p> <p>R2 - 0000X - LGC assumed option: 00001 Preferred 00002 Nominal 00003 REFSMMAT</p> <p>Accept: V33E Reject: Load desired option.</p> <p>Note: POSS FL V05, N09 R1 - 00215 (Preferred IMU not specified) Select: Nominal V32E or Preferred V37E, - - E (Program to define preferred IMU orientation)</p> | <p>1. Key into DEDA (AUTO SUBMODE) CLR, 400 + 10000, E</p> <p>2. Key into DEDA (CSI) CLR, 410 + 10000, E</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. POSS FL V06 N34 (nominal selected)</p> <p style="padding-left: 40px;">T (align) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p style="padding-left: 40px;">Accept: V33E Reject: Load desired T (align)</p> <p>5. FL V06 N90 (Gimbal angles)</p> <p style="padding-left: 40px;">Roll, pitch, yaw XXX.XX deg Check MGA</p> <p style="padding-left: 40px;">Accept: V33E Verify MODE CONTROL switch - ATT HOLD Reject: Maneuver using attitude controller</p> <p style="padding-left: 40px;">or</p> <p style="padding-left: 40px;">Select new program (R50 - Coarse align)</p> <p>6. Wait - - seconds for completion of coarse alignment until NO ATT light is extinguished.</p> <p>Depress PGNS/AOT LAMP (AC) circuit breaker.</p> <p>Ascend backpack (PLSS) on floor.</p> <p>Azimuth control - F detent (If undocked) - L or R (if docked)</p> <p>Operate AOT reticle illumination</p> <p>Operate AOT reticle control to zero degrees.</p> <p>POSS FL V05 N09 (two stars not available in AOT).</p> | | <p>5. If docked to CSM, request CSM relinquish attitude control.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 20px auto;">NOTE</div> <p>If undocked and the RR antenna blocks the center AOT detent, crew may slew antenna as desired on RADAR panel: RNDZ RADAR MODE switch - SLEW SLEW switch - As Desired.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>R1 - 00405 by pass R56 Verify MODE CONTROL switch - ATT HOLD. Maneuver to acquire stars V33E</p> <p>or</p> <p>Repeat R56 Verify MODE CONTROL switch - ATT HOLD. Maneuver to possible star acquisition V32E (R51 - fine align)</p> <p>7. FL V06 N70</p> <p>R1 000XX (Star code) R2 0000X (Detent code) Accept: V33E Reject: Repeat step 6</p> <p>8. Azimuth control - appropriate detent position If under control of preferred track- ing attitude routine go to step 11.</p> <p>9. FL V50 (Please perform) checklist item number 203 GUID CONT switch - PGNS MODE CONTROL switch - AUTO ENTER</p> <p>or</p> <p>MODE CONTROL switch - ATT HOLD V33E Go to step 12.</p> <p>10. FL V06 N90 R1 XXX.XX TBD Gimbal Angle R2 XXX.XX R3 XXX.XX</p> <p>11. Go to step 13.</p> | <p>Monitor FDAI to avoid gimbal lock.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>12. Maneuver using Attitude Controller.</p> <p>13. FL V50 N25 R100206 (Attitude Trim Maneuver) Accept: Go to step 14 Reject: Maneuver using Attitude Controller.</p> <p>14. Auto trim - GUID CONT switch - PGNS MODE CONTROL switch - AUTO</p> <p>No auto trim - V33E Repeat sequence from step 12.</p> <p>15. FL V21 N70</p> <p>16. Load __ star code and AOT detent.</p> <p>17. FL V53 (Please mark) Verify reticle counter - zero.</p> <p>18. Load V76E (DAP pulse mode). Verify MODE CONTROL switch - A1T HOLD.</p> <p>19. Maneuver using attitude controller.</p> <p>20. Mark X or Y Accept: Enter Reject: Mark reject Repeat 18 and 19 above.</p> <p>21. FL V51 or FL52 Verify reticle counter - zero.</p> <p>22. Maneuver using attitude controller.</p> | <p>Monitor FDAI to avoid gimbal lock.</p> | <div>NOTE</div> <p>An unsatisfactory mark may be rejected by pressing mark reject any time prior to terminating the marking sequence. Possible program alarm if mark reject without prior mark or if surplus mark is entered.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|------------------|---------|
| <p>23. Mark X or Y Accept: Enter Reject: Mark reject Repeat 21 and 22 above.</p> <p>24. FL V50 N25 R1-00016 (Terminate marks)</p> <p>25. Accept: Enter Reject: V33E Repeat sequence from step 16.</p> <p>26. FL V06 N70 R1 - 000XX (star code) R2 - 0000X (detent code) Accept: V33E Reject: V21E Repeat step 26.</p> <p>27. AOT azimuth control - appropriate detent position. If under control of preferred tracking attitude routine go to step 30.</p> <p>28. FL V50 N25 R1-00203 GUID CONT switch - PGNS MODE CONTROL switch - AUTO Enter or MODE CONTROL switch - ATT HOLD V33E (Go to step 31).</p> <p>29. FL V06 N90 R1 - XXX.XX TBD (Gimbal Angle) R2 - XXX.XX R3 - XXX.XX</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---------|
| <p>30. Observe attitude maneuver on FDAI.</p> <p>31. Maneuver using attitude controller.</p> <p>32. FL V50 N25 R1-00206 (Attitude Trim Maneuver) Accept: V33E Reject: Repeat steps 28 through 32</p> <p>33. FL V21 N70 Load star code, AOT detent.</p> <p>34. FL V53 Verify reticle counter - zero deg. V76E (DAP pulse mode) Verify MODE CONTROL switch - ATT HOLD</p> <p>35. Maneuver using attitude controller. Mark X or Y Accept: Enter Reject: Mark reject Repeat step 34 above.</p> <p>36. FL V51 or V52 Verify reticle counter - zero deg.</p> <p>37. Maneuver using attitude controller. Mark X or Y Accept: Enter Reject: Mark reject Repeat step 36 above.</p> <p>38. FL V50 N25 R1-00016 Terminate enter Continue V33E Go to step 33.</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>39. FL V06 N05</p> <p>R1 - XXX.XX If Difference < .05 deg V06 N05 (10 secs) R1 - Star angle difference 000.0X deg (good data, angle < 0.05 deg.)</p> <p>or</p> <p>FL V06 N05</p> <p>R1 - Star angle difference XXX.XX deg (bad data, angle > 0.05 deg.) Accept: V33E Reject: V37E - - E (Select new program) (R55 - Gyro Torquing) (Op- tional)</p> <p>40. V06 N67 (10 seconds)</p> <p>Delta gyro angles X, Y, Z XX.XXX deg All angles < 5 deg. (gyro are torqued)</p> <p>or</p> <p>FL V06 N67</p> <p>Delta gyro angles X, Y, Z XX.XXX deg If any angle > 5 deg. Accept: V33E (Gyros are torqued) Reject: V34E (LGC displays P00)</p> <p>41. FL V50 N25</p> <p>R1-00014 (Fine align check)</p> <p>Accept: Enter (Return to step 7) Reject: V33E</p> <p>42. P00</p> | | <p>If docked, CSM may re-acquire attitude control.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>43. AOT azimuth control Descend from backpack PGNS/AOT LAMP (AC) circuit breaker - OUT.</p> <p>2. <u>P53/LM - IMU ALIGN ROUTINE</u></p> <p>1. Set controls to nominal positions. Except:</p> <p>AOT LAMP circuit breaker - PUSH IN</p> <p>HEATERS/AOT circuit breaker - PUSH IN</p> <p>IMU OPR circuit breaker - PUSH IN</p> <p>2. Key V37E 53E (R02-IMU Status Check)</p> <p>3. POSS FL V50 N07 R1 00005 V37E 05E or POSS FL V50 N07 R1 00051 V37E 51E</p> <p>4. FL V06 N-- R1 000 - Option code, assumed IMU orientation selection R2 0000X - LGC assumed option 00001 = PREF 00002 = NOM</p> <p>Accept: V33E Reject: V22E Load desired code in R2</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>NOTE: POSS FL V05 N31</p> <p>R1 000XX (IMU orientation not specified)</p> <p>Choose nominal orientation: V32E</p> <p>or</p> <p>Select new program: V37E XXE (To specify orientation)</p> <p>For preferred IMU orientation, proceed to step 8.</p> <p>5. FL V06 N - -</p> <p>T (align) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: V25E load desired T (align)</p> <p>6. FL V06 N - -</p> <p>R1 000XX Option code, for assumed LM attitude selection</p> <p>R2 0000X LGC assumed option</p> <p>00001 = PREF 00002 = NOM</p> <p>Accept: V33E Reject: V22E load desired code in R2</p> <p>NOTE: POSS FL V05 N31</p> <p>R1 000XX (LM attitude not specified)</p> <p>Choose nominal attitude: V32E</p> <p>or</p> <p>Select new program: V37E XXE (To specify orientation)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. FL V06 N17</p> <p>OG, IG, MG XXX.XX deg</p> <p>If MG < 45 deg: V33E</p> <p>If MG > 45 deg: V32E - (restart program)</p> <p>8. V01 N25</p> <p>R1 0005X (SC attitude, IMU orientation)</p> <p>00051 = Final IMU and final vehicle</p> <p>00052 = Final IMU and interim vehicle</p> <p>00053 = Interim IMU and final vehicle</p> <p>00054 = Interim IMU and interim vehicle</p> <p>Record value (R60 - attitude maneuver routine)</p> <p>9. FL V50 N25</p> <p>R1 000XX (AUTO MODE control)</p> <p>Accept: MODE CONTROL switch - AUTO</p> <p>GUID CONT switch - PGNS ENTR</p> <p>Reject: GUID CONT and MODE CONTROL switches as desired</p> <p>V33E</p> <p>Maneuver vehicle as desired</p> <p>10. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX DEG</p> <p>Monitor maneuver on FDAI</p> <p>11. POSS FL V50 N25</p> <p>R1 00007 (Attitude trim maneuver)</p> | | <p>(If docked, request CSM to relinquish attitude control.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Accept: MODE CONTROL switch - AUTO GUID CONT switch - PGNS</p> <p>or</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired. V33E Maneuver vehicle as desired. (51 - Fine align)</p> <p>12. FL V06 N30</p> <p>R1 000XX (Star code) R2 XXXX (AOT detent)</p> <p>Accept: V33E Reject: V21E load desired star code (R60 - attitude maneuver)</p> <p>13. FL V50 N25</p> <p>R1 000XX (AUTO mode control)</p> <p>Accept: MODE CONTROL switch - AUTO GUID CONT switch - PGNS</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired V33E Maneuver vehicle as desired</p> <p>14. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX DEG Monitor maneuver on FDAI</p> <p>15. POSS FL V50 N25</p> <p>R1 00007 - Perform (ATT trim maneuver)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---------|
| <p>Accept: MODE CONTROL switch - AUTO GUID CONT switch - PGNS</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired V33E Maneuver vehicle as desired (R53 sighting mark)</p> <p>16. FL V21 N __ (Request load) Load star code in R1 Load AOT detent in R2</p> <p>17. FL V53 Step up on backpack. Reticle to zero, AOT detent as loaded above. Key in V--E (minimum impulse) MODE CONTROL switch - ATT HOLD Maneuver LM so star crosses X or Y reticle line and press appropriate mark button.</p> <p>NOTE: To reselect star: V32E</p> <p>18. POSS FL V51 (Y mark) or V52 (X mark) If necessary: Maneuver LM so star crosses X or Y reticle line and press ap- propriate mark button.</p> <p>19. FL V50 N25 R1 00016 (terminate marks)</p> <p>Accept: ENTR Reject for recycle: New star - V32E Same star - V33E</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>20. Repeat steps 12 through 19 for second star.</p> <p style="padding-left: 40px;">(R54 - star data test)</p> <p>21. V06 N05 (static or flashing)</p> <p style="padding-left: 40px;">Star angle difference XXX.XX deg</p> <p style="padding-left: 40px;">Static indication automatically exits R54</p> <p style="padding-left: 40px;">Flashing indication = angle > 0.5 deg</p> <p style="padding-left: 40px;">Key in new program: V37E --E</p> <p style="padding-left: 40px;">or</p> <p style="padding-left: 40px;">Proceed on bad data; V33E</p> <p style="padding-left: 40px;">(R55 - Gyro torquing)</p> <p>22. FL V06 N67 (Static or flashing)</p> <p style="padding-left: 40px;">Gyro X, Y, Z, XX.XXX DEG</p> <p style="padding-left: 40px;">Flashing indication = any angle > 5 DEG static indication automatically proceeds to next step</p> <p style="padding-left: 40px;">Accept: V33E</p> <p style="padding-left: 40px;">Reject (for termination): V34E</p> <p>23. FL V50 N25</p> <p style="padding-left: 40px;">R1 00014 (fine align check)</p> <p style="padding-left: 40px;">Accept: ENTR</p> <p style="padding-left: 80px;">Return to step 11</p> <p style="padding-left: 40px;">or</p> <p style="padding-left: 40px;">Reject: V33E</p> <p style="padding-left: 40px;">Final vehicle attitude</p> <p style="padding-left: 80px;">(R60 - attitude maneuver)</p> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>24. POSS FL V50 N25</p> <p>R1 000XX (AUTO MODE control)</p> <p>Accept: MODE CONTROL switch - AUTO GUID CONT switch - PGNS ENTER</p> <p>or</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired V33E</p> <p>25. POSS FL V06 N17</p> <p>OG, IG, MG XXX.XX DEG</p> <p>Monitor maneuver on FDAI</p> <p>26. POSS FL V50 N25</p> <p>R1 00007 (attitude trim man- euver)</p> <p>Accept: MODE CONTROL switch - AUTO GUID CONT switch - PGNS ENTR</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired V33E</p> <p>27. FL V50 N07</p> <p>R1 000XX (Original program calling for alignment)</p> <p>V37E --E</p> <p>AOT detent - CL Step down from backpack AOT LAMP circuit breaker - pull out</p> | | <p>(If docked, CSM may re-acquire attitude control.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. <u>P32/LM-PRE-THRUST CSI PROGRAM</u></p> | | <p>Purpose: To evaluate parameters for CSI, CDH, TPI, and TPF. Delta V (TPI) and delta V (TPF) are computed delta V (TPF) assumed to be single impulse midcourse and final corrections are not allowed.</p> |
| <p>1. Key V37E 32E</p> | <p>1. Receive from MCC/CSM & record TIG (CSI) N CDH APSIS E (TPI) TIG (TPI) DELTA T TRANS</p> | <p>2. Compare DSKY & MCC values.</p> |
| <p>2. FL V06 N30</p> <p>GET1 (CS1) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>2. Record TIG (CSI) if different from MCC value.</p> | |
| <p>3. FL V06 N55</p> <p>N CDH APSIS 0000X. E (TPI) XXX.XX DEG</p> <p>Accept: V33E Reject: Reload data</p> | <p>3. Record N CDH APSIS if different from MCC value.</p> | <p>3. Compare DSKY & MCC values.</p> |
| <p>4. FL V06 N37</p> <p>GET1 (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>4. Record TIG (TPI) if different from MCC value.</p> | |
| | <p>5. Record DELTA T TRANS if different from MCC value.</p> <p>If alarm flashes communicate which alarm to MCC.</p> | <p>4. Compare DSKY & MCC values.</p> |
| <p>5. FL V06 N39</p> <p>Delta T transfer 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> <p>NOTE: If FL V05N09 R1 (computation difficulty) Reselect P32 and adjust parameters or select new program.</p> | | <p>5. Compare DSKY & MCC values</p> <p>ALARMS No intersection of desired LOS at TPI with CSNI. Magnitude of delta V (CSI) > 1000 fps Computer cycles for solution excessive Perigee altitude (CSI) < 80 nm Perigee altitude (CDH) < 80 nm Time (CSI to CDH) < 10 minutes Time (CDH to TPI) < 10 minutes Hyperbolic velocity achieved at TPI using orbital parameters planned.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V06 N82 Delta V (CSI) XXXX.X FPS V33E</p> <p>7. FL V06 N31 GET 1 (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC V33E</p> <p>8. FL V06 N57 Delta V (CDH) XXXX.X FPS H (CDH) XXXX.X NM Delta H (CDH) XXXX.X NM V33E</p> <p>9. FL V06 N58 Delta V (TPI) XXXX.X FPS HP (TPI) XXXX.X NM Delta V (TPF) XXXX.X FPS V33E</p> <p>10. FL V16 N35 TT1 (CSI) 00XXX. HRS 000XX. MIN 0XX.XX SEC V33E</p> <p>11. FL V16 N45 N 000XX. MARKS TT1 (CSI) XXBXX MIN-SEC Check N increases 1/min Accept: V33E Reject: V32E V37E32E</p> <p>12. (R02 - IMU status check)</p> | <p>6. Record value of Delta V (CSI). Key into DEDA CLR, 507, Readout (DELTA V CSI, (V_O). Compare PGNCs and AGS DELTA V CSI.</p> <p>7. Key into DEDA CLR 373, Readout (coast time CSI to CDH, T_A). Record value. Subtract GET 1 (CSI) from GET 1 (CDH). Compare results with AGS.</p> <p>8. Key into DEDA CLR 371, Readout (DELTA V CDH, V_{PO}). Compare PGNCs and AGS DELTA V CDH</p> <p>9. Key into DEDA CLR 405, readout (dif- ferential altitude, Δ R_O). Compare PGNS and AGS Delta V. Record value.</p> <p>11. Check maneuver parameters with MCC.</p> | <p>Accept if TTI ≥ 10 minutes. Reject if TTI < 10 minutes or data is unsatisfactory.</p> <p>a) Recycle to step 02.</p> <p>b) Adjust input data.</p> <p>12. No crew action required.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>13. FL V06 N45</p> <p>N 000XX. MARKS TTI (CSI) XXBXX MIN-SEC MGA XXX.XX DEG V33E</p> <p>14. FL V50 N07 (select program) Select propulsion system DPS - Select P40 RCS - Select P41 APS - Select P42</p> | <p>13. On EVENT TIMER panel: TIMER CONT switch - STOP RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT/MIN switch - TENS (hold until___ minutes and release) SLEW CONT/MIN switch - UNITS (hold until___ minutes and release) SLEW CONT/SECS switch - TENS (hold until___ seconds and release) SLEW CONT/SECS switch - UNITS (hold until___ seconds and release) TIMER CONT switch - START Record MGA value.</p> <p>4. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>1. Key into DEDA: CLR, 414 + 10000, E 2. Key into DSKY: V37E, 02E 3. FL V50, N25, R, 00XXX Reject: V33E 4. FL V06, N34 R₁ HRS R₂ MIN R₃ CENTI SECS (K Correction) V33E 5. P20 (END) or FL V50, N07, R, 00000 V37E, 00E (END)</p> <p>5. <u>P41/LM - RCS MANEUVER, NOMINAL</u></p> | <p>Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> <p>Consider in maneuver decision with MCC/CSM</p> <ul style="list-style-type: none"> - Magnitude of DELTA V - Status of propulsion hardware - Time/need to realign IMU <p>NOTE</p> <p>Use this program 10 minutes or less, prior to burn.</p> |
| | <p>1. Observe on FDAI: Pitch angle</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. Key V37E41E (RCS program) (R02 - IMU status)</p> <p>3. FL V06 N46 (mass parameters) IX XXXXX. SLUG-FT SQ IY/IZ XXXXX. SLUG-FT SQ W XXXXX. LB Accept: V30E Reject: V25E Reload data.</p> <p>4. FL V06 N06 Assumed trans. axis code 000-- LM assumed axis option 0000X code Blank Accept: V33E Reject: V22E Reload axis option code in R2.</p> | <p>Roll angle Yaw angle ATTITUDE MON switch - PGNCS Verify on FDAI: Pitch angle Roll angle Yaw angle within ± 5 degrees of previous readings ATTITUDE MON switch - AGS Communicate to CDR that PGNS and AGS agree.</p> <p>3. Request from MCC and/or CSM data on estimated thrust parameters. Record information; transmit information to CDR.</p> <p>4. On EVENT TIMER panel: TIMER CONT switch - STOP RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT/MIN switch - TENS (hold until ____ minutes and release) SLEW CONT/MIN switch - UNITS (hold until ____ minutes and release) SLEW CONT/SEC switch - TENS (hold until ____ seconds and release) SLEW CONT/SECS switch - UNITS (hold until ____ seconds and release)</p> | <p>MCC DATA IX IY/IZ W VGX (LM) VGY (LM) VGZ (LM) PILOT PITCH } PILOT ROLL } for maneuver PILOT YAW }</p> <p>Reset EVENT TIMER only if update required (ignition time slipped, etc.).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>5. FL V06 N85 (VG at ignition)</p> <p>VGX (LM) XXXX.X FPS VGY (LM) XXXX.X FPS VGX (LM) XXXX.X FPS</p> <p>Estimate approx. thrust direction and attitude for various axes.</p> <p>Accept: V33E Reject: V32E</p> <p>Recycle to step 4.</p> <p>6. FL V06 N90 (resulting gimbal angles). Roll, Pitch, Yaw XXX.XX DEG</p> <p>Accept: V33E Reject: V32E</p> <p>Recycle to step 4 or V37E 53E (or 52E)</p> <p>Reselect P41 at completion of P53 (or P52).</p> <p>7. FL V06 N86 (Velocity to be gained local vertical)</p> <p>VGX (LU) .1 FPS VGY (LU) .1 FPS VGZ (LU) .1 FPS</p> <p>8. (R60 attitude maneuver). Monitor maneuver on FDAI.</p> <p>9. FL V50 N25 R1 00203 (Please perform PGNCS auto selection)</p> <p>a) Verify GUID CONT switch - PGNS MODE CONTROL switch - AUTO Key into DSKY, ENTR.</p> <p>b) If trim or manual thrust maneuver: GUID CONT - PGNCS MODE CONT - ATT HOLD</p> | <p>6. Record values.</p> <p>Record values. Transmit to CSM for R32 target delta V. Key into DEDA: CLR, 400 + 30000, E (align AGS to PGNCS) CLR, 400 + 10000, E (auto submode)</p> <p>Monitor maneuver on FDAI.</p> | <p>Consider if YAW > 45° if ±X axis translation used, in decision to accept or reject.</p> <p>May also select P52 or P53 based on time since last alignment, time available, RCS fuel available, and ground concurrence.</p> <p>5 MIN or less prior to burn.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p> V33E FL V06 N85 R1 VGX (LM) R2 VGY (LM) R3 VGZ (LM) Null VG components using TTCA. V33E Do orbital parameter display routine (R30). </p> <p>10. Observe V06 N40</p> <p> MM-SS TT1 (time to ignition) (.1 FPS) VG (velocity to be gained) (.1 FPS) Delta VM (delta V measured) </p> <p>11. Monitor FDAI Roll & Yaw angles for stability.</p> <p>13. Communicate countdown to thrust maneuver from minus 10 seconds to S.E., CSM, MSFN.</p> <p>14. FL V50 N11 (Please perform engine ON).</p> | <p>Key into DEDA (readout magnitude of velocity to be gained VG) CLR, readout. Update event timer if required.</p> <p>Verify CDR's warning lights, SE's caution lights, and master alarm lights-EXT and tone off.</p> <p>12. Verify fuel and oxidizer temp indicator pointers - Green band</p> <p>Verify fuel and oxid press indicator pointers - Aligned</p> <p>Verify RCS SYS A and B TEMP indicator pointers - Green band</p> <p>Verify communication links to CSM/MSFN are usable</p> <p>Verify suit and cabin press indicator pointers - Green band</p> <p>Verify part press CO₂ indicator - Green band</p> <p>Verify glycol temp and press indicator pointers - Green band.</p> | <p>10. If TIG has slip DSKY/EVENT timer will disagree.</p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px auto; width: 100px;">NOTE</div> <p>Do not scan propulsion parameters after last ascent burns.</p> <p>14. Option to inhibit thrust here. Key V34E, FL V50 N07, R1 00000. Key V37E 00E.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>15. Key into DSKY, ENTR.</p> <p>16. Experience RCS firing via vibration, acceleration. Observe V06 N40 R1 TG (time to go to shutdown) R2 VG R3 Delta VM</p> <p>17. Monitor FDAI for attitude error indication.</p> <p>18. Monitor DSKY as engine shutdown occurs. FL V06 N40 R1 - TG (N0) R2 - VG R3 - Delta VM</p> <p>21. Do orbital parameter routine (R30).</p> | <p>16. Experience RCS firing via vibration acceleration. Verify RCS firing to CSM/MSFN.</p> <p>17. Monitor FDAI. FDAI: ATT ERR < _ _ DEG ATT RATES < _ _ DEG/SEC.</p> <p>18. Compare VG on DSKY with VG on DEDA.</p> <p>19. Record final VG and DVM. Key into DEDA (READ OUT PERIGEE) CLR, 343, READOUT. Record perigee. Transmit final values to MSFN. Key into DEDA: CLR, 400 + 10000, E (AUTO SUBMODE)</p> <p>20. Observe Pitch, Roll, and Yaw angles on FDAI. ATTITUDE MON switch - PGNS Verify Pitch, Roll, and Yaw angles on FDAI are within 5 degrees of previous readings. ATTITUDE MON switch - AGS.</p> | <p>16. At TTI = 0, TTI becomes TG.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 6. <u>P40/LM-DPS PROGRAM, ALTERNATE FOR P41</u> | | |
| <p>1. Key V37E, 40E (R02 - IMU status check)</p> <p>2. POSS FL V50, N07 R, 00005 V37E, 05E</p> <p>3. POSS FL V50, N07 R, 00005 V37E, 51E</p> <p>4. FL V06 N46 IX XXXXX. Slug-Ft Sq IY/IZ XXXXX. Slug-Ft Sq W XXXXX. LB Accept: V33E Reject: Load desired parameters</p> <p>5. V06 N70 Pitch trim XXX.XX DEG Yaw trim XXX.XX DEG TLX XXXXX. 100 LB Accept: V33E Reject: Load desired parameters</p> <p>6. FL V06 N86 VGZ (LV) XXXX.X FPS VGY (LV) XXXX.X FPS VGZ (LV) XXXX.X FPS V33E</p> | <p>1. Receive from MCC/CSM and record: IX IY/IZ Yaw trim Pitch trim TLX VGX (LV) VGY (LV) VGX (LV)</p> <p>4. Record IX, IY, IZ & W if different from MCC values.</p> <p>5. Record VGX, VGY, VGZ if different from MCC values. Communicate values to CSM.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. FL V06 N90 (Future angles if preferred LM attitude and present IMU orientation.)</p> <p>If IMU orientation unsatisfactory, select P52 or P53, upon completion reselect P40.</p> <p>IMU orientation is satisfactory:</p> <p>V33E</p> <p>(R60 - attitude maneuver).</p> <p>8. POSS FL V50 N25</p> <p>R1 00203 (LM Mode - AUTO)</p> <p>Accept: MODE CONTROL switch - AUTO</p> <p>Enter</p> <p>Reject: GUID CONT and MODE CONTROL switches - As desired</p> <p>V33E</p> <p>9. POSS FL V06 N90</p> <p>OG XXX.XX DEG</p> <p>IG XXX.XX DEG</p> <p>MG XXX.XX DEG</p> <p>Monitor maneuver on FDAI.</p> <p>10. FL V50 N25</p> <p>R1XXXXXX - (Engine gimbal drive enable)</p> <p>Accept: ENTR</p> <p>Reject: V33E</p> | <p>7. Observe Pitch, Roll, & Yaw angles on FDAI.</p> <p>ATTITUDE MON switch - PGNS</p> <p>Observe Pitch, Roll, & Yaw angles on FDAI.</p> <p>ATTITUDE MON switch - AGS</p> <p>Compare maneuver requirements and on board propellant supplies.</p> <p>Communicate with MCC/CSM on maneuver attitude, propellant quantities, and ground station coverage.</p> <p>Key into DEDA: CLR, 400 + 30000, E (ALIGN AGS to PGNS).</p> <p>CLR, 400 + 10000, E (AUTO SUBMODE)</p> <p>Time constraint TIG - 5 minutes.</p> <p>8. Verify:</p> <p>MODE CONTROL switch - AUTO</p> <p>GUID CONT switch - PGNS</p> <p>Observe EVENT TIMER.</p> <p>Communicate time to CDR.</p> <p>Verify ENG GMBL switch - ENABLE</p> <p>ENG GMBL caution light - EXTINGUISHED</p> | <p>SE angles should be within $\pm 5^\circ$ of former values. If not see block L1.</p> <p>Consider in decision on IMU orientation:</p> <p>a) Is MGA $> 45^\circ$</p> <p>b) Is reorientation required?</p> <p>c) Is alignment required?</p> <p>d) Impact of manual thrust control</p> <p>No thrusting without ground station coverage.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>11. POSS FL V05 N09 R1 XXXXX (Ignition time < 45 sec) SLIP engine ignition - V33E</p> <p>12. Verify restraint cables attached. Secure cabin.</p> <p>13. Verify DEAD BAND switch - MIN Verify ATTITUDE CONTROL/ ROLL, PITCH, and YAW switches - MODE CONT Verify MODE CONTROL switch - AUTO Verify GUID CONT switch - PGNS Verify RATE/ERR MON switch - LDG RDR/CMPTR Verify angle error needles are within deadband. Verify THR CONT switch - AUTO Verify MAN THROT switch - CDR.</p> <p>14. FL V06 N40 TTI XXBXX MIN-SEC VG XXXX.X FPS Delta VM XXXX.X FPS Check C/W lamps. Delta VM > 0.5 FPS for TTI. Between 15 and 30 seconds.</p> <p>15. When Delta VM > FPS, ENG ARM switch - DES.</p> <p>16. Monitor EVENT TIMER. Monitor X-POINTER for azimuth LOS rate in the interval + or - * *M RAD/SEC and elevation LOS rate in the interval + or -* *M RAD/SEC as per flight plan.</p> | <p>12. Verify restraint cables attached. Secure cabin.</p> <p>13. Verify RCS TEMP/PRESS MON switch - He Verify HELIUM MON switch - DES/ SUPCRIT PRESS PRPLNT TEMP/PRESS MON switch - DES 1 PRPLNT QTY MON switch - DES 1 Verify O₂/H₂O QTY MON switch -DES Verify RATE/ERR MON switch - LDG RDR/CMPTR.</p> <p>Update EVENT TIMER.</p> <p>Key into DEDA (readout VG) CLR, 370 readout.</p> <p>16. Verify CDR's warning lights: ASC PRESS - EXT DES REG - EXT DES QTY - EXT CES AC - EXT CES DC - EXT</p> | <p style="text-align: center;">NOTE</p> <p>If Delta VM is greater than 0.5 FPS consider:</p> <p>a) Switching to AGS control. b) Manual firing of the engine. c) Firing with LGC anyway.</p> <p>If ignition slipped.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Monitor FDAI attitude error display - within deadband</p> <p>Monitor FDAI for zero attitude rates *+ or - DEG PER SEC*</p> <p>Monitor FDAI pitch angle is in appropriate interval for mission phase * to Degrees*</p> <p>Monitor FDAI Roll and Yaw angles for stability.</p> | <p>AGS - EXT LGC - EXT ISS - EXT RCS TCA - EXT RCS A REG - EXT RCS B REG - EXT DC BUS - EXT CABIN - EXT SUIT FAN - EXT</p> <p>Verify SE's caution lights:</p> <p>ASC HI REG - EXT ASC QTY - EXT ENG GIMBAL - EXT PGNS - EXT INVERTER - EXT BATTERY - EXT RNDZ RDR - EXT LDG RDR - EXT PRE AMPS - EXT RCS - EXT HEATER - EXT C/W PWR - EXT ECS - EXT O2 QTY - EXT GLYCOL - EXT WATER QTY - EXT</p> <p>Verify FUEL and OXID TEMP indicator pointer - Green band</p> <p>Verify FUEL and OXID PRESS indicator pointers - Aligned</p> <p>Verify RCS SYS A and B TEMP indicator pointer - Green band</p> <p>Verify RCS SYS A and B PRESS indicator pointers - Aligned</p> <p>Verify SUIT and CABIN PRESS indicator pointer - Green band</p> <p>Verify PART PRESS CO₂ indicator pointer - Green band</p> <p>Verify GLYCOL TEMP and PRESS indicator pointers - Green band</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>17. Communicate countdown to engine ignition from - 10 sec. Verify RCS ullage ignition via sound, vibration and acceleration at - 7.5 sec. Monitor error needles on FDAI for within deadband. Monitor FDAI for constant attitude.</p> <p>Pitch * * Roll * * Yaw * *</p> <p>18. FL V50 N11 (engine enable)</p> <p>TTI XX, XX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS</p> <p>Accept: ENTR Reject: -V34E (Thrust on at TTI = 0)</p> <p>19. Monitor descent engine ignition * 7.5 * SEC after RCS ignition via vibration, sound and acceleration. Verify that both thrust needles are aligned and indicate * * % thrust for * * seconds and then * * % thrust for * * seconds. Verify error needles stabilize at the error signal required to offset thrust misalignment. Verify that position error decreases as engine gimbaling decreases vehicle moment unbalance.</p> <p>Verify that thrust increases to * * % after error needles move to within deadband and that both needles are aligned.</p> <p>Monitor EVENT TIMER, monitor X-pointer for ZERO lateral velocity * + - FPS * and * * forward velocity indication.</p> <p>Monitor thrust indicator for ENG and CMD needles aligned * + or - * %.</p> | <p>17. Monitor ENG GMBL caution light for malfunction indication.</p> <p>19. Monitor RCS propellant quantities for about ____ % usage during gimbal alignment with decreased propellant expenditure as a function of decreasing vehicle moment of unbalance.</p> <p>Monitor descent propulsion OXID and FUEL QTY for about * * % usage.</p> <p>Communicate Delta V to CDR.</p> <p>Verify CDR's warning lights:</p> <p>ASC PRESS - EXT DES REG - EXT DES QTY - EXT CES AC - EXT CES DC - EXT AGS - EXT LGC - EXT ISS - EXT RCS TCA - EXT RCS A REG - EXT RCS B REG - EXT DC BUS - EXT CABIN - EXT SUIT FAN - EXT</p> | <p style="text-align: center;">NOTE</p> <p>The option of inhibiting engine ignition exists at this time. It has been assumed that the option will not be exercised during nominal sequences.</p> <p style="text-align: center;">NOTE</p> <p>The forward velocity indication depends upon whether the MODE SEL switch was set to PGNS or AGS in a previous task. In AGS it always reads zero, but in PGNS it reads correctly up to full scale.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>Monitor FDAI attitude error display for within deadband.</p> <p>Monitor FDAI for zero attitude rates * + or - DEG PER SEC*.</p> <p>Monitor FDAI pitch angle is in appropriate interval for mission phase * to degrees*.</p> <p>Monitor FDAI Roll and Yaw angles for zero degrees * + or - degrees*.</p> <p>Monitor T/W is in the appropriate interval for mission phase * to lunar G's*.</p> | <p>Verify SE's caution lights:</p> <p>ASC HI REG - EXT</p> <p>ASC QTY - EXT</p> <p>ENG GIMBAL - EXT</p> <p>PGNS - EXT</p> <p>INVERTER - EXT</p> <p>BATTERY - EXT</p> <p>RNDZ RDR - EXT</p> <p>LDG RDR - EXT</p> <p>PRE AMPS - EXT</p> <p>RCS - EXT</p> <p>HEATER - EXT</p> <p>C/W PWR - EXT</p> <p>ECS - EXT</p> <p>O2 QTY - EXT</p> <p>GLYCOL - EXT</p> <p>WATER QTY - EXT</p> <p>Verify FUEL and OXID TEMP indicator pointers - Green band</p> <p>Verify FUEL and OXID PRESS indicator pointers - Aligned</p> <p>Verify RCS SYS A and B TEMP indicator pointers - Green band</p> <p>Verify RCS SYS A and B PRESS indicator pointers - Aligned</p> <p>Verify SUIT and CABIN PRESS indicator pointers - Green band</p> <p>Verify PART PRESS CO2 indicator pointer - Green band</p> <p>Verify GLYCOL TEMP and PRESS indicator pointers - Green band</p> <p>Read DES PROPULSION OXID and FUEL QTY for * * to * * % remaining.</p> <p>Read descent propulsion helium pressure as * * to * * psia.</p> <p>Read RCS propellant QTY for about * * to * * % remaining.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>21. V06 N40 TG XXBXX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS When TG and VG = 0, position ENG ARM switch - OFF.</p> <p>22. Verify engine shut down via displays, and cessation of noise, vibration and acceleration. MASTER ARM - OFF.</p> <p>23. V06 N40 TG XXBXX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS V33E - No trim maneuver Key V37E 41E for final trim - RCS Receive orbital data from MSFN (R30 - orbital parameter display)</p> <p>7. <u>POST THRUST EVALUATION</u></p> <p>1. MODE CONTROL switch - AUTO</p> <p>2. R30 Orbital parameter routine.</p> | <p>20. Verify CDR bus reading is * * vdc. Operate POWER/TEMP MON switch BUS/SE and BUS/AC positions and verify voltages. Operate POWER/TEMP MON switch to BAT 1-6 and verify parameters on VOLTS and AMPS meters. POWER/TEMP MON switch - BUS/CDR.</p> <p>Compare VG on DSKY with VG on DEDA. Record final VG & Delta VM. Key into DEDA (Read out perigee) CLR, 343, READOUT Record Perigee. Key into DEDA: CLR, 400 + 10000 E (AUTO SUBMODE).</p> <p>23. Transmit to MSFN terminal values of Delta VM and VG. Receive opinion from MSFN on need for final RCS trim. Compare Delta VM value on DSKY against VG value on DEDA. Call up perigee on DEDA. Record VG & perigee from DEDA and Delta VM from DSKY. Transmit DEDA values to MSFN.</p> <p>2. Receive trajectory data from MCC: Perigee Apogee Time to freefall</p> | <p>Flash starts at TG = 0.</p> <p>NOTE</p> <p>The orbital parameter routine may also be entered by key V64E, though it is normally entered auto- matically after a thrust program.</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>9. Verify CDR's warning lights extinguished:</p> <p>ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT FAN</p> <p>10. Verify SE's caution lights extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O2 QTY GLYCOL WATER QTY</p> <p>11. Ascent and descent, FUEL TEMP indicator - Ascent and descent, OXID TEMP indicator - Ascent and descent, FUEL PRESS and OXID PRESS indicator - Aligned RCS SYS A and SYS B TEMP indicator - In Green Band</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>12. Receive optical tracking trajectory data from CSM.</p> <p>13. TM Calib - CALIB Hold for 12 seconds.</p> <p>14. Prepare for next maneuver.</p> <p>8. <u>USE PROGRAM NO. 25, PREFERRED TRACKING ATTITUDE</u></p> <p>1. Refer to flight data kit.</p> <p>2. Key V37E, 25E R01 Program selection check R02 IMU status check POSS FL V50, N07 R1 - 00005 (PGNCS startup request) V37E, 05E and/or POSS FL V50 N07 R1 - 00051 (IMU orientation determination request) V37E 51E Variable time.</p> <p>3. Key V56E to terminate.</p> | <p>RCS SYS A and SYS B PRESS indicator - Aligned SUIT PRESS indicator - In Green Band CABIN PRESS indicator - In Green Band PART PRESS CO₂ indicator - In Green GLYCOL TEMP and PRESS indicator - In Green Band</p> <p>Record. Compare MCC, CSM, DEDA & DSKY trajectory values.</p> | <p>NOTE</p> <p>P25 runs in the background without the program No. being displayed when another program is also running.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|---|
| <p>9. <u>P20 LM-RENDEZVOUS NAVIGATION PROGRAM</u></p> <p>1. Key V37E 20E (R02 - IMU status check)</p> <p>2. POSS FL V50 N07 R1-00005 (PGNCS startup request) V37E 05E or POS FL V50 N07 R1-00051(IMU orientation determination request) V37E 51E</p> <p>3. FL V06 N06 R1 00001(option code for assumed state vector to be updated) R2 0000X LGC assumed option 00001 - LM 00002 - CSM Accept (state vector improvement assumption): V33E Reject: V22E load desired state vector code in R2</p> <p>4. FL V06 N06 R1 00002(option code for assumed acquisition mode employment) R2 0000X LGC assumed option 00001 - AUTO 00002 - MANUAL Accept: (assumed acquisition mode): V33E Reject: V22E load desired acquisition mode code in R2 Confirm CSM at "preferred" attitude and transponder operable. Verify RR AC & DC circuit breakers closed.</p> | | <p style="text-align: center;">NOTE</p> <p>Recommend LM in preferred tracking attitude for manual acquisition.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>(R23 - RR manual acquisition routine)</p> <p>FL V50 N25</p> <p>00205 (perform manual acquisition)</p> <p>Set:</p> <p>RNDZ RADAR mode selector to SLEW</p> <p>Verify RATE/ERR MON switch - RNDZ RADAR</p> <p>Search for CSM manually and upon acquisition verify that acquisition is not side lobe. Then set RNDZ RADAR switch to LGC and key ENTR.</p> <p>NOTE:</p> <p>POSS FL V05 N09</p> <p>R1 00526</p> <p>(CSM > 400 NM)</p> <p>If desired to wait until CSM < 400 NM, rendezvous parameter display routine (R31) may be used to monitor range by keying in V--E and return to this display is made by keying KEY REL. Key V32E for recycle.</p> <p>or</p> <p>Terminate P20 by V56E</p> <p>(R61 - Preferred tracking attitude routine)</p> <p>5. POSS FL V50 N25</p> <p>R1-000XX - Perform auto mode selection</p> <p>Set MODE CONTROL switch to AUTO, V33E</p> <p>(R60 - attitude maneuver routine)</p> <p>Monitor maneuver on FDAI.</p> <p>(R21 - RR designate routine)</p> | | <p>SHFT/TRUN angles - $\pm 5^\circ$ or $\pm 50^\circ$ as required.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>NOTE:</p> <p>POSS FL V05 N09</p> <p>R1-XXXXXX</p> <p>If alarm code indicates CSM is not being acquired, key reset and perform one of the following:</p> <p>V33E for R24 RR search routing</p> <p>or</p> <p>V56E to terminate P20</p> <p>or</p> <p>V56E to terminate P20, then reselect P20</p> <p>(R20 - RR data read routine)</p> <p>POSS FL V05 N09 (delta theta alarm)</p> <p>R1-00525</p> <p>V33E</p> <p>6. POSS FL V06 N05</p> <p>Delta theta XXX.XX DEG</p> <p>Accept: V33E</p> <p>Reject: V32E (recycle to step 5)</p> <p>7. POSS FL V06 N48</p> <p>Delta P XXXX.X NM</p> <p>Delta V XXXXX.FPS</p> <p>Accept: V33E</p> <p>Reject: V32E (recycle to step 6)</p> <p>or</p> <p>V37E 20E and select manual acquisition.</p> <p>Variable time.</p> <p>8. V37E 00E (no other program in process)</p> <p>or</p> | | <p>NOTE</p> <p>Once CSM acquired P20 runs in the background until terminated.</p> |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| V56E (another program beside P20 in process) | 9. EXTERIOR LTG switch - TRACKING/ BRIGHT | (If distance to CSM equal to or greater than 130 NM) |
| 10. <u>P52/LM-IMU REALIGN PROGRAM (Repeat step 1)</u> | | |
| 11. <u>P53/LM-IMU ALIGN ROUTINE (Repeat step 2)</u> | | |
| 12. <u>P33/LM-PRE-THRUST CDH PROGRAM</u> | | Purpose: To calculate parameters for CDH, TPI and TPF. DELTA V (TPI) and Delta V (TPF) are computed. Delta V (TPF) assumed to be single impulse. Mid-course and final correction are not allowed for. |
| 1. Key V37E 33E | Receive from MCC/CSM & record: TIG (CDH) N CDH APSIS E TIG (TPI) DELTA T TRANS | |
| 2. FL V06 N31 GET1 (CDH) 00XXX. HRS 000XX. MIN 0XX.XX SEC | Record TIG (CDH) if different from MCC value. | |
| Accept: V33E Reject: Reload data | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. FL V06 N39</p> <p>Delta V transfer 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> | <p>Record DELTA T TRANS if different from MCC value.</p> | |
| <p>4. FL V06 N37</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX.XX SEC</p> <p>Accept: V33E Reject: Reload data</p> <p>FL V05 N31 Alarm</p> <p>V32E Recycle</p> | <p>Record TIG (TP1) if different from MCC value.</p> <p>If ALARM flashes, communicate to MCC which alarm</p> | <p>NOTE</p> <p>If GETI (TPI) - GETI (CHD) < 10 min.</p> <p>FL V05 N31 R1 00604</p> <p>Program alarm, reset, recycle V32E and define GETI (TPI).</p> <p>NOTE</p> <p>If hyperbolic LM velocity results:</p> <p>FL V05 N31 R1 00607</p> <p>Program alarm. 00607 Reset, recycle V32E and adjust parameters.</p> |
| <p>5. FL V06 N57</p> <p>Delta V (CDH) XXXX.X FPS ALT (CDH) XXXX.X NM Delta Alt (CDH) XXXX.X NM</p> <p>V33E</p> | <p>Record values.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. FL V06 N55</p> <p>Blank Blank HP (CDH) XXXX. X NM</p> <p>V33E</p> | Record value. | |
| <p>7. FL V06 N58</p> <p>Delta V (TPI) XXXX. X FPS HP (TPI) XXXX. X NM Delta V (TPF) XXXX. X FPS</p> <p>V33E</p> | Record value. | |
| <p>8. FL V16 N35</p> <p>TTI (CDH) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> | | |
| <p>9. FL V16 N45</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC Blank</p> <p>Check N increase 1/minute</p> <p>Accept: V33E Reject: V32E V37E33E</p> | Check maneuver parameters with MCC. | <p>Accept if TTI \geq 8 minutes. Reject if TTI < 8 minutes or data unsatisfactory.</p> <p>a) Recycle to step 02.</p> <p>b) Adjust input data.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>10. FL V16 N45</p> <p>N 000XX. MARKS TTI (CDH) XXBXX MIN-SEC MGA XXX. XX DEG</p> <p>V33E</p> | <p>On EVENT TIMER panel:</p> <p>TIMER CONT switch - STOP</p> <p>RESET/COUNT switch - RESET</p> <p>RESET/COUNT switch - DOWN</p> <p>SLEW CONT/MIN switch - TENS (hold until___ minutes and release)</p> <p>SLEW CONT/MIN switch - UNITS (hold until___ minutes and release)</p> <p>SLEW CONT/SECS switch - TENS (hold until___ seconds and release)</p> <p>SLEW CONT/SECS switch - UNITS (hold until___ seconds and release)</p> <p>TIMER CONT switch - START</p> <p>Record MGA value.</p> | <p>Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> |
| <p>11. FL V50 N07</p> <p>R1 00040 (select program)</p> <p>Select propulsion system.</p> | <p>Key into DEDA CLR, 410 + 20000, E (CDH burn).</p> | <p>Consider in maneuver decision with MCC/CSM</p> <ul style="list-style-type: none"> - Magnitude of delta V - Status of propulsion hardware - Time/need to realign IMU <p>Exact time TBD.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|--|---|
| 13. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS.</u> (Repeat step 4.) 14. <u>P41/LM-RCS MANEUVER, NOMINAL.</u> (Repeat step 5.) 15. <u>P40/LM-DPS PROGRAM, ALTERNATE FOR P41.</u> (Repeat step 6.) 16. <u>POST THRUST EVALUATION.</u> (Repeat step 7.) 17. <u>P52/LM-IMU REALIGN PROGRAM.</u> (Repeat step 1.) 18. <u>P53/LM-IMU ALIGN ROUTINE.</u> (Repeat step 2.) 19. <u>P34/LM-PRE-THRUST TPI PROGRAM</u> | | |
| 1. Key V37E 34E 2. FL V06 N06 R1-00003 (TPI load option) R2-00001 - Load GETI (LGC computes E) OR 00002 - Load E (LGC computes GETI) Accept: V33E Reject: LOAD DATA | Receive from MCC/CSM and record TIG (TPI) E DELTA T TRANS | <div>NOTE</div> <p> Purpose of this program is to calculate Delta V required and I. C. for TPI given GETI (TPI) or E (TPI) and transfer duration. </p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. IF 00001 Accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>Accept: V33E Reject: RELOAD DATA</p> <p>OR IF 00002 Accepted:</p> <p>FL V06 N55</p> <p>R2-E (TPI) XXX. XX DEG</p> <p>Accept: V33E Reject: LOAD DATA</p> <p>4. POSS FL V05 N31 R1 00611 (GETI IMPOSSIBLE)</p> <p>V32E- Load New E (TPI) or reselect P34 - Load new GETI</p> <p>5. FL V06 N39</p> <p>Delta T TRANS 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>Accept: V33E Reject: LOAD DATA</p> <p>6. POSS FL V05 N09 R1 00607 (DELTA V TOO GREAT)</p> <p>V32E - LOAD NEW DELTA T TRANS</p> | <p>Key into DEDA CLR, 277 + XXXXX (Tlgc .1 MIN, desired fixed absolute time of TPI.) CLR, 311 + XXX. XX (63 .01 MIN DELTA and TRANS) Record DELTA and TRANS USED if different from MCC value. Key into DEDA CLR, 410 + 40000 E (TPI)</p> <p>Tell MCC if alarm flashes.</p> | <p>NOTE</p> <p>Use of MCC values should prevent this alarm.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>7. IF 00001 Accepted:</p> <p>FL V06 N55</p> <p>R2- E (TPI) XXX.XX DEG V33E</p> <p>OR IF 00002 Accepted:</p> <p>FL V06 N34</p> <p>GETI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> <p>8. FL V06 N58</p> <p>Delta V (TPI) XXXX. X FPS HP (TPI) XXXX. X NM Delta V (TPF) XXXX. X FPS V33E</p> <p>9. FL V06 N35</p> <p>TTI (TPI) 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p>V33E</p> <p>10. FL V16 N45</p> <p>N 000XX. MARKS TTI (TPI) XXBXX MIN-SEC</p> <p>Check data with ground Check N increases 1/MIN.</p> <p>Accept: V33E (no later than TTI= 8 MIN)</p> <p>Reject: If time permits recycle V32E</p> <p>(R02-IMU status check)</p> | <p>Record value(s) used if different from MCC value(s).</p> <p>Record values</p> <p>Key into DEDA CLR, 343, readout (q, 1000 ft, predicted Perigee TPI) Compare (q1 with HP)</p> | <p>NOTE</p> <p>Must convert between NM and thousands of feet.</p> <p>NOTE</p> <p>RR active</p> |

| COMMANDER | | SYSTEMS ENGINEER | REMARKS |
|-----------|---|--|---|
| 11. | FL V06 N45 N TTI (TPI) MGA V33E 000XX. MARKS XXBXX MIN-SEC XXX. XX DEG | On EVENT TIMER panel: TIMER CONT switch - STOP RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT/MIN switch - TENS (hold until _____ minutes and release) SLEW CONT/MIN switch - UNITS (hold until _____ minutes and release) SLEW CONT/SECS switch - TENS (hold until _____ seconds and release) SLEW CONT/SECS switch - UNITS (hold until _____ seconds and release) TIMER CONT switch - START Record MGA value. | Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start). |
| 12. | FL V50 N07 R100040 (SELECT PROGRAM) | | Consider in maneuver decision with MCC/CSM: a. Value of Delta V b. Status of propulsion hardware c. Time available for IMU realignment |
| 20. | <u>USE LGC PROGRAM No. 2 TO UPDATE AGS STATUS VECTORS.</u> (Repeat step 4.) | | |
| 21. | <u>P41/LM - RCS MANEUVER, NOMINAL. (Repeat step 5.)</u> | | |
| 22. | <u>P40/LM - DPS PROGRAM, ALTERNATE FOR P41. (Repeat step 6.)</u> | | |
| 23. | <u>POST THRUST EVALUATION. (Repeat step 7.)</u> | | |

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| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>24. <u>P35/LM - PRE-THRUST TPM PROGRAM.</u></p> <p>1. Key V37E 35E</p> <p>2. FL V16 N35</p> <p style="margin-left: 40px;">TT INT 00XXX. HRS 000XX. MIN 0XX. XX SEC</p> <p style="margin-left: 40px;">V33E</p> <p>3. FL V16 N45</p> <p style="margin-left: 40px;">N 000XX. MARKS TT INT XXBXX MIN-SEC</p> <p style="margin-left: 40px;">NOTE: If TT INT < 20 MIN select P36.</p> <p style="margin-left: 40px;">Check N increases 1/MIN when ready: V33E</p> <p style="margin-left: 40px;">NOTE: Time on mission timer add 7 min., result TIG (ID) communicate to SE</p> | <p>Verify RR actively tracking CSM</p> <p>On EVENT TIMER panel:</p> <p style="margin-left: 20px;">TIMER CONT switch - STOP RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT/MIN switch - TENS (hold until ____ minutes and release) SLEW CONT/MIN switch - UNITS (hold until ____ minutes and release) SLEW CONT/SECS switch - TENS (hold until ____ seconds and release) SLEW CONT/SECS switch - UNITS (hold until ____ seconds and release) TIMER CONT switch - START</p> | <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">NOTE</div> <p>Purpose of this program is to calculate Delta V required and I. C. for next MCC during active LM rendezvous. To display data for crew to enter P36 at correct time to complete thrust maneuver at first range gate.</p> <p>Set EVENT TIMER to future DSKY time (Time of EVENT TIMER start).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| 4. FL V16 N45 N 000XX. MARKS TTI (MID) XXBXX MIN-SEC MGA V33E | Key into DEDA CLR, 227 + XXXX.X (T_{Lgc} .1 MIN, desired fixed absolute time and course) Record values | This assumes additional state vector updates not required. |
| 5. FL V16 N59 DELTA V XXXX.X FPS (MID) TTI (MID) XXBXX MIN-SEC DELTA V XXXX.X FPS (TPF) If MCC burn not required: V32E recycle to step 1. MCC burn required: V33E | Record values. | Consider in maneuver decision: a. Magnitude of Delta V. b. Status of propulsion hardware. c. Time/need to realign IMU. |
| 6. FL V50 N07 R1-00040 (select program) Select propulsion system DPS - Select P40 NCS - Select P41 APS - Select P42 | | |
| 25. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS. (Repeat step 4.)</u> | | |
| 26. <u>P41/LM-RCS MANEUVER. (Repeat step 5.)</u> | | |
| 27. <u>POST THRUST EVALUATION. (Repeat step 7.)</u> | | |
| 28. <u>P35/LM - PRE-THRUST TPM PROGRAM. (Repeat step 24.)</u> | | |
| 29. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS. (Repeat step 4.)</u> | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>30. <u>P41/LM - RCS MANEUVER, NOMINAL. (Repeat step 5.)</u></p> <p>31. <u>POST THRUST EVALUATION. (Repeat step 7.)</u></p> <p>32. <u>P35/LM - PRE-THRUST TPM PROGRAM. (Repeat step 24.)</u></p> <p>33. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS. (Repeat step 4.)</u></p> <p>34. <u>P41/LM - RCS MANEUVER, NOMINAL. (Repeat step 5.)</u></p> <p>35. <u>POST THRUST EVALUATION. (Repeat step 7.)</u></p> <p>36. <u>P36/CM TRANSFER PHASE FINAL.</u></p> | | |
| <p>1. Key V37E 36E</p> <p>2. FL V06 N54 (Rendezvous Data)</p> <p>Range XXX.XX NM Range Rate XXXX.X FPS Theta XXX.XX DEG</p> <p>3. Shaft/Trunnion - $\pm 5^\circ$ Mode Control - ATT HOLD Range ALT. MON - Range/Range Rate</p> <p>4. Drive pilot roll angle to zero using ATCA. Maintain attitude.</p> <p>5. Drive LOS Azimuth and Elevation angles to null on FDAI. Using ATCA maintain null.</p> <p>6. Drive azimuth and elevation angular rates to null using TTCA.</p> | <p>Receive from MCC/CSM and Record</p> <ul style="list-style-type: none"> - Range/Range Rate Schedule at each check point - Angle between +Z LM axis and Local horizontal plane per check point | <p>NOTE</p> <p>RR is active. Program 20 (Rendezvous Navigation) points LM +Z axis to CSM within $\pm 30^\circ$. FDAI cross pointer needless display LOS angles. Cross pointer meters display LOS azimuth and elevation angle rates.</p> <p>NOTE</p> <p>"Fly to" cross pointer needless on FDAI.</p> <p>NOTE</p> <p>"Fly to" cross pointer needles on cross pointer meter TTCA LEFT/RIGHT and/or UP/DOWN</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 7. Range * * Range Rate * * Drive Range Rate to * * using TTCA | Communicate Range/Range Rate data at each check point to MCC. Receive new Range/Range Rate schedule from MCC as required. | Follow MCC schedule Correct all non-null deviations immediately rather than allow deviation build-up TTCA IN/OUT |
| | 8. Monitor DSKY "Tracker" | RR data lost. Malfunction or CSM ≤ 0.02 NM away |
| 9. Repeat step 7 as required. V33E | | All maneuvers complete. |
| | 10. Verify FL V06 N54 stops | |
| 11. FL V50 N07 00000 V37E 00E | | |
| 12. P00 | | |
| 37. <u>P36/LM - TRANSFER PHASE FINAL. (Repeat step 36.)</u> | | |
| 38. <u>P36/LM - TRANSFER PHASE FINAL. (Repeat step 36.)</u> | | |
| 39. <u>P36/LM - TRANSFER PHASE FINAL. (Repeat step 36.)</u> | | |

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| | <p>40. P53/LM-IMU ALIGN ROUTINE (Repeat step 2)</p> <p>41. P52/LM-IMU REALIGN ROUTINE (Repeat step 1)</p> <p>42. P32/LM - PRE-THRUST CSI PROGRAM (Repeat step 3)</p> <p>43. USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS (Repeat step 4)</p> <p>44. P41/LM-RCS MANEUVER- NOMINAL (Repeat step 5)</p> | |
| 45. <u>APS THRUSTING - ALTERNATE TO P 41 RCS THRUSTING</u> | | |
| <p>1. Key V37E 42E (R02 - IMU status check)</p> <p>2. POSS FL V50 N07 R1 00005 (PGNCS startup) V37E 05E OR R1 0051 (IMU orientation determination) V37E 51E</p> | <p>1. Receive from MCC the following data: Ix Iy/Iz W VGx(LV) VGy(LV) VGz(LV)</p> <p>2. Cross check PGNCS against AGS with SE's FDAI.</p> <p>ATTITUDE MON - PGNS Verify Pitch, Roll, and Yaw angles are ±5° of previous readings. ATTITUDE MON - AGS.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>3. FL V06 N46</p> <p>IX XXXXX. 100 IY/IZ XXXXX. 100 W XXXXX. LB</p> <p>Accept: V33E Reject: V25E Load desired parameters</p> <p>--</p> <p>4. FL V06 N86</p> <p>VGX (LV) XXXX. X FPS VGY (LV) XXXX. X FPS VGZ (LV) XXXX. X FPS</p> <p>V33E</p> <p>5. FL V06 N90</p> <p>OG XXX. XX DEG IG XXX. XX DEG MG XXX. XX DEG</p> <p>Record angles and confirm with MCC.</p> <p>XXXXXXXXXXXXXXXXXXXXX If IMU orientation is unsatisfactory (MGA > 45 DEG) select P52 or P53. Upon completion reselect P42. XXXXXXXXXXXXXXXXXXXXX</p> <p>IMU orientation is satisfactory - V33E (R60 - Attitude maneuver)</p> | <p>5. Transmit DSKY values to MCC.</p> <p>Communicate with MCC concerning maneuver attitude, propellant quanti- ties, and ground station coverage.</p> | <p>Key into Deda:</p> <p>CLR, 400 +30,000 E (Align AGS to PGNS) CLR, 400 +10,000 E (AUTO Submode) CLR, 370, READOUT (VG)</p> <p>NOTE: Time Constraint TIG - 5 minutes</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|-----------------------------|
| <p>8. POSS FL V50 N25</p> <p>R1 00206 (Attitude trim maneuver)</p> <p>Accept: ATTITUDE CONTROL/MODE CONT - AUTO ENTER</p> <p>Reject: Select GUID CONT and MODE CONTROL as desired.</p> <p>V33E</p> <p>9. POSS FL V05 N09</p> <p>R1 01703 (ignition time < 45 SEC) Slip engine ignition: V33E</p> <p>or</p> <p>Terminate: V34E</p> <p>10. Secure self and cabin.</p> <p>11. FL V06 N40</p> <p>TTI XXBXX MIN-SEC VG XXXX. X FPS Delta VM XXXX. X FPS</p> <p>Check Delta VM < 0.5 FPS for TTI between 30 and 15 SEC.</p> | <p>8. Verify the following:</p> <p>GUID CONT - PGNS MODE CONT - AUTO ENG GMBL - ENABLE ENG GMBL CWEA - EXT</p> <p>9. Observe EVENT TIMER and transmit time to CDR.</p> <p>10. Secure self and cabin.</p> <p>11. Update EVENT TIMER.</p> | <p>If ignition slipped.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | |
|---|------------------|---------|---------|----|--------|-----|----------|--------|-----|--|--|
| <p>12. RATE/ERR MON switch - LDG RDR/ CMPTR</p> <p>ATTITUDE MON switch - PGNS SHFT/TRUN switch - $\pm 50^\circ$ X-POINTER SCALE switch - HI MULT GUID CONT switch - PGNS MODE SEL switch - AOS RNG/ALT MON switch - ALT/ALT RT X-TRANSL switch - 2 JETS BAL CPL switch - ON DEADBAND switch - MIN ATTITUDE CONTROL/ROLL, PITCH, YAW switches - MODE CONT MODE CONT ROL switch - AUTO</p> <p>(+X TRANSLATION: TTI = 12.5 SEC) When Delta VM > -- FPS, Position ENG ARM switch to ASC.</p> <p>13. FL V50 N11</p> <table> <tr> <td>TTI</td><td>XXBXX</td><td>MIN-SEC</td></tr> <tr> <td>VG</td><td>XXXX.X</td><td>FPS</td></tr> <tr> <td>Delta VM</td><td>XXXX.X</td><td>FPS</td></tr> </table> <p>Engine ignition enable: ENTER</p> <p>OR</p> <p>Terminate: V34E</p> <p>(Thrust on at TTI = 0)</p> <p>14. Monitor ascent engine ignition by vibration, sound, and acceleration.</p> | TTI | XXBXX | MIN-SEC | VG | XXXX.X | FPS | Delta VM | XXXX.X | FPS | <p>12. RATE/ERR MON switch - LDG RDR/ CMPTR</p> <p>ATTITUDE MON switch - AGS X-POINTER SCALE switch - HI MULT O2/H2O QTY MON switch - ASC 1 RCS QTY MON switch - SYS A RCS TEMP/PRESS MON switch - He PRPLNT TEMP/PRESS MON- ASC HELIUM MON - ASC/PRESS 1</p> <p>Verify all caution and warning lights are extinguished.</p> <p>14. Communicate to notify MCC/CSM of ascent engine firing.</p> | |
| TTI | XXBXX | MIN-SEC | | | | | | | | | |
| VG | XXXX.X | FPS | | | | | | | | | |
| Delta VM | XXXX.X | FPS | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| <p>15. Monitor T/W indicator increase from 0 to * * .</p> <p>Monitor ZERO attitude rates. Monitor termination of + X. Translation 0.5 SEC after engine ignition. Monitor change from TTI to TG on DSKY.</p> <p>16. BAL CPL switch - OFF (After about * 8 * seconds of ascent thrust)</p> <p>18. Observe PITCH, ROLL, and YAW on FDAL.</p> <p>ATTITUDE MON - AGS Verify pitch, roll, and yaw are ± 5 degrees of previous reading. ATTITUDE MON- PGNS.</p> <p>19. Monitor EVENT TIMER and DSKY TG.</p> <p>Monitor ZERO lateral velocity, * + - * FPS, and * * forward velocity. Monitor attitude error within deadband. Monitor for Zero Attitude Rates or * + or - DEG/SEC * Monitor PITCH Angle is * * to * * DEG. Monitor ROLL and YAW ANGLES are Zero or * * to * * DEG</p> <p>Monitor T/W indicator is * * LUNAR G's.</p> | <p>17. Enable supply of ascent propellant to RCS thrusters and disable RCS propellants.</p> <p>19. Monitor EVENT TIMER and DSKY TG.</p> <p>Monitor X-POINTER indicator for ZERO LAT VEL, * + - * FPS, and FWD VELOCITY * * FPS. Monitor attitude error within deadband. Monitor for Zero Attitude Rates or * + or - DEG/SEC * Monitor Pitch angle is * * to * * DEG Monitor ROLL and YAW angles are Zero or * * to * * DEG</p> <p>Monitor T/W indicator is * * LUNAR G's</p> | <p>NOTE</p> <p>15. If LM CG unbalance occurs, pitch and/or roll rates will decrease as RCS fires to correct recurrence of CG. Offset can result in varying pitch and/or roll rates during this task.</p> <p>NOTE</p> <p>17. This task is intended to be used shortly after engine ignition.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | | | | | | | | | | |
|--|------------------|---------|---------|----|--------|-----|----------|--------|-----|---|-------|---|---|------|---|---|-----|---|---|--|
| <p>21. Communicate countdown to thrust termination from minus 10 seconds.</p> <p>22. FL V06 N40</p> <table> <tr> <td>TG</td><td>XXBXX</td><td>MIN-SEC</td></tr> <tr> <td>VG</td><td>XXXX.X</td><td>FPS</td></tr> <tr> <td>Delta VM</td><td>XXXX.X</td><td>FPS</td></tr> </table> <p>When TG and VG = 0, position ENGINE ARM to OFF. Reset EVENT TIMER to Zero. Monitor T/W indicator indicates Zero and engine vibration and acceleration have ceased. Operate EVENT TIMER RESET/COUNT switch - RESET, and release to count up from zero. BAL CPL switch - ON.</p> | TG | XXBXX | MIN-SEC | VG | XXXX.X | FPS | Delta VM | XXXX.X | FPS | <p>20. Verify ASC PROPULSION FUEL AND OXID PRESS indicators pointers - Aligned</p> <p>Verify HELIUM MON - ASC/PRESS 1 or ASC/PRESS 2 Read HELIUM AS * * to * * PSIA. Read RCS OXID AND FUEL QTY for * * to * * PC remaining.</p> <p>21. Disable supply of ascent propellant to RCS thrusters and enable RCS propellants.</p> <p>22. Compare VG on DSKY with VG on DEDA</p> <p>Record final VG and Delta VM Key in to Deda (Read out Perigee) CLR, 343, READOUT Record Perigee. Key in to Deda CLR, 400 + 10,000, E (Auto Submode)</p> <p>23. Monitor change in LM orientation by FDAI:</p> <table> <tr> <td>PITCH</td><td>*</td><td>*</td></tr> <tr> <td>ROLL</td><td>*</td><td>*</td></tr> <tr> <td>YAW</td><td>*</td><td>*</td></tr> </table> | PITCH | * | * | ROLL | * | * | YAW | * | * | <p>NOTE</p> <p>21. This task is intended to be used just prior to completion of nominal ascent engine burn. (and must be accomplished before burn.)</p> <p>22. Flash starts at GB = Zero.</p> |
| TG | XXBXX | MIN-SEC | | | | | | | | | | | | | | | | | | |
| VG | XXXX.X | FPS | | | | | | | | | | | | | | | | | | |
| Delta VM | XXXX.X | FPS | | | | | | | | | | | | | | | | | | |
| PITCH | * | * | | | | | | | | | | | | | | | | | | |
| ROLL | * | * | | | | | | | | | | | | | | | | | | |
| YAW | * | * | | | | | | | | | | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>24. Monitor EVENT TIMER</p> <p>Monitor X-POINTER for Azimuth LOS RATE in the interval * + or - 0.7 * M RAD/SEC and elevation LOS Rate in the interval * + or - 5.0 * M RAD/SEC.</p> <p>Monitor FDAI attitude error display for within Deadband.</p> <p>Monitor FDAI for zero attitude rates * + OR - DEG/SEC *.</p> <p>Monitor FDAI Pitch Angle is in appropriate interval for mission phase * to * DEG</p> <p>Monitor FDAI ROLL and YAW angles for stability.</p> <p>25. Verify following CDR's warning lights are extinguished:</p> <p>ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC ISS RCS TCA RCS A REG RES B REG DC BUS CABIN SUIT FAN</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>Verify following SE's caution lights are extinguished:</p> <p>ASC HI REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O2 QTY GLYCOL WATER QTY</p> <p>26. Verify PROPULSION FUEL and OXID TEMP indicator pointers - Green Band.</p> <p>Verify PROPULSION FUEL and OXID PRESS indicators pointers - Aligned.</p> <p>Verify RCS SYS A AND B TEMP indicator pointers - Green Band.</p> <p>Verify RCS SYS A AND B PRESS indicator pointers - Aligned.</p> <p>Verify SUIT and CABIN PRESS indicator pointers - Green Band.</p> <p>Verify PART PRESS CO2 indicator pointer - Green Band.</p> <p>Verify GYLCOL TEMP and PRESS indicator pointer - Green Band.</p> <p>Verify ASC PROPULSION FUEL AND OXID PRESS indicator pointers - Aligned.</p> | |

| COMMANDER | SYSTEMS ENGINEER | | | | REMARKS |
|-----------|--|--------|-----------|-----------|---------|
| | Verify HELIUM MON - ASC/PRESS 1 or ASC/PRESS 2. | | | | |
| | Read HELIUM PRESS as * * to * * PSIA | | | | |
| | Read RCS OXID and FUEL QTY for * * to * * PC remaining. | | | | |
| | 27. Operate RCS QTY MON switch to SYS A and SYS B and read FUEL AND OXID QTY. | | | | |
| | | SYS A | | SYS B | |
| | OXID | * * PC | * * PC | | |
| | FUEL | * * PC | * * PC | | |
| | 27. Operate RCS TEMP/PRESS MON switch and read following SYS A and B parameters. | | | | |
| | HE PRPLNT | | | | |
| | TEMP | SYS A | 70±30 | 70±30 | |
| | | SYS B | 70±30 | 70±30 | |
| | PRESS | SYS A | * * | 180+25-15 | |
| | | SYS B | * * | 180+25-15 | |
| | FUEL MANF OXID MANF | | | | |
| | PRESS | SYS A | 175+25-15 | 175+25-15 | |
| | | SYS B | 175+25-15 | 175+25-15 | |
| | 28. Operate HELIUM MON switch, refer to TEMP/PRESS. curve and read following ascent propellant parameters. | | | | |
| TEMP 1 | PRESS 2 | TEMP 2 | PRESS 2 | | |
| 70±20 | * * | 70±20 | * * | | |
| | | | | | |

| COMMANDER | SYSTEMS ENGINEER | | | REMARKS |
|---|--|-------------|----------|---------|
| | 29. Refer to TEMP/PRESS curve and read the following Ascent propellant parameters. | | | |
| | FUEL | TEMP | 70±20 | |
| | | PRESS | * * | |
| | OXID | TEMP | 70±20 | |
| | | PRESS | * * | |
| | 30. Operate O2/H2O QTY MON switch and read H2O and O2 parameters. | | | |
| | | ASC 1 | ASC 2 | |
| | H2O QTY | * * PC | 100 PC | |
| | O2 QTY | * * PC | 100 PC | |
| | 31. O2/H2O QTY MON switch ASC1 | | | |
| | 32. Verify GLYCOL parameters: | | | |
| | TEMP: 45±20 PRESS: 30±10 | | | |
| | Verify CO2 PART PRESS > 7.6 Hg | | | |
| | Verify CO2 PART PRESS component light extinguished. | | | |
| 33. Verify RCS FLAG/VLV status: | | | | |
| SYS A/MAIN SOV - GRAY ASC FEED - Barber Pole Thruster Pair: | | | | |
| QUAD 1 - GRAY QUAD 2 - GRAY QUAD 3 - GRAY QUAD 4 - GRAY | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS | | | | | | | | | |
|--|------------------|---------|---------|----|---------|-----|----------|---------|-----|---|--|
| <p>34. EPS/CROSS TIE/BAL LOADS</p> <p>CB - Depress.</p> <p>35. Monitor FDAI for stable attitude.</p> <p>36. FL V06 N40</p> <table> <tr> <td>TG</td><td>XXBXX</td><td>MIN-SEC</td></tr> <tr> <td>VG</td><td>XXXX. X</td><td>FPS</td></tr> <tr> <td>Delta VM</td><td>XXXX. X</td><td>FPS</td></tr> </table> <p>Accept VG: V33E Reject VG: V37E 41E</p> | TG | XXBXX | MIN-SEC | VG | XXXX. X | FPS | Delta VM | XXXX. X | FPS | <p>SYS B/MAIN SOV - GRAY ASC FEED - Barber Pole THRUSTER PAIR:</p> <p>QUAD 1 - GRAY QUAD 2 - GRAY QUAD 3 - GRAY QUAD 4 - GRAY</p> <p>CRSFD - Barber Pole.</p> <p>34. EPS/CROSS TIE/BAL LOADS</p> <p>CB - Depress.</p> <p>Verify CDR BUS VOLTAGE IS * * VDC.</p> <p>36. Transmit to MCC terminal values of Delta VM and VG receive opinion from MCC on need for RCS trim maneuver.</p> <p>Compare Delta VM value on DSKY against VG on Deda.</p> <p>Record VG and Perigee from Deda.</p> <p>Transmit Deda values to MCC.</p> <p>Record Delta VM from DSKY.</p> | |
| TG | XXBXX | MIN-SEC | | | | | | | | | |
| VG | XXXX. X | FPS | | | | | | | | | |
| Delta VM | XXXX. X | FPS | | | | | | | | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---------|
| <p>48. <u>P20 LM-RENDEZVOUS NAVIGATION PROGRAM</u></p> <p>1. Key V37E 20E (R02-IMU status check)</p> <p>2. POSS FL V50 N07 R1-00005 (PGNCS STARTUP REQUEST) V37E 05E POSS FL V50 N07 R1-00051 IMU orientation determination request V37E 51E</p> <p>3. FL V06 N06 R1 00001 option code for assumed state vector to be updated R2 0000X LGC assumed option 00001 - LM 00002 - CSM</p> | <p>46. POST THRUST EVALUATION (Repeat step 7)</p> <p>47. USE PROGRAM NO. 25 PRE- FERRED TRACKING ATTITUDE (Repeat step 8)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|------------------|--|
| <p>Accept: (State vector improvement assumption): V33E</p> <p>Reject: V22E LOAD DESIRED STATE VECTOR CODE IN R2</p> <p>4. FL V06 N06</p> <p>R1 00002 option code for assumed acquisition mode employment.</p> <p>R2 0000X LGC assumed option</p> <p> 00001 - AUTO 00002 - MANUAL</p> <p>Accept: (Assumed acquisition mode): V33E</p> <p>Reject: V22E load desired acquisition mode code in R2</p> <p>Confirm CSM at Preferred Attitude and Transponder operable.</p> <p>Verify RR AC SOC C-B closed.</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>(R23 - RR manual acquisition routine)</p> <p>FL V50 N25</p> <p> 00205 (Perform manual acquisition)</p> <p>SET:</p> <p> RNDZ RADAR mode selector to SLEW.</p> <p> Verify RATE/ERR MON to RNDZ RADAR.</p> | | <p>Recommend LM in Preferred Tracking Attitude for manual acquisition.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|--|
| <p>Search for CSM manually and upon acquisition verify that acquisition is not side lobe. Then set RNDZ RADAR mode selector to LGC and key ENTR</p> <p>XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX</p> <p>NOTE:</p> <p>POSS FL V05 N09 R1 00526 (CSM > 400 NM)</p> <p>If desired to wait until CSM < 400 NM, rendezvous parameter display routine (R31) may be used to monitor range by keying in V--E and return to this display is made by keying KEY REL. Key V32E for recycle.</p> <p>or</p> <p>Terminate P20 by V56E</p> <p>(R61 - Preferred tracking attitude routine)</p> <p>5. POSS FL V50 N25</p> <p>R1-000XX - Perform auto mode selection</p> <p>Set mode control to AUTO V33E.</p> <p>(R60 - Attitude maneuver routine)</p> <p>Monitor maneuver on FDAL.</p> <p>(R21 - RR designate routine)</p> | | <p>SHFT/TRUN ANGLES - + - 5° or + - 50° as required.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|------------------|--|
| <p>NOTE:</p> <p>POSS FL V05 N09</p> <p>R1-XXXXXX</p> <p>If alarm code indicates CSM is not being acquired, key RESET and perform one of the following:</p> <p>V33E for R24 RR search routine</p> <p>or</p> <p>V56E to terminate P20</p> <p>or</p> <p>V56E to terminate P20, then reselect P20.</p> <p>(R20 - RR - Data read routine)</p> <p>POSS FL V05 N09 (Delta Theta alarm)</p> <p>R1-00525</p> <p>V33E</p> <p>6. POSS FL V06 N05</p> <p>Delta Theta XXX.XX DEG</p> <p>Accept: V33E</p> <p>Reject: V32E (Recycle to step 5)</p> <p>7. POSS FL V06 N48</p> <p>Delta P XXXX.X NM</p> <p>Delta V XXXXX. FPS</p> <p>Accept: V33E</p> | | <p>Once CSM acquired, P20 runs in the background until terminated.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|---|
| <p>Reject: V32E (Recycle to Step 6)</p> <p>or</p> <p>V37E 20E and SELECT MANUAL ACQUISITION</p> <p>Variable Time</p> <p>8. V37E 00E (No other program in process)</p> <p>or,</p> <p>V56E (Another program beside P20 in process)</p> | <p>49. <u>TRACKING LIGHT - BRIGHT</u></p> <p>EXTERIOR LTG - TRACKING/BRIGHT</p> <p>50. <u>P52/LM-IMU REALIGN ROUTINE</u></p> <p>(Repeat step 1)</p> <p>51. <u>P53/LM-IMU ALIGN ROUTINE</u></p> <p>(Repeat step 2)</p> <p>52. <u>P33/LM PRE-THRUST CDH PROGRAM</u></p> <p>(Repeat step 12)</p> | <p>(If distance to CSM equal to or greater than 130 N. M.)</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>53. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>(Repeat step 4)</p> <p>54. <u>P41/LM RCS MANEUVER - NOMINAL</u></p> <p>(Repeat Step 5)</p> <p>55. <u>APS THRUSTING - ALTERNATE TO P41 RCS THRUSTING</u></p> <p>(Repeat Step 45)</p> <p>56. <u>POST THRUST EVALUATION</u></p> <p>(Repeat step 7)</p> <p>57. <u>P52/LM-IMU REALIGN ROUTINE</u></p> <p>(Repeat step 1)</p> <p>58. <u>P53/LM-IMU ALIGN ROUTINE</u></p> <p>(Repeat step 2)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|------------------------------------|
| | <p>59. <u>POST CDH THROUGH AGS RCS TPI MANEUVER</u></p> <p>1. Key into DEDA (Updated values of desired IM transfer time interval. For direct intercept transfer routine, desired fixed absolute time of TPI respectively)</p> <p>CLR, TBD + XXX.XX, E (0.1 MIN)</p> <p>CLR, TBD + XX X.X, E (.1 MIN)</p> <p>Key into Deda ($S_{10} = 3$, direct transfer - time increment)</p> <p>CLR, 410 + 30000, E.</p> <p>2. Pre-set EVENT TIMER for later countdown.</p> <p>3. Refer to Flight Data Kit for predetermined value.</p> <p>4. On EVENT TIMER panel:</p> <p>TIMER CONT switch - STOP RESET/COUNT switch - RESET RESET/COUNT switch - DOWN SLEW CONT switch/MIN-TENS, UNITS until desired minutes displayed. SLEW CONT switch/SEC-TENS, UNITS until desired seconds displayed.</p> <p>60. <u>P34/LM PRE-THRUST TPI PROGRAM</u></p> <p>(Repeat step 19)</p> | <p>If available</p> <p>T Delta</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| | <p>61. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>(Repeat step 4)</p> <p>62. <u>MONITOR PREDICTED LOS ANGLE AFT DELTA * * MINS FROM NOW (DEDA SUB LOS) ON DEDA.</u></p> <p>Key into Deda READOUT THETA SUB LOS</p> <p>CLR, IBU, READOUT</p> <p>Monitor DEDA UNTIL 26. 6 DEGREES, communicate event to CDR</p> <p>EVENT TIMER/TIMER CENT-START.</p> <p>63. <u>SELECT DIRECT TRANSFER ABSOLUTE TIME GUIDANCE OPTION IN THE AEA.</u></p> <p>Key into Deda (S₁₀=4 Direct transfer- absolute time).</p> <p>CLR, 410 + 40000, E.</p> | |
| <p>64. <u>P47/LM - THRUST MONITOR PROGRAM</u></p> <p>1. Key V37E 47E (R02 - IMU status check)</p> <p>2. POSS FL V50 N07 R1 00005 (PGNCS startup) V37E 05E</p> | <p>X TRANSL switch - 4 JETS</p> <p>THROTTLE/JET LEVER - JET</p> <p>DEADBAND switch - MIN</p> <p>ENGINE STOP BUTTON - DEPRESS</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>or</p> <p>POSS FL V50 N07 R1 00005 R1 00051 (IMU orientation determination) V37E 51E</p> <p>3. FL V16 N83</p> <p>Delta VX (IMU) XXXX. X FPS Delta VY (IMU) XXXX. X FPS Delta VZ (IMU) XXXX. FPS</p> <p>Perform thrusting maneuver as desired. Monitor FDAI ball to avoid gimbal lock.</p> <p>4. V37E 00E</p> | <p>Monitor EVENT TIMER for reading of 01 MIN or SEC.</p> <p>GUID CONTROL switch - AGS</p> <p>ABORT BUTTON - DEPRESS</p> <p>Monitor FDAI attitude and error needles as AGS reorients LM.</p> <p>Key into Deda (READOUT Delta V SUB GX)</p> <p>CLR, TBD, READOUT</p> <p>Monitor EVENT TIMER for 00 MIN 00 SEC reading.</p> <p>Operate TRASLATION CONTROLLER FOR + X TRANSLATION. until Delta V SUB GX on Deda counts down to Zero.</p> <p>DEADBAND switch - MAX</p> <p>ABORT BUTTON - DEPRESS TO RESET</p> <p>GUID CONTROL switch - PGNS</p> <p>65. <u>TRACKING FLIGHT TO DIM.</u></p> <p>EXTERIOR LTG - TRACKING/DIM</p> <p>66. <u>P35/LM PRE-THRUST TPM PROGRAM</u></p> <p>(Repeat step 24)</p> | <p>(If distance to CSM equal to or less than 30 N. M.).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>67. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>(Repeat step 4)</p> <p>68. <u>P41/LM RCS MANEUVER - NOMINAL.</u></p> <p>(Repeat step 5)</p> <p>69. <u>POST THRUST EVALUATION</u></p> <p>(Repeat step 7)</p> <p>70. <u>P35/LM PRE-THRUST TPM PROGRAM</u></p> <p>(Repeat step 24)</p> <p>71. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>(Repeat step 4)</p> <p>72. <u>P41/LM RCS MANEUVER - NOMINAL</u></p> <p>(Repeat step 5)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|--|---------|
| | <p>73. <u>POST THRUST EVALUATION</u></p> <p>(Repeat step 7)</p> <p>74. <u>P35/LM PRE-THRUST TPM PROGRAM</u></p> <p>75. <u>USE LGC PROGRAM NO. 2 TO UPDATE AGS STATUS VECTORS</u></p> <p>(Repeat step 4)</p> <p>76. <u>P41/LM RCS MANEUVER - NOMINAL</u></p> <p>(Repeat step 5)</p> <p>77. <u>POST THRUST EVALUATION</u></p> <p>(Repeat step 7)</p> <p>78. <u>P36/LM TRANSFER PHASE FINAL</u></p> <p>(Repeat step 36)</p> <p>79. <u>P36/LM TRANSFER PHASE FINAL</u></p> <p>(Repeat step 36)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>80. <u>P36/LM TRANSFER PHASE</u> <u>FINAL</u></p> <p>(Repeat step 36)</p> <p>81. <u>P36/LM TRANSFER PHASE</u> <u>FINAL</u></p> <p>(Repeat step 36)</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|-----------------------------|---------|
| <u>JL 7-2 LM ACTIVE DOCKING</u> | | |
| <u>PERFORM DOCKING.</u> | | |
| 1. Verify following: | | |
| a. MODE CONTROL SWITCH TO ATT HOLD. | | |
| b. X - TRANSL SWITCH TO 2 JETS | | |
| c. RATE/ERR MON SWITCH TO RNDZ RADAR | RATE/ERR MON - RNDZ RADAR | |
| d. SHFT/TRUN (ANGLES) - $\pm 5^\circ$ | | |
| e. X-POINTER SCALE SWITCH TO LO MULT | X-POINTER SCALE - LO MULT | |
| f. COAS DETENT - LW | | |
| 3. Monitor following displays: | 2. EXTERIOR LIGHTING. | |
| a. RANGE/ALT FT | EXTERIOR LTG switch to DOCK | |
| b. RANGE RATE ALT RATE FPS | | |
| c. LOS RATES * *M. RAD/S * *M. RAD/S | | |
| d. LOS ANGLES * *DEG * *DEG | | |
| e. PITCH ANGLE * *DEG | | |
| f. ROLL ANGLE * *DEG | | |
| g. YAW ANGLE * *DEG | | |
| h. As per Flight Plan | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| <p>4. Start TRANSLATION to * 50 * ft in front of CSM and ROLL and YAW, as required, to achieve and maintain COAS RETICLE/STANDOFF TARGET Gross Alignment.</p> <p>5. Maneuver LM, as required, to achieve acceptable, initial docking conditions.</p> <p>8. Monitor:</p> <p>RANGE ALT TO 50 FT RANGE RATE ALTRATE - 5 TO -1 FPS LOS RATES LESS THAN 5 M. RAD/SEC</p> <p>9. Maintain visual sight of CSM and NULL LOS ANGLES, whenever angle reaches 10° until CSM ATTITUDE POINT is in center of FDAI.</p> | <p>7. Verify following:</p> <p>LOS ANGLES are 0° QUADRANT where LOS RATE needles cross is the same as FDAI Quadrant CONTAINING CSM ATTITUDE.</p> <p>10. Communicate LOS ANGLE(S) whenever 10°.</p> <p>11. Communicate LOS RATES whenever 5 MRAD/SEC.</p> | <p>6. If CSM not straight ahead use ATTITUDE CONTROL to correct. If CSM + X AXIS not swinging toward LM, use TRANSLATION CONTROL in direction CSM + X AXIS is swinging.</p> <p>7. Assume CSM ATTITUDE known with respect to LM IMU orientation.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p>12. NULL LOS RATE(S) whenever rate exceeds 5 MRAC/SEC, as follows:</p> <ul style="list-style-type: none"> a. Align LM so that CSM appears straight ahead in window and LOS ANGLES NULLED. b. NULL LOS RATE(S). c. Monitor range rate for -5 to -1 fps. <p>13. Maintain NULLED LOS RATES after CSM attitude reference and LOS ANGLES are NULLED.</p> <p>16. null RANGE RATE at 50 ft. range.</p> <p>17. Verify attitude consistent with flight plan.</p> <p>18. Rendezvous radar switch to SLEW.</p> <p>20. Position RNDZ RDR antenna to -36° shaft angle and 0° trunnion angle.</p> <p>21. Pull out following c/b s:</p> <p>PGNS/RNDZ RDR (ac) PGNS/RNDZ RDR</p> <p>22. Remove Optical Docking Aid from front window.</p> <p>23. Install Optical Docking Aid on top window.</p> | <p>14. Communicate ATTITUDE with respect to CSM ATTITUDE references.</p> <p>15. Communicate RANGE prior to 50 ft. and during range rate nulling.</p> <p>19. Maintain relative position of LM to CSM until CDR again assumes control.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>24. Docking reticle position control - ow.</p> <p>25. Adjust Docking Reticle Intensity Control, as required.</p> <p>26. Connect docking portion of restraint system.</p> <p>27. Reassume control of LM and maintain relative position of LM to CSM.</p> <p>30. Assume position for docking.</p> <p>31. Pitch down 90° to view CSM Docking Hatch.</p> <p>32. YAW LM 19° with respect to CSM until COAS RETICLE is aligned with CSM Standoff Target.</p> <p>33. Acquire and maintain Docking Reticle/CSM target alignment.</p> <p>34. Initiate final approach along +X AXIS.</p> <p>35. Maintain Docking Reticle/Target alignment until soft dock.</p> <p style="padding-left: 20px;">a. Receive verification of soft docking from CSM and shut off SCS.</p> <p style="padding-left: 20px;">b. Receive verification of soft docking from CSM.</p> <p style="padding-left: 20px;">c. MODE CONTROL off</p> | <p>28. Refer to Flight Data Kit for codes.</p> <p>29. Key into DSKY (min. impulse) TBD</p> <p>MODE CONTROL - ATT HOLD</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p><u>PRESSURIZE LM/CSM INTERLOCK.</u></p> <ol style="list-style-type: none"> X-Axis CABIN DUMP valve to dump Verify cabin pressure decreases to 4.6 psia and CABIN REPRESS valve opens. Monitor cabin pressure stabilizes 4.8 psia and verify CABIN REPRESS valve closes. Communicate with CSM to verify interlock pressure and leak rate. | <p><u>ACTIVATE OVERHEAD FLOOD LIGHTING.</u></p> <ol style="list-style-type: none"> Flood Light OVHD/FWD and verify Overhead and Forward Floods illuminate. Verify SE'S Flood reflect aft and COR'S Flood reflects light on front panel. Adjust OVHD/FWD Flood Light dimming control as required. <p><u>DEACTIVATE DOCKING LIGHT.</u></p> <p>EXTERIOR LTG off.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---|
| <u>JL8-2 EXTRAVEHICULAR CREW TRANSFER TO CSM - DOCKED</u> | | |
| <p>1. <u>COMMANDER PREPARE TO EGRESS LM CABIN.</u></p> <p>1. Disconnect LM RF hardline from stowed position.</p> <p>2. Open SE's PLSS thermal jacket flap to expose RF receptacle.</p> <p>3. Connect LM RF hardline to SE's PLSS RF receptacle.</p> <p>8. Verify SUIT CIRCUIT RELIEF valve - AUTO.</p> <p>9. CABIN GAS RETURN valve - EGRESS.</p> <p>10. PRESS REG A and B valves - EGRESS.</p> <p>11. Verify SUIT GAS DIVERTER valve - PULL - EGRESS.</p> <p>12. Verify CABIN REPRESS valve - AUTO.</p> <p>13. Depressurize cabin front hatch cabin relief and dump valve - DUMP.</p> <p>14. CABIN PRESS indicator - 0 PSIA.</p> | <p>4. Disconnect LM communications lead from PGA communications receptacle.</p> <p>5. Plug PLSS communications lead into PGA communications receptacle.</p> <p>6. PLSS SSC mode selector switch - 1.</p> <p>7. Verify voice and telemetry communications with MCC.</p> | <p>14. Cabin pressure is evacuated from 5 psia to 0.08 psia in 240 seconds.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>16. Insert universal tool in forward hatch latch receptacle and rotate to UNLOCK position.</p> <p>17. Pull front hatch to partial open (do not block cabin floor)</p> <p>18. Hand over universal tool to SE.</p> <p>26. SE SUIT FLOW valve - HELMET</p> <p>29A. Disconnect RF line from SE's PLSS.</p> | <p>15. Remove universal tool from storage and hand over to Commander.</p> <p>19. Stow universal tool.</p> <p>20. SE SUIT FLOW valve - SUIT DISCONNECT.</p> <p>21. Turn on PLSS fan and verify oxygen flow.</p> <p>22. Open PLSS oxygen shut-off valve.</p> <p>23. Verify telemetered battery current reading with MCC.</p> <p>24. Turn off PLSS oxygen shut-off valve.</p> <p>25. Turn off PLSS fan.</p> <p>27. PLSS SSC mode selector switch - 3 (off).</p> <p>28. Disconnect PLSS communications lead from PGA communications receptacle.</p> <p>29B. Connect LM communications lead to PGA communications receptacle.</p> <p>30. Verify communication with MCC.</p> | <p>17. This step is required to preclude the possible build up of ice in the LM once the PLSS begins emitting water vapor.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>31. Hand over RF line to SE.</p> <p>34. PLSS SSC mode selector switch - 1.</p> <p>35. Verify voice and telemetry communications with MCC.</p> <p>36. PLSS H₂O diverter (flow selector) valve - MINIMUM COOLING.</p> <p>37. PLSS feedwater shut-off valve - START.</p> <p>38. Activate Elapsed Time indicator.</p> <p>39. PLSS H₂O pump - ON (verify telemetered battery current increase with MCC and audible notice of pump running).</p> <p>40. CDR SUIT FLOW valve - SUIT DISCONNECT.</p> <p>41. Turn on PLSS fan. (Verify oxygen flow and telemetered battery current readings with MCC).</p> <p>42. PLSS oxygen shut-off valve - OPEN.</p> <p>43. SUIT GAS DIVERTER valve - PULL - EGRESS.</p> <p>44. After 5 minutes, PLSS feed water shut-off valve - RUN.</p> <p>45. PLSS H₂O diverter valve - Desired Position For Comfort.</p> <p>46. Disconnect LM ECS hoses from PGA.</p> | <p>32. Open CDR's PLSS thermal jacket flap to expose RF receptacle.</p> <p>33. Connect RF line to CDR's PLSS RF receptacle.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---------|
| <p>47. Hand over LM ECS umbilical assembly to SE.</p> <p>49A. Pull forward hatch to full open and secure.</p> <p>51. Position EV visor over helmet and secure in place.</p> <p>52. Check that visors function properly.</p> <p>53. Engage the slide fastener of TMG jacket and pull it closed. Cover fastener with flap provided.</p> <p>54. Engage the draw string slides on the TMG jacket. Pull collar of jacket around shell of EV visor then pull drawstring slides tight and secure.</p> <p>57. Don thermal mittens and secure.</p> | <p>48. Stow CDR's LM ECS umbilical assembly.</p> <p>49B. Remove CDR's EV visor from stowage.</p> <p>50. Handover EV visor to CDR.</p> <p>51. Assist CDR as necessary.</p> <p>55. Remove CDR's thermal mittens from storage.</p> <p>56. Hand over mittens to CDR and assist in securing.</p> <p>58. Disconnect RF line from CDR's PLSS and stow. CDR loses all communication at this point).</p> <p>59. Secure thermal flap over PLSS.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>2. <u>COMMANDER EGRESS LM CABIN</u></p> <p>1. Face aft, kneel down, close visor, and back out forward hatch. (Life line attachment to be determined).</p> <p>2A. Kneel on boarding platform and release PLSS antenna from velcro restraint.</p> <p>3. Verify communication with SE and MCC.</p> <p>5. Receive EVA equipment and secure together.</p> <p>6. Operate EVCT device and connect to CM.</p> | <p>2B. COMMUNICATIONS ANTENNAS panel.</p> <p>a. VHF antenna selector switch - EVA</p> <p>4. Remove EVA equipment from stowage and pass through forward hatch to CDR.</p> | <p>6. Navigator depressurizes CM upon verification that EVCT device has connected to CM. Remove and stow CM side hatch.</p> <p>The Commander will continue extra-vehicular activities while this task is performed.</p> |
| <p>3. <u>SE PREPARE TO PERFORM SIMULATED CABIN EGRESS</u></p> | <p>1. Disconnect LM RF line from stowed position.</p> <p>2. Open PLSS thermal jacket flap to expose RF receptacle.</p> <p>3. Connect RF line to PLSS RF receptacle.</p> <p>4. Disconnect LM communications lead from PGA communications receptacle.</p> <p>5. Request CDR to set CDR PLSS SSC mode selector switch to the 2 position.</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| <p>4. <u>COMMANDER COMPLETE EVA</u></p> <p>1. Move across to CM side hatch.</p> <p>2. Enter CM.</p> | <p>22. Stow LM ECS umbilical.</p> <p>23. CABIN REPRESS valve - CLOSE.</p> <p>24. ECS/SUIT FAN Δ P circuit breaker - PULL OUT.</p> <p>25. SUIT FAN switch - OFF.</p> <p>26. Remove EV visor from stowage.</p> <p>27. Position EV visor over helmet and secure in place.</p> <p>28. Check that visors function properly.</p> <p>29. Engage the slide fastener of TMG jacket and pull it closed. Cover fastener with flap provided.</p> <p>30. Engage the drawstring slides on the TMG jacket. Pull collar of jacket around shell of EV visor, then pull drawstring slides tight and secure.</p> <p>31. Remove thermal mittens from storage.</p> <p>32. Don thermal mittens and secure.</p> <p>33. Disconnect RF line from PLSS and stow.</p> <p>34. Secure thermal flap over PLSS.</p> <p>35. Face aft kneel down, and close visor.</p> | <p style="text-align: center;">NOTE</p> <p>Commander continues extra-vehicular activities.</p> <p>2. After entering the CM the CDR will attach to the CM ECS and remove PLSS and TMG. Commander will transfer PLSS and TMG to LM by using EVCT device.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <ol style="list-style-type: none"> 3. Extend torso into forward hatch opening. 4. Retrieve PLSS and TMG and remove from EVCT device. 5. Remove EVCT device from mount. 6. Stow PLSS on donning rig temporarily. 7. Stow TMG in TMG bag. 8. Stow EVCT device. | |
| <p>5. <u>PREPARE FOR HARD SUIT TRANSFER BACK TO CM AND DEACTIVATE LM</u></p> | <ol style="list-style-type: none"> 1. Secure forward hatch from inside. <ol style="list-style-type: none"> a. Release forward hatch from full open position and close hatch. b. Remove universal tool from stowage location in docking hatch. c. Insert universal tool in socket and turn to engage latch. d. Remove and stow universal tool and stow and secure PLSS in floor mount. 2. Remove donning rig and place in temporary stowage. 3. Prepare restraint system for soft stowage of probe and drogue. 4. Open top hatch <ol style="list-style-type: none"> a. Verify cabin relief and dump valve - AUTO. b. Remove universal tool from stowage in top hatch and insert in receptacle and rotate to unlock hatch. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>c. Pull hatch down and secure in open position.</p> <p>5. Reconnect CM/LM power umbilical.</p> <p>6. Remove drogue from tunnel.</p> <p>a. Insert universal tool in probe head to release finger latches.</p> <p>b. Insert universal tool in drogue lock release mechanism to unlock drogue latches.</p> <p>c. Grasp drogue handle and twist to release drogue from tunnel mounts.</p> <p>d. Pull drogue down into LM.</p> <p>7. Stow drogue in restraint.</p> <p>8. Simulate establishment of hard docked configuration, retrieve tool and operate docking latches.</p> <p>9. Remove probe from CM.</p> <p>a. Grasp probe release handle and pull to release probe from docking tunnel.</p> <p>b. Pull probe down into LM.</p> <p>10. Stow probe in restraint.</p> <p>11. Prepare equipment for transfer into CM, remove the following equipment from stowage:</p> | <p style="text-align: center;">NOTE</p> <p>CM will turn on power to LM. The CM pressure hatch and CM thermal hatch will be removed and stowed in CM.</p> <p>6. Navigator assist SE.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>a. Place the following in transfer bag:</p> <p>Sequence camera</p> <p>Film magazine</p> <p>Flight Data File</p> <p>LM Flight Plan (stowed in LM in front TMG bag)</p> <p>Radiation Survey Meter (stowed in LM below RH forward window)</p> <p>EOS (1) (stowed in right aft cabin bulkhead)</p> <p>b. Place the following in helmet stowage container and close:</p> <p>EV visor</p> <p>EV gloves (1 pair)</p> <p>EMU Maintenance Kit</p> <p>c. Close empty helmet stowage container.</p> <p>d. One PLSS</p> <p>e. One TMG</p> <p>12. Transfer equipment to CM.</p> <p>a. Guide equipment through interlock to CM.</p> <p>13. Secure cabin interior (to be determined).</p> <p>a. Scan cabin interior and verify all equipment and equipment compartments are secured.</p> <p>b. Secure all equipments not secured.</p> | <p>12. CDR receives equipment from SE while in CM.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| | <p>14. Connect to transfer umbilical.</p> <ul style="list-style-type: none"> a. Request CM transfer umbilical to be extended through tunnel to LM. b. Receive transfer umbilical from CM and verify no O₂ flow through umbilicals. c. Connect O₂ umbilical to left side of suit. d. Request CM to activate communications lead on transfer umbilical. e. Disconnect LM communication lead from suit. f. Connect transfer umbilical communication lead to suit. g. Verify voice communication with CM and request O₂ flow through transfer umbilical. h. SE SUIT FLOW valve - SUIT DISCONNECT (verify suit flow continues). j. Disconnect LM O₂ umbilicals from suit and attach to stowage plate. <p>15. Remove SE checklist from stowage (under Attitude Controller).</p> <p>16. Deactivate LM to a powered down configuration. This includes deactivation of those subsystems that were required for this period.</p> <ul style="list-style-type: none"> a. EPS - 16, 11, 10, 14, 4 b. ECS - 2, ECS MODULE, 16, 11 c. COMM - 8, 11, 12, 16 | <p>14. CDR assest SE as required.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| 6. <u>TRANSFER SE IN HARD SUIT TO CM</u> | d. CXWS - 16, 1, 2, 3, 14 e. Lighting - 16, 3 17. Return checklist to stowage location. | |
| | 1. Transfer SE into docking tunnel. a. Enter docking tunnel feet first. b. Push self into docking tunnel and grasp steps on top hatch. 2. Close LM top hatch (X - axis) from tunnel. a. Close and lock X - axis hatch. b. Verify cabin relief and dump valve (top hatch) - AUTO. 3. Complete SE transfer into CSM. | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <u>JL9-2 DESCENT BURN DOCKED (SPS BACKUP)</u> | | |
| <p>1. <u>PREPARE FOR DOCKED DESCENT BURN.</u></p> <p>2. Request CSM verify update of state vector and deactivation of SPS Gimbal Motors.</p> <p>3. R/D TLM CALIBRATE switch - ON (hold for 12 seconds)</p> <p>4. PRPLNT/TEMP/PRESS MON switch - DES 1</p> <p>HELIUM MON switch - DES/AMB PRESS</p> <p>MASTER ARM switch - ON</p> <p>DES PRESS switch - FIRE (momentary hold)</p> <p>MAIN PROPULSION/PRESS indicator - 235 PSIA</p> <p>MAIN PROPULSION/HELIUM indicator - decreasing pressure</p> <p>MASTER ARM switch - OFF</p> <p>PRPLNT/TEMP/PRESS MON switch - DES 2</p> <p>MAIN PROPULSION/PRESS indicator - 235 PSIA</p> | <p>1. Receive directive from MCC for Docked Descent Burn.</p> <p>4. Verify CDR BUS on VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/AC</p> <p>VOLTS indicator - GREEN BAND</p> <p>POWER/TEM MON switch - BAT/1 thru 4</p> <p>VOLTS indicator: AMPS indicator, each position:</p> <p style="padding-left: 40px;">VOLTS - 28.0</p> <p style="padding-left: 40px;">AMPS - <u>TBD</u></p> <p>POWER/TEMP MON switch - BAT/5</p> <p>BAT 5/NORMAL FEED switch - ON</p> <p>VOLTS indicator - 28.0</p> <p>BAT 5/NORMAL FEED indicator - GRAY FLAG</p> | <p>1. Directive must be received at least 30 minutes before engine ignition to permit ambient helium pressurization of propellant tanks.</p> <p>4. The 28.0 volts indications in this step are nominal readings.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>EPS/INV 2 - press</p> <p>EPS/CROSS TIE/BAT LOADS - pull out</p> <p>5. Request MCC verification of CMC and LGC clock readings on downlink for significant differences.</p> | <p>BAT 6/NORMAL FEED switch - ON</p> <p>BAT 6/NORMAL FEED indicator - GRAY FLAG</p> <p>POWER/TEMP MON switch - BAT/6</p> <p>VOLTS indicator - 28.0</p> <p>AMPS indicator - <u>TBD</u></p> <p>POWER/TEMP MON switch - BUS/CDR</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/AC</p> <p>VOLTS indicator - GREEN BAND</p> <p>AC PWR - INV 1</p> <p>VOLTS indicator - GREEN BAND</p> <p>EPS/INV 2 - pull out</p> <p>EPS/CROSS TIE/BAT LOADS - pull out</p> <p>VOLTS indicator - GREEN BAND</p> <p>POWER/TEMP MON switch - BUS/SE</p> <p>VOLTS indicator - 28.0</p> <p>POWER/TEMP MON switch - BUS/CDR</p> <p>VOLTS indicator - 28.0</p> | <p>5. If there are clock differences, repeat LGC initialization block L3-2 (P01).</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>6. Select External Delta V Program (P30).</p> <p>2. EXTERNAL DELTA V PROGRAM (P30).</p> <p>1. Key into DSKY V37E 30E</p> <p>2. FL V06 N34 TIG</p> <p>00XXX. HRS (GET) 000XX. MIN 0XX.XX SEC Accept: V33E Reject: Reload Data</p> <p>3. FL V06 N</p> <p>XXXX.X DELTA V_X XXXX.X DELTA V_Y XXXX.X DELTA V_Z Accept: V33E Reject: Reload Data</p> <p>4. FL V06 N45</p> <p>H_A XXXX.X NM H_p XXXX.X NM DELTA V XXXX.X FPS Accept: V33E</p> <p>(a) Reject: Reselect V37E 30E and adjust aim parameters</p> <p>(b) Select V37E 27E and load new aim parameters</p> | <p>6. Calibrate AGS.</p> <p>1. Receive from MCC/CSM & record</p> <p>TIG DELTA V_X DELTA V_Y DELTA V_Z Apogee Alt. (H_A) Perigee Alt. (H_p) DELTA V (TIG)</p> <p>2. Record TIG used if different from MCC/CSM value.</p> <p>3. Record Delta V_X, V_Y, V_Z used if different from MCC/CSM value.</p> <p>4. Compare DSKY values with MCC.</p> | <p>6. AGS calibration procedures TO BE SUPPLIED.</p> <p>NOTE</p> <p>PROGRAM 30 provides targeting parameters (TIG and impulsive Delta V along LM local ver- tical axes at TIG) from sources external to the LGC. It also calculates the Delta V and other initial conditions required for the maneuver.</p> <p>2. Delta V may already be available from LGC update program P27. Orbital parameters are optional output information.</p> <p>4. (a) Reselect P30 and adjust aim parameters (b) Select P27 and load new aim parameters; reselect P30 (c) Decide alternatives (d) See block _____</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>(c) Select new program.</p> <p>(d) Perform manually using PGNC/AGS data.</p> <p>5. FL V06 N35 TTI</p> <p>00XXX. HRS 000XX. MINS 0XX.XX SECS Accept: V33E Reject: Select desired program</p> | | |
| <p>6. (R02-IMU Status Check)</p> | | 6. Done automatically. |
| <p>7. FL V06 N__</p> <p>Blank TTI XXBXX MIN-SEC MGA XXX.XX DEG.</p> <p>V33E</p> | <p>7. EVENT TIMER/TIMER CONT switch - STOP (momentarily)</p> <p>RESET/COUNT - RESET</p> <p>RESET/COUNT - DOWN</p> <p>SLEW CONT/MIN - TENS (hold until EVENT TIMER displays desired minutes)</p> <p>SLEW CONT/MIN - UNITS (hold until desired minutes are displayed)</p> <p>SLEW CONT/SEC - TENS (hold until desired seconds are displayed)</p> <p>SLEW CONT/SEC - UNITS (hold until desired seconds are displayed)</p> <p>TIMER CONT - START</p> | <p>7. Set EVENT TIMER to future DSKY time (time of EVENT TIMER start).</p> |
| <p>8. FL V50 N07</p> <p>R1 00040 (Select program)</p> | <p>Verify maneuver with MCC.</p> | <p>Consider in maneuver decision with MCC/CSM:</p> <p>(a) Delta V magnitude</p> <p>(b) Propellant available</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>9. Select Propulsion System</p> <p>DPS V37E40E RCS V37E41E APS V37E42E</p> <p>3. <u>DESCENT PROPULSION SYSTEM PROGRAM (P40).</u></p> <p>1. KEY V37E (R02 - 1MU STATUS CHECKS)</p> <p>2. POSS FL V50 N07 R1 00005 V37E 05E</p> <p>3. POSS FL V50 N07 R1 00051 V37E 51E</p> | <p>Receive MCC go ahead</p> <p>1. Receive from MCC/CSM and record</p> <p>IX IY/IZ W Yaw Trim Pitch Trim VGX (LV) VGY (LV) VGZ (LV)</p> | <p>(c) Status of propulsion hardware</p> <p>(d) Time/Need for IMU realignment</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>4. FL V06 N__</p> <p>IX XXXXX. SLUG-FT SQ IY/IZ XXXXX. SLUG-FT SQ W XXXXX. LB</p> <p>5. V06 N70</p> <p>PITCH XXX. XX DEG TRIM YAW XXX. XX DEG TRIM TLX XXXXX. 100 LB</p> <p>6. FL V06 N__</p> <p>VGX (LV) XXXX. X FPS VGY (LV) XXXX. X FPS VGZ (LV) XXXX. X FPS</p> <p>7. FL V06 N17</p> <p>OG XXX. XX DEG IG XXX. XX DEG MG XXX. XX DEG</p> <p>a. If IMU orientation unsatisfactory, select P52 or P53, upon completion reslect P40</p> <p>b. If IMU orientation is satisfactory;</p> <p>V33E (R60 ATTITUDE MANEUVER)</p> | <p>4. Record I_X, I_Y/I_Z, and W if different from MCC valves.</p> <p>5. Record pitch and yaw trims, and TLX if different from MCC valves.</p> <p>6. Record VGX, VGY, VGZ if different from MCC valves. Communicate values to CSM.</p> <p>7. Observe pitch, roll, and yaw angles on FDAI. ATTITUDE NOM switch - PGNS. Observe pitch, roll, and yaw angles on FDAI. ATTITUDE NOM switch - AGS.</p> | <p>7. Assumes angles are in FDAI coordinates. SE angles should be within $\pm 5^\circ$ of former values if not, see L1-2. Consider in IMU orientation decision.</p> <p>a. Is MGA $> 45^\circ$</p> <p>b. Is reorientation required</p> <p>c. Is alignment required</p> <p>d. Impact of Docked thrusting</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
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| <p>8. Poss FL V50 N25</p> <p>R1 000 -- (Mode Control) MODE CONTROL - AUTO GUID CONTROL - PGNS ACCEPT: ENTR</p> | <p>8. Compare maneuver requirements and onboard propellant supplies.</p> <p>a. Communicate with MCC/CSM on maneuver attitude, propellant quantities, and ground station coverage.</p> <p>b. Key into DEDA CLR, 400 +30,000 E (Align AGS to PGNS)</p> <p>CLR, 400 +10,000 E (Auto Submode)</p> | <div style="border: 1px solid black; padding: 5px; text-align: center;">NOTE</div> <p>Time constrant TIG - 5 minutes</p> |
| <p>9. Poss FL V06 N17</p> <p>OG XXX.XX DEG IG XXX.XX DEG MG XXX.XX DEG</p> | <p>9. Verify:</p> <p>MODE CONTROL - AUTO GUID CONTROL - PGNS</p> | |
| <p>10. Monitor change in LM attitude on FDAI</p> <p>Pitch * *</p> <p>Roll * *</p> <p>Yaw * *</p> | <p>10. Observe EVENT TIMER, communicate time to CDR.</p> | |
| <p>11. FL 50 N25</p> <p>R1 XXXXXX (ENG GIMBAL Drive Enable)</p> <p>ACCEPT: ENTR REJECT: V33E</p> | <p>11. Verify:</p> <p>ENG GMBL - ENABLE ENG GMBL - OUT (CWEA)</p> | |
| <p>12. Poss FL V05 N31</p> <p>R1 XXXXXX (TIG 645 SECS) SLIP ENGINE IGNITION - V33E</p> | | |
| | | <p>12. Alternative: Key V34E</p> <p>FL V50 N07 R1 00000 Key V37E 00E</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|--|
| <p>13. FL V06 N51</p> <p>TTI XXBXX MIN - SECS VG XXXX.X FPS DELTA XXXX.X FPS Vm</p> <p>14. DEADBAND switch - MIN</p> <p>ATTITUDE CONTROL switches - MODE CONT (ROLL-PITCH-YAW)</p> <p>MODE SEL switch - PGNS RATE/ERR MON switch - LDG RDR/CMPTR Angle Error - in deadband</p> <p>FDAI - PITCH RATE * * ROLL RATE * * YAW RATE * *</p> <p>THR CONT - AUTO MAN THROT - CDR T/TCA THROTTLE/JETS SELECT LEVER - THROTTLE</p> <p>Operate Manual Throttle THRUST/CMD indicator - 10% MASTER ARM switch - ON ENG ARM - DES</p> | <p>13. Perform:</p> <p>a. Secure self and cabin for thrust. Verify restraint cables on COR and self are properly attached.</p> <p>b. Record VG</p> <p>c. Communicate TTI value to CSM.</p> <p>d. Update EVENT TIMER if re- quired.</p> <p>14. Monitor MASTER ALARM</p> <p>Light - extinguished Tone - inaudible</p> <p>TEMP/PRESS MON switch - He HELIUM MON Switch - DES/AMB PRESS</p> <p>PRPLNT TEMP/PRESS MON switch - DES 1 PRPLNT QTY MON switch - DES 1 O₂/H₂O QTY MON switch - DES RATE/ERR MON switch - LDG RDR CMPTR T/TCA THROTTLE/JETS SELECT LEVER - THROTTLE</p> <p>Operate Manual Throttle THRUST/CMD indicator - 10%</p> | <p>13. If TTI has been slipped, DSKY and EVENT TIMER will not agree.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|---|---|
| 15. Key V-- N-- EXX. 03 E | 15. Verify following caution lights - extinguished: <div> <div>CDR</div> <div> <div>ASC Press</div> <div>DES REG</div> <div>DES QTY</div> <div>CES AC</div> <div>CES DC</div> <div>AGS</div> <div>LGC</div> </div> <div> <div>RCS A REG</div> <div>RCS B REG</div> <div>DC BUS</div> <div>CABIN FAN</div> <div>SUIT FAN</div> <div>ISS</div> <div>RCS TCA</div> </div> </div> MASTER ALARM AND TONE | 15. DEADBAND 0.03 Degrees |
| 16. FL V06 N51 <div> <div>TTI</div> <div>VG</div> <div>DELTA</div> <div>VM</div> </div> <div> <div>XXBXX MIN SECS</div> <div>XXXX.X FPS</div> <div>XXXX.X FPS</div> </div> | 16. Verify following caution lights - extinguished: <div> <div>ASC HI</div> <div>REG</div> <div>ASC QTY</div> <div>ENG GMBL</div> <div>PGNS</div> <div>INVERT-</div> <div>ER</div> <div>BATTERY</div> <div>RNDZRDR</div> <div>LDG RDR</div> </div> <div> <div>PRE AMPS</div> <div>RCS</div> <div>HEATER</div> <div>C/W PWR</div> <div>ECS</div> <div>O₂ QTY</div> <div>GLYCOL</div> <div>WATER QTY</div> </div> MASTER ALARM AND TONE TEMP/FUELAND OXID POINTERS - Aligned PRESS/FUEL AND OXID POINTERS - Aligned RCS A and B TEMP Pointers - in Green RCS A and B PRESS Pointers - Aligned SUIT and CABIN PRESS Pointers - Aligned PART PRESS CO ₂ Pointer - in Green GLYCOL TEMP and PRESS Pointer - in Green | 16. At 15 < TTI < 30 SECS, if DELTA VM > 0.5 FPS consider: a. Switching to AGS b. Manual firing of engine c. Firing engine with PGNS anyway. |
| 17. Monitor EVENT TIMER FDAI ATT ERR - IN DEADBAND FDAI ATT RATES - * * DEG/ SEL FDAI PITCH - * * FDAI Roll and Yaw - STABLE | | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>18. Communicate countdown from TIG -10 secs. Verify RCS ignition for ullage at TIG - 7.5 secs by sound, vibration, and acceleration.</p> <p>FDAI error NEEDLES - in deadband FDAI Pitch * * } Roll * * } constant Yaw * * } DELTA VM * * FPS</p> <p>19. FL V50 N11 (ENGINE ENABLE)</p> <p>TT1 XXBXX MIN SECS VG XXXX. X FPS DELTA VM XXXX. X FPS</p> <p>Accept: ENTR</p> <p>21. Monitor descent engine ignition 5.5 seconds after RCS ignition by sound, vibration, and acceleration.</p> <p>23. Verify TTI changes to TG at TTI = ZERO.</p> | <p>19. Monitor EVENT TIMER</p> <p>20. Communicate "MARK" when EVENT TIMER reaches zero. EVENT TIMER/RESET/COUNT switch - UP</p> <p>21. Communicate "ENGINE FIRING" to MCC/CSM.</p> <p>22. ENG CMBL caution light - out REACTION CONTROL/QUANTITY Indicator * % * MAIN PROPULSION/QUANTITY OXIDIZER indicator - * * FUEL indicator - * *</p> | <p>19. Option exits to inhibit engine ignition at this time: Key V34E, FL V50 N07, Key V37E 00E</p> <p>20. Thrust on at TTI = ZERO</p> <p>21. Lock gimbal in position and compensate for trim manually if ENG GMBL caution light goes on.</p> <p>a. RCS oxidizer and fuel consumption decreases during gimbal alignment as vehicle moment unbalance decreases.</p> <p>b. Position error decreases as vehicle moment unbalance decreases.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>24. Observe FDAI pitch, roll, and yaw angles. ATTITUDE MON switch - AGS Observe FDAI pitch, roll and yaw angles.</p> <p>ATTITUDE MON - PGNS T/W indicator - * * ATTITUDE RATES - Zero FDAI ATTITUDE - Constant THRUST - 10% for 26 seconds. THRUST - * % * for * * seconds. FDAI error needles - stable</p> <p>25. FL V06 N51</p> <p>TG - XXBXX MIN SECS VG - XXXX.X FPS DELTA - XXXX.X FPS VM</p> | <p>24. Repeat steps 15 and 17 periodically.</p> <p>Request CSM FDAI pitch, roll and yaw values. Compare to LM and FDAI values.</p> <p>26. Verify the following:</p> <p>MAIN PROPULSION/TEMP/FUEL and OXID pointers - GREEN BAND MAIN PROPULSION/PRESS/FUEL and OXID pointers - aligned REACTION CONTROL/TEMP/A and B pointers - GREEN BAND REACTION CONTROL/PRESS/A and B pointers - aligned ENVIRONMENTAL CONTROL/PRESS/ SUIT and CABIN indicator pointers - GREEN BAND ENVIRONMENTAL CONTROL/PART PRESS CO₂ indicator - GREEN BAND ENVIRONMENTAL CONTROL/ GLYCOL/TEMP PRESS indicator pointers - GREEN BAND MAIN PROPULSION/QUANTITY indicators:</p> <p>OXIDIZER - * * FUEL - * *</p> | <p>24. ATTITUDE should agree to within ± 5 degrees. If not, see Block L1.</p> <p>If FDAI values are significantly different, MCC will request change. (CSM Roll and Yaw = LM Yaw and Roll Angles).</p> <p>If TG \leq 70 secs, switch to manual control. THR CONT switch - MAN</p> <p>Error needles stabilize at error signal required to offset thrust misalignment.</p> <p>25. During thrusting TG and VG decrease as Delta Vm increases.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|-----------------------------------|
| | <p>MAIN PROPULSION/HELIUM indicator - * *</p> <p>REACTION CONTROL/QUANTITY indicator - * to %*</p> <p>27. VOLTS indicator - 28.0 POWER/TEMP MON switch - BUS/SE VOLTS indicator - 28.0 POWER/TEMP MON switch - BUS/AC VOLTS indicator - GREEN BAND POWER/TEMP MON switch - BAT/ 1 thru 6 VOLTS indicator: AMPS indicator, each position:</p> <p>VOLTS - 28.0 AMPS - <u>TBD</u></p> <p>POWER/TEMP MON switch - BUS/CDR</p> | |
| <p>28. FL V06 N51</p> <p>TG XXBXX MIN -SEC VG XXXX.X FPS DELTA XXXX.X FPS VM</p> <p>When TG and VG =0 ENG ARM switch - OFF</p> <p>29. Verify engine shutdown via displays, and cessation of noise, vibration, and acceleration.</p> <p>MASTER ARM switch - OFF</p> | <p>29. Compare VG on DSKY with VG on DEDA.</p> <p>Record final VG and Delta VM Key into DEDA (read out Perigee) CLR 343 READOUT Record - Perigee Key into DEDA CLR 400 +10,000 ENTR (Auto Submode)</p> | <p>28. Flash starts at TG = 0</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|--|---|--|
| <p>30. V06 N51</p> <p>TG XXBXX MIN - SEC VG XXXX. X FPS DELTA XXXX. X FPS VM</p> <p>31. a. V33E - No Trim Maneuver</p> <p> b. Key V37E 41E for final RCS Trim.</p> <p>32. Receive orbital data from MSFN (R30 - Orbital Parameter Display)</p> <p> 4. <u>POST THRUST EVALUATION.</u></p> <p>1. ATTITUDE CONTROL/MODE CONTROL - AUTO</p> <p>3. FL V06 N43</p> <p>Apogee ALT XXXX. X NM Perigee ALT XXXX. X NM TFF XXBXX MIN - SEC V33E</p> | <p>30. Transmit to MCC terminal values of Delta VM and VG. Receive opinion from MCC on need for final RCS trim. Compare Delta VM value on DSKY with VG value on DEDA. Call up Perigee on DEDA CLR 343 READOUT</p> <p>Record VG and Perigee from DEDA, and Delta VM from DSKY.</p> <p>2. (R30 Orbital Parameter Routine) Receive trajectory data from MCC Perigee Apogee Time to free fall Total SENSED VELOCITY</p> <p>3. Record values if different from MCC values.</p> | <p>30. Consider CSM DSKY-display VG and Delta VM values in the decision concerning RCS Trim Maneuver.</p> <p>2. The orbital parameter routine may also be entered by Key V64E, though it is normally entered automatically after a thrust program.</p> <p>Time to free fall to 300,000 ft above launch pad radius.</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|--|
| <p>4. Poss FL V06 N35 T Perigee 00XXX. Hrs 000XX. Min 0XX. XX Secs V 33E</p> <p>5. FL V50 N07 R1 00000 V37E 00E</p> <p>7. Key V37E 25E</p> <p>8. Monitor FDAI PITCH * * ROLL * * YAW * *</p> <p>9. Azimuth LOS Rate - * * MRAD/SEC ELEVATION RATE - * * MRAD/SEC FDAI ATTITUDE ERROR - IN DEADBAND ATTITUDE RATES - * ZERO ± * DEG/SEC FDAI PITCH - * * DEG FDAI ROLL and YAW - STABLE</p> | <p>4. Record valve of T Perigee.</p> <p>5. Verify LM Safe Orbit</p> <p>6. Receive request from CSM for tracking attitude</p> <p>8. Tracking Light - * *</p> <p>9. Communication from CSM "Locked and tracking".</p> <p>10. Verify following CDR caution lights - OUT ASC PRESS DES REG DES QTY CES AC CES DC AGS LGC</p> | <p>8. <u>R to CSM</u> <u>Beacon Mode</u></p> <p>eye 1500 ft < R < 10^{NM} Dim 10^{NM} < R < 130^{NM} Bright</p> <p>telescope 1500 ft < R < 30^{NM} Dim 30^{NM} < R < 130^{NM} 130^{NM} > R < 400^{NM} Bright</p> |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|-----------|---|---------|
| | <p>ISS RCS TCA RCS A REG RCS B REG DC BUS CABIN SUIT FAN</p> <p>11. Verify following SE caution lights - OUT</p> <p>ASC Hi. REG ASC QTY ENG GMBL PGNS INVERTER BATTERY RNDZ RDR LDG RDR PRE AMPS RCS HEATER C/W PWR ECS O₂ QTY GLYCOL WATER QTY</p> <p>12. Monitor following Indicators:</p> <p>MAIN PROPULSION/TEMP FUEL - * * OXID - * * MAIN PROPULSION/PRESS FUEL and OXID pointers - aligned REACTION CONTROL/TEMP A and B pointers - Green Band REACTION CONTROL/PRESS A and B pointers - aligned ENVIRONMENTAL CONTROL PRESS/SUIT - GREEN BAND PRESS/CABIN - GREEN BAND PART PRESS CO₂ - GREEN BAND GLYCOL/TEMP - GREEN BAND GLYCOL/PRESS - GREEN BAND</p> | |

| COMMANDER | SYSTEMS ENGINEER | REMARKS |
|---|--|---------|
| <p>13. Receive optical tracking trajectory data from CSM.</p> <p>14. R/D TLM CALIBRATE - ON (12 seconds).</p> | <p>13. Record data and compare MCC, CSM, DEDA, and DSKY Trajectory Values.</p> | |

SECTION 9

MALFUNCTION PROCEDURES

INTRODUCTION

This section contains malfunction procedures for LM-2 subsystems and related hardware. It presents the means used to identify the malfunctions, corrective procedures, and alternate modes of operation where corrective action is not possible.

Failure types included in these procedures are those which are detectable by the crew and by MCC through telemetry channels. A functional approach to the malfunctions has been taken so that corrective actions proceed in a logical sequence to the point where no further action is required or possible.

These procedures are presented in tabular form and are arranged in subsystem order. The first column (SYMPTOM) presents the malfunction indication as seen by the crew, the second column (FAILURE) describes the probable cause of failure, the third column (PROCEDURES) contains the corrective actions and alternates available to the crew. The fourth column (REMARKS) contains notes, highlights or instructions pertinent to the procedures.

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|------------------------|---|--|---------|
| 1. LGC warning lt - On | 1A. CWEA circuitry - Failed | 1A. a. GUID CONT sw - AGS b. MCC verifies LGC - Good c. Request MCC continue to monitor LGC performance. d. Continue mission. | |
| | 1B. LGC power supply or scaler - Failed | 1B. a. Verify DSKY displays - No change during LGC self-test b. Check DSKY displays. c. Key into DSKY - V92E, 1N27E 77766E d. (1) Displays good - Power supply failed (2) Displays Malfunctioning - Scaler failed e. Continue mission on AGS | |
| | 1C. PGNS failure monitor - Failed | 1C. a. Verify PGNS caution lt - Off b. Initiate LGC self-test. c. Key into DSKY V92N27E 77767E d. Verify DSKY displays - Normal e. Request MCC notify crew of further PGNCs-associated malfunctions. | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------|--|--|--|
| 1. LGC warning lt - On (cont) | 1C. PGNS failure monitor - Failed (cont) | 1C. (cont) f. GUID CONT sw - PGNS g. Gain MCC agreement and continue mission. | a. Self-test alarm code: 01102 |
| | 1D. LGC hardware - Failed | 1D. a. Monitor R1 for LGC self-test alarm code. b. Request DSKY display of alarm address c. Key into DSKY V05N08E. d. Communicate alarm address to MCC e. Continue mission on AGS | |
| 2. ISS warning lt - On | 2A. ISS circuitry - Failed | 2A. a. GUID CONT sw - AGS b. MCC verifies ISS - Good c. Request MCC continue to monitor ISS performance. d. Continue mission. | Failure is indicated if ISS warning lt remains on. |
| | 2B. PIPA - Failed | 2B. a. Verify ISS caution lt - Off b. Verify PGNS caution lt and DSKY PROG lt - On; if not proceed with failure 2C c. Continue mission on AGS | b. Identifies PIPA failure |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------|--|---|---|
| 2. ISS warning lt - On (cont) | 2C. ISS CDU - Failed | 2C. a. Verify-PGNS caution and DSKY PROG lt-Remain off b. Request FDAI ball angles on DSKY Key into DSKY V06N94E c. Verify that FDAI and DSKY ball angles disagree. If not proceed with failure 2D. d. Continue mission on AGS. | |
| | 2D. IMU - Failed | 2D. a. Mode control - ATT HOLD b. Rotate vehicle about all axes c. Monitor ball angles on FDAI and DSKY d. Ball angle information - If not good continue mission on AGS; if good proceed with failure 2E | c. Identifies IMU failure |
| | 2E. PGNS failure monitor - Failed or ISS CWEA circuitry failed | 2E. a. Verify FDAI ball information acceptable b. Request MCC monitor ISS performance. c. GUID CONT sw - PGNS d. Continue mission on PGNS. | a. Identifies PGNS failure monitor failed or ISS CWEA circuitry failure |
| 3. RNDZ RDR caution lt - On | 3A. Loss of RR lock during powered phase | 3A. a. RR mode sw - SLEW b. TEST MONITOR sw - AGC | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|------------------------------------|--|--|---|
| 3. RNDZ RDR caution lt - On (cont) | 3A. Loss of RR lock during powered phase (cont) | 3A. (cont) c. Slew antenna tilt signal strength is maximum on SIGNAL STRENGTH mtr | c. If mtr reads TBD, perform procedure 3B. |
| | 3B. Loss of RR lock during coasting phase | 3B. a. Key into DEDA - CLR, 400, +, 20,000 E, VCE b. RATE/ERR MON sw - RNDZ RADAR c. Slew antenna to null angle and error needles on FDAI. d. Maximize signal strength on SIGNAL STRENGTH mtr. e. Continue mission. | Wait until after maneuver if procedure 3A cannot be performed during maneuver |
| | 3C. Temporary loss of track, possibly due to exceeding gimbal limits | 3C. a. RR mode sw - AUTO TRACK b. Continue mission. | |
| | 3D. RR or CM transponder failed (Range to CM: < 40,000 ft) | 3D. a. Verify RNDZ RDR caution lt and NO TRACK lt - On b. Use derived inertial data to achieve rendezvous. | b. PGNS or AGS data can be used. |
| | 3E. RR or CM transponder failed (Range to CM: > 40,000 ft) | 3E. a. Verify RNDZ RDR caution lt and NO TRACK lt - On b. Request CM transponder self-check. | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|------------------------------------|---|--|--|
| 3. RNDZ RDR caution lt - On (cont) | <p>3E. RR or CM transponder failed (Range to CM: > 40,000 ft) (cont)</p> <p>3F. RR CWEA - Failed</p> | <p>3E. (cont)</p> <p>c. Request derived data to accomplish rendezvous.</p> <p>d. Continue mission.</p> <p>3F.</p> <p>a. Verify RNDZ RDR caution lt - On</p> <p>b. Verify NO TRACK lt - Off</p> <p>c. Request CM transponder track RR energy.</p> <p>d. Monitor-NO TRACK lt for subsequent track losses.</p> <p>e. Continue mission.</p> | <p>c. Request MCC data if transponder failed.</p> <p>d. Request CM data if LM RR failed</p> <p>a. Any other possibility reflects at least a triple failure.</p> <p>c. Track loss by CM can be relayed over voice link.</p> |
| 4. LDG RDR caution lt - On. | 4A. LR CWEA - Failed | <p>4A.</p> <p>a. Verify PGNS caution lt and DSKY TRACKER lt - Off</p> <p>b. MODE SEL sw - PGNS RNG/ALT MON sw - ALT/ALT RT</p> <p>c. ALT/ALT RT ind - Observe Record altitude and altitude-rate.</p> <p>d. MODE SEL sw - LDG RADAR</p> <p>e. ALT/ALT RT ind - Observe Record altitude and altitude-rate.</p> <p>f. Verify that recorded values are the same.</p> | <p>If PGNS caution lt and DSKY TRACKER lt go on, perform procedures associated with PGNS caution lt symptoms 7 through 13.</p> <p>f. Identifies LDG RDR CWEA failure</p> |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|--|--|
| 4. LDG RDR caution lt - On (cont) | 4A. LDG RDR CWEA - Failed (cont) | 4A. (cont) g. Monitor PGNS caution lt and DSKY TRACKER lt for subsequent LR problems. h. Continue mission. | a. Lack of LR data good signals, when required c. As vehicle approaches target, differences between PGNS and LR data decrease. LR weight data on LM state vector increases as LM approaches target. |
| | 4B. LGC-LR interface - Failed | 4B. a. Compare PGNS and LR data on ALT/ALT b. Verify that data differs significantly. c. If LR data impact on LM state vector > 10%, consider alternate flight plan. d. If LR data impact on LM state vector is $\geq 90\%$, rely on PGNS data to accomplish mission. | |
| 5. HEATER caution lt - On | 5A. RR temperature transducer No. 1 Failed | 5A. a. TEMP MONITOR sw - RNDZ b. Verify HEATER caution lt - Off c. Request RR temperatures from MCC d. Compare MCC value and TEMP ind value. e. Verify that temperature values disagree. f. Request MCC constantly monitor RR temperature. g. Continue mission. | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|----------------------------------|--|--|--|
| 5. HEATER caution lt - On (cont) | 5B. RR heater CWEA - Failed | <p>5B.</p> <p>a. Verify MCC and TEMP ind values -Normal.</p> <p>b. Request MCC notify crew of any out-of-tolerance (temp) condition.</p> <p>c. Continue mission</p> | a. Normal temperature range is $-40^{\circ} \text{ F} \leq \text{RR temp} \leq +145^{\circ} \text{ F}$ |
| | 5C. RR heater, heater electronics, or heater cb - Failed | <p>5C.</p> <p>a. Verify RR temperature: MCC and TEMP ind - $< -40^{\circ} \text{ F}$</p> <p>b. PGNS - RNDZ RDR cb - In</p> <p>c. Monitor rise in temperature to normal range</p> <p>d. Continue mission. Operate RR as required.</p> | |
| | 5D. Heater control circuitry - Failed | <p>5D.</p> <p>a. Verify RR temperature: MCC and TEMP ind - $> +145^{\circ} \text{ F}$</p> <p>b. Verify STBY and OPR cb for RR heater - In</p> <p>c. HEATER/RNDZ RDR OPR cb - Pull</p> <p>d. Monitor temperature decrease If temperature does not decrease: HEATER/RNDZ RDR STBY cb - Pull</p> <p>e. Continue mission</p> | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|----------------------------------|--|--|--|
| 5. HEATER caution lt - On (cont) | 5E. RR - Overheated | 5E. a. Verify RR temperature: MCC and TEMP ind - $>+145^{\circ}\text{F}$ b. Verify STBY and OPR cb for RR heater - Out c. PGNS - RNDZ RDR cb - Out d. Continue mission, using PGNS - or AGS-derived data e. Monitor TEMP ind for RR temperature decrease f. Attempt to operate RR when temperature is within normal range. | |
| | 5F. Heater caution circuitry - Failed | 5F. a. TEMP MONITOR sw - RNDZ - LDG - QUAD 1 - QUAD 2 - QUAD 3 - QUAD 4 - S BAND b. Verify HEATER caution lt - On. c. Request MCC monitor all temperatures d. Continue mission | b. Identifies HEATER caution circuitry failure |
| | 5G. LR temperature transducer No. 1 - Failed | 5G. a. TEMP MONITOR sw - LDG RADAR b. Verify HEATER caution lt - Off | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|----------------------------------|--|---|--|
| 5. HEATER caution lt - On (cont) | 5G. LR temperature transducer No. 1 - Failed (cont) | 5G. (cont) c. Verify LR temperature: MCC and TEMP ind disagree d. Request MCC constantly monitor LR temperature. e. Continue mission. | c. Identifies LDG RDR: temperature No. 1 failure |
| | 5H. LR heater caution circuitry - Failed | 5H. a. Verify LR temperature: MCC and TEMP ind - Normal b. Request MCC notify of any out of tolerance condition. c. Continue mission | b. Normal temperature range +50° F < LR temp < +150° F |
| | 5J. LR heater, heater electronics, or heater cb - Failed | 5J. a. Verify MCC and TEMP ind indicate LR temperature - < +50° F b. PGNS-LDG RDR cb - In c. Monitor rise in temperature to normal range d. Continue mission. Operate LR as required. | |
| | 5K. LR heater or heater electronics - Failed | 5K. a. Verify LR temperature: MCC and TEMP ind - > +150° F b. Verify HEATER/LDG RDR cb - In | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 5. HEATER caution lt - On (cont) | 5K. LR heater or heater electronics - Failed | 5K. (cont) c. HEATER/LDG RDR cb - Pull d. Monitor LR temperature for changes. (1) If temperature stabilizes, continue mission. (2) If temperature continues to increase, PGNS/LDG RDR cb - Pull e. Consider alternate flight plan. | c. LR is not actively cooled. As LM approaches target, LR temperature should normally increase if descent engine is burning. |
| 6. Continued flashing of DSKY VERB lt after input of data has been attempted for V54, V52 or V53 | 6A. AOT lamp - Failed 6B. AOT heater - Failed | 6A. a. Rotate reticle illumination control while looking through eyepiece. b. Verify that reticle cannot be seen. c. Mount COAS at CDR's window. d. Use COAS to mark star positions. e. Continue mission. 6B. a. Check for moisture on eyepiece b. Verify AOT cb - In | b. AOT can only be used against a bright background if lamps fail. d. Coordinated effort with SE is required; mark button is out of CDR's reach. |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|---|
| 6. Continued flashing of DSKY VERB It after input of data has been attempted for V54, V52 or V53 (cont) | 6B. AOT heater - Failed | 6B. (cont) c. AOT cb - Pull d. AOT cb - Push e. Continue mission. | d. No further action is possible. |
| | 6C. AOT optics darkened from contamination. | 6C. a. Observe degraded optics through eyepiece. b. Mount COAS at CDR's window. c. Use COAS to mark star positions. d. Continue mission. | b. COAS star sightings are not as accurate as AOT star sightings. c. Coordinated effort with SE is required to sight star and press mark button. |
| | 6D. AOT mark sw - Failed | 6D. a. Sight star. b. Appropriate mark X or Y button - Press c. Observe DSKY verb display continues flashing d. Mark reject - Press e. Sight star. f. Mark (X or Y) button - Press g. Observe DSKY verb display continues flashing h. Key into DSKY - V33E; then proceed | d. Button R |
| | 6E. Angle readout gear train - Failed | 6E. a. Exercise AOT mechanisms | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|-------------------|
| 6. Continued flashing of DSKY VERB lt after input of data has been attempted for V54, V52 or V53 (cont) | 6E. Angle readout gear train - Failed (cont) | 6E. (cont) b. Verify angle readout - Constant c. ATTITUDE CONTROL sw (ROLL, PITCH, and YAW) - PULSE d. Rotate vehicle until star crosses appropriate reticle line. e. Mark (X or Y) button - Press f. Rotate vehicle to achieve next mark. g. Repeat steps d through f for at least four star sightings. h. Continue mission. | |
| | 6F. Optics drive - Failed | 6F. a. Exercise AOT mechanisms. b. Verify AOT will not change detent position. c. Repeat steps c through h of procedure 6E. | |
| | 7A. DSKY lamp - Failed | 7A. a. Perform DSKY lamp check: Key in to DSKY-V35E b. Observe failed DSKY lamp. c. React to failed lt as if on. | b. Double failure |
| 7. PGNS caution lt - On DSKY caution lt - Off | 7B. PGNS failure monitor circuitry - Failed | 7B. a. Perform DSKY lamp check: Key in to DSKY-V35E | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---------|
| 7. PGNS caution lt - On DSKY caution lt - Off (cont) | 7B. PGNS failure monitor circuitry - Failed (cont) | 7B. (cont) b. Observe all DSKY lamps - On. c. DSKY RSET pb - Press d. Observe PGNS caution lt - Out; then On e. Request MCC monitor LGC performance. f. Monitor DSKY condition lt for subsequent caution conditions. g. Continue mission | |
| | 7C. PGNS caution CWEA circuitry - Failed | 7C. a. Perform DSKY lamp check: Key in to DSKY-V35E b. Observe all DSKY lamps - On c. DSKY RSET pb - In d. Observe PGNS caution lt - On e. Request MCC monitor LGC performance. f. Monitor DSKY condition lt for subsequent caution conditions g. Continue mission. | |
| 8. PGNS and DSKY TEMP caution lt - On | 8A. IMU temperature control circuitry - Failed | 8A. a. Request MCC monitor IMU performance. b. Request LM attitude: Key into DSKY - V06 N94E | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|---------|
| 8. PGNS and DSKY TEMP caution lt - On (cont) | 8A. IMU temperature control circuitry - Failed (cont) | 8A. (cont) c. MCC relays data: (1) PIPA or IRIG temperature out of tolerance (2) Resolver sine and cosine output voltages not acceptable d. Observe DSKY displayed attitude is unreasonable. e. GUID CONT sw - AGS f. Continue mission | |
| | 8B. IMU temperature control circuitry - Failed | 8B. a. MCC relays data: IMU performance - Acceptable. b. LM attitude from DSKY (V06N94E) - Acceptable. c. DSKY RSET pb - Pressed d. Request MCC continue monitor IMU performance. e. Continue mission. | |
| 9. PGNS and DSKY GIMBAL LOCK caution lt - On | 9A. ISS or LGC hardware - Failed No. 1 | 9A. a. Key into DSKY-V06 N94E b. DSKY and FDAI roll gimbal angle displays $\pm 70^\circ + 15^\circ - 0^\circ$. c. DSKY RSET pb - Pressed d. Perform manual roll | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|--|
| 9. PGNS and DSKY GIMBAL LOCK caution lt - On (cont) | 9A. ISS or LGC hardware - Failed No. 1 (cont) | <p>9A. (cont)</p> <p>e. Observe GIMBAL LOCK caution lt - On</p> <p>f. GUID CONT sw - AGS</p> <p>g. Monitor LGC and ISS warning lt for specific hardware malfunction.</p> <p>h. Continue mission on AGS</p> | <p>e. Additional indications of hardware failures appear in the illumination of other caution or warning lights.</p> <p>b. LGC automatically down modes IMU to coarse align when roll gimbal angle exceeds 85° from its zero position.</p> |
| | 9B. ISS or LGC hardware - Failed No. 2 | <p>9B.</p> <p>a. Key into DSKY-V06 N94E</p> <p>b. DSKY and FDAI roll gimbal angle displays $\pm 85^\circ + 5 - 0^\circ$</p> <p>c. Observe NO ATT lt on DSKY - On</p> <p>d. Observe (after roll gimbal angle decreases to less than $\pm 70^\circ$) GIMBAL LOCK lt - On</p> <p>e. GUID CONT sw - AGS</p> <p>f. Monitor warning lt for specific hardware malfunction.</p> <p>g. Continue mission on AGS</p> | |
| | 9C. PGNCS Failure monitor - Failed | <p>9C.</p> <p>a. Key into DSKY-V06 N94E.</p> <p>b. DSKY and FDAI roll gimbal angle displays $< \pm 70^\circ$</p> | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 9. PGNS and DSKY GIMBAL LOCK caution lt - On (cont) | 9C. PGNCS Failure monitor - Failed (cont) | 9C. (cont) c. DSKY RSET pb - Press d. PGNS caution lt and DSKY GIMBAL LOCK lt - Remain on e. Request MCC to alert crew to any further PGNCS malfunctions. f. Continue mission. | |
| 10. PGNS caution lt and DSKY PROG and/or RESTART lt - On | 10. LGC hardware - Failed | 10. a. Observe DSKY display of V05, N09 and verb-noun displays flashing b. Observe alarm identification code in R1. If program alarm code is displayed, crew can key into DSKY: V32E (Recycle), V33E (Proceed), V34E (Terminate), or V-N-E (restart current program). Or they can select AGS and verify the malfunction c. DSKY RSET pb - Press d. Observe caution lt - Off (momentarily) e. GUID CONT sw - AGS f. Initiate LGC self-check: Key into DSKY-V21 N27E 77767E | c. If first digit in R1 is a 4, skip step d. |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

[illegible]

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| 11. PGNS caution and DSKY TRACKER caution lt - On (cont) | 11B. PGNS failure monitor - Failed (cont) | 11B.(cont) e. DSKY RSET pb - Press f. Verify PGNS caution lt and DSKY TRACKER lt - Off (momentarily) g. Request MCC monitor LR and RR performance. h. Continue mission. | f. Identifies PGNS failure monitor fail (rendezvous radar information is still available to the crew on cockpit displays) |
| | 11C. PGNS failure monitor or RR CDU failure | 11C. a. Key into DSKY: V06N72E b. Set the following: (1) TEST MONITOR sw - SHAFT ERR or TRUN ERR (2) RR MODE sw - SLEW (3) RATE/ERR MON - RNDZ RADAR c. Compare FDAI error needles and SIGNAL STRENGTH mtr angle error signals. d. Verify-Antenna tracking properly. e. DSKY RSET pb - Press f. Verify PGNS and DSKY tracker lt - Out; then on (stays on) g. Request MCC to monitor RR performance and continue mission | f. Identifies PGNS failure monitor or RR CDU failure. |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 12. PGNS caution, DSKY TRACKER, and radar panel NO TRACK lt - On | 12A. Possible PGNS failure monitor - Failed | 12A. a. Verify RR was not tracking when symptoms appeared. b. Continue mission. | |
| | 12B. CM transponder - Failed | 12B. a. Monitor DSKY for PROG lt and alarm code in R1. b. DSKY RSET pb - Press DSKY PROG lt - Off c. Request CM self-check transponder d. Receive verification that transponder is not working properly. e. Use PGNS - or AGS-derived inertial data. f. Continue mission. | a. 00503 (RR designate fail) or RR will not accept designated commands. |
| | 12C. LGC CM and LM state vector information in doubt | 12C. a. Monitor DSKY PROG lt and alarm code. b. DSKY RSET pb - Press DSKY PROG lt - Off c. Verify-In coasting flight d. Key into DEDA-CLR, 400, +, 20000, E VCE ABORT sw - Press | a. 00525 (RR actual less calculated LOS > 3°) d. Point LM +Z-axis at CM. |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|----------------------------------|
| 12. PGNS caution, DSKY TRACKER, and radar panel NO TRACK lt - On (cont) | 12C. LGC CM and LM state vector information in doubt (cont) 12D. RR antenna drives, frequency tracker, or range tracker - Failed | 12C.(cont) e. RR mode sw - SLEW TEST MONITOR sw - AGC SLEW sw - UP, DOWN, RIGHT, LEFT: Observe SIGNAL STRENGTH meter - AGC voltage. f. Verify CM is acquired PGNS caution lt - Off TRACKER lt - Off NO TRACK lt - Off g. GUID CONT sw - AGS h. Request state vector information from CM or MCC. i. Update LM state vector: Key into DSKY-V37 N27E j. Continue mission on AGS until LGC is certified good. 12D. a. Verify that CM is not acquired when LM +Z-axis is pointed at CM by AGS. b. Monitor SIGNAL STRENGTH mtr - AGC value constant c. GUID CONT sw - AGS. d. Request state vector information from CM or MCC. e. Update LM state vector: Key into DSKY-V37 N27E. f. Continue mission on AGS until LGC is certified good. | e. Seek maximum signal strength. |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|----------------------------------|
| 12. PGNS caution, DSKY TRACKER, and radar panel NO TRACK It - On (cont) | 12E. RR lock-on circuitry - Failed | 12E.Repeat procedure 12D. | AGC value will be erratic |
| 13. PGNS caution, DSKY TRACKER, and LDG RDR caution It - On | 13A. LR velocity transmitter - Failed | 13A. a. DSKY RSET pb - Press b. Verify DSKY TRACKER, PGNS caution and LDG RDR caution It - Off (momentarily) c. TEST MONITOR sw - LDG RADAR PWR: VEL XMTR d. Verify VEL XMTR power output unacceptable on SIGNAL STRENGTH mtr. e. Continue mission. | e. This failure is not critical. |
| | 13B. LR altimeter transmitter- Failed | 13B. a. DSKY RSET pb - Press b. Verify PGNS caution, DSKY TRACKER and LDG RDR caution It - Off (momentarily) c. TEST MONITOR sw - LDG RADAR PWR: ALT XMTR d. Verify ALT XMTR power output unacceptable on SIGNAL STRENGTH mtr. e. Continue mission | e. This failure is not critical. |
| | 13C. Frequency tracker - Failed | 13C. a. Verify velocity and altimeter transmitter outputs - Normal b. RADAR TEST sw - LDG | |

Table 9-1. Guidance, Navigation, and Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|----------------------------------|
| 13. PGNS caution, DSKY TRACKER, and LDG RDR caution lt - On (cont) | 13C. Frequency tracker - Failed (cont) | 13C.(cont) c. Verify X-pointer-Out of tolerance d. Continue mission. | d. This failure is not critical. |
| | 13D. Range tracker - Failed | 13D. a. Verify velocity and altimeter transmitter outputs - Normal b. RADAR TEST sw - LDG c. Verify ALT/ALT RT ind - Out of tolerance d. Continue mission | d. This failure is not critical. |
| | 13E. LR error-detection circuitry - Failed | 13E. a. Verify transmitter outputs - Normal b. RADAR TEST sw - LDG c. Verify X-pointer and ALT/ALT RT ind - Normal d. Request MCC monitor LR performance e. Continue mission. | e. This failure is not critical. |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|--|
| 1. % ENG THRUST ind does not agree with % CMD THRUST ind | 1. Engine pressure transducer - Failed or % CMD THRUST ind - Failed or % ENG THRUST ind - Failed | 1. a. Check % CMD THRUST ind readings with MCC. (1) If readings do not agree % CMD THRUST ind - Failed (2) If readings do agree pressure transducer - Failed (3) Derive information concerning engine performance from % CMD THRUST ind and ΔV information displayed on DSKY. b. Check % ENG THRUST ind readings with MCC. (1) If readings do not agree % CMD THRUST ind - Failed (2) If readings do agree pressure transducer - Failed (3) Derive information concerning engine performance from % ENG THRUST ind and ΔV information displayed on DSKY. | (1) MCC AUTO THRUST CMD readings are 10% less than crew readings. This is due to a 10% internal indicator bias. b. Erroneous readings, but in agreement |
| 2. ENG GMBL caution - On | 2. Gimbal drive assembly - Failed. | 2. a. ENG GMBL sw - OFF | a. If ENG GMBL caution It does not go off when ENG GMBL is set to OFF, ENG GMBL caution circuitry in CWEA failed. Set ENG GMBL to ENABLE and continue mission. |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|---|
| 2. ENG GMBL caution lt - On (cont) | 2. Gimbal drive assembly - Failed. (cont) | 2. (cont) b. Attitude error and RCS propellant consumption - Monitor If attitude error or RCS propellant consumption becomes critical: STOP sw - Press c. Initiate nominal ascent engine testing when advised by MCC. | |
| 3. CES AC warning lt - On (AGS in control) or CES DC warning lt - On (AGS in control) | 3. 800-cps, single-phase power and/or 800-cps, three-phase power - Failed. or Any one, or combination, of following output voltages from CWEA power supply: +28 vdc, +15 vdc, -15 vdc, +6 vdc, -6 vdc, -4 vdc | 3. a. During coast, initiate gyro self test b. Gyro self test - not good; ac or dc failure c. GUID CONT sw - PGNS d. Do not attempt further AGS testing. e. If gyro self test is good - CWEA power supply failed; AGS testing can continue | If this failure occurs during powered phase, switch to PGNS and complete engine burn. During coast, follow procedure given. |
| 4. AGS warning lt - On | 4. AEA or power supplies - Failed. | 4. a. Enter CLR, 412, READOUT on DEDA to determine how AEA has failed. b. GUID CONT sw - PGNS | If this failure occurs during powered phase, switch to PGNS and complete engine burn. During coast, follow procedure given. a. Readout of AEA address 412 +10000-test successfully completed +30000-logic test failure +40000-memory test failure +70000-logic and memory test failure |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|---------|
| 4. AGS warning lt - On (cont) | 4. AEA or power supplies - Failed. (cont) | 4. (cont) c. Do not attempt further testing of AGS. d. If AEA self test is good - CWEA failed; AGS testing can continue, key into DEDA CLR, 412+00000 ENTR (restart self test) | |
| 5. % CMD THRUST and % ENG/THRUST ind - 10% LGC does not provide proper thrust commands. (Automatic engine burn) | 5. THR CONT sw (deck No. 2 wiper) - Failed to MAN | 5. a. THR CONT sw - MAN b. Control thrust with CDR's TTCA. (THRUST ind will now function correctly) c. Confirm orbit and trajectory with MCC. | |
| 6. % CMD THRUST ind - 10% (Automatic and manual engine burns) | 6. THR CONT sw (deck No. 2 wiper open or AUTO deck No. 3 wiper) - Failed open | 6. Derive information concerning engine performance from % ENG THRUST ind and ΔV information displayed on DSKY. | |
| 7. % CMD THRUST ind - 10% in MAN mode Ind functions correctly when in AUTO mode. | 7. THR CONT sw (deck No. 3 wiper) - Failed to AUTO | 7. Derive information concerning engine performance from % ENG THRUST ind and ΔV information displayed on DSKY. | |
| 8. % ENG THRUST ind - 10% when in AUTO mode Ind functions correctly when in MANUAL mode. | 8. THR CONT sw (deck No. 3 wiper) - Failed to MAN | 8. Derive information concerning engine performance from % ENG/THRUST ind and ΔV information displayed on DSKY. | |
| 9. Neither T TCA can control engine thrust. (Manual engine burns) | 9. MAN THROT sw (deck No. 1 or 2 wiper) - Failed open | 9. a. Allow engine to burn until required ΔV is displayed on DSKY. | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|--|
| 9. Neither T TCA can control engine thrust. (Manual engine burns) (cont) | 9. MAN THROT sw (deck No. 1 or 2 wiper) - Failed open (cont) | 9. (cont) <div style="border: 1px solid black; padding: 2px; margin: 10px 0;"> WARNING </div> If present engine output is in the 60% to 90% thrust region, press STOP sw and check with MCC to determine if descent engine testing (using automatic mode), nominal ascent engine testing, or abort stage situation is appropriate. b. When required ΔV is attained: STOP sw - Press c. Continue nominal testing of descent engine automatic mode | b. Assuming that engine was allowed to continue thrusting. |
| 10. SE's T TCA cannot control engine thrust. CDR's T/TCA functions normally. (Manual engine burns) | 10. MAN THROT sw (deck No. 1 or 2 wiper) - Failed to CDR | 10. a. MAN THROT sw - CDR b. CDR controls engine thrust. | |
| 11. CDR's T TCA cannot control engine thrust. SE's T/TCA functions normally. (Manual engine burns) | 11. MAN THROT sw (deck No. 1 or 2 wiper) - Failed to SE | 11. a. MAN THROT sw - SE b. SE controls engine thrust. | |
| 12. CDR cannot initiate translation maneuvers. | 12. CDR's T TCA - Failed to THROTTLE | 12. a. SE's T TCA - JET b. SE initiates translation maneuvers c. CDR controls engine thrust | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| 13. CDR cannot control descent engine thrust. | 13. CDR's T TCA - Failed to JET | 13. a. SE's T TCA - THROTTLE b. SE controls engine thrust. c. CDR initiates translation maneuvers. | |
| 14. SE cannot initiate translation maneuvers. | 14. SE's T TCA - Failed to THROTTLE | 14. a. CDR's T TCA - JET b. CDR initiates translation maneuvers c. SE controls engine thrust | |
| 15. SE cannot control descent engine thrust. | 15. SE's T TCA - Failed to JET | 15. a. CDR's T TCA - THROTTLE b. CDR controls engine thrust c. SE initiates translation maneuvers. | |
| 16. Ascent or descent engine does not start at time indicated on DSKY. (Automatic or manual) | 16. ENG ARM sw (deck No. 1 or 2 wiper) - Fails open or to OFF | 16. ABORT or ABORT STAGE sw. (as appropriate for mission phase) - Press | If manual start has failed, program LGC for automatic burn before pressing ABORT or ABORT STAGE sw. |
| 17. Ascent engine does not start at time indicated on DSKY. (Automatic or manual) | 17. ENG ARM sw - Deck 1 or deck 2 fails - DES | 17. a. (1) If in MAN-switch to AUTO and attempt LGC controlled burn. (2) If in AUTO-switch to MAN and attempt manual controlled burn. (3) If (1) and (2) fail proceed to step b. b. ABORT STAGE sw - Press | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---------|
| 18. Descent engine fails to start when START sw - Pressed | 18. ENG ARM sw - Deck 3 wiper failed - Open or - OFF | 18. a. THR CONT sw - AUTO b. Program LGC for automatic descent engine burn c. If auto start is unsuccessful: ABORT sw - Press | |
| 19. Ascent engine fails to start when START sw - Pressed | 19. ENG ARM sw - Deck 3 failed - DES | 19. a. Attempt automatic start. If automatic start fails proceed to step b. b. ABORT STAGE sw - Press | |
| 20. Ascent engine fails to start when START sw - Pressed | 20. ENG ARM sw - Deck 4 failed Open or to OFF or DES | 20. a. Attempt automatic start. If automatic start fails proceed to step b. b. ABORT STAGE sw - Press | |
| 21. Descent engine does not restart after CDR's STOP sw - Pressed | 21. CDR's STOP sw - Deck 1 or deck 2 fails - Open | 21. a. STOP switch - Reset b. Attempt descent engine start. If descent engine start fails proceed to step c. c. Initiate nominal ascent engine testing when advised by MCC. d. If ascent engine does not start: ABORT STAGE sw - Press | |
| 22. Ascent engine does not restart after CDR's STOP sw - Pressed | 22. CDR's STOP sw - Deck 3 wiper failed - Open | 22. a. STOP switch - Reset | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---------|
| 22. Ascent engine does not restart after CDR's STOP sw - Pressed (cont) | 22. CDR's STOP sw - Deck 3 wiper failed - Open (cont) | 22. (cont) b. Attempt ascent engine start. If ascent engine start fails proceed to step c. c. ABORT STAGE sw - Press | |
| 23. Ascent engine fails to shut down when CDR's STOP sw - Pressed | 23. CDR's STOP sw - Deck 3 failed - On | 23. a. SE's STOP sw - Press b. ENG ARM sw - OFF c. Continue nominal testing of ascent engine. | |
| 24. CDR's STOP pb - Not illuminated when pressed | 24. CDR's STOP sw - Deck 4 failed - Open. | 24. None required | |
| 25. CDR's STOP pb - Remains illuminated when reset | 25. CDR's STOP sw - Deck 4 failed - On. | 25. None required | |
| 26. SE's STOP sw malfunctions (Identical with symptoms 21 thru 25), for CDR's STOP sw) | 26. Same as failures 21 through 25. | 26. Same as procedures 21 through 25. | |
| 27. Engine does not start when ABORT pb is pressed under AGS control. | 27. ABORT sw - Deck 2 failed - Off | 27. a. GUID CONT sw - PGNS b. ABORT sw - Press If not successful, proceed to step c. c. ABORT STAGE sw - Press | |
| 28. Engine does not start when ABORT pb is pressed under PGNS control | 28. ABORT sw - Deck 3 failed - Off | 28. a. GUID CONT sw - AGS b. ABORT sw - Press If not successful, proceed to step c. c. ABORT STAGE switch - Press | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---------|
| 29. MCC does not receive abort telemetry signal when abort is executed | 29. ABORT sw - Deck 4 failed - Off | 29. Abort in progress; use VHF to notify MCC | |
| 30. Ascent engine does not start when ABORT STAGE sw - Pressed | 30. ABORT STAGE sw - Deck 3 or deck 4 failed - Off. | 30. a. MASTER ARM sw - ON b. ASC He SEL sw - BOTH c. ASCENT He PRESS sw - FIRE d. ENG ARM sw - ASC e. START sw - Press | |
| 31. Ascent or descent engine does not start when START sw - Pressed | 31. START sw - Failed off (START sw lt - Off) | 31. NOTE If MCC decides to abort, proceed with step c. a. THR CONT sw - Auto b. Program LGC for automatic burn of ascent or descent engine. c. ABORT or ABORT STAGE sw (as appropriate for mission phase) - Press | |
| 32. Ascent or descent engine does not shut down when STOP sw - Pressed | 32. START sw failed - On. (START sw lt - Remains on) | 32. a. ENG ARM sw - OFF b. ENG START OVRD cb - Pull c. Do not attempt further manual engine burns. d. If necessary to fire ascent engine again: ABORT STAGE sw - Press | |

Table 9-2. Stabilization and Control Section in Abort Guidance Mode, Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--------------------|---------|
| 33. Loss of rate stabilization when attitude maneuvers are commanded (automatic or manual); guidance control in AGS | 33. Rate gyro assembly - Failed to ROLL, PITCH, or YAW | 33. Fly open loop. | |
| 34. Rate gyro test, negative or positive, in any axis cannot be executed. | 34. GYRO TEST sw deck 1 or deck 2 wiper - Fails open or - Failed to OFF | 34. None required | |
| 35. NEG RT GYRO TEST in any axis cannot be executed. | 35. GYRO TEST sw deck 1 or deck 2 - Failed to POS RT | 35. None required | |
| 36. POS RT GYRO TEST in any axis cannot be executed. | 36. GYRO TEST sw deck 1 or deck 2 - Failed to NEG RT | 36. None required | |
| 37. Rate gyro test in any axis, negative or positive, cannot be executed. | 37. GYRO TEST sw deck 1 wiper - Failed open | 37. None required | |
| 38. Only rate gyro test in ROLL axis, negative and positive, can be executed. | 38. GYRO TEST sw deck 1 - Failed to ROLL | 38. None required | |
| 39. Only rate gyro test in PITCH axis, negative and positive, can be executed. | 39. GYRO TEST sw deck 1 - Failed to PITCH | 39. None required | |
| 40. Only rate gyro test in YAW axis, negative and positive, can be executed. | 40. GYRO TEST sw deck 1 - Failed to YAW | 40. None required | |

Table 9-3. Descent Propulsion Section Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|----------------------------|--|--|---|
| 1. DES REG warning lt - On | 1A. Primary helium regulator assembly - Failed open during powered flight (unstaged) | <p>1A.</p> <p>a. DESCENT He/REG 1 sw - CLOSE (momentarily)</p> <p>DES REG warning lt - Off</p> <p>b. DESCENT He/REG 2 sw - OPEN (momentarily)</p> <p>c. Verify FUEL and OXID PRESS ind - Normal pressure</p> <p>d. Verify HELIUM ind - Adequate helium pressure to complete mission If helium pressure is adequate, continue mission.</p> <p>If helium pressure is not adequate:</p> <p>Engine STOP pb - Press</p> <p>e. Coordinate alternate mission sequence with MCC.</p> | <p>Exact time between taking corrective action and warning light going out is a function of quantities remaining; it has not been determined.</p> <p>d. Compare this pressure reading with mission profile helium envelope in flight data kit.</p> <p>e. Several alternatives are available:</p> <p>(1) FIFTH using AGS (DPS off). This is recommended and nominal sequence</p> <p>(2) Manual staging</p> |
| | 1B. Helium regulator outlet manifold pressure sensor or Associated or signal conditioner failed - High or low or CWEA DES REG warning lt - Fails on. | <p>1B.</p> <p>a. DESCENT He/REG 1 sw - CLOSE (momentarily)</p> <p>Verify DES REG warning lt - on</p> <p>b. FUEL and OXID PRESS ind - Normal pressure</p> <p>c. DESCENT He/REG 1 sw - OPEN (momentarily)</p> | |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|--|---|
| 1. DES REG warning lt - On (cont) | 1B. Helium regulator outlet manifold pressure sensor or Associated or signal conditioner failed - High or low or CWEA DES REG warning lt - Fails on (cont) | 1B. (cont) d. Continue nominal mission, frequently checking HELIUM and FUEL and OXID ind. | d. If regulator fails, helium overpressurization or underpressurization will be displayed. |
| | 1C. Leak in helium lines during powered flight (unstaged) | 1C. a. DESCENT He/REG 1 sw - CLOSE (momentarily) Verify DES REG warning lt - On b. FUEL and OXID PRESS ind - Pressures very low c. HELIUM ind - Helium tank pressure rapidly decaying d. Engine STOP pb - Press e. Coordinate alternate mission sequence with MCC. | Omit procedural step d if this failure occurs during coasting flight (undocked). e. Several sequences are available: FIFTH, using AGS (DPS off) (This is recommended and nominal sequence.) Manual staging. |
| | 1D. Primary helium regulator assembly - Failed closed | 1D. a. DESCENT He/REG 1 sw - CLOSE (momentarily) Verify DES REG warning lt - On b. FUEL and OXID PRESS ind - Very low pressures c. HELIUM ind - Pressure not decaying | |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|---|---|---|
| 1. DES REG warning lt - On (cont) | 1D. Primary helium regulator assembly - Failed closed (cont) 1E. Leak in propellant tanks or lines; massive blockage in helium lines or filter upstream of regulator assembly during powered flight (unstaged) | 1D. (cont) d. DESCENT He/REG 2 sw - OPEN (momentarily) Verify DES REG warning lt - Out e. FUEL and OXID PRESS ind - Normal pressures f. Continue nominal mission. 1E. a. DESCENT He/REG 1 sw - CLOSE (momentarily) Verify DES REG warning lt - Off b. FUEL and OXID PRESS ind - Very low pressures c. HELIUM ind - Pressure not decaying d. DESCENT He/REG 2 sw - OPEN (momentarily) Verify DES REG warning lt - On e. FUEL and OXID PRESS ind - Low pressures f. Engine STOP pb - Press g. Coordinate alternate mission sequence with MCC. | d. Exact time between taking corrective action and warning light going out is a function of quantities remaining; it has not been determined. f. This failure is not critical. g. Several sequences are available: FIFTH, using AGS (DPS off) (This is recommended and nominal sequence.) Manual staging. |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|--|
| 2. DES QTY warning lt - On | 2A. Leaks in propellant tanks or lines during powered flight | 2A. a. OXIDIZER and FUEL QUANTITY ind - Quantity below normal (for mission phase) in affected system b. Engine STOP pb - Press c. Communicate with MCC to confirm propellant low level telemetry signal. d. Coordinate alternate mission sequence with MCC. | d. Several sequences are available: FIFTH, using AGS (DPS off) (This is recommended and nominal sequence.) Manual staging. |
| | 2B. Propellant tanks liquid low level sensor fails on; CWEA DES QTY warning lt fails - On (e.g., AND gate input line fails open) during all mission phases. | 2B. a. OXIDIZER and FUEL QUANTITY ind - Verify quantity is normal for mission phase b. Continue nominal mission. | Frequently check propellant quantity to detect any subsequent leak or premature propellant depletion. |
| 3. MCC telemetered signal from redundant helium manifold pressure sensor indicates maximum or zero regulator outlet pressure. | 3. Redundant helium regulator outlet manifold pressure sensor - Failed high or low during all mission phases | 3. a. FUEL and OXID PRESS ind - Verify normal pressures b. Continue nominal mission. | Net effect of this failure is loss of helium regulator outlet manifold pressure redundancy. |
| 4. DES REG warning lt - On MASTER ALARM lt - Off | 4. DES REG warning lt - Relay driver or relay - Failed on | 4. a. HELIUM ind - Pressure normal. b. FUEL and OXID PRESS ind - Pressures normal. c. Continue nominal mission. | If helium manifold fails, MASTER ALARM lt goes on, helium tank pressure drops sharply, and propellant tank pressure is higher than regulator pressure. |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|---|
| 5. DES QTY warning lt - On MASTER ALARM lt - Off | 5. DES QTY warning lt relay driver or relay - Failed on | 5. a. OXID and FUEL QUANTITY ind - Quantity normal. b. LAMP/TONE TEST sw - ALARM TONE c. Verify MASTER ALARM - On d. LAMP/TONE TEST sw - Off e. Verify MASTER ALARM - Off f. Continue nominal mission. | If descent propellant is depleted, MASTER ALARM goes on, QUANTI- TY indicator reads percent of pro- pellant remaining < 120 seconds of engine burn time at hover thrust level (approximately 25% thrust). |
| 6. HELIUM ind reads maximum or zero pressure when HELIUM MON sw is set to DES SUPCRIT PRESS. | 6. Supercritical helium tank pressure sensor - Failed high or low | 6. a. FUEL and OXID PRESS ind - approximately 235 PSIA when descent engine is firing b. Periodically check supercritical helium tank pressure with MCC. | Isolation of a failed-high sensor can be identified after descent engine has been fired. A subsequent helium leak triggers DES REG warning lt. In either case, when LM is in line of sight, confirmation of helium tank pressure can be obtained via MCC. |
| 7. MCC real-time telemetered signal for supercritical helium tank pressure indicates zero or maximum reading. | 7. Redundant supercritical helium tank pressure sensor - Failed low or high | 7. a. HELIUM MON sw - DES SUPCRIT PRESS b. HELIUM ind - Normal pressure c. Continue nominal mission. | The net effect of this failure is loss of supercritical helium tank pres- sure sensor redundancy. Net effect of this failure is loss of MCC backup capability. |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|--|
| 8. Loss of MCC real-time tele-metered indication of supercritical helium tank pressure | 8. Supercritical helium tank pressure PCMTEA channel - Failed off | 8. a. HELIUM MON sw - DES/SUPCRIT PRESS b. HELIUM ind - Normal pressure c. Continue nominal mission. | 8. Net effect of this failure is loss of MCC backup capability. |
| 9. HELIUM ind - Same value for all positions of HELIUM MON sw | 9. HELIUM MON sw - Failed | 9. Verify He TEMP/PRESS cb - In If circuit breaker cannot be reset, communicate with MCC to coordinate alternate mission sequence. | 9. Net effect of this failure is loss of onboard capability for monitoring either descent or ascent helium tank pressures and temperatures. MCC must monitor these tank pressures frequently. Crew can monitor periodically FUEL and OXID PRESS ind for propellant tank inlet pressures. This gives a cue to helium tank pressures. |
| 10. FUEL or OXID PRESS ind - High or zero pressure while FUEL or OXID TEMP ind reads normal temperature | 10. Fuel tanks ullage pressure sensor - Failed high or low. Oxidizer tanks ullage pressure sensor - Failed high or low | 10. Alternate indications a. Verify THRUST ind - Normal ENG thrust b. Periodically monitor FUEL or OXID TEMP ind - Green band c. Periodically monitor oxidized or FUEL QUANTITY ind - Quantity normal d. Continue nominal mission. | 10. MCC can monitor fuel and oxidizer engine interface pressure readings, for a cue of premature propellant depletion. DES QTY warning It provides crew with indication of propellant status. In addition, isolation of a failed-high ullage pressure sensor can be identified after descent engine has been fired, by noting that FUEL or OXID tank pressure indication does not decay. |
| 11. MCC real-time fuel or oxidizer engine interface pressure readings - Maximum or minimum | 11. Engine interface fuel or oxidizer pressure sensor - Failed high or low | 11. a. Verify THRUST ind - Normal ENG thrust b. Periodically monitor FUEL and OXID PRESS ind - Normal pressure | |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|--|
| 11. MCC real-time fuel or oxidizer engine interface pressure readings - Maximum or minimum (cont) | 11. Engine interface fuel or oxidizer pressure sensor - Fail high or low (cont) | 11. (cont) c. Compare quantities between affected tanks and nonaffected tanks and verify relative depletion rates within nominal limits d. Continue nominal mission. | c. Quantities remaining depend on mission phase and will be verified by MCC. d. If subsequent propellant leak occurs, DES QTY warning It goes on. If a subsequent propellant blockage occurs upstream at fuel or oxidizer filter, DES REG warning It goes on. |
| 12. FUEL or OXID TEMP ind - reads maximum or minimum for affected tank while FUEL or OXID PRESS ind reads normal pressure for affected tank | 12. Fuel or oxidizer tank No. 1 or 2 bulk temperature sensor or associated signal conditioner - Failed high or low | 12. a. Periodically monitor FUEL or OXID PRESS ind - Normal pressure b. Continue nominal mission. | 12. Critical changes in tank temperatures are not expected. If they do occur, associated tank pressure readings reflect them. |
| 13. FUEL or OXID TEMP ind reads minimum, maximum, or remains in last indicated position. | 13. FUEL or OXID TEMP ind - Failed | 13. a. Communicate with MCC and request periodic monitoring of status of affected propellant tank. b. Continue nominal mission. | Net effect of this failure is loss of onboard capability to monitor descent or ascent propellant tank temperatures. |
| 14. FUEL or OXIDIZER QUANTITY ind - Quantities less than or greater than nominal when PRPLNT QTY MON sw - DES 1 or DES 2 | 14. Fuel or oxidizer tank No. 1 or 2 quantity sensor - Failed high or low | 14. Communicate with MCC and request periodic monitoring of status of affected propellant tank. | |
| 15. DESCENT He/REG 1 flag - Barber pole | 15. Helium primary solenoid valve sensor - Failed closed or DESCENT He/REG 1 flag - Failed barber pole | 15. a. DESCENT He/REG 1 sw - OPEN (momentarily) | |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|--|
| 15. DESCENT He/REG 1 flag - Barber pole (cont) | 15. Helium primary solenoid valve sensor - Failed closed or DESCENT He/REG 1 flag - Failed barber pole (cont) | 15. (cont) b. DESCENT He/REG 1 flag - Gray If not gray: DESCENT He/REG 2 sw - OPEN (momentarily) c. Continue nominal mission. | |
| 16. DESCENT He/REG 2 flag - Gray | 16. Helium secondary solenoid valve sensor - Failed open or DESCENT He/REG 2 flag - Failed gray | 16. a. DESCENT He/REG 2 sw - CLOSE (momentarily) b. DESCENT He/REG 2 flag - If barberpole, continue nominal mission; if not, DESCENT He REG 1 sw - CLOSED (momentarily) c. Observe DESCENT He/REG 1 flag - Barberpole d. DESCENT He/REG 1 sw - OPEN (momentarily) e. DESCENT He REG 1 flag - Gray f. Continue nominal mission. | |
| 17. DESCENT He/REG 2 flag - Gray | 17. DESCENT He/REG 2 sw - Failed open | 17. a. DESCENT He REG 2 sw - CLOSE (momentarily) b. DESCENT He REG 2 flag - Barber pole c. Continue nominal mission. | If associated helium pressure regulator fails open, DES REG warning It will go on. |
| 18. MCC real-time shutoff valve position indicates at least one of a pair of valves - Failed open or closed, or one valve hung up in mid-position | 18. Failure in shutoff valves A and B or C and D position sensor or associated signal conditioner | 18. Coordinate alternate mission sequence with MCC. | |

Table 9-3. Descent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| 19. THRUST ind reads 0% ENG thrust all the time | 19. Thrust chamber pressure sensor - Failed off | 19. a. Communicate with MCC to confirm that THRUST ind reads ENG 0% b. Continue nominal mission with MCC coordination. | This failure requires more frequent monitoring of ΔV requirements (DSKY) and the QUANTITY, PRESS, and T/W |
| 20. QUANTITY ind - Blank | 20. Loss of power to QUANTITY ind or PRPLNT QTY MON sw - Failed | 20. Coordinate alternate mission sequence with MCC. | 20. CWEA DES QTY warning lt functions when 120 seconds of descent engine burn time is left. The effect of these failures is loss of onboard detection of remaining propellant quantities. |
| 21. QUANTITY ind - Zero oxidizer or fuel quantity, but not both | 21. Loss of driver signal to QUANTITY ind | 21. Coordinate alternate mission sequence with MCC. | |
| 22. QUANTITY ind - Indicates that FUEL and OXIDIZER decreasing ratio is out of tolerance (due to either oxidizer or fuel quantities, but not both) | 22A. Loss of clock signal to QUANTITY ind 22B. Propellant quantity gaging unit - Failed | 22A. Coordinate alternate mission sequence with MCC. 22B. Coordinate alternate mission sequence with MCC. | |
| 23. DESCENT He/REG 1 flag - Barber pole during preseparation checkout | 23. DESCENT He/REG 1 sw - Failed CLOSE | 23. a. DESCENT He/REG 1 sw - OPEN (momentarily) b. Verify DESCENT He/REG 1 flag - Gray If not gray: DESCENT He/REG 2 sw - OPEN (momentarily) c. Continue nominal mission. | 23. These procedures also apply if this failure occurs after descent propulsion section is pressurized; however, DES REG warning lt will also go on. |

Table 9-4. Ascent Propulsion Section Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------|--|--|--|
| 1. ASC HI REG caution lt - On | 1A. Regulator assembly No. 2 - Failed open | 1A. a. ASCENT He REG 1 sw - Momentarily CLOSE ASCENT He REG 2 sw - Momentarily CLOSE b. Verify ASC HI REG caution lt - Off c. ASCENT He REG 1 sw - Momentarily OPEN d. ASC HI REG caution lt - Off e. FUEL and OXID PRESS ind - 195 psia f. Continue nominal mission. | d. Double regulator failure f. Failure is not critical. |
| | 1B. Regulator assembly No. 1 - Failed open | 1B. a. ASCENT He REG 1 sw - Momentarily CLOSE ASCENT He REG 2 sw - Momentarily CLOSE b. Verify ASC HI REG caution lt - Off c. ASCENT He REG 1 sw - Momentarily OPEN d. ASC HI REG caution lt - On e. FUEL and OXID PRESS ind - 225 psia | e. Double regulator failure |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---|
| 1. ASC HI REG caution lt - On (cont) | 1B. Regulator assembly No. 1 - Failed open (cont) | 1B. (cont) f. ASCENT He REG 1 sw - Momentarily CLOSE ASCENT He REG 2 sw - Momentarily OPEN g. Continue mission. | g. Failure is not critical. |
| | 1C. Helium regulator outlet manifold pressure sensor - Failed high ASC HI REG caution lt - Failed on | 1C. a. ASCENT He REG 1 sw - Momentarily CLOSE ASCENT He REG 2 sw - Momentarily CLOSE b. Verify ASC HI REG caution lt - On c. Verify helium and propellant tank pressures - Normal d. Request MCC to constantly monitor tank pressures. e. Continue mission. | |
| 2. ASC PRESS warning lt - On | 2A. Leak in helium lines with unstaged LM | 2A. a. Monitor pressure in helium tanks No. 1 and 2 - $\leq 3,000$ psia b. HELIUM MON sw - ASC PRESS 1 if tank 2 malfunctions; ASC PRESS 2 if tank 1 malfunctions | a. If pressure in either tank reads zero, suspect pressure trans- ducer failure. These procedures remain the same. |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|--|---|--|
| 2. ASC PRESS warning lt - On (cont) | 2A. Leak in helium lines with unstaged LM (cont) | <p>2A. (cont)</p> <p>c. HELIUM MON sw - ASC TEMP 1 if tank 1 malfunctions;</p> <p>ASC TEMP 2 if tank 2 malfunctions</p> <p>d. Monitor helium tank temperature.</p> <p>e. Continue mission.</p> | c. Critical temperature changes are not expected. If they occur, there is a helium leak. |
| | 2B. Leak in helium lines with staged LM | <p>2B.</p> <p>a. Monitor pressure in helium tanks No. 1 and 2 - $\leq 3,000$ psia</p> <p>b. HELIUM MON sw - ASC PRESS 1 if tank 2 malfunctions;</p> <p>ASC PRESS 2 if tank 1 malfunctions</p> <p>c. Monitor helium tank temperature.</p> <p>HELIUM MON sw - ASC TEMP 1 if tank 1 malfunctions;</p> <p>ASC TEMP 2 if tank 2 malfunctions</p> <p>d. Monitor DSKY for ΔV-to-go to clear pericyynthion. If required ΔV is observed, continue mission; if not, proceed to step e.</p> | a. If pressure in either tank reads zero, suspect pressure transducer failure. These procedures remain the same. |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|---|---|---|
| 2. ASC PRESS warning lt - On (cont) | 2C. Leak in propellant lines before pressurization (cont) | <p>2C. (cont)</p> <p>(1) ABORT pb - Press</p> <p>(2) Key into DSKY-V37 N34E: Provide proper input parameters.</p> <p>Choose DPS (P40) and initiate engine firing.</p> <p>e. Monitor DSKY for time-to-go to engine shutdown.</p> <p>When time-to-go is zero: engine STOP pb - Press</p> <p>f. MASTER ARM sw - ON</p> <p>g. STAGE sw - Release guard; then FIRE (momentary)</p> <p>h. MASTER ARM sw - OFF</p> <p>i. Verify ASC PRESS warning lt - Off</p> | <p>(1) CSI, CDH, TPI, TPM (if required), rendezvous, and docking</p> <p>Pressing ABORT pb is considered the nominal routine.</p> <p>(2) TPI, TPM (if required), rendezvous, and docking are achieved by keying into DSKY (V37 N34E) and entering time of engine ignition or elevation of LM-CM LOS at TPI and time from TPI to intercept.</p> |
| | 2D. Leak in propellant lines during powered flight | <p>2D.</p> <p>a. Verify helium tank pressures >3,000 psia (one or both)</p> | <p>a. If LM is in AGS mode, +X TRANSL pb must be pressed to provide ullage maneuvers when procedure steps c and e are performed.</p> |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|---|---|--|
| 2. ASC PRESS warning lt - On (cont) | 2D. Leak in propellant lines during powered flight (cont) | <p>2D. (cont)</p> <p>b. Verify propellant tank pressures - Decaying rapidly</p> <p>c. If this malfunction occurs during powered flight crew must decide which sequence of maneuvers will bring them to CM in shortest time, based on their current trajectory, position, and propulsion capability.</p> <p>(1) ABORT pb - Press</p> <p>(2) Engine STOP pb - Press</p> <p>(3) Key into DSKY-V37E, N34E: Provide proper parameters.</p> <p>Choose DPS program (P40) and initiate engine firing.</p> | <p>c. Crew maneuver sequence alternatives are:</p> <p>(1) CSI, CDH, IPI, TPM (if required), rendezvous, and docking.</p> <p>Pressing ABORT pb is considered nominal routine.</p> <p>(2) TPI, TPM (if required), rendezvous, and docking. The descent engine must be shut down first if this option is chosen.</p> <p>Program 34 (P34) and enter time of engine ignition or elevation of LM-CM LOS at TPI and time-to-go from TPI to Intercept.</p> |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|---|--|--|
| 2. ASC PRESS warning lt - On (cont) | 2D. Leak in propellant lines during powered flight (cont) | <p>2D. (cont)</p> <p>d. PRPLNT TEMP/PRESS MON sw - ASC</p> <p>DES QTY warning lt - Monitor</p> <p>e. ABORT STAGE pb - Press</p> <p>Verify ASC PRESS warning lt - Off</p> <p>CAUTION</p> <p>ENG ARM sw - ASC MASTER ARM sw - ON Engine START pb - Press</p> <p>f. At TTI (DSKY or DEDA) + 10 seconds (ascent engine start):</p> <p>SYSTEM A ASC FEED sw - OPEN</p> <p>SYSTEM A MAIN SOV sw - CLOSE</p> <p>SYSTEM B ASC FEED sw - OPEN</p> <p>SYSTEM B MAIN SOV sw - CLOSE</p> <p>CRSFD sw - OPEN</p> | <p>d. If DES QTY Warning lt goes on before end of burn, go to step e; if not, go to step h.</p> <p>e. These actions require manual engine shutdown at end of burn.</p> |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| 2. ASC PRESS warning lt - On (cont) | <p>2D. Leak in propellant lines during powered flight (cont)</p> <p>2E. Oxidizer or fuel isolation valve inlet pressure sensor - Failed low</p> <p>or</p> <p>CWEA ASC PRESS warning lt - Failed on</p> | <p>2D. (cont)</p> <p>g. At TG - 10 seconds</p> <p>CRSFD - CLOSE</p> <p>SYSTEM B MAIN SOV sw - OPEN</p> <p>SYSTEM B ASC FEED sw - CLOSE</p> <p>SYSTEM A MAIN SOV sw - OPEN</p> <p>SYSTEM A ASC FEED sw - CLOSE</p> <p>h. If engine START pb was pressed: Engine STOP pb · Press</p> <p>i. When LGC or AGS commands ascent engine shutdown: MASTER ARM sw - ON</p> <p>j. STAGE sw - FIRE</p> <p>k. MASTER ARM sw - OFF</p> <p>2E.</p> <p>a. Verify helium tank pressures >3,000 psia (one or both)</p> <p>b. Verify propellant tank pressures - ≈190 psia</p> <p>c. PRPLNT TEMP/PRESS MON sw - ASC</p> <p>Monitor FUEL/OXID temperature and pressure on TEMP ind and PRESS ind</p> | <p>b. ≈165 psia, during powered flight</p> |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|---|---|---|
| 2. ASC PRESS warning lt - On (cont) | <p>2E. Oxidizer or fuel isolation valve inlet pressure sensor - Failed low</p> <p>or</p> <p>CWEA ASC PRESS warning lt - Failed on (cont)</p> <p>2F. CWEA relay driver - Failed on</p> | <p>2E. (cont)</p> <p>d. Request MCC monitor propellant temperature and pressure.</p> <p>e. If in powered flight, monitor DSKY (DEDA is AGS controls) for time-to-go to engine shut-down (TG)</p> <p>f. At TG - 10 sec</p> <p>CRSFD sw - CLOSE</p> <p>SYSTEM B MAIN SOV sw - OPEN</p> <p>SYSTEM B ASC FEED sw - CLOSE</p> <p>SYSTEM A MAIN SOV sw - OPEN</p> <p>SYSTEM A ASC FEED sw - CLOSE</p> <p>g. If ascent engine shutdown occurs before TG=0: +X TRANSL pb - Press</p> <p>Monitor DSKY for final ΔV achieved.</p> <p>2F.</p> <p>a. Verify MASTER ALARM lt - Off</p> <p>b. PRPLNT TEMP/PRESS MON sw - ASC</p> <p>HELIUM MON sw - PRESS 1 or PRESS 2</p> | <p>g. RCS trim maneuver may be required in addition to +X-translation thrust.</p> |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-------------------------------------|--|---|--|
| 2. ASC PRESS warning lt - On (cont) | 2F. CWEA relay driver - Failed on (cont) | 2F. (cont) c. Verify HELIUM and PRESS - ind Normal d. Continue mission and constantly monitor helium and propellant pressures. | |
| | 2G. CWEA ascent pressure isolation pressure relay contact - Failed off or on Relay driver - Failed off | 2G. a. Verify MASTER ALARM lt - Off b. PRPLNT TEMP/PRESS MON sw - ASC HELIUM MON sw - PRESS 1 or PRESS 2 c. Verify HELIUM and PRESS ind - Normal d. Continue mission and constantly monitor helium and propellant pressures. | |
| 3. ASC QTY caution lt - On | 3. Fuel or oxidizer tank liquid level sensor signal conditioner - Failed off CWEA: ASC QTY caution lt - Failed on CWEA ascent quantity relay contact - Failed on | 3. a. Verify configuration and mission phase. b. Verify propellant tank pressure - ≈ 190 psia c. PRPLNT TEMP/PRESS MON sw - ASC Monitor FUEL/OXID temp and pressure on TEMP mtr and PRESS ind. | a. Configuration: unstaged Phase: preseparation check-out through powered flight b. ≈ 165 psia, during powered flight |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--------------------------------------|---|--|--|
| 3. ASC QTY caution lt - On (cont) | 3. Fuel or oxidizer tank liquid level sensor signal conditioner - Failed off CWEA: ASC QTY caution lt - Failed on CWEA ascent quantity relay contact - Failed on (cont) | 3. (cont) d. Request MCC monitor propellant temperatures and pressures. e. If in powered flight, monitor DSKY (DEDA if in AGS control) for time-to-go to engine shutdown (TG) f. At TG - 10 sec CRSFD sw - CLOSE SYSTEM B MAIN SOV sw - OPEN SYSTEM B ASC FEED sw - CLOSE SYSTEM A MAIN SOV sw - OPEN SYSTEM A ASC FEED sw - CLOSE g. If ascent engine shutdown occurs before TG=0: +X TRANSL pb - Press Monitor DSKY for final ΔV valve achieved. | g. RCS trim maneuver may be required in addition to +X-translation thrust. |
| 4. ASC HI REG caution lt - On | 4. CWEA ascent high regulator relay driver or relay contact - Failed on | 4. a. Verify following: MASTER ALARM lt - Off Helium tank pressure - Normal Propellant tank pressures - \leq helium pressure relief reseal pressure b. Continue normal mission. | |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 5. ASCENT He REG 1 or REG 2 flag - Barber pole | 5. Ascent helium reg 1 or 2, primary or secondary solenoid valve or associated signal conditioner - Failed closed Ascent He REG 1 or 2 sw - Failed closed ASC He REG cb - Failed open | 5. a. Verify ASCENT He REG 1 or REG 2 flag - Gray b. Verify ASC He REG cb - In (Panel 16) c. ASCENT He REG 1 or REG 2 sw: Momentarily - OPEN Momentarily - CLOSE Momentarily - OPEN d. Verify ASCENT He REG 1 or REG 2 flag - Barber pole e. Request MCC to verify position of helium regulator solenoid valves. (1) Receive verification helium regulator solenoid valves open. (2) Continue mission. | |
| 6. ASC HI REG caution lt - On. ASCENT He REG 1 or REG 2 flag - Gray | 6. ASCENT He REG 1 or REG 2 sw - Inoperative when set to CLOSE | 6. a. ASC HI REG caution lt - On b. ASCENT He REG 1 or REG 2 sw - CLOSE c. ASCENT He REG 1 or REG 2 flag - Gray ASC HI REG caution lt - On | a. This assumes that either the primary or secondary helium regulator failed. c. If ASC HI REG caution lt goes off, continue mission. |

Table 9-4. Ascent Propulsion Section Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 6. ASC HI REG caution lt - On. ASCENT He REG 1 or REG 2 flag - Gray (cont) | 6. ASCENT He REG 1 or REG 2 sw - Inoperative when set to CLOSE (cont) | <p>6. (cont)</p> <p>d. ASCENT He REG 1 or REG 2 sw - Momentarily CLOSE Momentarily OPEN Momentarily CLOSE</p> <p>e. ASCENT He REG 1 or REG 2 flag - Barber pole ASC HI REG caution lt - Off</p> <p>f. ASCENT He REG 1 or REG 2 sw - OPEN</p> <p>g. Continue nominal mission.</p> <p>h. If ASC HI REG caution lt did not go off, continue ascent engine firing until shutdown.</p> <p>i. Use +X TRANSL pb for additional ΔV, if required.</p> <p>j. Monitor DSKY (or DEDA) for appropriate ΔV required.</p> | <p>e. If ASC HI REG caution lt does not go off proceed to step h.</p> <p>f. Whichever regulator is not affected</p> <p>h. Refer to step e.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) | <p>1A. Helium regulator pressure sensor or signal conditioner fails high or low.</p> <p>1B. Helium regulator - Fail open</p> | <p>1A.</p> <p>a. Helium regulator pressure (SYS A or SYS B) - ≥ 205</p> <p>b. Helium tank pressure - Not decaying indicates helium regulator sensor failure; continue mission.</p> <p>c. Helium tank pressure - Decaying helium regulator failed open. Perform procedure 1B.</p> <p>1B.</p> <p>a. Helium regulator pressure (SYS A or SYS B) - ≥ 205</p> <p>b. Helium tank pressure - Decaying indicates helium regulator failed open.</p> <p>c. Preseparation checkout:</p> <p>(1) Failed system THRUSTER PAIR QUAD sw - Momentarily CLOSE</p> <p>(2) Do not separate; consider alternate mission.</p> <p>d. Coasting flight (undocked), LM near CM:</p> <p>(1) ABORT pb - Press</p> <p>(2) Monitor helium tank pressure When failed system tank pressure = 500 psia: CRSFD sw - Momentarily OPEN</p> | Warning lt RCS A REG or RCS B REG cannot be extinguished. This does not mask a subsequent failure in other system. RCS TEMP/PRESS MON sw - PRPLNT. Monitor pressure frequently. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|---------|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) (cont) | 1B. Helium regulator - Fail open (cont) | <p>1B. (cont)</p> <p>(3) Failed system MAIN SOV sw - Momentarily CLOSE</p> <p>(4) At completion of descent engine burn: MASTER ARM sw - ON</p> <p>STAGE sw - FIRE</p> <p>(5) MASTER ARM sw - OFF</p> <p>(6) Complete rendezvous and docking.</p> <p>(7) Consider alternate mission.</p> <p>e. Coasting flight (undocked), LM not near CM:</p> <p>(1) Continue coasting orbit.</p> <p>(2) When failed system tank pressure = 500 psia: CRSFD sw - Momentarily OPEN</p> <p>(3) Failed system MAIN SOV sw - Momentarily CLOSE</p> <p>(4) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start</p> <p>(5) At appropriate time: ABORT pb - Press</p> <p>(6) At completion of descent engine burn: MASTER ARM sw - ON</p> <p>STAGE sw - FIRE</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---------|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) (cont) | 1B. Helium regulator - Fail open (cont) | 1B. (cont) (7) MASTER ARM sw - OFF (8) Complete rendezvous and docking. (9) Consider alternate mission. | |
| | 1C. Leak in helium lines or helium tank | 1C. a. Helium regulator pressure (SYS A or SYS B) - 0 b. Verify FUEL/OXID MANF PRESS - Not decaying Probable helium regulator sensor failures. Perform procedure 1A. c. Verify FUEL/OXID MANF PRESS - Decaying Leak in helium lines; perform procedures 1B. | |
| | 1D. Regulator failed closed or filter clogged | 1D. a. Helium pressure (SYS A or SYS B) - ≤ 165 b. Helium tank pressure - Decaying. Leak in helium lines; perform procedure 1C. c. Helium tank pressure - Not decaying indicates regulator failed closed or filter clogged. d. Preseparation checkout: (1) Failed system THRUSTER PAIR QUAD sw - Momentarily CLOSE (2) Consider alternate mission with unaffected system. | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) (cont) | 1D. Regulator failed closed or filter clogged (cont) | <p>1D. (cont)</p> <p>e. Coasting flight (undocked), LM near CM:</p> <p>(1) ABORT pb sw - Press</p> <p>(2) CRSFD sw - Momentarily OPEN</p> <p>(3) Failed system MAIN SOV sw - Momentarily CLOSE</p> <p>(4) At completion of descent engine burn: MASTER ARM sw - ON</p> <p>(5) STAGE sw - FIRE</p> <p>(6) MASTER ARM sw - OFF</p> <p>(7) Complete rendezvous and docking.</p> <p>(8) Consider alternate mission.</p> <p>f. Coasting flight (undocked), LM not near CM:</p> <p>(1) Continue coasting orbit.</p> <p>(2) CRSFD sw - Momentarily OPEN</p> <p>(3) Failed system MAIN SOV sw - Momentarily CLOSE</p> <p>(4) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start</p> <p>(5) At appropriate time: ABORT pb - Press</p> | <p>(2) If LM is in AGS mode of control, + X TRNSL pb - Press to provide ullage maneuver</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|--|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) (cont) | 1D. Regulator failed closed or filter clogged (cont) | <p>1D. (cont)</p> <p>(6) At completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(7) MASTER ARM sw - OFF</p> <p>(8) Complete rendezvous and docking</p> <p>(9) Consider alternate mission.</p> <p>g. Powered flight unstaged LM:</p> <p>(1) ABORT pb sw - Press</p> <p>(2) CRSFD sw - Momentarily OPEN</p> <p>(3) Failed system MAIN SOV sw - Momentarily CLOSE</p> <p>(4) MASTER ARM sw - ON ASCENT He PRESS - FIRE MASTER ARM sw - OFF</p> <p>(5) If DES QTY warning lt goes on before completion of descent engine burn: ABORT STAGE pb - Press. Proceed with steps (7) through (13).</p> <p>(6) If DES QTY warning lt does not go on before completion of descent engine burn, proceed to step (14).</p> <p>(7) MASTER ARM sw - ON</p> <p>(8) ENG ARM sw - ASC</p> <p>(9) Engine START sw - Press</p> | <p>(9) This is redundant action to ensure uninterrupted engine start signal.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---|
| 1. RCS A REG or RCS B REG warning lt - On (SYS A or SYS B) (cont) | 1D. Regulator failed closed or filter clogged (cont) | <p>1D. (cont)</p> <p>(10) MASTER ARM sw - OFF</p> <p>(11) When DSKY or DEDA indicates 10 sec after ascent engine start: ASC FEED A sw - OPEN Unaffected system MAIN SOV sw - CLOSE ASC FEED B sw - OPEN</p> <p>(12) When DSKY or DEDA indicates 10 sec of ascent engine burn remain: Unaffected MAIN SOV sw - OPEN ASC FEED B sw - CLOSE ASC FEED A sw - CLOSE</p> <p>(13) (Refer to REMARKS column) Engine STOP pb - Press</p> <p>(14) When PGNS commands descent engine shutdown: MASTER ARM sw - ON</p> <p>(15) STAGE sw - FIRE</p> <p>(16) MASTER ARM sw - OFF</p> <p>(17) Complete rendezvous and docking.</p> <p>h. Powered flight staged LM: (1) CRSFD sw - OPEN (2) Failed system MAIN SOV sw - CLOSE (3) Continue nominal mission.</p> | <p>CAUTION</p> <p>(13) Initiate this step only if step (9) had been accomplished.</p> <p>(17) RCS propellant quantities may be insufficient to perform attitude maneuvers. CM active docking may have to be initiated.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|------------------------|---|---|--|
| 2. RCS caution lt - On | 2A. CWEA flip-flop or gate failure | 2A. a. Helium tank pressure (SYS A and SYS B) - $\geq 1,700$ b. CWEA flip-flop or gate failure c. Continue mission. | MCC can assist in monitoring tank pressures. Sudden drop due to tank failure or leak is indicated by RCS A REG or RCS B REG warning lt going on. |
| | 2B. Leak in helium tank | 2B. a. Helium tank PRESS (SYS A and SYS B) - $\leq 1,700$ ($P \neq 0$) b. Leak in helium tank. Perform corrective action given for helium regulator fail open (1B) | |
| | 2C. Helium tank pressure sensor failure | 2C. a. Helium tank pressure (SYS A and SYS B) - $\leq 1,700$; or 0 RCS being used. b. Helium tank pressure sensor failure; continue mission c. Helium tank pressure (SYS A and SYS B) - $\leq 1,700$; or $P = 0$. RCS not being used. d. Check RCS thrusters by hot firing. e. RCS A REG or RCS B REG warning lt - On f. Leak in helium tank. RCS A REG or RCS B REG warning lt - On | MCC can assist in monitoring tank pressures. A sudden drop due to a tank failure or leak will be shown by an RCS A REG or RCS B REG warning lt going on. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---|
| 2. RCS caution lt - On (cont) | 2C. Helium tank pressure sensor failure (cont) | 2C. (cont) g. RCS A REG or RCS B REG warning lt - Off h. Helium tank pressure sensor failure. RCS A REG or RCS B REG warning lt - On | |
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind | 3A. Propellant quantity measuring device failure for SYS A or SYS B 3B. Propellant leak upstream of main shutoff valves | 3A. a. Helium tank pressure (for system showing low quantity) is normal indicates propellant quantity measuring device failure b. Continue mission. Monitor tank pressure for the unaffected system as an indication of quantity. 3B. a. Helium tank pressure for the system showing low quantity, pressure low; (Staged LM in powered flight.) indicates propellant leak upstream of main shutoff valves. b. Preseparation checkout. Do not separate; consider alternate mission c. Coasting flight undocked, LM near CM: (1) Failed system MAIN SOV sw - OPEN Failed system THRUSTER PAIR QUAD sw - OPEN (2) After 3 sec: Failed system TCA cb - Push | a. If helium tank pressure is less than normal, refer to procedures given for staged LM in powered flight (1D, h), or all other mission phases as applicable. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3B. Propellant leak upstream of main shutoff valves (cont) | <p>3B. (cont)</p> <p>(3) ABORT pb - Press</p> <p>(4) Monitor quantity of leaking propellant. When quantity = 5%: CRSFD sw - OPEN Failed system MAIN SOV sw - CLOSE</p> <p>(5) After descent engine burn is completed: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(6) MASTER ARM sw - OFF</p> <p>(7) Complete nominal rendezvous and docking.</p> <p>d. Coasting flight undocked, LM not near CM:</p> <p>(1) Continue coasting orbit.</p> <p>(2) Failed system MAIN SOV sw - OPEN Failed system THRUSTER PAIR QUAD sw - OPEN</p> <p>(3) After 3 sec: Failed system TCA cb - Push</p> <p>(4) Monitor quantity of leaking propellant. When quantity = 5%: CRSFD sw - OPEN Failed system MAIN SOV sw - CLOSE</p> <p>(5) Obtain optimum time for abort from LGC. EVENT TIMER - Start</p> | (4) Propellants from failed system should not be used if amount remaining is very low (approx $\geq 10\%$) at the time of detection. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---------|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3B. Propellant leak upstream of main shutoff valves (cont) | <p>3B. (cont)</p> <p>(6) At appropriate time: ABORT pb - Press</p> <p>(7) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(8) MASTER ARM sw - OFF</p> <p>(9) Complete rendezvous and docking.</p> <p>e. Powered flight unstaged LM:</p> <p>(1) CRSFD sw - OPEN</p> <p>(2) Verify THRUSTER PAIR QUAD sw - OPEN</p> <p>(3) After 10 sec: TCA cb - Push</p> <p>(4) ABORT pb - Press</p> <p>(5) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(6) MASTER ARM sw - OFF</p> <p>(7) Complete nominal rendezvous and docking.</p> <p>f. Powered flight staged LM:</p> <p>(1) Monitor DSKY or DEDA for time-to-go to engine shutdown.</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3B. Propellant leak upstream of main shutoff valves (cont) | 3B. (cont) (2) When time-to-go = 10 sec: Unfailed system MAIN SOV sw - OPEN (3) Complete nominal rendezvous and docking. | |
| | 3C. Propellant manifold leak. | 3C. a. Helium tank pressure for the system showing low quantity: pressure low NOTE (LM not staged, and powered) b. Affected system TCA cb - Pull c. Affected system THRUSTER PAIR QUAD sw - CLOSE d. MAIN SOV sw - CLOSE e. Tank pressure for affected system f. Affected system MANF PRESS - < 170 g. Propellant - Manifold leak (1) Preseparation checkout. Do not separate from CM; consider alternate mission h. Coasting flight undocked, LM near CM: | e. Observe pressure for later use in diagnostic procedure. f. If MANF PRESS ≥ 170 , perform procedure given in 3D. (Failure: Leak in lines downstream of thruster pair isolation valves, or failed-open TCA valve.) |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|-------------------------------------|---|--|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3C. Propellant manifold leak (cont) | <p>3C. (cont)</p> <ol style="list-style-type: none"> (1) Failed system MAIN SOV sw - OPEN (2) Failed system THRUSTER PAIR QUAD sw - OPEN (3) After 3 sec: All TCA cb - Push (4) ABORT pb sw - Press (5) QUANTITY ind - Monitor When quantity = 5%: Failed system THRUSTER PAIR QUAD sw - CLOSE Failed system MAIN SOV sw - CLOSE (6) After descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE (7) MASTER ARM sw - OFF (8) Complete rendezvous and docking. <p>i. Coasting flight, not near CM:</p> <ol style="list-style-type: none"> (1) Continue coasting orbit. (2) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start (3) Twenty sec before abort initiation: Failed system MAIN SOV sw - OPEN Failed system THRUSTER PAIR QUAD sw - OPEN (4) After 3 sec: All TCA cb - Push | <ol style="list-style-type: none"> (5) Use of the eight thrusters in failed system is not worthwhile if propellant remaining is low (approx 10%) when detected. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|-------------------------------------|--|---------|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3C. Propellant manifold leak (cont) | <p>3C. (cont)</p> <p>(5) At appropriate time: ABORT pb - Press</p> <p>(6) QUANTITY ind - Monitor When quantity = 5%: Failed system THRUSTER PAIR QUAD sw - CLOSE Failed system MAIN SOV sw - CLOSE</p> <p>(7) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(8) MASTER ARM sw - OFF</p> <p>(9) Complete rendezvous and docking</p> <p>j. Powered flight unstaged LM:</p> <p>(1) Failed system MAIN SOV sw - OPEN Failed system THRUSTER PAIR QUAD sw - OPEN</p> <p>(2) After 8 sec: All TCA cb - Push</p> <p>(3) ABORT pb - Press</p> <p>(4) QUANTITY ind - Monitor leaking propellant. When quantity = 5%: Failed system THRUSTER PAIR QUAD sw - CLOSE Failed system MAIN SOV sw - CLOSE</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|-------------------------------------|--|--|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3C. Propellant manifold leak (cont) | <p>3C. (cont)</p> <p>(5) If DES QTY warning It goes on before completion of descent engine burn: ABORT STAGE pb - Press Proceed with step (7) to (13).</p> <p>(6) If DES QTY warning It does not go on before completion of descent engine burn, proceed to step (14).</p> <p>(7) MASTER ARM sw - ON</p> <p>(8) ENG ARM sw - ASC</p> <p>(9) Engine START pb - Press</p> <p>(10) MASTER ARM sw - OFF</p> <p>(11) When DSKY or DEDA indicates 10 sec after start of ascent engine: Unaffected system ASC FEED sw - OPEN Unaffected system MAIN SOV sw - CLOSE</p> <p>(12) When DSKY or DEDA indicates 10 sec of ascent engine burn remain: Unaffected system ASC FEED sw - CLOSE Unaffected system MAIN SOV sw - OPEN</p> <p>(13) Engine STOP pb - Press</p> <p>(14) When PGNS or AGS commands descent engine to shut down: MASTER ARM sw - ON</p> | <p>(9) This is redundant action to ensure uninterrupted engine start signal.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3C. Propellant manifold leak (cont) | <p>3C. (cont)</p> <p>(15) STAGE sw - FIRE</p> <p>(16) MASTER ARM sw - OFF</p> <p>(17) Complete nominal rendezvous and docking.</p> <p>k. Powered flight (staged LM). (Not detectable.)</p> | <p>k. Because the affected system MAIN SOV's are in CLOSE position during descent engine burn, failure would be undetected until crew attempts to open them.</p> |
| | 3D. Leak in lines downstream of thruster pair isolation valve, or failed - open TCA valve. | <p>3D.</p> <p>a. Manifold pressure associated with low propellant quantity - ≥ 170</p> <p>b. THRUSTER PAIR QUAD sw - OPEN</p> <p>c. Manifold pressure - Decaying indicates leak in line downstream of thruster pair isolation valve, or failed-open TCA valve</p> <p>d. Preseparation checkout (Do not separate; consider alternate mission.)</p> <p>e. Coasting flight undocked, LM near CM:</p> <p>(1) THRUSTER PAIR QUAD sw associated with leak - CLOSE</p> <p>(2) All other THRUSTER PAIR QUAD sw - OPEN</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---------|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3D. Leak in lines downstream of thruster pair isolation valve, or failed - open TCA valve. (cont) | <p>3D. (cont)</p> <p>(3) Failed system MAIN SOV - sw - OPEN</p> <p>(4) After 3 seconds: TCA cb not associated with failed TCA - Push</p> <p>(5) ABORT pb - Press</p> <p>(6) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(7) MASTER ARM sw - OFF</p> <p>(8) Complete nominal rendezvous and docking.</p> <p>f. Coasting flight (undocked), LM not near CM:</p> <p>(1) Continue coasting orbit.</p> <p>(2) THRUSTER PAIR QUAD sw associated with leak - CLOSE</p> <p>(3) All other THRUSTER PAIR QUAD sw - OPEN</p> <p>(4) Failed system MAIN SOV - OPEN</p> <p>(5) After 8 sec: TCA cb not associated with failed TCA - Push</p> <p>(6) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start</p> <p>(7) At appropriate time; ABORT pb - Press</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---------|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3D. Leak in lines downstream of thruster pair isolation valve, or failed - open TCA valve. (cont) | <p>3D. (cont)</p> <p>(8) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(9) MASTER ARM sw - OFF</p> <p>(10) Complete nominal rendezvous and docking.</p> <p>g. Powered flight (unstaged LM):</p> <p>(1) THRUSTER PAIR QUAD sw associated with leak - CLOSE</p> <p>(2) Verify all other THRUSTER PAIR QUAD sw - OPEN</p> <p>(3) Failed system MAIN SOV sw - OPEN</p> <p>(4) After 3 sec: TCA cb not associated with failed TCA - Push</p> <p>(5) ABORT pb - Press</p> <p>(6) MASTER ARM sw - ON EXPLOSIVE DEVICES/ ASCENT He PRESS sw - FIRE MASTER ARM sw - OFF</p> <p>(7) If DES QTY warning It goes on before descent engine burn: ABORT STAGE pb - Press Proceed with step (9) through (15).</p> <p>(8) If DES QTY warning It does not go on before completion of descent engine burn proceed with step (15) through (18).</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---------|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3D. Leak in lines downstream of thruster pair isolation valve or failed-open TCA valve (cont) | <p>3D. (cont)</p> <p>(9) MASTER ARM sw - ON</p> <p>(10) ENG ARM sw - ASC</p> <p>(11) Engine START pb - Press</p> <p>(12) MASTER ARM sw - OFF</p> <p>(13) When DSKY or DEDA indicates 10 sec after start of ascent engine burn:</p> <p>ASC FEED A sw - OPEN MAIN SOV A sw - CLOSE ASC FEED B sw - OPEN MAIN SOV B sw - CLOSE CRSFD sw - OPEN</p> <p>(14) When DSKY or DEDA indicates 10 sec of ascent engine burn remain:</p> <p>CRSFD sw - CLOSE MAIN SOV B sw - OPEN ASC FEED B sw - CLOSE MAIN SOV A sw - OPEN ASC FEED A sw - CLOSE</p> <p>(15) Engine STOP pb - Press</p> <p>(16) When PGNS or AGS commands descent engine shutdown MASTER ARM sw - ON</p> <p>(17) STAGE sw - FIRE</p> <p>(18) MASTER ARM sw - OFF</p> <p>(19) Complete nominal rendezvous and docking</p> <p>h. Powered flight (staged LM). Not detectable.</p> <p>i. Coasting ascent through docking:</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|---|
| 3. SYS A or SYS B propellant quantity less than nominal on QUANTITY ind (cont) | 3D. Leak in lines downstream of thruster pair isolation valve or failed-open TCA valve (cont) | 3D. (cont) (1) THRUSTER PAIR QUAD sw associated with leak - CLOSE (2) Verify remaining THRUSTER PAIR QUAD sw - OPEN (3) Complete nominal rendezvous and docking. | c. If helium tank pressure has not decayed from value noted in step a above, perform procedure 1A |
| | 3E. Propellant leak upstream of MAIN SOV | 3E. a. THRUSTER PAIR QUAD sw - OPEN b. Manifold pressure does not decay. c. Helium tank pressure decayed from value noted in previous step. d. Propellant leak upstream of MAIN SOV. Refer to procedure 3D. | |
| 4. RCS TCA warning lt - On | 4A. Propellant manifold leak or MAIN SOV - Failed CLOSE | 4A. a. THRUSTER PAIR QUAD flags: No flags red - Refer to procedure 4H One flag red - Refer to procedure 4B. More than one flag red - Proceed to step b. b. MAIN SOV sw - CLOSE c. Preseparation checkout: (1) Failed system THRUSTER PAIR QUAD sw - CLOSE | b. This is a MAIN SOV failure in CLOSE position. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|--|--|
| 4. RCS TCA warning lt - On (cont) | 4A. Propellant manifold leak or MAIN SOV - Failed CLOSE (cont) | <p>4A. (cont)</p> <p>(2) Monitor fuel manifold and oxidizer manifold pressure of failed system.</p> <p>(3) Failed system MAIN SOV sw - OPEN</p> <p>(4) If manifold pressure indicates valve remained closed; do not separate, consider alternate mission.</p> <p>If manifold pressure indicates valve opened; failed system TCA cb - Pull out</p> <p>(5) Failed system THRUSTER PAIR QUAD sw - OPEN</p> <p>(6) After three sec: All TCA cb - Push</p> <p>(7) Continue nominal mission.</p> <p>d. Coasting flight (undocked) LM near CM:</p> <p>(1) Failed system THRUSTER PAIR QUAD sw - CLOSE</p> <p>(2) Failed system TCA cb - Pull out</p> <p>(3) Failed system FUEL MANF and OXID MANF PRESS - Monitor</p> <p>(4) Failed system MAIN SOV sw - OPEN</p> | (2) Manifold below failed MAIN SOV will have low pressure (<140 psia). |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--------------------------------------|--|---|---------|
| 4. RCS TCA warning lt - On (cont) | 4A. Propellant manifold leak on MAIN SOV - Failed CLOSE (cont) | <p>4A. (cont)</p> <p>(5) Manifold Pressure indicates valve remained-CLOSE. Proceed with steps (6) to (13). If manifold pressure indicates valve has opened, proceed to steps 8 and 9, and continue nominal mission.</p> <p>(6) Failed system MAIN SOV sw - CLOSE</p> <p>(7) CRSFD sw - OPEN</p> <p>(8) THRUSTER PAIR QUAD sw - OPEN</p> <p>(9) After 3 sec: TCA cb - Push</p> <p>(10) ABORT pb - Press</p> <p>(11) After descent engine completes burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(12) MASTER ARM sw - OFF</p> <p>(13) Complete nominal rendezvous and docking.</p> <p>e. Coasting flight (undocked), LM not near CM:</p> <p>(1) Failed system THRUSTER PAIR QUAD sw - CLOSE</p> <p>(2) Failed system TCA cb - Pull</p> <p>(3) Monitor fuel manifold and oxidizer manifold pressure of failed system.</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--------------------------------------|---|--|---------|
| 4. RCS TCA warning lt - On (cont) | 4A. Propellant manifold leak MAIN SOV - Failed CLOSE (cont) | <p>4A. (cont)</p> <p>(4) Failed system MAIN SOV sw - OPEN</p> <p>(5) If manifold pressure indicates valve remained closed, follow steps (6) to (15). If manifold pressure indicates valve has opened proceed to steps 10 and 11 and continue normal mission.</p> <p>(6) Continue coasting orbit.</p> <p>(7) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start</p> <p>(8) Failed system MAIN SOV sw - CLOSE</p> <p>(9) CRSFD sw - OPEN</p> <p>(10) THRUSTER PAIR QUAD sw - OPEN</p> <p>(11) After 3 sec: TCA cb - Push</p> <p>(12) At appropriate time: ABORT pb - Press</p> <p>(13) After completion of descent engine burn, MASTER ARM sw - ON, STAGE sw - FIRE.</p> <p>(14) MASTER ARM sw - OFF</p> <p>(15) Complete nominal rendezvous and docking.</p> <p>f. Powered flight (unstaged LM):</p> <p>(1) CRSFD sw - OPEN</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--------------------------------------|---|---|---------|
| 4. RCS TCA warning lt - On (cont) | 4A. Propellant manifold leak MAIN SOV - Failed CLOSE (cont) | 4A. (cont) (2) Failed system MAIN SOV sw - CLOSE (3) ABORT pb - Press (4) MASTER ARM sw - On EXPLOSIVE DEVICES/ ASCENT HE PRESS sw - FIRE MASTER ARM sw - OFF (5) If DES QTY warning lt goes on before completion of descent engine burn: ABORT STAGE pb - Press. Proceed with steps (7) to (13). (6) If DES QTY warning lt does not go on before completion of descent engine burn, pro- ceed to step (14). (7) MASTER ARM sw - ON (8) ENG ARM sw - ASC (9) Engine START pb - Press (10) MASTER ARM sw - OFF (11) When DSKY or DEDA indi- cate 10 sec after start of ascent engine burn: ASC FEED A sw - OPEN MAIN SOV sw for unaffected system - CLOSE ASC FEED B sw - OPEN (12) When DSKY or DEDA indi- cate 10 sec of ascent engine burn remain: MAIN SOV sw for unaffected system - OPEN ASC FEED B sw - CLOSE ASC FEED A sw - CLOSE | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--------------------------------------|--|--|--|
| 4. RCS TCA warning lt - On (cont) | <p>4A. Propellant manifold leak MAIN SOV - Failed CLOSE (cont)</p> <p>4B. Jet driver - Failed ON or TCA - Failed OFF</p> | <p>4A. (cont)</p> <p>(13) Engine STOP pb - Press</p> <p>(14) When PGNS or AGS commands descent engine shutdown: MASTER ARM sw - ON</p> <p>(15) STAGE sw - FIRE</p> <p>(16) MASTER ARM sw - OFF</p> <p>(17) Complete nominal rendezvous and docking.</p> <p>g. Powered flight (staged LM). Not detectable.</p> <p>4B.</p> <p>a. THRUSTER PAIR QUAD flags - One flag red</p> <p>b. Affected system THRUSTER PAIR QUAD sw - CLOSE. If TCA warning lt does not go out, proceed with RCS TCA warning lt fail On procedure given in 4C. If TCA warning lt - goes out, proceed to next step.</p> <p>c. Verify cb for appropriate TCA: If cb is in, jet Driver failed on, or TCA failed off.</p> <p>Follow procedure given below, as appropriate to mission phase; if cb is not in - Push</p> <p>d. Affected system THRUSTER PAIR QUAD sw - OPEN</p> | <p>g. Because both MAIN SOV sw are in CLOSE position during ascent engine thrusting, failure would be undetected until crew attempts to reopen valves.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|---|---|---------|
| 4. RCS TCA warning lt - On (cont) | 4B. Jet driver - Failed ON or TCA - Failed OFF (cont) | <p>4B. (cont)</p> <p>e. TCA warning lt does not go on. Continue mission. (Cb had been open.) RCS TCA warning lt - On, Jet driver failed on or TCA failed off.</p> <p>f. Preseparation checkout:</p> <p>(1) THRUSTER PAIR QUAD sw associated with red flag - CLOSE</p> <p>(2) Consider alternate mission.</p> <p>g. Coasting flight (undocked), LM near CM:</p> <p>(1) THRUSTER PAIR QUAD sw associated with red flag - CLOSE</p> <p>(2) ABORT pb - Press</p> <p>(3) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(4) MASTER ARM sw - OFF</p> <p>(5) Complete nominal rendezvous and docking.</p> <p>(6) Consider alternate mission.</p> <p>h. Coasting flight (undocked), LM not near CM:</p> <p>(1) THRUSTER PAIR QUAD sw associated with red flag - CLOSE</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|---|--|---------|
| 4. RCS TCA warning lt - On (cont) | 4B. Jet driver - Failed ON or TCA - Failed OFF (cont) | <p>4B. (cont)</p> <p>(2) Continue coasting orbit.</p> <p>(3) Obtain optimum time for abort from LGC. EVENT TIMER - Start</p> <p>(4) At appropriate time: ABORT pb - Press</p> <p>(5) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(6) MASTER ARM sw - OFF</p> <p>(7) Complete nominal rendezvous and docking.</p> <p>(8) Consider alternate mission.</p> <p>i. Powered flight (unstaged LM):</p> <p>(1) THRUSTER PAIR QUAD sw associated with red flag - CLOSE</p> <p>(2) ABORT pb - Press</p> <p>(3) If DES QTY warning lt - On before completion of descent engine burn: ABORT STAGE pb - Press. Proceed with steps (5) to (11).</p> <p>(4) If DES QTY warning lt does not go on before completion of descent engine burn: Proceed to step (12).</p> <p>(5) MASTER ARM sw - ON</p> <p>(6) ENG ARM sw - ASC</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|---|---|---------|
| 4. RCS TCA warning lt - On (cont) | 4B. Jet driver - Failed ON or TCA - Failed OFF (cont) | <p>4B. (cont)</p> <p>(7) Engine START pb - Press</p> <p>(8) MASTER ARM sw - OFF</p> <p>(9) When DSKY or DEDA indicates 10 sec after engine start: ASC FEED A sw - OPEN MAIN SOV A sw - CLOSE ASC FEED B - OPEN MAIN SOV B sw - CLOSE CRSFD sw - OPEN</p> <p>(10) When DSKY or DEDA indicates 10 sec of engine burn remain: CRSFD sw - CLOSE MAIN SOV B sw - OPEN ASC FEED B sw - CLOSE MAIN SOV A sw - OPEN ASC FEED A sw - CLOSE</p> <p>(11) Engine STOP pb - Press</p> <p>(12) When PGNS or AGS commands descent engine shut-down: MASTER ARM sw - ON</p> <p>(13) STAGE sw - FIRE</p> <p>(14) MASTER ARM sw - OFF</p> <p>(15) Complete nominal rendezvous and docking.</p> <p>j. Powered flight (staged LM):</p> <p>(1) THRUSTER PAIR QUAD sw associated with red flag - CLOSE</p> <p>(2) Complete nominal rendezvous and docking.</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|---|---|
| 4. RCS TCA warning lt - On (cont) | 4C. CWEA/RCS TCA warning lt failed on. | 4C. a. RCS TCA warning lt - On b. Monitor flags: (1) New flag in same system turns red - Perform MAIN SOV failed CLOSED (4A) or propellant manifold leak (3C) or RCS TCA associated electronic failed (4B) procedure as required. (2) New flag in same system does not turn red - RCS TCA warning lt failed on (refer to proper corrective action in procedure 3C). | |
| | 4D. Flag failed (Preseparation checkout) | 4D. THRUSTER PAIR QUAD flags - None red. Flag failed; continue mission. | 4D. If flag fails, flag turns red. QUANTITY ind drops sharply if RCS TCA fails. |
| | 4E. CWEA - Failed on (coasting phase) | 4E. a. THRUSTER PAIR QUAD flags - None red b. All THRUSTER PAIR QUAD sw - CLOSE c. RCS TCA warning lt - On CWEA failed on d. Continue nominal mission. | If RCS TCA fails, MASTER ALARM goes on and appropriate flag turns red. |
| | 4F. CWEA - Failed on (powered phase) | 4F. a. THRUSTER PAIR QUAD flags - None red b. QUANTITY ind - Indicates normal fuel consumption in both systems | If RCS TCA fails MASTER ALARM goes on and appropriate flag turns red. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|--|--|
| 4. RCS TCA warning lt - On (cont) | <p>4F. CWEA - Failed on (powered phase) (cont)</p> <p>4G. Jet driver - Failed on or RCS TCA failed off and flag failed off (coasting phase)</p> <p>4H. Jet driver failed on or RCS TCA failed off and flag failed off (powered phase).</p> | <p>4F. (cont)</p> <p>c. MCC verifies RCS TCA normal operation</p> <p>d. CWEA failed on; continue nominal mission.</p> <p>4G.</p> <p>a. THRUSTER PAIR QUAD flags - None red</p> <p>b. All THRUSTER PAIR QUAD sw - CLOSE</p> <p>c. RCS TCA warning lt - Off</p> <p>d. THRUSTER PAIR QUAD sw - OPEN</p> <p>e. THRUSTER PAIR QUAD sw associated with RCS TCA warning lt - CLOSE</p> <p>f. All other THRUSTER PAIR QUAD sw - OPEN</p> <p>g. Jet driver failed on or TCA failed off. (Refer to corrective procedure 4Bg.)</p> <p>4H.</p> <p>a. THRUSTER PAIR QUAD flags - None red</p> <p>b. QUANTITY ind - indicates rapid fuel depletion in system A or B. (Refer to corrective procedure 4A.)</p> | <p>d. Accomplish this step carefully so that particular THRUSTER PAIR QUAD sw responsible for causing RCS TCA warning lt to go on may be determined.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|--|
| 4. RCS TCA warning lt - On (cont) | 4H. Jet driver failed on or RCS TCA failed off and flag failed off (powered phase). (cont) | 4H. (cont) c. QUANTITY ind - indicates normal fuel consumption in both systems. d. MCC verified RCS TCA does not open. (See corrective procedure 4Bi.) | This procedure applies to all mission phases. Critical changes in temperature are not expected. If they occur, associated pressure readings will reflect them. If a failure requires use of this manifold pressure measurement for diagnosis, worst-case failure must be assumed. |
| 5. Propellant TEMP ind - 20° or 120° | 5. Fuel tank temperature sensor - Failed high or low | 5. Continue nominal mission. Monitor associated pressure reading on PRESS ind | |
| 6. Manifold pressure, when TEMP/PRESS MON SEL sw is set to MANF - 0 to 350 psia | 6. Propellant manifold sensor - Failed high or low | 6. Continue nominal mission. | |
| 7. ASC FEED flag - Last position ASC FEED flag - Gray ASC FEED flag - Barber pole MCC real-time valve position | 7. ASC FEED sw fails; ASC FEED flag or associated signal conditioner fails CLOSE. ASC FEED flag or associated signal conditioner fails OPEN. | 7. a. Preseparation checkout through powered flight (unstaged LM). Not applicable. b. Powered flight (staged LM): (Cannot close ASC FEED valve for system A or B.) (1) Confirm valve position with MCC. If T/M shows valves closed, continue nominal mission. (2) If T/M shows valves open: Affected system MAIN SOV sw - CLOSE Unaffected system ASC FEED sw - CLOSE CRSFD sw - CLOSE Affected system THRUSTER PAIR QUAD sw - CLOSE Continue nominal mission with one RCS system. | |
| | | | (1) Failure of sw, or signal conditioner failing open, is not detectable because flag remains in last position (gray). Open applicable cb. CM rescue may have to be initiated. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---------|
| 8. MAIN SOV flag - Last position | 8. MAIN SOV sw - Inoperative MAIN SOV cb fail open | 8. a. Preseparation checkout: (1) Verify MAIN SOV cb - In (2) MAIN SOV sw - Recycle OPEN (3) RCS system - Pressurize (4) Monitor fuel and oxidizer pressures in failed system: If both pressures >165 psia, continue nominal mission. If either or both pressures are <165 psia, consider alternate mission. Do not separate from CM. b. Powered flight (staged LM): (1) FUEL and OXIDIZER QUANTITY ind - Monitor: If ind shows one shutoff valve remains open, continue until end of ascent burn or until At "TBD" quantity reaches "TBD." Failed system THRUSTERS - Shut off (2) Complete rendezvous and docking, using remaining eight thrusters. | |
| 9. RCS QUANTITY ind shows fuel and oxidizer usage during ascent engine burns. MCC real-time PVT computer quantity indication. | 9. MAIN SOV fails OPEN during ascent engine burns, or associated signal conditioner fails open. | 9. a. Powered flight (staged LM): (1) Affected MAIN SOV sw - Recycle If valve closes - Continue mission | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---------|
| <p>9. RCS QUANTITY ind shows fuel and oxidizer usage during ascent engine burns. MCC real-time PVT computer quantity indication. (cont)</p> <p>10. Manifold pressure reads >175 psia when TEMP/PRESS MON sw is set to FUEL MANF or OXID MANF. MAIN SOV flag - Barber pole Absence of RCS TCA warning lt when jet is commanded to fire</p> | <p>9. MAIN SOV fails OPEN during ascent engine burns, or associated signal conditioner fails open. (cont)</p> <p>10. MAIN SOV flag, or associated signal conditioner fails CLOSE</p> | <p>9. (cont)</p> <p>If valve does not close - monitor QUANTITY ind Continue till end of burn or until quantity reaches x "TBD".</p> <p>At "TBD":</p> <p>Failed system thrusters - Shut off</p> <p>(2) Complete rendezvous and docking, using remaining eight thrusters.</p> <p>10.</p> <p>a. Preseparation checkout: Flag display remains barber pole after associated sw is set to OPEN.</p> <p>(1) Associated MAIN SOV sw - Recycle OPEN</p> <p>(2) Oxidizer manifold and fuel manifold pressures - Monitor: If both are nominal, continue mission.</p> <p>If one or both are <165 psia, consider alternate mission; do not separate.</p> <p>b. Coasting flight (undocked), LM near CM:</p> <p>(1) MCC does not verify MAIN SOV feed CLOSE. Continue mission.</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|---------|
| <p>10. Manifold pressure reads >175 psia when TEMP/PRESS MON sw is set to FUEL MANF or OXID MANF. MAIN SOV flag - Barber pole Absence of RCS TCA warning lt when jet is commanded to fire (cont)</p> | <p>10. MAIN SOV flag, or associated signal conditioner fails CLOSE (cont)</p> | <p>10. (cont)</p> <p>MCC verifies MAIN SOV feed - CLOSE; perform steps (2) through (6).</p> <p>(2) CRSFD sw - OPEN</p> <p>(3) ABORT pb - Press</p> <p>(4) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(5) MASTER ARM sw - OFF</p> <p>(6) Complete rendezvous and docking.</p> <p>c. Coasting flight (undocked), LM not near CM:</p> <p>(1) MCC does not verify MAIN SOV - CLOSE. Continue nominal mission. MCC verifies MAIN SOV - CLOSE, continue coasting orbit, and perform steps (2) through (5).</p> <p>(2) ABORT pb - Press</p> <p>(3) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(4) MASTER ARM sw - OFF</p> <p>(5) Complete rendezvous and docking.</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|---|
| <p>10. Manifold pressure reads >175 psia when TEMP/PRESS MON sw is set to FUEL MANF or OXID MANF.</p> <p>MAIN SOV flag - Barber pole</p> <p>Absence of RCS TCA warning lt when jet is commanded to fire (cont)</p> | <p>10. MAIN SOV flag, or associated signal conditioner fails CLOSE (cont)</p> | <p>10. (cont)</p> <p>d. Coasting flight, LM not near CM:</p> <ol style="list-style-type: none"> (1) MCC does not verify MAIN SOV - CLOSE. Continue nominal mission. MCC verifies MAIN SOV - CLOSE. Continue coasting orbit and perform steps (2) through (7). (2) CRSFD sw - OPEN (3) Obtain optimum time for abort from LGC. EVENT TIMER - Start (4) At appropriate time: ABORT pb - Press (5) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE (6) MASTER ARM sw - OFF (7) Complete rendezvous and docking. <p>e. Powered flight (unstaged LM): Continue nominal mission. Monitor FUEL MANF and OXID MANF pressures of failed system frequently.</p> <p>f. Powered flight (staged LM): Not detectable.</p> | <p>Because both MAIN SOV's are nominally closed during ascent engine burns, failure would be undetected until crew attempts to reopen valves shortly before ascent engine shutdown.</p> |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|---------|
| 11. MAIN SOV flag - Gray QUANTITY ind - No propellant depletion | 11. MAIN SOV flag, or associated signal conditioner fails OPEN. | <p>11.</p> <p>a. Preseparation checkout:</p> <p>(1) MCC verifies valve is closed. Continue mission.</p> <p>(2) Monitor FUEL MANF and OXID MANF pressures in failed system. If both pressures are > 165 after pressurization, MAIN SOV is closed. Continue mission.</p> <p>b. Powered flight (staged LM):</p> <p>(1) FUEL and OXIDIZER QUANTITY ind - Monitor: If ind shows one shutoff valve remains open, continue until quantity reaches TBD. At TBD Failed system THRUSTER PAIR QUAD sw - shutoff</p> <p>(2) Complete rendezvous and docking, using remaining eight thrusters.</p> | |
| 12. RCS TCA warning lt - On MASTER ALARM - On CRSFD flag - Last position MCC real-time valve position indication | 12. CRSFD sw fails to operate or either CRSFD valve fails to OPEN or CLOSE on command. | <p>12.</p> <p>a. Powered flight (staged LM):</p> <p>(1) If this failure occurs just after ascent engine ignition, continue powered flight and proceed to step (2).</p> | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|--|
| 12. RCS TCA warning lt - On MASTER ALARM - On CRSFD flag - Last position MCC real-time valve position indication (cont) | 12. CRSFD sw fails to operate or either CRSFD valve fails to OPEN or CLOSE on command. (cont) | 12. (cont) (2) When DSKY or DEDA indi- cate 10 sec of engine burn remain: APS/RCS interconnect - Disable Communicate with MCC to determine which valve failed open. (3) Failed system MAIN SOV sw - CLOSE Failed system THRUSTER PAIRS - CLOSE (4) Complete rendezvous and docking, using remaining eight thrusters. | |
| 13. CRSFD flag - Barber pole CRSFD flag - Gray MCC real-time valve position indication | 13. CRSFD flag, or associated signal conditioner fails CLOSE. | 13 CRSFD flag normally closed - Bar- berpole. If CRSFD flag fails open, valve position can be confirmed with MCC: If MCC indicates CRSFD valve OPEN, mission must be aborted. If CRSFD valve - CLOSE, continue nominal mission. | |
| 14. Helium pressure - >3500 psia. MCC real-time tank pressure indication | 14. Helium tank pressure sensor or signal conditioner fails high. | 14. a. Continue mission. TEMP/PRESS MON sw - PRPLNT Monitor helium regulator output b. Monitor QUANTITY ind for affect- ed system as indication of actual helium tank pressure. | a. RCS caution lt will not indicate status of affected tank. MCC will read constant high pressure. Other system is not affected. Radical drops in helium tank pressure will be reflected as lower-than- nominal quantity remaining for affected system. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|--|
| 15. Helium pressure - 1,700 psia. MCC real-time tank pressure indication. | 15. RCS caution lt fails - Off | 15. Because this general class of failures cannot be detected until a subsystem failure occurs, preventive, rather than corrective, action must be taken. This action will be frequent monitoring of the displays, especially by MCC. | In the event of relay driver failures MASTER ALARM lt may go on with no corresponding caution or warning indication. LAMP/TONE TEST CWEA if a caution or warning lt does not go on to isolate the failure. If all go on, a priority troubleshooting procedure (to be determined at a later date) will be instituted. |
| 16. He REGULATOR outlet pressure, when TEMP/PRESS MON sw is set to PRPLNT - 165 to 205 psia. MCC real-time helium regulator outlet pressure indication | 16. CWEA/RCS A REG or RCS B REG warning lt fails - Off | 16. Same as procedure 15 | Same as for procedure 15 |
| 17. Helium regulator outlet pressure remains at blanket level of 15 ± 5 psia when TEMP/PRESS MON sw - PRPLNT. MCC real-time helium regulator outlet pressure indication. | 17. EXPLOSIVE DEVICES/RCS PRESS sw fails to operate or helium regulator fails closed before pressurization. | 17. a. Preseparation checkout: (1) Verify helium pressure. If unpressurized condition exists: Do not separate. Abort mission. If pressurized condition exists: Continue nominal mission. | |
| 18. THRUSTER PAIR QUAD flag - Barber pole MCC real-time valve position | 18. THRUSTER PAIR QUAD sw fails to open valves. | 18. a. Preseparation checkout: Abort Mission. Do not separate. All THRUSTER PAIR QUAD sw - CLOSE. b. Coasting flight (undocked) LM near CM: (1) ABORT pb - Press (2) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|--|
| 18. THRUSTER PAIR QUAD flag - Barber pole MCC real-time valve position (cont) | 18. THRUSTER PAIR QUAD sw fails to open valves. (cont) | <p>18. (cont)</p> <p>(3) MASTER ARM sw - OFF</p> <p>(4) Complete nominal rendezvous and docking.</p> <p>c. Coasting flight (undocked), LM not near CM:</p> <p>(1) Continue coasting orbit.</p> <p>(2) Obtain optimum time for abort initiation from LGC. EVENT TIMER - Start</p> <p>(3) At appropriate time: ABORT pb - Press</p> <p>(4) After completion of descent engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> <p>(5) MASTER ARM sw - OFF</p> <p>(6) Complete nominal rendezvous and docking.</p> <p>d. Powered flight (unstaged LM):</p> <p>(1) ABORT pb - Press</p> <p>(2) DES QTY warning It goes on before the end of descent engine burn: ABORT STAGE pb - Press ENG ARM sw - ASC Engine START pb - Press</p> <p>(3) After completion of main engine burn: MASTER ARM sw - ON STAGE sw - FIRE</p> | (2) Engine must be shut down manually. |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---|
| 18. THRUSTER PAIR QUAD flag remains - Barber pole. MCC real-time valve position (cont) | 18. THRUSTER PAIR QUAD switch fails to OPEN valves. (cont) | 18. (cont) (4) MASTER ARM sw - OFF (5) Complete nominal rendezvous and docking. | |
| 19. THRUSTER PAIR QUAD flag - Barber pole MCC real-time valve position | 19. THRUSTER PAIR QUAD flag or associated signal conditioner fails CLOSE. | 19. Continue nominal mission. | |
| 20. THRUSTER PAIR QUAD flag - Red MCC real-time valve position | 20. THRUSTER PAIR QUAD flag fails OPEN. | 20. Continue nominal mission. | |
| 21. THRUSTER PAIR QUAD flag - Red MCC real-time valve position | 21. THRUSTER PAIR QUAD switch fails to close valves | 21. Continue nominal mission | If there is a TCA leak, an entire RCS system must be shut down, using the MAIN SOV. |
| 22. THRUSTER PAIR QUAD flag - Red. LAMP/TONE TEST sw. | 22. CWEA relay for THRUSTER PAIR flags fails - On | 22. Continue nominal mission | If relay fails, the CWEA and MASTER ALARM It remain operative. |
| 23. TEMP ind - 120° and 190° (for single quad) MCC real-time cluster temperature indication | 23. Engine heater fails - On | 23. HEATERS RCS SYS A/B-1. Cb associated with failed heater - Pull Continue mission | |
| 24. TEMP ind - 0° or 200° (single QUAD temperature) MCC real-time cluster temperature indication HEATER caution lt - On | 24. QUAD cluster temperature sensor fails - high or low | 24. Continue mission. a. Each quad has two parallel heaters per engine. Heaters are only required for low-ambient-temperature environment. Ambient temperature can be obtained by shutting heaters to a cluster on the same side as the failed sensor and reading TEMP ind after a period of time. Decision to continue might be made on basis of obtained temperature. Heaters may be shut off with the associated quad cb. | |

Table 9-5. Reaction Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| 25. TEMP ind reads the same for all positions of TEMP/PRESS MON sw | 25. Loss of power to TEMP ind, or TEMP/PRESS MON sw fails, or loss of power to RCS TEMP ind. | 25. Mission might be continued, but this is a potential abort situation because a leak could not readily be identified and onboard means could not provide rapid indication. Mission would be continued in the event of the loss of RCS TEMP ind because temperature monitoring is not critical. | CWEA will function. No onboard means of monitoring tank or manifold pressure. Monitoring will have to be assumed by MCC. |
| 26. QUANTITY ind pntr remain at last position. MCC real-time helium tank pressure indication. | 26. Loss of power to QUANTITY ind, or PQGS cb fails - Open | 26. Continue nominal mission with frequent monitoring of helium tank pressure, especially by MCC. | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|----------------------------------|--|---|
| 1. MASTER ALARM - On DC BUS warning lt - On One DC BUS VOLT cb - Out All applicable Flags - Gray | 1A. DC BUS VOLT cb - Failed open | 1A. a. DC BUS VOLT cb - Press b. If cb reopens, monitor applicable battery flags (Panel 14) (1) Descent battery flags (2) VOLTS mtr (3) AMPS mtr | (2) Voltage monitoring of associated d-c bus is disabled. D-C bus voltage monitoring is disabled for both buses. Voltage integrity is verified by monitoring other subsystems. |
| | 1B. SCERA attenuator - Failed | 1B. None possible | |
| | 2. CWEA DC BUS warning - Failed | 2. Monitor both d-c buses using VOLTS mtr and/or MCC. | |
| 3. MASTER ALARM - On DC BUS - On CWEA cb - In (Panel 16) BAT Flags - Barber pole Floodlights - Out | 3. Feeder short on SE's panel | 3. a. Before staging proceed as follows: (1) Both SE's (Panel 16): BAT FEED TIE cb - Out (2) Both CROSS TIE BAL LOAD cb - Out (3) Reduce load on SE's d-c bus (4) Both CROSS TIE BAL LOAD cb - In If cb reopens, ASCENT POWER BAT 5: BACKUP FEED sw - ON If cb remains in, proceed with step (5). | |
| | | | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---------|
| 3. MASTER ALARM - On DC BUS warning lt - On CWEA cb - In (Panel 16) BAT flags - Barber pole Floodlights - Out (cont) | 3. Feeder short on SE's panel (cont) | <p>3. (cont)</p> <p>(5) Both CROSS TIE: BUS cb (Panel 11 and 16) - In</p> <p>(6) Both CROSS TIE: BAL LOADS cb (Panel 11 and 16) - Out</p> <p>(7) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>ASCENT POWER BAT 6: NORMAL FEED sw - ON</p> <p>(8) Verify SE's d-c bus voltage - Nominal</p> <p>(9) DES BATS sw - DEAD FACE (Panel 14)</p> <p>b. During DPS BURNS proceed as follows:</p> <p>(1) Both SE's BAT FEED TIE cb - Out</p> <p>(2) Both CROSS TIE: BAL LOADS cb (Panel 11 and 16) - Out</p> <p>(3) Reduce load on SE's d-c bus</p> <p>(4) Both CROSS TIE: BAL LOADS cb - In</p> <p>(5) If cb reopens, ASCENT POWER BAT 5: BACKUP FEED sw - ON If cb remains in, pro- ceed with step (6).</p> <p>(6) Both CROSS TIE cb - In</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|---------|
| 3. MASTER ALARM - On DC BUS warning lt - On CWEA cb - In (Panel 16) Bat flags - Barber pole Floodlights - Out (cont) | 3. Feeder short on SE's panel (cont) | <p>3. (cont)</p> <p>(7) Both CROSS TIE BAL LOADS cb - Out</p> <p>(8) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>(9) Verify SE's d-c bus voltage - Nominal</p> <p>(10) DES BAT's sw - DEAD FACE (Panel 14)</p> <p>c. After staging, proceed as follows:</p> <p>(1) Both SE's BAT FEED TIE cb - Out</p> <p>(2) Both CROSS TIE BAL LOADS cb - Out</p> <p>(3) Reduce load on SE's d-c bus</p> <p>(4) Both CROSS TIE BAL LOADS cb - In If cb reopens, ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>If cb remains in, proceed to step (5).</p> <p>(5) Both CROSS TIE BUS cb - In</p> <p>Both CROSS TIE BAL LOAD cb - Out</p> <p>(6) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>(7) Verify SE's d-c bus voltage - Nominal</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|----------------------------|--|---------|
| 4. DC BUS warning lt - On MASTER ALARM - On CWEA cb - In (Panel 16) All EPS flags - Barber pole Floodlights - Off | 4. DC BUS short - Panel 16 | <p>4.</p> <p>a. Before staging, proceed as follows:</p> <p>(1) Both SE's BAT FEED TIE cb - Out</p> <p>(2) Both CROSS TIE BAL LOADS cb - Out</p> <p>(3) Reduce load on SE's d-c bus</p> <p>(4) Both CROSS TIE BAL LOADS cb - In If cb remains in, both CROSS TIE BUS cb - In If cb reopens, proceed to step (5).</p> <p>(5) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>(6) ASCENT POWER BAT 6: NORMAL FEED sw - ON</p> <p>(7) DES BATS sw - DEAD FACE</p> <p>b. During DPS BURNS, proceed as follows:</p> <p>(1) Both SE's BAT FEED TIE cb - Out</p> <p>(2) Both CROSS TIE BAL LOADS cb - Out</p> <p>(3) Reduce load on SE's d-c bus</p> <p>(4) Both CROSS TIE BAL LOADS cb - In</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--------------------------------------|--|---------|
| 4. DC BUS warning lt - On MASTER ALARM - On CWEA cb - In (Panel 16) All EPS flags - Barber pole Floodlights - Off (cont) | 4. DC BUS short - Panel 16 (cont) | <p>4. (cont)</p> <p>If cb remains in, both CROSS TIE BUS cb - In</p> <p>If cb reopens, proceed to step (5).</p> <p>(5) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> <p>(6) DES BATS sw - DEAD FACE</p> <p>c. After staging, proceed as follows:</p> <p>(1) Both SE's BAT FEED TIE cb - Out</p> <p>Both CROSS TIE BAL LOADS cb - Out</p> <p>(2) Reduce load on SE's d-c bus</p> <p>(3) Both CROSS TIE BAL LOADS cb - In If cb remain in, both CROSS TIE BUS cb - In</p> <p>If cb reopen, proceed to step (4).</p> <p>(4) ASCENT POWER BAT 5: BACKUP FEED sw - ON</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--------------------------------|---|---------|
| 5. DC BUS warning lt - On MASTER ALARM - On BATTERY CAUTION lt - On DESCENT POWER: BAT flags - 3, 4, and/or 6 - Barber pole | 5. Feeder short on CDR's panel | 5. a. Before staging, proceed as follows: (1) GUID CONT sw - AGS (Panel 1) (2) Both BAT FEED TIE cb - Out (Panel 11) (3) Both CROSS TIE BAL LOADS cb - Out (4) Reduce load on CDR's d-c bus (5) Both CROSS TIE BAL LOADS cb - In If cb reopens, ASCENT POWER BAT 5: NORMAL FEED sw - ON If cb remain in, proceed with step (6). (6) ASCENT POWER BAT 5: NORMAL FEED sw - ON ASCENT POWER BAT 6: BACKUP FEED sw - ON (7) Verify CDR's d-c bus voltage - Nominal (8) DES BATS sw - DEAD FACE b. During DPS BURNS, proceed as follows: (1) GUID CONT sw - AGS (2) Both BAT FEED TIE cb - Out (Panel 11) | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---------|
| 5. DC BUS warning lt - On MASTER ALARM - On BATTERY CAUTION lt - On DESCENT POWER: BAT flags - 3, 4, and/or 6 - Barber pole (cont) | 5. Feeder short on CDR's panel (cont) | <p>5. (cont)</p> <p>(3) Both CROSS TIE BAL LOADS cb - Out</p> <p>(4) Reduce load on CDR's d-c bus</p> <p>(5) Both CROSS TIE BAL LOADS cb - In If cb reopen, ASCENT POWER BAT 6: BACKUP FEED sw - ON</p> <p>If cb remains in, proceed with step (6).</p> <p>(6) ASCENT POWER BAT 6: BACKUP FEED sw - ON</p> <p>(7) Verify CDR's d-c bus voltage - Nominal</p> <p>(8) DES BATS sw - DEAD FACE</p> <p>c. After staging, proceed as follows:</p> <p>(1) GUID CONT sw - AGS</p> <p>(2) Both BAT FEED TIE cb - Out (Panel 11)</p> <p>(3) Both CROSS TIE BAL LOADS cb - Out</p> <p>(4) Reduce load on CDR's d-c bus</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---------|
| 5. DC BUS warning lt - On MASTER ALARM - On BATTERY CAUTION lt - On DESCENT POWER: BAT flags - 3, 4, and/or 6 - Barber pole (cont) | 5. Feeder short on CDR's panel (cont) | 5. (cont) (5) Both CROSS TIE BAL LOADS cb - In If cb reopen, ASCENT POWER BAT 6: BACKUP FEED sw - ON If cb remain in, proceed to step (6). (6) ASCENT POWER BAT 6: BACKUP FEED sw - ON (7) Verify CDR's d-c bus voltage - Nominal | |
| 6. DC BUS warning lt - On MASTER ALARM - On BATTERY caution lt - On DES POWER BAT flags - 3, 4, and/or 6 - Barber pole | 6. DC BUS short, panel 11 | 6. a. Before staging, proceed as follows: (1) GUID CONT sw - AGS (2) Both BAT FEED TIE cb - Out (Panel 11) (3) Both CROSS TIE BAL LOADS cb - Out (Panel 11) (4) Reduce load on CDR's d-c bus (5) Both CROSS TIE BAL LOADS cb - In If cb remain in, ASCENT POWER BAT 5: NORMAL FEED sw - ON If cb reopens, proceed to step (6). (6) ASCENT POWER BAT 5: NORMAL FEED sw - ON | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|-------------------------------------|--|---------|
| 6. DC BUS warning lt - On MASTER ALARM - On BATTERY caution lt - On DES POWER BAT flags - 3, 4 and/or 6 - Barber pole (cont) | 6. DC BUS short, panel 11 (cont) | <p>6. (cont)</p> <p>(7) ASCENT POWER BAT 6: BACKUP FEED sw - ON</p> <p>DES BATS sw - DEAD FACE</p> <p>b. During DPS BURNS, proceed as follows:</p> <p>(1) GUID CONT sw - AGS</p> <p>(2) Both BAT FEED TIE cb - Out (Panel 11)</p> <p>(3) Both CROSS TIE BAL LOADS cb - Out (Panel 11)</p> <p>(4) Reduce load on CDR's d-c bus</p> <p>(5) Both CROSS TIE BAL LOADS cb - In If cb remain in, ASCENT POWER BAT 6: BACKUP FEED sw - ON</p> <p>If cb reopen, proceed to step (6).</p> <p>(6) ASCENT POWER BAT 6: BACKUP FEED sw - ON</p> <p>(7) DES BATS sw - DEAD FACE</p> <p>c. After staging, proceed as follows:</p> <p>(1) GUID CONT sw - AGS</p> <p>(2) Both BAT FEED TIE cb - Out (Panel 11)</p> | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| 6. DC BUS warning lt - On MASTER ALARM - On BATTERY caution lt - On DES POWER BAT flags - 3, 4, and/or 6 - Barber pole (cont) | 6. DC BUS short, panel 11 (cont) | 6. (cont) (3) Both CROSS TIE BAL LOADS cb - Out (Panel 11) (4) Reduce load on CDR's d-c bus (5) Both CROSS TIE BAL LOADS cb - In If cb remain in, ASCENT POWER BAT 6: If cb reopens, proceed to step (6). (6) ASCENT POWER BAT 6: BACKUP FEED sw - ON | |
| 7. MASTER ALARM - On BATTERY caution lt - On All flags - Gray | 7. Descent battery failed (Overtemperature or reverse current) | 7A. a. Cycle POWER/TEMP MON switch - BAT 1, 2, 3, 4, 5, 6 b. Applicable BAT sw - OFF/RESET | a. All switch position must be selected to determine if a descent or ascent battery failed. The BAT FAULT light will go on when a faulty battery is selected. Failure of two descent batteries re- quires taking all descent batteries off line and turn- ing on ascent batteries |
| | 7B. Ascent battery failure | 7B. a. Before staging: (1) Cycle POWER/TEMP MON sw - BAT 1, 2, 3, 4, 5, 6 (2) Applicable BAT sw - OFF/RESET | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|--|
| 7. MASTER ALARM - On BATTERY caution lt - On All flags - Gray (cont) | 7B. Ascent battery failure (cont) | 7B. (cont) (3) Do not stage b. After staging: (1) Cycle POWER/TEMP MON sw - BAT 5, 6 (2) Applicable BAT sw - OFF/RESET (3) Nonessential equipment - Deactivated (4) Applicable BAT FEED TIE cb - Pull (5) CROSS TIE FEED BUS (Panel 11 and Panel 16) - Push (6) CROSS TIE BAL LOADS (Panel 11 and Panel 16) - Pull | (3) An abbreviated mission can be pursued with descent batteries, using remaining ascent battery as backup. |
| | 7C. BATTERY caution lt - Failure | 7C. Monitor batteries individually, using BAT FAULT component caution light, VOLTS mtr, AMPS mtr, and/or MCC. | |
| 8. a. MASTER ALARM - On b. INVERTER caution - On | 8A. SCERA frequency-to-dc converter failure | 8A. a. POWER/TEMP MON sw - AC BUS Verify VOLTS mtr - within green band (35.8 - 37.7): (1) Verify with MCC that frequency < 398 cps. | VOLTS mtr-green band (35.8 +037.7 vdc) is equal to 112 to 118 vac. (1) SCERA frequency-to- dc converter failure will not alter mission. |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 8. (cont) | <p>8A. SCERA frequency-to-dc converter failure (cont)</p> <p>8B. Inverter failure</p> <p>8C. AC BUS failure</p> <p>8D. AC BUS VOLT cb - Failed open</p> | <p>8A. (cont)</p> <p>(2) Verify frequency-sensitive equipment operation (NUM and INTGL lighting) is satisfactory; if not satisfactory, proceed with failure 7B.</p> <p>8B.</p> <p>a. AC PWR sw - INV 2</p> <p>b. Verify VOLTS mtr - within green band (112 to 118 volts AC)</p> <p>c. If voltage below green band, verify AC BUS VOLT CB - In. If cb in, proceed with failure 7C; if not, push. If cb reopens proceed with failure 7D.</p> <p>8C.</p> <p>CB INV - Pull (Panel 11 and Panel 16)</p> <p>8D. Verify proper operation of NUM and INTGL lighting. If lighting is operating properly, monitor bus, using NUM and INTGL lighting</p> <p>9.</p> <p>a. MASTER ALARM - Press</p> <p>b. POWER/TEMP MON sw CDR or SE BUS</p> <p>c. VOLTS mtr - CDR or SE BUS < 26.5 vdc</p> | <p>a. Normally, AC PWR sw - INVI</p> <p>b. This indicates inverter No. 1 has failed. Normal operations may continue, using inverter No. 2 (AC PWR sw - INV 2).</p> <p>c. If cb remains in, then it inadvertently opened.</p> <p>Determine remainder of mission with MCC.</p> <p>Voltage-monitoring of a-c bus is disabled and frequency-monitoring by MCC is disabled.</p> |
| 9. MASTER ALARM - On DC BUS warning lt - On | 9. Low d-c bus voltage | | |

Table 9-6. Electrical Power Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|----------------------------------|--|---------|
| 9. MASTER ALARM - On DC BUS warning lt - On (cont) | 9. Low d-c bus voltage (cont) | 9. (cont) d. Reduce load on affected bus until VOLTS mtr \geq 26.5 vdc e. Monitor continuously - VOLTS mtr and MCC | |

Table 9-7. Environmental Control Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| <p>1. Cabin Pressurized</p> <p>Cabin Pressure and suit pressure - < 4.8 psia and gradually decaying (Refer to "remarks" column.)</p> <p>MASTER ALARM - Cabin On Pressure and suit CABIN warning pressure lt - On < 4.1 psia</p> <p>Cabin unpressurized</p> <p>Suit pressure < 3.8 psia and gradually decaying (Refer to "remarks" column.)</p> <p>MASTER ALARM - Suit On pressure < 3.1 SUIT/FAN warning psia lt - On</p> <p>2. MASTER ALARM - On ECS caution lt - On SUIT FAN component caution lt - On</p> | <p>1A.</p> <p>Before FITH</p> <p>Descent oxygen tank filter - clogged</p> <p>or</p> <p>One DES O₂ high-pressure regulator - Failed closed</p> <p>or</p> <p>DES O₂ valve - Failed closed</p> <p>1B.</p> <p>After FITH</p> <p>#1 ASC O₂ - Failed closed</p> <p>or</p> <p>#1 ASC O₂ tank filter - Clogged</p> <p>2. Suit fan No. 1 - Failed</p> | <p>1A.</p> <p>a. DES O₂ valve - CLOSE</p> <p>b. #1 ASC O₂ valve - OPEN</p> <p>1B.</p> <p>a. #1 ASC O₂ valve - CLOSE</p> <p>b. #2 ASC O₂ valve - OPEN</p> <p>2. SUIT FAN sw - 2</p> | <p>Decay of cabin pressure and/or suit pressure is not readily apparent. Pressure must be monitored.</p> <p>Decay of suit pressure is not readily apparent. Pressure must be monitored.</p> |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| 3. MASTER ALARM - On CABIN warning lt - On Cabin pressure < 4.1 psia | 3. Cabin puncture or Forward or overhead cabin relief and dump valve failed open in AUTO | 3. a. PRESS REG A and PRESS REG B valves - EGRESS b. Verify SUIT GAS DIVERTER valve - EGRESS (PULL) c. CABIN GAS RETURN valve - EGRESS d. Forward and overhead cabin relief and dump valve - CLOSE e. Monitor PRESS/CABIN ind for further decay. f. Overhead Cabin relief and dump valve - AUTO (e and f, REMARKS column) g. Monitor PRESS/CABIN ind for decay. If cabin pressure does not decay: Forward cabin relief and dump valve - AUTO (f, REMARKS column) h. Monitor PRESS/CABIN indicator for decay. If cabin pressure does not decay: PRESS REG A valve and PRESS REG B valve - CABIN. i. CABIN GAS RETURN valve - AUTO j. SUIT GAS DIVERTER valve - PUSH - CABIN | e. Omit procedural steps f to j if continuing cabin pressure decay indicates a cabin puncture, or if failure occurs after FITH staging f. The Cabin Relief and Dump causing further cabin pressure decay will be kept in CLOSE. i. Optional, depending on mission phase. j. Optional, depending on mission phase |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| <p>4. MASTER ALARM - On SUIT/FAN warning lt - On Suit pressure < 3.1 psia and decreasing</p> <p>NOTE</p> <p>Cabin is depressurized or being depressurized.</p> <p>Decrease in suit pressure can be immediately felt, and observed on the indicator.</p> | <p>4. SUIT CIRCUIT RELIEF valve fails open in AUTO (a, REMARKS column)</p> <p>or</p> <p>SUIT GAS DIVERTER valve fails in PUSH - CABIN position when electrically energized.</p> <p>or</p> <p>CABIN GAS RETURN check valve fails open in AUTO</p> | <p>4.</p> <p>a. Set and/or verify:</p> <p>(1) SUIT CIRCUIT RELIEF valve - CLOSE</p> <p>(2) SUIT GAS DIVERTER valve PULL - EGRESS</p> <p>(3) CABIN GAS RETURN valve - EGRESS</p> | <p>Rate of suit pressure decay is a function of the oxygen flow through PRESS REG A and PRESS REG B which, in turn, is a function of the oxygen supply pressure.</p> |
| <p>5. Cabin pressure and suit pressure > 5.0 psia after actuation of indicated valve</p> | <p>5A. CABIN REPRESS valve - Failed open in AUTO</p> <p>5B.</p> <p>a. PRESS REG A valve or PRESS REG B valve locks in DIRECT O₂</p> <p>or</p> <p>CABIN REPRESS valve locks - OPEN</p> | <p>5A. CABIN REPRESS valve - CLOSE</p> <p>5B.</p> <p>a. Regulate cabin pressure by opening and closing appropriate O₂ valve.</p> <p>(1) DES O₂ valve before FITH.</p> <p>(2) #1 ASC O₂ valve after FITH.</p> | <p>5B.</p> <p>a. If CABIN REPRESS valve locks in OPEN, cabin cannot be depressurized.</p> <p>Valves are modulated to control pressure.</p> |
| <p>6. Cabin pressure and/or suit pressure > 5.0 psia</p> | <p>6. PRESS REG A valve or PRESS REG B valve does not regulate in CABIN setting.</p> <p>or</p> <p>CABIN REPRESS valve - Leaks</p> | <p>6.</p> <p>a. Isolate leak.</p> <p>(1) Before FITH: DES O₂ valve - CLOSE</p> <p>(2) After FITH: #1 ASC O₂ or #2 ASC O₂ valve</p> | |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| 6. Cabin pressure and/or suit pressure > 5.0 psia (cont) | <p>6. PRESS REG A valve or PRESS REG B valve does not regulate in CABIN setting.</p> <p>or</p> <p>CABIN REPRESS valve - Leaks (cont)</p> | <p>6. (cont)</p> <p>b. Proceed as follows:</p> <p>(1) PRESS REG A valve - CLOSE</p> <p>(2) PRESS REG B valve - CLOSE</p> <p>(3) CABIN REPRESS valve - CLOSE</p> <p>c. Allow PRESS CABIN and PRESS SUIT to decay to 4.6 psia</p> <p>d. Appropriate O₂ valve - OPEN</p> <p>e. PRESS REG A valve - CABIN</p> <p>f. Monitor PRESS/CABIN and PRESS/SUIT ind for rise above 5.0 psia.</p> <p>g. PRESS REG B valve - CABIN</p> <p>h. Monitor PRESS/CABIN and PRESS/SUIT ind for rise above 5.0 psia.</p> | <p>c. If cabin pressure and suit pressure do not decay to 4.6 psia, leak is indicated in the oxygen high-pressure supply line. No corrective action is possible.</p> <p>If only suit pressure or cabin pressure decays, PRESS ind has failed.</p> <p>d. DES O₂ valve - before FITH</p> <p>#1 ASC O₂ or #2 ASC O₂ - after FITH</p> <p>e. If leakage is determined to be from PRESS REG A valve, PRESS REG B valve, or CABIN REPRESS valve, set failed component to CLOSE</p> <p>g. Same as e above.</p> |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|--|--|
| 6. Cabin pressure and/or suit pressure > 5.0 psia (cont) | 6. PRESS REG A valve or PRESS REG B valve does not regulate in CABIN setting. or CABIN REPRESS valve - Leaks (cont) | 6. (cont) i. CABIN REPRESS valve - AUTO j. Monitor PRESS/CABIN and PRESS/SUIT ind for rise above 5.9 psia. | i. Same as e above. |
| 7. CO ₂ CANISTER SEL valve - Inoperative MASTER ALARM - On ECS caution lt - On CO ₂ Component caution lt - On PART PRESS CO ₂ ind > 7.6 mm Hg. | 7. CO ₂ CANISTER SEL valve fails in PRIM. or CO ₂ CANISTER SEL valve fails in SEC. | 7. a. Cabin Pressurized: If PART PRESS CO ₂ rises to 30 mm Hg, dump cabin and repressurize. b. Cabin Unpressurized: If PART PRESS CO ₂ rises to 30 mm Hg, vent suit circuit assembly, as required: SUIT CIRCUIT relief valve - OPEN Monitor suit pressure to prevent pressure from falling below 3.5 psia. | CO ₂ CANISTER SEL valve is moved to SEC only when PRIM CO ₂ CANISTER is changed. Depressurizing cabin for normal mission profile exhausts most of CO ₂ . Crew can breathe several hours in pressurized cabin without CO ₂ removal, before CO ₂ builds up to a point where it must be exhausted. Rate of CO ₂ buildup is directly related to metabolic output. Tolerance to high CO ₂ levels is a function of the individual crewman. |
| 8. MASTER ALARM - On ECS caution lt - On CO ₂ component caution lt - On PART PRESS CO ₂ ind > 7.6 mm Hg. | 8. Original PRIMARY CO ₂ CARTRIDGE failed or saturated | 8. a. CO ₂ CANISTER SEL valve - SEC b. Primary VENT - PUSH (Refer to REMARKS column, step a.) c. Primary CO ₂ cartridge cover - OPEN. | a. If replaced primary CO ₂ cartridge fails, delete steps b through g. |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|---|
| 8. MASTER ALARM - On ECS caution lt - On CO ₂ component caution lt - On PART PRESS CO ₂ ind > 7.6 mm Hg. (cont) | 8. Original PRIMARY CO ₂ CARTRIDGE failed or saturated (cont) | 8. (cont) d. Remove primary CO ₂ cartridge. e. Replace with new primary CO ₂ cartridge. f. Primary CO ₂ cartridge cover - CLOSE. g. CO ₂ CANISTER SEL valve - PRIM. | |
| 9. Improper flow distribution to PGA. | 9A. SE (CDR) SUIT FLOW valve fails in TORSO. 9B. SE (CDR) SUIT FLOW valve fails in HELMET. | 9A. Reverse hose connections on PGA when helmet and gloves are donned (REMARKS). 9B. Reverse hose connections on PGA when helmet and gloves are doffed (REMARKS). | 9A or 9B. Only crewmember whose SUIT FLOW has malfunctioned should take corrective action. WARNING Crewmember whose SUIT FLOW has malfunctioned <u>MUST NOT DISCONNECT</u> from ECS while cabin is unpressurized. |
| 10. MASTER ALARM - On O ₂ QTY caution lt - On Before FITH DES O ₂ quantity < 5%. or ASC 1 or ASC 2 O ₂ quantity < 80%. | 10A. Descent oxygen tank - Leaks (REMARKS column) 10B. Before FITH Ascent oxygen tank No. 1 or 2 - Leaks | 10A. a. DES O ₂ valve - CLOSE. b. #1 ASC O ₂ valve - OPEN. 10B. Before FITH a. Read REMARKS column before proceeding with next step. b. DES O ₂ valve - CLOSE c. #1 (#2) ASC O ₂ valve - OPEN after depleting ASC 1 (2) supply. d. #1 (#2) ASC O ₂ valve - CLOSE e. DES O ₂ valve - OPEN. | 10A. Assumes unstaged LM. 10B. a. Assumes some oxygen remaining in ascent oxygen tank No. 1 or 2. If either tank is depleted omit steps b to e. |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| <p>10. MASTER ALARM - On O₂ QTY caution lt - On</p> <p>Before FITH</p> <p>DES O₂ quantity < 5%.</p> <p>or</p> <p>ASC 1 or ASC 2 O₂ quantity < 80%. (cont)</p> <p>After FITH</p> <p>ASC 1 O₂ quantity < 12% (i, REMARKS)</p> | <p>10B. Before FITH (cont)</p> | <p>10B.(cont)</p> <p>Just before FITH</p> <p>f. DES O₂ valve - CLOSE.</p> <p>g. #2 (#1) ASC O₂ valve - OPEN.</p> <p>After FITH (A, REMARKS)</p> <p>h. #1 (#2) ASCS O₂ valve - CLOSE.</p> <p>i. #2 (#1) ASC O₂ valve - OPEN.</p> | <p>After FITH</p> <p>h. Continue using ascent oxygen tank No. 1 or 2 supply until depleted.</p> <p>i. After FITH, there is no CWEA indication for an ascent oxygen No. 2 tank leak.</p> |
| <p>11. MASTER ALARM - On WATER QTY caution lt - On</p> <p>Before FITH</p> <p>Descent H₂O quantity < 10%</p> <p>or</p> <p>Ascent 1 or 2 H₂O quantity 100%</p> <p>After FITH</p> <p>Unequal ASC 1 or 2 H₂O QTY (a, b REMARKS)</p> | <p>11A. Descent water tank leak.</p> <p>11B. Ascent 1 or ascent 2 water tank leaks (a, REMARKS).</p> | <p>11A.WATER TANK SELECT valve-ASC</p> <p>11B.</p> <p>a. Before FITH: Hold WATER TANK SELECT valve - DES</p> <p>b. Immediately before FITH: WATER TANK SELECT valve - ASC</p> | <p>11B.</p> <p>a. No corrective action is possible after FITH.</p> <p>b. Depending on mission profile, it may be necessary to power down LM.</p> |
| <p>12. MASTER ALARM - On ESC caution lt - On GLYCOL PUMP comp caution lt - On Suit temperature increases.</p> | <p>12. GLYCOL PUMP 1 fails</p> <p>or</p> <p>Bypass relief valve downstream of GLYCOL PUMP 1 fails open.</p> | <p>12. GLYCOL PUMP sw - 2</p> | |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 13. MASTER ALARM - On ECS caution lt - On WATER SEP component caution lt - On | 13. Water separator fails or Check valve(s) downstream of WATER SEP 1 fails in closed position. | 13. WATER SEP SEL valve - PULL: SEP 2 | 13. If both water separators fail, control of humidity is impos- sible. Amount of crew dis- comfort is subjective. |
| 14. MASTER ALARM - On GLYCOL caution lt - On GLYCOL TEMP - >50° F (b, REMARKS) Suit temperature increases. | 14. Primary glycol loop leak (b, REMARKS) or Check valve downstream of primary water pressure regulators fails close. or One primary water pressure regulator fails CLOSE. or PRIM EVAP FLOW solenoid fails CLOSE. or WATER TANK SELECT valve fails in DES before FITH (a, REMARKS). | 14. NOTE Procedures are applicable for failure of PUMP 1 or PUMP 2. a. (a, REMARKS) b. WATER TANK SELECT valve - SEC c. GLYCOL PUMP sw - EMER d. SEC GLYCOL EVAP FLOW valve - OPEN e. All equipment requiring cooling and not mounted on secondary glycol loop cold plates - Deactivated. | 14. a. If WATER TANK SELECT valve fails in DES, omit procedural step b. Cooling capacity on secondary glycol loop will be degraded because no accumulator action is available from the water management section if the WATER TANK SELECT valve cannot be set to SEC. b. Glycol temperature may not rise out of normal range of +32° to +50° F, if failure is due to leak in glycol loop. |

Table 9-7. Environmental Control Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 15. No flow to PGA | 15. SE (CDR) suit flow fails in SUIT DISCONNECT. | 15. SE (CDR) remove helmet | 15. Assumes cabin is or will be pressurized before removing helmet. PLSS may be donned to ensure against possible subsequent cabin puncture. |
| 16. MASTER ALARM - On SUIT/FAN warning lt - On SUIT FAN component caution lt - On | 16. SUIT FAN - Failed NOTE Assumes Suit Fan No. 1 previously failed | 16. a. Both men remove helmet b. Cabin fans - ON c. CABIN TEMP valve - MAX COOL | 16. a. Same as 15 above. |

Table 9-8. Communications Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|--|
| 1. Loss of LM S-band voice transmission to MCC. (MCC notifies LM.) | 1A. VOX circuitry | 1A. a. VOX sw - PTT b. PTT sw - Press or c. AUDIO CONT sw - BU | a. Audio centers each contain separate VOX circuits for S-band, VHF, and ICS modes. c. Astronaut will maintain VOX communication with MCC via other astronaut's audio center. AUDIO CONT sw may not be used during EVA, due to relay switching constraints. |
| | 1B. Primary S-band power amplifier - Failed | 1B. S-Band PWR AMPL sw - SEC | Loss of equipment redundancy |
| | 1C. Primary S-band transmitter - Failed | 1C. S-Band XMTR/RCVR sw - SEC | Loss of equipment redundancy |
| | 1D. PMP PM circuitry (e.g., PM mixer) - Failed | 1D. S-band MODULATE sw - FM | Loss of redundant mode of communication |
| | 1E. Signal processor S-band voice circuitry (e.g., low-pass filter) - Failed | 1E. a. All phases, except EVA: (1) S-BAND FUNCTIONS VOICE sw - VOICE BU (2) S-BAND TELEMETRY BIOMED sw - OFF b. EVA phase: (1) Recall EVA to LM. (2) S-BAND FUNCTION VOICE sw - VOICE BU (3) S-BAND TELEMETRY BIOMED sw - OFF | Selection of VOICE BU will preclude S-band ranging, high-bit-rate PCM, and biomed data. With BIOMED sw set to OFF, additional speech processing enhances intelligibility of voice signal from LM. |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|---|
| <p>1. Loss of LM S-Band voice transmission to MCC. (MCC notifies LM.) (cont)</p> <p>2. Loss of LM S-band voice reception SIGNAL STRENGTH mtr - 0 (LM crew is informed by CM (if in LOS) that MCC receives LM transmission.)</p> <p>3. Loss of S-band voice trans- mission and reception SIGNAL STRENGTH mtr - 0 Crew aware of no LM/MCC communication CM informs LM, via VHF, that MCC no longer receives LM.</p> | <p>1F. Audio center (diode sw, transformer, etc) - Failed</p> <p>2A. Primary S-band receiver - Failed</p> <p>2B. PMP (discriminator and associated circuitry) - Failed</p> <p>2C. S-band diplexer - Failed</p> <p>2D. S-band transceiver RF diode sw - Failed</p> <p>3A. Primary S-band transceiver - Failed</p> | <p>1F. AUDIO CONT sw - BU</p> <p>2A. a. Verify SIGNAL STRENGTH mtr - 0 b. S-BAND XMTR/RCVR sw - SEC</p> <p>2B. Communicate with MCC via VHF thru CM relay.</p> <p>2C. Same as procedure 2B.</p> <p>2D. Same as procedure 2B.</p> <p>3A. a. Verify SIGNAL STRENGTH mtr - 0 b. Circuit breakers (Panel 16) (1) Verify COMM-PRIM S-BD XMTR/RCVR - In (2) Verify COMM-S-BD ANT - In c. Circuit breakers (Panel 11) Verify COMM-SEC S-BD XMTR/RCVR - In</p> | <p>Loss of equipment redundancy</p> <p>It is possible that SIGNAL STRENGTH mtr will peak with this failure.</p> <p>(1) If COMM: PRIM S-BAND XMTR/RCVR cb is out, this is fault. Close cb and attempt communications. If communications not re- gained, continue procedure.</p> |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| <p>3. Loss of S-band voice transmission and reception SIGNAL STRENGTH mtr - 0</p> <p>Crew aware of no LM/MCC communication</p> <p>CM informs LM, via VHF, that MCC no longer receives LM. (cont)</p> | 3A. Primary S-band transceiver - Failed (cont) | <p>3A. (cont)</p> <p>d. A-C circuit breakers (Panel 11) Verify COMM-S-BD AND (CDR) - In</p> <p>e. S-BAND XMTR/RCVR sw - SEC</p> | <p>a. Select 1 or 2, depending on LM orientation with respect to earth.</p> <p>c. During earth orbital flight, LM may communicate with earth via VHF. An alternate mode would be CM relay of earth voice to LM.</p> <p>If communications is not reestablished using this procedure, perform procedures for failure 3C.</p> |
| | 3B. S-band steerable antenna loss of earth track - Failure | <p>3B.</p> <p>a. COMMUNICATIONS ANTENNAS/S-BAND sw - 1 or 2</p> <p>b. Reestablish communications.</p> <p>c. Obtain pitch angle and yaw angle from MCC.</p> <p>d. Set PITCH and YAW sw to obtained angles.</p> <p>e. COMMUNICATIONS ANTENNAS/S-BAND sw - SLEW</p> <p>f. Verify PITCH and YAW mtr readings.</p> <p>g. Verify TRACK MODE sw - AUTO</p> | |
| | 3C. Steerable antenna, mechanical or electronics - Failure | <p>3C.</p> <p>a. COMMUNICATIONS ANTENNAS/S-BAND sw - 1 or 2</p> | <p>a. Select 1 or 2, depending on LM orientation with respect to earth.</p> |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| <p>3. Loss of S-band voice transmission and reception SIGNAL STRENGTH mtr - 0</p> <p>Crew aware of no LM/MCC communication</p> <p>CM informs LM, via VHF, that MCC no longer receives LM. (cont)</p> | <p>3C. Steerable antenna, mechanical or electronics - Failure (cont)</p> <p>3D. Omni antenna, mechanical - Failure</p> <p>3E. S-band diplexer or S-band XMTR/RCVR sw - Failed</p> | <p>3C. (cont)</p> <p>b. TRACK MODE sw - OFF</p> <p>c. Reestablish communications.</p> <p>3D.</p> <p>a. COMMUNICATIONS ANTENNAS/S-BAND sw - 1 or 2 (depending on which antenna failed)</p> <p>or</p> <p>b. Activate simplex VHF A mode:</p> <p>(1) Verify or set COMMUNICATIONS ANTENNAS/VHF sw - 1 or 2</p> <p>(2) AUDIO: VHF A sw - T/R</p> <p>(3) VHF A XMTR sw - ON</p> <p>(4) VHF A RCVR sw - ON</p> <p>(5) VHF B XMTR sw - OFF</p> <p>(6) VHF B RCVR sw - OFF</p> <p>3E.</p> <p>a. Communicate with MCC via VHF.</p> <p>or</p> <p>b. Communicate with MCC via VHF thru CM relay.</p> | <p>c. Steerable antenna is used only for checkout purposes on earth orbital flight.</p> <p>a. It may be necessary to reorient LM with respect to earth.</p> <p>b. During earth orbital flight, LM is within VHF communication range of earth.</p> <p>a. It may be necessary to reorient LM with respect to earth.</p> <p>b. During earth orbital flight, LM is within VHF communication range of earth.</p> |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|--|
| 4. Loss of VHF voice reception (VHF A) Crew aware of no reception | 4. VHF A receiver, or PMP VHF A circuitry - Failed | 4. a. Circuit breakers (Panel 11) COMM-verify VHF A RCVR - In b. Circuit breakers (Panel 16) COMM-verify PMP - In c. If circuit breakers are closed, reestablish communications via simplex VHF B mode. (1) VHF A XMTR sw - OFF (2) VHF A RCVR sw - OFF (3) VHF B XMTR sw - VOICE (4) VHF B RCVR sw - ON (5) AUDIO VHF B sw - T/R | |
| 5. Loss of VHF voice transmission (VHF A) (CM notifies LM, or MCC notifies LM.) | 5A. VOX circuitry - Failed 5B. Audio center (diode sw, transformer, etc) - Failed 5C. VHF A transmitter, or PMP VHF A circuitry - Failed | 5A. a. VOX sw - PTT b. PTT sw - Press or c. AUDIO CONT sw - BU 5B. AUDIO CONT sw - BU 5C. a. Circuit breakers (Panel 16) | a. Audio centers each contain separate VOX circuits for S-band, VHF, and ICS modes. c. Astronaut will maintain VOX communication with MCC via other astronaut's audio center. This corrective procedure is in- valid during EVA phases. For procedure for EVA phases, refer to symptom 8. |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---|
| 5. Loss of VHF voice transmission (VHF A) (CM notifies LM, or MCC notifies LM.) (cont) | 5C. VHF A transmitter, or PMP VHF A circuitry - Failed (cont) | 5C. (cont) (1) COMM-verify VHF A XMTR - In (2) PMP - In b. If circuit breakers are closed, reestablish communication via simplex VHF B mode. (1) VHF A XMTR sw - OFF (2) VHF A RCVR sw - OFF (3) VHF B XMTR sw - VOICE (4) VHF B RCVR sw - ON (5) AUDIO: VHF B sw - T/R | |
| 6. Loss of VHF voice transmission and reception (VHF A) | 6A. VHF antenna No. 1 or 2 - Failed 6B. VHF diplexer, or COMMUNICATION ANTENNAS/VHF antenna sw failed to open. | 6A. COMMUNICATIONS ANTENNAS/VHF sw - 1 or 2 6B. Communicate via S-band with MCC and MCC relay to CM. | It may be necessary to change LM attitude in relation to CM during coasting flight, to bring VHF antenna into position to reestablish communications. The same maneuver, with respect to earth, may be necessary if LM is using VHF as prime mode of LM-MCC communication. When this maneuver is not feasible, communications will be handled via S-band to MCC, and MCC relay to CM. This failure during EVA operations will blank out LM/EVA communications. During EVA operations, LM voice will be relayed through MCC and CM to EVA. |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|--|
| 6. Loss of VHF voice transmission and reception (VHF A) (cont) | 6B. VHF diplexer, or COMMUNICATION ANTENNAS/VHF antenna sw failed to open. (cont) | 6B. Communicate via S-band with MCC and MCC relay to CM. | Under normal conditions, during EVA operations, CM will not transmit directly to LM or EVA, due to Communications Subsystem constraints. CM voice will be relayed through MCC to LM and further through LM to EVA. |
| 7. Loss of SE's voice to EVA (EVA retains MCC voice relayed via LM and notifies LM of loss of SE's voice.) | 7A. Umbilical communication lead or SE's audio center - Failure (diode sw, transformer) | <p>7A.</p> <p>a. Enable SE's use of CDR's audio center and use alternate relay equipment:</p> <p style="text-align: center;">NOTE</p> <p>If failure occurs during mission phases other than EVA:</p> <p>AUDIO CONT sw - BU and disregard steps b through c.</p> <p>b. SE detach umbilical communication lead from PGA.</p> <p>c. SE attach CDR's umbilical communication lead to PGA.</p> <p>(1) CDR/AUDIO-S-BAND sw - T/R</p> <p>(2) CDR/AUDIO-VHFB sw - RCV</p> <p>(3) CDR/AUDIO-RELAY sw - OFF</p> <p>(4) SE/AUDIO-RELAY sw - ON</p> <p>(5) SE/AUDIO-S-BAND sw - OFF</p> <p>(6) S-BAND TELEMETRY BIOMED sw - LEFT</p> | <p>Relay mode, required by constraints of EVA operations, necessitates use of both audio centers; therefore, AUDIO CONT sw is not used.</p> |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|----------------------------------|---|--|
| 7. Loss of SE's voice to EVA (EVA retains MCC voice re- layed via LM and notifies LM of loss of SE's voice.) (cont) | 7B. Double microphone - Failure | 7B. None | CDR will have to perform all com- munications during mission phases other than EVA. During EVA operations, SE must return to CM. |
| 8. Loss of SE's voice to EVA Loss of LM relay of MCC voice to EVA (EVA notifies LM of loss of SE's and MCC's voices.) | 8A. PLSS VHF A receiver - Failed | 8A. a. Establish secondary mode of LM-EVA communication: (1) VHF B sw - T/R (2) VHF A RCVR sw - ON (3) VHF A XMTR sw - OFF (4) VHF B XMTR sw - VOICE (5) VHF B RCVR sw - OFF b. Recall EVA c. If EVA enters LM, check out PLSS. d. EVA may don second PLSS and continue mission. e. If EVA dons second PLSS, reestablish primary mode of LM/EVA communication: (1) VHF A sw - T/R (2) VHF B sw - RCV (3) VHF A XMTR sw - ON | a. Assume EVA sets SSC MODE SELECT switch - 4 b. EVA may elect to enter CM instead of LM, thereby ending EVA phase of mission. |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| 8. Loss of SE's voice to EVA Loss of LM relay of MCC voice to EVA (EVA notifies LM of loss of SE's and MCC's voices.) (cont) | 8A. PLSS VHF A receiver - Failed (cont) | 8A. (cont) (4) VHF A RCVR sw - OFF (5) VHF B XMTR sw - OFF (6) VHF B RCVR sw - ON | a. Assume EVA sets SSC MODE SEL sw - 4 Failure in any part of communication between LM and EVA will cause EVA to switch to secondary mode of communication. a. Loss of equipment redundancy |
| | 8B. LM VHF A transmitter or PMP VHF A circuitry - Failed | 8B. a. Enable secondary mode of LM-EVA communication: (1) VHF B sw - T/R (2) VHF A RCVR sw - ON (3) VHF A XMTR sw - OFF (4) VHF B XMTR sw - VOICE (5) VHF B RCVR sw - OFF | |
| | 8C. CDR RELAY switch or PMP control amplifier or isolation amplifier - Failed | 8C. a. Switch to redundant relay equipment: (1) CDR/AUDIO-S-BAND sw - T/R (2) CDR/AUDIO-VHF B sw - RCV (3) CDR/AUDIO-RELAY sw - OFF | |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|--|
| <p>8. Loss of SE's voice to EVA Loss of LM relay of MCC voice to EVA</p> <p>(EVA notifies LM of loss of SE's and MCC's voices.) (cont)</p> | <p>8C. CDR RELAY switch or PMP control amplifier or isolation amplifier - Failed (cont)</p> | <p>8C. (cont)</p> <p>(4) SE/AUDIO-RELAY sw - ON</p> <p>(5) SE/AUDIO-S-BAND sw - OFF</p> | |
| <p>9. Loss of EVA voice and EMU data to LM and MCC</p> | <p>9. PLSS B transmitter, or LM VHF B receiver, or PMP (RFI filter on transformer) - Failed</p> | <p>9.</p> <p>a. Enable secondary mode of LM-EVA communication:</p> <p>(1) VHF B XMTR sw - VOICE</p> <p>(2) VHF B RCVR sw - OFF</p> <p>(3) VHF A XMTR sw - OFF</p> <p>(4) VHF A RCVR sw - ON</p> <p>(5) SE AUDIO: VHF B sw - T/R</p> <p>b. Instruct EVA to return to LM</p> <p>c. Check out PLSS</p> <p>d. EVA may don second PLSS and continue mission if defect is isolated to first PLSS.</p> | <p>a. EVA telemetry can be transmitted only on VHF B.</p> <p>b. EVA may elect to enter CM instead of LM, thereby ending EVA phase of mission.</p> <p>d. If PLSS operates properly, LM equipment is at fault.</p> |
| <p>10. Loss of EMU data (LM notified by MCC.)</p> | <p>10A. CDR's relay circuitry - Failure</p> | <p>10A.</p> <p>a. Switch to SE's relay:</p> <p>(1) CDR/AUDIO-S-BAND sw - T/R</p> <p>(2) CDR/AUDIO-VHF B sw - RCV</p> | <p>a. Loss of equipment redundancy</p> |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|---|
| 10. Loss of EMU data (LM notified by MCC.) (cont) | 10A. CDR's relay circuitry - Failure (cont) | 10A.(cont) (3) CDR/AUDIO-RELAY sw - OFF (4) SE/AUDIO-RELAY sw - ON (5) SE/AUDIO-S-BAND sw - OFF b. Request MCC verify EMU data reception. | |
| | 10B. PMP (data high-pass filter, data signal amplifier, or PMP power) - Failure | 10B. a. No corrective action is possible. b. Recall EVA to LM or CM. | a. Complete loss of EMU data |
| 11. LM loss of EVA voice (MCC retains reception of EVA voice and EMU data.) | 11. SE's headset amplifier or PMP (isolation amplifier, control amplifier) - Failure | 11. a. Enable SE's use of CDR's audio center and use alternate relay equipment b. SE detach umbilical communi- cation lead from PGA c. SE attach CDR's umbilical com- munication lead to PGA (1) CDR/AUDIO-S-BAND sw - T/R (2) CDR/AUDIO-VHF B sw - RCV (3) CDR/AUDIO-RELAY sw - OFF (4) SE/AUDIO-RELAY sw - ON (5) SE/AUDIO-S-BAND sw - OFF | a. Loss of equipment redundancy. b. Communications subsequent to EVA phase will be impaired |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|--|---|
| 12. LM/MCC loss of EVA voice (MCC retains reception of EMU data. EVA retains reception from LM/MCC.) | 12. PMP (voice low-pass filter or voice signal amplifier) - Failure | 12. a. No corrective action is possible. b. Recall EVA to LM or CM | |
| 13. Loss of all communication between LM/MCC and EVA | 13A. PLSS primary transceiver or LM VHF B receiver - Failed | 13A. a. EVA: SSC MODE SEL sw - 4 b. LM astronaut will enable secondary mode of LM/EVA communication: (1) VHF B XMTR sw - VOICE (2) VHF B RCVR sw - OFF (3) VHF A XMTR sw - OFF (4) VHF A RCVR sw - ON (5) SE/AUDIO-VHF B sw - T/R (6) SE/AUDIO-VHF A sw - RCV | a. Loss of EVA telemetry |
| | 13B. VHF antenna - Failed | 13B. Select alternate VHF antenna with COMMUNICATIONS ANTENNAS/VHF sw | |
| | 13C. VHF diplexer - Failed | 13C. No corrective action is possible. | EVA must enter LM or CM after determination of no possible fix. |
| 14. HEATER caution lt - On | 14A. CWEA heater caution circuitry - Failure | 14A. a. MASTER ALARM pb - Press b. Verify MASTER ALARM lt - Off | |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|---|--|--|
| 14. HEATER caution lt - On (cont) | 14A. CWEA heater caution circuitry - Failure (cont) | 14A.(cont) c. TEMP MONITOR sw - Each position, sequentially (including return to starting position) d. If HEATER lt does not go off - Request MCC to monitor radars, RCS, and S-band temperatures | |
| | 14B. Radars or RCS - Failure | 14B. a. MASTER ALARM pb - Press b. MASTER ALARM lt - Off c. TEMP MONITOR sw - Each position, sequentially (including return to starting position) and observe the switch position that causes HEATER lt to go off. NOTE Position other than S-BAND indicates out of tolerance. d. Refer to malfunction procedures for affected subsystem | |
| | 14C. S-band steerable antenna heater temperature regulator (one of eight in electronics package) - Failed | 14C. a. MASTER ALARM pb - Press | Each S-band heater assembly consists of two thermostats and one heater. Eight assemblies are used to control temperature. The heater assembly locations are as follows: 4 - Electronics package 1 - Microwave network 1 - X-gimbal housing 1 - Y-gimbal housing 1 - X-gimbal spindle |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|-----------------------------------|--|---|---|
| 14. HEATER caution lt - On (cont) | 14C. S-band steerable antenna heater temperature regulator (one of eight in electronics package) - Failed (cont) | 14C.(cont) | Failure of the microwave network heater assembly would result in progressively degraded performance until unit reaches a temperature of -100° F. Thereafter S-band steerable auto tracking fails. |
| | | b. MASTER ALARM lt - Off | |
| | | c. TEMP MONITOR sw - Each position sequentially (including return to starting position) and observe HEATER lt goes off in S-BAND position | This failure cannot be detected until after it occurs, because the single temperature monitoring point is located within the electronics package (which contains four heater assemblies). |
| | | d. TEMP mtr - Check that reading for S-BAND is >+160° F. | |
| | | e. COMMUNICATIONS ANTENNAS/ S-BAND sw - 1 or 2 | |
| | 14D. Heater circuitry failure or short | 14D. | |
| | | a. MASTER ALARM pb - Press | |
| | | b. Observe MASTER ALARM lt - Off | |
| | | c. TEMP MONITOR sw - Each position, sequentially (including return to starting position) and observe HEATER lt goes off in S-BAND position. | |
| | | TEMP mtr - Check that reading for S-BAND is <-65° F. | |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|--|
| 14. HEATER caution lt - On (cont) | 14D. Heater circuitry failure or short (cont) | 14D.(cont) d. Circuit breakers (Panel 16) Verify position of S-BD ANT cb (1) In: circuitry failure (2) Out: short-circuit e. COMMUNICATIONS ANTENNAS/ S-BAND sw - 1 or 2 | |
| 15. Loss of S-band telemetry transmission (MCC notifies LM.) | 15A. S-band transceiver - Failed 15B. PMP (PM mixer) - Failed 15C. PCMTEA high-bit circuits - Failed 15D. PMP (high-pass filter, data modulator amplifier) - Failed | 15A.S-BAND XMTR/RCVR sw - SEC 15B.S-BAND MODULATE sw - FM 15C.S-BAND TELEMETRY PCM sw - LO 15D.No corrective action is possible for S-band transmission. | 15D.DFI telemetry transmission is used in conjunction with S-band or by itself. |
| 16. Loss of S-band Ranging (MCC notifies LM.) | 16A. Primary S-Band transmitter - Failure 16B. RANGE/TV sw - Failed 16C. PMP - Failed | 16A.S-BAND XMTR/RCVR sw - SEC 16B.No corrective action is possible for S-band ranging loss. 16C.Same as 16B | C-band transponder is normal tracking mode. 16C.CM may track LM when in undocked configuration. |
| 17. Loss of TV (MCC notifies LM.) | 17A. Primary S-Band power amplifier - Failed | 17A.PWR AMPL sw - SEC | 17A.RANGE/TV sw in TV position grounds range gate, therefore precluding ranging operation. Switch does not enable TV transmission; TV is enabled: a. MODULATE sw - FM b. Circuit breakers (Panel 16): TV cb - In |

Table 9-8. Communications Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|------------------------------------|--|
| 17. Loss of TV (MCC notifies LM.) (cont) | 17A. Primary S-Band power amplifier - Failed (cont) | 17A.PWR AMPL sw - SEC (cont) | c. S-BAND PWR AMPL sw - PRIM or SEC |
| | 17B. FM Circuitry or TV camera or cable assembly - Failure | 17B.No corrective action available | |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|--|
| <p>1. LDG GEAR DEPLOY flag (before landing gear deployment) - Gray</p> | 1A. LDG GEAR DEPLOY flag - Failed | 1A. SE and CDR - Verify that X and Y axis legs are not deployed and locked. MCC may confirm that two remaining legs did not deploy. | Normally, LDG GEAR DEPLOY flag is gray if all four legs are deployed. Each landing gear contains markings of dayglow yellow, which is readily visible from CM when landing gear is down and locked. |
| | 1B. LDG GEAR DEPLOY sw - Failed in FIRE position | 1B. NOTE | Once landing gears are properly deployed, failure in LDG GEAR DEPLOY circuitry is of no consequence. |
| | or | These failure possibilities exist if the MASTER ARM sw was inadvertently left in ON position. | |
| | Electrical failure - Relay K8 - Failed closed | a. MASTER ARM sw - OFF | <p>Each landing gear contains markings of dayglow yellow, which is readily visible from CM when landing gear is down and locked.</p> <p>This failure does not affect subsequent testing. The mission will be compromised only to the extent that control characteristics are changed. However, if landing gear is close enough to plume during descent engine firing, staging and omission of descent engine tests might be necessary.</p> <p>(1) It is improbable that both circuit breakers will be out; at least one had to be in to previously pressurize RCS.</p> |
| | 2A. LDG GEAR DEPLOY flag - Failed | 2A. After LM separates from CM, have CM verify that legs are deployed and locked. Confirmation from MCC may also be obtained. | |
| | 2B. Mechanical failure in landing gear or initiators in landing gear leg(s) did not fire | 2B. If CM reports that all landing gears have not deployed, do not attempt to deploy them again. Continue mission. | |
| <p>2. LDG GEAR DEPLOY flag (after landing gear deployment is commanded) - Barber pole</p> | 2C. LDG GEAR DEPLOY sw - Failed SAFE or multiple electrical failure, or circuit breakers not in | 2C. a. If CM reports that no landing gears have deployed: | |
| | | <p>(1) ED: LOGIC PWR A and LOGIC PWR B cb - In</p> <p>(2) MASTER ARM sw - ON</p> | |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|---|---|---|
| 2. LDG GEAR DEPLOY flag (after landing gear deployment is commanded) - Barber pole (cont) | 2C. LDG GEAR DEPLOY sw - Failed SAFE or multiple electrical failure, or circuit breakers not in (cont) | 2C. (cont) (3) LDG GEAR DEPLOY sw - FIRE (4) If gears deploy - cb failure; if not deployed failure was in switch or electrical circuitry (5) Continue mission. | |
| 3. REACTION CONTROL (Panel 2) PRESS ind (before pressurization of RCS) - > Blanket pressure (15 ± 5 PSIA) | 3A. REACTION CONTROL PRESS mtr 3B. RCS PRESS sw - Failed on (FIRE position) or electrical failure - relay K7 failed closed 3C. RCS initiators fire prematurely. | 3A. Confirm with MCC. MCC indicates RCS is not pressurized, continue mission. 3B. These failure possibilities exist if MASTER ARM sw was inadvertently left in ON position. a. MASTER ARM sw - OFF b. Continue mission. 3C. No corrective action is required. | Early RCS pressurization is of no consequence. This failure could occur regardless of setting of MASTER ARM sw. It can only be isolated by inference. Electrical failures are deemed less likely if MASTER ARM sw is set to OFF. |
| 4. REACTION CONTROL (Panel 2) PRESS ind (after pressurization of RCS) - < Blanket pressure (15 ± 5 PSIA) | 4A. REACTION CONTROL PRESS ind - Failed 4B. Multiple initiator failure (for system A or B) 4C. RCS PRESS sw - Failed SAFE | 4A. Confirm with MCC. MCC indicates RCS is pressurized. Pressurization can be confirmed during subsequent nominal check-out procedures. 4B. Check with MCC whether possible degraded mission should continue. 4C. Confirm with MCC. If MCC indicates RCS is not pressurized, do not separate from CM. | This would probably require use of RCS crossfeed. Another failure (leak in manifold) could affect crew safety situation. |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|---|---|---|
| <p>5. HELIUM ind indicates that supercritical helium is not being expended after initiation of descent engine burn. (PRESS ind on MAIN PROPULSION panel indicates decrease in descent tank pressures.)</p> | 5A. Instrumentation | <p>5A. Confirm supercritical helium pressure with MCC. If pressure drops, instrumentation failed. Continue mission.</p> <p>If pressure does not drop: STOP pb - Press - Proceed to failure 5B.</p> | <p>If supercritical helium initiator does not fire, eliminate descent engine testing.</p> |
| | 5B. Supercritical helium initiator did not fire. | | |
| <p>6. MAIN PROPULSION (Panel 1) PRESS ind (before descent pressurization) - > Blanket pressure (210 to 235 PSIA)</p> | 6A. MAIN PROPULSION PRESS ind - Failed | <p>6A. Confirm with MCC.</p> <p>a. MCC indicates descent tanks not pressurized</p> <p>b. Continue mission.</p> | <p>Early descent pressurization is of no consequence.</p> |
| | 6B. DES PRESS sw - failed on (FIRE position) or relay K14 failed closed | <p>6B. These failure possibilities exist if MASTER ARM sw was inadvertently in ON position.</p> <p>a. MASTER ARM sw - OFF</p> <p>b. Continue mission.</p> | |
| | 6C. Descent compatibility initiator (fuel or oxidizer) and supercritical helium initiator fired prematurely (before prepressurization). | <p>6C.</p> <p>a. Monitor FUEL and OXID pressure on MAIN PROPULSION PRESS ind</p> <p>>235 psia or \approx250 psia for FUEL or OXID</p> <p>b. HELIUM MON sw - AMB PRESS; monitor HELIUM ind</p> | |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|---|
| 6. MAIN PROPULSION (Panel 1) PRESS ind (before descent pressurization) - > Blanket pressure (210 to 235 PSIA) (cont) | 6C. Descent compatibility initiator (fuel or oxidizer) and supercritical helium initiator fired prematurely (before prepressurization). (cont) | 6C. (cont) (1) Ambient pressure - 1,700 to 1,750 psia; check with MCC for mission status. (2) Ambient pressure - decreasing, proceed with failure 6D. | (1) Ambient helium is not being expended; supercritical helium entered fuel or oxidizer tank before ambient helium. This may cause a freezing problem in tank. Freezing would eliminate descent engine firing or testing. |
| | 6D. Descent compatibility initiator (fuel or oxidizer) and ambient helium initiator fired prematurely. | 6D. Continue mission. | 6D. This failure (early prepressurization of fuel or oxidizer) is of no consequence. However, pressurize remaining fuel or oxidizer tanks. |
| 7. MAIN PROPULSION (Panel 1) PRESS ind (before ascent pressurization) - > Blanket pressure (190 PSIA) | 7A. MAIN PROPULSION PRESS ind - Failed | 7A. Confirm ascent pressure with MCC If ascent tanks are unpressurized, continue mission. If ascent tanks are pressurized, proceed to failure 7B. | 7B. Once ascent engine is pressurized, failure of ASCENT He PRESS switch or relays K10 and K11 is of no consequence. MCC will determine maximum time ascent tanks can be pressurized before firing. |
| | 7B. ASCENT He PRESS sw - Failed on (FIRE position) or electrical failure - Relay fails on. | 7B. These failure possibilities exist if MASTER ARM sw was inadvertently in ON position. a. MAIN PROPULSION: FUEL and OXID > 190 PSIA - MASTER ARM sw - OFF; continue mission. b. If FUEL or OXIDIZER ind > 190 PSIA; pressurize remaining fuel or oxidizer tank. | |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|---|
| 7. MAIN PROPULSION (Panel 1) PRESS ind (before ascent pressurization) -> Blanket pressure (190 PSIA) (cont) | 7C. Ascent initiator failed prematurely | 7C. MAIN PROP PRESS mtr: FUEL or OXID > 190 - Pressurize the remaining fuel or oxidizer tank. | 7C. This failure could occur regardless of setting of MASTER ARM sw. It can only be isolated by inference. Electrical failures are deemed less likely if MASTER ARM sw is set to OFF. |
| 8. MAIN PROPULSION PRESS ind - no increase in pressure (> 190 PSIA) after pressurizing ascent tanks | 8A. MAIN PROPULSION PRESS ind - Failed | 8A. Confirm ascent pressure with MCC If ascent tanks are pressurized, continue mission. If ascent tanks are unpressurized, proceed to failure 8B. | |
| | 8B. ASC He SEL switch contacts for one tank failed open or multiple initiator or electrical failure (e.g., both relays K10 or both relays K11 fail open) | 8B. a. Verify following: ED: (1) LOGIC PWR A or LOGIC PWR B cb - In (2) ASC He SEL sw - BOTH (3) MASTER ARM sw - ON (4) ASCENT He PRESS sw - FIRE (5) PRPLNT TEMP/PRESS MON-ASC (6) HELIUM MON sw - ASC PRESS 1 or ASC PRESS 2 b. Monitor MAIN PROPULSION PRESS ind and HELIUM ind (1) If one tank is pressurized (> 190 PSIA) proceed with step 8. (2) If neither tank is pressurized, proceed with failure 8C. | |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|---|
| 8. MAIN PROPULSION PRESS ind - no increase in pressure (> 190 PSIA) after pressurizing ascent tanks (cont) | <p>8B. ASC He SEL switch contacts for one tank failed open or multiple initiator or electrical failure (e.g., both relays K10 or both relays K11 fail open) (cont)</p> <p>8C. ASC He SEL sw - Failed open ASCENT He PRESS sw - Failed SAFE</p> | <p>(3) If both tanks are pressurized, continue mission.</p> <p>c. ASC He SEL sw - TANK 1 (if not pressurized); TANK 2 (if not pressurized)</p> <p>d. ASCENT He PRESS sw - FIRE</p> <p>(1) Monitor MAIN PROPULSION PRESS mtr.</p> <p>(2) If unpressurized tank became pressurized, contacts of ASC He SEL sw for that tank and/or ASCENT He PRESS sw did not make. Continue mission.</p> <p>(3) If unpressurized tank did not become pressurized, check with MCC for decision to continue mission.</p> <p>8C.</p> <p>a. Verify following:</p> <p>(1) ASC He SEL sw - TANK 1</p> <p>(2) ASCENT He PRESS sw - FIRE MAIN PROPULSION PRESS ind - Tank No. 1 pressurized</p> <p>(3) ASC He SEL sw - TANK 2 MAIN PROPULSION PRESS ind - Tank No. 2 pressurized</p> <p>b. If tanks became pressurized, contacts of ASC He SEL sw for both tanks and/or ASCENT He PRESS sw did not make. Continue mission.</p> | <p>(3) If only one tank is pressurized, mission will probably have to be shortened.</p> |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|--|--|
| 8. MAIN PROPULSION PRESS ind - no increase in pressure (>190 PSIA) after pressurizing ascent tanks (cont) | 8C. ASC He SEL sw - Failed open ASCENT He PRESS sw - Failed SAFE | 8C. (cont) c. If tanks did not become pressurized, determine whether RCS can perform ΔV maneuver to rendezvous and dock with CM. If it can, use RCS for rendezvous docking. d. If RCS cannot provide required ΔV , use descent engine with RCS assist to rendezvous and dock. | c. If RCS is being used to rendezvous and dock, staging may be desired once CM is in range. |
| 9. Loss of descent power | 9A. Electrical circuit interrupter connector deadface or cable-cutting initiators failed, or electrical failure - relay K4 or K6 failed closed | 9A. a. Verify following: (1) BAT 5 NORMAL FEED sw - ON (2) BAT 6 NORMAL FEED sw - ON (3) DES BATS sw - DEAD FACE b. If power is restored, proceed with step c. If not, proceed with failure 9B. c. SE's STAB/CONT: AELD cb - Out d. CDR's STAB/CONT: AELD cb - Out e. Determine if RCS is capable of providing ΔV necessary for rendezvous and docking with CM. f. If RCS is not capable of providing ΔV , call for CM rescue g. If RCS is capable of providing ΔV , use RCS for rendezvous and docking with CM. | 9A. The electrical failures can occur if MASTER ARM sw ON and deemed less likely if MASTER ARM sw OFF. |

Table 9-9. Explosive Devices Subsystem Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---------------------------------|--|---|--|
| 9. Loss of descent power (cont) | 9B. Cable-cutting initiator fired; cutter shorted power leads. | 9B. Don backpack and call MCC for instructions. | 9B. This malfunction would result in a crew safety situation. The option is whether to attempt a CM active docking to an unstabilized LM or to perform a double EVT with an unstabilized LM. |

Table 9-10. LM-2 Lighting Malfunction Procedures

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|---|--|---|--|
| 1. Single panel integral lt - Failed off 2. All panel integral lighting fails - On 3. All panel integral lighting fails - Off 4. Side panel integral lighting fails - On 5. All electroluminescent numerics fail - Off 6. All electroluminescent numerics fail - Off | 1. Open circuit in electro-luminescent strip 2. Short in electroluminescent dimming circuitry, control, or INTGL OVERRIDE sw 3. CB failed, or short in main panel electroluminescent circuitry Open circuit in a-c dimming high-power assembly or in integral dimming control 4. Short in side panel electro-luminescent circuitry or failure in SIDE PANEL 5. Open circuit in a-c dimmer, low-power assembly, or in ANUN/NUM dimmer 6. Short in a-c dimmer, low-power assembly, or in ANUN/NUM dimming controls Short in numeric lighting assembly, or failed numeric cb | 1. FLOOD SW - ON/OFF/PARTIAL 2. a. INTGL cb - Pull b. FLOOD SW - ON/OFF/PARTIAL c. INTEGRAL OVERRIDE sw - On 3. a. FLOOD sw - ON/OFF/PARTIAL b. INTEGRAL dimming control Counterclockwise; or, If visual task permits: INTEGRAL OVERRIDE sw - ON 4. a. SIDE PANELS sw - OFF b. FLOOD sw - ON 5. a. ANUN/NUN dimmer - Counterclockwise If lamps go on, continue with numerics dim. If lamps do not go on, no corrective action is possible. 6. a. NUM OVERRIDE sw - ON b. NUM cb - Pull when numerics are not required | <div style="border: 1px solid black; padding: 5px; text-align: center;">WARNING</div> <p>Floodlight failure may threaten crew safety; therefore, this is a potential abort.</p> |

Table 9-10. LM-2 Lighting Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|--|--|
| 7. Single electroluminescent numeric readout fails - Off | 7. Burned-out lamp or blown fuse in single output of lighting control assembly transformer | 7. No corrective action is possible. | <div>WARNING</div> <p>Potential abort. Decision must be based on particular failed numeric readout and mission phase.</p> <p>Decision, based on mission phase, must be made to abort or continue mission. Docking lights are required for dark phase docking. C/W PWR caution lt is required if both caution and warning electronics assembly power supplies fail.</p> <p>If circumstances permit, LM should be active docking vehicle. Keep cabin floodlights off for maximum dark adaptation.</p> |
| 8. All electroluminescent numerics fail - On | 8. Numeric dimming circuitry, control, or NUM OVERRIDE sw fails | 8. Use numerics only when necessary. Leave on, or pull NUM cb | |
| 9. Docking, LUNAR CONTACT, and C/W PWR lt fail - Off | 9. Limiter in lighting control assembly fails | 9. <ol style="list-style-type: none"> Verify LAMP/TONE TEST sw - COMPNT Verify C/W PWR caution lt and LUNAR CONTACT lt - ON | |
| 10. Docking lt fail - Off | 10. EXTERIOR LTG control; docking lt only fails | 10. If failure occurs before docking, and docking takes place during dark or earthshine orbital phases, turn on floodlights to provide cabin lighting that will be visible through LM windows. | |
| 11. All component lt fail off except docking, LUNAR CONTACT and caution/warning power lt | 11. ANUN/NUM dimmer circuitry or control fails | 11. ANUN/NUM control - counter-clockwise <p>If lamps go on, continue at lower illumination level.</p> <p>If lamps do not go on:</p> <p>ANUN/OVERRIDE sw - ON</p> <p>Continue at high illumination level.</p> | |
| 12. MASTER ALARM lt - On Tone-Failed - Off | 12. Master alarm circuitry fails | 12. Monitor caution and warning panels frequently. | |

Table 9-10. LM-2 Lighting Malfunction Procedures (cont)

| SYMPTOM | FAILURE | PROCEDURE | REMARKS |
|--|--|---|--|
| 13. Tracking lt - Failed off (CSM informs LM, by VHF, that it cannot see tracking lt.) | 13. EXTERIOR LTG sw circuitry fails | 13. None required | If CM rescue is required, transmit range and range-rate data to CM, by VHF link, until docking lights become visible. |
| 14. Overhead and forward floodlights do not go on when overhead hatch is opened. | 14. Failure of hatch interlock sw or FLOOD cb | 14. a. Check hatch sw for hang-up and position of FLOOD cb. If breaker closed: FLOOD sw - PARTIAL and ON b. If breaker or flood circuitry failure, use flashlight. SE directs light onto flight instru- ments while CDR pilots craft. | a. If hatch switch fails; continue mission. b. Potential abort if FLOOD cb or circuitry fails |
| 15. Overhead and forward flood- lights - Failed On | 15. Short in floodlight circuitry, or failed FLOOD cb | 15. a. Leave floodlights on, if needed. b. Turn off floodlights, if not needed: FLOOD cb - Pull | |